
Akira Nishimura
National Research Institute of Far Seas Fisheries

1991 October
Fisheries Agency of Japan

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Akira Nishimura
National Research Institute of Far Seas Fisheries

ABSTRACT

The Japanese midwater trawl fisheries targeting on pollock in the international waters of the Bering Sea have been operating at full scale since 1986. The number of fishing vessels authorized to operate in these waters in 1990 was 104; this was a reduction by 6 from 110 in 1986. Most fishing vessels were small boats of less than 500 G.T. and their percentage of the total number of vessel operating in these waters increased from 66% in 1986 to 77% in 1990.

Fishing effort (towing hours) has been increasing since 1986, and fishing effort in 1990 has increased by 66% since 1986. In conjunction with the increase of fishing effort, the catch increased from 698,000 tons in 1986 to 804,000 tons in 1987. However, the catch in 1988 decreased to 750,000 tons despite the increase of fishing effort, and in 1989 the catch decreased to 655,000 tons, and in 1990 catch decreased further to 417,000 tons. Consequently, CPUE declined from 8.58 tons/hours in 1986 to 3.08 tons/hours in 1990. Although there are several problems in the interpretation of CPUE, it has been decided that the drastic decreases of catch and CPUE indicate that the abundance of pollock stocks in the Aleutian Basin including the international waters of the Bering Sea has declined significantly.

The primary fishing seasons were January-February and November-December in 1986 and 1987, however, the catch in January-February has decreased markedly since 1988. In 1988, the catch in October-November increased considerably, and in 1989 the catch in April and November-December was greater than in other months. In 1990, the catch in April was greatest, but the catch in November-December decreased dramatically. Fishing grounds with high CPUE were generally located at the western end of the international waters of the Bering Sea in September or October and extended eastward mainly in the southern part of the international waters, but fishing grounds with high CPUE were rare in February and March. High CPUE's temporarily appeared in April on fishing grounds in a comparatively wide area and have been recorded regularly in the eastern part of the international waters since 1988. Although the basic pattern has not changed since 1989, the area of fishing grounds with high CPUE has become noticeably smaller.

There has been little change in length composition of the catch by Japanese trawler's since it was reported in 1987, and the mode was at 48-50 cm each year. The mean body length was 49.1 cm in 1987, 49.6 cm in 1988, 48.3 cm in 1989, and 49.3 cm in 1990.
1. Introduction

The Japanese midwater trawl fishery targeting on pelagic and midwater pollock in the Aleutian Basin was started by a limited number of fishing vessels about 1980. Initially, most of the catch came from the Aleutian Basin of the U.S. 200 mile zone, and catch from the international waters of the Bering Sea was very small. The catch of pollock in the international waters of the Bering Sea increased sharply following drastic reductions in the catch quotas in the U.S. and the U.S.S.R. zones. Notably, 1986 saw a dramatic increase in catch over the previous years to approximately 700,000 tons. This paper is intended to present a summary of the pollock fishery by Japanese fishing boats in the international waters of the Bering Sea since 1986.

1. Type of Fishery and the Number of Fishing Boats

Three types of trawl fisheries are now authorized for Japanese fishing boats in the international waters of the Bering Sea: North Pacific Trawl Fishery, Tenkan Trawl Fishery and Landbased dragnet Trawl Fishery. These three types of operations have been created out of the process of fisheries regulations in Japan, and have different terms and limitations for authorization. However, no substantial difference exists among them when they are considered from the viewpoint of the pollock fishery in the international waters of the Bering Sea.

As shown in the Table below, the number of vessels authorized to operate in this fishery in 1986 and 1987 was 110; 40 North Pacific trawl vessels, 16 Tenkan trawl vessels and 54 landbased dragnet trawl vessels. In 1988, however, North Pacific trawl vessels were reduced by one to 39, and Tenkan trawl vessels were reduced by 2 to 14. In 1989, North Pacific trawl vessels were reduced further by 2 to 37 and the total number of authorized vessels was 105. In 1990, Tenkan trawl vessels were reduced by one and the total number of authorized vessels in that year was 104. All fishing vessels authorized to operate do not always participate in the fishery, and the number of vessels actually engaged in this operation is shown in the parenthesis in the Table.

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<tbody>
<tr>
<td>North Pacific trawl fishery</td>
<td>40 (28)</td>
<td>40 (34)</td>
<td>39 (36)</td>
<td>37 (31)</td>
<td>37 (31)</td>
</tr>
<tr>
<td>Tenkan trawl fishery</td>
<td>16 (11)</td>
<td>16 (12)</td>
<td>14 (13)</td>
<td>14 (13)</td>
<td>13 (12)</td>
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<tr>
<td>Landbased dragnet trawl fishery</td>
<td>54 (54)</td>
<td>54 (54)</td>
<td>54 (54)</td>
<td>54 (54)</td>
<td>54 (53)</td>
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Although only one vessel is authorized to operate under the same license number, it is possible for another vessel to take over the license during the fishing season to meet the needs of the fishing companies.
Therefore, the number of vessels actually engaged in fishing may exceed that of the licensed vessels when more than one vessel which operated under the same license number is counted as an operating vessel. The figures used in this Table assume that only one vessel operated under each license.

There are some small vessels, about 280 GT, among North Pacific trawl vessels but about one half of the vessels are large, 2,500 GT or over (Table 1). Tenkan trawl vessels consist of fishing vessels ranging from 380 GT to 550 GT and all of the landbased dragnet trawl vessels are small, 350 GT or less. That is, most fishing vessels are small boats of less than 500 GT and their percentage to total number increased from 66% in 1986 to 77% in 1990.

2. Fishing Effort and Catch
   1) Fishing Effort

As shown in the Table below, the vessel days of the Japanese trawl vessels in the international waters of the Bering Sea showed a gradual increase from 7,265 days in 1986 to 9,061 days in 1988. However, 1989 showed a 12% decline from the previous year to 7,943 days, and in 1990, increased again to 9,700 days. Overall fishing effort increased from 81,311 hours in 1986 to 95,375 hours in 1987 and further increased in 1988 to 109,742 hours. Fishing effort in 1989 was 108,813 hours which was almost the same as in the previous year. The effort in 1990 totalled 135,368 hours which was an increase of 66% from that in 1986.

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<tr>
<th>Year</th>
<th>Vessel days</th>
<th>Fishing effort, hours</th>
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<tbody>
<tr>
<td>1986</td>
<td>7,265</td>
<td>81,911</td>
</tr>
<tr>
<td>1987</td>
<td>8,449</td>
<td>95,375</td>
</tr>
<tr>
<td>1988</td>
<td>9,061</td>
<td>109,742</td>
</tr>
<tr>
<td>1989</td>
<td>7,943</td>
<td>108,813</td>
</tr>
<tr>
<td>1990</td>
<td>9,700</td>
<td>135,368</td>
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The monthly changes in effort have shown similar trends for each year since 1986; much effort was spent in January-February and November-December, whereas effort in June-September was at a very low level (Table 2, Fig. 1). However, more effort was spent in February-March in 1986 and 1987, but effort has decreased since 1988. Effort in November-December increased remarkably year by year and in 1989 was 3.4 times greater than that in 1986. However, effort in 1990 in November-December decreased by 23% from the previous year. In addition, the effort spent in January, April, May, and October in 1990 was the greatest ever recorded. The increase of effort in April was particularly obvious.
2) Catch

The catch of pollock, as shown in the following table, reached 698,000 tons in 1986 and rose to a record of 804,000 tons in 1987, but fell to 750,000 tons in 1988, 655,000 tons in 1989, and 417,000 tons in 1990.

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<tr>
<td>Catch (t)</td>
<td>697,975</td>
<td>803,550</td>
<td>749,982</td>
<td>654,907</td>
<td>417,049</td>
</tr>
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In terms of monthly change (Table 2, Fig. 1), catches in January, February and December accounted for 71.4% of the total annual catch in 1986. The catches peaked in January, declined until March and, after a slight recovery in April, dropped sharply in the summer during June to August. Large catches started in September and increased rapidly in November and December. The year 1987 also showed a similar trend, but due to a 146% increase in November catch over the same period of the previous year, the catch in January, February, November and December combined accounted for 77.7% of the total annual catch. Further, the catch in October also grew 185% from a year earlier. The increasing catch in autumn, observed in 1987, became more conspicuous in 1988, with the catch in October-December rising 34% from the corresponding period of the preceding year, and accounting for 67.2% of the total annual catch. Conversely, the catch in January-February dropped 63% from the same period of the previous year. Although the trend in 1989 was almost the same as in 1988, the catch for the three months from October to December decreased by 26% from the previous year, and as a percentage of the total annual catch also decreased to 57%. In contrast, the catch in April-May 1989 dramatically increased from the same period of the preceding year, particularly in April when catch increased 59% from a year earlier to 87,000 tons. In 1990, the catch in October-December decreased by 66% from the previous year, and a dramatic decrease was seen in the catch in November-December. On the other hand, the catch in April was recorded to be 119,000 tons, the greatest for that month in the past, much greater than in other months in 1990.

3. CPUE

The pollock fishery in the international waters of the Bering Sea is a relatively new type of operation using midwater trawl nets which previously had not been well known to Japanese trawl fisherman. With catch increases, the development of the midwater trawl nets entered a full scale phase about 1984. Fishing efficiency is deemed to have improved each year because midwater trawl nets with new specifications were developed year after year and fishing vessels competed in replacing the conventional nets with new ones. The differences in catch efficiencies widened because net specifications differed accordingly to vessel size and engine power and human capability differed even when nets with the same specifications were used. It seems
virtually impossible to correct for these differences and standardize the fishing efficiency. Therefore, it is inappropriate to use nominal CPUE (catch per hour towed) as an accurate index of stock abundance, but it can be used as an approximate index to determine increasing or decreasing trends of the abundance of fish.

As shown in the table below, CPUE in 1986 had reached 8.58 tons/hour. Although the CPUE in 1987 remained at almost the same level as in the previous year, in 1988 it fell 19% to 6.83 tons/hour, and that in 1989 decreased further to 6.02 tons/hour. CPUE in 1990 decreased by 49% from the previous year to 3.08 tons/hour and in comparison with that in 1986, had declined by 64%.

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<tr>
<td>CPUE (t/hour)</td>
<td>8.58</td>
<td>8.43</td>
<td>6.83</td>
<td>6.02</td>
<td>3.08</td>
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</table>

It is not believed that pollock make the same migration pattern every year and there might be considerable annual differences as regards migration period and routes and also CPUE is largely affected by the ecological properties of fish schooling on the fishing grounds etc. In any case, it is not possible to determine precisely the change in abundance of pollock stocks in the entire area of the Aleutian Basin based only on the data obtained from the international waters of the Bering Sea. Since it is considered that the catching efficiency of the fishing vessels has improved year by year due to accumulation of experience of fishermen and improvement of fishing nets, the decline in CPUE suggests that the size of the migrating stock of pollock in the international waters of the Bering Sea has decreased considerably.

The monthly changes in CPUE more or less coincide with monthly changes in catch amount, and months with large catches showed a higher CPUE (Table 2, Fig. 1). However, the change in CPUE in 1989 was quite different from that in the previous three years: the CPUE was high in April-June and was particularly high in April and no sharp increase in CPUE was observed after September. The CPUE in 1990 was highest in April when the catch was greatest, and second highest record in September, and thereafter decreased until December.

4. CPUE on the Fishing Grounds

CPUE was plotted by statistical fishing blocks of 30 minutes of latitude and one degree of longitude in order to examine the distribution of fishing grounds for pollock in the international waters of the Bering Sea (Fig. 2). As mentioned earlier, CPUE -- catch per one hour towed -- does not correct for changes in fishing efficiencies between vessels and years. Therefore, while it can not be said to represent accurately the relative
abundance between fishing blocks, there should be no problem in using CPUE as an approximate index of abundance by fishing ground.

The monthly distribution of CPUE in the period from 1986 to 1988 showed a similar tendency on the whole, and a concentration of high CPUE was observed in the western or southwestern part of the international waters. Differences from year to year were observed when examined more closely, with 1986 showing high CPUE also in the northeastern part of the international waters. Further, high CPUE was observed slightly north of the western part of the international waters in 1988. The CPUE distribution in 1989 was very different from that in the previous three years: high CPUE appeared in the eastern part of the international waters and CPUE was particularly high in the northeastern part of the international waters close to the continental shelf of the eastern Bering Sea. In 1990, the high CPUE on fishing grounds of 20 tons/hour and over which appeared in many fishing blocks in the past only appeared in one block in the northwestern part of international waters of the Bering Sea, and CPUE was generally low. Fishing blocks with relatively high CPUE of 6 tons/hour appeared in a narrow area in the northwestern and southeastern parts of the international waters of the Bering Sea.

In terms of monthly change, high CPUE was apparent in the western part of international waters in September or October and in a wider area of international waters in December until 1988, but in 1989, the fishing grounds became smaller. In 1990, although fishing grounds were formed on the western side of international waters of the Bering Sea in September, no fishing grounds had high CPUE in and after October. High CPUE was apparent in the southern part of international waters in January and February in 1986 and 1987, but in January 1988, high CPUE was observed only in a limited area of the western part and had disappeared in February. This tendency became more marked from 1989 to 1990. The high CPUE distribution in April, when the catch recovered slightly each year, was widespread. No characteristic pattern was observed in April 1986 and 1987, but high CPUE areas have been concentrated in the eastern part of international waters since 1988.

5. Length Composition

Little or no data on length composition of the catch from fishing vessels were available in 1986. The length compositions of pollock caught by the Japanese fishing vessels which operated in the international waters of the Bering Sea since 1987 were more or less the same: the mode for the four years was 48-50 cm. The mean length was 49.1 cm in 1987, 49.6 cm in 1988, 48.3 cm in 1989, and 49.3 cm in 1990.

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Tables 1 and 2 and Figs. 1 to 3 are in English in the Japanese document.