STATUS OF SABLEFISH RESOURCES IN THE BERING SEA

by

L. L. Low

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L. L. Low, NMFS

INTRODUCTION

Sablefish or blackcod, Anoploma fimbria, has been harvested off North America between northern California and southeastern Alaska by United States and Canadian commercial fishermen for over half a century. In the Bering Sea and the Gulf of Alaska, sablefish resources were lightly or not exploited until Japanese and, to a lesser extent, USSR fishing activities intensified in these regions in the mid-1960's. In 1972, Japan and the USSR removed a total of 18 and 38 thousand metric tons (MT) of sablefish from the Bering Sea and the northeastern Pacific Ocean respectively. In the same year, the U.S.-Canadian catch amounted to slightly over 5 thousand MT—small by comparison to catch by other nations.

In the relatively short history of the Japanese and Soviet fisheries in the Bering Sea (since 1954), certain species are believed to have been over-exploited by them (e.g. yellowfin sole in the eastern Bering Sea). Although their fleets are certainly capable of overfishing sablefish resources as well, little is known about the present stock condition. The purpose of this report is to provide information on the status of the Bering Sea sablefish resource and its interrelationship with northeast Pacific sablefish.

CATCH HISTORY OF THE FISHERY

In the Bering Sea, sablefish has not exceeded 4% by weight of all groundfish landed. The percentage of sablefish in the total groundfish catch by
Japan from 1961 through 1972 is as follows:

<table>
<thead>
<tr>
<th>Year</th>
<th>% sablefish</th>
</tr>
</thead>
<tbody>
<tr>
<td>61</td>
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</tr>
<tr>
<td>62</td>
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<td>.8</td>
</tr>
<tr>
<td>72</td>
<td>.9</td>
</tr>
</tbody>
</table>

Japan has accounted for about 84% of the total sablefish landed by all nations in recent years (Table 1, Fig. 1); the USSR has accounted for the rest. The relative amounts of sablefish caught by the two major Japanese fisheries, namely the mothership, longline gillnet and independent trawl fisheries (MS-LG-IT), and the land-based dragnet fishery are shown in Figures 2 and 3 (the vertical scales representing the magnitude of catch are different for each figure). In general, sablefish are caught in waters of the continental slope and the location of greatest catch follows the 200 m depth contour.

The MS-LG-IT fisheries started in 1954 and their recorded catches of sablefish increased rapidly from 32 metric tons (MT) in 1958 (Table 1) to more than 28 thousand MT by 1962. Catches decreased thereafter and have remained relatively stable around 6 thousand MT since 1964. The main types of gear used for harvesting sablefish are longlines and trawls, particularly the stern trawler in recent years.

It is known that the MS-LG-IT fisheries target on other species, such as walleye pollock. The land-based dragnet fishery, comprising Danish seiners and stern trawlers of less than 350 GRT size, has been landing greater amounts of sablefish than the MS-LG-IT fisheries in recent years. The catch for 1971-72 averaged 9 thousand MT, or roughly 60% of the total Japanese sablefish catch.

The amount of sablefish caught by the USSR before 1966 is not known but was probably less than 1 thousand MT annually. The 1971-72 catch, all by trawls, averaged 2,700 MT.
BIOLOGICAL INFORMATION

Unity of stocks

The number of discrete stocks in the Bering Sea and the northeastern Pacific is unknown. From tagging experiments, it has been shown that there is an interchange of sablefish between the Bering Sea and the northeastern Pacific (Fig. 4). Some tagged fish released within Puget Sound, Washington have been recovered in the Bering Sea and tagged fish released in the Bering Sea have been recovered off southeastern Alaska.

The extent of mixing has not been estimated and may very well involve a small portion of the stocks. If there is a mass migration of fish, then heavy exploitation of sablefish in the northeastern Pacific Ocean may affect the catch rates and size composition of fish in the Bering Sea and vice versa.

Length-Age-Weight relationships

Length-age and weight-age keys as constructed from samples collected in the Bering Sea during 1958-60 (Shubnikov, 1963) are given in Figure 5. Important relationships of Fig. 5 are summarized in Table 2. Rapid growth (>2 lbs/year) was observed for fish from ages 4 to 6; after age 7 (28 inches fork length), growth rates decrease. These data suggest that sablefish should be harvested after 6 years of age (26 inches, 6.1 lbs) to take advantage of the high growth rates over the age 4-6 period.

Most of the fish taken by Japanese trawl gear in the Bering Sea are smaller (ages 4-5 or 19-23 inches) than those taken by longlines (ages 5-6 or 23-26 inches). The trawl generally fish in shallower depths where the smaller fish are found.
Biological data from the Japanese MS-LG-IT fisheries are incomplete in time and areal sequence and are inadequate to accurately determine changes in size composition of sablefish in the Bering Sea. The problem is further complicated when trawl mesh size and depth of fishing are taken into consideration. However, there is no indication of a major change in the size composition of the fish harvested between 1964 and 1972.

Trawl surveys in the Bering Sea during 1958-60 by the USSR (Shubnikov, 1963) indicated that most of the fish caught were between ages 4-6 (Fig. 6a-c). Unfortunately, in as much as the depth from which the samples were taken is not known, data from recent surveys (such as the data shown in Figure 6d) cannot be compared to the USSR findings. Recent data from the Japanese commercial fisheries show, however, that 4-6 year old fish are still common in the catch.

Trawls are used extensively in the Bering Sea by the MS-LG-IT fisheries for other species, and sablefish caught incidentally by them (just like Pacific halibut) are smaller than considered advantageous for harvest. Likewise, the small stern trawlers of the Japanese land-based dragnet fishery, which apparently target on sablefish in the outer continental shelf west of 170°W, probably catch substantial numbers of 4-5 year old fish.

A yield per recruit analysis (which takes into account growth rates, mortality, age of recruitment, and other biological parameters) should be made to determine if there is an actual disadvantage in harvesting fish younger than 6 years of age.

RELATIVE STOCK ABUNDANCE

Longline CPUE

Sablefish catch per unit of longline effort is the best available indicator of stock abundance because the fishing power of longline gear probably did
not change as much as for trawl gear. Furthermore, longline gear accounts for most of the sablefish harvest in the southern areas of the eastern Bering Sea and its CPUE analysis should be especially applicable to the Aleutian area.

Longline catch and effort data prior to 1968 were not reported by vessel class. The data from 1968 indicate that most of the longline vessels were of the 201-500 GRT (class 3 and 4) size and it is assumed that these classes were predominant in the fishery prior to 1968. Therefore, in the following analysis of the 1964-72 catch-effort data, classes 3 and 4 vessels were combined to compute CPUE indices.

CPUE indices for the second quarter of the year (April-June), when most of the sablefish were caught in INPFC halibut conservation areas A, B, C, F1, F2, and F3 (Fig. 7), are computed to indicate relative stock abundances.

There is no common trend of CPUE in the southern areas (B, F1-F3) evaluated (Fig. 7) between 1964 and 1972. CPUE generally fluctuates about 175 kg per ten hachi longline units, and no substantial signs of deteriorating stock conditions can be observed in these areas. In northern areas (area C), there are signs of declining stock abundance since 1970; especially when CPUE is computed on an annual basis (Table 3, Fig. 8).

**Trawl CPUE**

Trawl CPUE is generally not considered an appropriate index of sablefish stock abundance because most of the effort was directed to other species. The allocation of Japanese MS-LG-IT and Soviet trawl effort expended in the harvest of the minor sablefish component is impractical. An acceptable trawl CPUE index of sablefish abundance may, however, be derived from the land-based stern trawl statistics in as much as sablefish is an important species harvested by this fishery.
### Percentage Composition of Sablefish to Total Catch

<table>
<thead>
<tr>
<th>Year</th>
<th>61</th>
<th>62</th>
<th>63</th>
<th>64</th>
<th>65</th>
<th>66</th>
<th>67</th>
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<th>69</th>
<th>70</th>
<th>71</th>
<th>72</th>
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<tr>
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<td>6.5</td>
<td>1.7</td>
<td>1.1</td>
<td>1.4</td>
<td>0.9</td>
<td>0.8</td>
<td>0.8</td>
<td>0.4</td>
<td>0.4</td>
<td>0.4</td>
</tr>
<tr>
<td>Land-based (N. A.)</td>
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<td>21.9</td>
<td>18.5</td>
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</table>

Changes in the fishing power of these small stern trawlers of the land-based dragnet fishery with time are not known, but should be borne in mind when resulting CPUE figures are interpreted.

Stern trawls were introduced into the land-based dragnet fishery in 1967, and complete data for this fishery are currently available through 1971. Sasaki (1972) summarized the CPUE of this fleet by three large areas in the Bering Sea (Fig. 9). No adjustments for fishing power, such as would be affected by horse power changes, were made.

A drop in CPUE (from 150 kg per hour to 25 kg per hour) from 1965 to 1971 is observed in area 3 (Fig. 9). There is also a slight decrease of CPUE from 1969 to 1971 in area 2. These two areas (areas 2 and 3) are actively fished by the land-based dragnet fishery (Fig. 3) while area 5 (which corresponds to areas F1-F4 of Fig. 7) is less important. However, the relative abundance of sablefish (100-300 kg per hour trawling) in area 5 (the Aleutians) was higher than in areas 2 and 3 for 1968-71.

In general, signs of decreasing abundance of sablefish are evident in the northern areas (corresponding to areas C and D of Fig. 7) where sablefish have been heavily exploited by trawlers of both land-based dragnet and MS-LG-IT fisheries (CPUE from 1969 to 1971 declined from 35 to 75%). In the Aleutian area, a decrease in CPUE of 26% is apparent for the same period (Fig. 9).
Assuming that there is one stock unit, an overall CPUE was calculated and weighted by estimated available fishing grounds for areas 2, 3, and 5 (Fig. 10 and Table 4). The overall decrease in CPUE from 1969 to 1971 was 35%.

CONCLUSION

Although it is not clear whether the sablefish resource of the Bering Sea is in any immediate danger of over-exploitation, the overall stock size has apparently been reduced about 35% from 1969 to 1971. The 1969 stock level appears to be the best since 1962 when catches of sablefish were at a peak of 28,000 MT. The more northerly areas of the Bering Sea (along the continental slope north of 55°N) have been very intensively fished by trawl gear of both the MS-LG-IT and land-based dragnet fisheries. Any reduction in fishing effort for such species as pollock and Pacific cod in these areas should provide significant relief to the sablefish resource. In the Aleutian area, sablefish abundance has apparently not declined as much as in the northern areas because little Soviet and Japanese trawling takes place there. However, since the trawl CPUE has been declining, catch levels for sablefish should not exceed the 1970-72 catch levels until higher yields can be shown to be sustained.

Research should be directed to the determination and monitoring of population structure through length, age, and weight studies at known depth and location. Tagging experiments have shown sablefish movement between the northeastern Pacific Ocean and the Bering Sea. Even though the extent of stock mixing is not known, the effects of increasing catches in the northeastern Pacific may eventually be felt in the Bering Sea.

Literature Cited


Table 1.--Sablefish catch in metric tons in the Bering Sea by nations, 1958-72.

<table>
<thead>
<tr>
<th>Year</th>
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</tr>
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<td>6659</td>
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</table>

1. MS-LG-IT denotes Japanese mothership, longline-gillnet and independent trawl fisheries.
2. LB denotes Japanese land-based dragnet fishery.

Data sources: Bering Sea; Japanese data from Sasaki (1972) and Yawaguchi (1973). Soviet data through bilateral meetings with the U.S.

Figure 1.--Sablefish catch in the Bering Sea and the northeastern Pacific Ocean, 1958-72.
Figure 2.--Sablefish catch by the Japanese mothership, longline-gillnet and independent trawl fisheries in the Bering Sea, 1964-71.
Figure 3.--Sablefish catch by the Japanese land-based dragnet fishery in the Bering Sea, 1965-71.
Figure 4.--Release and recovery locations of tagged sablefish in the Bering Sea and the northeast Pacific (After Sasaki, 1971).
Figure 5.--Relationships of (a) length-age and (b) weight-age for sablefish in the Bering Sea, 1958-60 (After Shubnikov, 1963).

Table 2.-- Age-Length-Weight relationships for sablefish in the Bering Sea from Fig. 5.

<table>
<thead>
<tr>
<th>Age</th>
<th>Length cm</th>
<th>Length inches</th>
<th>Weight kg</th>
<th>Weight lbs</th>
<th>Weight Increment (lbs)</th>
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Figure 6.—Age composition of sablefish in the Bering Sea in (a, b) 1958 and (c) 1960 from Soviet trawl surveys and (d) 1971 from Japanese trawl surveys (Sources: Soviet data from Shubnikov, 1963 and Japanese data from Anon, 1972).
Figure 7.--Sablefish catch per unit of longline effort (CPUE) by classes 3 and 4 vessels combined for the second quarter of each year (April-June) in the Bering Sea by halibut reference areas, 1964-72.
Figure 8.--Sablefish catch per unit of longline effort (CPUE) by all vessels for all months during the year combined in the Bering Sea by halibut reference areas, 1964-72.
Table 3.--Catch, effort and catch per unit effort of sablefish by all sizes of longline vessels combined in the Japanese longline fishery in the Bering Sea, 1964-72.

<table>
<thead>
<tr>
<th>Area</th>
<th>Year</th>
<th>Catch</th>
<th>Effort</th>
<th>CPUE</th>
<th>Area</th>
<th>Year</th>
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Note: Catch in metric tons
Effort in 10 hachi longline units
CPUE in tons per 10 hachi longline units
Figure 9.—Sablefish catch per stern trawl hour by the Japanese land-based fishery in the Bering Sea in areas designated, 1967-71 (After Sasaki, 1972).
Table 4.--Catch per unit of effort (kilograms per hour) of sablefish by Japanese land-based stern trawlers in the Bering Sea, 1967-71.

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<th>CPUE by area**</th>
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* Data from Sasaki (1972).

** Weighting factors in Areas 2, 3, and 5 are .64, .15, and .21 respectively. They are based upon estimated available fishing grounds.

Figure 10.--Sablefish catch per stern trawl hour by the Japanese land-based fishery in the Bering Sea weighted by estimated available fishing areas, 1967-71.