Report on Japan-U.S.S.R. Joint Longline Survey
by the Koei maru No. 10 in 1990

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National Research Institute of Far Seas Fisheries

1991 October
Fisheries Agency of Japan

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:
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ABSTRACT

From June to August, 1990, Japan conducted a survey on groundfish stocks using on-bottom longline gear jointly with the U.S.S.R., within the U.S.S.R. 200-mile zone of the Gulf of Anadeyrskiy, Navarin and Olyutorskiy areas, with the purpose of obtaining information on the distribution, abundance, and size composition, etc. of groundfishes, especially Pacific cod. This third joint survey was a continuation of the Japan-U.S.S.R. longline survey which was conducted in Navarin and Olyutorskiy areas during January to February in 1989, which was a continuation of the Japan-U.S.S.R. longline survey which was conducted in Anadeyrskiy-Navarin, west Kamchatka, and Sakhalin areas during October to November in 1989.

Although the survey was conducted at depths of 50 m to 800 m, most of the research effort was expended at depths of 200 m and shallower. Pacific cod was dominant throughout the research area, but pollock was abundant in Gulf of Anadeyrskiy and Navarin area. In addition, halibut was comparatively abundant in waters of Navarin and Olyutorskiy areas. The abundance of other commercial species was extremely low, compared with the abundance of these species in the U.S. 200 miles zone.

By area and depth zone, the stock abundance of Pacific cod at depths between 50 m and 100 m was highest (12.4 fish in 44.8 kg/hachi) in the Olyutorskiy area, and was lowest (4.4 fish; 19.3 kg/hachi) in the Gulf of Anadeyrskiy. In the Navarin area, the abundance of Pacific cod was 11.3 fish (43.4 kg/hachi). At depths between 100 m and 200 m, the stock abundance of Pacific cod was 14.3 fish; (65.5 kg) /hachi in the Olyutorskiy area, and 12.2 fish (52.8 kg) /hachi in the Navarin area. These abundance levels were almost the same as those in the same depth zone in the eastern Bering Sea in the U.S. waters.

The length of Pacific cod caught during the summer survey in 1990 ranged from 32 cm to 108 cm in the whole research area, mode was between 68 cm and 70 cm, the mean length was 68.1 cm and mean weight was 4.22 kg. These features were almost the same as those of Pacific cod in the eastern Bering Sea obtained from the Japan-U.S. Joint Longline Survey which was conducted during the summer in 1990. However, the length composition of Pacific cod varied significantly in both areas. In the length composition of Pacific cod in the northwestern Bering Sea, a small-sized fish group which had a mode between 52 cm and 54 cm was observed, and it indicated that the abundance of the recruit year-class of 1990 was high. A total of 818 Pacific cod was tagged and released in order to study the movement, migration, growth, and structure of stock of Pacific cod.
Introduction

The Fisheries Agency of Japan conducted the first joint survey with the U.S.S.R. on groundfish stocks using on-bottom longline gear on board the Fukuyoshi maru No. 26 within the U.S.S.R. 200-mile waters of the northwestern Bering Sea during January to February 1989. Much important information on the distribution and abundance, etc. of groundfishes during the winter season was obtained from the survey (Sasaki and Fujii, 1989). The meeting of Japanese and U.S.S.R. scientists on the survey was held at the Pacific Research Institute of Fisheries and Oceanography in Vladivostok in July 1990, and they agreed that it is important to continue the surveys from now on. As a continuation of the first research survey, the second survey was conducted in Anadyrskiy-Navarin, west Kamchatka, and north-east Sakhalin area during October to November, 1989 (Sasaki, 1990), and to evaluate the results obtained, a meeting of Japanese and U.S.S.R. scientists was held at the Far Seas Fishery Research Laboratory in Shimizu City in July 1990. The survey was conducted as the third Japan-U.S.S.R. joint survey in Navarin-Olyutorskiy areas and the Gulf of Anadyrskiy area in which Pacific cod stocks are recognized to be the most abundant among the areas surveyed in the past. Because results obtained in the past showed that the abundance of important species was extremely low on the continental slope in depths of 400 m and deeper of the north-western Bering Sea, the survey was mainly conducted on the continental shelf in depths of 200 m and shallower. The meeting of Japanese and U.S.S.R. scientists on the results obtained from the survey was held in Tokyo in December 1990, and an assessment of the Pacific cod stock was made as well as consideration of the results of the survey.

The Japanese organizations which participated twice in the surveys were the Fisheries Agency of Japan for the first survey and the non-governmental North Pacific Longline-Gillnet Association for the second survey. However, since the operation of both surveys was conducted on the basis of agreement in the Japan-U.S.S.R. Fisheries Commission, the National Research Institute of Far Seas Fisheries provided guidance for the survey and analysis of data. Although the agreement in the Japan-U.S.S.R. Fisheries Commission effected the operations of these two surveys, at the meeting of Japanese and U.S.S.R. scientists on the joint longline survey, which was held at the National Research Institute of Far Seas Fisheries in Shimizu in July 1990, it was decided that the Japanese organization which conducted the survey would be non-governmental, the survey itself will be continued this way from now on, and the National Research Institute of Far Seas Fisheries will continue to provide guidance for the survey and analysis of data. Because the operational body of the Japanese side was non-governmental since the second survey, the experimental fishing operation was mainly conducted at each station due to economic reasons, and the detailed scientific surveys similar to the previous survey only were conducted occasionally. Although there were such restrictions, the data obtained was determined to be sufficiently effective to evaluate the conditions of groundfish stocks in the U.S.S.R. areas. In particular, in this survey, extremely detailed data were collected, because the researchers and all crew members of the research vessel understood fully the purpose of the survey and accomplished their role.

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In advance of submission of the report, I would like to pay my respects to the concerned organization of Japan and the U.S.S.R. and the scientists on board who directed their efforts and conducted the survey and also to the crew of the *Koei maru No. 10* who had charge of the operation of the research vessel and participated in the research activities.

I. Objectives of Research

The objectives of this research were to conduct a survey using on-bottom longlines for groundfish on the continental shelf and continental slope in the areas of Olyutorskiy and Navarin and the Gulf of Anadeyrskiy area within the U.S.S.R. 200-mile zone, and collect information on the distribution, abundance and length composition, etc. of groundfish, especially Pacific cod, in order to use them as the basic data to assess stock conditions. In addition, the tagging of Pacific cod is conducted to study the movement, migration, growth and structure of Pacific cod stock.

II. Specification of the Research Vessel

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<tr>
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<th>Koei maru No. 10</th>
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<tr>
<td>Registration No.</td>
<td>NG1-1480</td>
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<tr>
<td>Owner</td>
<td>Marue Co., Ltd.</td>
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<tr>
<td>2-12-16, Minato,</td>
<td></td>
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<tr>
<td>Miyagi Prefecture</td>
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III. On Board Researchers and Crew

<table>
<thead>
<tr>
<th>Japanese researcher</th>
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<td>V.L. Kostarev</td>
</tr>
<tr>
<td></td>
<td>(Pacific Research Institute of</td>
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<tr>
<td></td>
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<td>A.I. Polutov</td>
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<td>V.I. Toloknev (Interpreter)</td>
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<td>Fishing Master</td>
</tr>
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<td>Masao Suda</td>
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<td></td>
<td>Captain</td>
</tr>
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<td></td>
<td>Hideo Takahashi</td>
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IV. Area of Survey, Period of Survey, and Activities of Research Vessel

The survey was conducted in the northwestern Bering Sea (Olyutorskiy and Navarin areas and Gulf of Anadeyrskiy within the U.S.S.R. 200-miles zone (Fig. 1). The number of stations was 55 in total, and by area, 8 stations in the Olyutorskiy area, 25 in the Navarin area, and 22 in the Gulf of Anadeyrskiy (Fig. 1).

The survey was conducted for 84 days from June 11 to September 2, but the number of days when actual operations were conducted was only 72 days, as shown in Table 1. The research vessel departed from Shiogama on June 11 and arrived off the Cape Olyutorskiy on June 16. After the survey was conducted in the Olyutorskiy area from June 17 to 24, the survey was conducted in the Navarin area from June 25 to July 24. The survey was conducted in the Gulf of Anadeyrskiy from July 25 and research activities were completed on August 12. After that, only experimental fishing operations were conducted in the Navarin and Olyutorskiy areas from August 13 to 27, and the vessel returned to the port of Shiogama on September 2.

V. Method of Research

The research conducted at this time, as well as two Japan-U.S.S.R. joint longline surveys in the past, was also designed to be directly comparable to the results obtained from the Japan-U.S. joint longline survey which had been conducted within the U.S. 200-mile zone of the eastern Bering Sea since 1982. The method used for the research was basically the same as the method which has been established by the Japan-U.S. joint longline survey (Sasaki, 1985; Sasaki and Yano, 1990). However, because of the cost of the cruise, the operations at each station used 400 hachi, which is the commercial operation scale, and of those, 100 hachi of longline gear was used for research as it had been for the longline survey in the past, and the remaining 300 hachi, longline of other structure was used for a fishing experiment. However, even in the gear for the experimental fishing operation, we collected the detailed data from 100 hachi on 150 hachi.

The structure of the one hachi of on-bottom longline used for the research was as follows: the on-bottom longline, with 45 branch lines (1.2 m in length) were attached to the main line of 100 m and a hook was tied to the tip of each branch line. The interval between branch lines was 2.0 m. Cod hook of No. 18 point was used as a hook, and squid which was cut in round slices or in long narrow rectangular pieces was used as bait. Two hours after setting, hauling of the research longline was begun from the setting location. In addition, the structure of the hachi of on-bottom longline used for the experimental fishing operation was as follows: on the average, 38 hooks were attached to the main line of 75 m, and the interval between branch lines was 1.5 m.

For the 100 hachi of longline used for research, all catches obtained by every hachi were recorded by species or species group at the side of the vessel and after they were landed on the vessel, they were further
sorted by species and the number caught and the weight was measured. At that time, we also recorded by species and number the fish which we could not take aboard the vessel, because they had come off the hooks and dropped into the sea. After that, the lengths of all major species were measured. The length measurements were made for 7 species: Pacific cod, pollock, halibut, sablefish, arrowtooth flounder, Greenland turbot and rougheye rockfish. Body position of measurement was the same for all species, but for Pacific cod and halibut, it is equivalent to total length and for other species, it is equivalent to fork length. Because of the few fish caught, all fish, other than Pacific cod and pollock were generally measured. For Pacific cod, we were supposed to sample randomly 200 fish by station and by depth, and then the length measurements were expected to be made by dividing into male and female, but because the advance arrangement was inconclusive, 100 fish each of male and female were sampled. Therefore, the number of male and female, which was shown in Table of length composition did not show the sex ratio of population and when the sex ratio was not 1:1, it is necessary to attend to that the length composition with combined male and female is somewhat different from the actual composition of the population. In addition, for pollock, the maximum 100 fish were measured at each station.

The depth of the catch was obtained from the fish finder by measuring the depth of seabottom at every five hachi haulings. Thus, the depth of the catch recorded was somewhat different than the depth at which the longlines were actually set.

For tagging of Pacific cod, we held the Pacific cod caught from the depths of 150 m and shallower into a tank, selected the fish which were determined to be most viable, and recorded the number of the tag and fish length, attached Anchor-type tags to the fresh part of bases of the first dorsal fin and released the fish.

VI. Results of Research

Although we collected data from all research longlines of 100 hachi and some data from the experimental fishing longlines of 300 hachi, we are only reporting analytical results on the data obtained from the research longline.

1. Analytical Methods of Collecting Data

The survey area was divided into three geographical sub-areas in order to analyze the data obtained. The sub-areas were Olyutorskiy, Navarin, and the Gulf of Anadeyrskiy. The Olyutorskiy sub-area included the operation numbers from L-1 to L-8, the Navarin sub-area included the operation numbers from L-9 to L-33, and the Gulf of Anadeyrskiy sub-area included the operation numbers from L-34 to L-55 (Fig. 1).

The analysis of catch in the three sub-areas, as shown in Fig. 1, was conducted by dividing the depth zone into 100 m units. The average number and average weight per hachi of the major species was calculated by depth zone
on the basis of the fishing data. The average number and the average weight by each depth zone was not obtained by dividing the total number or total weight by the total number of hachi which were cast, but they were obtained as the average value in the depth zone at each station.

During the on-bottom longline surveys, incidents occurred such as catching the net on a rock or cutting the net in the rough bottom areas. In these cases, hooks and bait frequently disappeared and accordingly the catch was lost, so it was necessary to omit them as ineffective effort in the analysis of data. In the research conducted this time, as there were almost nil ineffective effort which was caused from catching on a rock and cutting on the rough bottom areas. We dealt with all numbers of hachi of the research longlines as no ineffective effort. In addition, in the first Japan-U.S.S.R. joint longline survey conducted by the *Fukuyschi maru No. 26* in Navarin-Olyutorskiy areas from January to February in 1989, at some of the survey stations large-sized sea anemones attached to small gravel on the sea bottom swallowed the hook with bait (squid) into their mouths, the phenomenon was observed frequently (50 to 60% of the maximum numbers of hook per hachi). As the sea anemones which swallowed squid were attached to the hooks and hauled on the vessel with small gravel, these hooks were regarded as ineffective effort for fishing of groundfish (Sasaki and Fujii 1989). In the survey conducted this time, swallowing of bait by starfish as well as sea anemones was also observed in wide areas of the survey stations between L-3 and L-15. Although the numbers of individuals caught and the average numbers of individuals caught per hachi by sea anemones and starfish were shown in Table 2 by station and by depth zone, the catches were particularly abundant in L-7 in Olyutorskiy area and L-12 in Navarin area. Therefore, in those survey stations, abundance of Pacific cod was regarded as an underestimate, however, as the levels of underestimate in the sub-areas L-7 and L-12 which were considered to be affected most severely was 12% and 15%, respectively and was ascertained that these phenomena would not have a great effect on the average abundance by station and by depth, in the analysis of the results of the survey conducted at this time, no correction of effort for those causes was made.

2. Outline of Operation and Catch

Table 3 shows the records of operation of the longline surveys, and Table 4 shows outline of the catches (in number and weight) by area and by principal species. In addition, Tables 5 and 6 show details of the catch (in number and weight) by station and species. In the Japan-U.S. longline survey, the time of casting of longline gear was the same for all stations, however, in the Japan-U.S.S.R. survey, the time of setting the longline gear varied at each station, because the research activities were conducted with commercial scale experimental fishing operations. Although the depth range surveyed was from 50 m to 800 m, all stations were in depths of 100 m and shallower in the Gulf of Anadeyrskiy, and most of the survey effort was expended in depths of 100 m to 200 m in the Olyutorskiy and Navarin areas (Table 3).
The total catch (in number) of fishes, crabs and octopuses caught during the survey was 75,909 individuals. Of those, 12,556 individuals were caught in Olyutorskiy, 47,065 were caught in the Navarin area, and 16,288 were caught in the Gulf of Anadeyrskiy area (Tables 4 and 5). By species, Pacific cod was dominant in all areas, and a total of 50,293 individuals was caught, and the percentage of Pacific cod was highest (82%) in the Olyutorskiy area and was lowest (60%) in the Gulf of Anadeyrskiy area, and followed by pollock and 15,930 individuals were caught. By area, the proportion of pollock in the total catch was in contrast with Pacific cod, and the percentage of pollock was highest (34%) in the Gulf of Anadeyrskiy area and was lowest (6%) in the Olyutorskiy area. For other important species, it was noticed that 1,510 halibut were caught. Most of the halibut were caught in the Olyutorskiy and Navarin areas.

On the other hand, the total catch (in weight) was 282.0 t, and of this, 48.2 t were caught in the Olyutorskiy area, and 177.0 t in the Navarin area, and 56.7 t in the Gulf of Anadeyrskiy area, respectively (Tables 4 and 6). The catch by species was Pacific cod 212.4 t, and pollock 25.8 t, and those two species accounted for 84.5% of the total catch (in weight). By area, 128.7 t of Pacific cod were caught in the Navarin area, and 41.3 t and 42.4 t were caught in the Olyutorskiy area and the Gulf of Anadeyrskiy area, respectively. For pollock, 13.1 t were caught in the Gulf of Anadeyrskiy, and only 1.1 t were caught in Olyutorskiy area. The total catch (in weight) of halibut was 9.6 t, of those, 3.3 t and 5.7 t was caught in the Olyutorskiy and Navarin areas, respectively, and only 0.5 t were caught in the Gulf of Anadeyrskiy.

3. The Distribution and Abundance of Major Species

Table 7 and Figs. 2 to 4 show the mean catch rate (in weight) per hachi of Pacific cod, pollock, and halibut by survey station to show the geographical distribution. Table 8 shows the fishing effort (number of hachi fished effectively) by area and by depth zone of Pacific cod, pollock, sablefish, halibut, Arrowtooth flounder, Greenland turbot, rougheye rockfish and giant grenadier, and Table 9 compares the average catch rate of Pacific cod (in number and in weight) per hachi by area and by depth zone and the results obtained from the Japan-U.S. joint longline survey conducted in the eastern Bering Sea in 1988. In addition, Table 10 shows the average catch rate (in number) per hachi of pollock, sablefish, halibut, Arrowtooth flounder, Greenland turbot, rougheye rockfish, and giant grenadier by area and by depth zone.

Although I reported the following results by species, as stated before, because the catch (in number) of species other than Pacific cod, pollock, and halibut, was scarce or their economic value was low, so just the catch data were described in Tables 8 and 10.

(a) Pacific cod

From the observation of geographical distribution of the mean catch
(in weight) per hachi by station, the abundance of Pacific cod in the northwestern Bering Sea during the summer in 1990 was greatest (over 100 kg) in the offshore stations from the south of Cape Navarin to the west side of Cape Rubikon (Table 7 and Fig. 2). In the southeast of Cape Navarin to the west side of the Gulf of Anadyrskiy, the abundance was not so high (20 kg to 50 kg), but along the eastern coast in the Gulf of Anadyrskiy looking out to the Chukotskiy Peninsula, the distribution of high abundance of 50 to 100 kg was observed. In the coastal area adjacent to the innermost part of the Gulf of Anadyrskiy, no Pacific cod were observed, nor were there any Pacific cod in the areas extending from the mouth of the Gulf of Anadyrskiy to the southeastern part of the Gulf adjacent to the U.S. and U.S.S.R. border line. However, the distribution of high abundance of 50 kg to 100 kg was also observed off Cape Olyutorskiy. On the other hand, for the abundance (the average catch rate (in number and weight) per hachi) of Pacific cod by area and by depth zone, at depths of 100 m and shallower, it was greatest (12.43 fish and 44.8 kg) in the Olyutorskiy area, and was smallest (4.41 fish and 19.3 kg) in the Gulf of Anadyrskiy (Table 9). The abundance in the Navarin area was 11.33 fish (43.4 kg) and was slightly smaller than that in Olyutorskiy. At depths of 100 m to 200 m, the abundance in the Olyutorskiy area was 14.34 fish (65.5 kg) which was slightly greater than 12.22 fish (52.8 kg) in the Navarin area, however, at depths of 200 m to 300 m, the abundance of Pacific cod in the Navarin area was extremely high (22.35 fish and 96.8 kg), while the abundance in the Olyutorskiy area was 12.78 fish and 48.7 kg. At depths of 300 m and deeper, only data on the abundance of Pacific cod in the Navarin area was available, but the comparatively high abundance of 13.41 fish and 53.4 kg was observed in depths of 300 m to 400 m. However, the high abundance which was observed at depths of 200 m to 300 m and 300 m to 400 m in the Navarin area was not fully representative of the average abundance throughout those depth zones, because the survey effort in those depth zones was extremely low, compared with that in depths of 100 m to 200 m (Table 8). The abundance of Pacific cod in the Navarin area decreased to 0.18 fish and 0.8 kg at depths of 400 m to 500 m, and no distribution was observed at depths of 500 m and deeper.

Although there are some problems in comparing directly the results of the survey in 1990 with the results of the survey which was conducted by the *Ebisu maru No. 88* in 1989, because the period of the survey was different and the numbers and location of the survey stations was different; if we compare for reference, the abundance of Pacific cod within the Gulf of Anadyrskiy was 6.75 fish (25.7 kg) per hachi in 1989 (Sasaki 1990), while the abundance in 1990 was 4.41 fish (19.3 kg) per hachi in 1990 which had decreased from the previous year. However, in the survey which was conducted within the Gulf of Anadyrskiy in 1990, as the numbers of survey stations were increased extensively, from the previous year with the object of covering throughout the Gulf, no Pacific cod was observed at eight stations (Table 7 and Fig. 2). Except for these stations, the average abundance of Pacific cod within the Gulf of Anadyrskiy in 1990 was 6.93 fish (30.3 kg) per hachi, the catch (in number) was almost the same with that in the previous year and the catch (in weight) was increased by 18% from the previous year. At depths of 3647--9
100 m to 200 m in the Navarin area, the abundance of Pacific cod was 7.88 fish (41.1 kg) in 1989 while the abundance was 12.22 fish (52.8 kg) per hachi in 1990, the catch (in number) was increased by 55% and the catch (in weight) was increased by 29%.

In addition, according to the results of the Japan-U.S. joint longline survey which was conducted in the eastern Bering Sea during the summer in 1988 (Sasaki and Yano, 1990), the abundance of Pacific cod at depths of 100 m to 200 m varied by area, and the catch (in number) ranged from 13.25 fish/hachi to 14.40 fish/hachi and the catch (in weight) ranged from 42.9 kg/hachi to 57.2 kg/hachi (Table 9). Although the year was different, the abundance of Pacific cod at depths of 100 m to 200 m in the Olyutorskiy and Navarin areas in 1990 was 14.34 fish (65.5 kg/hachi) and 12.22 fish (52.8 kg/hachi) (Table 9), and the abundance of the Pacific cod stock in the northwestern Bering Sea was estimated to be almost the same level as that in the eastern Bering Sea.

(b) Pollock

The geographical distribution of abundance (the mean catch rate (in weight) /hachi by station) of pollock was high in the coastal areas along Chukotskiy Peninsula which is located in the eastern part inside the Gulf of Anadeyrskiy and in offshore area of Cape Navarin, and was low in areas from Cape Olyutorskiy to the west side of Cape Navarin and from the southeastern Gulf of Anadeyrskiy to the area adjacent to the U.S. and U.S.S.R. border line (Table 7 and Fig. 3).

The abundance (the mean catch in number/hachi) by area and by depth zone was highest (2.49 fish) in the Gulf of Anadeyrskiy and was lowest (0.85 fish) in the Olyutorskiy area at depths of 100 m and shallower (Table 10). In the Navarin area which is sandwiched in between these areas, the abundance was 1.79 fish. At depths of 100 m to 200 m, the abundance of pollock was highest (5.34 fish) in the Navarin area and was 0.79 fish in the Olyutorskiy area. In contrast with this, at depths of 200 m to 300 m, the abundance of pollock in the Olyutorskiy area was 1.95 fish which was higher than the 0.29 fish in the Navarin area. Pollock were not caught at depths of 400 m and deeper. There were 9 stations in which pollock were not caught at all inside the Gulf of Anadeyrskiy, except for these stations, the average abundance of pollock in the distributional areas was 4.22 fish, indicating that the abundance of pollock inside the Gulf was comparatively high relative to the abundance in the three areas. In addition, pollock are assumed to be caught at mid-depth during casting and hauling of the longline, and the results obtained not only indicate the abundance of pollock which lived near the seabottom, but because pollock were not caught in offshore areas at depths of 400 m and deeper it appears that the abundance of pollock has a tendency to be lower in offshore areas of the continental shelf both near the seabottom as well as at mid-depth.

According to the results obtained from the Japan-U.S. joint longline survey which was conducted during the summer of 1988, the abundance of pollock...
at depths of 100 m to 200 m in the eastern Bering Sea ranged from 2.00 fish/hachi to 3.07 fish/hachi (unpublished data by Far Seas Fish. Res. Lab.), and the abundance (5.34 fish/hachi) of pollock at depths of 100 m to 200 m in the Navarin area in 1990 was higher than that in the eastern Bering Sea. However, the abundance of pollock at depths of 200 m to 300 m in the eastern Bering Sea ranged from 3.64 fish/hachi to 6.28 fish/hachi, while those in Olyutorskiy and Navarin areas at the same depths were quite low.

(c) Halibut

The geographical distribution of abundance (the mean catch rate (in weight)/hachi by station) of halibut was greatest in offshore areas in Cape Olyutorskiy (L-1) and Cape Navarin (L-24), and there were some areas from Cape Olyutorskiy to Cape Navarin in which the abundance was comparatively high (Table 7 and Fig. 4). In the Gulf of Anadeyrskiy, there were 12 stations in which halibut was not caught at all and even the stations in which halibut was caught, the abundance was small.

The abundance (the mean catch (in number) per hachi) by area and by depth zone of halibut showed a tendency to be greater, as the depth increases up to the depth of 300 m in the Olyutorskiy area and up to a depth of 400 m in the Navarin area (Table 10). However, halibut were seldom distributed in the depths exceeding 400 m. At depths of 100 m and shallower, the abundance of halibut in the Olyutorskiy area was great (0.51 fish) and the abundance in the Gulf of Anadeyrskiy was extremely small (0.03 fish). At depths of 100 m to 200 m, the abundance in the Olyutorskiy area was 0.88 fish which was greater than the 0.22 in the Navarin area, but at depths of 200 m to 300 m, the abundance in the Olyutorskiy area was 1.11 fish which was almost the same as the 1.20 fish in the Navarin area. At depths of 300 m to 400 m in the Navarin area, great abundance (2.00 fish) was recorded, but we can not say that this abundance is representative of the average abundance throughout the depth zones, because the survey effort was extremely limited.

According to the results obtained from the Japan-U.S. joint longline survey which was conducted during the summer in 1988, the abundance of halibut at depths of 100 m to 200 m in the eastern Bering Sea was observed to be high (2.63 fish/hachi) in a relatively narrow area of the southeastern Bering Sea (Sasaki and Yano, 1990), and the abundance of halibut in the other three areas ranged from 0.23 fish/hachi to 0.66 fish/hachi, and the abundance of halibut in the Olyutorskiy and Navarin areas in 1990 was almost at the same level with those areas in the eastern Bering Sea. At depths of 200 m to 300 m, the abundance of halibut in the Olyutorskiy and Navarin areas was substantially greater than those in the eastern Bering Sea. We could not compare accurately the abundance, because the survey effort at this depth zone in the northwestern Bering Sea was restricted.

4. Size Composition and Mean Body Weight of Major Species

Table 11 shows a summary by area of the mean length and weight of the major species caught in the northwestern Bering Sea during the survey.
which was conducted in 1990, and Table 12 shows the length frequency distribution by area, by depth zone, and by sex of Pacific cod, and Fig. 5 shows the length composition by area and by depth zone of Pacific cod combined male and female. In addition, Fig. 6 shows a comparison of the length composition of Pacific cod in the northwestern Bering Sea and eastern Bering Sea. Furthermore, Tables 13 and 14 and Figs. 7 and 8 show the length frequency distribution of pollock and halibut by area, and Tables 15 to 18 show the length frequency distribution of sablefish, Arrowtooth flounder, Greenland turbot, and rougheye rockfish by area. Although I reported the results on the distribution and abundance, as shown in the previous report, I omitted the description of the species other than Pacific cod, pollock, and halibut, and Table 11 and Tables 15 to 18 describe only the results.

(a) Pacific cod

The length of Pacific cod obtained from the survey which was conducted during the summer in 1990 ranged from 32 cm to 108 cm throughout the survey areas, and mode was in 68 to 70 cm, the mean length was 68.1 cm and the mean weight was 4.22 kg (Tables 11 and 12). By area and by depth zone, at depths of 100 m and shallower, the mean length in the Olyutorskiy area was smallest (63.7 cm and 3.60 kg) and the mean length of Pacific cod in the Navarin and Gulf of Anadeyrskiy areas was 67.7 cm (3.83 kg) and 68.0 cm (4.37 kg), respectively, which was almost the same length, but the mean weight of Pacific cod inside the Gulf of Anadeyrskiy was heavier than that in the Olyutorskiy area (Tables 11 and 12, and Fig. 5). At depths of 100 m to 200 m, the mean length of Pacific cod in the Olyutorskiy area was 70.9 cm (4.57 kg) which was slightly greater than 68.5 cm (4.32 kg) in the Navarin area. At depths of 200 m to 300 m, in contrast with this, the mean length of Pacific cod in the Navarin area was 69.1 cm (4.33 kg) which was slightly greater than 65.5 cm (3.81 kg) in the Olyutorskiy area.

According to the results obtained from the survey which was conducted during the fall in 1989, the mean length of Pacific cod inside the Gulf of Anadeyrskiy was 64.1 cm and the results obtained from the survey which was conducted in 1990 indicated the length composition of Pacific cod inside the Gulf of Anadeyrskiy were larger. In the length composition of Pacific cod in 1989, the fish group which formed a low and independent mode at 40 cm to 50 cm was observed, but the mode of this group was not observed in 1990, and the mode shifted from 66-68 cm to 68-70 cm. On the other hand, at depths between 100 m and 200 m in the Navarin area, the mean length of Pacific cod in 1989 was 73.4 cm, while the mean length in 1990 was 68.5 cm. Modes were between 70 cm to 72 cm in 1989 and 1990 which was almost the same. The miniaturization of length composition in 1990 resulted from a decrease of the frequency of the large-sized fish in lengths of 80 cm and larger, and the frequency of small-sized fish in lengths between 50 cm and 60 cm increased extensively. Although the survey was conducted during January to February in 1989 in the Olyutorskiy area, the length composition by depth zone of Pacific cod was considered to be much different between the winter season and summer season, and the location of the survey stations was completely different between the two surveys.
Therefore, it is impossible to compare directly the results in 1990 and the results in 1989.

The mode of length composition of Pacific cod at depths of 100 m and shallower in the Olyutorskiy area was in 52-56 cm, and even at depths between 100 m and 200 m, the frequency distribution was not uni-modal and was bi-modal with a peak in 50 cm to 60 cm (Fig. 5-1). In addition, the frequency distribution of Pacific cod at depths of 100 m and shallower, and at depths between 100 m and 200 m in the Navarin area (Fig. 5-2) and inside the Gulf of Anadeyrskiy (Fig. 5-3) indicated a bi-modal distribution. These things indicate that the recruitment of a strong year-class had taken place in the Olyutorskiy and Navarin areas in 1990. For the trend of recruits of Pacific cod, forming an independent peak, even if it is low in the extent of lengths between 40 cm and 50 cm in the length frequency distribution has been known empirically from the Japan-U.S. joint longline survey which had been conducted in the U.S. waters for many years to indicate the appearance of the strong year-class. As mentioned before, a low peak was observed at lengths between 40 cm and 50 cm in the Gulf of Anadeyrskiy in 1989, the recruitment of this year-class was estimated to be high in 1990 is considered to be comparable to the estimate of results obtained from the survey, which was conducted in the Gulf of Anadeyrskiy in 1989. On the other hand, because the independent peaks were not observed at body lengths between 40 cm and 50 cm in any areas or depth zones in the survey which were conducted in 1990, the abundance of the recruit year-class with body lengths between 50 cm and 60 cm in 1991 is estimated not to be high.

In comparison with the mean length of Pacific cod in the northwestern Bering Sea within the U.S.S.R. waters in 1990 and the mean length of Pacific cod in the eastern Bering Sea within the U.S. waters obtained from the Japan-U.S. joint longline survey which was conducted in 1990 (unpublished data from National Research Institute of Far Seas Fisheries), the mean length of Pacific cod obtained at depths between 100 m and 200 m of the northwestern Bering Sea was 69.0 cm and the mean length of Pacific cod obtained from the eastern Bering Sea was 70.2 cm, while at depths between 200 m and 300 m the mean length of Pacific cod obtained from the northwestern Bering Sea was 68.2 and the mean length of Pacific cod obtained from the eastern Bering Sea was 68.7 cm, and the mean length of Pacific cod obtained from both areas was almost the same at all depth zones. However, the length composition of Pacific cod at depths between 100 m and 200 m of the northwestern Bering Sea, there were small-sized fish which had an independent mode in the lengths between 52 cm and 54 cm, and the proportion of large-sized fish at lengths of 70 cm and larger was high, and the fish between 60 cm and 70 cm in length were few compared with the length composition of Pacific cod in the same depth zone in the eastern Bering Sea, and indicated obvious differences in the distribution pattern (Fig. 6). In addition, at depths between 200 m and 300 m, in comparison with the length composition of Pacific cod in the northwestern Bering Sea and the length composition in the eastern Bering Sea, the peaks were generally low and modes were unclear (Fig. 6).
(b) Pollock

The mean length and mean weight of pollock in the Gulf of Anadeyrskiy was greatest as 65.9 cm (2.11 kg), and the mean length and mean weight of pollock in the Olyutorskiy area was smallest as 57.2 cm (1.41 kg) (Tables 11 and 13 and Fig. 7), and it was a feature that the large-sized fish in lengths of 50 cm and larger amounted to a large part of the catches obtained from all areas. Although the length of pollock caught in the longline survey which was conducted in the eastern Bering Sea was considerably greater than that of pollock caught by the trawlers, according to the results obtained from the Japan-U.S. joint longline survey which was conducted in 1988, the mean length of pollock in the eastern Bering Sea was 54.1 cm (unpublished data from the National Research Institute of Far Seas Fisheries), and the length of pollock caught by the longline survey which was conducted in the northwestern Bering Sea was even greater than the length of pollock in the eastern Bering Sea.

(c) Halibut

Most of the halibut were caught in the Olyutorskiy and Navarin areas, and the mean length and mean weight of halibut was 8.11 cm (6.97 kg) in the Navarin area and 73.0 cm (5.39 kg) in the Olyutorskiy area (Tables 11 and 14 and Fig. 8). According to the results obtained from the Japan-U.S. longline survey which was conducted in 1988, the mean length of halibut in the eastern Bering Sea was 69.7 cm (Sasaki and Yano, 1990), and halibut in the northwestern Bering Sea was greater than that in the eastern Bering Sea.

5. Tagging of Pacific Cod

During the surveys, a total of 818 Pacific cod was tagged and released (Table 19). Of those, 39 of Pacific cod were released in the Navarin area during the experimental fishing operations. By area, 196 individuals were released in the Olyutorskiy area and 266 individuals in the Navarin area and 356 individuals in the Gulf of Anadeyrskiy, respectively. Although the length of Pacific cod tagged ranged from 30 cm to 78 cm, most of the fish was accounted for Pacific cod between 48 cm and 60 cm (Table 20 and Fig. 9). The mean length of released fish was 52.5 cm which was substantially smaller than the mean length (68.1 cm) of the entire catch, as more smaller sized fish among the catch were tagged.

Problems in the Future

In comparison with this third Japan-U.S.S.R. joint longline survey which was conducted in the northwestern Bering Sea during the summer in 1991 and two Japan-U.S.S.R. joint longline surveys which had been conducted in the past, we could have more survey stations in the former surveys than those obtained in the latter surveys and the quality of data obtained was higher than those obtained in the latter surveys. However, it is necessary to point out several problems which should be improved in order to obtain more accurate data.
information on the distribution, abundance and size composition, etc. of Pacific cod. Those problems are as follows: 1) the number of survey stations in the Olyutorskiy area was not sufficient, and the survey stations were one-sided; 2) the survey effort expended at depths between 200 m and 300 m and depths between 300 m and 400 m was not sufficient, and the average abundance which was represented by the entire depth range was not available, and 3) the number of length measurements of Pacific cod were not sufficient. In particular, regarding 2) above, as depths between 200 m and 300 m are a part of the main habitat depth of Pacific cod even during the summer season, so it is necessary to expand the survey efforts of future surveys.

As the research area in 1990 is assumed to cover most of the expected fishing grounds for Pacific cod, it is important to conduct continuously the research surveys from now on to monitor the stock abundance, size composition and yearly change of recruitment in order to maintain and manage Pacific cod stock at an appropriate level. Furthermore, it is necessary to extend the survey area to the east Kamchatka coast, and to obtain comprehensive information on the distribution, abundance, and size composition, etc. of Pacific cod stock in areas from the western Bering Sea to the Kamchatka coast.

References, Tables 1 to 20, and Figs. 1 to 9 are in English in the Japanese document.