CONDITION OF GROUNDFISH RESOURCES IN THE GULF OF ALASKA

by

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by the U. S. NATIONAL SECTION

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Seattle, Washington 98112

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</table>
The annual catch of pollock from the Gulf of Alaska by foreign trawl fisheries has increased rapidly since 1971 reaching its highest level (120.4 thousand mt) in 1977 (Table 1). The 1978 catch shows a 19% decrease from that of the 1977 catch due to decreases in the Japanese and ROK catches. The USSR annual catch in 1978 rose to its highest level so far. U.S. landings from the Gulf of Alaska in 1978 were estimated at 1,103 mt.

The ROK catch was considerably higher in the Shumagin area than that of the Japanese and USSR in both 1977 and 1978 (Table 2). All or most of the ROK catch in this area for those years was taken in the second half of the year. Most of the Japanese and USSR catches in 1977 and 1978 were obtained in the Chirikof-Kodiak area. Of interest was the concentration of USSR fishing effort in this area during the second quarter of 1978 when this fishery caught some 28.1 thousand mt, 67% of its total annual pollock catch, from the Gulf of Alaska. Japan continues to be the only fishing nation that takes significant amounts of pollock from the Yakutat-Southeastern area.

**Catch Per Unit of Effort**

The CPUE of pollock in the Japanese trawl fishery was examined for changes in relative abundance during the years 1973 through 1978. CPUE is based on catch and effort of stern trawlers (class 7 and 9) in INPFC statistical blocks and months when the total catch of bottomfish was composed of

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50% or more of pollock. CPUE is presented by three periods: January-May, June-September, and October-December (Table 3).

CPUE's of vessel class 9 were found to be consistently higher than those of the other vessel class for each time period. This is particularly marked for the Shumagin area where some CPUE's of vessel class 9 were over 20 mt/hour. For vessel class 7, CPUE's rarely exceeded 4 mt/hour but did reach 7.94 mt/hour for the June-September period of 1973 and 7.60 mt/hour for the last period of 1978 in the Chirikof-Kodiak area.

The most complete record of CPUE estimates is that for vessel class 7 in the Chirikof-Kodiak area. For this area and vessel class, annual trends in CPUE for the fall period (October-December) differ from those of the two earlier periods which have similar CPUE trends. In the fall period, CPUE increased 3-fold from 1974 to 1978, while that for the other time periods peaked in 1976-77 (January-May) and in 1976 (June-September), and then declined in the subsequent years. This rise and fall in CPUE of vessel class 7 for January-May was similar to the trend in CPUE of vessel class 9 for the same period.

The relationship of changing CPUE trends to the rise and fall in population abundance is not known. Combining all those periods for an overall CPUE estimate for each year (1976-78) suggests pollock density peaked in 1977 and then declined slightly in 1978 in the Chirikof-Kodiak area, as shown in the table below:

<table>
<thead>
<tr>
<th>Year</th>
<th>1976</th>
<th>1977</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>mt/hour</td>
<td>3.00</td>
<td>3.82</td>
<td>3.53</td>
</tr>
<tr>
<td>(vessel class 7)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**Size and Age Composition**

Estimates of the size and age composition of pollock were derived from the analysis of U.S. observer data from the foreign trawl fisheries in 1976 through 1978. When size or age compositions from different areas, time periods, and fishing nations were combined, they were weighted by the catch in numbers for these categories for an overall estimate. For some areas and fishing nations, no estimates are given because of the absence or lack of sufficient data.

In both 1977 and 1978, most of pollock catch by areas and nations was comprised of fish greater than 40 cm in length with modes occurring within the length intervals of 42, 44, 46, and 48 cm (Table 4). Exceptions were the estimated size compositions of pollock in the USSR catches in the Shumagins and Chirikof-Kodiak areas in 1978. The USSR fishery had a higher proportion of smaller fish in their catches than the other nations' fisheries. This is of considerable significance in the Chirikof-Kodiak area because the USSR catch of some 40.1 thousand mt from this area in 1978 represents an estimated 221.5 million fish comprised mostly of smaller sizes and younger ages (3-and-4-year-olds) than taken in the other nations' fisheries. The 221.5 million fish represents 74% of the total Gulf of Alaska pollock catch in numbers in 1978.

The higher proportion of age 3-and-4-year-old fish in the Chirikof-Kodiak area is a departure from the trend towards the dominance of 6-year-old fish, which was expected for that area in 1978 (Table 5). As early as 1975 it was observed that the 1972 year-class was relatively strong. In 1976, this year-class dominated the catch as 4-year-olds, at least in the Chirikof-Kodiak area (Table 5). By 1977, over 50% of the pollock catch in both the
Shumagin and Chirikof-Kodiak areas was composed of this year-class. The importance of the 1972 year-class in the fisheries continued in 1978 in the Shumagin area for all nations, and in the Chirikof-Kodiak area for the Japanese fishery only (Table 6). Because of the dwarfing of the Japanese catch in numbers by that of the USSR fishery, the overall estimate of the age composition of the catch in the Chirikof-Kodiak area in 1978 shows the dominance of 4-year-olds followed by 3-year-olds (Table 5 and 6).

The 1972 year-class has been a mainstay of the pollock fisheries for the years 1976-1978 and its importance may have diminished in 1979. However, there are suggestions that the 1974 and 1975 year-classes may be relatively strong. The 1974 year-class as 4-year-olds was important in the Japanese fishery in the Shumagins, and in the USSR fishery in the Chirikof-Kodiak area in 1978. The 1975 year-class was important in both the Japanese and USSR fisheries in the Chirikof-Kodiak area in 1978 (Table 6).

**Yield Estimates**

A first approximation of the maximum sustainable yield was obtained from the following relationship:

$$MSY = 0.4 \, M \bar{P}_W$$

(see Alverson and Pereyra, 1969)

where $M$, the natural mortality, is estimated at 0.4, and $\bar{P}_W$ is an estimate of the virgin stock biomass. Stock biomass was estimated from NMFS bottom trawl survey which took place in the western and northeastern Gulf of Alaska in 1973-75, and in southeastern Alaskan waters in 1976-77. From these surveys the standing stock of pollock was approximated using the relationship:

$$\bar{P}_W = \frac{(CPUE) \, A}{C \, a}$$
where $A$ is the total area, and $\bar{a}$ is the average bottom area covered by the trawl per standard tow, and $c$ is a coefficient related to the effectiveness of the trawl in capturing pollock. It was assumed to be 1.0.

It can be argued that to assume that $c = 1.0$ is unrealistic and that more likely it is less than 1.0, and perhaps, close to 0.5. Whatever $c$ may be, it will be highly variable, and perhaps never be satisfactorily estimated. A $c$ of 1.0 was assumed because biomass estimates from trawl surveys are rough approximations due to considerable sampling error. Point estimates, therefore, could very well overestimate stock size, even with an assumed $c$ of 1.0; hence, the reason for a conservative approach in estimating MSY.

From the above formulations and assumptions, an MSY of 166 thousand metric tons was estimated for the Gulf of Alaska with an apportioning of this total by INPFC areas (Table 7). Equilibrium yield (EY) at the present time is assumed to be MSY.

As of 1978, the MSY has only been reached in the Shumagin area in 1977 with no subsequent signs of any serious effects on the stocks in that area. Although CPUE data for the Shumagin area is lacking to examine annual trends, the fishery as of 1978 continues to concentrate on relatively large, mature fish. For the other INPFC areas, the annual catch has yet to approach MSY.

There is no evidence for any of the INPFC areas of a decline in stock abundance, and the present recommended potential yields, although possibly conservative, should be attainable on an annual basis.
Literature Cited


Table 1.—Annual catch (metric tons) of pollock in the Gulf of Alaska, 1964-78.

<table>
<thead>
<tr>
<th>Year</th>
<th>Japan-1/</th>
<th>USSR</th>
<th>ROK</th>
<th>Poland</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1964</td>
<td>1,126</td>
<td>Unknown</td>
<td></td>
<td></td>
<td>1,126</td>
</tr>
<tr>
<td>1965</td>
<td>2,749</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>2,749</td>
</tr>
<tr>
<td>1966</td>
<td>8,932</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>8,932</td>
</tr>
<tr>
<td>1967</td>
<td>6,276</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>6,276</td>
</tr>
<tr>
<td>1968</td>
<td>6,164</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>6,164</td>
</tr>
<tr>
<td>1969</td>
<td>17,553</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>17,553</td>
</tr>
<tr>
<td>1970</td>
<td>9,343</td>
<td>&quot;</td>
<td></td>
<td></td>
<td>9,343</td>
</tr>
<tr>
<td>1971</td>
<td>9,018</td>
<td>440</td>
<td></td>
<td></td>
<td>9,458</td>
</tr>
<tr>
<td>1972</td>
<td>13,696</td>
<td>20,385</td>
<td></td>
<td></td>
<td>34,081</td>
</tr>
<tr>
<td>1973</td>
<td>6,706</td>
<td>30,130</td>
<td></td>
<td></td>
<td>36,836</td>
</tr>
<tr>
<td>1974</td>
<td>30,433</td>
<td>31,000</td>
<td>447</td>
<td></td>
<td>61,880</td>
</tr>
<tr>
<td>1975</td>
<td>13,032</td>
<td>39,949</td>
<td>5,900</td>
<td>631</td>
<td>59,512</td>
</tr>
<tr>
<td>1976</td>
<td>10,672</td>
<td>37,825</td>
<td>36,906</td>
<td>---</td>
<td>85,403</td>
</tr>
<tr>
<td>1977</td>
<td>41,953</td>
<td>41,588</td>
<td>35,579</td>
<td>1,256</td>
<td>120,376</td>
</tr>
<tr>
<td>1978</td>
<td>25,900</td>
<td>41,881</td>
<td>28,198</td>
<td>1,229</td>
<td>97,208</td>
</tr>
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</table>
Table 2.--Pollock catch (metric tons) by principal fishing nation and by INPFC areas in the Gulf of Alaska in 1977 and 1978.

<table>
<thead>
<tr>
<th>Year</th>
<th>Period</th>
<th>Shumagin</th>
<th>Chirikof-Kodiak</th>
<th>Yakutat-Southeastern</th>
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</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Japan</td>
<td>USSR</td>
<td>ROK</td>
</tr>
<tr>
<td>1977</td>
<td>Jan-June</td>
<td>646</td>
<td>183</td>
<td>---</td>
</tr>
<tr>
<td></td>
<td>July-Dec</td>
<td>7,980</td>
<td>13,798</td>
<td>34,166</td>
</tr>
<tr>
<td></td>
<td>All months</td>
<td>8,626</td>
<td>13,981</td>
<td>34,166</td>
</tr>
<tr>
<td>1978</td>
<td>Jan-June</td>
<td>2,090</td>
<td>1,756</td>
<td>1,916</td>
</tr>
<tr>
<td></td>
<td>July-Dec</td>
<td>836</td>
<td>42</td>
<td>25,693</td>
</tr>
<tr>
<td></td>
<td>All months</td>
<td>2,926</td>
<td>1,798</td>
<td>27,609</td>
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</tbody>
</table>
Table 3.--Catch and catch-per-unit of effort (metric tons per one hour) of pollock by directed Japanese trawl fisheries on pollock in the western Gulf of Alaska (1973-77). Catch-per-unit of effort is based on catch and effort of stern trawlers (vessel classes 7 and 9 1/) in statistical blocks and months where the pollock catch was 50 percent or more of the total fish catch.

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan-May</th>
<th>Jun-Sep</th>
<th>Oct-Dec 2/</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Class 7</td>
<td>Class 9</td>
<td>Class 7</td>
</tr>
<tr>
<td>1973</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1974</td>
<td>---</td>
<td>583.0</td>
<td>282.0</td>
</tr>
<tr>
<td>1975</td>
<td>619.0</td>
<td>1.68</td>
<td>---</td>
</tr>
<tr>
<td>1976</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>1977</td>
<td>139.0</td>
<td>2.67</td>
<td>---</td>
</tr>
<tr>
<td>1978</td>
<td>123.0</td>
<td>2.17</td>
<td>---</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Jan-May</th>
<th>Jun-Sep</th>
<th>Oct-Dec 2/</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Class 7</td>
<td>Class 9</td>
<td>Class 7</td>
</tr>
<tr>
<td>1973</td>
<td>167.5</td>
<td>7.94</td>
<td>155.5</td>
</tr>
<tr>
<td>1974</td>
<td>519.0</td>
<td>2.16</td>
<td>733.4</td>
</tr>
<tr>
<td>1975</td>
<td>1774.0</td>
<td>1.90</td>
<td>4142.0</td>
</tr>
<tr>
<td>1976</td>
<td>119.0</td>
<td>2.64</td>
<td>4901.1</td>
</tr>
<tr>
<td>1977</td>
<td>917.0</td>
<td>2.64</td>
<td>982.0</td>
</tr>
<tr>
<td>1978</td>
<td>1648.0</td>
<td>2.01</td>
<td>305.0</td>
</tr>
</tbody>
</table>

1/ Vessel class 7 has gross tonnage between 2,505 and 3,504, and that of vessel class 9 of 4,505 and greater.

2/ January of following year.
Table 4.— Size composition (%) of pollock taken in the trawl fisheries in 1977 and 1978 by nation and INPFC area.

|-----------|---------------|---------------|----------------------|----------------------|---------------------------|
Table 5.–Age composition (%) of pollock in the foreign trawl fisheries in the years 1976–78 by INPFC areas.

<table>
<thead>
<tr>
<th>Age</th>
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</tr>
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<td></td>
</tr>
<tr>
<td>1</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>4.9</td>
<td>2.6</td>
</tr>
<tr>
<td>3</td>
<td>2.4</td>
<td>3.7</td>
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<tr>
<td>4</td>
<td>9.9</td>
<td>16.9</td>
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<td>5</td>
<td>55.4</td>
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<td>6</td>
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<td>43.2</td>
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<tr>
<td>7</td>
<td>4.6</td>
<td>10.5</td>
</tr>
<tr>
<td>8</td>
<td>0.6</td>
<td>2.5</td>
</tr>
<tr>
<td>9</td>
<td>0.4</td>
<td>0.6</td>
</tr>
<tr>
<td>10</td>
<td>1.0</td>
<td>0.6</td>
</tr>
<tr>
<td>11</td>
<td>0.2</td>
<td>0.3</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
<td>0.1</td>
</tr>
<tr>
<td>13</td>
<td>0.0</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Age</th>
<th>Chirikof-Kodiak 1976</th>
<th>1977</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>0.0</td>
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<td></td>
</tr>
<tr>
<td>2</td>
<td>0.6</td>
<td>3.3</td>
<td>0.1</td>
</tr>
<tr>
<td>3</td>
<td>9.3</td>
<td>7.3</td>
<td>24.1</td>
</tr>
<tr>
<td>4</td>
<td>57.1</td>
<td>13.9</td>
<td>54.8</td>
</tr>
<tr>
<td>5</td>
<td>20.4</td>
<td>52.5</td>
<td>4.2</td>
</tr>
<tr>
<td>6</td>
<td>8.3</td>
<td>14.0</td>
<td>9.2</td>
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<td>7</td>
<td>1.8</td>
<td>6.0</td>
<td>5.3</td>
</tr>
<tr>
<td>8</td>
<td>1.8</td>
<td>1.3</td>
<td>1.9</td>
</tr>
<tr>
<td>9</td>
<td>0.6</td>
<td>1.2</td>
<td>0.1</td>
</tr>
<tr>
<td>10</td>
<td>0.1</td>
<td>0.3</td>
<td>0.1</td>
</tr>
<tr>
<td>11</td>
<td>0.2</td>
<td>0.2</td>
<td>0.1</td>
</tr>
<tr>
<td>12</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
<tr>
<td>13</td>
<td>0.0</td>
<td>0.0</td>
<td>0.0</td>
</tr>
</tbody>
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Table 6.--Age composition (%) of pollock taken in the trawl fisheries in 1977 and 1978 by nation and INPFC area.

<table>
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<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>USSR</td>
<td>JAP.</td>
<td>USSR</td>
<td>ROK</td>
</tr>
<tr>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>4.9</td>
<td>0.3</td>
<td>14.1</td>
<td>1.4</td>
</tr>
<tr>
<td>3</td>
<td>2.4</td>
<td>3.9</td>
<td>0.4</td>
<td>4.1</td>
</tr>
<tr>
<td>4</td>
<td>9.9</td>
<td>39.4</td>
<td>9.1</td>
<td>13.8</td>
</tr>
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<td>5</td>
<td>55.4</td>
<td>16.1</td>
<td>13.9</td>
<td>20.3</td>
</tr>
<tr>
<td>6</td>
<td>20.4</td>
<td>28.0</td>
<td>41.3</td>
<td>46.2</td>
</tr>
<tr>
<td>7</td>
<td>4.6</td>
<td>9.3</td>
<td>16.2</td>
<td>9.9</td>
</tr>
<tr>
<td>8</td>
<td>0.6</td>
<td>0.8</td>
<td>1.1</td>
<td>3.0</td>
</tr>
<tr>
<td>9</td>
<td>0.4</td>
<td>0.5</td>
<td>2.2</td>
<td>0.4</td>
</tr>
<tr>
<td>10</td>
<td>1.0</td>
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<tr>
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<td>0.2</td>
<td>0.9</td>
<td>1.2</td>
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<tr>
<td>12</td>
<td>0.0</td>
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<td>13</td>
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<td>0.0</td>
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Table 7.—Pollock catch (metric tons) by foreign fisheries in the Gulf of Alaska in 1977 and 1978, and potential yield by INPFC areas.

<table>
<thead>
<tr>
<th>Area</th>
<th>1977</th>
<th>1978</th>
<th>Potential Yield (MSY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shumagin</td>
<td>56,773</td>
<td>32,361</td>
<td>57,000</td>
</tr>
<tr>
<td>Chirikof-Kodiak</td>
<td>55,900</td>
<td>60,535</td>
<td>95,000</td>
</tr>
<tr>
<td>Yakutat-S.E.</td>
<td>7,703</td>
<td>4,312</td>
<td>14,000</td>
</tr>
<tr>
<td>Total</td>
<td>120,376</td>
<td>97,208</td>
<td>166,000</td>
</tr>
</tbody>
</table>
STATUS OF SABLEFISH RESOURCES IN THE GULF OF ALASKA

by Loh-Lee Low*

INTRODUCTION

The sablefish resource is found in waters off California, northward to the Gulf of Alaska, westward to the Aleutian Region, and into the Bering Sea. The major fishing area for this species over this range is in the Gulf of Alaska and generally in depths exceeding 500 m. The species is taken mostly by longline gear, but trawlers and trap (pot) gear also account for some catches.

The fishery for sablefish has existed in certain parts of the Gulf of Alaska for more than 50 years, but the resource was not fully utilized until Japan entered the fishery in the mid-1960's. Catches increased substantially then and peaked at 36,500 mt in 1972 (Table 1). Catches declined to 30,300 mt in 1973, and following some area-wide catch restrictions and declining stock abundance, catches in 1977 declined to 16,800 mt. Further fishery restrictions were imposed in 1978, and catches amounted to about 9,000 mt when the limit was set at 10,000 mt.

STOCK STRUCTURE

The number and delineation of sablefish stocks in the North Pacific has not been satisfactorily determined. The sablefish throughout this wide geographical area are apparently genetically related in the sense that some individuals have been noted to migrate over long distances. However, the degree of interchange between regions is thought to be small in relation to the stock size within each region, which led Low et al. (1976) and Wespestad et al. (1977) to suggest that management of the resource be conducted by discrete geographical regions. These geographical regions are the eastern Bering Sea, the Aleutian
Region, the Gulf of Alaska, waters off Canada, and waters off Washington to California.

MAXIMUM SUSTAINABLE YIELD

Although the sablefish resource should be managed by regions, the long-term productivity in each region is probably related to the overall condition of the resource. Therefore, it is difficult to get an accurate estimation of the MSY within each region by using fishery information of that region alone. To reduce this problem, both Japanese and U.S. scientists have estimated MSY of the resource as a whole and apportioned MSY according to region. The latest Japanese estimate of MSY for the entire resource from California to the Bering Sea was 69,600 mt (Anon. 1978). The best U.S. estimate of MSY was 50,300 mt (Low and Wespestad 1979), using essentially the same general production model, but with a different weighting of data among regions.

The overall MSY estimate of 50,300 mt was apportioned to individual management areas according to their catch history. By region, the weighting factors were Bering Sea (25%), Aleutian region (4%), Gulf of Alaska (47%), and British Columbia-Washington region (25%). These apportioned MSY estimates were then compared to MSY estimates derived by applying general production models region by region. The resulting mean and overall estimate of MSY was 25,100 mt for the Gulf of Alaska (Low and Wespestad 1979).

EQUILIBRIUM YIELD

Catch and effort information from the Japanese North Pacific longline fishery is the most consistent source of information for assessing the condition of sablefish stocks in the Gulf of Alaska. In the computation of longline CPUE, however, various methods of estimating fishing effort have been used to derive the best measure of stock abundance. The latest and
most detailed procedure was presented by Japanese scientists in Doc. 2080 and took into consideration only that portion of the time spent fishing by excluding time spent for travelling, landing, weathering storms, repairs, and other activities not considered to be associated with productive fishing. This analysis provided CPUE data standardized to catch per boat-day on the basis of 376 hachi longline units per boat-day. Doc. 2118 by U.S. scientists assumed all longline fishing effort (hachi units) to target on sablefish and computed catch per hachi as an index of abundance (Table 2).

Trends in CPUE computed according to the above procedures of analyses are summarized in Table 3. Based on kg per 10 hachi data, catch rates were generally greater than 200 in all INPFC areas prior to 1974. In 1975 catch rates dropped to as low as 154 in the Shumagin Area and were generally about 185 in the other areas. In 1976, CPUE increased in all areas of the Gulf of Alaska (Shumagin-Southeastern Region). A dramatic change occurred from 1976 to 1977--CPUE dropped in all areas. The decline ranged from 13-34% and averaged 25%.

In 1978, some fishing regulations in the Gulf of Alaska were changed which permitted Japanese longliners to fish in depths shallower than 500 m in the Shumagin-Chirikof Region for Pacific cod. This resulted in a shift of some Japanese longline fishing effort towards Pacific cod in depths of 100-300 m, while in the past all of the effort was directed to catching sablefish in depths generally greater than 500 m. Since catch-effort statistics are reported to the U.S. without reference to depth, it is not now possible to distinguish effort directed towards cod as opposed to those efforts directed towards sablefish. Therefore, comparable CPUE data for 1978 cannot be computed to reflect stock conditions of sablefish in the Shumagin-Chirikof Region. In addition, the southeast area was closed to foreign longlining so Japanese CPUE data for that area is no longer available. In the Kodiak Area, where fishing regulations remained essentially the same, Japanese longline data show that CPUE remained
about the same in 1978 as in 1977 (Table 2). The eastern one-third of the Yakutat Area was closed to foreign longlining in 1978, but the CPUE remained about the same as in 1977.

As a result of changes in fishing regulations in the Shumagin-Chirikof Region, CPUE trends for sablefish were determined from U.S. observer data. Observers were first placed aboard Japanese longliners in late 1977, and the data collected since are tabulated in Table 4. In order to determine CPUE trends for sablefish, data collected from depths exceeding 500 m are considered to be directed towards sablefish. For the months of September-October, when observers were present both years, CPUE trends (kg per 1000 hooks) for sablefish in depths greater than 500 m were:

<table>
<thead>
<tr>
<th></th>
<th>Shumagin</th>
<th>Chirikof</th>
<th>Kodiak</th>
<th>Yakutat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>0.2337</td>
<td>--</td>
<td>0.2448</td>
<td>0.3582</td>
</tr>
<tr>
<td>1978</td>
<td>--</td>
<td>--</td>
<td>0.2097</td>
<td>0.1441^1</td>
</tr>
</tbody>
</table>

^1/ Part of Yakutat was closed to foreign longlining in 1978.

These observer data show that CPUE may have declined in the Kodiak-Yakutat Region from 1977 to 1978.

By comparing the catch and CPUE trend through 1976, it was determined in the Fishery Management Plan for the Gulf of Alaska Groundfish Fishery during 1978 (DOC 1978) that the equilibrium yield for sablefish in the Gulf of Alaska was in the 17,400-19,800 mt range. This range was viewed to be optimistic because CPUE data used to derive EY had not been adjusted by gear efficiency and saturation factors. In view of the fact that CPUE declined an additional
25% from 1976 to 1977, EY in 1978 appears to have declined further to about about 14,000 mt.

This EY value represented catches of those large sablefish (generally exceeding 7 lbs round weight, age 6-7 years) generally taken in the Japanese longline fishery. In 1979, U.S. research surveys in the Gulf of Alaska and the Bering Sea that show recruitment of 3 and 4 year-old sablefish (1975 and 1976 year-classes) is higher than normal. Although the absolute strength of these year-classes has not been quantified, large numbers of them have been observed by U.S. fishermen fishing in southeast Alaska (Jake Phillips and Dan Cushing pers. comm.). U.S. fishermen also noted that large sablefish (generally exceed 9 lbs round weight, age 8-9 years) were scarce in 1979. This latter observation seems to be consistent with general conclusions drawn from declining Japanese longline CPUE trends through 1978.

The 1975 and 1976 year-classes which are apparently stronger than normal will begin to contribute to the fishery in 1980. They should be fully recruited to the domestic setline fishery by 1983. Therefore, although the current (1979) EY may be somewhat below the 14,000 mt of 1978, abundance of the exploitable portion of the population will begin to increase in 1980, and there is no reason to consider ABC for 1980 to be less than the current OY of 13,000 mt. However, until the 1975 and 1976 year-classes reach maturity and enhance the stock's production potential, ABC should remain below the current estimate of EY which is no greater than 14,000 mt.
LITERATURE CITED


# TABLE 1. -- HISTORICAL CATCHES OF SABLEFISH IN METRIC TONS BY AREA AND NATION 1958-78.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>U.S.</th>
<th>CANADA</th>
<th>JAPAN A/</th>
<th>USSR</th>
<th>ROK B/</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
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<td>--</td>
<td>C/</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
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<td>--</td>
<td>--</td>
</tr>
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<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
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<td>--</td>
<td>--</td>
<td>--</td>
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</tr>
<tr>
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<td>C/</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td>--</td>
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<td>--</td>
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<tr>
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<td>--</td>
<td>2,214</td>
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<tr>
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<tr>
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<td>--</td>
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<td>--</td>
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<tr>
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<td>C/</td>
<td>19,587</td>
<td>--</td>
<td>--</td>
<td>19,889</td>
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<tr>
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<td>21,397</td>
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<tr>
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<td>15</td>
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<tr>
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<td>16</td>
<td>29,246</td>
<td>109</td>
<td>58</td>
<td>30,926</td>
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<tr>
<td>1974</td>
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<td>10</td>
<td>23,300</td>
<td>38</td>
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<td>26,169</td>
</tr>
<tr>
<td>1975</td>
<td>1,088</td>
<td>16</td>
<td>21,561</td>
<td>33</td>
<td>3,000</td>
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<td>22,947</td>
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<td>4</td>
<td>1,594</td>
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<tr>
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<td>C/</td>
<td>6,458</td>
<td>4</td>
<td>665</td>
<td>8,940</td>
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</tbody>
</table>

A/ JAPANESE CATCH IS REPORTED BY FISHING YEAR; ALL OTHERS ARE REPORTED CALENDAR YEAR.
B/ INCLUDES CATCHES FROM OTHER AREAS IN THE NORTHEASTERN PACIFIC.
C/ DATA NOT AVAILABLE.
D/ TRAWL DATA ONLY; POT AND LINE CATCH NOT INCLUDED.

CANADIAN DATA 1971-76 FROM PMFC DATA SERIES, GROUNDFISH SECTION; 1958-70 DATA NOT AVAILABLE.
JAPANESE, USSR, ROK DATA FROM INPFC DOCUMENT 1883 AND PERS. COMM. T. SASAKI, FAR SEAS FISHERY LAB., SHIMIZU, JAPAN.
### Table 2: Total Sablefish Catch in Metric Tons (MT), Longline Catch (MT), Longline Effort (in 10 Hachi Units), Longline CPUE (MT/10 Hachi), and Total Effort Based on Longline CPUE for Sablefish by INPFC Areas for 1966 to 1978.

<table>
<thead>
<tr>
<th>YEAR</th>
<th>TOTAL CATCH</th>
<th>LONGLINE CATCH</th>
<th>LONGLINE EFFORT</th>
<th>LONGLINE CPUE</th>
<th>TOTAL EFFORT</th>
</tr>
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<td>1,088</td>
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<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1967</td>
<td>514</td>
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<td>217</td>
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</tr>
<tr>
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<td>297</td>
<td>67</td>
<td>445</td>
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<tr>
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<td>3,077</td>
<td>16,329</td>
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<tr>
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<tr>
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<td>5,448</td>
<td>26,366</td>
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<tr>
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<tr>
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<td>4,978</td>
<td>24,599</td>
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<td>30,573</td>
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<td>4,612</td>
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<tr>
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<td>2,555</td>
<td>18,403</td>
<td>0.137</td>
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</tbody>
</table>

### Areas

- **Shumagin**: 1966-1978
- **Chirikof**: 1966-1978
- **Kodiak**: 1966-1978
- **Yakutat**: 1966-1978
- **Southeastern**: 1966-1978

* Prior to 1970, Japanese longliners were not permitted to fish in depths shallower than 500 m. In 1970, some longliners were permitted to fish in waters shallower than 500 m for Pacific Cod — therefore, the total fishing effort no longer reflects effect on sablefish.
Table 3.—Indices of blackcod abundance in the Gulf of Alaska, 1967-1978 (Docs. 2080 and 2118).

A. CPUE (kg per 10 hachi) by Japanese and United States scientists

<table>
<thead>
<tr>
<th>Year</th>
<th>Shumagin</th>
<th>Chirikof</th>
<th>Kodiak</th>
<th>Yakutat</th>
<th>Southeastern</th>
<th>Shumagin-Southeastern</th>
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</thead>
<tbody>
<tr>
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<td>175</td>
<td>301</td>
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<td>207</td>
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<tr>
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<td>191</td>
<td>185</td>
<td>191</td>
<td>195</td>
<td>190</td>
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<td>*</td>
<td>136</td>
<td>137</td>
<td>---</td>
<td>137</td>
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</tbody>
</table>

Footnotes: * Prior to 1978, Japanese Longliners were not permitted to fish in depths shallower than 500m. In 1978, some of these Longliners were permitted to fish in waters shallower than 500m for Pacific Cod. Therefore, the total Longline fishing effort no longer reflects total effort on sablefish.

B. CPUE (m.t. per boat-day, standardized on 376 hachi per boat-day) by Japanese scientists

<table>
<thead>
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Footnotes: * No Foreign Longline was permitted in the Southeastern Area and an eastern part of the Yakutat Area in 1978.
TABLE 4. -- JAPANESE LONGLINE CATCH-EFFORT DATA ON SABLEFISH COLLECTED BY U.S.
OBSERVERS IN THE GULF OF ALASKA, 1977-78.

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STATUS OF PACIFIC COD RESOURCE IN GULF OF ALASKA

by Vidar G. Wespestad and Eric S. Brown*

INTRODUCTION

Japan and the U.S.S.R. have been primary exploiters of the cod resource in the Gulf of Alaska while the U.S. has engaged in a limited amount of cod harvesting primarily for halibut and crab bait (Table 1). Korea and Poland also operate fisheries in the Gulf and in 1978 reported 1,369 and 13.6 mt of cod respectively.

The foreign trawl fisheries take cod incidentally when targeting on other species. From 1971 to 1977, the cod catch in the Gulf of Alaska averaged 4,200 mt or 2.1% of the total annual Gulf of Alaska groundfish catch (Table 1). In 1978, the catch of cod increased to about 11,400 mt or 6.9% of the total groundfish catch. This increase was primarily due to the development of a cod longline fishery by the Japanese in the western Gulf of Alaska which accounted for 60% of the total 1978 codfish harvest.

MAXIMUM SUSTAINABLE YIELD

Based on NMFS resource assessment surveys, the maximum sustainable yield for Pacific cod in the Gulf of Alaska is estimated at 88,000-177,000 mt (Table 2). This estimate is derived from the Gulland (1969) equation:

$$MSY = 0.4 \frac{B_0}{M}$$

and assumes that the biomass is near the level of the virgin population ($B_0$) and natural mortality ($M$) is equal to 0.6, the rate reported by Ketchen (1964) for British Columbia stocks.

The total exploitable biomass ($B_0$) of 368,000-736,000 mt was estimated using trawl survey data from the period 1973-78. Population estimates for the Kodiak and Chirikof regions are based on the period January-April 1977 and 1978. The biomass estimate for these two regions is substantially higher than estimates

obtained from previous surveys (1973-74), but there is no indication that the increase is due to year class fluctuation but instead may be due to a long term increase in biomass and/or changes in resource availability. Biomass estimates from the remaining Gulf of Alaska regions are from the period April-October 1973-76 and each region is defined as follows:

1. Fairweather: 136°00'W long. to 140°00'W long.
2. Yakutat: 140°00'W long. to 144°30'W long.
3. Prince William: 144°30'W long. to 148°00'W long.
4. Kenai: 148°00'W long. to 151°00'W long.
5. Kodiak: 151°00'W long. to 154°00'W long. south of Kodiak Island
6. Shelikof: 152°22'W long. to 156°38'W long. north of 57°00'N lat.
7. Chirikof: 154°00'W long. to 158°00'W long. south of 57°00'N lat.
8. Shumagin: 158°00'W long. to 161°00'W long.
9. Sanak: 161°00'W long. to 165°00'W long.

All catch data were standardized to kg/hr and mean CPUEs were calculated for each region by depth zones. The overall mean CPUE for a region and the entire Gulf of Alaska was calculated by area-weighted CPUEs.

The standing stock for each survey region or INPFC area was approximated using the following relationship:

$$P_w = \frac{\text{CPUE}(A)}{c}$$

where $P_w$ is equal to the average standing stock in weight of the exploitable population; $A$ is the total area; $a$ is the average bottom area covered by the trawl per standard tow; and $c$ is a coefficient related to the effectiveness of the trawl related to the availability of cod and to the degree which cod are vulnerable to capture when they come under the influence of the trawl.

Estimates of $c$ given for some gadoid species of the northeast Atlantic vary considerably by species ranging from 0.08 to 0.51 (Edwards 1968). For
Pacific cod in the Gulf of Alaska, the coefficient is not known but is assumed to lie within the range of 0.5 to 1.0. The standing stock estimates given in this report, therefore, have a minimum and maximum value.

For those portions of an INPFC area which were not surveyed, the biomass was estimated using the average CPUE from the surveyed portion. A full description of survey procedures and locations is presented in Alton et al. (1977).

**EQUILIBRIUM YIELD**

Current catch levels are much below estimated MSY, but there does not appear to be any biological reason that MSY cannot be attained. Available data from U.S. observers and research cruises show that ages 2, 3, and 4 compose the major portion of the catch and the biomass (Table 3). Length frequency data from 1967 to the present indicate that generally this distribution has prevailed (Table 4).

Although EY is assumed to be MSY, ABC may have to be set at a lower level to minimize the incidental catch of halibut as U.S. trawl survey data indicate a high degree of co-occurrence between cod and halibut. Both species were taken together in 85% and 95% of all hauls completed during the 1977 and 1978 winter survey in the Kodiak Island area (Table 5). These data, however, do not reflect the amount of cod taken per unit of halibut. The weight ratios of cod to halibut were summed over hauls where both species occurred to obtain mean ratios by depth zones and year (Table 6). In general, the ratio of cod to halibut was highest in the 100-300 meter depth range with ratios varying from 2.7 to 10.9. In 300-400 meter depths, the ratio fell below a value of one for both years, indicating that halibut catches generally exceeded those of cod.
Commercial operations, unlike research trawl surveys, concentrate fishing effort on target species in selected areas and depths which could result in a lower proportion of halibut in catches than found in research trawl catches. The incidence of halibut for Japanese trawl and longline gear as reported by U.S. observers during 1977–78 shows a range of less than one halibut per metric ton of catch for the Chirikof region in 1977 to nearly seven halibut per metric ton in the Shumagin region in 1978 (Table 7). These values which are weighted heavily towards the 100–300 meter depth range where foreign fishing effort has been highest could increase if targeting on Pacific cod by both U.S. and foreign fleets increases.

For 1980, ABC has been tentatively established to be 60,000 mt for the entire Gulf of Alaska.
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<td>YAKUTAT</td>
<td>95</td>
<td>16</td>
<td>694</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOUTHEASTERN</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WESTERN GULF B/</td>
<td>176</td>
<td>2696</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>EASTERN GULF C/</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>D/</td>
<td>176</td>
<td>2696</td>
<td>3395</td>
<td>2136</td>
<td>2551</td>
<td>2995</td>
<td>525</td>
<td>1141</td>
</tr>
<tr>
<td><strong>U.S.</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SHUHAGIN</td>
<td>0</td>
<td>0</td>
<td>36</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>13</td>
<td>53</td>
<td></td>
</tr>
<tr>
<td>CHIRIKOF</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>42</td>
<td>52</td>
<td>16</td>
<td></td>
</tr>
<tr>
<td>KODIAK</td>
<td>44</td>
<td>12</td>
<td>10</td>
<td>28</td>
<td>71</td>
<td>40</td>
<td>96</td>
<td>140</td>
<td></td>
</tr>
<tr>
<td>YAKUTAT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>SOUTHEASTERN</td>
<td>18</td>
<td>7</td>
<td>15</td>
<td>31</td>
<td>67</td>
<td>34</td>
<td>52</td>
<td>55</td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>GRAND TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>PERCENT TOTAL GROUND FISH CATCH</td>
<td>0.5</td>
<td>1.8</td>
<td>3.4</td>
<td>2.6</td>
<td>3.3</td>
<td>2.2</td>
<td>1.2</td>
<td>6.9</td>
<td></td>
</tr>
</tbody>
</table>

**TABLE 1.--ANNUAL CATCH IN METRIC TONS OF PACIFIC COD IN THE GULF OF ALASKA BY INPFC AREA FOR JAPAN, ROK, U.S.S.R., AND U.S. FROM 1970-78.**

### Notes

- **A/** UNAVAILABLE
- **B/** U.S.S.R. REPORTING UNIT WHICH INCLUDED INPFC AREAS: SHUHAGIN, CHIRIKOF AND KODIAK.
- **C/** U.S.S.R. REPORTING UNIT WHICH INCLUDE INPFC AREAS: YAKUTAT AND SOUTHEASTERN.
- **D/** CATCH, IF ANY, INCLUDED IN OTHER SPECIES CATEGORY.

**DATA SOURCES:**
- JAPAN - DATA FURNISHED TO THE UNITED STATES THROUGH INPFC.
- USSR - DATA FURNISHED TO THE UNITED STATES UNDER BILATERAL AGREEMENT.
- US - ALASKA DEPT. FISH & GAME.
Table 2.—Estimated exploitable biomass in metric tons of Pacific cod by INPFC areas and depth strata from NMFS resource assessment surveys.1/

<table>
<thead>
<tr>
<th>Depth stratum (meters)</th>
<th>Shumagin</th>
<th>Chirikof</th>
<th>Kodiak</th>
<th>Yakutat</th>
<th>Southeastern</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>0–91</td>
<td>10,597</td>
<td>502</td>
<td>8,585</td>
<td>8,452</td>
<td>--</td>
<td>28,136</td>
</tr>
<tr>
<td>92–183</td>
<td>22,554</td>
<td>141,775</td>
<td>70,516</td>
<td>9,062</td>
<td>--</td>
<td>243,997</td>
</tr>
<tr>
<td>184–366</td>
<td>6,388</td>
<td>44,129</td>
<td>39,111</td>
<td>524</td>
<td>--</td>
<td>90,152</td>
</tr>
<tr>
<td>Total</td>
<td>39,539</td>
<td>186,406</td>
<td>118,212</td>
<td>18,038</td>
<td>5,922</td>
<td>368,117</td>
</tr>
</tbody>
</table>

1/ Estimates in the Kodiak and Chirikof regions are from data obtained during Jan-April 1977-78. Estimates from the remaining regions are from April-Oct. 1973-75.
Table 3.—Pacific cod age-frequency (%) by area and year.

<table>
<thead>
<tr>
<th>Age</th>
<th>Shumagin 1977(^a)</th>
<th>1978(^b)</th>
<th>Chirikof 1977(^a)</th>
<th>1978(^b)</th>
<th>Kodiak 1977(^a)</th>
<th>1978(^c)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>43</td>
<td>11</td>
<td>22</td>
<td>2</td>
<td>49</td>
<td>35</td>
</tr>
<tr>
<td>3</td>
<td>38</td>
<td>56</td>
<td>64</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>4</td>
<td>15</td>
<td>20</td>
<td>6</td>
<td>33</td>
<td>0</td>
<td>10</td>
</tr>
<tr>
<td>5</td>
<td>2</td>
<td>9</td>
<td>4</td>
<td>12</td>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>&lt;1</td>
</tr>
<tr>
<td>Mean age</td>
<td>2.76</td>
<td>3.16</td>
<td>2.92</td>
<td>3.66</td>
<td>2.50</td>
<td>2.80</td>
</tr>
<tr>
<td>Mean length</td>
<td>50.5</td>
<td>62.0</td>
<td>55.8</td>
<td>65.76</td>
<td>51.56</td>
<td>55.15</td>
</tr>
<tr>
<td>N</td>
<td>197</td>
<td>6,688</td>
<td>139</td>
<td>10,408</td>
<td>283</td>
<td>2,279</td>
</tr>
</tbody>
</table>

\(^a\)/ Soviet large trawler

\(^b\)/ Japanese longline

\(^c\)/ U.S. trawl survey
Table 4.—Mean and modal lengths of Pacific cod sampled from the Japanese (1967-78) and Soviet (1977) fisheries in the Gulf of Alaska.

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Mode</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>1967</td>
<td>52.9</td>
<td>52</td>
<td>8,635</td>
</tr>
<tr>
<td>1968</td>
<td>52.4</td>
<td>50</td>
<td>1,241</td>
</tr>
<tr>
<td>1969</td>
<td>55.6</td>
<td>54</td>
<td>1,511</td>
</tr>
<tr>
<td>1970</td>
<td>52.9</td>
<td>52</td>
<td>879</td>
</tr>
<tr>
<td>1971</td>
<td>63.5</td>
<td>68</td>
<td>166</td>
</tr>
<tr>
<td>1972</td>
<td>50.1</td>
<td>52</td>
<td>392</td>
</tr>
<tr>
<td>1973</td>
<td>55.7</td>
<td>56</td>
<td>1,011</td>
</tr>
<tr>
<td>1974</td>
<td>57.3</td>
<td>58</td>
<td>747</td>
</tr>
<tr>
<td>1975</td>
<td>62.5</td>
<td>58</td>
<td>332</td>
</tr>
<tr>
<td>1976</td>
<td>--</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>1977</td>
<td>54.5</td>
<td>53</td>
<td>619</td>
</tr>
<tr>
<td>1978</td>
<td>64.3</td>
<td>--</td>
<td>17,096</td>
</tr>
<tr>
<td>Depth (meters)</td>
<td>1977</td>
<td>1978</td>
<td></td>
</tr>
<tr>
<td>---------------</td>
<td>------</td>
<td>------</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cod only</td>
<td>Halibut only</td>
<td>Cod and halibut</td>
</tr>
<tr>
<td>0-100</td>
<td>3</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>14-200</td>
<td>1</td>
<td>2</td>
<td>42</td>
</tr>
<tr>
<td>201-300</td>
<td>2</td>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>301-400</td>
<td>--</td>
<td>--</td>
<td>6</td>
</tr>
<tr>
<td>&gt; 400</td>
<td>--</td>
<td>--</td>
<td>1</td>
</tr>
<tr>
<td>TOTAL</td>
<td>6</td>
<td>6</td>
<td>99</td>
</tr>
</tbody>
</table>
Table 6.--Mean ratio of weight (kg) of Pacific cod to Pacific halibut in catches where both species occurred during research trawl surveys off Kodiak Island (Jan.-April 1977-78).1/

<table>
<thead>
<tr>
<th>Depth (Meters)</th>
<th>Ratio of cod/halibut (kg)</th>
<th>1977</th>
<th>1978</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-100</td>
<td></td>
<td>1.51</td>
<td>--</td>
</tr>
<tr>
<td>101-200</td>
<td></td>
<td>4.78</td>
<td>10.86</td>
</tr>
<tr>
<td>201-300</td>
<td></td>
<td>2.70</td>
<td>6.53</td>
</tr>
<tr>
<td>301-400</td>
<td></td>
<td>0.30</td>
<td>0.39</td>
</tr>
</tbody>
</table>

1/ Weight ratios of cod to halibut were summed by haul to obtain mean ratios by depth zones and year.
Table 7.--Average incidence of Pacific halibut (number per metric ton of catch) for Japanese trawl and longline gear (0-500 meters).

<table>
<thead>
<tr>
<th>Area</th>
<th>Longline</th>
<th>Small independent stern trawler</th>
<th>Large independent stern trawler</th>
</tr>
</thead>
<tbody>
<tr>
<td>Shumagin</td>
<td>--</td>
<td>2.59</td>
<td>3.36</td>
</tr>
<tr>
<td>Chirikof</td>
<td>--</td>
<td>2.70</td>
<td>0.96</td>
</tr>
<tr>
<td>Kodiak</td>
<td>--</td>
<td>--</td>
<td>1.35</td>
</tr>
</tbody>
</table>
STATUS OF THE ATKA MACKEREL RESOURCE
IN GULF OF ALASKA
by Vidar G. Wespestad*

INTRODUCTION

Atka mackerel, Pleurogrammus monopterygius, is a member of the greenling family (Hexagrammidae) which, until recent years, has been a largely unknown and unexploited species. In the early 1970's, the Soviet trawl fishery began to fish Atka mackerel and other lightly-exploited species when their principal target species, Pacific ocean perch, declined in abundance. Since its inception, the Atka mackerel fishery has been conducted predominantly by Soviet trawlers and small catches of this species have, since 1974, been taken by Polish and Japanese trawlers in the Gulf of Alaska.

The fisheries for Atka mackerel are centered south and west of Kodiak Island in the Chirikof and Kodiak areas (Figure 1). Atka mackerel are also taken in the eastern Bering Sea and in the Shumagin, Southeastern, and Yakutat areas of the Gulf of Alaska.

In the Gulf of Alaska, the Soviet catch rose from 7,282 mt in 1970 to 27,776 mt in 1975, then declined and stabilized around 19,000 mt (Table 1). The Soviet allocation of Atka mackerel in the Gulf of Alaska for 1978 was 21,570 mt and 22,600 mt in the Bering Sea.


MAXIMUM SUSTAINABLE YIELD

MSY in the Gulf of Alaska has been tentatively established to be 28,700 mt based on Soviet research. The Soviet assessment of MSY in the Gulf is based on results of 1979 trawl-hydroacoustic surveys which found the biomass to be 95,552 mt. Based on life history parameters, Soviet scientists believe that it is possible to harvest 30% of the biomass annually on a sustained basis.

EQUILIBRIUM YIELD

There is not sufficient data available to determine EY for Atka mackerel. U.S. observer data obtained from the Soviet Atka mackerel fisheries in the Gulf of Alaska, when that species was the obvious fishery target, do not show appreciable changes in the fisheries (Table 2). However, in 1978 catches increased in the Chirikof area and decreased in the Kodiak area. Insufficient data exists at this time to assess the significance, if any, of this shift in catch. Comparison of age frequency and length-at-age data for the Soviet fishery in 1974-76 and U.S. trawl surveys in 1978 in the Kodiak area indicate an increase in length-at-age from 1976 to 1978 (Table 3). This may indicate some decrease in biomass; however, it is inconclusive since 1978 values are similar to those found in 1974.

Data from U.S. trawl surveys indicate that Atka mackerel concentrate in dense localized concentrations, generally between 100-200 m, and that CPUE is more a function of density than abundance. Also, Atka mackerel concentrations appear to remain in the same area, since hauls containing Atka mackerel were taken from the same positions after intervals of 1 month and 1 year. If this is the true condition, it is possible that the biomass could be rapidly reduced without any change in population parameter estimates.
Since 1977, the Allowable Biological Catch (ABC) of Atka mackerel has been established at 24,800 mt, 75 percent of a previous unverified Soviet estimate of an MSY of 33,000 mt. For 1980, ABC is increased to the most recent estimate of MSY, 28,700 mt, since there are no indications that this cannot be sustained.
Table 1.—Reported catches of Atka mackerel in metric tons in the Gulf of Alaska by the USSR and Japan.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>USSR</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Shumagin</td>
<td>4,742</td>
<td>2,132</td>
<td>--</td>
<td>69</td>
<td>184</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Chirikof</td>
<td>2,748</td>
<td>743</td>
<td>--</td>
<td>2,056</td>
<td>17,320</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kodiak</td>
<td>10,041</td>
<td>23,688</td>
<td>19,721</td>
<td>17,120</td>
<td>883</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yakutat</td>
<td>0</td>
<td>1,213</td>
<td>311</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Southeastern</td>
<td>0</td>
<td>0</td>
<td>--</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>7,282</td>
<td>6,282</td>
<td>10,998</td>
<td>17,531</td>
<td>27,776</td>
<td>20,032</td>
<td>19,245</td>
<td>18,387</td>
<td></td>
</tr>
</tbody>
</table>

| **JAPAN**    |       |       |       |       |       |       |       |       |       |
| Shumagin     | 243   |       |       |       |       |       |       |       |       |
| Chirikof     | 265   |       |       |       |       |       |       |       |       |
| Kodiak       | 338   |       |       |       |       |       |       |       |       |
| Yakutat      | 125   |       |       |       |       |       |       |       |       |
| Southeastern | 165   |       |       |       |       |       |       |       |       |
| **TOTAL**    |       |       |       |       |       |       |       |       | 1,136 |

---

a/ Reported as western Gulf of Alaska
b/ Reported as eastern Gulf of Alaska
c/ Reported under "other species" category
Table 2.—Mean age, length, weight and CPUE of Atka mackerel in the Gulf of Alaska.

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Area</td>
<td>Kodiak</td>
<td>Kodiak</td>
<td>Kodiak</td>
<td>Kodiak</td>
<td>Chirikof</td>
</tr>
<tr>
<td>Mean age</td>
<td>1.01</td>
<td>2.08</td>
<td>2.03</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td>Mean length (cm)</td>
<td>27.0</td>
<td>28.0</td>
<td>29.8</td>
<td>30.5</td>
<td>35.1</td>
</tr>
<tr>
<td>Mean weight (kg)</td>
<td>0.25</td>
<td>0.27</td>
<td>0.31</td>
<td>0.33</td>
<td>0.34</td>
</tr>
<tr>
<td>Sample size</td>
<td>1,240</td>
<td>1,055</td>
<td>948</td>
<td>695</td>
<td>155</td>
</tr>
</tbody>
</table>
Table 3.—Age frequency and length-at-age of Atka mackerel in the Kodiak area.

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>N</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Age frequency in percent</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>95</td>
<td>2</td>
<td>7</td>
<td></td>
<td></td>
<td></td>
<td>1,240</td>
</tr>
<tr>
<td>1975</td>
<td>--</td>
<td>91</td>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td>1,055</td>
</tr>
<tr>
<td>1976</td>
<td>T</td>
<td>72</td>
<td>23</td>
<td>3</td>
<td></td>
<td></td>
<td>948</td>
</tr>
<tr>
<td>1978&lt;sup&gt;a&lt;/sup&gt;</td>
<td>T</td>
<td>72</td>
<td>22</td>
<td>4</td>
<td>1</td>
<td>1</td>
<td>675</td>
</tr>
</tbody>
</table>

| B. Length-at-age in cm |   |   |   |   |   |   |    |
| 1974  | 27| 32| 35|   |   |   |    |
| 1975  | 28| 31|   |   |   |   |    |
| 1976  | 22| 30| 30|31|   |   |    |
| 1978<sup>a</sup> | 23| 31| 33|34|34|36|    |

<sup>a</sup> Data from U.S. trawl surveys, other years from data collected by U.S. observers aboard Soviet fishing vessels.

T = Trace amounts of less than 1%
Fig. 1.—Location of Atka mackerel fisheries in the northeastern Pacific Ocean.