THE 1996 SABLEFISH SURVEY RESULTS FOR THE SOUTHERN SOUTHEAST INSIDE AND NORTHERN SOUTHEAST INSIDE MANAGEMENT AREAS IN SOUTHEAST ALASKA

By

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ABSTRACT

Since 1988, the Alaska Department of Fish and Game has conducted an annual longline survey to assess the relative abundance of sablefish (*Anoplopoma fimbria*) in the Southern Southeast Inside (SSEI) and Northern Southeast Inside (NSEI) management areas. The abundance index, measured by catch per unit effort (CPUE; fish/hook), estimates the change in abundance over time. A general linear multivariate model (GLMM) was used to detect trends across years and to estimate the power of the survey to detect such trends. Approximately one-tenth of the fish were sampled for biological characteristics including length, weight, sex, age, and percent maturity.

Using the GLMM model, both the linear and quadratic trends were significant over an eight-year period (α=0.10, P=0.04 for linear and P=0.01 for quadratic) in the SSEI management area. The linear trend was positive between 1989 and 1996. The elevated 1998 and 1994 CPUEs most likely were responsible for the significant quadratic trend during these years. Although the bycatch species composition varied widely between stations, spiny dogfish (*Squalus acanthias*) dominated the bycatch, especially in the southern portion of the survey area. Biological characteristics were within ranges reported in previous surveys except the percent males in the population. In 1996, 69% of the samples were male compared to 57-51% in previous years. Although the CPUE was significantly higher using swivel hooks compared to standard hooks, tide speed and depth did not explain these differences.

In the NSEI area, CPUE results showed a positive linear trend (P=0.02) and a highly significant quadratic trend (α=0.10, P=0.0001) from 1989 to 1996. The unusually high CPUE in 1993 most likely influenced these results. Thorneyhead rockfish dominated the bycatch in the NSEI area. Biological characteristics were within ranges reported in previous surveys. The percent immature in the last three years (21-26%) is double the percent recorded in the earlier surveys (1988-1992; 6-12%). There was no significant difference between the catch rates from the commercial boat and the research vessel (α=0.10, P=0.55). However, the mean length of the sablefish captured on fixed longline gear (71 cm) was significantly higher than fish landed on the snap-on gear used on the research vessel (67 cm; α=0.05, P=1.18 x 10^{-5}). In addition, the percent male was less on the commercial vessel (41%) compared to the research vessel (50%). The proportion of immature fish on the research vessel (21%) was double that recorded on the commercial vessel (9%).

Major changes to the 1997 survey design include changing from a one-hour to a three-hour soak time, from herring to squid bait, and using commercial vessels to conduct the survey. Studies conducted on the longline sink rate and sablefish catch rates at different soak times suggest that a longer soak time may be a more appropriate measure of CPUE. The change in soak time requires a change in bait from herring to squid because herring tends to disintegrate on longer soaks. Commercial vessels will be used to conduct a more efficient and less costly survey.

INTRODUCTION

The Alaska Department of Fish and Game (ADF&G) manages two limited-entry state sablefish (*Anoplopoma fimbria*) fisheries in the internal waters of Southeast Alaska: 1) The Southern Southeast Inside (SSEI) fishery primarily occurring in Clarence Strait and Dixon Entrance and 2) the Northern Southeast Inside (NSEI) fishery occurring mostly in Chatham Strait and Fredrick Sound. The department annually conducts a relative abundance longline survey in each management area to assess the status of these sablefish stocks. The abundance index, measured by catch per unit effort (CPUE; fish/hook), estimates change in abundance over time. In addition, an adequate number of biological samples are collected to provide auxiliary information on the inter-annual population trends within each management area. In some years, experiments are performed to answer gear performance questions, obtain insight into fish behavior on longline gear or as a pilot study for future studies. This report summarizes the results of the 1999 sablefish surveys conducted in the SSEI and NSEI management areas.

SSEI SURVEY

In 1996, the department performed the ninth SSEI annual sablefish longline survey in Clarence Strait and Dixon Entrance from May 1-17, 1996 on the *R/V Medeia* (Figure 1). In addition to collecting biological and CPUE data, the following two changes were made to the design of the survey in 1996: 1) expansion of the area surveyed to include the four Dixon Entrance statistical areas (six new stations) and 2) CPUE comparisons between swivel hook and non-swivel hook types.

Since the late 1980s fleet effort has shifted from three main statistical subareas in Clarence Strait (315432, 315502, and 32531) to four areas in Dixon Entrance (DE), 325431, 325401, 315401, and 315431 (Figure 2). Therefore, we expanded the area surveyed to include those portions of areas in Dixon Entrance that were greater than 200 fathoms (Table 1).

Non-swivel hooks have been used exclusively in past surveys. department personnel tallying the catch and condition (bait or no bait) of each hook returning, noted that many baitless hooks had twisted gangion line. These observers hypothesized that a bare hook with a twisted gangion could be the result of a fish twisting free. Although CPUE is a relative measure and consistent use of the same hook type would theoretically yield more comparable among-year results, tide speed and fishing depth would not be consistent year-to-year for a given set and may increase the number of twisted gangion lines. Therefore a change in CPUE could be an artifact of hook type and tide speed or depth rather than true measurement of change in sablefish density.

Survey Objectives

1. To estimate relative abundance of sablefish in Clarence Strait and Dixon Entrance.

2. To collect otoliths (aging structures), length, weight, sex, and stage of gonad maturity. Biological information provides auxiliary information for the stock assessment including age and size-structured analysis, biomass/hook, percent males and percent immature fish.

3. To determine if CPUE was significantly different between swivel and non-swivel hooks. If there is a significant difference, determine if tide speed and fishing depth can account for these differences.

Methods

Survey Design

The survey was composed of 38 pre-designated stations (see Bracken et al. 1997 for a detailed description of how station sites were originally selected). The sample area included 32 stations of the original 52 randomly selected in 1988 and six new stations in Dixon Entrance (Table 1). The northern-most station is located near Tolstoi Bay (Prince of Wales Island, latitude 55°38.22' and longitude 132°18.86'). The survey extends south and west of Cape Muzon (Dall Island, latitude 54°31.03', longitude 132°40.65'; Figure 1). All stations were greater than 200 fathoms. The research survey was performed three weeks prior to the commercial fishery opening, June 8-10, to minimize the potential differences between the sablefish population available to the research survey and the commercial fishery.

The snap-on longline gear consisted of snaps 13 cm in length with 25 cm of gangion line (#48 hard lay on standard hooks and #42 hard lay on swivel hooks) between the snap and the hook. Circle hooks (Mustad #13/0) with 1.2 cm between the hook point and the shank were used. Hooks were snapped on the line at approximately three-meter intervals, alternating between standard and swivel hooks. The groundline was 5/16" (8 mm) diameter hard lay Aqualine[TM2] and the total length of groundline deployed for each set was approximately 1600 m. Anchors weighing 20.5 kg were used at each end of the set. Hooks were counted as they were deployed, and a marker and a lead weight (2.26 kg) were attached to the groundline after every 100 hooks. The lead weight was added to increase the likelihood that all portions of the groundline reached the bottom in areas of rough topography. Sets were made in the same direction as the tidal current. Each set was retrieved one hour after initial set time. Haul-back direction was either in the same direction as set (first buoy set was picked up first) or the opposite direction (last buoy set was first buoy picked up) depending on the tide, wind direction, and currents.

During retrieval of each set, the species of each fish brought to the surface and the condition of the fishless hooks (i.e. baited, unbaited, or broken) were recorded. The 100-hook subsections within a set were tallied separately to allow estimation of variance components among sets and between the sections within a set. This also allowed inclusion of invalid sections in the analysis of CPUE rather than excluding the data for an entire station. Sections with more than 25 hooks in a snarl were automatically invalid. Sections with less than 25 snarled hooks were determined valid or invalid based on the spatial pattern of the snarls. For example, if there were 20 hooks snarled together, the section was considered invalid. However, if the 20 non-fishing hooks were in small groups, the section was considered valid. The survey crew leader would make the final decision in marginal cases. CPUE was expressed as the mean ratio of the number of sablefish per hook. Relative recruitment strength was calculated by multiplying the overall CPUE (sablefish/hook) by the proportion of sablefish that are less than the length at which 50% of the fish are mature. The confidence intervals were calculated using each section (100 hooks) as the sampling unit within each set.

All sablefish brought onboard were sampled for length (nearest cm). Every tenth sablefish caught on the swivel hooks and every tenth on the standard hook was sampled for weight (nearest 0.1 kg), sex, and stage of gonad maturity. Stage of gonad maturity was coded according to list of six descriptions of gonad conditions for each sex (Appendix 1). Otoliths were extracted and paired with the biological data and sent

[2] Product names used in this report are included for scientific completeness but do not constitute product endorsement.

to the ADF&G Division of Commercial Fisheries, Coded Wire Tag (CWT) & Otolith Processing Lab in Juneau for age analysis.

A general linear multivariate model (GLMM) was used to detect linear and trends over an eight-year period and to estimate the power of the survey to detect such trends. Using an alpha level of 0.10 and a power of 0.8, the survey was designed to detect a linear and polynomial trend that results in approximately a 20% change in sablefish CPUE over eight years (Bracken et al. 1997). The 1988 survey was considered a pilot study. Therefore, the 1988 CPUE was excluded from the analysis.

Results and Discussion

Relative Abundance Indexing CPUE

A total of 36 out of 38 stations were successfully sampled for CPUE and biological data in the SSEI research survey in 1996 (Table 1). Stations 27 and 57 were not surveyed due to a combination of weather, tides and insufficient time. Of the 180 sections sampled within the 36 stations, 178 sections were valid. The CPUE by station ranged from 0.01 (station 56) to 0.29 (station 44) with an overall CPUE of 0.11 sablefish/hook (Table 1). The overall CPUE was 0.10 and 0.12 fish/hook for standard and swivel hooks respectively. The overall CPUE in the five Dixon Entrance sets was 0.08 sablefish/hook compared to the 0.11 CPUE for the Clarence Strait area. Very few fish were captured at the two new sets near Cape Chacon (stations 55 and 56; Figure 2) which depressed the Dixon Entrance CPUE considerably (Table 1). Both the linear and quadratic trend was significant over an eight-year period (P=0.04 for the linear and P=0.01 for the quadratic trend). There is a positive linear trend in the mean CPUE (fish/hook) between 1989 and 1996 (Figure 3). The elevated 1988 and 1994 CPUEs most likely were responsible for the significant quadratic trend in this data (Figure 3). In other words, the high CPUEs in 1988 and 1994 were followed by lower CPUEs in the intervening years.

Bycatch species included spiny dogfish (*Squalus acanthias*), thornyheads (Sebastolobus spp.), Pacific halibut (*Hippoglossus stenolepis*), longnose skate, (*Raja rhina*), other skates (*Raja* spp.), arrowtooth flounder (*Atheresthes stomias*), shortraker rockfish (*Sebastes borealis*), rougheye rockfish (*S. aleutianus*), redbanded rockfish (*S. babococki*), pollock (*Theragra chalcogramma*), spotted ratfish (*Hydrolagus colliei*), and hagfish (*Eptatretus* spp.). The majority of the catch was dogfish in the southern Clarence Strait and Dixon Entrance survey areas (Table 2, Figure 4). Although dogfish were also caught in high numbers in the central and northern Clarence Strait area, sablefish, thornyheads and other by-catch (mostly hagfish) species dominated the catch at several stations (Figure 4).

Biological Characteristics

Sablefish varied in length from 33 to 104 cm, with a mean of 58.9 cm (n=1876). Two modes were evident in the length frequency, one at 45 and another at 60 cm (Figure 5). The variances between Dixon Entrance and Clarence Strait sablefish lengths were not statistically significantly different (F-test, P=0.44). However, the mean length of Clarence Strait fish was significantly lower than the mean length of fish captured in Dixon Entrance (T-test, t=-3.06, df=206, P=0.002, α=0.05, n_{DE}=24. $n_{CLAR=}$ 184; Figure 5).

We subsampled sablefish for length, weight, sex and stage of maturity (N=208). Samples ranged from 43-82 cm in length, and mean length was 58.8 cm (± 1.1, 95% CI, Table 3). The mean lengths of the subsamples were comparable to the length frequencies taken on the majority of fish. However, the minimum and maximum lengths were not as extreme in the subsample. The length frequency distribution

of sablefish from the subsample in the 1996 SSEI survey shows patterns similar to samples collected in previous years (Figure 5). Forty-nine percent of the fish sampled were ≤ 59 cm, showing a strong pattern of young fish recruiting into the survey. However, the 1996 relative recruitment strength was 0.05 recruits/hook compared to 0.06 recruits/hook in 1994 and 1995.

The age distribution of the sablefish collected in the 1996 survey showed the majority of fish to be less than 20-years old with very pronounced modes at two and six years and a lesser mode at 18 years (n=208; Figure 6). Ages ranged from two to 43 years and the mean age was 11.1 years. The high percent of age-2 fish (12.6%) supports length distribution data showing a high number of young fish present in the survey.

Other biological data collected included weight, sex, and stage of maturity. Within the same biological range as past surveys, mean weight was 2.11 kg (± 0.12, 95 % CI; n=208) in 1996 and ranged from 0.6-5.6 kg. There were 204 samples identified by sex of which 69% were male, a substantial increase from previous years (Table 3). Fifty percent of the fish subsampled were classified as immature.

Hook Type Experiment

Catch statistics, separated according to hook type, showed a mean of 0.10 fish/hook and a range of 0-0.36 fish/hook for standard hooks and a mean of 0.12 fish/hook and a range of 0-0.46 sablefish/hook for swivel hooks (Figure 7). A paired comparison between swivel and non-swivel within each section across all stations showed the difference between swivel and standard hook CPUE to be highly significant (t-test, t= 4.69, df=35, P=0.00004). However, regression of swivel hook CPUE on standard hook CPUE showed a strong, positive linear relationship and was statistically significant ($P=1.2X10^{-14}$) between CPUEs for the two hook types (R^2 = 0.83, Figure 8). In other words, if standard hook CPUE was high, swivel hook CPUE was also high. This suggests that swivel hooks could be used in future surveys to increase the number of fish caught if revenue generation was necessary to support stock assessment activities. Regressing the difference of CPUE between hook types against tide speed and depth suggested that neither tide speed (Figure 9) nor depth (Figure 10) significantly influenced the difference between the two CPUEs.

NSEI SURVEY

In 1996, the department performed the ninth annual sablefish longline survey in the Chatham Strait from August 17 to August 31 on the *R/V Medeia* (Figure 11). In addition to our regular survey, we conducted a parallel survey with a commercial boat using conventional fixed gear and hook spacing, squid bait, and soak times 3-11 hours in the northern survey area to compare catch per unit effort and biological characteristics of sablefish captured on the *R/V Medeia*. The department is considering the use of commercial vessels to conduct the survey in the future. The major advantage to using several commercial vessels simultaneously is the ability to conduct the survey in one week. This enables the survey to be completed within one tide cycle, reduces staff time at sea, and is more economical by reducing sea duty pay and vessel operational costs. The use of commercial vessels would require switching from snap-on gear to conventional fixed gear, herring to squid bait, and variable hook spacing. Completing the survey within a tide cycle would also require extending soak times to 3-11 hours. Sigler (1993) showed that CPUE is not affected by soak time restricted between 3-11 hours. The major disadvantage in switching to commercial vessels is the introduction of operational changes that may be unrelated to fish density but could effect CPUE. Therefore, we wanted to conduct a longline survey with a commercial boat and gear during a portion of the regular survey to compare differences in CPUE and biological characteristics.

Survey Objectives

1. Collect biological samples including otoliths, length, weight, sex, and stage of sexual maturity.

2. Estimate relative abundance of sablefish in the NSEI subdistrict of the Southeast District.

3. Compare catch per unit effort (CPUE) between the *R/V Medeia* and a commercial vessel using different gear configurations and soak times.

4. Compare biological data collected on the *R/V Medeia* and the commercial vessel.

Methods

Survey Design on the *R/V Medeia*

The survey was composed of 38 pre-designated stations (see Bracken et al. 1997 for a detailed description of how station sites were originally selected). The northern-most station was located near Point Hepburn (Admiralty Island, latitude 57°55.84' and longitude 134°47.65') and the survey extended several miles southeast of Cape Omanney (Baranof Island, latitude 56°05.2' and longitude 134°30.4'; Figure 11). Longline gear was configured and set using the same methods outlined in the SSEI survey.

Survey Design on the *F/V Ida June*

A commercial fishing vessel, the *F/V Ida June*, was contracted to longline 16 stations randomly selected in Chatham Strait between Yakatz Bay (57°07.5') and Freshwater Bay (57°51.5') from August 19 to 22 (Table 6, Figure 12). Gear configuration included 39" hook spacing, 122 hooks per skate, 300-fathom skate length, 60-pound anchor weights and a two-pound skate weight every 150 fathoms. A total of 750 circle hooks were set at each station. Consistent with the *R/V Medeia* survey, the depth of each station was greater than 200 fathoms. The *F/V Ida June* fished four stations per day using conventional fixed longline gear, set soak times were three to seven hours, and squid as bait. The catch rates and biological characteristics collected on stations 22-51 on the *R/V Medeia* were compared to the 16 stations fished by the *F/V Ida June*.

Similar to the research survey, as the line was retrieved, the species of each fish brought to the surface and condition of the fishless hooks was recorded. A length (nearest cm) was taken on the majority of fish brought on deck and every tenth fish caught was additionally sampled for sex and stage of gonad maturity. Otoliths were extracted and paired with biological data.

RESULTS AND DISCUSSION

Relative Abundance Indexing CPUE

A total of 36 out of 38 stations were successfully sampled for CPUE and biological data in the NSEI survey in 1996 aboard the *R/V Medeia* (Table 4). Stations 18 and 47 were excluded from the analysis due to snarls and loss of gear. Of the 180 sections sampled within the 36 stations, 179 sections were valid.

The average depth fished was 308 fm ranging from 221 fm (Station 13) to 428 fm (Station 27: Table 4). A total of 2,982 sablefish were caught on 17,730 valid hooks. The overall mean number of fish/hook was 0.17 and a range of 0.05 (Station 27) to 0.38 (Station 39) fish/hook. The mean CPUE based on biomass was 1.27 kg/hook and ranged between 0.46 (Station 27) and 2.23 kg/hook (Station 39). The GLMM analysis indicated a highly significant difference between years (P=0.0001). The results showed a significant linear trend (P=0.0233) and a quadratic trend (P=0.0157 but no significant cubic trend (sine curve; P=0.4806). The mean survey CPUE plotted from 1989 to 1996 showed a slightly positive linear trend (Figure 13). The highly significant quadratic trend is mostly likely influenced by the unusually high mean CPUE in 1993. Because the management of the fishery changed from a "derby" style to a shared quota fishery in 1994, the model was rerun using only survey data for 1994-1996. The results showed no significant difference in linear, quadratic or cubic trends between years (P=0.5499, P=0.6327, P=0.3667, respectively).

Bycatch species included 23 halibut, 31 rockfish, 342 thornyheads, and 361 "other." The "other" category includes arrowtooth flounder, sole, and skates. Thornyhead catches dominated the bycatch composition in the two most southern statistical areas of Chatham Strait, 345631 and 345701 (Table 5 and Figure 14). Skates listed in the "other" category were the major bycatch species caught in the northern statistical area, 345731.

All 16 stations were successfully fished in four days on *F/V Ida June*. The mean number of fish/hook was 0.20 (± 0.02, 90% CI), ranging from 0.11 to 0.27 fish/hook (Table 6). A comparison of CPUE between the two boats indicated that variances were unequal (F-test=0.31, df=15,17, P=0.014) and the mean CPUEs were not significantly different (T-test=0.99, df=27, P=0.33; Figure 15).

Biological Characteristics

A total of 316 sablefish were sampled for length, weight, sex, and stage of maturity on the *R/V Medeia*. The average length was 67 cm (±0.89, 95% CI) ranging between 43 and 93 cm. Similar to the distribution of all fish brought on board, the mean length was 67 cm. The length range was 38 cm to 102 cm with a mode of 64 cm (Figure 16). A statistical comparison between mean length for all fish and for a subset of fish, indicated that the variances and means were not significantly different (F-test: F=1.06; df=2,577,314; P=0.25; T-test: t= 1.41; df=2891; P=0.16). Similar to the lengths measured in the SSEI survey, the subsample did not contain the extreme low and high lengths observed from the total population of sablefish brought on board. Mean weight was 3.51 kg (±0.15, 95 % CI) and ranged from 0.91-8.4 kg (Table 7). Fifty percent of the samples were males. Approximately 21% of the sampled sablefish had not spawned previously indicating about 0.04 recruits/hook. An index of the relative strength of younger sablefish in NSEI area was derived by multiplying the overall CPUE (fish/hook) by the proportion of sablefish that were ≤ 59 cm, the length at which 50% of the fish are mature. In 1996, CPUE was 0.08 juvenile sablefish/hook compared to 0.04 and 0.08 fish/hook in 1994 and 1995 respectively.

On the *F/V Ida June*, 197 sablefish were sampled for length, sex, and stage of maturity information. Samples ranged from 48-98 cm in length and mean length was 71cm (±1.3, 95% CI). Length frequency data collected from all fish brought on board showed a mean of 68.2 cm, a range from 39 cm to 102 cm and a mode of 71cm. The mean sablefish length captured on commercial gear was significantly different than the mean length reported on the *R/V Medeia* (T-test stat=4.44, df=357, $P=1.18 \times 10^{-5}$; Figure 17). However, the mean length by station was highly variable on the research vessel (Figure 18). Male sablefish comprised 40.8% of the sample population and 9.2% of the samples were immature fish. The substantial difference in the percent immature between the commercial vessel and the research vessel may be due to the somewhat subjective process of determining the stage of maturity in sablefish. Because several samplers on the research vessel have participated in the survey from the beginning, the coding of

maturity stage is fairly consistent between years on the research vessel. A more thorough description of each stage of maturity will be needed to standardize maturity stage coding with the use of two to three commercial vessels.

The age distribution of the sablefish collected on the *R/V Medeia* in 1996 indicated that the majority of fish were less than 20 years old with the mode at eight years (Figure 19). Ages ranged from one to 43 years and the mean age was 12.4 years. Otoliths taken on the *F/*V *Ida June* were collected but not aged due to time and budgetary constraints.

1997 Survey Design

The reliability of CPUE information derived from one-hour soak is somewhat questionable and continues to undermine our confidence in the research survey results. Several studies conducted to determine the sinking rate of sablefish longline gear (Sigler 1993) showed sink rate varied between 11 to 15 meters per minute. The average station depth in the Clarence survey is 437 m, suggesting that for the first 30 to 40 minutes of the average set, the line is not on the bottom. In another study, catch rates after one-hour, two-hour and three-hour soaks were compared to the catch after a seven-hour soak (Sigler 1993). The proportion of the seven-hour catch was 50%, 70%, and 90-95% for one-hour, two-hour and three-hour soaks respectively. This suggests the possibility that CPUE associated with a one-hour soak time may be partially influenced by soak time. Paired comparisons of CPUE between one-hour and three-hour soaks conducted at the same stations in the NSEI research survey in 1995, showed no strong correlation between CPUEs for the two soak times (Gordon 1996). The results were inconclusive in part because assumptions that habitat (depth) and bait effectiveness were the same in each treatment group may have been violated (see Gordon 1996). Because of the uncertainties surrounding the one-hour soak time, we have decided to switch to a three to eleven hour soak time at each station in 1997.

Three additional proposed changes in the survey design include: 1) the use of commercial vessels to conduct the survey, 2) a change in bait from herring to squid (required for bait retention for longer soak times), and 3) the discontinuation of measuring the length of every sablefish that is captured. The operational costs and personnel time at-sea and associated sea duty costs were substantially reduced using the commercial vessel. The change in bait from herring to squid is necessary because herring tends to disintegrate when soaked for longer than one hour. Statistical analysis of the difference between the mean length of sablefish subsampled for biological data and other fish caught was not significantly different when tested using 1996 NSEI survey data. Because the labor-intensive practice of measuring every sablefish that comes onboard does not add critical information to the biological and stock assessment analysis, it will be dropped from the sampling design.

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Meg Cartwright	Fisheries Biologist II	Crew leader	SSEI NSEI
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***R/V Medeia* Personnel**		
Wade Loofbourrow	Boat Officer III	Captain
Pat Kellen	Boat Officer II	First Mate
Helmer Olson	Boat Officer I	First Mate (Alt.)
Russell Sandstrom	Boat Officer I	Crew
Becky Wilson	Fisheries and Wildlife Tech. II	Crew

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Table 1. Set and catch information for the 36 stations fished in the 1996 SSEI sablefish longline survey.

Location	Station	Beginning Latitude	Beginning Longitude	Ending Latitude	Ending Longitude	Soak Time (Min.)	Average Depth (fm)	Number Of Sablefish	Average rd. wt. (kg)	CPUE Fish/Hook	Variance 2 SE	CPUE kg/Hook	Hooks
Cape Chacon	2	5441.06	13154.25	5439.77	13154.53	63	199	79	2.09	0.16	0.02	0.34	490
W Devil Rock	3	5443.82	13143.85	5442.87	13144.63	59	208	42	0.85	0.09	0.02	0.07	493
W Devil Rock	4	5443.31	13144.05	5444.36	13144.42	60	209	26	0.87	0.05	0.02	0.05	498
W Devil Rock	5	5446.40	13142.80	5447.39	13142.73	61	225	47	2.46	0.09	0.02	0.23	498
Mclean Point	6	5447.80	13150.58	5446.73	13150.78	61	214	36	1.28	0.07	0.02	0.09	498
West Rock	10	5447.31	13141.90	5448.49	13142.30	60	242	30	2.07	0.06	0.02	0.12	502
Hassler Reef	11	5448.37	13141.79	5449.54	13141.79	59	257	40	2.00	0.08	0.03	0.16	502
Island Pt	12	5448.99	13152.86	5447.52	13153.22	61	214	59	2.01	0.12	0.03	0.24	493
Hassler Reef	14	5451.89	13142.70	5450.75	13142.85	60	227	39	1.42	0.08	0.02	0.11	505
Kendrick Is	15	5452.71	13156.57	5451.46	13156.33	61	231	30	1.37	0.06	0.03	0.08	504
Kendrick Is	16	5453.51	13155.80	5454.68	13155.87	60	230	35	1.48	0.07	0.02	0.10	499
Kendrick Is	17	5454.46	13151.52	5455.45	13151.59	59	227	43	2.55	0.09	0.05	0.22	498
Hidden Bay	18	5455.42	13148.20	5454.42	13148.27	60	225	56	1.43	0.11	0.03	0.17	485
Pt. Davidson	20	5500.77	13143.19	5459.58	13142.86	60	217	20	1.13	0.04	0.02	0.05	492
Rip Point	21	5502.64	13149.04	5501.30	13149.15	62	223	58	1.02	0.11	0.02	0.12	508
Dall Head	26	5509.84	13154.31	5511.21	13154.46	62	216	51	2.80	0.17	0.04	0.48	299
Chasina Point	30	5518.72	13155.85	5517.58	13156.13	60	231	48	3.10	0.10	0.03	0.30	504
Skin Island	31	5518.87	13159.60	5519.87	13200.20	60	239	35	1.18	0.07	0.03	0.08	501
Chasina Point	33	5520.65	13158.92	5521.78	13158.98	60	221	14	0.65	0.03	0.01	0.02	496
Vallenar Point	35	5525.47	13159.11	5524.30	13158.89	61	247	48	2.28	0.10	0.04	0.22	496
Vallenar Point	36	5524.50	13156.81	5525.50	13157.98	60	249	99	2.26	0.20	0.05	0.45	498
Caamano Point	37	5529.53	13201.53	5528.70	13200.17	61	221	66	2.34	0.13	0.04	0.31	495
Niblack Point	39	5530.28	13207.82	5531.46	13208.34	60	276	115	2.43	0.23	0.04	0.56	497
Niblack Point	41	5532.40	13207.76	5531.82	13206.43	60	264	64	2.85	0.13	0.03	0.37	499
Niblack Point	43	5532.18	13210.89	5532.80	13212.58	60	217	86	2.12	0.17	0.04	0.37	496
Ship Island	44	5534.72	13214.42	5533.77	13213.58	60	265	147	2.24	0.29	0.06	0.65	503
Ship Island	46	5535.57	13215.59	5536.43	13216.34	61	323	52	1.85	0.10	0.03	0.19	498
Ship Island	47	5536.11	13217.26	5535.14	13216.44	64	284	94	2.16	0.19	0.05	0.41	496
Ship Island	48	5537.39	13215.27	5536.35	13214.64	60	338	56	2.55	0.11	0.05	0.29	499
Tolstoi Pt	49	5538.60	13217.08	5537.58	13216.50	61	338	49	1.75	0.10	0.03	0.17	491
Tolstoi Pt	50	5538.22	13218.86	5539.38	13219.06	61	350	53	3.06	0.11	0.05	0.33	499
Cape Muzon	52	5431.03	13240.65	5430.63	13239.36	72	179	41	3.60	0.08	0.03	0.30	485
Cape Muzon	53	5428.01	13233.65	5427.99	13234.83	61	204	54	2.23	0.11	0.04	0.25	479
Cape Muzon	54	5428.64	13222.41	5428.27	13224.28	73	198	100	2.68	0.21	0.07	0.55	484
Cape Chacon	55	5429.43	13149.02	5430.14	13147.67	62	190	9	1.65	0.02	0.01	0.03	501
Cape Chacon	56	5430.58	13148.97	5431.01	13147.06	62	190	3	0.90	0.01	0.01	0.01	504
Average							239	53	1.96	0.11	0.03	0.24	
Maximum							350	147	3.60	0.29	0.07	0.65	
Minimum							179	3	0.65	0.01	0.01	0.01	
Total								1924					

*variance calculated between sections (n=5 per set)

Table 2. 1996 SSEI sablefish survey catch by species and station.

Station	Area	Sablefish	Dogfish	Halibut	Thornyheads	Rockfish	Other
2	So. Clarence	79	13	7	4	0	6
3	So. Clarence	42	40	1	9	0	16
4	So. Clarence	26	37	4	9	0	19
5	So. Clarence	47	84	1	6	0	3
6	So. Clarence	36	20	1	6	0	10
10	So. Clarence	30	163	2	0	0	5
11	So. Clarence	40	116	0	0	0	2
12	So. Clarence	59	40	2	13	0	6
14	So. Clarence	39	124	3	23	0	17
15	So. Clarence	30	29	0	13	0	6
16	So. Clarence	35	22	0	9	0	4
17	So. Clarence	43	53	0	14	0	11
18	So. Clarence	56	72	0	6	0	2
20	So. Clarence	20	11	0	14	0	14
21	Central Clarence	58	8	3	10	0	13
26	Central Clarence	51	16	7	5	0	12
30	Central Clarence	48	51	1	5	0	6
31	Central Clarence	35	2	1	1	1	48
33	Central Clarence	14	5	0	13	0	5
35	Central Clarence	48	16	1	14	0	6
36	Central Clarence	99	44	4	4	1	9
37	Central Clarence	66	28	29	5	3	34
39	No. Clarence	115	6	5	4	0	11
41	No. Clarence	64	9	7	4	5	7
43	No. Clarence	86	5	7	13	0	20
44	No. Clarence	147	6	2	5	1	10
46	No. Clarence	52	1	0	1	1	18
47	No. Clarence	94	7	0	3	0	5
48	No. Clarence	56	11	1	0	1	4
49	No. Clarence	49	1	0	0	2	22
50	No. Clarence	53	15	0	2	0	6
52	Dixon Entrance	41	12	9	28	1	20
53	Dixon Entrance	54	10	25	11	0	19
54	Dixon Entrance	100	16	22	12	0	12
55	Dixon Entrance	9	242	0	1	0	1
56	Dixon Entrance	3	218	0	2	0	1
Total		1924	1553	145	269	16	410

Table 3. Summary of SSEI survey data.

Year	1988	1989	1990	1991	1992	1993	1994	1995	1996
CPUE (fish/hook)	0.14	0.09	0.08	0.1	0.1	0.11	0.14	0.11	0.11
Mean length (cm)	55.7	62.2	61.4	59.6	59.2	59.9	59.3	59.1	58.8
Range	40-97	48-97	45-93	41-94	44-86	42-90	41-82	41-80	43-82
Mean weight (kg)	1.83	2.68	2.57	2.27	2.33	2.30	2.14	2.16	2.11
Range	0.6-9.2	0.9-10.4	0.9-8.0	0.6-9.8	0.7-6.5	0.6-6.8	0.7-5.9	0.7-5.7	0.6-5.6
Mean age	7.2	12.0	11.7	8.4	12.0	10.2	10.9	14.0	11.1
Range	2-39	2-44	3-46	2-34	2-51	2-32	1-60	2-50	2-52
% Male	56.8	51.1	56.5	60.0	53.3	57.5	53.5	55.2	68.8
% Immature	68.4	30.0	32.8	48.8	46.7	48.6	45.1	51.6	49.8
Sample N	421	207.0	161	188	167	186	275	217	208

Table 4. Set and catch information for the 36 stations fished in the 1996 NSEI sablefish longline survey.

Location	Station	Date	Beginning Latitude	Beginning Longitude	Ending Latitude	Ending Longitude	Soak Time (min)	Avg Depth (fm)	Number Sablefish	CPUE Fish/Hook	Variance* (2SE)	Average rd. wt.(lb.)	CPUE kg/Hook
Patterson Pt	1	8/17/96	5632.61	13434.66	5631.26	13434.44	60	288	81	0.16	0.06	7.1	1.16
Patterson Pt	2	8/17/96	5633.54	13435.22	5634.74	13435.42	60	264	71	0.14	0.07	6.9	0.97
Patterson Pt	3	8/17/96	5633.58	13430.97	5634.83	13430.95	60	360	47	0.09	0.07	7.2	0.68
Washington Bay	4	8/19/96	5641.29	13434.72	5639.88	13434.81	64	369	106	0.21	0.07	6.6	1.40
Washington Bay	5	8/19/96	5641.52	13433.33	5642.39	13433.26	60	378	62	0.12	0.06	9.2	1.14
Washington Bay	6	8/18/96	5642.05	13425.7	5640.68	13425.74	61	242	81	0.16	0.06	8.4	1.37
Hoggatt Bay	7	8/18/96	5642.39	13425.91	5643.3	13426.02	60	239	83	0.17	0.07	9.9	1.66
Gut Bay	8	8/19/96	5643.06	13433.42	5644.16	13433.25	60	393	43	0.09	0.07	7.1	0.61
Gut Bay	9	8/18/96	5644.54	13428.8	5645.79	13428.73	61	347	42	0.08	0.07	8.8	0.74
Gut Bay	10	8/18/96	5648.65	13432.08	5647.64	13432.18	60	383	38	0.08	0.08	7.1	0.55
Red Bluff Bay	13	8/20/96	5649.83	13431.04	5651.09	13431.25	60	221	66	0.13	0.07	8.2	1.09
Yasha Island	15	8/20/96	5654.65	13438.89	5653.47	13438.67	60	360	109	0.22	0.08	7.4	1.61
Kingsmill Pt	16	8/20/96	5654.49	13433.26	5653.66	13433.16	60	339	58	0.12	0.08	9.6	1.12
Cascade Bay	19	8/23/96	5701.42	13443.71	5702.41	13444.07	60	345	59	0.12	0.08	5.6	0.66
Warm Springs	21	8/23/96	5707.11	13442.27	5706.07	13442.19	60	349	58	0.12	0.08	8.2	0.95
White Cliff	22	8/23/96	5711.63	13448.4	5710.56	13447.82	60	317	110	0.22	0.09	8.9	1.97
Wilson Cove	23	8/24/96	5711.61	13440.83	5712.75	13440.59	59	330	26	0.05	0.08	10.5	0.54
Pt Caution	24	8/24/96	5714.16	13440.73	5713.24	13440.63	60	292	67	0.13	0.09	10.0	1.35
Woody Point	25	8/24/96	5716.86	13439.12	5715.76	13439.21	60	230	125	0.25	0.09	7.7	1.94
Chaik Bay	27	8/25/96	5719.17	13444.3	5718.2	13444.34	59	428	25	0.05	0.09	9.2	0.46
Village Point	28	8/25/96	5719.64	13442.73	5718.67	13442.78	60	283	49	0.10	0.08	7.6	0.75
Point Lull	29	8/25/96	5719.83	13437.09	5720.82	13436.95	60	294	91	0.23	0.08	6.9	1.56
Point Lull	30	8/25/96	5720.53	13439.34	5721.47	13439.45	60	300	79	0.16	0.08	10.2	1.64
Fishery Point	32	8/31/96	5724.21	13445.8	5722.94	13445.68	60	361	138	0.27	0.08	7.9	2.15
S Passage Point	33	8/31/96	5725.48	13441.59	5726.72	13441.58	60	295	79	0.16	0.08	6.1	0.97
Fishery Creek	35	8/30/96	5731.5	1.34E+07	5732.61	13441.8	60	257	117	0.23	0.08	8.5	1.99
Basket Bay	37	8/30/96	5732.4	13445.11	5733.63	13445.13	59	330	92	0.19	0.08	8.2	1.52
S Passage Point	39	8/30/96	5735.81	13442.87	5734.78	13442.16	60	226	152	0.38	0.09	5.8	2.23
S Passage Point	41	8/29/96	5741.38	13452.37	5740.2	13452.35	60	310	67	0.14	0.08	7.8	1.05
Parker Point	42	8/29/96	5742.79	13452.98	5743.9	13453.08	60	296	76	0.15	0.08	7.4	1.12
White Rock	43	8/28/96	5744.28	13445.72	5745.49	13445.96	60	291	73	0.15	0.08	10.8	1.62
Danger Point	44	8/29/96	5745.04	13448.72	5746.28	13448.74	60	279	66	0.13	0.08	5.3	0.70
Pt Thatcher	45	8/28/96	5745.98	13450.12	5747.21	13450.11	60	290	102	0.20	0.08	5.7	1.17
Distant Point	46	8/28/96	5749.18	13448.71	5748.11	13448.67	60	264	113	0.23	0.08	7.0	1.59
Fishery Point	49	8/27/96	5751.57	13447.14	5752.65	13446.93	60	275	183	0.37	0.09	5.2	1.90
Fishery Point	51	8/27/96	5755.28	13447.82	5756.4	13448.13	60	284	94	0.19	0.05	8.9	1.69
Average								309	81	0.17	0.08	7.9	1.27
Maximum								428	183	0.38	0.09	10.8	2.23
Minimum								221	25	0.05	0.05	5.2	0.46
Total									2928				

*Variance Calculated Between Sections (N=5 Per Set)

Table 5. 1996 NSEI sablefish survey catch by species and station.

Station	Area	Sablefish	Halibut	Thornyhead Rockfish	Other Rockfish	Spiny Dogfish	Other
1	Central Chatham Strait	81	1	12	0	0	10
2	Central Chatham Strait	71	0	12	0	0	8
3	Central Chatham Strait	47	0	20	0	0	7
4	Central Chatham Strait	106	0	3	0	0	4
5	Central Chatham Strait	62	0	0	0	0	5
6	Central Chatham Strait	81	0	11	0	0	3
7	Central Chatham Strait	83	1	9	1	0	16
8	Central Chatham Strait	43	0	4	0	0	3
9	Central Chatham Strait	42	0	17	5	0	4
10	Central Chatham Strait	38	0	9	0	0	2
13	Central Chatham Strait	66	1	14	4	0	1
15	Central Chatham Strait	109	0	7	0	0	7
16	Central Chatham Strait	58	0	12	2	0	7
18	Central Chatham Strait	4	0	3	0	0	5
19	Central Chatham Strait	59	0	5	0	0	4
21	Central Chatham Strait	58	5	5	0	0	12
22	Central Chatham Strait	110	0	9	0	0	11
23	Central Chatham Strait	26	0	12	0	0	3
24	Central Chatham Strait	67	0	20	1	0	11
25	Central Chatham Strait	125	2	15	0	0	35
27	Central Chatham Strait	25	0	5	0	0	8
28	Central Chatham Strait	49	0	27	2	0	3
29	Central Chatham Strait	91	0	9	0	0	11
30	Central Chatham Strait	79	0	12	12	0	5
32	Central Chatham Strait	138	0	19	0	0	9
33	Northern Chatham Strait	79	0	2	0	0	19
35	Northern Chatham Strait	117	2	16	2	0	7
37	Northern Chatham Strait	92	0	4	0	0	6
39	Northern Chatham Strait	146	0	3	0	1	8
41	Northern Chatham Strait	67	0	5	0	0	12
42	Northern Chatham Strait	76	2	6	0	0	8
43	Northern Chatham Strait	73	0	5	0	0	15
44	Northern Chatham Strait	66	0	14	0	0	8
45	Northern Chatham Strait	102	0	3	0	0	10
46	Northern Chatham Strait	113	1	4	0	0	16
49	Northern Chatham Strait	183	1	6	0	0	25
51	Northern Chatham Strait	94	1	1	0	0	10
		2926	17	340	29	1	338

Table 6. Set and catch information for the 16 stations fished by the *F/V Ida June* in Northern Chatham Strait.

Location	Station	Date	Start Latitude	Start Longitude	Depth (fa)	Number Sablefish	CPUE (fish/hk.)
Takahtz	1	8/22/97	5721.85	13441.14	340	145	0.19
Graystone	2	8/22/97	5736.22	13448.15	240	147	0.20
Kelp	3	8/22/97	5713.49	13449.18	435	206	0.27
Woody Pt	4	8/21/97	5732.33	13444.23	275	135	0.18
Rocky Pt	5	8/21/97	5740.05	13447.73	310	134	0.18
Village Pt	6	8/21/97	5717.26	13439.56	325	159	0.21
White Rk	9	8/20/97	5708.55	13444.64	315	164	0.22
Parker Pt	11	8/20/97	5715.96	13444.37	275	206	0.27
Basket Bay	12	8/20/97	5745.93	13451.65	230	100	0.13
Fishery Creek	13	8/19/97	5723.82	13437.57	270	162	0.22
So. Passage Pt	14	8/19/97	5746.11	13453.64	275	134	0.18
So. Passage Pt	15	8/19/97	5718.46	13438.12	300	164	0.22
East Pt	16	8/19/97	5743.16	13445.47	225	86	0.11
Parker Pt	10*	8/20/97	5737.03	13445.47	325	128	0.17
Distant Pt	7*	8/21/97	5712.00	13445.47	250	182	0.24
Waterfall	8*	8/22/97	5749.21	13455.29	325	126	0.17
Average					295	149	0.20
Maximum					435	206	0.27
Minimum					225	86	0.11

*Stations Relocated From Original Stations.
Soak Time: 3.5-7 Hours
Bait: Squid

Table 7. Summary of NSEI survey the biological data 1988-1996.

	1988	1989	1990	1991	1992	1993	1994	1995	1996
CPUE (fish/hook)	0.23	0.13	0.12	0.16	0.11	0.23	0.17	0.15	0.16
Mean length (cm)	68.1	67.6	68.4	68.8	69.8	66.9	66.6	66.1	67.5
Range	50.2-95.3	51.7-98.5	51.5-97.2	53.8-109.5	51.5-102.2	38.0-110.0	44.0-109.0	41.0-106.0	38.0-102.0
Mean weight (kg)	3.5	3.4	3.6	3.6	3.8	3.4	3.4	3.2	3.5
Range	1.00-10.20	1.50-11.90	1.20-10.20	1.50-14.00	1.10-12.30	1.10-10.40	0.90-14.50	0.80-11.30	0.91-8.39
Mean age	13.8	12.6	12.8	13.1	17.6	15.8	12.7	13.7	12.3
Range	2-60	3-52	3-49	2-44	2-60	1-60	2-88	2-52	1-43
% Male	0.52	0.5	0.58	0.55	0.44	0.56	0.45	0.62	0.50
% Immature	0.12	0.1	0.09	0.06	0.09	0.18	0.26	0.22	0.21
Sample size	314	248	222	290	212	410	339	250	316

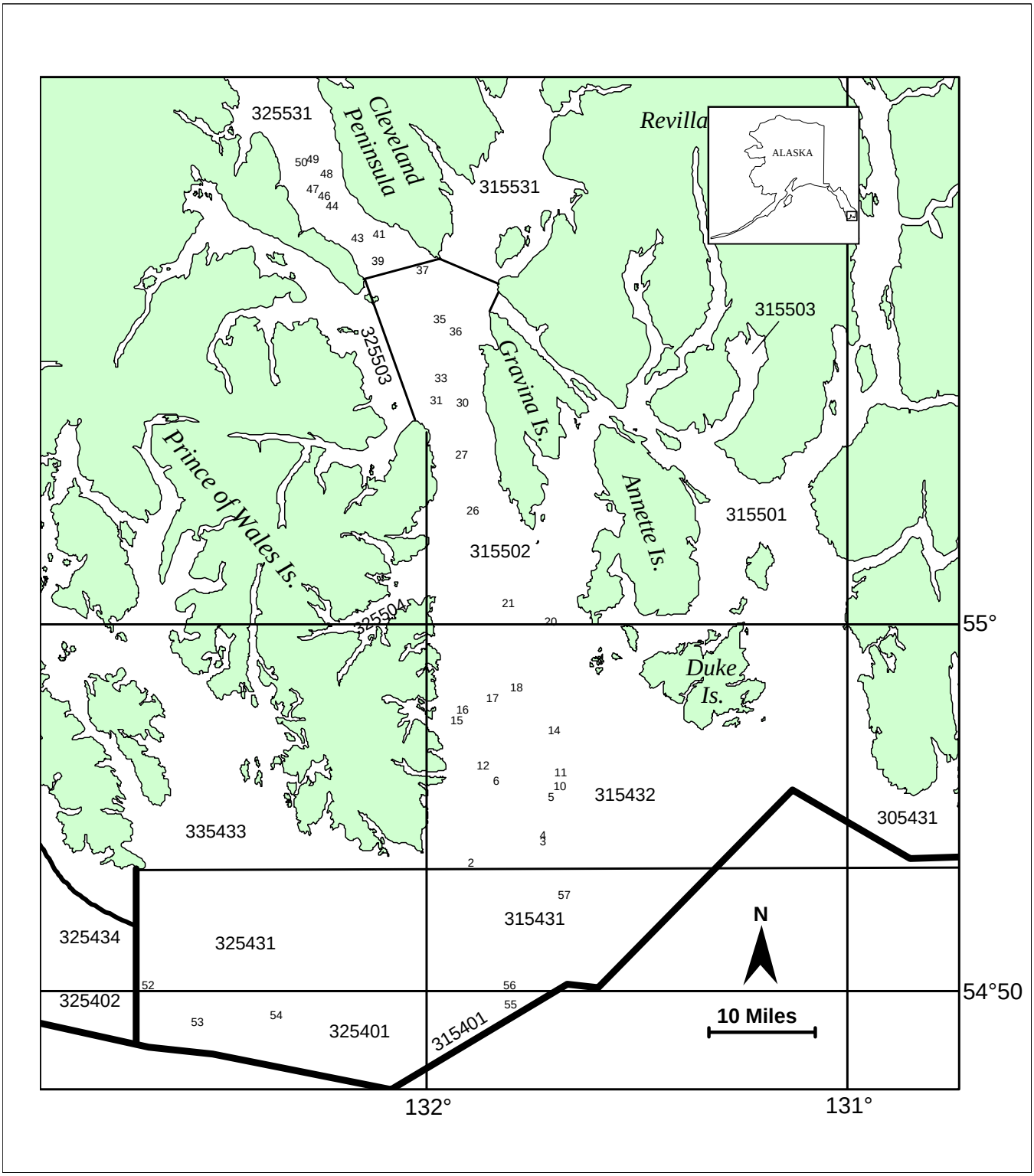

Figure 1. Southern Southeast Inside (SSEI) sablefish longline survey area including station locations (small numbers) within groundfish statistical areas (large six-digit numbers).

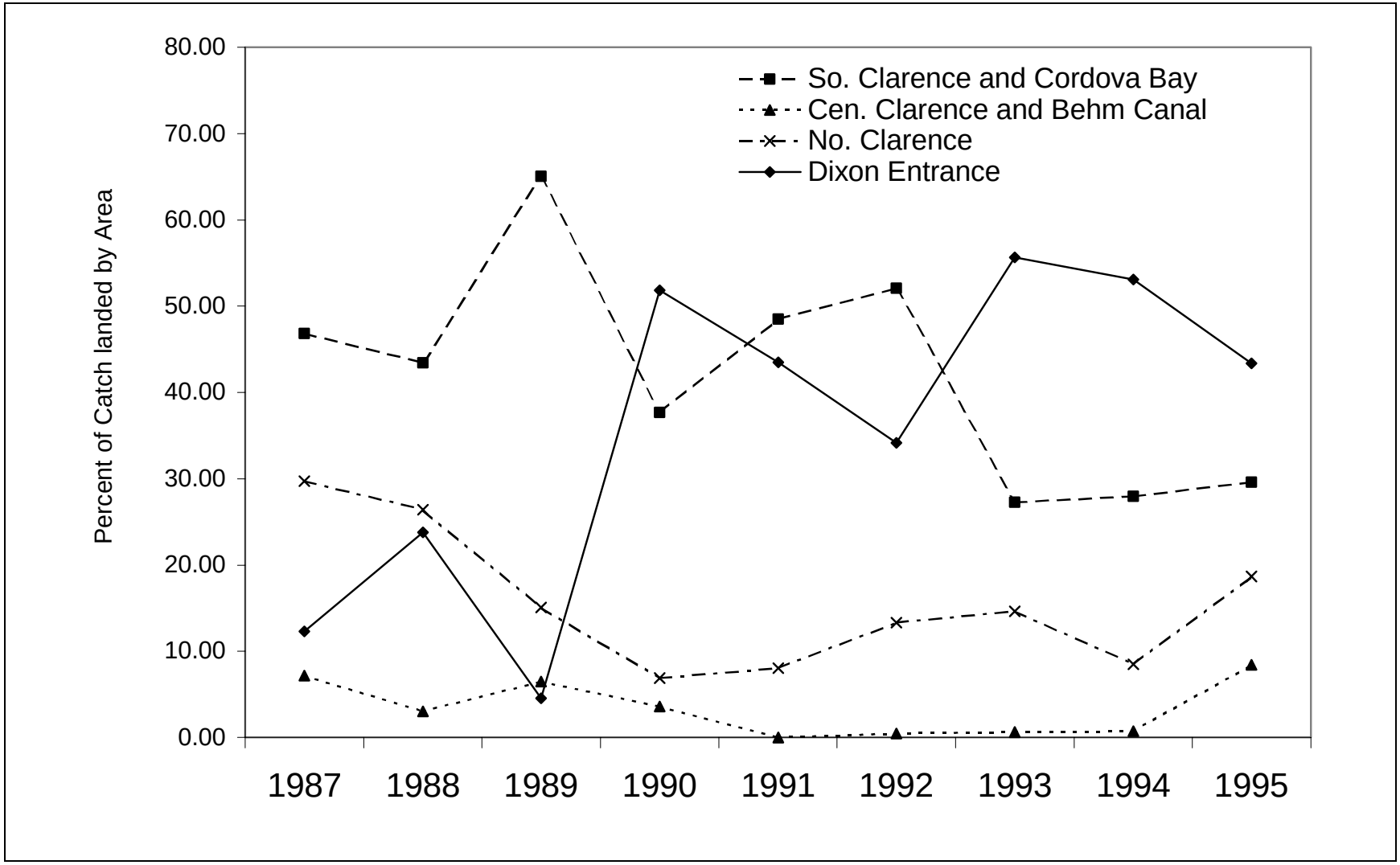

Figure 2. Percent of sablefish commercial catch landed by area from 1987-1995.

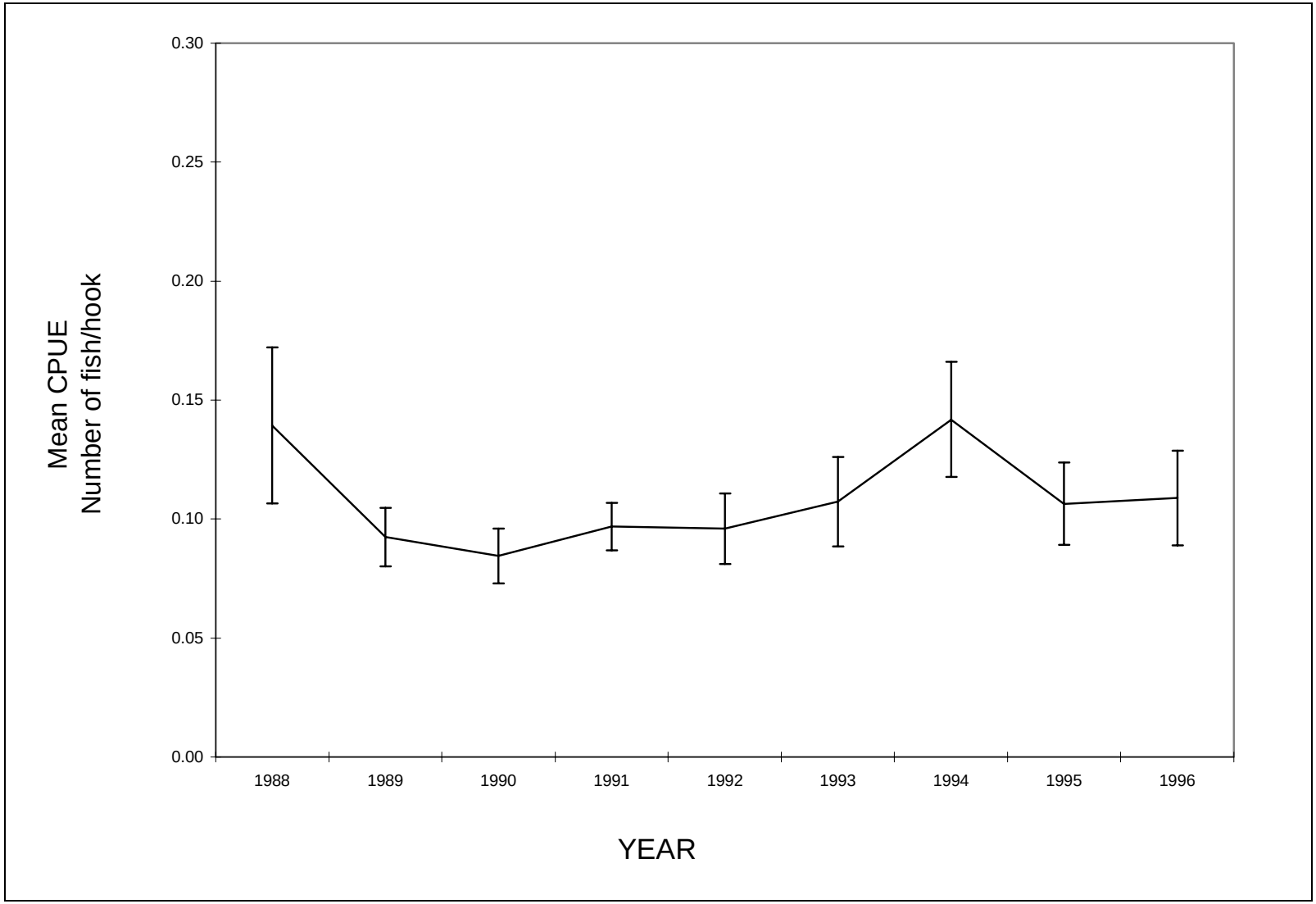

Figure 3. SSEI survey CPUE (fish/hook), 1988-1996. Error bars represent a 90% confidence interval.

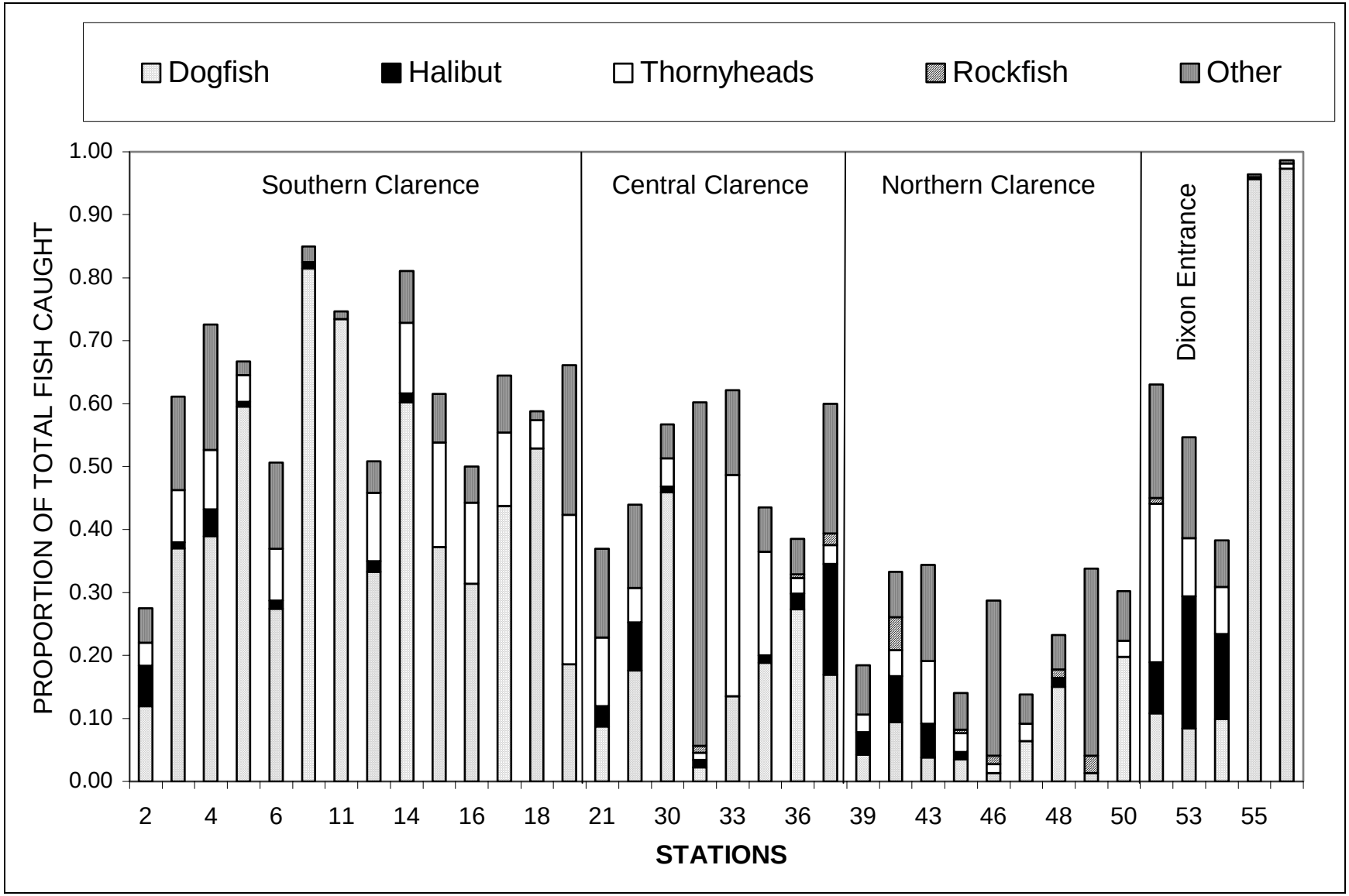

Figure 4. 1996 SSEI Proportion of by-catch by species, station and area. The remaining proportion is sablefish (not shown).

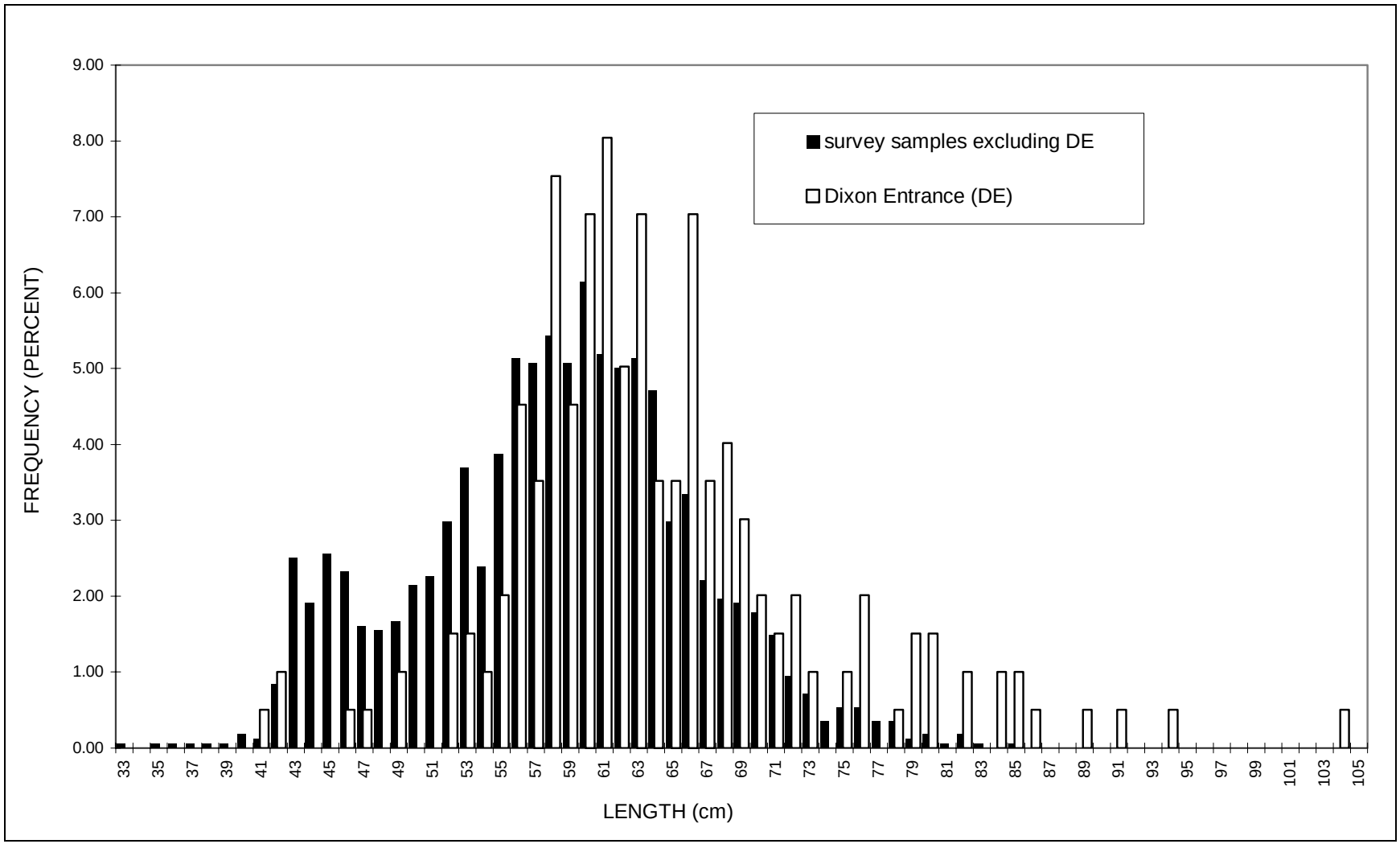

Figure 5. Sablefish length distribution for Dixon Entrance sets compared to fish caught in Clarence Strait.

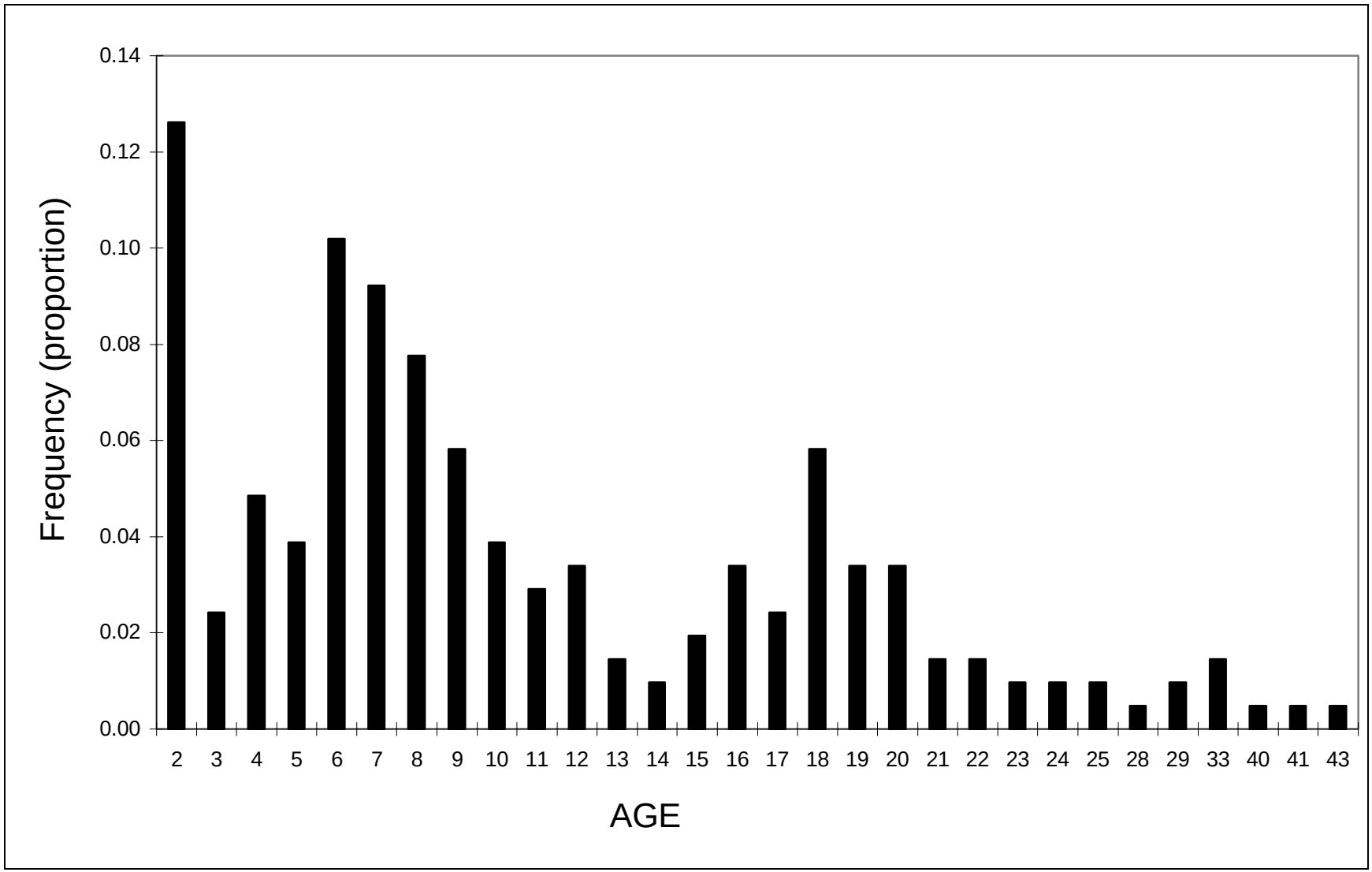

Figure 6. SSEI 1996 age frequency distribution by proportion.

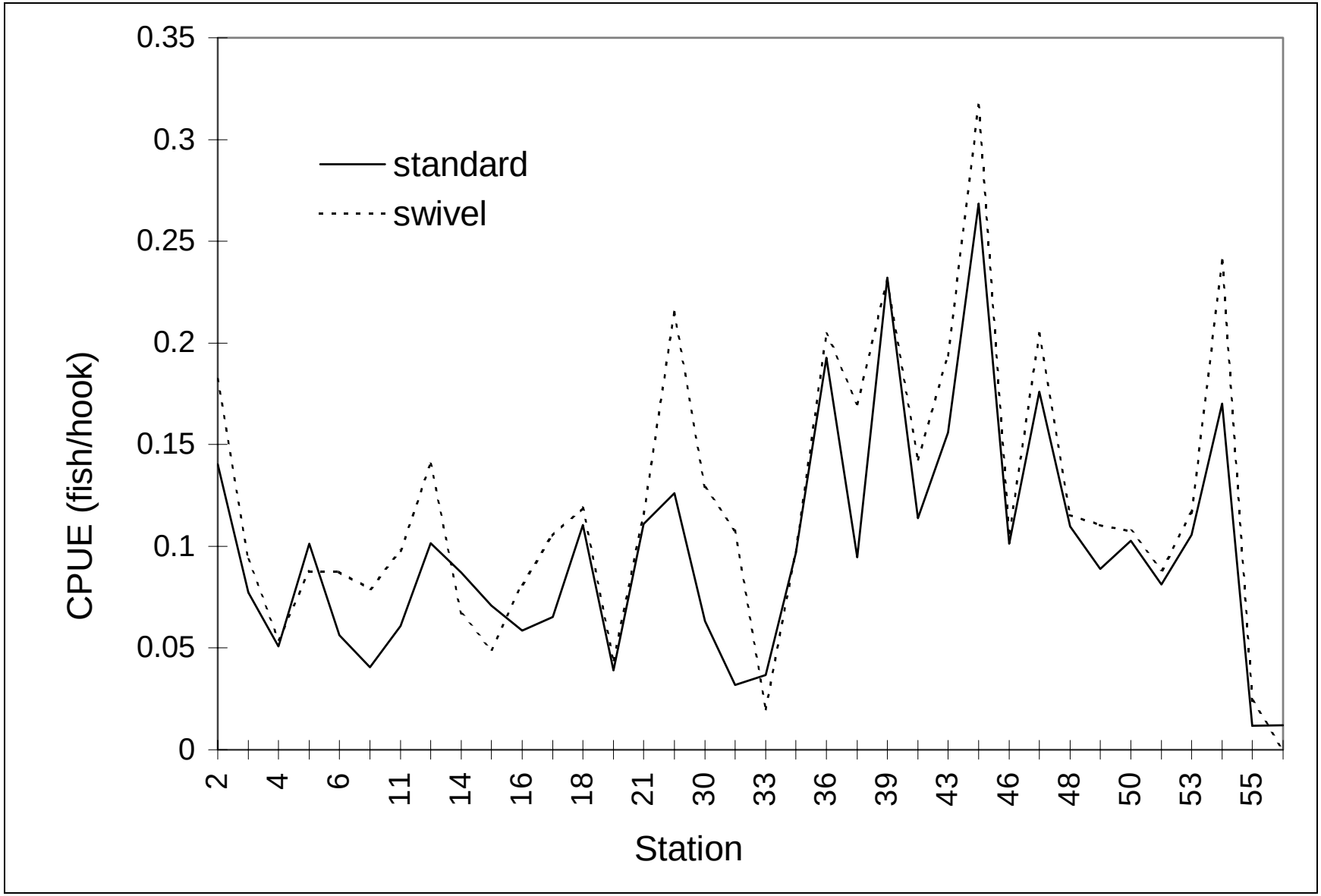

Figure 7. CPUE per station for swivel and standard hook types.

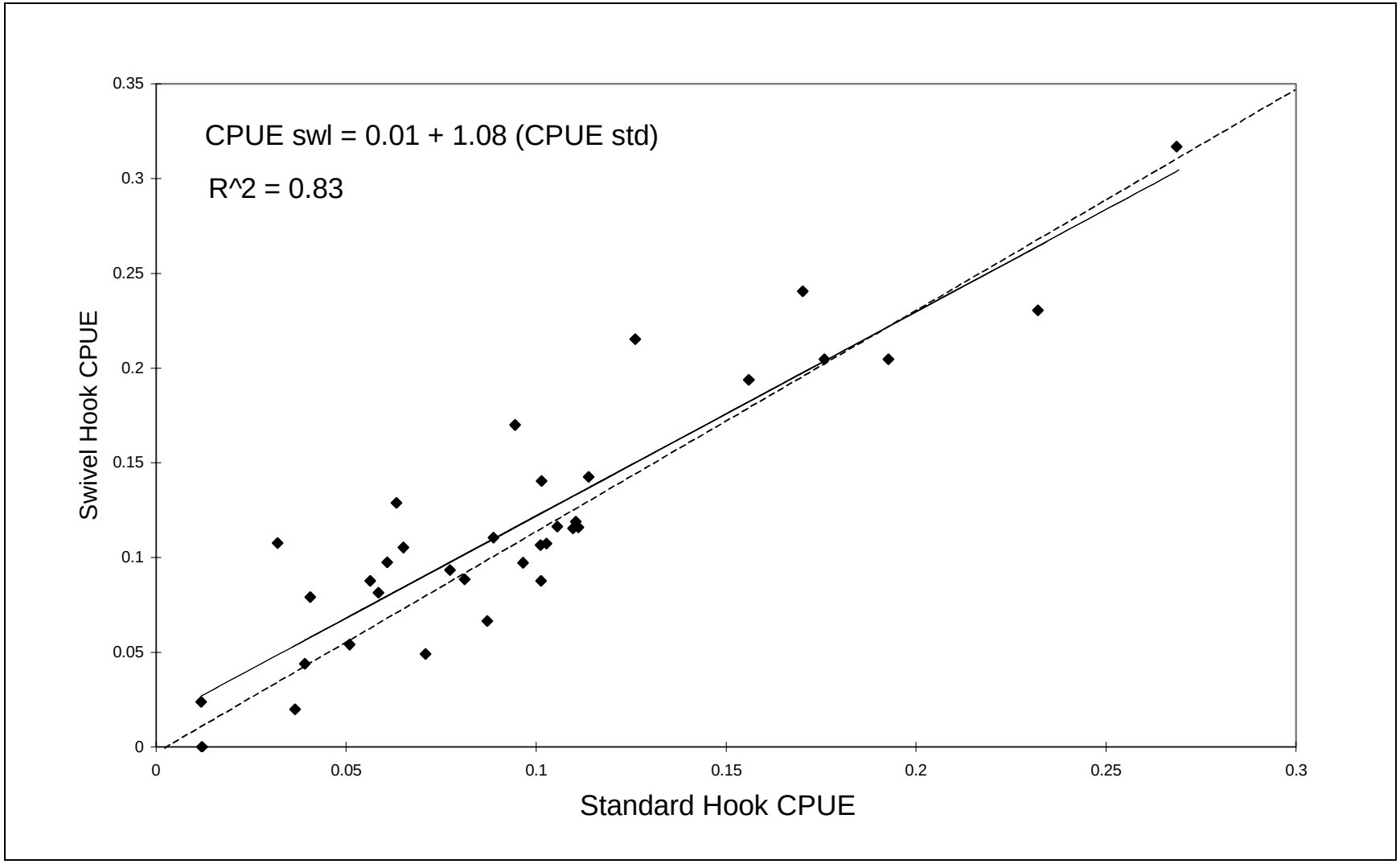

Figure 8. Regression of CPUE of standard hook versus CPUE of swivel hook.

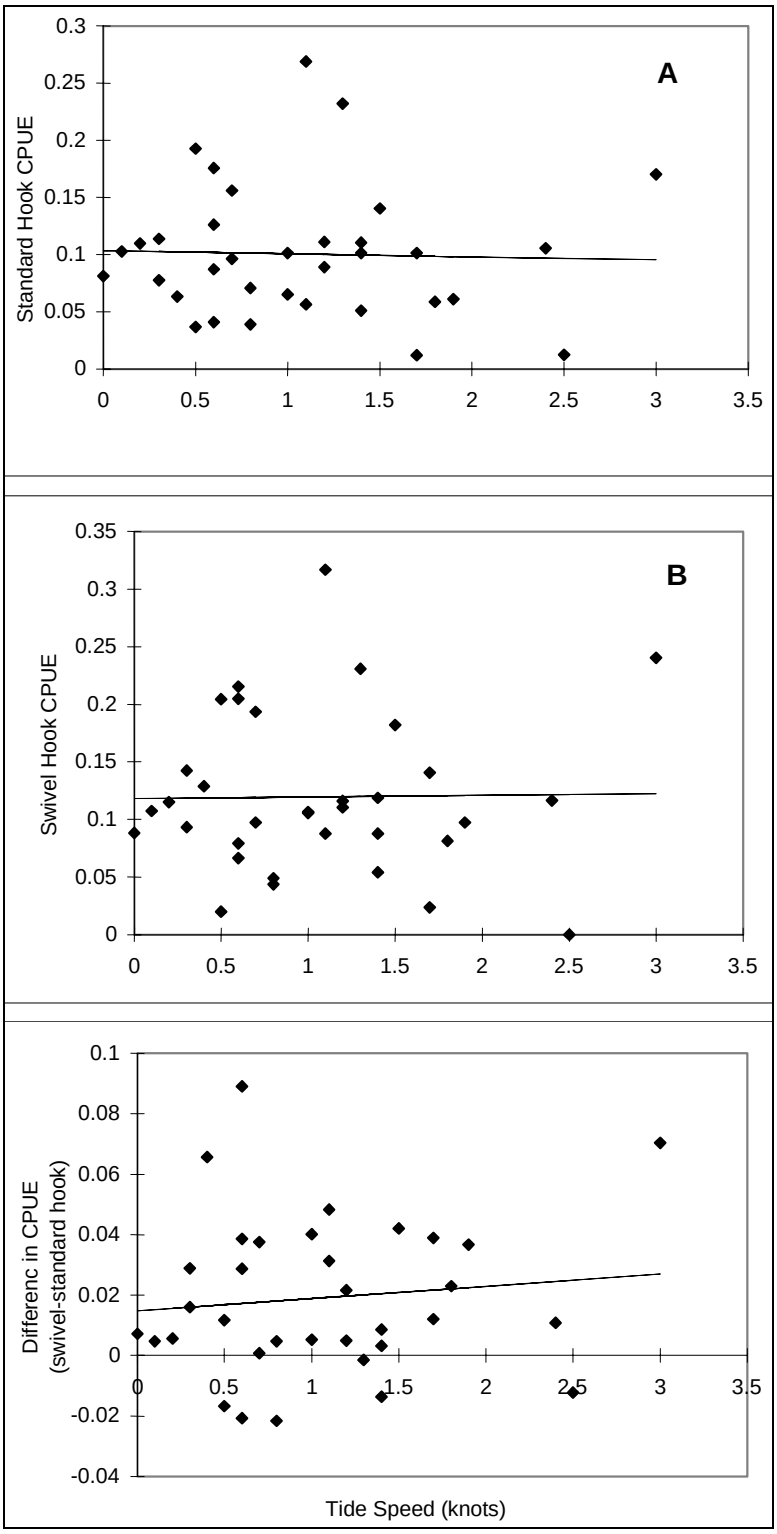

Figure 9. The relationship between standard (A) and swivel (B) hook CPUE (fish/hook) and tide speed and the regression of the difference between CPUE on tide speed (C).

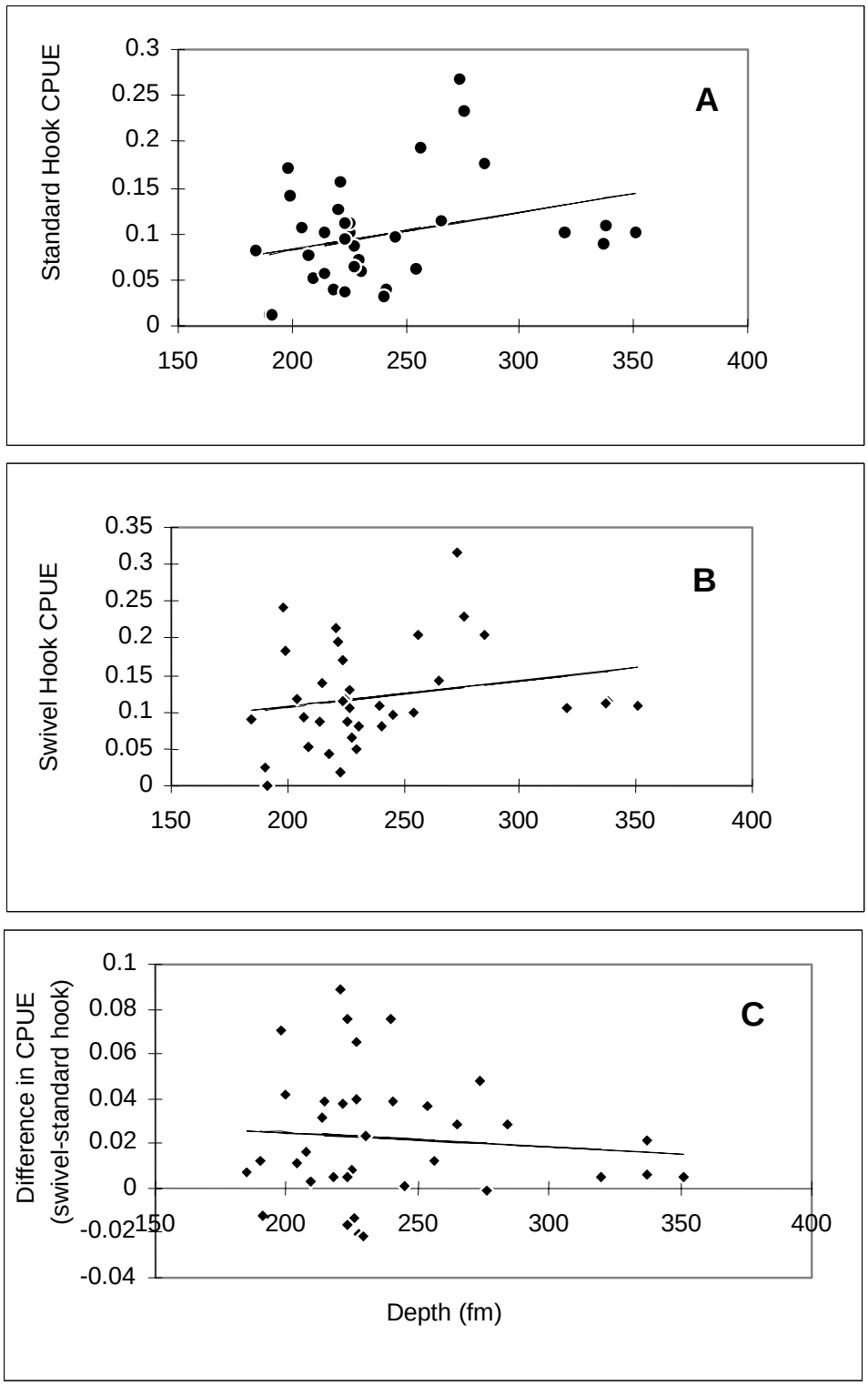

Figure 10. The relationship between standard (A) and swivel (B) hook CPUE (fish/hook) and fishing depth and the regression of the difference between CPUE on depth (C).

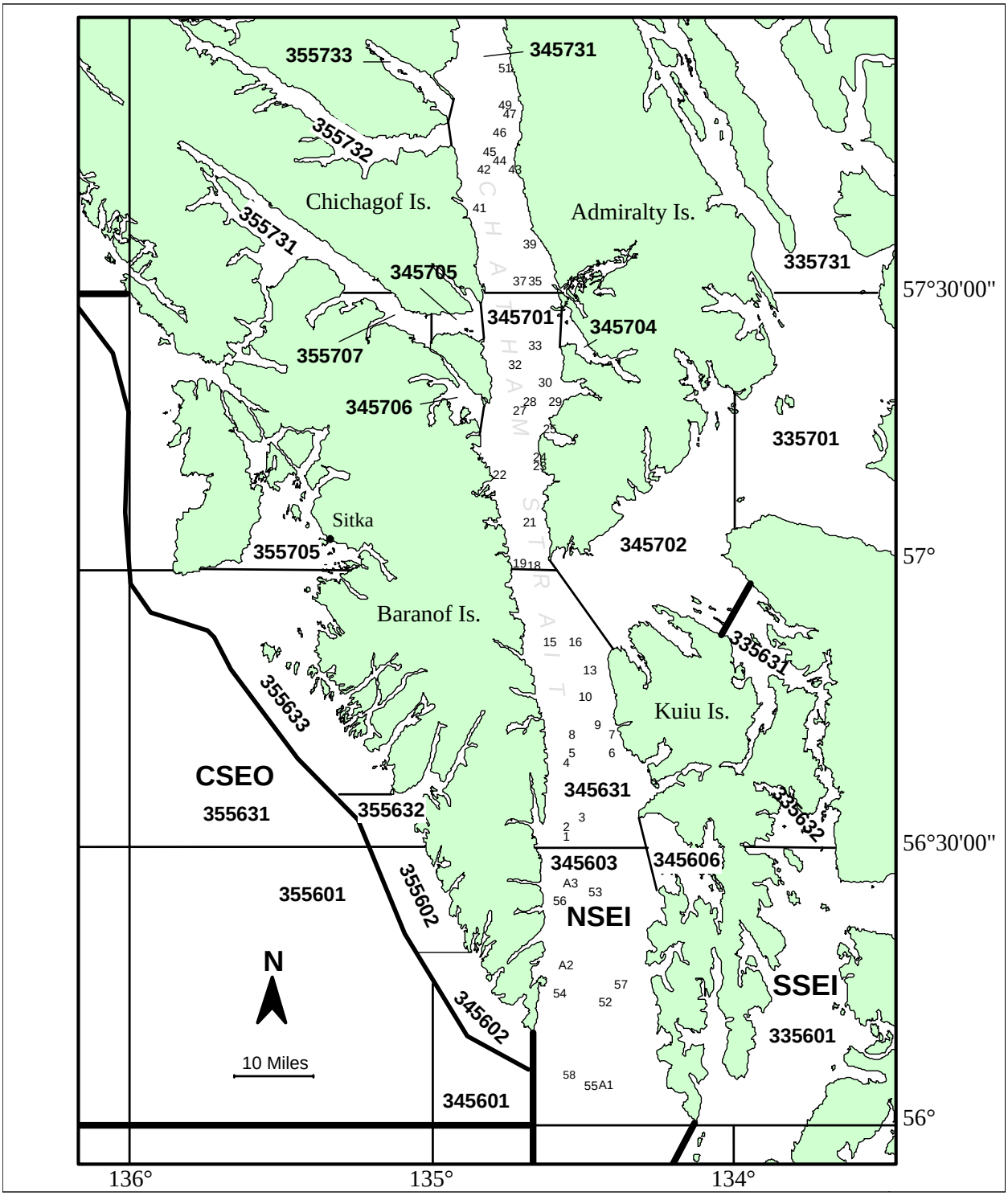

Figure 11. Chatham Strait survey station locations. Numbered marks represent location of stations within each groundfish statistical area.

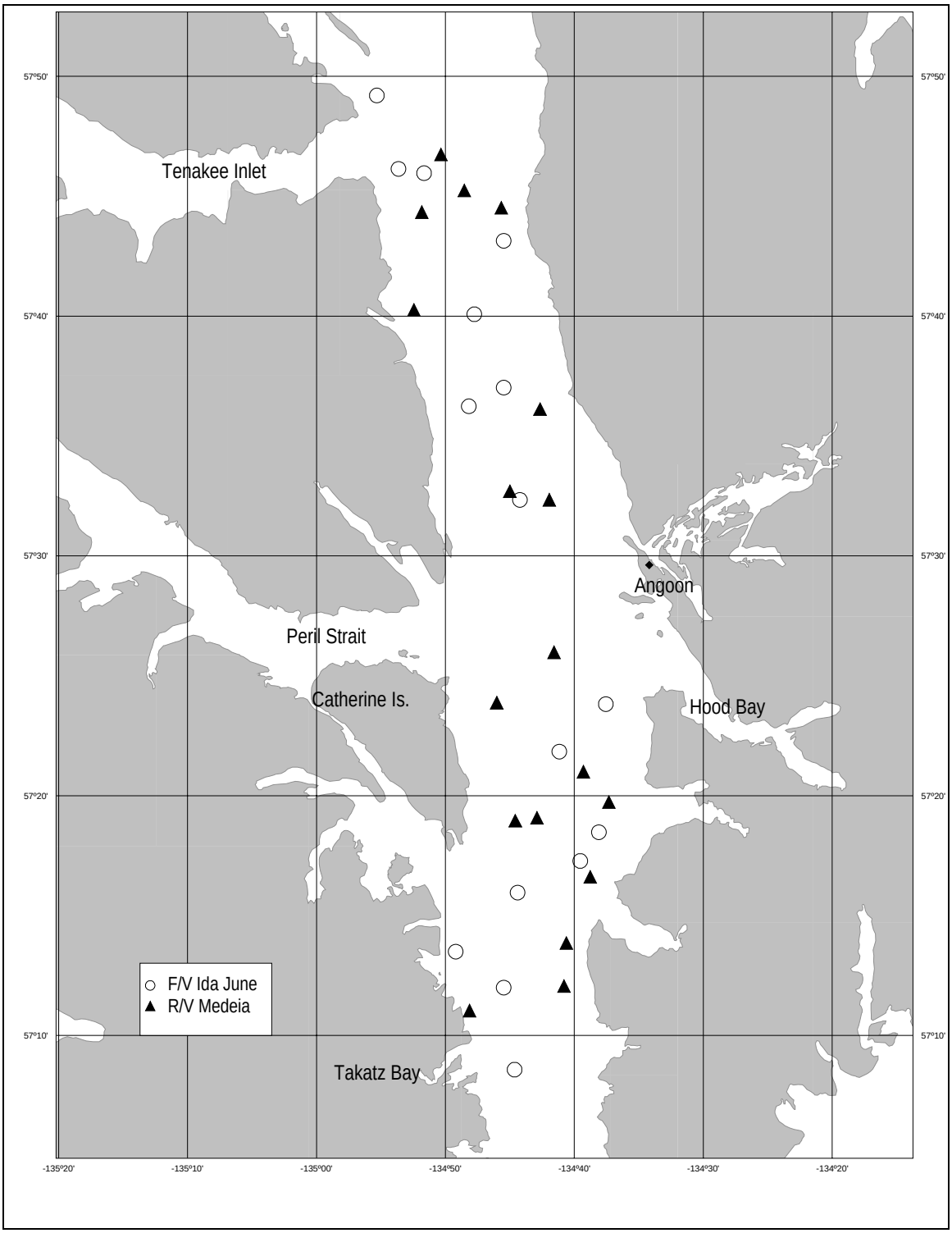

Figure 12. Map of the northern portion of NSEI management area showing the stations fished each year in the NSEI longline survey (▲) and the sixteen randomly selected stations fished by the commercial boat (O).

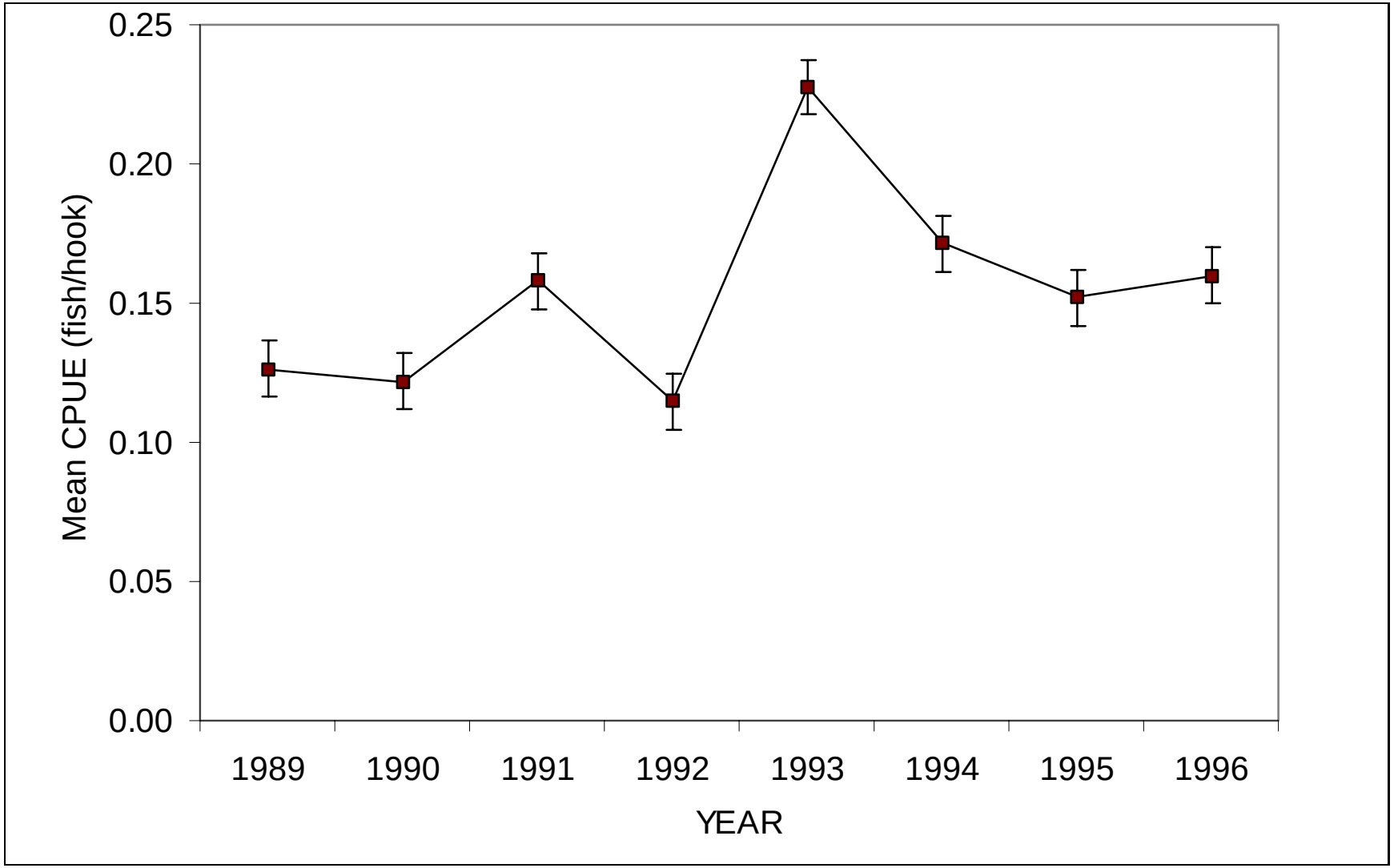

Figure 13. NSEI survey CPUE from 1989-1996. Error bars represent a 90% confidence interval.

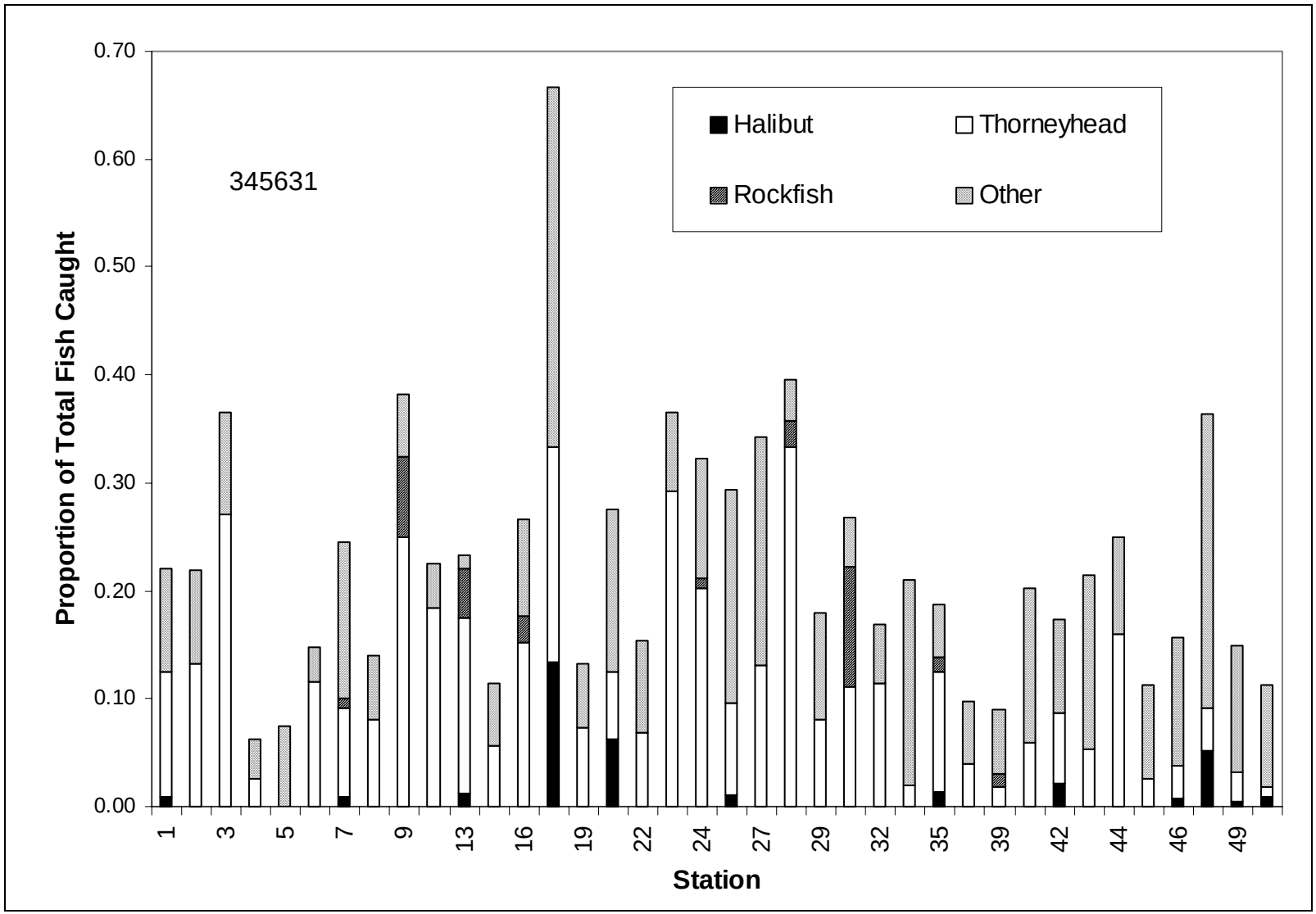

Figure 14. The proportion of bycatch by species caught in each set in the NSEI survey in 1996. The proportion of sablefish captured by set is not represented in this graph. For example, station 1 species composition included 78% sablefish and 22% other species. The six-digit numbers represent statistical areas in Chatham Strait.

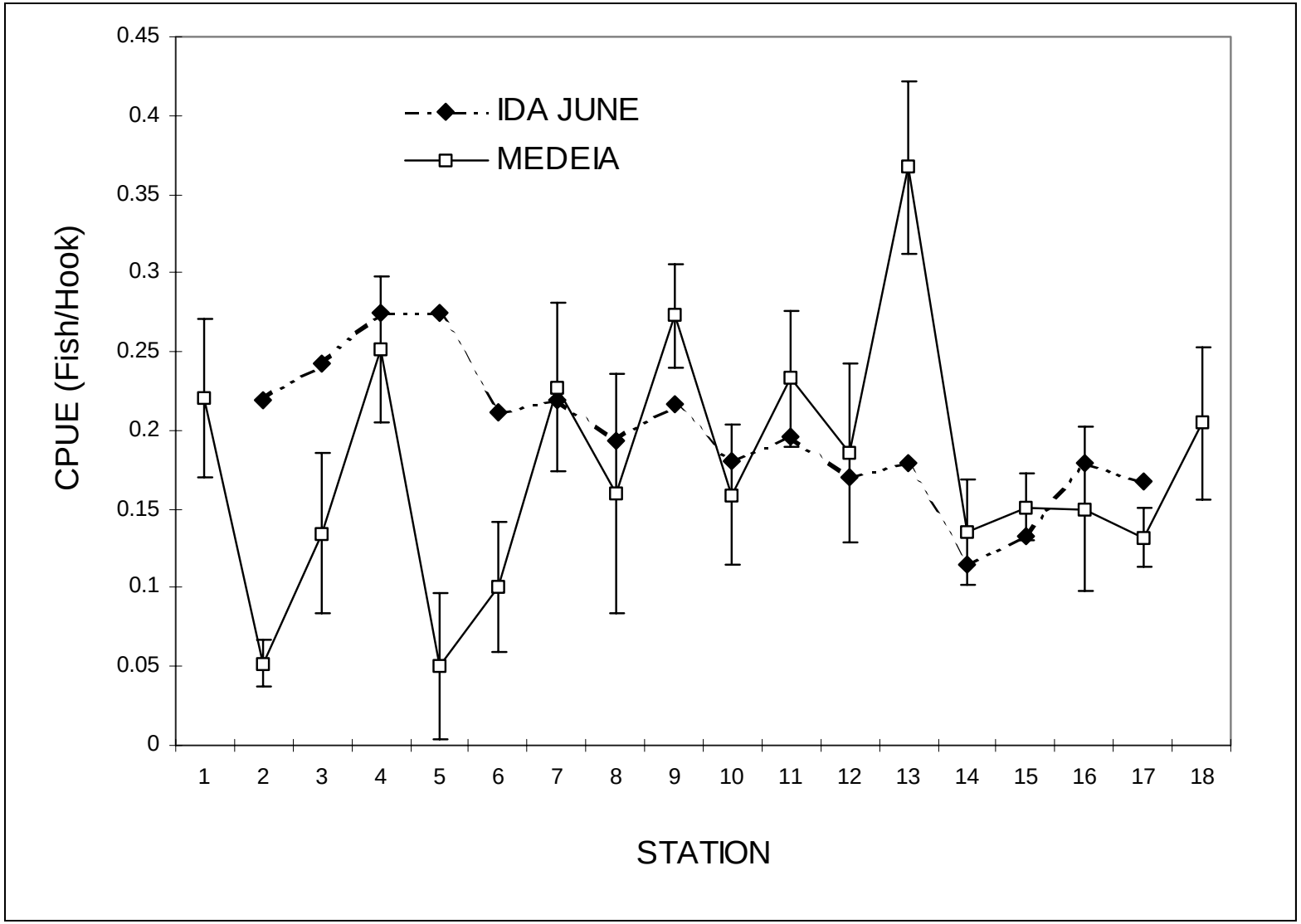

Figure 15. The CPUE (fish/hook) by station fished by the *R/V Medeia* and the *F/V Ida June* in the northern Chatham Strait survey area. The error bars represent 90% confidence intervals around the survey mean CPUE. Note: Stations fished by the *F/V Ida June* were randomly selected and are not paired with the survey stations.

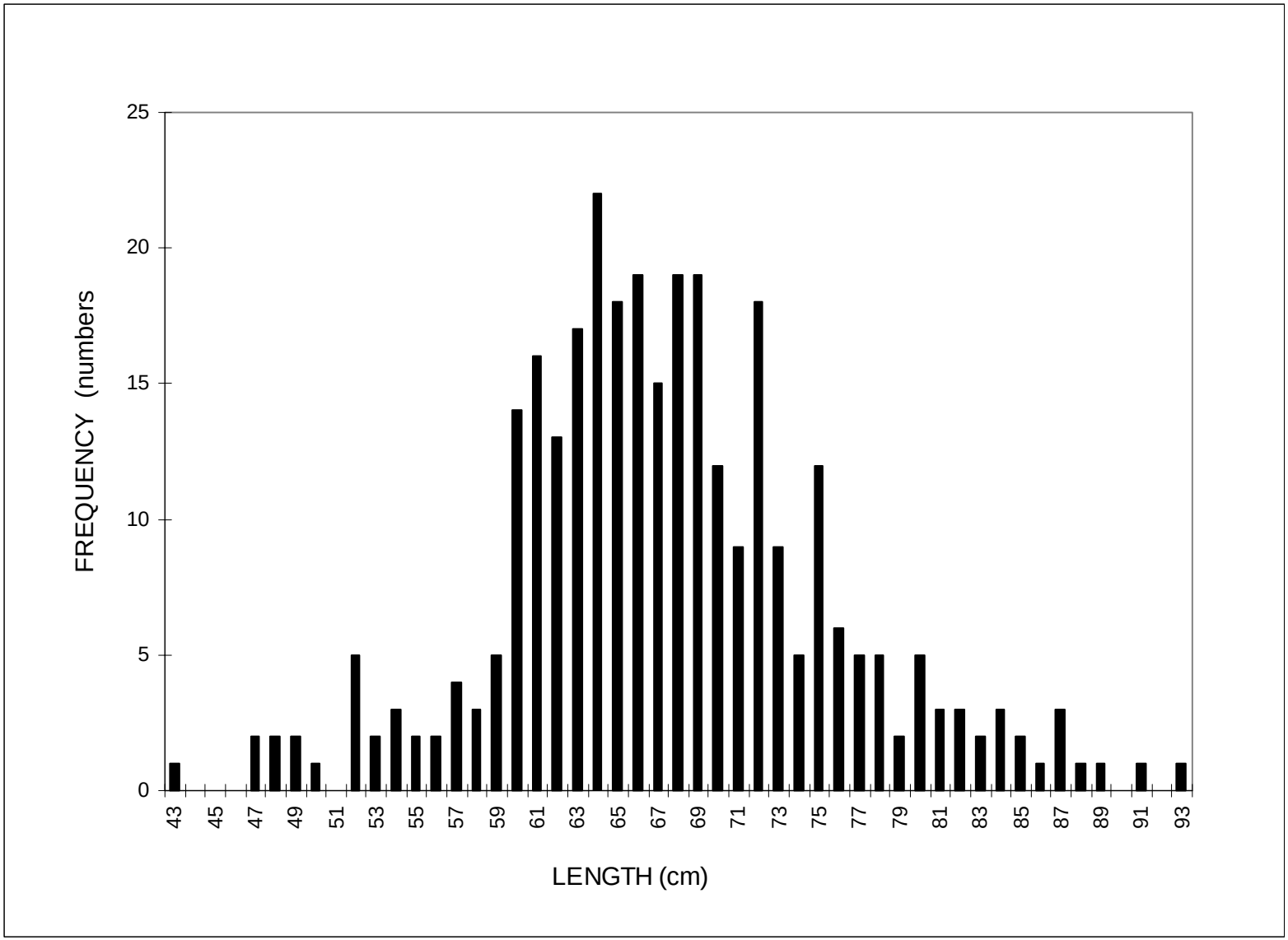

Figure 16. The 1996 NSEI sablefish length distribution taken from all sablefish landed on the *R/V Medeia*.

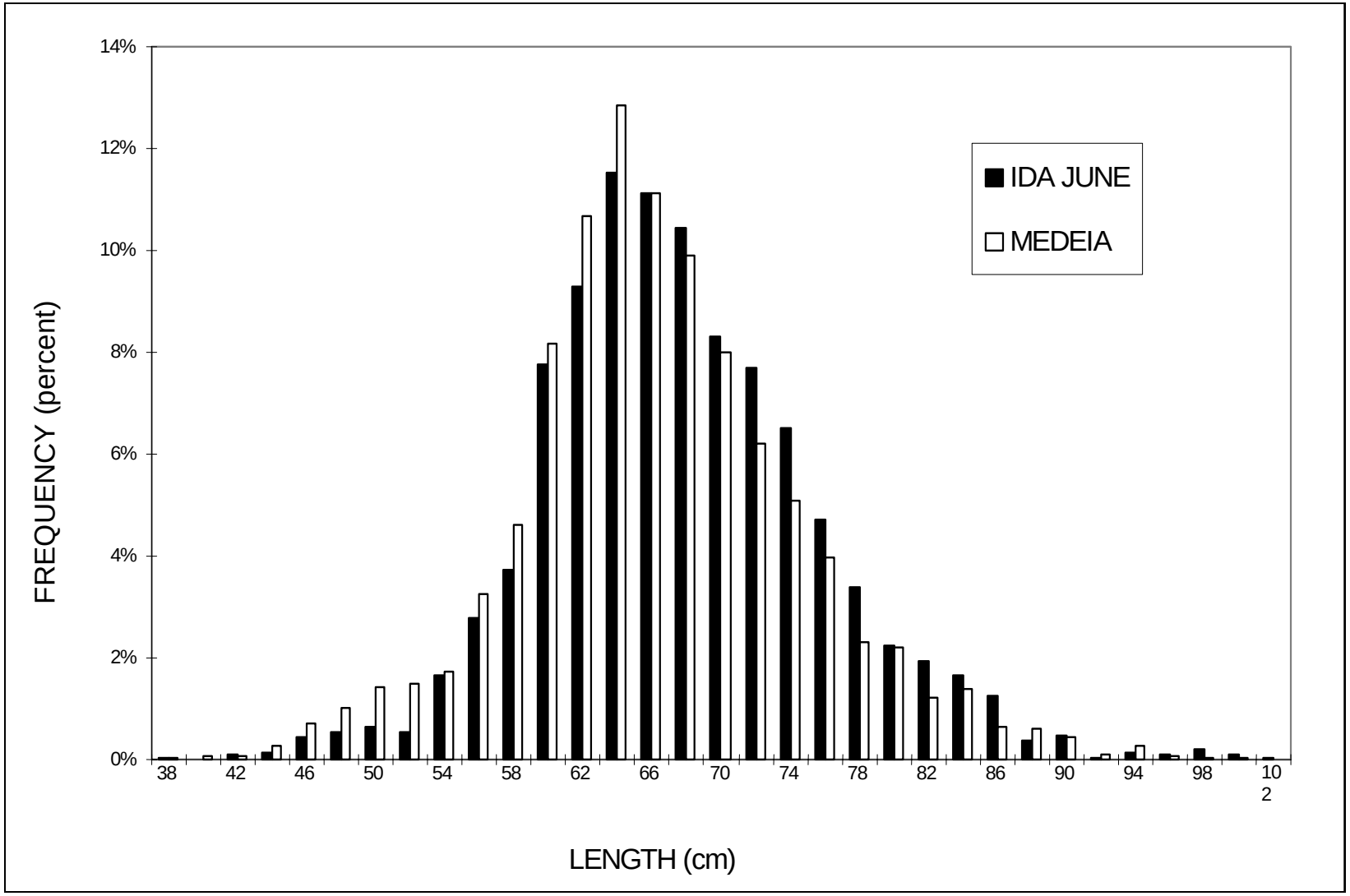

Figure 17. *F/V Ida June* (16 stations) and *R/V Medeia* (18 stations) length distributions in northern Chatham Strait area.

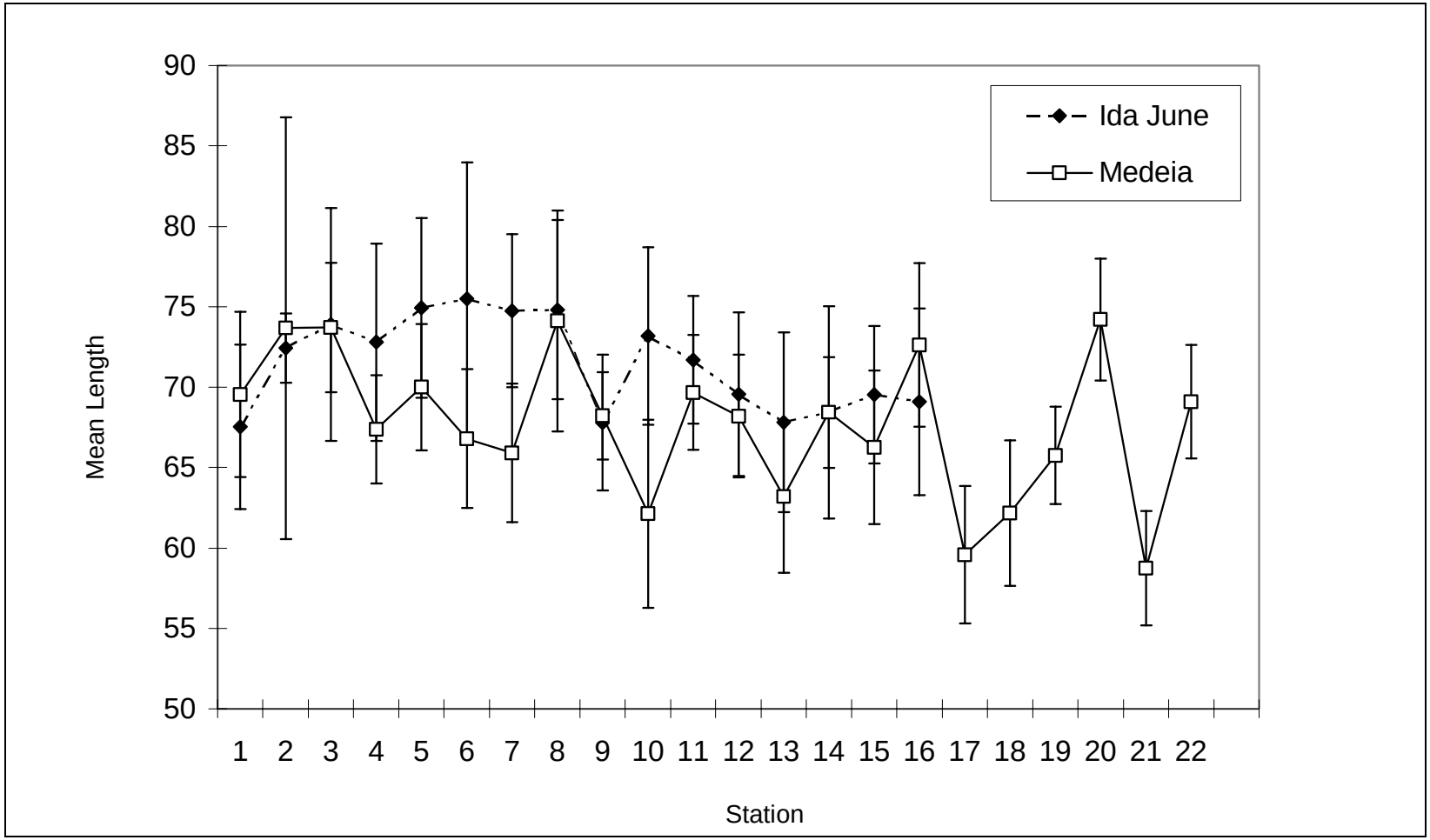

Figure 18. Comparison of sablefish mean length at each station between the *F/V Ida June* and the *R/V Medeia*. All stations were in the northern portion of Chatham Strait and were not paired. Error bars represent a 95% confidence interval.

Appendix 1. Sablefish Maturity Codes.

Sablefish Maturity Codes			
Maturity Code	Gonad Condition	Males (1) Description	Females (2) Description
1	Immature	Testes very narrow, parallel, flat and ribbon-like, almost clear in color. Longitudinal creases are easily discernable.	Ovaries appear as two narrow(slender) ovoids. May be vained.
2	Maturing Juvenile	Testes enlarging, not ribbon-like, with four discernable creases running full length. Light pink in color. Has not spawned before.	Ovaries enlarging, translucent and pinkish to clear: eggs not yet discernable. Has not spawned before. Will spawn coming year. More veined. Cloudy, but not necessarily throughout.
3	Mature/Developing	Testes large and white, each with four distinct lobes. No milt present.	Ovaries large and becoming white to yellowish white with developing eggs discernable and firmly attached.
4	Spawning	Testes very large and white, extruding milt freely under slight pressure or when cut.	Ovaries very large with large translucent eggs loose within ovary or extruding from the oviduct.
5	Spent/ Post Spawning	Testes large, shriveled, often with wrinkles, and bloodshot. No milt present.	Ovaries shriveled and opaque, soft and flaccid, often reddish in color.
6	Resting	Testes large and firm, light brown to off-white in color. No milt present. Has spawned previously. May have wrinkles.	Ovaries large, firm, and opaque, not shriveled. No eggs discernable. Has Spawned previously. Noticeable follicle structure.

(Revised 1982, 1987, 1994, 1997. Maturity code 6 (resting) added April 1994)