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Relative Abundance of Gulf of Alaska Sablefish and Other Groundfish Based on National Marine Fisheries Service Longline Surveys, 1988–90

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RELATIVE ABUNDANCE OF GULF OF ALASKA SABLEFISH AND OTHER GROUNDFISH BASED ON NATIONAL MARINE FISHERIES SERVICE LONGLINE SURVEYS, 1988-90

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ABSTRACT

This report summarizes the results of the 1990 National Marine Fisheries Service (NMFS) longline survey of the Gulf of Alaska and compares them to those of previous annual surveys. Sablefish (*Anoplopoma fimbria*) was the principal target species, although other commercially important groundfish populations appear to have been sampled adequately enough to derive meaningful indices of abundance and to determine the significance of changes in population size.

Sablefish abundance indices (relative population number, RPN) decreased in the gullies and increased on the upper slope; however, the combined totals remained nearly the same as in 1989. Decreases in the 1990 RPN for Shelikof Trough and Shumagin Gully combined were nearly the same as the RPN increase for the adjacent upper slope. It appears that a sablefish year class recruited to Shelikof Trough in 1987 and moved to the adjacent upper slope region between the 1989 and 1990 surveys. No comparable incoming year classes were seen in the shallow waters of the Gulf of Alaska in 1990.

The apparent abundance of some other species seems to be influenced by sablefish abundance. Thornyhead (*Sebastolobus* spp.) and giant grenadier (*Albatrossia pectoralis*) catch rates might be particularly affected by competition with sablefish for baited hooks. Rougheye (*Sebastes aleutianus*) and shortraker rockfish (*Sebastes borealis*) catch rates have been quite variable and might be influenced more by chance gear placement on rockfish habitat than by changes in abundance or competition for hooks.

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INTRODUCTION

Since 1978, Japan and the United States have cooperatively conducted an annual longline survey covering the upper continental slope of the eastern Bering Sea, the Aleutian Islands region, and the Gulf of Alaska. The research has supplied information needed to estimate the abundance of sablefish (*Anoplopoma fimbria*) and other groundfish species (Sasaki and Yano 1990, Clausen and Sigler 1989, Lowe and Sigler 1989).

Since 1987 the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS), Alaska Fisheries Science Center, has conducted an independent annual longline survey designed to preserve the time series in the Gulf of Alaska should Japan discontinue as a cooperating partner. The NMFS longline survey covers the same stations (Fig. 1a) and season and uses similar sampling gear as the cooperative longline survey (Sasaki 1985). In addition, the NMFS longline survey has expanded areal coverage from the upper continental slope to major deepwater gullies on the continental shelf. The primary purpose of the NMFS longline survey is to annually determine the relative abundance and size composition of sablefish, shortspine thornyhead (*Sebastolobus alascanus*), rougheye rockfish (*Sebastes aleutianus*), and shortraker rockfish (*Sebastes borealis*) in the Gulf of Alaska.

This report presents the 1990 survey results and updates reports on the 1987 (Sigler and Zenger 1989), 1988 (Zenger et al. 1992), and 1989 surveys (Sigler and Zenger 1992). Preliminary

results related to sablefish from the 1990 Japan-U.S. cooperative longline survey were documented in stock assessment and fishery evaluation reports by Fujioka (1991) for the Gulf of Alaska and by Lowe (1991) for the eastern Bering Sea and Aleutian Islands region. A comparison of the catch rates of sablefish from the NMFS and cooperative longline surveys will be reported in a separate document (Zenger 1992).

MATERIALS AND METHODS

Vessel and Gear

The chartered fishing vessel *Ocean Prowler* (47 m, 155 ft) was used for the 1990 survey. As in the 1988 and 1989 surveys, 16 km (8.6 nautical miles, nmi) of groundline were set each day. The groundline consisted of 160 sections called skates, and each skate was 100 m (55 fathoms) long with 45 Mustad[1] size 13/0 circle hooks spaced 2 m (6.5 ft) apart. The groundline was weighted with 3.2 kg (7 lb) lead balls snapped on at the end of every skate. Each hook was hand baited with chopped squid (*Illex illecebrosus*) at a rate of about 5.5 kg (12.0 lb) per 100 hooks. The squid mantle lengths were 15-23 cm (6-9 in) long. Each mantle was cut into 3-4 pieces, each about 4-5 cm (1.5-2 in) long.

Bait type, gangion and becket line weight, and hook brand differed between 1987 and 1988-90. Details and reasons for these

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changes are described in Zenger et al. (1992). Data from the 1987 survey are considered to be experimental and are not included in the 1988-90 time series.

Survey Area and Operations

The survey area extends from Islands of Four Mountains (52°50'N 170°W) eastward to Dixon Entrance (Fig. 1b) and covers the upper continental slope (hereafter referred to as "upper slope") and selected gullies. Sampled depths range from about 200 to 1,000 m, although some stations were sampled to 150 m or less. The survey period extended from 26 June to 12 September 1990.

The sampling gear was set from shallow to deep water and usually was retrieved in the same order. Setting and retrieval began about 0630 and 0930 hours, respectively, and retrieval was completed at about 1900 hours. Soak time ranged from 3 to 11 hours.

Seventy-three stations were sampled: 45 along the upper slope, 27 in gullies, and 1 on the continental shelf[2]. Sampling in gullies has been expanded each year since the beginning of the NMFS longline survey (Table 1). Because of this expansion, the

[2]The 45 stations on the upper continental slope correspond to station numbers 62-86, 88-102, and 104-108 of the Japan-U.S. cooperative longline survey (Sasaki and Yano 1990). Gully station 26 corresponds to station 87 of the cooperative longline survey. Shelf station 42 corresponds to station 103 of the cooperative longline survey and is located on the continental shelf off Baranof Island. The remaining 26 gully stations are additional to the original 47 stations of the cooperative longline survey.

survey area in 1989-90 generally corresponded to the adult sablefish habitat in the Gulf of Alaska.

Data Collection

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

Arrowtooth flounder (*Atheresthes stomias*), rockfish (*Sebastes* spp.), and thornyhead (*Sebastolobus* spp.) fork lengths (FL) were measured. For grenadiers (Macrouridae), vent lengths (VL)[3] were measured. Only sablefish and Pacific cod (*Gadus macrocephalus*) were sorted into eight depth strata (Table 2) for measuring fork length and for sexing.

Prior to 1990, catches of all grenadier species were tallied together and as a result no indices of relative abundance could be computed for each of the two most common species, giant grenadier (*Albatrossia pectoralis*) and popeye grenadier (*Coryphaenoides cinereus*). Consequently, abundance was estimated for the family Macrouridae. During the 1990 survey, giant grenadier and popeye grenadier were tallied separately and abundance indices were computed for each species.

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[3]Vent length (VL) is the distance between the tip of the snout and the anterior origin of the anus.

Analytical Methods

A more detailed treatment of these analytical methods may be found in Sigler and Zenger (1989)a The number of fish caught per skate (catch per unit effort or CPUE) was calculated by species for each depth stratum (hereafter referred to as "stratum") sampled at a station. Relative population number (RPN, an index of relative abundance in numbers) was computed for each species (Gulland 1969; Quinn et al. 1982; Sasaki 1985)a Catch per unit effort for each stratum of a station was multiplied by the area of the stratum (Table 3) and the resultant values were averaged within the stratum to obtain an RPN[4]. Relative population numbers were calculated only for depths 201-1,000 m because only these depths were considered to have been adequately sampled.

Relative population number weighted length frequencies (RPN-LF) were computed for depths 201-1,000 m to examine the size compositions of the principal species. Catch per unit effort weighted length frequencies (CPUE-LF) were computed for depths 101-200 m because RPN was not estimated for these depths (Sigler and Zenger 1989)a Frequency modes for depths 101-200 m from previous Japan-U.S. cooperative longline surveys were used to document the presence of the relatively strong 1977 and 1980 year classes of sablefish (Sigler and Fujioka 1988).

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[4]Stations 1-47, established by the cooperative longline survey, previously were classified as upper continental slope stations, although this designation was incorrect for two of them. Stations 26 and 42 have been reclassified with the gully stations. As a result, 1988 RPN and RPW values reported in Zenger et al. (1992) differ slightly from those presented in this report.

Relative population weights (RPW) were computed from RPN-LF and length-weight equations to assess relative biomass (Sigler and Zenger 1989)a Although rougheye and shortraker rockfish were grouped together as catches were recorded, length frequencies were tallied separately. These separate tallies allowed us to estimate RPW for each species. Computation of RPN, RPW, and weighted length compositions is described in more detail in Sigler and Zenger (1989)a

Each RPN applies only to the area surveyed and represents only the portion of each species' population resident in the survey area during the survey period. The survey area includes the vast majority of the adult habitat of sablefish, rougheye and shortraker rockfishes, and shortspine thornyheads, and therefore samples the adult fraction of their populations on the upper continental slope of the Gulf of Alaska. In contrast, large portions of the adult habitat of Pacific cod, Pacific halibut, rockfish species other than rougheye and shortraker rockfishes, grenadiers, and arrowtooth flounder are not included in the survey area and thus the RPN does not reflect the total abundance of those species.

Because giant and popeye grenadiers were tallied together in 1988 and 1989, data from those years could not be used to provide separate estimates of relative abundance. To provide separate abundance indices, 1990 ratios of those species' CPUE, by station and depth, were applied to the 1988 and 1989 CPUE estimates for combined grenadiers at matching stations and depths. The

adjusted CPUE estimates for giant grenadier were used to compute 1988 and 1989 RPN and RPN-LF for that species. (This method of obtaining giant grenadier abundance indices assumes that giant and popeye grenadier catch ratios were constant from 1988 to 1990. Future data collections should allow us to compare grenadier species catch ratios over time and to test the validity of that hypothesis.)

Relative population numbers were compared to determine if differences between years were statistically significant ($P \leq 0.05$). The null hypothesis tested was that of:

$$RPN_{i,j,k} - RPN_{i',j,k} = 0,$$

where subscripts i and i′ are pairs of sequential years; for example, i = 1988 and i′ = 1989, j = area, and k = species. As in Sigler and Fujioka (1988), the bootstrap method (Efron 1982, Efron and Tibshirani 1986) was used to compare RPNs for the upper slope.

The paired t-test was used to compare RPN for gullies where two or more paired stations were sampled (all gullies except Yakutat Valley). The paired t-test was used instead of the bootstrap method because the small number of samples for comparison (2-4) in each gully could produce misleading bootstrap results.

COMPARISONS OF ABUNDANCE AND BIOLOGICAL CONDITION

Sablefish

Relative Abundance

Domestic longline survey estimates of 1990 sablefish abundance in the Gulf of Alaska for the upper continental slope and gullies combined remained essentially unchanged from 1989 estimates, increasing only 2.8% from 697,586 to 717,424. However, estimated abundance of sablefish for the upper slope, in terms of RPN, increased 21% from 1989 to 1990 (Table 4a). This increase followed an 18% decrease from 1988 to 1989. Both changes in RPN were statistically significant ($P \leq 0.05$). The net result of the decrease from 1988 to 1989 and the increase from 1989 to 1990 is that estimated abundance of sablefish on the upper slope in 1990 was similar to that of 1988. Abundance increased for all areas on the upper slope from 1989 to 1990, except the International North Pacific Fisheries Commssion (INPFC) Southeastern statistical area, which decreased only slightly (Table 4a). The increases in the Shumagin and Kodiak INPFC areas were statistically significant. These increases follow sharp declines from 1988 to 1989 in the Shumagin, Chirikof, and Kodiak INPFC areas. As a result, sablefish abundance in 1990 in the Chirikof and Kodiak INPFC areas was similar to that in 1988. Sablefish abundance in 1990 in the Shumagin area continued to be lower than in 1988.

Estimated sablefish abundance in gullies dropped notably from 1989 to 1990 (Table 4b), but in terms of percentage

decrease, the drop was greatest in Shumagin Gully (87.5%) where RPN decreased from 12,210 to 1,531. The decrease in gully RPN was accompanied by an increase on the adjacent Shumagin INPFC area upper slope (Table 4a)[5]. Although less dramatic than Shumagin Gully on the basis of percentage decrease, the Shelikof Trough sablefish RPN dropped 24% from 1989 to 1990, a decrease 3.5 times larger in terms of estimated abundance (Table 4b). The decreases in these two gullies were statistically significant. Total estimated sablefish abundance in the Shumagin and Chirikof INPFC areas (upper slope and gullies combined) was approximately the same in both 1989 and 1990. The total decrease of 45,119 in RPN from Shumagin Gully and Shelikof Trough combined was roughly balanced by an RPN increase of 50,602 on the adjacent upper slope. We believe that this is important because, in general, young sablefish move from the gullies and the continental shelf to the upper slope as they grow and mature (Heyamoto and Alton 1965). Later, we discuss size composition changes that support the hypothesis of such a movement from Shelikof Trough and Shumagin Gully to adjacent slope areas. Thus gullies, and Shelikof Trough in particular, may play an important role as productive feeding grounds for young sablefish and as sanctuaries from directed commercial fisheries concentrated on the upper slope.

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[5]No overall comparison for gullies will be made from 1988-89 because not all gullies sampled in 1989-90 were sampled in 1988.

Catch Rate Distribution Patterns

From 1988 to 1989, sablefish catch rates decreased in the area west of station 14 located at the mouth of Shelikof Trough, especially in the deeper strata. Generally the areas and depths that showed CPUE rates smaller than 10 sablefish/skate widened (Fig. 2)a The pattern of lower catch rates on the upper slope west of Shelikof Trough also was apparent in 1990. Annual sablefish catch rates in the Southeastern INPFC area have been much higher than those in the rest of the survey area.

One of the premises of this survey states that the sample area covers the depth range inhabited by a very large proportion of the sablefish population resident on the upper continental slope of the Gulf of Alaska. In most parts of the gulf this appears to be a valid assumption. Based on evidence of decreasing catch rates from the deepest skates of longline gear, we believe that sablefish abundance decreases rapidly below 1,000 m (Fig. 2)a In addition, the amount of sablefish habitat deeper than 1,000 m appears to be relatively small. Thus, it appears likely that the portion of the sablefish population that resides in those depths is also relatively small. However, deepwater (> 1,000 m) sablefish abundance might be a function of overall abundance in the adjacent sampled strata. For example, in 1988 and 1989 more stations in the Southeastern INPFC area had relatively high deepwater catch rates than in 1990 (Fig. 2)e, and in the same area the first two survey years also had total estimated sablefish abundances (RPN estimates) 7-9% higher than

in 1990 (Table 4a). Thus, the deepwater proportion of the Southeastern INPFC area sablefish population might not be constant; efforts should be made to assess it in much the same way that we extended the original survey to include the large gullies.

Relative Biomass

From 1989 to 1990, RPW increased 16% from about 1,250,000 to 1,460,000 for the upper slope (Table 5a) and decreased 15% from about 1,100,000 to 938,000 for the gullies (Table 5b). For the Gulf of Alaska overall, like the total RPN, total RPW changed relatively little from 1989 to 1990.

The RPW for depths of 400-1,000 m were used to allocate catch quotas among Gulf of Alaska North Pacific Fishery Management Council (NPFMC) areas. Table 5c shows RPW distributed in depths of 401-1,000 m, by NPFMC area, and Table 5d shows percentage RPW for the same depth interval and areas. In 1988 the proportion of RPW distributed in waters deeper than 400 m was 1,122,000 (Table 5c), about half of the total gulfwide RPW. Although the total sablefish RPW increased slightly in 1989, the proportion of RPW in depths greater than 400 m decreased to 957,000, only 41% of the total. This decrease in relative biomass may have been caused by commercial exploitation in depths greater than 400 m, migration, relatively low recruitment to depths greater than 400 m from 1988 to 1989, or to increased recruitment and growth of a year class of sablefish in depths less than 400 m and in gullies. The decrease was not caused by

movement into shallower waters because sablefish RPW also decreased in depths of 301-400 m. In 1990, sablefish RPW in depths greater than 400 m increased to the 1988 level, corresponding to apparent movement of sablefish from gullies to the upper slope.

Size Compositions

Sablefish size composition data often show recruitment of incoming year classes and growth within the adult population. Male sablefish length compositions shifted to the right slightly, and there was evidence of more small males in the 45-55 cm range from 1989 to 1990 (Fig. 3a). For females the ascending side of the frequency curve shifted to the right and the descending side remained about the same. The locations of female major modes were largely unchanged. The ascending side of the 1988 female sample showed evidence of a recruiting year class with a modal length in the 58-62 cm range. Comparably sized female sablefish were not as abundant in 1989 or 1990. Similar to the males, in 1990, small female sablefish (45-55 cm) were slightly more abundant than during the previous 2 years. Even though the length compositions differed, mean lengths changed very little due to the presence of these smaller fish in the 1990 survey data (Fig. 3a)a Mean lengths were 62.9 and 62.9 cm for males and 70.8 and 70.5 cm for females in 1989 and 1990, respectively. Upper slope size compositions had similar length ranges and shape characteristics by sex within each area throughout the three survey years (Figs. 3b-f). Mean lengths differed relatively

little within each sex, although the short-term trend was for mean lengths to increase in all areas except the Southeastern INPFC area (Fig. 3f) where mean lengths decreased 0.8 and 1.0 cm since 1988 for males and females, respectively.

Recent changes in gulfwide length frequencies (Fig. 3a) appear to be most closely related to changes in Shelikof Trough sablefish size compositions. What appears to be a unique example of recruitment and subsequent growth of a year class in Shelikof Trough is shown by annual survey percent length frequencies (1987-90) in Figure 3g. (Although RPN-LF for 1987 would not be directly comparable to those for 1988-90 because of changes in sampling procedures after 1987, percentage length frequencies allow size composition comparisons to show presence or absence of specific frequency modes.) Generally, most percent frequency modes coincided for all survey years, with the notable exception of small modes at about 54 and 57 cm for males and females, respectively, in 1987. Modes at comparable lengths did not appear in 1988-90. We interpreted these small modes as the first signs of a year class that recruited to Shelikof Trough between 1987 and 1988. Subsequent data showed it developing into the local, dominant year class during the next 2 years (Fig. 3h)a Modes were observed at 59, 61, and 63 cm for males and at 62, 66, and 69 cm for females in 1988-90. Lower sablefish abundance in Shelikof Trough and increased abundance on the adjacent slope (Chirikof INPFC area) in 1990 appear to be due to the movement of that year class to deeper waters. Although we lack conclusive

tag and recovery data to substantiate this movement, a comparison of size composition modes in Figures 3c and 3h also support such a movement. For both males and females in Shelikof Trough, abundance in terms of RPN-LF decreased in 1990 at modal lengths of 63 and 69 cm, respectively, whereas increases occurred at the same modal lengths on the adjacent upper slope (Chirikof INPFC area). Modes at the shorter lengths similar to those found in Shelikof Trough in 1988-89 were not present on the adjacent upper slope during those years. The absence of modes at shorter lengths may mean that most recruitment to the upper slope occurred after male and female sablefish reached lengths of about 61 and 66 cm, respectively. A similar sequence of events appears to have occurred in Shumagin Gully and on the adjacent upper slope, although on a smaller scale (Figs. 3b and 3i).

The changes in abundance and size compositions demonstrate what seems to be a close relationship between recent abundance in major gullies and present abundance on the continental slope. Shelikof Trough is the largest gully in the Gulf of Alaska, producing 40% of the total RPN of gully sablefish in 1989 and 36% in 1990 (Table 4b). The area appears to be a major waypoint where juvenile and young adult sablefish reside before moving into deeper slope waters. Thus, monitoring sablefish abundance and size compositions in major gullies appears to contribute information on year-class strength. Assuming that the movement cited above is a repeating facet of the local recruitment pattern, then the apparent size of the year class (in terms of

RPN-LF) that should have moved out of Shelikof Trough to the adjacent upper slope in 1988 (modes at 63 cm for males and 69 cm for females) appears to have been relatively small compared to the abundance of comparably sized sablefish in 1990. As the data time series expands, we should be able to predict more accurately sablefish recruitment on the continental slope and future abundance trends from prior knowledge of abundance and size or age compositions in major gullies.

With the exception of Amatuli Gully, the mean lengths of sablefish sampled in gullies were smaller than mean lengths from their respective adjacent upper slope areas. Amatuli Gully showed consistently larger sablefish than other gullies and the adjacent Kodiak upper slope area (Table 6, Figs. 3d and 3j). With the exceptions of the W-grounds and Yakutat Valley (Figs. 3k and 3 1), where the numbers of relatively small fish increased from 1989 to 1990, annual sablefish length frequencies from each of the remaining gully areas (Alsek Strath, Spencer Gully, Ommaney Trench, Iphigenia Gully, and Dixon Entrance) were similar with respect to size ranges and locations of modes (Figs. 3m-3q).

Mean sablefish lengths from the 101-200 m stratum generally were shorter than those from adjacent slope or gully areas (Table 6). Frequency distributions from the Shumagin shelf area (101-200 m) remained largely unchanged from 1989 to 1990 (Fig. 4a). The pronounced modes for both males and females that were detected in 1988 were not as prominent in 1989 or 1990. Mean lengths from Yakutat shelf increased and relative abundance was

higher, especially for large females (Fig. 4b). The 101-200 m stratum in the Chirikof, Kodiak, and Southeastern INPFC areas and in Shumagin Gully, Shelikof Trough, Amatuli Gully, and the W-grounds showed decreases in relative abundance from 1989 to 1990, consistent with the hypothesis of movements into deeper strata (Figs. 4c-i).

Potential Year-Class Strength

We have been unable to place prerecruit year-class strength in perspective with longline survey catches because the data time series is short and a large year class has not been detected by this research program. However, mean sablefish lengths in the 101-200 m stratum generally are smaller than those from the adjacent slope and gully areas (Table 6); thus, prerecruit year-class strength might be indexed by catches of sablefish in the shallowest stratum. Length-at-age distributions for sablefish in the Gulf of Alaska sampled previously during the 1984 cooperative longline survey (Fig. 5) showed age-4^{+} males were mostly 46-54 cm (mean 51.7 cm) and age-4^{+} females were 46-58 cm (mean 54.6 cm). There are no modes at or below these length ranges from 1988 to 1990 in the 101-200 m stratum (Figs. 4a-i) that we consider to be exceptionally large. Thus, there is no evidence from length frequencies from the 101-200 m stratum of the presence of any upcoming strong year classes after 1985.

Rougheye and Shortraker Rockfish

Relative Abundance

Assessment of these two species with longline survey data is difficult because of the variability of catch rates and catch ratios between them. Changes in RPN of 35-40% have been common, but these large fluctuations have not been statistically significant ($P \leq 0.05$). The distribution of survey effort and the highly contagious nature of rockfish distributions may be largely responsible for the variability of the longline survey rockfish data. Sample density is low in the relatively narrow depth interval, 301-400 m, (Table 7a) and on the hard or rocky substrates where these rockfish species are most commonly captured. Current drift, especially pronounced during tide cycle extremes, carries longlines off planned tracklines and may determine whether rockfish habitat is sampled or not.

The 1988-90 patterns of combined rockfish catch rates for the upper slope, by station and depth, are plotted in Figure 6. Generally, catch rates were highest in the Southeastern INPFC area in 1988-89, but in 1990, the mid-gulf region produced the largest catch rates.

Survey estimates of rougheye and shortraker rockfish abundance on the upper slope decreased 2% (RPN = 39,178 to 38,405) from 1989 to 1990 (Table 7a). This slight change follows a 35% (RPN = 28,939 to 39,178) increase from 1988 to 1989. Neither of these changes was statistically significant ($P \leq 0.05$). The RPN decreased in the Shumagin, Chirikof, and

Southeastern INPFC areas and increased in the Kodiak and Yakutat INPFC areas. The largest change was in the Southeastern INPFC area where these rockfishes decreased 40%, but none of theses changes was significant.

The number of rougheye and shortraker rockfish in gullies is relatively small compared to the number on the upper slope. Gully rougheye and shortraker populations (RPN = 3,089) accounted for only 9% of the total RPN (RPN = 42,214) in 1990 (Table 7b).

Relative Biomass

Total RPW for the combined species on the upper slope remained at about 59,000 from 1989 to 1990 (Table 8). The rougheye rockfish RPW decreased 21%, but the drop was balanced by a nearly equal increase (23%) in the shortraker rockfish RPW. From 1989 to 1990, rougheye rockfish RPW decreased in all areas except the Kodiak INPFC area where RPW increased. The greatest drop (44%) was in the Southeastern INPFC area. Shortraker rockfish RPW increased in the Shumagin, Kodiak, and Yakutat INPFC areas and decreased in the Chirikof and Southeastern INPFC areas. The greatest change was the 46% increase in the Yakutat INPFC area.

Size Compositions

The number of rougheye rockfish at lengths greater than or equal to 44 cm decreased from 1989 to 1990 (Fig. 7a). As a result, mean length decreased nearly 1 cm. Mean lengths decreased slightly in all INPFC areas except the Yakutat area (Figs. 7b-d).

For shortraker rockfish, the general shape of the length compositions were similar for 1989 and 1990 (Fig. 8a). The 1988 length composition was dissimilar due to higher estimated abundance of fish at lengths less than 50 cm. (At larger sizes the shapes of the annual length compositions were more similar.) Two distinct modes located in the interval 35-50 cm were observed in 1988 but were not as apparent in 1989 and 1990. These modes were primarily attributable to the Shumagin area (Fig. 8b). Overall mean length for shortraker rockfish sampled by this survey has consistently increased from 1988 to 1990 (Fig. 8a). However, all areas except Shumagin have shown decreases in mean length since 1988 (Figs. 8b-d).

Thornyheads

Relative Abundance

Thornyheads occurethroughout the Gulf of Alaska on the upper slope and in most gullies. In general, catches have been less variable than those of each of the two major rockfish species. The general pattern of thornyhead catch rates for the upper slope is plotted by station and depth in Figure 9. Apparent abundance is highest in the western Gulf of Alaska, and about half as high, but relatively uniform throughout the central gulf. Thornyhead catches may be influenced more by catches of other species than by their actual presence in the survey area. The eastern gulf region typically has shown the lowest thornyhead catch rates, although those generally correspond to areas of high sablefish

catch rates (Figs. 2 and 9). From 1988 to 1989 a large increase in apparent thornyhead abundance in the western gulf coincided with a decrease in sablefish catches in the same area. Increases in sablefish abundance generally have coincided with decreases in thornyhead catches. We believe that sablefish compete successfully against thornyheads for baited hooks.

Thornyhead RPN on the upper slope decreased 12% (about 36,800 to 31,900) from 1989 to 1990 (Table 9a); this decrease was not statistically significant ($P \leq 0.05$). The decrease from 1989 to 1990 follows a significant increase of 77% from 1988 to 1989. Although abundance decreased in the Shumagin, Kodiak, Yakutat, and Southeastern INPFC areas, only the decrease in the Kodiak INPFC area was significant.

Gullies contributed 26% of the total RPN in 1990. Thus, the gully fraction represents an important part of the thornyhead population. Relatively large numbers of thornyheads were found in Amatuli Gully, Yakutat Valley, Ommaney Trench, and Dixon Entrance where RPN increased from 1989 to 1990 (Table 9b). None of these changes was significant.

Relative Biomass

Thornyhead abundance (upper slope and gully RPN combined) decreased 7% for the Gulf of Alaska. The upper slope thornyhead RPW mimicked changes in RPN in all INPFC areas (Table 10a); and like RPN, total RPW decreased (4%) (Table 10b). The gulfwide size compositions and mean lengths were similar from 1988 to 1990

(Fig. 10a)e Substantive differences in size compositions were not evident among the areas (Figs. 10b-g)e

Other Species

As stated in the Materials and Methods section above, only some unknown fraction of the following species' geographic distributions were sampled. Thus, these results do not represent their whole populations.

Giant Grenadier

Giant grenadier is consistently the second most frequently caught species during NMFS longline surveys. The survey does not adequately cover the full depth range occupied by this species, and competition for baited hooks from other more mobile or aggressive species may also determine the survey's ability to measure giant grenadier abundance. Sablefish and giant grenadier catch rate patterns, by station and depth, are shown in Figures 2 and 11, respectively. Giant grenadier are captured most frequently in areas where sablefish appear to be less abundant. Thus, competition for baited hooks by sablefish and other deepwater species such as thornyheads may be an important factor that affects giant grenadier catch rates. Our field observations of the typical lethargy displayed by grenadiers, along with their body shape and lack of a powerful caudal structure, indicate that this species may be less able to compete for baited hooks when other, more energetic species such as sablefish are present. Apparent abundance of giant grenadier is highest in the western

Gulf of Alaska where recent abundance of sablefish has been relatively low. Bottom type may also influence catches of grenadiers. For example, Station 9 was resampled in 1990 and the catch of giant grenadier increased 40% in the second set that fell on harder bottom than the first set.

In the area east of station 9, including shallow depths, giant grenadier catch rates increased notably from 1988 to 1989 (Fig. 11)a In 1990, the abundance was once again highest in the deeper parts of westward stations. These changes appear to be related (Sigler and Zenger 1992), although the increase in giant grenadier catch rates may be influenced more by the presence or absence of sablefish rather than by an increase in grenadier abundance.

The highest survey catch rates of giant grenadier were in the Shumagin and Chirikof slope areas (Table 11)a Significant increases in giant grenadier RPN occurred from 1988 to 1989 in all areas except Yakutat. Grenadiers were most frequently captured at depths greater than 400 m during all 3 years. From 1989 to 1990 the 15.7% decrease in giant grenadier RPN was not statistically significant. In general, size ranges have not changed, but annual size compositions differ somewhat (Fig. 12)ę especially in the 1988 data from the Shumagin and Chirikof INPFC areas where proportionately more small giant grenadier were sampled. Popeye grenadier, a much smaller species than giant grenadiers (Figs. 12 and 13)ę is the other Macrourid routinely

captured. It is typically found at the deepest depths sampled and is caught much less frequently than giant grenadier.

Pacific Cod

The geographic distribution of Pacific cod is not sampled adequately by this survey, thus we make no generalizations about the status of that population. However, sampling in Shelikof Trough could supply valuable information about incoming year classes. Data from future surveys may show the area to be a valuable monitoring point from which to judge the overall condition of Pacific cod stocks in the western Gulf of Alaska. Pacific cod abundance indices were high in Shelikof Trough during the 1990 survey.

Survey estimates of Pacific cod abundance on the upper slope increased 35% from 1989 to 1990 to near the 1988 abundance level (Table 12a), however this change was not statistically significant. Abundance increased in all areas of the upper slope of the Gulf of Alaska, but especially in the Chirikof and Southeastern INPFC areas where increases were statistically significant.

The 1990 RPN increases for the Chirikof and Southeastern INPFC area upper slope were matched by RPN increases in adjacent gullies. Shelikof Trough was by far the most important area in terms of Pacific cod abundance, contributing 76% of the total cod RPN. That area showed a significant increase of 46% since 1989, whereas increases in gully RPNs in the remaining areas were not significant. Gullies yielded the vast majority of Pacific cod

captured during the 3 annual NMFS longline surveys ranging from 79% of the total cod catch in 1988 to 84% in 1990 (Table 12b).

Length compositions of Pacific cod from the Gulf of Alaska as a whole did not change appreciably during 1988-90 survey periods (Figs. 14a-f). The most notable difference was the marked increase in cod abundance in 1990 (Fig. 14a), which was largely due to the increases on the Chirikof INPFC area upper slope region (Fig. 14b) and in nearby Shelikof Trough (Fig. 14e).

Pacific Halibut

Pacific halibut (*Hippoglossus stenolepis*) abundance indices for the upper slope changed very little during annual NMFS longline surveys (Table 13a). This was true also in the gullies from 1989 to 1990, the years when the gully sampling program was fully established. It appears there was little change in the abundance of Pacific halibut in the largest and best sampled of the gullies, Shelikof Trough, over the 3-year sample period (Table 13b). Changes in size composition could not be studied because Pacific halibut lengths were not recorded.

Arrowtooth Flounder

Arrowtooth flounder represents the largest single species biomass in the Gulf of Alaska (NPFMC 1991), but the longline survey does not sample the entire geographic distribution of the species. Although longline survey results do not reflect the total relative biomass of arrowtooth flounder, the species has shown increases in abundance and what appears to be relatively strong recruitment since 1988, especially in the central and

western gulf regions. This appears to be consistent with trawl survey results from the same area[4]. Arrowtooth flounder has been most commonly captured at survey stations in the western and central Gulf of Alaska (Tables 14a and b). The upper slope segment of the population has shown steady increases since 1988, although the annual changes for the Gulf of Alaska have not been statistically significant (Table 14a). The only significant change was an increase in the Chirikof INPFC area from 1989 to 1990. A statistically significant increase in arrowtooth flounder abundance was detected in Shelikof Trough, which is adjacent to the upper slope area of the Chirikof INPFC area cited above (Table 14b). Figure 15a reflects the increased abundance of arrowtooth flounder in the Gulf of Alaska from 1988 to 1990, and shows what appears to be recruitment and growth of a year class over those 3 years. There appears to be a recruiting year class at about 45-47 cm in 1990, and initial recruitment in all years appears to be most common on the upper slope of the Shumagin INPFC area (Fig. 15b), in Amatuli Gully, and especially in Shelikof Trough (Fig. 15c). Upper slope areas of the Chirikof, Kodiak, and Yakutat INPFC areas contained slightly larger arrowtooth flounder (Figs. 15b and c).

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[4]Eric Brown, Alaska Fisheries Science Center, 7600 Sand Point Way NE, BIN C15700, Seattle, WA 98115. Pers. commun., 1991.

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Table 1.e--Gulf of Alaska gullies sampled by National Marine Fisheries Service longline surveys, 1987-90, and their respective International North Pacific Fisheries Commission (INPFC) statistical areas.

INPFC area/Gully name	1987	1988	1989	1990
Shumagin				
Shumagin Gully		✓	✓	✓
Chirikof				
Shelikof Trough	✓	✓	✓	✓
Kodiak				
Amatuli Gully	✓	✓	✓	✓
Yakutat				
W-grounds			✓	✓
Yakutat Valley			✓	✓
Alsek Strath			✓	✓
Southeastern				
Spencer Gully		✓	✓	✓
Ommaney Trench	✓		✓	✓
Iphigenia Gully			✓	✓
Dixon Entrance			✓	✓

Table 2.e-Depth stratification codes used for National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1987-90.

Stratum	Depth range (m)
0	All depths
1	0 - 100
2	101 - 200
3	201 - 300
4	301 - 400
5	401 - 600
6	601 - 800
7	801 - 1,000
8	1,001 - 1,200

Table 3.e--Areas (km^2) of Gulf of Alaska depth strata from 201 to 1,000 m. Areas are listed by International North Pacific Fisheries Commission (INPFC) statistical area for the upper continental slope and by gully name.

	Depth (m)					
	201-300	301-400	401-600	601-800	801-1,000	201-1,000
INPFC area, upper continental slope						
Shumagin	2,837	1,264	2,269	1,629	1,248	9,247
Chirikof	1,533	817	1,766	1,955	2,012	8,083
Kodiak	1,626	1,480	2,255	1,923	2,296	9,580
Yakutat	1,494	1,494	1,666	1,470	1,489	7,613
Southeastern	891	891	822	1,006	1,165	4,774
Total	8,281	5,946	8,778	7,983	8,210	39,197
Gullies						
Shumagin Gully	665	0	0	0	0	665
Shelikof Trough	13,076	0	0	0	0	13,076
Amatuli Gullies	6,346	0	0	0	0	6,346
W-Grounds	1,508	302	0	0	0	1,810
Yakutat Valley	1,268	768	0	0	0	2,036
Alsek Strath	565	0	0	0	0	565
Spencer Gully	189	189	301	50	0	729
Ommaney Trench	521	610	122	0	0	1,253
Iphigenia Gully	1,918	0	0	0	0	1,918
Dixon Entrance	1,430	793	58	0	0	1,980
Total	26,685	2,662	481	50	0	29,878

Sources: Eric Brown, Alaska Fisheries Science Center, RACE Division, Seattle, WA. Pers. commun., 1985. Richard Haight, Alaska Fisheries Science Center, Auke Bay Laboratory, Pers. commun., 1986.

Table 4a.--Relative population number (RPN) of sablefish by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	20,783	20,883	11,893	7,548	2,568	63,675
	1989	18,537	21,276	9,837	10,055	3,231	62,936
	1990	20,565	17,172	11,499	12,429	2,590	64,255
301-400	1988	10,922	10,649	11,162	7,472	7,133	47,338
	1989	5,681	8,057	9,429	9,660	6,554	39,380
	1990	11,497	7,244	11,472	9,688	6,270	46,171
401-600	1988	29,692	25,830	30,596	24,509	13,052	123,679
	1989	12,836	17,062	31,911	22,304	12,894	96,507
	1990	21,288	26,341	33,058	26,415	11,517	118,618
601-800	1988	15,719	26,086	26,832	23,747	18,242	110,626
	1989	4,268	12,470	30,885	21,928	18,543	88,094
	1990	11,512	24,648	32,526	27,164	17,298	113,147
801-1,000	1988	7,045	5,185	31,298	13,482	19,210	76,221
	1989	4,020	5,072	13,090	14,999	20,698	57,880
	1990	4,936	14,678	19,623	16,102	18,359	73,699
201-1,000	1988	84,161	88,632	111,781	76,757	60,206	421,538
	1989	45,342[s]	63,936[s]	95,153[n]	78,946[n]	61,420[n]	344,798[s]
	1990	69,798[s]	90,082[n]	108,179[s]	91,797[n]	56,034[n]	415,891[s]

Table 4b.--Relative population number (RPN) of sablefish by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or 1989 to 1990; superscript "n" indicates no significant change. No superscript indicates that the significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	9,419	141,730	90,575	--	--	--	--	--	--	--	241,723	305,399
	1989	12,210	142,693	92,806	16,020	12,994	2,712	2,967	1,957	11,922	6,274	302,556	365,492
	1990	1,531	108,253	89,837	15,151	11,296	3,064	2,156	2,359	8,988	10,181	252,816	317,072
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	47,338
	1989	--	--	--	3,716	5,267	--	5,168	10,656	--	15,261	40,068	79,449
	1990	--	--	--	4,793	12,901	--	3,901	7,866	--	9,959	39,420	85,591
401-601	1988	--	--	--	--	--	--	6,184	--	--	--	6,184	129,863
	1989	--	--	--	--	--	--	7,839	--	--	1,024	8,863	105,370
	1990	--	--	--	--	--	--	7,038	--	--	792	7,830	126,448
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	110,626
	1989	--	--	--	--	--	--	1,302	--	--	--	1,002	89,396
	1990	--	--	--	--	--	--	1,168	--	--	--	1,168	114,315
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	76,221
	1989	--	--	--	--	--	--	--	--	--	--	--	57,880
	1990	--	--	--	--	--	--	--	--	--	--	--	73,699
201-1,000	1988	9,419	141,730	90,575	--	--	--	6,184	--	--	--	247,908	669,445
	1989	12,210	142,693[s]	92,806[s]	19,737	18,261	2,712	17,276	12,613	11,922	22,559	352,790	697,586
	1990	1,531[s]	108,253[s]	89,837[s]	19,943[s]	24,198[s]	3,064[s]	14,263[s]	10,225[s]	8,988[s]	20,932[s]	301,234	717,124

Table 5a.--Relative population weight (RPW) of sablefish by International North Pacific Fisheries Commission (INPFC) statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	58,765	63,560	37,392	26,605	9,024	195,346
	1989	50,611	61,872	32,760	40,945	11,388	197,576
	1990	61,077	51,370	37,462	48,065	8,537	206,511
301-400	1988	33,477	34,848	36,262	25,089	24,968	154,645
	1989	16,703	26,718	29,961	36,307	21,161	130,850
	1990	36,388	22,623	37,820	37,053	20,309	154,192
401-600	1988	103,138	86,365	95,341	84,594	45,222	414,659
	1989	45,558	62,927	111,752	79,739	39,979	339,954
	1990	77,663	89,615	108,709	87,665	37,701	401,353
601-800	1988	57,697	89,923	91,082	85,137	63,396	387,234
	1989	16,110	51,279	129,040	85,686	66,182	348,297
	1990	46,861	89,996	119,259	98,288	60,911	415,315
801-1,000	1988	27,363	20,942	123,663	53,111	73,397	298,475
	1989	14,408	17,080	58,428	67,593	78,431	236,040
	1990	22,174	51,434	76,450	62,412	67,900	280,370
201-1,000	1988	280,440	295,637	383,740	274,535	216,007	1,450,359
	1989	143,390	219,976	361,941	310,269	217,141	1,252,718
	1990	244,164	305,038	379,700	333,482	195,358	1,457,741

Table 5b.--Relative population weight (RPW) of sablefish by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	23,406	397,913	307,237	--	--	--	--	--	--	--	728,555	923,901
	1989	30,866	415,133	338,545	55,570	42,726	7,522	7,605	5,275	34,195	12,833	950,269	1,147,845
	1990	4,396	338,789	312,605	34,661	25,615	9,572	6,615	7,666	24,432	29,704	794,056	1,000,567
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	154,645
	1989	--	--	--	12,267	18,247	--	16,320	33,705	--	42,032	122,572	253,422
	1990	--	--	--	12,069	33,768	--	12,624	25,000	--	27,979	111,440	265,631
401-601	1988	--	--	--	--	--	--	21,220	--	--	--	21,220	435,879
	1989	--	--	--	--	--	--	25,595	--	--	3,059	28,654	368,607
	1990	--	--	--	--	--	--	25,427	--	--	2,191	27,619	428,972
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	387,234
	1989	--	--	--	--	--	--	4,252	--	--	--	4,252	352,549
	1990	--	--	--	--	--	--	4,224	--	--	--	4,224	419,539
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	298,475
	1989	--	--	--	--	--	--	--	--	--	--	--	236,040
	1990	--	--	--	--	--	--	--	--	--	--	--	280,370
201-1,000	1988	23,406	397,913	307,237	--	--	--	21,220	--	--	--	749,775	2,200,134
	1989	30,866	415,133	338,545	67,837	60,973	7,522	53,772	38,979	34,195	57,924	1,105,746	2,358,464
	1990	4,396	338,789	312,605	46,730	59,383	9,572	48,890	32,667	24,432	59,874	937,338	2,395,079

Table 5c.--Relative population weight (RPW) of sablefish from commercially harvested depths of 401-1,000 m for the upper continental slope and gullies combined by North Pacific Fisheries Management Council (NPFMC) sablefish regulatory area from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. The NPFMC Western and Central areas refer to the Shumagin INPFC area and the combined Chirikof and Kodiak INPFC areas, respectively0

Year	Western	Central	West Yakutat	East Yakutat/ Southeastern	Total
1988	188,098	507,815	182,870	243,706	1,121,689
1989	76,077	430,606	191,600	258,914	957,197
1990	146,699	535,464	203,859	242,860	1,128,882

Table 5d.--Percentage distribution of sablefish relative population weights (RPW) by North Pacific Fisheries Management Council sablefish regulatory area from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Depth intervals and regulatory areas are described in Table 5c above.

Year	Western	Central	West Yakutat	East Yakutat/ Southeastern	Total
1988	1608	45.2	1603	21.7	100.0
1989	8.0	45.0	20.0	27.0	100.0
1990	13.0	47.4	18.1	21.5	10000

Table 6.--Differences in mean sablefish length (ML) in centimeters between continental slope regions of Gulf of Alaska International North Pacific Fisheries Commission (INPFC) statistical areas and adjacent gullies (Gully ML - Slope ML), and between continental slope areas and adjacent 101-200 m depths (101-200 m ML - Slope ML) on the continental shelf and near gullies from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90.

Comparison areas		Survey year					
		1988	1989	1990	1988	1989	1990
INPFC area slope regions vs. adjacent gullies					**Males**		
Females							
Shumagin	Shumagin Gully	-2.7	-1.4	-3.5	-6.5	-4.9	-3.6
Chirikof	Shelikof Trough	-2.6	-0.9	-0.9	-4.3	-4.0	-2.3
Kodiak	Amatuli Gully	0.6	0.3	0.6	0.2	-0.6	0
Yakutat	W-Grounds (>400 m)	-	-1.4	-5.4	-	-2.1	-10.3
	Yakutat Valley	-	-1.1	-4.8	-	-2.7	-10.4
	Alsek Strath	-	-5.4	-3.6	-	-9.6	-5.1
South-eastern	Spencer Gully	-1.3	-1.3	-0.3	0.5	-2.2	0.3
	Ommaney Trench	-	-0.7	-1.1	-	-2.5	-1.4
	Iphigenia Gully	-	-3.3	-3.7	-	-5.6	-6.7
	Dixon Entrance	-	-3.8	-1.0	-	-7.2	-4.4
INPFC area slope regions vs. adjacent 101-200 m depth areas							
Shumagin	Shumagin shelf	-4.6	-3.3	-5.9	-8.7	-5.8	-9.1
	Shumagin Gully	-4.8	-1.5	-3.4	-8.9	-4.8	-3.8
Chirikof	Chirikof shelf	-3.5	-0.9	-3.9	-6.7	-4.5	-6.0
	Shelikof Trough	-4.4	-0.8	2.2	-8.1	-3.9	-1.4
Kodiak	Kodiak shelf	-1.8	-0.1	-2.3	-1.6	-2.5	-4.6
	Amatuli Gully	-2.0	0.3	-0.5	-2.7	-0.8	-2.1
Yakutat	Yakutat shelf	-3.2	1.6	1.3	-5.7	1.8	1.8
	W-Grounds (201-400 m)	-	0.9	-10.8	-	2.1	-4.7
South-eastern	S'eastern shelf	-3.3	-2.3	-3.9	-2.4	-3.0	-5.5

Table 7a.--Relative population number (RPN) of rougheye and shortraker rockfish by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	2,551	194	889	1,612	468	5,714
	1989	3,444	1,062	1,483	1,926	1,439	9,354
	1990	2,992	484	1,107	2,398	372	7,352
301-400	1988	3,470	1,957	3,732	5,465	3,811	18,435
	1989	3,973	1,639	4,112	6,819	6,694	23,237
	1990	3,803	1,185	7,091	8,329	3,616	24,024
401-600	1988	706	76	234	1,470	1,310	3,796
	1989	1,204	39	293	1,708	2,501	5,745
	1990	1,011	139	800	2,094	2,356	6,401
601-800	1988	10	0	0	125	109	243
	1989	6	43	0	125	430	605
	1990	41	0	0	134	195	370
801-1,000	1988	498	0	0	79	174	751
	1989	0	0	0	6	229	235
	1990	0	0	0	5	253	259
201-1,000	1988	7,234	2,227	4,855	8,751	5,872	28,939
	1989	8,627[s]	2,783[s]	5,889[s]	10,585[s]	11,294[s]	39,178[s]
	1990	7,847[s]	1,807[s]	8,998[s]	12,961[s]	6,793[s]	38,405[s]

Table 7b.--Relative population numbers (RPN) of rougheye and shortraker rockfish by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or 1989 to 1990; superscript "n" indicates no significant change. No superscript indicates that the significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	11	839	380	--	--	--	--	--	--	--	1,230	6,944
	1989	28	1,719	478	0	66	191	0	39	49	0	2,571	11,925
	1990	60	1,072	642	13	164	42	24	20	268	178	2,482	9,834
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	18,435
	1989	--	--	--	0	271	--	7	794	--	34	1,106	24,343
	1990	--	--	--	0	257	--	37	641	--	368	1,303	25,327
401-601	1988	--	--	--	--	--	--	21	--	--	--	21	3,816
	1989	--	--	--	--	--	--	13	--	--	12	24	5,770
	1990	--	--	--	--	--	--	9	--	--	14	22	6,423
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	243
	1989	--	--	--	--	--	--	2	--	--	--	2	608
	1990	--	--	--	--	--	--	1	--	--	--	1	372
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	751
	1989	--	--	--	--	--	--	--	--	--	--	--	235
	1990	--	--	--	--	--	--	--	--	--	--	--	259
201-1,000	1988	11	839	380	--	--	--	21	--	--	--	1,251	30,189
	1989	28	1,719[s]	478[s]	0	337	191	22	833	49	45	3,703	42,881
	1990	60[s]	1,072[s]	642[s]	13[s]	421	42[s]	71[s]	661[s]	268[s]	559[s]	3,809	42,214

Table 8.--Relative population weights (RPW) of rougheye and shortraker rockfish for the upper continental slope by International North Pacific Fisheries Commission statistical area, and for gully areas sampled by National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

	Rougheye			Shortraker		
Area	1988	1989	1990	1988	1989	1990
Shumagin	3,348	6,610	5,277	4,924	4,272	4,972
Chirikof	1,186	2,414	1,136	2,574	1,441	1,208
Kodiak	2,786	3,752	6,315	5,010	5,795	6,742
Yakutat	3,816	5,116	4,365	13,233	13,247	19,382
Southeastern	5,976	13,068	7,303	2,458	3,362	2,199
Slope total	17,112	30,960	24,396	28,199	28,117	34,503
Shumagin Gully	8	8	49	0	7	3
Shelikof Trough	68	1,469	912	426	399	575
Amatuli Gully	237	160	315	0	179	88
W-Grounds	--	0	2	--	0	19
Yakutat Valley	--	271	227	--	65	279
Alsek Strath	--	129	20	--	49	43
Spencer Gully	0	0	32	0	49	85
Ommaney Trench	--	838	555	--	897	304
Iphigenia Gully	--	43	41	--	35	170
Dixon Entrance	--	96	635	--	0	437
Gully total	313	3,014	2,778	426	1,680	2,003
Gulf total	17,424	33,974	27,184	28,625	29,798	36,506

Table 9a.--Relative population number (RPN) of thornyheads by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	2,390	504	438	656	388	4,376
	1989	2,656	524	625	1,443	642	5,891
	1990	2,689	1,092	665	1,667	713	6,726
301-400	1988	1,428	504	823	1,034	238	4,027
	1989	1,298	478	617	1,600	516	4,509
	1990	1,805	652	828	1,273	695	5,253
401-600	1988	1,645	1,137	1,156	555	438	4,931
	1989	2,724	1,523	1,907	1,342	674	8,170
	1990	1,232	1,536	1,611	1,092	603	6,074
601-800	1988	1,558	1,416	990	401	253	4,617
	1989	1,877	2,444	2,154	1,180	672	8,327
	1990	1,634	3,177	1,036	596	666	7,009
801-1,000	1988	1,412	0	431	393	254	2,491
	1989	2,985	2,150	1,949	1,600	688	9,372
	1990	1,236	3,461	1,273	472	375	6,817
201-1,000	1988	8,433	3,560	3,838	3,039	1,571	20,442
	1989	11,540[n]	7,119[s]	7,252[s]	7,165[s]	3,192[s]	36,268[s]
	1990	8,496[n]	9,919[n]	5,414[s]	4,999[n]	3,053[n]	31,880[n]

Table 9b.--Relative population number (RPN) of thornyheads by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript"s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or 1989 to 1990; superscript "n" indicates no significant change. No superscript indicates that the significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	0	0	1,471	--	--	--	--	--	--	--	1,471	5,847
	1989	0	0	2,874	526	1,077	54	0	852	449	1,895	7,727	13,618
	1990	0	0	2,932	617	1,324	74	24	601	356	2,547	8,474	15,200
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	4,027
	1989	--	--	--	47	394	--	4	932	--	445	1,821	6,330
	1990	--	--	--	101	544	--	78	1,467	--	330	2,519	7,772
401-601	1988	--	--	--	--	--	--	100	--	--	--	100	5,030
	1989	--	--	--	--	--	--	160	--	--	75	235	8,404
	1990	--	--	--	--	--	--	154	--	--	22	176	6,251
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	4,617
	1989	--	--	--	--	--	--	27	--	--	--	27	8,353
	1990	--	--	--	--	--	--	26	--	--	--	26	7,035
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	2,491
	1989	--	--	--	--	--	--	--	--	--	--	--	9,372
	1990	--	--	--	--	--	--	--	--	--	--	--	6,817
201-1,000	1988	0	0	1,471	--	--	--	100	--	--	--	1,571	22,012
	1989	0	0	2,874[s]	573	1,471	54	190	1,784	449	2,415	9,810	46,077
	1990	0	0	2,932[s]	718[s]	1,868	74[s]	281[s]	2,068[s]	356[s]	2,899[s]	11,195	43,075

Table 10a.--Relative population weight (RPW) of thornyheads by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	1,332	279	212	369	197	2,389
	1989	1,322	313	294	701	332	2,961
	1990	1,616	659	296	745	392	3,709
301-400	1988	849	276	408	538	133	2,205
	1989	641	269	293	750	285	2,238
	1990	1,000	361	375	599	393	2,728
401-600	1988	955	603	556	291	338	2,743
	1989	1,346	847	902	615	376	4,086
	1990	738	840	710	515	336	3,139
601-800	1988	774	807	500	217	176	2,474
	1989	937	1,488	1,028	538	365	4,357
	1990	801	1,891	465	288	360	3,805
801-1,000	1988	744	0	200	214	171	1,328
	1989	1,707	1,393	937	748	384	5,170
	1990	647	2,090	551	228	201	3,716
201-1,000	1988	4,655	1,965	1,876	1,628	1,014	11,139
	1989	5,953	4,311	3,454	3,352	1,742	18,812
	1990	4,802	5,841	2,397	2,375	1,682	17,097

Table 10b.--Relative population weight (RPW) of thornyheads by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	0	0	500	--	--	--	--	--	--	--	500	2,889
	1989	0	0	1,202	275	451	50	0	350	131	1,360	3,819	6,780
	1990	0	0	1,012	329	651	23	8	238	98	1,825	4,285	7,994
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	2,205
	1989	--	--	--	24	174	--	1	412	--	320	930	3,168
	1990	--	--	--	53	251	--	37	615	--	238	1,194	3,922
401-601	1988	--	--	--	--	--	--	0	--	--	--	0	2,743
	1989	--	--	--	--	--	--	76	--	--	55	130	4,217
	1990	--	--	--	--	--	--	73	--	--	17	90	3,229
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	2,474
	1989	--	--	--	--	--	--	13	--	--	--	13	4,369
	1990	--	--	--	--	--	--	12	--	--	--	12	3,817
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	1,328
	1989	--	--	--	--	--	--	--	--	--	--	--	5,170
	1990	--	--	--	--	--	--	--	--	--	--	--	3,716
201-1,000	1988	0	0	500	--	--	--	0	--	--	--	500	11,639
	1989	0	0	1,202	299	625	50	90	761	131	1,734	4,892	23,704
	1990	0	0	1,012	382	902	23	130	853	98	2,080	5,581	22,678

Table 11.--Relative population number (RPN) of giant grenadiers by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	87	0	0	314	0	401
	1989	650	13	111	0	7	780
	1990	87	1,056	203	207	149	2,002
301-400	1988	6,051	2,884	2,024	307	6	11,272
	1989	12,006	5,304	3,747	569	240	21,865
	1990	7,266	5,874	2,634	628	78	16,380
401-600	1988	17,587	12,356	7,692	1,878	122	39,635
	1989	34,381	29,527	14,309	3,286	640	82,143
	1990	30,997	19,083	13,696	3,774	286	67,836
601-800	1988	19,864	18,921	7,627	3,018	427	49,858
	1989	31,849	39,046	14,934	3,646	994	90,468
	1990	27,033	23,973	10,842	3,859	767	66,574
801-1,000	1988	13,392	8,928	16,040	5,447	1,931	45,739
	1989	18,798	32,920	22,006	6,864	2,762	83,350
	1990	25,443	30,200	17,327	7,341	1,672	81,983
201-1,000	1988	57,082	43,090	33,383	10,963	2,687	147,005
	1989	97,683[s]	106,810[s]	55,106[s]	14,365[n]	4,663[s]	278,606[s]
	1990	90,926[n]	80,486[n]	44,602[s]	15,809[n]	2,952[s]	234,775[n]

Table 12a.--Relative population number (RPN) of Pacific cod by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript0"s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	14,027	3,024	3,881	3,179	989	25,099
	1989	9,634	2,423	3,771	1,297	576	17,700
	1990	10,973	6,083	4,330	1,754	1,629	24,769
301-400	1988	58	0	28	169	95	349
	1989	403	0	297	21	0	721
	1990	115	0	70	7	25	217
401-600	1988	0	0	87	83	0	169
	1989	61	0	0	0	2	63
	1990	0	0	0	0	0	0
601-800	1988	0	0	0	0	0	0
	1989	0	0	12	0	0	12
	1990	0	0	0	0	0	0
801-1,000	1988	0	0	0	0	0	0
	1989	0	0	0	0	0	0
	1990	0	0	0	0	0	0
201-1,000	1988	14,085	3,024	3,995	3,431	1,084	25,618
	1989	10,098[s]	2,423[s]	4,079[s]	1,318[s]	578[s]	18,495[s]
	1990	11,088[s]	6,083[s]	4,400[s]	1,761[s]	1,654[s]	24,986[s]

Table 12b.--Relative population number (RPN) of Pacific cod by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript "s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or 1989 to 1990; superscript "n" indicates no significant change. No superscript indicates that the significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	1,090	88,659	4,069	--	--	--	--	--	--	--	93,818	118,917
	1989	166	79,441	2,305	26	132	38	0	835	3,145	378	86,466	104,166
	1990	285	115,820	1,513	0	65	55	0	1,145	7,632	435	126,949	151,718
301-400	1988	--	--	--	--	--	--	--	--	--	--	0	349
	1989	--	--	--	0	0	--	0	13	--	26	39	759
	1990	--	--	--	0	0	--	0	127	--	8	135	352
401-601	1988	--	--	--	--	--	--	0	--	--	--	0	169
	1989	--	--	--	--	--	--	0	--	--	2	2	65
	1990	--	--	--	--	--	--	0	--	--	0	0	0
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	0
	1989	--	--	--	--	--	--	0	--	--	--	--	12
	1990	--	--	--	--	--	--	0	--	--	--	--	0
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	0
	1989	--	--	--	--	--	--	--	--	--	--	--	0
	1990	--	--	--	--	--	--	--	--	--	--	--	0
201-1,000	1988	1,090	88,659	4,069	--	--	--	0	0	0	0	93,818	119,436
	1989	166	79,441^{s}	2,305^{s}	26	132	38	0	848	3,145	406	86,507	105,002
	1990	285	115,820^{s}	1,513^{s}	0	65	55	0	1,272	7,632	442	127,084	152,070

Table 13a.--Relative population number (RPN) of Pacific halibut by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. The significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	3,239	978	2,379	2,359	2,549	11,503
	1989	5,004	2,861	2,580	1,340	1,152	12,936
	1990	5,244	1,248	3,384	1,155	1,363	12,394
301-400	1988	301	119	664	432	384	1,901
	1989	559	608	772	205	193	2,037
	1990	821	142	585	293	296	2,137
401-600	1988	7	11	12	16	11	57
	1989	8	25	68	30	33	165
	1990	76	8	36	29	29	178
601-800	1988	0	0	0	0	2	2
	1989	0	0	0	0	0	0
	1990	0	0	55	0	3	58
801-1,000	1988	0	0	0	0	0	0
	1989	0	0	0	0	0	0
	1990	0	0	0	0	0	0
201-1,000	1988	3,547	1,108	3,055	2,806	2,946	13,463
	1989	5,571	3,494	3,420	1,575	1,378	15,438
	1990	6,140	1,399	4,061	1,476	1,691	14,767

Table 13b.--Relative population number (RPN) of Pacific halibut by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. The significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	145	19,944	3,921	--	--	--	--	--	--	--	24,010	35,513
	1989	375	20,057	3,997	720	660	582	207	1,008	5,582	7,395	40,583	53,519
	1990	322	20,855	5,601	872	1,514	505	95	623	8,004	2,351	40,741	53,036
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	1,901
	1989	--	--	--	76	409	--	5	360	--	740	1,590	3,926
	1990	--	--	--	225	509	--	23	315	--	292	1,364	3.501
401-601	1988	--	--	--	--	--	--	0	--	--	--	0	57
	1989	--	--	--	--	--	--	0	--	--	37	37	202
	1990	--	--	--	--	--	--	20	--	--	9	29	207
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	2
	1989	--	--	--	--	--	--	0	--	--	--	0	0
	1990	--	--	--	--	--	--	3	--	--	--	3	61
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	0
	1989	--	--	--	--	--	--	--	--	--	--	--	0
	1990	--	--	--	--	--	--	--	--	--	--	--	0
201-1,000	1988	145	19,944	3,921	--	--	--	0	--	--	--	24,010	37,472
	1989	375	20,057	3,997	796	1,069	582	212	1,368	5,582	8,172	42,210	57,648
	1990	322	20,855	5,601	1,097	2,023	505	141	937	8,004	2,651	42,137	56,904

Table 14a.--Relative population number (RPN) of arrowtooth flounder by International North Pacific Fisheries Commission statistical area and depth interval for the upper continental slope from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript0"s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or from 1989 to 1990; superscript "n" indicates nonsignificant change; and no superscript indicates that the significance of the RPN change was not tested.

Depth (m)		Shumagin	Chirikof	Kodiak	Yakutat	Southeastern	Total
201-300	1988	4,975	3,718	4,872	2,254	685	16,505
	1989	6,772	3,012	4,858	1,0956	583	17,0182
	1990	5,850	5,746	5,393	2,030	170	19,188
301-400	1988	1,806	983	1,753	1,511	448	6,501
	1989	1,884	1,336	2,428	1,026	363	7,037
	1990	2,517	840	3,0033	787	359	7,0536
401-600	1988	376	160	160	236	86	1,018
	1989	1,207	436	920	188	161	2,911
	1990	1,447	456	517	128	82	2,630
601-800	1988	7	66	4	6	19	101
	1989	42	73	29	8	38	191
	1990	51	0	10	8	18	88
801-1,000	1988	0	0	0	0	0	0
	1989	0	0	0	0	5	5
	1990	0	0	0	0	3	3
201-1,000	1988	7,165	4,0927	6,789	4,007	1,236	24,124
	1989	9,906[s]	4,857[s]	8,235[s]	3,179[s]	1,0150[s]	27,0126[s]
	1990	9,865[s]	7,042[s]	8,953[s]	2,952[s]	634[s]	29,445[s]

Table 14b.--Relative population number (RPN) of arrowtooth flounder by gully area and depth interval from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90. Superscript0"s" indicates that the RPN change was significant ($P \leq 0.05$) from 1988 to 1989 or 1989 to 1990; superscript "n" indicates no significant change. No superscript indicates that the significance of the RPN change was not tested. Fewer gullies were sampled in 1988, thus totals for 1988 cannot be compared to those for 1989-90.

Depth (m)		Shumagin Gully	Shelikof Trough	Amatuli Gully	W-Grounds	Yakutat Valley	Alsek Strath	Spencer Gully	Ommaney Trench	Iphigenia Gully	Dixon Entrance	Gully total	Gulf total
201-300	1988	509	19,510	7,005	--	--	--	--	--	--	--	27,023	43,528
	1989	486	42,342	9,076	405	1,541	1,396	0	1,282	1,692	2,463	51,903	69,085
	1990	839	62,346	12,167	523	1,848	903	47	1,383	755	1,581	82,392	101,580
301-400	1988	--	--	--	--	--	--	--	--	--	--	--	6,501
	1989	--	--	--	14	322	--	11	786	--	272	1,405	7,037
	1990	--	--	--	123	469	--	21	834	--	142	1,589	9,125
401-600	1988	--	--	--	--	--	--	66	--	--	--	66	1,084
	1989	--	--	--	--	--	--	14	--	--	18	32	2,926
	1990	--	--	--	--	--	--	45	--	--	3	48	2,678
601-800	1988	--	--	--	--	--	--	--	--	--	--	--	101
	1989	--	--	--	--	--	--	2	--	--	--	2	191
	1990	--	--	--	--	--	--	7	--	--	--	7	95
801-1,000	1988	--	--	--	--	--	--	--	--	--	--	--	0
	1989	--	--	--	--	--	--	--	--	--	--	--	5
	1990	--	--	--	--	--	--	--	--	--	--	--	3
201-1,000	1988	509	19,510	7,005	0	0	0	66	0	0	0	27,089	51,214
	1989	486	42,342[s]	9,076[s]	419	1,863	1,396	27	2,068	1,692	2,752	62,120	79,243
	1990	839[s]	62,346[s]	12,067[s]	646[s]	2,317	903[s]	120[s]	2,217[s]	755[s]	1,726[s]	84,036	113,481

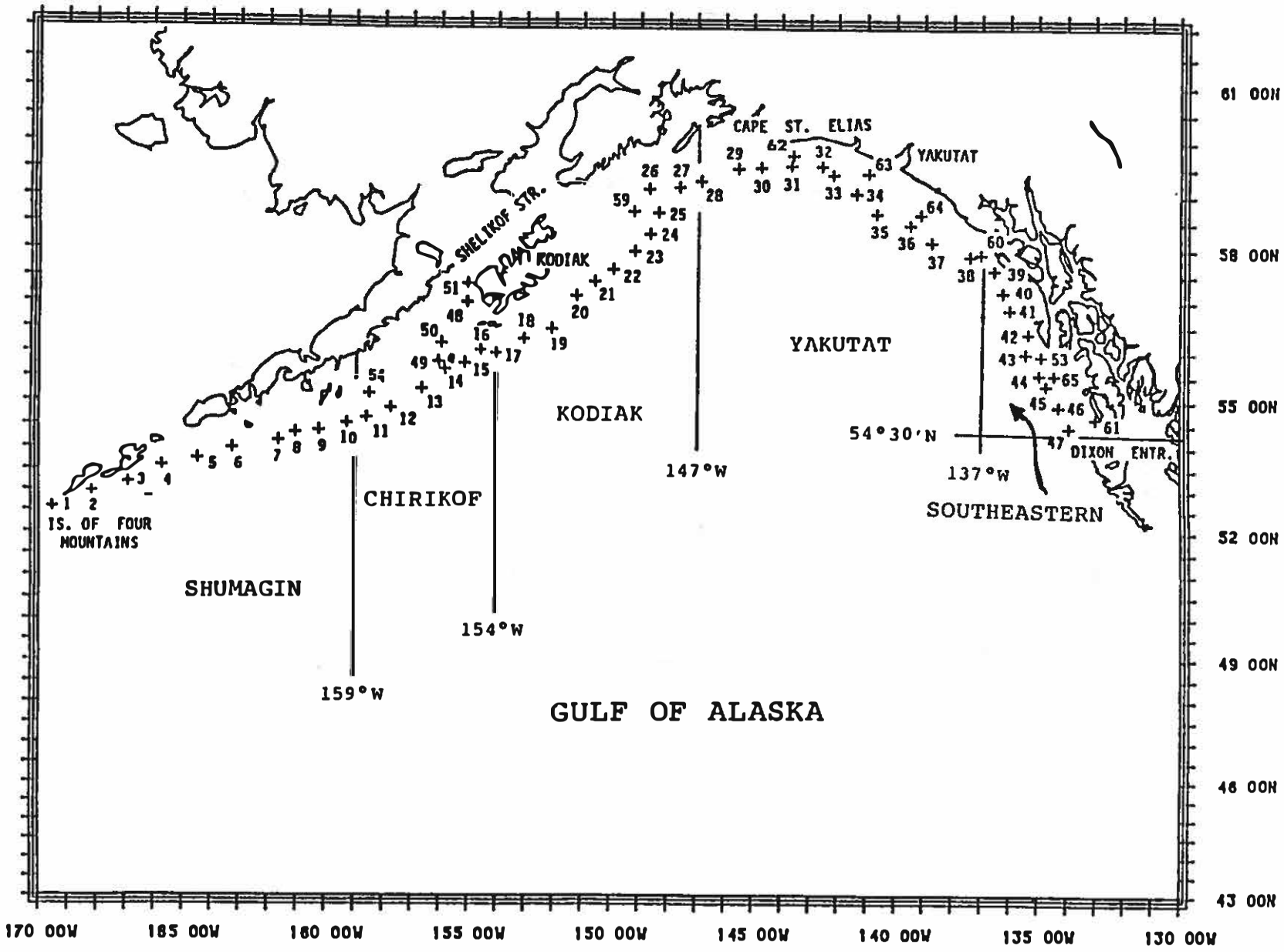

Figure 1a.--Station locations for the 1990 NMFS longline survey of the Gulf of Alaska and boundaries of International North Pacific Fisheries Commission statistical areas.

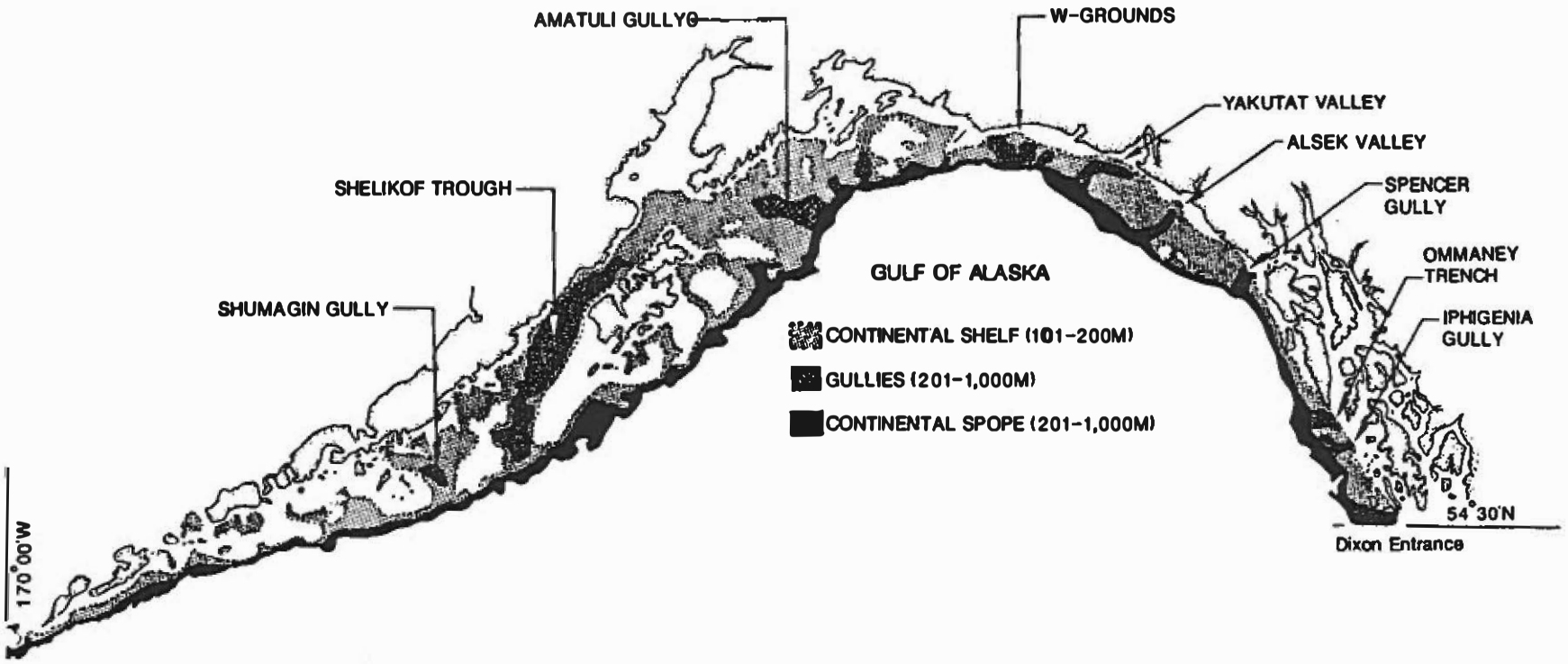

Figure 1b.--Distribution of continental shelf (101-200 m), continental slope (201-1,000 m), and gully areas in the Gulf of Alaska.

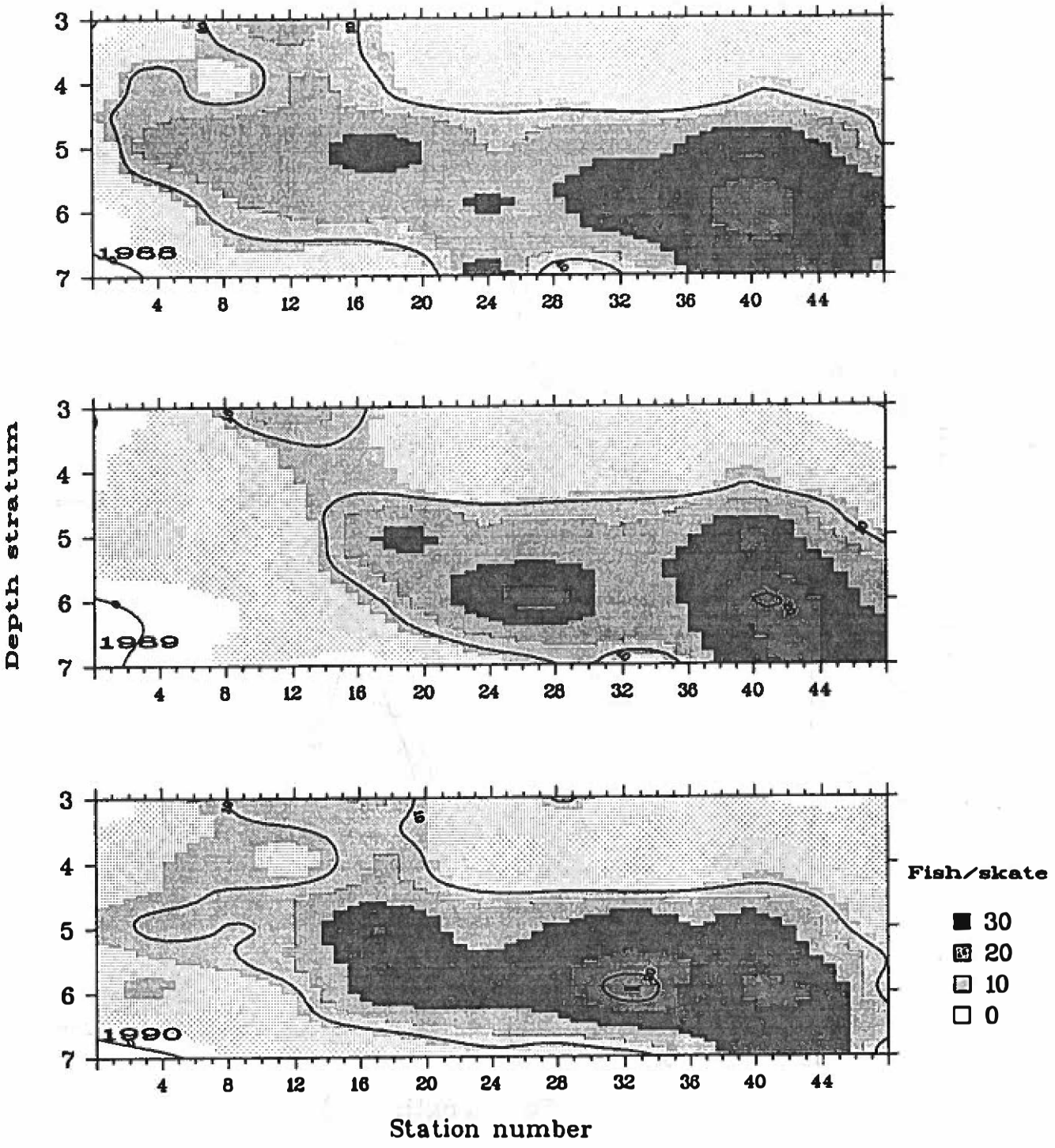

Figure 2.--Distribution of sablefish catch per unit effort (fish/skate) from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90, smoothed by distance-weighted least squares with depth stratum and station number. Depth strata: 3 = 201-300 m; 4 = 301-400 m; 5 = 401-600 m; 6 = 601-800 m; and 7 = 801-1,000 m.

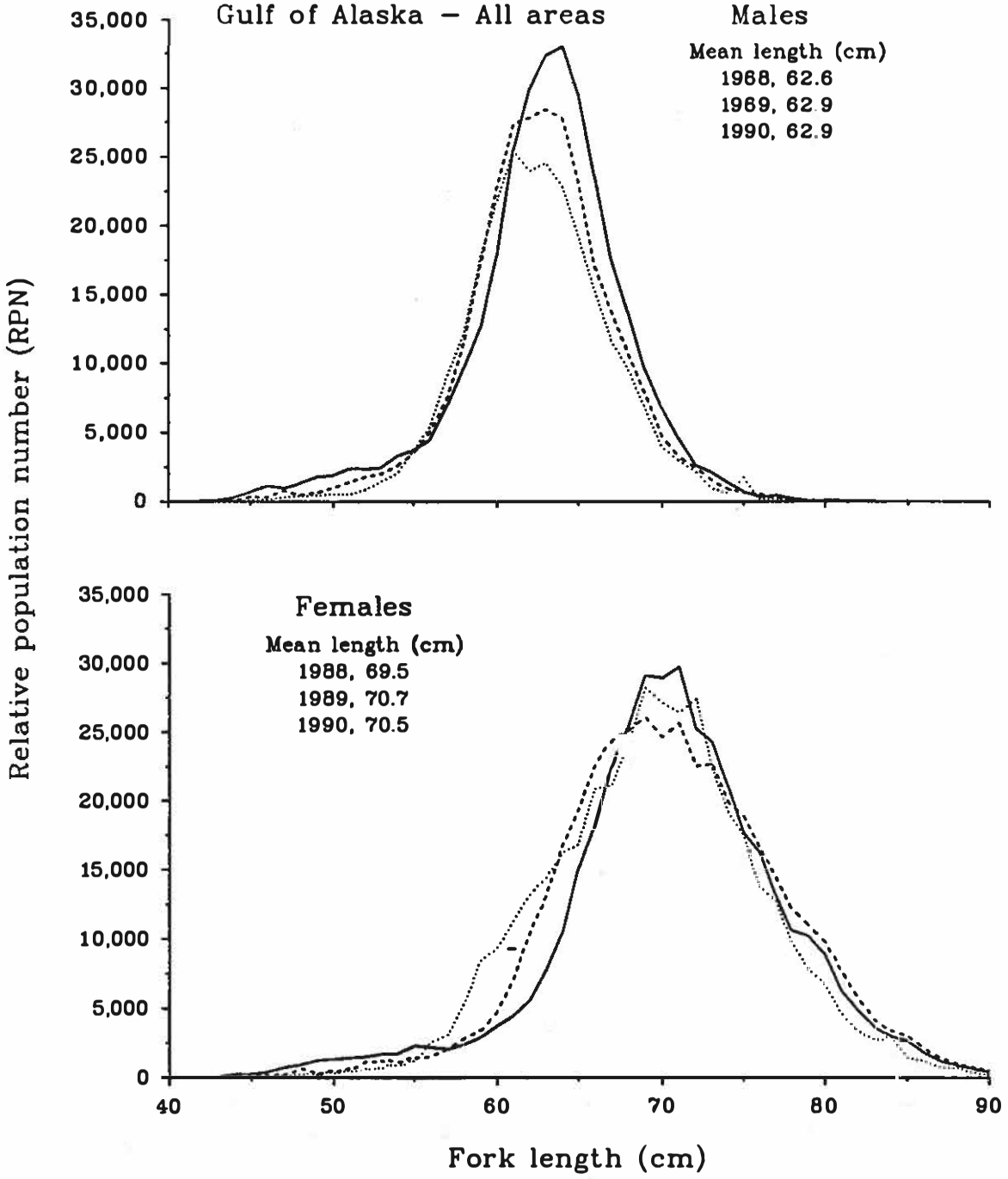

Figure 3a.--Sablefish length frequencies weighted by relative population number, by sex, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990(___). Note: In 1988, sample included the upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W-grounds, Yakutat Valley, Alsek Strath, Ommaney Trench, Iphigenia Gully, and Dixon Entrance.

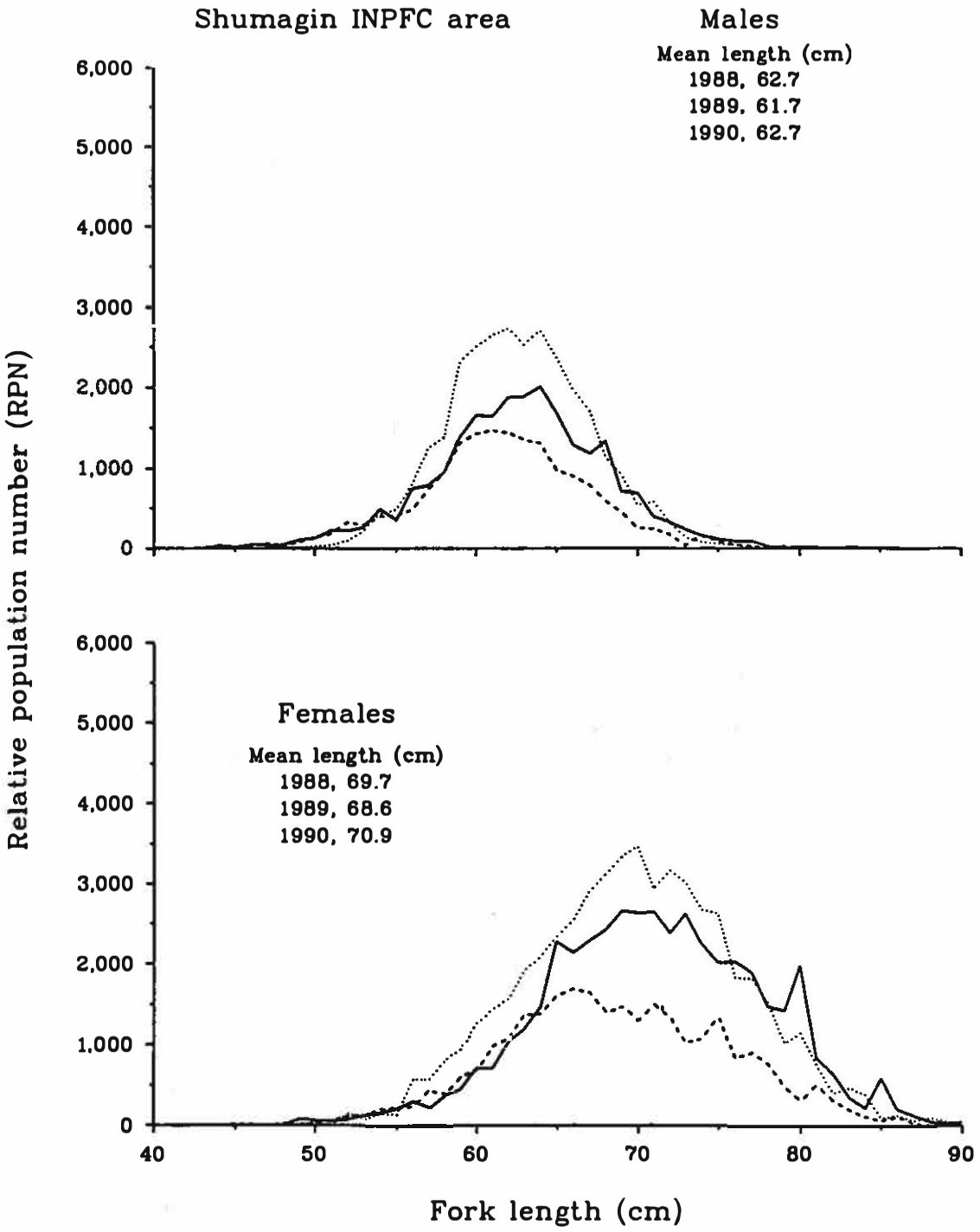

Figure 3b.--Sablefish length frequencies weighted by relative population number, by sex, for the International North Pacific Fisheries Commission Shumagin statistical area, upper continental slope, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

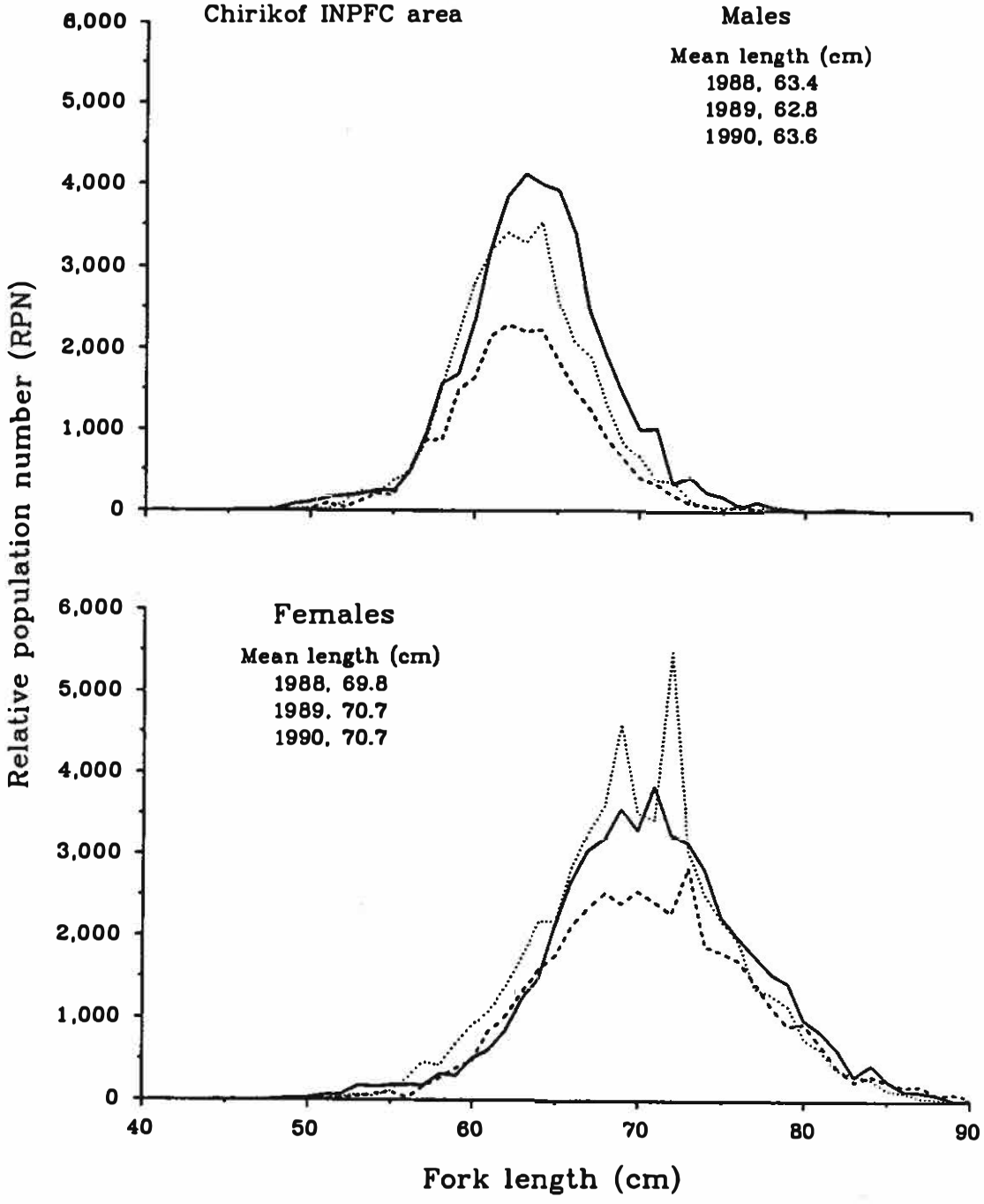

Figure 3c.--Sablefish length frequencies weighted by relative population number, by sex, for the International North Pacific Fisheries Commission Chirikof statistical area, upper continental slope, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (___).

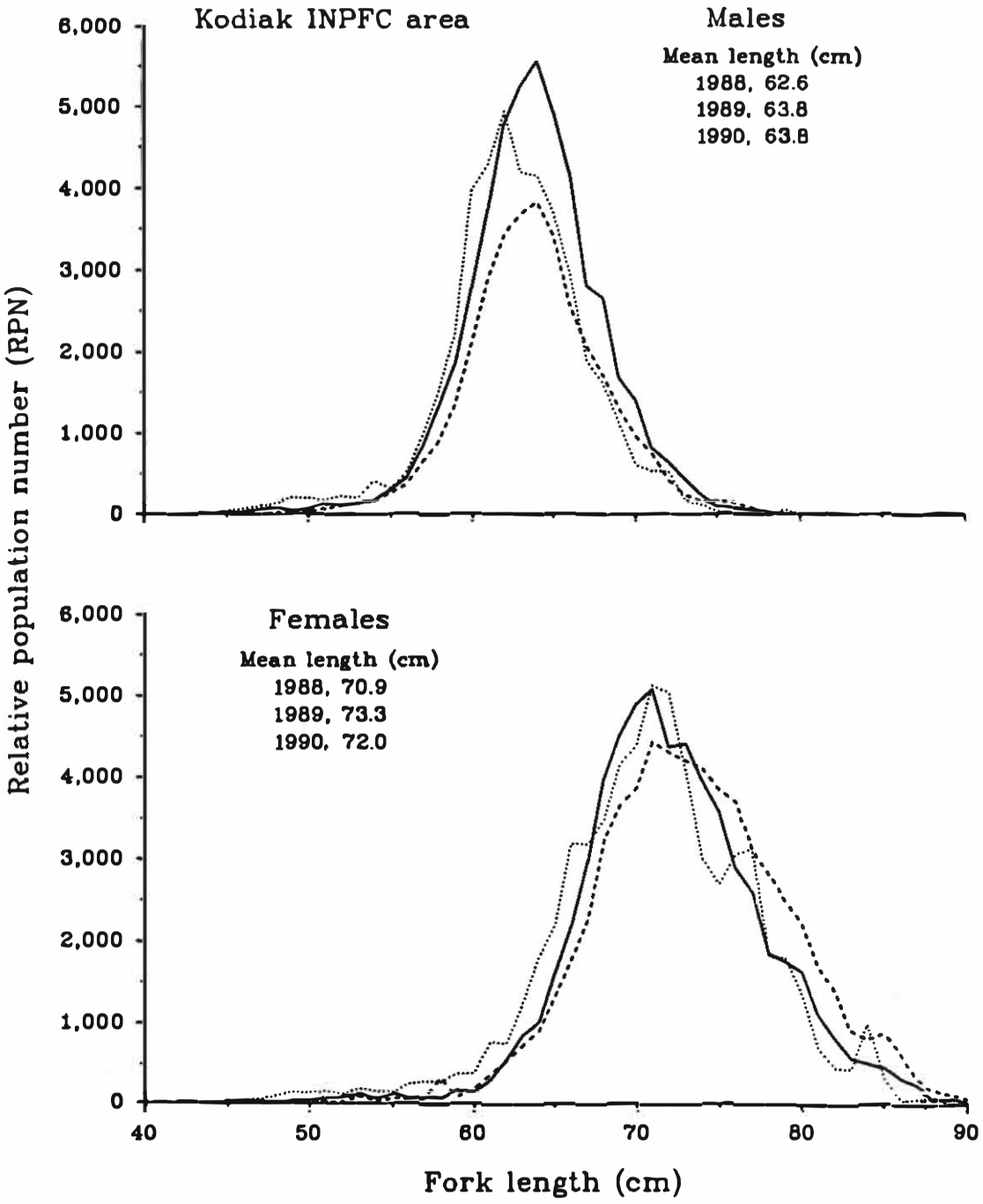

Figure 3d.--Sablefish length frequencies weighted by relative population number, by sex, for the International North Pacific Fisheries Commission Kodiak statistical area, upper continental slope, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

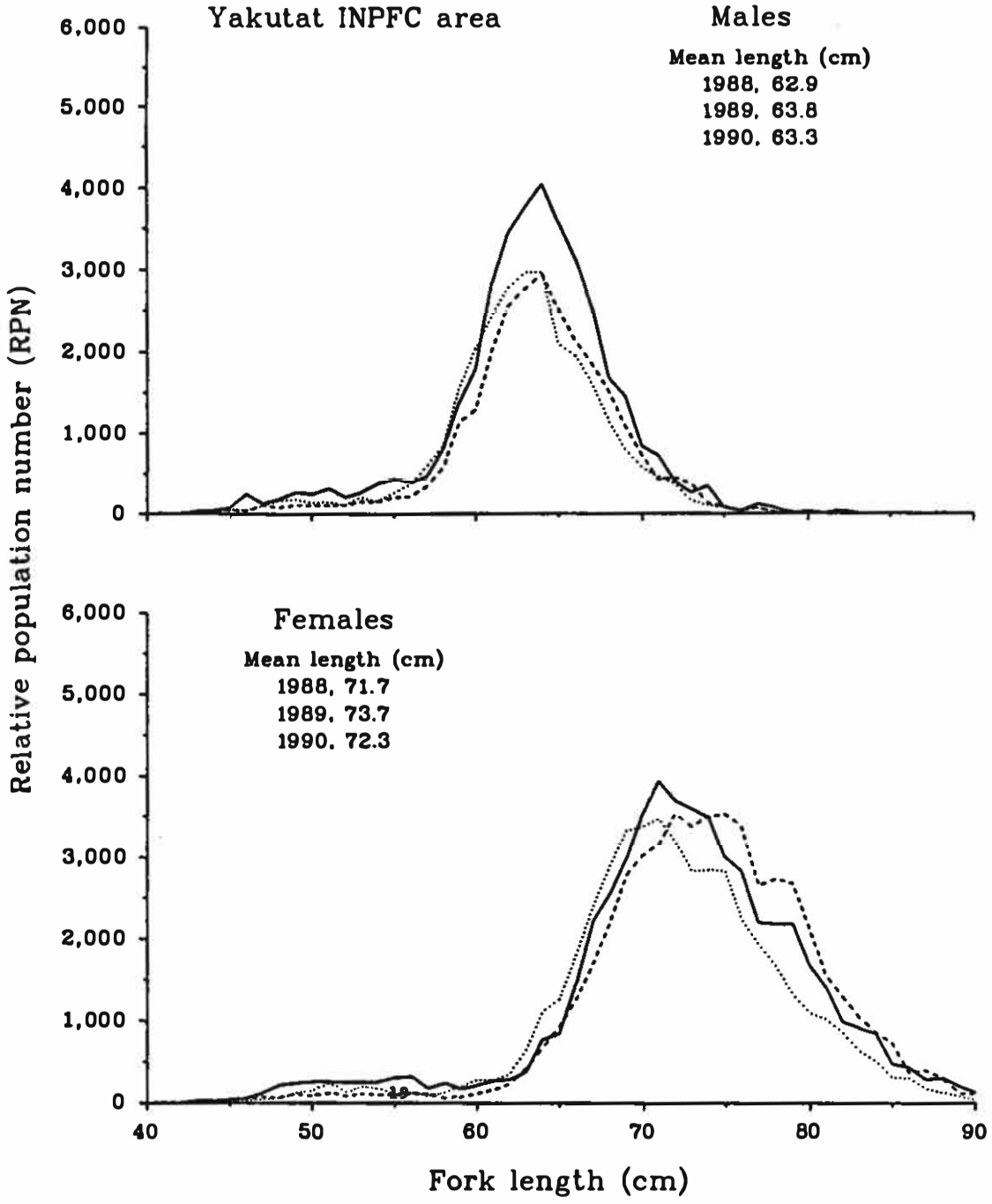

Figure 3e.--Sablefish length frequencies weighted by relative population number, by sex, for the International North Pacific Fisheries Commission Yakutat statistical area, upper continental slope, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

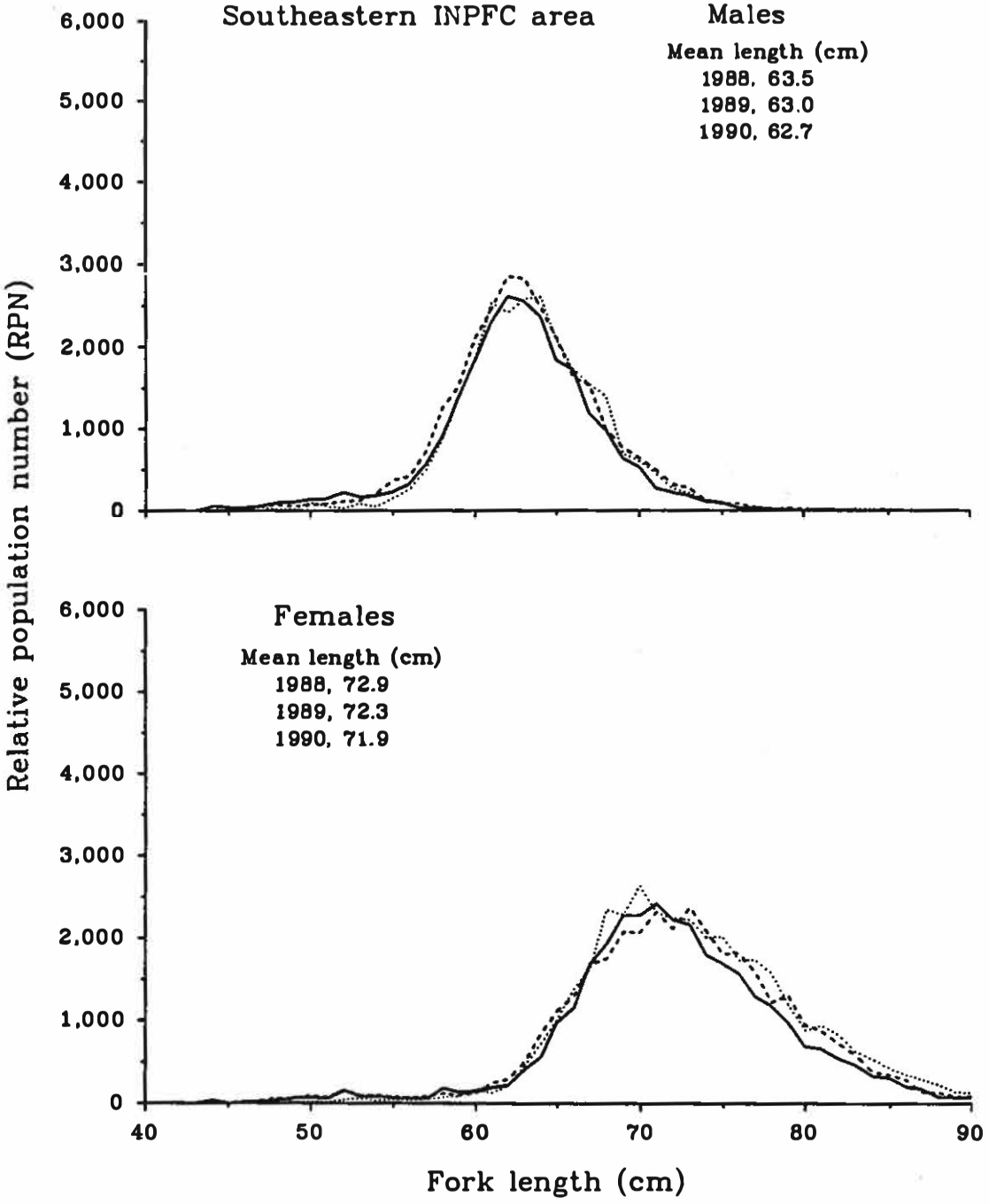

Figure 3f.--Sablefish length frequencies weighted by relative population number, by sex, for the International North Pacific Fisheries Commission Southeastern statistical area, upper continental slope, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (__).

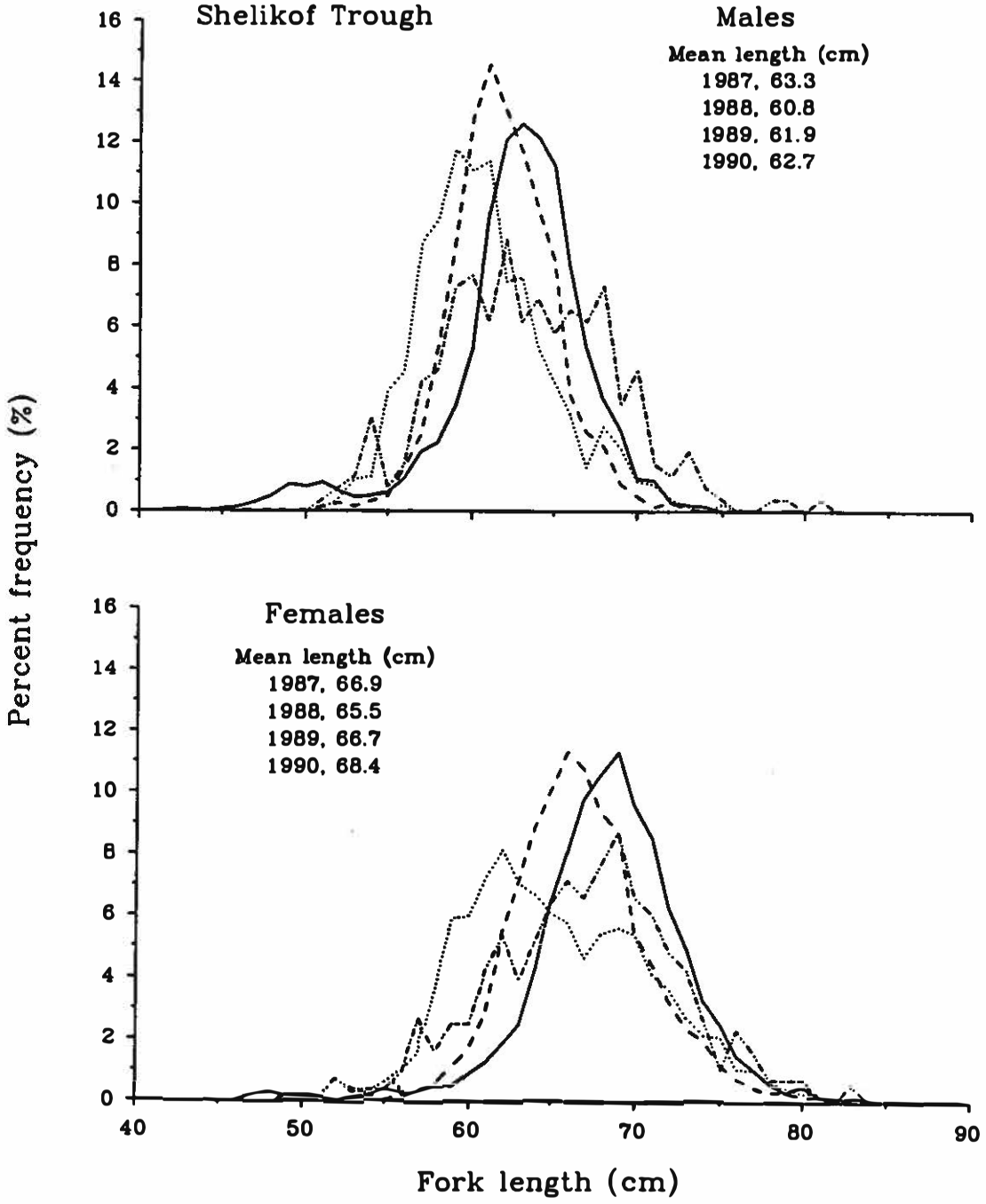

Figure 3g.--Sablefish percent length frequencies, by sex, for Shelikof Trough, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1987 (—··), 1988 (.....), 1989 (––), and 1990 (——).

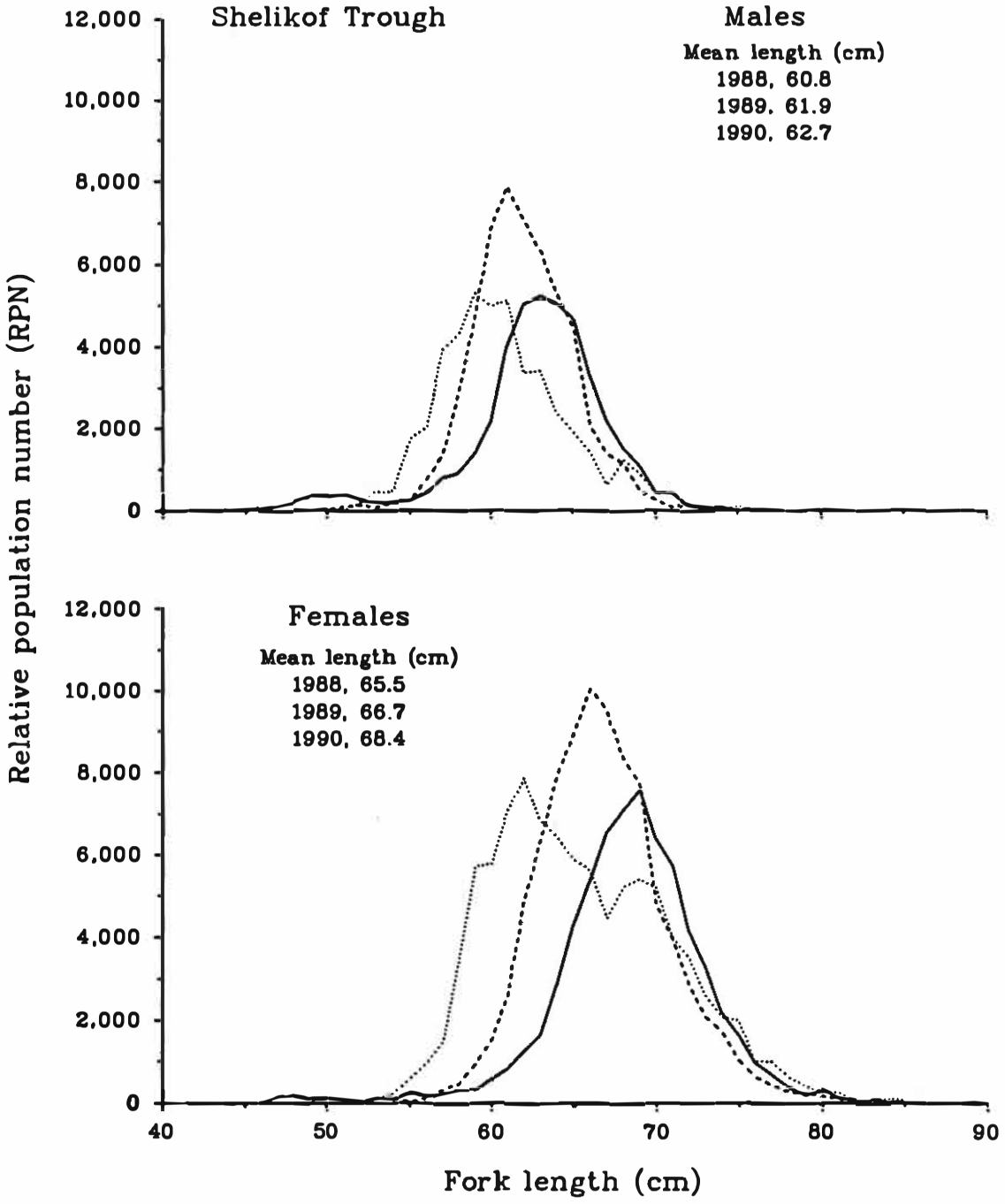

Figure 3h.--Sablefish length frequencies weighted by relative population number, by sex, for Shelikof Trough, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (___).

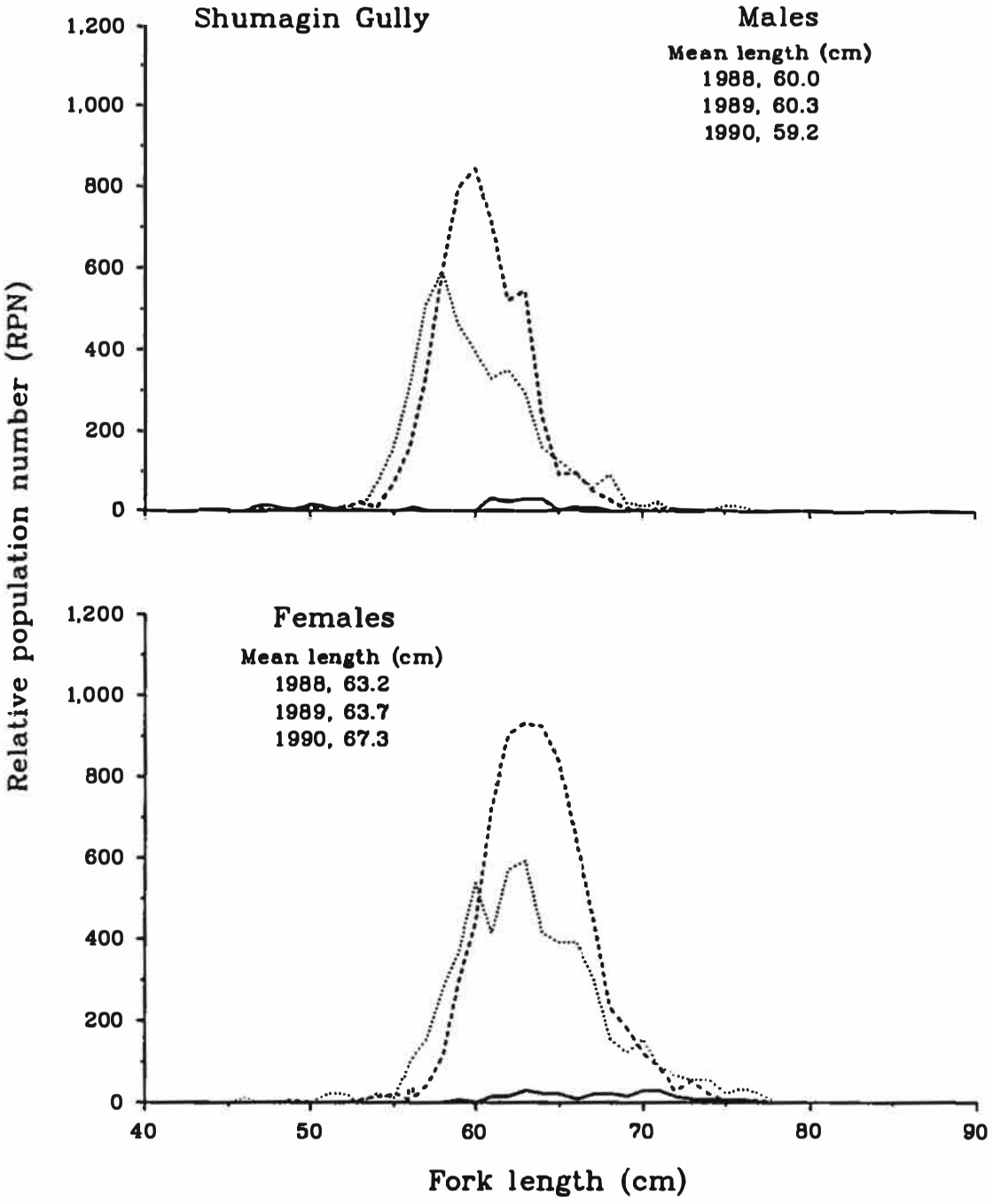

Figure 3i.--Sablefish length frequencies weighted by relative population number, by sex, for Shumagin Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

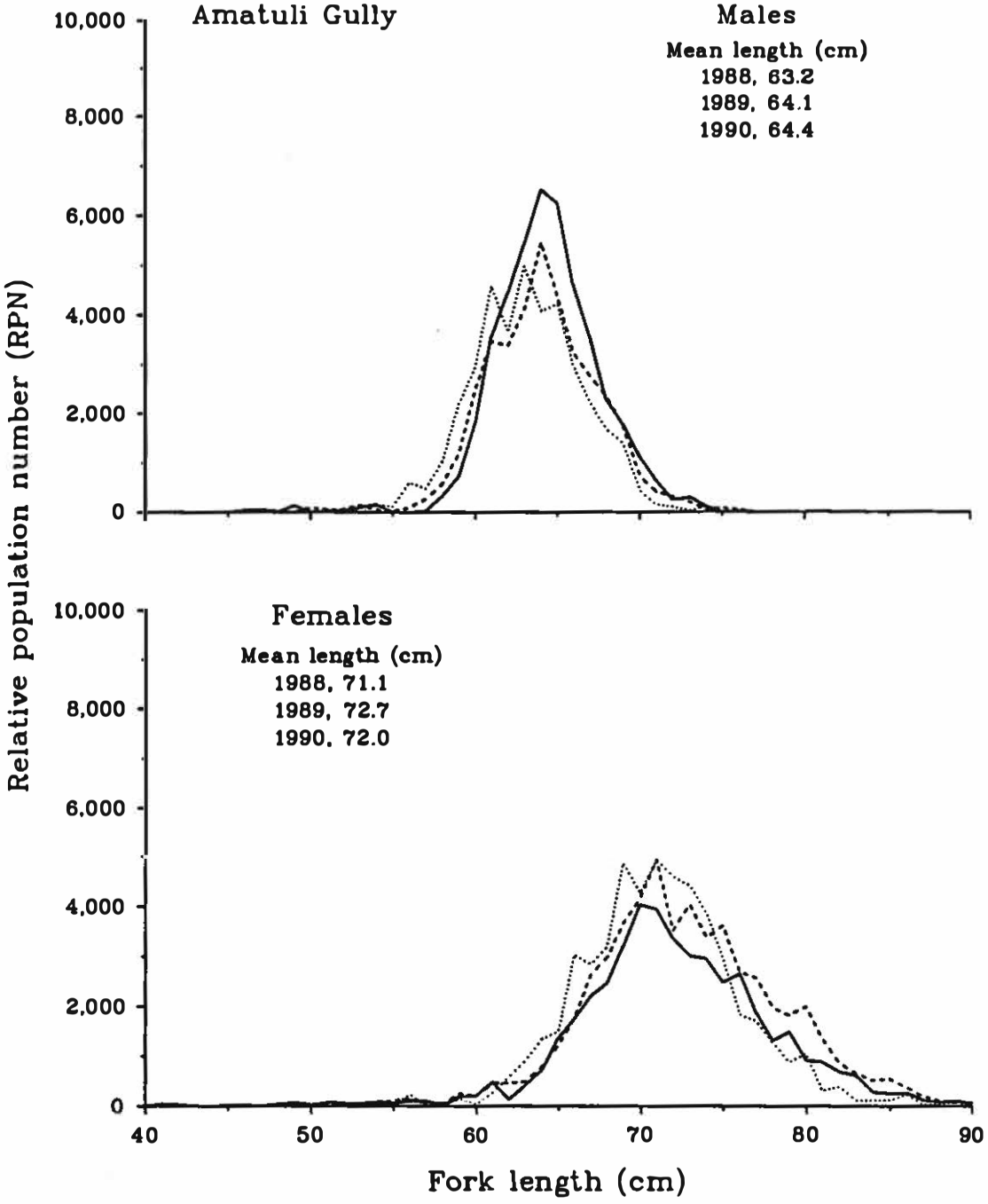

Figure 3j.--Sablefish length frequencies weighted by relative population number, by sex, for Amatuli Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

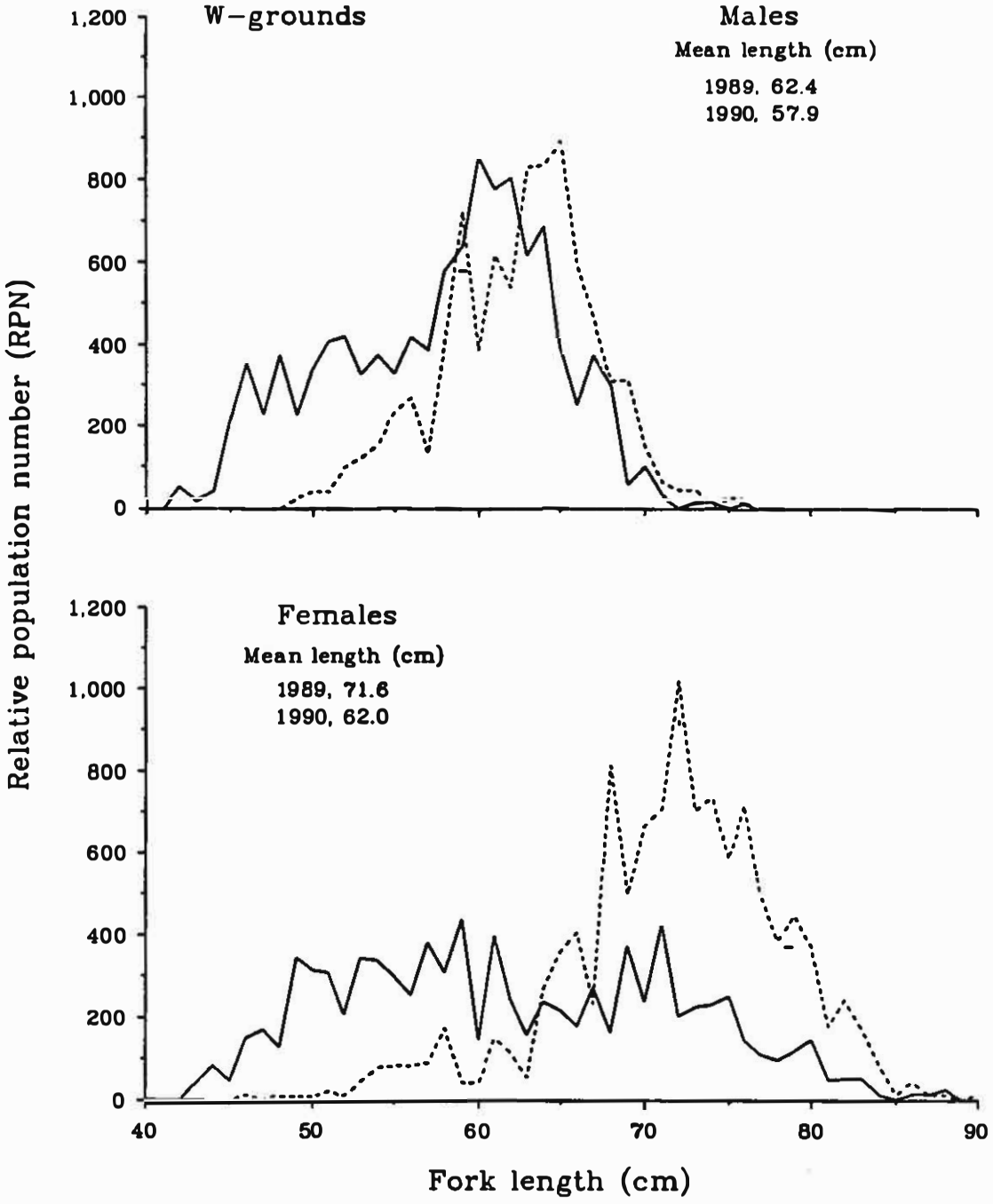

Figure 3k.--Sablefish length frequencies weighted by relative population number, by sex, for the W–grounds, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (—).

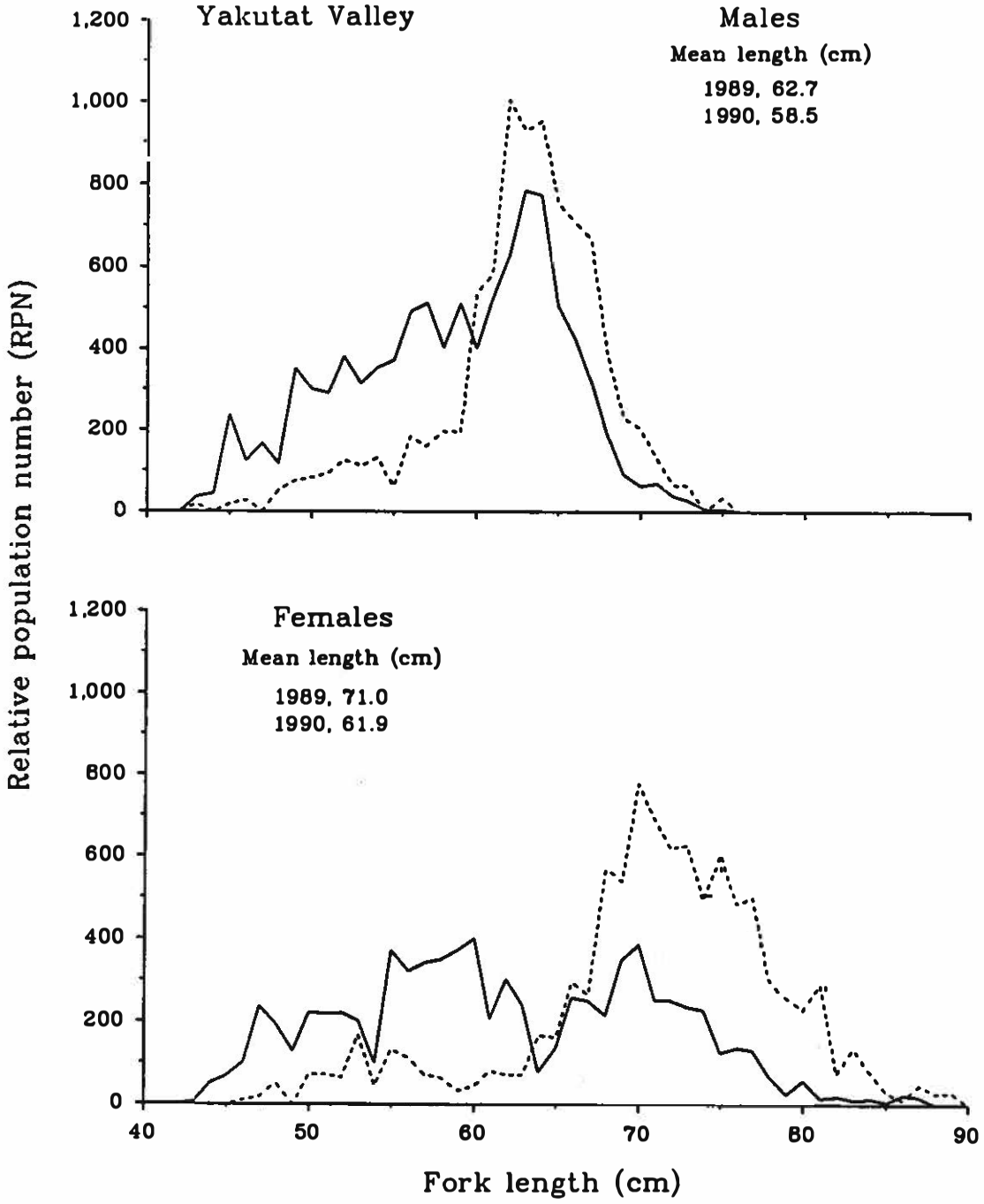

Figure 3 1.--Sablefish length frequencies weighted by relative population number, by sex, for Yakutat Valley, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (__).

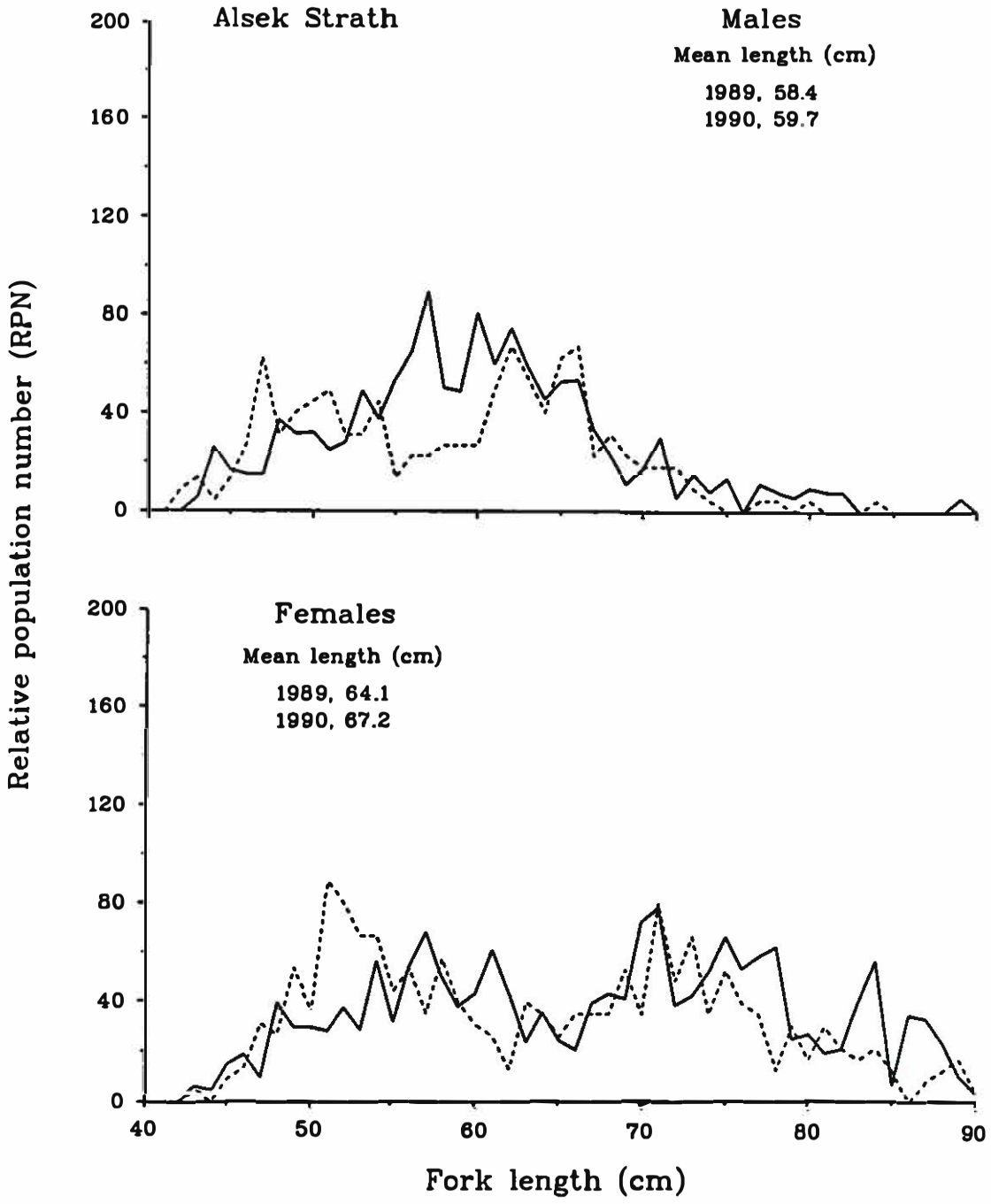

Figure 3m.--Sablefish length frequencies weighted by relative population number, by sex, for Alsek Strath, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (—).

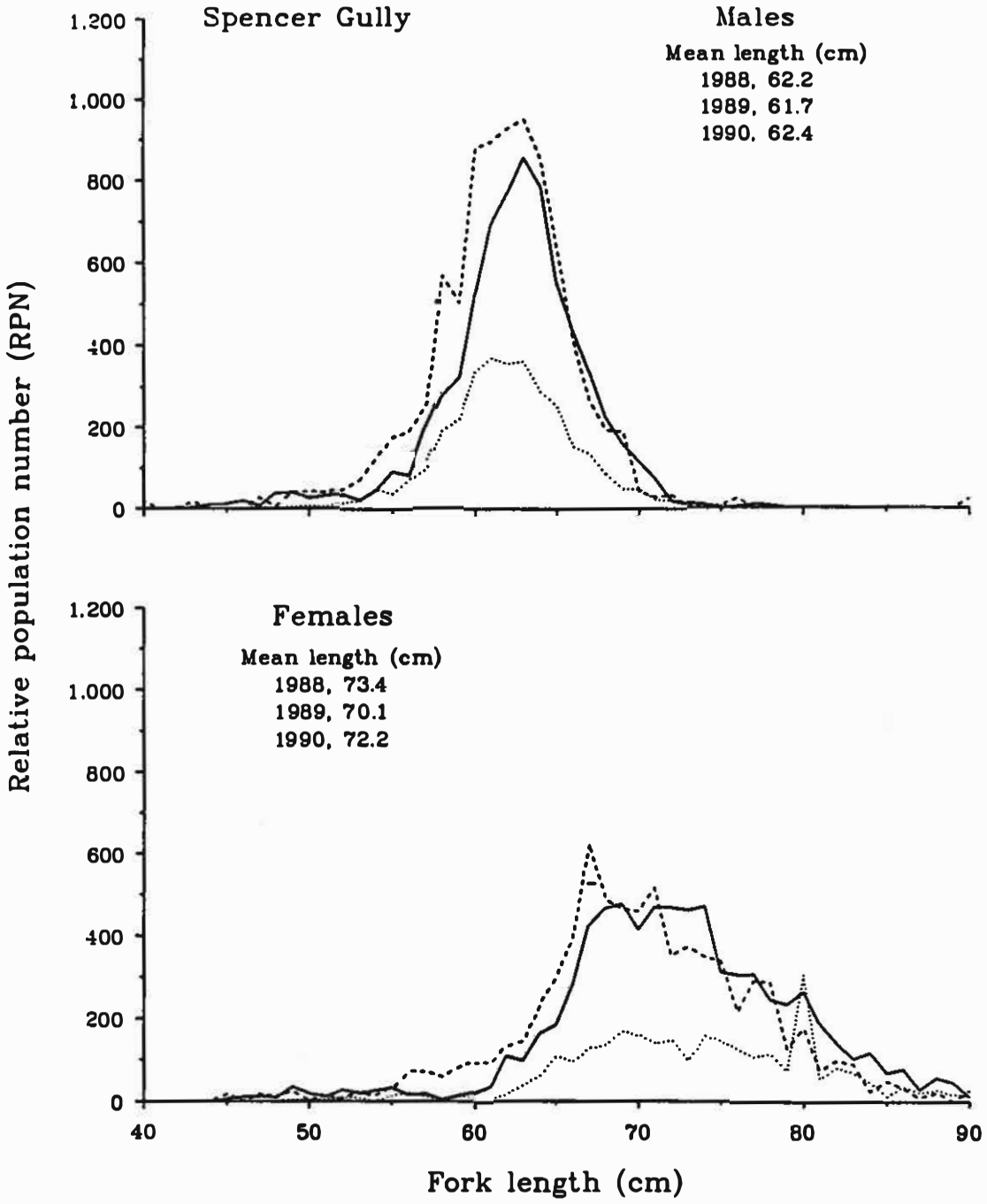

Figure 3n.--Sablefish length frequencies weighted by relative population number, by sex, for Spencer Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (—).

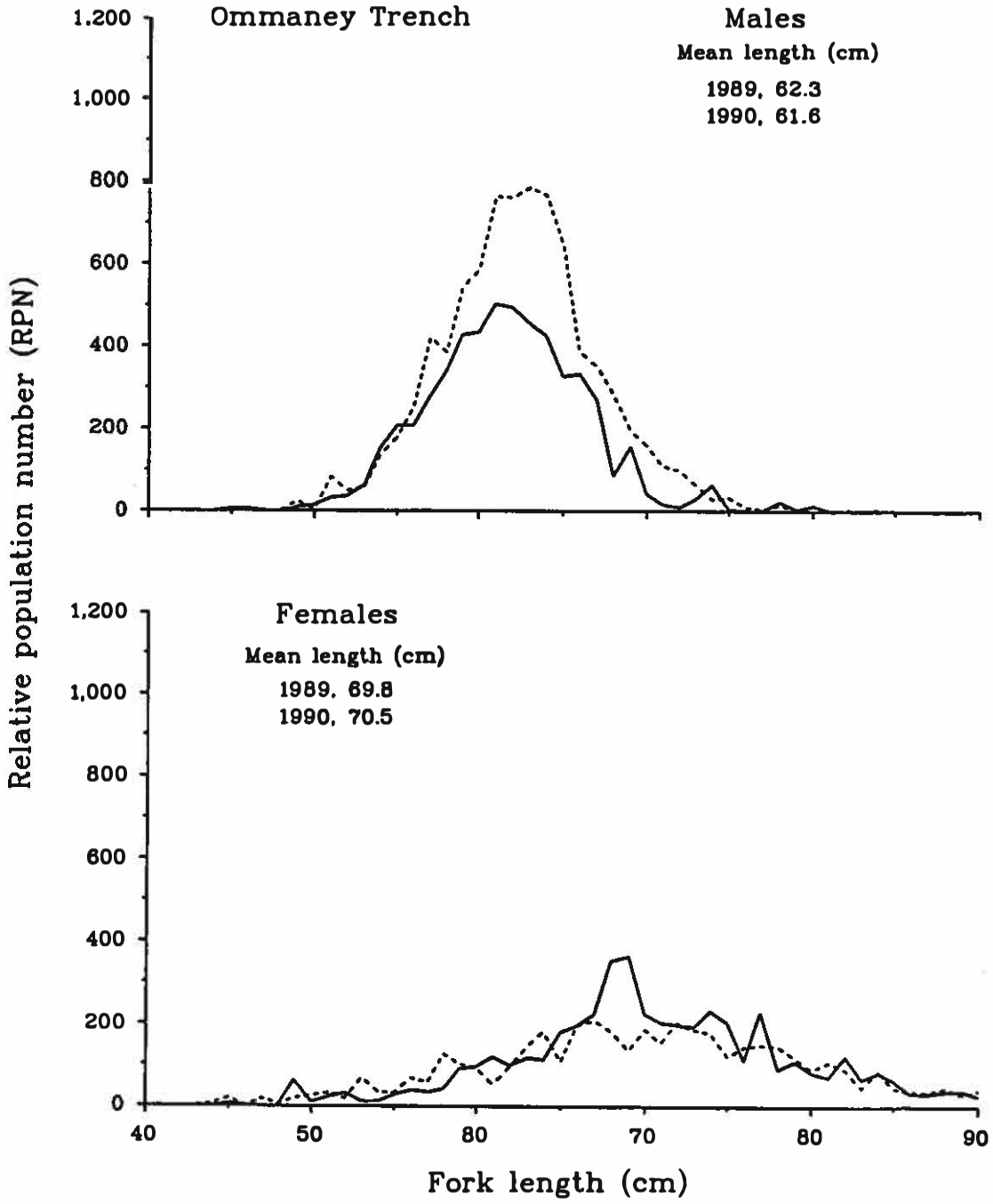

Figure 30.--Sablefish length frequencies weighted by relative population number, by sex, for Ommaney Trench, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (—).

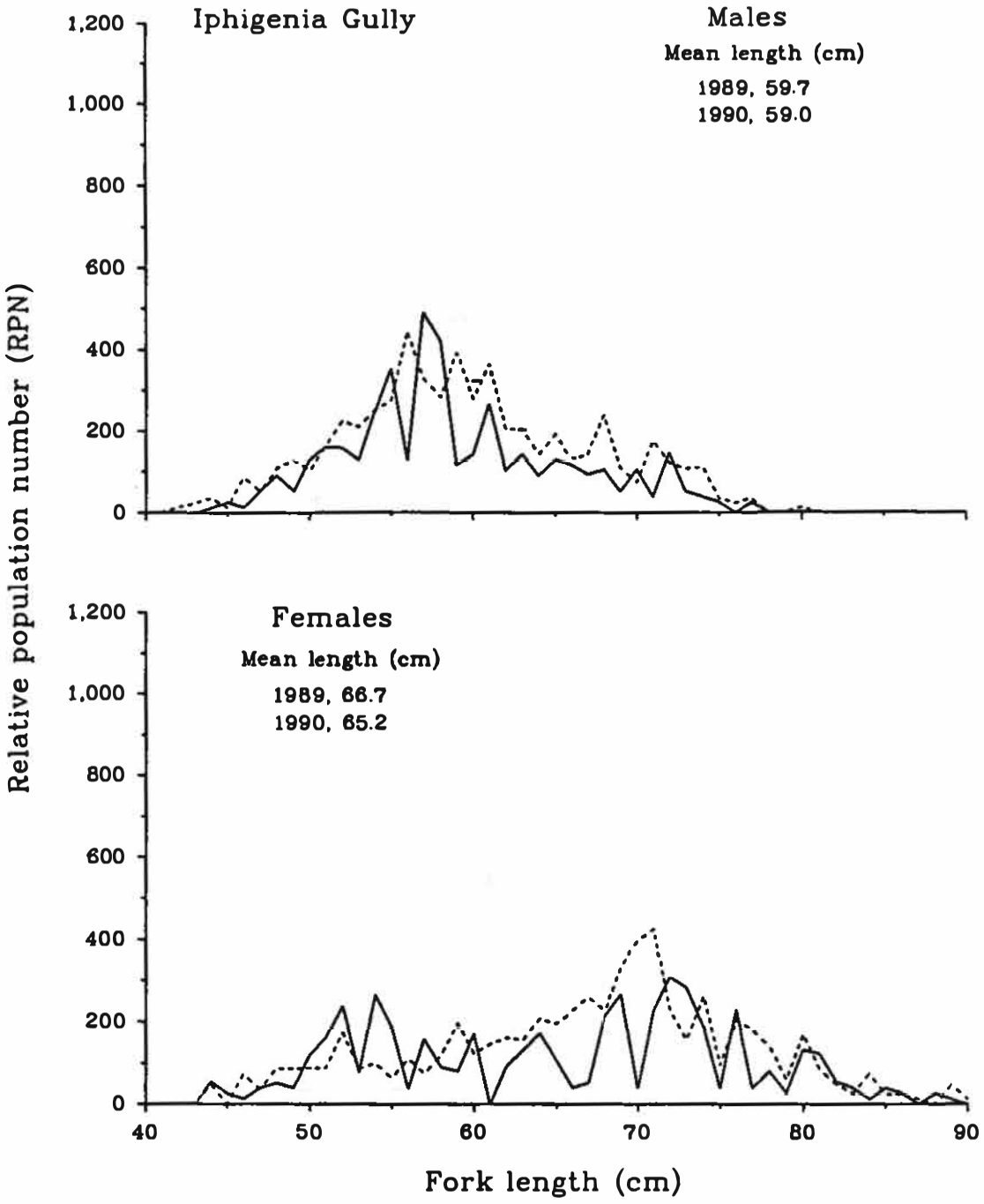

Figure 3p.--Sablefish length frequencies weighted by relative population number, by sex, for Iphigenia Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (—).

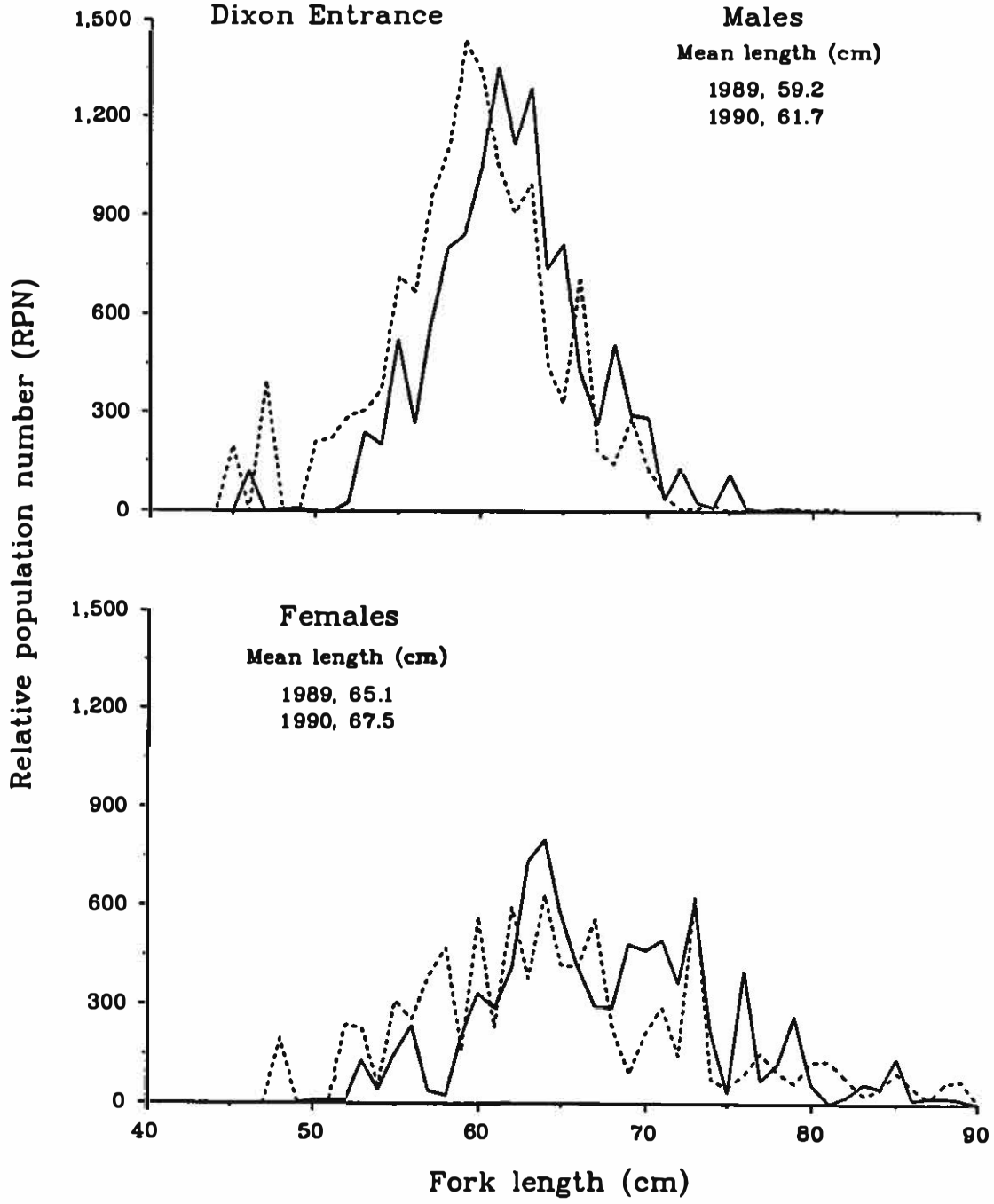

Figure 3q.--Sablefish length frequencies weighted by relative population number, by sex, for Dixon Entrance, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and. 1990 (—).

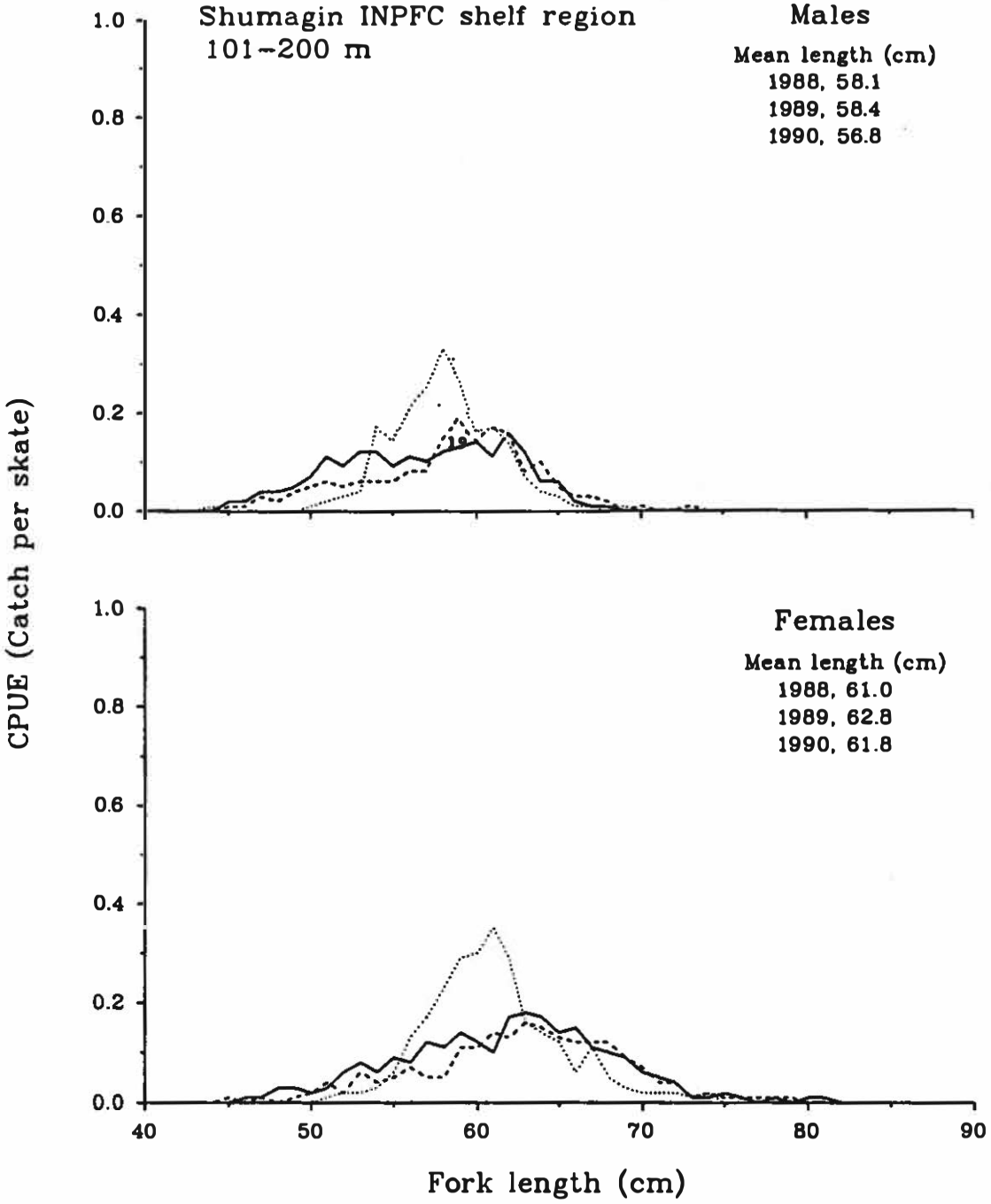

Figure 4a.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in the International North Pacific Fisheries Commission Shumagin statistical area, sampled along the outer continental shelf during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

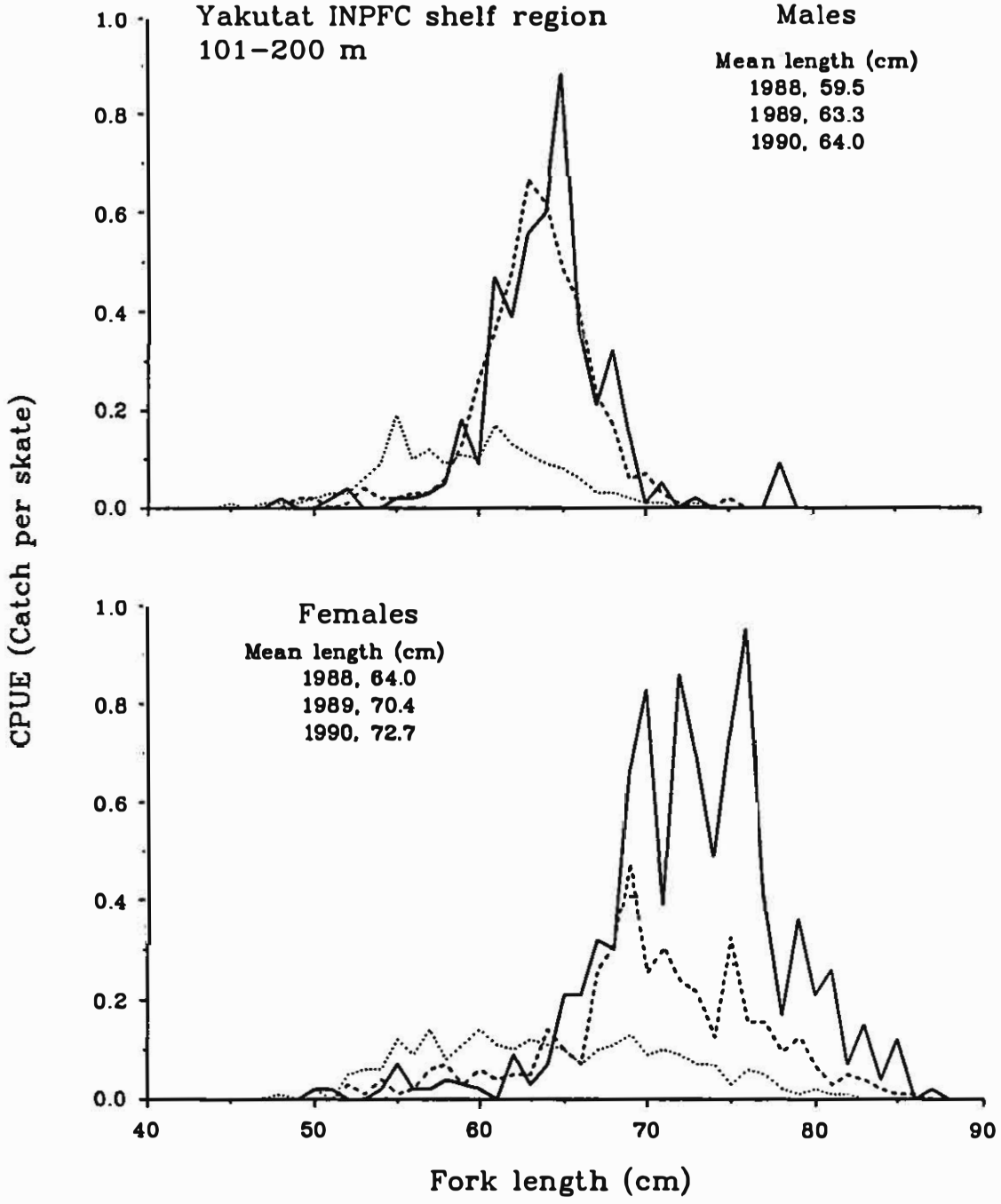

Figure 4b.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in the International North Pacific Fisheries Commission Yakutat statistical area, sampled along the outer continental shelf during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (___).

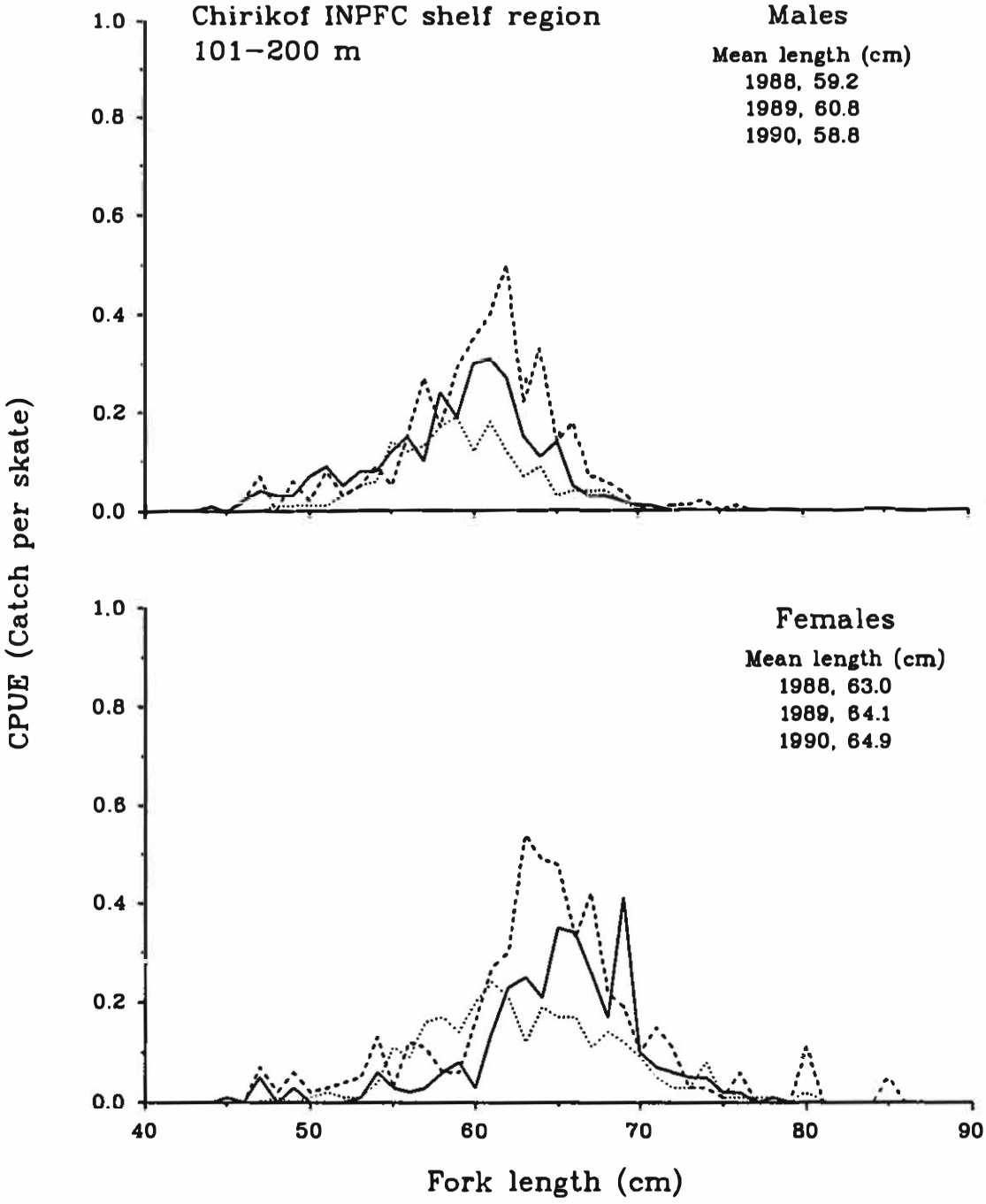

Figure 4c.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in the International North Pacific Fisheries Commission Chirikof statistical area, sampled along the outer continental shelf during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

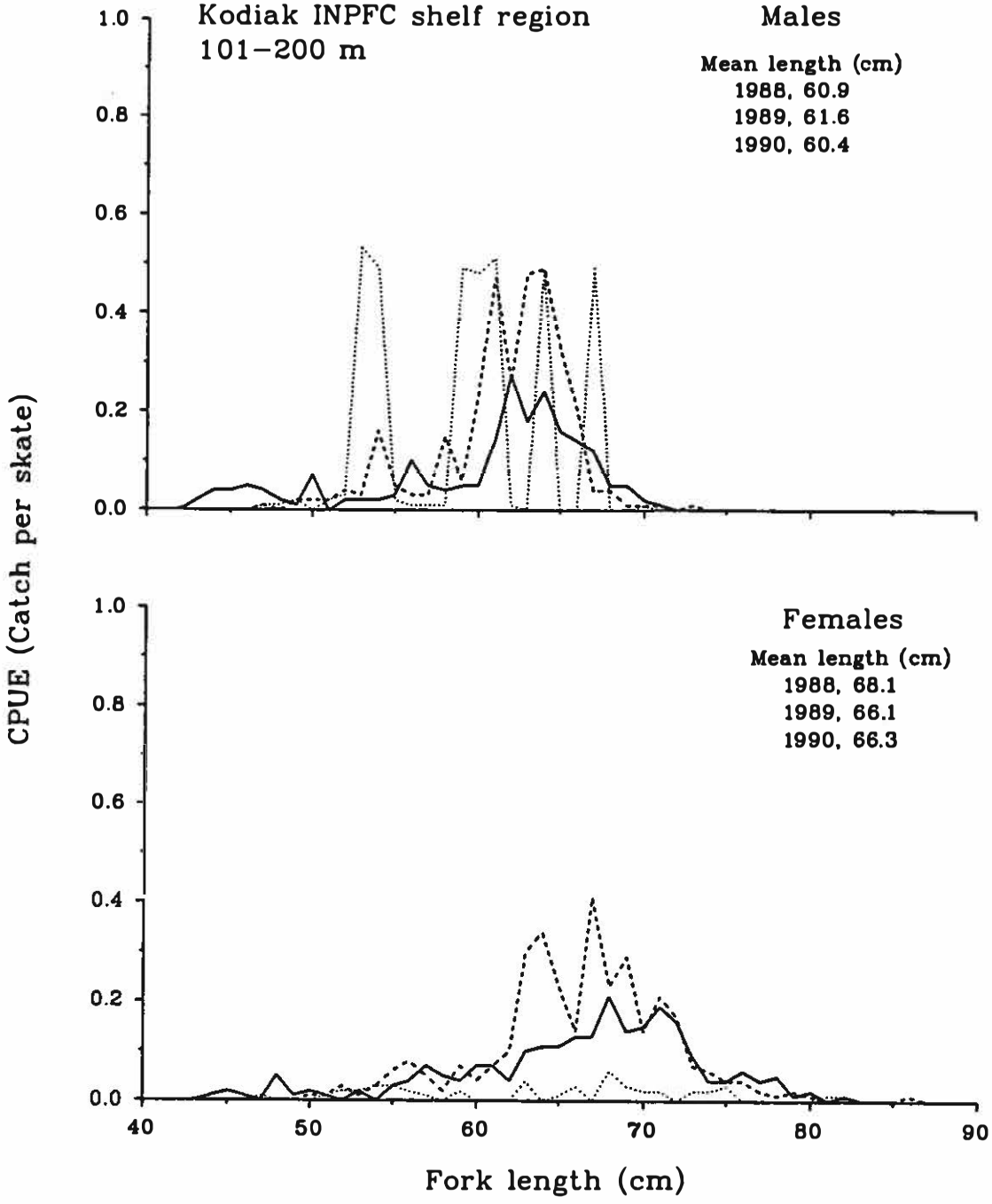

Figure 4d.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in the International North Pacific Fisheries Commission Kodiak statistical area, sampled along the outer continental shelf during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

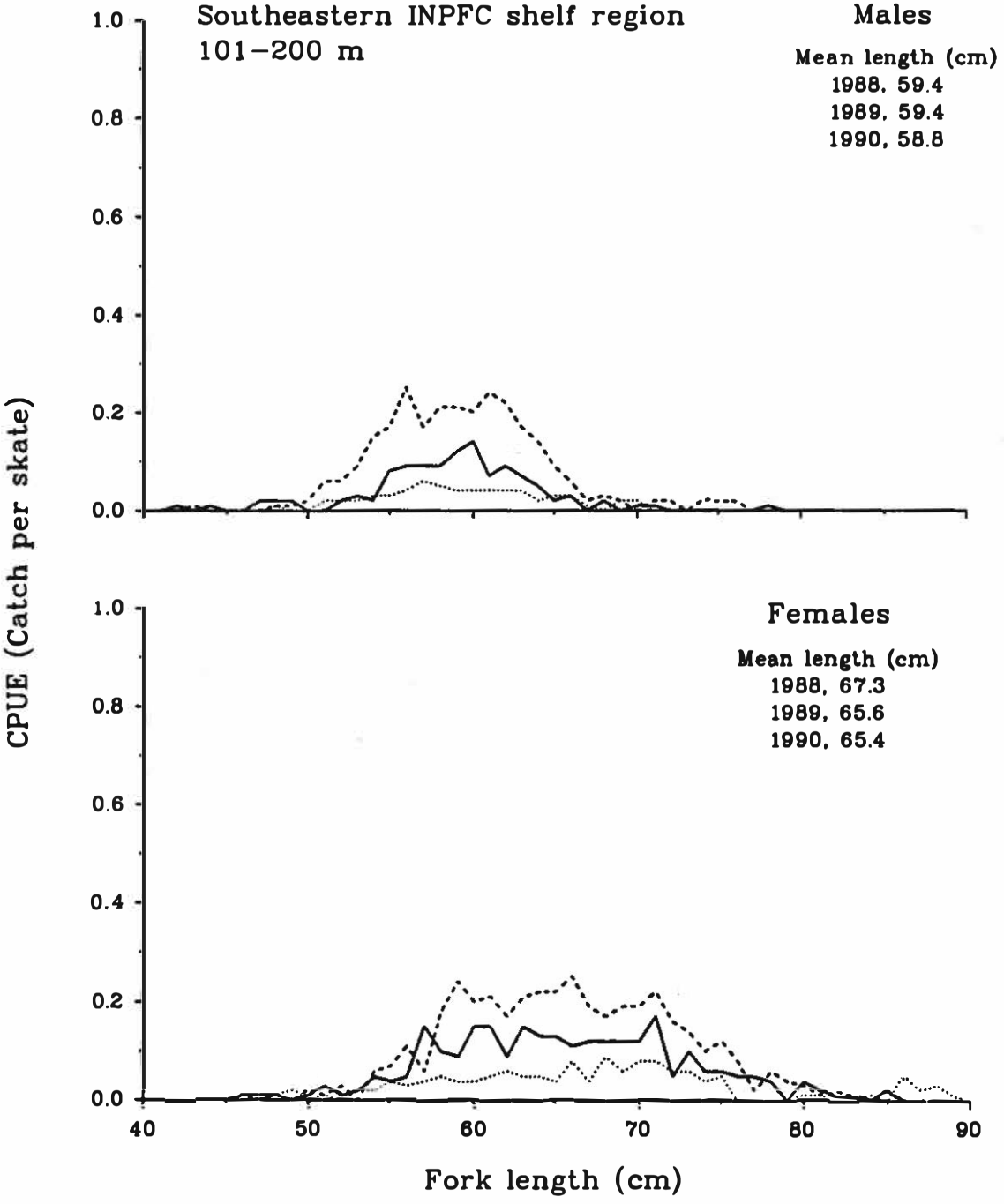

Figure 4e.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in the International North Pacific Fisheries Commission Southeastern statistical area, sampled along the outer continental shelf during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

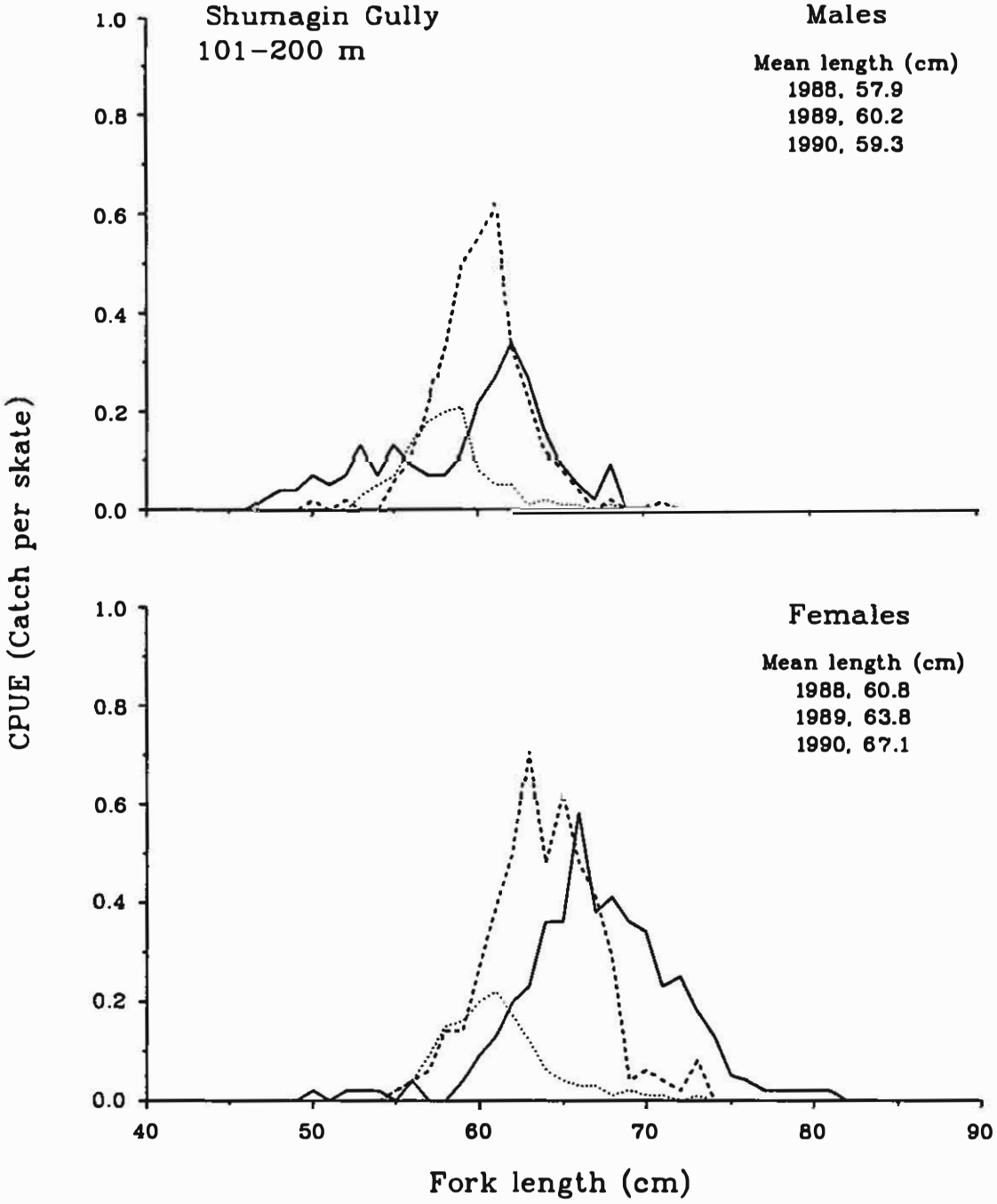

Figure 4f.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in Shumagin Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

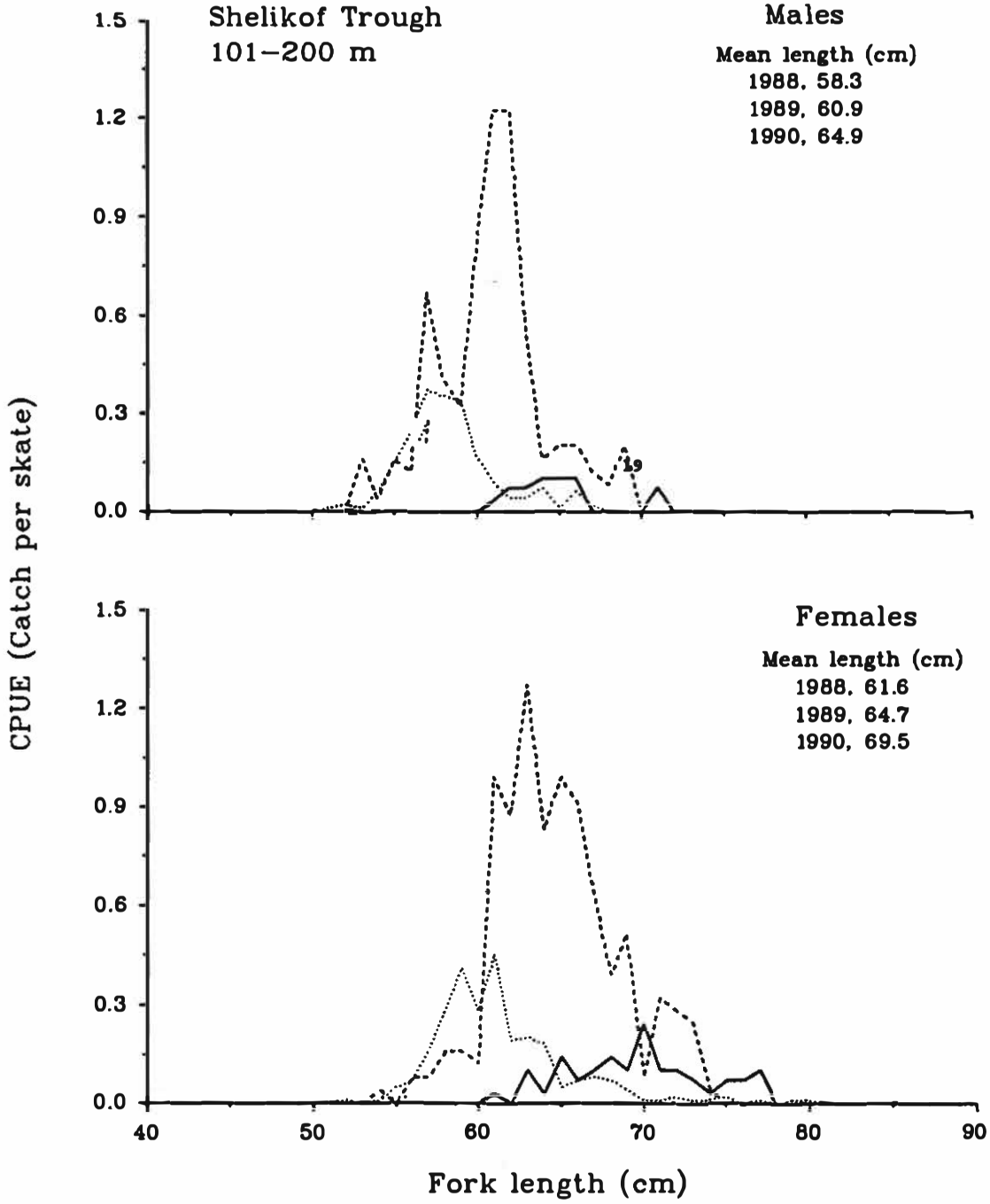

Figure 4g.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in Shelikof Trough, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

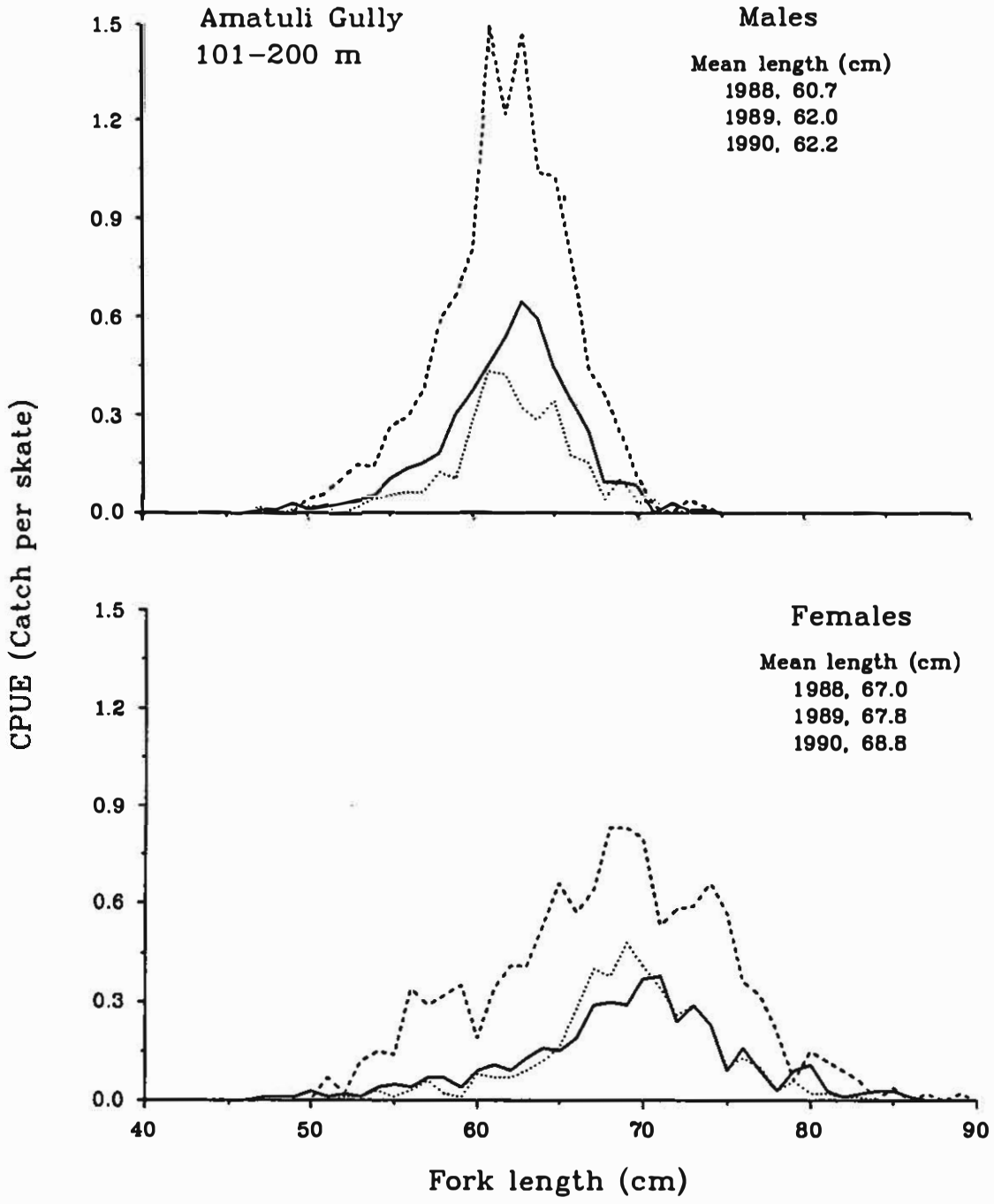

Figure 4h.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101–200 m in Amatuli Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

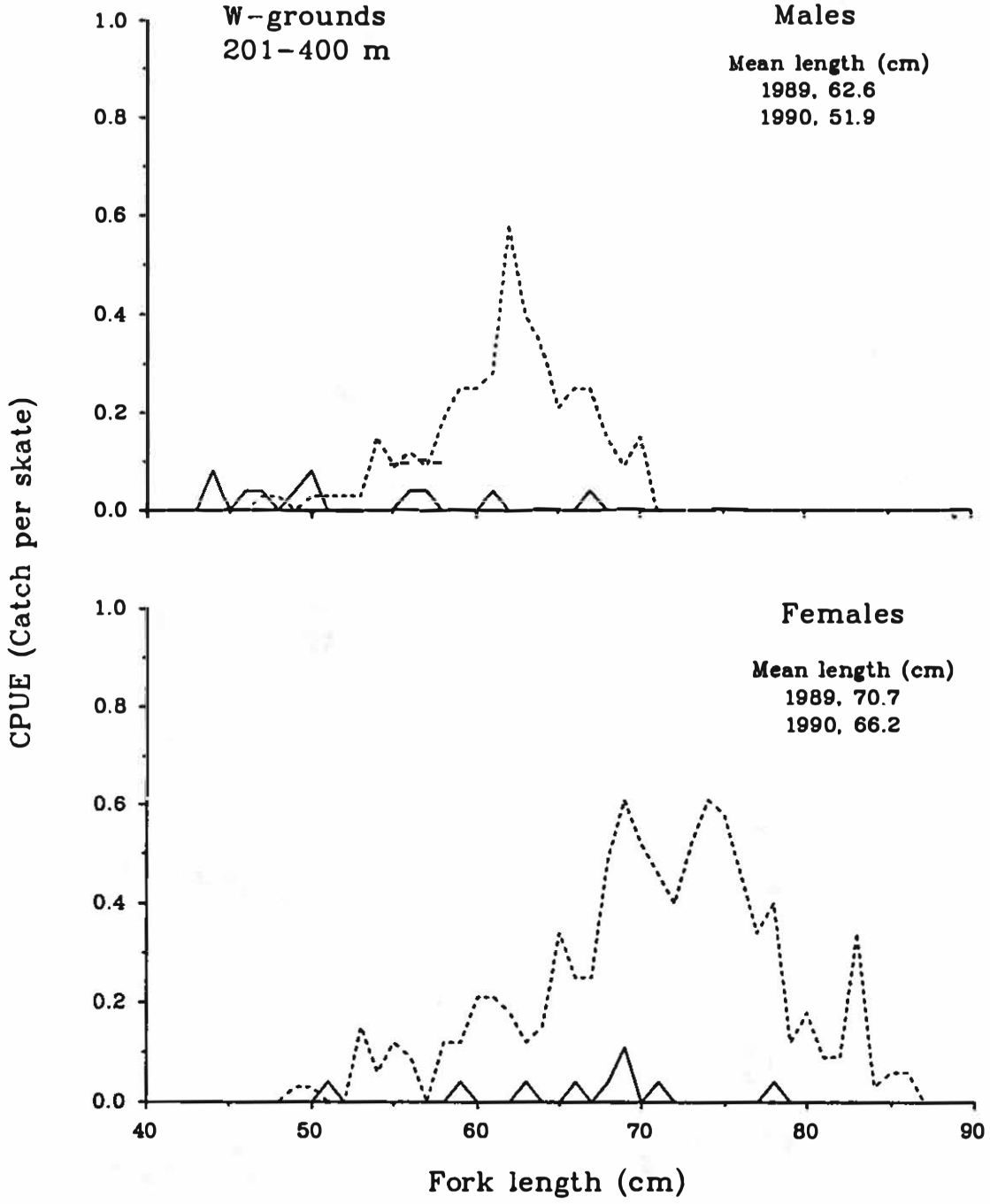

Figure 4i.--Sablefish length frequencies weighted by catch per unit effort (CPUE), by sex, for depths 101-200 m on the W-grounds, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (___)..

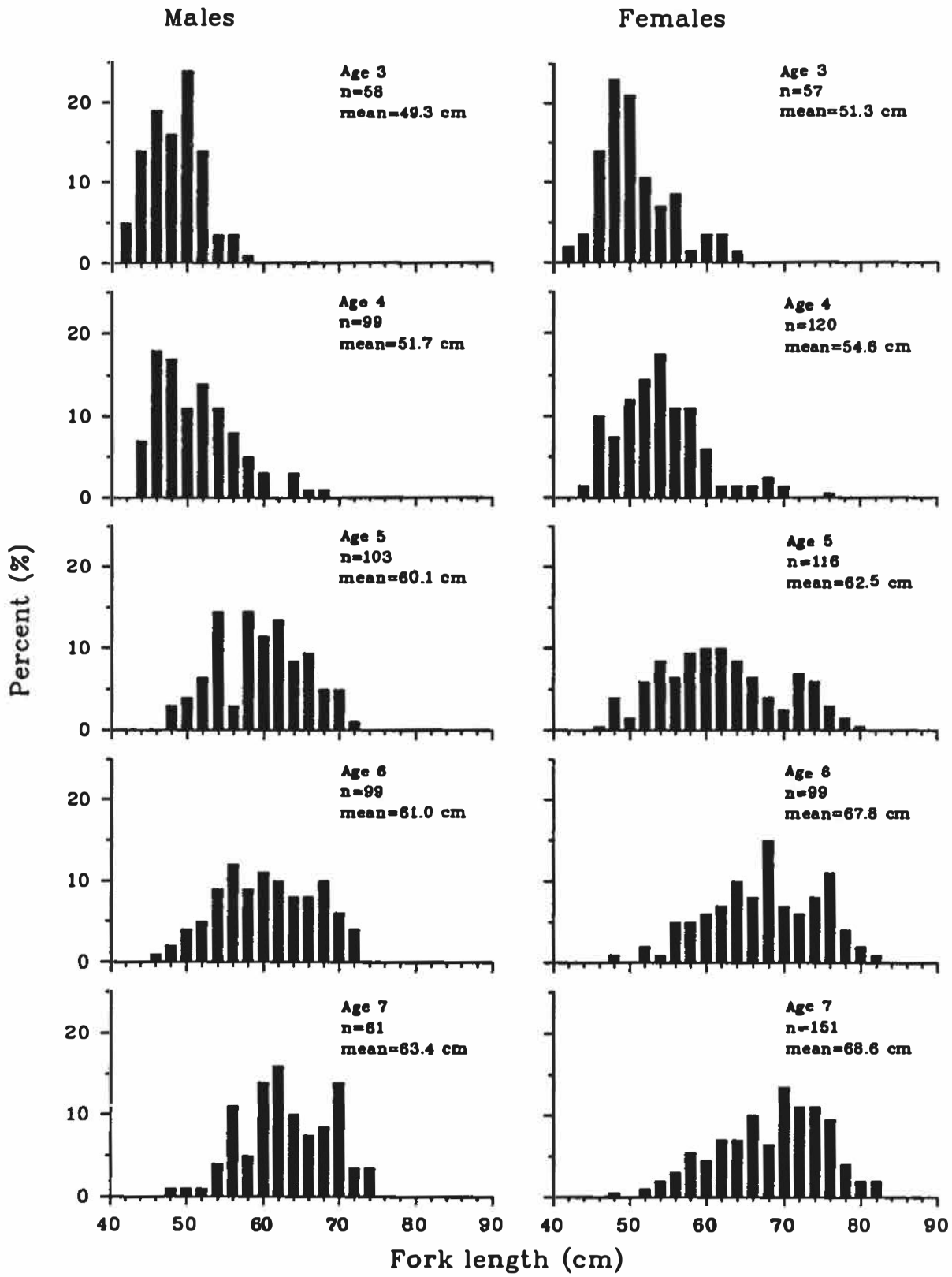

Figure 5.--Length-at-age distribution of sablefish for the upper continental slope of the Gulf of Alaska (201-1,000 m depth), based on samples collected during the 1984 Japan-U.S. cooperative longline survey. "n" refers to the number of fish aged. (Ages determined by the "break-and-burn" method, a technique that is being reevaluated. Thus changes in the above ages may result. From Clausen and Sigler 1989).

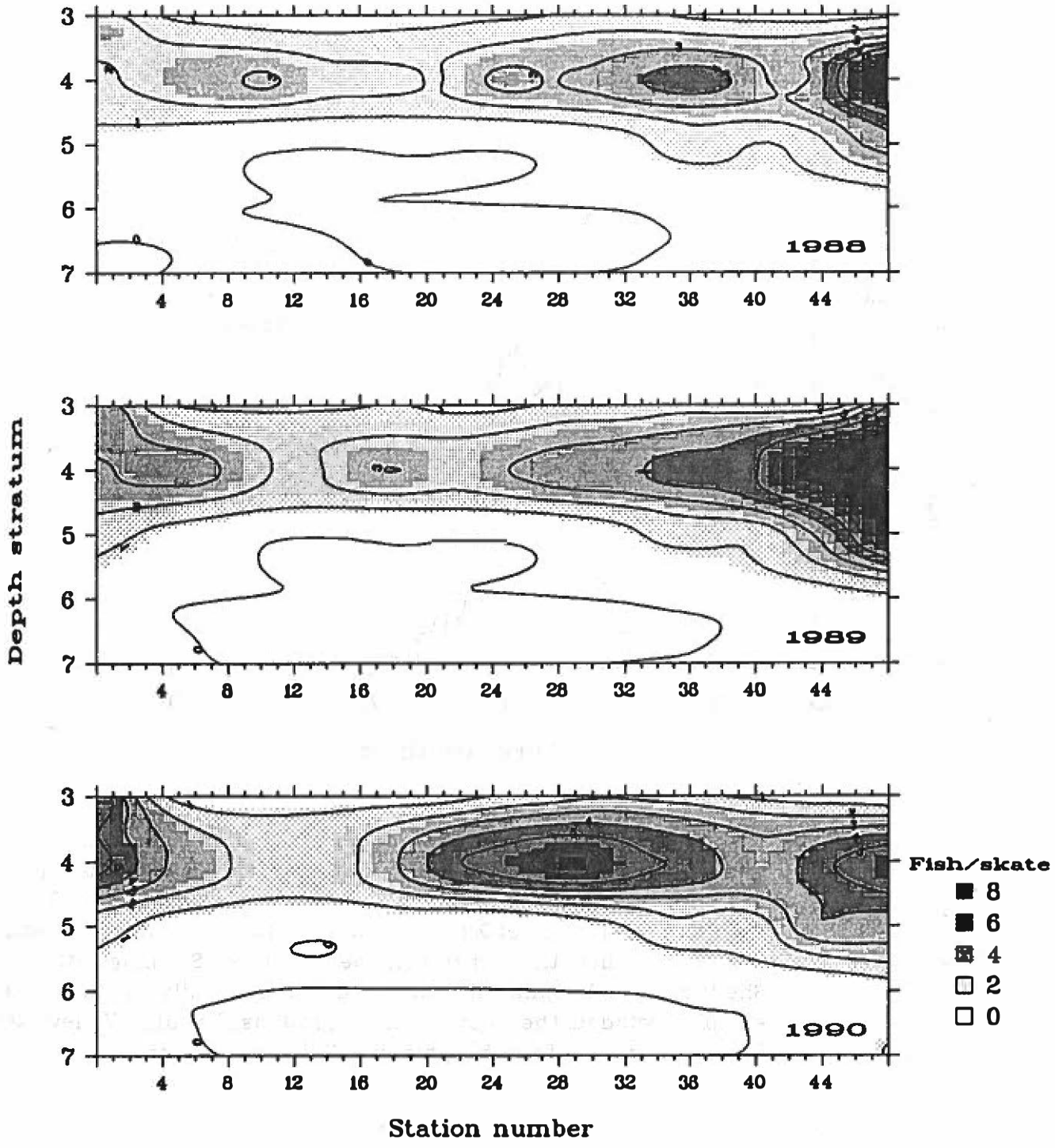

Figure 6.--Distribution of combined shortraker and rougheye rockfish catch per unit effort (fish/skate) from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90, smoothed by distance-weighted least squares with depth stratum and station number. Depth strata: 3 = 201-300 m; 4 = 301-400 m; 5 = 401-600 m; 6 = 601-800 m; and 7 = 801-1,000 m.

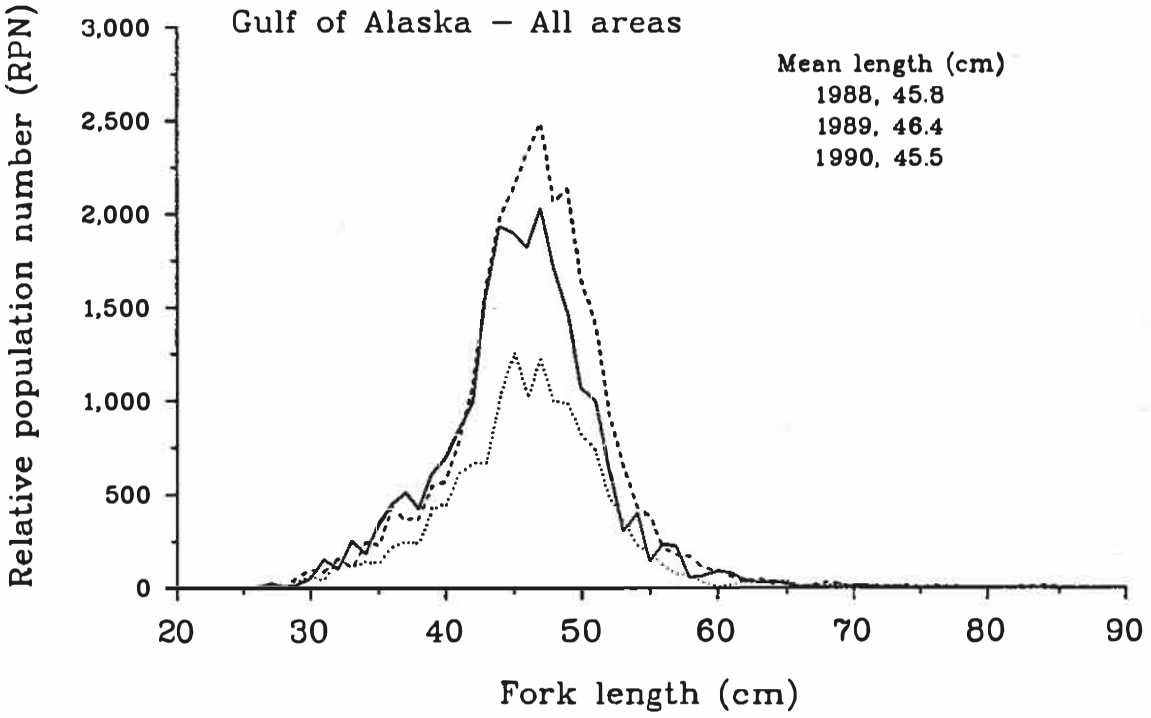

Figure 7a.--Rougheye rockfish length frequencies weighted by relative population number, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——). Note: In 1988, sample included the upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W–grounds, Yakutat Valley, Alsek Strath, Ommany Trench, Iphigenia Gully, and Dixon Entrance.

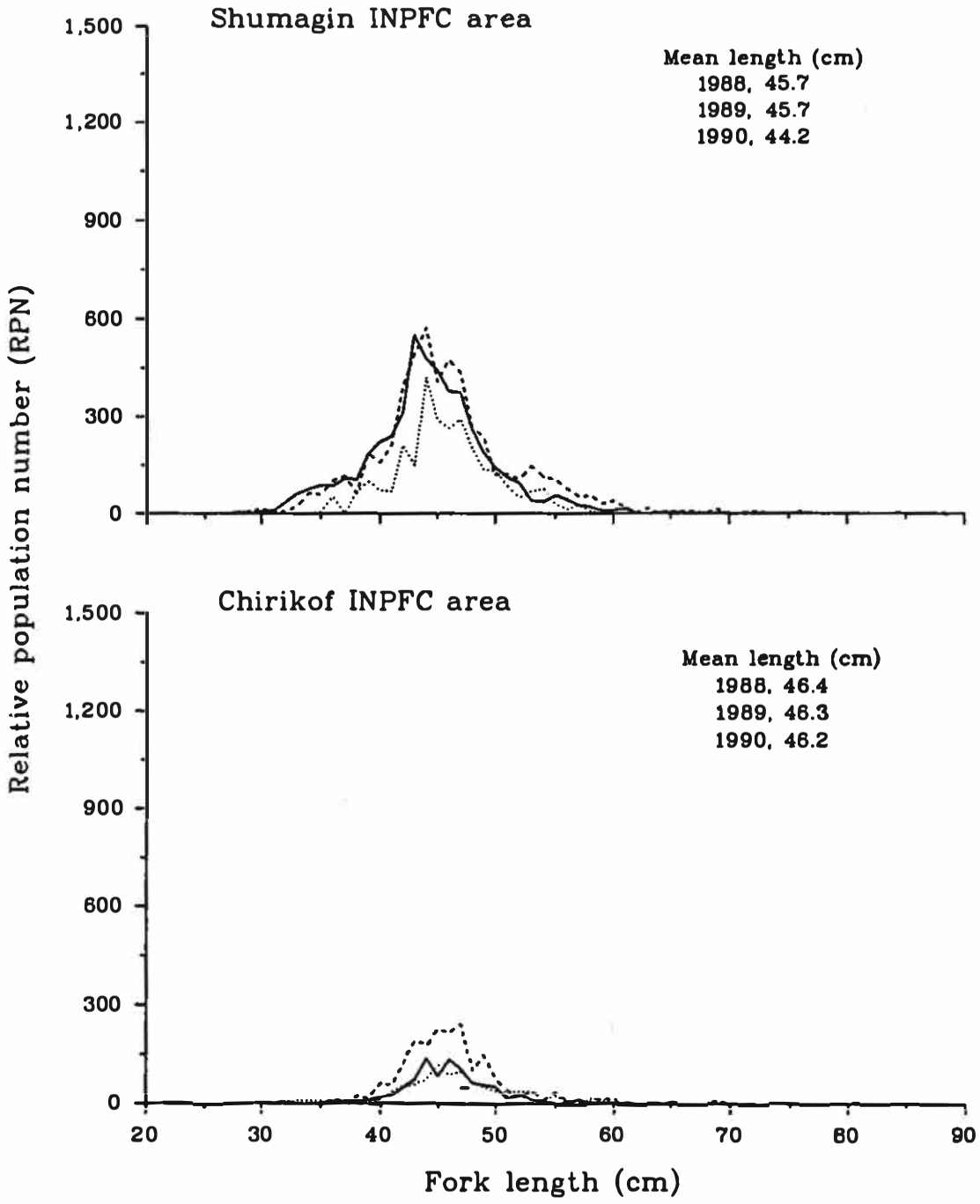

Figure 7b.--Rougheye rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Shumagin and Chirikof statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

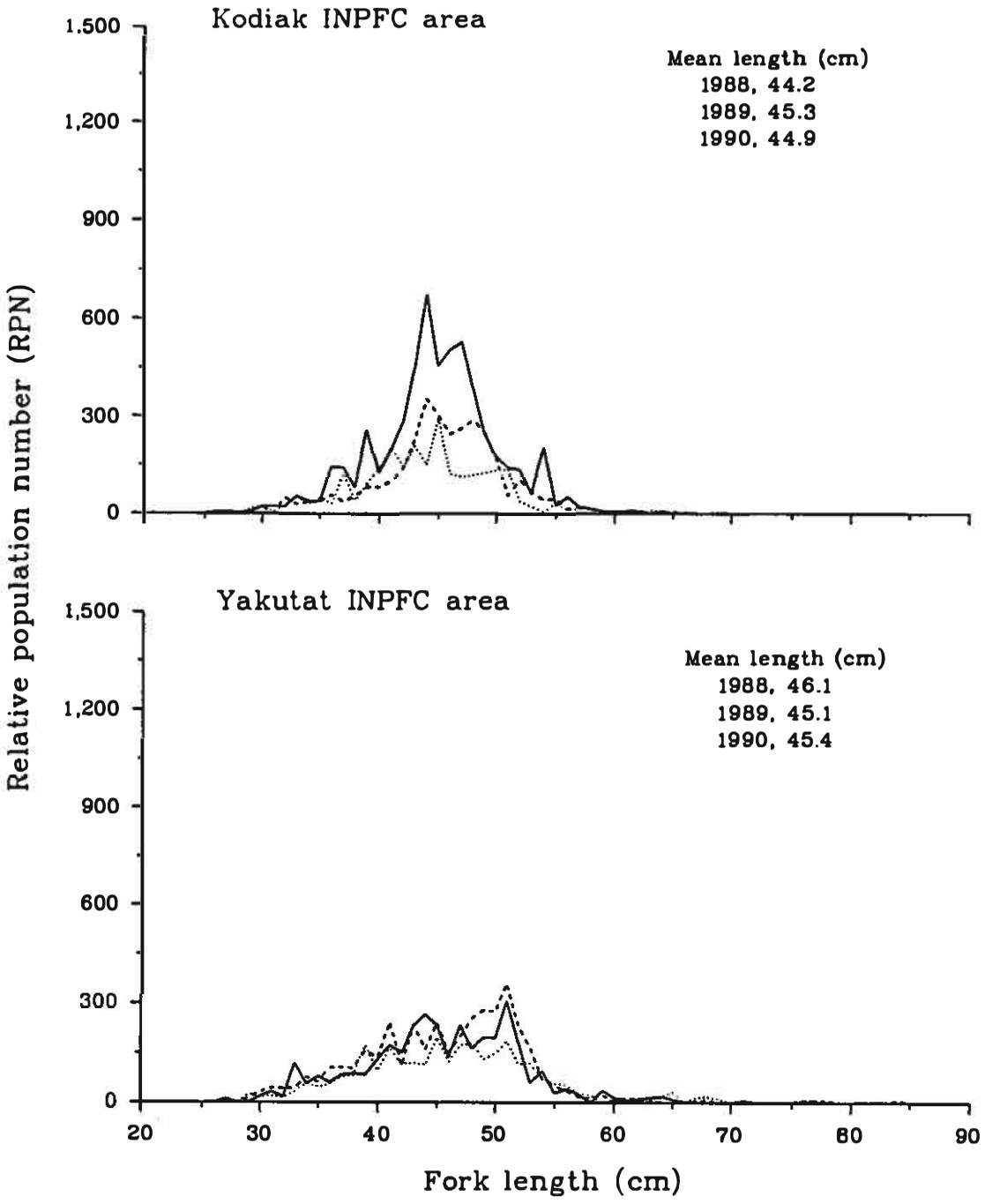

Figure 7c.--Rougheye rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Kodiak and Yakutat statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

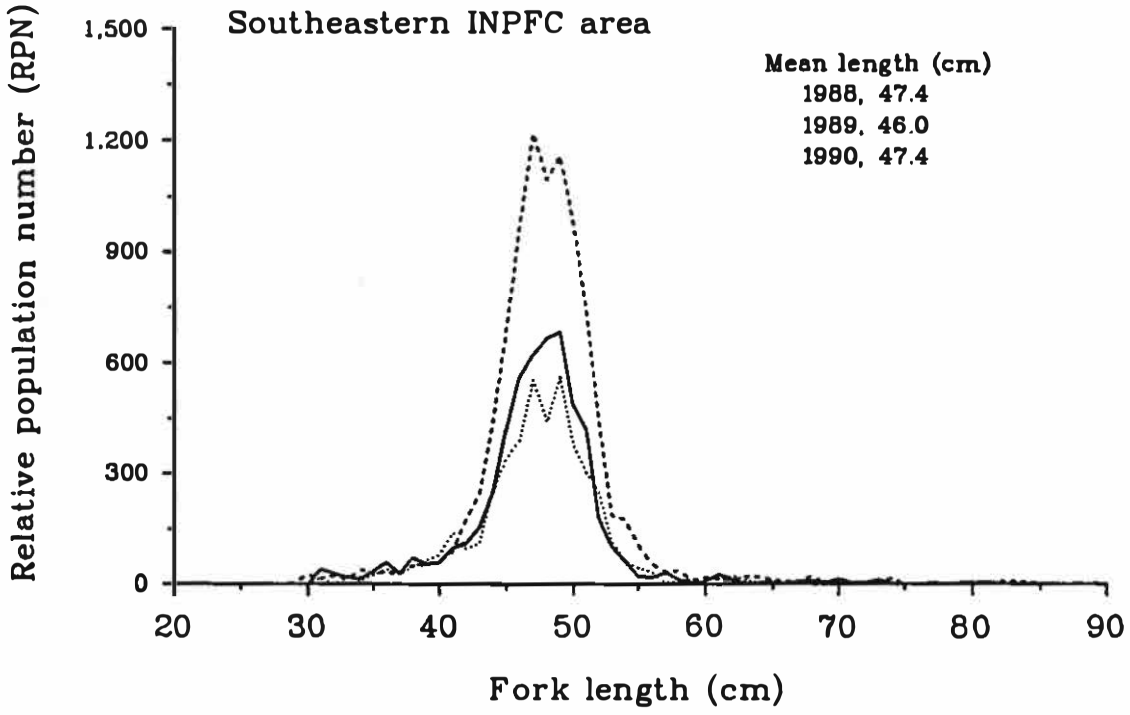

Figure 7d.--Rougheye rockfish length frequencies weighted by relative population number, for the International North Pacific Fisheries Commission Southeastern statistical area, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (___).

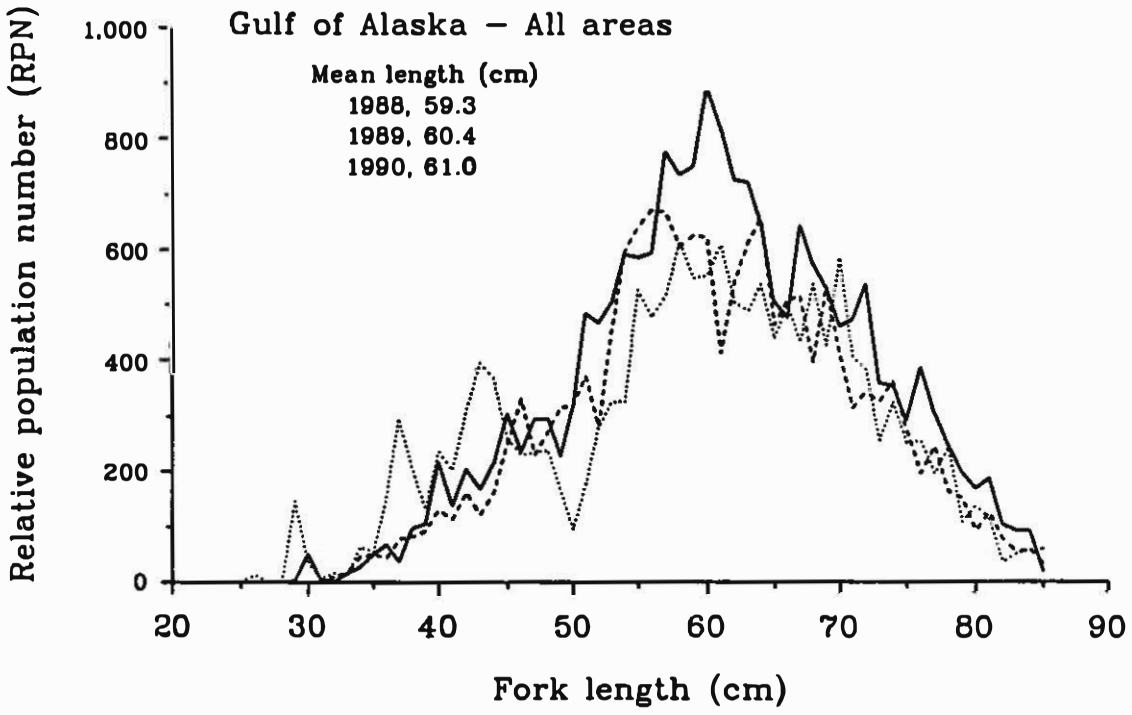

Figure 8a.--Shortraker rockfish length frequencies weighted by relative population number, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——). Note: In 1988, sample included upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W-grounds, Yakutat Valley, Alsek Strath, Ommaney Trench, Iphigenia Gully, and Dixon Entrance.

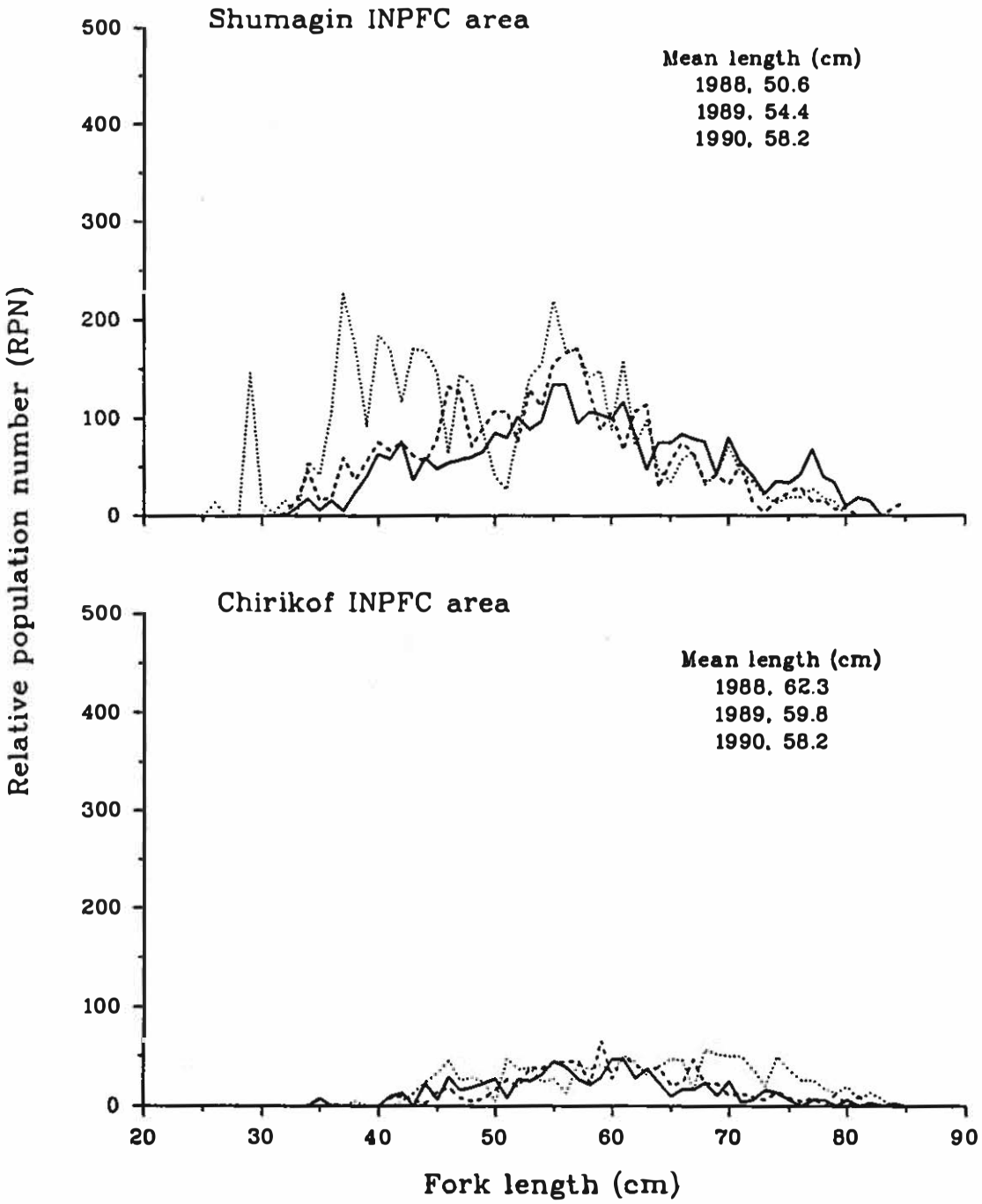

Figure 8b.--Shortraker rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Shumagin and Chirikof statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (____).

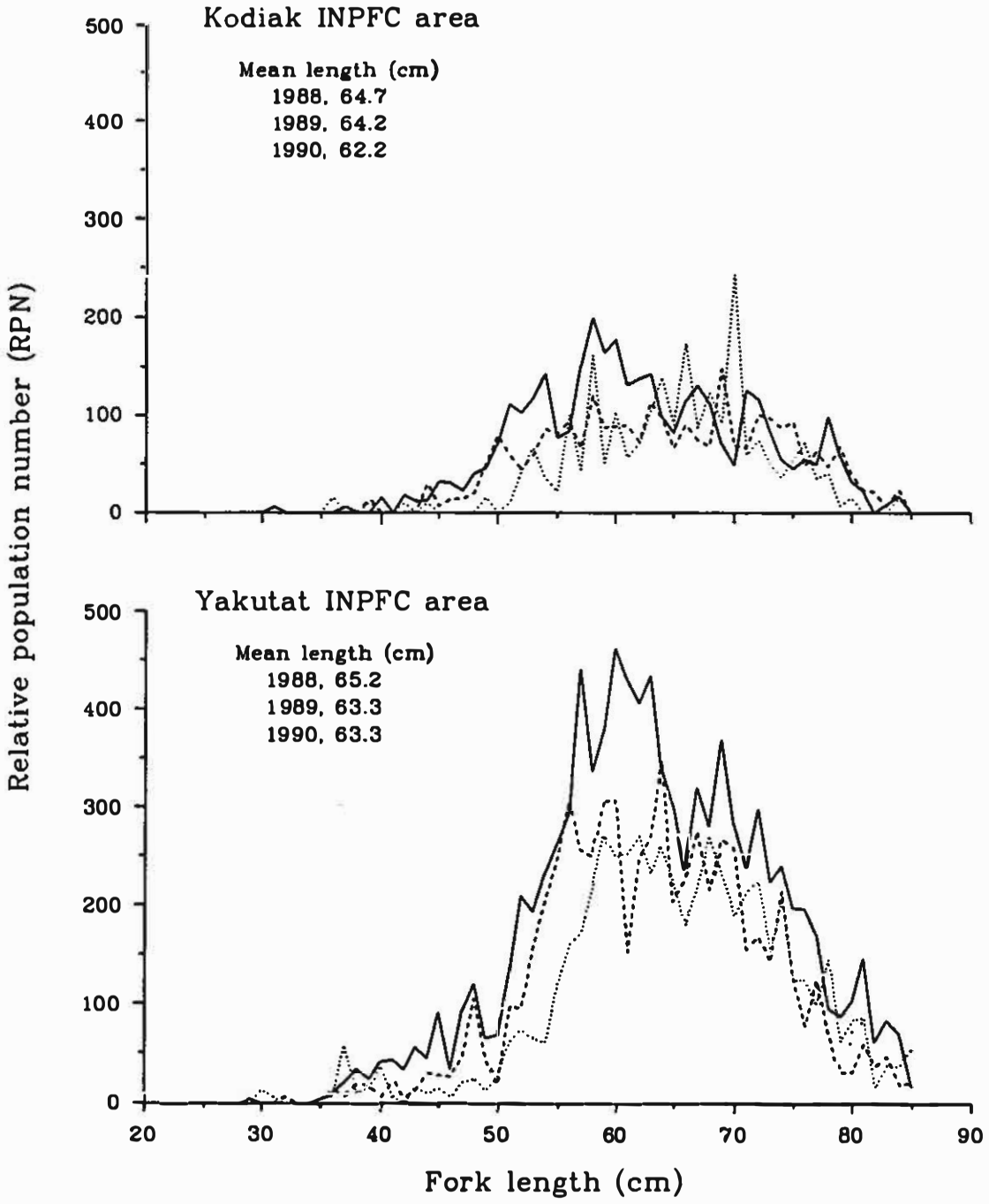

Figure 8c.--Shortraker rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Kodiak and Yakutat statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

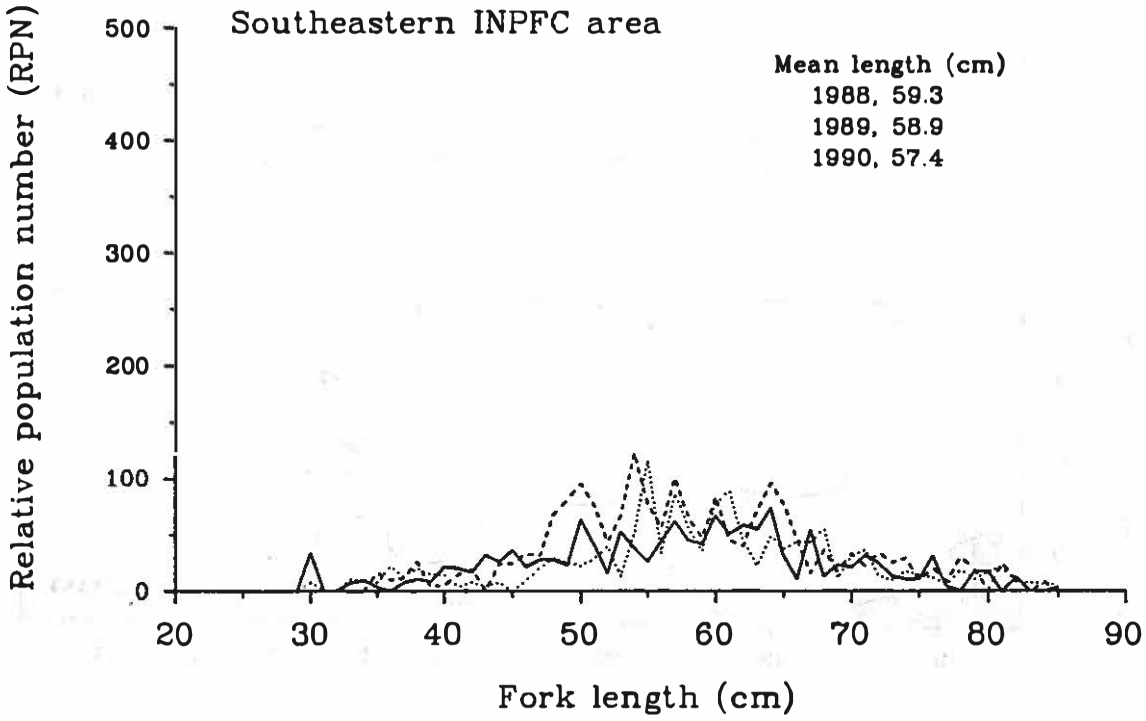

Figure 8d.--Shortraker rockfish length frequencies weighted by relative population number, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

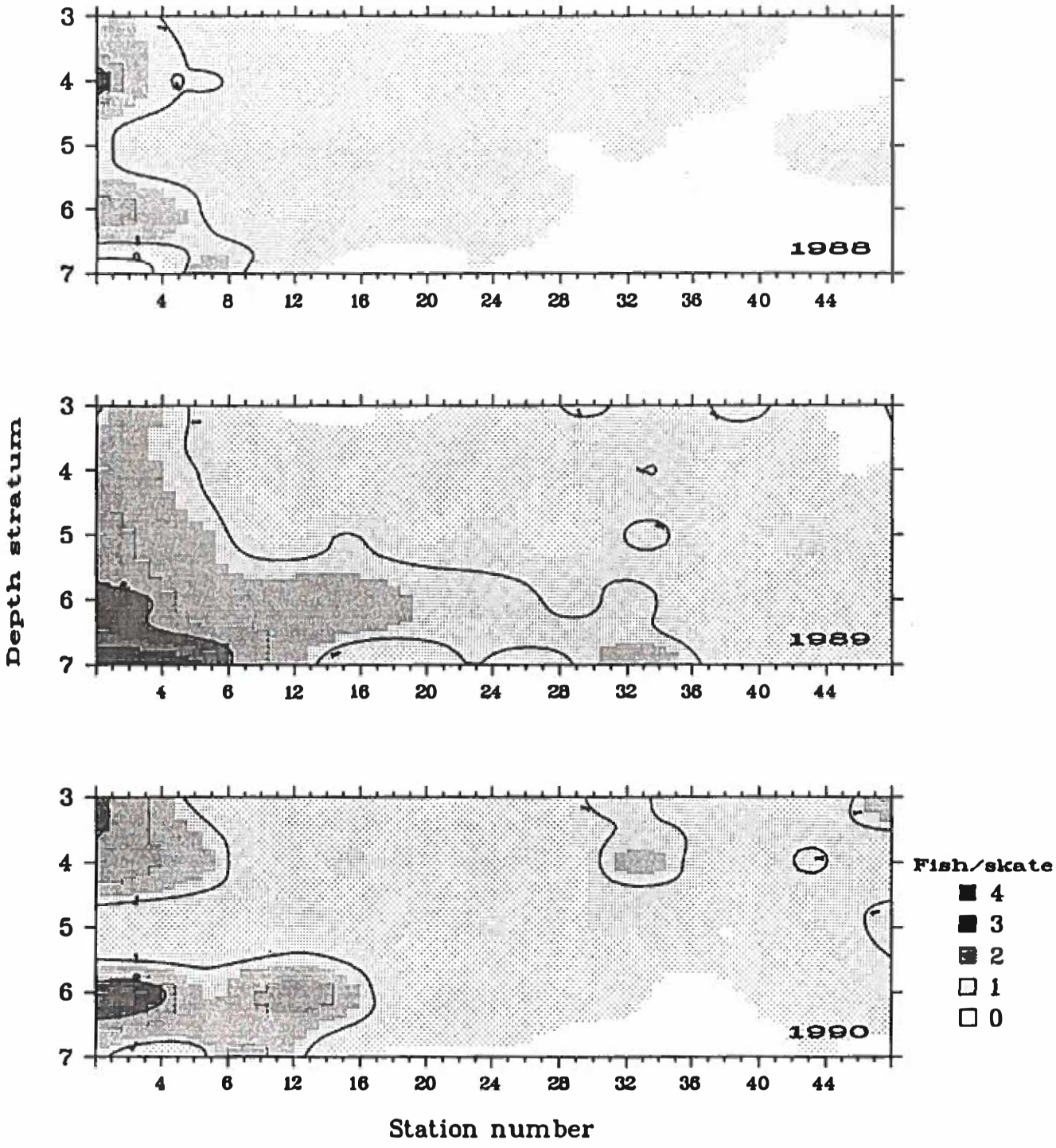

Figure 9.--Distribution of thornyhead catch per unit effort (fish/skate) from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90, smoothed by distance-weighted least squares with depth stratum and station number. Depth strata: 3 = 201-300 m; 4 = 301-400 m; 5 = 401-600 m; 6 = 601-800 m; and 7 = 801-1,000 m.

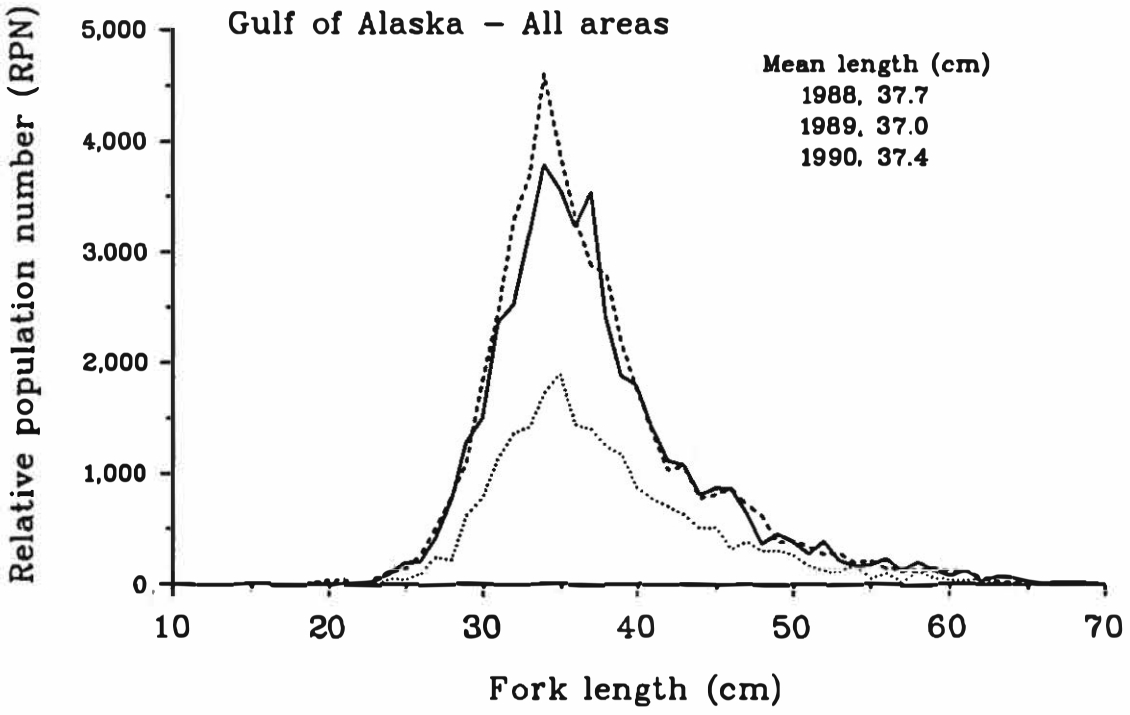

Figure 10a.--Thornyhead rockfish length frequencies weighted by relative population number, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——). Note: In 1988, sample included the upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W–grounds, Yakutat Valley, Alsek Strath, Ommaney Trench, Iphigenia Gully, and Dixon Entrance.

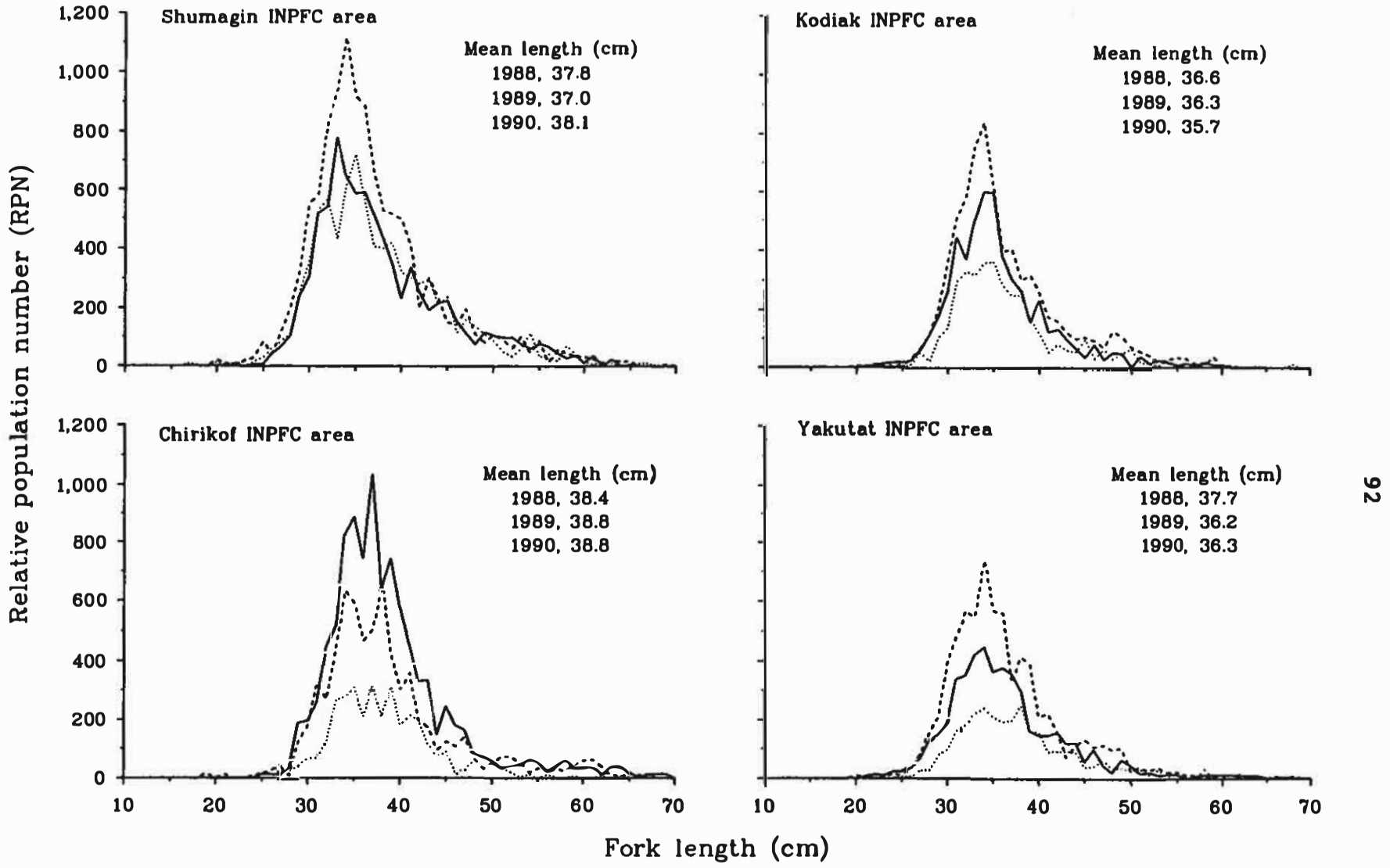

Figure 10b.--Thornyhead rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Shumagin, Chirikof, Kodiak, and Yakutat statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

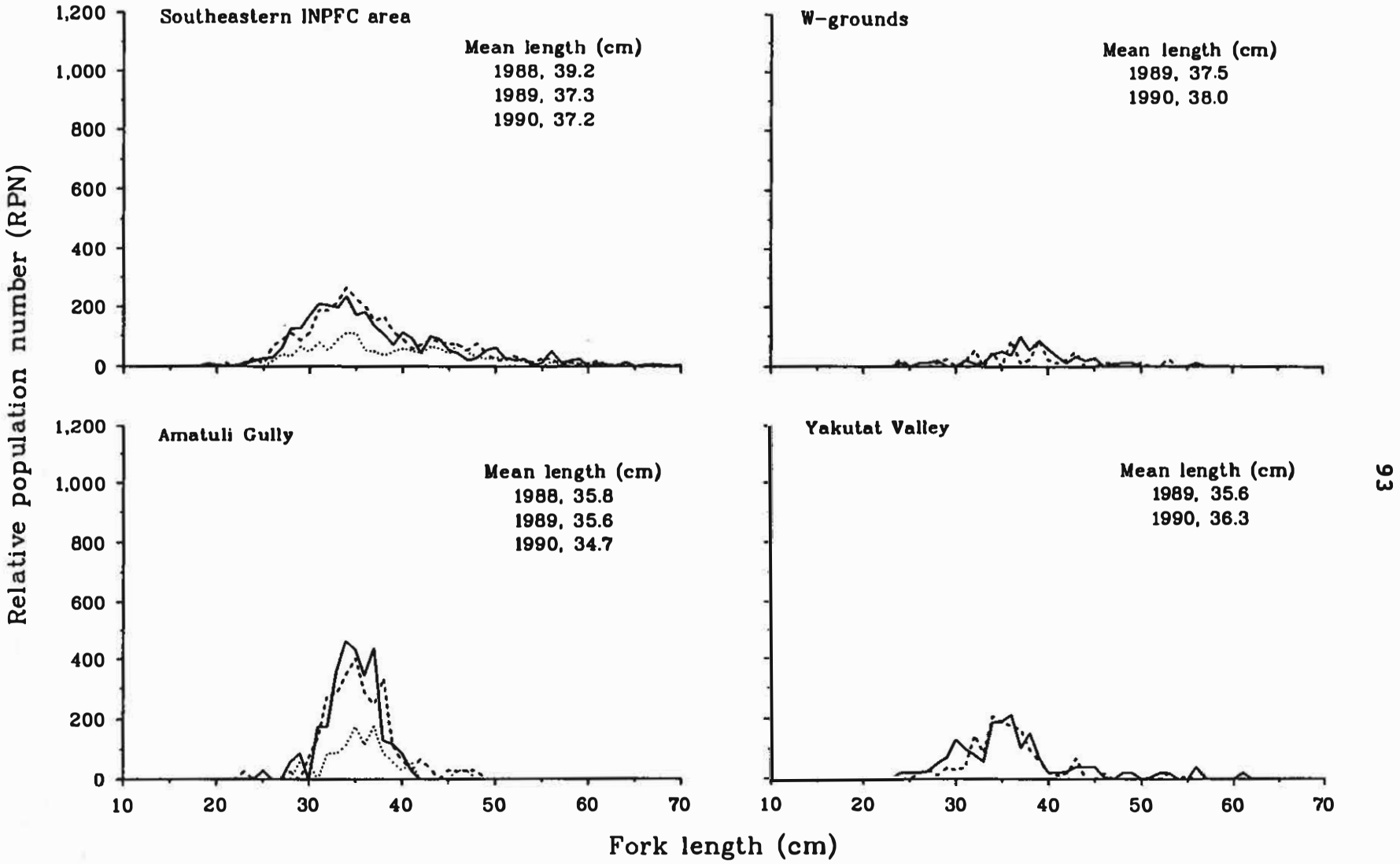

Figure 10c.--Thornyhead rockfish length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Southeastern statistical area, and Amatuli Gully, the W-grounds, and Yakutat Valley, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

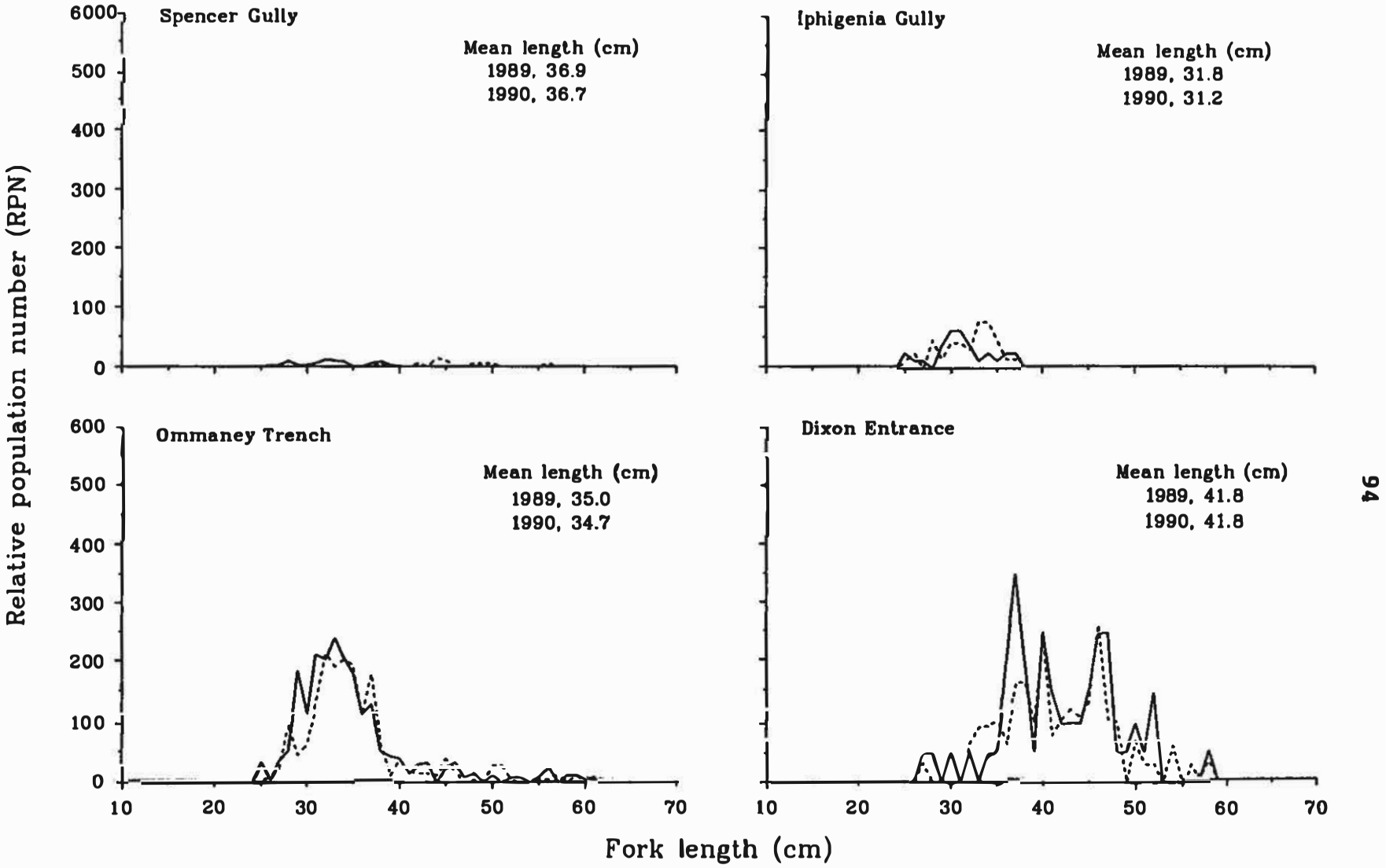

Figure 10d.--Thornyhead rockfish length frequencies weighted by relative population number for Spencer Gully, Ommaney Trench, Iphigenia Gully, and Dixon Entrance, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1989 (--) and 1990 (——).

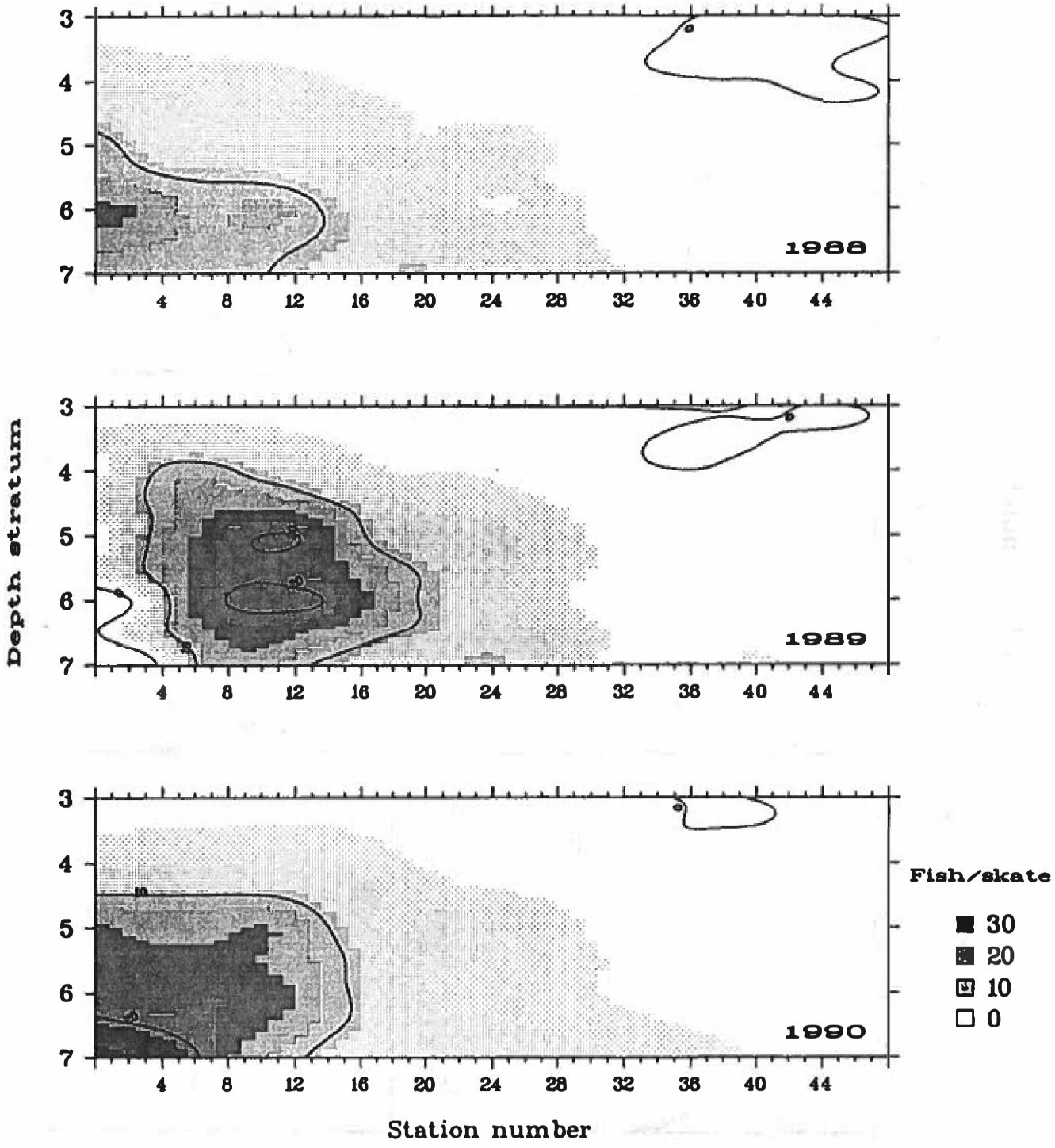

Figure 11.--Distribution of giant grenadier catch per unit effort (fish/skate) from National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988-90, smoothed by distance-weighted least squares with depth stratum and station number. Depth strata: 3 = 201-300 m; 4 = 301-400 m; 5 = 401-600 m; 6 = 601-800 m; and 7 = 801-1,000 m.

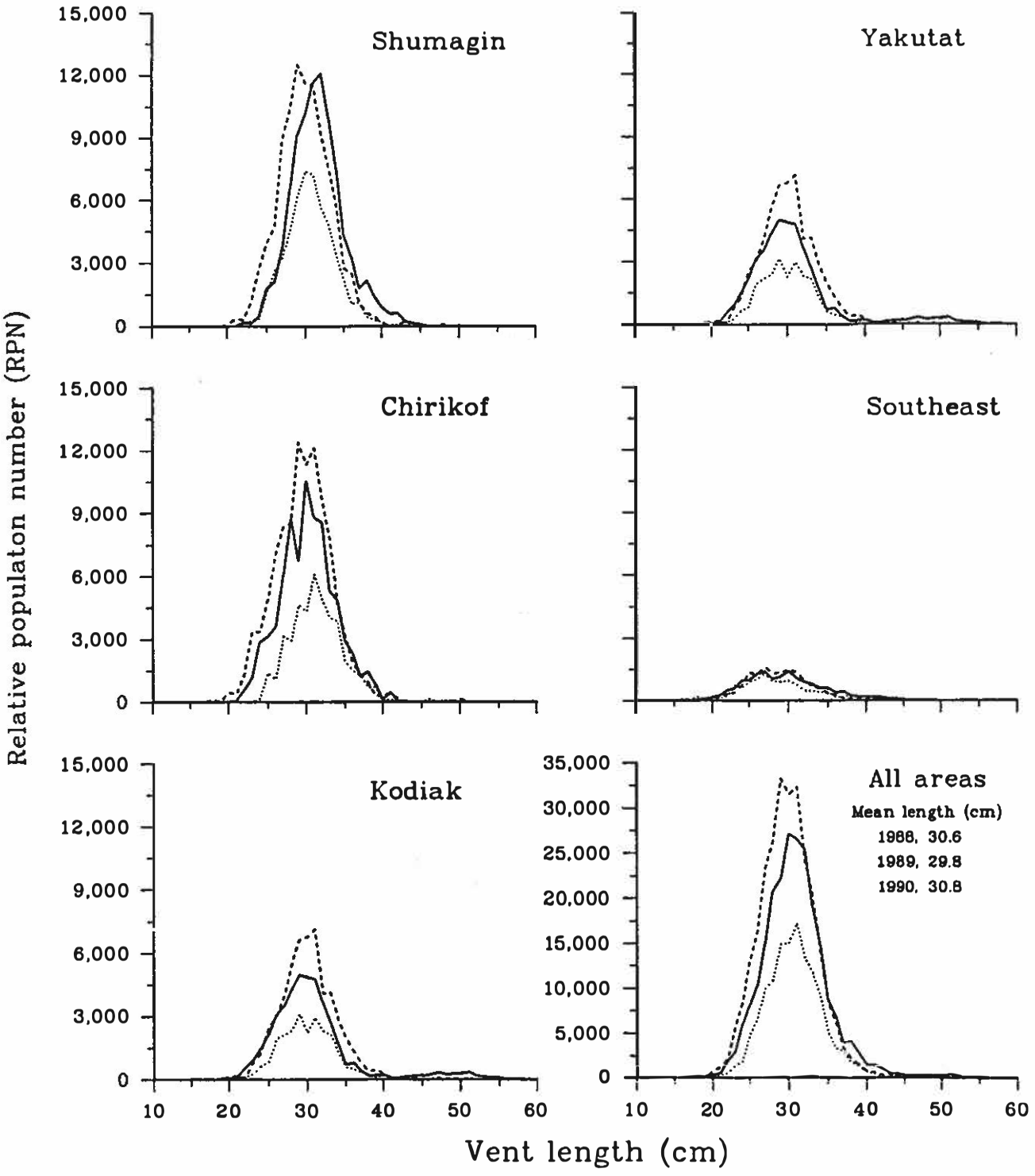

Figure 12.--Giant grenadier length frequencies weighted by relative population number for the upper continental slope and International North Pacific Fisheries Commission statistical area, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (___).

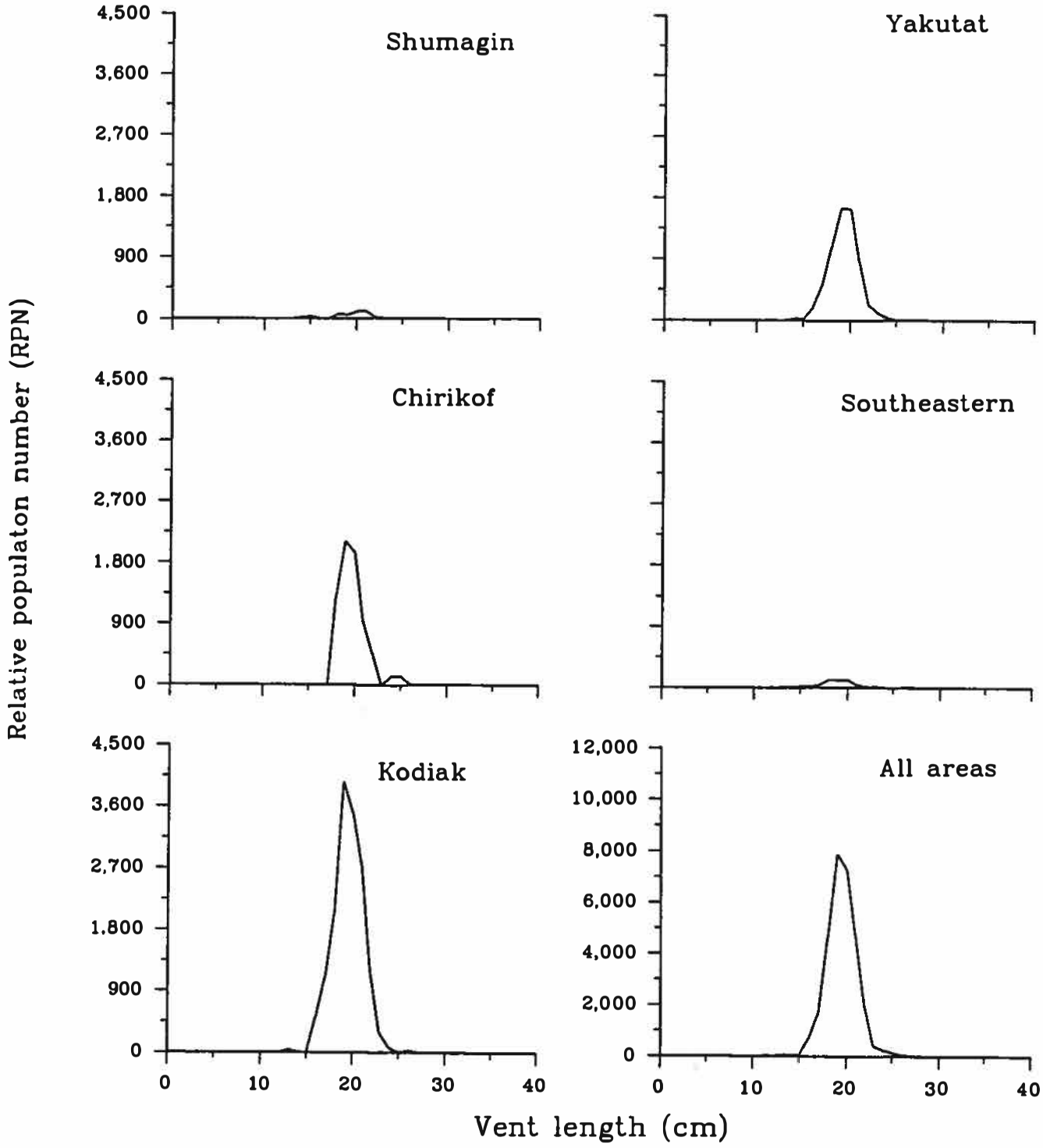

Figure 13.--Popeye grenadier length frequencies weighted by relative population number for the upper continental slope and International North Pacific Fisheries Commission statistical area, sampled during the 1990 National Marine Fisheries Service longline survey of the Gulf of Alaska.

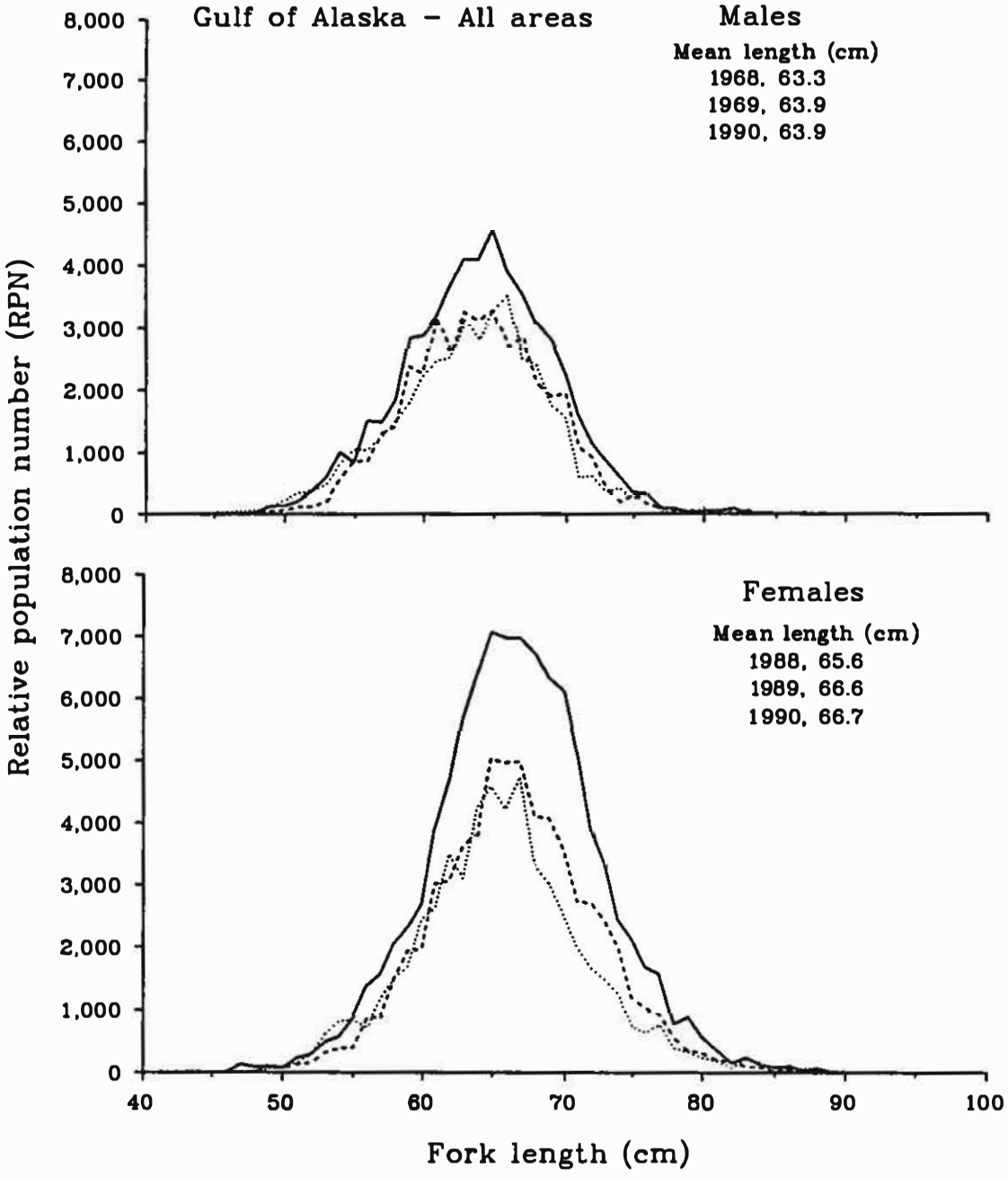

Figure 14a.--Pacific cod length frequencies weighted by relative population number, by sex, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——). Note: In 1988, sample included the upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W-grounds, Yakutat Valley, Alsek Strath, Ommaney Trench, Iphigenia Gully, and Dixon Entrance.

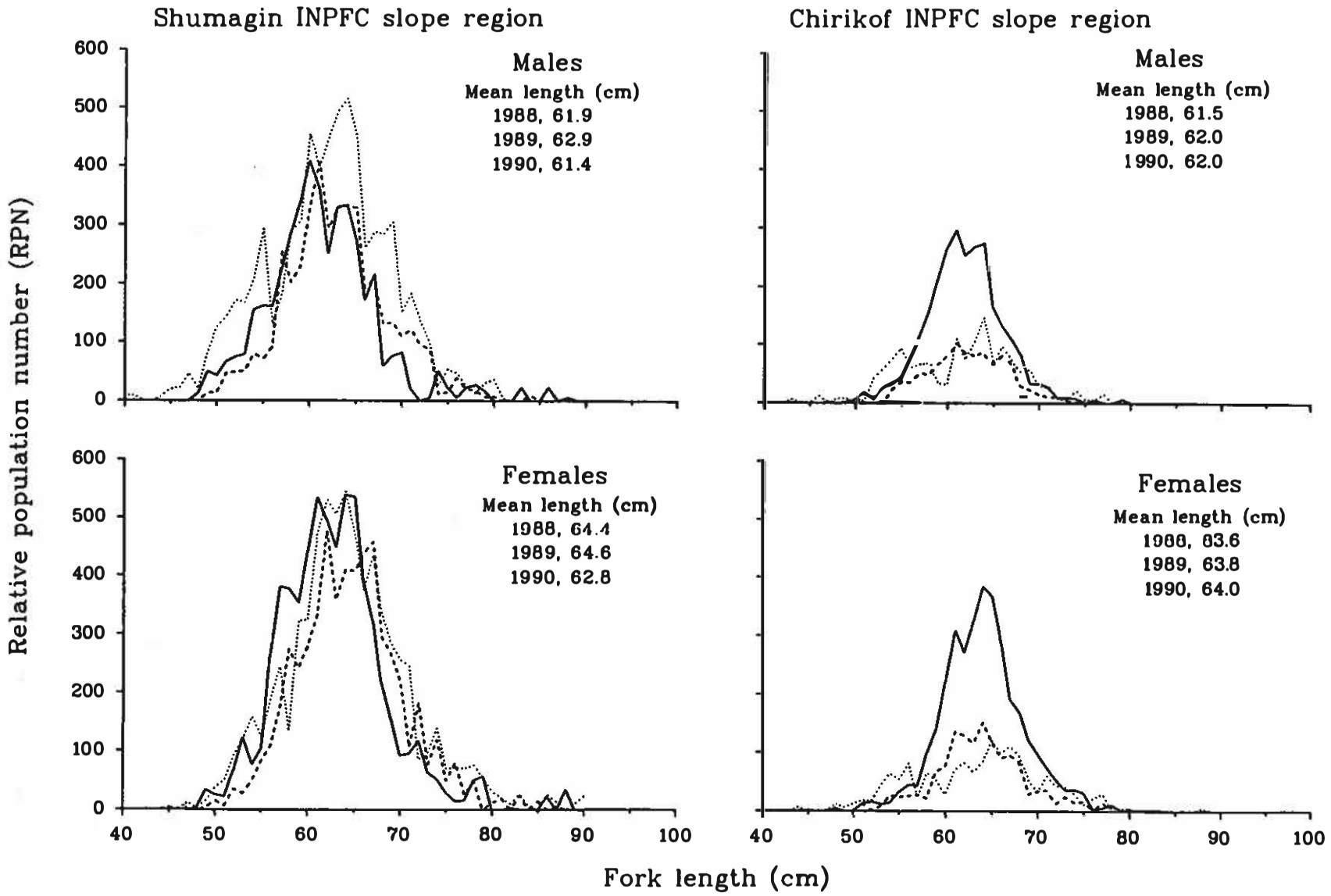

Figure 14b.--Pacific cod length frequencies weighted by relative population number, by sex, for the upper continental slope of the International North Pacific Fisheries Commission Shumagin and Chirikof statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

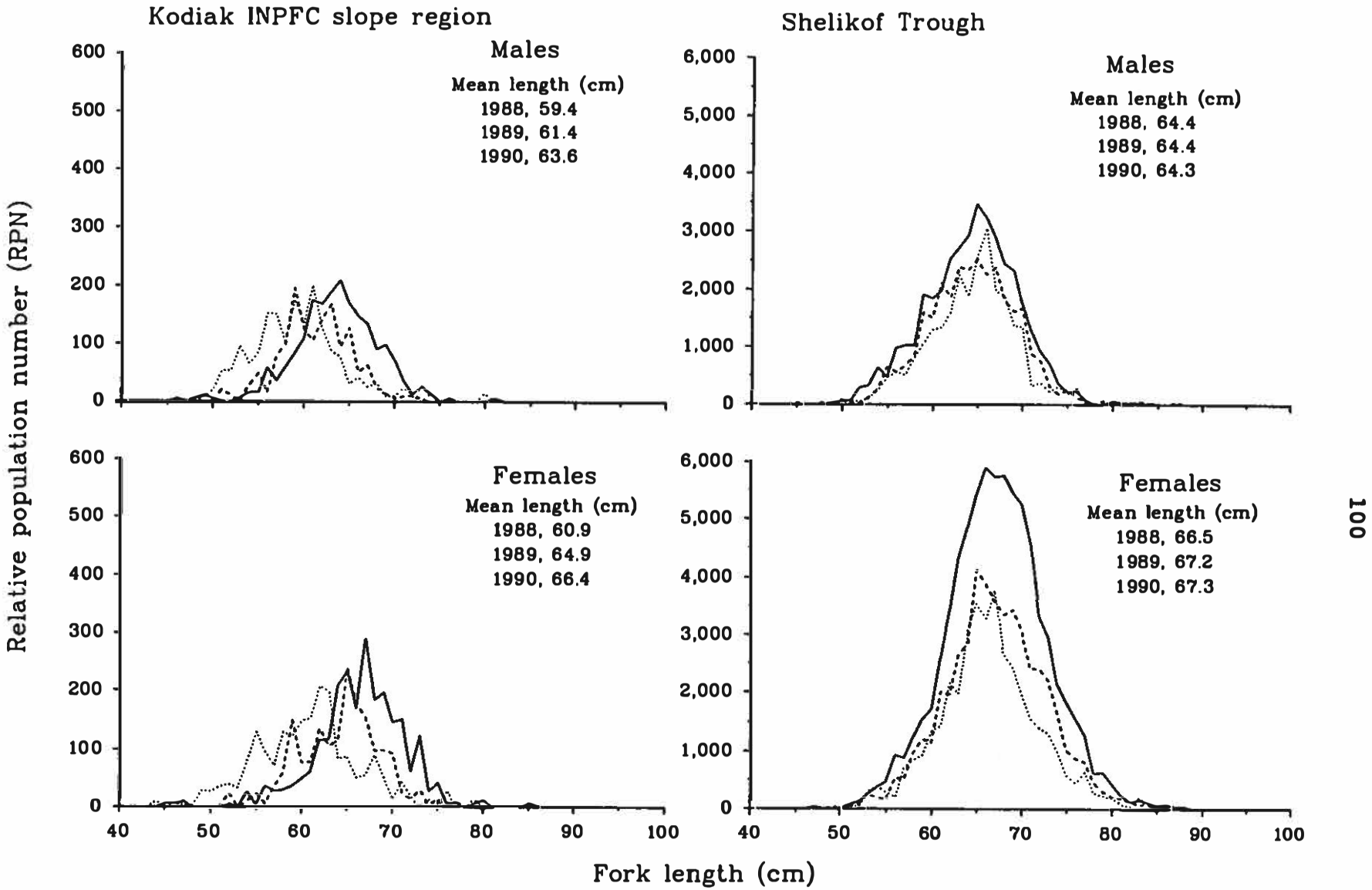

Figure 14c.--Pacific cod length frequencies weighted by relative population number, by sex, for the upper continental slope of the International North Pacific Fisheries Commission Kodiak statistical area and Shelikof Trough, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

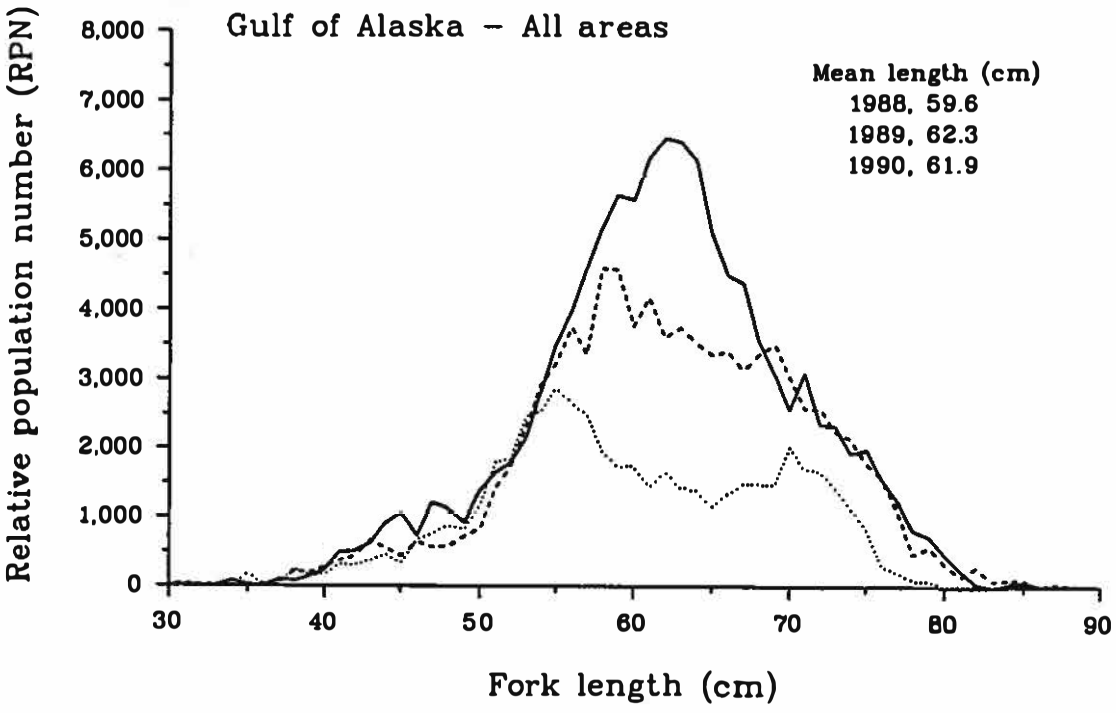

Figure 15a.--Arrowtooth flounder length frequencies weighted by relative population number, for the combined areas sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (____). Note: In 1988, sample included the upper continental slope, Shumagin Gully, Shelikof Trough, Amatuli Gully, and Spencer Gully; in 1989–90, sample included the above plus W-grounds, Yakutat Valley, Alsek Strath, Ommaney Trench, Iphigenia Gully, and Dixon Entrance.

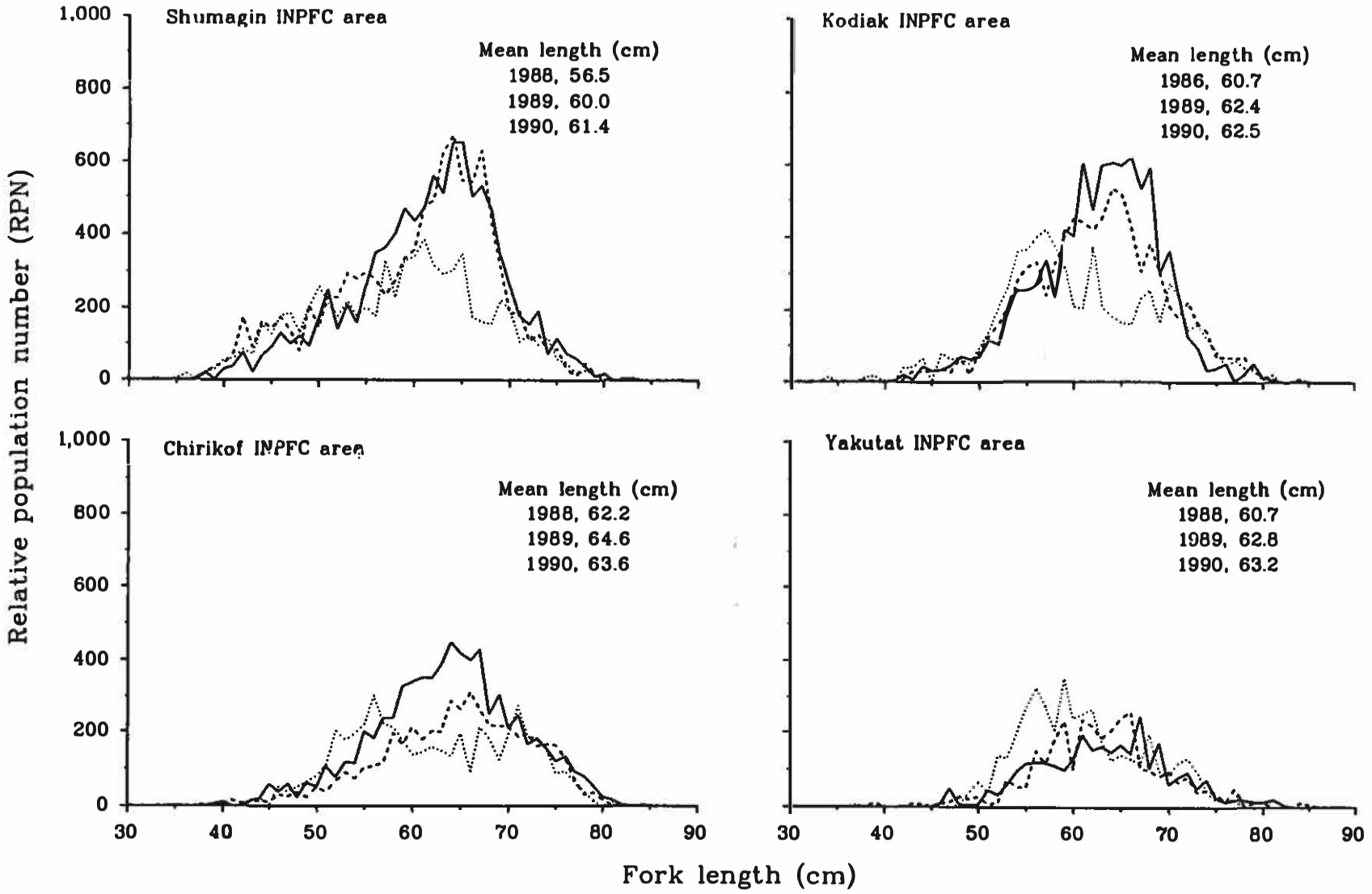

Figure 15b.--Arrowtooth flounder length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Shumagin, Chirikof, Kodiak, and Yakutat statistical areas, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--),. and 1990 (___).

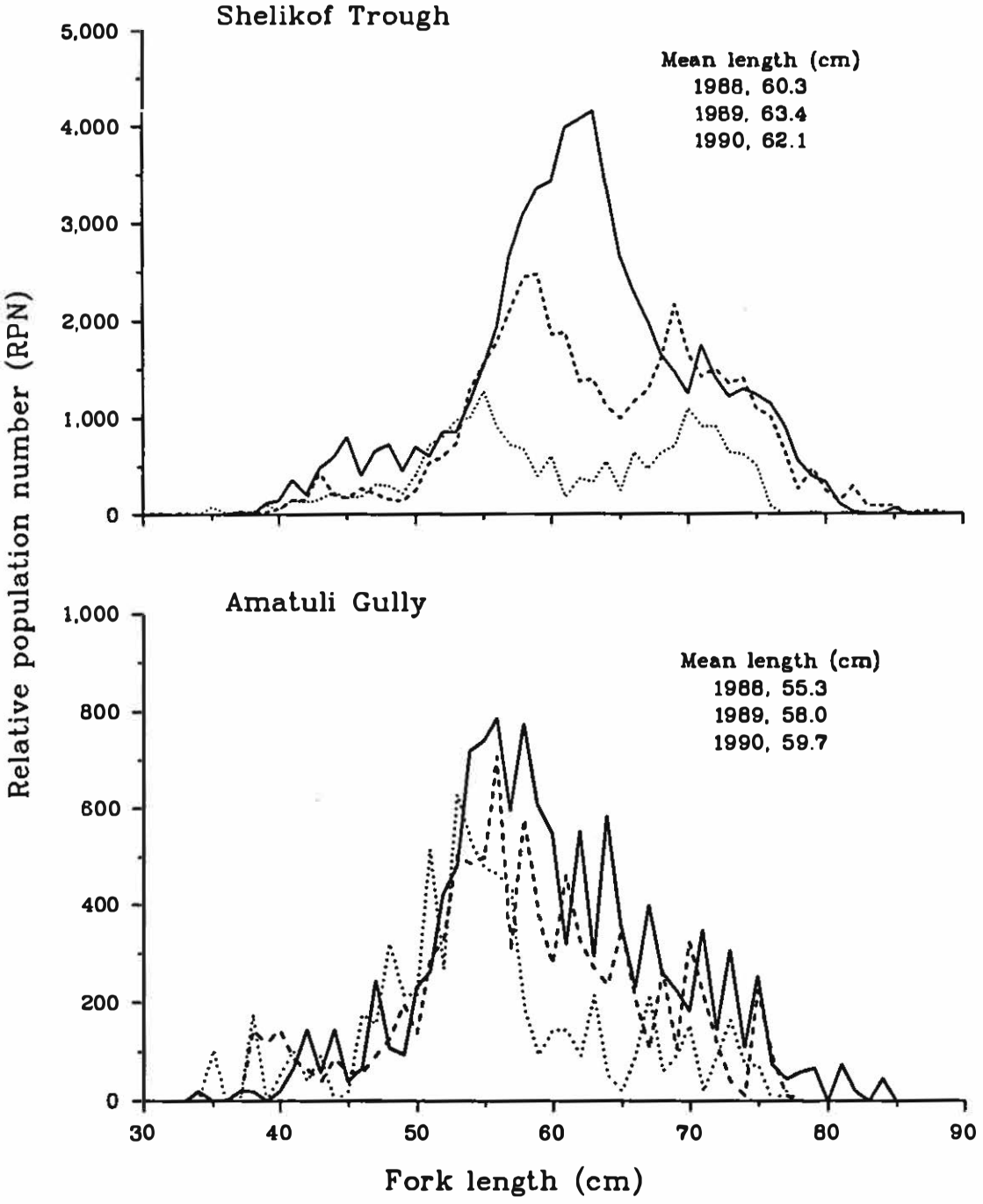

Figure 15c.--Arrowtooth flounder length frequencies weighted by relative population number for the International North Pacific Fisheries Commission Southeastern statistical area and for Amatuli Gully, sampled during National Marine Fisheries Service longline surveys of the Gulf of Alaska, 1988 (.....), 1989 (--), and 1990 (——).

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