FISHERIES AND MARINE SERVICE

Translation Series No. 3247

The spawning range of Okhotsk herring

by B.V. Tyurnin

Original title: Nerestovyi areal okhotskoi sel'di

From: Izvestiya Tikhookeanskogo Nauchno-Issledovatel'skogo Instituta Rybnogo Khozyaistva i Okeanografii (TINRO) (Proceedings of the Pacific Scientific Research Institute of Marine Fisheries and Oceanography), 86 : 12-21, 1973

Translated by the Translation Bureau(NDE)
Multilingual Services Division
Department of the Secretary of State of Canada

Department of the Environment
Fisheries and Marine Service
Biological Station, St. John's, Nfld.
Pacific Biological Station, Nanaimo, B.C.
Marine Ecology Laboratory, Dartmouth, N.S.
Arctic Biological Station, Ste. Anne de Bellevue, P.Q.

1974

18 **pages typescript**

DEPARTMENT OF THE SECRETARY OF STATE
TRANSLATION BUREAU

MULTILINGUAL SERVICES DIVISION

CANADA

SECRÉTARIAT D'ÉTAT
BUREAU DES TRADUCTIONS

DIVISION DES SERVICES MULTILINGUES

F&M 3247

TRANSLATED FROM – TRADUCTION DE	INTO – EN
Russian	English

AUTHOR – AUTEUR

B.V. Tyurnin

TITLE IN ENGLISH – TITRE ANGLAIS

The spawning range of Okhotsk herring

TITLE IN FOREIGN LANGUAGE (TRANSLITERATE FOREIGN CHARACTERS)
TITRE EN LANGUE ÉTRANGÈRE (TRANSCRIRE EN CARACTÈRES ROMAINS)

Nerestovyi areal okhotskoi sel'di

REFERENCE IN FOREIGN LANGUAGE (NAME OF BOOK OR PUBLICATION) IN FULL. TRANSLITERATE FOREIGN CHARACTERS.
RÉFÉRENCE EN LANGUE ÉTRANGÈRE (NOM DU LIVRE OU PUBLICATION), AU COMPLET, TRANSCRIRE EN CARACTÈRES ROMAINS.

Izvestiya TINRO

REFERENCE IN ENGLISH – RÉFÉRENCE EN ANGLAIS

PUBLISHER – ÉDITEUR	DATE OF PUBLICATION / DATE DE PUBLICATION			PAGE NUMBERS IN ORIGINAL / NUMÉROS DES PAGES DANS L'ORIGINAL
TINRO	YEAR / ANNÉE	VOLUME	ISSUE NO. / NUMÉRO	12—21
PLACE OF PUBLICATION / LIEU DE PUBLICATION				NUMBER OF TYPED PAGES / NOMBRE DE PAGES DACTYLOGRAPHIÉES
—"—, USSR	1973	86	---	18

REQUESTING DEPARTMENT / MINISTÈRE-CLIENT: Environment

BRANCH OR DIVISION / DIRECTION OU DIVISION: Fisheries Service

PERSON REQUESTING / DEMANDÉ PAR: Mr G.H. Winters, St John's

YOUR NUMBER / VOTRE DOSSIER N°: 5053-1-VI

DATE OF REQUEST / DATE DE LA DEMANDE: October 6, 1974

TRANSLATION BUREAU NO. / NOTRE DOSSIER N°: 676644

TRANSLATOR (INITIALS) / TRADUCTEUR (INITIALES): N. De.

UNEDITED TRANSLATION
For information only
TRADUCTION NON REVISÉE
Information seulement

SOS-200-10-6 (REV. 2/68)
7630-21-029-5333

DEPARTMENT OF THE SECRETARY OF STATE
TRANSLATION BUREAU
FOREIGN LANGUAGES DIVISION

CANADA

SECRÉTARIAT D'ÉTAT
BUREAU DES TRADUCTIONS
DIVISION DES LANGUES ÉTRANGÈRES

YOUR NO. VOTRE N°	DEPARTMENT MINISTÈRE	DIVISION/BRANCH DIVISION/DIRECTION	CITY VILLE
	Environment	Fisheries Service	St.John's,Nfld.
OUR NO. NOTRE N°	**LANGUAGE LANGUE**	**TRANSLATOR (INITIALS) TRADUCTEUR (INITIALES)**	**DATE**
676644	Russian	N. De.	NOV 19 1974

Izvestiya TINRO, 1973, vol. 86, pp. 12-21

The spawning range of Okhotsk herring

(12)*

by B.V. Tyurnin

Studies of the spawning range of Okhotsk herring were begun in the mid 1940s by B.N. Ayushin (1947) who detected a number of spawning grounds in the Okhotsk area and presented a brief description of them. Further investigations in this area were continued by a staff member of TINRO; A.N. Roganov, who headed the ichthyological operations during the period from 1953 to 1958, by L.A.Vostrikov who worked there in 1954-1958, and by B.V. Tyurnin who has conducted observations on the spawning grounds from 1954 to the present day. However, despite the many years of observations and the vast amount of data collected, the results of these studies remained unpublished. This paper is the first attempt to generalize the long-term data on the distribution of Okhotsk herring during the reproduction period, our own observations and collections serving as the basis of the study.

---

*The numbers in the right-hand margin are the pages of the Russian text - translator

The materials used in compiling this paper are commercial statistics (1940-1970), the results of investigations conducted by research vessels (1954-1958), aerovisual observations on the distribution of herring (1963-1970), spawn survey data (1959-1970), hydrometeorological information (1945-1970) and census data.

As investigations over the years have shown, the spawning range of Okhotsk herring covers the coastal zone of the northwestern part of the Sea of Okhotsk from Tauyskaya Guba to the Ayan area. The largest spawning grounds are located in Shel'ting Zaliv*, Eirineiskaya Guba, Loshadinaya Bukhta, Shilka Zaliv, Tungusskaya Bukhta, at Cape Nogdan, at the mouths of the Otynda and Gyrba, at Cape Plosky, at the mouths of the rivers Mana and Olyungdzha, west of the mouth of the Kulyukli River, east and west of the mouth of the Unche, at Cape Khanyangda, between the mouths of the rivers Kekra and Ongandya, at Cape Odzhan, in the area where the Tukchi River flows into the sea, at Cape Ugol, Plosky and Mirmilan, east of the mouth of the Kokhalmichan, in Feodot Zaliv and Fedor Zaliv, west of Cape Nel'ba and Ulkansky, in Aldoma Zaliv, at Cape Mal'mansky, Grendya and Naklonny, west and east of the mouth of the Nyacha, in Ayan Zaliv, at Cape Tolkuchy, Dzhelarik and Lantarsky and in Borisov Bukhta. During certain years, the herring also spawn in the estuaries of the rivers Ini and Kukhtuya.

The most concentrated spring migrations of herring are observed almost every year along the coast from Cape Marekan to Cape Odzhan, which is why this area can be considered as the central part of the spawning range. The coastal areas from Cape Odzhan to Borisov Bukhta constitute the western portion of the range, while the area from Cape Marekan to Tauyskaya Guba

---

*All the geographical names have been transliterated; Zaliv is the Russian for gulf, bay, cove, inlet; bukhta - bay, inlet - translator.

is its eastern part.

As observations have shown, the boundaries of the spawning range do not remain constant from year to year. For example, a shifting of the south-western boundaries of the range far to the northeast over the past three decades was observed in 1944, 1946, 1948, 1953, 1955, 1959, 1960 and 1966. In the Ayan area, which takes in the western part of the range, there was either no spawning migration of herring during these years, or else the migration was very weak, which was reflected in the size of the catch. For example, as a result of the exceptionally weak migration of spawning herring in 1953, the landings of this fish were almost 1000 times smaller than in 1952 and 1954. Due to the extreme fluctuations in the landings, the fishing industry in this area has not developed to the same extent as in the neighbouring Okhotsk area, and so in 1959 the local fisheries were closed down because of their unprofitableness. (13)

The eastern boundary of the spawning range cannot be considered stable either. Judging by fishery statistics, the results of aerovisual observations and spawn surveys, there were hardly any migrations of spawning herring in the eastern part of the range in 1950, 1951, 1959, 1960, 1965, 1966, 1967, 1968 and 1970. Due to the inconstancy of the raw material base, the fish processing plants on this section of the coast were also closed down.

During the years when there is no migration of spawning herring to the eastern or western parts of the range, vast ice masses which are often many hundreds of square miles in area form in this region during spring and move inshore. In 1953, for example, continuous masses of ice extended from the water edge for more than 200 km into the sea over the entire Ayan area. The coastal zone was jammed with ice even in July.

On the eastern part of the range, the masses of ice usually form near the coast on the area from Lisyansky Peninsula to Khmitievsky Peninsula, thus preventing the herring from entering the spawning grounds in Shel'ting and Ushki Zaliv, Luzhina Bukhta, Eirineiskaya Guba and Loshadinaya Bukhta.

Great masses of ice in direct proximity to the shore have a significant effect on the hydrology of the coastal zone, on which, as we know, depends the reproduction of herring. By preventing the sun's rays from penetrating the water layers, the ice determines one of the most important environmental parameters for living organisms - the temperature regime. The data in table 1 show just how great an effect ice has on the heating up of coastal waters. An asterisk marks the temperature of the water in coastal areas blocked by ice.

Table 1

Water temperature (monthly average) in Ayan Zaliv and in the area of Lisyansky Peninsula in June 1960-1970

Spawning range	Years										
	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970
Lisyansky Peninsula	1,5*	5,1	5,9	4,2	4,3	2,5*	0,5*	2,9*	2,4*	3,0	1,3*
Ayan Zaliv	0,4*	3,1*	6,6	4,9	4,0	5,7	0,4*	5,1	5,1	4,0	4,8

The peak spawning migration of herring begins when the water has warmed up to 2-3°C. The normal development of embryos requires a temperature of about 5-8°C. As indicated in table 1, the water in the coastal zone at the boundaries of the range during the very icy years does not heat up to the temperature required for spawning and embryonic development. The absence of

optimal temperature conditions for reproduction is basically why herring avoid the areas which are covered with thick ice for long periods of time. However, it should be noted that the severe temperatures brought on by the ice are not the only obstacle in the way of reproduction. During certain years, e.g. in 1960 and 1966, onshore winds increased the drift of ice towards shore to such an extent that the coastal zone was completely jammed by ice blocks right up to the 15-20 m isobath; during these years, the ice remained on the bottom for a long period of time, occupying the spawning zone which for Okhotsk herring is limited to the 5-10 m isobaths. Ice can therefore serve as a purely mechanical means of obstructing reproduction. (14)

The central part of the range is also frequently affected by ice. The effect of ice masses on the spawning migration of herring in the central part of the range was discussed by B.N. Ayushin (1947). On the basis of his observations, all the biological processes related to the reproduction of herring occur at a later period during the very icy years. However, at the boundaries of the range, reproduction can cease altogether during the years of subzero temperatures caused by longer periods of ice.

The changes in the spawning range of Sakhalin-Hokkaido herring have been discussed in detail by A.N. Probatov (1954). It was his idea to introduce a classification of spawning ranges. In correlating the migrations of this herring, under the influence by the Kuroshio Current, with its numbers, A.N. Probatov established the following four types of spawning range:

1) an extensive spawning range with high numbers of herring;

2) a reduced spawning range with high numbers of herring;

3) a reduced spawning range with low numbers of herring;

4) an extensive spawning range with low numbers of herring.

Some doubt may arise as to the fourth type of spawning range, as it was conjectured on the basis of theoretical assumptions. On the admission of the author himself, this type of spawning range has never been observed in all the long history of the fishery. In actuality, when the depression of the Sakhalin-Hokkaido stock set in a diminution of the spawning range occurred and not the distribution of herring over all the spawning grounds.

A.N. Probatov's idea of grading of the spawning ranges can also be applied to herring of the northwestern coast of the Sea of Okhotsk, though the principle of classifying the types of spawning grounds in this area is altogether different. As shown above, the changes in the spawning range of Okhotsk herring are effected by the ice masses. Depending on their distribution, the following types of spawning range can be defined quite clearly:

1) reproduction in favourable ice conditions within the bounds of the entire range;

2) reproduction in unfavourable ice conditions on the eastern and western parts of the range;

3) reproduction in unfavourable ice conditions on the eastern part of the range;

4) reproduction in unfavourable ice conditions on the western part of the range.

Each type of spawning range is characterized by certain hydrologic conditions and is distinguished by peculiarities of herring migration.

The spawning of herring in favourable ice conditions was observed in 1945, 1947, 1949, 1952, 1954, 1957, 1958, 1962, 1963, 1964 and 1969. During these years, the ice was found at a comparatively great distance from shore throughout the entire period of reproduction (May, June) as a result of the heightened effect of offshore winds from the north and northwest. A polynya (15)

100-150 km in width usually stretched along the coast. In rare cases, small stretches of ice cake, resulting from the destruction of the fast ice, drifted into the coastal zone. However, this brief appearance of ice did not have any significant effect on either the hydrologic regime or the migration or landings of fish. The melting of the ice usually ended during the first half of June, with the exception of the southern part of Shantarsk Sea, where comparatively large areas of ice were preserved beyond the range, disappearing in the second half of the month. The location of the ice masses during the first half of June and the extent of the spawning range are depicted in fig. 1.

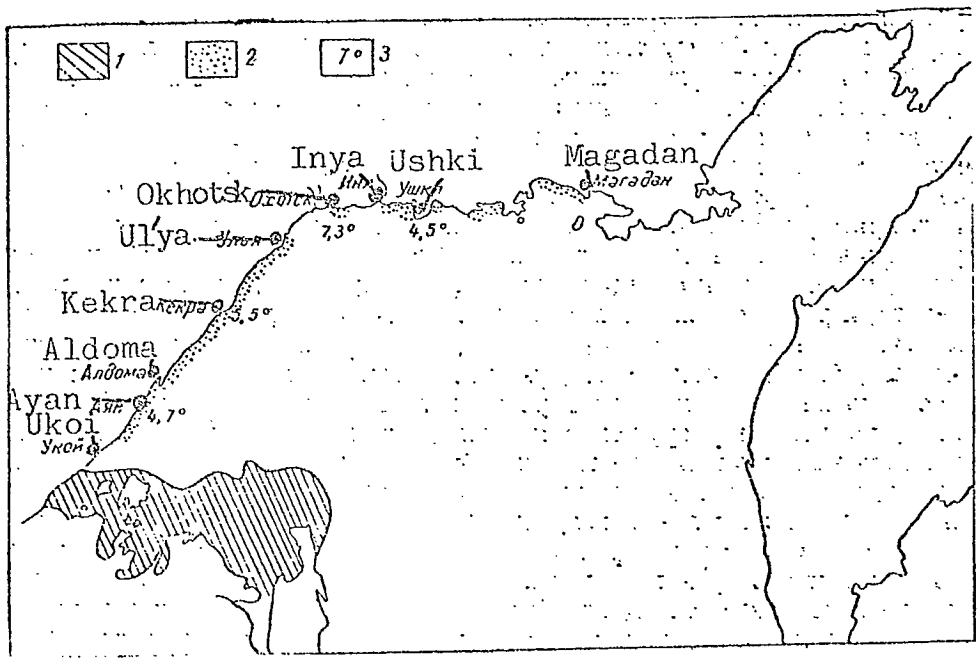

Fig. 1. First type of spawning range:

1 - ice cover during the first half of June; 2 - spawning grounds of herring; 3 - long-term average water temperature in June.

In the described ice conditions, the heating up of coastal waters began early and progressed rapidly. In the third ten-day period of April, the temperature of the water was already going over the zero mark; in May the temperatures were above zero; and in the first half of June the water temperature was up to 3-6°C.

In favourable ice conditions, herring were detected in the coastal zone during the third ten-day period of April or the first ten days of May. Mass spawning began during the fourth or fifth five-day periods of May. Spawning was concerted and almost simultaneous both at the boundaries of the range and in its central part.

With the stock at high numbers, the spawners occupied to capacity and more or less uniformly all the spawning grounds without exception. Aerovisual observations uncovered a multitude of shoals which were mostly ribbon-like in form and concentrated in direct proximity to the shoreline. Some of these "fish ribbons" were often tens of kilometres in length. The spawning was easily detected owing to the very large white spots formed by (16) the milt discharged by the males.

With the spawning stock at low numbers, the herring did not occupy all the spawning grounds. Localization was observed in certain areas which were mainly situated in the central part of the range. The abandonment of numerous spawning grounds, brief migration, a decrease in landings, sharp peaks in the catches and their sporadic nature are the basic features of spawning migration when spawners are in low numbers. The spawning of an unproductive stock in favourable ice conditions over the entire range was observed in 1954.

Reproduction of herring in unfavourable ice conditions in the eastern

and western parts of the range occurred in 1950, 1951, 1959, 1960 and 1966. During the spring periods of these years, easterly and southeasterly gales persisted, driving heavy and large chunks of ice towards the shore and blocking the polynya lead. This hydrologic formation is quite typical of the northwestern coast of the Sea of Okhotsk, appearing each winter as a result of the winter monsoons. During the first half of May, a continuous mass of ice covered the entire northwestern part of the sea. In the second half of the month, a "tongue" of clear water began to form on the side of the sea from somewhere near Iona Is. to the central part of the range. During the first half of June, usually towards the middle of the month, the clear water spread inshore and the once continuous ice layer broke into two separate masses - a northern mass in the eastern part of the range and a larger southern mass blocking its western part. In the second half of June, the area of ice considerably decreased due to melting, however it disappeared completely only in July. The breaking of the ice cover into two masses is a phenomenon typical of the Sea of Okhotsk. It is interesting to note that herring have a special way of reacting to this hydrologic peculiarity; first of all, they appear close to shore in commercial numbers some time after the ice has disappeared and, secondly, they approach the shore in the vicinity of the "channel" of clear water and then move along shore in either a southwestern or northeastern direction, occupying the different spawning grounds. During the indicated years, the first area to be cleared of ice was the central part of the range, in the vicinity of Cape Marekan and Cape Khanyangda. Most of the spawners migrated to this area, it being the most favourable. The sporadic drift of ice to this area continued up to July.

During the years of such ice conditions the temperature regime was distinguished by late and extremely slow heating up of the coastal zone. In

the central part of the range, the temperature began to gradually rise at the end of March, remaining sub-zero, however, up to the first five days of June. The mean water temperature in June was 3-4°C. However, on certain days, when the ice was driven into the coastal zone, the temperatures continuously dropped below zero. Temperature conditions were exceptionally severe in the western and eastern parts of the range. The average monthly temperature for June in this area only slightly exceeded 0°C during other years.

With the eastern and western parts of the range blocked by ice, the reproduction of herring took place only in its central part. The spawning grounds located in the eastern and western parts of the range were unsuitable for reproduction due to extremely severe hydrologic conditions, and so the herring did not approach these parts of the coast.

The other peculiarities of spawning migration, which are quite (17)
characteristic of the described type of spawning range, should also be noted. Due to low water temperature, all the biological processes associated with the reproduction of herring the onshore run, maturing of genital products to the running stage, the onset of spawning, the incubation period of development, the hatching out of larvae, etc.) progressed slowly, beginning a whole month later than usual. Due to the smaller area of the spawning range, the spawning grounds were overcrowded. A deposit of eggs was exceptionally thick (up to 100 layers of eggs and more). Due to the extended periods of spawning, the shoals spawning a second time often deposited their eggs on substrate already covered with spawn, which had a negative effect on the development of the embryos. Spawning was often observed in places where herring do not normally reproduce, such as river estuaries, pebbly shores, sandy and pebbly bottoms, littoral areas devoid of vegetation, underwater rocks, the bases of precipitous rocks that are revealed at low tide and substrate

at depths over 10-15 m. Because of the unfavourable conditions, the spawn perished, and the stench from billions of decomposing eggs spread for several kilometres beyond the spawning grounds, attracting multitudes of sea birds, brown bears and other animals which ate up the eggs. However, a particularly large amount of spawn perished when ice was driven back into the spawning zone. During low tide, the ice settled on the bottom, destroying the spawn deposited there. These phenomena sometimes acquired the character of a natural disaster.

Reproduction of an unproductive spawning stock under unfavourable ice conditions in the eastern and western parts of the range was observed in 1959 and 1960. The stock numbers during these years were so low that despite the accumulation of fish in the central part of the range, where most of the fishing was concentrated, there was a sudden drop in both the total landings and the catch per net. The rate of exploitation during fishing operations can greatly increase if not controlled, which can result in even greater depression of the stock.

The distribution of ice and the location of spawning grounds typical of the described type of spawning range are depicted in fig. 2.

The blocking of the eastern part of the range by ice during the period of herring reproduction and early melting of ice in the central and western parts was observed in 1965, 1967, 1968 and 1970.

During these years, a vast polynya formed in the ice along the northwestern coast, usually at the beginning of April. The off-shore water extended from Lisyansky Peninsula to Cape Ukoi, sometimes reaching Chumikan. By the end of April, the width of the Polynya had increased to 30-50 miles. The ice was especially quick to melt in the western part of the range where

its edge extended for 75-80 miles offshore. By the end of the first half of May, the ice in this area was up to 150 miles from shore. In the eastern part of the range at this time, there was a movement of ice towards the shore, and as a result of this - a decrease in the clear water surface of the polynya. During the second half of May, the ice cover usually broke into two separate masses - a northern mass which by the end of the month moved right up to the coastline blocking the shore from Cape Odzhan to Shelikhov Zaliv, and a southern one located in the Shantarsk Sea beyond the spawning range. In the first half of June the area of the ice masses considerably diminished as a result of melting. By the end of the month, comparatively narrow strips of ice lay adjacent to shore in the area from Cape Gadikan to the Yamsky Islands and in the southern part of the Shantarsk Sea. Complete destruction of the ice (18) cover was observed at the end of June or beginning of July.

Under ice conditions such as these, the temperature regime of the coastal waters differed in the following ways. The most intensive heating of water took place in the western part of the range. During the first five days of May, the water temperature was already at 2-3^{o}C, i.e. at values conducive to the reproduction of herring. In the central part of the range, the increase in temperature began at the end of March. During the first half of May, the water temperature was up to 1.5-2.0^{o}C. In the second half of May, the temperature dropped as a result of ice being driven into the coastal zone, and usually remained at sub-zero values for 10 to 15 days. In the second half of June, there was intensive heating of the coastal waters. It should be noted that such severe temperature conditions did not always recur in the central part of the range. It should be stressed, however, that unexpected and abrupt fluctuations in water temperature are typical of this type of spawning range. There was quite a delay in the heating up of the water in the eastern part of

the range, due to the long ice periods in the coastal zone. The water temperature began to gradually increase beginning with the second five-day period in May. At the end of the month, the water temperature transcended $0^{\circ}C$, rising above $1^{\circ}C$ only at the end of June. As can be seen, the temperature conditions here were not suitable for the reproduction of herring.

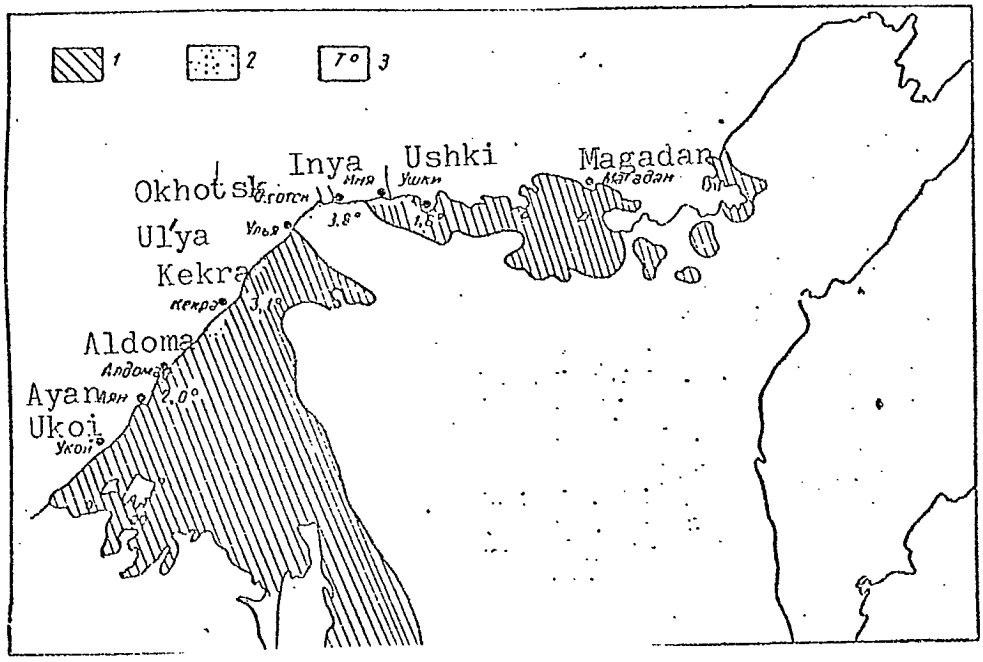

Fig. 2. Second type of spawning range:

1 - ice layer during the first half of June; 2 - spawning grounds of herring; 3 - long-term average of water temperature in June.

The migration of herring during the years under study began in the Ayan area, i.e. in the western part of the spawning range. The herring approached this area during the third ten-day period of May. During the

first ten days of June, herring appeared in the western part of the Okhotsk area (Cape Marekan - Cape Khanyangda). In the eastern half of the Okhotsk area (Cape Marekan - Eirineiskaya Guba), the migration of herring was usually observed in the second half of June. The same sequence was observed during peak migration, departure from the spawning grounds to forage in the open (19)
sea, the hatching out of larvae, etc. There were no migrations of herring east of Eirineiskaya Guba. The gradual course and development of the biological processes which accompany the reproduction of herring from south to north is a feature very typical of the type of spawning area under study. The distribution of ice and the location of spawning grounds for the third type of spawning range are depicted in fig. 3.

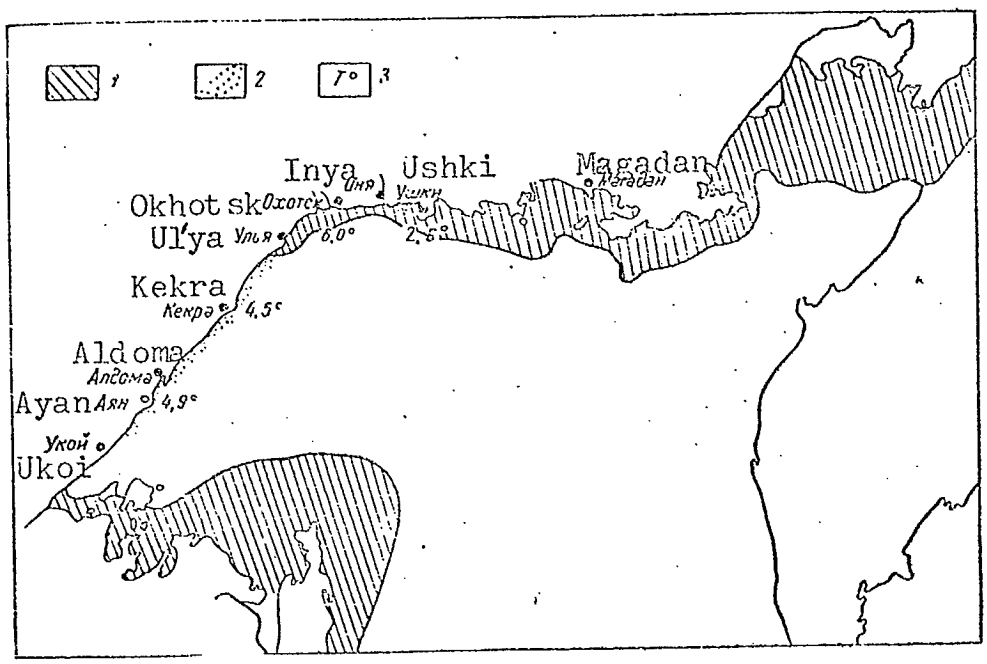

Fig. 3. Third type of spawning range.

1 - ice layer during the first half of June; 2 - spawning grounds of herring; 3 - long-term average water temperature in June.

Spawning with lengthy periods of ice in the western part of the spawning range was observed in 1946, 1948, 1953, 1955, 1956 and 1961.

During these years, the "channel" of clear water dividing the ice cover into two masses flowed in the direction of Cape Marekan - Lisyansky Peninsula, which was many miles farther northeast than usual. The rather small northern ice mass usually disappeared in the middle of June. The melting of the larger southern mass ended only at the end of June or beginning of July.

The average monthly water temperature in June was 5.6°C in the eastern part of the range, and did not exceed 1-2°C in the western part.

The migration of herring was confined to the central and eastern parts of the range. Due to unfavourable ice conditions, the western part was ignored by the spawners. This type of spawning range has many of the characteristic features observed of the eastern and western parts during reproduction in ice conditions, namely overcrowding of the spawning grounds by the brood stock, late periods of migration and spawning, spawning in places unsuitable for reproduction, a rather long embryonic stage, the accumulation of ice on the spawning grounds resulting in the destruction of the spawn, etc. True, these phenomena are less defined than in the second type of range. A feature characteristic of the fourth type of range is that (20)
the coastal waters are heated through from north to south; in the same sequence the "biological" spring sets in and is followed by all the phenological phenomena observed during the reproduction of herring. The distribution of ice and spawning grounds for this type of spawning range is depicted in fig.4.

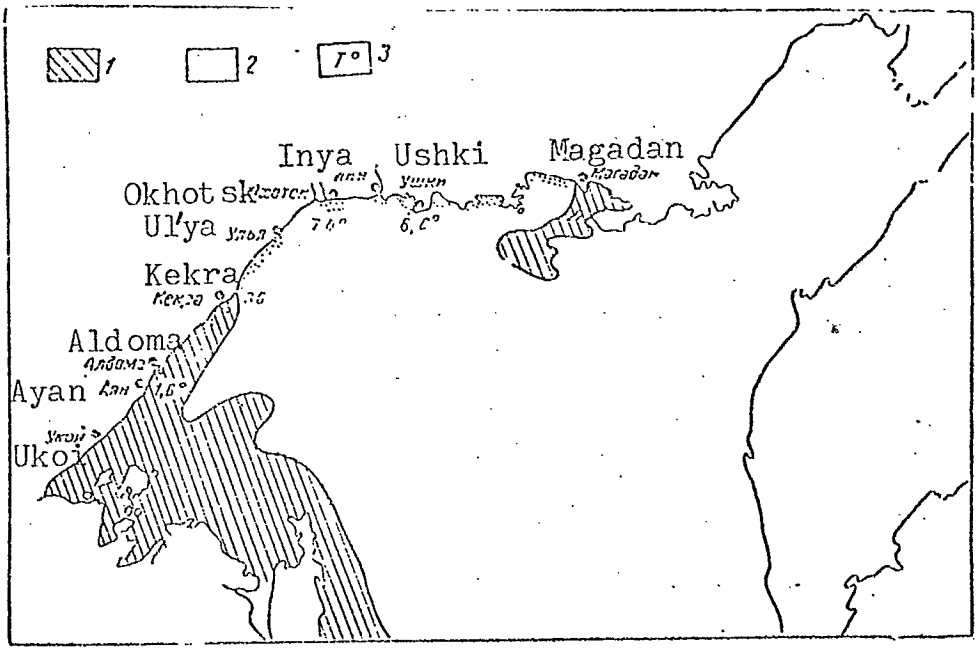

Fig. 4. Fourth type of spawning range.

1 - ice cover during the first half of June; 2 - spawning grounds of herring; 3 - long-term average water temperature in June.

As the above data indicate, each type of spawning range is characterized by a certain complex of biotic and abiotic conditions of the environment, and it is this difference in conditions that apparently determines to some extent the effectiveness of herring reproduction. The qualitative characteristic of the relation between the type of spawning range and productivity is defined by the data in table 2.

A marked correlation based on certain regularities is observed between the type of spawning range and the numbers of the year-class produced in certain conditions, these regularities being

1) strong year-classes appear when a spawning stock of high numbers

reproduces in favourable ice conditions within the spawning range (type 1);

2) the spawning of an abundant stock with ice masses blocking the eastern part of the range also results in strong year-classes (type III); apparently, the detachment of the eastern spawning grounds does not have any significant effect on spawning efficiency;

3) during reproduction in unfavourable ice conditions in the western and eastern parts of the range, the number of newly-hatched is negligible (type II);

4) the spawning of an abundant population with ice blocking the western part of the range produces weak year-classes. Apparently, the detachment of western spawning grounds results in a sudden drop in reproduction due to unknown causes (type IV);

5) the reproduction of a spawning stock of low numbers on all the types of spawning range results in weak year-classes. (21)

Table 2

Conditions of reproduction, the relative numbers of the spawning stock and the relative numbers of newly-hatched

Type of range	Year of spawning	Numbers of the spawning stock	Year-class numbers
First	1945	High	Strong
	1947	High	Strong
	1949	High	Strong
	1952	High	Strong
	1954	Low	Weak
	1957	High	Strong
	1958	High	Strong
	1962	High	Strong
	1963	High	Strong
Second	1950	High	Weak
	1951	High	Weak
	1959	Low	Weak
	1960	Low	Weak
Third	1942	High	Strong
	1943	High	Strong
	1965	High	Average
	1967	High	Strong
Fourth	1946	High	Weak
	1948	High	Weak
	1953	High	Weak
	1955	Low	Weak
	1956	Low	Weak
	1961	Low	Average

The noted peculiarities of the spawning range of Okhotsk herring can be used to a certain degree to forecast the distribution of fish during the spawning period, to plan research operations at the beginning of the foraging period, and to make the qualitative assessment of spawning efficiency required for long-term forecasting.

References

Ayushin B.N. 1947. Spring herring in the northwestern part of the Sea of Okhotsk. Izv. TINRO, vol. 25.

Probatov A.N. 1954. Distribution and numbers of spawning herring off the eastern coast of the Sea of Japan. Izv. TINRO, vol. 39.