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By A.I. Frolov

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Distribution and Environmental Conditions of Lake Herring in Sakhalin Waters

By: A. I. Frolov

Of the two groups of herring, the Sakhalin-Hokkaido herring and the lake herring, found in the waters of Sakhalin (Frolov, 1949; 1950, 1964), at the present time the latter group has the greater commercial significance. These herring form a number of local shoals in the above-mentioned waters, inhabiting the northern part of Tatar Strait, the Sakhalin Bay, the northeastern seacoast of Sakhalin, the Terpenie Bay, and the Tunaicha and Raichisi lakes (Frolov, 1964). The lake herring have not been sufficiently investigated as yet. Especially few data are available concerning their environmental conditions. /20*

*Numbers in the right margin indicate the corresponding pages in the original.

In this report we will present their distribution and describe their environmental conditions in each of the above-mentioned regions. By way of material for this report, we have used our collections and the results of observations conducted from 1937 through to 1958.

Herring in the northern part of Tatar Strait*

(De-Kastri herring)

The herring of the De-Kastri shoal inhabit the region of Tatar Strait through the whole year. During the spawning period in the spring (from the middle of May until the middle of June), these herring live in the shallowest parts of Tatar Strait with the highest fresh water content.

In years which are normal from the hydrological point of view, herring runs may be observed from De-Kastri Bay to Cape Lazarev on the continental coast and from the Chernaya Rechka settlement to Cape Pogibi on the coast of Sakhalin.

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* By the northern part of Tatar Strait, we understand the region from the line of De-Kastri Bay - Cape Zhon'ker on the south to line of Cape Lazarev - Cape Pogibi on the north.

In 1949, during the herring spawning migration, the hydrological conditions were characterized by the following data (according to the Hydrometeorological Station in De-Kastri): the water temperature of the coastal zone in De-Kastri Bay in May varied between 0.5 and 7.0°C (on an average by 3.8°) in June, from 6.0 to 13.0° (on an average by 11.2°). The average water salinities over these months were the following: in May, 21.91‰, and in June 27.88‰. According to the data of the Hydrometeorological Station in Pogibi, in the Pogibi region the water temperature in May and in June has varied between 0.2 and 15.2° (the average was 12.3°). During the same time period the water salinity fluctuated between 2.00 and 30.06‰ (with an average of 25.28‰). The temperature and salinity curves for the coastal waters in May and June are illustrated in Fig. 1a. /21

The mass migration of spawning De-Kastri herring to the regions having water of normal marine salinity was not observed.

During the spawning period the lake herring avoid the high salinity waters of oceanic origin. For this reason when the waters from Tsushima in the northern part of Tatar Strait enter into the spawning area of the De-Kastri herring, their location in their spawning grounds

Figure 1.

Temperature and salinity of the water during the migration period of the spawning herring: a/ the northern part of Tatar Strait (1 - De-Kastri; 2 - Aleksandrovsk; 3 - Pogibi);

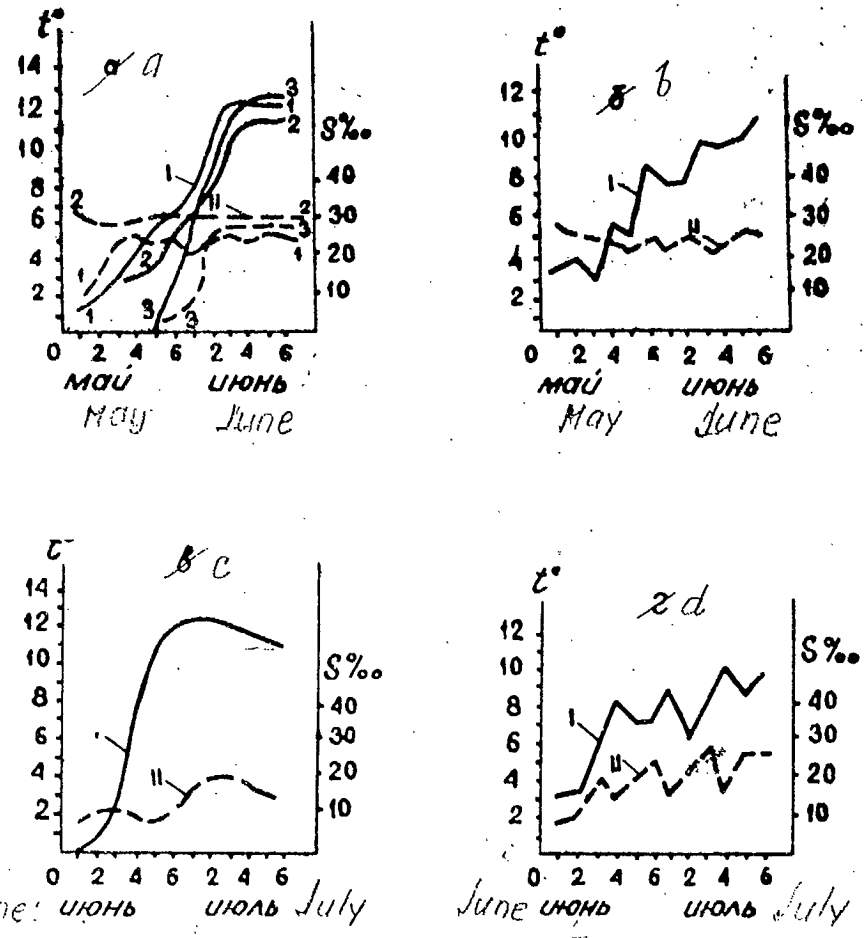

Рис. 1. Температура и соленость воды в период хода сельди на нерест: а, а) северная часть Татарского пролива, (1 — Де-Кастри, 2 — Александровск, 3—Погиби);

b/ Terpenie Bay (Vladimirov region); c/ Baikal Bay (Sakhalin Bay); d/ Chaivo Bay: I - temperature; II - salinity. On the abscissa: five-day intervals.

changes somewhat. The migrations in the southern part of the spawning area are discontinued and increase in the northern part. During this period a certain portion of the spawning herring migrates to the southern part of the Amur estuary, reaching the Chakmut Island on the continental coast and the Zelenyi Gai settlement on the coast of Sakhalin. We have observed such a change of position during the spawning period from 1934 to 1940, and other investigators have observed it in 1955-1959 (Kozlov, Shchelegova, 1961).

The catches of spawning herring are characterized by the following data: on the continental coast from De-Kastri Bay to Cape Lazarev, the yearly catches have /22
varied between 8.0 and 56.0 thousand centners during the period from 1940 to 1944. The yearly average was about 25.0 thousand centners. On Sakhalin, from the Chernaya Rechka settlement to Cape Pogibi, the catches have fluctuated between 5.0 and 39.2 thousand centners (with an average of 20.0 thousand centners) for the same period.

The results of the experimental fishing with drift nets as carried out by the author farther north from De-Kastri Bay in 1942-1943 have shown that the herring do not remain for a long time in the northernmost part of the Strait. After spawning they leave the area

of the main spawning grounds, and form concentrations when feeding somewhat farther south, in the regions of Aleksandrovsk and Shirokaya Pad', since the feeding resources in the shallow parts of the Strait with freshened water are much lower than in the waters in its central part. The herring feed until October, then they leave to winter.

In November, 1958 the trawler "Ogon'" trawled more than 100 times in the northern and central part of Tatar Strait. According to the unpublished data of A. P. Nikolaev (1959) herring were found in the catches of 22 trawlings when being taken only in the northern part of the Strait. The highest yield was obtained in the central part of the Strait between the lines of Cape Uandy - De-Kastri Bay and Aleksandrovsk city - Mosolov Inlet. The catches reached up to one centner per trawling hour (770 fish per trawling). In this time period the herring lived in waters of temperature between 0.30 and 3.2°, on the average 1.2°.

In winter (in January, February), according to the data obtained during the fishing period of Eleginus, the water temperature in this region sinks down to -1.6° (Kozlov, 1959).

Herring in Terpenie Bay

The spawning of the local herring shoal in Terpenie Bay takes place on its coastal parts in May and June. Here the herring are distributed along almost the entire coast from the Kotikov settlement to the Novoe settlement. During the spawning period they migrate to regions which have stably freshened water; however, they avoid the places where the fresh water content is high. This peculiarity may be observed in the Poronai river area. Here is a fishing region to which the herring migrate regularly in those years in which the water level in the river is low during spring, and in the region itself the fresh water content is not too high in the area of the seine. In those years, however, in which the water level in the river is high, this region has a high fresh water content, and the herring do not migrate. In these years they remain farther from the coast, where they are caught with trap nets. On areas without freshened water, no mass spawning takes place. In Terpenie Bay, the Kotikovo region may serve as an example: here/there is no river at all, and the waters of the coastal zone have a low fresh water content. Here the catch of spawning herring is very low (Table 1).

Table 1.

Salinity of the coastal waters and the average catches of spawning herring in the region of Terpenie Bay over the 1949-1952 period

Соленость воды в прибрежной зоне и средний вылов нерестовой сельди за период 1949—1952 гг. по районам зал. Терпения

Район 1	Соленость воды 2 в июне 1949 г., ‰	3 Средний вылов, ц.
Пос. Котиково 4	12 более 31,5	330
Пос. Владимирово 5	28,03	2290
Пос. Нева 6	27,23	3160
Пос. Устье 7	22,11	2313
Гор. Поронайск (в 3 км к югу 8 от устья р. Поронай)	—	1198
Пос. Гастелло 9	23,63	1608
Пос. Лермонтово 10	27,44	1493
Пос. Новое 11	—	217

1 - region;

2 - water salinity in June, 1949, in ‰;

3 - average catch, in centners;

4 - Kotikovo settlement;

5 - Vladimirovo settlement;

6 - Neva settlement;

7 - Ust'e settlement;

8 - Poronaisk city, three km south of the mouth of Poronai river;

9 - Gastello settlement;

10 - Lermontovo settlement;

11 - Novoe settlement;

12 - more than.

During the spawning migration period the water temperature in the coastal zone varies between 0.6 and 9.6° in May, and between 6.9 and 12.3° in June. Figure 1/b indicates the water temperature and salinity for May and June 1958 in five-day intervals.

After spawning the herring do not leave the Bay. Throughout almost the whole summer they may be fished by trap nets and drag seines. The largest quantities may be caught in June. Their migration to the coast in this month may be probably explained by the somewhat higher water temperature of the coastal waters than that of the sea at this time. At the same time, this gives rise to favourable feeding conditions. In August and September the warming period of the coastal waters sets in, and the mature herring leave the coast. /23 In this period only juvenile fish may be found in control catches. In October, with the cooling of the waters, the adult herring again appear along the coast and the catches somewhat increase (Table 2.).

Every year in winter, [herring] are caught together with Eleginus during ice-fishing in Poronaisk region and at the "Ust'e" fish hatchery.

Table 2.

Catches of the local herring shoal in Terpenie Bay, in centners

Таблица 2

Вылов сельди местного стада в зал. Терпения, ц

Месяцы /	2 Годы				
	1948	1949	1950	1951	1952
Май 3	7040	7700	5684	6899	3628
Июнь 4	12319	12059	7978	5642	8878
Июль 5	6894	1751	197	2566	398
Август 6	265			51	221
Сентябрь 7	27			28	289
Октябрь 8	112	61	115	нет данных	526
Всего: 9	26657	21571	13947	15186	13950

1 - month; 2 - year; 3 - May; 4 - June; 5 - July;
6 - August; 7 - September; 8 - October; 9 - total;
10 - no data.

The hydrological conditions of the waters of the southeastern part of Sakhalin, and specifically Terpenie Bay, are influenced by two currents: the cold eastern Sakhalin current and a warm current whose waters the Soiya current transports to this coast. In normal years, as far as the hydrological conditions are concerned, the waters of the eastern Sakhalin current are dominant in almost all regions of the southeastern coast. During this period the catches in Terpenie Bay consist exclusively of local herring.

In the event of the warm current increasing in the direction of the coast, the Sakhalin-Hokkaido herring appear in Terpenie Bay, since the distribution of this herring is connected with the above-mentioned waters. Lately, according to the data of S. K. Shchelegova (1958), increased activity of the warm current was observed from 1953 through to 1958. The catches in Terpenie Bay in this period began to consist of local and Sakhalin-Hokkaido herring (Table 3.). Their ratio in the catches, as listed in the Table, is calculated on the basis of the differences in the rate of growth.

Table 3.

Composition of the catches of spawning herring in Terpenie Bay, in percent

Таблица 3

Состав уловов нерестовой сельди в зал. Терпения, %

Годы 1	Уловы 2	Местная 3	Сахалино-хоккайдосская 4
1948	19359	100	
1949	19759	100	
1950	12662	100	
1951	12540	100	
1952	12506	100	
1953	14267	59,5	40,5
1954	13229	29,5	70,5
1955	15117	13,0	87,0
1956	4259	24,4	75,6
1957	13762	30,9	69,1
1958	26385	21,0	79,0

1 - year; 2 - catch; 3 - local herring; 4 - Sakhalin-Hokkaido herring.

From the presented data it may be seen that /24
for the period of the warm current dominance the Sakhalin-Hokkaido herring formed the basic part of the catch. In our opinion, to avoid the disadvantageous conditions, the major part of the local herring migrated into regions farther north, into the Pil'tun, Chaivo and Nyivo bays. This is demonstrated by the fact that in the above-mentioned bays until 1953 the catches of herring were not higher than six to seven thousand centners, whereas after that year the catch immediately doubled. In 1954, for example, the catch reached 14.3 thousand and in 1955 15.2 thousand, centners.

The small portion of local herring which remained in Terpenie Bay from 1953 to 1958, inhabited the Poranaisk and Ust'e regions where, due to the waters drained in large quantities by the rivers, advantageous conditions were sustained for the herring. Here they might be found in catches with trap nets in the spring and in the summer, and in catches with fyke nets in the winter.

Herring in Sakhalin Bay

The freshened water of Skahalin Bay, as caused by the Amur river, is not uniform in all parts of the Bay.

The highest fresh water content is in the southern and eastern parts, while the northwestern part is of marine character and, as far as the hydrological characteristics are concerned, it differs only insignificantly from the open regions of Sea of Okhotsk. In this part of the Bay the water is always colder and its salinity always higher than in the southern and eastern parts. According to the measurements carried out on the ship "Gidrolog" on 29 July 1949, the temperature of the surface water at the eastern shore of the Bay was 14.0 to 14.8° and the salinity, 20.0 to 23.72%. At the same time, at the northwestern shore the water temperature varied between 7.8 and 9.2° and the salinity, between 31.20 and 31.77%.

In the eastern part of the Bay the warm, superficial water layer is only 10 m deep, and the thickness of this layer progressively decreases to the north and west. The cold waters from the Sea of Okhotsk are located at greater depth. According to the measurements carried out by the hydrological station on 29 July 1949, the temperature on the surface was 14.80°, at 10 m depth 0.5°, and at 20 m depth (bottom) 0.9°. Salinity: on the surface 20.06‰, at 10 m depth 32.07‰, and on the bottom 32.97‰.

In Sakhalin Bay herring can be caught during /25 the whole summer and autumn from July to October inclusive. (Table 4.).

Table 4.

Herring caught by the fishery combine in Lyugi, in centners

Таблица 4

Уловы сельди Люгинским рыбокомбинатом, ц

/ Месяцы	1940	1941	1942	1943	1944
Июнь 2	362	5343	754	3862	495
Июль 3	2817		2949	253	546
Август 4	1811		927	165	959
Сентябрь 5	311	551	1034	491	131
Октябрь 6	55	59	413	232	
Всего: 7	5356	5953	6077	5003	2131

1 - month; 2 - June; 3 - July; 4 - August; 5 - September; 6 - October; 7 - total.

We may see from the table that the highest catches were in June and in July. This may be explained by the fact that in the first half of summer the spawning herring are caught which migrate to the coast in greater mass and with higher frequency than the feeding [fattening] herring in August-October.

At the shore of Sakhalin Bay the fishing is carried out by trap nets and drag seines. During the

period from 1940 to 1944 ten drag seines and eight trap nets were applied for the herring catch along the Sakhalin coast. About the same amount of fishing gear was used on the continental coast.

As soon as Sakhalin Bay becomes free of ice, the spawning herring appear on both coasts. The spawning of the herring may be observed almost everywhere on the continental coast from Baidukov Lake to the Kol' river, and on the Sakhalin coast from Vereshchagin Inlet to Kuegda Bay. Apart from being on the coast of Sakhalin Bay, the herring also migrate into the Bakal, Pom'r, Schast'e and Kuegda bays. The strength of their migrations through individual regions is characterized by the catch listed in Table 5.

It may be seen from Table 5 that the herring are not uniformly distributed along the coasts. On the continental seaboard their highest concentrations are observed at the Kol' river and in the Petrovskaya Kosa region, whereas on the seaboard of Sakhalin they are noted in the region of the Kirpichi, Lyugi, Muz'ma and /26
Rybnoe settlements. In the Baikal, Pomr' and Schast'e bays there is no fishing, since these are very shallow and densely overgrown with sea grass. In the spring the herring do not live in these bays; after spawning they migrate to Sakhalin Bay without delay.

Table 5.

Average catches of herring in Sakhalin Bay during the period of 1940-1944

Таблица 5

Средний вылов сельди в Сахалинском заливе за период с 1940 по 1944 гг.

1 Районы	2 Вылов, ц	3 Удельное значение района от общего вылова по заливу, %
Материковое побережье 4		
Рыбозавод «Коль» 5	1113,0	49
Петровская Коса 6	972,0	44
О-в Байдукова 7	158,0	7
Всего: 15	2242.0	100
Сахалинское побережье 8		
Зал. Куэгда 9	128,0	4
Рыбалка Музьма 10	450,0	15
Пос. Кирпичики 11	1260,0	42
Пос. Люги 12	850,0	30
Пос. Рыбное 13	250,0	8
Б. Верещагина 14	40,0	1
Всего: 15	2978.0	100

1 - region; 2 - catch, in centners; 3 - percentage rate of the region in the total catch in the Bay, %;
4 - continental coast; 5 - Kol' fish hatchery;
6 - Petrovskaya Kosa; 7 - Baidukov Island; 8 - seaboard of Sakhalin; 9 - Kuegda Bay; 10 - Rybalka Muz'ma;
11 - Kirpichi settlement; 12 - Lyugi settlement;
13 - Rybnoe settlement; 14 - Vereshchagin Inlet;
15 - total.

Comparing the runs of herring by regions with the distribution of salinity in Sakhalin Bay (Fig. 2.), we can state that these runs occur only towards those sections of the coast of Bay which are subject to the effect of fresh water. On those sections which are not affected by the water of the Amur river and where the local rivers are too small, herring runs are not observed. The northwestern coast of the Bay is specifically such a region.

Figure 2.

Spring distribution of herring on the coast (of Sakhalin Bay)

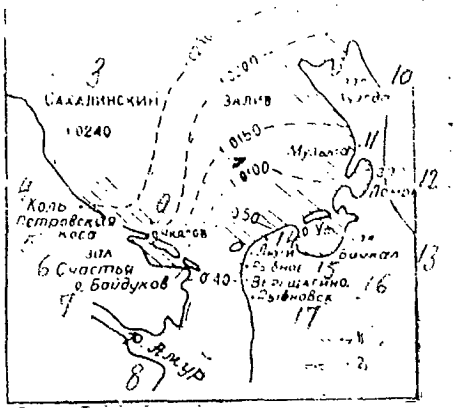

Рис. 2. Распределение сельди по побережью весной (Сахалинский залив).

1 - regions of the passages [runs] of herring; 2 - level of the average specific weight [gravity] of the water (according to Brazhnikov, 1904); 3 - Sakhalin Bay; 4 - Kol'; 5 - Petrovskaya Kosa; 6 - Schast'e Bay; 7 - Baidukov Island; 8 - Amur river, 9 - Chkalov; 10 - Kuegda Bay; 11 - Muz'ma; 12 - Pomr' Bay; 13 - Baikal Bay; 14 - Lyugi; 15 - Rybnoe; 16 - Vereshchagin Inlet; 17 - Rybnovsk.

The herring spawn in Sakhalin Bay in June and in July; at the beginning of spawning the water temperature in the coastal part is, as a rule, low, i.e., in the range of one degree, but after that, due to the shallowness of the water it warms up rapidly and by the end of June the water temperature reaches 12-14°.

According to the data of the "Moskal'vo" hydrometeorological station in Baikal Bay, the water temperature varied between 0.2 and 17.8° during the spawning period in 1945; the average value was 7.9° for June, and 12.2° for July. The salinity varied between 8.06 and 24.01‰; the average value was 10.64 for June and 18.11‰ for July. The temperature and salinity of water in Baikal Bay for June and July, 1945 are illustrated in Fig. 1/c.

During the summer the herring do not go out from the Bay. They feed here during the whole summer and appear periodically on the seaboard where they are caught with trap nets and drag seines.

It is to be assumed that the food in the Bay is enough for the small shoal of local herring.

The plankton in Sakhalin Bay develops well. According to the data of E. K. Lubny-Gertsyk (1959), the biomass of the zooplankton reaches the value of 500 mg/m^3 in the 0-50-m layer. The richest layer was the superficial layer (0-10 m) in which the biomass of the zooplankton has a value higher than 2000 mg/m^3.

The experimental catches with drift nets as carried out in 1936 by D. I. Okhryamkin and in 1944-1945 by the present author, have shown that in summer, after spawning, the herring are distributed all over the Bay. They live in very scattered formations and until the middle of September the catches were low. On an average the catches were not higher than one hundred fish for ten 300 mesh nets per drift. The herring fell into the nets only in the superficial water layer. Nets installed deeper than 10 m failed to yield a catch.

Sakhalin Bay is inhabited only by a small local shoal of herring. For this reason, due to their low abundance they do not form highly concentrated feeding accumulations. Small catches with nets are usual in summer.

By autumn (in September) the distribution of herring in the Bay is somewhat changed. They are more seldom at any distance from the coast, but on the other hand in the coastal regions, especially in the southern /27
part of the Bay, the concentration of the shoals increases. In the second half of September and in October, the catches ranged from one to seven centners per drift when using the same system of nets. The fishermen in the Rybnoe region, in addition to the migration of the herring in spring, have also found an autumn migration. During this migration the catches with trap nets and drag seines increase in comparison with the catches during the summer months, but due to the disadvantageous meteorological conditions in the second half of September and in October the number of fishing days decreases abruptly.

In Sakhalin Bay the water temperature starts abruptly to fall in the second half of September and already in October it is only one half to one third of the July and August temperature (Table 6.). For this reason the autumn herring concentrations in the coastal waters may be considered evidently as the beginning of the winter concentrations. This is corroborated by the following fact: in September, as may be seen from Table 7., 91.6% of the individuals in the sample had their reproductive

Table 6.

Average water temperature according to the "Moscal'vo" hydrometeorological station

Таблица 6

Средняя температура воды по данным гидрометеорологической станции «Москальво»

Годы 1	Май 2	Июнь 3	Июль 4	Август 5	Сентябрь 6	Октябрь 7
1943	—0,5		15,4	15,5	13,6	7,6
1944	—0,9	7,1	16,4	15,4	13,9	
1945	—0,3	7,9	14,8	15,0	12,2	5,0
1946	—0,7	5,0	16,3	17,2	11,7	
1947	—0,8		15,7	12,3	12,3	6,0
1948	—0,5		16,8	17,9	13,3	7,1

1 - year; 2 - May; 3 - June; 4 - July; 5 - August; 6 - September; 7 - October.

Table 7.

Maturity stages of the reproductive organs of herring from the catches with trap nets and drag seines in Sakhalin Bay (Rybnoe-Kirpichiki region, 1944), in %

Таблица 7

Стадии зрелости половых продуктов сельди из уловов ставных и закидных неводов в Сахалинском заливе (район Рыбное—Кирпичики, 1944), %

Дата 1	I	II	III	IV	V	VI	Кол-во исследованных экз. 2
7. IV		2,1		12,8	47,0	17,2	98
6. VII		22,4	1,0		10,2	66,4	99
20—24 VII	15,6	76,7	5,3	1,8	0,6		197
3—12 VIII		14,3	85,7				197
4—5 VIII	97,6	2,4					140
26—27 IX		9,4	62,4	29,2			197

1 - data; 2 - number of investigated specimens.

organs in the III and IV phase of maturity, i.e., the herring are in such a physiological state when the spring-spawning fish begin to winter.

Herring may be seen in Sakhalin Bay also in winter. During the ice-fishing of Eleginus, the herring yields a significant side recovery almost every year. In the region of the Rybnoe and Lyugi settlements and in the Baikal and Pomr' bays they enter fyke nets. D. I. Okhryamkin still in 1936 indicated that in Pomr' Bay, along with winter Eleginus caught in fyke nets the side recovery of herring reached 10 centners daily. In the Lyugi region herring were also taken in fyke nets every day, and there was one instance when fifty centners were caught in one lifting of the fyke net. From all these facts it may be concluded that the herring do not go out from Sakhalin Bay, either in winter or in summer. They form concentrations to overwinter in the southern part of the Bay and in the channels of the Baikal, Pom'r and Schast'e bays, and during winter /28 generally concentrate in regions with lower water temperatures. The somewhat higher temperatures during winter in the above-mentioned regions may be explained by arrival of relatively warm water from the rivers. But just the same, the herring winter under severe hydrological conditions. In the regions where they winter, the water temperature sinks to -1.0° -1.5°.

Herring in the northern part of the eastern coast of Sakhalin

The distribution of herring on the northeastern coast is confined to those parts of it where the bays are located[*]. Here the fishing begins in July and finishes in October. The herring are fished in the channel with drag seines. The catches in the most important bays are listed in Fig. 3.

In this area the habitat of herring is closely associated with the bays; however, they do not go into all of those which are located on this seaboard, but only into five, i.e., into the Pil'tun, Chaivo, Dagi, Nyivo and Nabil' bays. The herring do not go in the Kolendu, Khanguza, Urkt, Ekhabi or Odaptu bays located north of Pil'tun Bay or into Len'skii Bay (south of Nabil' Bay). This phenomenon may be explained by the hydrological conditions in the bays. Many rivers empty into those five bays where the herring enter, and the water in them is freshened, whereas few, if any, rivers empty into the other bays. For this reason the salinity of the water in these bays differs little /29 from that of sea water. This factor is very important for the distribution of herring.

[*] These are marine basins connected with the sea by narrow (300-500 m) channels.

Figure 3.

Catches of herring in the Pil'tun (1), Chaivo (2), and Nyivo (3) bays by months

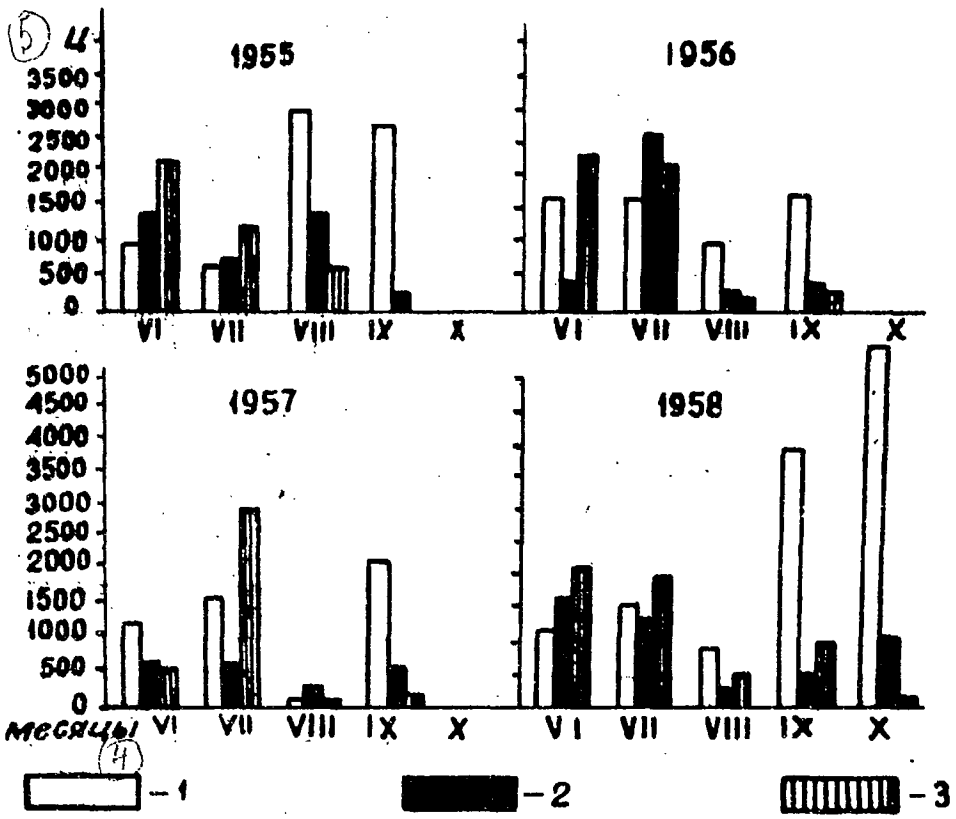

Рис. 3. Вылов сельди по месяцам в заливах Пильтун (1), Чайво (2), Ныйво (3).

4 - month; 5 - metric centner.

However, the herring do not live in the bays, but migrate there at definite periods of their life. They enter regularly during the reproduction period in spring. The herring first appear in Nyivo Bay, then their run extends to more northerly regions. In Pil'tun Bay, as a rule, the spawning herring will appear five, and in some years even ten, days later than in Nyivo Bay. The difference in timing of the spawning migration is due to the retarded warming up of the water in the Pil'tun Bay region. A. P. Vedenskii (1950) is of the opinion that there is a direct relationship between the entry of the herring into the bays and the quantity of the warm water flowing out of them into the sea. This assumption is also corroborated by our observations.

Comparing the catches of herring in the bays for June and July (Fig. 3.), we may clearly establish that the catch of spawning herring in Nyivo Bay is higher than in Pil'tun Bay. In this respect, Chaivo Bay occupies mostly an intermediate position. A large river empties into Nyivo Bay, and for this reason a large quantity of warm water emerges from the latter. This creates the conditions for herring concentration in the sea at this Bay in winter, and for obtaining a heavy catch in the spring.

We are of the opinion that not only the outflow of warm water influences the migration of spawning herring into the bays but also the rate of freshening of the water. We may find corroboration of this assumption in the following: if at the beginning of the migration, i.e., in June, there is a difference in the quantities of warm water flowing out of the bays, then by July the water in all the bays is sufficiently warmed up, consequently, the temperature differences between the bays are equalized. Nevertheless, the catch of spawning herring in July is higher in Nyivo Bay. In our opinion, this may be explained by the fact that the water flowing out of Nyivo Bay is always of lower salinity than the water from the other bays (Table 8.).

Table 8.

Water temperature and salinity in July, 1949

Таблица 8.

Температура и соленость воды в июле 1949 г.

	Зал. Пильтун	Зал. Ныйво
	Температура	
Отлив	16,2°	17,2°
Прилив	4,8°	3,8°
	Соленость	
Отлив	12,98‰	3,22‰
Прилив	28,62‰	28,95‰

1 - Pil'tun Bay; 2 - Nyivo Bay; 3 - temperature; 4 - salinity; 5 - ebb; 6 - flow.

Day-by-day observations of water temperature and salinity during the run of spawning herring have shown that the water temperature in the bays ranges between 1.8 and 9.0° (the average is 6.1°) in June, and between 6.2 and 11.1° (the average is 8.7°) in July. The water salinity varies between 4 and 30‰, having an average of 16.36 for June and 24.16‰ for July. Fig. 1/d represents the temperature and salinity curves of water in Chaivo Bay in 1955.

After spawning the herring go out [from the bays] to feed in the sea. Here, they are distributed over the entire water area adjoining the bays. Experimental fishing carried out by us with drift nets from July to October in 1937-1939 showed that the herring live in very scattered formations in the sea. Catches of up to three centners per drift were obtained only at the entrances into the bays, during those periods when the herring was going in or out of the bays. In other areas of the sea, the catches were low and did not exceed 30 kg per drift (Table 9.).

A. P. Vedenskii (1950) assumes that the basic /30
mass of herring feed beyond the east Sakhalin current.

It was established by our observations on the expenditionary ship "Zhemchug" in 1955 that the local herring do not feed in the open part of the Sea of Okhotsk where the cold and warm oceanic waters meet. Analysis of collected materials has shown that here the catches consist exclusively of herring of the Sakhalin-Hokkaido stock (Frolov, 1957). In this way, Vedenskii's assumption was not verified. We have arrived at the conclusion that the local herring feed within the limits of the east Sakhalin current, and that they do not migrate far from the coast. This area of the sea is fairly rich in zooplankton. According to Lubny-Gertsyk (1959) the average biomass of the zooplankton at the northeastern coast of Sakhalin reaches the magnitude of 300 to 500 mg/m^3 in August through to November. The zooplankton consist of oceanic and neritic groupings characteristic of cold waters. In the stomachs of the herring representatives of both groupings may be found: those of the oceanic forms Calanus glacialis, about 8%, Metridia sp, 11%; Euphausiacea, 10%, and the neritic forms Mysidacea, Cumacea, Gammaridae and Isopoda compose more than 50%.

The observations of the water temperature conditions during the feeding period have shown that, in the catches with nets, herring may be found at water

temperatures from 5 to 16°. The most frequent and highest catches occur at water temperatures from 10 to 13° (Table 9.).

Table 9.

Distribution of herring catches fished by nets on the northeastern coast of Sakhalin as the function of the surface temperature of water in 1937-1939

Таблица 9

Распределение уловов сельди сетями у северо-восточного побережья Сахалина в зависимости от температуры воды на поверхности в 1937—1939 гг.

	Температура воды во время лова												
	3°	4°	5°	6	8	9	10°	11°	12°	13°	14°	15
Общее кол-во дрейфов 2	1	1	3	3	2	4	3	4	4	6	4	1	1
Дрейфов с уловами 3			2	1	2	2		2	4	5	2	1	1
Общий улов, кг 4			3,0	1,0	16,8	1,8		470,0	301,0	143,4	0,4	0,1	0,6
Средний улов за дрейф на 10 сетей, кг 5			1,6	0,5	8,4	0,5		235,0	75,0	28,7	0,2	0,1	0,6

1 - water temperature at the time of fishing;

2 - total number of drifts;

3 - drift with catch;

4 - total catch, in kg;

5 - average catch per drift for 10 nets, in kg.

Here as well as in Sakhalin Bay, the low catches of feeding herring are due to the fact that the total number of the shoal is small. During the summer / period, the herring are scattered over a large water area and do not form dense concentrations.

During the whole summer the herring appear periodically in the channels. It cannot be stated that their appearances are associated with feeding, since the food supply in the channels, and even in the bays themselves, is much lower than in the sea. Nor can these visits be regarded as accidental, as is assumed by A. I. Ambroz (1931), because they occur in the channels of all the bays at the same time.

Vedenskii (1950) has stated that in the event of southwesterly winds the herring concentrate in the channels, and the catches increase. The southerly winds drive seawater of oceanic origin from the open part of Sea of Okhotsk to the eastern coast, and in the event of enduring and strong winds these waters flow close to the coast and give rise to disadvantageous conditions /31 for the lake herring. To avoid the sea water, the herring go into the channels. In the event of northerly winds the inverse phenomenon may be observed.

In these areas herring may be caught also in winter. With the onset of colder weather, the herring accumulate at the channels of the bays and from here pass into the channels proper. This may be established by the fact alone that in winter in Pil'tun, Chaivo and Nyivo bays during the ice-fishing of Eleginus, herring are always found in the catches, and after the breakup of ice in the inlets the herring appear at once.

Herring in Tunaicha Lake

(Tonnai herring)

In Tunaicha Lake[A] a small shoal of herring multiply and overwinter (Probatov, Frolov, 1951, 1958). The yearly catch of this herring fluctuates between two and five thousand centners.

The spawning begins at the breakup of the ice on the Lake at 1-2° water temperature. The temperature rises quickly and by the middle of June it reaches 14.0 - 17.0°. Our observations have shown that the Lake water warms up well to the bottom (Table 10.). The spawning is finished by the end of June.

[A] Basically the Tunaicha Lake is a sea inlet connected with the sea by a narrow channel.

Table 10.

Water temperature in Tunaicha Lake on 20 June 1950

Таблица 10

Температура воды в оз. Тунайча 20 июня 1950 г.

	1 Стан 1, глубина 14 м	2 Стан 2, глубина 16 м	3 Стан 3, глубина 20 м	4 Стан 4, глубина 17 м
Поверхность 5	15,2°	14,8°	16,2°	17,0°
Дно 6	12,5°	11,5°	8,9°	120°

1 - station 1, depth 14 m; 2 - station 2, depth 16 m;
3 - station 3, depth 20 m; 4 - station 4, depth 17 m;
5 - surface; 6 - bottom.

The salinity of the lake water is not high; it is 4.18 - 4.54‰ on the surface, and 10.23‰ at 20 meter depth.

After spawning the herring go to the sea, and during the whole summer live in Mordvinov Bay. Here they often enter trap nets installed for catching chum salmon and pink salmon. At the end of September or in October, they return from the sea into the Lake to overwinter. In January, 1954 experimental ice-fishing was carried out by nets. Herring were caught everywhere, but the catches were very low. From 10 to 20 of January the total catch was about one centner.

The Tunaicha Lake is a wide basin. The herring can winter in it freely. In this respect the shoal of Tonnai herring differs from the other shoals of the lake type, the majority of which winter in the coastal zone of the sea.

The herring in Raichisi Lake has a yearly life cycle analogous to that of the Tonnai herring. The former also spawn and winter in the lake itself and feed in the sea (Rumyantsev, A. I., Frolov and others, 1958). The abundance of this herring is low, and it has no commercial importance. The environmental conditions are similar in both lakes. The water salinity in the Raichisi Lake is not higher than 5-7‰, and the water temperature varies within wide limits: in winter it sinks to negative values (-0.2), whereas in summer it rises up to 16-19°.

Inferences drawn from the material /32

It is characteristic of lake herring that they spawn in shallow regions on wide banks. The explanation for the adaptation of their spawning to such regions is that these herring live under severe hydrological conditions (Frolov, 1964) and in the spring, i.e., during the period when the gonads are maturing and spawning occurs, they disperse over a region where the water warms up rapidly.

In Fig. 1., it may be seen that on the spawning grounds the water temperature rises from 1 - 3° to 9 - 13° over 10-15 days. The other characteristic peculiarity of these herring is that they spawn in marine regions which contain fresh water. Observations have shown that the herring do not go for spawning to an area without freshened water. In addition to this, if under the influence of sea currents, high salinity waters begin to intrude into the spawning grounds, then the herring will discontinue to go to the latter. Consequently, the freshening of water on the spawning grounds during the spawning period is a necessary condition for the lake herring.

From Table 11,, it may be seen that the spawning takes place in waters freshened to various degrees. The herring in Tunaicha Lake can bear the lowest salinity. The spawning in Terpenie Bay and in the northern part of Tatar Strait takes place at a relatively high water salinity. The herring in Sakhalin Bay and on the northeastern coast of Sakhalin occupy an intermediary position in this aspect.

Table 11.

Environmental conditions and catches of lake herring in the waters of Sakhalin

	Water temperature during the spawning period in C°	Water salinity on the spawning ground in ‰	Area of Spawning	Feeding	Wintering	Catches, in thousands of centners
Raichisi Lake	--	5-7	lake	sea	lake	of no commercial interest
Tunaicha Lake	2,0-14,0°	4-5	lake	sea	lake	2,0-5,0
Northeastern Sakhalin	3,0-11,7	16-20	bay	sea	seaboard	6,0-8,0
Sakhalin Bay	1,0-13,0	10-18	bay	Sakh.Bay	Sakh.Bay	4,0-6,0
Terpenie Bay	4,0-11,4	22-28	coast	Terp.Bay	Shore of the bay	15.0-21,0 spawning
Northern part of Tatar Strait	3,0-11,2	21-27	coast	Tatar Bay	Tatar Strait	about 40,0 feeding

-35-

Условия обитания и вылов сельдей озерного типа в водах Сахалина.

	Температура воды в период нереста	Соленость воды в районе нереста, ‰	Место нереста	Место нагула	Место зимовки	Улов, тыс. ц
Оз. Райчиси	—	5 - 7	озеро	море	озеро	промыслового значения не имеет
Оз. Тунайча	2,0 -14,0°	4 —5	озеро	море	озеро	2,0—5,0
Северо-восточный Сахалин	3,0--11,7°	16 -20	залив	море	прибрежная часть моря	6,0—8,0
Сахалинский залив	1,0 -13,0°	10 -18	залив	Сах. зал.	Сахалинский зал.	4,0—6,0
Зал. Терпения	4,0 - 11,4°	22—28	прибрежн. часть	зал. Терпения	прибрежная часть залива	15,0—21,0 нерестовая
Северная часть Татарского пролива	3,0 -11,2°	21—27	прибрежн. часть	Татарский залив	Татарский пролив	около 40,0 нагульная

Connection with enclosed basins is different for all the herring we have investigated. As we have already mentioned above, the herring spawn and winter in the Tunaicha and Raichisi Lakes.

On the northeastern coast and in Sakhalin Bay at the present time the herring go into the bays only during the spring for reproduction. In the past, however, when the bays were deep, they have evidently served also for wintering. However, due to silting from the rivers and the settling of residues of water plants, the bays became shallow, and at the present time a substantial portion of their area becomes dry at ebbtide, and on the remaining portion, except the water courses, the depth is insignificant. The water of the rivers flows only in the water courses and in the channels.

In this way, due to the geomorphological changes in the bays, the wintering of lake-type herring has gradually developed under marine conditions.

We assume that the herring in Terpenie Bay and in the northern part of Tatar Strait has undergone the same process of adaptation during the spawning and wintering periods to conditions of a more marine character.

At the present time the former has lost the persistent connection with the Neva Lake, and the latter, with the Amur estuary. The gradual geomorphological changes in the living area have forced these herring to adapt not only to wintering in the sea but also to reproduce in the open coastal region with freshened water under conditions which are similar to those in the sea. This adaptation is to be regarded as progressive, since their abundance is substantially higher than that of the herring which multiply in half-closed basins.

Vedenskii (1960) has classified the lake herring into two groups. To the first group he has assigned the herring which spawn and overwinter in the lakes, and to the second, those that are lakebound only for the reproduction period. In the waters of Sakhalin the herring in the Tunnaicha and Raichisi lakes belong to the first group, whereas those on the northeastern coast of the Island and in Sakhalin Bay belong to the second group. We are of the opinion that, in addition to these groups, the lake herring also form a third group not at all connected with half-closed basins. The De-Kastri and Terpenie herring belong to this group.

Conclusions /34

1/ During the spawning period the lake herring are distributed over wide, shallow regions of the sea. The spawning begins at relatively low water temperatures in the range of 1-3°, but the water being shallow, afterwards it rapidly warms up and by the end of spawning its temperature reaches 10-13°.

2/ The water salinity in the spawning areas varies between 4-5 and 28-30‰. It is characteristic that during the spawning period the herring do not go en masse into areas having water salinity higher than 30 or lower than 4-5‰. Furthermore, during the spawning and feeding period they avoid waters of oceanic origin (with high salinity).

3/ As far as mode of life is concerned, the lake herring are of neritic form. They do not go far from the coast and inhabit coastal waters during their whole life. Under normal hydrological conditions, they do not make long migrations, but always remain near their reproducing grounds. For the winter they concentrate in areas with less reduced water temperatures, e.g., in the mouth of the rivers and in channels. Nonetheless the herring winter under severe hydrological conditions. In some regions where they winter the water temperature sinks to -1.0 and even to -1.5°.

Literature

1/ Ambroz, A. I.: Vostochno-Sakhalinskaya sel'd' raiona Nyisk-Chaivo.
/Eastern Sakhalin herring in the Nyisk-Chaivo region/
Soc. rekonstruktsiya rybnogo khozyaistva Dal'nego Vostoka. No. 5-7, 1931.
/Soc. reconstruction of fisheries in Far East/

2/ Brazhnikov, V. K.: Materialy po topografii i fizicheskoi geografii Nikolaevskogo rybopromyslovogo raiona. Rybnye promysly Dal'nego Vostoka. Part 2. S. Peterburg, 1904.
/Materials on topography and physical geography of the Nikolaevsk commercial fishing area/

3/ Vedenskii, A. P.: Sel'd' vostochnogo poberezh'ya Sakhalina
/Herring on the eastern coast of Sakhalin/
Izvestiya TINRO, (TINRO Journal, Vol. 32, 1950).

4/ Kozlov, B. M.: Biologiya i promysel navagi v severnoi chasti Tatarskogo proliva.
/Biology and fishing of Eleginus in the northern part of Tatar Strait/
Izvestiya TINRO, (TINRO Journal, Vol. 47, 1959).

5/ Kozlov, B. M., Shchelegova, E. K.: Usloviya, vliyayushchie na promysel v severnoi chasti Tatarskogo proliva.
/Conditions influencing fishing in northern part of Tatar Strait/
Rybnoe khozyaistvo, No. 7, 1961.

6/ Lubny-Gertsyk, E. A.: Sostav i raspredelenie zooplanktona Okhotskogo morya.
/Composition and distribution of the zooplankton in the Sea of Okhotsk/
Trudy instituta okeanografii, (Publications of the Institute of Oceanography, Vol. 30, 1959).

7/ Probatov, A. N., Frolov, A. I.: Sel'd' ozera Tonnai.
/Herring in Tonnai Lake/
Izvestiya TINRO, (TINRO Journal, Vol. 35, 1951).

8/ Probatov, A. N., Frolov, A. I.: K voprosu o proiskhozdenii sel'd' ozera Tunaicha.
/Origin of the herring in Tunaicha Lake/
Uchenye zapiski Rostovskogo-na-Dony Gosudarstvennogo universiteta. t.
/Scientific reports of the State University in Rostov-on-Don, Vol. 51, No. 6, 1958./

9/ Rumyantsev, A. I. Frolov, A. I. et al.: Migratsiya i raspredelenie sel'di v vodakh Sakhalina.
/Migration and distribution of herring in waters of Sakhalin/
VNIRO, 1958.

10/ Frolov, A. I.: O lokal'nykh stadakh Sakhalinskoi sel'di.
/Local shoals of Sakhalin herring/
Doklady Akademii Nauk (Reports of the Academy of Sciences, Vol. 69, No. 6, 1949.)

11/ Frolov, A. I.: O lokal'nykh formakh sakhalinskoi sel'di
/Local forms of the Sakhalin herring/
Izvestiya TINRO, (TINRO Journal, Vol. 32, 1950.)

12/ Frolov, A. I.: Novye raiony nagula sel'di v Okhotskom more
/New feeding areas for the herring in the Sea of Okhotsk/
Rybnoe khozyaistvo (Fisheries), No. 3, 1957.

13/ Frolov, A. I.: Morfologicheskaya kharakteristika sel'di vod Sakhalina.
/Morphological characteristics of herring in the waters of Sakhalin/
Izvestiya TINRO, (TINRO Journal, Vol. 55, 1964.)

14/ Shchelegova E. K.: Vliyanie yaponomorskikh vod na termicheskii rezhim i promysel sel'di u yugo-vostochnoi chasti berega Sakhalina. /Influence of the waters of the Sea of Japan on the thermal conditions and on the herring fishing off the southeastern coast of Sakhalin/ Byulleten' Tekhniko-ekonomicheskoi informatsii, No. 5. Sakhalinskoi sovnarkhoz, /Bulletin of Technico-economical Information No. 5. Council of National Economy in Sakhalin. Yuzhno-Sakhalinsk., 1958.

ЛИТЕРАТУРА

1 Амброз А. И. Восточно-Сахалинская сельдь района Ныйск—Чайво. Соц. реконструкция рыбного хозяйства Дальнего Востока, № 5—7, 1931.

2 Бражников В. К. Материалы по топографии и физической географии Николаевского рыбопромыслового района. Рыбные промыслы Дальнего Востока, ч. II, С.-Петербург. 1904.

3 Веденский А. П. Сельдь восточного побережья Сахалина. Известия ТИНРО, т. 32, 1950.

4 Козлов Б. М. Биология и промысел наваги в северной части Татарского пролива. Известия ТИНРО, т. 47, 1959.

5 Козлов Б. М., Шелегова Е. К. Условия, влияющие на промысел в северной части Татарского пролива. Рыбное хозяйство, № 7. 1961.

6 Лубны-Герцык Е. А. Состав и распределение зоопланктона Охотского моря. Труды института океанографии, т. 30. 1959.

7 Пробатов А. Н., Фролов А. И. Сельдь озера Тоннай. Известия ТИНРО, т. 35, 1951.

8 Пробатов А. Н., Фролов А. И. К вопросу о происхождении сельди озера Тунайча. Ученые записки Ростовского-на-Дону Государственного университета, т. 51, вып. 6, 1958.

9 Румянцев А. П., Фролов А. И., Дружинин А. Д., Козлов Б. М., Соколов В. А. Миграция и распределение сельди в водах Сахалина. Изд. «Рыбное хозяйство», ВНИРО, 1958.

10 Фролов А. И. О локальных стадах сахалинской сельди ДАН, т. 69, вып. 6, 1949

11 Фролов А. И. О локальных формах сахалинской сельди. Известия ТИНРО, т. 32. 1950.

12 Фролов А. И. Новые районы нагула сельди в Охотском море. Рыбное хозяйство. № 3, 1957.

13 Фролов А. И. Морфологическая характеристика сельди вод Сахалина Известия ТИНРО, т. 55, 1964.

14 Шелегова Е. К. Влияние япономорских вод на термический режим и промысел сельди у юго-восточной части берега Сахалина. Бюллетень Технико-экономической информации, № 5, Сахалинский совнархоз, Южно-Сахалинск, 1958.