AVERAGE YEAR'S FISHING CONDITION OF TUNA LONGLINE FISHERIES 1952 EDITION

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Assistant Director Nakayama of the Federation of Japanese Tuna Fishermen's Associations for their efforts in behalf of the publication.

/s/ Motosaku Fujinaga
Director of the Research Branch
of the Fisheries Agency

June 6, 1953

ATLAS OF AVERAGE YEAR'S FISHING CONDITIONS IN THE TUNA LONGLINE FISHERIES

Editor's Preface

The study of fisheries resources has come to be a subject of general discussion in recent years, and the significance of this work has gradually come to be correctly understood and highly valued. This is very encouraging to those of us who are engaged in this field, but, on the other hand, it makes us feel very keenly the importance of our responsibilities.

The final objective of the study of fisheries resources is, of course, to make it possible for human efforts to regulate the resource. To put it more plainly, according to my way of thinking, it is to give the maximum possible production without overstepping the limits of overfishing and to endow mankind broadly and perpetually with the blessings of aquatic products. Or, to state it from the opposite point of view, it is a study of the application of planning to fisheries so as to make planned production possible.

Our Nankai Regional Fisheries Research Laboratory has been given as its most important mission the carrying out of studies of this sort with regard to the tuna fisheries. It is extremely simple to express our objectives in such phrases as "management of resources" or "planned production," but it can be judged that this is not an easy task when we consider that even in such limited bodies of water as lakes control of production does not often succeed, or when we take the case of fisheries, such as that for sardines, where the species exploited is produced only from limited areas comparatively near the coasts, and yet cannot be easily accounted for. I think it need hardly be stated how much more this is the case in the tuna longline fishery, the fishing grounds of which extend over broad areas of the open sea, and the catch of which comprises a rather large number of species of fish.

The approaches which we are using at present in the study of fisheries resources may be very broadly listed as follows:

1. The study of the biological characteristics of the fishes which are the object of the fishery.

2. Clarification of their relationships with ecological factors.

3. Ascertaining the amount of the catch.

4. Studying the changes in the size of the fish taken over a number of years and the reasons for these changes.

5. Deducing, on the basis of these data and the results of these studies, the quantity of the resource, finding the proportion of the catch to the resource, and determining the proper amount of fish to be caught.

The studies which we are making of the tuna fisheries are, of course, based on these orthodox research methods. On the one hand, we carry out investigations of the environment and the biological characteristics of these fishes at sea, enduring the tropical heat of the South Seas and the stormy weather of northern waters. On the other hand, we make morphological measurements of the catch in the fish markets in the freezing early dawn, or we go for the purpose of collecting data on fishing conditions to visit fishing boats, where we are often met with a very cool reception, or even abused. Some of these data have already been assembled and reported in the preliminary reports of investigations of the resources by the Nankai Regional Fisheries Research Laboratory. The results of our studies come out as Reports of the Laboratory or as Progress Reports, and further reports will be published continuously in the future.

The basis for the construction of these charts of the average year's fishing conditions comprises the data from prewar operations of research vessels from all parts of the country, which were recorded in Report No. 1 of the Nankai Regional Fisheries Research Laboratory, and material which has been gathered since the war from the reports of experimental and research vessels and by interviewing personnel of commercial fishing boats. For the purposes of this compilation, the cutoff date has been determined as March 1952. However, where it appeared necessary, later data have been added. It is regrettable that very few oceanographical data are presented, but this was unavoidable because the majority of the data were gathered from ordinary commercial fishing vessels.

It is anticipated that there will be various divergent views and criticisms on the point of whether a work based on this amount of data can be called representative of the average year, and also on the point of whether it is proper to take 1° squares as the unit for fishing grounds.

However, I do not think of these charts of the fishing conditions as final or as the best that can be achieved. On the contrary, they are only a beginning and therefore are quite inadequate. I intend to take these charts as a foundation and, hereafter, to make up charts of the fishing conditions each year, compare and review them, and in from 3 to 5 years to again bring out charts of the average year's fishing conditions in amplified and perfected form.

My reasons for thinking up a project like this were in general as follows. In the first place, if we look at the operating conditions of the tuna longline fishery, which is the main part of the tuna fishery,

1. At the present time, there is absolutely no knowledge or means by which to tell, as the vessel is running along, where one may set the lines and be certain of catching fish.

2. Once a place is chosen and the line is set, it becomes, in the final analysis, a matter of waiting for the fish to bite on the hooks, and as long as there is no positive way of making the fish congregate in the vicinity of the lines and bite on the hooks, there is no particular skill or technique involved in the operation.

3. The selection of fishing grounds is made, as a general rule, on the basis of fishermen's experience, or often by picking up on the radio information on the success which other fishing vessels are having.

4. Consequently, catching tuna on longlines, at least under present conditions, may be thought of as a problem in probabilities. I do not think that any special inspiration, talent, or skill is involved in it.

In the second place, as far as our mission and objectives are concerned,

5. If it were possible to plot the movements of fishing grounds as the movements of typhoons are plotted on weather charts, it would be possible

6. To fill in the data and at the same time

   a. To evaluate the character of the population.

   b. To clarify its relations to its environment.

   c. To grasp the seasonal changes in fishing conditions and fishing grounds.

d. To grasp the changes in fishing conditions in given fishing grounds from year to year.

7. It may be though that if these things were accurately grasped as phenomena, principles applicable to these phenomena would automatically be established and would provide a path leading to the objective of the study of the resource.

In the third place, in such a research process, it is thought that

8. The information and data assembled here can certainly serve to guide the operations of commercial fishermen and can be useful as a basis for business operations. On various levels they can probably contribute to the stabilization of the fishery. Furthermore, they will probably reveal the fishing grounds on which it is possible for various types of vessels of various characteristics to make a profit and will thus serve as a basic and valuable reference in the establishment of government policies and administrative measures.

9. It is the responsibility of the fishery research laboratories, which are industrial research organizations attached to administrative bureaus, to have at all times their information and data assembled up to date and to be always ready to answer the questions of the administrative authority and to guide the operations of private enterprise. As for the question of the accuracy and reliability of the information and the data, it is unavoidable, of course, that they cannot be expected to be perfect, but they should be the best possible at the particular stage of the investigations.

It goes without saying that this type of undertaking cannot ever approach its goal using only the data collected by a small number of experimental and research vessels. The number of fishing vessels which show a correct understanding of our work and which supply us with reports of their operations is slowly but steadily increasing, and this is extremely heartening and strongly encouraging to us. It is our hope that not only will the boats which have been supplying us data hitherto continue doing so, but that all tuna longline vessels will proffer accurate reports of their operations. I believe that the objectives listed above can be attained only if the researchers and the commercial operators not only cooperate but become a single, harmonious whole. If it is possible to bring about a situation where there is a division of labor under which the commercial vessels all turn in accurate data on the fishing conditions each time they make a cruise, while the research vessels take over the field of study of ecology and oceanography, which is impossible for commercial vessels, and also that of testing the theories to which the results of these studies lead, we will be able to expect an improvement in the stability of this fishery.

Up to the present, the work of compiling these charts of the average year's fishing conditions has not been taken up as a part of the regular work of the Nankai Regional Fisheries Research Laboratory. The main reason why we have hesitated to make it a part of our regular work has been our lack of confidence in our ability to turn out something worthy of being called "charts of the average year's fishing conditions" because of our inadequate personnel and financial support. These fears of mine have been realized in the form of the poverty of the data. This poverty of the data is most conspicuous in the case of the fishing grounds in home waters where small vessels operate with a strongly local character. This fact largely reflects deficiencies in the network for the collection of data. However, we have no way of telling when, if ever, we will be permitted to strengthen our personnel and financial resources and consequently we are completely unable to predict when we can collect satisfactory data. For my own part, I expect that there may be dissatisfaction and general criticism, but my concept of a fishery research laboratory is such that I am prepared to accept in good part any sort of criticisms that will lead to progress, and therefore I have gone ahead with the publication of this volume. It will be a source of the greatest satisfaction if our ideas are understood, if budgetary measures are taken which will permit us to intensify our research activity, if we gain the general cooperation of the fishermen, and if we can have our errors and shortcomings pointed out to us.

For the reasons set forth above, the preparation of these charts has not been carried on as a regular work of this laboratory, but the personnel of our High Seas Resources Section, even though engulfed in their regular research work, have pitched in and worked together using every bit of leisure time, working until late at night in their spare time. The work of organizing the data and writing the explanatory material has been divided as indicated below; I have revised and edited the manuscripts.

In gathering the data, we have enjoyed the cooperation of the Tōhoku Regional Fishery Research Laboratory and the Fisheries Experiment Stations of Chiba, Tokyo, Kanagawa, Shizuoka, Mie, Kōchi, and other prefectures. We wish to express our deep thanks to them and to the fishermen who have taken time out from their arduous work to prepare and send to us reports, and we trust that in the future we may enjoy even closer liaison with them in order to work together for a healthy development of the fishery.

The publication of these charts has been supported by the Fisheries Agency in various ways. The editor is also deeply sensible of the kindness of the Federation of Japanese Tuna Fishermen's Associations in the efforts they made toward the publication of this volume.

Section	Person in Charge
Albacore	Akira Suda
Yellowfin	Yōichi Yabuta
Striped marlin	Shōji Ueyanagi
Broadbill swordfish	Shōji Kikawa
Bigeye tuna	Tadao Kamimura
Black tuna	Hajime Yamanaka
Black marlin	Yōichi Yabuta
Overall responsibility	Hiroshi Nakamura and Hajime Yamanaka

January 5, 1953

To the reader:

In some cases there are inconsistencies in the names used for fishing grounds in this work. In the present stage of our study, it is not clear how the sea areas should be divided up, and however we try dividing them it is impossible to arrive at a precise and proper division in accordance with the characteristics of the fishing grounds. For these reasons, each author has used the division which best suited his exposition. It is anticipated that this may be a source of some confusion to the readers. We expect to systematize these names in the future.

ALBACORE, Thunnus germo

SEPTEMBER

General

Within the scope of our data, albacore fishing in September is still extremely sparsely distributed, and no fishing grounds showing concentrated catches are formed in any of the sea areas. However, this season is the period at which fishing grounds are beginning to be formed in the North Pacific and, although at the present time our studies have not advanced to the point where these data are very pertinent, it is believed that hereafter they may prove to have an important significance in judging the formation of fishing grounds and the fishing situation.

As the chart shows, the data are concentrated in the North Pacific along 40°N., in the subtropical region (middle latitudes), and in the tropical sea area. Considering them by sea areas, they are in general as follows.

1. North Pacific Area

The fishing grounds are centered along the line of 40°N. and extend east and west in a zone.

This sea area is confined between the Polar Front and the Subtropical Convergence. It corresponds to the area of the flow of the North Pacific Current, and according to the North Pacific current charts (Japanese Hydrographic Office, No. 6031C), the current flows to the east at speeds of 0.3 to 0.7 knots, mainly 0.3 to 0.4 knots. Along the northern edge, however, the direction of flow is irregular. Since we have no data on the distribution of water temperatures, we know nothing about the picture over the whole sea area, however, the following table presents extracts from the results of sectional observations directly east of Same, in Aomori Prefecture (about 40°30'N.).

Translator's note:

The longline "catch rate," which is constantly referred to in this report, is the catch per 100 hooks fished per day. For the location of the major sea areas mentioned, see the frontispiece.

In order to save a great deal of typing and drafting the original tables and figures have been photographically copied. Clarifying notes have been added where necessary, but minor faults of typography and spelling have not been corrected.

Table 1. --Distribution of water temperatures due east of Same, Aomori Prefecture. (Based on Semi-annual Reports of Oceanographical Investigations, No. 63, 1939)

Month	Distance from coast in miles															
	浬 10	〃 50	〃 100	〃 150	〃 200	〃 250	〃 300	〃 350	〃 400	〃 450	〃 500	〃 600	〃 700	〃 800	〃 900	〃 1.000
Ⅷ	21.7 15.6	21.7 8.4	24.4 11.3	22.8 10.4	23.2 8.0	21.8 7.3	21.8 10.0	18.7 3.5	20.3 9.8	19.8 4.3	21.4 12.8	18.5 8.5	17.2 9.2	17.4 7.8	16.3 7.0	20.0 9.0
Ⅸ	23.0 17.7	22.6 17.3	21.5 15.4	21.5 19.2	21.2 15.5	20.4 11.5	22.7 14.0	—	—	—	—	—	—	—	—	—

Note: Upper figure is temperature at surface, lower at 50 m.

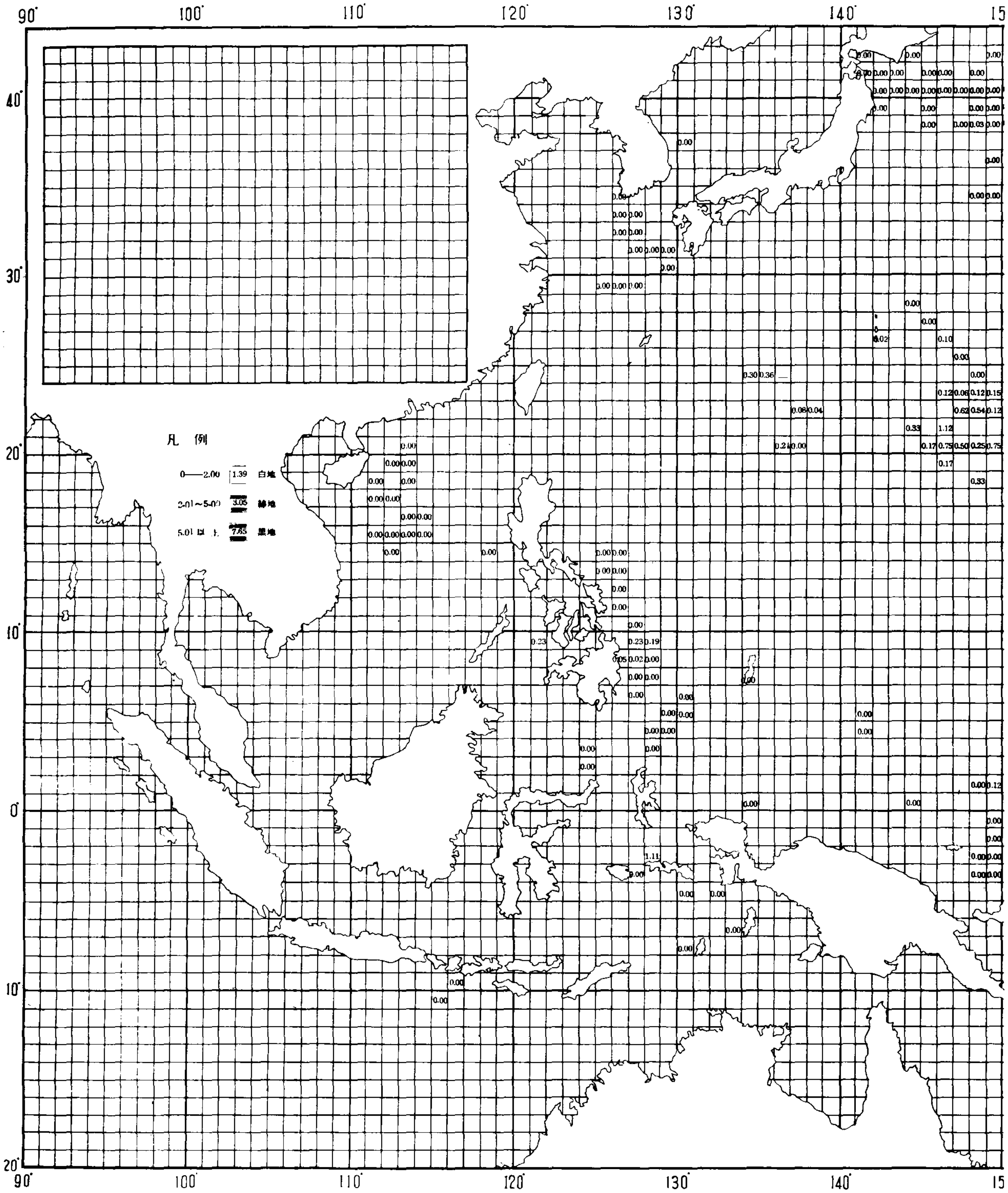
The following table shows data on oceanographic conditions in this area from commercial fishing vessels.

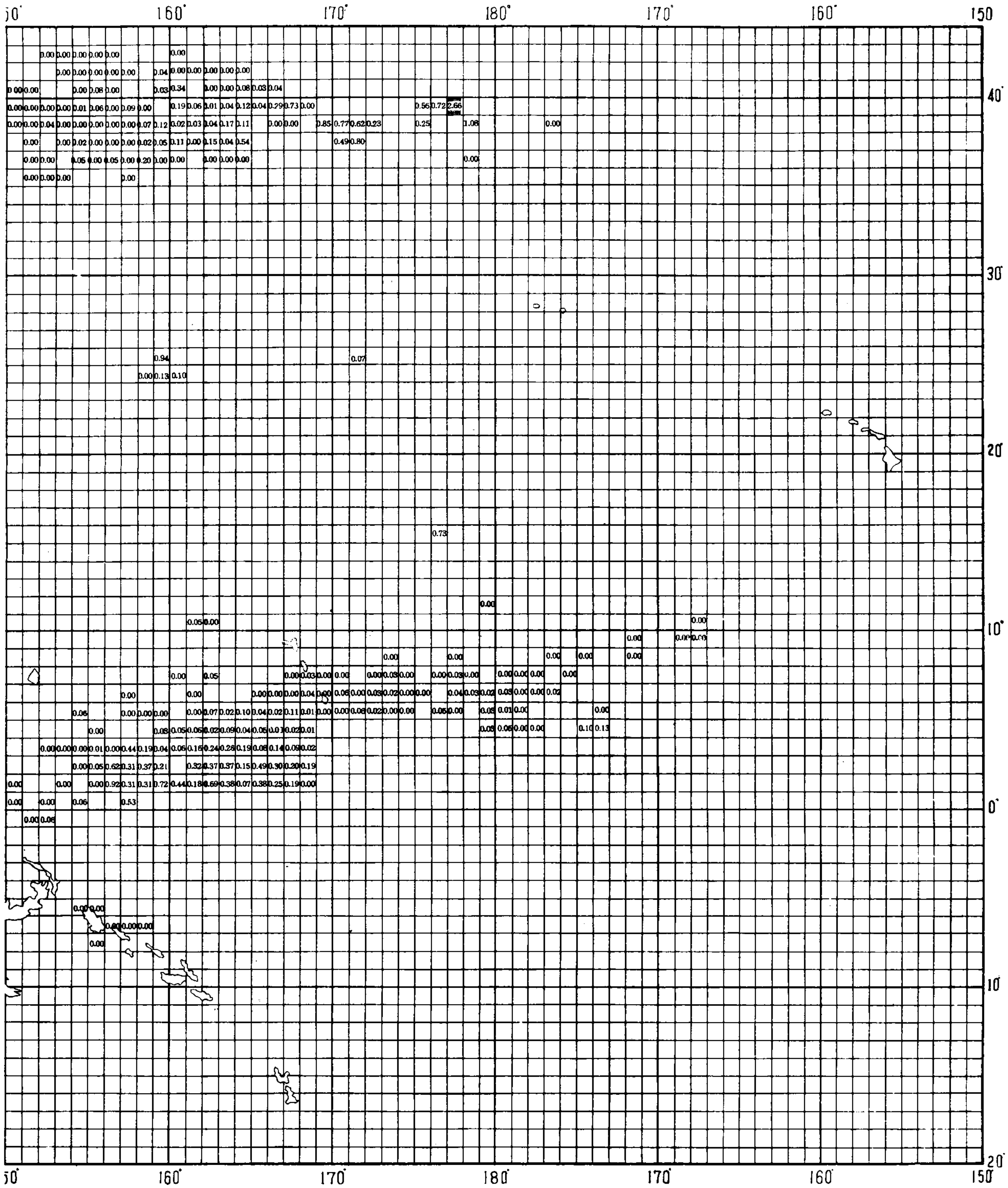
Table 2. --Water temperature data from reports of fishing boats

Date and position		0m	50m	100m	Date and position		0m	50m	100m	Date and position		0m	50m	100m
1949 Ⅸ 2	156°50′E 37°02′N	26.8°C	17.7°C	—	1949 Ⅸ 2	164°8 5′E 40°08′ N	23.6°C	16.0°C	12.0°C	1949 Ⅸ 23	159°12′E 39°55′N	20.3°C	13 4°C	9.3°C
〃 〃 7	157°20′ 36°14′	26.5	15.2	—	〃 〃 8	163°09′ 39°27′	20.2〜21.2	18.0	13.2	〃 Ⅹ 1	159°52′ 33°09′	23.2	16.5	—
〃 〃 12	160°27′ 38°12′	24.0	18.0	—	〃 〃 12	164°07′ 40°08′	18.3〜19.4	15.0	12.7	〃 〃 6	158°24′ 37°41′	21.9	16.5	—
〃 〃 17	160°18′ 38°12′	24.3	18.0	—	〃 〃 17	161°17′ 39°19,8′	19.5〜20.2	17.0	13.0					
〃 〃 22	159°55′ 38°40′	23.9	17.2	—	〃 〃 22	160°34′ 40°21′	21.9〜23.2	17.5	16.3					

In this sea area in September, as will be set forth in later sections, the catch is made up principally of spearfishes and bigeye tuna, and the albacore catch is of very small significance in the fishery. Geographically, the catch rates show a tendency to be high in the east and low in the west, with almost no catch west of 150°E. and with hardly any cases where the catch rate rises above 0.1 percent even in the area between 150°E. and 160°E. At 160°E. to 170°E. the catch rate is rather conspicuously increased over that in the area of 150°E. to 160°E., and at 170°E. to 180°, although there are few data, the catch rates increase still further and in one case a rate of ˳2.66 was recorded. Farther to the east there are no data at all so we have no idea of the situation in that sea area, but it is thought that there is a possibility that the fishing grounds continue on into west longitudes.

ビ　ン　ナ　ガ　(Albacore (*Thunnus germo*))　9　月　(September)




160°
170°
180°
170°
160°
150
40°
30°
20°
10°
0°
10°
20°

The fish taken are all generally large for albacore, most of them weighing about 15 to 19 kilograms.

2. Areas of the Middle Latitudes

Throughout this sea area as a whole the data are very scarce and scattered. The only places in which there are some concentrations of data are around the Ogasawara Islands and Marcus Island, in Philippine waters, and in the northwest part of the South China Sea. We have no records at all of captures of albacore from the South China Sea and Philippine waters. In the other areas, there are no high catch rates, but a certain number of albacore always appear in the catch. The fish are generally large, the majority of them being over 19 kilograms.

The following table gives the comparison with the catch rate cited by Nakamura (1951).[1/]

Table 3.--Comparison of prewar and postwar catch rates

Area	Pre-war	Post-war
140° E ~ 150° E 25° N ~ 30° N	0.02	0.02
140° E ~ 150° E 20° N ~ 25° N	0.38	0.31

Notes: 1. The figures are catch rates.
2. The "postwar" data are those of this atlas and include the prewar data.

3. Tropical Seas (10°N. to 15°S.)

The data are rather generally distributed between 1°N. and 8°N. in the longitudes of 150°E. to 170°E. and between 5°N. and 9°N. at 170°E. to 180°. There is also somewhat of a concentration of data for the waters east and southeast of Mindanao; in the Southern Hemisphere there are scattered data for the Banda Sea and the waters around the Molucca Islands, and there is again somewhat of a concentration in waters around the Solomon Islands.

1/ Nakamura, Hiroshi. Nankai Regional Fisheries Research Laboratory, Report No. 1, 1951.

Hardly any albacore catch is recorded for the Southern Hemisphere, although there are some cases in Moluccas waters where there are catch rates of over 1.0 but these are probably anomalous. Fishing conditions in tropical waters of the Northern Hemisphere, as in the case of mid-latitude waters, show no outstanding catch rates, but a certain amount of albacore is taken generally over the area. At times there are fairly concentrated catches mixed in with yellowfin and bigeye. The size of the fish taken in this area, in general, appears to be somewhat smaller than the fish taken in the mid-latitude waters.

OCTOBER

General

The fishing situation in low-latitude waters (0° to 10°N.) in October is just about the same as in the preceding month, with no outstanding catch rates but with a certain amount of fish taken everywhere. In middle-latitude waters, along the line of 25°N., we have continuous data from east to west which appear to show catch rates not greatly different from those of September. However, there appears to be somewhat of a tendency for the values to increase. Far to the south of the Kii Peninsula, in the vicinity of 22°N. to 25°N., 135°E., there is an area of somewhat concentrated fishing.

1. North Pacific Area

The fishing grounds of the North Pacific east of northeastern Honshū have moved quite conspicuously southward compared with the previous month, this trend toward the south being particularly marked west of 170°E. Albacore fishing is a good deal more active than in the preceding month, and catch rates are generally above 1.0 in the area of 36°N. to 40°N., between 160°E. and 175°W., with scattered places showing catch rates of about 5.0.

Between 150°E. and 160°E. fishing is generally slow, with few places where the catch rate rises above 1.0. West of 150°E., where there was almost no catch in September, concentrated fishing grounds have developed and in some cases catch rates are better than 5.0.

It is not possible adequately to examine annual fluctuations because of the inadequacy of the past data; however, in 1949[2/] also fishing was

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2/ Nankai Regional Fisheries Research Laboratory, High Seas Resources Section, Summary Report of Investigations, 1952, Chart No. 11.

fairly good between 150°E. and 160°E., but no concentrated fishing grounds had developed west of 150°E. In 1950[3] the trends were in good agreement with the chart presented here.

Table 1.--Comparison of prewar and postwar catch rates

	140°E～150°E 35°N～40°N	150°E～160°E 35°N～40°N	160°E～170°E 35°N～40°N	170°E～180°E 35°N～40°N	180°E～170°W 35°N～40°N
Pre-	0.00	0.48	–	3.15	–
Post-	0.49	0.29	1.27	1.75	0.91

The "postwar" figures include the prewar data

Table 1 is a comparison with prewar data (from Nankai Regional Fisheries Research Laboratory Report No. 1). Except for the area west of 150°E. longitude, in general the fishing conditions appear to be inferior to those of the prewar period, but the reasons for this are not clear.

The distribution of catch rates appears to show a gap between 150°E. and 160°E. According to Uda[4], judging from the sizes of the fish there are three different age groups in this area, each following a different migratory path but all migrating in a clockwise direction. Nakamura[5] pointed out that at the beginning of the fishing season (November) there is one group appearing in the area centered at 150°E. and another group in the area centered at 165°E.; in December isolated fishing grounds are formed in the Kinan Sea Area, and a tendency can be detected for part of the group in the vicinity of 150°E. to appear to move toward the southeast, but aside from these observations it is not possible to show any differences between the groups on the basis of catch rates.

The sizes of albacore taken in the North Pacific show local differences in the east-west direction and also in the north-south direction. Table 2 shows these local differences.

3/ Nankai Regional Fisheries Research Laboratory, High Seas Resources Section, Summary Report of Investigations, 1952, Chart No. 23.

4/ Uda, Michitaka and Eimatsu Tokunaga, Bull. Jap. Soc. Sci. Fish., Vol. 5, No. 5, pp. 295-300, 1937.

5/ Nakamura, Hiroshi. Nankai Regional Fisheries Research Laboratory Report No. 1, 1951.

Table 2.--Local differences in size composition of North Pacific albacore (October, 1949-51)

	36°N~38°N							North of 38°N					
Longitude	65cm ~ 75cm	75cm ~ 85cm	85cm ~ 95cm	95cm ~ 105cm	105cm ~ 115cm	平均 (M)	Longitude	65cm ~ 75cm	75cm ~ 85cm	85cm ~ 95cm	95cm ~ 105cm	105cm ~ 115cm	平均 (M)
140°E~150°E	1	41	58			3.5	140°E~150°E						
150°E~160°E		13	76	9	3	4.3	150°E~160°E						
160°E~170°E		7	59	15	20	4.9	160°E~170°E	2	32	66			3.7
170°E~180°E		5	52	28	15	5.0	170°E~180°E		13	60	18	10	4.6

Notes: (1) Fork length in cm. "North of 38°N." may be taken to mean 38°N.-40°N.
(2) Figures in columns are percentage of size class in catch.
(3) Column headed (M) is mean weight in *kan* [8.27 lbs.].
(4) Length-weight relationship: 70 cm., about 1.9 *kan*; 80 cm., about 2.8 *kan*; 90 cm., about 4.1 *kan*; 100 cm., about 5.8 *kan*; 110 cm., about 7.4 *kan*. These length classes coincide approximately with Aikawa's age groups.

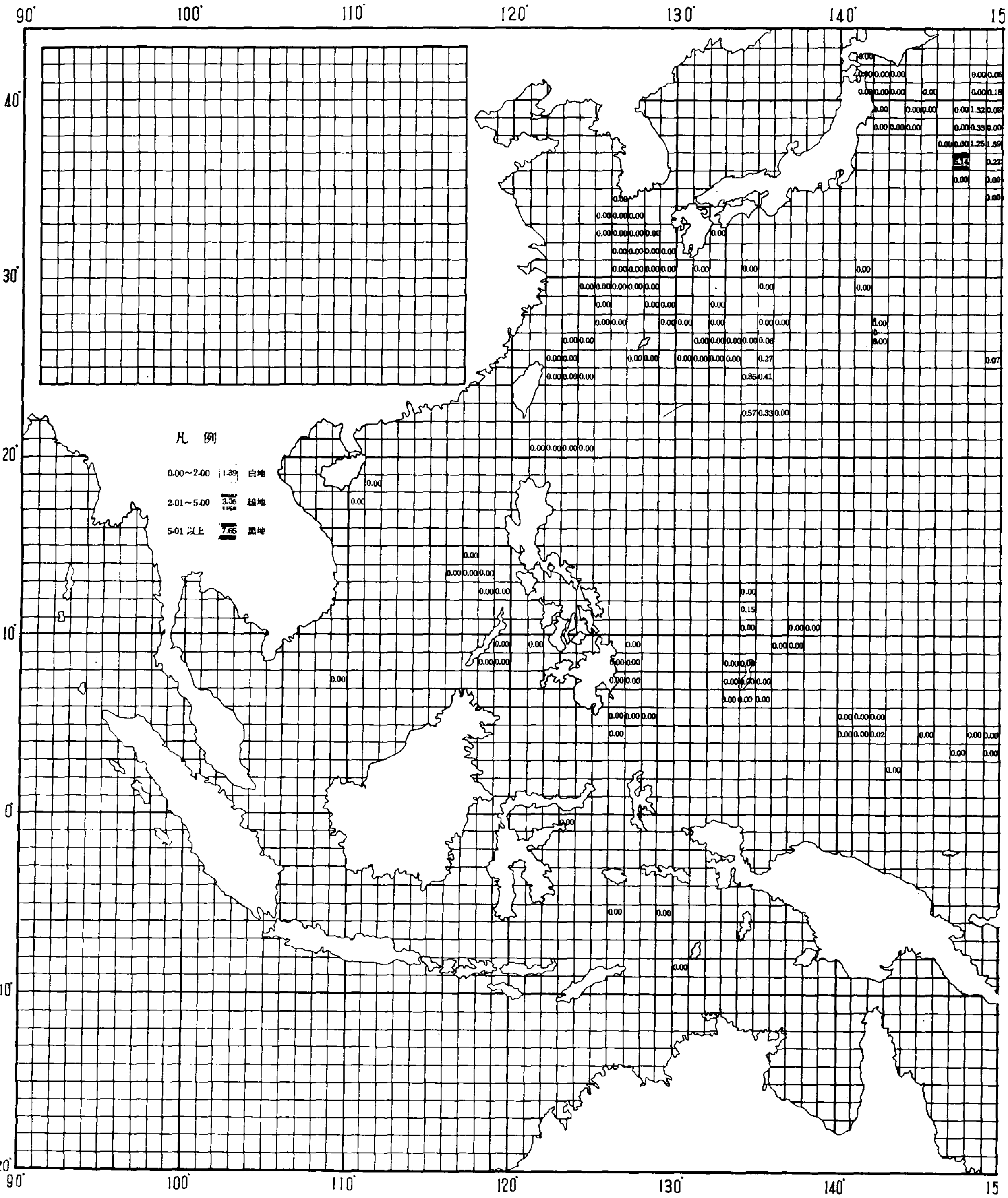
As is clear from table 2, the greater part of the catch in this region, regardless of locality, is in the 85-95 cm. size class. There is clearly a tendency for smaller fish in the west and larger fish in the east to mingle with this mean size group, but this trend is a continuous one and shows no conspicuous gaps. However, since table 2 combines the results of measurements in the years from 1949 to 1951, it also includes local movements of the fishing grounds from year to year. Consequently, it is not possible to discuss, on the basis of these results, Uda's hypothesis of three groups of schools. The data are by no means adequate, but table 3 shows the local differences in albacore sizes for the month of October 1950 alone.

In table 3 the local mingling of size classes is approximately as shown in table 2; that is, it is continuous without any sharp discontinuities.

From tables 2 and 3 the following observations can be made:

1. If the sizes of albacore taken at the same latitudes are compared from east to west, the mean size group is 85-95 cm., but toward the east the proportion of larger fish mixed in with this catch increases, and west of 150°E. smaller fish increase.

ビ　ン　ナ　ガ　(Albacore (*Thunnus germo*))　　１０月　(October)



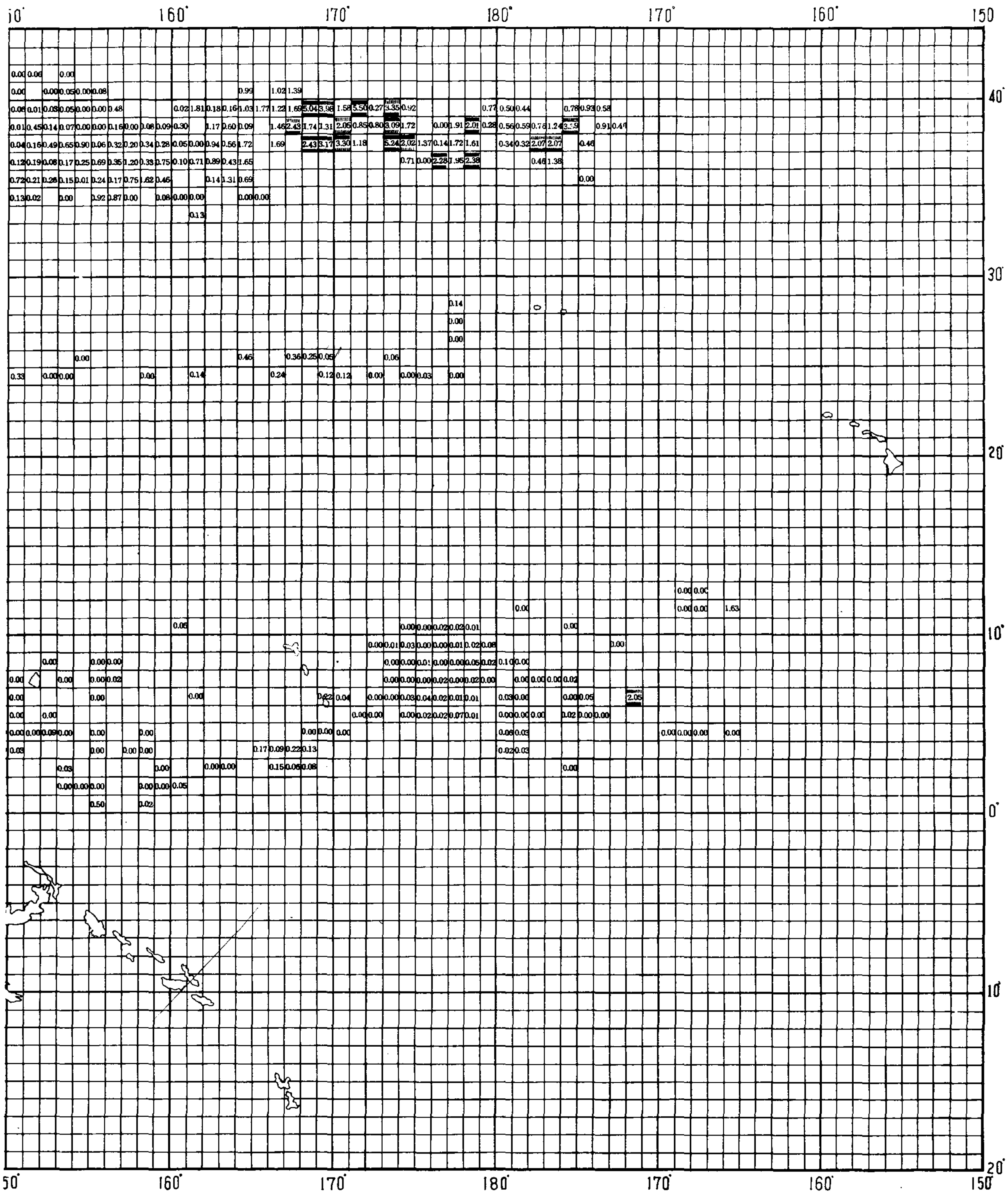

150
160°
170°
180°
170°
160°
150
40°
30
20
10°
0°
10
20°

Table 3.--Local differences in the size composition of North Pacific albacore (October 1950)

経度 Longitude.	65cm ~ 75cm	75cm ~ 85cm	85cm ~ 95cm	95cm ~ 105cm	150cm ~ 115cm	平均 (M)
140° E~150° E	1 1	39 41	56 58			3.5
150° E~160° E	1 1	21 10.5	167 83.0	7 3.5	5 2.5	4.1
160° E~170° E		4 2.5	24 57.8	11 12.4	25 27.3	5.6
170° E~180° E		4 12.8	93 59.7	44 17.9	20 9.7	4.9

Notes: (1) The upper figure is the number of fish measured, the lower the percentage.
(2) The area of 38°N.-40°N. has been omitted.
(3) The column headed (M) is average weight in kan.

2. If a comparison is made between north and south in sea areas of the same longitude, the fish are larger to the south and tend to be smaller to the north.

These two phenomena are not limited to October, but appear in November and thereafter. In the charts from November on, a gradual southward movement of the fishing grounds in these waters can be clearly seen. Kishinouye[6] stated that in the case of the black tuna the fish taken at the beginning of the fishing season were mostly large ones and that, with the passage of time, the fish making up the catch gradually became smaller. The facts stated under 2, above, show that this same phenomenon can be seen in the case of the albacore. What it means is that large fish are more numerous at the leading edge of the migration.

The fishing grounds in this region extend a long way from east to west, but from north to south their width is not great, being about 200 to 250 miles, and although they move southward with the passage of time, there is no great variation in their breadth. It goes without saying that there is an indivisible relationship between the development of the fishing

[6] Kishinouye, Kamakichi. Jour. College Agr., Imperial University, Tokyo, 1923.

grounds and the movements of the schools, but the movements of the fishing boats are also based on economic considerations. Given the same requirement of labor and capital, it is more profitable to fish for large fish than for small fish as long as there are no great differences in the catch rates. As stated above, the breadth of the fishing grounds from north to south is from 200 to 250 miles, but there is a possibility that schools of smaller fish are migrating farther to the north. To underwrite our estimate of this possibility, it is known that occasionally on the northern extremity of the fishing grounds astonishingly high catch rates are made on schools of small fish.

There are almost no data on oceanographic conditions in this area for October. There is a particular dearth of data regarding current boundaries and vortices, which are thought to have a particularly important connection with fishing conditions. Tables 4 and 5 present postwar data on surface water temperatures and fishing conditions from commercial fishing vessels.

Table 4.--Surface water temperature and catch rate (170°E.-175°E.)

釣獲率 Catch-rate. / 水温 Temperature.	0.0 ~ 0.5	0.5 ~ 1.0	1.0 ~ 1.5	1.5 ~ 2.0	2.0 ~ 2.5	2.5 ~ 3.0	3.0 ~ 3.5	3.5 ~ 4.0	4.0 ~ 4.5	4.5 ~ 5.0	5.0 ~ 5.5	5.5 ~ 6.0	Total.	M_2
17°C					1		1						2	2.75
18	1	1		1						2			5	2.45
19	2	2		1								1	6	1.75
20	2	5	2	4		1	3						17	1.54
21	2	1	1	2	3		2						11	1.75
22	1	1											2	0.50
23		2											2	0.75
Total	8	12	3	8	4	1	6			2		1	45	
M_1	20.0	20.4	20.3	19.9	20.0	20.0	19.8			18.0		19.0		

Table 5.--Surface water temperature and catch rate (145°E.-150°E.)

釣獲率 Catch-rate. / 水温 Temperature.	0.0 ~ 0.5	0.5 ~ 1.0	1.0 ~ 1.5	1.5 ~ 2.0	2.0 ~ 2.5	2.5 ~ 3.0	3.0 ~ 3.5				7.0 ~ 7.5	7.5 ~ 8.0	8.0 ~ 8.5	8.5 ~ 9.0	Total
16°C															0
17	1														1
18															0
19	6														6
20	20	2		2		1					1		1	1	28
21	7		2												9
22	11														11
23	11		1												12
Total.	56	2	3	2		1					1		1	1	67

2. Areas of Middle Latitudes

In the waters east of 140°E. there is a scattering of data centered around 25°N., but the albacore catch rates are low and not worth recording. West of 140°E. there are some more or less concentrated catches in the area of 22°N. to 26°N., 134°E. to 136°E. Good fishing grounds are formed in this area from November on, and the advance signs of this development can be seen even in October. This is called the "Okinotorishima fishing ground," and it is one of extremely interesting character.

3. Tropical Seas

Low catch rates are shown for the region in general, but there is always a certain amount of albacore taken. Within the scope of our data, there are cases of rather high catch rates in the extreme eastern part of the area, but judging from conditions in surrounding areas this is probably anomalous.

NOVEMBER

General

In November, in the overall picture, the albacore fishing conditions gradually reach their full season stage and, compared with October, fishing is a great deal more active. Not only do fishing conditions become good in the North Pacific grounds, but in the middle latitudes at 20°N. to 25°N., centered on 135°E. longitude (hereafter this region will be referred to as the Okinotorishima fishing ground), concentrated fishing grounds are formed. However, the so-called Nankai Sea Area ground (centered on Kinan Reef, north of 28°N. at 130°E. to 140°E.) does not as yet show the slightest sign of the formation of fishing grounds.

1. North Pacific Area

The fishing grounds east of northeastern Honshū, as compared with October, are about 2° of latitude farther south, and they extend a long distance east and west in the vicinity of 31°N. to 40°N., with the main fishing grounds between 34°N. and 38°N.

There are hardly any data concerning the oceanographic conditions, but table 1 gives the data from the Fuji Maru, research vessel of Shizuoka Prefecture, collected between November 3 and 28, 1951.

Table 2 shows the size of the albacore by areas of 2° of latitude by 10° of longitude.

Table 1.--Water temperatures and catch rates observed by the Shizuoka Prefecture research ship *Fuji Maru* in 1951

年月日 Date.	位置 Station.	m 0	m 25	m 50	m 75	m 100	釣獲率 Catch-rate.	年月日 Date.	位置 Station.	m 0	m 25	m 50	m 75	m 100	釣獲率 Catch-rate.
1951 11.3	162°48′E 37°59′N	18.4	18.3	18.5	17.1	13.0	6.00	1951 11.15	175°08′E 36°00′N	18.8	18.8	18.8	18.1	16.5	2.47
4	162°28′ 37°59′	19.1	—	—	—	—	3.53	17	175°03′ 35°56′	19.2	18.8	18.8	18.6	16.9	4.40
7	164°40′ 36°25′	21.1	21.5	21.5	21.5	17.8	1.13	19	174°19′ 35°43′	20.2	20.2	20.0	—	16.3	5.26
8	164°30′ 36°15′	20.8	21.8	20.8	21.2	19.6	2.34	20	174°24′ 35°37′	20.3	20.3	20.5	17.6	16.6	3.80
12	174°24′ 35°34′	19.6	19.3	19.2	17.5	17.9	3.47	21	174°50′ 35°28′	19.4	19.2	19.2	19.0	17.0	2.94
13	174°20′ 35°31′	18.7	18.8	18.8	18.1	18.7	2.47	27	163°29′ 36°54′	19.5	—	19.4	19.4	—	3.13
14	174°44′ 35°59′	19.8	18.5	18.2	18.3	18.5	2.07	28	163°36′ 37°13′	19.2	19.1	19.1	19.1	19.0	0.40

Table 2.--Local differences in albacore weight composition (November, 1948-52)

緯度 Latitude. / 体重 B.w / 経度 Longitude.	32° N～34° N								34° N～36° N							
	貫 0.7	貫 1.1	貫 1.9	貫 2.8	貫 4.1	貫 5.8	貫 7.4	平均貫 M.	貫 0.7	貫 1.1	貫 1.9	貫 2.8	貫 4.1	貫 5.8	貫 7.4	平均貫 M.
140° E ～ 150° E				52	46	1	2	3.5		4	24	60	10	1		2.7
150° E ～ 160° E										2	5	38	40	12	3	3.7
160° E ～ 170° E												23	69	7	1	4.0
170° E ～ 180° E												31	46	15	8	4.2

緯度 Latituda. / 体重 B.w / 経度 Longitude.	36° N～38° N								38° N～40° N							
	貫 0.7	貫 1.1	貫 1.9	貫 2.8	貫 4.1	貫 5.8	貫 7.4	平均貫 M.	貫 0.7	貫 1.1	貫 1.9	貫 2.8	貫 4.1	貫 5.8	貫 7.4	平均貫 M.
140° E ～ 150° E	5	8	27	55	6			2.4	7	23	33	34	2			2.0
150° E ～ 160° E	1	1	18	39	36	4	1	3.3								
160° E ～ 170° E			3	61	29	5	1	3.4								
170° E ～ 180° E		1	3	36	34	20	6	4.1								

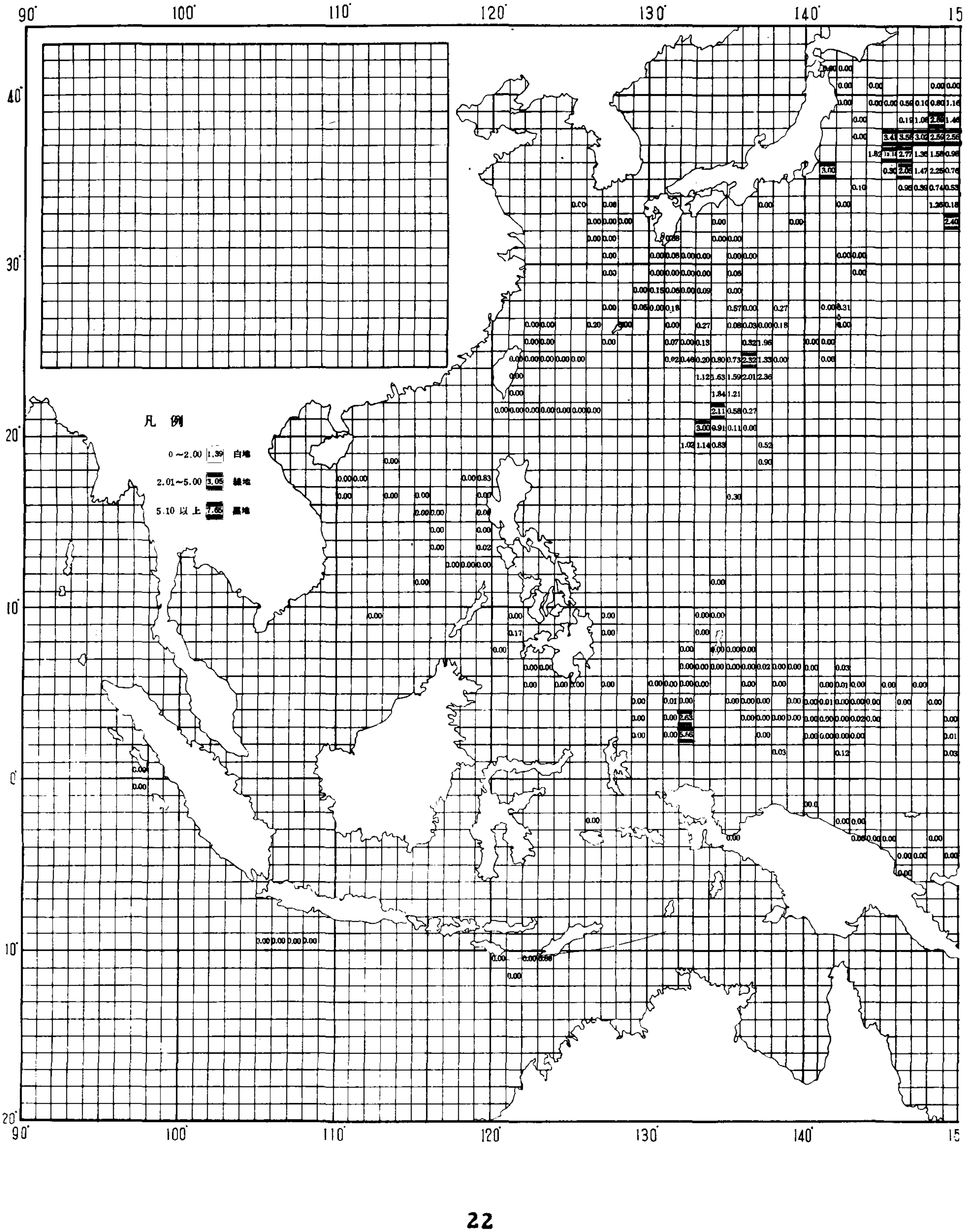
Notes: (1) Columns are weights in *kan* [8.27 lbs.]; figures in columns are percentages of the total number of fish.

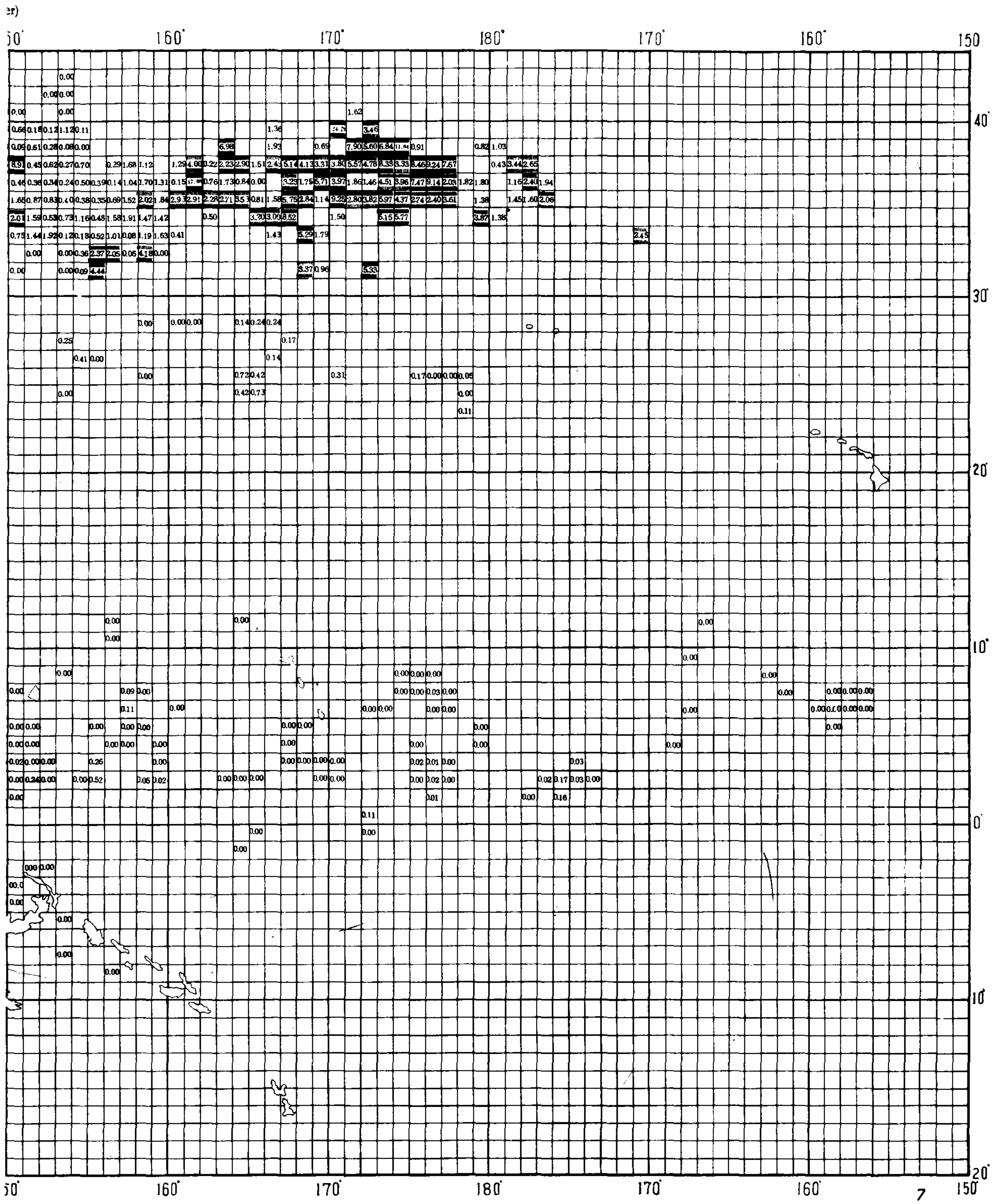
(2) Length-weight relationship is the same as for October. For the smaller sizes, 1.1 *kan* corresponds to 60 cm. and 0.7 *kan* to 50 cm.

(3) Fish 45-55 cm. long are represented in the 0.7 *kan* column, those 55-65 cm. long in the 1.1 *kan* column, and so forth.

(4) The column headed M gives the average weight in *kan*.

ビ　ン　ナ　ガ　(Albacore (*Thunnus germo*))　　１１月　(Novembe




160°
170°
180°
170°
160°
150
40°
30°
20°
10°
0°
10°
20°
7

In October, in all areas, the major part of the catch was fish of 85 to 95 cm. (4.1 kan weight), but in November there was a general and conspicuous increase in fish of the 75 to 85 cm. length class (2.8 kan). Furthermore, the tendency mentioned for October for the fish to be smaller in the south and larger in the north, as well as smaller in the west and larger in the east, is extremely clearly shown in table 2.

In October the fishing conditions between 150°E. and 160°E. were remarkably poor compared with areas to the east and west, but in November, although an area of rather low catch rates can be seen in the central part, the fishing conditions had picked up considerably over the whole area. From what is shown in the chart, it looks as if this change in the fishing conditions was brought about by a movement of the schools in from the east and the west, particularly from the east. However considering the size of the fish in the catch, the changes are gradual, just as they were in October, and with the amount of data available it is not possible to reach any conclusions as to whether the schools originated in the areas to the east or to the west.

Looking at the shifts in the fishing conditions from December on, it is thought that the schools in the extreme western portion (west of 150°E.) gradually move toward the west, while those east of 150°E. or 160°E. simply keep moving south.

2. Areas of the Middle Latitudes

Considering the middle-latitude sea areas as a whole, data are very scarce and the overall situation is not clear. Although the data are inadequate, between 24°N. and 30°N. on 165°E. the catch rates are rather high.

The so-called Okinotorishima fishing ground, which in October was showing signs of developing, is very clearly marked in this month, and fishing is active there. This fishing ground appears in complete isolation, with its center at 20°N. to 25°N., 132°E. to 137°E. Stated very broadly, this fishing ground is surrounded on three sides, on the south, west, and north, by the North Equatorial Current and the Kuroshio, while on the east it is covered by the Ogasawara Current, flowing north along the Ogasawaras and Marianas. In the waters where this fishing ground is formed the currents are as shown in the supplementary chart* and the direction of flow is locally complicated, however, in general it is a circular flow in a

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* From North Pacific Current Chart No. 6031-D.

clockwise direction. Furthermore, within this area there are small islands such as Okinodaitōshima and Okinotorishima, as well as elevations of the sea floor, so that hydrographic conditions are quite complex.

As subsequent charts will show, from November on with the passage of the season this fishing ground gradually extends southward, reaching to the vicinity of 12°N. above the Palau Islands at the end of the fishing season (see supplementary charts 1 and 2**). The fishing ground in November is formed in a circular current, and the catch rates are over 2.0 in quite an extensive area.

Looking at the size composition of the catch, the albacore taken in this area are very large for that species, with hardly any under 4 kan (15 kilog.). If we try bringing together all recorded measurement data, fish of around 5.8 kan make up 40 percent, those of around 7.4 kan make up 60 percent, and the average weight is 6.8 kan /1 kan = 8.27 lbs./.

Besides albacore, yellowfin and spearfishes are important elements in the catch in this area. The albacore is by no means the most important but its significance is comparatively great. It appears, however, that changes in albacore fishing conditions from year to year are great, and the catch rate, as shown in the following table, fluctuates widely.

Table 3.--Annual fluctuations in the albacore catch rate on the Okinotorishima fishing ground

a). 135°E～136°E (November)

年次 Year. \ 緯度 Latitude.	21°N～22°N	22°N～23°N	23°N～24°N	24°N～25°N
1950	—	1.83	1.59	1.27
1951	0.58	0.59	—	0.19

b). 135°E～136°E (December)

年次 Year. \ 緯度 Latitude.	20°N～21°N	21°N～22°N	22°N～23°N	23°N～24°N	24°N～25°N
1949	—	—	0.46	0.57	—
1950	2.26	2.70	2.84	1.83	—
1951	0.16	0.37	0.34	—	1.37

** From North Pacific Current Chart No. 6031-A. /Translator's note: These "supplementary charts" are probably the two small unnumbered charts on page 55 in the December section./

Table 3.--Annual fluctuations in the albacore catch rate on the Okinotorishima fishing ground (cont'd)

c). 135° E～136° E (January.)

緯度 Latitude. / 年次 Year.	18° N～19° N	19° N～20° N	20° N～21° N	21° N～22° N
1949	—	0.78	2.08	2.00
1950	0.58	0.58	—	—
1951	—	—	0.83	—
1952	—	—	0.45	—

North of this sea area from December to March good albacore fishing grounds develop north of 28°N. latitude. These are the so-called Kinan Reef and Tosa albacore fishing grounds. Hereafter, in this work, these Kinan Reef and Tosa grounds will be referred to as the Kinan fishing ground. Although the Okinotorishima ground and the Kinan ground are close together, and in March actually overlap in part, they are thought to be quite different in character. The reasons for this belief are: (1) the albacore taken on the Kinan ground are much smaller than those from the Okinotorishima ground; (2) the fishing grounds develop in the two areas at different times. As will be shown later, the length group of 75 to 85 cm. is the main group of albacore on the Kinan fishing ground, these being the so-called "3-kan albacore." On the Okinotorishima ground, as already stated, the average weight is 6.8 kan, a size which is in good agreement with that of the fish occurring broadly south of the Subtropical Convergence.

3. Tropical Seas

There is a certain amount of albacore catch generally distributed over the South Sea area, but except for a small area south of Palau there are no fishing grounds with concentrated catches. There appears to be some concentration of catch near Kapingamarangi Island, but the average catch rate does not reach 1.0.

The albacore catches south of Palau continue until around January, but there appear to be great variations in the fishing conditions from day to day and an extreme lack of stability. The reasons for such variations in the fishing conditions are not known, but they appear to be largely related to the patterns of current boundaries and the topography of the islands, and this also appears to be true in the Kapingamarangi area.

Nothing at all is known at present of the relationships of the schools appearing in Palau waters, but as the following table shows their average weight is about 1 kan [8.27 lbs.] less than that of fish in the Okinotorishima region and, since these two fishing grounds are widely separated, it is deduced that they are of different stocks.

Table 4.--Size composition of albacore catches in Palau waters

85cm~95cm	95cm~105cm	105cm~115cm
(4.1貫)	(5.8貫)	(7.4貫)
13%	65%	22%

Note: Figures in parentheses are weight in kan /8.27 lbs./. Mean weight is 5.9 kan (49 lbs.)

Although the data are inadequate, the size composition of the albacore in the Kapingamarangi Island region is as shown in the following table.

Table 5.--Size composition of albacore catches in Kapingamarangi I. waters

85cm~95cm	95cm~105cm	105cm~115cm
(4.1貫)	(5.8貫)	(7.4貫)
11%	44%	44%

Note: Figures in parentheses are weight in kan. Mean weight is 6.3 kan (52 lbs.)

There are very few data on the size of the albacore which are taken sporadically in waters along the Equator east of 140°E. longitude, but within the scope of existing data their average weight is shown to be 6.7 kan (about 25 kilog.), which is extremely large. It is thought worthy of note that such large fish are distributed very sparsely over an extraordinarily broad area of the sea, and they are thought to have a different ecological significance from the schools of the North Pacific. Only further research in the future can show whence such schools of large fish are replenished and what their ecological significance may be, however, it is hypothesized that these schools of large fish bear a close relationship to spawning, and there is a considerable amount of information backing up this hypothesis.

DECEMBER

General

In December the albacore fishing conditions become even more active than in November. The fishing grounds in the North Pacific are generally extended to the south and reach the line of 30°N., running east and west with a breadth from 30°N. to 40°N. The fishing grounds in this region not only extend themselves southward, but also westward and approach the waters off northeastern and east central Honshū. West of 150°E. the fishing grounds also extend to the southwest, and their advance extremity reaches the vicinity of the waters east of the Izu Islands around 27°N.

The Okinotorishima fishing ground is also more active than it was in November, and the grounds are extended to the southwest, reaching the line of 130°E. longitude.

The most noteworthy thing in this month is the clear appearance of signs of the formation of fishing grounds in the Kinan Sea Area, where there were no signs at all of such development in November. This fishing ground gradually increases in activity from January on, spreads southward, and overlaps the northern part of the Okinotorishima grounds, but the fish taken in Kinan are small and are clearly of a different character from those of the Okinotorishima grounds.

In South Sea waters there are scattered areas with rather high catch rates. Particularly in the area of 130°E. to 140°E., there are somewhat concentrated catches. At 11°N. to 13°N., 172°W. to 173°W., there is even a catch rate of 2.5, showing possibilities for a considerable catch in this region. In the various sea areas west of 130°E., including the Indian Ocean region, hardly any albacore are taken, with only a small catch reported from the central part of the South China Sea.

1. North Pacific Area

Compared with November, the fishing grounds have extended southward by 3° to 4° of latitude, and their southern extremity is at 30°N. or, in places, below that line. The grounds have extended not only southward but also westward, and in the west they also show a tendency to extend southwestward, so that they are broadly continuous over the area of approximately 140°E. to 180°.

In general the catch rates show high values, particularly high east of 160°E., in which region the majority of the unit areas have catch rates of better than 3.0. In the waters between 150°E. and 160°E., in October fishing was generally a good deal poorer than in areas to the east and west; in November this area of low catch rates is conspicuously narrower than in October, but in December there still remains an area of poor fishing running obliquely north and south and dividing the fishing in the North Pacific into two parts.

Annual variation

There appears to be considerable variation from year to year in the positions at which fishing grounds are formed and in the quality of the fishing on the North Pacific grounds. The reasons for such fluctuations are thought to be two: (a) differences from year to year in the amount of fish present; (b) differences from year to year in the movements of the fishing grounds. It is difficult to examine this situation on the basis of data for December alone, so an attempt will be made to outline our knowledge of it using data extending throughout the fishing season.

In figure 1 this area is first divided into four segments of 10° of longitude, these are further divided into segments of 2° of latitude, and the catch rates are shown for each of these sections.

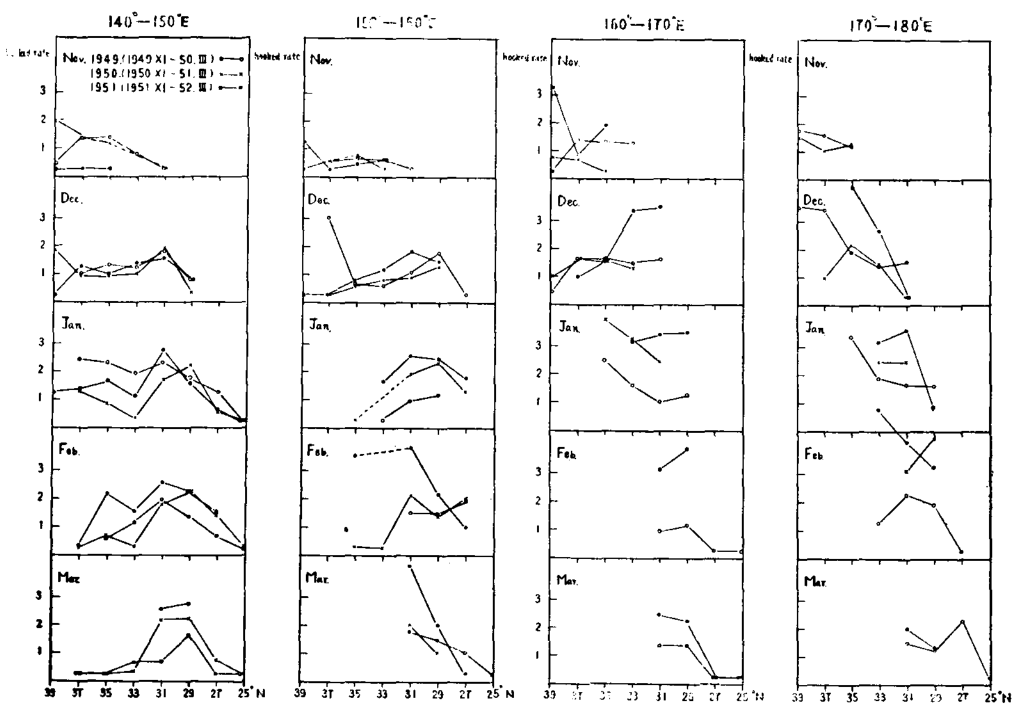

Figure 1. --Catch rates by month and area.

Among the areas shown in figure 1 there are data for each month covering the fishing grounds from north to south for the section of 140°E. to 150°E., so here the movements of the fishing grounds can be quite clearly deduced. In the early part of the fishing season, i.e., in October and November, the catch rates are generally higher in the north and drop off gradually to the south, with the southern extremity at 31°N. It is impossible to make any assertions concerning the conditions which define this southern limit, but there is a barrier to distribution and migration and this barrier moves southward with the passage of the season until it reaches the vicinity of 25°N. Looking at the variations in the catch rates, we see a tendency for the schools to accumulate gradually in the waters along the northern side of this barrier, a condition which Nakamura[7/] has pointed out in support of his idea that this is a feeding migration. For the areas east of 150°E. data are fragmentary so the situation is not well known, but in its tendency it appears to resemble the area of 140°E. to 150°E. The quantity of schools present is, of course, high in this area of accumulation, but the catch rates, at any rate, trail out far to the north up to January and show a considerably dense distribution in the north also.

It cannot be stated at present what the barrier is that defines the southern limit of the grounds, but judging from the pattern of southward movement of the fishing grounds it is thought that the most powerful influence is the Subtropical Convergence, and this is considered to show the correctness of Uda's[8/] view that the southern limit of migration is controlled by the Subtropical Convergence.

In any case, the positions in which the albacore fishing grounds of the North Pacific develop and their form coincide well with the areas of flow of the Kuroshio and the North Pacific Current, and it is thought that a thorough study should be made of the relationship between these currents and the formation and movements of the fishing grounds.

Considering in terms of figure 1 the variations in speed from year to year of the southward movement of the schools between 140°E. and 150°E., it is deduced that in 1950 (November 1950 to March 1951) the main schools were located farther north in November than they were in the same month of 1949 (November 1949 to March 1951), but in December

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7/ Nakamura, Hiroshi. Nankai Regional Fisheries Research Laboratory, Report No. 1, 144 p., 1951.

8/ Uda, Michitaka. Bull. Jap. Soc. Sci. Fish., Vol. 5, No. 5, pp. 295-300, 1937.

they were at about the same position in both years, and from January on they seem to have moved south faster than in 1949. In 1949 and in 1951 (November 1951 to March 1952) the main schools are seen to have reached 29°N. around March of both years, but in 1950 they were already at 29°N. in January. In 1951 the southward movement is thought to have been slow in the first part of the fishing season, but from December on it moved at about the same speed as in 1949. It is difficult to make any judgments about the waters east of 150°E. because of the scarcity of data, but the trend of southward movement of the schools there does not necessarily coincide with that in the area of 140°E. to 150°E. If it can be assumed that the catch rates are proportional to the quantity of schools present, throughout the sea areas as a whole it can be said that the quantity of fish was greatest in 1951.

With regard to figure 1, it was stated that from November to January north of the area of accumulation (or main group of schools) where catch rates are high the catch rate curve trails out to a great length, and if we consider this trailing portion to be a group of schools which replenishes the main concentration, we can detect important differences in the variations of the catch rates as between these two groups of schools. The coefficient of variation in the catch rate is small for the main group or accumulated group and shows large values for the replenishment group. In other words, on the fishing grounds for the main group or accumulated group, the fishing conditions are stable, but on the fishing grounds for the replenishment group fishing conditions are unstable and fluctuate widely.

In the east-west direction, too, there appear to be variations from year to year in the positions at which the fishing grounds develop. The data used herein are almost entirely derived from commercial fishing and do not represent a deliberate disposition of vessels with the objective of investigating changes in the locations of the fishing grounds, so what they actually show is the pattern of operations of the commercial fleet. This fact must be fully taken into consideration. But if we take it that the grounds where the fishing vessels concentrate are the main grounds, then the following conclusions can be drawn from table 1a, b, and c. In 1949 the fishing grounds developed on about an average year's pattern, but in 1950 the grounds east of 140°E. were, on the whole, pushed to the eastward, while in 1951, in general, they were pushed to the westward.

It has already been stated that between 150°E. and 160°E. the catch rates at the beginning of the fishing season are lower than they are in the areas to the east and west. In the following discussion we will divide the fishing grounds of the North Pacific into those west of 150°E., those between 150°E. and 160°E., and those east of 160°E.

Table 1.--December albacore catch rates on the North Pacific fishing ground by years, 1949-51

a. 1949

°E. longitude

°N. latitude	140°~41°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40																				
38 ~ 39									16.30											
37 ~ 38			0	0	0.11	0.92														
36 ~ 37					0		1.68	2.57	2.92	8.15	6.30	6.15								
35 ~ 36			11.12		0.25	0.08	0.11	3.87	0.70	1.31		2.33						0.60		
34 ~ 35	0	4.86	2.70	28.61	0.28	0.44	0.20	2.16	1.95	3.78			0.22						1.00	
33 ~ 34				3.53	1.68	0.62	0.96		4.07	5.25					0	0.50	1.44			
32 ~ 33			0.05		0.84			2.56	3.81	3.70						1.37	1.50	0.20	2.22	
31 ~ 32					4.22	2.92		1.92	3.43	4.29		0.39		2.08	3.35	2.86				
30 ~ 31					2.20				2.73	3.58					2.67					1.95
29 ~ 30			0					2.56		2.51	3.33									
28 ~ 29			0.71																	
27 ~ 28	0	0	0.10	0			0.91													
26 ~ 27	0.09	0	0.01	0																

°N. latitude	160°~161°	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40																				
38 ~ 39										1.37	7.45									
37 ~ 38									3.20	8.29	8.83	7.80								
36 ~ 37		0.64		0.92			5.02	2.89	3.07	9.83	8.23	4.85	2.57	13.05						
35 ~ 36	1.85		1.92			3.88	1.78	2.07	2.16	4.43	4.37		2.83	5.63	4.47	4.41	5.43			
34 ~ 35					4.77	5.62	5.25	3.39	3.35		6.36	3.36	1.85	3.00	2.25			3.12		3.66
33 ~ 34	4.40		0.49		3.08		2.92	2.89	2.95			2.56	2.12	2.06	2.37	2.78	2.74	3.39	1.63	2.36
32 ~ 33	3.30	2.80			3.75	2.10	4.09	4.12	2.79	2.32		2.80	1.80	2.00	2.45	2.84	2.19	3.45	5.50	
31 ~ 32							3.03	2.51	2.59	3.71	3.44		0.67	0.99		3.52	1.93	4.48	4.23	
30 ~ 31	3.01						1.59					1.39	3.16	3.24	4.25	4.80	3.14			
29 ~ 30																				
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				

b. 1950

°N. latitude	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40										5.85										
38 ~ 39					4.49			2.76	2.31											
37 ~ 38			0		1.92	5.95				0.10	0.40									
36 ~ 37			0.20	1.39	7.91	6.42	1.30	0.35	0.38	0.84						0.20	0.24			
35 ~ 36				3.15	1.50	1.28	3.42	3.10	1.99	0.58				0	0.19	0.08	0.34			
34 ~ 35		0	2.05	1.67	1.61	1.84	0.89	3.30	1.08	1.07	1.57	0		1.34						
33 ~ 34			0.38	2.56	3.88	4.23	0.34	0.94		2.35	1.11			2.54						
32 ~ 33				2.16	1.45		2.72			0.32	0.54									
31 ~ 32							2.81	7.37	4.22		0.99		1.98	1.41						
30 ~ 31							2.46	4.77	3.40	2 50	2.84									
29 ~ 30				0																
28 ~ 29			0.75	0																
27 ~ 28	0		0.50	0																
26 ~ 27	0.41		0	0	0															

Table 1.--December albacore catch rates on the North Pacific fishing ground by years, 1949-51 (cont'd)

b. 1950 (cont'd) °E. longitude

°N. latitude	160°~161°	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40			2.04																	
38 ~ 39																				
37 ~ 38	0.27	2.20		3.74	2.78	6.78	6.69													
36 ~ 37		0.10	0.07	3.59	3.62	4.06		2.30	5.07				1.36	1.57	2.43					
35 ~ 36				4.17	3.22	1.63		3.62		4.43					1.94			6.53		
34 ~ 35				2.95	4.17	1.71			4.00					6 40	5.17		5.50	2.92		
33 ~ 34															3.20	2.77		3.09		
32 ~ 33			2.07	2.60														2.05	2.52	
31 ~ 32																				0.50
30 ~ 31																				
29 ~ 30																				
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				

c. 1951 °E. longitude

°N. latitude	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40										0.31	0	0	0.59							
38 ~ 39			0	0					0.78											
37 ~ 38					2.07	2.09	0.24						0							
36 ~ 37				5.78	0.22	3.74					0	0	0	0			0.15	0		0
35 ~ 36			1.11	1.39		0,94	1.59					0					2.03	1.04		
34 ~ 35			1.45	4.73	5.84	1.04	1.66	1.31	0.31	0.98	1.48		0.70	0.10	0.66	4.43	0.58	1.13	2.55	2.31
33 ~ 34		7.34			0.47	1.73	1.95	2.64	0.30			2.08	2.58	2.91	2.21	2.09	1.89	1.73		3.83
32 ~ 33								4.51			1.99	0.47	0.36	2.41	1.17	3.34	3.52	4.24	3.65	
31 ~ 32						4.04	3.53		2.12	0.82	2.33	3.90	2.74	2.80	3.50	4.63	4.59	5.63	1.84	
30 ~ 31			3.10			4.42	3.35			0.27	1.43	2.70	4.75	2.92			9.00			
29 ~ 30	0.21	2.90			0.40			2.80				2.17					5.61			2.13
28 ~ 29												0.56								
27 ~ 28			0.08																	
26 ~ 27					0.08															

°N. latitude	160°~161°	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40																				
38 ~ 39																				
37 ~ 38																				
36 ~ 37																				
35 ~ 36		4.01																		
34 ~ 35	1.28	5.08	3.27						0.75								8.09			
33 ~ 34	4.70		4.20		6.28	11.54	14.56			4.65		7.77					3.66	5.58		
32 ~ 33					7.83	7.69		8.77	5.23	5.22	1.24					0.60	6.07	7.58	7.60	
31 ~ 32								7.24			0.40									6.74
30 ~ 31																				
29 ~ 30																				
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				

I). <u>West of 150°E.</u>

For convenience this ground is referred to as west of 150°E., but it is not a matter of mechanical division along the line of that longitude, for the area of low catch rates between 150°E. and 160°E. appears to run obliquely from the vicinity of 40°N., 155°E., to the vicinity of 30°N., 150°E., so the area discussed is actually that west of a line connecting these two points. However, there are considerable changes from year to year in the way in which this area of low catch rates appears, as is shown in table 1a, b, and c, so a rigorous delimitation is difficult.

In the overall view the catch rate is somewhat higher than it was in November, and there are a large number of unit areas with catch rates above 5.0. Unit areas with high catch rates are mostly distributed along the southern and northern edges of this fishing ground, and the rates are generally lower in the central portion. If we examine the catch rates in detail, however, there are rather large variations between neighboring unit sea areas, and there are also rather large variations in the amount of fishing done within the different unit areas. Although this variation is large, if the periods of time and the geographical extent of the areas are not increased above a certain level, it is thought that the variations closely resemble each other in character. In other words, between grounds where the same groups of schools are fished at positions not too widely separated there will probably be a close resemblance in the fluctuations in the fishing conditions, and hereafter this type of fluctuation will be referred to as variation within the fishing ground.

Table 2 gives two or three examples of variations in the fishing conditions in unit areas west of 150°E.

Table 2.--Deviation of catch rates in certain unit areas west of 150°E. in December

a. Area of 31°N.-33°N., 147°E.-149°E.

Position		Catch rates								Mean rate	Std. dev.	変異係数
°E.	°N.	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	(M)	(SD)	S.D/M
147~148	31~32	1	1	2	1					2.10	1.02	49%
148~149	〃		2	4	2	3	1		1	3.58	1.63	43
147~148	32~33		2	2	1	1				2.67	1.06	40
148~149	〃		1	6	5	6	2	1	1	3.91	1.43	29

Table 2.--Deviation of catch rates in certain unit areas west of 150°E. in December (cont'd)

b. Area of 33°N.-35°N., 143°E.-145°E.

Position		Catch rates											Mean rate (M)	Std. dev. (SD)	変異係数 S.D/M
°E.	°N.	0~1	1~2	2~3	3~4	4~5	5~6		9~10	10~11		13~14			
143~144	33~34	3(1)	3	2						1			2.60	2.87	110%
144~145	〃	6(1)	2	1	2	1	2		1			2	3.97	4.23	107
143~144	34~35	2			1	1							1.50	1.41	94
144~145	〃	7	4	1	1								1.58	1.62	103

Note: Figures in ( ) are times of 0 catch.

As can be seen from table 2, the coefficients of variation for the catch rates had high values, particularly in 1950, when the majority were over 100 percent. This shows that the catch rates, even within a single unit area, can vary greatly from one day's operation to the next, and that they can, in some cases, be widely different from the catch rates shown in the average year's fishing condition charts.

The most notable thing about tables 2a and b is that the average catch rate is almost always somewhat higher than the most frequent catch rate within an area, and this is also true of the South Sea yellowfin grounds.

In table 3 this whole area is divided into sections of 1° of latitude, in 10° of longitude, and the coefficients of variation of the catch rates are shown for each section. In the table a tendency can be seen for the values of this coefficient to be smaller in the south and larger in the north, with the highest values in the intermediate area. This shows that in the southern part of the area the fishing conditions are comparatively stabilized, with little deviation from the average catch rate, whereas in the northern part fishing conditions are unstable, with large catches in some cases and no catch at all in others. The very same sort of situation is found in the area north of 35°N., between 150°E. and 155°E., which is considered to be a prolongation of the fishing grounds west of 150°E.

This table shows that throughout this sea area as a whole the average coefficient of variation is 70 percent, from which it can be seen that the fluctuations in albacore fishing conditions in this region are rather large. As will be noted later, the variations in the fishing conditions in the waters east of 160°E. are not as great as they are in this area and, from this point of view, it can probably be thought that the two fishing grounds differ in character.

Table 3.--Coefficient of variation of catch rate by latitude, North Pacific ground

°N. latitude	0~10	10~20	20~30	30~40	40~50	50~60	60~70	70~80	80~90	90~100	100~110	110~120	120~130	130~140	140~150	150~160	160~170	170~180	平均 Mean.
30 ~ 31		2	1	2	1			1											39
31 ~ 32	1	2		2	3														30
32 ~ 33		1		2	1							1							49
33 ~ 34	1	1			1	2		1	1	1	3	1	1		1		1	1	92
34 ~ 35		2		2	1	2			2	3	1	1	1	1	3				86
35 ~ 36				1	1	1	1	2	1	3			1		1				83
36 ~ 37		1		1		2	1			2	3				1		1		87
37 ~ 38					1		2		1	1									71
30 ~ 38	2	9	1	10	9	7	5	4	5	10	7	3	3	1	6		2	1	70

Size of the fish

Table 4 shows the size of the albacore taken in this area. The table shows the average length and weight compositions for December for the period from 1948 to 1951.

Table 4.--Albacore size composition at 140°E.-150°E. in December 1948-1951.

Latitude	45~55 cm (0.7 kan)	55~65 (1.1)	65~75 (1.9)	75~85 (2.8)	85~95 (4.1)	95~105 (5.8)	105~115 (7.4)	平均体重 貫 (kan)	測定尾数 No. Fish.
30°N~32°N	—	0.1	4.3	32.7	53 4	8.3	1.2	3.76	853
32 ~34	0.3	3.0	7.1	60.1	20.9	7.5	1.1	3.23	703
34 ~36	2.6	15.7	37.5	24.5	19.1	0.6	—	2.41	353
36 ~38	—	21.0	27.0	49.9	1.9	—	—	2.22	504

Note: Size classes in cm. and in ( ) kan /1 kan = 8.27 lbs./.
The figures in the columns are percentages.

The average weight of the albacore taken in this area in December is below 4 kan (33 lbs.), and north of 34°N. it is less than 3 kan (25 lbs.). The modes of the length (weight) classes are located at 85 to 95 cm. (4.1 kan) south of 32°N., and they appear 10 cm. to the left for every 2° one goes toward the north, but north of 36°N. they are 1 cm. larger than they are in the area between 34°N. and 36°N. The fish taken east of 150°E. are all larger than in this area. The trend seen in November for the fish to be larger in the south and smaller in the north is also clearly apparent in December.

Oceanographic conditions

This sea area is where the Kuroshio, flowing up along the Japanese islands, turns to the east away from the islands, and consequently the currents are a great deal more complex than they are farther to the east.

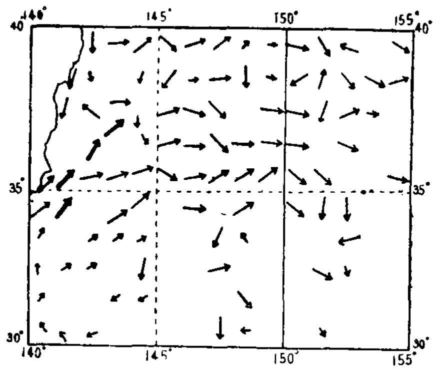


Figure 2.--Vector current chart (based on J.H.O. 6031A)

Figure 2 shows the currents for the period December to March, based on the North Pacific Current chart, Hydrographic Office Chart 6031A. As the figure shows, between 35°N. and $37^\circ30'$N., east of 145°E., the currents run almost due east. Farther north the currents also trend generally to the east, but they flow somewhat irregularly and instances can be seen where they flow to the south, to the southwest, or to the north. West of 145°E., between central Honshu and the waters off Kinkazan in northeast Honshu, there is a strong current flowing to the northeast, with another current flowing south along the coast. The waters south of 35°N. are the Kuroshio Countercurrent area, and there we see a clockwise gyre taking in all of the area from 30°N. to 35°N., 140°E. to 145°E. An area of irregular currents can be seen centered at 150°E. Farther to the south no strongly marked currents can be seen.

The main fishing grounds are in general on the east side of the Kuroshio. The area of low catch rates running from the vicinity of 40°N., 155°E. to 30°N., 150°E. appears to correspond to the area of irregular currents.

Before the war there were regular transverse observation lines running from east to west across this area, but the data for December extend to only 200 miles off the coast and, therefore, there is no way of knowing the overall oceanographic situation.

Table 5 consists of data from sectional observations running from Cape Nojima to northeast of Iwojima in November and December of 1949 and the same months of 1950.

Figure 3a and b depicts the distribution of water temperatures and salinities given in table 5.

From this table and the figures it can be seen that between 32°N. and 34°N. water of high temperature reaches fairly great depths, and this

Table 5. --Water temperatures and chlorinities between Cape Nojima and Iwojima

年月日 Date.	位置 Station.	0m	10m	25m	50m	75m	100m	150m	200m	300m	400m	潮流 Current.
1949 11−26	34°42′N 139°51′E	23.2 (19.19)	21.65 (19.14)	21.98 (19.12)	21.65 (19.10)	18.00 (19.10)	20.84 (19.19)	17.95 (19.18)	14.70 (19.11)			
〃	34°39′N 139°55′E	21.3 (19.16)	21.7 (19.14)	21.64 (19.12)	22.58 (19.13)	22.14 (19.09)	18.96 (19.19)	16.03	13.58 (19.10)			
〃	34°28′N 140°05′E	20.5 (19.01)	20.15 (19.04)	20.05 (19.03)	26.57 (19.02)	19.97 (19.14)	19.55 (19.09	14.50 (19.16)	10.11 (19.01)			
〃	34°04′N 140°22′E	21.4 (19.16)	20.65 (19.09)	21.25 (19.09)	21.17 (19.05)	21.78 (19.06)	19.71	15.69 (19.12)	12.44 (19.09)			
11−27	33°39′N 140°39′E	21.5 (19.02)	21.5 (19.09)	21.63 (19.07)	20.60 (19.06)	20.84 (19.03)	20.83 (19.06)	17.90 (19.19)	14.97 (19.16)			
〃	33°15′N 140°56′E	23.2 (19.18)	22.66 (19.27)	22.97 (19.18)	22.55 (19.18)	23.21 (19.18)	23.24 (19.19)	22.49 (19.20)	17.68 (19.24)			
〃	32°51′N 141°14′E	23.0 (19.20)	22.76 (19.18)	23.07 (19.18)	23.10 (19.18)	22.82 (19.18)	22.79	19.07 (19.25)	21.21 (19.25)			
〃	32°26′N 141°30′E	22.65 (19.13)	22.16 (19.12)	22.10 (19.13)	22.46 (19.17)	22.16	19.88	17.99 (19.30)	17.30 (19.25)			
〃	32°09′N 141°43′E	22.7 (19.13)	22.44 (19.26)	22.01 (19.18)	22.41 (19.15)	22.05 (19.13)	19.33 (19.26)	17.83 (19.25)	17.20 (19.24)			
〃	31°41′N 141°56′E	22.6 (19.12)	22.26 (19.12)	22.29 (19.16)	22.44 (19.16)	22.18 (19.16)	22.39 (19.16)	19.56 (19.29)	17.95 (19.29)			
11−28	30°30.5′N 142°20′E	22.5 (19.18)	22.29 (19.12)	22.25 (19.12)	21.99 (19.12)	22.23 (19.12)	22.10 (19.22)	18.16 (19.25)	17.71 (19.26)	17.16	15.60	NW 0.4′
29	30°10′N 143°18′E	23.2 (19.21)	23.10	23.28 (19.21)	23.10 (19.21)	23.27 (19.21)	22.85 (19.21)	18.41 (19.23)	17.72 (19.23)	16.59	15.05	0
30	29°30′N 143°30′E	23.0 (19.13)	22.67 (19.18)	23.31 19.18)	22.71 (19.17)	22.24 (19.13)	19.57 (19.23)	17.71 (19.23)	17.33 (19.23)		14.38	0
12− 1	27°13′N 143°20′E	25.1 (19.31)	24.96 (19.30)	25.00 (19.29)	24.60 (19.28)	22.22 (19.32)	20.11 (19.31)	18.60 (19.26)	17.46 (19.24)	16.68	14.50	SW Slow
2	26°19.2′N 143°09′E	25.4 (19.29)	25.03 (19.27)	25.29 (19.30)	25.18 (19.30)	24.04 (19.31)	21.04 (19.31)	18.02 (19.25)	17.58 (19.22)	16.49	14.30	SSW 0.4′
3	25°31.4′N 143°21′E	25.0 (19.28)	24.87 (19.30)	24.96 (19.29)	24.60 (19.29)	19.35 (19.26)	20.89 (19.25)	17.58 (19.23)	17.07 (19.21)	16.24	15.00	〃
5	24°15′N 143°24′E	26.5 (19.26)	26.23 (19.28)	26.64 (19.29)	26.04 (19.29)	24.99 (19.27)	21.97 (19.31)	19.36 (19.28)	17.91 (19.25)	16.38	14.00	SW 1.0′〜2.0′
1950 11−26	34°48′N 139°55′E	20.6 (19.02)	20.80 (19.00)	20.82 (18.99)	20.70 (19.00)	19.80 (19.00)						
〃	34°33′N 140°05′E	19.9 (18.98)	20.61 (18.99)	20.50 (18.98)	19.80 (19.04)	19.52 (19.01)	17.28 (19.10)	16.00 (19.17)	14.14 (19.13)		18.62 (19.00)	
〃	34°06′N 140°21′E	22.4 (19.06)	22.90 (19.08)	22.83 (19.05)	22.93 (19.04)	22.87 (19.05)	22.87 (19.05)	20.70 (19.28)	19.58 (19.26)	16.47 (19.20)	13.77 (19.17)	
11−27	33°40′N 140°37′E	21.2 (19.14)	22.00	22.02 (19.11)	22.10 (19.13)	22.03 (19.12)	(19.29)	22.14 (19.28)	19.14 (19.28)	18.08 (19.27)	16.52 (19.04)	
〃	33°13′N 140°53′E	20.7 (19.11)	21.85 (19.11)	21.83 (19.14)	21.80 (19.11)	21.74	21.71 (19.11)	20.70 (19.26)	19.72 (19.26)	17.20 (19.24)	15.75 (19.22)	
〃	32°46′N 141°09′E	21.3 (19.14)	22.12 (19.12)	18.75 (19.11)	22.06 (19.15)	22.05 (19.19)	21.85 (19.10)	21.07 (19.11)	19.45 (19.27)	17.21 (19.26)	16.10 (19.22)	
〃	32°19′30″N 141°23′E	21.6 (19.12)	22.23 (19.13)	22.22 (19.11)	22.32 (19.17)	22.31 (19.13)	22.35 (19.14)	20.29 (19.28)	20.63 (19.14)	18.48 (19.26)	17.15 (19.29)	
〃	31°51′30″N 141°41′E	21.7 (19.24)	21.78 (19.14)	21.82 (19.14)	21.82 (19.17)	21.95 (19.28)	21.93 (19.18)	19.10 (19.27)	18.69 (19.26)	17.85 (19.27)	16.80 (19.21)	
〃	31°24′30″N 141°55′36″E	20.9 (19.16)	21.60 (19.17)	21.62 (19.17)	21.71 (19.15)	21.69 (19.17)	21.60 (19.17)	18.40 (19.26)	17.60 (19.28)	16.91 (19.23)	15.96 (19.20)	
11−28	30°57′N 142°11′E	21.7 (19.11)	22.17 (19.18)	22.20 (19.17)	22.28 (19.17)	22.02 (19.17)	21.90 (19.17)	19.67 (19.17)	18.45 (19.27)	17.30 (19.23)	16.25 (19.21)	
29	30°27.5′N 142°14.5′E	22.1 (19.18)	22.38 (19.16)	22.40 (19.16)	22.50 (19.17)	22.44 (19.17)	20.69 (19.29)	18.80 (19.28)	17.75 (19.26)	16.50 (19.21)	14.30 (19.17)	W/S 0.5′
30	29°09′N 142°39′E	22.4 (19.16)	22.48 (19.17)	22.51 (19.17)	22.41 (19.17)	22.41 (19.13)	21.31 (19.19)	18.80 (19.27)	17.82 (19.27)	16.61 (19.19)	15.14 (19.17)	E/S 0.5′
12− 2	28°35′N 143°30′E	22.8 (19.12)	22.82 (19.15)	22.78 (19.14)	22.62 (19.14)	21.64 (19.26)	21.04 (19.25)	19.64 (19.25)	18.10 (19.21)	17.38 (19.21)	16.25 (19.22)	0
4	27°04′N 143°27′E	22.3 (19.21)	23.65 (19.21)	23.68 (19.21)	22.95 (19.21)	20.68 (19.20)	20.85 (19.24)	17.99 (19.21)	17.45 (19.35)	16.76 (19.25)	16.58 (19.24)	SE/E 0.3′
5	26°27′N 143°08.5′E	22.9 (19.18)	23.05 (19.15)	22.96 (19.16)	22.93 (19.15)	23.06 (19.15)	21.35 (19.24)	20.01	18.26 (19.24)	17.04 (19.22)	16.50 (19.24)	SE 0.5′
8	25°23′N 142°27.5′E	25.3 (19.35)	25.66 (19.37)	25.60 (19.35)	25.60 (19.35)	24.90 (19.42)	24.49 (19.41)	19.54 (19.33)	17.79 (19.24)	16.89 (19.24)	15.70 (19.19)	SW/S 0.3′以下
10	24°31′N 143°29′E	25.5 (19.34)	25.70 (19.35)	25.63 (19.34)	25.70 (19.34)	24.40 (19.35)	24.25 (19.35)	20.04 (19.32)	18.15 (19.24)	16.60 (19.22)	14.25 (19.22)	0

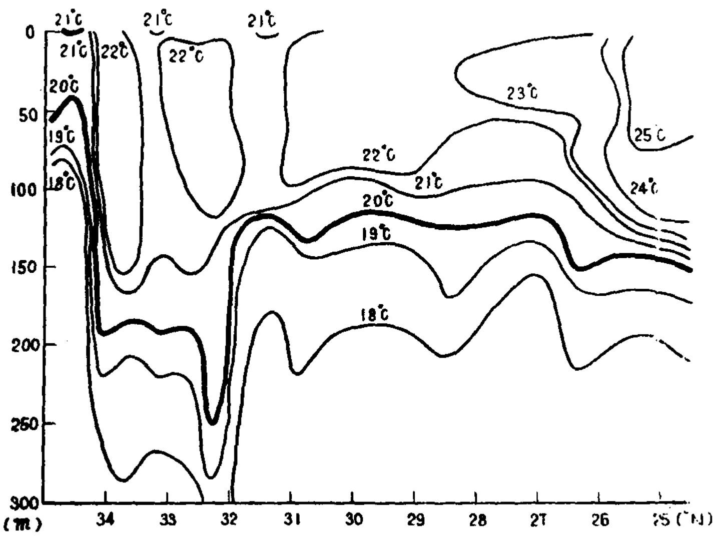


Figure 3a. --Water temperatures between Cape Nojima and Iwojima.

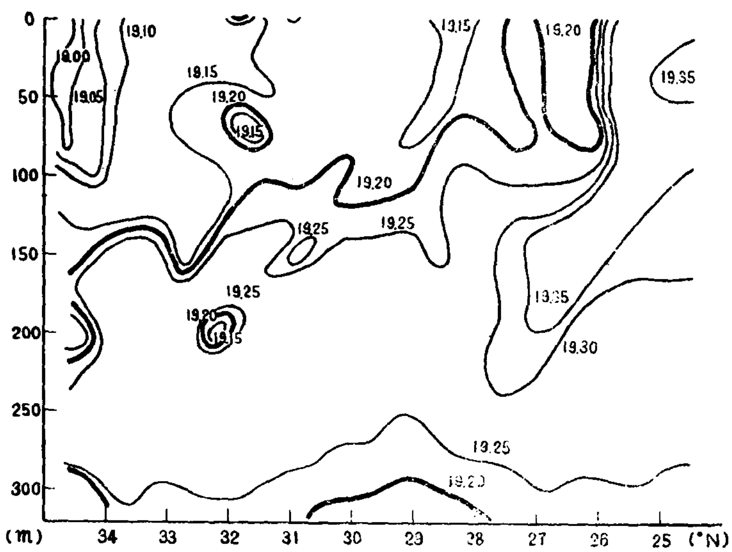


Figure 3b. --Chlorinities between Cape Nojima and Iwojima.

is thought to correspond to the main flow area of the Kuroshio. Farther to the south the water temperatures below 200 m. drop sharply, and the 20°C. isotherm runs at approximately 150 m. South of 28°N. the surface water temperature rises markedly, and from about 25°30'N. southward the temperatures are above 25°C. Off the coast near Cape Nojima the isotherms and isochlors are almost vertical, from which it can be seen that the oceanographic conditions change abruptly there.

Figure 4a and b shows the distribution of water temperatures based on data from sectional observations extending 200 miles due east of Cape Inubo. Figure 4a represents data from the 8th and 9th of December. At about 40 miles from the coast temperatures of 20°C. reached deeper than 300 m., and this is thought to be the main stream of the Kuroshio. In b, which is for the 29th and 30th of December of the same year, the mass of 20°C. water has already disappeared. The 19°C. isotherm reaches or nearly reaches the 300-m. level at 70 and 90 miles from the coast, so it appears that in this vicinity the main flow of the Kuroshio is divided into two branches. Although figures a and b represent data collected only 20 days apart, there are major changes in the pattern of the currents, and the main flow of the Kuroshio has moved about 50 miles farther offshore at the end of the month as compared with its position in the early part of the month.

In figure 4b the isotherms are almost vertical, and from this it can be seen that the changes in oceanographic conditions in this area are locally abrupt.

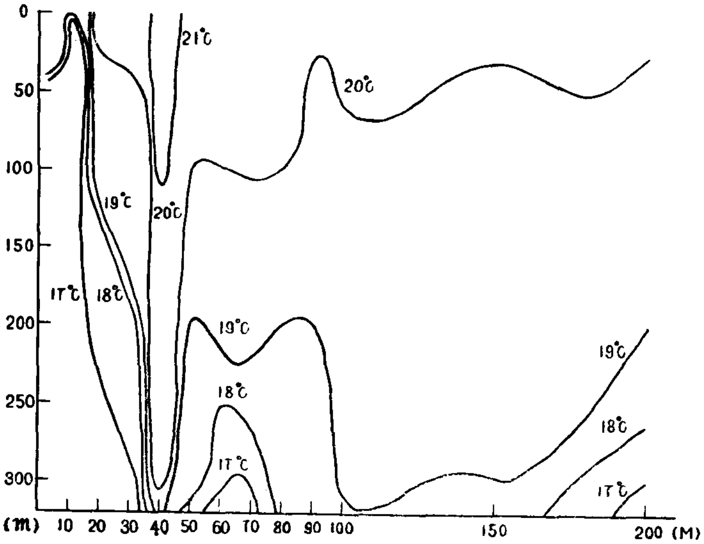


Figure 4a. --Water temperatures on a 200-mile section due east of Inubozaki, December 8-9, 1938.

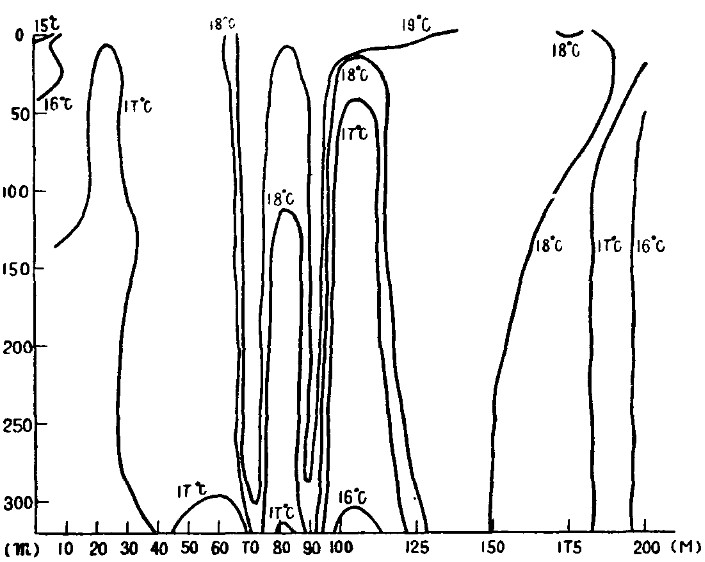


Figure 4b. Water temperatures on a 200-mile section due east of Inubozaki, December 29-30, 1938.

In December the southern extremity of the albacore fishing grounds, as has been shown in the figures, is at 27°N., and to the northward the grounds extend to 39°N. Consequently, this means that fishing grounds appear within the Kuroshio as well as to the north and south of it. If the oceanographic observation data and the data on the fishing conditions were for the same year, it would probably be possible to make some observations concerning the relationship between currents and fishing grounds, but, unfortunately, at present we do not have any data of this sort.

Table 6a and b shows the relationship between the surface water temperature and the catch rate for this area, which is divided into one part from 30°N. to 35°N. and another part from 35°N. to 40°N.

Stated very generally, table 6a represents the Kuroshio Countercurrent, and b represents the main Kuroshio and the waters to the north of it. South of 35°N. the catch rates are highest within the range of water temperatures of 20° to 21°C., followed by the rates at water temperates of 21° to 22°C. Below that the catch rates drop as the water temperatures fall. In the areas north of 35°N. the highest catch rates are at water temperatures of 17° to 18°C., followed by those areas having water temperatures of 18° to 19°C. The catch rates are lower where the water temperatures are above or below this range. South of 35°N. the average temperature at which catches are

Table 6a.--Surface temperature and catch rate, December, 30°N.-35°N., 140°E.-150°E.

水温 Temperature. \ 釣獲率 Catch-rate.	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	12~13	平均 Mean.
16°C~17°C	1	–	–	–	–	–	–	–	–	–	–	–	–	0.00
17 ~18	–	–	–	–	–	–	–	–	–	–	–	–	–	–
18 ~19	12	4	–	1	–	2	–	–	–	1	–	1	–	2.50
19 ~20	21	9	11	6	6	7	3	2	1	1	–	1	–	3.00
20 ~21	24	25	27	24	17	7	9	3	–	1	1	–	1	3.31
21 ~22	6	2	3	5	3	2	1	1	–	–	–	–	–	3.20

Note: The "mean" is the average catch rate.

Table 6b.--Surface temperature and catch rate, December, 35°N.-40°N., 140°E.-150°E.

水温 Temperature. \ 釣獲率 Catch-rate.	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8		15~16	平均 Mean.
14°C~15°C	6	–	–	–	–	–	–	–		–	0.50
15 ~16	1	–	–	–	–	–	–	–		–	0.50
16 ~17	3	2	1	–	–	–	–	–		–	1.17
17 ~18	1	1	–	2	–	1	–	–		–	2.90
18 ~19	21	6	3	2	–	1	1	–		2	2.14
19 ~20	17	6	4	4	3	1	–	1		–	1.89
20 ~21	25	7	5	4	3	–	–	1		–	1.57
21 ~22	13	–	–	1	–	–	–	–		–	0.75

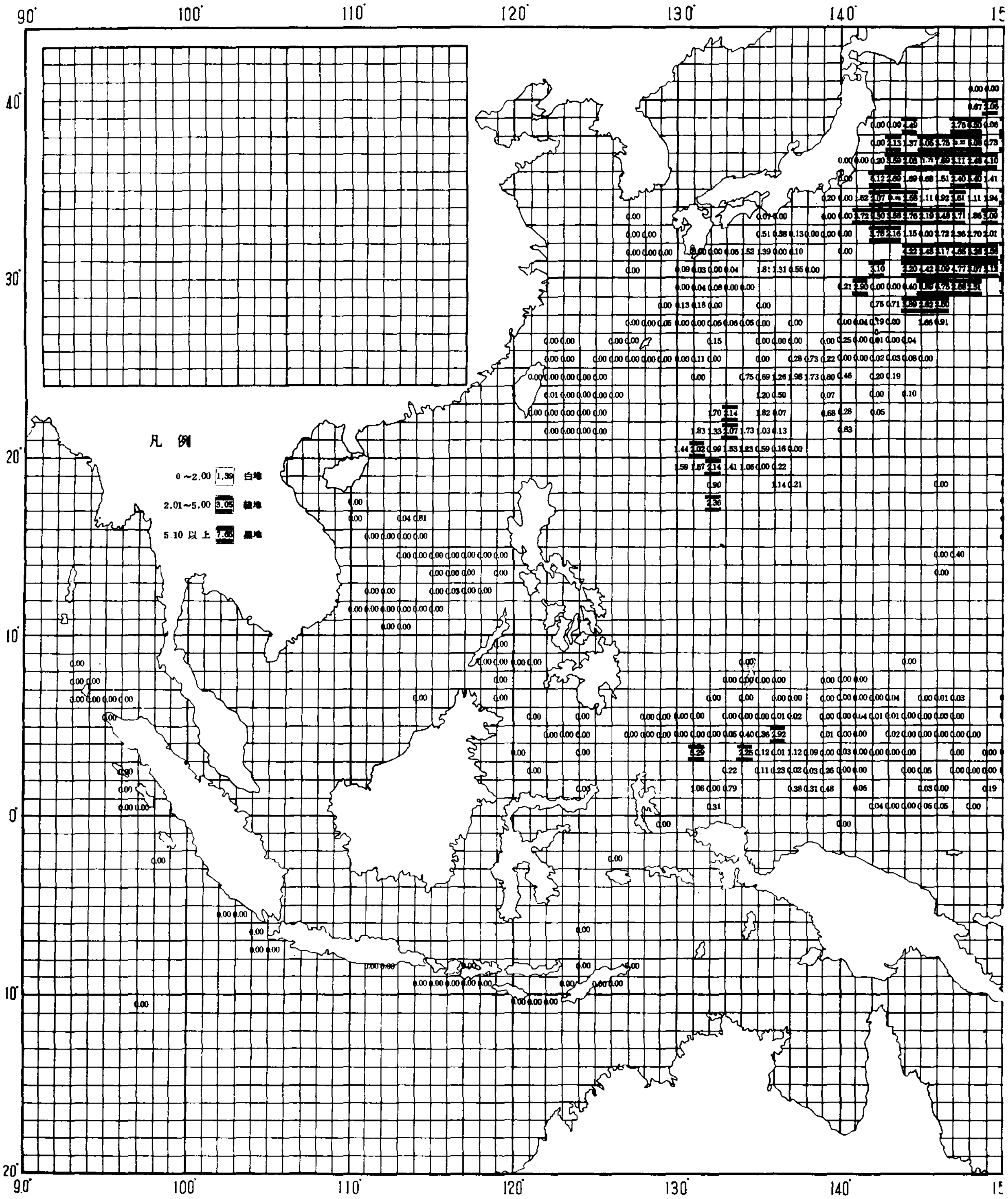
made and the standard deviation are $19.6^{\circ} \pm 1.09^{\circ}$C. North of 35°N. these figures are $17.8^{\circ} \pm 1.75^{\circ}$C. Thus the water temperature at which the highest catch rates are recorded is different in the two areas, and it is thought to be probably unreasonable to attempt to determine a so-called favorable water temperature which can be applied to the whole fishing ground.

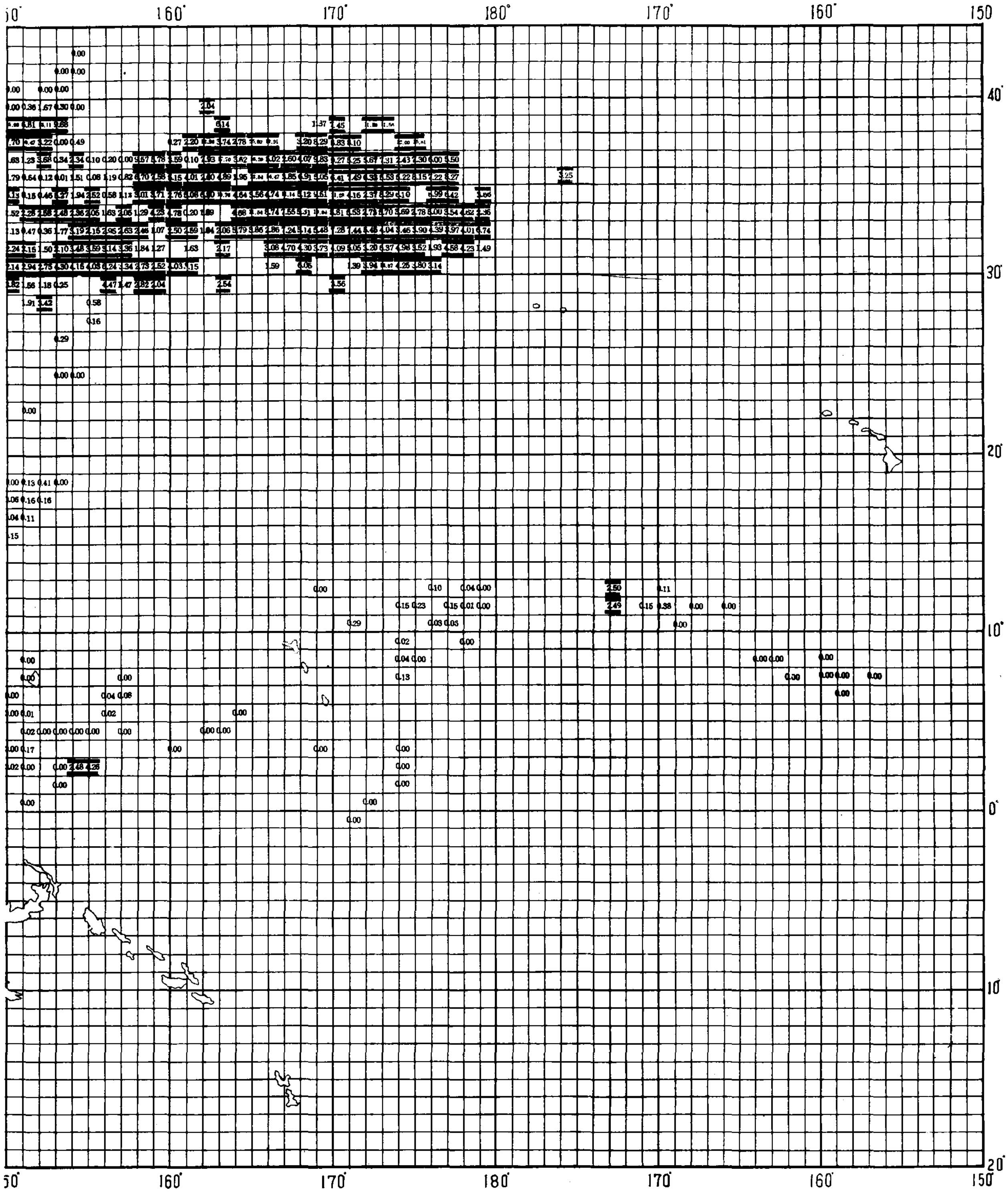
Table 7.--Standard deviation (σ) and coefficient of variation (σ/M) of catch rate with temperature

海域 Locality. °E	°N	水温 Temperature.	標準偏差 σ	変異係数 σ/M
140~150	30~35	19°C	2.48	83%
〃	〃	20°C	2.22	67
〃	35~40	17°C	1.74	60
〃	〃	18°C	3.64	170

Table 7 shows the difference in the catch rates at a given water temperature for the areas north and south of 35°N.; the coefficients of variation are greater than 60 percent. It is thought that such a large deviation indicates that there are other important elements in the formation of the fishing grounds besides water temperature. At any rate, the surface water temperature, although it may be an essential element in the development of a

ビ　ン　ナ　ガ　(Albacore (*Thunnus germo*))　１２　(December)




160°
170°
180°
170°
160°
150
40°
30°
20°
10°
0°
10°
20°
160°
170°
180°
170°
160°
150°

fishing ground, can hardly be thought to be the only condition governing that development. This, consequently, automatically limits the significance which the surface water temperature can have as an indicator in scouting for fishing grounds. In undertaking fishing operations in these waters in December it will be better to avoid water masses with temperatures below 18°C. south of 35°N., and north of that latitude it will probably be advantageous not to operate in waters with a temperature below 17°C. or above 20°C.

II). Area of 150°E. to 160°E.

This is the area of low catch rates between the waters west of 150°E. and those east of 160°E. The difference between the catch rates in this area and in those adjacent to it on the east and west is extraordinarily conspicuous in October, but in November areas of high catch rates intrude from the east and west and the area of low catch rates is considerably narrowed. In December the catch rates here are still lower than in the waters to the east and west, particularly low catch rates being seen in those sections running southwest from the vicinity of 40°N., 155°E.

Looking over this area as a whole, we find a row of unit areas with comparatively high catch rates running along its southern part; i.e., along 30°N. In the northwestern part, also, north of 34°N. there is a triangular area of high catch rates. Judging from the way in which the fishing grounds develop from November on, the former section of high catch rates is a prolongation of the waters east of 160°E., while the latter is probably an extension from west of 150°E. If we omit these sections with high catch rates, throughout this area as a whole there is a trend for the catch rate to be lower in the west and higher in the east. This pattern probably is a result of the extension of the fishing grounds westward from east of 160°E.

The position at which the part with low catch rates appears shifts east and west considerably from year to year, and these shifts appear to parallel the movements of the North Pacific fishing grounds as a whole.

Catch rates over this whole sea area are higher than they were in November. Between 29°N. and 32°N. unit areas with catch rates of 2.0 to 5.0 are lined up solidly. Between 32°N. and 37°N., east of 155°E., there are many catch rates of 1.0 to 3.0 and at times they go higher than 5.0, but west of 155°E., in general, the catch rates are low and there appears to be a wedge-shaped trough of low catch rates.

As for the changes in the catch rates in the triangular area of high rates in the northwest, the values increase just like those in the northern part of the area west of 150°E. In waters south of 35°N. the coefficients of variation of the catch rates are 30 to 40 percent and the fishing conditions appear to be rather stable.

Table 8 shows the length (weight) composition of the catch in this sea area.

Table 8.--Albacore size composition, December 1948-51, 150°E.-160°E. longitude (in percentages)

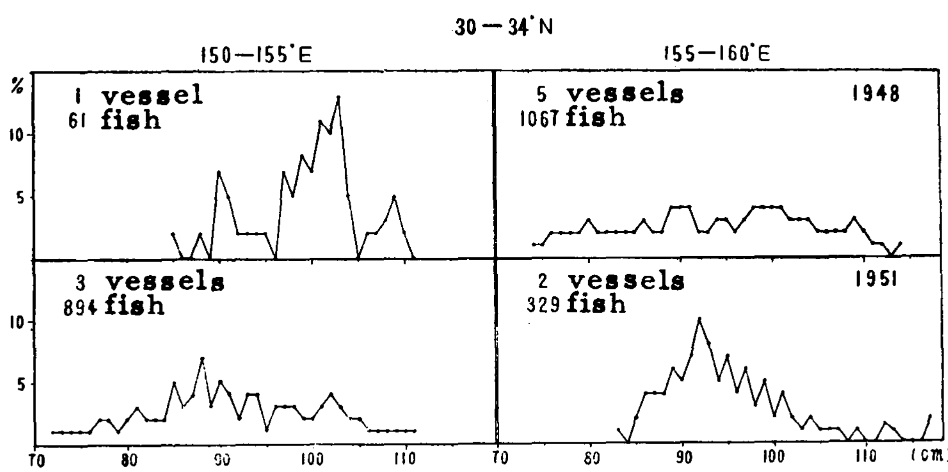
体長(重) Length (weight) / 緯度 Latitude.	55~65cm (1.1)貫	65~75 (1.9)	75~85 (2.8)	85~95 (4.1)	95~105 (5.8)	105~115 (7.4)	平均体重 Mean. (W)	140°E~150°Eの体重 Mean (W')	同右との比 W/W'	N
30°N~32°N	—	0.3	2.1	43.3	41.8	12.7	5.20	3.76	1.4	818
34 ~36	0.9	5.1	43.0	38.9	9.9	3.0	3.67	2.41	1.5	513

Note: "Mean (W')" is the average weight of albacore caught between 140°E. and 150°E. Weights are in kan /8.27 lbs./.

The fish are clearly larger in the south and smaller in the north. Comparing this with the composition of the catch at 140°E. to 150°E., in terms of weight the fish are about 1.5 times larger.

Table 9 shows the size composition of the fish in this area divided into eastern and western parts in order to compare the size of fish on each side of the area of low catch rates.

Table /sic/ 9.--Comparison of length frequencies east and west of 155°E. longitude



The relationship between the surface water temperature and the catch rate is shown in table 10.

Table 10a.--Catch rate and surface temperature, December, 30°N.-35°N., 150°E.-160°E.

釣獲率 Catch-rate. / 水温 Temperature.	0 ~ 1	1 ~ 2	2 ~ 3	3 ~ 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8	8 ~ 9	9 ~ 10	10 ~ 11	11 ~ 12	12 ~ 13	13 ~ 14	14 ~ 15	平均釣獲率 Mean.
17°C ~ 18°C	1		1		1											2.50
18 ~ 19	3	3	2	3	6	2		1								3.45
19 ~ 20	39	24	14	16	11	8	7	3	3		2					2.79
20 ~ 21	15	27	17	19	25	8	2	5	1	1			1			3.26
21 ~ 22	11	13	22	16	5	2	3	3	1						1	3.05
22 ~ 23		1	3	1												2.50
23 ~ 24		1														1.50

Table 10b.--Catch rate and surface temperature, December, 35°N.-40°N., 150°E.-160°E.

釣獲率 Catch-rate. / 水温 Temperature.	0 ~ 1	1 ~ 2	2 ~ 3	3 ~ 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8	8 ~ 9	9 ~ 10	10 ~ 11	11 ~ 12	12 ~ 13	13 ~ 14	14 ~ 15	平均釣獲率 Mean.
17°C ~ 18°C	6	1		1												1.00
18 ~ 19			1		2	1	3	3	1	1		1	1	1	4	9.08
19 ~ 20	7		1	1	1			1	1		1				1	3.92
20 ~ 21	5	4	1	1	1		1									1.96
21 ~ 22	1															0.50

The water temperatures at which the catch rates are highest differ north and south of 35°N., just as they did in the area of 140°E. to 150°E. In the area of 30°N. to 35°N. two modes are seen at 18° to 19°C. and at 20° to 21°C., while at 35°N. to 40°N. the mode appears at 18° to 19°C. The average temperature at which fish were taken was 19.8°C. south of 35°N. and 18.5°C. north of that latitude, the temperatures in both cases being higher than in the waters west of 150°E.

It appears from table 9 that between 30°N. and 35°N. the surface water temperatures at which fishing is good have a broad range of 18° to 22°C., while north of 35°N. the best fishing is shown for the range of 18° to 19°C.

III). <u>Sea areas east of 160°E.</u>

This sea area has the highest catch rates with the least variation of any of the North Pacific albacore fishing grounds. The albacore caught here are also the largest taken on any of the grounds. This is the offshore group hypothesized by Uda[9]. Most of the large-sized vessels which put out with the objective of fishing albacore have operated in this region, particularly between 1925 and 1935, when it was the main fishing ground for the larger vessels. Around 1936 the yellowfin grounds of the South Seas were opened up, and thereafter the number of vessels operating in this region greatly diminished. After the war, when the fishing grounds were limited by the so-called MacArthur Line, the number of vessels operating in this region again increased, but with the disappearance of the MacArthur Line there was another marked decrease in the number of vessels operating.

In this sea area the fishing is already quite good in November; the catch rates further rise in December, and east of 165°E. almost all of the unit areas show catch rates above 3.0. The catch rates for unit areas are highest in the north, with the majority above 34°N. showing rates above 5.0. Along the southern edge of this area, contrary to the case of the areas west of 160°E., the catch rates are somewhat lower than the overall average for the area.

Table 11 shows the frequency distribution of coefficients of variation for six divisions of this area made by dividing it into east and west halves of 10° of longitude each and further dividing these into three parts of 3° of latitude each.

Table 11.--Variation in fishing conditions between 160°E. and 180° in December

位置 Station. °E	変異係数 Coefficient of variance. °N	0~10 %	10~20 %	20~30 %	30~40 %	40~50 %	50~60 %	60~70 %	70~80 %	80~90 %	90~100 %	100~110 %	110~120 %	平均 Mean. %
160~170	30~33	1	1	5	2	1	1	2	1					37
〃	33~36		4	3	3	2	2	3	1			1	1	47
〃	36~39	1		1		2	2		3					51
170~180	30~33	1	1	5	3	2	4	1						37
〃	33~36		2	3	9	2	7	2	1		1			44
〃	36~39			1	1									30

Just as in the waters west of 160°E., the variation in fishing conditions is small in the south, and this is judged to indicate fairly stable conditions. Conditions in the most northern part of the section of 170°E. to 180° are not well known because of the paucity of data, but it is clear

[9] Uda, Michitaka. Bull. Jap. Soc. Sci. Fish., Vol. 5., No. 5.

that the variability increases to the northward. It appears that on both the east and west sides of the 170°E. boundary line the changes with latitude in the coefficient of variation are approximately equal. It should also be noted that compared with the various sea areas west of 160°E. the values for the coefficient of variation are in general small. In this connection it can probably be said, for the North Pacific albacore fishing situation as a whole, that it is more stable along the southern boundary and that its variability increases to the northward. Furthermore, the variability is greater in the west and the stability increases to the eastward.

As for the size of the fish, it has already been stated several times that they are larger in the south, smaller in the north, smaller in the west, and larger in the east, and this seems to mean that the larger the fish taken in the fishery, the more stable the fishing conditions on the fishing grounds. This is a point which should be thoroughly considered in connection with the economic operation of the fishery.

Table 12 presents data on the length (weight) composition of the catch in various sections of the area between 160°E. and 180° which is divided up as in table 11 into an eastern and western half and further into sections of 2° of latitude.

The table shows that the fish are larger in the south and smaller in the north and, furthermore, although the difference is small, that they are larger between 170°E. and 180° than they are between 160°E. and 170°E.

Table 12.--Albacore size composition in December at 30°N.-40°N., 160°E.-180°. Weights are in kan (k.) = 8.27 lbs.

経度 Long. °E	緯度 Lat. °N	cm 55~65 貫 (1.1)	〃 65~75 〃 (1.9)	〃 75~85 〃 (2.8)	〃 85~95 〃 (4.1)	〃 95~105 〃 (5.8)	〃 105~115 〃 (7.4)	平均 Mean.	測定尾数 No. fish	140°~150°との比率	10月との比	11月との比	150°~160°の魚体
160~170	30~32			12.9	65.4	19.0	2.7	4.31貫	184	1.2			5.20貫
〃	32~34		0.2	25.2	53.8	15.3	5.5	4.21〃	830	1.3			
〃	34~36		3.9	49.7	34.5	7.9	4.1	3.64〃	170	1.5		0.9	3.67
〃	36~38	0.2	2.8	43.0	37.5	16.1	0.4	3.76〃	459	1.7	0.8	1.1	
170~180	32~34	0.3	3.2	18.1	46.8	19.8	11.8	4.51〃	1318	1.4			
〃	34~36	0.8	6.3	36.4	38.2	10.8	7.6	3.90〃	754	1.6		0.9	

Note: Column headed "Mean" is weight in kan; "No. fish" is number measured; last four columns are, left to right, ratio to 140°-150°E., ratio to October, ratio to November, and weight (in kan) of fish at 150°-160°E.

Compared with the waters between 140°E. and 150°E. the fish are generally 1.2 to 1.7 times larger. At 30°N. to 32°N., 150°E. to 160°E., the size of the fish is greater than in any sea area to the east or west, marking a break in the general trend for the size of the fish to increase to the eastward. It is, however, impossible to tell whether this condition always obtains without accumulating more data.

Table 13a and b presents the relationship between the surface water temperature and the catch rates between 160°E. and 170°E.

Table 13a.--Surface temperature and catch rate, December, 30°N.-35°N., 160°E.-170°E.

釣獲率 % Catch-rate. / 水温°C Temperature.	0 ~ 1	1 ~ 2	2 ~ 3	3 ~ 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8	8 ~ 9	9 ~ 10	10 ~ 11	11 ~ 12	13 ~ 14	14 ~ 15	平均 Mean.
16 ~ 17		1													1.50
17 ~ 18		4	4	2	1	2									2.96
18 ~ 19	7	12	10	4	10	4	5	3		1	2		2	3	4.50
19 ~ 20	12	10	17	16	15	7	5	3	1	1	1				3.51
20 ~ 21	5	4	7	9	11	3	3	3							3.68
21 ~ 22	2	4	1	2											1.83

Average water temperature where fish were taken, 18.6°C.

Table 13b.--Surface temperature and catch rate, December, 35°N.-40°N., 160°E.-170°E.

釣獲率 % Catch-rate. / 水温°C Temperature.	0 ~ 1	1 ~ 2	2 ~ 3	3 ~ 4	4 ~ 5	5 ~ 6	6 ~ 7	7 ~ 8	8 ~ 9	9 ~ 10	10 ~ 11	11 ~ 12	平均 Mean.
15 ~ 16			1										2.50
16 ~ 17													—
17 ~ 18		2	6	1	1	1	2	2	1	1			4.56
18 ~ 19	3	2	4	1	2	1	2			2		1	4.22
19 ~ 20	1	4	2	1	1								2.17
20 ~ 21	1		1	1		1							3.00

Average water temperature where fish were taken, 17.8°C.

It can be seen from the table that between 30°N. and 35°N. the mode is between 18° and 19°C. and catch rates are approximately 3.0 or above within the range of 17°C. to 21°C. Consequently, it will be profitable to avoid waters having temperatures below 17°C. or above 21°C. in operating in this area.

Between 35°N. and 40°N., the mode is between 17°C. and 19°C. but fairly good catch rates are seen at the other water temperatures represented.

Table 14a and b shows the relationship between surface water temperature and catch rate in the area of 170°E. to 180°.

Table 14a.--Surface temperature and catch rate, December, 30°N.-35°N., 170°E.-180°

釣獲率 % Catch-rate. / 水温°C Temperature.	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	平均 Mean.
17 ~ 18	1	7	17	5	3	1		2	2.92
18 ~ 19	3	17	19	6	3	2		1	2.50
19 ~ 20	6	24	19	15	6	5	3	1	2.95
20 ~ 21	1	16	4	2		1	1		2.14
21 ~ 22	2			2					2.00

Table 14b.--Surface temperature and catch rate, December 35°N.-40°N., 170°E.-180°

釣獲率% Catch-rate / 水温°C Tamperature.	0~1	1~2	2~3	3~4	4~5	5~6	6~7	7~8	8~9	9~10	10~11	11~12	平均 Mean.
17 ~ 18		1	1	1	2	1		3	1		1		5.68
18 ~ 19	1	2	1	5	3	2	3	1	1	2	1		5.14
19 ~ 20			3		2	4	1		1				4.86

Average water temperature where fish were taken, 17.9°C.

For the waters between 30°N. and 35°N. little difference in the catch rates is shown within the range of 17° to 21°C., and modes can be seen at 17°-18°C. and at 19°-20°C.

At 35°N. to 40°N. the range of change in water temperature is narrow, and catch rates are generally shown to be high within the range of 17° to 20°C., with a mode appearing at 17°-18°C.

Comparing the relationships between catch rates and surface water temperatures over the whole area of 140°E. to 180°, we find:

1. Between 30°N. and 35°N. the modes appear as follows:

   a. At 19°-21°C. between 140°E. and 150°E.
   b. At 18°-19°C. and at 20°-21°C. between 150°E. and 160°E.
   c. At 18°-19°C. between 160°E. and 170°E.
   d. At 17°-18°C. and at 19° to 20°C. between 170°E. and 180°.

Consequently, as a trend, it can probably be said that for each 10° of longitude one moves eastward the surface water temperature at which the catch rate mode appears is lowered by 1°C.

2. Making the same sort of comparison for the waters between 35°N. and 40°N., the modes appear:

   a. At 17°-18°C. between 140°E. and 150°E.
   b. At 18°-19°C. between 150°E. and 160°E.
   c. At 17°-19°C. between 160°E. and 170°E.
   d. At 17°-19°C. between 170°E. and 180°.

Thus it is difficult to see any difference between areas, although the temperatures appear to be somewhat higher in the central part.

As a general trend over the whole sea area, the catch rates are higher south of 35°N. and the range of water temperatures is broader, while north of 35°N. the range is narrower, however, between 170°E. and 180° the contrary is true, with good fishing shown north of 35°N. in a broad range of surface water temperatures.

2. Kinan Sea Area

In December fishing grounds are clearly developing in this sea area, where in November no albacore appeared at all. Fishing is still sparse here in December, but unit areas with catch rates above 1.0 are seen at 30°N. to 32°N., 134°E. to 137°E. Fishing in this area becomes active from January on, and it is an important fishing ground for small and medium-sized vessels.

Table 15 shows water temperatures for this area based on oceanographic observations made by the Hyūga Maru in 1952.

Table 15.--Water temperatures in the Kinan Sea Area, December 1952

St. No.		I	II	III	IV	V	VI	VII
位置 Station	N E	33° 24′ 135° 45′	33° 16′ 135° 47′	33° 06′ 135° 53′	32° 46′ 135° 53′	32°26.5′ 135°57.5′	32° 07′ 136° 02′	31° 47′ 136° 06′
日付 Date.		12.15.1952	12.15	12.15	12.15	12.16	12.16	12.16
時間 Hour.		9^{00}~10^{15}	11^{20}~12^{50}	14^{30}~15^{15}	18^{35}~20^{10}	23^{05}~ 0^{05}	3^{30}~ 4^{52}	7^{45}~ 9^{25}
Water temperature	Stratum (m)							
	0	22.2	22.2	23.3	22.9	21.4	21.4	21.5
	10	21.76	21.99	23.35	22.99	21.48	21.39	21.45
	25	20.38	22.01	23.28	23.00	21.45	21.47	21.39
	50	18.99	21.58	23.30	22.45	21.51	21.45	21.45
	100	18.59	20.07	22.53	22.14	21.39	20.37	21.37
	150	16.50	20.49	21.24	20.84	19.29	18.91	20.33
	200	14.92	19.09	19.21	19.03	18.59	18.58	19.12
	400	10.52	13.73	15.13	15.49	16.56	17.05	16.51
	600		5.62	9.14	10.49	11.47	12.98	12.51

3. Okinotorishima Fishing Ground

The position of this fishing ground has not changed much from November, but it shows a tendency to expand to the southwest and its southern extremity reaches 17°N. With this expansion of the fishing ground, its center also moves gradually to the south or southwest. In general the catch rates are about 1.0 to 2.5, not greatly different from November.

There appear to be extreme fluctuations in fishing conditions on this fishing ground from year to year, and table 16 shows these changes in the catch rates for the period 1949 to 1951.

Table 16.--Annual fluctuations in the catch rate on the Okinotorishima fishing ground

釣獲率 % Catch-rate. / 年次 year.	0 ~0.5	0.5~1.0	1.0~1.5	1.5~2.0	2.0~2.5	2.5~3.0	3.0~3.5	平均 Mean.
1949	3	3		1				0.68
'50	2	2	4	5	9	5	1	1.89
'51	13	8	4	2				0.66

As the table shows, the catch rates in 1950 were nearly three times those of the preceding and following years. There are also violent fluctuations in catch rates within unit areas, as shown in table 17.

Table 17.--Fluctuations in the catch rates by unit areas [frequency of coefficients of variation]

C. V.	0~10	10~20	20~30	30~40	40~50	50~60	60~70	70~80	80~90	90~100	平 均 Mean.
Frequency	2	4	4	6	6	10	5	3	1	1	46

The oceanographic conditions have changed considerably since November. In November there was a clearly marked gyre, with the fishing grounds developing in its middle, but in December this gyre has become unclear and displaced to the southeast (see the supplementary chart for November).

The albacore taken in this area, as shown in table 18, are all extraordinarily large fish.

Table 18.--Albacore size composition in the Okinotorishima area by years, 1949-51. Weights (W) in ( ) are in kan = 8.27 lbs.

年 次 year.	海 域 Locality. °N	75~85cm (2.8)	85~95cm (4.1)	95~105cm (5.8)	105~115cm (7.4)	平均(貫) Mean W.	測定尾数 No. fish
1949	22~24			8	45	7.16	53
1950	18~20		15	153	153	6.48	321
″	20~26	1	9	185	315	6.75	510
1951	18~24		6	80	121	6.69	207

As can be seen from the table, the fish are extraordinarily large, with a great difference in size as compared with those from the North Pacific fishing grounds. South of the Subtropical Convergence, at about the same longitude, the density of distribution of albacore is generally low and the fish are generally large, apparently of about the same size as the fish taken on this ground.

4. South Seas

The catch rates are generally up as compared with November. As has already been stated, there is a scattering of unit areas with catch rates of 1.0 or greater.

a. Palau waters

In November, there were unit sea areas with high catch rates in the waters southwest of Palau, and in December there is a row of unit areas with high catch rates to the south of Palau at 1°N. to 4°N., between 130°E. and 140°E.

For this sea area as a whole the albacore catch rates show wide fluctuations, with a coefficient of variation of almost 100 percent. This fact is thought to indicate somewhat of a difference in character between the schools here and those in the Okinotorishima fishing ground and the North Pacific fishing ground. It is also thought that the topography may have something to do with this phenomenon, but under present conditions an adequate explanation is impossible.

There are few data on the size of the fish, but as shown in the following table they are somewhat smaller than those on the Okinotorishima grounds.

Table 19.--Albacore size composition in waters south of Palau Is., 1950-1951

年 次 year.	cm 65~75	75~85	85~95	95~105	105~115	平均(貫) Mean(kan)
1950	3	9	1	16	11	5.23
1951			2	34	10	6.07

The table shows that the fish are generally larger than those of the North Pacific fishing ground, but smaller than those of the Okinotorishima fishing ground. It will also be noted that, as compared with the Okinotorishima fishing ground, the range of distribution of the lengths appears broader.

b. Caroline Islands waters

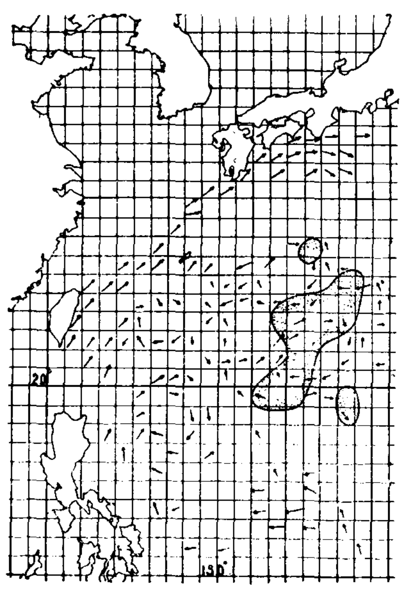
Although they are extremely limited, in comparison with the area south of Palau, the waters around Kapingamarangi Island show some areas of catch rates of 2.0 or more, and the data indicate a possibility that at times there may be rather concentrated catches. We have very few data on the size of the fish, but five which we were able to weigh have an average weight of 7.08 kan [58.5 lbs.], so they are rather large.

c. Marshall Islands to south of Hawaii

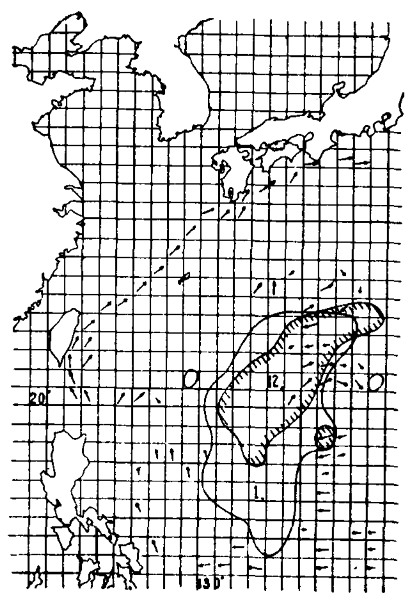
This region, as will be noted in a later section, is a fishing ground principally for bigeye, the fishing grounds in general running east and west at around 8°N. to 12°N. Some albacore are also taken mixed with the bigeye. On the whole, catch rates are low, but occasionally high catch rates are recorded. As we have extremely little data from investigations of the sizes of albacore in this region, we have no way of knowing the general situation. The average weight of 30 specimens from the area of 8°N. to 12°N., 170°E. to 180°, was 6.87 kan /56.8 lbs./, which is little different from the average weight of 6.7 kan of 16 specimens from 8°N. to 12°N., 170°W. to 160°W.

In these waters of the South Seas, or south of the Subtropical Convergence, the albacore are generally broadly but sparsely distributed. Their size in general is extremely large. These facts are thought to have a great significance ecologically, but we have hardly any concrete information. We believe, however, that the source of replenishment and manner of replenishment of these schools of large fish offers an interesting theme for research. /Translator's note: The following two unnumbered figures are inserted here in the original. See page 25/.

Supplementary chart /unnumbered/. -- Fishing grounds and vector currents in the Okinotorishima area in November



Supplementary chart /unnumbered/. -- Fishing grounds and vector currents in the Okinotorishima area in December



JANUARY

General

The distribution of the fishing grounds is in basic agreement with the December pattern. If we except the South Seas area, where the albacore schools already show signs of a decline, all fishing grounds show an increase in the density of albacore occurrence as compared with December. This is particularly outstanding in the case of the albacore schools of the Kinan Sea Area, where the catch rates make a sudden jump in January and make this one of the most important albacore grounds. The density of the albacore also increases in the sea areas of the middle latitudes and in the Okinotorishima fishing ground, where along with the expansion of the area of the grounds the catch rates rise higher than their December levels, producing the peak season in this area. Elsewhere albacore also begin to appear even in comparatively enclosed waters, and areas with fairly high albacore catch rates are seen from west of the Bashi Strait to the central part of the South China Sea. Some albacore also cross to the west of the line of the Okinawa archipelago and appear in the East China Sea.

Grounds North of the Subtropical Convergence

(1) North Pacific Ground

In general, the points of difference with December are as follows:

1. The southern edge of the fishing ground is about 1° to 2° farther south than in January [Translator's note: probably a misprint for December].

2. The northern edge of the fishing ground has shifted 2° to 3° south from its December position. Because the southward movement of the northern edge of the ground is faster than that of the southern edge, it looks as if the ground, as compared with December, has been pushed somewhat to the southward and its north-south extent somewhat narrowed.

3. The western extremity of the ground is completely in contact with the line of the Izu and Ogasawara archipelagoes.

4. The position of the intermediate zone has been pushed considerably to the westward, as compared with its position in December and earlier, and there appears to be a portion of the area of low catch rates between 145°E. and 150°E. However, in general this is not very clear.

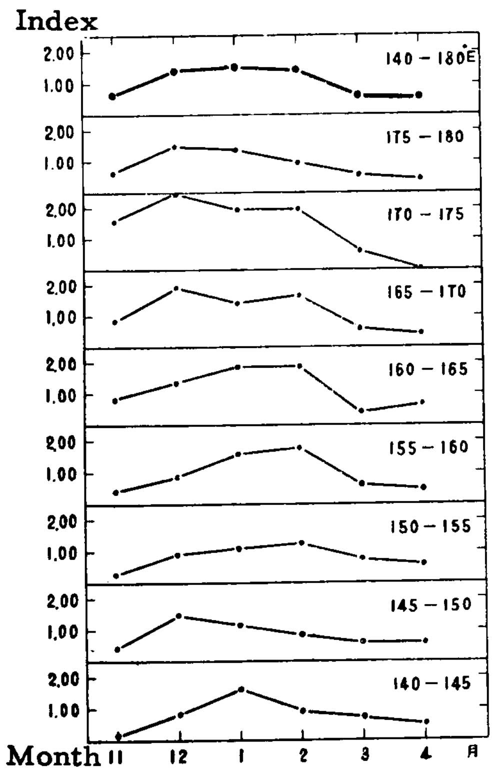


Figure 1.--Indices of seasonal changes in catch rates.

In figure 1 the rise and decline of this fishing ground are shown by index figures. In the figure, the average monthly catch rates within segments of 2° of latitude by 5° of longitude are assembled for each longitude division, the values are averaged for the period of November to April, and these averages are further averaged to get a value which is taken as 1.0 on the index scale. As the figure shows, for each division of the area the peak of the season is either in January or thereabouts. If we compare the rise and decline of the fishing conditions in the whole area by months, we find that the best fishing season is between December and February, with January having somewhat higher values than the preceding or following months. East of 165°E. the peak of the season appears in December and then is maintained with little change until February. West of 165°E. the peak is either in January or February, except for its appearance in December at 145°E. to 150°E. At 150°E. to 160°E. the peak fishing season is in February, whereas at 145°E. to 150°E. the fishing is rather slack in January and February. This condition is thought to arise from the shift of the intermediate zone. In any case, the period when fishing is most active is around January.

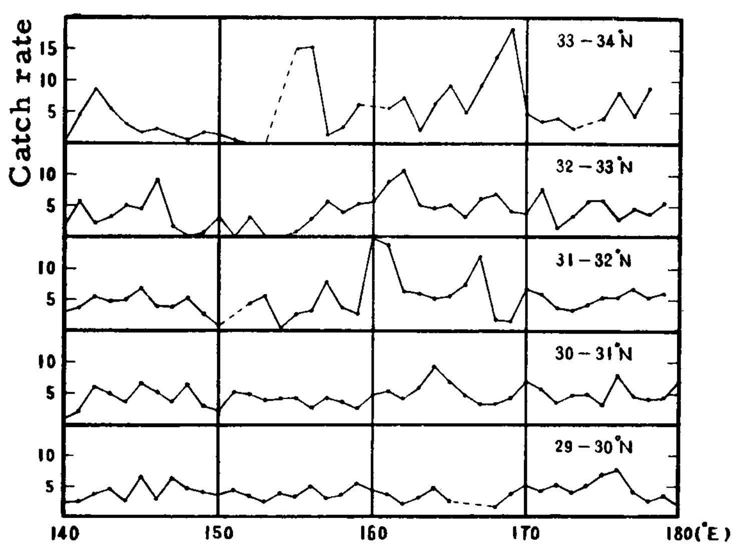


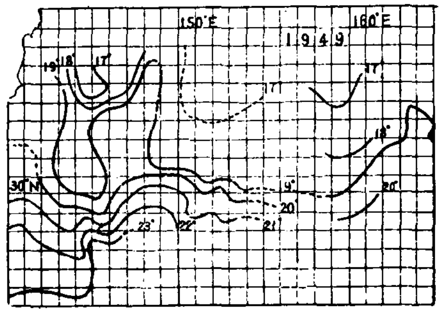
Figure 2.--Catch rates by latitude.

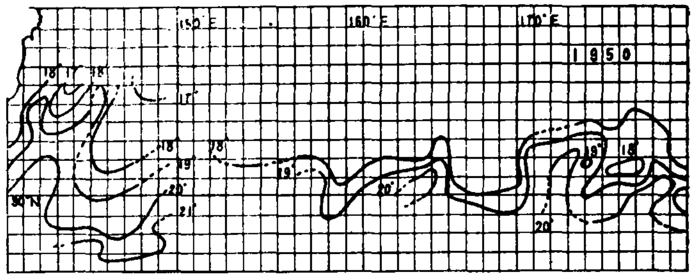
In figure 2 it appears that south of 30°N., along the southern edge of the area, the geographical distribution of catch rates of 3.0 to 5.0 is continuous and there is no great variation from area to area. Between 30°N. and 31°N. the catch rates vary around 3.0 to 5.0, but they show a tendency to become higher to the eastward and, at the same time, the variability within the area is somewhat greater than it is south of 30°N. Between 31°N. and 32°N. the existence of the intermediate zone can be detected at 150°E. to 160°E., and we see scattered here and there areas of low catch rates. With the exception of these areas the catch rates are even higher than they are in the more southerly parts of the ground, but their variability is greater. North of 32°N. the intermediate zone exercises some effect between 145°E. and 150°E. and, in general, the variability of the fishing grounds is even greater, with occasional indications of highly outstanding catch rates. As for the changes from year to year in the position at which the intermediate zone appears (see table 1), in 1949 its position was quite far from the coast, but in 1950, 1951, and 1952 its western edge was running southwest to northeast in the vicinity of 35°N., 145°E.

The isotherms shown on the supplementary charts are based on data supplied by commercial fishing vessels and are an attempt to show the general picture of the distribution of water temperatures in this fishing ground. (The data are for the period of December 10-15 of each of the years covered.) Comparing the pattern in the different years, we see quite well-marked differences in the area where the Kuroshio turns eastward. In 1949 a zone of high water temperatures is seen intruding in a northeasterly direction considerably farther offshore than in an average year and, as a result, the tongue-shaped zone of low weather temperatures on its eastern side protruding to the southwest was pushed conspicuously eastward and was located east of 150°E. longitude. In 1950 and 1952 (data for 1951 are lacking), in comparison with 1949, the area in which the current swings to the east was located much closer to Japan. The tongue-shaped low temperature water mass on the east side of the main current of the Kuroshio was located right on the intermediate-zone fishing ground, and this change was in good agreement with the annual change in the intermediate zone. In waters east of 150°E. longitude, as a general rule, the isotherms follow the parallels of latitude and run east and west, but, between the point of eastward deflection of the current and the countercurrent, large and small vortices are formed which in some years appear to develop on an extremely large scale, forming a good fishing ground.

Table 2 presents the results of sectional observations made off Kinkazan in 1936 (a year of particularly low water temperatures).

Supplementary charts /unnumbered/.--Distribution of isotherms in the North Pacific, January, 1949, 1950, 1952.





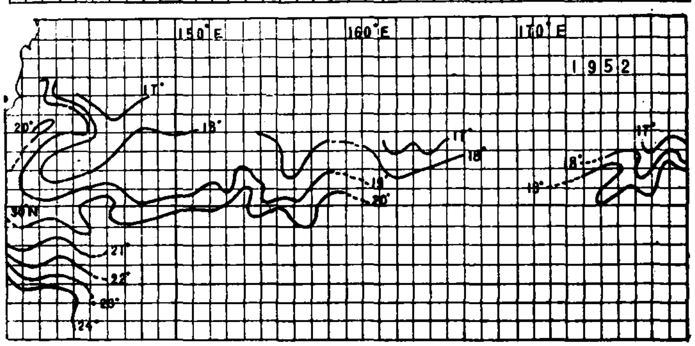


Table 1.--Albacore fishing conditions (catch rates) in the North Pacific by years

1949

経度 °E. / 緯度 °N.	140°~141°	141~142	142~143	143~144
39~40				
38~39				
57~38				
36~37				
35~36				8.34
34~35	0.98	2.94	4.31	2.61
33~34	4.24	9.91	9.10	12.30
32~33	3.81	11.30		11.10
31~32				4.66
30~31				
29~30	1.56			
23~29			3.27	1.85
27~28	4.61		0.27	2.15
26~27	1.18			
25~26				

緯度 °E. / 経度 N.	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160	160~161	161~162	162~163	163~164	164~165
39~40																					
38~39																					
37~33																					
36~37	2.90	6.92	12.58	1.04											11.37	7.01					
35~36	2.00	0	0.85	3.74	0.27										11.16	7.78	3.92				13.55
34~35	12.44	2.27	0.71	0	19.67										6.56	5.91					12.35
33~34	6.96	3.76	5.69	2.67										1.36	4.46	2.99		1.19	7.43	5.25	5.63
32~33	8.80	1.87		1.82								1.81	2.26	6.21	4.46	2.74				3.53	7.66
31~32	6.52		2.66	4.33			1.50				1.80		2.32		3.14	4.30		1.53			8.22
30~31	0	15.26	2.55	4.47	4.03	1.99	1.83		5.10	3.71	2.23		2.96	2.00	4.40			4.64		3.45	
29~30			2.71		4.90		2.80	4.60	7.00	2.99	3.77	3.14	4.91		1.57		5.74	3.65	2.20	4.28	
28~29	3.01		1.77		3.45	2.59	2.64				3.26					0.76	3.56	2.10	2.95		
27~28	3.02		1.37		2.58	2.73	2.56														
26~27																					
25~26																					

Table 1.--Albacore fishing conditions (catch rates) in the North Pacific by years (cont'd)

1950

経度 °E. / 緯度 °N.	140°~141°	141~142	142~143	143~144	141~145	145~146	145~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40																				
33 ~ 39																				
37 ~ 38				0	13.30															
36 ~ 37	0	3.24	11.60	16.52	1.93	3.17	2.20													
35 ~ 36		7.55	9.09	6.13	0.57	1.25														
34 ~ 35	12.38	11.05	11.82	1.39	0.90			0.15	0.55			0								
33 ~ 34	5.64	8.07	4.83	0.42	0.37		6.42		0.46	0.15									0.90	
32 ~ 33	2.27	9.40	6.15	1.23	2.78															
31 ~ 32	7.47	7.80	10.48	5.13	2.62		2.28												1.85	2.60
30 ~ 31			7.12	1.37		2.27		1.93	3.90					0	1.00	1.68	2.41	2.05	2.36	2.46
29 ~ 30					2.29	2.71	2.23	3.37	2.55	3.26	3.80		0.65		1.33	1.65	4.19	2.44	1.81	2.65
28 ~ 29			4.16	3.23	4.92	4.54	3.73	3.79	5.09	2.26								2.41		
2˘ ~ 28			3.01		2.86	2.31	2.94	2.71	3.16	3.09										
26 ~ 27						0.57		1.28		0										
25 ~ 26																				

経度 °E. / 緯度 °N.	160°~161°	161~162	162~163	163~164	164~165	165~166	166~167	167~163	163~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40																				
38 ~ 39																				
37 ~ 33																				
36 ~ 37																				
35 ~ 35					1.59	5.23						9.47								
34 ~ 35					5.26	4.33					1.36	6.62					9.93			
33 ~ 34		1.19		0.71	6.55	5.29					2.71	5.05	3.97	2.27		3.91	6.95	4.00		
32 ~ 33	1.14				2.27	4.41	3.18	3.89			1.86	4.16		3.42	2.59	2.22	3.66	3.38	4.19	
31 ~ 32	0.67		1.60	2.24	1.67	2.20	1.83		1.73	1.46	1.46	4.10	1.61	2.43	3.25	3.10	2.89	3.75	4.77	3.84
30 ~ 31	2.54	2.89	2.52	2.53		4.17	1.12	0.85	2.29	2.50	2.66	3.09	2.02	1.46	4.61	3.58	4.39	2.01	3.08	4.60
29 ~ 30	2.13	2.83	3.36		1.73	2.28				2.76	3.61	4.17		2.21	3.72	3.52		2.91	2.10	2.96
23 ~ 29																				
27 ~ 28																				
2˘ ~ 27																				
25 ~ 26																				

Table 1.--Albacore fishing conditions (catch rates) in the North Pacific by years (cont'd)

1951

経度 °E. / 緯度 °N.	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40																				
38 ~ 39																				
37 ~ 38				3.49	4.32	0.30														
36 ~ 37		0.68	1.61	6.07	1.73						0									
35 ~ 36		0.98	4.59	2.43	1.06	0		0												
34 ~ 35	0	3.14	5.71	1.99	0.19	0.27	0.22		0.41											
33 ~ 34	0.96	0.75	0.99	0.78	0.18		0	0.54	0.31											
32 ~ 33	0.60	0.72	0.37	0.11				1.56	0.17											
31 ~ 32	2.15	1.18	0.07						7.24							1.57	1.85			1.11
30 ~ 31	0.25						2.33	4.39	8 38	1.11				6.56	7.41	4.06	1.07	6.04	4.56	2.53
29 ~ 30	4.60					5.70			3.56	5.75		2.95		2.95	3.91					4.77
28 ~ 29						3.58	5.70	0.92		2.27	5.73	9.50	4.19	0.99						
27 ~ 28		1.73	0.59		3.52							2.84								
26 ~ 27		0	0.16	0.05	0															
25 ~ 26																				

経度 °E. / 緯度 °N.	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40																				
38 ~ 39																				
37 ~ 38																				
36 ~ 37																				
35 ~ 36				9.97	7.87															
34 ~ 35				7.27	9.09		8.93	1.63												
33 ~ 34		10.00				7.50		7.51												
32 ~ 33		11.32	8.99			4.85		2.87	6.74	3.19	3.89				8.93			3.92	2.75	4.41
31 ~ 32	6.97	6.69	3.62	7.17										3.84	7.86	3.62	3.80	5.56	5.61	3.63
30 ~ 31	2.92	4.50	3.76																	6.30
29 ~ 30																				
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				
25 ~ 26																				

Table 1.--Albacore fishing conditions (catch rates) in the North Pacific by years (cont'd)

1952

緯度 °N. \ 経度 °E.	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
39 ~ 40																				
38 ~ 39			6.00	0	0.75															
37 ~ 33			4.19	8.31	2.29	1.53				0										
36 ~ 37		1.44	4.99	9.39	3.41	1.91	0.22			0.70										
35 ~ 36		0	1.44	10.04	4.14	0	0	2.56												
34 ~ 35	7.93		5.16	10.25	1.63	0.45	1.99	0.86	0.23	0.15										
33 ~ 34	0.35	5.09	4.34	8 81	5.97	0.63	0	0.75	0.53	0.77	1.65			0						
32 ~ 33	1.31	2.51	2.57	0.56	1.45	1.87	1.22	1.56	0.17	0			3.05	0			3.47	5.34	7.53	
31 ~ 32	7.99	9.33	6.38		3.18	9.16	4.00			2.77			4.44	5.73	0	5.29	4.37	4.35	5.96	
30 ~ 31	1.81	4.37	10.80	4.96	2.98	3.36	4.46	3.54	3.90	5.79	2.94	5.06	4.55	4.25	10.19	6.38	4.75	6.25	5.70	
29 ~ 30	1.55	2.80	3.98	4.34	3.04	4.19	3.74	3.16	5.75	3.91	4.32	5.98	3.35	2.87	6.49	5.56	6.77	4.20	7.64	9.41
28 ~ 29	0.94	3.72	3.76	4.16	1.89	3.39	3.74	2.99	3.81	2.80	2.49	2.27	2.54							
27 ~ 28										2.96	3.83									
26 ~ 27		0	0																	
25 ~ 26																				

緯度 °N. \ 経度 °E.	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
39 ~ 40																				
38 ~ 39																				
37 ~ 38																				
36 ~ 37																				
35 ~ 36																				
34 ~ 35																				
33 ~ 34																	8.95		8.60	
32 ~ 33			6.05	6.96	4.82	6.31										9.50	1.97	6.04	4.00	5.90
31 ~ 32				5.31	3.83	9.37	4.33						3.85			9.63	9.58	10.53		10.09
30 ~ 31	8.20	8.53	8.27	11.37	7.04	11.78	9.20	3.03	3.17	5.80				4.00		3.31	11.27	10.55	3.97	
29 ~ 30		8.34													0.38		1.64	2.81		
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				
25 ~ 26																				

Table 2.--Results of oceanographic observations off Kinkazan in 1936. (From Hydrographic Office reports)

月 日 Date.	1—8	〃	〃	〃	〃	1—9	〃	〃	〃
位 置 Station.	5 mi. off Utatsu	38°16.'2 141°41.'3	38°16.'2 141°54.'2	33°16.'2 142°15.'0	33°16.'2 142°38.'0	33°16.'2 143°12.'0	38°16.'2 143°44.'5	38°00' 144°50'	38°00' 145°53'
0	9.7	9.9	8.6	6.0	7.8	9.0	12.8	12.5	11.5
10	9.5	9.9	8.5	6.1	7.7	9.4	12.3	11.6	11.3
25	9.5	9.9	8.5	6.0	7.5	9.6	12.0	11.4	11.0
50	9.5	9.9	8.3	5.8	6.6	9.5	12.0	11.3	10.2
100	9.3	9.9	8.0	5.8	4.7	8.9	10.6	10.7	11.5
200			5.2	2.5	2.5	3.5	4.8	8.3	7.3
400				3.1	3.3	3.4	4.8	4.8	4.8

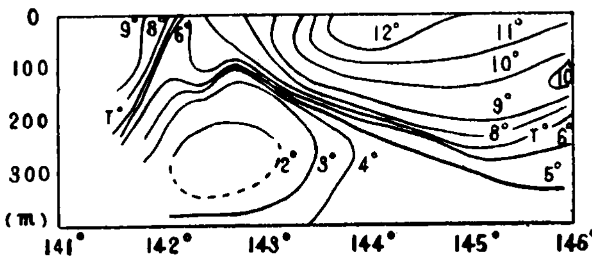


Figure 3.--Vertical temperature section off Kinkazan (from Hydrographic Office reports).

The results of observations made directly east of Cape Inubō are shown in the following table.

Table 3.--Results of oceanographic observations due east of Cape Inubō, 1936. (From reports of oceanographic investigations of the Central Fisheries Station)

月 日 Date.	1—8	〃	〃	〃	〃	1—9	〃	〃	〃	〃
位 置 Station.	5'	20'	40'	60'	80'	100'	125'	150'	175'	200'
0	10.0	12.1	17.0	18.8	19.2	19.5	19.2	18.0	18.0	18.0
10	—	12.0	16.8	19.0	19.2	19.2	18.2	18.0	17.5	18.0
25	10.2	11.4	16.8	18.7	19.2	19.0	18.2	18.0	17.5	17.8
50	10.2	11.4	16.2	18.6	19.2	19.0	18.2	18.0	17.4	17.0
100	9.6	10.5	16.2	18.2	19.0	19.1	18.0	18.0	18.0	17.0
200		9.2	15.2	16.5	19.0	19.0	18.0	17.1	17.0	17.5
300		8.5	11.0	16.1	17.0	17.0	18.0	17.0	17.0	16.0
400		6.0	9.0	14.1	—	—	—	—	—	—

Comparing these two sets of observational results, it can be seen that there are marked changes in the Kuroshio between Cape Inubō and

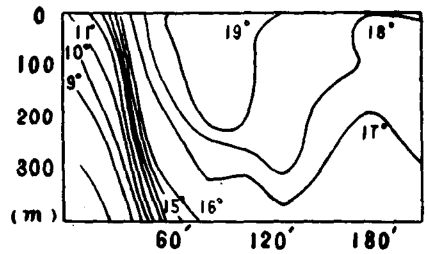


Figure 4. --Vertical temperature section due east of Cape Inubō.

Kinkazan. Off Inubozaki the current flows northeast near the coast with considerable strength, producing water temperatures about 17°C. even below the depth of 300 m., but off Kinkazan it is spread out in a shallow layer on top of the Oyashio and the water temperatures are markedly lower. Just north of the section line running due east of Kinkazan there is a front running in a northeasterly direction and marking the northernmost limit of the Kuroshio. Between 35°N. and 38°N. the Kuroshio turns to the east to northeast, and since we have no data on sectional observations through this area of eastward deflection we cannot clarify its structure. However, east of the areas shown in figures 3 and 4, the isotherms become complex and, when we consider the existence of what are thought to be isolated water masses, it appears that considerable mixing is going on.

The direction of flow of the currents in the area where the Kuroshio turns eastward is quite complicated, and it is thought that this sort of mixing extends all across this area. We have little data on the northern edge of the eastward-flowing North Pacific Current, and there are many points which are not clear about it; it has already been noted that from the isotherms we can detect a large number of large and small vortices in the North Pacific Current and in the countercurrent region on its south side. Most of these vortices run clockwise.

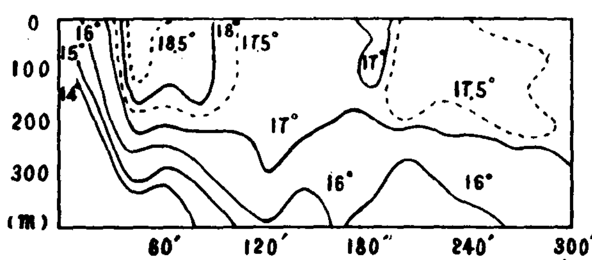


Figure 5. --Vertical temperature section 300 miles southeast of Cape Nojima.

Figure 5 shows the results of sectional observations extending 300 miles southeast of Cape Nojima made in 1936. An area about 150 miles off the coast corresponds to the vicinity of the boundary between the Kuroshio and its countercurrent, and farther offshore the area of vortices appears. Low-temperature water masses thought to have been produced by these vortices are also apparent. For the North Pacific Current, which is farther offshore to the eastward of the area shown in figure 5, and for the countercurrent area on its south side we have no suitable data and the structure is not clear, but it is thought to be quite complex.

Table 4 presents the results of observations made on fishing grounds west of Midway Island in January 1951.

Table 4.--Data from observations west of Midway I. (No. 1 Taiyō Maru of Mie Prefecture) 1951

実施月日 Date.	実施位置 Locality.	潮流 Current.	水温 Water temperature. 0	25	50	100	150	塩分 Salinity. 0	25	50	100	150
1.8	31°23′N 178°20′E	ENE	20.05	20.10	20.16	20.11	16.62	34.81	34.79	34.81	34.81	34.65
9	32°22′ 177°46′	〃 Slow	19.0	18.91	18.94	16.23	15.31	34.61	34.61	34.60	34.61	34 54
10	32°03′ 177°11′	ENE Slow	18.4	18.54	18.60	18.38	14.56	34.63	34.61	34.61	34.61	34.51
11	32°04′ 177°45′	〃	19.0	19.10	19.06	19.06	15.24	34.63	34.61	34.69	34.63	34.52
12	31°39′ 178°17′	NE	18.8	18.99	19.00	18.99	15.31	34.61	34.61	31.63	34.61	34.51
13	31°34′ 178°03′	E	18.4	18.57	18.60	18.60	15.01	34.61	34.61	34.60	34.60	34.49
14	31°29′ 178°10′	E～ESE Slow	19.0	18.95	18.59	18.60	15.80	34.63	34.63	34.61	34.61	34.61
15	31°56′ 177°49′	SE 1.0′	18.6	18.62	18.62	18.44	14.80	34.60	34.61	34.60	34.61	34.50
16	31°45′ 177°55′	SE	19.0	19.04	18.56	18.14	15.08	34.61	34.63	34.60	34.60	34.51
17	31°53′ 178°05′	SE～ESE	18.6	18.46	18.28	17.63	15.35	34.61	31.60	34.61	34.61	34.54

The marked differences in water temperatures, even between adjacent areas, indicate the complexity of the oceanographic conditions. The thermocline between the depths of 150 and 200 m., which was not apparent in the observations 200 miles directly east of Cape Inubō or those 300 miles directly east of Cape Nojima, are clearly revealed in this sea area. The lower limit of 18°C. is at the depth of 100 to 150 m., and thus the eastern North Pacific Current has a greatly reduced depth as compared with the main Kuroshio, however, it still shows considerable strength. As for the chlorinity, it indicates rather high values as compared with the main Kuroshio at roughly the same time. However, below the thermocline the chlorinities are rather low.

Table 5.--Sizes of albacore taken in the North Pacific in January (weights in kan = 8.27 lbs.)

°E. longitude	°N. latitude 24～26	26～28	28～30	30～32	32～34	34～36	36～38
140°E～150°E	6.9	6.1	4.7	2.3	2.6	2.4	2.0
150 ～160			5.4	4.7	2.8	2.3	
160 ～170				3.4	3.3		
170 ～180				4.7	4.7		

Table 5 shows the average weight of the albacore taken in this sea area in January. The general tendency, just as in the preceding month, is for the fish to be larger on the southern side of the fishing grounds and for the size to decrease to the northward. The size of the fish also increases from west to east. However, on the east and west sides of the line of 160°E. longitude the trends in the change of fish size are somewhat different. That is, east of 160°E. the change in the size of the fish from north to south is not as clear as it is west of that longitude. The albacore taken north of 30°N. to 32°N. in the sea areas east of 150°E. are particularly small, with an average weight of less than 3 kan [24.8 lbs.]. One thing that stands out is a rather conspicuous exception to the tendency for the size of the fish to increase as one goes offshore to the eastward, this exception showing up in the southern part of the fishing grounds around 160°E. As can be seen from table 4, at the latitudes of 30°N. to 32°N., east and west of 160°E., the fish on the eastern side are conspicuously smaller. The same thing is true in December. The question of whether or not the albacore of the North Pacific fishing grounds form a single population is extremely important for any consideration of the quantity of the resource, and it is thought that, from this point of view, the line of 160°E. longitude should be thoroughly examined.

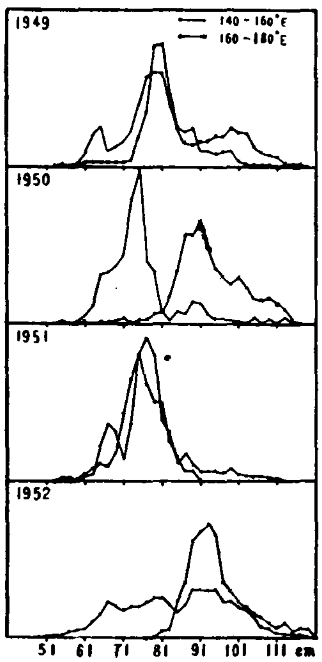


Figure 6.--Length frequency of albacore taken in the North Pacific, by years. The two curves represent different ranges of longitude, but the original figure is too small to distinguish them.

Figure 6 shows the yearly changes in the length composition of albacore east and west of 160°E. longitude. In general, the fish are larger on the east side of that longitude. On both sides of 160°E. the length class appearing most frequently differs from year to year. However, any length class which is conspicuous on either the east or west side of 160°E. will also form a peak, or a size group very close to it will form a peak, of some degree on the other side of the line. The difference in the positions of the peaks on either side of the line is less than the difference from year to year in the positions at which the peaks appear in either one of the areas, and this indicates that there is a considerable relatedness between the sizes of fish in the two areas.

Furthermore, there are times when a comparison of the sizes of fish at 150°E. to 160°E. and at 160°E. to 170°E. shows that they are larger between 150°E. and 160°E. Nevertheless, in the overall picture, the fish are bigger the farther one goes from Japan. The fact that this trend is a gradual one is thought to indicate that all of the albacore in the northwest Pacific fishing grounds are under the control of one great law. Figures 7 and 8 show respectively for 1949 and 1950 the size composition of fish between 140°E. and 150°E. by months and by latitude in terms of percentages. Throughout these two figures we see that the fish are larger the farther south one goes, and that the size of the fish taken clearly decreases with the passage of time. Table 6 shows the seasonal changes in the average weight of fish in this sea area by months.

Table 6.--Mean weight of albacore, by months, for the area of 140°-150°E.

月 別 Monthly	11月 Nov.	12月 Dec.	1 月 Jan.	2 月 Feb.	3 月 Mar.
36~38	2.4	2.2		1.6	
34~36	2.7	2.4	2.4	2.0	
32~34	3.5	3.2	2.6	1.9	2.0
30~32		3.8	2.3	2.6	2.4
28~30			4.7	4.0	3.0
26~28			6.1	6.4	

At the southern limit of the fishing grounds, which in November is between 32°N. and 34°N. latitude, the fish weigh about 3.5 kan /30 lbs./. Since the fish of this size group are thought to be south of 28°N. to 30°N. in March, this means that they travel more than 240 miles south in a period of 4 months. Consequently, the amount of southward movement in 1 month is on the order of 60 miles or more. It has already been noted that from year to year the modes appear in different length classes, but it can be seen from figures 7 and 8 that even within a given year the mode does not appear at one fixed position, but that there may be a number of intermediate sizes. It may be thought that with fishes having a small annual growth, like the albacore, there will be overlapping of the length ranges of the various year classes, and this sort of instability in the length classes in which the modes appear in a given year gives rise to various difficulties in using the size composition to deduce the age of the fish.

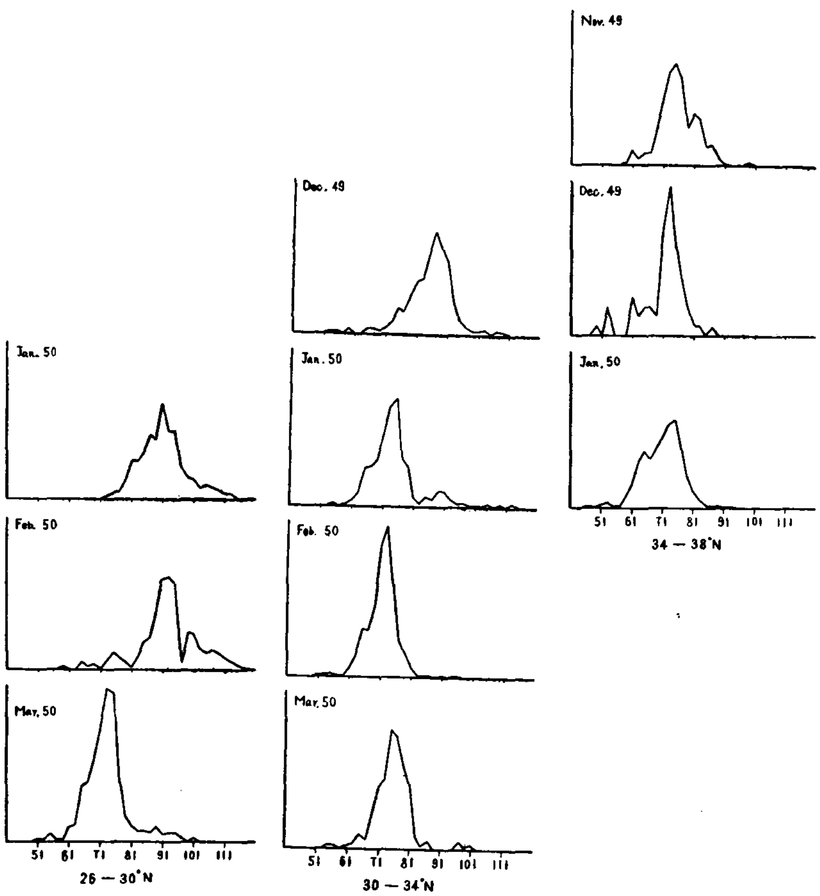


Figure 7.--Albacore length frequency by months in the North Pacific at 140°-150°E., 1949-50.

The relationship between albacore catch rates and surface water temperature was touched upon in the section for the preceding month, but the relationship for January is shown in table 7.

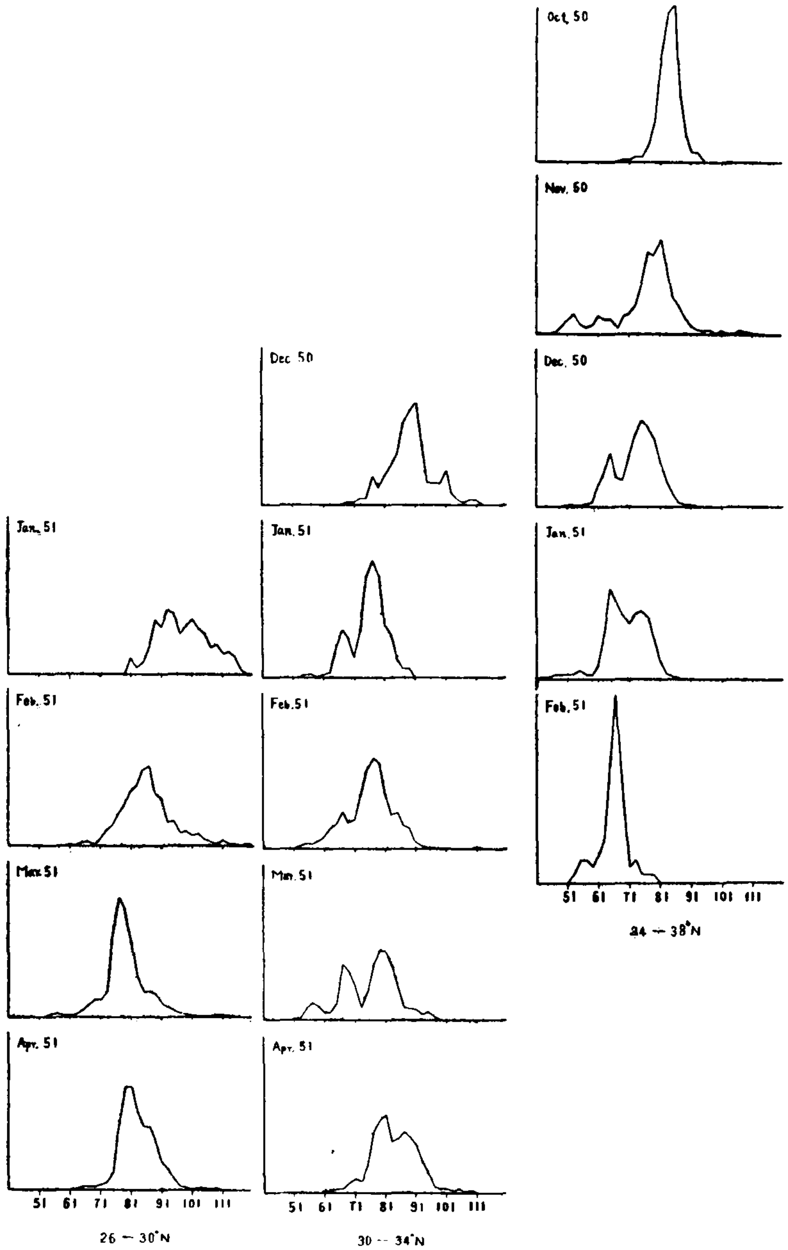


Figure 8.--Albacore length frequency by months in the North Pacific at 140°-150°E., 1950-51.

In the northern part of the fishing ground the fishing conditions are conspicuously variable, as can be seen from figure 2. Table 8 shows how the variability of the catch rate within a single sea area increases to the north, particularly between 140°E. and 150°E.

Table 7.--Collation of catch rate and surface temperature, North Pacific, January

Area	c/r °C.	0~0.5	0.5~1.0	1.0~1.5	1.5~2.0	2.0~2.5	2.5~3.0	3.0~3.5	3.5~4.0	4.0~4.5	4.5~5.0	5.0~5.5	5.5~6.0	6.0~6.5	6.5~7.0	7.0~7.5	7.5~8.0	8.0~805	8.5~9.0	9.0~9.5	9.5~10.0	10.0~10.5	10.5~11.0	11.0~11.5	11.5~12.0	12.0~12.5	12.5 以上	
30°~ 35° N	17																											
130°~140° E	18	6		1				1			1	1		2		1				1			1	1		1	2	以上 5.5
	19	18	10	7	2	5	6	3	1	1	2		1	1	1	1		2		1				1			2	以上 2.6
	20	8	6	5	2	4	1	3	3	1	1	1	1	2		1						1						2.5
	21	2																										0.3
	22	1																										0.3
Av. temp.		19	19	19	20	19	19	19	20	20	19	19	20	19	19	19		19		19		20	18	19		18	19	
30°~ 35° N	16												1															5.8
140°~150° E	17	32	16	8	3	1	5	3		1	1	4				1		1	1			1					2	以上1.66
	18	119	31	50	18	14	12	9	16	13	8	12	15	12	2	5	6	7	6	4	7	6	4	5	6	4	74	以上4.60
	19	68	23	29	25	14	25	15	19	23	15	10	9	14	13	12	15	7	13	5	2	8	5	5	4	1	87	以上5.50
	20	27	10	8	6	8	7	13	3	5	7	7	5	2	2	1	4	2		2	1			2			7	以上4.2
	21				1	1		1																				2.4
Av. temp.		18	18	18	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	19	18	18	19	19	18	18	19	
30°~ 35° N	17									1		1		1	2	1	1			1	1		1					7.4
150°~160° E	18	1	2	2	6	3	9	2	6	3	5	3	1	3	3	2	2		1		1	3	2	1	4	2	10	以上 6.3
	19	2	2	5	4	9	6	9	4	6	12	13	6	6	1	2	3	2	1	1	3	2			1		3	以上 4.8
	20		1	4	7	1	9	2	4		3	2	1				1	1				1						3.3
	21					1	2	1	1		1																	3.3
Av. temp.		19	19	19	19	19	19	19	19	19	19	19	19	19	18	18	19	19	19	18	18	19	18	18	18	18	18	
30°~ 35° N	17	2	3		1		3	1	5	2	1	2	1	4		4	3											4.4
160°~170° E	18	1	1	2	1	5	7	3	6	8	3	9	6	4	9	6	4	7	4	6	5	5	4	2	1	1	7	以上 6.7
	19	1	1	3	3	1	4	1	7	4	6	4	12	3	3	1	2	2	1	1	1		2	1			4	以上 5.6
	20	1			3		2	2		1	1	1			2													3.5
	21									1																		4.25
Av. temp.		18	18	19	19	18	18	19	18	18	19	18	19	18	19	18	18	18	18	18	18	18	18	18	18	18	18	
30°~ 35° N	17			1		2	2	2	2	2		2	2	5	5	2	5	2	1	1	1	3	2	3	1	2	14	以上 8.4
170°~180° E	18	2	1	3	6	14	7	13	6	11	9	10	18	5	7	6	10	5	3	1	6	2	3	5	2		11	以上 5.9
	19	1	2	6	11	10	13	15	10	16	11	10	9	10	7	7	2	2	1		1	2		2		1	5	以上 4.7
	20	1	1	1	2	1	5	3	2			2		1														2.9
	21						1			1																		3.5
Av. temp.		19	19	19	19	18	19	19	19	19	19	19	18	18	18	18	18	18	18	18	18	18	18	18	18	18	18	
35°~40° N	15	1																										0.25
140°~150° E	16					2																					1	以上 5.8
	17	7		3	1	1	4	4	1	1	2	2	1	5	2	3			1	1		4	1			1	6	以上 5.7
	18	10	3	6	4	5	3	3	2	3			2	1	2	1	1	3	2				1	2		1	18	以上 5.9
	19	31	3	12	2	3	3	1	3	1			1		3	1	2	1				1			3		18	以上 4.4
	20	4	2							2			1		1			1				1					1	以上 4.2
Av. temp.		19	19	18	18	18	18	18	18	19	17	17	18	17	18	18	19	19	18	17		18	18	18	19	18	18	

Table 7.--Collation of catch rate and surface temperature, North Pacific, January (cont'd)

Area	C/r °C.	0~0.5	0.5~1.0	1.0~1.5	1.5~2.0	2.0~2.5	2.5~3.0	3.0~3.5	3.5~4.0	4.0~4.5	4.5~5.0	5.0~5.5	5.5~6.0	6.0~6.5	6.5~7.0	7.0~7.5	7.5~8.0	8.0~8.5	8.5~9.0	9.0~9.5	9.5~10.0	10.0~10.5	10.5~11.0	11.0~11.5	11.5~12.0	12.0~12.5	12.5 以上	
35°~ 40° N	15																											
150°~160° E	16																											
	17									2								1				1		1		1		8.4
	18	2						1	2	1	3		3	2		2	1	2	2		1	1		2	1		1	以上 6.8
	19		1						1				1							1								4.9
	20																											
Av. temp.		18	19					18	18	17	18		18	18		18	18	18	18	19	18	18		18	18	17	18	
35°~ 40° N	15																											
160°~170° E	16																											
	17																		1									8.75
	18										1	1			1												1	以上 7.4
	19						1																				1	以上 7.8
	20																											
Av. temp.							19				18	18			18				17								19	

Table 8.--Frequency of coefficients of variation of catch rates in the North Pacific at 140°-150°E.

	0~10	10~20	20~30	30~40	40~50	50~60	60~70	70~80	80~90	90~100	100~110	110~120	120~130	130~140	140~150	150~160	160~170	170~180	180~190	190~200	200~210	210~220	220~230	230~240	240~250	250~260	260~270	270~280	280~290	290~300	300~310	310~320	平均 M
28~30	1	2	10	3	6	3	8	4	2		1																						48
30~32	1	2	4	10	2	5	6	4	2	1			1																				51
32~34		2	2	4	5	2	3	3	3	3	1	3	2	2	1	2	2	2	1	1													91
34~36		1		1	2	2	1	3	6	2	3	3	2	4	3		3	-			1		1			1					1		116
36~38			2		1	3	1	8	1		1			1	1	1	1	1															86

Note: "M" indicates the average.

If we compare in terms of the coefficient of variation the variability in fishing conditions among unit areas, as between 30°N.-32°N. and 32°N.-34°N. at 170°E. to 180°, we get 41.8 percent for the former and 40.0 percent for the latter, showing almost no north-south difference. Consequently, we can conclude that in the waters farther offshore, although we may see considerable differences in fishing conditions as between areas, the fishing is relatively stable within a given area.

(2) Kinan Fishing Ground

It has already been noted that in January the albacore catch rates in this sea area take a sudden jump upward. At this season areas of high catch rates are continuous from 140°E. westward to 134°E., and no boundary is apparent between this fishing ground and the grounds east of the line of islands. The southern limit of the fishing ground is in the vicinity of 27°N. latitude and coincides approximately with the southern limit of the North Pacific fishing ground. The northern edge is not very clear, but it appears to be in the vicinity of the boundary between the main current of the Kuroshio and its countercurrent. However, fairly high catch rates are occasionally shown in the main current area.

Considering now the oceanograhic conditions in this area, we find that the main stream of the Kuroshio, which flows northeast directly south of Honshu, is conspicuously narrowed here. A very clear clockwise gyre is formed on its south side. The southern limit of this gyre is at 28°N., and its eastern side impinges upon the current flowing northward east and west of the Izu Shichitō Islands, while its western and northern sides are bounded by the main Kuroshio current. Figure 9 gives the results of observations made 300 miles south of Shionomisaki in January 1936, the left-hand graph showing the temperature and the right-hand graph the salinity. The Kuroshio is conspicuously pushed in against the coast, and there is a mass of low-salinity water between it and the gyre. Within the radius of 60 to 200 miles off the coast is the area where the gyre is clearest, with its center in the vicinity of 120 to 150 miles off the coast and with the salinity dropping toward its edges. South of a point 250 miles out (at about 30°N.) we find the southern edge of the gyre, and in this section the temperature and salinity are both rising, appearing to indicate a connection with the source of waters in the Okinotorishima area.

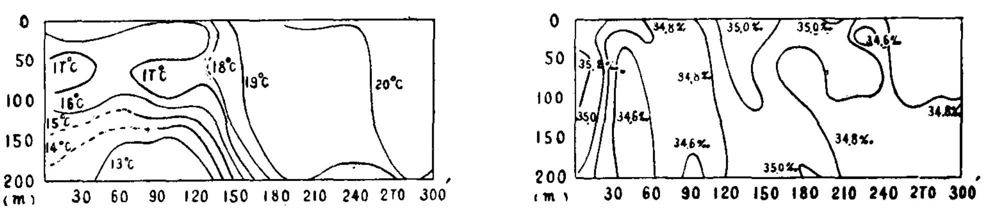
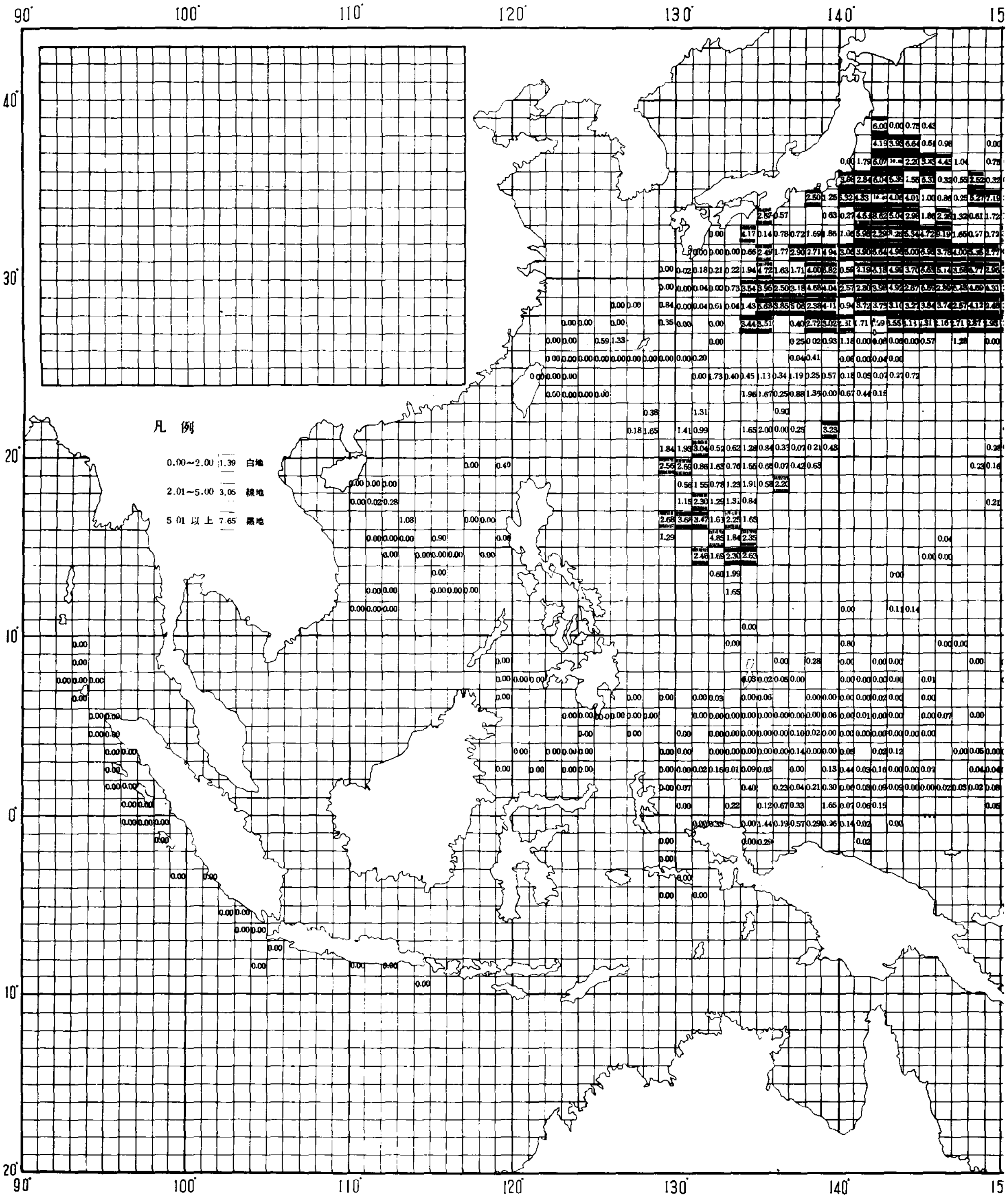
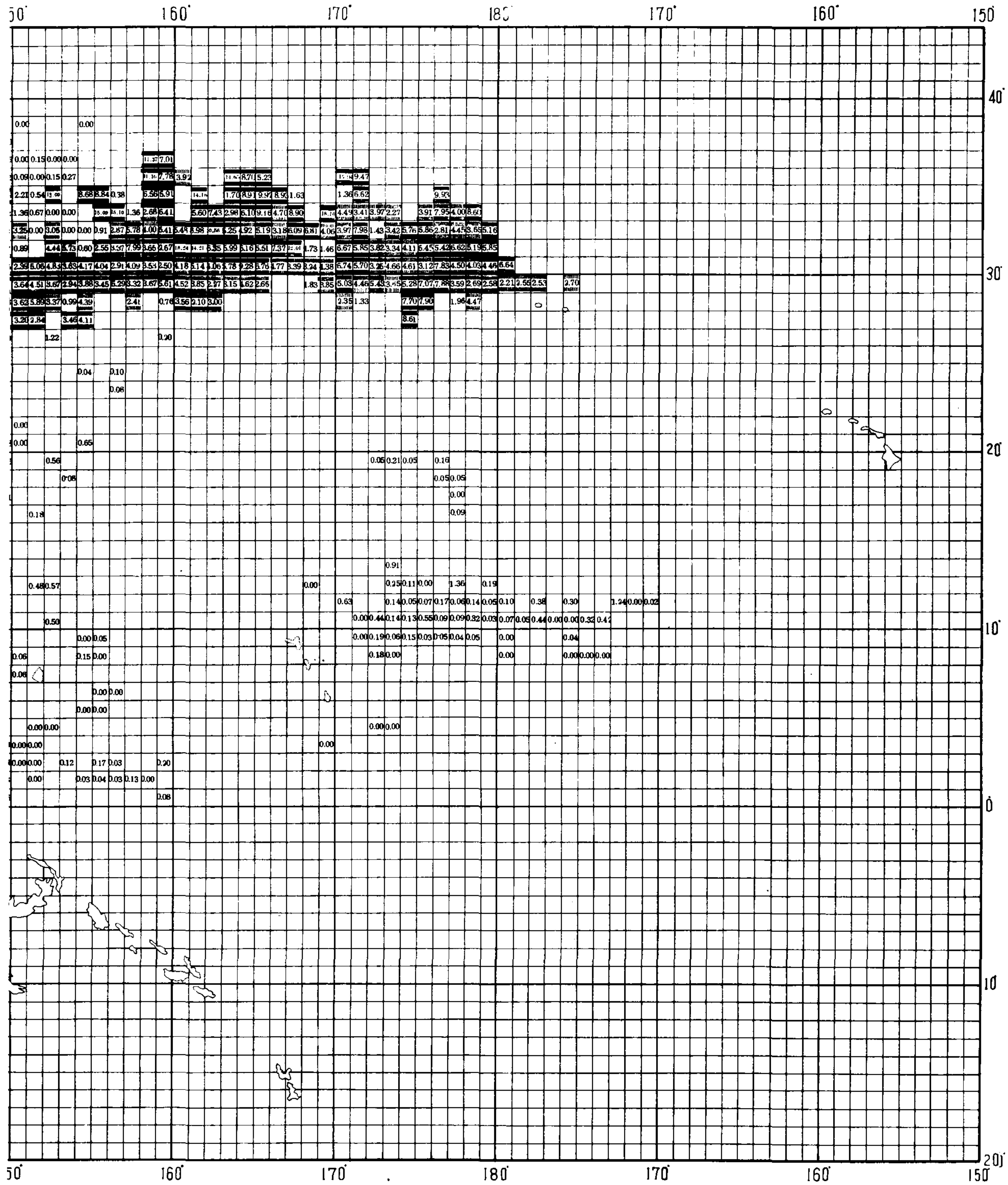


Figure 9. --Results of an oceanographic section 300 miles due south of Cape Shionomisaki in 1936. (From Semi-annual Reports of Oceanographical Observations, Central Fisheries Experiment Station.) Left, isotherm distribution; right, isochlors.

The fishing grounds develop within this vortex area, and with the passage of time they extend themselves to the westward. In January the western edge of the fishing grounds is in the vicinity of 134°E., but in February it reaches the vicinity of 132°E. We can see many areas in which catch rates of 3.0 or more are indicated, particularly in a row

ビ ン ナ ガ (Albacore (*Thunnus germo*))　　1 月 (January)




160°
170°
180°
170°
160°
150°
40°
30°
20°
10°
0
10
20

of areas of high catch rates extending from the east side of the fishing grounds to their southern edge. The variation in the catch rates in this sea area gives a coefficient of variance of about 50 percent, so that we can consider this a fairly stabilized fishing ground.

Table 9.--Frequency of coefficients of variation of catch rates in unit areas on the Kinan ground at 130°-140°E.

	0~10	10~20	20~30	30~40	40~50	50~60	60~70	70~80	80~90	90~100	100~110 %	平 M 均
28°~30°N	2	1	2	3	4	3	2	4	1		1	50%
30°~32°E			1	3	1	3	6					52%

The majority of the albacore taken in this sea area are medium-sized (2 to 4 kan [16 to 33 lbs.]), and the proportion of admixture of large (over 5 kan [41 lbs.]) and small (under 2 kan) fish is less than in the North Pacific fishing ground at the same longitudes. The outstanding peculiarity of the size composition of the albacore in this sea area is the extraordinary uniformity of size, as shown clearly in figure 10, where it can be seen that there is not a number of modes but one single predominant mode. With regard to the question of whether or not greater variability in fish size appears as one goes farther to the north and south, we have only data for the year 1952, but according to this the fish are somewhat larger to the south. It is difficult, however, to affirm that this difference represents a difference in age groups.

Grounds South of the Subtropical Convergence

(1) Okinotorishima Ground

The distribution of the fishing grounds in January is considerably different from what it was in December. That is, the fishing grounds have extended markedly to the southward and their center has moved to the vicinity of 14°N. to 20°N. North of 20°N. latitude signs of a falling off of the fishery can already be seen. As the fishing grounds move south, they simultaneously extend gradually to the westward and reach the waters west of 130°E. longitude, indicating that their position has moved considerably to the southeast as compared with the first part of the fishing season in October. In general, the central part of the fishing ground has catch rates of 1.0 to 2.0, but there are not a few areas with high catch rates of 2.0 to 4.0. The fishing grounds reach their maximum extent at this season.

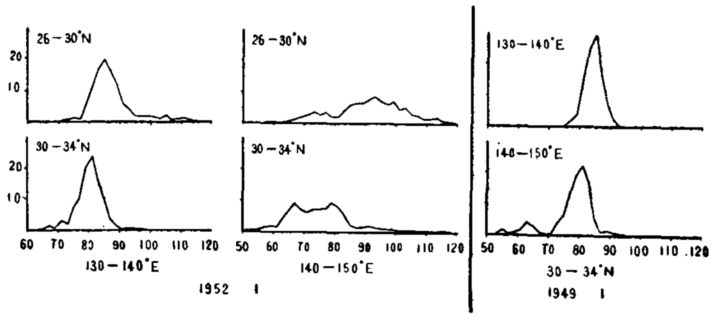


Figure 10.--Comparison of length frequencies of albacore taken at 130°-140°E. and at 140°-150°E.

Table 10.--Albacore catch rate frequencies, by years, in the area of 12°N.-25°N., 128°E.-140°E. "M" is the average catch rate

釣獲率 Hooked-rate. / 年次 The year.	0 ~ 0.5	0.5 ~ 1.0	1.0 ~ 1.5	1.5 ~ 2.0	2.0 ~ 2.5	2.5 ~ 3.0	3.0 ~ 3.5	3.5 ~ 4.0	4.0 ~ 4.5	4.5 ~ 5.0	平均 M
1949	4	4	1		3						1.00
1950	6	2		1							0.53
1951	6	10	10	14	6	4	3	1		1	1.61
1952	7	1	2	1	1						0.75

As table 9 shows, the catch rates vary considerably from year to year. The year 1951 was a particularly active one on this fishing ground, and many fishing vessels concentrated in this area. It is difficult to make any definite affirmation because of a lack of continuing data, but it is thought that there may be an appearance of high catch rates every other year.

The size composition of the catch is as shown in table 11, with the average weight above 6 kan [50 lbs.]

Table 11.--Size composition of albacore taken on the Okinotorishima ground, in percentages. Lower figures are weights in kan (k.) = 8.27 lbs.

体長(重) B.L(W) / °N. lat.	65~75(cm) 1.9(k.)	75~80 2.8	85~95 4.1	95~105 5.8	>105以上 7.4	平均体重 M.	調査尾数 Fish measured.
12~14		0.5	59	47.3	46.4	6.4	220
14~16			4.6	36.1	59.3	6.7	108
16~18			10.4	50.1	39.6	6.3	268
18~20			4.2	57.2	38.6	6.3	329
20~22		8.9	11.3	39.5	40 3	6.0	394

Almost all of the fish are of large size, a characteristic which is in good agreement with the fishing grounds south of the Subtropical Convergence.

Table 12. --Mean weight (in kan) of albacore taken on the Okinotorishima ground, by month and latitude

月 Month. / 緯度 Latitude.	11月 Nov.	12月 Dec.	1 月 Jan.	2 月 Feb.
22～24° N		7.2貫		
20～22	6.7		6.0	5.5
18～20		6.5	6.3	
16～18			6.3	
14～16			6.7	
12～14			6.4	

Table 12 shows the average weight of the albacore landed from this fishing ground by area and season. As the fishing season progresses, the average size of the fish gradually becomes smaller. We cannot, however, detect any marked difference in the size of the fish in the northern and southern parts of the fishing ground as we did in the North Pacific fishing ground.

When we consider the season at which this ground appears, its movements, and the size of fish taken there, we cannot discover anywhere a population which would seem to be directly related to the albacore that appear in this ground. It is thought that when favorable conditions for the schools to accumulate obtain in this sea area, they simply assemble here like a rising tide and, after a few months, they disperse and disappear no one knows where. This is thought to be indicated by the fact that even after the end of the fishing season, considerable numbers of albacore occur in this area. We do not yet have any data on the gonads of albacore from this area, nor do we have any information on their stomach contents, so whether their appearance here has anything to do with feeding or reproduction is completely unknown.

St. No	位置 Locality.		月日 Date.	潮流 Current.
1	21°31′ N	135°16′ E	1—31	
2	19°44′	134°47′	2—1	
3	17°26′	134°49′	2—2	W
4	15°41′	133°51′	2—3	W
5	13°50′	132°52′	2—4	
6	11°10′	131°50′	2—5	

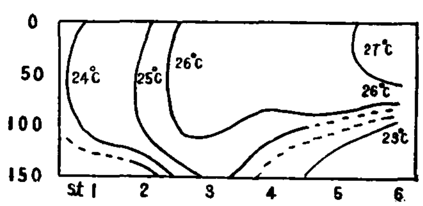


Figure 11. --Results of an oceanographic section in Okinotorishima waters.

Oceanographic conditions do not seem to differ greatly from those which obtained in December. Figure 11 gives the results of sectional observations from Okinotorishima in about a southeast direction to the North Equatorial Current (carried out in January 1953). The surface water temperature rises to the south, and just in the area which corresponds to this fishing ground the warm water is distributed to a considerable depth and the thermocline is quite deep. (Since we have data from observations only to 150 m., the location of the thermocline is not very clear.) Waters of low temperatures form a peak between this area and the area of the North Equatorial Current (station 6), clearly showing its boundary and indicating that conditions in this sea area are quite different from those in the area of the North Equatorial Current.

(2) Other Grounds in the Waters Between 10°N. and 25°N. Latitude

It has already been remarked that there is always a scattering of catches of large albacore over all areas of the Pacific, and at this season, too, there are more or less albacore taken everywhere. Since we have quite a bit of data for the bigeye tuna fishing grounds east of the Marshall Islands on the north side of the boundary between the Countercurrent and the North Equatorial Current, we can offer some discussion of this area.

Although they cannot, in general, be said to be abundant, albacore are taken here and at times the catch rates rise above 1.0. These catches, as is shown by the following table, are composed of extremely large albacore.

Table 13.--Albacore size composition (%) east of Marshall Is., January. Weights in kan = 8.27 lbs.

海域 Waters.	調査尾数 Fish measured.	85cm ~ 95	95 ~ 105	105 以上	平均体重 Mean value of body weight.
10~12°N 170~180°E	99尾	0.6%	38.6	60.8	6.8貫
10~12°N 180~170°W	252	2.0	26.6	71.5	6.9貫

Table 14 shows the frequency of catch rates per day's fishing. The column headed "0" represents the number of times when no albacore at all were taken. This is a rather small percentage of the total number of operations, being about 30 percent in 1951 and about 25 percent in 1952.

Table 14.--Albacore catch rate frequency, by years, east of Marshalls

年度 The year.	調査航海数 Number of vessels investigated.	0	0 ~ 0.25	0.25 ~ 0.50	0.50 ~ 0.75	0.75 ~ 1.00	1.00 ~ 1.25	1.25 ~ 1.50	1.50 ~ 1.75	平均 Mean.
1951	7	45	96	13	1					0.11
1952	8	25	51	12	6	2		2	1	0.21

It can therefore be considered that the albacore catch in this sea area does not show extremely great variation.

The albacore also sometimes penetrate into comparatively enclosed waters, and the catch rates become fairly high in such places as the South China Sea, west of the Bashi Strait and southeast of Hainan Island. We have no data on the sizes of fish from these waters, but they are said to be large albacore.

(3) Grounds of Tropical Seas

In January there are already signs that the abundance of fish is declining. In general the catch rates are lower, but from time to time there are still cases of rates of 1.0 or more. The appearances of albacore are still more conspicuous around the current boundary between the Equatorial Countercurrent and the South Equatorial Current south of Palau than in other areas. As the size composition in table 15 shows, the albacore from this sea area are somewhat smaller than they are at 10°N. to 25°N.

Table 15.--Size composition of albacore taken south of Palau in 1952. Actual numbers of fish measured; weights in kan

海 域 Waters.	85cm ～ 95	95 ～ 105	105 以上	平均貫數 Mean value of body weight.
0～ 2°N 130～140°E	18	51	18	5.8貫
2～ 4°N 130～140°E	20	33	9	5.5

Table 16 shows the frequency of catch rates by numbers of days' operations.

Table 16.--Catch rate frequency south of Palau (south of 3°N., 130°-140°E.)

0	0.0 ～ 0.25	0.25 ～ 0.50	0.50 ～ 0.75	0.75 ～ 1.00	1.00 ～ 1.25	1.25 ～ 1.50	1.50 ～ 1.75	1.75 ～ 2.00	2.00 ～ 2.25	2.25 ～ 2.50	2.50 ～ 2.75	2.75 ～ 3.00	平均 Mean.
54	30	10	3	7		1	1	1			1	1	0.24

The proportion of days' fishing in which no albacore were taken at all is 50 percent. Compared with similar data for waters east of the

Marshall Islands, the variability is quite a bit greater. The catch rates are higher in sections where there are islands and shoals, and this is thought to have a close relationship to this condition. Because of (1) the small size of the fish and (2) the great variability of the catch rates, these fish are thought to be of a somewhat different character from the albacore of the mid-latitude waters.

We do not have much data for equatorial waters east of 140°E., so there are many points that are unclear about this area. Between 140°E. and 150°E. the catch rates are in general somewhat higher than in the preceding month. It may be thought that the albacore schools south of Palau may have extended their eastern edge into this sea area. There appear to be no albacore catches worthy of attention east of the line of 150°E. longitude, but there are still scattered catches there. At 0° to 4°N., 140°E. to 160°E., the size composition is as shown in table 16, with the average weight less than 6 kan [50 lbs.], leading to the belief that these albacore may be of the same character as those taken south of Palau.

Table 17.--Albacore size composition (actual numbers of fish) at 0°-4°N., 140°-160°E.

85~95cm	95~105	105 以上	平均体重 Number indicates fish measured.
8	20	11	5.8 kan

FEBRUARY

General

The most conspicuous tendency at this season is for all of the fishing grounds simultaneously to diminish in extent. In the South Sea areas the signs of a falling off in abundance are strongly marked, and we can no longer see any areas with catch rates above 1.0. However, in the Kinan Sea Area the catch rates are generally higher than in the preceding months, and the western portion of the grounds extends farther until it reaches the vicinity of the Satsunan Islands. The Okinotorishima fishing ground shows a conspicuous expansion to the southwest, reaching into the sea areas east of Luzon, but the number of vessels operating there has diminished. As a result, the principal fishing grounds now extend east and west in a single line continuously from the Kinan ground to the North Pacific ground. However, the landings from these fishing grounds continue, as in the preceding months, to be very high, and this month corresponds to the latter part of the peak season.

1. North Pacific Ground

Figure 1a and b shows the general distribution of isotherms on this fishing ground based on data supplied by commercial fishing vessels (only the data for the period of February 10-15 are used). Figure 1a uses data for 1950, and figure 1b data for 1952. All of the isotherms are 2° to 3° farther south than they were in January. The 19°C. isotherm has moved farther south than the 20°C. isotherm, and the 18°C. isotherm has moved south more than the 19°C. isotherm, with the result that these isotherms are closer together and the change in temperature from north to south is more abrupt. However, in both years in the waters west of 150°E. the 19°C. isotherm and the 18°C. isotherm are rather far apart, and it is the isotherms above 19°C. that are close together.

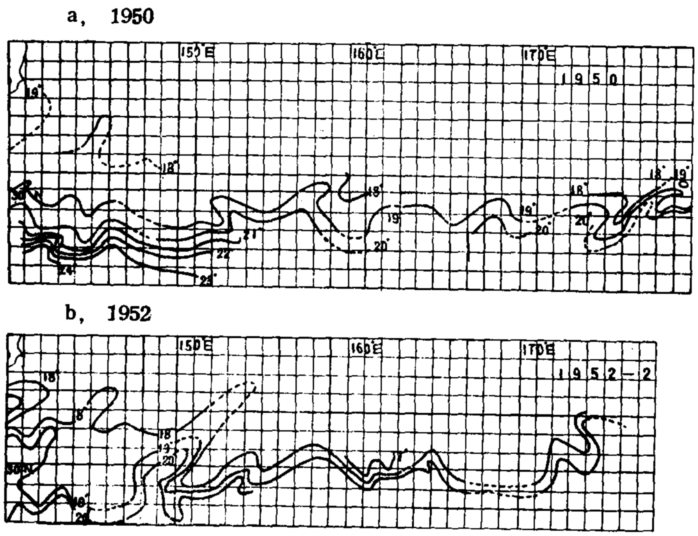


Figure 1.--Distribution of surface water temperatures in the North Pacific.

Consequently, in the general view, the North Pacific Current is flowing to the eastward through sea areas farther south than those in which it flowed in the preceding month. Looking at the areas east of 150°E., in 1950 the 19°C. and 20°C. isotherms are south of 30°N., while the 18°C. isotherm runs east and west crossing back and forth over the line of 30°N. In 1952 the southward movement was somewhat slower than in 1950, and the 18° and 19°C. isotherms are approximately on the latitude of 30°N., while the 20°C. isotherm runs somewhat south of 30°N.

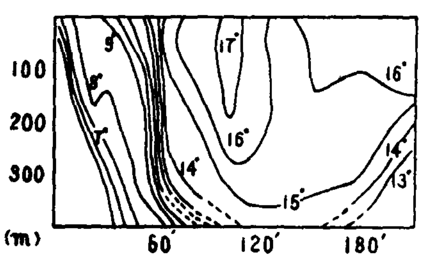


Figure 2.--Vertical temperature section due east of Cape Inubō (1936). From Semi-ann. Rpts. Oceanog. Observations.

In the area around 140°E. to 150°E., where the Kuroshio turns to the eastward, in both years the 18°C. isotherm extends out farther to the northward than in the area of 150°E. and is in about the vicinity of 32°N. At times it extends out in a tongue to the southwest, reaching to the westward of 140°E.

Figure 2 shows the results of sectional observations due east from Cape Inubō in 1936.

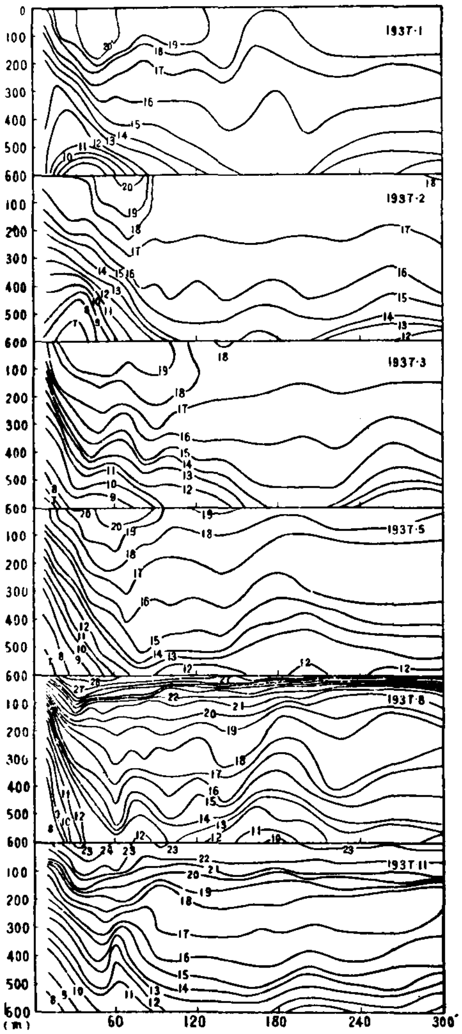


Figure 3.--Vertical temperature section 300 miles southeast of Cape Nojima (1937).

It can be seen that the strength of the Kuroshio has declined from the previous month. Figure 3 shows the results of observations 300 miles southeast from Cape Nojima and indicates that the strength of the Kuroshio is at its lowest level of the year in February and March.

Compared with January, the southern edge of the fishing grounds is about 1° farther to the south. The speed of the southward movement is rather slow as compared with the period of October to December and is nearly at a standstill. It appears that one can say that in the early part of the fishing season the rate of southward movement is great and that it decreases as we approach the end of the fishing season.

In February it is nearly at a standstill, and in March it is completely stopped, with its southern edge at exactly the same position that it occupied in February, while in April there is a general trend toward the north. As for the northern edge of the fishing grounds, it is farther south than in January, and north of 34°N. it is discontinuous except for the areas closer to Japan. Consequently, the north-south extent of the fishing grounds is extraordinarily narrow; east of 150°E. it is less than 300 miles. In the sea areas along the Japanese coast there are still fishing grounds developed fairly far north. East of 150°E. the isotherms are from 1° to 2° farther south than they were in January and are distributed in a compressed pattern. West of 150°E. the Kuroshio has penetrated and there is an invasion, in a complex form, of water masses of rather high temperatures considerably to the north. This agrees quite well with the shrinking and expansion of the fishing grounds. That is, along the Japanese coasts the extent of the fishing grounds from north to south is broad, and they have developed broadly over most of the Kuroshio intrusion. The isotherms in this sea area have not drawn close together, as they have east of 150°E. longitude, and there is quite a broad space between the 17° and 20° isotherms. East of 150°E. the fishing grounds are about 1° farther south than they were in January, and their breadth from north to south has decreased, a condition which is in good agreement with the fact that the isotherms have drawn closer together than they were in January and have moved about 1° farther south.

The catch rates continue to be at high levels, as they were in January. On the North Pacific fishing ground the overall average catch rate per unit area for January was 3.83, and in February it is 3.98 (in March it drops off abruptly to 2.42). In table 1, the sea area is divided into smaller segments of 2° of latitude by 5° of longitude in order to show the changes in the catch rates from month to month; the pattern of areas in which the catch rates have increased, and areas in which they have decreased, is extremely complex.

Table 1.--Monthly changes in the catch rates in each 5 degrees of longitude

海域 Latitude.	月 Month.	140° E ~ 145	145 ~ 150	150 ~ 155	155 ~ 160	160 ~ 165	165 ~ 170	170 ~ 175	175 ~ 180
28~30	1 Jan.	3.17	4.18	3.69	3.50	3.38	2.78	4.40	4.77
	2 Feb.	3.50	4.44	3.71	3.00	3.50	3.90	3.53	3.73
	3 Mar.	2.11	2.56	3.16	3.05	3.25	3.50	3.08	3.21
	4 Apr.	2.63	2.41	1.42		5.98	1.61		
30~32	1 Jan.	4.02	4.79	3.53	3.73	7.84	5.06	4.88	5.25
	2 Feb.	3.86	3.08	5.23	4.27	6.17	6.27	7.08	6.00
	3 Mar.	2.11	2.56	5.72	5.62	2.56	5.11	2.31	3.21
	4 Apr.	2.77	5.15	2.72	6.25	3.91	3.89	6.15	

Agreement in the monthly changes in the catch rates is apparent as between the areas of 140°E. to 145°E. and 145°E. to 150°E., and again as between 170°E. to 175°E. and 175°E. to 180°, however, no such analogies appear in the area centered around 160°E. In general the north-south extent of the fishing grounds is extraordinarily narrow, and it is thought that within this sphere the southward-moving albacore are compressed to the maximum, giving rise to the high catch rates.

Differences from year to year in the catch rates are rather well marked. As can be seen in table 2, the catch rates were higher in 1949 and 1952 than in 1950 and 1951, being particularly high in 1952. The annual ups and downs of the catch rate appear to be characteristic for the fishing ground as a whole, and in 1949 and 1952 catch rates were generally high everywhere between 140°E. and 180°, while in 1950 and 1951 they were generally low. This is thought to indicate that the North Pacific fishing ground is, as a whole, under a single regime.

Table 2.--February albacore catch rates by longitude and year

年次 / 経度	1949	1950	1951	1952
140°~150°E	4.04	2.38	2.67	4.01
150°~160°E	4.10	3.02	3.28	5.60
160°~170°E	4.04	2.15	(5.95)	7.52
170°~180°E		3.83	6.87	10.03

Note: Data at 160°-170°E. for 1951 are from only one station.

In the case of skipjack, big catches are made on cycles of alternate years and 4 years, but in the case of albacore, considering just the period of 1949 to 1952, no such phenomenon is apparent.

Looking at the position of the intermediate zone (table 3), in 1949 it was at its farthest offshore, being located east of 146°E., whereas in 1951 it was closest to the coast. Although in average years the area of 30°N. to 35°N., 140°E. to 145°E., shows very high catch rates (particularly for small- and medium-sized albacore), in 1951 the catch rates were extremely low because of the intermediate zone's closing in very near to the coast. In 1950 and 1952 it was located somewhat farther west than in 1949.

Table 3.--February albacore catch rates, averaged for squares of 1 degree of latitude and longitude, by years, in the North Pacific

1949--2

緯度 N / 経度 E	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
35 ~ 36		3.41																	13.04	
34 ~ 35		6.74	3.94		1.08	2.48												7.30	8.82	
33 ~ 34	11.43	6.61	3.96	2.99	3.01	7.58													7.21	
32 ~ 33	1.23	4.11	8.85	5.67	21.86	5.01	0.42											4.97	4.72	
31 ~ 32			6.86	4.15	2.95														4.92	3.81
30 ~ 31	0.98	3.50	4.81	2.12	4.35	4.58	3.20	3.20							4.27		1.80	0		2.95
29 ~ 30	3.10	7.22	7.67	1.59	3.67	6.48	6.87	3.77	2.86	2.00			3.79	2.61	2.55	1.92				
28 ~ 29	5.92	5.81	6.49	2.04	1.70			0.41	1.86	1.91		7.51	3.27	2.55	3.04	1.14				6.83
27 ~ 28	5.81		2.06	0.53	0.59	0.89		0.40				2.72								
26 ~ 27	3.25		0.17	0.08								0.31	0.50							

緯度 E / 経度 N	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
35 ~ 36																				
34 ~ 35																				
33 ~ 34				5.04																
32 ~ 33			6.80	6.06																
31 ~ 32	1.82	5.98	4.95	3.61	6.97															
30 ~ 31			3.33	2.78	2.80															
29 ~ 30	7.37	2.75	4.43	3.60																
28 ~ 29	3.89	3.71	2.99	3.84	2.81															
27 ~ 28	1.35				2.01															
26 ~ 27																				

Table 3.--February albacore catch rates, averaged for squares of 1 degree of latitude and longitude, by years, in the North Pacific (cont'd)

1950--2

経度 E / 緯度 N	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
35 ~ 36		0.75	0.75																	
34 ~ 35	1.30	1.27			1.11															
33 ~ 34	0.60	5.38	9.96	0.65	0.57				0.44	0.19										
32 ~ 33	0.60	5.99	4.97	2.09	1,12	1.08			0.90											
31 ~ 32	7.67	3.81	9.18	0.93	1.52				3.77										3.00	
30 ~ 31	5.85	7.28	3.34	1.73	2.15	0.72		3.91	2.03				1.46						2.82	4.76
29 ~ 30		4.31	1.92	2.07	3.20	4.51						4.74	2.10	2.41	2.45	1.52	1.75		2.17	4.03
28 ~ 29	1.81	1.47	2.99	2.93	1.26	3.21		3.08	1.06		2.16	3.03		2.98	2.94	2.82	3.90			
27 ~ 28	0	0.37	0.39	2.07	0.97	1.79	1.93	4.27		2.89	2.89	4.60		4.84						
26 ~ 27	0.04	0	0.48	0		0														

経度 E / 緯度 N	160°~161°	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
35 ~ 36																				
34 ~ 35																				
33 ~ 34																				
32 ~ 33																				
31 ~ 32			0.72						2.98									6.56	9.02	1.11
30 ~ 31		2.19						2.08	2.79		5.41	3.47		2.53	5.70	2.17	3.26	4.56	4.07	4.29
29 ~ 30	1.89				1.49			2.80	1.93	2.76	5.10	4.04	1.07	2.50	2.65	7.42	8.13	5.75	3.08	3.21
28 ~ 29							3.71	1.29	3.85	1.64	3.85			2.09	3.52	4.29	3.09	2.51	0.44	
27 ~ 28																				
26 ~ 27										0.10	0									

1951--2

経度 E / 緯度 N	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
35 ~ 36	2.60	0	0			0.11														
34 ~ 35	0.22	0.99	4.17		0						0									
33 ~ 34	1.16	0.53	0.44	0.53	0.31	0					0									
32 ~ 33	0.85	0.80	0.50	0.89	0.09				0.08											
31 ~ 32	0.77	0.71	0.85	4.73												1.80	3.98		6.60	
30 ~ 31	1.89	2.50	2.48	3.54			3.16	4.37	9.74	7.09					3.59	6.58	2.42	4.51	5.31	
29 ~ 30	4.38	5.78	6.41	4.83	4.58				10.53			3.41			2.17	2.61	2.10	1.78	2.36	4.68
28 ~ 29		3.90	3.71	4.23	4.68	4.79		3.84	2.44	0.78	3.90	3.38				2.33	3.96	1.56		
27 ~ 28		0.51	2.20		2.87	3.11	3.94	5.43			2.99	5.28					5.74	2.36		
26 ~ 27																				

Table 3.--February albacore catch rates, averaged for squares of 1 degree of latitude and longitude, by years, in the North Pacific (cont'd)

1951--2 (cont'd)

經度 E / 緯度 N	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
35 ~ 36																				
34 ~ 35																				
33 ~ 34																				
32 ~ 33																				8.78
31 ~ 32																		5.99	7.95	9.34
30 ~ 31				5.95									8.01					3.95	4.17	6.77
29 ~ 30																				
28 ~ 29																				
27 ~ 28																				
26 ~ 27																				

1952--2

經度 E / 緯度 N	140°~141°	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
35 ~ 36																				
34 ~ 35	1.45		9.93	5.25		0.20									7.10					
33 ~ 34	1.44	3.62	7.28	0.86	1.67	0.35														
32 ~ 33	8.82	3.44	5.27	5.91	1.39	0.20	0.69													
31 ~ 32	2.04	5.38	9.24	9.08	2.39		0	1.13							11.35					
30 ~ 31	3.93	7.40	5.82	6.69	5.95			0.93	4.62	0.71	9.75	2.98	4.54	3.16	9.69	11.91	10.72	8.30	6.28	7.20
29 ~ 30	4.54	4.92	4.95	4.58	2.26	0.89		5.80	5 33	4.46	7.18	3.97	3.20	5.38	6.59	5.32	3.51	4.29	5.18	5.99
28 ~ 29	3.91	4.04	5.15							8.50	3.49	1.03				2.66	3.45	1.92		
27 ~ 28	3.10	2.86									0.63									
26 ~ 27																				

經度 E / 緯度 N	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
35 ~ 36																				
34 ~ 35																				
33 ~ 34																				
32 ~ 33														16.85						
31 ~ 32									7.75	10.27	8.67	11.80	9.07		16.15					
30 ~ 31	7.76	8.71		5.95	3.74	14.46	9.30	5.22	1.25		9.21	3.71		5.92		8.93		13.15	13.59	11.07
29 ~ 30	8.39	8.29		2.99	9.79	7.28	8.18			8.46	8.07						4.17			
28 ~ 29																				
27 ~ 28																				
25 ~ 27																				

In all years the location of the intermediate zone was somewhat more to the west than in January. As a result, the zone of high catch rates on the west side of the intermediate zone is pressed in closer to Japan than it was in January. The pattern of variation from year to year in the location of the intermediate zone appears to continue on from January, but the zone of high catch rates on the west shows some points of difference in 1951. In this year, because of the extreme approach of the intermediate zone to the coast of Japan, the zone of high catch rates did not develop north of 30°N. but shifted to the sea areas south of 30°N. For the sea area east of 150°E. we do not have adequate data so that annual changes there are not clear.

The pattern of variation of fishing conditions in unit sea areas between 140°E. and 150°E. is shown in table 4 and closely resembles the situation in January. In continuation of the situation in the preceding month, the fishing grounds along the southern edge show small variability in fishing conditions, while there is a tendency for the variability to increase toward the northern edge.

Table 4.--Frequency of coefficients of variation (C.V.) of catch rates in unit areas, divided by 2 degrees of latitude, between 140° and 150°E.

変異係数 C.V. / 緯度 Lat.	0% ~ 10	10 ~ 20	20 ~ 30	30 ~ 40	40 ~ 50	50 ~ 60	60 ~ 70	70 ~ 80	80 ~ 90	90 ~ 100	100 ~ 110	110 ~ 120	120 ~ 130	130 ~ 140	140 ~ 150	150 ~ 160	160 ~ 170	170 ~ 180	180 ~ 190	190 ~ 200	200 ~ 210
28 ~ 30	2	4	7	7	11	11	2	2	1	1											
30 ~ 32	2	1	2	7	2	4	7	4	5	1	2	1	2		1			1			
32 ~ 34	1	1	5	3	2		4	4	4	4	1	4	4	3	4		2	1			1

Note: Averages are 42.7% for 28°-30°N., 66.7% for 30°-32°N., and 93.1% for 32°-34°N.

The variability of catch rates in unit sea areas for the waters east of 150°E. is as shown in table 5; the variability is very slight and hardly any difference between the northern and southern parts of the area can be detected. In this area the north-south compression of the fishing grounds is extreme and the albacore are accumulated within a narrow range, which is thought to give rise to the stabilized fishing conditions.

The average weight of the fish landed from this sea area is shown in table 6. As in the preceding month, the fish are bigger along the southern edge of the ground and are smaller the farther north one goes. The size also decreases toward the Japanese coast and increases offshore to the east. As compared with January, however, with one exception, the size of the fish is a good deal smaller.

Table 5.--Frequency of coefficients of variation of catch rates in unit areas east of 150°E. longitude

経度 Longitude.	緯度 Latitude	% 0~10	10~20	20~30	30~40	40~50	50~60	60~70	70~80	80~90	平均 Mean.
150°~160° E	28 ~ 30° N		3	5	5	6	2	2	1	1	40.6
	30 ~ 32	1		3	1		1		1	1	41.3
160°~170° E	28 ~ 30	2	2	3	5			1		1	31.4
	30 ~ 32	1		3		1	2				33.6
170°~180° E	28 ~ 30		1	1	4	1	5				41.7
	30 ~ 32		3	1	3	2	2	1			36.7

Table 6.--Average weight (in kan = 8.27 lbs.) of albacore landed from the North Pacific ground in March. Figures in ( ) are ratio to February

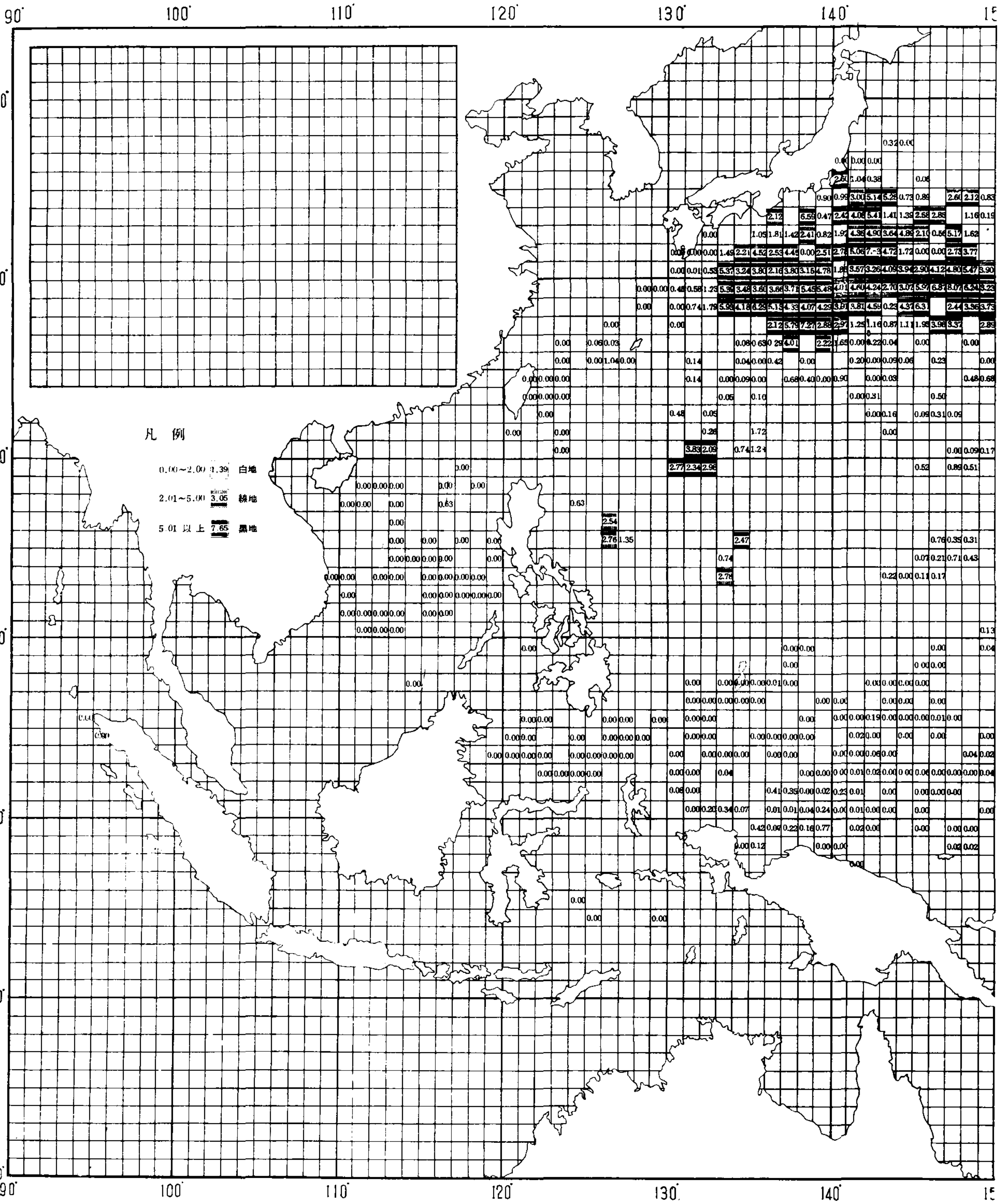
	140~150° E	150~160° E	160~170° E	170~180° E
28~30° N	3.95 (85)	4.29 (80)	4.85	5.39
30~32° N	2.56 (113)	3.17 (68)		3.86 (83)
32~34° N	1.91 (73)			
34~36° N	1.56 (80)			
36~38° N	1.65			

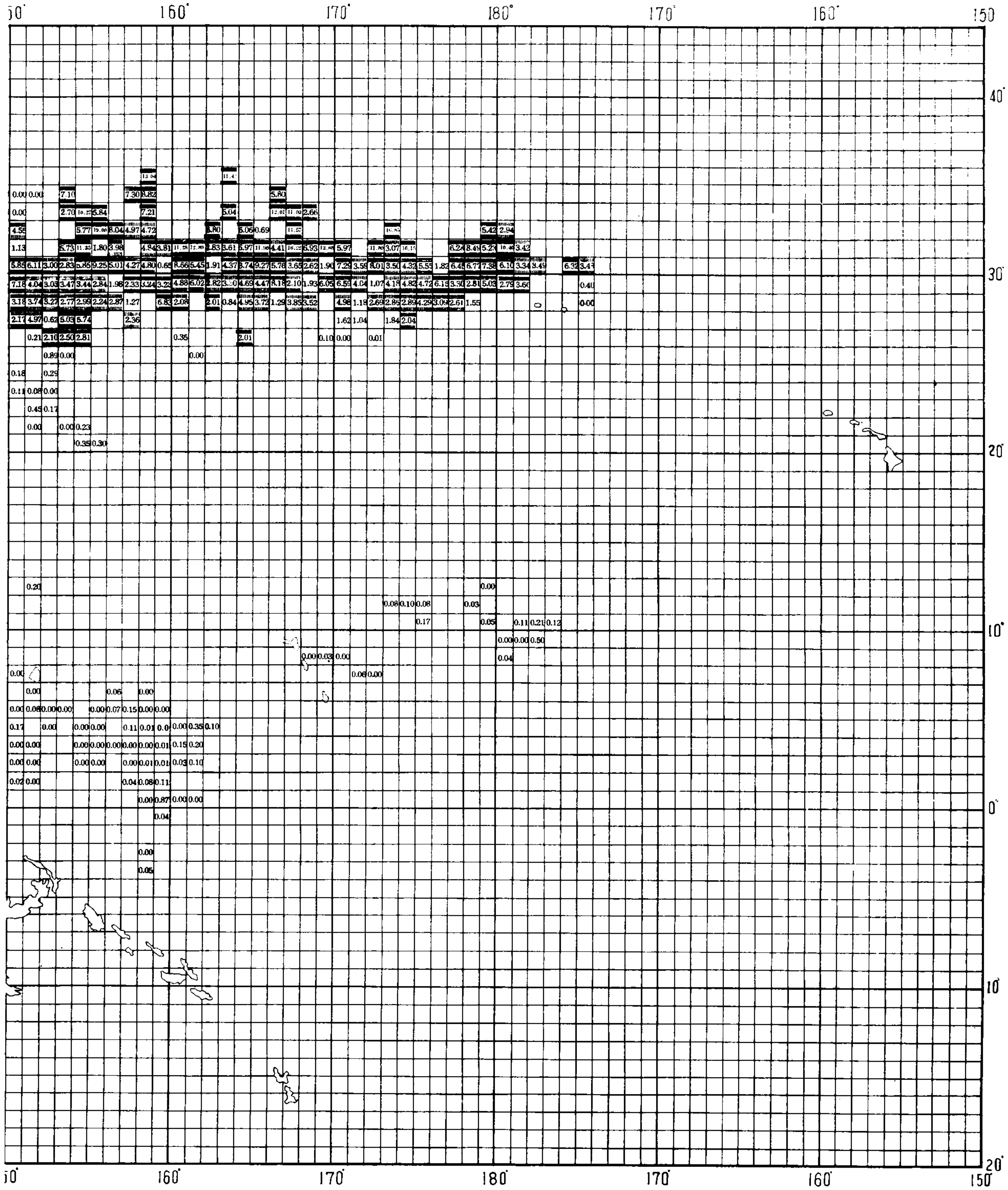
2. Kinan Ground

Figure 5 presents the results of sectional observations made to the south-southeast of Cape Ashizuri in 1936. There is a good deal of difference in the water temperatures at intermediate levels as between the main stream of the Kuroshio and the gyre area; in 1936 there was a conspicuous boundary in the vicinity of 31°N., and south of it, in the gyre area, the difference between temperatures of the upper and lower levels was slight. A similar small difference in the temperatures at upper and lower levels within the gyre area was found as a result of sectional observations south of Cape Shionomisaki in January. The distribution of the surface isotherms is shown in figure 6, where it is indicated that the water temperature at the surface was about 1° lower than in January.

The cases with the highest catch rates are in the gyre region, where there is little difference between the water temperatures at the upper and lower levels, and in the sea areas adjacent to it on the south

ビンナガ (Albacore (*Thunnus germo*)) 2月 (February)

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150°

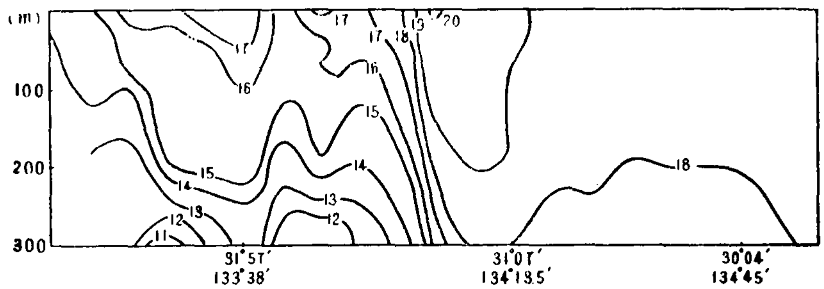


Figure 5. --Vertical temperature section south-southeast of Cape Ashizuri (1936, from Semi-ann. Rpts. of Oceanog. Obs.)

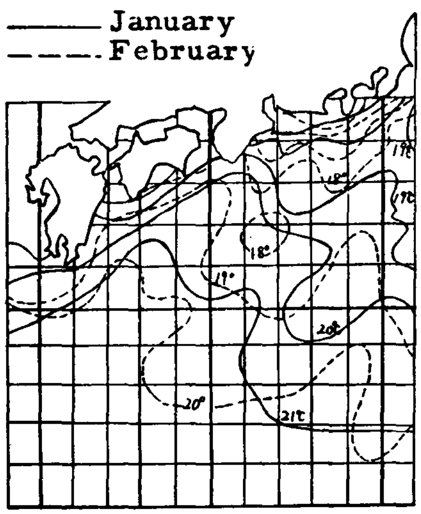


Figure 6. --Distribution of isotherms in Kinan area.

as far as 27°N. Within the area of the main flow of the Kuroshio, although there are occasional outstanding values indicated, in general the catch rates have become low.

No southward movement can be detected as compared with the positions of the fishing grounds in January. However, there is a further expansion to the west, and the grounds are almost in contact with the Ryukyu archipelago. In the overall view, the catch rates are even higher than in January, with an average of 2.73 as compared with 1.95 in January in this area (north of 27°N., between 130°E. and 140°E.). (In March it drops somewhat to 2.31.) The average catch rates for this area show considerable differences from year to year, having been 3.60 in 1949, 3.39 in 1950, 4.45 in 1951, and 3.05 in 1952. (Since the charts of the average year's fishing conditions include data from coastal operations, which are mainly aimed at catching sharks, the values they show for these 4 years are all somewhat lower.) Data are comparatively scarce for the period 1949 to 1951, so the values shown cannot be relied on completely, but they indicate that the catch rates are high and low every other year. The high catch rate in the odd-numbered years agrees well with the situation in the Okinotorishima fishing ground. On the other hand, it differs from the trend in the part of the North Pacific fishing ground lying east of the Izu and Ogasawara archipelagoes. The alternate-year phenomenon also appears to be seen in the manner in which the areas of high catch rates appear, for in even-numbered years the zone of high catch rates advances westward to the vicinity of 135°E., or even west of that longitude, whereas in odd-numbered years it appears farther east between 135°E. and 140°E. longitude.

There are a number of points which should be examined with regard to the size of the fish, and there are several circumstances to consider in regard to the relationships of this population. The character of the size composition of the albacore landed from this sea area agrees well with that of fish from the North Pacific fishing ground east of the line of the Izu and Ogasawara archipelagoes on the following counts:

(1) When we consider the sea areas east and west of the island chains, we find that the farther west we go the smaller the fish are, and the farther east we go the larger they are, and this trend on the North Pacific fishing ground can be extended to fit the whole area between 130°E. and 180°.

(2) The trend toward larger sizes in the south is also in good agreement with the situation on the North Pacific fishing ground.

Table 7.--Average catch rates by 1-degree squares by years, Kinan area.

1949

経度 °E. / 緯度 °N.	130~131	131~132	132~133	133~134	134~135	135~136	136~137	137~138	138~139	139~140
34~35										
33~34										
32~33										
31~32						0.60	0.53			
30~31							2.18			
29~30						4.89	3.18	1.58	4.00	4.38
28~29						6.66	3.86	3.49	3.00	4.43
27~28							2.12		8.12	
26~27								4.01		2.22
25~26										
24~25										

1950

経度 °E. / 緯度 °N.	130~131	131~132	132~133	133~134	134~135	135~136	136~137	137~138	138~139	139~140
34~35										
33~34										0.30
32~33						1.34	1.81			0.48
31~32					3.31	1.51	0.87	5.09		4.17
30~31				3.81	4.49	4.92				
29~30				3.55	4.57	3.94	4.79	3.85	4.17	
28~29				1.73	3.96	8.45				
27~28										
26~27										
25~26					0.08					
24~25					0.08					

1951

経度 °E. / 緯度 °N.	130~131	131~132	132~133	133~134	134~135	135~136	136~137	137~138	138~139	139~140
34~35										
33~34										0.77
32~33						0.17				3.34
31~32					3.06	6.67				
30~31						2.65	3.93	3.32	2.08	4.85
29~30	4.95				1.35	2.62	4.64	4.53	9.22	7.35
28~29					1.96	8.08	4.43	6.66	6.41	4.42
27~28								7.90	6.42	
26~27										
25~26					0	0			0.85	
24~25										

1952

経度 °E. / 緯度 °N.	130~131	131~132	132~133	133~134	134~135	135~136	136~137	137~138	138~139	139~140
34~35										0.90
33~34										0.75
32~33										0
31~32				2.18	2.33					3.25
30~31	0	0	2.93	3.40	2.96	1.88			4.21	4.70
29~30	0.63	0.09	2.45	5.74	4.51	2.95	2.83	4.86	4.42	4.71
28~29		1.09	3.19	8.02	6.62	4.18	3.74	2.83	2.79	4.03
27~28							3.68			2.88
26~27							0.29			
25~26							0.42			
24~25										

Table 8.--Monthly changes in mean weight of albacore on various grounds (in kan)

月 Monthly.	経度 Long. / 緯度 Lat.	130~ 140° E	140~ 150° E	150~ 160° E	160~ 170° E	170~ 180° E
1	28~30° N	3.7貫	4.7	5.4		
	30~32		2.3	4.7	3.4	4.7
	32~34	3.0	2.6	2.8	3.3	4.7
(Jan.)	34~36		2.4	2.3		
	36~38		2.0			
2	28~30	3.3	4.0	4.3	4.9	5.4
	30~32		2.6	3.2		3.9
	32~34		1.9			
(Feb.)	34~36	2.0				
	36~38		1.6			
3	28~30	2.4	3.0	3.3	2.7	4.3
	30~32		2.4			3.5
	32~34	2.5	2.0			
(Mar.)	34~36					
	36~38					

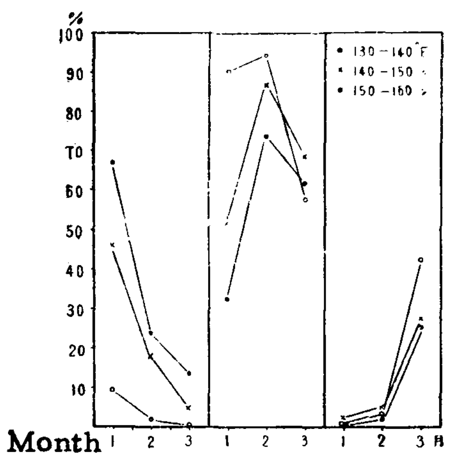


Figure 7.--Percentages of small, medium, and large albacore in the catch at 28°-30°N., 130°-160°E. Left panel - over 85 cm. Center panel - 65-85 cm. Right panel - below 65 cm.

(3) There is also agreement in the tendency for the size of the fish to diminish with the passage of the season.

(4) The proportion of large, medium, and small albacore in the catch, as shown in figure 7, shows the same trend as in the sea areas east of the archipelagoes.

The size composition of the albacore taken in this area closely resembles that between 140°E. and 150°E. Medium-sized albacore are overwhelmingly predominant, but as the season advances there is an increase in the groups of smaller fish. It will be noted that in the first part of the fishing season in January the majority of the fish are medium-sized albacore. At this season, the proportion of small albacore in the catch in the Kinan Sea Area is less than it is between 140°E. and 150°E. (The area of 140°E. to 150°E. is the part of the North Pacific fishing ground with the smallest average size of fish.) Nevertheless, the average weight of the fish here is even smaller than it is at 140°E. to 150°E., and the population has the smallest number of large albacore of any fishing ground north of the Subtropical Convergence. In March there is a great increase in the proportion of small albacore until their percentage is the highest of any of the fishing grounds north of the Subtropical Convergence. The pattern is for the albacore schools which appeared in November at 140°E. to 150°E. to move westward as well as south, and proceed southwestward along the coast of Honshu. It is thought that the southwestern extremity of this population first appears in this sea area, and that this is the reason why the proportion of large and small albacore is small and the population which appears here is composed almost entirely of medium-sized albacore. The schools which moved southwest closest to Japan represent the western extremity of the schools moving through the North Pacific fishing ground as a whole, and this population has the largest proportion of schools of small fish. It is thought that this group appears in the Kinan Sea Area in March. Even within the Kinan Sea Area the albacore which migrate closest to the coast of Japan, and are taken in the areas west of the Izu Islands have an extremely high proportion of schools of small fish.

The length composition of the albacore landed from this sea area in many cases coincides with or is extremely close to the size composition on the North Pacific fishing ground, although there are differences from year to year in the length classes at which the modes appear.

In the early part of the season, for a time, the central portion of this sea area has fishing grounds which appear in isolation from the North Pacific fishing ground, but these grounds suddenly extend and quickly become continuous with the North Pacific fishing ground. The zone of high catch rates expands from the east toward the west. Judging from this pattern of movement of the fishing grounds, there is thought to be a very high possibility that this population originates in the albacore distributed in the area of 140°E. to 150°E.

East and west of the line of the Izu, Ogasawara, and Mariana archipelagoes differences of various sorts can be found in the other tuna and spearfish species. For example, the bigeye tuna which are taken mixed with the albacore on the west side of the island chain reach a considerable number, but on the east side the proportion decreases drastically. In the case of albacore, too, the schools of large fish which appear around Okinotorishima find no analogy on the east side of the island chain. Changes from year to year in the catch rates appear to be in agreement as between the Kinan fishing ground and the Okinotorishima fishing ground. (There is a need for a further examination of this point when more data have been assembled.) Consequently, there are a number of circumstances remaining to be further examined with regard to whether or not the albacore of the Kinan fishing ground and those of the North Pacific fishing ground can be considered to be one population.

An outstanding characteristic of this sea area is the great speed with which the albacore fishing grounds are formed. It is thought that this phenomenon may be based on the special characteristics of the oceanographic conditions in this sea area. This phenomenon does not immediately negate the connection with the area of 140°E. to 150°E., but, on the other hand, neither can it be explained by hypothesizing the independence of the

Kinan population and the North Pacific population. Consequently, it is believed that this rapid development of the fishing grounds is not a problem connected with the relationships of the population.

Table 9.--Length frequency (in numbers of fish) of albacore taken in February at 130°-140°E. and at 140°-150°E.

年 月 Date.	海 域 Locality.	51	53	55	57	59	61	63	65	67	69	71	73	75	77	79	81	83	85
1949 2	26~ 30°N 130~140°E															8	9	30	44
	26~ 30°N 140~150°E														13	62	94	74	81
	30~ 34°N 140~150°E	1	2			3	5	12	24	23	32	21	35	84	143	223	190	120	55
1950 2	26~ 30°N 130~140°E												1		4	12	26	26	24
	26~ 30°N 140~150°E					1			4	2	3	1	6	9	6	4	1	7	16
	30~ 34°N 140~150°E	2	5	8	4	4	19	57	118	115	178	312	373	224	66	21	4	1	2
1951 2	26~ 30°N 130~140°E						1	1	13	12	28	23	48	71	99	67	34	29	15
	26~ 30°N 140~150°E						1	1	4	5	2	8	18	23	41	47	63	71	89
	30~ 34°N 140~150°E	1	6	13	13	17	25	51	63	89	62	72	134	198	228	141	138	84	91
1952 2	26~ 30°N 130~140°E						1	14	49	96	104	71	61	54	67	123	145	132	85
	30~ 34°N 130~140°E						1		3	20	32	30	19	10	11	5	2		
	26~ 30°N 140~150°E																1	2	10
	30~ 34°N 140~150°E						25	32	131	257	278	256	224	157	201	168	97	69	68

年 月 Date.	海 域 Locality.	87	89	91	93	95	97	99	101	103	105	107	109	111	113	115	117	119
1949 2	26~ 30°N 130~140°E	41	16	3	3	2			1	3		1						
	26~ 30°N 140~150°E	38	30	11	8	2												
	30~ 34°N 140~150°E	18	10	3		1	3		1	1								
1950 2	26~ 30°N 130~140°E	30	13	8	5	8	1				1							
	26~ 30°N 140~150°E	18	33	51	52	48	3	22	20	12	10	12	9	6	5	2	1	
	30~ 34°N 140~150°E		1		3													
1951 2	26~ 30°N 130~140°E	17	12	13	3	1												
	26~ 30°N 140~150°E	92	90	56	29	29	16	17	12	14	7	6		6	2	1		1
	30~ 34°N 140~150°E	57	51	15	10	3	3	2	1					1				
1952 2	26~ 30°N 130~140°E	47	47	21	7	4	7	3		2	2	3			1			
	30~ 34°N 130~140°E																	
	26~ 30°N 140~150°E	46	99	137	126	73	62	58	49	22	15	15	9	3	4	4	3	1
	30~ 34°N 140~150°E	1		1														

3. Grounds South of the Subtropical Convergence

(1) Okinotorishima Ground

In February the number of vessels operating in this sea area declines and the details of the fishing ground become unclear. The albacore catch rates still appear to be high, indicating that there is still a considerable occurrence of albacore in the area. It is particularly noted that the fishing grounds are thought to be still expanding in area, extending on the south to the northern edge of the main current of the North Equatorial Current and on the west to the eastern side of the area where the Kuroshio originates east of the Philippines. It is not clear, however, whether the density of distribution of the albacore has remained at the same level and the fishing grounds have expanded over a greater area, or whether the fish have already begun to diminish in numbers and the schools have begun to disperse with a resultant expansion of the fishing grounds. The size composition is shown by the following small table.

体長 Body Length	75~85cm	85~95cm	95~105cm	>105cm.
測定尾数 Fish measured	1	31	83	8

The average weight is 5.45 kan /47.5 lbs./ somewhat smaller than in the period of November to January.

Considerable numbers of large albacore also appear from time to time in the waters of the Ryukyu archipelago. It is not clear whether this group originates in the albacore on the Okinotorishima ground or, as will be explained later, whether they have come from north of the Subtropical Convergence to join the population on the south side of the Convergence.

(2) Other Grounds Between 10°N. and 25°N.

In the South China Sea, as in the preceding months, some occurrence of albacore is noted, although it is sparse. From the areas south of the Kinan fishing ground and the North Pacific fishing ground to the vicinity of 10°N. we find no catch rates as high as 1.0, with the exception of the Okinotorishima ground, but there is thought to be a broad occurrence here of large albacore. On the grounds from the area northeast of the Marshall Islands to Hawaii the albacore catch rates appear to be somewhat lower than in January.

The size composition is as shown in table 8 and reveals the highest average weight of any sea area in the northwest Pacific.

Table 10.--Size composition (numbers of fish) of albacore taken in middle latitude waters

長体 B.L / 海域. Locality	85~ 95cm	95~105cm	>105cm以上	平均(貫) Mean(kan)
10~12° N.,170~180° E.		10	7(尾)	6.46
14~16° N.,140~150° E.	1	34	45	6.68

(3) Grounds of Tropical Seas

In general the catch rates are lower than they were in January. In the Palau area the catch rate is down below that of the preceding month, but many areas with catch rates above 0.2 are noted where the albacore schools seen from November to January are lingering on. In March the catch rates become extraordinarily low, and it is thought that February is the season at which the Palau population is in the process of disappearing. We have no data on the size of fish in the Palau group, but believe that they are of about the same size as in the preceding month. In the area of 0° to 4°N., 140°E. to 150°E., the average weight of the albacore is 6 kan [50 lbs.] which is smaller than the fish of the mid-latitude areas.

MARCH

General

Indications of the decline of the fishing grounds are conspicuous and all grounds look to be in their final stage of the fishing season. There are no longer any noteworthy catches in the South Sea areas. Around Okino-torishima, cases of catch rates of 2.0 or more are still seen, but the catch rates appear to have fallen around the edges of that fish ground. On the fishing grounds north of the Subtropical Convergence (North Pacific ground and Kinan ground) absolutely no southward movement of the southern edges is seen, indicating that the southward movement has already stopped. On the other hand, the northernmost portions of the fishing grounds are conspicuously fading out, and either there is no operation at all north of 32°N. or the catch rates are extraordinarily low. Between 140°E. and 150°E. in February there was a continuous row of areas of high catch rates extending to the vicinity of 35°N., but in March this drops off conspicuously. As a result, the fishing grounds have a breadth from north to south of about 200 miles and extend from 130°E. to 170°W. The overall average catch rate for the areas east of the Ogasawara and Izu archipelagoes, which was 3.98 in February, is 2.42 in March, while in the areas to the west of the islands the 2.73 catch rate of February is down to 2.31 in March, indicating that the end of the fishing season is approaching. One noteworthy thing, however, is the beginning of a completely new movement of the albacore. This group of fish cannot be said to be concentrated, but it is thought to have an important meaning ecologically as a link between the populations distributed north and south of the Subtropical Convergence. Although the northern group (the albacore schools distributed on the north side of the Subtropical Convergence) has stopped its southward movement between 140°E. and 155°E., a part of this group at this season continues to move south and breaks through the Convergence into the sea areas to its south, so that we find recorded occasionally catch rates of about 1.0 in the area of 20°N. to 27°N. or 28°N. We have hardly any data east of 155°E., so the movements in this area are not clear, but judging from the conditions in April, May, and June it is thought that probably part of the fish continue moving south after the main group has stopped its southward migration, just as was the case between 140°E. and 155°E.

1. Grounds North of the Subtropical Convergence

(1) North Pacific Ground

The southern edge of the fishing grounds, just as in February, is along the line of 26°N. to 27°N., with absolutely no southward movement shown. In April the fishing grounds show some northward movement, so the position of the southern edge in March represents the farthest south position of the North Pacific fishing ground. At this season the position of the Subtropical Convergence between 140°E. and 170°W. is between 22°N. and 24°N. Consequently, this means that the North Pacific fishing ground, at the time of its farthest south movement, is still on the north side of the Convergence. There are a number of things to be thoroughly considered in connection with the proposition that there is a deep relationship between the oceanographic conditions and the line on which the southward movement of the albacore stops:

(1) This line is approximately parallel to the Subtropical Convergence.

(2) It appears to be in the vicinity of the boundary between the easterly flowing portion of the North Pacific Current and the countercurrent portion on its south side.

The intrusion of the Kuroshio between 140°E. and 150°E. shows a decline in strength as compared with February, with its head pushed down by the Oyashio so that the 18° to 20°C. isotherms are compressed from the north southward and throughout the North Pacific fishing ground as a whole are distributed in close proximity to each other between 28°N. and 31°N.

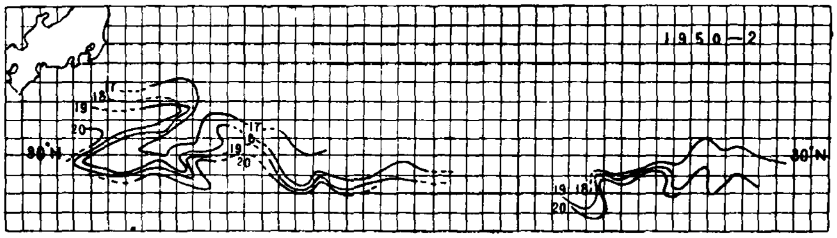


Figure 1.--Distribution of isotherms on the North Pacific ground.

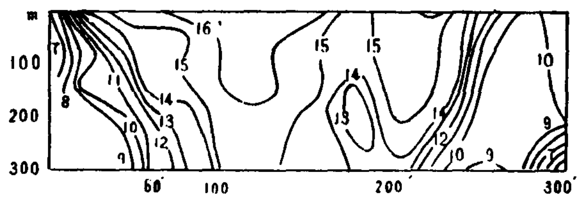


Figure 2.--Vertical temperature section 300 miles due east of Cape Inubō, 1936.

March is the time when the strength of the Kuroshio is at its lowest ebb, and this condition can be clearly seen by comparing the results of observations due east of Cape Inubō, shown in figure 2, and the data on sectional observations southeast of Cape Nojima, shown in figure 3 for February, with the months preceding and following. This is the season when the southward migration of the albacore comes to an end, and this is thought to be an extremely important datum.

Table 2 gives a comparison of the catch rates from year to year. March shows approximately the same sort of relationships as obtained in February. However, it appears that we cannot say that the March catch rates for 1951 were on the whole lower than those for 1949. The unusually high catch rates of 1952 and the particularly low ones of 1950 are the same as in February. The movements of the intermediate zone are not clear because of the scattered character of the albacore fishing in the Kuroshio intrusion and because of resulting inadequacy of the data, but judging by the 1950 and 1951 data it appears to have been pushed closer to Japan than in February (fig. 1). Particularly in 1951, the intermediate zone obtrudes into the sea areas just along the east side of Japan, with areas of high catches distributed to the south of it between 27°N. and 31°N. and on its east side at 140°E. to 150°E.

The range of variability in fishing conditions within unit areas is considerably different from that of February. The tendency for fishing conditions along the southern edges of the fishing grounds to be quite stable and with little variation, but with the variability increasing to the northward begins to disappear in March. In the sea areas east of 150°E. in February quite stable values were already shown and we did not see any trend for variability of the fishing conditions to become conspicuous to the northward, but between 140°E. and 150°E. there were still high values for the coefficient of variation along the northern edges of the fishing ground, as has been stated earlier. In March between 140°E. and 150°E. north of 32°N. little fishing was done, so the situation there is not very clear, but between 30°N. and 32°N. the fishing conditions were more stabilized than in January, and for the area of 28°N. to 32°N. an approximately uniform value is shown, as indicated in table 3.

Table 1.--Albacore fishing conditions (catch rates) by unit areas on 1 degree of latitude and longitude for March, 1949-52

1949. 3

緯度 °N. \ 経度 °E.	140~141	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
33 ~ 34	0	0	0.72	1.61	2.67	0														
32 ~ 33	4.21	0.42	0.34		0.67	1.22														
31 ~ 32																				
30 ~ 31	0.74								2.81	3.40				0.83			1.89		5.67	
29 ~ 30	6.72	5.27					4.11		5.73	2.69	2.00				6.54	4.30	1.65		4.39	4.99
28 ~ 29	5.50	2.39	2.29												6.49	4.30				
27 ~ 28	5.98			0				4.46	5.43	0.80		0.50			3.92	5.99	1.82			
26 ~ 27	7.79				0			0.13		1.54						1.36				
25 ~ 26	6.15					0.27			0.27		0.27				0					
24 ~ 25				0	0			1.56		2.22	2.50	1.09			0.43	0.35				

緯度 °N \ 経度 °E	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170
33 ~ 34										
32 ~ 33										
31 ~ 32										
30 ~ 31	2.00				4.08					
29 ~ 30	2.91	3.66	2.79	4.74	3.35					
28 ~ 29										
27 ~ 28										
26 ~ 27										
25 ~ 26										
24 ~ 25										

1950. 3

緯度 °N \ 経度 °E	140~141	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
33 ~ 34	0.22	0.24	0	1.45	0.43															
32 ~ 33	2.20	7.45	1.07	0.52	0.11		0.76	0		0.11										
31 ~ 32	0.84		1.08	0.80	0.91	0.56	0.51	0.64												
30 ~ 31	1.97	1.05	2.82	3.20	3.71	2.18			0.61				3.06							
29 ~ 30	4.18	3.21	4.74	3.32	2.87	2.41	1.60	3.16	1.96	5.77		3.15	2.86			2.86	3.31	3.12	2.73	4.00
28 ~ 29	3.13		2.74	4.23				0.27	2.00		2.61	2.03	2.32	2.17	2.26				1.92	
27 ~ 28			0.54	0						0.16	2.65	1.49	3.10	0.06						
26 ~ 27		0		0																
25 ~ 26		0	0	0					0									0		
24 ~ 25			0													0.32	0.06	0.05		

Table 1.--Albacore fishing conditions (catch rates) by unit areas on 1 degree of latitude and longitude for March, 1949-52 (cont'd)

1950. 3 (cont'd)

経度 °E / 緯度 °N	160 ~ 161	161 ~ 162	162 ~ 163	163 ~ 164	164 ~ 165	165 ~ 166	166 ~ 167	167 ~ 163	168 ~ 169	169 ~ 170	170 ~ 171	171 ~ 172	172 ~ 173	173 ~ 174	174 ~ 175	175 ~ 176	176 ~ 177	177 ~ 178	178 ~ 179	179 ~ 180
33 ~ 34																				
32 ~ 33																				
31 ~ 32																				
30 ~ 31												2.29	3.77		0.09		0.80	4.25	5.15	3.36
29 ~ 30									2.15	3.45	4.42	3.87	2.74	1.51	1.92	3.35	2.50	1.25	1.65	2.86
28 ~ 29			2.70	1.75					3.94	2.68		3.64		0.51	2.68	1.01	4.48		0.29	
27 ~ 28								0.44				8.94								
26 ~ 27				0	0			0.14	0.16	0.71	0.06									
25 ~ 26	0	0		0.14	0				0	0		0.05								
24 ~ 25	0						0.07	0												

1951. 3

経度 °E / 緯度 °N	140 ~ 141	141 ~ 142	142 ~ 143	143 ~ 144	144 ~ 145	145 ~ 146	146 ~ 147	147 ~ 148	148 ~ 149	149 ~ 150	150 ~ 151	151 ~ 152	152 ~ 153	153 ~ 154	154 ~ 155	155 ~ 156	156 ~ 157	157 ~ 158	158 ~ 159	159 ~ 160
33 ~ 34	0.21	0.33			0.52															
32 ~ 33	0.23	0.71	0.82	1.14					1.20											
31 ~ 32	0.20			0	1.00	0.27	2.20											4.41	3.80	
30 ~ 31	4.80	6.73	4.94		5.95			5.01	6.80	11.21								4.35	5.10	
29 ~ 30	5.00	5.72	4.66	3.90	3.31	4.96	2.63	6.22	7.96	8.07							3.14			
28 ~ 29		2.29	5.01	2.52	3.29	0.67		4.27	6.37	1.07							0.40			
27 ~ 28		0.43		2.23	3.76	0.63											0			
26 ~ 27	0	0		0.08					3.18											
25 ~ 26					0															
24 ~ 25						0.23														

経度 °E / 緯度 °N	160 ~ 161	161 ~ 162	162 ~ 163	163 ~ 164	164 ~ 165	165 ~ 166	166 ~ 167	167 ~ 168	168 ~ 169	169 ~ 170	170 ~ 171	171 ~ 172	172 ~ 173	173 ~ 174	174 ~ 175	175 ~ 176	176 ~ 177	177 ~ 178	178 ~ 179	179 ~ 180
33 ~ 32																				
32 ~ 31																				
31 ~ 30																				
30 ~ 29																				
29 ~ 28																				
28 ~ 27																				
27 ~ 26																				
26 ~ 25																				
25 ~ 24																				
24 ~ 23																				

Table 1.--Albacore fishing conditions (catch rates) by unit areas on 1 degree of latitude and longitude for March, 1949-52 (cont'd)

1952. 3

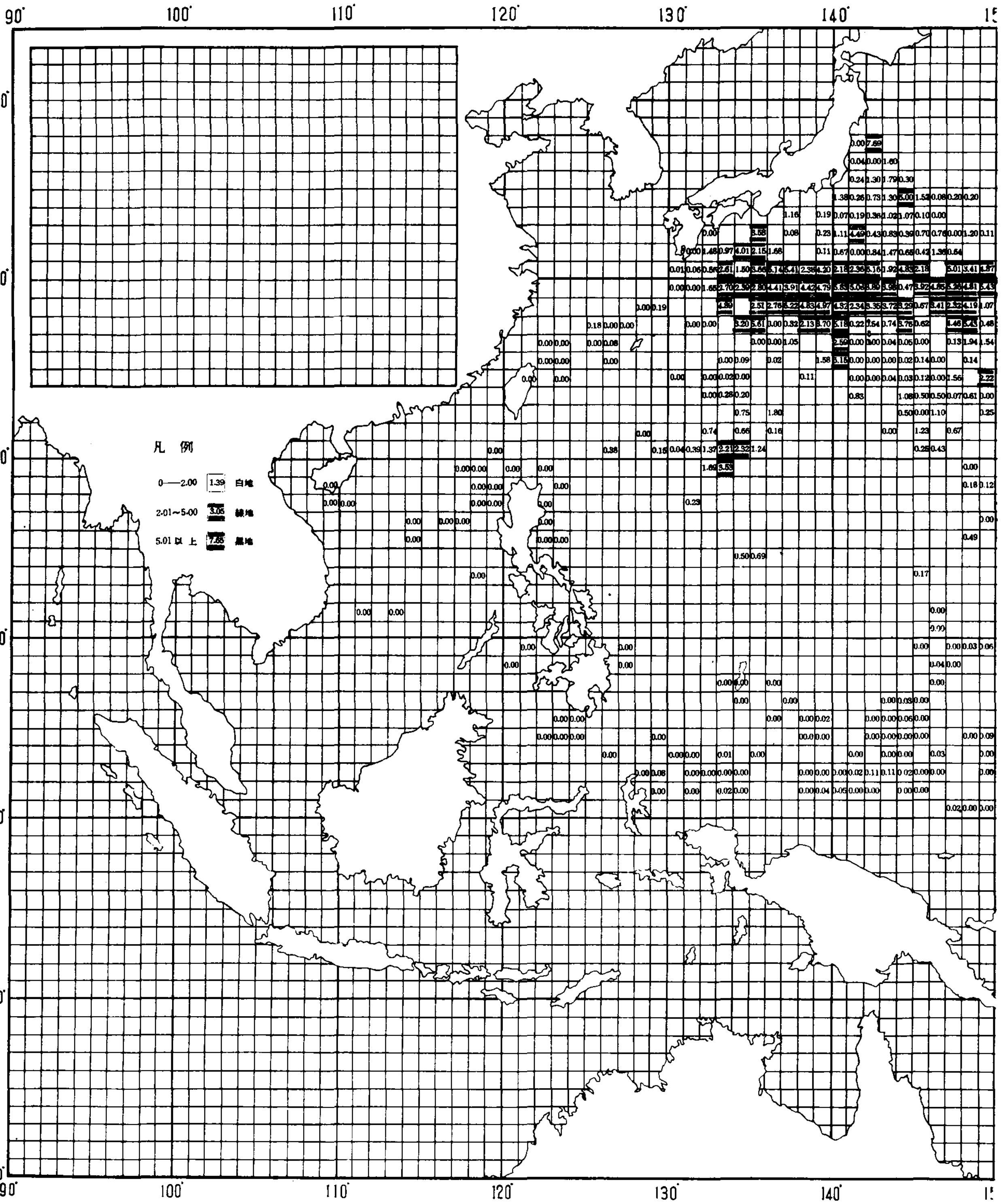
経度 °E / 緯度 °N	140~141	141~142	142~143	143~144	144~145	145~146	146~147	147~148	148~149	149~150	150~151	151~152	152~153	153~154	154~155	155~156	156~157	157~158	158~159	159~160
33 ~ 34																				
32 ~ 33																				
31 ~ 32				5.07																
30 ~ 31	3.16	4.01	10.68	1.94										4.60	11.05	8.21	7.57	5.70		
29 ~ 30	7.42	5.12	17.28	4.71			6.46	6.41	3.57	5.20	8.58				3.86		1.41	4.48	4.93	
28 ~ 29							3.41	2.43								3.84	1.21			
27 ~ 28																				
26 ~ 27																				
25 ~ 26																				
24 ~ 25																				

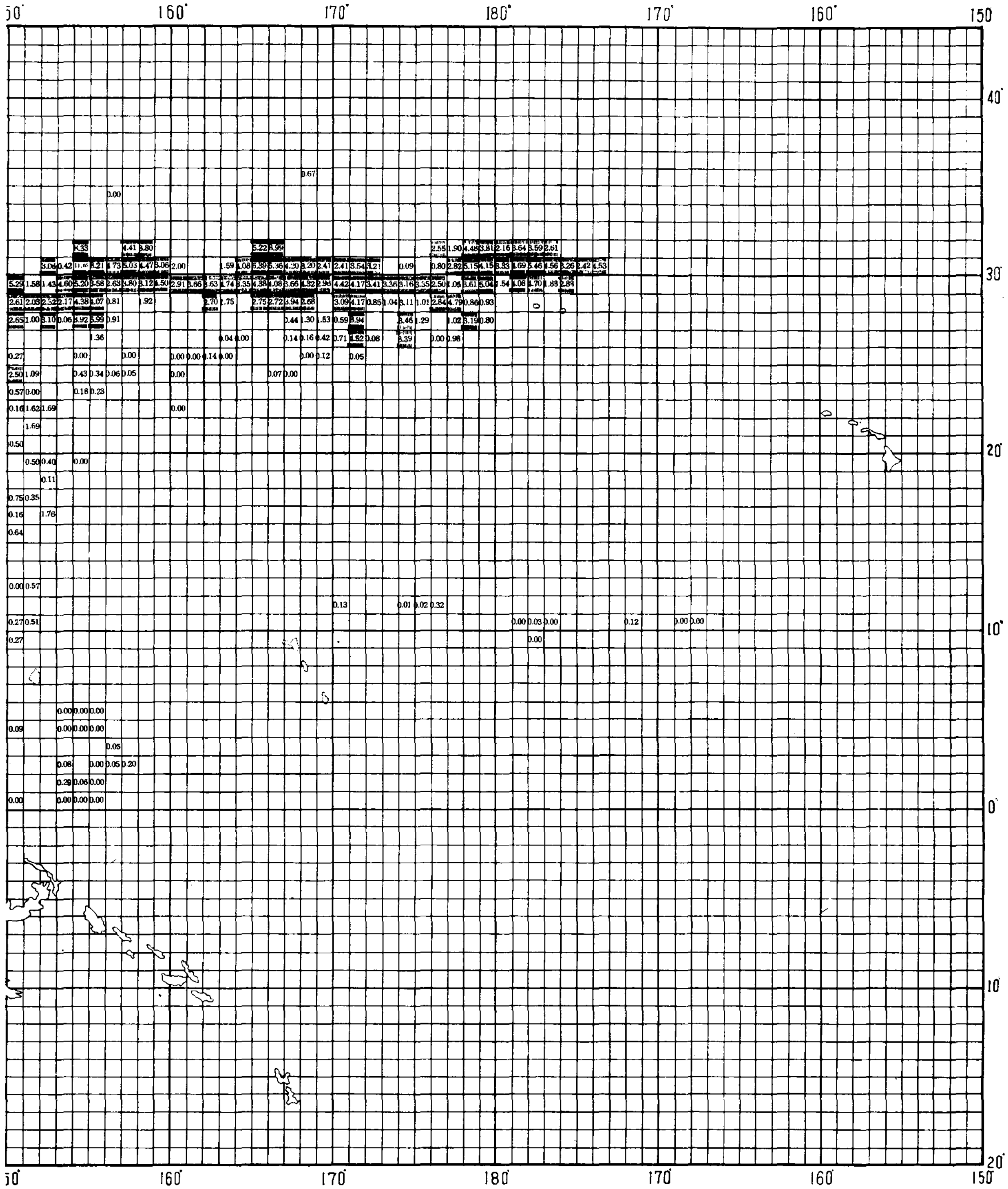
経度 °E / 緯度 °N	160~161	161~162	162~163	163~164	164~165	165~166	166~167	167~168	168~169	169~170	170~171	171~172	172~173	173~174	174~175	175~176	176~177	177~178	178~179	179~180
33 ~ 34																				
32 ~ 33																				
31 ~ 32							8.99												4.48	3.81
30 ~ 31							4.18	4.20	3.20	3.20	2.41							3.48		4.93
29 ~ 30			4.47			4.74														2.52
28 ~ 29																				
27 ~ 28																				
26 ~ 27				0.07						0.13										
25 ~ 26										0.24										
24 ~ 25																				

Table 2.--Albacore catch rates, by years, in the North Pacific ground

経度 Longi. / 年次 The year.	140~150° E	150~160° E	160~170° E	170~180° E
1949	3.71	3.65	3.36	
1950	2.10	2.54	2.50	2.81
1951	3.94	3.03		
1952	5.79	5.45	4.71	3.84

ビ ン ナ ガ (Albacore (*Thunnus germo*)) 3 月 (March)





150°
160°
170°
180°
170°
160°
150
40°
30°
20°
10°
0°
10°
20°

Table 3.--Coefficients of variance of catch on the North Pacific ground

緯度 Lat. / 経度 Longi.	28~30° N	30~32° N
140~150° E	49.7	56.5
150~160° E	42.1	37.5
160~170° E	—	—
170~180° E	46.3	56.4

From December on there is a gradual narrowing of the north-south extent of the fishing grounds, and the form that it takes is a fading-out of the northern edge of the grounds. What this means is that the areas where the fishing is unstable gradually cease to be fished. It is thought that this is because the schools which are being pushed south from the northern areas have declined in numbers and, as a result, all that is left is the accumulation of schools in the fishing grounds along the southern edge.

Table 4.--Length composition (%) of albacore landed from the North Pacific ground. Mean weights are in kan = 8.27 lbs.

緯度 Lat.	経度 Longi.	測定尾数 Fish measured.	45~55 (cm)	55 ~ 65	65 ~ 75	75 ~ 85	85 ~ 95	95 ~ 105	>105 以上	平均貫数 Mean weight.	平均貫数の前月比(%) Ratio of mean weight of March to February.
28~30° N	140~150° E	3481		1	26	44	24	4		3.02	76
	150~160° E	196		1	24	39	22	10	4	3.33	78
	160~170° E	142		6	20	65	6	2		2.65	55
	170~180° E	468			2	26	45	20	6	2.64	79
30~32° N	140~150° E	306		5	47	43	5			2.38	93
	170~180° E	222			15	42	30	9	4	3.50	91
	180~170° W	78			3	30	39	18	12	4.35	
32~34° N	140~150° E	54	4	15	57	25				1 96	103

Note: Underlined figures are the most numerous length classes.

Size of fish

In general, the tendency for the fish to be larger in the east than in the west and smaller in the north than in the south continues. The fish are smaller than in the preceding month, a trend which is particularly outstanding in the fishing grounds of the southern edge.

Table 5.--Monthly changes in mean weight (in kan) in the North Pacific at 30°-32°N.

月別 Monthly. / 経度 Longi.	12月 Dec.	1月 Jan.	2月 Feb.	3月 Mar.
140~150° E	3.8	2.3	2.6	2.4
170~180° E		4.7	3.9	3.5

Table 5 shows a comparison of the changes from month to month in the average weight of the fish as between the area of 140°E. to 150°E., where the fish are smallest, and the area of 170°E. to 180°, where they are largest. (Since there is also a difference in size from north to south, the comparison is based on landings from areas along 30°N. to 32°N.)

In both areas the size of the fish has become markedly smaller with the passage of time, and it will be noted that the fish taken at the close of the season in the area of 170°E. to 180°, where the fish are on the average largest, are smaller than those taken at the beginning of the season at 140°E. to 150°E., where the fish average smallest. Table 4 shows the relationship between the sizes of the fish taken in December at 140°E. to 150°E., and those taken in March at 170°E. to 180°. This indicates that we must take into consideration as one cause for the larger size of the fish far off to the eastward the possibility that the small albacore put in their appearance later in this area, and in view of the point that the formation of the North Pacific fishing ground begins in the areas east of 160°E., it may be wondered whether this does not mean that the albacore in the western sea areas begin their southward movement earlier. At the close of the season between 170°E. and 180° there are rather concentrated catches of small albacore of less than 3 *kan* [25 lbs.] in the northern part of the fishing ground; an example of this may be shown in the results of an investigation carried on from the middle to the latter part of March 1950.

According to table 6, at stations 1, 9, and 10 concentrated catches of small albacore were made. Their size was very small, the average weights being 2.6 *kan* [21.5 lbs.] at station 1 and 2.0 *kan* [16.5 lbs.] at stations 9 and 10. At all other stations, the catch was mainly large albacore, with the average body weight in all cases above 4 *kan* [33 lbs.]. It is noted that the water temperatures were lower where the small albacore were taken than where the big albacore were caught, and this is thought to represent a difference in the environments inhabited by the large and small fish.

There is also a difference in the size of the fish from east to west, and as reasons for the greater size of the fish to the eastward we may cite:

(1) Off to the eastward the quantity of large albacore is greater than it is in the sea areas nearer to the Japanese coast.

(2) Small albacore also occur in the waters far off to the eastward, but their appearance is late.

It is also thought that we cannot overlook the factor of "economic selection." On the far offshore grounds, because of financial considerations, large-size albacore are the main objective of the fishing, and when the size of the fish in the catch declines the vessels immediately move south and look again for schools of larger fish, which results in an increase in the average size of fish in their catches. Nevertheless, the question of whether the schools of small fish in the waters far offshore to the eastward are actually more numerous or less numerous than those in sea areas closer to the Japanese coast is one which must be examined further in the future.

In table 7 the albacore taken between 140°E. and 150°E. are divided into three categories, those below 75 cm., those 75 to 95 cm., and those over 95 cm., and the percentage of each class in the total landings is shown by months.

Table 6.--Results of oceanographic observations by the *Sagami Maru*, March 1950

St. No.	月日 Date.	投繩開始位置 Start point of setting of lines.	水温 Water temperature.				投繩終了位置 End point of setting of lines.	水温 Water temperature.					ビンナガ釣獲率 Hooked-rate of Albacore	ビンナガ平均体長 Mean length of Albacore
			0m	50	75	100		0m	50	75	100	150		
1	3.18	29° 37′N 174° 05′E	17.95	17.5	17.4		29° 51′N 174° 06′E	17.8	17.6	17.6	16.3	15.1	4.33	77.1
2	19	29° 27′ 174° 52′	20.1	18.55	18.25	17.7	29° 45′ 174° 57′	19.9	18.65				1.72	96.6
3	20	29° 29′ 174° 46′	19.4	18.9	17.6	17.3	29° 33′ 174 °25′	18.4	17.6	17.4	17 5	15.9	2.86	96.7
4	21	29° 36′ 174° 31′	18.2	17.95	17.85	17.6	29° 52′ 174° 24′	18.7	17.75	17.85	17.05	15.85	0.52	94.2
5	22	29° 19′ 174° 49′	18.4	17.85	17.9	17.5	29° 30′ 174° 15′	19.1					0.48	90.2
6	23	29° 07′ 174° 42′	19.4		17.6	17.55	29° 26′ 174° 32′	18.45	17.25	16.95	16.7	16.35	0.92	97.4
7	24	29° 30′ 174° 19′		17.75	16.95	16.75	29° 46′ 174° 10′	18.75	17.55	17.35	16.70	15.70	1.96	90.2
8	25	30° 10′ 174° 10′	19.6	18.65	17.9	17.25	30° 09′ 174° 26′			17.65	17.1	16.6	0.09	
9	26	30° 03′ 171° 55′	18.0	17.15	17.15	16.25	29° 44′ 171° 58′	17.15	17.25	17.25	17.0	16.1	2.29	72.8
10	27	30° 26′ 172° 02′	17.1	17.45	16.85	16.2	30° 26′ 172° 06′	17.85	17.15	17.1	17.1	16.75	3.92	72.8
11	29	29° 00′ 168° 31′	19.8	18.65	18.1	17.65	28° 48′ 168° 54′	19.6	18.1	17.6	17.35	17.95	3.76	99.3
12	30	28° 53′ 168° 26′	19.7	19.55	19.5	19.0	29° 11′ 168° 39′				16.65	16.35	3.78	96.0
13	31	29° 05′ 168° 55′			17.65	17.35							1.60	

According to the following table, areas where the majority of the fish were under 75 cm. were all north of 30°N. Fish in the size range of 75 to 95 cm., for the period January to March, made up the majority of the catch between 28°N. and 30°N. and thus were farther south than the fish below 75 cm. in length.

Table 7.--Percentages of small medium, and large albacore in the North Pacific catch at 140°-150°E. by month and by latitude

Fish under 75 cm.

緯度 Lat.	10月 Oct.	11月 Nov.	12月 Dec.	1月 Jan.	2月 Feb.	3月 Mar.
36~38° N	1	39	48	75	98	
34~36° N		28	56	58		
32~34° N		0	10	39	74	76
30~32° N			5	50	34	52
28~30° N				3	4	28
26~28° N				0	0	
24~26° N				0		

Fish 75 to 95 cm.

緯度 Lat.	10月 Oct.	11月 Nov.	12月 Dec.	1月 Jan.	2月 Feb.	3月 Mar.
36~38° N	99	61	51	34	2	
34~36° N		71	44	35		
32~34° N		97	81	57	26	24
30~32° N			86	50	65	48
28~30° N				51	78	68
26~28° N				21	5	
24~26° N				4		

Fish over 95 cm.

緯度 Lat.	10月 Oct.	11月 Nov.	12月 Dec.	1月 Jan.	2月 Feb.	3月 Mar.
36~38° N	0	0	0	1	0	
34~36° N		2	1	6		
32~34° N		3	9	4	0	0
30~32° N			10	0	0	0
28~30° N				46	18	5
26~28° N				79	95	
24~26° N				96		

Note: Underlining shows where more than half of the fish were in that length group.

Data are lacking for March from south of 28°N., so it is not known to what extent the fish of 75 to 95 cm. have moved south. South of 28°N. in January and February, however, albacore above 95 cm. in length predominate overwhelmingly, and in April and May also in this area fish above 95 cm. make up almost all of the catch, so it seems likely that not many of the medium-sized albacore come south of 28°N. Considering these various points together, it is thought that the smaller the fish, the farther north the position at which the various size classes of albacore stop their southward progress. Albacore above 95 cm. in length are thought to pass south of the Subtropical Convergence, but more will be said about this later.

The depth at which albacore are caught is thought to be related to various factors such as oceanographic conditions and weather conditions (for example, the amount of light in the water), but not much is known because of the inadequacy of the data. According to the data presented below, the efficiency is highest on the branch lines which reach the greatest depths. We find exceptionally cases in which there is almost no difference in the number of fish taken by the deepest hooks (145 to 150 m.) and those next deepest (120 to 125 m.), but in the Sagami Maru's case hooks number 3 and number 5 are at almost the same depth. Catching efficiency appears to drop considerably on the shallowest hooks (85 to 95 m.). The data are given in tables 8 and 9.

Table 8.--Depth of capture of albacore. (a) Results of Sagami Maru's investigation, March 1950, at 28°-30°N., 170°-175°E.

枝縄番号 No. of hook.	1	2	3	4	5	6	7
推定深度 (m) Depth estimated.	90	125	145	150	145	125	90
3月18日 18th. Mar.		3	6	4	5	2	
〃 19日 19th. 〃	2	4	5	7	3	5	1
〃 20日 20th. 〃	2	4	10	11	14	4	

Note: See table 6 for water temperatures and size of fish. Hooks 1 and 7 are shallowest, 4 deepest. Actual numbers of fish caught.

Table 8b-(1).--Results of No. 3 Nissho Maru's investigations, March 1953, at 28°-30°N., 145°-160°E.

月 日 Date.	漁獲尾数 Catch of No.	1	2	3	4	5
2.18	2		1	1		
2.19						
2.20	1				1	
2.22	1				1	
2.26	38+2	3	13	15	6	1
2.28	13+1	2	2	5	2	2
3. 1	29	1	7	15	4	2
3. 2	23+1	2	4	9	6	3
3. 3	25	1	9	9	6	
3. 4	51	2	16	20	7	4
3. 5	14+3	1	7	5	3	1
3. 6	44	1	12	14	15	2
3. 7	37+1	3	9	13	8	3
3. 8	62	7	21	24	4	5
3. 9	28+1	2	5	9	6	5
3.11	19	1	3	10	4	1
3.12	37+2	4	5	14	10	6
3.13	27	4	5	12	5	1
3.14	30+1	4	8	8	7	3
3.16	19	2	4	7	5	1
3.17	7		2	1	3	
3.18	19		5	7	6	1
3.19	54	10	12	14	11	6
計 Total.	580+12	50	150	212	120	47

Note: Estimated depths of hooks are 85 m. for 1 and 5, 120 m. for 2 and 4, and 145 m. for 3. /Translator's note: Figures after plus signs are probably numbers of shark-damaged fish./

Table 8b-(2).--Results of oceanographic observations by No. 3 Nissho Maru

月 日	位置	時刻 hm	0 m 水温	0 m 塩素量	10 m 傾角	10 m 水温	10 m 塩素量	25 m 傾角	25 m 水温	25 m 塩素量
2 10	野島岬 S E 5′	15 05 15 40	18.3		20	18.69		14	18.70	
2 10	〃 S E20′	18 20 19 30	16.5		29	16.84		29	16.34	
2 18	22°10′N 148°51′E	12 00 13 10	23.9		7	24.38		7	23.83	
2 19	21°46′N 150°09′E	08 30 09 50	25.3		0	25.24		0	24.89	
2 20	22°53′N 150°16′E	08 56 09 50	24.5		24	24.60		24	24.55	
2 22	23°03′N 153°49′E	08 05 09 30	21.9		13	22.07		9	22 01	
2 26	27°51′N 159°11.1′E	08 05 09 40	19.5		7	19.75		12	19.86	
2 28	28°43′N 161°10′E	06 16 07 10	18.1		21	18.55		28	18.44	
3 1	29°34′N 160°28′E	07 08 08 20	17.9		14	18.45		14	18.48	
3 2	29°02′N 160°59′E	05 36 06 30	18.1		5	18.50		5	18.51	
3 3	29°22′N 159°44′E	05 30 06 55	17.6		4	17.90		4	17.76	
3 4	28°48′N 160°08′E	08 40 09 35	19.7		10	19.63		10	19.63	
3 5	28°40′N 160°22′E	08 04 08 54	18.8		10	18.95		10	18.78	
3 6	29°08′N 160°22′E	05 44 06 30	19.2		12	19.42		12	19.56	
3 7	29°13′N 160°28′E	06 03 07 10	18.4					15	18.70	
3 8	29°50′N 159°52′E	09 37 10 20	17.7		4	18.00		4	17.85	
3 9	30°22′N 159°24′E	05 56 06 49	18.1		6	18.19		6	18.11	
3 11	29°42′N 155°28′E	05 58 07 10	17.8		3	18.35		3	18.46	
3 12	29°46′N 155°26′E	08 35 09 25	18.5		11	18.66		11	18.43	
3 13	29°26′N 154°18′E	05 59 06 53	18.3		4	18.49		4	18.34	
3 14	29°16′N 153°52′E	07 07 08 10	18.6		5	18.84		5	18.62	
3 16	30°10′N 149°26′E	07 49 08 47	18.9		16	19.01		16	17.01	
3 17	29°12′N 149°13′E	07 28 08 26	18.5		13	18.88		13	18.76	
3 18	28°45′N 148°20′E	07 12 07 55	18.9		17	19.30		17	19.35	
3 19	29°09′N 148°29′E	05 50 06 26	17.0		8	18.51		8	17.64	

/Translator's note to table 8b-(2); Columns from left to right are month and date, position, time, wire angle, water temperature, and chlorinity (blank)./

Table 8b-(2).--Results of oceanographic observations by No. 3 Nissho Maru (cont'd)

月日	位置	時刻 h m	50m 傾角	50m 水温	50m 塩素量	75m 傾角	75m 水温	75m 塩素量	100m 傾角	100m 水温	100m 塩素量	150m 傾角	150m 水温	150m 塩素量	200m 傾角	200m 水温	200m 塩素量	300m 傾角	300m 水温	300m 塩素量	400m 傾角	400m 水温	400m 塩素量	500m 傾角	500m 水温	500m 塩素量	600m 傾角	600m 水温	600m 塩素量
2 10	野島岬 SE 5′	15 05 15 40	14	18.69		20	18.35		14	16.83																			
2 10	〃 SE 20′	18 20 19 30	32	16.18		23	15.78		23	15.35		32	14.80		23	11.87		30	9.89		30	8.45					30	5.85	
2 18	22°10′N 148°51′E	12 00 13 10	7	23.74		7	23.43		7	23.38		7	21.03		7	17.49		5	15.58		5	13.26					5	7.79	
2 19	21°46′N 150°09′E	08 30 09 50	0	24.82		2	24.78		2	24.90		3	21.17		2	19.91		3	16.14		3	13.41							
2 20	22°53′N 150°16′E	08 56 09 50	24	24.27		24	24.14		24	23.90		24	20.42		24	18.78		44	17.75		44	16.23					44	13.05	
2 22	23°03′N 153°49′E	08 05 09 30	12	21.47		9	20.91		13	20.41		12	20.28		12	18.19		26	16.42		26	15.14					26	10.03	
2 26	27°51′N 159°11.1′E	08 05 09 40	12	19.73		7	19.74		7	19.86		12	16.84		8	16.19		8	14.19					8	10.01				
2 28	28°43′N 161°10′E	06 16 07 10	21	18.43		21	18.25		27	18.26		28	18.29		45	17.80		45	16.52					45	13.62				
3 1	29°34′N 160°28′E	07 08 08 20	22	18.45		22	18.50		21	18.54		21	17.80		21	18.05		21	15.55		21	14.14		21	11.21				
3 2	29°02′N 160°59′E	05 36 06 30	5	18.64		5	18.50		11	18.53		11	17.33		11	17.48		15	15.25		16	13.49							
3 3	29°22′N 159°44′E	05 30 06 55	4	17.76		4	17.76		9	17.80		9	17.58		9	16.85		4	15.56		4	13.82		4	12.39				
3 4	28°48′N 160°08′E	08 40 09 35	10	18.83		11	18.53		7	18.17		7	17.66		7	16.54		15	15.62		15	14.09		15	11.33				
3 5	28°40′N 160°22′E	08 04 08 54	10	18.44		10	17.98		21	17.83		21	16.77		21	16.65		35	15.72		35	14.72		35	12.57				
3 6	29°08′N 160°22′E	05 44 06 30	12	19.45		12	19.32		12	18.32		12	17.45		12	16.44		12	15.46		12	13.72		12	11.49				
3 7	29°13′N 160°28′E	06 03 07 10	15	18.58		15	18.38		25	18.06		25	17.37		25	16.48		55	15.87		55	15.26							
3 8	29°50′N 159°52′E	09 37 10 20	4	17.80		8	17.78		8	17.62		8	17.37		19	16.79		19	15.70		19	14.32							
3 9	30°22′N 159°24′E	05 56 06 49	6	17.97		6	18.09		12	17.96		12	17.66		12	16.97		12	15.78		12	14.41		12	11.48				
3 11	29°42′N 155°28′E	05 58 07 10	3	18.33		3	18.17		8	17.80		8	17.37		8	17.12		4	15.81		4	14.20		4	11.81				
3 12	29°46′N 155°26′E	08 35 09 25	11	18.38		11	18.43		26	18.02		26	17.67		26	17.03		31	16.09		31	15.36		31	15.90				
3 13	29°26′N 154°18′E	05 59 06 53	4	18.22		4	18.20		15	18.19		15	17.88		15	17.47		21	16.00		21	15.58		21	12.86				
3 14	29°16′N 153°52′E	07 07 08 10	5	18.29		5	18.28		6	18.20		6	18.02		6	17.59		9	16.34		9	15.12		9	12.74				
3 16	30°10′N 149°26′E	07 49 08 47	16	18.97		16	18.97		16	18.70		16	17.74		16	16.80		18	15.96		18	14.07		18	12.02				
3 71	29°12′N 149°13′E	07 28 08 26	13	18.68		13	18.22		20	17.78		20	17.25		20	17.08		29	16.33		29	15.31		29	12.49				
3 18	28°45′N 148°20′E	07 12 07 55	17	19.44		17	19.30		31	19.36		31	18.86		31	18.23													
3 19	29°09′N 148°29′E	05 50 06 26	8	17.52					23	16.98		23	17.01		23	16.88													

/Translator's note to table 8b-(2): Columns from left to right are month and date, position, time, wire angle, water temperature, and chlorinity (blank)./

(2) Kinan Ground

Along the northern part of the fishing ground the fishing conditions are dull, and the zone of high catch rates lies between 27°N. and 31°N. The catch rates are highest in the areas east of 136°E., with values of 3.0 to 6.0 indicated. West of 136°E., in most areas, the rate is below 3.0. The oceanographic conditions do not differ much from those of the preceding months, but the size of the fish is considerably smaller.

Table 9.--Length composition (%) of albacore landed from the Kinan ground. Mean weight in kan = 8.27 lbs.

緯度 Latitude.	測定尾数 Fish measured.	体長組成 (%) Length composition. 55~65	65~75	75~85	85~95	95~105	平均体重 Mean weight.	平均体重の前月比 Ratio of mean weight of March to February.
26~28° N	201		1	59	39	1	3.34	
28~30° N	1278	2	40	55	3		2.44	75%
32~34° N	3						2.50	

It will be noted that in this area fish of the 75 to 95 cm. group have penetrated quite far south. It is characteristic that the catch is made up only of medium and small albacore, and that hardly any large albacore are seen.

2. Grounds South of the Subtropical Convergence

(1) Okinotorishima Ground

At this season there are few vessels operating, so little is known of conditions, but compared with the preceding month it is thought that the catch rates are somewhat lower. Particularly around the periphery of the fishing ground, and taking into account conditions in April, the drop is conspicuous. It is thought that the schools have probably moved away somewhere else, but of this we have absolutely no knowledge. There are still, however, catch rates of 3.0 or better indicated in the vicinity of Okinotorishima, and it appears that the albacore in this sea area can by no means be ignored. Judging from the size composition on the Kinan fishing ground, the recruitment from that area of schools of large-sized fish is thought to be extremely slight. It is thought that the schools that were in this ground in the preceding month stay there, or else the ground is replenished from some other area. We have no information on the size composition of the fish, but they are thought to be probably large albacore as in the preceding month.

(2) Albacore Migrating Southward from North Pacific Areas Across the Subtropical Convergence

In the waters east of the line of the Izu, Ogasawara, and Mariana archipelagoes and north of 10°N. latitude from September to February large albacore are taken in some numbers everywhere, but the catch rates rise above 1.0 only in extremely rare cases. Then in March between 15°N. and 25°N. the albacore catch rates rise, and cases of rates above 1.0 appear in considerable numbers. Data from east of 155°E. are very few, so the trend there cannot be fully seen, however, it is thought to show the same pattern as the areas west of 155°E. It has been pointed out that on the North Pacific fishing ground the positions at which the albacore stop their southward migration are thought to be farther south, the bigger the fish are. The albacore which appear in March between 15°N. and 25°N. are, as shown in table 10, extremely large, and it is thought that these albacore continue their southward movement after the small albacore in the North Pacific fishing ground have stopped between 26°N. and 32°N., and that this continuing southward movement brings them into this sea area.

Table 10.--Length composition (numbers of fish) of albacore landed from 20°-25°N., 145°-150°E. Weight in kan

体長級 B.L	95~105cm	105~115cm	>115cm以上	平均貫数 Mean weight.
測定尾数 Fish measured.	90	151	7	6.82

Since the Subtropical Convergence in March is between 22°N. and 24°N., this means that the schools of albacore break through the convergence and continue on south of it. These albacore are of no great importance as the objective of a fishery, but as a link between the albacore distributed north and south of the Subtropical Convergence, and from the standpoint that they are thought to have some connection with spawning, they are believed to be important ecologically.

(3) South Seas Grounds

In general, the fishing is at an extremely low ebb. West of 140°E. there is almost no trace left of the Palau fish, and the albacore in the South China Sea have also disappeared. East of 140°E. there are still occasionally cases of catch rates above 0.1.

We have very few data on the size composition of these albacore and can therefore give no detailed analysis, but average weights of 5.95 kan [50 lbs.] (based on measurements of 10 fish) at 0° to 2°N., 150°E. to 160°E., and 6.8 kan [56 lbs.] (based on measurements of 8 fish) at 10°N. to 12°N., 170°W. to 180°, show that at this season the albacore south of 10°N. are smaller than those occurring north of that latitude.

APRIL

General

In April the aspect of the fishing grounds changes completely. This is the season of change from the winter-type to summer-type fishing conditions, and it is just at this time that in the northwest Pacific Ocean the changeover occurs from the season of northwesterly winds to that of southeasterly winds. Comparing the winter-type fishing conditions (during the period of northwesterly seasonal winds in the northwest Pacific) and summer-type fishing conditions (during the period of southeasterly seasonal winds in the northwest Pacific), the summer-type fishing conditions are, as a rule, extremely inactive as far as longline fishing is concerned, in comparison with the winter-type fishing conditions. Furthermore, on some fishing grounds the character of the population is in sharp contrast, as between these two seasons. At the height of the season of northwesterly winds, from November to February, albacore fishing is active simultaneously on all fishing grounds regardless of whether they are north or south of the Subtropical Convergence, and at times the albacore fishing is even quite good in South Sea areas. However, by February there are already indications of a decline on all the fishing grounds, and this time corresponds to the end of the season of northwesterly winds. In March the South Sea fishing grounds disappear and the grounds north of the Subtropical Convergence cease their southward movement. (We have no detailed knowledge of what happens on the Okinotorishima fishing ground because of inadequacy of the data, but it is a fact that the fishing drops off.) In April the grounds north of the Subtropical Convergence begin moving north, in a direction opposite to their movements under the winter pattern. Longline fishing operations cease in April and pole-and-line catches begin to be made. Also, we begin to see southward migrations of large albacore, which have separated off from the populations on the grounds north of the Subtropical Convergence, something which was never seen in the winter-type fishing situation. There is still a considerable occurrence of albacore in the Okinotorishima ground, but on the other grounds they have completely disappeared.

Thus the albacore fishing conditions make a complete change with the month of April as the dividing line.

1. Grounds North of the Subtropical Convergence

(1) North Pacific Ground

The most notable point is that the fishing grounds, which until March were moving southward, in April come to be distributed in two narrow zones lying separate but parallel in an east-west direction, with albacore fishing active only on the northern side. Signs of this development can already be seen in March, but in April it becomes extremely clear. For convenience in explanation, these will be referred to as the northern zone and the southern zone. The northern zone runs east and west, centered on 30°N. latitude, while the southern zone, also running east and west, lies between 23°N. and 26°N. The position of the Subtropical Convergence in April is at 23°N. to 24°N. between 140°E. and 170°E., while farther to the eastward it runs in the vicinity of 25°N. Consequently, the northern zone is far to the north of the Subtropical Convergence, while the southern zone, on the other hand, is thought to consist of fishing grounds which have preserved a close relationship with the Convergence. (The fishing grounds which are noted in the vicinity of 22°N. to 23°N. or farther south are thought to reflect the effects of the restrictions on fishing areas which obtained from 1945 to 1950.) The albacore fishing conditions and the size composition of the catch in the southern zone show great differences from the northern zone and the North Pacific fishing grounds above it, indicating that the northern and southern zones are of a completely different character. The principal catch in the southern zone is striped marlin, and in April rather dense concentrations of this species are seen between 20°N. and 25°N.; this point indicates that the southern zone corresponds exactly to the northern edge of the range of the striped marlin.

In the northern zone the positions at which fishing vessels are operating are in the sea area centered at 30°N. and thus are somewhat north of their position in March. In April the fishing season is already near its close and the number of vessels operating has fallen off, so data are few and the values shown for unit areas are not reliable, but from a comparison with the catch rates in March (see table 1 for February) it appears that between 28°N. and 30°N. the catch rates are lower in April. At 30°N. to 32°N., on the contrary, the April rates tend to be higher. Considering points of this sort, it is thought that the albacore, which continued moving southward until February and stopped in March, have in April begun a simultaneous northward migration both in the east and in the west. Catch rates in the northern zone are still high in April, with many cases of values over 5.0. Many areas with high catch rates appear north of 30°N. As for the intermediate zone, it is not very clear because of the scarcity of data, but it appears that with the passage of time it continues moving to the southwest and it seems to be located in the vicinity of 30°N., 140°E. As a result, in the vicinity of 140°E. the zone of high catch rates appears to be pushed from 30°N. southward to the vicinity of 25°N. to 27°N.

Uda[10/], studying the fishing conditions in 1935 and 1936, hypothesized that the albacore east of 150°E. may have, after moving south to the north side of the Subtropical Convergence, migrated west along to the line of 150°E. and then turned north. However, when we consider the movements of these albacore which have migrated south to the north side of the Subtropical Convergence in terms of catch rates, we may wonder whether they do not turn directly back north without moving west.

Judging from the fact that we can detect no tendency for the catch rates to decline in the areas far off to the east, and from the fact that there is, on the contrary, a tendency for the catch rates to rise simultaneously in the east and west between 30°N. and 32°N. in April as compared with March, it is thought that the albacore which migrated south in the form of an elongated band and stopped on the north side of the Convergence directly enter upon their northward migration in that same form.

As for the size composition, the pattern of larger fish on the south side and smaller fish on the north side which was seen during the period of southward migration now becomes unclear (see table 1).

Table 1.--Length composition (%) of albacore landed from the North Pacific ground in April. Mean weight in kan (8.27 lbs.)

緯度 Lat.	経度 Longi.	測定尾数 Fish measured.	55～65	65～75	75～85	85～95	95～105	105以上	平均貫数 Mean weight.
28～30° N	140～150° E	952	0.3	5.8	64.9	27.5	1.4	0.1	3.15
30～32° N	140～150° E	1303	0.7	11.1	50.9	34.0	3.2	0.2	3.23
28～30° N	160～170° E	65			4.6	29.2	58.4	7.7	5.29

There is still room for investigation of the question of whether or not this tendency is a phenomenon that is limited to the southern extremity of the fishing ground. It still appears that the fish are larger off to the eastward. Between 140°E. and 150°E. medium-sized albacore of about 3 kan [25 lbs.] predominate overwhelmingly. Between 28°N. and 30°N. the size composition shows practically no change from the preceding month,

[10/] Uda, Michitaka and ~~Hide~~Eimatsu Tokunaga. 1934. Relationship between albacore fishing conditions and oceanographic conditions. Bull. Jap. Soc. Sci. Fish., Vol. 5, No. 5.

but between 30°N. and 32°N. the size has become larger, with an average weight of 3.2 kan /26 lbs./ as compared with 2.4 kan /20 lbs./ in the preceding month. This increase in the size of the fish taken between 30°N. and 32°N. is thought to be one bit of evidence for a retrograde movement of albacore which had descended farther south.

(2) Kinan Ground

The center of the fishing ground has clearly shifted to north of 30°N., indicating that the albacore have begun their northward migration. Catch rates continue high as in the preceding month, and there are cases with values above 10.0. Just as in the sea areas east of the Izu and Ogasawara archipelagoes, the waters north of 30°N. continue to offer the most active fishing conditions (see table 2).

Table 2.--Albacore catch rates of the Kinan ground, 28°-32°N., 133°-140°E.

緯度 Lat. \ 月 Monthly.	3月 Mar.	4月 Apr.
28~30° N	3.89	1.83
30~32° N	2.82	5.03

The composition of the schools is not known because of a lack of measurement data, but the size of the fish is thought to be approximately the same as that found in the area of 28°N. to 32°N., 140°E. to 150°E.

2. Grounds South of the Subtropical Convergence

A. Grounds in the Area Between 10°N. and 25°N.

(1) Albacore East of the Line of the Izu and Bonin Islands

(Albacore of the Southern Zone)

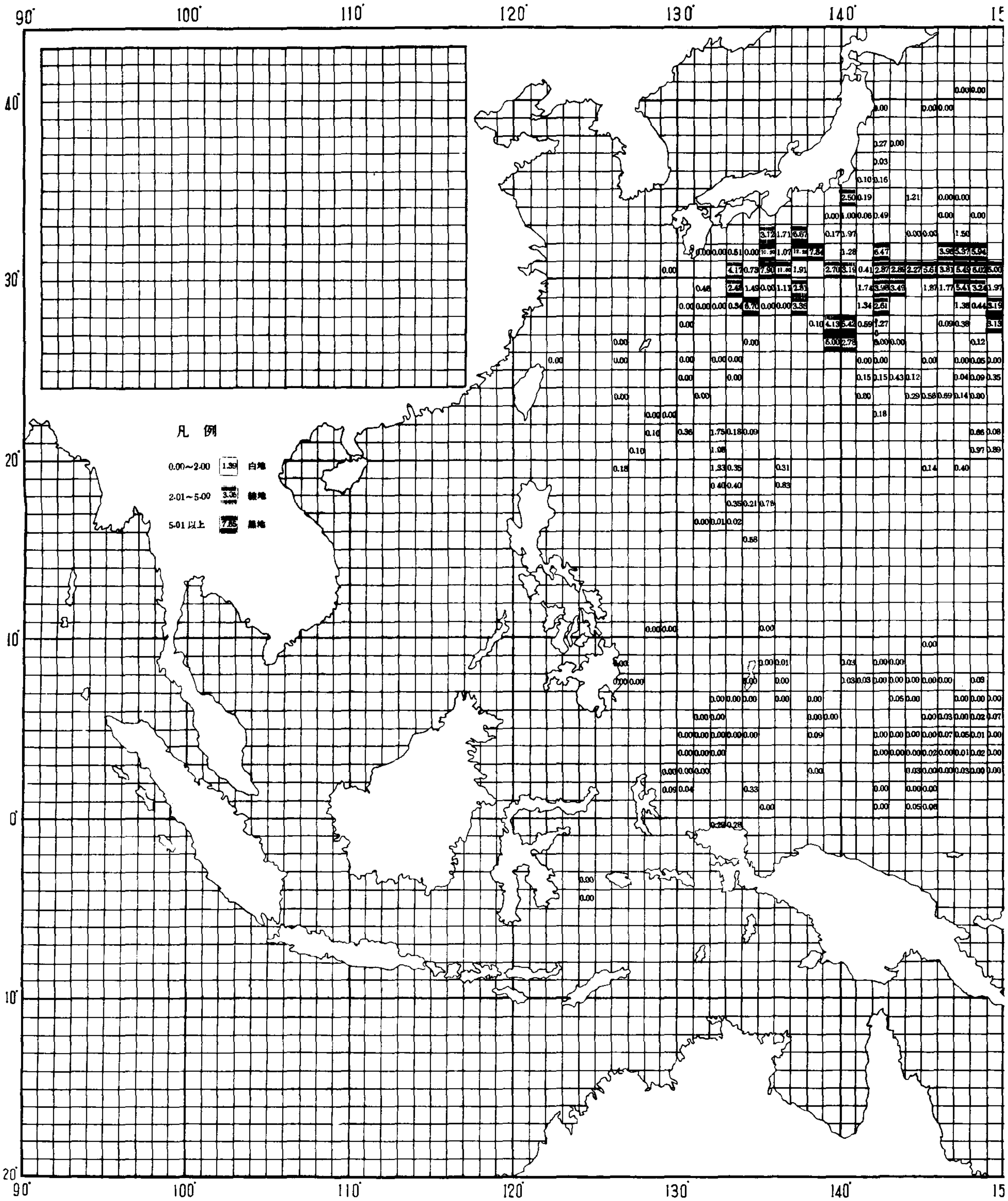
In the section on the North Pacific fishing ground it was stated that the albacore of the northern and southern zones differ markedly with regard to fishing conditions and size composition. The size composition of albacore taken in the southern zone is shown in table 3.

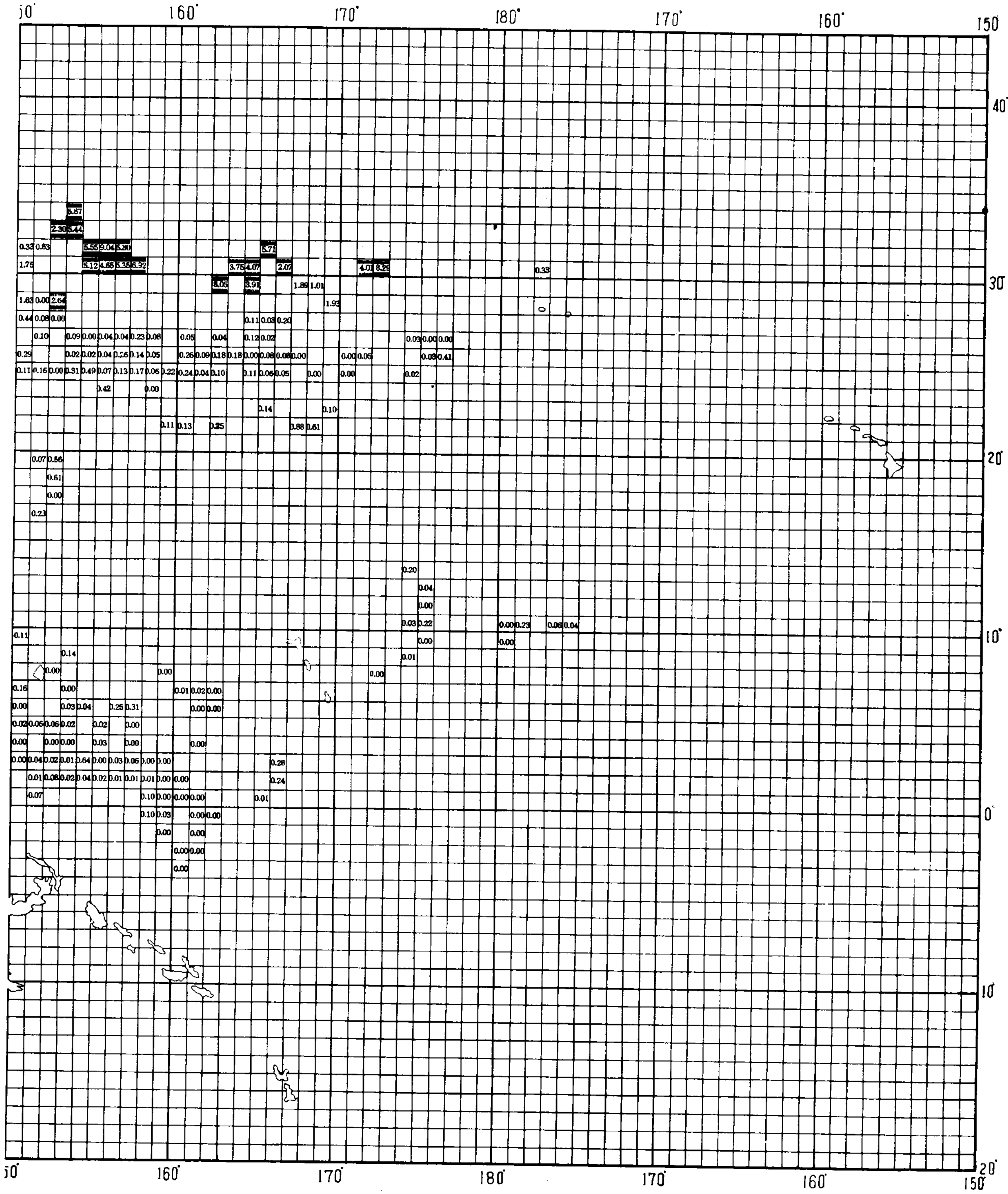
Table 3.--Size composition (actual numbers) of albacore landed from the southern zone (mid-latitudes east of the Bonin Is.).

体長 B. L	95~105cm	>105cm以上	平均体重 Mean weight.
測定尾数 Fish measured.	21	57	6.97貫

The catch is composed entirely of large albacore and thus differs conspicuously from the size composition on the North Pacific fishing ground. The catch rates are not very high, with a continuous line of areas showing values of around 0.1 to 0.5. This sort of ground appears not only in the southern zone, but seems to extend far southward to the vicinity of 15°N.

ビ ン ナ ガ (Albacore (*Thunnus germ*)) 4 月 (April)




160°
170°
180°
170°
160°
150
40°
30°
20°
10°
0°
10°
20°
150

latitude. The changes in the albacore catch rates in this area from March to July are as follows.

In March in the areas adjacent to the south side of the North Pacific fishing ground the catch rates are high, and although the situation is not quite clear in April, from May to July the catch rates are also high from 10°N. to 20°N. The fact that in April the catch rates appear to be lower than in the preceding and following months is thought to be due to the scarcity of data for the vicinity of 20°N. In actuality, judging from the small amount of data we have, the catch rates in the vicinity of 20°N. appear to be higher than in the southern zone. Consequently, these large albacore are thought to have split off from the North Pacific fishing ground, broken through the Subtropical Convergence to the south, and continued on to the southward.

In fishing in the areas of middle latitudes for striped marlin and black marlin, a few albacore are always taken, and even from August on, although the catch rates drop somewhat, the fish are scattered over a broad area of the South Seas. They are so scarce as to be almost without importance as an objective of the fishery, but they are thought to be important from the point of view of the life history of the species. Although the medium- and small-sized albacore which appear on the North Pacific fishing ground never cross the Subtropical Convergence, these large albacore do cross the Convergence to the southward. As will be noted later in the section for June, the gonads of these albacore are fairly ripe, and they are thought to bear a deep relationship to the spawning of the species. Consequently, these fish are extremely important, both as a link between the albacore north and south of the Subtropical Convergence, and as an indication of the spawning habits of the albacore.

Hasegawa[11] has postulated that the albacore of the area from the Ogasawaras to Uracas Island are a separate stock from those which migrate into Japanese coastal waters. But the albacore in this sea area, as stated above, are large fish which have continued southward through the Subtropical Convergence to appear in this sea area after the southward movement of albacore on the North Pacific ground has ceased. It cannot definitely be asserted that all of the albacore occurring on the south side of the Subtropical Convergence originated in the North Pacific fishing ground, but it is a fact, at any rate, that they receive some recruitment from the North Pacific ground.

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[11] Hasegawa, Kinei. 1938. On the report of albacore investigations. In Oceanic Fisheries (Kaiyō Gyogyō) No. 20.

(2) Albacore West of the Izu and Ogasawara Archipelagoes

(Albacore of Waters Around Okinotorishima)

In the waters around Okinotorishima there continues to be in April a considerable occurrence of albacore, just as in March. However, the catch rates are lower than in March, and compared with the peak fishing season on this ground the area of the grounds is much reduced and is limited to the immediate vicinity of the island of Okinotorishima. The catch rates are about 1.0 in the immediate vicinity of the island and drop off as one goes toward the periphery. The albacore in this sea area continue to be present even in May and June, although they gradually decline in abundance. Seasonally, the rise and decline of this fishing ground is similar to that of the North Pacific fishing ground, but it remains in existence for about 2 months longer before it fades out, making one of its characteristics this extremely long fishing season. Furthermore, the fishing ground itself does not move much, but expands to the southwest in the fall and winter (the center of the ground appears to move somewhat), and in the spring it shrinks into the very close proximity of Okinotorishima, this pattern of movement being repeated from year to year. Taking such points into consideration, it is thought that this area offers some conditions which make albacore likely to stop there, and that this probably naturally increases the density of occurrence. As was noted in the March section, just like the sea areas east of the Izu and Ogasawara archipelagoes, this area is entered by large albacore moving south from the Kinan fishing ground around March and April, but judging by the size composition of fish taken on the Kinan ground, the quantity of such fish is extremely small, and since the fishing ground shows a decline from January onward, it is imagined that there is no important direct connection between it and the fishing grounds north of the Subtropical Convergence.

In the size composition, 85- to 95-cm. fish are about 10 percent, 95- to 105-cm. fish about 60 percent, and fish above 105 cm. about 30 percent, with the average weight around 6 kan /50 lbs./. These values are based on measurements of only 16 fish, and although it appears that the weight is somewhat greater than in March, when we consider the changes in the average weight for the whole period of November to April, we may wonder whether the average size is not gradually getting smaller.

The oceanographic conditions show almost no change from December to March, and it is thought that this may be one reason why the close of the fishing season is so much later than in other fishing grounds.

B. Grounds in Tropical Seas South of 10°N.

Throughout the whole area from 130°E. to 170°E. albacore fishing is extremely inactive. Rare albacore catches are made along the boundary of the North Equatorial Countercurrent and the South Equatorial Current, but there appear to be almost no cases of catch rates higher than 0.3. The fish are less than 6 kan /50 lbs./ in weight and thus smaller than those of the middle latitudes.

MAY

General

The albacore longline fishery has completely ceased to figure in the general picture. The fishing vessels, which were still fairly active in the preceding month in the North Pacific fishing ground, have almost completely ceased to operate. About all that is left is the incidental catches of albacore taken by longline vessels fishing for spearfishes in the mid-latitude areas. On the other hand, this is the season when pole-and-line fishing for albacore is gradually becoming active in the waters close to Japan, and thus the aspect of the albacore fishery is completely different from what it was during the winter.

(1) North Pacific Ground and Kinan Ground

Oceanographic conditions

In April and May the oceanographic conditions on this ground are the exact opposite of what they were during the height of the longline fishing season up to March. That is, the isotherms which had been continuing to move south have now begun to move northward, and the Kuroshio, which was continuously declining in strength, is gradually strengthening. As figure 1 (distribution of isotherms on the average year's pattern, abridged from data of the Northeastern Regional Fisheries Research Laboratory) shows, in April the isotherms begin a general northward movement, and in May the 15°C. isotherm runs east and west between 37°N. and 39°N., while the 20°C. isotherm penetrates deeply to the northeast into the cold water mass east of Cape Nojima, its most advanced point reaching to 37°N. It will be noted that the northward movement of the 20°C. isotherm is more conspicuous than the northward shift of the isotherms from 10° to 15°C. The considerable revival in May of the Kuroshio, which around February and March was at an extremely low ebb, is well shown by the results of sectional observations 300 miles southeast of Cape Nojima in figure 3 for February. In May this sea area has lost its significance, at least as a

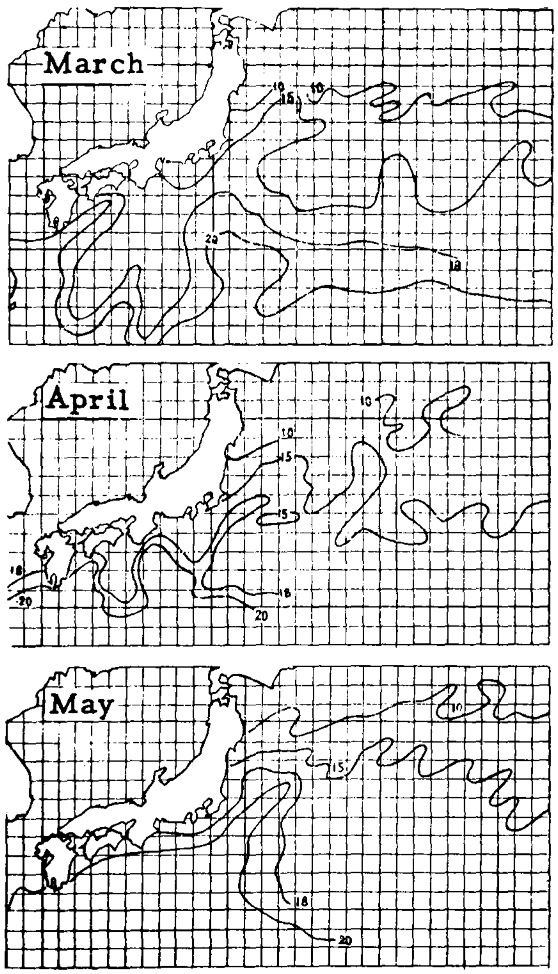


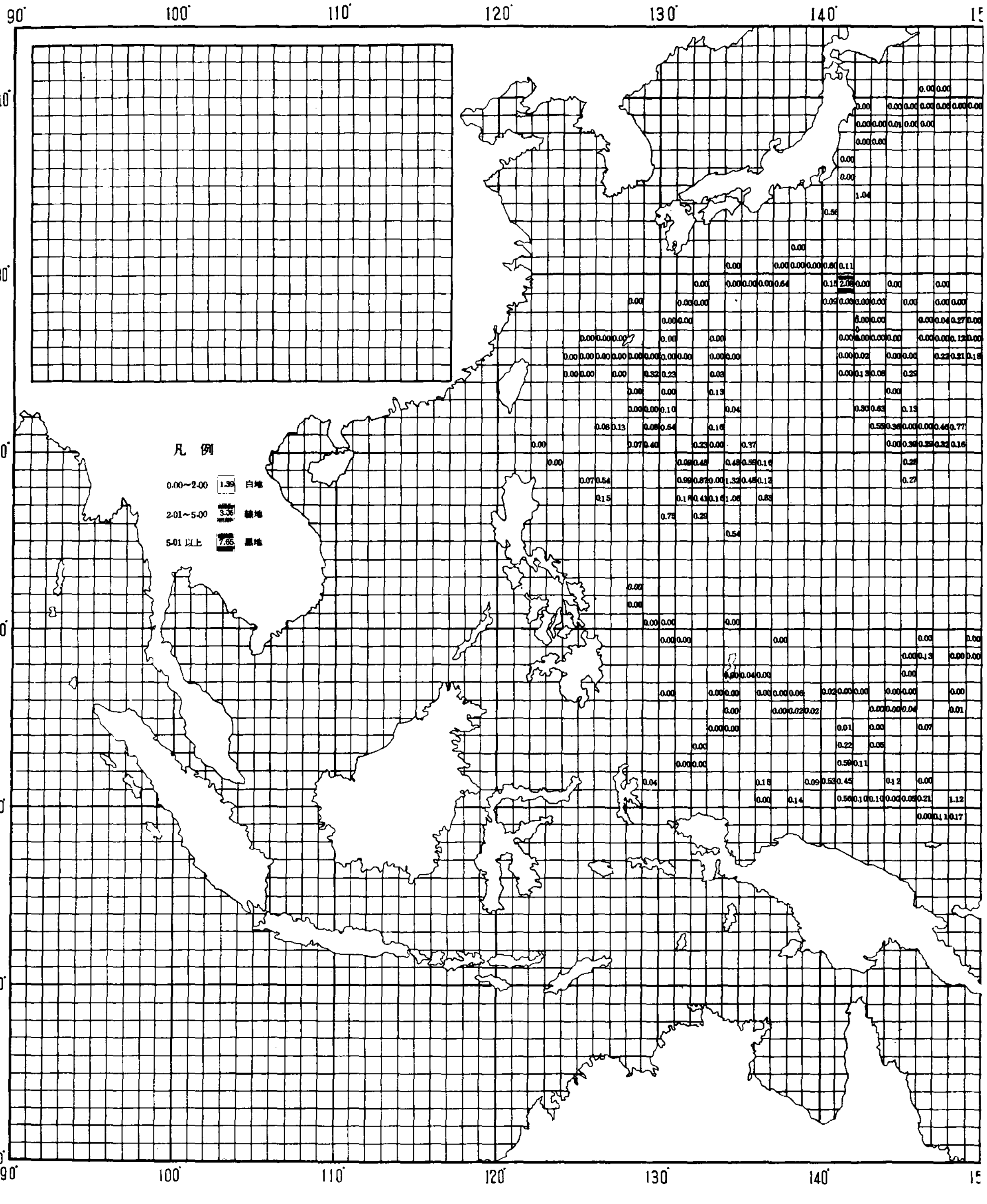
Figure 1.--Average distribution of isotherms (from data of the Tohoku Region. Fish. Research Lab.).

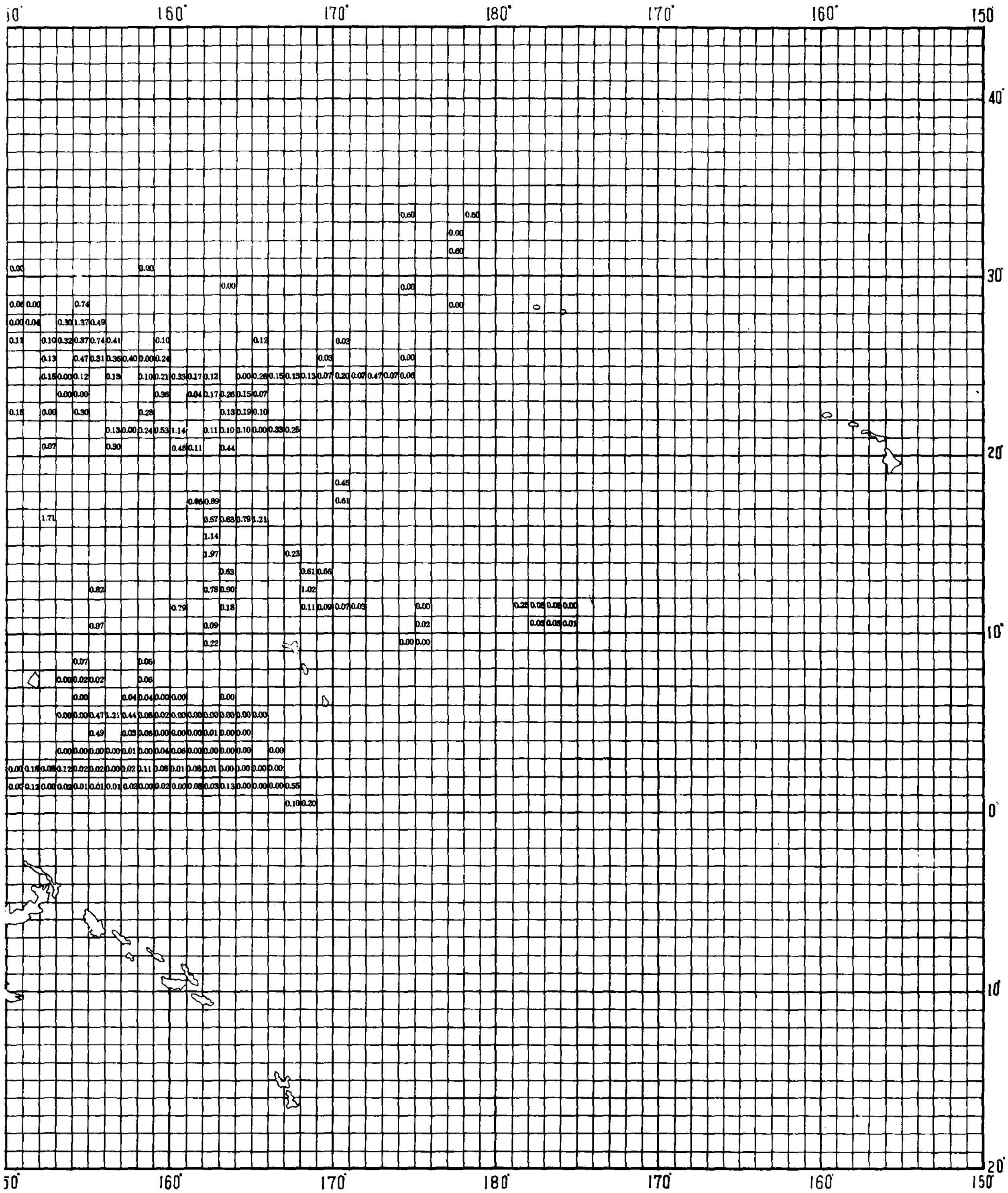
longline fishing ground for albacore. In April it has already been noted that there was quite active longline fishing around 30°N. for the northward-moving albacore, but in spite of this in May there is a very sudden cessation of fishing operations. We have only scattered data from the sea areas between 28°N. and 35°N., and although these data show occasional cases of catch rates of 1.0 in this area, the albacore catch as a whole is much less than in the preceding month. It is thought that the albacore, which in April still occurred in a considerable density, have either suddenly moved north or, if they are still present, they have ceased to become an object of the longline fishery because of some extraordinary change in their ecology. Judging from the fact that simultaneously with the ending of the longline fishing it is replaced by an increasingly active pole-and-line albacore fishery, one is inclined to think that at this season, because of some change in ecological conditions, the fish have just ceased to be available to the longline fishery.

Figures 2 and 3 show by 10-day periods the distribution of the albacore pole-and-line fishing grounds in 1951 and 1952. In both years the pole-and-line fishery began in the eastern part of the Kinan Sea Area. With the progress of the fishing season the fishery moves to the northeast, and the first grounds to disappear are those west of the Izu and Ogasawara archipelagoes, while operations continue the latest in the vicinity of 35°N., 150°E., or even farther to the north. The direction in which these fishing grounds move is exactly the opposite to that taken by the albacore which, after their appearance west of 150°E. in October, moved south until March. The size composition of these fish for 1951 is shown in table 1.

When we consider the movements of the albacore in April, it appears that they begin to move north simultaneously from east to west across the Kinan fishing ground and the North Pacific fishing ground. The fact that, in spite of this, we see no pole-and-line albacore fishing in the areas east

ビ　ン　ナ　ガ　(Albacore (*Thunnus germo*))　　5　月　(May.)




160°
170°
180°
170°
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of 150°E. is thought to be due to the limitations on the operating radius of the vessels under present conditions because of the use of live bait.

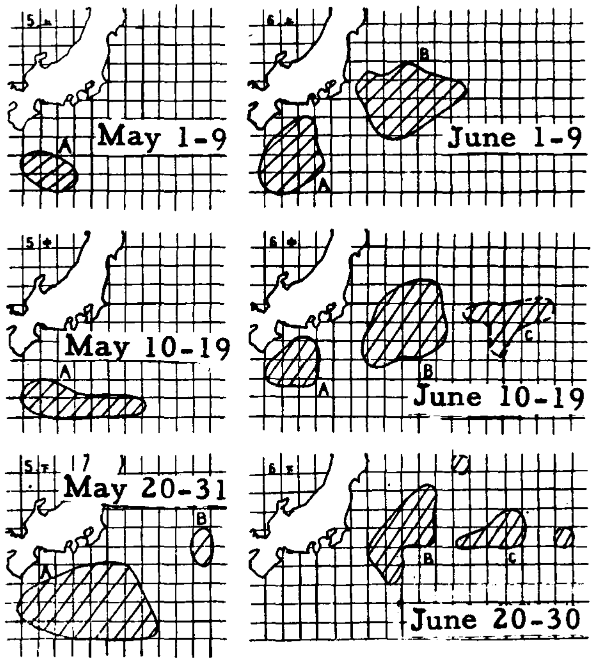


Figure 2.--Distribution of pole-and-line albacore fishing grounds, May-June 1951, by 10-day periods.

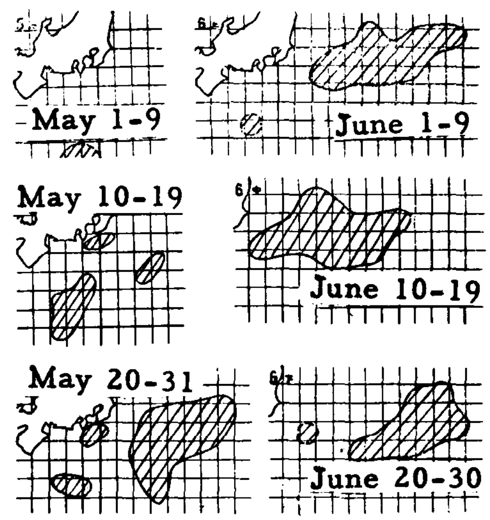


Figure 3.--Distribution of pole-and-line albacore fishing grounds, May-June 1952, by 10-day periods.

Table 1.--Length composition (numbers of fish) of albacore taken on pole and line in 1951, by grounds

漁場 A. Ground A.

時期 Period.	測定尾数 Fish measured.	65~75cm	75~85cm	85~95cm	95~105cm	>105以上	平均貫数 Mean weight.
May 10-19	696		28	458	203	1	4.6
" 20-31	4387	6	1528	2686	167		3.7
June 1-9	1385	1	450	918	16		3.7
" 10-19	619	1	146	443	29		3.9

漁場 B. Ground B.

時期 Period.	測定尾数 Fish measured.	65~75cm	75~85	85~95	95~105	>105以上	平均貫数 Mean weight.
June 1-9	2165	316	1545	303	1		2.9
" 10-19	518	52	305	161			3.1
" 20-30	1507	56	988	462	1		3.2

漁場 C. Ground C.

時期 Period.	測定尾数 Fish measured.	65~75cm	75~85	85~95	95~105	>105以上	平均貫数 Mean weight.
June 20-30	1059	57	671	330	1		3.2

(2) Grounds South of the Subtropical Convergence

Albacore fishing in these areas is extremely dull, with only a few taken from time to time incidental to fishing for other species. Since no important changes in the location of the albacore can be detected during the period of May to August, they will be summarized in the next section.

JUNE - AUGUST

General

During this 3-month period the albacore continue, as in May, to be unavailable to the longline fishery. In waters near Japan throughout all of June and up to the middle of July pole-and-line fishing for albacore is carried on, following the schools of medium-sized and small albacore moving northward, but throughout all sea areas of the northwest Pacific there is no concentrated albacore longline catch. From June to the middle part of July albacore landings continue high, but these are all fish taken by pole and line, not by longline.

(1) North Pacific Ground

In the overall picture longline catches of albacore are extraordinarily rare. We have some data showing fair catch rates in June west of Midway Island in the vicinity of 33°N. to 34°N., 170°E. to 180°. From June to September the position of the Subtropical Convergence runs through the points of 31°N. at 150°E., 29°N. at 160°E., 30°N. at 170°E., 32°N. at 180°, and 33°N. at 170°W., or somewhat south of the area of albacore catches noted above. The data are the results of observations made by the Shizuoka Prefecture fisheries guidance vessel _Fuji Maru_ in May and June 1937, and according to these data considerable numbers of albacore are taken at times, but the fishing situation appears to lack stability. The weight of the fish ranged from 2.5 _kan_ to 4 _kan_ /21 to 33 lbs./ and averaged 3 _kan_ /25 lbs./ resembling the fish which are taken by pole-and-line fishing in Japanese waters; they are considered to be clearly different from the large albacore occurring south of the Subtropical Convergence.

As was stated in the April section, the medium-sized and small albacore are thought to turn back to the northward altogether without penetrating south of the Convergence, and the results of the _Fuji Maru's_ investigations are also thought to indicate this sort of situation. The pole-and-line fishing grounds in Japanese waters are formed slightly to the north of the Subtropical Convergence, and the above-mentioned results obtained by the Fuji Maru also seem to show the position of the albacore in June as being not very far north, but rather just on the north side of the Convergence.

The Fuji Maru also made an investigation in August 1937 of the waters west of Midway Island. According to their results, the catch rates were extremely low, and the fish were still about 3 to 4 kan /25 to 33 lbs./ in weight. (The same vessel, fishing south of 30°N., that is, on the south side of the Convergence, captured large albacore, but more will be said about this later.)

To summarize the above, the movements of the albacore from June to August are such that longline fishing is extremely dull, and although fair catch rates appear in rare cases, the fishing is extremely unstable.

Judging from the fact that albacore pole-and-line fishing is flourishing in Japanese waters in June, it is thought that the northward-moving albacore schools are distributed slightly to the north of the Subtropical Convergence. The occasional high catch rates recorded from the waters west of Midway Island and the fact that albacore still sometimes remain in the Kinan Sea Area are thought to result from this situation. However, the very small longline catches and their instability are thought to indicate the effect of some ecological factors. We have hardly any data for July, but judging from the movement of the pole-and-line fishing grounds, it is clear that the northward movement continues. In the last 10 days of July the pole-and-line fishing grounds fade out in the vicinity of 40°N. and although it is believed that in August the albacore reach even more northern sea areas, the details of this situation are not known.

(2) Grounds South of the Subtropical Convergence

In general these grounds are inactive, but there is a scattered occurrence of albacore over the whole area. No longline fishing aimed at taking albacore is being carried on, and the only ones taken are those caught incidental to fishing for other species. Since little change in fishing conditions is shown for the period of May to August, it will be summarized here.

For convenience in the explanation, the area will be divided into sections north and south of 10°N., and the areas north of that latitude will be further divided into those east and west of the line of the Izu, Ogasawara, and Mariana archipelagoes.

1. Waters north of 10°N. and east of the line of islands

It has already been noted that beginning around March albacore of large size split off from the population on the grounds north of the Convergence and move south into this sea area. From May to August over this sea area as a whole the albacore catch rates rise, and cases of catch rates higher than 1.0 are not unusual. In July, particularly, we see catch rates of 3.0 or more. In August the picture is not clear because we lack data between 10°N. and 20°N., but judging from the distribution of albacore in this area from September on it is thought that approximately the same condition is maintained. From October to January fairly high catch rates occur just north of 10°N. and judging from this point it is thought that the albacore in this area may continue their southward movement from May on continuously to early winter. However, the occurrence of albacore is not very abundant and therefore our data are inadequate, so we have no accurate knowledge of the situation.

Table 1 shows the size composition of the catch, which in this area is composed of extremely large albacore.

Table 1.--Length composition of albacore landed from waters between 10°N. and 25°N. from May to June (actual numbers)

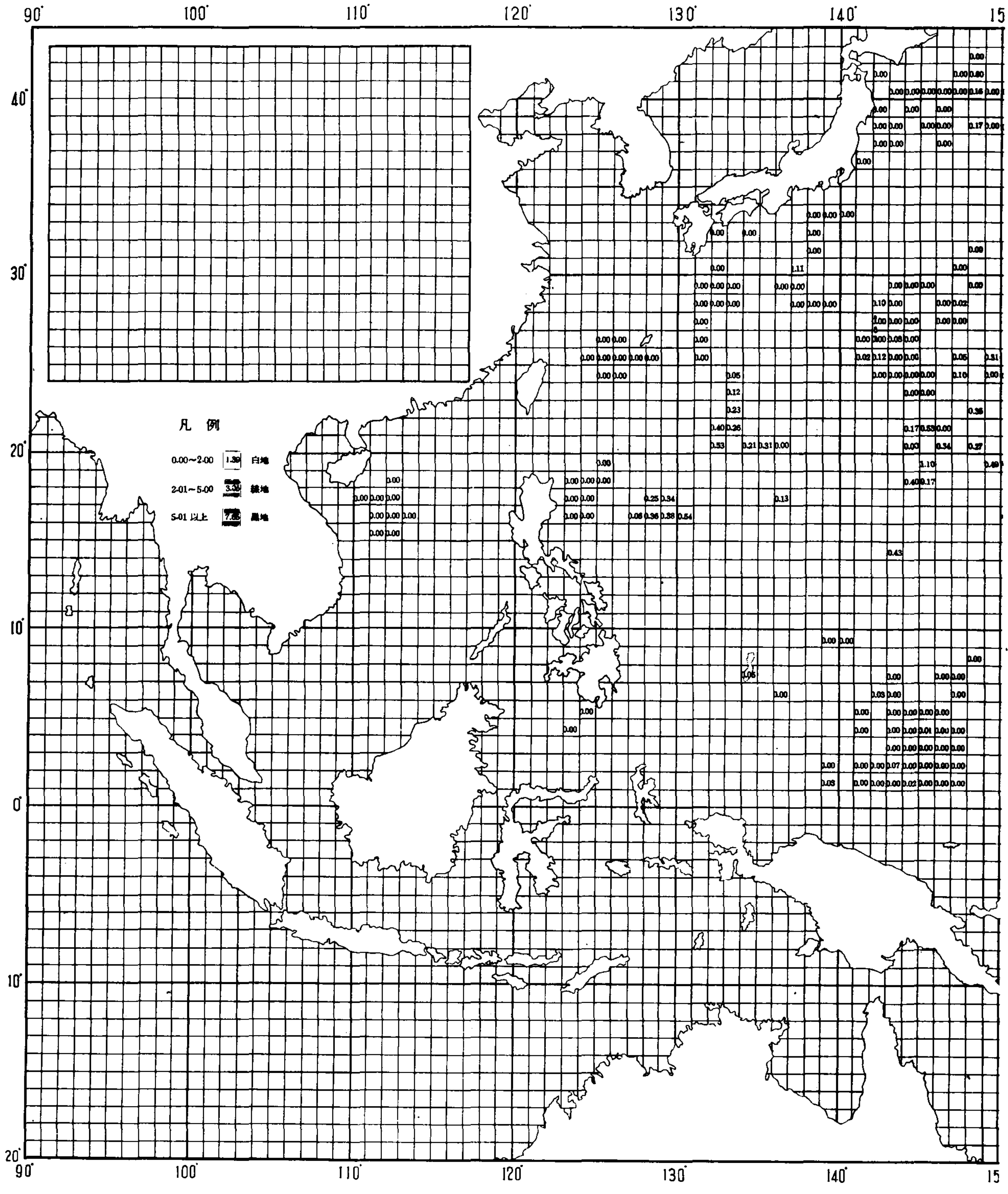
月 Monthly.	測定尾数 Fish measured.	85~95cm	95~105cm	105~115cm	>115以上	平均貫数 Mean weight.
5 May.	206	9	68	125	4	6.75
6 June.	103	2	45	56		6.64
7 July.	74	2	25	45		6.80
8 Aug.	177	4	27	132	14	7.17

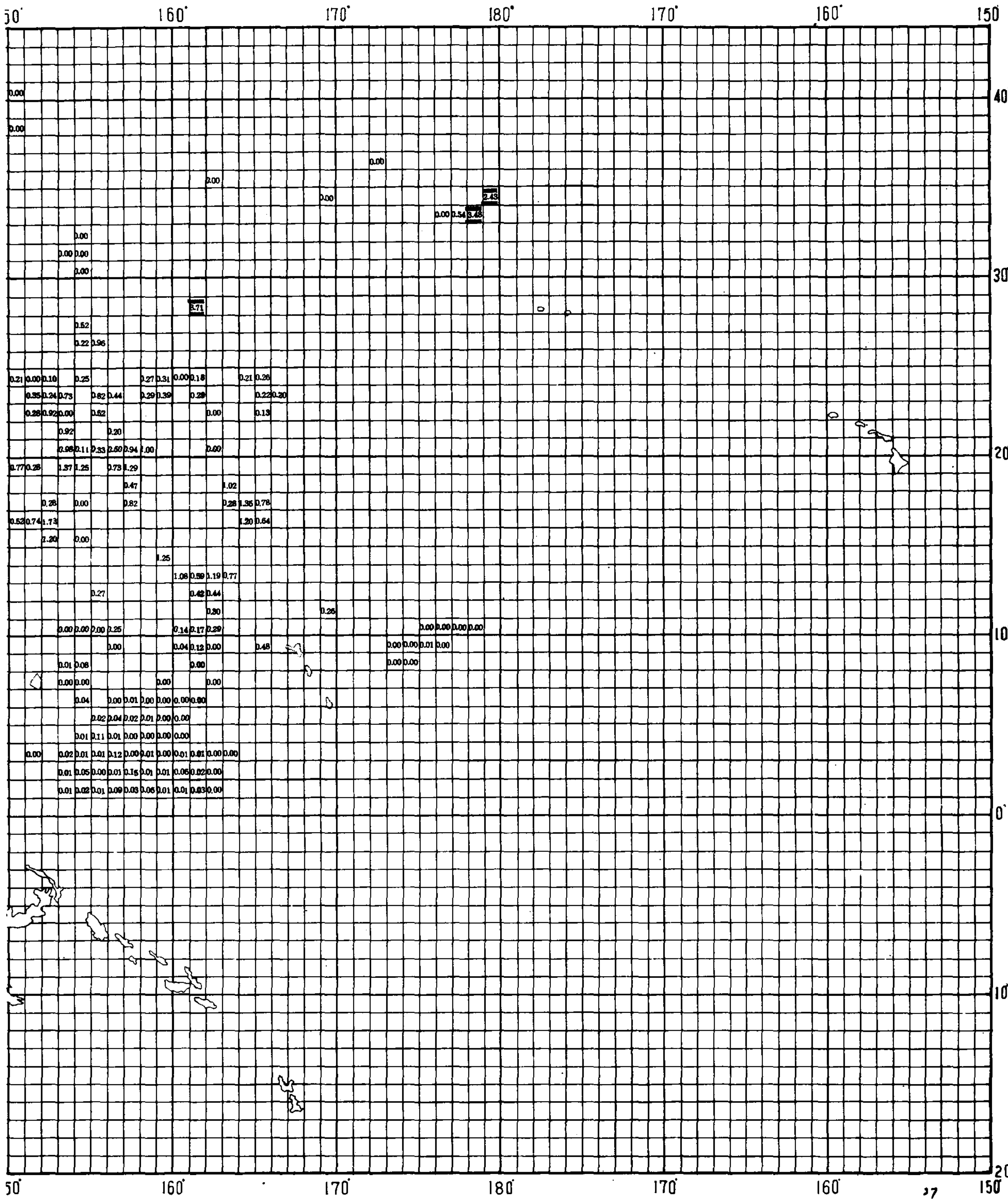
The albacore occurring in this sea area show a difference in size between the sexes. The males are larger, an overwhelming proportion of those over 105 cm. in length being males. The results of this study are shown in table 2.

Table 2.--Length frequency of albacore by sex (in cm.)

	90~95	95~100	100~105	105~110	110~115	115~120
雄(♂) male	0	1	12	25	16	
雌(♀) Female	1	19	6	0	0	

ビ ン ナ ガ (Albacore (*Thunnus germo*)) 6 月 (June)





Consequently, it can be thought that the sex ratio will have a great effect on the size composition. The size of fish in August, as shown in table 1, is especially large, and it is thought that these albacore have a high proportion of males.

A noteworthy point about these albacore is the development of their gonads. As early as June individuals are noted in which the males' gonads weigh more than 200 grams and those of the females more than 400 grams. The presence in July of males with gonad weights of 300 grams and females with gonad weights of 400 to 500 grams is thought to indicate that the development of the gonads has progressed somewhat since June. In August 1937 the Shizuoka Prefecture research vessel Fuji Maru reported gonad weights of 260 grams from the waters west of Midway Island; judging from the position of the fishing grounds, these are thought to have been albacore occurring south of the Subtropical Convergence. The albacore which move south into the area south of the Convergence and spread widely over the South Seas waters are thought gnerally to have well-developed gonads at this season, and it is imagined that their spawning is carried on over broad areas of the South Seas completely separated from the main fishing grounds. However, no completely ripe eggs have as yet been encountered, so we have no definite proof of spawning.

As for the condition of the gonads of albacore occurring in areas north of the Subtropical Convergence, those taken west of Midway Island were all extremely immature, with gonad weights below 50 grams for both males and females. The results of investigations made in March at 28°N. to 30°N., 145°E. to 160°E., showed very few of the females above 90 cm. in length to have ovaries weighing more than 100 grams, and these fish are thought not to move northward but to continue south. More than 90 percent of the specimens examined had gonad weights of less than 100 grams and were extremely immature. Studies of the albacore taken by pole-and-line fishing in May and June show only immature fish.

2. Waters north of 10°N. and west of the line of islands

These are the albacore around Okinotorishima. For May catch-rate values of about 1.0 are indicated. From June on some albacore continue to appear in this sea area, and it looks as if albacore always occur there throughout the year. It will be noted, however, that the albacore catch rates in this area are high from November to February, in seasonal contrast to the southward-moving albacore east of the line of islands. Nothing is known of the size composition of the albacore which occur in this area from May to August because of a lack of measurement data.

3. Albacore of the equatorial areas south of 10°N.

In general, these fish are very scarce, but some are taken at all times. In May cases of catch rates as high as 1.0 appear, but from June to August it appears that catch rates even as high as 0.3 are extremely rare, the fish being broadly but sparsely distributed. The question of the effect produced on the occurrence of albacore in this sea area by those fish which separate from the fishing grounds of the North Pacific and appear in the waters of middle latitudes is one which will be very important for future study.

The size composition, as shown by the following table, is made up of fish smaller than those found north of 10°N.

Table 3.--Length frequency of albacore taken in the tropical Pacific, 0°-10°N., 140°-160°E. (actual numbers of fish)

月 Monthly.	測定尾数 Fish measured.	79~87cm	87~95cm	95~103cm	103~111cm	111~119cm
6 June.	3		1	2		
7 July.	108	13	51	38	6	
8 Aug.	250	15	58	110	66	1

As has already been noted, the larger albacore show a considerable difference in size composition with sex. The following causes can be thought of for the difference in the size composition north and south of 10°N.

1. A difference in sex ratio.
2. The occurrence of albacore of different age groups.
3. Occurrence of albacore of completely different stocks.

There is a necessity for further study of these points in the future.