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Review of the Set-Net Fishery Off the Washington Coast, 1982–84

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by

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ABSTRACT

A set-net fishery for sablefish (Anoplopoma fimbria) has operated off the Washington coast since 1980. Experimental fishing permits were granted to one vessel in 1982, two in 1983, and three vessels in 1984. Fishing activities have been closely monitored by observers the past two years.

The set-net vessels fished from June-October and the depth interval 100-200 fathoms was intensively fished. A total of 757 mt were caught in 1984, including 377 mt of sablefish, 137 mt of lingcod (Ophiodon elongatus), 59 mt of rockfish (Sebastes spp.) and 221 mt of other species. Sablefish landings doubled from 1983 to 1984.

High catch rates of sablefish were obtained off the northern Washington coast in the Nitinat Canyon; sablefish catch rates were six times greater in the Nitinat Canyon than sets fished south of 47°30'N latitude. Sets fished shallower than 90 fathoms targeted more effectively on lingcod and rockfish than sablefish. Only one salmon (Oncorhynchus spp.) was observed in 1984 and the incidence of halibut (Hippoglossus stenolepis) was less than 1% of the catch. Gear conflicts and losses of gear were minimal. An analysis of 1982-84 set-net landings revealed that a June 15--October 15 season was optimal in maximizing sablefish landings and minimizing the incidence of lingcod and rockfish.

Compared to trawl, trap, and longline gear, set-nets harvest the largest-sized sablefish and trawl gear the smallest. The average ex-vessel prices were $.49/lb for longline, $.41/lb for set-net, $.29/lb for trap, and $.19/lb for trawl-caught sablefish. During 1983-84, sablefish catch per trip for set-net and trap vessels was 2-4 times greater than the catch/trip for trawl or longline vessels. A reduction in trawl harvests while increasing the catch of other gear types would reduce landings of small sablefish and increase economic yield.

Future expansion of the sablefish set-net fishery raises two concerns. First, sablefish resources off the Washington-Oregon-California coast are fully utilized by existing vessels in the fishery--any future expansion of the set-net fleet would impact these vessels, change the gear composition of the fishery, increase the size composition of the catch, and would likely shorten the fishing season. Secondly, high sablefish catch rates have only occurred in one area, the Nitinat Canyon. If other productive areas do not exist, overfishing, gear conflicts, and gear losses may ensue if additional fishing effort occurs in such a limited area.

CONTENTS

CONTENTS

INTRODUCTION

Groundfish set-nets are currently prohibited off the Washington-Oregon-California (WOC) coast north of 38° N latitude, primarily to prevent the use of set-nets in areas of salmon (Oncorhynchus spp.) abundance (Pacific Fishery Management Council (PFMC), 1982). Other concerns include the lack of catch data on the incidence of halibut (Hippoglossus stenolepis), lingcod (Ophiodon elongatus), and rockfish (Sebastes spp.); gear conflicts with trawlers and hook-and-line fishermen; and losses of set-net gear ("ghost fishing"). One, or all of these problems have confronted groundfish set-net fisheries elsewhere, including Puget Sound (Pedersen, 1980, 1981), southern California, Alaska (Bracken, 1980; Eastwood, 1981) Canada, the eastern United States, and Newfoundland (Fosnaes, 1975; High, 1981).

When the groundfish Fishery Management Plan (FMP) was implemented in 1982, the PFMC adopted the state's regulations prohibiting the use of set-nets north of 38°N latitude. One provision of the FMP, however, authorizes the Regional Director of the National Marine Fisheries Service (NMFS) to grant experimental fishery permits (EFP's). The issuance of EFP's allows permit holders to conduct fishing activities that would otherwise be prohibited by federal regulations.

Set-nets were fished off the Washington coast from 1980-82 without state or federal permits. In October 1982, after implementation of the FMP, the F/V Jenny L was granted an EFP to obtain catch data on the use of set-nets north of 38° N latitude. An observer was present on the vessel's final trip of the season.

In 1983, two vessels, the F/V Harvester and Zarana (formerly the Jenny L) were issued EFP's from 1 May to 31 October. Two observers monitored the fishing activities of each vessel throughout the summer. The 1983 landings totalled 360 mt, including 179 mt of sablefish (Anoplopoma fimbria), 127 mt of lingcod, and 54 mt of rockfish. An extensive analysis of the catch data showed that sets-nets are an effective gear type for harvesting groundfish, particularly sablefish, and secondly, that impacts upon other resources and resource-users were negligible (Klein, 1984).

Specific conclusions drawn from the 1983 experimental fishery included the following:

1. Set-nets effectively target on sablefish from July through September, when sablefish migrate up the continental slope from deeper waters.
2. High catch rates of sablefish are obtainable off the northern Washington coast, but not southward.
3. Set-nets fished in shallower waters (less than 90 fathoms) yield reduced quantities of sablefish and potentially large by-catches of lingcod and rockfish.
4. The incidence of salmon and halibut in the gear is low.

EFP's were issued to the F/V Harvester, Zarana, and Sea Angel in 1984. The objectives for issuing these permits were to obtain an additional year of catch data to assess the impacts of set-net gear, and secondly, to gather catch data from shallow sets and southern regions (south of 47°30') to more fully assess the widespread usage of set-nets.

The purpose of this report is to describe the WOC sablefish fishery, summarize the findings from the 1984 experimental fishery, compare the

1984 results with the findings from the 1982 and 1983 fisheries, and to discuss the management implications for the future use of set-net gear.

OVERVIEW OF WOC SABLEFISH FISHERY

Landings

Sablefish landings off the WOC area have increased sporadically since 1976 (Table 1). The optimum yield (OY) for sablefish was established at 13,400 mt in September, 1982. In October 1982, landings exceeded the OY, but rather than terminate the fishery, the PFMC increased the OY 30% to 17,400 mt and imposed trip limits of 3,000 pounds (PFMC, 1984). The 1982 landings approached 19,000 mt, but declined below the OY of 17,400 mt in both 1983 and 1984.

Estimates of maximum sustainable yield (MSY) range from 6,200 to 13,400 mt. Francis (1984) believes MSY is around 7,200 mt, which implies that the stock has been harvested above MSY levels the past nine years, and stock abundance must be declining. For 1985, the PFMC has recommended an OY of 13,600 mt, which is just slightly above the highest MSY estimate.

Historically, over 50% of the sablefish harvested off the WOC coast has been landed in California. Oregon landings have exceeded the Washington landings four of the past five years. Thus, Washington ranks third in landings among the three states.

Fleet Composition

Since 1980, trap and trawl gear have accounted for most of the sablefish landings. In 1984, 82 trawlers, 11 trap vessels, 49 longliners and 3 set-net vessels made at least one sablefish landing from Washington coastal waters (Table 2). In 1984, trawlers harvested 52% of the 4,261 mt

landed in Washington state through December 5. Trap, longline, and set-net boats landed 21%, 18%, and 9% of the sablefish catch, respectively. Trawl and trap landings were nearly equal in 1983; therefore, the sablefish fleet changed dramatically from 1983 to 1984. Trawl effort (i.e., number of landings) increased 60% in 1984 whereas trap effort decreased 40%, resulting in a 900 mt increase in trawl landings and a 550 mt decrease in trap landings.

Landing Rates

In terms of sablefish tonnage landed per trip (Table 2), traps and set-nets yield the highest landing rate. However, this measure neglects vessel size and days fished per trip. On an annual basis, trawling has the lowest landing rate but trawling is most often directed at rockfish and sole rather than sablefish. For the years 1978-83, sablefish has never comprised more than 5% of trawlers' total groundfish catch (Tagart, 1984).

From 1983 to 1984, landing rates increased for all four gear types; longliners nearly doubled their sablefish tonnage per trip. The landing rate of all vessels combined, however, actually decreased from 3.4 to 3.2 mt/trip because the 1984 landings were weighted more heavily towards trawlers rather than trap vessels.

Size Composition and Ex-vessel Prices

Landings are graded into the following size categories (round weight): large (over 7 lbs), medium (5-7 lbs), and small (under 5 lbs). The majority of trawl-caught sablefish is under 5 pounds--73% smalls in 1984 (Table 3). Trap landings are roughly divided equally between the three size categories. The longline catch is mostly composed of large sablefish,

but set-nets generally harvest the largest-sized sablefish. From 1980-84, the percentage of the catch that was graded large was always greatest for set-nets.

Not only does the size composition differ among the various gear types, but the ex-vessel prices and type of products also vary. Traditionally trawl, trap, and set-net vessels off the Washington coast deliver their catches in the round whereas longliners deliver western-dressed fish. In 1984, 81% of the longline catch was dressed; other gear types delivered less than 6% of their catch dressed. Thus, longliners sacrifice high volumes, but receive the highest prices (Table 4). Trawl-caught sablefish receive the lowest prices.

Based upon the dealer's reported price on Washington fish tickets, average ex-vessel prices can be calculated for each gear. The average price per pound (round weight), accounting for the size composition of the landings, is as follows: trawl, $.19/lb; trap, $.29/lb; longline, $.39/lb; and set-net, $.41/lb. Since 81% of the longline catch is western-dressed, though, the average price for longliners becomes $.49/round lb.

Minimum Size Limit

On March 1, 1983, the PFMC established a minimum size limit of 22 inches total length (56 cm) with an incidental catch allowance for undersized fish. The size limit was intended to minimize targeting on small sablefish (less than four pounds round weight) and was expected to reduce trawl landings (Hardwick, 1983). The incidental catch allowance (modified to 5,000 lbs per trip on June 28, 1983) was designed to reduce the waste from discarding undersized sablefish.

In 1982, when no size limit was in effect, 56% of the total catch was graded small. The percentage of small fish remained above 50% in both 1983 and 1984 (Table 3); therefore, the minimum size limit and trip limits have not

affected sablefish landings. Although trawl landings decreased from 1982 to 1983, the size composition remained unchanged. Increased trawl effort in 1984 doubled the trawl landings and over 1,500 mt of small sablefish were caught.

1984 SET-NET FISHERY

Description of Vessels, Gear, and Operation

The F/V Harvester, Sea Angel, and Zarana ranged from 42 to 54 feet in length (24-50 gross tons), carrying a master and 1-4 crew members. Similar to last year, the vessels targeted on sablefish because of the favorable markets for this species ($.42-.46/lb in the round). Although the EFP's were issued from 1 May to 31 October, the vessel captains only fished from 10 June to 23 October, largely due to sablefish availability at the depths fished.

Lingcod and rockfish were target species only during the final two trips of the season (October 17-23), after sablefish catches had diminished. Both lingcod and rockfish could be successfully targeted on throughout the year, but were not because of unfavorable markets (large supply, low prices). Also, greater gear damage and lower catches (sablefish can be picked out of the nets much more quickly) result when lingcod and rockfish are the target species.

Permit holders were limited to 1600 fathoms of gear onboard the vessel. An average of 1000-1200 fathoms of gear was fished each day. In 1983, the set-nets were usually fished from 100-130 fathoms and the sets varied from 200-400 fathoms in length. This year, the entire depth range of 100-200 fathoms was intensively fished and set lengths varied from 200-1200 fathoms. The mean set length was 450 fathoms.

Monofilament webbing was required in all commercial shackles, and a minimum mesh size of 5-7/8 in. was imposed. Both 5-7/8 in. and 6 in. mesh sizes were used in commercial nets this year. The set-net vessels were further required to fish a shackle of test net with the commercial gear. Each vessel

used a different mesh size in the test net. Test net shackles were either composed of 5 in. multifilament, 5-1/4 in. monofilament, or 5-1/2 in. monofilament webbing.

Fishing trips lasted 2-4 days and the vessels were usually able to fill their fish holds (10-25 tons) in two days. Fishing operations are described in Klein (1984). The major differences this year were that sets were fished deeper and longer set-nets were used.

Marketed species included sablefish, lingcod, most Sebastes species, Pacific cod (Gadus macrocephalus) and petrale sole (Eopsetta jordani). Discarded Sebastes species included greenstriped (S. elongatus), rosethorn (S. helvomaculatus), and redstripe rockfish (S. proriger)--species averaging less than 1 kg in weight. About one-fourth of the Pacific ocean perch (S. alutus) catch was also discarded. All other species (e.g., arrowtooth flounder, Atheresthes stomias; spiny dogfish, Squalus acanthias) were discarded. Marketed species were landed at Neah Bay, Washington, most often in the round.

Areas Fished

Although the EFP's allowed the set-net vessels to fish anywhere in the Fishery Conservation Zone (FCZ) north of 38° N, the vessels only fished the continental slope of the Washington coast. Last year, the most productive grounds were the Nitinat Canyon and the set-netters again fished this area heavily in 1984 (Fig. 1). (NOTE: In this report, the Nitinat Canyon area refers to the combined sites of the Nitinat Canyon and Canadian border sites discussed in Klein, 1984).

To obtain catch data from different areas and depths, permit-holders were required to fish (1) one trip each month (at least 2 days) south of 47°30'N latitude, and (2) at least one set per month in depths of less than

90 fathoms (shallow set). A total of 34 sets were fished south of 47°30'N (Table 5), hereafter referred to as the southern area. Eighteen shallow sets were fished in four different areas. None of the shallow sets fished on the Prairie were observed.

SAMPLING METHODS AND ANALYTICAL TECHNIQUES

Sampling Methods Aboard Vessels

Sampling methods are fully documented in Klein (1984). Counts and weights were obtained from each observed set and were tallied separately for the test net. If marketable species were discarded (e.g. sand flea infested sablefish), the number of discards were also included in the count. Sample errors were derived for sablefish, lingcod, and rockfish on each observed trip, and represented the difference between observer estimates and actual trip landings. Thus, sample errors provide a measure of the validity of the observers' samples.

All landings are reported as round weights. When sablefish or lingcod were dressed, product recovery rates were obtained to convert the dressed weights to round weight. The following recovery rates were obtained: eastern-dressed sablefish, 0.528-0.600 (mean of 0.567); western-dressed sablefish, 0.691; and western-dressed lingcod, 0.75.

Analytical Techniques

Catches over the entire season were calculated for 13 species groups comprising all 38 species observed during the season (Table 6). For sablefish and lingcod, the landed weights were summed for all 64 trips. Total catches of *Sebastes* and other spp. were calculated separately for each vessel,

stratified by area and depth:

For Sebastes spp.,

$$CATCH(i,j,k) = RL(i,j) * RC(i,j,k)$$

For Other spp.,

$$CATCH(i,j,k) = TL(i,j) * \frac{OGC(i,j)}{1.0 - OGC(i,j)} * OC(i,j,k)$$

By summing over all vessels and strata, the total seasonal weight was obtained:

$$TOTAL \quad CATCH(k) = \sum_{i=1}^{3} \sum_{j=1}^{6} WT(i,j,k)$$

Where,

RC(i,j,k) = Proportion of species k in observed rockfish catch for vessel i in strata j

OC(i,j,k) = Proportion of species k in observed other spp. catch for vessel i in strata j

OGC(i,j) = Proportion of other spp. group in total catch for vessel i in strata j = $\sum$ OC(i,j,k)

RL(i,j) = rockfish landings by vessel i in strata j

TL(i,j) = total landings of sablefish, lingcod and rockfish by vessel i in strata j

This extrapolation technique yields the seasonal catches for all 13 species/species groups, but three problems arose. First of all, sample data was not collected from the Praire. This creates no bias for sablefish or lingcod, since these species are summed over the entire season. Weights for rockfish and other species were obtained from the species composition of the closest area, the shallow Nitinat Canyon stratum.

Secondly, actual trip landings for the southern and shallow sets rarely existed because such sets were either fished simultaneously on the same trip or occurred in conjunction with Nitinat Canyon sets (i.e., the trip landings represented catches from two or more strata). If sample data existed for the trip, the strata were separated by using the observer's sample weights, adjusting for the sample error; otherwise, the on-deck

estimates recorded by the vessel captain were used. The on-deck estimates were logged for each set and were actually quite accurate, thus allowing the separation of strata.

Thirdly, the species composition derived from observer samples included discards of marketable species (e.g. lingcod). When a significant portion of the sablefish, lingcod, or rockfish catch was discarded, the landings were not representative of the actual species composition. For three trips, the error associated with using the actual landings was judged significant, altering the percent composition of a single species by more than 20% (e.g. 10% vs. 8%). On these three occasions, the weight of the discarded species was added to the vessel landings, resulting in the addition of 1,482 kg of lingcod and 127 kg of Pacific ocean perch to the landed weights.

Since the majority of the landings came from the Nitinat Canyon with most trips strictly from this area, I decided that this extrapolatian technique provided accurate tonnages for both the deep Nitinat Canyon stratum and the total seasonal catches. For the remaining area/depth strata, though, the above listed shortcomings might significantly alter the catch statistics. Since at least 70% of the sets were observed in the remaining area/depth strata (except the Prairie), the observed catch was used. Thus the catch reported for the season and the deep Nitiant Canyon stratum represent the total catch (i.e., observed catch extrapolated to vessel landings); for all other strata, the catch represents the observed catch. Species composition was calculated accordingly.

Average weights and catch rates were calculated solely from the sample data. The catch rate, or catch per unit effort (CPUE), was defined as kilograms caught per 100-fathoms of net fished (kg/100 fm net). Catch rates for the entire season were calculated as the total weight caught divided by the total number of 100-fathom units of gear observed (564.07 100-fathom units).

Means and standard errors were calculated for the CPUE when area or depth effects were considered, as follows:

$$\bar{y}_{st} = \frac{\sum_{h=1}^{3} N_h \bar{y}_h}{N}$$

$$SE(\bar{y})_{st} = \left(\frac{1}{N^2} \sum_{h=1}^{3} N_h^2 \frac{s^2_h}{n_h} \right)^{1/2}$$

where $\bar{y}_h$ = mean catch rate on boat h

n_h = number of sets observed on boat h

N = total number of sets fished = ΣN_h

N_h = total number of sets fished on boat h

s^2_h = sample variance on boat h

Catch rates over time were only evaluated for the deep Nitinat Canyon stratum. Daily catch rates on observed dates were used through September. Since sets weren't observed during October, trip catch rates were used for this month to document the CPUE.

The total catch of halibut was calculated separately for each vessel, stratified by area and depth. For each stratum, the total net length fished was multiplied by the observed CPUE, yielding the extrapolated catch when summed over all three vessels. The Prairie sets were included in the shallow Nitinat Canyon stratum.

OBSERVER COVERAGE AND VALIDITY OF SAMPLE ESTIMATES

The three set-net vessels fished from 10 June to 23 October, completing 64 trips totaling 123 vessel-days. The F/V Harvester only fished 10 trips (13 days) before sinking on August 15; therefore, only two vessels fished under

EFP's after this date. Twenty-eight of the 64 trips were observed (53 out of 123 vessel-days). Observer coverage spanned the period 10 June to 29 September; none of the four trips fished in October were observed.

Observer coverage on the F/V Harvester was 62%, based on the percentage of landings sampled; coverage on the F/V Sea Angel and Zarana was 40% and 37%, respectively. The F/V Harvester was intensively sampled during the month of July to collect biological data from sablefish, resulting in the increased coverage.

Observers sampled 40% of the sablefish, lingcod, and rockfish landings. Sample estimates were within 10% of the actual landings for 64 of the 84 estimates (76%). Of the 20 occasions where the sample error exceeded +10% three occurred for sablefish, ten occurred for lingcod, and seven occurred for rockfish. The overall sample errors were 1.0%, 2.6%, and -0.3% for sablefish, lingcod, and rockfish, respectively. Thus, the sample errors evened out over the course of the season and statistics derived from the sample data should be accurate.

SUMMARY OF 1984 CATCHES

A total of 794 mt of fish was harvested by set-nets in 1984--377 mt of sablefish, 137 mt of lingcod, 59 mt of rockfish, and 221 mt of non-marketed species (Table 7). By weight, nearly half of the catch was sablefish; lingcod, arrowtooth flounder, and spiny dogfish were the only other species comprising more than ten percent of the catch.

The major Sebastes spp. caught by set-nets included bocaccio (S. paucispinis), red-banded (S. babcocki), canary (S. pinniger), and silvergray rockfish (S. brevispinis). All rockfish species combined comprised 7.4% of the total catch, which is considerably less than 12.9% for last year. This is partially due to the deeper depths fished this year (i.e. fewer sets on the shelf proper). The

greater catches of red-banded, shortraker (S. borealis) and rougheye rockfish (S. aleutianis) observed this year supports this claim since these species inhabit the continental slope. Furthermore, the silvergray-bocaccio-canary complex (shelf-species) prevailed in the catches to a far lesser extent: 12% in 1983 versus 5% in 1984.

Approximately 220 mt of other species were discarded this year--one-fourth the total catch. The major discard species were arrowtooth flounder and spiny dogfish. The other miscellaneous species comprised less than 1% of the catch. Dogfish composition increased from 2.7% in 1983 to 10.2% in 1984.

Large fish were harvested by the set-net gear: sablefish averaged 4.4 kg, lingcod averaged 5.9 kg, and the average weight of major Sebastes spp. ranged from 1.2 kg for Pacific ocean perch to 5.8 kg for shortraker rockfish. Arrowtooth flounder and spiny dogfish averaged over 2.3 kg in weight.

The 1984 seasonal catch rates are lower than the corresponding 1983 catch rates for most species. However, the experimental fisheries for the past two years were conducted under different conditions. In particular, more fishing effort was directed outside the Nitinat Canyon in 1984. Comparisons from 1983 and 1984 can be made for a particular area, but the seasonal catch rates among years is not an appropriate comparison.

ANALYSIS OF VESSEL LANDINGS, 1982-84

Landings have increased as the number of vessels have increased. Sablefish landings have increased the most (Table 8). The 1984 landings of sablefish increased two-fold over the 1983 landings. Lingcod landings have also escalated over the three-year period, but not as drastically.

Rockfish landings in 1983 and 1984 were below the 1982 levels, in spite of the increase in the number of vessels. Rockfish are also comprising a

significantly lower proportion of the landings, decreasing from 25% in 1982 to 10% in 1984. The 1983-84 decrease can be partially attributed to the deeper depths fished this year, but this doesn't explain the 1982-83 decrease in rockfish CPUE. Perhaps the vessel captains are becoming more proficient at avoiding incidental captures of rockfish.

Two-thirds of the 1984 landings were sablefish; in 1982 and 1983, sablefish landings comprised 48-50% of the catch. For all three years, over 80% of the sablefish were caught from July-September and over 95% of the sablefish catch occurred between June and September. In 1983, sablefish catches were low during the month of June, but in 1982 and 1984, sablefish catches in June were fairly productive. This discrepancy may have been caused by the warm water temperatures from El Nino in 1983, delaying the up-slope migration of sablefish by one month.

Lingcod catches fluctuated very little among months. From June to July, though, lingcod composition decreased by at least 50% every year when the catch rate of sablefish increased. When sablefish catches decreased in October, lingcod composition rose.

Rockfish landings were always greatest during the months of July and August; therefore rockfish composition wasn't affected by the increased catches of sablefish from July through September. During other months, lingcod catches are higher, so the portion of the catch that was rockfish remained fairly constant among months.

NITINAT CANYON CATCHES

The catch statistics reported here and in the next section only pertain to deep sets (i.e. entire set in depths of more than 90 fathoms). Shallow sets shall be addressed separately in a later section.

Catch Statistics for 1984

A total of 764 mt of groundfish were caught in deep sets within the Nitinat Canyon (Table 9)--96% of the total catch from all areas and depths. Half of the Nitinat Canyon catch was sablefish. The weight of sablefish averaged 4.36 kg in this area, and the CPUE averaged 359 kg per 100 fathoms of net fished. Over 100 mt of lingcod were caught (17% of the catch), and the lingcod averaged almost 6 kg.

Over fifty metric tons of rockfish were caught in the Nitinat Canyon, comprising 7% of the catch. Bocaccio, red-banded, canary, and silvergray rockfish were the major Sebastes species, and these species averaged 1.8 to 4.6 kg in weight. Only bocaccio had a mean catch rate greater than 10 kg/100 fm net.

Catches of other species totalled 215 mt in the Nitinat Canyon, including 129 mt of arrowtooth flounder and 79 mt of dogfish. These two species made up a significant portion of the catch (27%), with catch rates of 117 and 70 kg per 100 fathoms of net, respectively.

Comparison of 1983 and 1984 Catch Statistics

Sablefish composition did not differ between 1983 and 1984, varying by only 0.3% between the two years (Table 10). The percent composition of lingcod and rockfish decreased this year, whereas the other species group was much more abundant. The increase in the other species group is largely due to the greater occurrence of dogfish in the catches this year. In 1983, dogfish comprised 2% of the catches, but in 1984, this increased to 10%.

These same trends are also apparent in the catch rates: Sablefish catch rates were remarkably similar, lingcod and rockfish catch rates decreased, and the catch rate of other species increased. The lower catch rates of lingcod and rockfish in 1984 are most likely due to the deeper depths fished this year.

The deeper depths fished this year also resulted in a change in the rockfish composition. Last year, canary, bocaccio and silvergray rockfish comprised 92% of the total rockfish catch, but this year, the percentage was 65%. A six-fold increase in the percent composition of red-banded rockfish occurred. Also, no rougheye or shortraker rockfish were captured in 1983, but in 1984, 2.4 mt of these deeper-dwelling species were captured.

Catch Rates Over Time

On the first fishing date this year, 10 June, sablefish CPUE was below 100 kg per 100 fathoms of gear (Fig. 2). By 20 June though, the daily catch rate of sablefish had soared above 500 kg/100 fm net. Catch rates peaked around mid-July at 800 kg/100 fm net, and then remained around 400 kg/100 fm net until October. In October, CPUE declined rapidly to less than 50 kg/100 fm net.

Lingcod catch rates were high intially and peaked early in the season at 500 kg/100 fm net. From mid-July to 10 September, lingcod catch rates remained below 100 kg/100 fm net. From 10 September till the end of the season, the average CPUE was approximately 150 kg/100 fm net.

Rockfish catch rates were relatively constant throughout the season, and exceeded 100 kg/100 fm net on only three occassions. The highest rockfish CPUE occurred on 1 August. On this date, 93% of the Sebastes catch consisted of the silvergray-bocaccio-canary complex (55% canary rockfish). A set fished on the exact same grounds one day earlier yielded only one-fourth of the rockfish catch obtained on 1 August.

Comparison of Nitinat Canyon Catch Rates, 1983-84

The seasonal trends in the catch rates for 1983 and 1984 were similar for all three species groups in the Nitinat canyon. However, high catch rates of

sablefish and the peak CPUE occurred one month earlier in 1984. CPUE did not increase until mid-July in 1983 and peaked in mid-August. This one-month delay in 1983 was probably caused by the warmer water temperatures occurring off coastal waters during the 1983 summer. In both years, sablefish catch rates in October declined significantly.

The lingcod and rockfish CPUE trends were identical between years, but the 1983 catch rates were approximately two times greater for both species groups. In both years, lingcod CPUE peaked early in the season, then dropped to low levels from mid-July to September, and increased late in the season. Rockfish catch rates remained constant throughout the season in both years.

Comparison of Daytime and Evening Sets

Catch statistics from 1983 revealed that daytime sets fished in Grays Canyon caught increased quantities of lingcod and rockfish but reduced amounts of sablefish compared to nighttime sets. In the Nitinat Canyon, this was only true half the time in 1984. The peak sablefish CPUE that occurred on 12 July was derived from both day and evening sets. Daytime sets averaged 955 kg sablefish/100 fm net and the total catch was 89% sablefish; corresponding figures for nighttime sets were 763 kg sablefish/100 fm net and 57% sablefish. One daytime set soaked for 1.5 hours: the sablefish CPUE was 1069 kg/100 fm net and was 98% sablefish; therefore daytime sets can catch large quantities of sablefish with a very low incidental catch of lingcod and rockfish.

SOUTHERN AREA CATCHES

A total of 26 deep sets were fished in the southern area of which 19 sets were fished during the day. The variability between time, sub-areas within the southern region, and even boats would render any stratification of the data as meaningless. The most important aspect of the southern sets

is the comparison of such sets to the Nitinat Canyon, so catches south of 47° 30'N were lumped together without sub-dividing the area.

Catch Statistics for 1984

The most frequently caught species in southern sets were sablefish, arrowtooth flounder, and Pacific ocean perch, respectively (Table 11). Forty percent of the catch was sablefish. Lingcod comprised only 5% of the catch. Sablefish averaged 4.8 kg and lingcod averaged 5.6 kg.

Over 1.2 mt of Pacific ocean perch occurred in observer samples--12% of the total catch. Other Sebastes spp. that exceeded 2% of the catch included canary, bocaccio, shortraker, and silvergray rockfish. Shortraker rockfish averaged over 10 kg in weight. Nearly one-fifth of the catch was composed of arrowtooth flounder, but less than 1% of catch was composed of dogfish.

Comparison of 1983 and 1984 Catch Statistics

The species composition and average weights of sablefish and lingcod were remarkably similar in 1983 and 1984 (Table 12). The differences in the rockfish and other species composition was due to the higher catches of arrowtooth flounder in 1984. Arrowtooth flounder comprised 18% of the catch in 1984, but only 10% in 1983. This increase in arrowtooth flounder catches resulted in a higher average weight of the other species group in 1984. The high incidence of Pacific ocean perch caused the average weight of rockfish to decline in 1984.

The catch rates of all four species groups were lower in 1984. For sablefish, lingcod, and rockfish, catch rates decreased by approximately one-half. This result is probably not due to changes in fish abundance or availability, but rather, to the unfamiliarity of the fishing grounds and the lack of searching operations on the part of the vessel captains. Most often,

the vessels steamed across the 47° 30'N boundary and set their nets to fulfill their permit requirements, not to catch fish. Very little time was spent searching for productive fishing grounds and vessel captains usually just fished the minimum amount of gear necessary to fulfill their permit obligations (i.e. one set of slightly more than half the gear per day).

Comparison with Nitinat Canyon

The most striking differences between the catches from the Nitinat Canyon (Table 9) and the southern area (Table 11) are the catch rates. Sablefish, lingcod, and dogfish catch rates were 6, 17, and 80 times greater in the Nitinat Canyon. The overall catch rate of rockfish was slightly greater in the southern area. Higher catch rates of Pacific ocean perch, canary, shortraker, yellowtail, and yellowmouth rockfish were obtained in the southern area. The southern catch rate of Pacific ocean perch was 14 kg/100 fm--10 times the catch rate within the Nitinat Canyon.

The species composition also differed significantly between the two areas. Only 40% of the southern area catch was sablefish, compared to 48% in the Nitinat Canyon. Lingcod composition was three times greater in the Nitinat Canyon, whereas the rockfish composition was much greater in the southern area: 30% versus 7%. For other species, the composition did not differ.

The average weight of the sablefish was almost 0.5 kg more in the southern area (Tables 9, 11). The abundance and average weight of sablefish were usually inversely proportional--in areas (and depths) where sablefish were less abundant, the average weight of this species was greater. Lingcod weighed slightly less in the southern area. The average weight of shortraker rockfish was 6.4 kg greater in the southern area; bocaccio averaged 0.7 kg more in the Nitinat Canyon.

SHALLOW SETS

For shallow sets, the following depth ranges were fished: Nitinat Canyon, 80-90 fms; Juan de Fuca Canyon, 67-90 fms; southern area 75-90 fms; Prairie, 80-81 fms. Four sets were sampled in the Nitinat Canyon, 3 in the Juan de Fuca Canyon, and 7 in the southern area. Eight of the 14 observed sets were daytime sets.

Species composition

Either lingcod or rockfish dominated the catches in shallow waters (Table 13). In the Juan de Fuca Canyon, only 6% of the catch was sablefish. Sablefish comprised 21% of the catch in both the Nitinat Canyon and southern area--less than one-half the sablefish composition of deep sets fished in the same areas. For all shallow sets combined, sablefish, lingcod, and rockfish comprised 19, 40, and 24% of the sampled catch, respectively. Pacific ocean perch, shortraker, and rougheye rockfish were not observed in any shallow sets.

In the southern area and San Juan Canyon, rockfish comprised 58% and 50% of the catch, respectively. Canary rockfish was the major species in both areas. Yellowmouth and yellowtail rockfish were other significant species in the southern area. Spiny dogfish comprised one-third of the San Juan Canyon catch.

Lingcod dominated the shallow sets fished in the Nitinat Canyon, making up 57% of the catch. Sablefish and dogfish were the only other species exceeding 10% of the catch. The major *Sebastes* spp. were canary and bocaccio rockfish.

Catch Rates

The total CPUE of all species was 79, 446, and 248 kg/100 fm net for shallow sets in the southern area, Nitinat and San Juan Canyons, respectively.

For all species combined, deep sets fished within the Nitinat Canyon and southern area averaged 706 and 137 kg/100 fm; therefore, catch rates from shallow sets in these two areas were almost one-half as much as the deep sets.

Comparing deep and shallow sets within the Nitinat Canyon, it appears that the shallow sets are particularly effective for lingcod while deep sets target on sablefish. Sablefish catch rates were five times greater in the deep sets. Conversely, lingcod catch rates in the shallow sets were twice that of the deep sets.

Nitinat Canyon catch rates of rockfish did not differ significantly between deep and shallow sets. Bocaccio was the major Sebastes spp., regardless of depth. Red banded rockfish, a major rockfish species in the deep sets, was not caught in the shallow sets. CPUE of other species was two times greater in the deep sets due to the greater occurrence of arrowtooth flounder in deep sets, 117 versus 7 kg/100 fm set.

In the southern area, sablefish catch rates in deep sets were 4.3 times greater than shallow sets--approximately the same difference as the Nitinat Canyon. Lingcod and rockfish catch rates, however, were only slightly greater in the southern shallow sets. The CPUE of arrowtooth flounder was 10 times greater in the deep sets.

Sablefish and lingcod catch rates in the Juan de Fuca Canyon were very similar to the southern area catch rates. The highest CPUE of any Sebastes spp. occurred in the San Juan Canyon: 116 kg/100 fm net for canary rockfish. The rockfish catch rate in this area was much higher than any other area, whether shallow or deep sets were fished. However, only three sets were fished in the San Juan Canyon.

Based upon on-deck estimates and net lengths recorded by the vessel captain, catch rates can be calculated for the Prairie sets. No sablefish were

logged for this area. The CPUE of lingcod and rockfish were 161 and 41 kg/100 fm net, respectively.

Average Weights

For shallow sets, the average weight of sablefish exceeded 5 kg in both the southern area and San Juan Canyon--the two areas in which catch rates were lowest. For the Nitinat Canyon shallow sets, where sablefish catch rates were five times greater, the average weight of sablefish was only 4.2 kg. Lingcod average weights varied by almost 1.0 kg among the three areas; rockfish and other species average weights were relatively constant between areas.

INCIDENCE OF PROHIBITED SPECIES

Only one salmon was observed in the 125 sampled sets--a chinook weighing 3.5 kg. The salmon was caught in a shallow southern set on July 22. In the past two years, five salmon have been observed in 242 sampled sets.

A total of 249 halibut were observed from the 53 sample dates. An average of five halibut were caught per vessel-day and halibut incidence ranged from 0-56 per vessel-day. By extrapolation, an estimated 607 halibut weighing 4.8 mt (10,500 lbs) were caught during the 1984 season (Table 14). Halibut CPUE decreased this year, from 5.4 kg/100 fm net in 1983 to 3.5 kg/100 fm net in 1984.

The catch rate of halibut was greatest in the Nitinat Canyon, particularly in shallow sets, but only four sets were fished in the shallow portion of the Nitinat Canyon. The lowest halibut CPUE occurred in the three sets fished on the shelf of the Juan de Fuca Canyon.

Halibut condition was recorded for 206 halibut: 60 were judged excellent, 72 poor, and 74 were dead. The survival rate, therefore, ranged from 29-64%, depending upon the survival of the halibut classified as poor. Halibut

survival did not differ between 1983 and 1984; the survival rate in 1983 ranged from 31-64%.

GEAR CONFLICTS AND LOSSES

Gear Conflicts

Three gear conflicts involving set-net vessels occurred in 1984, two with trawlers and one with a pot vessel. The only loss of gear from these three conflicts happened when a trawler ran through a set-net. The trawl (or trawl door) stripped 70 fathoms of float-line from the net but the webbing and lead-line were retrieved by the set-net vessel. The cotton twine securing the float-line to the webbing ripped when the incident occurred, so only the float-line was lost, presumably hauled in by the trawler. This gear conflict could have been avoided--a NMFS observer radioed the trawler prior to the incident and gave the LORAN readings of the set. But when the net was retrieved, the float-line was stripped away from the shallowest shackle.

A second gear conflict occurred when a trawl was dragged through a set-net and some trawl cable became entangled in the middle of the set. Upon retrieval of the set, two shackles of gear were bunched up; the bundle was not retrieved but set back in the water. Hauling from the other end of the set, the trawl cable came up and the net was parted. The vessel towed a hook-chain-anchor set-up for 12 hours during the next two days with no success. The vessel again towed for the gear on the following trip and retrieved the bundle of two shackles (140 fms) on the second drag.

The third gear conflict happened when a net was set over a string of pots. When the set-net was retrieved, the buoy-line broke on one end and the net parted on the other, leaving an anchor and 140 fathoms of net submerged. After the trap vessel retrieved its gear five days later, the set-net vessel then towed for and retrieved the lost gear.

Losses of Gear

The only loss of webbing occurred when the F/V Harvester sunk on 15 August. Approximately 700 fathoms of gear was onboard the vessel when it capsized. What happened to the gear when the vessel sank remains unanswered. If the gear did sink away from the vessel, it's unlikely that the gear is now fishing because the cotton twine securing the float-line to the webbing has undoubtedly rottened, so the webbing would be laying flat on the bottom.

In addition to the 700 fathoms of gear that was onboard the F/V Harvester, another 100 fathoms of net was secured to an anchor and was being retrieved; when the captain realized the vessel was going to capsize, the net was cut and sank with the anchor. The 100 fathoms of gear and anchor were later retrieved by the F/V Sea Angel while towing at the given LORAN readings.

On two other occasions, gear was lost and later retrieved. On one trip, the buoy attached to the shallow end of the set was submerged and the deep buoy-line broke upon retrieval. The vessel towed for the shallow buoy-line, caught it, and retrieved the set. The second loss-recovery of gear happened when a buoy-line broke and the set parted between the anchor and first shackle on the other end. Because of heavy seas, the set was left on the grounds but was subsequently recovered on the following trip.

Assessment of Gear Conflicts/Losses

Seventy fathoms of float-line were lost this summer due to a gear conflict; the other two conflicts did not result in any loss of gear. Three minor gear conflicts out of 288 sets is certainly not excessive, particularly since none of the monofilament webbing was lost. Four gear types--pot, longline, trawl, and set-net--intensively fish the Nitinat Canyon; conflicts between gears other than set-net also occurred and were probably at the same level as observed on the set-net vessels.

The only permanent gear loss happened when a vessel sank. Fortunately, no lives were lost, but 700 fathoms of set-net gear went down with the vessel.

Approximately 900 fathoms of set-net gear was temporarily lost but later recovered. The retrieval of such lost gear may not always occur, but this year, the accuracy of LORAN demonstrated that gear can be pinpointed and retrieved without any surface markings.

A common factor in the gear conflicts/losses was the breaking of 1/2" buoy-lines. Should set-net gear be used in the future, a requirement specifying the use of 3/4" buoy-lines would reduce the occurrences of potentially lost gear. Requiring the use of bio-degradable twine insures that lost gear does not fish indefinitely.

Adverse impacts arising from gear conflicts/losses include lost fishing time and wastage of fish resources. From the 900 fathoms of gear that was temporarily lost but then retrieved within a week, up to 5 mt of marketable species may have been wasted due to decomposition and predation. Few marketable or live fish were found in lost-recovered nets. This indicates that nets left unattended for over 3 days waste the catch, and secondly, free-swimming fish are not attracted to such nets (i.e., few live fish observed).

Except for the 6 sets resulting in gear conflicts/losses, all nets were removed from the fishing grounds within 24 hours. Of the 6 most troublesome sets, one was caused by the most experienced permit holder and four were caused by a new entrant into the fishery. If set-net gear were legalized, regulations could be established that require set-netters to be experienced and to obtain revocable nontransferable permits, requirements in effect south of 38° N latitude to minimize gear conflicts and losses of gear (PFMC, 1982).

DISCUSSION

An experimental groundfish set-net fishery has been operating off the Washington coast for the past three years. Data on vessel landings has been submitted all three years, and for the past two years, set-net operations

have been closely monitored by observers. Conclusions drawn from the 1983 experimental set-net fishery are almost in full agreement with the 1984 results, as discussed below:

Low Incidence of Salmon and Halibut

The greatest concern with ocean set-netting is the incidence of salmon, whether intentional or not. Only one salmon was observed this year, a decrease from the four salmon observed last year. The incidence of halibut also decreased in 1984, from 5.4 to 3.5 kg/100 fm net; halibut incidence did not exceed 1% of the annual set-net catch in 1983 or 1984. An average of five halibut were caught per vessel-day in both years. Thus, we can again conclude that the incidence of prohibited species is negligible for salmon and not excessive for halibut under EFP conditions.

This conclusion is based solely on trips where an observer was present. It is possible, but highly unlikely, that the set-net vessels targeted on salmon during unobserved trips. However, the set-netting vessels always landed in Neah Bay, where NMFS and WDF enforcement agents frequently check. Furthermore, the landings from unobserved trips were often examined by observers at the dock--vessel landings were similar to unobserved trips and salmon were never seen. Since EFP's are revocable, it is unlikely that any of the vessel captains would jeopardize their permits by targeting on salmon or even selling incidentally caught salmon.

If set-net gear were to become legalized, set-netters could fish illegally for salmon. A legal set-net fishery would be closely scrutinized, both by enforcement officers and other user groups, so sales of directed or incidental catches of salmon would not likely occur (Forrest Carvey, NMFS Law Enforcement, pers. comm.). The maximum penalty for such an offense is $25,000 and perpetrators would probably be severely fined. The issuance of revocable

permits would further discourage any illegal activities.

Set-nets effectively target on sablefish

Set-net gear seems to have been ideally developed for targeting on sablefish within the Nitinat Canyon. Catch rates are high, 80% of the fish are graded large, and total landings have averaged over 48% sablefish in each of the past three years. This year, the vessels were particularly effective in targeting on sablefish--66% of the 1984 landings were composed of sablefish. This was largely due to the avoidance of high incidental catches of lingcod and rockfish by fishing deeper depths.

In the Nitinat Canyon, sablefish move up the continental slope in June or July. In 1983, this upward migration occurred in mid-July, and in 1984, mid-June. For the duration of the summer, sablefish catch rates remained high until mid-September to mid-October, when the sablefish move back down the slope into deeper waters.

It appears a 1 June - 31 October fishery would fully encompass the period of sablefish availability to set-nets. A more restrictive 15 June - 15 October season would include the high catch rate periods observed the past three years and further reduce lingcod and rockfish landings, if this is desirable. The more restrictive season would have permitted at least 98% of the 1983-84 sablefish catches to have been caught, but would have reduced lingcod landings by 19-28 mt (14-22%) and rockfish landings by 6-9 mt (10-16%).

One 1984 permit holder has expressed interest in a year-round fishery. The data from the past three years indicate that sablefish cannot be successfully targeted on before 15 June or after 15 October. Modifications in gear-rigging or areas/depths fished may enable one to target on sablefish outside a 15 June - 15 October season, but no data exists from the past three years to substantiate this.

Low catch rates of sablefish occur outside the Nitinat Canyon

This was concluded in 1983 after evaluating catch rates from Grays Canyon. In 1984, 26 sets were fished from 47°30'N southward to Grays Canyon. Although adverse impacts did not occur, high catch rates were again not found. However, the vessels were unfamiliar with the fishing grounds, did not search for productive areas, and expended little effort actually trying to catch fish.

High catch rates from the southern Washington coast might be obtained by fishermen familiar with the grounds. Alternatively, if vessels were forbidden to fish set-nets in the Nitinat Canyon, other productive areas may be found. It took three years of trial-and-error set-netting (i.e., net rigging, area/depth fished) to obtain profitable catch rates in the Nitinat Canyon (Leo Cramer, pers. comm.).

First-time permit holders have been able to conduct profitable fishing operations because they were told (or knew) how and where to fish. But in 1983, the F/V Harvester was unable to obtain high catch rates of sablefish in Grays Canyon, either because this area isn't as productive or the captain's unfamiliarity with the fishing grounds prevented him from doing so. I suspect that set-net catch rates are higher in the Nitinat Canyon than any other region off the Washington coast. Fishermen with better knowledge of other areas would, undoubtedly, have better successes than what we've witnessed outside Nitinat Canyon.

Shallow sets do not target on sablefish

In 1983, six sets were fished shallower than 80 fathoms. These sets were fished on the Prairie and yielded 3 mt of lingcod and 1 mt of rockfish, but only 0.05 mt of sablefish (Klein, 1984). I, therefore, concluded that shallow sets are more effective for lingcod and rockfish than sablefish.

Fourteen shallow sets (less than 90 fathoms) were observed in 1984 from three different areas: the Nitinat and Juan de Fuca Canyons and the southern area. In each area, low catch rates of sablefish were observed and sablefish comprised less than one-fourth of the total catch. Lingcod and rockfish comprised the majority of the catch (56-69% in the three areas). This also pertained to the unobserved sets on the Prairie: the highest catch rate was for lingcod and no sablefish were caught. Thus, we can again conclude that sets fished shallower than 90 fathoms do not effectively catch sablefish and large incidental catches of lingcod and rockfish can occur.

Gear Comparison

All gears have negative impacts, and set-nets are no exception. But when compared to existing gear types that presently harvest sablefish, the impacts of set-net gear are comparable or even less adverse.

In the Nitinat Canyon set-nets have proven to be effective for sablefish during summer months. Compared to other gear types, set-nets (with mesh sizes greater than 5-3/4 in.) harvest the largest-sized sablefish. Only longliners, which dress most of their fish, receive a higher average price than set-netters.

Under 1984 conditions, the average sablefish caught by set-nets weighed 10 lbs valued at $.46/lb; the average trawl-caught sablefish weighed 5 lbs and was worth $.13/lb. Therefore, a set-net-caught sablefish was worth $4.60, on the average, compared to $.65 for a trawl-caught sablefish. This implies that it takes seven trawl-caught sablefish to receive the same value as one set-net-caught sablefish. Considering the age and reproductive value of these fish, this difference is even more profound.

Gear Conflicts

Gear conflicts occur between all gear types. Gear conflicts between set-netters have not occurred, but set-net vessels have encountered five conflicts with other gear types in the past two years. Monofilament webbing, however, was not lost in any of these conflicts.

Few gear conflicts have occurred with EFP set-net vessels primarily because the various user-groups fish different areas and depths. Of course, some overlap does occur, but the different user-groups usually cooperated with one another and, therefore, avoided potential gear conflicts. The few conflicts reported during the past two years demonstrate that set-nets can co-exist with existing gear types.

The most serious gear conflict is a trawl coming into contact with fixed gear, particularly set-nets and pots. Such gear conflicts could result in ghost fishing. Whether the loss of a set-net is worse than the loss of a string of pots is difficult to evaluate, but biodegradable twine is used on both gears to insure that lost gear doesn't fish more than a few months. From my discussions with trap and set-net fishermen, I am not aware of any lost gear and I genuinely believe that these fishermen would go to extreme measures to retrieve lost gear.

Information Gaps

One major information gap is the lack of catch data on set-net operations from 38° N latitude to the Columbia River. Not a single set has been fished in this area, and catch data from the Washington coast cannot be extrapolated to this area. Set-net operations off the Oregon and northern California coasts, therefore, should only be allowed on an experimental basis.

The lack of catch data on ocean set-net fisheries targeting on other species is another information gap. Set-net gear has demonstrated that it

can effectively target on lingcod and rockfish, particularly in shallow waters. A lingcod or rockfish fishery would likely be conducted under different conditions than a sablefish fishery (e.g., shallower depths, nearshore areas). Although these potential fisheries may have merit, little information exists to evaluate such fisheries.

One of the major problems with marketing lingcod is maintaining a year-round supply, particularly during winter months. Winter set-netting operations targeting on lingcod may fill this void. Large quantities of lingcod can be caught with short soak times, yielding large, high quality products if the lingcod are bled immediately, then dressed. Additional catch data is needed before such a fishery could be considered, including assessment of potential gear conflicts with hook-and-line gear.

The outlook for a rockfish set-net fishery is much more bleak. Merits of set-net gear include large, high quality products. But the rockfish fishery is grossly over-capitalized and some Sebastes spp. are presently over-harvested. Pacific ocean perch stocks are severely depressed. The addition of another gear type under such conditions would, undoubtedly, complicate an already desperate fishery.

Management Implications

Set-nets have been used successfully to target on sablefish in the Nitinat Canyon during summer months. Catch rates are high, large fish are harvested, the incidence of salmon and halibut in the gear has been low, and gear conflicts and losses of gear have been minimal. Insufficient information exists to assess the merits of a lingcod or rockfish set-net fishery; but it is possible that a set-net fishery could be regulated so that sablefish is the target species with restrictions such as:

1. Minimum depth restriction of 100 fathoms.
2. Landing percentage on sablefish (e.g., no more than two trips per month shall consist of less than 50% sablefish).
3. Set-net season from 15 June to 15 October.

The depth restriction would require set-net gear to be marked in such a way as to distinguish set-nets from other fixed gears; this restriction would greatly reduce the potential of intentional targeting on salmon. An additional regulation, the issuance of non-transferable revocable permits, might eliminate this potential altogether as well as minimize gear conflicts and losses.

Even with the above restrictions, two major concerns arise with regard to a sablefish set-net fishery. First, sablefish is currently a fully utilized species off the WOC coast and harvesting capacity will likely exceed the OY in the future. Although the fishery is fully utilized by existing gears, this is not grounds for disallowing set-nets for three reasons:

1. There is no limitation on the number of additional trap, longline, or trawl vessels that can enter the fishery; therefore, the amount of sablefish available to existing fishermen would also be reduced by entry of additional trap, longline or trawl vessels.
2. Allowing the use of set-nets would likely promote efficiency and increase economic yield.
3. Since set-nets harvest such large fish, the use of set-nets would conserve sablefish resources by reducing captures of immature fish, assuming that the OY is not above MSY.

Any expansion of the set-net fleet would reduce the landings of existing vessels in the fishery. If 10 set-net vessels entered the fishery, set-net landings would likely exceed 1,000 mt. Based upon 1984 landings, this harvest would exceed the landings by either trap or longline vessels in Washington

state and the OY would be reached before December. Alternatively, the fishery could be extended over the entire year by increasing the minimum size limit and imposing trip limits, but discard rates of undersized fish would need to be assessed. Further expansion of the set-net fleet would significantly impact existing vessels in the fishery, but would also increase the size composition of the landings.

My second concern with a sablefish set-net fishery is that only one productive area has been found in the past two years, the Nitinat Canyon. Fishermen knowledgable of other fishing grounds may be able to find other productive areas, but this is not known. If high catch rates cannot be obtained in other areas, future expansion of the set-net fleet would occur in the Nitinat Canyon. Two questions arise. How much more additional fishing pressure can occur in the Nitinat Canyon without depleting the sablefish resource in this area? Secondly, would gear conflicts and losses of gear escalate if more vessels fished the Nitinat Canyon? If high catch rates cannot be obtained from areas outside the Nitinat Canyon, these two factors severely limit the expansion potential of a set-net fishery.

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Table 1.--Domestic landings of sablefish by state and gear type, 1976-83.

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

[a] Includes 26 t taken by set net.
[b] Longline catch in California was a very small percentage of combined trap and longline catch until 1980 when longline catch rose to 28%.

SOURCE: Parks (1984)

Table 2.--Sablefish landings, fishing effort, and landing rates by gear type for the Washington coast, 1983-84.

Year	Gear	No. Vessels	No. trips	Sablefish Landings (mt)	No. Vessels landing more than 50 mt sablefish	Sablefish Landing Rate	
						mt/vessel	mt/trip
1983	Trawl	72	592	1285.4	6	17.9	2.2
	Trap	10	187	1471.9	4	147.2	7.9
	Longline	31	162	354.9	2	11.4	2.2
	Set-net	2	40	178.3	1	89.1	4.5
		115	981	3290.5	13	28.6	3.4
1984*	Trawl	82	953	2195.9	15	26.8	2.3
	Trap	11	108	917.1	2	83.4	8.5
	Longline	49	197	771.5	5	15.7	3.9
	Set-net	3	64	376.7	2	125.6	5.9
		145	1322	4261.2	24	29.4	3.2

*Compiled through Dec. 5.
Source: Washington Department of Fisheries/fish ticket records.

Table 3.--Washington sablefish landings (mt) by gear type and size category, 1978-1984 (Graded landings only).

Year	Size	Trawl mt	Trawl %	Trap mt	Trap %	Longline mt	Longline %	Set-net mt	Set-net %	Total mt	Total %
1980	large	137	35	130	37	446	83		91		57
	medium	49	12	99	28	37	7		0		14
	small	203	52	121	35	54	10		9		29
	total	389	100	350	100	538	100		100		100
1981	large	133	24	589	47	356	78		96		48
	medium	14	3	286	23	52	11		1		15
	small	415	74	367	30	48	10		3		36
	total	562	100	1241	100	456	100		100		100
1982	large	121	8	599	37	225	54		75		28
	medium	156	10	356	22	85	20		6		16
	small	1318	83	662	41	104	25		19		56
	total	1594	100	1616	100	413	100		100		100
1983	large	99	8	518	35	221	62	116	70	954	30
	medium	93	8	422	29	76	21	2	1	594	19
	small	987	84	532	36	58	16	48	29	1625	51
	total	1179	100	1472	100	355	100	166	100	3172	100
1984	large	541	25	275	29	456	63	57	64	1329	34
	medium	35	2	325	34	131	18	26	29	517	13
	small	1579	73	362	38	141	19	6	7	2088	53
	total	2154	100	962	100	729	100	89	100	3935	100

Source: Washington Department of Fisheries fish ticket records

Table 4.--Typical ex-vessel prices received for sablefish from May-September, 1984, by product, size category, and gear type in the state of Washington.

		Ex-vessel Price			
Product	Size Category	Longline	Set-net	Trap	Trawl
Round	Large (>7)	.48	.46	.48	.37
	Medium (5-7)	.30	.35	.28	.16
	Small (<5)	.18	.25	.14	.13
Dressed*	Large (>5)	.85	.80	.80	.58
	Medium (3-5)	.65	.50	.45	.32
	Small (<3)	.40	.35	.30	.25

* No distinction made between western-dressed and eastern-dressed on WDF fish tickets.

SOURCE: Washington Department of Fisheries
fish ticket records

Table 5.--Areas and depths fished, fishing effort, and sampling effort during the 1984 season by set-net vessels off the Washington coast.

Area/Depth Fished	No. Vessel-Days	No. Sets Fished	No. Sets Sampled	Net Length Sampled (100's of fathoms)
Nitinat Canyon				
Deep	102.3	244	92	421.18
Shallow	1.3	4	4	17.05
Juan de Fuca Canyon				
Shallow	0.4	3	3	6.67
Prairie				
Shallow	1.0	3	0	0.00
Southern Area				
Deep	13.0	26	19	82.37
Shallow	5.0	8	7	36.80
Total	123.0	288	125	564.07

Table 6.--Species observed during the 1984 set-net season and species groups used for data analysis.

Observed Species		Species Groups
Sablefish	Anoplopoma fimbria	Sablefish
Lingcod	Ophiodon elongatus	Lingcod
		Silvergray Rockfish
Rockfish	Scorpaenidae	Bocaccio Rockfish
		Canary Rockfish
Silvergray Rockfish	Sebastes brevispinis	Redbanded Rockfish
Bocaccio Rockfish	S. paucispinis	Shortraker Rockfish
Canary Rockfish	S. pinniger	Rougheye Rockfish
Pacific Ocean Perch	S. alutus	Other Rockfish
Redbanded Rockfish	S. babcocki	Arrowtooth Flounder
Yellowtail Rockfish	S. flavidus	Spiny Dogfish
Yellowmouth Rockfish	S. reedi	Miscellaneous Species
Darkblotched Rockfish	S. crameri	
Sharpchin Rockfish	S. zacentrus	
Splitnose Rockfish	S. diploproa	
Redstripe Rockfish	S. proriger	
Shortraker Rockfish	S. borealis	
Rougheye Rockfish	S. aleutianis	
Greenstriped Rockfish	S. elongatus	
Widow Rockfish	S. entomelas	
Yelloweye Rockfish	S. ruberrimus	
Rosethorn Rockfish	S. helvomaculatus	
Other species		
Shortspine Thornyhead	Sebastolobus alascanus	
Arrowtooth Flounder	Atheresthes stomias	
Spiny Dogfish	Squalus acanthias	
Ratfish	Hydrolagus colliei	
Pacific Halibut	Hippoglossus stenolepis	
Pacific Cod	Gadus macrocephalus	
Pacific Hake	Merluccius productus	
Walleye Pollock	Theragra chalcogramma	
King Salmon	Oncorhynchus tsawytscha	
Soupfin Shark	Galeorhinus zypoterus	
Longnose Skate	Raja rhina	
Black Skate	Raja kincaidi	
American Shad	Alosa sapidissima	
Prowfish	Zaprora silenus	
Petrale Sole	Eopsetta jordani	
Rex Sole	Glyptocephalus zachirus	
Dover Sole	Microstomus pacificus	
English Sole	Parophyrys vetulus	
Flathead Sole	Hippoglossoides elassodon	

Table 7.--Catch Statistics, by species, for the Washington set-net fishery in 1984.

	Total Catch (mt)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net)
Sablefish	376.67	4.38	47.47	285.60
Lingcod	137.12	5.94	17.28	94.71
Rockfish				
Silvergray	7.39	2.41	0.93	4.44
Bocaccio	19.34	4.44	2.44	10.35
Canary	10.86	2.22	1.37	7.93
Pac. Ocean Perch	3.87	1.18	0.49	3.34
Red Banded	12.32	1.81	1.55	6.57
Shortraker	1.15	5.84	0.15	1.08
Rougheye	1.28	2.34	0.16	0.85
Other Rockfish	2.41	1.43	0.30	2.43
Other Species				
Arrow. Flounder	131.45	2.33	16.57	92.66
Spiny Dogfish	80.88	2.49	10.19	55.73
Misc. Species	8.73	2.01	1.10	6.87
Total	793.47	3.51	100.00	572.56

Table 8.--Washington set-net landings (mt) and landed catch composition by month, 1982-84.

Year	Month	Catch Composition						Monthly Catch	
		Sablefish		Lingcod		Rockfish			
		mt	%	mt	%	mt	%	mt	% of Annual Catch
1982	April		1.9		36.7		61.4		2.7
	May		3.4		72.6		24.0		11.0
	June		42.0		41.5		16.5		17.8
	July		52.2		16.5		31.3		13.6
	August		57.2		9.6		33.2		24.5
	September		68.1		15.3		16.6		26.5
	October		48.3		31.3		20.4		3.9
1982 Totals			49.0		26.2		24.8		100.0
1983	May	0.9	4.4	15.3	73.0	4.7	22.6	20.9	5.8
	June	5.8	13.6	27.7	65.3	8.9	21.1	42.4	11.8
	July	50.8	55.7	22.2	24.4	18.1	19.9	91.1	25.3
	August	71.9	62.4	28.6	24.8	14.8	12.8	115.3	31.9
	September	43.8	60.7	22.0	30.5	6.4	8.8	72.2	20.0
	October	5.1	27.2	11.3	59.6	2.5	13.2	18.9	5.2
1983 Totals		178.3	49.4	127.1	35.2	55.4	15.4	360.8	100.0
1984	June	29.4	42.2	34.4	49.4	5.9	8.4	69.7	12.2
	July	130.9	75.0	28.8	16.5	14.8	8.5	174.5	30.5
	August	128.0	68.7	38.2	20.5	20.2	10.8	186.4	32.6
	September	79.8	69.5	22.7	19.8	12.2	10.7	114.7	20.0
	October	8.6	31.8	13.0	48.0	5.5	20.2	27.1	4.7
1984 Totals		376.7	65.8	137.1	24.0	58.6	10.2	572.4	100.0

Table 9.--Catch Statistics for Nitinat Canyon, extrapolated from 1984 observer samples.

	Total Catch (mt)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net) Mean	SE of Mean
Sablefish	368.63	4.36	48.24	358.97	30.04
Lingcod	129.25	5.93	16.91	113.84	17.04
Rockfish					
Silvergray	6.79	2.44	0.89	6.20	2.54
Bocaccio	18.35	4.55	2.40	12.30	2.30
Canary	8.32	2.23	1.09	6.45	2.20
Pac Ocean Perch	2.27	1.24	0.30	1.44	0.20
Red Banded	12.12	1.80	1.59	8.31	0.66
Shortraker	0.78	3.79	0.10	0.66	0.22
Rougheye	1.22	2.30	0.16	0.94	0.33
Other Rockfish	1.24	1.08	0.16	0.86	0.24
Other Species					
Arrow Flounder	128.70	2.33	16.84	117.48	11.75
Spiny Dogfish	78.90	2.49	10.33	70.45	18.82
Misc. Species	7.59	1.81	0.99	7.60	1.04
Total	764.16	3.54	100.00	705.50	32.24

Table 10.--Comparison of 1983 and 1984 catch statistics for the set-net fishery in the Nitinat Canyon.

	Catch* (mt)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net) Mean	SE of Mean
1983					
Sablefish	114.70	4.68	47.9	395.3	42.8
Lingcod	55.48	5.49	23.2	186.8	20.3
Rockfish	25.59	2.94	10.7	85.6	6.9
Other spp.	43.50	2.10	18.2	141.8	15.6
1984					
Sablefish	368.63	4.36	48.2	359.0	30.0
Lingcod	129.25	5.93	16.9	113.8	17.0
Rockfish	51.09	2.43	6.7	37.2	4.9
Other spp.	215.19	2.36	28.2	195.5	18.9

*1983 catches are observed catch, not total catch. 1984 catches represent total catch (observed catch extrapolated to vessel landings).

Table 11.--Catch statistics for the southern area, based upon 1984 observer samples.

	Observed Catch (kg)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net) Mean	SE of Mean
Sablefish	4210.5	4.83	40.58	61.01	18.22
Lingcod	519.2	5.58	5.00	6.84	1.29
Rockfish					
Silvergray	212.7	2.01	2.05	2.93	1.67
Bocaccio	405.8	3.83	3.91	5.60	1.65
Canary	415.1	2.20	4.00	6.90	4.14
Pac. Ocean Perch	1241.3	1.16	11.96	13.79	5.08
Red Banded	167.0	1.96	1.61	2.35	1.24
Shortraker	337.6	10.23	3.25	3.70	1.06
Rougheye	63.2	2.63	0.61	0.73	0.30
Other Rockfish	309.9	1.52	2.99	4.27	1.53
Other Species					
Arrow. Flounder	1886.8	2.68	18.18	21.89	8.99
Spiny Dogfish	72.1	2.77	0.69	0.85	0.24
Misc. Species	534.8	3.47	5.15	6.22	1.85
Total	10376.0	2.83	100.00	137.08	20.60

Table 12.--Comparison of 1983 Grays Canyon catches with 1984 catches from the southern area, based upon observer samples.

	Observed Catch (kg)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net) Mean	SE of Mean
1983					
Sablefish	5330.2	4.49	40.6	92.8	12.8
Lingcod	692.7	5.29	5.3	11.4	3.9
Rockfish	4903.0	2.26	37.3	90.5	22.6
Other spp.	2210.0	1.85	16.8	37.5	7.1
1984					
Sablefish	4210.5	4.83	40.6	61.0	18.2
Lingcod	519.2	5.58	5.0	6.8	1.3
Rockfish	3152.6	1.73	30.4	40.3	10.0
Other spp.	2493.7	2.82	24.0	29.0	10.3

Table 13.--Catch statistics for shallow sets, by area, based upon 1984 observer samples.

	Observed Catch (kg)	Average Weight (kg)	Species Composition (%)	Catch Rate (kg/100 fm net) Mean	SE of Mean
			NITINAT CANYON		
Sablefish	1565.1	4.24	20.53	75.81	55.10
Lingcod	4304.3	6.15	56.46	254.83	52.92
Rockfish					
Silvergray	105.5	2.85	1.38	4.69	4.69
Bocaccio	146.2	3.85	1.92	10.60	8.12
Canary	239.2	2.42	3.14	10.63	10.63
Other Rockfish	27.7	2.13	0.36	1.30	1.00
Other Species					
Arrow. Flounder	133.5	2.09	1.75	6.53	4.69
Spiny Dogfish	919.7	2.32	12.06	71.00	58.24
Misc. Species	182.7	3.73	2.40	10.10	2.53
Total	7623.9	4.32	100.00	445.51	131.03
			JUAN de FUCA CANYON		
Sablefish	92.2	5.12	5.81	14.14	6.23
Lingcod	89.7	5.28	5.65	14.23	5.02
Rockfish					
Silvergray	5.5	2.75	0.35	0.80	0.41
Bocaccio	26.9	4.48	1.69	4.00	2.23
Canary	739.5	2.14	46.57	115.86	84.93
Other Rockfish	20.1	1.26	1.27	3.20	2.00
Other Species					
Arrow. Flounder	31.5	1.75	1.98	4.50	1.77
Spiny Dogfish	507.2	2.87	31.94	79.89	21.94
Misc. Species	75.4	1.54	4.75	11.73	2.48
Total	1588.0	2.45	100.00	248.34	83.14
			SOUTHERN AREA		
Sablefish	547.7	5.22	20.85	14.08	6.76
Lingcod	299.9	5.45	11.41	9.44	3.78
Rockfish					
Silvergray	52.6	2.29	2.00	2.40	2.09
Bocaccio	142.2	3.65	5.41	6.08	4.73
Canary	646.6	2.19	24.61	21.52	9.75
Red Banded	3.4	1.70	0.13	0.17	0.17
Other Rockfish	671.4	1.64	25.55	21.26	9.26
Other Species					
Arrow. Flounder	109.3	1.99	4.16	2.17	1.23
Spiny Dogfish	70.4	2.71	2.68	1.52	1.07
Misc. Species	83.9	3.11	3.19	0.60	0.27
Total	2627.4	2.53	100.00	79.23	28.62

Table 14.--Incidence of Pacific halibut and estimated 1984 catch, by area and depth.

Area/Depth	Number of Halibut Observed	Observed Catch (kg)	Observed Effort (100-fm net)	Average Weight (kg)	Catch Rate (kg/100 fm net)	Estimated 1984 Catch No.	Estimated 1984 Catch WT (kg)
Nitinat Canyon							
Deep	203	1575.3	421.2	7.76	3.74	540	4174.8
Shallow*	14	136.2	17.0	9.73	7.99	24	234.5
Juan de Fuca Canyon							
Shallow	1	13.5	6.7	13.50	2.02	1	13.5
Southern Area							
Deep	28	244.3	82.4	8.73	2.97	39	333.2
Shallow	3	11.5	36.8	3.83	0.31	3	11.8
Total	249	1980.9	564.1	7.96	3.51	607	4767.8

*Includes 3 prairie sets.

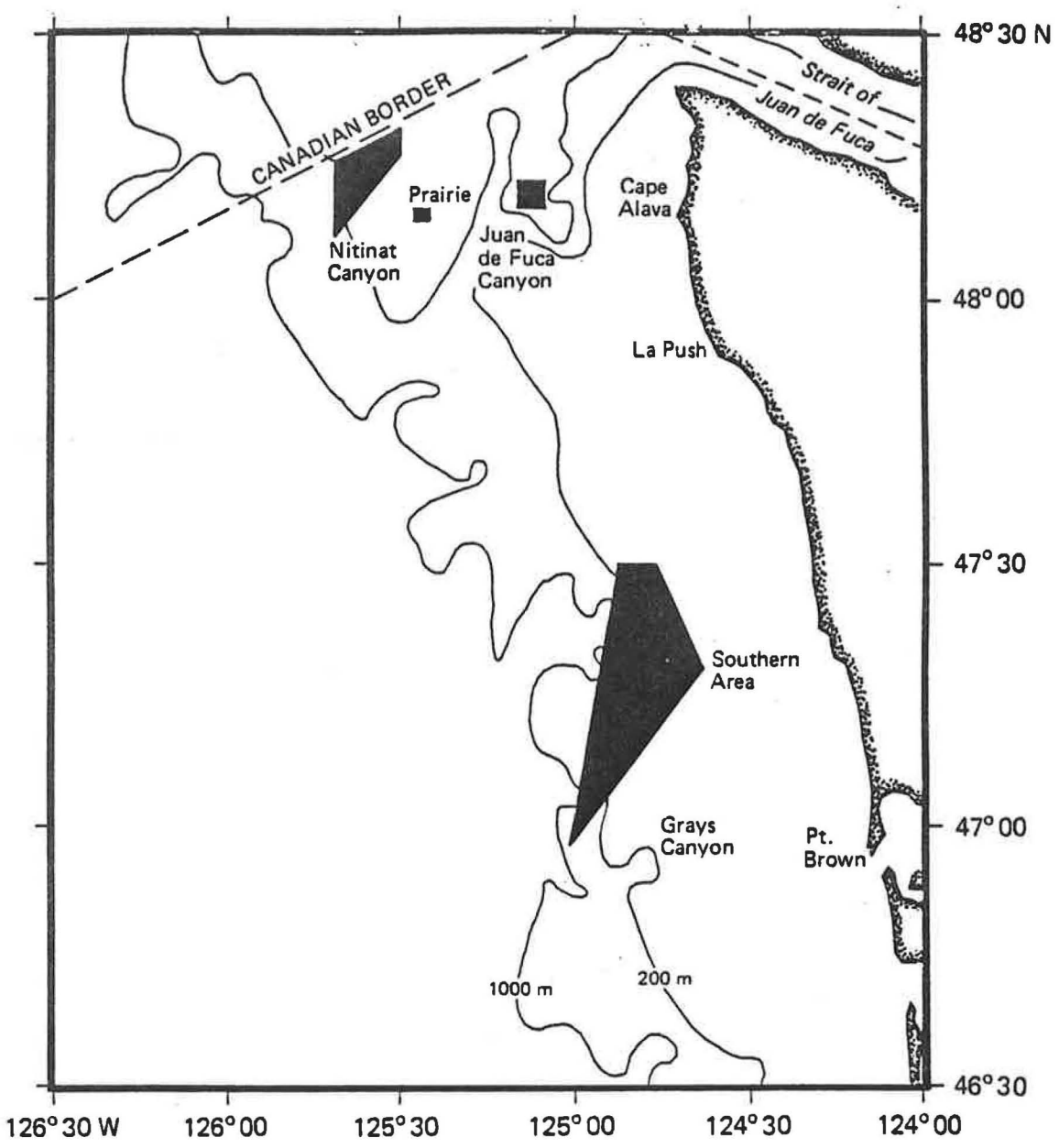

Figure 1.--Areas fished by the Harvester, Sea Angel, and Zarana during the 1984 season.

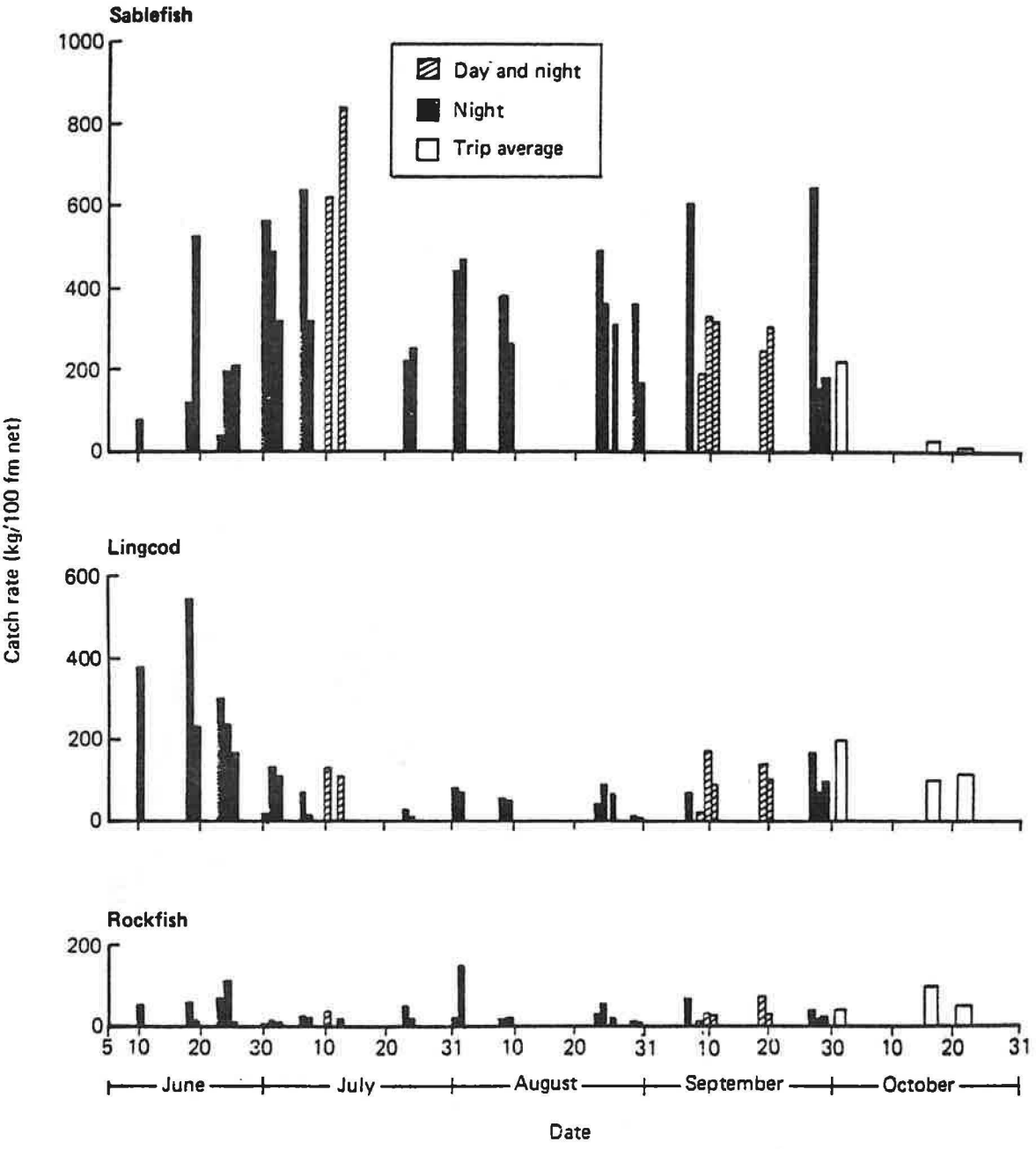

Figure 2.--Daily catch rates of sablefish, lingcod, and rockfish in the Nitinat Canyon on observed dates during 1984; nighttime sets are denoted by black bars, the combination of day and night sets by cross-hatched bars, and trip catch rates (unobserved) by open bars.