THE CATCH COMPOSITION OF TWO MONOFILAMENT GILL NET FISHERIES IN MONTEREY BAY, CALIFORNIA

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The catch composition of 2 Monterey Bay monofilament gill net fisheries was determined by at-sea observations. Halibut gill nets (8 in mesh) were inefficient at entangling the target species, California halibut. The halibut fishery caught 27 taxa of fishes, 6 species of seabirds, and 3 species of marine mammals. Seabirds were the most numerically important taxa, with a catch rate of 15.7 birds per net. Overall, 68% of the halibut gill net catch was discarded at-sea. Croaker gill nets (2 1/2 in mesh) were clearly dominated by the target species, white croaker. The croaker fishery caught 27 taxa of fishes and 4 species of seabirds. White croaker accounted for 60% of the total catch. Overall, 33% of the croaker gill net catch was discarded at-sea. Large mesh gill nets set nearshore may pose a potential threat to associated seabird and marine mammal populations.

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INTRODUCTION

Gill nets are efficient at catching widely distributed fish, and require minimal investment in manpower and equipment (Hamley 1975). They can be constructed of twine, multifilament nylon, or monofilament nylon material, and form an invisible panel of netting suspended in the water column which passively awaits the encounter of fishes. Gill nets are highly efficient at entangling certain species of fish and are size-specific (Hamley 1975), due to the mesh size. Other factors which contribute to gill net selectivity include the elastic stretching of the net, its hanging coefficient, the strength, flexibility, and visibility of the netting material, the shape of the fish it encounters, the degree to which fishes are meshed at parts of their body other than their pectoral area, and the patterns of fish behavior.

Marine gill net fisheries can be divided into two categories (Rounsefell 1975, Scofield 1951). One is the drift net fishery, in which gill nets are suspended from floats near or at the ocean's surface and function as an invisible curtain occupying the upper few meters of the water column (Cailliet and Bedford 1983). Drift nets are commonly employed in fishing salmon in the North Pacific Ocean, Bering Sea, and North Atlantic Ocean, and more recently for swordfish (Xiphias gladius) and sharks off California (Cailliet and Bedford 1983). Bottom-set fisheries anchor gill nets to the sea floor, occupying the bottom few meters of depth, while the curtain formed by the netting is pulled taut by a system of small floats. Bottom-set gill net fisheries are generally nearshore and target upon a great diversity of species worldwide.

Recent studies suggest that drift and bottom set gill nets entangle many non-commercial (i.e. incidental) vertebrate and invertebrate species. In particular, the incidental entanglement of seabirds and mammals in gill nets has produced a great deal of concern about their impact upon these populations. DeGange (1983) estimated that 400,000 seabirds may be killed each year by the salmon drift net fishery in the Northern Pacific and Bering Sea. Ainley et al. (1981) recorded 15 species of seabirds entangled in gill nets in the same areas. Piatt et al. (1984) calculated that approximately 30,000 Common Murres (Uria aalge), or 20% of the local breeding population, were drowned in bottom gill nets set for cod (Gadus morhua) in 1971. Tull et al. (1972) estimated an incidental mortality of 500,000 Thick-billed Murres (Uria lomvia) in the salmon (Salmo salar) drift net fishery off western Greenland for the years 1969 to 1971.

Marine mammals have also been reported drowned in gill net fisheries (Northridge 1984). Mitchell (1975) stated that an estimated 10,000 Dall's porpoise (*Phocoenoides dalli*) are killed annually in the salmon drift net fishery of the North Pacific and Bering Sea. Lear and Christensen (1975) reported that 1,500 harbor porpoise (*Phocoena phocoena*) were drowned in the western Greenland salmon drift net fishery in 1972. Pinnipeds are also highly vulnerable to incidental entanglement in gill nets (Northridge 1984).

Incidental catch data for many non-commercial fish and invertebrate species entangled by gill net fisheries are unavailable, especially off California. The majority of the fish and invertebrate by-catch is discarded at sea and goes unrecorded.

The Monterey Bay area of the central California coast is an important habitat for an impressive array of seabirds (Ainley 1976; Baltz and Morejohn 1977, Stallcup 1976) and marine mammals (Baltz and Morejohn 1977, Leatherwood et al. 1982). From 1978 to 1981, Monterey Bay experienced a steady increase in commercial fishing with monofilament bottom set gill nets. Two distinct fisheries developed. A seasonal fishery, primarily April to October, targeted on the California halibut (*Paralichthys californicus*) in nearshore waters of 3 to 25 meters depth. The mesh size of these halibut nets was approximately 20 cm (8 in). A second fishery, active year-round, targeted on the white croaker (*Genyonemus lineatus*), and fished in slightly deeper waters of 10 to 70 meters. The mesh size of these croaker nets measured approximately 7 cm (2.5 in).

During the summers of 1980 and 1981, large numbers of drowned seabirds, approximately 10,000 per year, began appearing on Monterey Bay beaches (Hardwick et al. 1981). My project was stimulated by the possibility that the halibut and croaker gill net fisheries were the source of this bird mortality. Monterey Bay conservation groups also considered it possible that a portion of the sea otter (Enhydra lutris) carcasses found washed up on Monterey Bay beaches might have been victims of gill net entanglement. Thus, a study was proposed that would monitor the catches of both gill net fisheries at-sea, and collect data on the numbers of all species entangled in the nets.

Previous gill net studies have emphasized an individual fishery's selectivity in capturing discrete size classes of the target fish species. A traditional size selectivity study is inadequate in assessing the effect of gill net fisheries on marine communities in light of the potentially high incidental mortality of marine birds and mammals. An analysis of the species composition of the total catch is necessary to arrive at a fuller understanding of the impact of a gill net fishery.

Therefore, my study had two objectives. The first was to determine the degree to which the catch compositions of

Monterey Bay gill net fisheries are dominated by the target species. The second was to evaluate whether or not seabirds and marine mammals constitute a significant portion of the catch composition of Monterey Bay gill net fisheries.

MATERIALS AND METHODS

Study Area

This study was restricted to the gill net fishery of Monterey Bay (Fig.1) between Pt. Santa Cruz (122° W Long., 36° 57' W Lat.) and Pt. Pinos (122° W Long., 36°37' N Lat.). Monterey Bay, located approximately 200 km south of San Francisco, is dominated by the Monterey Submarine Canyon which is aligned southwest-northeast and has its head near Moss Landing (Broenkow and Smethie 1978). Broad sandy beaches rim the bay from the Monterey peninsula to Seacliff State Beach. Gill nets monitored in this study were set upon sandy substrate, which extends well offshore in these areas. Strong northwesterly afternoon winds prevail for most of the year, making small boat operation, such as those utilized by the gill net fisheries and the monitoring project, hazardous.

The Fisheries

My study concerned the catch composition of halibut and croaker gill nets constructed of monofilament nylon only. The small portion of the halibut gill net fleet that fished with multifilament nylon or twine gill and trammel nets was not included in this analysis. Typical monofilament gill nets measured approximately one mile (1.6 km) in length for both fisheries. For this study, each full net unit was assumed to equal 1.6 km. The gill net panels were approximately 6 ft high, and were stretched taut by a bottom lead weighted line and a top line of plastic floats. The endpoints of the nets were secured to the sandy bottom by makeshift anchors of iron, cement slabs, or large rocks. The end positions of the gill nets were generally marked by small colored flags fastened to bamboo poles suspended above the surface by styrofoam floats. The nets were generally set parallel to shore during late morning or early afternoon (10:00 to 13:00 hours) before the onshore winds became prevalent. They were allowed to soak overnight for a period of 16 to 20 hours. The net-pulling process would usually begin shortly after dawn the following day, barring inclement weather conditions. Initially, the majority of the nets were pulled over the stern of the boat by hand requiring two to five hours. As the fishery developed, many boats switched to power-driven net drums that cut retrieval time in half.

Sampling Program

For the major part of this study, observations of gill net pulls were accomplished from small boats less than 25 feet in length. A team of two observers would set out at dawn with the gill net fleet from one of three Monterey Bay harbors: Moss Landing, Monterey, or Santa Cruz (see Fig. 1). During the period of peak fishing effort, June to October, sampling was attempted three days each week. During periods of minimal gill net fishing activity, sampling was attempted as often as possible. Sea conditions and fog influenced our ability to observe net retrievals. Boat availability limited the number of observation trips.

Our sampling strategy depended on the activity patterns of the fisheries. Our primary goal was to maximize the number of nets observed, while at the same time attempting to obtain a representative sample of the range of depths and locations within the bay in which the fisheries operated.

A number of sampling vessels was used over the course of this study. Initially, Moss Landing Marine Laboratories' 16 ft Boston whalers, the RV Belukha and the RV Blue Whaler, were used to monitor the fisheries. Later in the study the California Department of Fish and Game provided a 24 ft cathedral hull vessel, the RV Pandalus.

When observers located a gill net vessel that was preparing to retrieve its net or in the process of pulling its net, we would position our boat approximately 10 meters off the boat's stern. From this vantage point the panel of gill net was clearly visible as it was slowly pulled on board. One observer tallied every fish, bird, and mammal entangled in the net, while the second observer maintained the boat's position relative to the net. Invertebrate species were occasionally entangled in gill nets. They were excluded from this study because of their low catch rate and the difficulty of making a positive identification.

Every vertebrate entangled was identified to species except the following groups, which were difficult to identify from a distance. Fishes of the families Pleuronectidae and Bothidae were lumped together into the taxonomic grouping of "flatfishes" with the exception of the readily recognized California halibut and starry flounder (Platichthys stellatus). Fishes of the genus Sebastes (family Scorpaenidae) were combined in the taxon "rockfishes". Fishes of the family Embiotocidae were grouped as "surfperches" and members of the genus Raja (family Rajidae) were grouped under the category of "skates". We used Miller and Lea (1972) when an identification was in question. The number of individuals discarded at sea from each taxonomic group was recorded. Bird carcasses were collected from the fishermen for analysis of feeding habits for a separate study (Croll, In prep.).

Several features of the vessel and its net were recorded. These included the size of the mesh, the proportion of net observed, the estimated distance of the net from shore, the depth of net set, and the name of the boat. The proportion of the net pull observed was estimated in quarter net units (0.4 km was one quarter of a net). The location of the net relative to shore was distinguished by the many landmarks along the Monterey Bay shoreline that are visible from sea. The depth of the set was measured in meters by one of two methods: by fathometer when available or by a line marked off in meters suspended over the side of the sampling vessel.

Sufficiency of Number of Samples

To determine if we had adequately sampled the gill nets for the common, representative incidental taxa, the cumulative number of taxa captured was plotted against the randomly ordered number of net observations for both the halibut and white croaker catches. The plots were examined to see if they leveled off after a certain number of nets (Hurtubia 1973). Separate plots were constructed for each year the halibut fishery was monitored.

Fractional Observations of Net Pulls

Not all gill net pulls were observed in their entirety. An analysis of variance (ANOVA) was performed to determine if fractional net pull observations (1/4, 1/2, and 3/4) could be lumped with entire net pull observations for both the halibut and croaker fisheries. The percent similarity index, PSI (Whittaker 1952, Silver 1975), was used to compare the degree of similarity between all possible pairs of net pull observations within each quarter net category. The percent by number (pi) was calculated for each taxa in each net pull. A PSI value was calculated by summing the smallest percent by number (min pi) of each taxa between pairs of net pulls. The value of the index may range from 0 to 100% with the value increasing with a greater degree of similarity between the two samples (Silver 1975). Mean PSI values were calculated for all the comparisons of net pulls within each quarter net category. The mean PSI values for each quarter net category were compared by an ANOVA (Zar 1974).

Comparisons of Year-to-Year Species Composition

An ANOVA was performed to determine if gill net observations from different years were the same. The mean percent PSI for each year was computed by calculating the PSIs for all possible combinations of sample pairs within each year. Mean annual PSIs were compared by an ANOVA.

Year-to-year comparisons of the croaker fishery were not performed because the fishery was only monitored for a little more than a year. Sample sizes were insufficient for making seasonal comparisons.

Gill Net Fisheries Species Composition

The percent by number (%N) and percent frequency of occurrence (%F.O.) of all recognizable taxa were calculated for each gill net set. Both measures are needed because the numerical importance measures the relative abundance of a taxon while the frequency of occurrence measures how often a certain species was selected (Cailliet 1976).

The overall importance of a taxon within the catch assemblage of the halibut and white croaker fisheries was calculated using a modified version of the index of relative importance (Pinkas et al. 1971), in which the percent by number was multiplied by the percent frequency of occurrence to derive an index of relative importance (IRI). The percent index of relative importance (%IRI) was calculated by dividing the individual IRI values of each taxon by the sum of the IRI values for all the taxa in the fishery and multiplying by one hundred. The %IRI values allow comparisons to be made between different fisheries, years, locations, seasons, etc.

Catch rates per taxon and their percent frequency of occurrence were graphed to illustrate the relative importance of each taxon with standard error bars to represent the variability. The 6 species of seabirds present in the halibut fishery were lumped into one taxon, as were the marine mammals, incidental fishes that were retained and accounted for less than 1% of the IRI, and incidental fishes that were discarded and accounted for less than 1% of the IRI. Identical lumping criteria were utilized for the croaker fishery and year-to-year comparisons of the halibut fishery. Year-to-year variations in catch composition in the halibut fishery were represented by graphing the percent number versus the percent frequency of occurrence.

Comparison of Gill Net to Otter Trawl Samples

The cumulative species compositions of the halibut and croaker gill net fisheries were compared to the fish species composition over the sandy floor of Monterey Bay (Kukowski 1973) in an attempt to assess gear selectivity. Kukowski's (1973) samples were obtained by otter trawling at two depths (8 and 19 fathoms) between March 1971 and May 1972, similar depths to my study. I reanalyzed Kukowski's (1973) data by calculating the IRI values for his reported species, and lumped his species to conform to my taxa where necessary. The cumulative species compositions of the the fishing gear were described using the total number of common taxa captured and calculating the percent dominance, D (the square of the sum of the individual percentages by numbers) (Cailliet et al. 1979).

Since halibut nets were set in shallower waters than the croaker nets, the halibut gill net species composition was compared with the 8 fathom trawl data and that of the croaker gill net fishery with the 8 and 19 fathom trawl data combined. Kendall's rank correlation analyses were used to determine the similarity between the ranks of species taken with the two kinds of gear (Sokal and Rohlf 1981) and to possibly assess gear selectivity relative to the previous otter trawl samples.

The catch compositions of the two fishing methods were illustrated by graphing the percent number versus the percent frequency of occurrence for otter trawls and halibut nets, and otter trawls and croaker nets. The graphs included taxa from each fishery which comprised greater than 1% of the total catch.

Comparison of Halibut Gill Net to Croaker Gill Net Samples

The cumulative species compositions of the halibut gill net fishery and that of the croaker gill net fishery were described using the total number of common taxa captured and the percent dominance. Kendall's rank correlation analysis was used to determine the similarity between the ranks of taxa taken with the two mesh sizes.

The catch composition of the two fisheries were illustrated by graphing the percent number versus the percent frequency of occurrence. The graph included taxa from each fishery which comprised greater than 1% of the total catch.

RESULTS

Fractional Observations of Net Pull Species Composition

Species compositions of less-than-total net pulls were found to be significantly different from those of total net pulls for both the halibut fishery (one way ANOVA $F=4.67$, $p<0.05$) and the white croaker fishery (one way ANOVA $F=3.03$, $p<0.05$). The one-quarter net observations showed the greatest variability and the lowest mean percent similarity indices for both the halibut and white croaker fisheries (Fig. 2 and Fig. 3). Therefore it was decided to exclude the one-quarter net observations from further analysis, establishing the criterion that one half or more of a gill net pull must have been observed to obtain a representative sample of species composition.

Year to Year Variability of Net Pull Species Composition

The variability of species composition within each year for the California halibut fishery was significantly different when mean PSIs were compared among years (one way ANOVA $F=3.50$, $0.01<p<0.05$). Halibut net pulls from 1980 exhibited the lowest mean PSI of catch composition (Fig. 4). Due to this difference among years, it was decided to present the yearly halibut fishery data both as a 3 year total and as individual yearly totals.

Location and Distribution of Net Pull Observations

Forty nine halibut gill nets, totaling approximately 39 miles (63km) in length, were observed from June 1980 to July 1982 (Fig. 1). Forty seven percent of the nets sampled were observed in their entirety. Fifty seven white croaker gill nets, totaling approximately 46 miles (74 km) in length, were observed from July 1981 to October 1982 (Fig.1). Forty seven per cent of the nets sampled were observed in their entirety. A summary of the data collected for both fisheries can be found in Appendix A.

Gill net observations were approximately equally distributed between the northern half of the bay (55%) and the southern half (45%) (Fig. 1). Halibut gill net observations were concentrated between Monterey harbor and Marina and north of Moss Landing harbor, while croaker gill net observations were concentrated north of Moss Landing harbor. White croaker gill nets were set deeper than California halibut gill nets. Croaker nets were set in depths between 11 and 74 m, with a mean depth of 34.5m (±18.3 standard deviations, n=57). Halibut nets were set in depths between 3 and 24 m, with a mean depth of 10.7 m (±5.1 s.d., n=49). Generally halibut nets were set within the 10 fathom line, while croaker nets were set beyond the 10 fathom line.

Catch Composition of California Halibut Fishery

The cumulative species curve for the halibut gill net fishery indicated that sufficient nets had been sampled. It leveled at approximately 20 net sets, with the additional taxa added after that being very rare (Fig. 5), comprising less than 1% by number of the total catch.

The halibut gill net fishery caught 36 taxa, including 27 taxa of fishes, 6 species of seabirds, and 3 species of marine mammals (Table 1). Seven taxa accounted for 96.7% of the index of relative importance: flatfishes, California halibut, Common Murres, Pacific hake (*Merluccius productus*, skates, starry flounder and spiny dogfish (*Squalus acanthias*). Pacific mackerel (*Scomber japonicus*), thresher sharks (*Alopias vulpinus*), white croakers, and Sooty Shearwaters (*Puffinus griseus*) also represented greater than 1% of the cumulative catch. California halibut and flatfishes occurred in over 85% of the nets sampled. Those taxa low in percent number but relatively high in frequency of occurrence included smoothhound sharks (*Mustelus spp.*), bat rays (*Myliobatis californica*), Brandt's Cormorants (*Phalacrocorax pencillatus*), salmon (*Oncoryhnchus spp.*), Pigeon Guillemots (*Cepphus columba*), sturgeon (*Acipenser spp.*), and Common Loons (*Gavia immer*). Pacific hake were numerically dominant (16.0% by number) followed by the flatfishes (14.5%) and Common Murres (14.3%) (Table 2). Most of the other fishes, birds, and mammals were rare, comprising less than 1% by number of the total catch.

Halibut gill nets caught 7 taxa at approximately equal rates (Table 2). Pacific hake, flatfishes, Common Murres, California halibut, skates, spiny dogfish, and starry flounders averaged between 6 and 13 individuals caught per net. Pacific hake, flatfishes, and Common Murres displayed a high degree of variability in numbers present, as indicated by their large standard error values. The standard errors for California halibut, skates, and starry flounders were relatively low, indicating that a consistent number of individuals of each taxa were caught in gill nets.

Overall, 68% of the catch was discarded in the halibut gill net fishery (Table 2). Seventy two percent of the taxa were discarded at rates of 50% or greater. Pacific hake, other flatfishes, skates, and spiny dogfish had discard rates of greater than 75%. All the birds and mammals were discarded at sea. These taxa combined accounted for 52% of the total catch. The target species, California halibut, and starry flounder were discarded at rates lower than 12% and accounted for 16% of the total catch. All taxa were discarded dead except for the flatfishs, sharks, and rays.

A general analysis of catch rates and frequency of occurrence indicates that seabirds, when lumped, become the leading taxon caught, with a mean value of 15.7 birds per net (19.5% by number) (Fig. 6). The target species, California halibut, accounted for only 11.2% of the catch with a mean value of 9.1 individuals per net. A low mean of 0.2 marine mammals per net were drowned in halibut gill nets, however, they were drowned in 12.2% of the nets set.

Year-to-Year Comparisons of Halibut Gill Nets

The cumulative species curves for halibut gill nets set during each of the 1980, 1981, and 1982 seasons indicate that sampling was adequate in all three years (Fig. 7). The 1980 and 1981 species curves leveled off at approximately 24 species after 12 net observations. The curve for 1982 began to level off at 21 species after seven net observations.

Each year that the halibut fishery was monitored, a different taxon was most abundant when ranked by the percent index of relative importance values (Fig. 8). The flatfishes (leader in 1980), Pacific hake (leader in 1981, but slightly less abundant than seabirds), and spiny dogfish (leader in 1982) all displayed a great deal of variability in ranking from year to year. In contrast, the relative positions of seabirds, California halibut, skates, and starry flounder remained relatively constant at the high end during the three years sampled. Seabirds ranked second in relative importance and consistently ahead of the target species, California halibut, for all 3 years. Thus, despite changes in abundance ranks, it appeared that the same 6 species groups were among the most abundant and frequent during the entire study.

Catch Composition of White Croaker Fishery

The cumulative species curve for the white croaker fishery leveled at approximately 20 net sets, indicating that sampling was adequate (Fig. 9). Additional taxa added after 20 net sets were rare, comprising less than 1% by number of the total catch.

A total of 31 taxa were observed in the gill net fishery for white croaker, 27 of which were fish taxa and four species of seabirds (Table 3). The target species, white croaker, clearly dominated the catch composition of the fishery (59.8% by number) and was present in 98% of the nets sampled. Flatfishes comprised the second most important group, accounting for 22% of the total catch. Together, white croakers and flatfishes comprised approximately 91% of the IRI values. Pacific hake, rockfishes, surfperches, spiny dogfish, and sablefish (*Anoplopoma fimbria*) formed a second group, each accounting for between 1 and 5% of the total catch by number. Those taxa low in percent number but relatively high in frequency of occurrence included smoothhound sharks, staghorn sculpins

(*Leptocottus armatus*), plainfin midshipmen (*Porichthys notatus*), Common Murres, lingcod (*Ophiodon elongatus*), Pacific butterfish (*Peprilus simillimus*), jacksmelt (*Atherinopsis californiensis*), ratfish, and American shad (*Alosa sapidissima*). The majority of the other fishes and birds were rare, comprising less than 0.05% of the total catch.

White croakers (722.7 per net) and flatfishes (267.5 per net) were entangled in substantially greater numbers per net set than all other categories (Table 4). Although low in percent numerical importance, six taxa, the Pacific hake, Pacific mackerel, rockfishes, spiny dogfish, sablefish, and surfperches had catch rates between 20 and 100 individuals per net. Pacific hake (63.3 per net) and Pacific mackerel (47.3 per net) had relatively high catch rates while occurring in less than 60% of the net sets.

The overall discard rate for the white croaker fishery was approximately 33% (Table 4). Sixty eight percent of the taxa were discarded at levels of 50% or greater. White croakers, Pacific mackerel, rockfishes, and sablefish, comprising approximately 67% of the total catch, were discarded at rates equal to or less than 30% of their individual catch totals. Flatfishes, Pacific hake, spiny dogfish, and surfperches, comprising approximately 31% of the total catch, were discarded at rates greater than 90% of their individual catch totals. All taxa were discarded dead except for flatfishes, sharks, rays, sculpins, and plainfin midshipmen.

A general analysis of catch rates and frequency of occurrence indicates that the target species, white croaker, clearly dominated the catch composition of the the 2 inch gill net fishery (Fig. 10). A mean of 4.1 seabirds per net were drowned in croaker gill nets and seabirds were present in 54% of the net sets.

Comparison of Halibut Gill Nets With Croaker Gill Nets

The halibut and croaker fisheries were not similar in their respective catch compositions (Fig. 11). The croaker fishery was dominated by two taxa (D=41.2%) as compared to the relatively equal distribution of catch abundance among the 7 commonly occurring taxa in halibut nets (D=10.9%). The percent dominance values for the halibut fishery remained approximately equal for the 3 years monitored (1980=16.3%, 1981=12.7%, and 1982=15.9%). The ranks of the taxa comprising greater than 1% by number of the total catch from each fishery were different (Kendall's tau=-0.078; $p>0.05$). Five taxa were common to both orderings: flatfishes, Pacific hake, spiny dogfish, Pacific mackerel, and white croaker. Flatfishes and Pacific hake were numerically important to both fisheries. Seabirds represented a substantial portion of the catch composition in the halibut fishery (15.7 birds per net and 19% by number) as compared to the croaker fishery (4.1 birds per net and 0.3% by number). Marine mammals (California sea lions, harbor seals, and sea otters) were only observed in the halibut gill nets.

Comparison of Halibut Gill Nets With Otter Trawls

Otter trawl data from Kukowski (1973) were extremely different from halibut gill net data compiled for this study (Fig.12). A comparison of the taxa comprising greater than 1% of the total catch from each fishery produced a pronounced negative correlation between ranks (Kendall's tau=-0.296, 0.01>p>0.05). Halibut gill nets caught more taxa (36), most notably six species of seabirds and three species of marine mammals, which were absent from the otter trawls. Eight fathom otter trawls were dominated by two taxa, nightsmelt (*Spirinchus starksi*) and flatfishes (D=32.7%), while the halibut gill nets were more evenly distributed (D=10.9%). The two fisheries had an overlap of only 3 taxa when considering taxa present in greater than 1% by number, flatfishes, starry flounder, and white croaker. Flatfishes were the only taxa present in substantial numbers in both types of fishing gear. The northern anchovy (*Engraulis mordax*) and the nightsmelt were unique to the otter trawls.

Comparison of Croaker Gill Nets With Otter Trawls

Otter trawl catches (Kukowski, 1973) were more similar to the white croaker gill net catches than with the California halibut gill net catches (Fig. 13). However, a comparison of the taxa comprising greater than 1% of the total catch of each fishery produced a nonsignificant correlation between ranks (Kendall's tau=0.010, p>70.05). Both fishing methods were dominated by two taxa, but they were different taxa: the trawls by flatfishes and nightsmelt (D=32.3%), the gill nets by white croakers and flatfishes D=41.2%). Approximately 30 taxa were caught by gill nets and trawls. Five taxa out of the top rankings were common to both fishing methods: white croaker, flatfishes, rockfishes, surfperches, and plainfin midshipmen. Nightsmelt, northern anchovy, and Pacific tomcod (*Microgadus proximus*) were unique to the otter trawls.

DISCUSSION

The two monofilament gill net fisheries active in Monterey Bay from 1980 to 1982 differed dramatically in their ability to entangle their respective target species and at minimizing their catch of incidental species. The halibut gill net fishery was basically inefficient at capturing California halibut. The majority of the catch was composed of seven taxa in approximately equal proportions, and only two of these taxa were marketable. Seabirds were the dominant taxon represented in halibut gill nets at a rate of 15.7 birds per net. More than two-thirds of the monitored catch was discarded at sea.

In contrast, the croaker gill net fishery was effective mostly at capturing white croaker. Its catch composition was dominated by the target species, which constituted 60% of the monitored catch. Less than one-third of the monitored catch was discarded at sea.

Wild (unpublished data) monitored the California halibut gill net fishery operating off central California between Half Moon Bay and Bodega Bay during the 1983 season. He observed 46 monofilament gill nets and reported catch rates of 7.7 halibut per net, 15.2 seabirds per net, and 0.13 marine mammals per net. My estimated catch rates for these taxa in Monterey Bay, 9.1 halibut per net, 15.7

seabirds per net, and 0.20 marine mammals, were nearly identical.

Halibut gill nets had the lowest reported percent dominance value (D=10.7%) and numerical importance of the target species (11.2%) of any reported for a Monterey Bay fishery. Heimann (1963) reported the total catch composition, in pounds landed, for Monterey Bay based trawl fisheries in 1960. The shallow target species, English sole (Parophrys vetulus) and petrale sole (Eopsetta jordani), accounted for 51.5% of trawls, the intermediate target species, chilipepper (Sebastes goodei) and bocaccio (Sebastes paucispinis), 89.6% of the trawls, and the deep target species, splitnose rockfish (Sebastes diplopora), 58.4% of trawls.

Discard rates are another way of assessing the efficiency of a fishery. Heimann (1963) reported discard rates of 43.1% for the shallow water trawls, 15.7% for the intermediate depth trawls and 14.0% for the deep water trawls. The 32.9% discard rate for the white croaker fishery is in line with the values reported for the trawl fisheries. The 67.8% discard rate for the halibut fishery exceeds both the trawl and croaker fisheries.

The catch composition of research otter trawls (Kukowski, 1973) exhibited low similarity with monofilament gill nets set in the same areas in later years. Gill nets caught a greater diversity of taxonomic groups than otter trawls. Otter trawls captured smaller sized fishes (e.g. night smelt and northern anchovy) than gill nets, most likely because of the small mesh size of the cod end of the net. Otter trawls are dragged over the surface of the bottom substrate at a relatively slow speed allowing sufficient time for quick maneuvering organisms to avoid capture. Therefore, otter trawls are effective at capturing inactive species distributed above or within the bottom substrate. In contrast, gill nets capture active species during the day or night. Any conclusions reached in contrasting otter trawl data (Kukowski, 1973) and gill nets monitored in this study must take into account that the otter trawl data were collected 10 years prior to this study. Although unlikely, it is possible that the assemblage of nearshore organisms has changed in the last decade.

Gill net selectivity depends mainly on mesh size and the size, shape, and activity pattern of the species entangled (Hamley 1975). Therefore, the large size of the mesh used in the halibut fishery selects relatively large-bodied species. The inefficiency of the halibut gill netting documented in this study is due to the non-specific capture of large, active predators. Sea birds are enmeshed by their heads and wings, marine mammals by their heads and flippers, and large predatory fish by their girth. Gill nets present serious management problems because they select what they catch primarily by size and activity pattern, and to a much lesser degree by characteristics which discriminate marketable species from commercially unimportant ones.

During the halibut fishing season, 2 1/2 in mesh croaker nets were often set in the same areas as the 8 in mesh halibut nets. White croaker gill nets selected taxa of smaller size due to the smaller mesh size utilized by the fishery. Seabirds were present as part of the incidental catch because they became entangled by their beaks and wings. Pacific hake were enmeshed in croaker nets by their long canine teeth. Marine mammals were excluded from the incidental catch due to their large girth and lack of small protruding body parts. The croaker fishery was far more successful at entangling its target species than the halibut fishery because it selected small bodied bottom feeders, of which white croakers constitute a large proportion of the nearshore community.

Seabirds, marine mammals, and large predatory fishes concentrate nearshore in Monterey Bay presumably to exploit the extensive food resource of schooling fishes and squid present from April to October. Northern anchovy form large schools nearshore from April to June (Frey 1971, Cailliet et al. 1979) and were found to be the dominant prey item in Common Murres drowned in gill nets from the early upwelling period (Croll, in prep.). During the late upwelling period, Croll (in prep.) found that Common Murres switched to eating juvenile rockfish. The market squid (Loligo opalescens) and the nightsmelt were also important prey items for Common Murres. Morejohn et al. (1978) found that market squid, northern anchovy, and juvenile rockfish were important components in the diets of Sooty Shearwaters, Brandt's Cormorants, California sea lions, and harbor porpoises. Pacific hake were caught in large numbers in halibut and croaker gill nets. Alverson and Larkin (1969) reported that adult hake undergo northward and inshore summer migrations. I inspected the stomach contents of approximately 20 hake entangled in gill nets and found that they had been feeding on northern anchovy and juvenile rockfish. Pacific mackerel and sablefish, two species that were at times present in great numbers in gill nets, also prey on squid, anchovy and juvenile fishes (Frey, 1971). This concentrated, active pursuit of schooling organisms by large predatory species probably determines the numerical importance of these species as incidental catch in gill nets.

Monterey Bay monofilament gill nets drowned seabirds in excess of the rate reported for the North Pacific salmon fishery. DeGange (1982) calculated that an average of 22.3

(±1.6 SE) seabirds per net were entangled in the north Pacific salmon drift net fishery in 1982. Short-tailed Shearwaters (*Puffinus tenuirostris*) accounted for 41.8% of the seabird catch and Tufted Puffins (*Fratercula cirrhata*) for 38.1%, with 14 other species of seabirds accounting for the rest of the bird catch. The nets measured 15 km in length, approximately 10 times the length of Monterey Bay bottom set gill nets, with a mesh size of 11 to 13 cm. When length of net is corrected for, the California halibut fishery of central California has a seabird catch rate approximately 7 times greater than that of the drift net fishery. The catch rate of seabirds in the white croaker fishery was roughly twice that of the salmon drift net fishery.

The incidental entanglement of Common Murres and, to a lesser degree, Pigeon Guillemots in gill nets may have a serious effect on their Central California breeding populations. Common Murres, the seabird species entangled in the greatest number in both fisheries, are most abundant in Monterey Bay during the period of late upwelling (Croll in prep.), June to September, which coincides with the peak of gill netting effort. Hardwick et al. (1981) estimated that 11,300 Common Murres were killed in Monterey Bay gill nets during a 14 month period, June 1980 to July 1981. Central California supports a breeding population of approximately 110,000 Common Murres (Sowls et al. 1980). Therefore, roughly 10% of the Central Californian Common Murre population may have been killed in gill nets during a 14 month period. Hardwick et al. (1980) estimated that 72 Pigeon Guillemots were drowned in gill nets during the same period. The Monterey Bay area supports a breeding population of approximately 2,500 Pigeon Guillemots (Sowl et al. 1980). Therefore, roughly 3% of the local breeding population may have drowned in gill nets.

Marine mammals were not caught in great numbers by halibut gill nets monitored by this study. However, their incidental drowning represents a potential threat to their population levels in Monterey Bay. Bonnell et al. (1980) estimated that approximately 1300 sea otters, excluding pups dependent on mothers, comprise the California population. Wendell et al. (unpublished report) concluded that the accidental take of sea otters in gill and trammel nets set along the central California coastline for halibut might have contributed significantly to the lack of sea otter population growth in recent years. Between 1973 and 1983, an estimated 105 sea otters were killed annually through entanglement in gill and trammel nets (Marine Mammal Commission 1986). Therefore, gill nets may account for an annual sea otter mortality of 10% of the breeding population.

Monofilament gill nets were often set in areas of high concentrations of harbor porpoises, however, there were no drownings observed. Two harbor porpoises were observed caught in trammel nets that were excluded from this analysis. Wild (unpublished data) observed 4 harbor porpoises drowned in gill and trammel nets during the 1983 halibut season along the central California coast, 2 of which were caught in monofilament nylon gear. Since 1983 the rate of entanglement of harbor porpoises has increased each year along the California coast: 21 porpoises drowned in 629 net set in 1984 and 26 porpoise drowned in 266 net sets in 1985 (Marine Mammal Commission 1986).

Presently, gill net monitoring projects are conducted by on-board observers. Monitoring catch on-board overcomes several of the limitations of this study, most notably: the difficulty of species identification from a distance, observations of less than total net pulls, and difficulty in gathering life history data. Conversely, monitoring gill nets from a small, independent vessel allowed flexibility in sampling, more than one net to be monitored during a single trip, and probably had less influence on the behavior of the gill net fleet. Throughout this study it was difficult to be aware of the large scale pattern of gill net fishing. Daily or weekly aerial surveys would have greatly improved the sampling strategies used in this study.

Conclusions

The catch composition of the Monterey Bay monofilament gill net halibut fishery lacked a single dominant species. Seabirds, as a group, were the most numerically important taxa, with a catch rate of 16 birds per net. California halibut, the target species, accounted for less than 15% of the total catch of the fishery. California sea lions, sea otters and harbor seals were drowned in gill nets at very low rates.

The catch composition of the monofilament gill net croaker fishery was clearly dominated by the target species, white croaker. White croaker accounted for 60% of the total catch. Seabirds comprised an insignificant percentage of the catch composition, but, an average of 4 birds per net were drowned. No marine mammals were observed in croaker gill nets.

Gill nets set in nearshore areas that support local or migratory seabird and marine mammal populations present serious management problems. Entanglement rates of seabirds and marine mammals will increase as mesh size increases. A careful monitoring of the catch composition of gill net fisheries at their inception is imperative to assessing the potential threat to incidentally entangled vertebrate species.

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Table 1. The catch composition of halibut gill nets ranked by the percent index of relative importance.

SPECIES	SCIENTIFIC NAME	PERCENT NUMBER	FREQUENCY OCCURRENCE	INDEX RELATIVE IMPORTANCE	PERCENT IRI
Flatfishes	Pleuronectidae and Bothidae	14.55	87.76	1276.91	20.92
California Halibut	Paralichthys californicus	11.24	89.80	1009.35	16.54
Common Murre	Uria aalge	14.37	67.35	967.82	15.86
Pacific Hake	Merluccius productus	16.01	51.02	816.83	13.38
Skates	Raja spp.	10.10	79.59	803.86	13.17
Starry Flounder	Platichthys stellatus	8.47	75.51	639.57	10.48
Spiny Dogfish	Squalus acanthias	9.54	40.82	389.42	6.38
Pacific Mackerel	Scomber japonicus	1.81	20.41	36.94	0.61
Thresher Shark	Alopias vulpinus	1.45	22.45	32.55	0.53
White Croaker	Genyonemus lineatus	2.02	14.29	28.87	0.47
Smoothhound Sharks	Mustelus spp.	0.92	20.41	18.78	0.31
Bat Ray	Myliobatis californica	0.92	16.33	15.02	0.25
Brandt's Cormorant	Phalacrocorax pencillatus	0.90	16.33	14.70	0.24
Salmon	Oncorhynchus spp.	0.97	14.29	13.86	0.23
Sooty Shearwater	Puffinus griseus	3.23	4.08	13.18	0.22
Pigeon Guillemot	Cepphus columba	0.75	12.24	9.18	0.15
Lingcod	Ophiodon elongatus	0.51	6.12	3.12	0.05
Ratfish	Hydrolagus colliei	0.33	8.16	2.69	0.04
Sturgeon	Acipenser spp.	0.17	10.20	1.73	0.03
Common Mola	Mola mola	0.21	8.16	1.71	0.03
Common Loon	Gavia immer	0.16	10.20	1.63	0.03
California Sea Lion	Zalophus californianus	0.16	8.16	1.31	0.02
Leopard Shark	Triakis semifasciata	0.11	6.12	0.67	0.01
Surfperch	Embiotocidae	0.13	4.08	0.53	0.01
Pacific Bonito	Sarda chiliensis	0.12	4.08	0.49	0.01
Jack Mackerel	Trachurus symmetricus	0.23	2.04	0.47	0.01
Cabezon	Scorpaenichthys marmoratus	0.09	4.08	0.37	0.01
Rockfishes	Sebastes spp.	0.17	2.04	0.35	0.01
Jacksmelt	Atherinopsis californiensis	0.08	4.08	0.33	0.01
Harbor Seal	Phoca vitulina	0.05	4.08	0.20	0.00
White Seabass	Cynoscion nobilis	0.07	2.04	0.14	0.00
Sea Otter	Enhydra lutris	0.05	2.04	0.10	0.00
Torpedo Ray	Torpedo californica	0.03	2.04	0.06	0.00
Blue Shark	Prionace glauca	0.03	2.04	0.06	0.00
Triggerfishes	Balistidae	0.03	2.04	0.06	0.00
Western Grebe	Aechmorphorus occidentalis	0.03	2.04	0.06	0.00

Table 2. The catch composition of halibut gill nets ranked by catch per net.

SPECIES	SCIENTIFIC NAME	TOTAL CATCH	CATCH PER NET	STANDARD ERROR	PERCENT DISCARDED
Pacific Hake	Merluccius productus	635	12.96	3.27	100.0
Flatfishes	Pleuronectidae and Bothidae	577	11.78	4.07	75.0
Common Murre	Uria aalge	570	11.63	4.25	100.0
California Halibut	Paralichthys californicus	446	9.10	1.12	1.8
Skates	Raja spp.	401	8.18	1.46	82.1
Spiny Dogfish	Squalus acanthias	378	7.71	4.35	82.1
Starry Flounder	Platichthys stellatus	336	6.86	1.59	11.9
Sooty Shearwater	Puffinus griseus	128	2.61	2.56	100.0
White Croaker	Genyonemus lineatus	80	1.63	1.06	8.4
Pacific Mackerel	Scomber japonicus	72	1.47	0.98	9.2
Thresher Shark	Alopias vulpinus	58	1.18	0.63	10.3
Salmon	Oncorhynchus spp.	39	0.80	0.42	100.0
Smoothhound Sharks	Mustelus spp.	36	0.73	0.25	75.9
Bat Ray	Myliobatis californica	36	0.73	0.33	58.7
Brandt's Cormorant	Phalacrocorax pencillatus	36	0.73	0.33	100.0
Pigeon Guillemot	Cepphus columba	30	0.61	0.34	100.0
Lingcod	Ophiodon elongatus	20	0.41	0.36	0.0
Ratfish	Hydrolagus colliei	13	0.27	0.14	100.0
Jack Mackerel	Trachurus symmetricus	9	0.18	0.18	0.0
Common Mola	Mola mola	8	0.16	0.09	100.0
Rockfishes	Sebastes spp.	7	0.14	0.13	100.0
Sturgeon	Acipenser spp.	7	0.14	0.06	100.0
Common Loon	Gavia immer	6	0.12	0.06	100.0
California Sea Lion	Zalophus californianus	6	0.12	0.06	100.0
Surfperches	Embiotocidae	5	0.10	0.08	0.0
Pacific Bonito	Sarda chiliensis	5	0.10	0.07	0.0
Cabezon	Scorpaenichthys marmoratus	4	0.08	0.05	0.0
Leopard Shark	Triakis semifasciata	4	0.08	0.05	100.0
Jacksmelt	Atherinopsis californiensis	3	0.06	0.05	100.0
White Seabass	Cynoscion nobilis	3	0.06	0.05	100.0
Sea Otter	Enhydra lutris	2	0.04	0.00	100.0
Harbor Seal	Phoca vitulina	2	0.04	0.00	100.0
Triggerfish	Balistidae	1	0.02	0.00	100.0
Torpedo Ray	Torpedo californica	1	0.02	0.00	100.0
Western Grebe	Aechmorphorus occidentalis	1	0.02	0.00	100.0
Blue Shark	Prionace glauca	1	0.02	0.00	100.0
Total Catch		3966	80.94		67.8

Table 3. The catch composition of croaker gill nets ranked by the percent index of relative importance.

SPECIES	SCIENTIFIC NAME	PERCENT NUMBER	FREQUENCY OCCURRENCE	INDEX RELATIVE IMPORTANCE	PERCENT IRI
White Croaker	Genyonemus lineatus	59.78	98.25	5873.39	66.04
Flatfishes	Bothidae and Pleuronectidae	22.13	100.00	2213.00	24.88
Pacific Hake	Merluccius productus	5.24	59.65	312.57	3.51
Rockfishes	Sebastes spp.	2.09	64.91	135.66	1.53
Pacific Mackerel	Scomber japonicus	3.91	28.07	109.75	1.23
Surfperches	Embiotocidae	1.64	50.88	83.44	0.94
Spiny Dogfish	Squalus acanthias	2.14	29.82	63.81	0.72
Sablefish	Anoplopoma fimbria	1.41	33.33	47.00	0.53
Smoothhound Sharks	Mustelus spp.	0.32	47.37	15.16	0.17
Staghorn Sculpin	Leptocottus armatus	0.27	43.86	11.84	0.13
Plainfin Midshipman	Porichthys notatus	0.24	47.37	11.37	0.13
Common Murre	Uria aalge	0.14	43.86	6.14	0.07
Lingcod	Ophiodon elongatus	0.13	33.33	4.33	0.05
Pacific Butterfish	Peprilus simillimus	0.11	21.05	2.32	0.03
Brandt's Cormorant	Phalacrocorax pencillatus	0.16	5.26	0.84	0.01
Jacksmelt	Atherinopsis californiensis	0.07	10.53	0.74	0.01
Ratfish	Hydrolagus colliei	0.04	14.04	0.56	0.01
American Shad	Alosa sapidissima	0.04	12.28	0.49	0.01
Skates	Raja spp.	0.03	8.77	0.26	0.00
Red-throated Loon	Gavia stellata	0.03	8.77	0.26	0.00
Salmon	Oncorhynchus spp.	0.02	8.77	0.18	0.00
California Lizardfish	Synodus lucioceps	0.03	5.26	0.16	0.00
Starry Flounder	Platichthys stellatus	0.01	7.02	0.07	0.00
Thresher Shark	Alopias vulpinus	0.01	3.51	0.04	0.00
Marbeled Murrelet	Brachyramphus marmoratus	0.01	1.75	0.02	0.00
Leopard Shark	Triakis semifasciata	0.01	1.75	0.02	0.00
California Halibut	Paralichthys californicus	0.00	3.51	0.00	0.00
Bay Ray	Myliobatis californica	0.00	1.75	0.00	0.00
Torpedo Ray	Torpedo californica	0.00	3.51	0.00	0.00
Pacific Herring	Clupea harengus	0.00	3.51	0.00	0.00
Jack Mackerel	Trachurus symmetricus	0.00	1.75	0.00	0.00

Table 4. The catch composition of croaker gill nets ranked by catch per net.

SPECIES	SCIENTIFIC NAME	TOTAL CATCH	CATCH PER NET	STANDARD ERROR	PERCENT DISCARDED
White Croaker	Genyonemus lineatus	41195	722.70	105.3	2.2
Flatfishes	Bothidae and Pleuronectidae	15247	267.50	45.5	92.2
Pacific Hake	Merluccius productus	3610	63.30	21.8	100.0
Pacific Mackerel	Scomber japonicus	2694	47.30	20.9	3.1
Spiny Dogfish	Squalus acanthias	1472	25.80	18.1	100.0
Rockfishes	Sebastes spp.	1442	25.30	7.8	30.3
Surfperches	Embiotocidae	1127	19.80	7.6	96.7
Sablefish	Anoplopoma fimbria	971	17.00	11.0	4.8
Smoothhound Sharks	Mustelus spp.	222	3.90	1.2	100.0
Staghorn Sulpin	Leptocottus armatus	184	3.20	1.1	100.0
Plainfin Midshipman	Porichthys notatus	165	2.90	0.9	100.0
Brandt's Cormorant	Phalacrocorax pencillatus	109	1.90	1.8	100.0
Common Murre	Uria aalge	99	1.70	0.4	100.0
Lingcod	Ophiodon elongatus	87	1.50	0.5	27.3
Pacific Butterfish	Peprilus simillimus	77	1.30	0.6	57.3
Jacksmelt	Atherinopsis californiensis	45	0.80	0.4	55.0
Ratfish	Hydrolagus colliei	30	0.50	0.2	100.0
American Shad	Alosa sapidissima	29	0.50	0.2	0.0
Red-throated Loon	Gavia stellata	23	0.40	0.2	100.0
California Lizardfish	Synodus lucioceps	19	0.30	0.3	100.0
Skates	Raja spp.	18	0.30	0.2	87.7
Salmon	Oncorhynchus spp.	13	0.20	0.1	100.0
Starry Flounder	Platichthys stellatus	9	0.20	0.1	7.7
Thresher Shark	Alopias vulpinus	5	0.10	0.1	0.0
Leopard Shark	Triakis semifasciata	4	0.10	0.1	100.0
Marbeled Murrelet	Brachyramphus marmoratus	4	0.10	0.1	100.0
Torpedo Ray	Torpedo californica	3	0.10	0.0	100.0
Pacific Herring	Clupea harengus	3	0.10	0.0	0.0
California Halibut	Paralichthys californicus	3	0.10	0.0	0.0
Bat Ray	Myliobatis californica	2	0.03	0.0	100.0
Jack Mackerel	Trachurus symmetricus	1	0.01	0.0	100.0
TOTAL		68912	1208.98		32.9

Figure 1. Map of study area and distribution of gill nets sampled (croaker nets-open circles, halibut nets-closed circles).

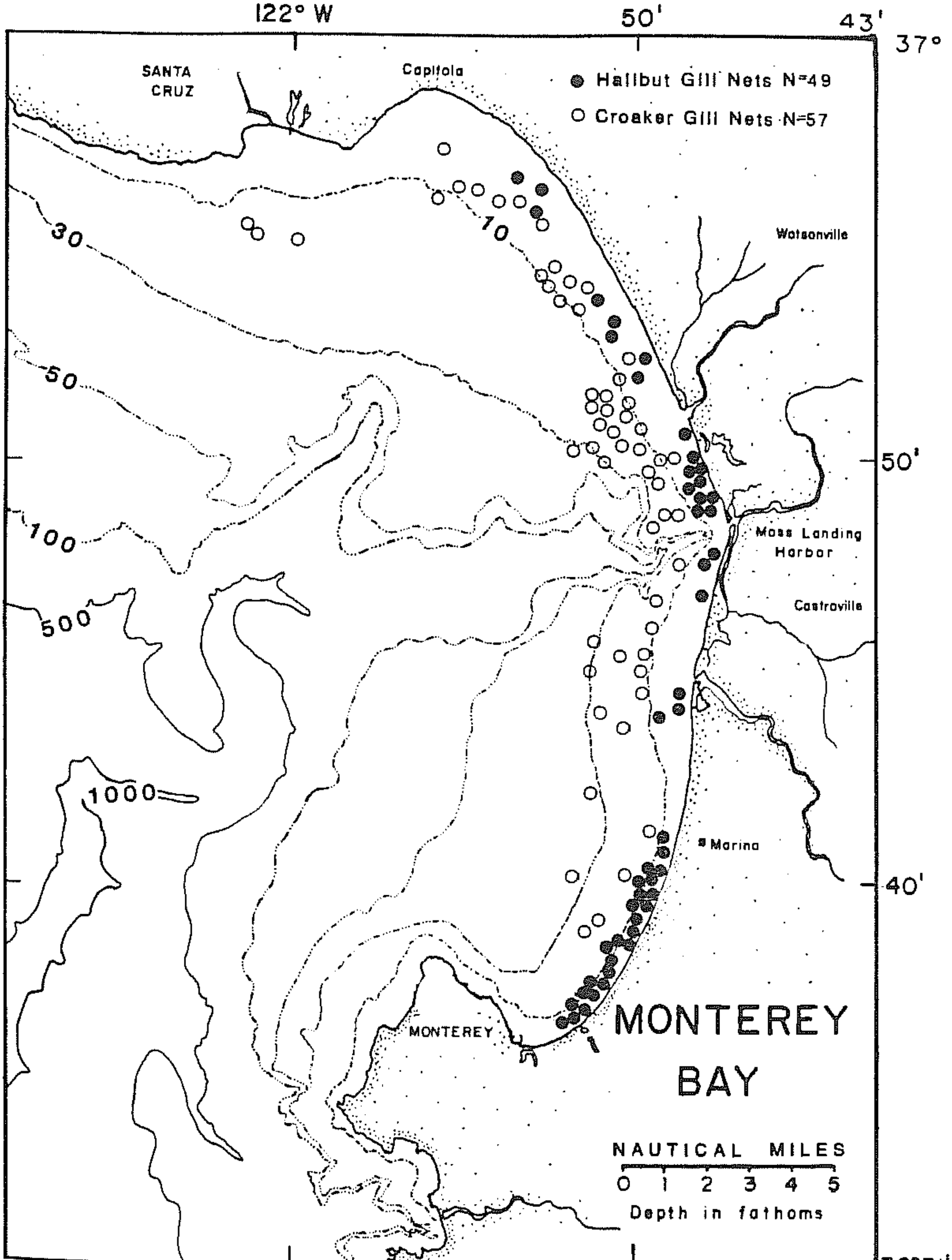
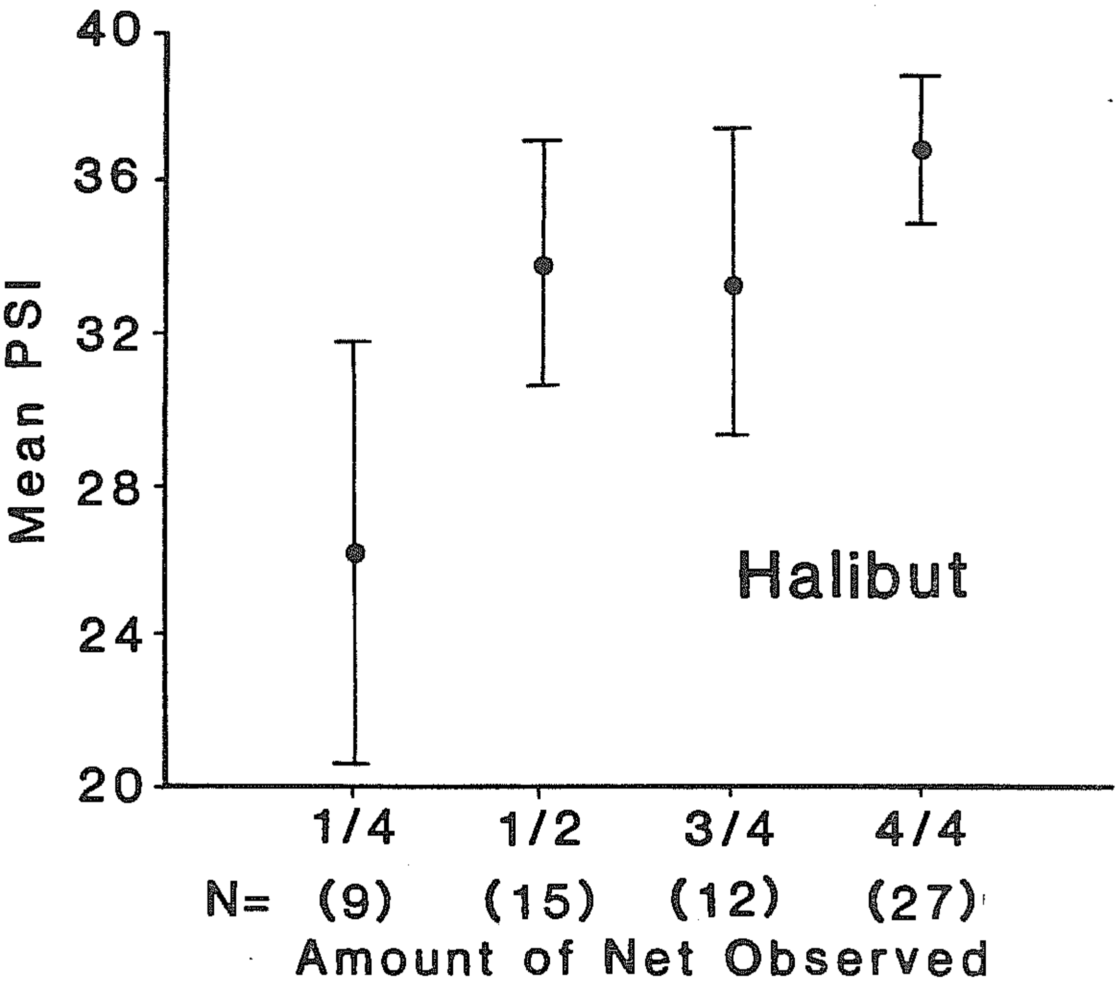

122° W
50'
43'
37°
50'
40'
36°31'
SANTA CRUZ
Capitola
Watsonville
Moss Landing Harbor
Castroville
Marina
MONTEREY
Halibut Gill Nets N=49
Croaker Gill Nets N=57
10
30
50
100
500
1000
MONTEREY BAY
NAUTICAL MILES
0 1 2 3 4 5
Depth in fathoms

Figure 2. Means and 95% confidence intervals for quarter unit observations of halibut gill nets.



40
36
32
28
24
20
Mean PSI
Halibut
1/4
1/2
3/4
4/4
N= (9) (15) (12) (27)
Amount of Net Observed

Figure 3. Means and 95% confidence intervals for quarter unit observations of croaker gill nets.

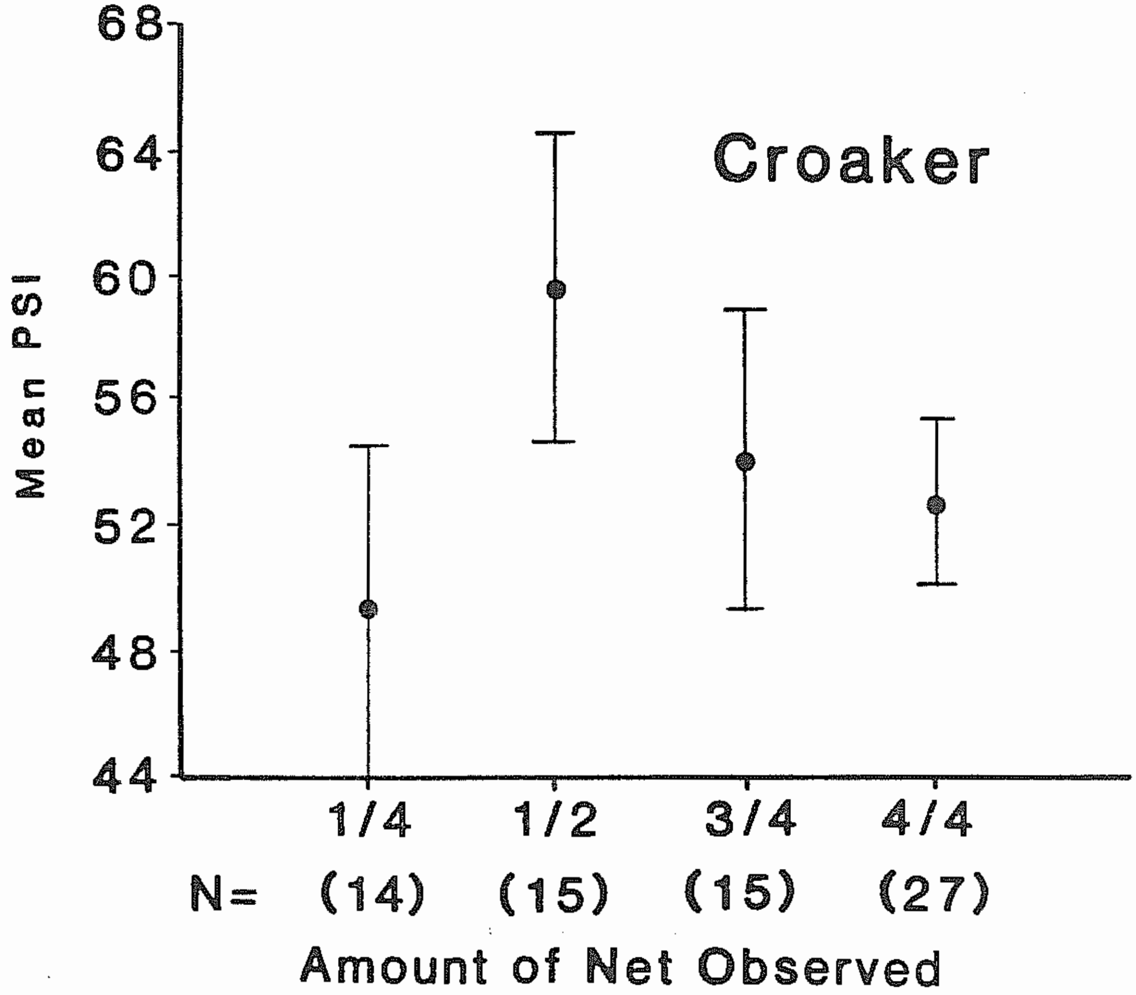

Croaker
68
64
60
56
52
48
44
Mean PSI
1/4
1/2
3/4
4/4
N= (14) (15) (15) (27)
Amount of Net Observed

Figure 4. Means and 95% confidence intervals for yearly observations of halibut gill nets.

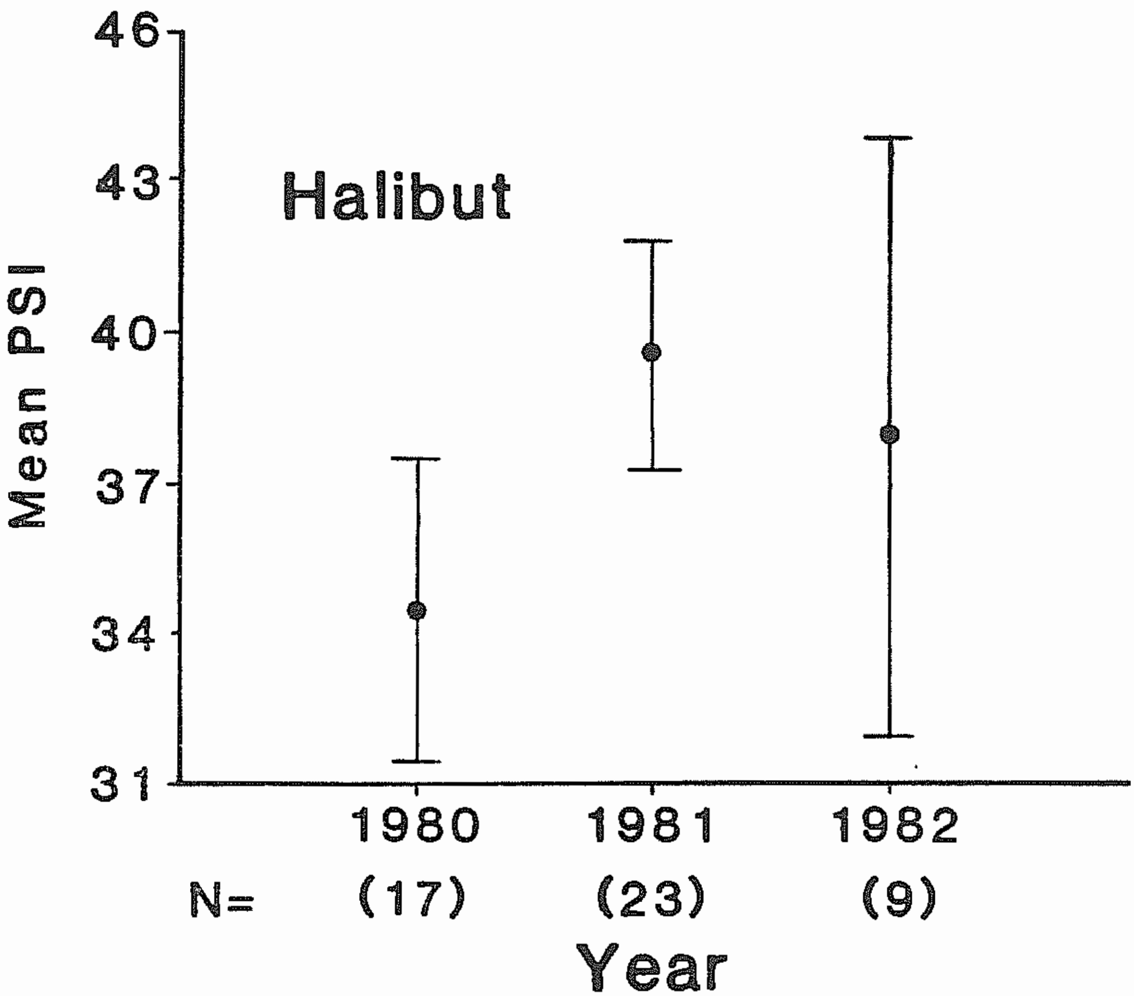

46
43
40
37
34
31
Mean PSI
Halibut
1980
1981
1982
N=
(17)
(23)
(9)
Year

Figure 5. The cumulative number of species versus sequentially ordered halibut gill nets.

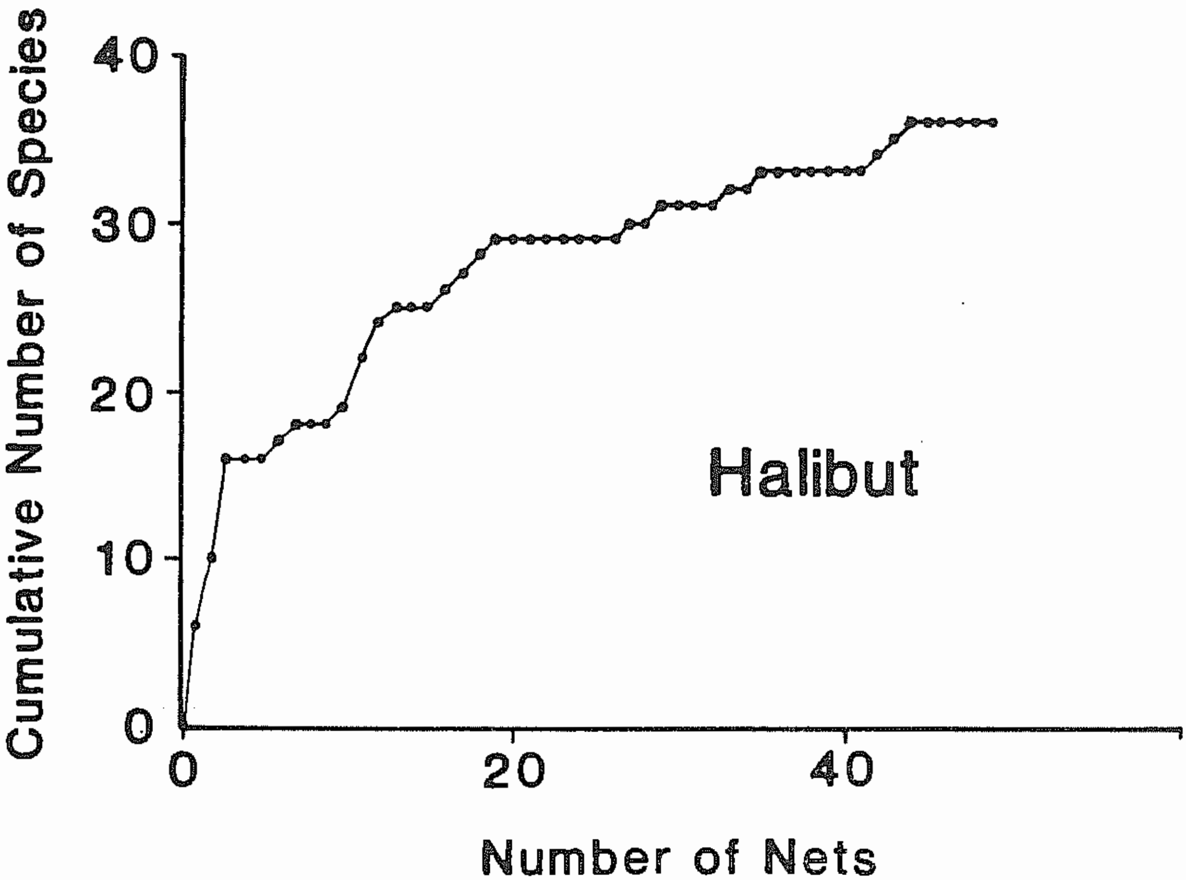

Cumulative Number of Species
40
30
20
10
0
0
20
40
Number of Nets
Halibut

Figure 6. Mean number of individuals per net and percent frequency of occurrence of the catch composition of halibut gill nets. Vertical bars are 1 standard error of the mean.

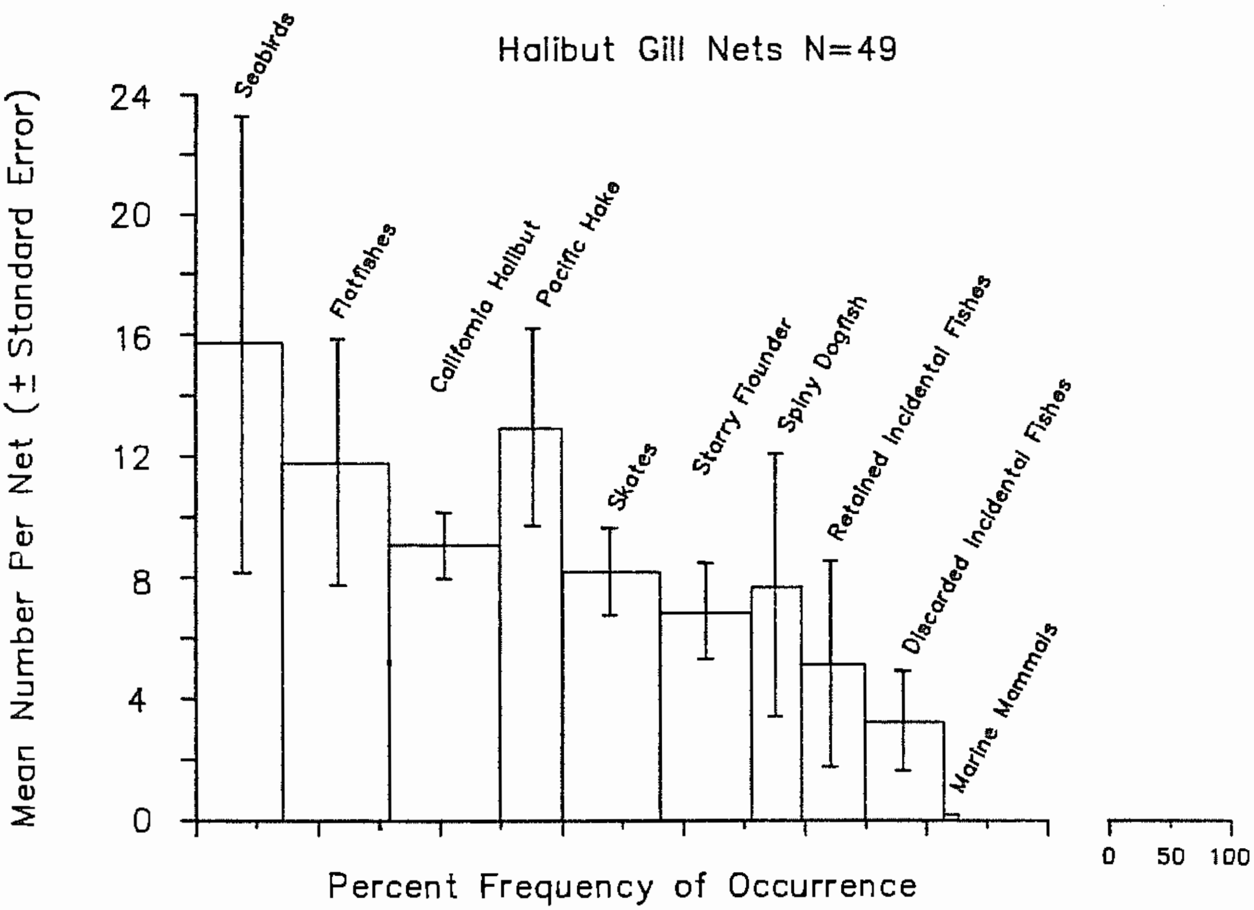

Halibut Gill Nets N=49
Mean Number Per Net (± Standard Error)
24
20
16
12
8
4
0
Seabirds
Flatfishes
California Halibut
Pacific Hake
Skates
Starry Flounder
Spiny Dogfish
Retained Incidental Fishes
Discarded Incidental Fishes
Marine Mammals
0
50
100
Percent Frequency of Occurrence

Figure 7. The cumulative number of species versus randomly ordered halibut gill nets for 1980, 1981, and 1982.

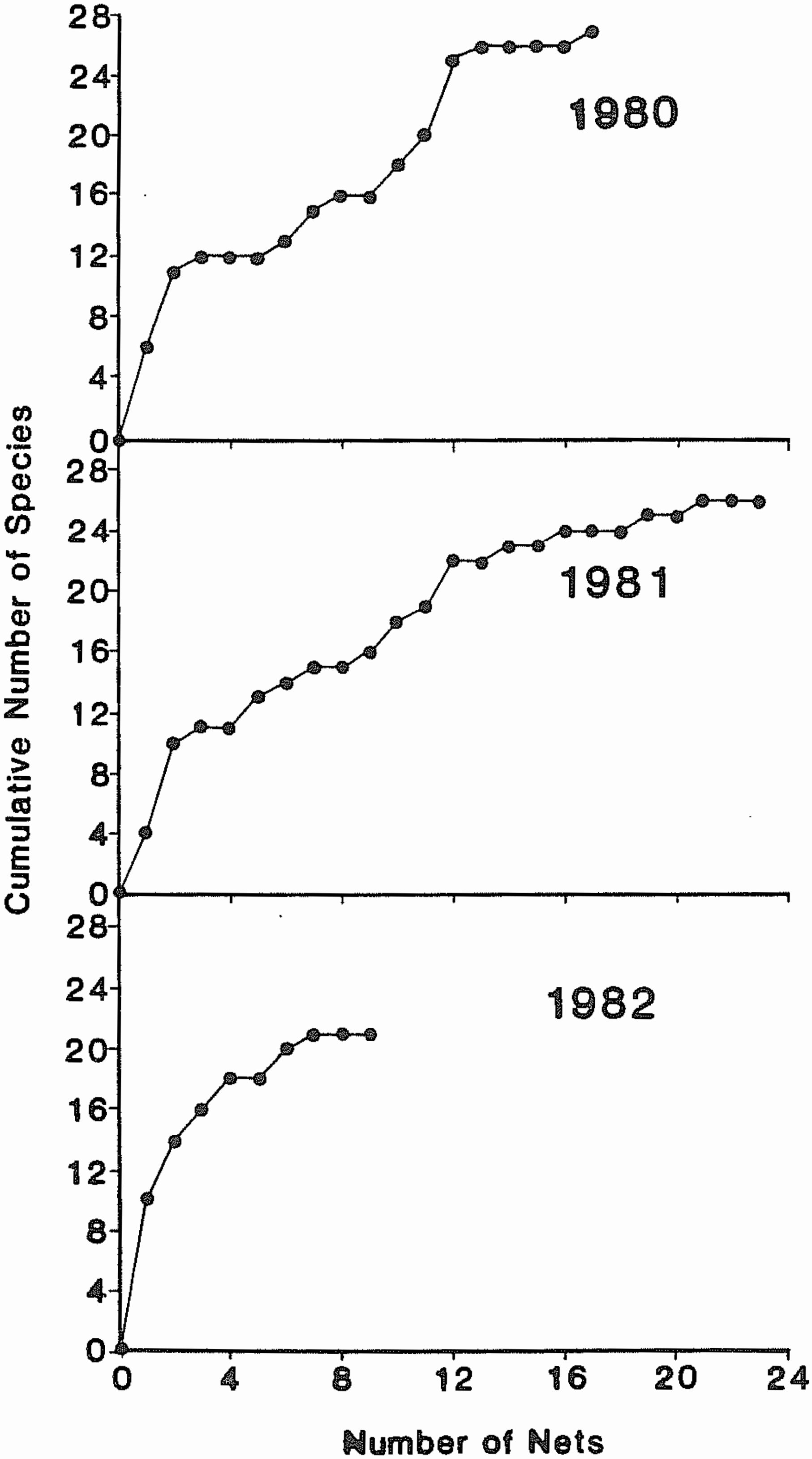

1980
1981
1982
Cumulative Number of Species
Number of Nets
0
4
8
12
16
20
24
28

Figure 8. Percent frequency of occurrence and percent by number of yearly catch compositions of halibut gill nets.

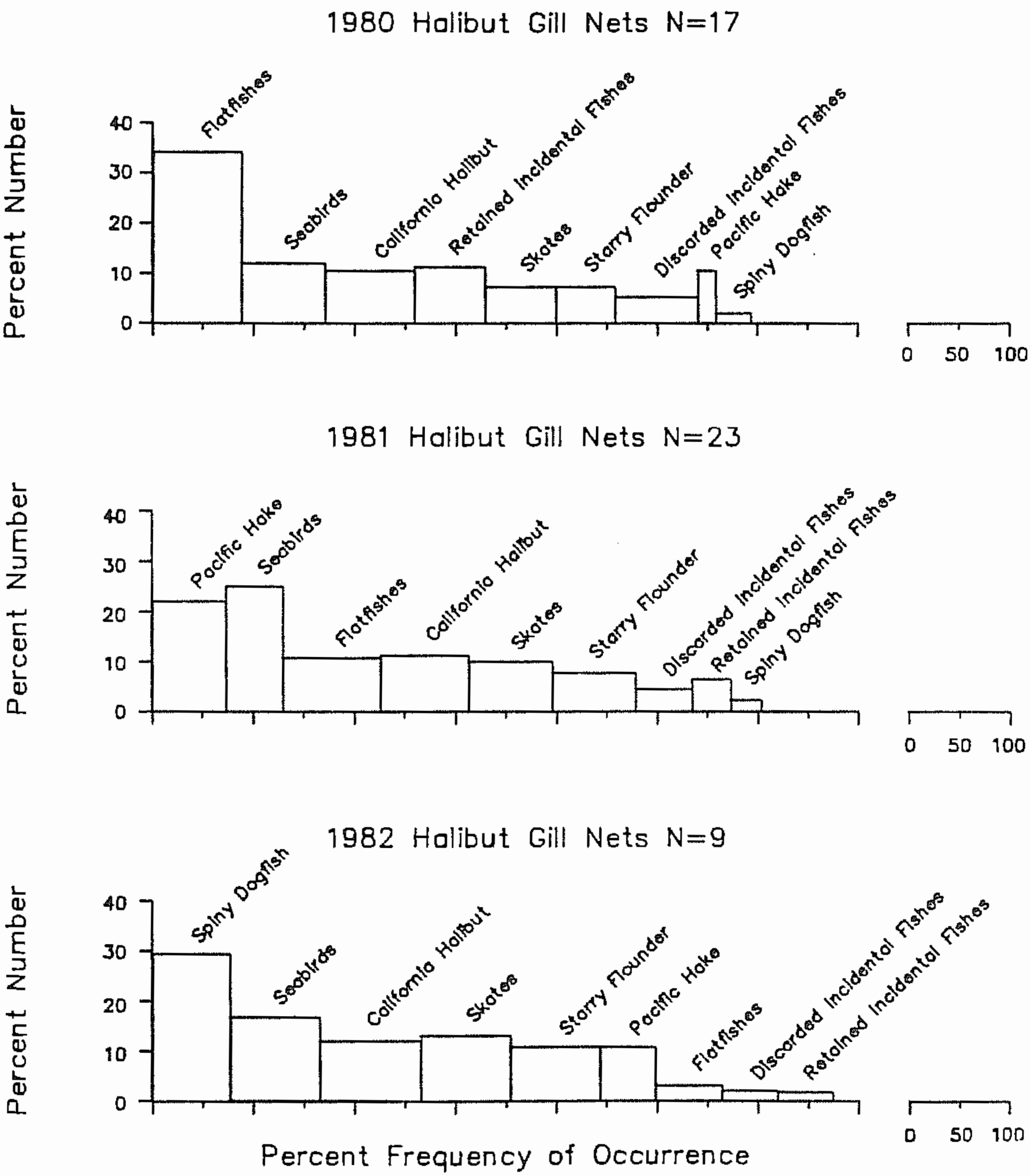

1980 Halibut Gill Nets N=17
Percent Number
40
30
20
10
0
Flatfishes
Seabirds
California Halibut
Retained Incidental Fishes
Skates
Starry Flounder
Discarded Incidental Fishes
Pacific Hake
Spiny Dogfish
0
50
100
1981 Halibut Gill Nets N=23
Percent Number
40
30
20
10
0
Pacific Hake
Seabirds
Flatfishes
California Halibut
Skates
Starry Flounder
Discarded Incidental Fishes
Retained Incidental Fishes
Spiny Dogfish
0
50
100
1982 Halibut Gill Nets N=9
Percent Number
40
30
20
10
0
Spiny Dogfish
Seabirds
California Halibut
Skates
Starry Flounder
Pacific Hake
Flatfishes
Discarded Incidental Fishes
Retained Incidental Fishes
0
50
100
Percent Frequency of Occurrence

Figure 9. The cumulative number of species versus sequentially ordered croaker gill nets.

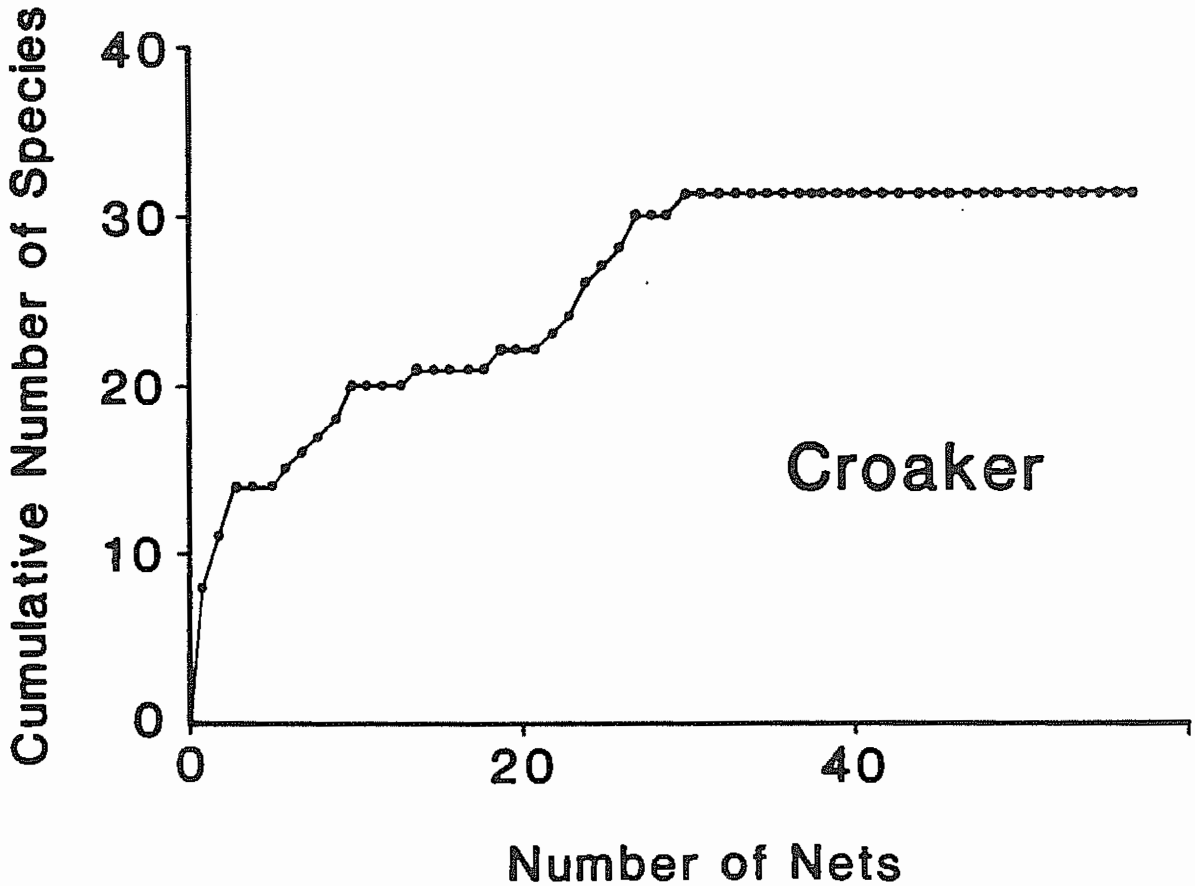
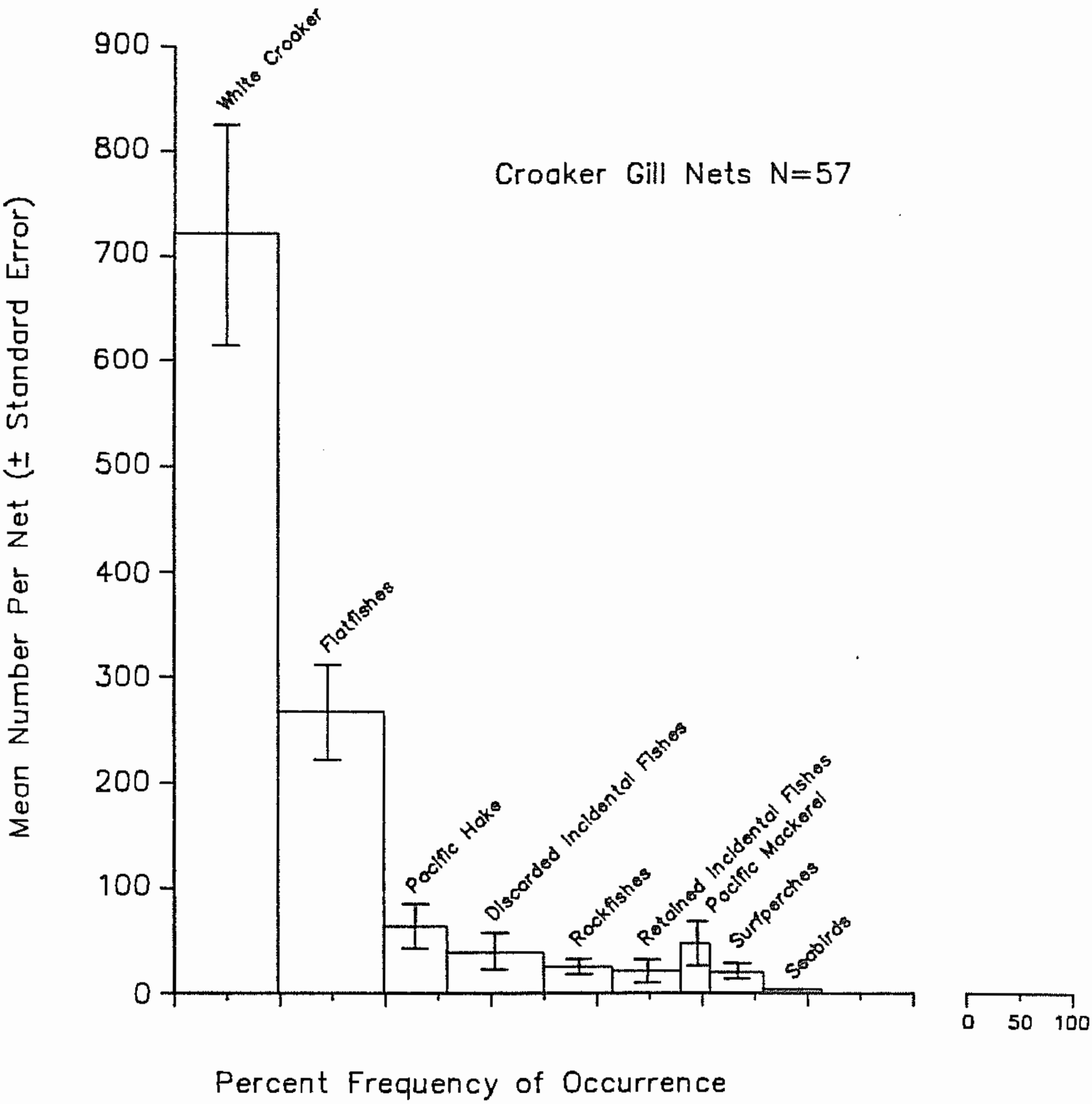

Cumulative Number of Species
40
30
20
10
0
0
20
40
Number of Nets
Croaker

Figure 10. Mean number of individuals per net and percent frequency of occurrence of the catch composition of croaker gill nets. Vertical bars are 1 standard error of the mean.



Crooker Gill Nets N=57
Mean Number Per Net (± Standard Error)
Percent Frequency of Occurrence
900
800
700
600
500
400
300
200
100
0
White Croaker
Flatfishes
Pacific Hake
Discarded Incidental Fishes
Rockfishes
Retained Incidental Fishes
Pacific Mackerel
Surfperches
Seabirds
0
50
100

Figure 11. A comparison of percent frequency of occurrence and percent by number of the catch compositions of croaker and halibut gill nets.

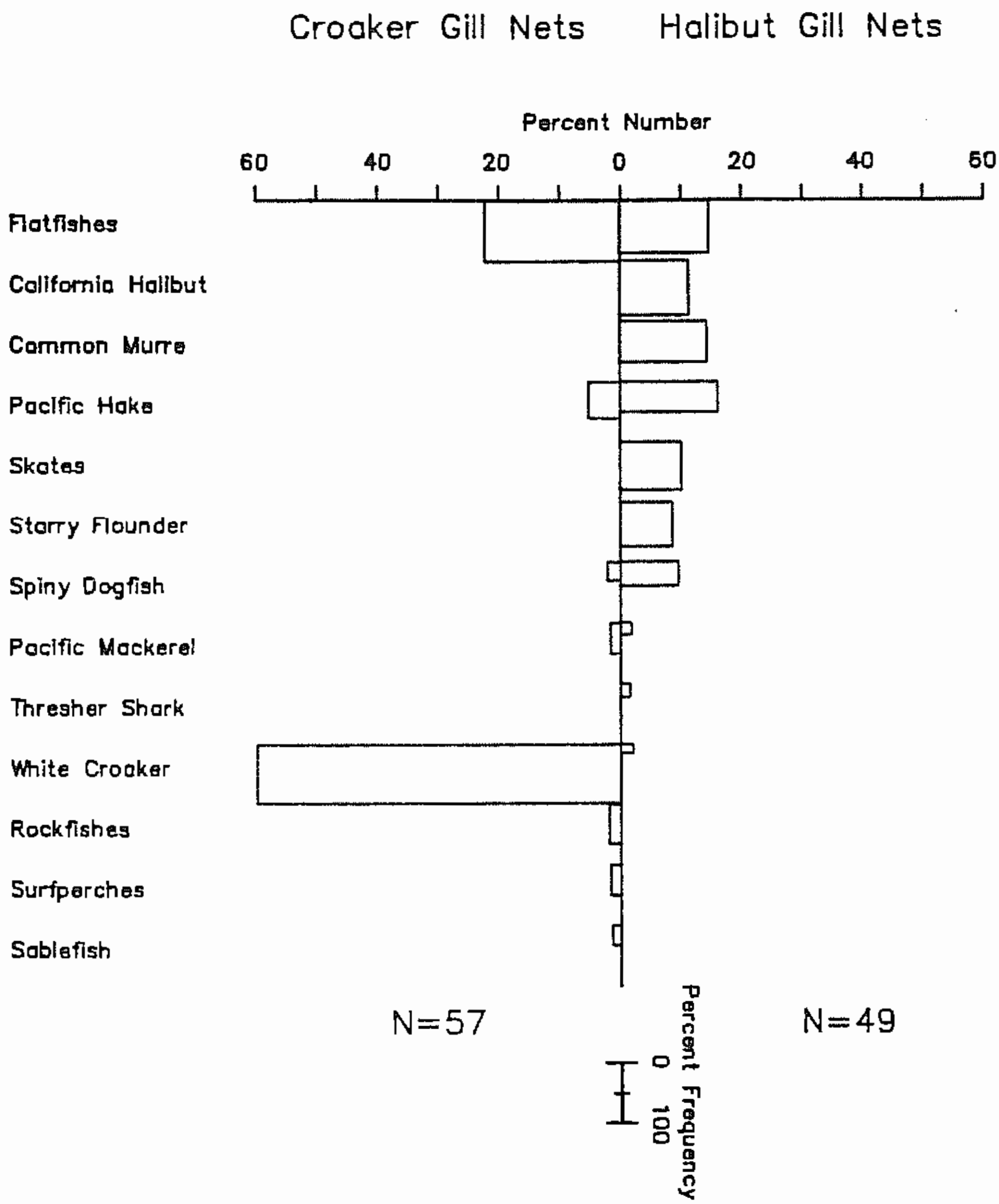

Croaker Gill Nets
Halibut Gill Nets
Percent Number
60
40
20
0
20
40
60
Flatfishes
California Halibut
Common Murre
Pacific Hake
Skates
Starry Flounder
Spiny Dogfish
Pacific Mackerel
Thresher Shark
White Croaker
Rockfishes
Surfperches
Sablefish
N=57
N=49
Percent Frequency
0
100

Figure 12. A comparison of percent frequency of occurrence and percent by number of the catch compositions of otter trawls and halibut gill nets.

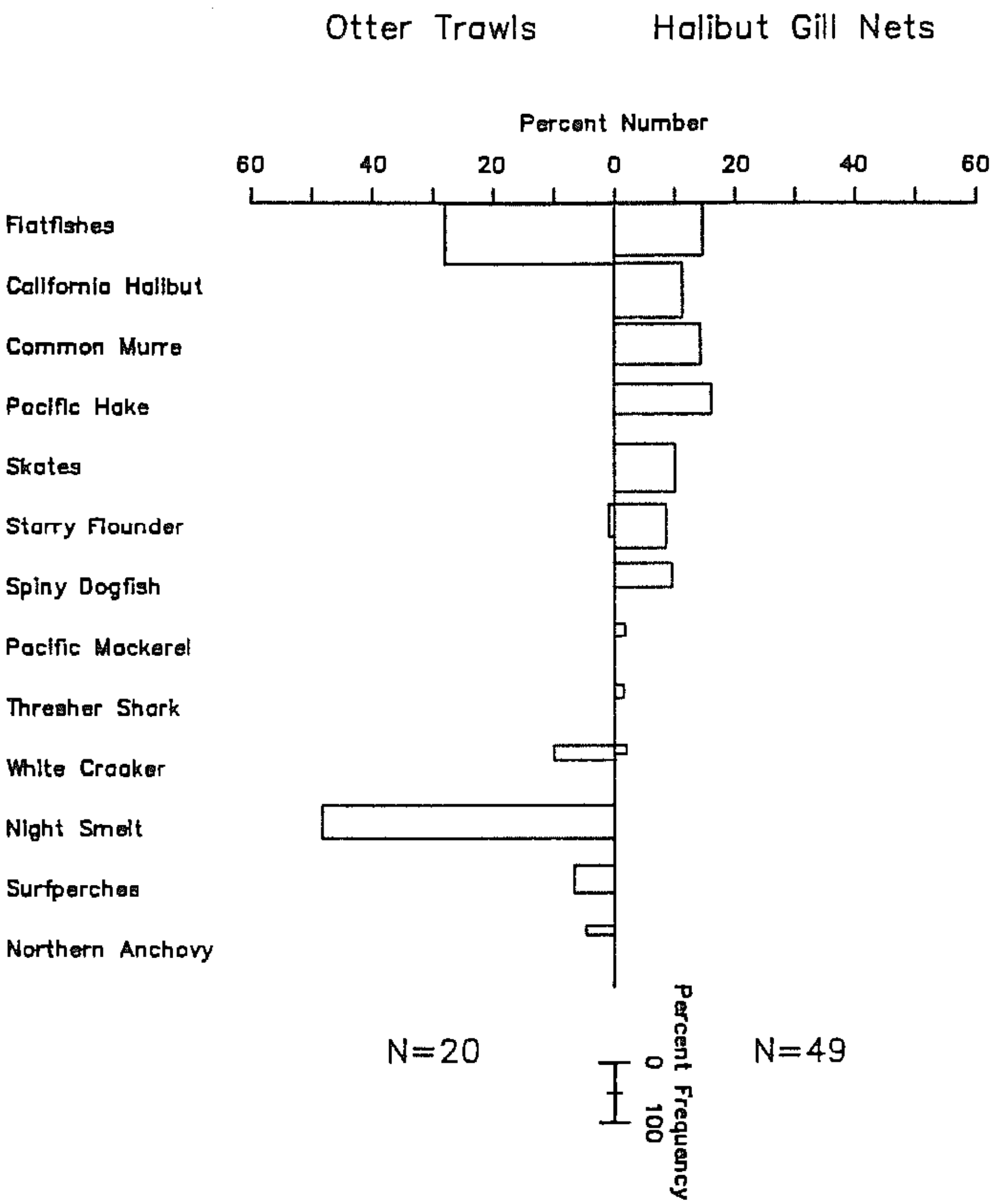
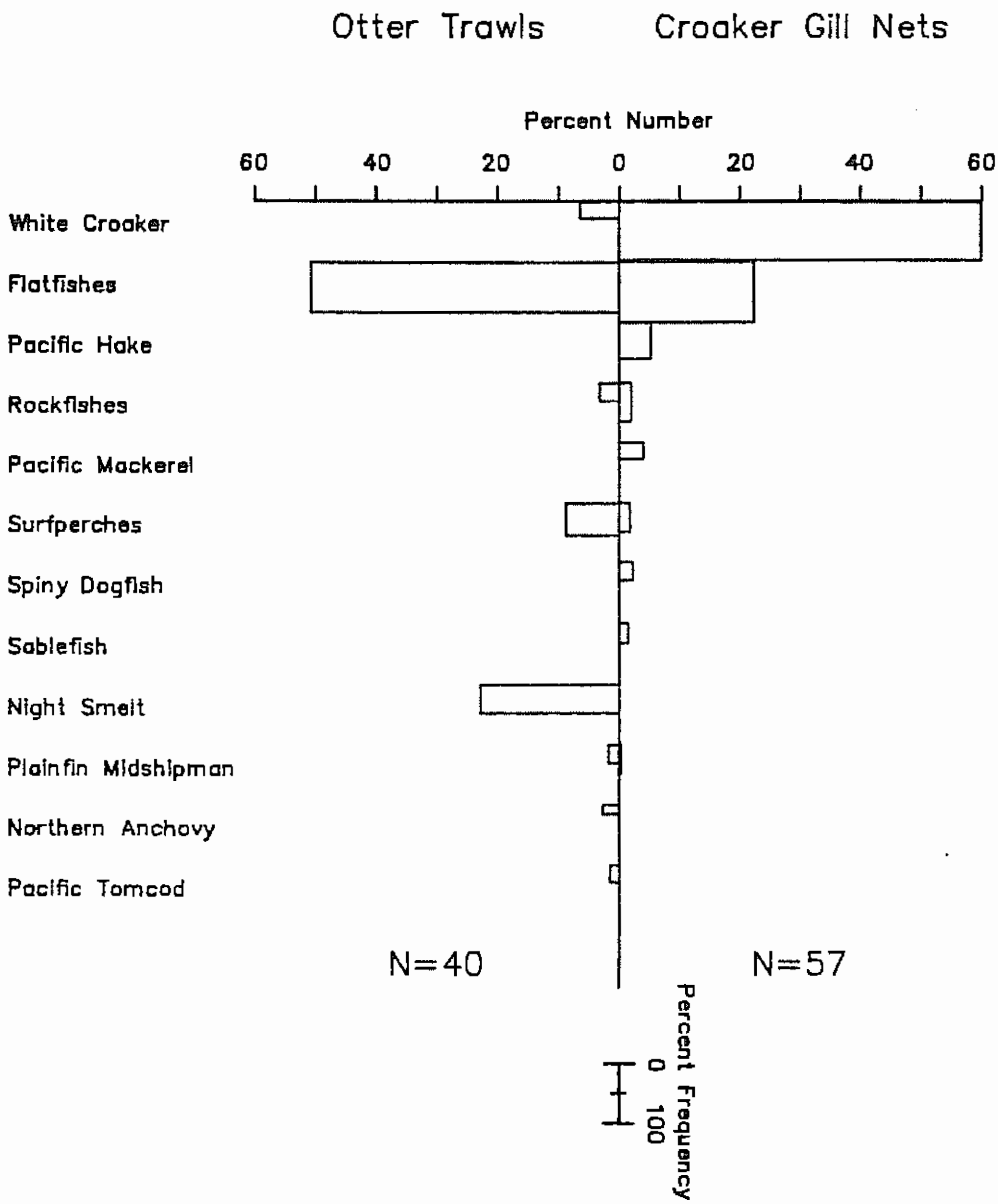

Otter Trawls
Halibut Gill Nets
Percent Number
60
40
20
0
20
40
60
Flatfishes
California Halibut
Common Murre
Pacific Hake
Skates
Starry Flounder
Spiny Dogfish
Pacific Mackerel
Thresher Shark
White Croaker
Night Smelt
Surfperches
Northern Anchovy
N=20
N=49
Percent Frequency
0
100

Figure 13. A comparison of percent frequency of occurrence and percent by number of the catch compositions of otter trawls and croaker gill nets.


Otter Trawls
Croaker Gill Nets
Percent Number
60
40
20
0
20
40
60
White Croaker
Flatfishes
Pacific Hake
Rockfishes
Pacific Mackerel
Surfperches
Spiny Dogfish
Sablefish
Night Smelt
Plainfin Midshipman
Northern Anchovy
Pacific Tomcod
N=40
N=57
Percent Frequency
0
100

Appendix A. Raw catch data for halibut gill nets.

Date	Depth (meters)	Amt Obs (quarters)	Location (NorS)	California Halibut	Starry Flounder	Thresher Shark	Flatfishes	Skates
06-08-80	15	4	S	9	0	2	0	23
07-28-80	10	4	N	4	1	4	4	1
08-06-80	9	4	S	13	35	0	80	14
08-13-80	13	4	S	3	0	1	1	0
08-13-80	13	4	S	4	1	0	9	2
08-20-80	12	2	N	5	3	7	0	0
08-22-80	9	4	S	2	0	0	4	0
08-22-80	12	4	S	9	2	0	7	7
08-26-80	9	4	N	5	0	2	1	3
08-29-80	13	4	S	0	5	0	13	4
08-29-80	13	4	S	4	0	0	190	0
09-03-80	3	3	S	0	0	0	2	0
09-04-80	8	4	N	8	1	0	15	1
09-04-80	6	1	N	1	0	0	0	0
09-05-80	9	3	N	4	9	1	1	9
09-05-80	9	2	N	7	0	0	2	1
09-05-80	4	1	N	2	2	0	3	2
09-12-80	3	4	S	7	9	0	12	1
09-16-80	5	4	N	10	3	1	1	4
06-04-81	6	3	N	12	7	0	8	24
06-06-81	8	3	N	26	6	21	5	8
06-16-81	9	2	N	5	10	0	11	11
06-17-81	9	4	N	7	11	0	16	14
06-18-81	6	4	S	4	8	0	23	9
06-18-81	9	2	S	0	13	0	4	5
07-06-81	8	1	N	1	1	2	0	1
07-10-81	4	4	N	4	2	0	2	2
07-15-81	21	2	S	17	3	0	4	8
07-15-81	15	2	S	7	3	0	7	2
07-16-81	20	3	S	10	1	0	5	0
07-20-81	4	4	N	4	2	0	6	2
07-22-81	9	3	N	8	2	1	2	10
07-31-81	4	2	N	9	1	1	2	0
07-31-81	4	4	N	2	0	1	6	2

Date	Depth (meters)	Amt Obs (quarters)	Location (NorS)	California Halibut	Starry Flounder	Thresher Shark	Flatfishes	Skates
08-03-81	19	4	S	8	23	0	20	19
08-07-81	11	3	S	5	0	0	18	4
08-07-81	9	2	S	0	0	0	2	0
08-10-81	8	3	S	2	0	0	2	0
08-12-81	8	3	S	9	4	0	5	4
08-18-81	6	2	N	1	1	0	1	1
08-19-81	13	2	S	0	3	0	1	5
08-20-81	11	2	S	1	1	0	0	3
08-24-81	15	4	S	5	2	0	4	3
06-16-82	7	1	S	1	1	0	1	0
06-22-82	10	1	S	4	2	5	0	1
06-23-82	12	3	S	15	5	0	1	0
06-24-82	5	2	S	11	2	0	1	3
07-02-82	4	3	S	17	2	0	0	3
07-07-82	12	1	S	1	2	0	1	0
07-09-82	20	4	S	7	9	0	2	2
07-09-82	15	2	S	6	0	0	0	10
07-12-82	16	4	S	9	17	0	4	3
07-12-82	19	2	S	5	1	0	0	10
07-26-82	22	4	S	20	65	0	20	42
07-28-82	20	2	S	3	5	0	1	21
06-22-83	18	3	N	24	13	0	28	17
06-22-83	18	1	S	1	3	1	2	0
06-22-83	18	1	S	0	8	0	1	0
06-29-83	18	4	N	0	8	0	3	0
06-29-83	19	1	S	2	34	4	5	0
07-07-83	20	4	N	6	1	1	6	4

Date	Pacific Mackerel	Rockfishes	Striped Bass	Pacific Bonito	Sturgeons	Salmon	Surfperches	White Croakers
06-08-80	0	0	0	0	1	0	0	0
07-28-80	0	0	0	0	0	0	0	0
08-06-80	0	0	0	0	0	0	0	49
08-13-80	0	0	0	0	0	0	0	0
08-13-80	0	0	0	0	0	0	0	0
08-20-80	0	0	0	0	0	0	0	0
08-22-80	0	0	0	0	0	0	0	0
08-22-80	0	0	0	0	0	0	0	1
08-26-80	0	0	0	0	0	0	0	0
08-29-80	0	0	0	0	0	0	0	0
08-29-80	1	0	0	0	0	0	0	0
09-03-80	0	0	0	0	0	0	2	2
09-04-80	0	0	0	0	0	0	0	2
09-04-80	0	0	0	0	0	0	0	0
09-05-80	0	0	0	0	0	0	0	0
09-05-80	0	0	0	0	0	0	0	0
09-05-80	0	0	0	0	0	0	0	0
09-12-80	0	0	0	0	0	0	0	0
09-16-80	0	0	0	0	0	1	0	0
06-04-81	0	0	0	0	0	0	0	0
06-06-81	0	0	0	0	0	0	0	0
06-16-81	0	0	0	0	1	2	0	0
06-17-81	0	0	0	0	0	0	0	0
06-18-81	0	0	0	0	0	1	0	0
06-18-81	0	0	0	0	0	0	0	0
07-06-81	0	0	0	0	0	0	0	0
07-10-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-16-81	0	5	0	0	0	0	0	13
07-20-81	1	0	0	0	0	0	0	0
07-22-81	0	0	0	0	0	12	0	0
07-31-81	24	0	0	0	0	1	0	0
07-31-81	6	0	0	0	0	0	0	0

Date	Pacific Mackerel	Rockfishes	Striped Bass	Pacific Bonito	Sturgeons	Salmon	Surfperches	White Croakers
08-03-81	1	0	0	0	0	0	0	2
08-07-81	0	0	0	2	1	10	0	4
08-07-81	0	0	0	1	0	0	0	0
08-10-81	0	0	0	0	0	0	0	0
08-12-81	0	0	0	0	0	0	0	0
08-18-81	0	0	0	0	0	0	0	0
08-19-81	0	0	0	0	0	0	0	0
08-20-81	0	0	0	0	0	0	0	0
08-24-81	0	0	0	0	0	0	0	0
06-16-82	0	0	0	0	0	0	0	0
06-22-82	1	0	1	0	0	0	1	0
06-23-82	1	0	0	0	1	0	0	0
06-24-82	1	0	0	0	0	0	0	0
07-02-82	1	0	0	0	0	1	2	0
07-07-82	0	0	0	0	0	0	0	0
07-09-82	3	0	0	0	0	0	0	0
07-09-82	0	0	0	0	0	0	0	0
07-12-82	7	0	0	0	1	0	0	0
07-12-82	0	0	0	0	0	0	0	0
07-26-82	0	0	0	0	0	0	0	0
07-28-82	0	0	0	0	0	0	0	0
06-22-83	0	0	0	0	0	0	0	0
06-22-83	0	0	0	0	0	0	0	0
06-22-83	8	0	0	0	0	0	0	0
06-29-83	0	0	0	0	0	2	0	0
06-29-83	0	0	0	0	0	0	0	0
07-07-83	1	0	0	0	0	0	0	0

Date	Smoothhound Sharks	Spiny Dogfish	Leopard Shark	Jacksmelt	Cabezon	Lingcod	Bat Ray	White Seabass
06-08-80	0	0	0	0	0	0	0	0
07-28-80	0	0	0	0	0	0	0	0
08-06-80	6	1	0	0	0	1	0	0
08-13-80	0	0	0	0	0	0	0	0
08-13-80	2	10	0	0	0	0	0	0
08-20-80	4	1	0	0	0	0	1	0
08-22-80	0	0	0	0	0	0	0	0
08-22-80	0	0	0	0	0	0	0	0
08-26-80	3	0	0	0	0	0	3	0
08-29-80	0	0	0	0	0	0	1	0
08-29-80	0	0	0	0	1	18	0	0
09-03-80	0	0	0	1	0	0	0	0
09-04-80	4	2	0	0	0	0	2	0
09-04-80	0	0	0	0	0	0	0	0
09-05-80	0	3	0	0	0	0	0	0
09-05-80	2	0	0	0	0	0	0	0
09-05-80	0	1	0	0	0	0	0	0
09-12-80	0	0	0	0	0	0	3	0
09-16-80	0	1	0	0	0	0	6	0
06-04-81	1	0	1	0	0	0	0	0
06-06-81	0	0	0	0	0	0	0	0
06-16-81	0	0	0	0	0	0	0	0
06-17-81	0	0	0	0	0	0	0	0
06-18-81	1	1	0	0	0	0	0	0
06-18-81	0	13	1	1	0	0	0	0
07-06-81	0	0	0	0	0	0	0	0
07-10-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-16-81	0	0	0	0	2	0	0	0
07-20-81	0	0	0	0	0	0	0	0
07-22-81	0	1	0	0	0	0	0	0
07-31-81	0	0	0	0	0	0	0	0
07-31-81	3	2	1	0	0	0	0	0

Date	Smoothhound Sharks	Spiny Dogfish	Leopard Shark	Jacksmelt	Cabezon	Lingcod	Bat Ray	White Seabass
08-03-81	0	8	0	0	0	0	0	0
08-07-81	3	0	0	0	0	0	0	0
08-07-81	0	0	0	0	0	0	0	0
08-10-81	0	0	0	0	0	0	0	0
08-12-81	0	0	0	0	0	0	0	0
08-18-81	0	0	0	0	0	0	0	0
08-19-81	0	2	0	0	0	0	0	0
08-20-81	0	0	0	0	0	0	7	0
08-24-81	0	1	0	0	0	0	0	0
06-16-82	0	0	0	0	0	0	0	0
06-22-82	0	0	0	0	0	0	0	0
06-23-82	0	0	0	0	0	1	0	0
06-24-82	0	0	0	0	0	0	0	0
07-02-82	0	9	0	0	0	0	4	2
07-07-82	0	1	0	0	0	0	0	0
07-09-82	0	2	0	0	0	0	0	0
07-09-82	0	3	0	0	0	0	0	0
07-12-82	0	1	0	0	0	0	0	0
07-12-82	0	1	0	0	0	0	0	0
07-26-82	0	194	0	0	0	0	0	0
07-28-82	0	49	0	0	0	0	0	0
06-22-83	0	0	0	0	0	0	0	0
06-22-83	0	0	0	0	0	0	0	0
06-22-83	0	0	0	0	0	0	0	0
06-29-83	0	0	0	0	0	0	0	0
06-29-83	12	0	0	0	0	0	0	0
07-07-83	0	1	0	0	0	0	0	0

Date	Jack Mackerel	Triggerfish	Pacific Hake	Common Mola	Pacific Electric Ray	Ratfish	Blue Shark	Common Murre
06-08-80	0	0	0	0	0	0	0	5
07-28-80	9	0	0	0	0	0	1	24
08-06-80	0	0	82	0	0	0	0	1
08-13-80	0	0	2	0	0	0	0	0
08-13-80	0	0	22	0	0	0	0	15
08-20-80	0	0	0	0	0	0	0	4
08-22-80	0	0	0	1	0	0	0	0
08-22-80	0	0	0	0	0	0	0	3
08-26-80	0	0	0	0	0	0	0	3
08-29-80	0	0	0	0	0	0	0	0
08-29-80	0	0	0	0	0	2	0	0
09-03-80	0	0	0	0	0	0	0	3
09-04-80	0	1	0	0	0	0	0	10
09-04-80	0	0	0	0	0	0	1	12
09-05-80	0	0	0	0	0	0	0	3
09-05-80	0	0	0	0	0	0	0	6
09-05-80	0	0	3	0	0	0	0	6
09-12-80	0	0	0	0	0	0	0	4
09-16-80	0	0	0	0	0	0	0	5
06-04-81	0	0	1	0	0	0	0	0
06-06-81	0	0	34	0	0	0	0	4
06-16-81	0	0	8	0	0	0	0	0
06-17-81	0	0	0	0	0	0	0	0
06-18-81	0	0	1	0	0	0	0	0
06-18-81	0	0	0	0	0	0	0	0
07-06-81	0	0	9	0	0	0	0	2
07-10-81	0	0	12	0	0	0	0	0
07-15-81	0	0	8	1	0	0	0	1
07-15-81	0	0	51	0	0	0	0	8
07-16-81	0	0	17	0	0	0	0	41
07-20-81	0	0	28	0	0	0	0	4
07-22-81	0	0	12	0	0	0	0	150
07-31-81	0	0	6	0	0	0	0	1
07-31-81	0	0	37	0	0	0	0	16

Date	Jack Mackerel	Triggerfish	Pacific Hake	Common Mola	Pacific Electric Ray	Ratfish	Blue Shark	Common Murre
08-03-81	0	0	6	0	0	0	0	0
08-07-81	0	0	59	2	0	0	0	15
08-07-81	0	0	8	0	0	0	0	1
08-10-81	0	0	1	0	1	0	0	3
08-12-81	0	0	0	2	0	0	0	0
08-18-81	0	0	1	0	0	0	0	0
08-19-81	0	0	0	0	0	0	0	3
08-20-81	0	0	0	0	0	0	0	0
08-24-81	0	0	0	0	0	0	0	3
06-16-82	0	0	0	0	0	0	0	0
06-22-82	0	0	3	0	0	0	0	0
06-23-82	0	0	0	0	0	0	0	1
06-24-82	0	0	0	0	0	0	0	0
07-02-82	0	0	0	0	0	0	0	0
07-07-82	0	0	0	0	0	0	0	0
07-09-82	0	0	0	0	0	0	0	6
07-09-82	0	0	27	0	0	0	0	10
07-12-82	0	0	26	0	0	3	0	16
07-12-82	0	0	5	0	0	0	0	29
07-26-82	0	0	12	0	0	6	0	10
07-28-82	0	0	7	0	0	1	0	13
06-22-83	0	0	36	0	0	0	0	9
06-22-83	0	0	2	0	0	0	0	9
06-22-83	0	0	0	0	0	3	0	14
06-29-83	0	0	916	0	0	0	0	0
06-29-83	0	0	90	0	0	1	0	11
07-07-83	0	0	12	0	0	0	0	2

Date	Sooty Shearwater	Pigeon Guillemot	Brandt's Cormorant	Western Grebe	Common Loon	California Sea Lion	Harbor Seal	Sea Otter
06-08-80	0	0	0	0	0	1	0	0
07-28-80	0	0	0	0	0	0	0	0
08-06-80	0	0	1	0	0	0	0	0
08-13-80	0	0	0	0	0	0	0	0
08-13-80	0	0	0	0	0	0	0	0
08-20-80	0	0	0	0	0	0	0	0
08-22-80	0	0	0	0	0	0	0	0
08-22-80	0	0	13	0	0	0	0	0
08-26-80	0	0	0	0	0	0	0	0
08-29-80	0	1	1	0	0	0	0	0
08-29-80	0	0	0	0	0	0	0	0
09-03-80	0	0	0	0	0	0	0	0
09-04-80	0	0	0	0	0	0	0	0
09-04-80	0	0	0	0	0	0	0	0
09-05-80	0	0	0	0	0	0	0	0
09-05-80	0	0	0	0	0	0	0	0
09-05-80	56	0	17	0	0	0	0	0
09-12-80	0	0	0	0	1	0	0	0
09-16-80	0	0	7	0	1	0	0	0
06-04-81	0	0	0	0	0	1	0	0
06-06-81	1	0	0	0	0	0	0	0
06-16-81	0	0	0	0	0	1	0	0
06-17-81	0	0	0	0	0	0	0	0
06-18-81	0	0	0	0	0	0	0	0
06-18-81	0	0	0	0	0	0	0	0
07-06-81	0	0	0	0	0	0	0	0
07-10-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-15-81	0	0	0	0	0	0	0	0
07-16-81	0	3	0	0	0	0	0	0
07-20-81	0	0	0	0	0	0	0	0
07-22-81	95	0	0	1	0	0	0	0
07-31-81	0	0	0	0	0	0	0	0
07-31-81	0	0	0	0	1	0	0	0

Date	Sooty Shearwater	Pigeon Guillemot	Brandt's Cormorant	Western Grebe	Common Loon	California Sea Lion	Harbor Seal	Sea Otter
08-03-81	0	0	0	0	0	0	0	0
08-07-81	0	0	0	0	0	0	0	0
08-07-81	0	0	0	0	0	0	0	0
08-10-81	0	0	0	0	0	0	0	0
08-12-81	0	0	0	0	0	0	0	0
08-18-81	0	0	0	0	0	0	0	0
08-19-81	0	0	0	0	0	0	0	0
08-20-81	0	0	0	0	0	0	0	0
08-24-81	0	0	0	0	0	0	0	0
06-16-82	0	0	0	0	0	0	0	0
06-22-82	0	0	0	0	0	0	0	0
06-23-82	0	2	3	0	1	0	0	0
06-24-82	0	0	0	0	0	1	0	1
07-02-82	0	0	2	0	0	0	0	0
07-07-82	0	0	0	0	0	0	0	0
07-09-82	0	2	0	0	0	0	1	0
07-09-82	0	0	0	0	0	0	0	0
07-12-82	0	16	1	0	0	0	1	0
07-12-82	0	2	3	0	1	0	0	0
07-26-82	0	0	0	0	0	0	0	0
07-28-82	0	0	0	0	0	0	0	0
06-22-83	0	0	0	0	0	1	0	0
06-22-83	0	1	0	0	0	0	0	0
06-22-83	0	3	0	0	0	3	0	0
06-29-83	0	0	0	0	0	0	0	0
06-29-83	0	3	0	0	0	1	0	0
07-07-83	0	0	0	0	0	1	0	0

Date	Harbor Porpoise	TOTAL CATCH
06-08-80	0	41
07-28-80	0	48
08-06-80	0	283
08-13-80	0	7
08-13-80	0	65
08-20-80	0	25
08-22-80	0	7
08-22-80	0	42
08-26-80	0	20
08-29-80	0	25
08-29-80	0	216
09-03-80	0	10
09-04-80	0	46
09-04-80	0	14
09-05-80	0	30
09-05-80	0	18
09-05-80	0	92
09-12-80	0	37
09-16-80	0	40
06-04-81	0	55
06-06-81	0	105
06-16-81	0	49
06-17-81	0	48
06-18-81	0	48
06-18-81	0	37
07-06-81	0	16
07-10-81	0	22
07-15-81	0	42
07-15-81	0	78
07-16-81	0	97
07-20-81	0	47
07-22-81	0	294
07-31-81	0	45
07-31-81	0	77

Date	Harbor Porpoise	TOTAL CATCH
08-03-81	0	87
08-07-81	0	123
08-07-81	0	12
08-10-81	0	9
08-12-81	0	24
08-18-81	0	5
08-19-81	0	14
08-20-81	0	12
08-24-81	0	18
06-16-82	0	3
06-22-82	0	18
06-23-82	0	31
06-24-82	0	20
07-02-82	0	43
07-07-82	0	5
07-09-82	0	34
07-09-82	0	56
07-12-82	0	105
07-12-82	0	57
07-26-82	0	369
07-28-82	0	100
06-22-83	1	129
06-22-83	0	19
06-22-83	0	40
06-29-83	0	929
06-29-83	0	163
07-07-83	0	35

Appendix B. Raw catch data for croaker gill nets.

Date	Depth (meters)	Amt Obs (quarters)	Location (NorS)	White Croaker	Rockfishes	Pacific Mackerel	Lingcod	Pacific Butterfish
07-02-81	18	3	S	312	0	0	0	6
07-03-81	16	4	S	692	2	0	0	0
07-03-81	20	2	N	105	50	0	10	0
07-08-81	17	4	S	263	1	0	0	0
07-22-81	12	3	S	349	7	0	0	0
07-23-81	13	4	S	857	0	0	0	0
07-27-81	13	4	S	726	0	0	0	0
07-29-81	11	4	S	1244	36	0	4	0
08-12-81	27	1	N	52	3	21	0	21
08-14-81	20	1	N	14	1	20	0	0
08-19-81	45	1	N	54	0	14	0	0
08-26-81	11	4	S	229	1	0	1	0
09-02-81	74	4	S	1909	91	115	13	5
09-08-81	25	1	N	153	0	10	0	0
09-08-81	23	4	S	716	40	33	1	1
09-16-81	26	1	N	1028	0	3	0	0
09-16-81	35	4	S	890	0	233	0	24
09-23-81	22	3	S	226	0	494	0	0
09-24-81	45	3	S	189	0	709	0	0
09-30-81	50	3	S	2091	7	4	0	1
10-01-81	50	2	N	1946	2	16	1	0
10-08-81	45	4	S	2940	4	1	0	0
10-15-81	45	1	N	421	242	0	3	0
10-22-81	51	3	S	417	0	0	1	0
10-29-81	42	3	S	90	3	0	0	0
10-29-81	48	2	N	56	0	0	0	0
11-05-81	35	4	S	0	0	0	0	0
11-19-81	58	4	S	555	2	0	0	0
11-24-81	22	2	N	553	10	0	0	0
12-02-81	58	1	N	191	0	1	0	0
12-02-81	24	1	N	25	0	0	0	0
12-03-81	19	3	S	410	2	0	0	1
12-03-81	19	2	N	131	0	0	0	0
12-10-81	58	4	S	0	2	0	0	0

Date	Depth (meters)	Amt Obs (quarters)	Location (NorS)	White Croaker	Rockfishes	Pacific Mackerel	Lingcod	Pacific Butterfish
01-12-82	22	1	N	43	0	0	0	0
01-12-82	24	4	S	476	3	0	0	0
01-13-82	18	2	N	664	3	0	0	0
01-13-82	15	2	N	448	0	0	0	0
01-14-82	15	2	N	444	0	0	0	0
01-14-82	16	1	N	99	0	0	0	0
01-15-82	18	3	S	142	0	0	0	0
01-15-82	20	1	N	131	0	0	0	0
01-18-82	16	4	S	380	0	0	0	0
03-22-82	74	3	S	498	3	0	1	0
03-23-82	73	4	S	1294	2	0	0	0
04-13-82	45	4	S	154	1	22	0	0
04-19-82	46	2	N	194	0	0	0	0
04-20-82	54	3	S	847	9	0	1	0
05-03-82	50	3	S	427	1	0	2	0
05-03-82	30	2	N	123	1	0	0	0
05-04-82	16	4	S	261	0	0	0	0
05-05-82	47	4	S	520	0	3	1	0
05-12-82	24	4	S	90	0	0	0	21
05-17-82	69	4	S	1045	100	0	0	1
05-19-82	65	4	S	138	9	0	0	4
05-25-82	20	4	S	257	1	0	1	4
06-03-82	25	3	S	323	35	0	0	3
06-04-82	20	1	N	55	16	0	0	0
06-07-82	20	4	S	358	159	0	1	0
06-09-82	25	3	S	271	36	0	0	0
06-15-82	20	1	N	46	0	0	0	0
07-15-82	55	1	N	311	132	15	1	0
07-19-82	44	2	N	26	4	0	0	0
07-21-82	52	4	S	331	12	0	1	0
07-27-82	55	2	N	462	58	43	1	0
08-02-82	36	4	S	135	0	131	6	0
08-03-82	23	2	N	339	1	0	0	0
08-19-82	62	2	N	197	15	14	0	1
10-02-82	31	4	S	3296	1	0	9	0
10-11-82	29	4	S	910	314	354	13	0
10-12-82	25	3	S	181	178	20	4	0
10-29-82	50	2	N	61	0	10	0	0

Date	Flatfishes	California Halibut	Starry Flounder	Thresher Shark	Salmon	Pacific Herring	Jacksmelt	American Shad
07-02-81	7	0	0	1	0	0	0	0
07-03-81	44	0	0	0	0	0	0	0
07-03-81	30	1	2	2	0	0	0	0
07-08-81	67	0	0	0	0	0	0	0
07-22-81	26	0	0	0	0	0	0	0
07-23-81	29	0	0	0	5	0	0	0
07-27-81	70	0	0	0	2	0	0	0
07-29-81	18	0	0	0	0	0	0	0
08-12-81	236	1	0	0	0	0	0	0
08-14-81	396	0	0	0	0	0	0	0
08-19-81	3	0	0	0	0	0	0	0
08-26-81	32	0	0	0	0	0	0	0
09-02-81	188	0	0	0	0	0	0	0
09-08-81	21	0	0	0	0	0	0	0
09-08-81	352	0	0	0	0	0	0	0
09-16-81	160	0	0	0	0	0	0	0
09-16-81	228	0	0	0	0	0	0	0
09-23-81	530	0	0	0	1	0	0	0
09-24-81	43	0	0	0	0	0	0	0
09-30-81	136	0	0	0	0	0	0	0
10-01-81	312	0	0	0	0	0	0	0
10-08-81	536	0	0	0	0	0	0	0
10-15-81	192	0	0	0	0	0	0	0
10-22-81	411	0	0	0	0	0	0	0
10-29-81	104	0	0	0	0	0	0	0
10-29-81	15	0	0	0	0	0	0	0
11-05-81	1211	0	0	0	0	0	0	0
11-19-81	120	0	0	0	0	0	0	0
11-24-81	17	0	0	0	0	0	0	0
12-02-81	94	0	0	0	0	5	0	0
12-02-81	3	0	1	0	0	0	0	0
12-03-81	116	0	0	0	0	1	0	0
12-03-81	3	0	1	0	0	1	0	0
12-10-81	0	0	0	0	0	0	0	0

Date	Flatfishes	California Halibut	Starry Flounder	Thresher Shark	Salmon	Pacific Herring	Jacksmelt	American Shad
01-12-82	12	0	0	0	0	0	1	0
01-12-82	284	0	0	0	0	0	0	2
01-13-82	51	0	0	0	0	0	6	0
01-13-82	19	0	1	0	0	0	3	0
01-14-82	25	0	0	0	0	0	0	0
01-14-82	6	0	0	0	0	0	1	0
01-15-82	15	0	0	0	0	0	0	0
01-15-82	12	0	0	0	0	0	0	0
01-18-82	52	0	0	0	0	0	2	0
03-22-82	56	0	0	0	0	0	0	0
03-23-82	35	0	0	0	0	0	0	0
04-13-82	73	0	0	0	0	0	0	0
04-19-82	46	0	0	0	0	0	0	0
04-20-82	501	0	0	0	1	0	13	0
05-03-82	385	0	0	0	0	0	0	0
05-03-82	220	0	0	0	0	0	0	0
05-04-82	23	0	1	0	0	0	0	0
05-05-82	283	0	0	0	0	0	0	0
05-12-82	231	0	0	0	3	0	0	0
05-17-82	169	0	0	0	0	0	0	1
05-19-82	446	0	0	0	0	0	0	3
05-25-82	488	0	0	0	0	0	0	0
06-03-82	392	0	0	0	0	0	3	3
06-04-82	27	0	0	0	0	0	0	0
06-07-82	456	0	0	0	0	0	0	2
06-09-82	860	1	0	0	0	0	0	8
06-15-82	407	1	0	0	0	0	0	2
07-15-82	965	0	0	0	0	0	0	0
07-19-82	160	0	0	0	0	0	0	0
07-21-82	36	0	0	0	0	0	0	0
07-27-82	152	0	0	0	0	0	2	3
08-02-82	1896	0	0	0	0	0	0	0
08-03-82	119	0	0	0	0	0	0	0
08-19-82	183	0	0	0	0	0	0	0
10-02-82	375	0	0	0	0	0	0	0
10-11-82	8	0	0	0	0	0	0	0
10-12-82	4	0	0	0	0	0	0	0
10-29-82	6	0	0	0	0	0	0	0

Date	Surfperches	Sablefish	Smoothhound Sharks	Spiny Dogfish	Leopard Sharks	Skates	Soupfin Shark	Staghorn Sculpin
07-02-81	1	0	0	0	0	0	0	9
07-03-81	0	0	4	0	0	0	0	1
07-03-81	100	0	1	0	0	0	0	0
07-08-81	13	0	21	0	0	0	0	2
07-22-81	243	0	0	0	0	0	0	3
07-23-81	7	0	0	0	0	0	0	14
07-27-81	11	0	2	4	0	0	0	53
07-29-81	145	0	0	7	0	0	0	3
08-12-81	3	0	0	0	0	0	0	39
08-14-81	2	0	0	0	0	0	0	17
08-19-81	3	0	0	0	0	0	0	0
08-26-81	5	0	0	959	0	0	0	3
09-02-81	185	24	0	0	0	0	0	0
09-08-81	1	0	0	0	0	0	0	0
09-08-81	16	1	1	3	0	0	0	6
09-16-81	0	0	0	1	0	0	0	10
09-16-81	9	0	0	2	0	0	0	0
09-23-81	12	1	0	3	0	0	0	25
09-24-81	0	0	1	1	0	0	0	1
09-30-81	0	17	0	0	0	0	0	0
10-01-81	7	9	0	0	0	0	0	0
10-08-81	7	0	4	0	0	0	0	4
10-15-81	3	0	0	0	0	0	0	2
10-22-81	51	4	0	0	0	0	0	0
10-29-81	0	0	2	0	0	0	0	3
10-29-81	11	0	0	0	0	1	0	0
11-05-81	0	0	4	0	0	0	0	4
11-19-81	2	2	6	4	0	0	0	0
11-24-81	1	1	0	2	0	0	0	4
12-02-81	4	0	0	1	0	0	0	0
12-02-81	0	0	5	0	0	0	0	4
12-03-81	11	6	1	10	0	0	0	1
12-03-81	0	0	2	3	0	0	0	3
12-10-81	0	1	5	0	0	0	0	0

Date	Surfperches	Sablefish	Smoothhound Sharks	Spiny Dogfish	Leopard Sharks	Skates	Soupfin Shark	Staghorn Sculpin
01-12-82	1	0	12	0	0	0	0	2
01-12-82	0	0	22	0	0	1	0	9
01-13-82	2	0	6	0	0	0	0	1
01-13-82	0	0	11	0	2	3	0	1
01-14-82	0	0	24	0	0	3	0	2
01-14-82	0	1	0	0	0	0	0	0
01-15-82	0	0	24	0	0	2	0	0
01-15-82	0	0	7	0	0	0	2	1
01-18-82	0	0	2	0	0	0	0	3
03-22-82	0	0	5	0	0	0	0	0
03-23-82	0	0	2	0	0	0	0	0
04-13-82	0	1	0	0	0	0	0	0
04-19-82	0	0	1	0	0	0	0	0
04-20-82	0	4	0	0	0	0	0	0
05-03-82	3	0	1	0	0	0	0	0
05-03-82	0	0	0	0	0	0	0	0
05-04-82	0	0	0	0	0	0	0	0
05-05-82	0	0	0	0	0	0	0	0
05-12-82	3	620	2	0	0	0	0	2
05-17-82	0	85	0	0	0	0	0	0
05-19-82	0	13	0	0	0	0	0	0
05-25-82	4	8	0	0	0	0	0	0
06-03-82	0	16	0	1	0	0	0	0
06-04-82	0	83	0	0	0	0	0	0
06-07-82	1	126	0	0	0	0	0	0
06-09-82	2	0	2	4	0	0	0	0
06-15-82	1	11	0	0	0	1	0	0
07-15-82	3	0	0	2	0	0	0	0
07-19-82	0	0	0	210	0	0	0	0
07-21-82	1	1	0	0	0	0	0	0
07-27-82	0	0	0	5	0	0	0	0
08-02-82	0	0	0	2	0	0	0	0
08-03-82	0	0	0	13	0	0	0	0
08-19-82	0	3	0	0	0	0	0	0
10-02-82	2	0	7	0	0	0	0	1
10-11-82	22	0	6	0	0	0	0	1
10-12-82	16	0	1	0	0	0	0	0
10-29-82	0	0	0	0	0	0	0	0

Date	Plainfin Midshipman	Pacific Hake	Jack Mackerel	Torpedo Ray	Ratfish	Bat Ray	California Lizardfish	Common Murre
07-02-81	0	11	0	0	0	0	0	10
07-03-81	4	313	0	0	0	0	0	0
07-03-81	1	86	0	0	0	0	0	1
07-08-81	0	853	0	0	0	0	0	2
07-22-81	1	0	0	0	0	0	0	2
07-23-81	0	3	0	0	0	0	0	0
07-27-81	0	91	0	0	0	0	0	14
07-29-81	33	2	1	0	0	0	0	2
08-12-81	0	0	0	0	0	0	5	0
08-14-81	0	0	0	0	0	0	3	0
08-19-81	0	0	0	0	0	0	0	0
08-26-81	0	0	0	0	0	0	0	2
09-02-81	0	23	0	0	0	0	0	0
09-08-81	0	0	0	0	0	0	0	0
09-08-81	3	56	0	0	0	0	0	4
09-16-81	0	0	0	0	0	0	0	2
09-16-81	1	0	0	0	0	0	0	0
09-23-81	0	3	0	0	0	0	0	10
09-24-81	0	0	0	0	0	0	1	0
09-30-81	2	44	0	0	0	0	0	2
10-01-81	2	2	0	0	0	0	0	1
10-08-81	1	9	0	0	0	0	0	1
10-15-81	3	0	0	0	0	0	0	3
10-22-81	0	11	0	0	0	0	0	1
10-29-81	0	0	0	0	0	0	0	1
10-29-81	4	0	0	0	0	0	0	1
11-05-81	1	0	0	0	0	0	0	1
11-19-81	1	2	0	0	0	0	0	0
11-24-81	0	0	0	1	0	0	0	0
12-02-81	2	0	0	0	0	0	0	0
12-02-81	0	0	0	0	0	0	0	0
12-03-81	3	0	0	0	0	0	0	0
12-03-81	0	0	0	0	0	0	0	0
12-10-81	0	0	0	0	1	0	0	0

Date	Plainfin Midshipman	Pacific Hake	Jack Mackerel	Torpedo Ray	Ratfish	Bat Ray	California Lizardfish	Common Murre
01-12-82	1	0	0	0	0	0	0	0
01-12-82	0	0	0	0	0	0	0	0
01-13-82	0	0	0	0	0	0	0	0
01-13-82	0	0	0	0	0	1	0	0
01-14-82	0	0	0	0	0	0	0	0
01-14-82	0	0	0	0	0	0	0	0
01-15-82	0	0	0	0	0	0	0	0
01-15-82	0	0	0	0	0	0	0	0
01-18-82	0	0	0	0	0	0	0	0
03-22-82	0	0	0	0	6	0	0	0
03-23-82	0	0	0	0	2	0	0	1
04-13-82	1	7	0	0	0	0	0	0
04-19-82	3	4	0	0	0	0	0	1
04-20-82	1	37	0	0	7	0	0	0
05-03-82	4	20	0	0	0	0	0	0
05-03-82	5	45	0	0	0	0	0	0
05-04-82	0	0	0	0	0	0	0	0
05-05-82	1	0	0	1	0	0	0	0
05-12-82	0	1	0	0	0	0	0	5
05-17-82	2	199	0	0	4	0	0	0
05-19-82	5	71	0	0	0	0	0	0
05-25-82	1	4	0	0	1	0	0	0
06-03-82	6	96	0	0	2	0	0	0
06-04-82	0	61	0	0	0	0	0	0
06-07-82	37	33	0	0	0	0	0	0
06-09-82	4	179	0	0	0	0	0	0
06-15-82	1	9	0	0	0	0	0	0
07-15-82	3	65	0	0	0	0	0	0
07-19-82	0	69	0	0	1	0	0	0
07-21-82	14	17	0	0	1	0	0	0
07-27-82	1	433	0	0	0	0	0	0
08-02-82	0	50	0	0	0	0	2	8
08-03-82	0	7	0	0	0	0	0	3
08-19-82	0	24	0	0	0	0	0	0
10-02-82	0	1	0	0	0	0	16	6
10-11-82	0	0	0	0	0	0	0	1
10-12-82	0	0	0	0	0	0	0	1
10-29-82	0	0	0	0	0	0	0	1

Date	Red-throated Loon	Brandt's Cormorant	Marbeled Murrelet	Total Catch
07-02-81	0	0	0	357
07-03-81	0	0	0	1060
07-03-81	0	0	0	389
07-08-81	0	0	0	1222
07-22-81	0	0	0	631
07-23-81	0	0	0	915
07-27-81	0	0	0	973
07-29-81	0	0	0	1495
08-12-81	0	0	0	381
08-14-81	0	0	0	453
08-19-81	0	0	0	74
08-26-81	0	5	0	1237
09-02-81	0	0	0	2553
09-08-81	0	1	0	186
09-08-81	0	101	0	1334
09-16-81	0	0	0	1204
09-16-81	0	3	0	1390
09-23-81	0	0	0	1305
09-24-81	0	0	0	945
09-30-81	0	0	0	2304
10-01-81	0	0	0	2298
10-08-81	0	0	0	3507
10-15-81	0	0	0	869
10-22-81	0	0	0	896
10-29-81	0	0	0	203
10-29-81	0	0	0	88
11-05-81	0	0	0	1221
11-19-81	0	0	0	694
11-24-81	0	0	0	589
12-02-81	0	0	0	298
12-02-81	0	0	0	38
12-03-81	0	0	0	562
12-03-81	2	0	2	148
12-10-81	0	0	0	9

Date	Red-throated Loon	Brandt's Cormorant	Marbeled Murrelet	Total Catch
01-12-82	0	0	0	72
01-12-82	4	0	0	801
01-13-82	1	0	0	734
01-13-82	0	0	0	489
01-14-82	1	0	0	499
01-14-82	1	0	0	108
01-15-82	8	0	0	191
01-15-82	1	0	0	154
01-18-82	0	0	0	439
03-22-82	0	0	0	569
03-23-82	0	0	0	1336
04-13-82	0	0	0	259
04-19-82	0	0	0	249
04-20-82	0	0	0	1421
05-03-82	0	0	0	843
05-03-82	0	0	0	394
05-04-82	0	0	0	285
05-05-82	0	0	0	809
05-12-82	0	0	0	978
05-17-82	0	0	0	1606
05-19-82	0	0	0	689
05-25-82	0	0	0	769
06-03-82	0	0	0	880
06-04-82	0	0	0	242
06-07-82	0	0	0	1173
06-09-82	0	0	0	1367
06-15-82	0	0	0	479
07-15-82	0	0	0	1497
07-19-82	0	0	0	470
07-21-82	0	0	0	414
07-27-82	0	0	0	1160
08-02-82	0	0	0	2230
08-03-82	0	0	0	482
08-19-82	0	0	0	437
10-02-82	0	0	0	3714
10-11-82	0	0	0	1629
10-12-82	0	0	0	405
10-29-82	0	0	0	78