Kamchatka Branch of FSBRI “VNIRO” (“KamchatNIRO”)

REPORT
ON RESEARCH AND SCIENTIFIC WORKS

Monitoring of pollock fishery in the northern part of the Sea of Okhotsk in January – first 10-day period of April 2019

Petropavlovsk-Kamchatsky, 2019

1. INTRODUCTION

Our research and scientific works were performed in January – April 2019 in the northern part of the Sea of Okhotsk within Kamchatka-Kuril, West Kamchatka and North Sea of Okhotsk subzones:

— onboard 4 catchers/processors (BATM *Polluks, Mikhail Staritsyn, Moscow Olympiad* and MRKTM *Boris Trofimenko*) engaged in target pollock and herring fishery using pelagic trawls;

— onboard the *Zaliv Vostok* factory mother ship receiving catches from STR-type vessels catching pollock by pelagic trawls;

— onboard the *Victor Gavrilov* factory mother ship receiving catches from STR-type vessels engaged on target pollock and by-caught species fishery using Danish seines;

— onboard the STR *Ogni* engaged in fishing for pollock and by-caught species using Danish seines off West Kamchatka.

Total number of KamchatNIRO observers was 7.

Details on vessel names, research team, duration of studies, number of analyzed fishing operations and volume of collected biological information are provided in Appendix 1 and a map of operations of vessels with scientific observers onboard is shown in Fig. 2.1.

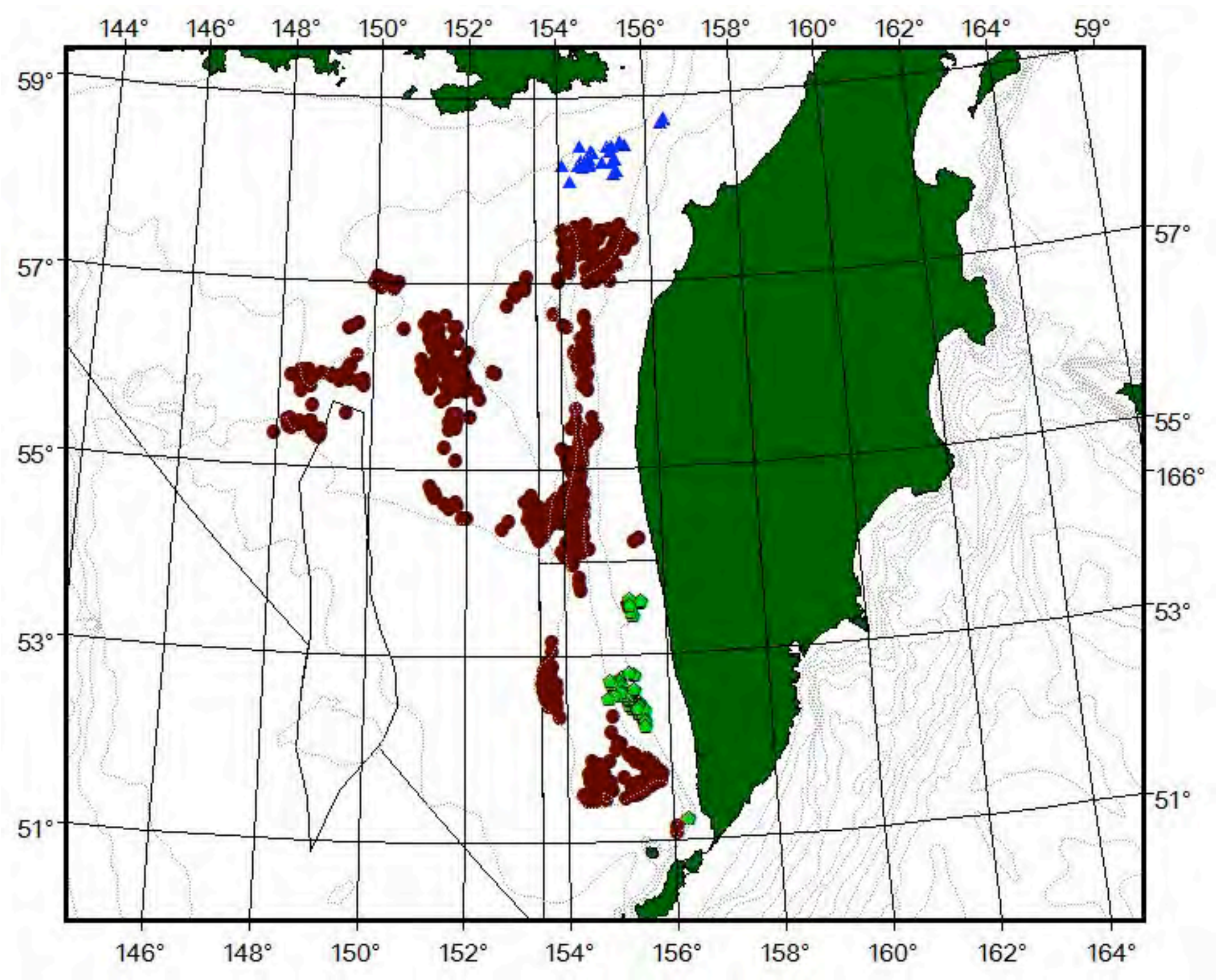

Figure 2.1. Coverage by observers in 2019 (Burgundy color circles – target pollock trawl fishery; blue triangles – target herring trawl fishery, green diamonds – pollock Danish seine fishery)

2. METHODS OF STUDY

All works completed by KamchatNIRO observers were performed in accordance with standard methods generally accepted for ichthyologic studies.

2.1. Assessment of catch size and species composition

2.1.1. Works onboard catchers/processors

The quantitative and species composition of catches was determined for at least one catch every day, with all fishing operations recorded (coordinates, catch, etc.).

Information about each fishing operation was entered into a fishing operation card and included coordinates, water depth and fishing operation depth, duration of operation, total catch, etc. Observers based on board ships identified fishing gear's full name, type and key parameters (vertical and horizontal opening distance, mesh size, etc.).

Total catch size was determined visually based on the volume it occupied in the receiving bin. To identify its species composition, we consecutively sampled approximately 300 individuals belonging to the target species (pollock, herring, etc.) and all by-caught species. Furthermore, we inspected the remaining catch to register species not included in this sample. Then we counted individuals of each species in the sample and determined the range of length variation and mean weight of one individual.

We identified species using various identification keys such as "Field Identification Key for Commercial and Mass Species in the Far Eastern Seas of Russia" (V.N. Tuponogov, L.S. Kodolov, 2014).

The species composition of catches was determined as follows:

1) we deducted total catch of individuals not covered by sampling from total catch weight;

2) then we expressed the species composition of our test sample in per cent by weight, i.e. determined the weight percentage of each species in the weight of the whole test sample;

3) as the weight of the remaining portion of catch was known (see paragraph 1 above), we determined the weight of each species in it in accordance with its share (in %) in the test sample.

4) quotient obtained through dividing the weight of harvested aquatic organisms by their mean weight is their total number expressed in individuals.

Upon completion of these calculations, which included but were not limited to variation of length, mean weight of individuals, catch in kilograms and in individuals, data on the species composition of catch were transferred from deck log to haul card. This card mandatorily specified the target species (or group of target species) of the fishing operation.

2.1.2. Works onboard factory mother ships

A focus of activities onboard mother factory ships was placed on collection of biostatistical data as observers had to deal with miscellaneous segregated catches generated in the course of several fishing operations performed by several ships.

Nonetheless, such data were also of much interest as they give an idea of the degree of selectivity of use of catches. That's why, same as onboard catchers/processors, observers determined a species composition of at least one catch every day in accordance with the above said method, with all catches subject to recording (coordinates, catch size, etc.).

All data were recorded in fishing operation cards. Vessel names and numbers of fishing operations were specified in a note. Subsequently, fishing areas were identified for each catching vessel using the IMS (Industry-specific Monitoring System).

2.2. Biological analysis

After determination of the species composition of the catch, observers performed biological analysis of mass commercial fishes.

Mass pollock measurements with dissection (MMD) were performed on 1–2 catches every day. Observers measured fish length by Smitt (from the tip of snout to the end of middle rays of the caudal fin, length spacing 1 cm, right boundary). Then fish was dissected and its sex and gonad maturity stage was identified. Gonad maturity stages for pollock, cod and saffron cod were determined as per field identification manuals developed by N.P. Sergeyeva and A.I. Varkentin (2015) and a standard 6-point scale was used for other fish species.

When measurements were made without dissection, only Smitt length was measured.

Full biological analysis (FBA) was performed on commercial fishes as well as on all rare and valuable species (halibuts, etc.). Analysis frequency rate was 30 to 50 individuals every day. Effort was taken to cover by analysis sufficient numbers both of most frequently occurring size groups and large-size individuals and particularly small-size individuals as well as separately females and males. The required number of tests is 10 females and 10 males per each 1 cm of the size distribution row in each fishing area (zone or subzone).

FBA included weight of the whole fish and fish without viscera, its length with an accuracy of 0.1 cm as per Smitt (from the tip of snout to the end of middle rays of the caudal fin, AC) and commercial length (from the tip of snout to the end of scales), weight of liver (for gadid fishes only) and gonads (with an accuracy of 1 g), determination of sex and gonad maturity stage for males and females, visual evaluation of stomach fullness in scores (0 to 4 on a 5-point scale) and food contents. Gonads and liver (for gadid fishes only) were weighed during FBA in addition to weighing of individuals.

Fish was weighed on a scale resistant to sea motions (manufactured by Marell).

To determine fish age, observers collected scales (from herring) or otoliths (from all other species). All data characterizing the biological condition of fish were entered into FBA log and such entry included date, coordinates, trawling number and depth. Numbering was continuous for each fish species.

Special analysis is a simplified variety of full biological analysis omitting some parameters and either including or not including sampling of structures characterizing age of fish. It was performed for some rare species (instead of FBA) or low-value commercial fishes (sculpins, rayfish, etc.). This analysis included measurement of Smitt length with an accuracy of up to 0.1 cm, whole fish weight, determination of sex and gonad maturity stage for males and females, with or without sampling of structures characterizing fish age.

2.3. Collection of information about by-catch and death of marine mammals

During all daytime operations, by-catch and death of marine mammals was registered where possible.

When fishing gear was hauled on board the ship, all captured marine mammals (live and dead) were counted, if any. Animal species was identified using one of the following identification manuals:

— A.Yu. Artyukhin, V.N. Burkanov. 1999. Marine birds and mammals of the Far East;

— V.V. Melnikov. 2001. Field identification key of marine mammals for Pacific waters of Russia;

— A.M. Burdin, O.A. Filatova, E. Khoyt. 2009. Marine mammals of Russia.

Observers determined the sex of animals and took pictures.

They watched the procedure of releasing all live marine mammals captured in fishing gear.

They stated in notes to daytime fishing operation cards whether marine mammal by-catch was registered or not.

If by-caught marine mammals were found, special registration cards were filled in (for live or dead animals).

2.4. Seabird by-catch recording

By-catch and death of seabirds was monitored during all daytime operations.

When fishing gear was hauled on board the ship, all captured seabirds (live and dead), if any, were counted, if any. Bird species was identified using such identification manuals as *A.Yu. Artyukhin, V.N. Burkanov. 1999. Marine Birds and Mammals of the Far East*. Observers took pictures.

Live birds were released.

If any bird tags were found, observers photographed them, registered their color, shape and number.

Observers stated in notes to daytime fishing operation cards whether seabird by-catch was registered or not.

If any birds were by-caught, observers filled in a special bird registration card.

2.5. Information and reporting

Every week (Monday by 10:00 a.m.), KamchatNIRO scientific observers sent their findings by electronic mail to the KamchatNIRO Institute and to the fishing area fleet commander – Omelchenko Yu.V. based on the RTMK-S *Vasily Kalenov*.

Their reports included the following information:

— operating area (coordinates, subzone, fishing depths);

— number of operations analyzed during reporting period and cumulative since year’s beginning;

— variation limits and mean pollock catch per unit effort (per haul and per 1 trawling hour);

— variation limits and mean pollock weight;

— relative ratio of pollock females (%);

— pollock size distribution (spaced at 1 cm) in individuals or per cent;

— ratio of gonad maturity stages for pollock females and males;

— number of analyzed individuals of each species and using each analysis method during reporting period and cumulative since year’s beginning (e.g.: MMD pollock 2000/15000, FBA 100/500, etc.).

If works were performed in different subzones during the same reporting period, findings were reported for each area separately. If mass measurements of other fish species were performed in the reporting period, their results were also included in reports.

Operational information received from observers was also forwarded to TINRO and used in analytical materials prepared for video conferences held by P.S. Savchuk, Federal Fishery Agency deputy director, every week on Tuesdays.

Either during voyage or immediately after completion of voyage, all collected information was entered into a dedicated database run by the Marine Commercial Fishes Laboratory. Upon return to port, all collected materials, pollock and by-catch species biological analysis logs and updated database were handed over to responsible persons in respective subdivisions.

3. VOLUME OF COLLECTED MATERIALS

Information about the volume of collected biological data broken down by analysis types, aquatic organism species and fishing areas is presented in Appendix 2.

In total, institute observers worked 555 days (534 in last year), analyzed 1,195 fishing operations (905 in last year), performed 98,396 biological tests of pollock (88,451 in last year) and 9,866 tests of other fish species (27,385 in last year), organized 701 stations for marine mammal and seabird by-catch recording (731 in last year).

4. KEY FINDINGS OF STUDIES

4.1. Results of remote (satellite) monitoring of meteorological, thermal and ice conditions in the northern part of the Sea of Okhotsk during winter-spring pollock fishing season in 2019

Effects of meteorological conditions on operations of the whole fleet, particularly medium- and small-tonnage vessels, are obvious. Frequent storms directly interfere with normal operations of vessels, lead to down time and affect fish distribution. In particular, search for fish aggregations after storms normally takes more effort.

Temperature conditions directly affect ice formation processes and, secondly, essentially affect formation of stable fishable aggregations, rate of gamete maturity and, consequently, roe yield and male-to-female ratio, and govern the start time of spawning season.

In 2019, meteorological conditions had less adverse effects on fishing conditions for pollock fishery in the northern part of the Sea of Okhotsk than in 2017–2018, when deep cyclones directly affected the Sea of Okhotsk basin and brought storm weather. There were relatively few such cyclones in 2019.

Ice conditions

The early winter season in December – mid-January in the northeast of the Sea of Okhotsk was characterized by normal rates of ice cover formation (Fig. 4.1.4). A very strong cyclone in the middle of January significantly slowed down this process, but from late January till early March ice cover continued growing even more intensively and through late March the amount of ice cover was remaining at a rather lengthy seasonal peak of its development exceeding its multi-year mean. In the first ten-day period of April, the square area of sea ice abruptly shrank due to persisting favorable meteorological conditions and intensively growing radiation heating of the surface.

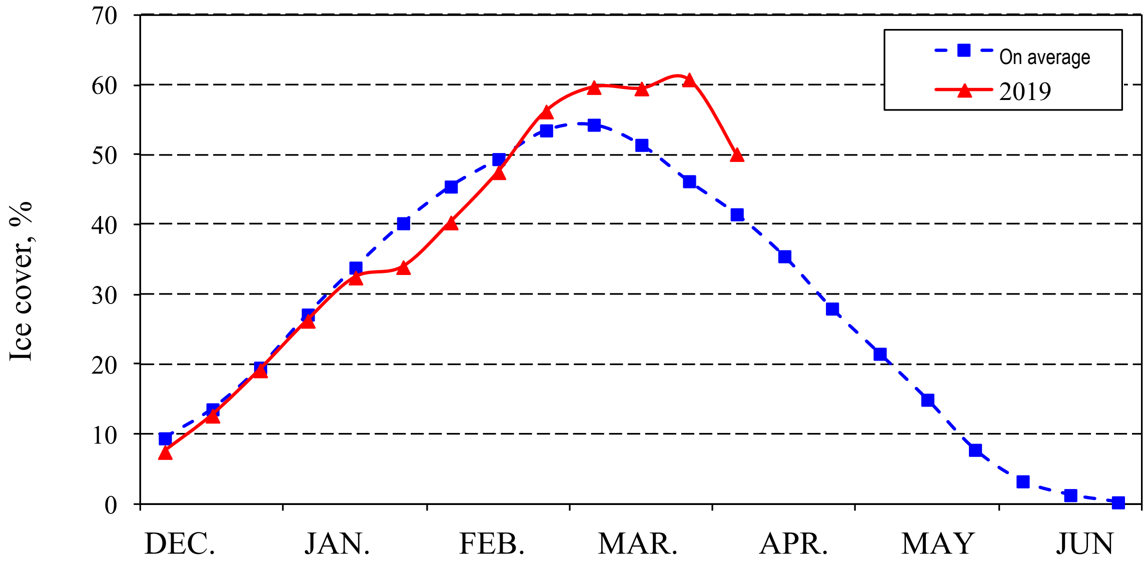

Fig. 4.1.4. Variation of the amount of ice cover in the northeastern part of the Sea of Okhotsk in winter of 2018–2019 and during 1995–2017 on average

In year-to-year terms, mean amount of ice cover during February – March (period of maximum ice cover development) was 54% which is generally consistent with the normal but noticeably higher in comparison with the 2017 and 2018 winters characterized by a small amount of ice cover and less than in the 2016 winter with a large amount of ice cover (Fig. 4.1.5).

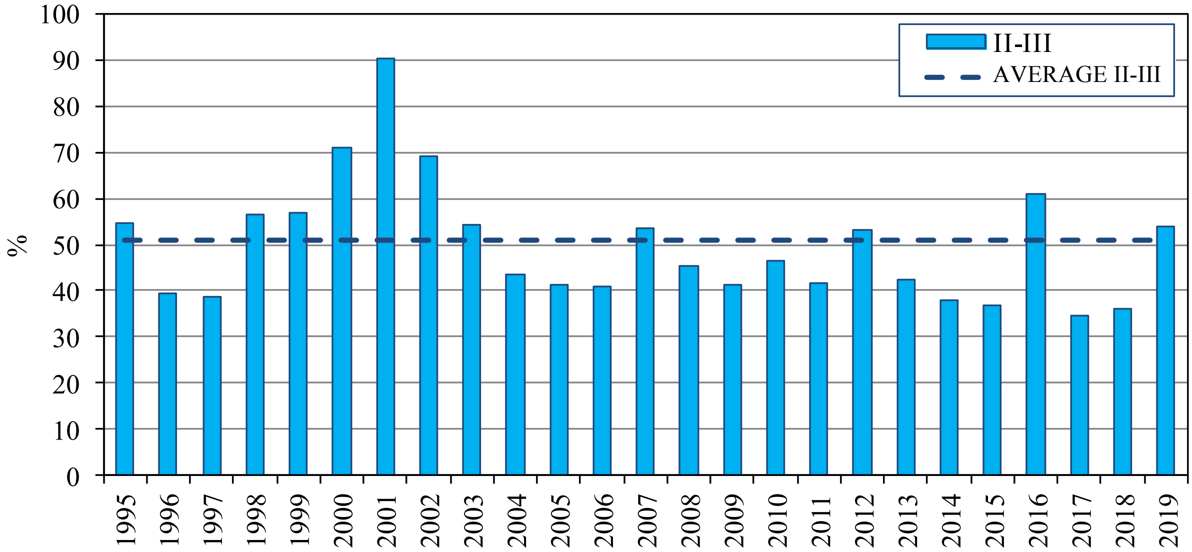

Fig. 4.1.5. Year-to-year variation of mean amount of ice cover in February–March in the northeastern part of the Sea of Okhotsk during 1995–2019

In summary, ice conditions during the pollock fishing season of 2019 had no critical effects on fishing conditions off West Kamchatka and, on the contrary, prevented effective performance of fleets, particularly medium-tonnage vessels, in some areas of the North Sea of Okhotsk subzone.

Thermal conditions

According to Figures 4.1.6–8 showing mean monthly fields of sea surface temperature (SST) and its anomalies (aSST), its maximum values in January – March were traditionally observed in a strip stretching in a meridional direction at some distance from West Kamchatka and associated with the area to which relatively warm transformed ocean waters, coming with the West Kamchatka Current, flow. Minimum SST values were registered near the shore along West Kamchatka and in the north and west of the area under consideration – in intensive ice formation areas. According to distribution of SST anomaly, it is obvious that water temperatures higher than normal prevailed in January and were localized more narrowly in areas with relatively warm waters of the West Kamchatka Current in February and March. This may be indicative of a higher intensity of the current versus its multi-year mean pattern.

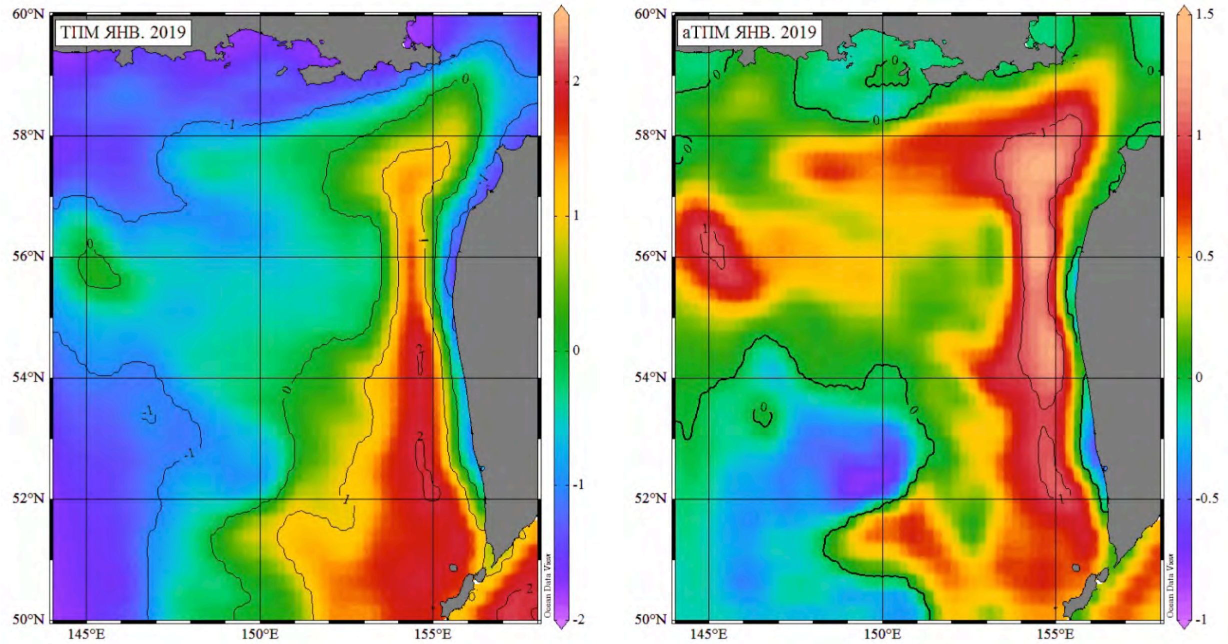

Fig. 4.1.6. Distribution of sea surface temperature (SST) and its anomaly (aSST) in the northeastern part of the Sea of Okhotsk in January 2019
ТПМ ЯНВ. = SST JAN.; аТПМ ЯНВ. = aSST JAN.

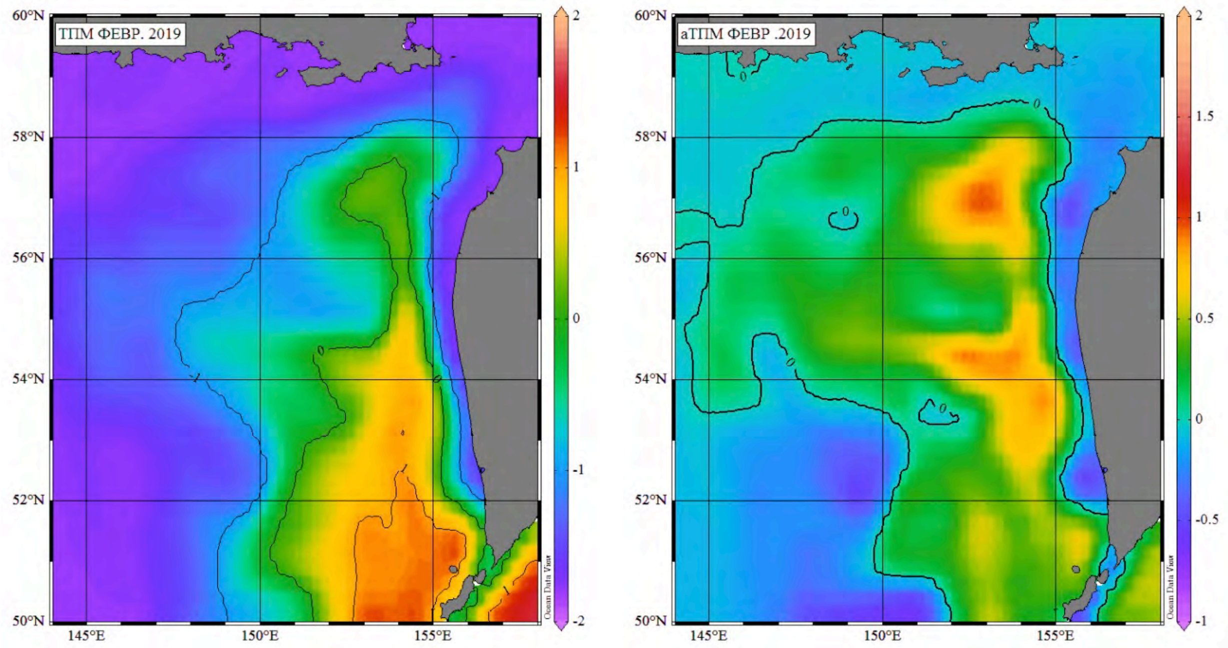

Fig. 4.1.7. Distribution of sea surface temperature (SST) and its anomaly (aSST) in the northeastern part of the Sea of Okhotsk in February 2019
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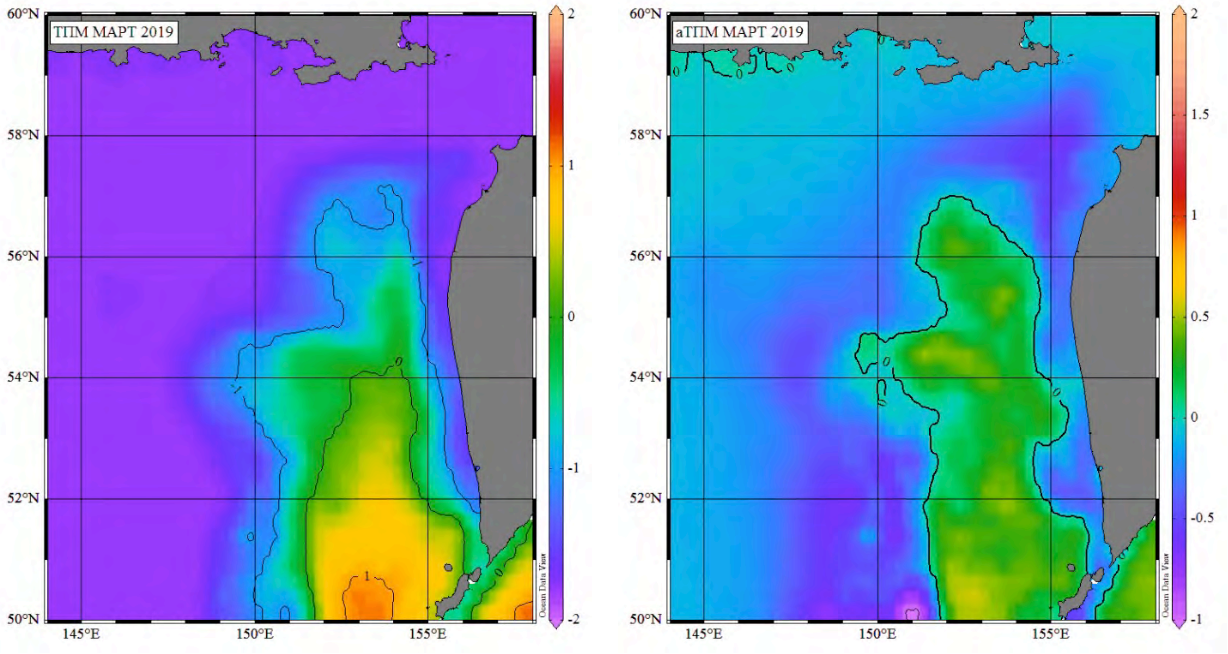


Fig. 4.1.8. Distribution of sea surface temperature (SST) and its anomaly (aSST) in the northeastern part of the Sea of Okhotsk in March 2019
ТПМ МАРТ = SST MARCH; aТПМ МАРТ = aSST MARCH

Surface temperature variability, averaged for the northeastern part of the Sea of Okhotsk, was characterized during the winter season by gradually decreasing values with a minimum in mid-March which is a normal pattern for the intra-seasonal dynamic of this hydrological parameter (Fig. 4.1.9). We would like to note, against the background of winter cooling down, some warming trends in the middle of January associated with a heat inflow coming with a strong southern cyclone. Temperatures were above normal during the greater portion of the period and a relatively cold period occurred in March. Early radiation heating of the surface began in early April which is seen from rapid growth of the SST anomaly to above-zero values.

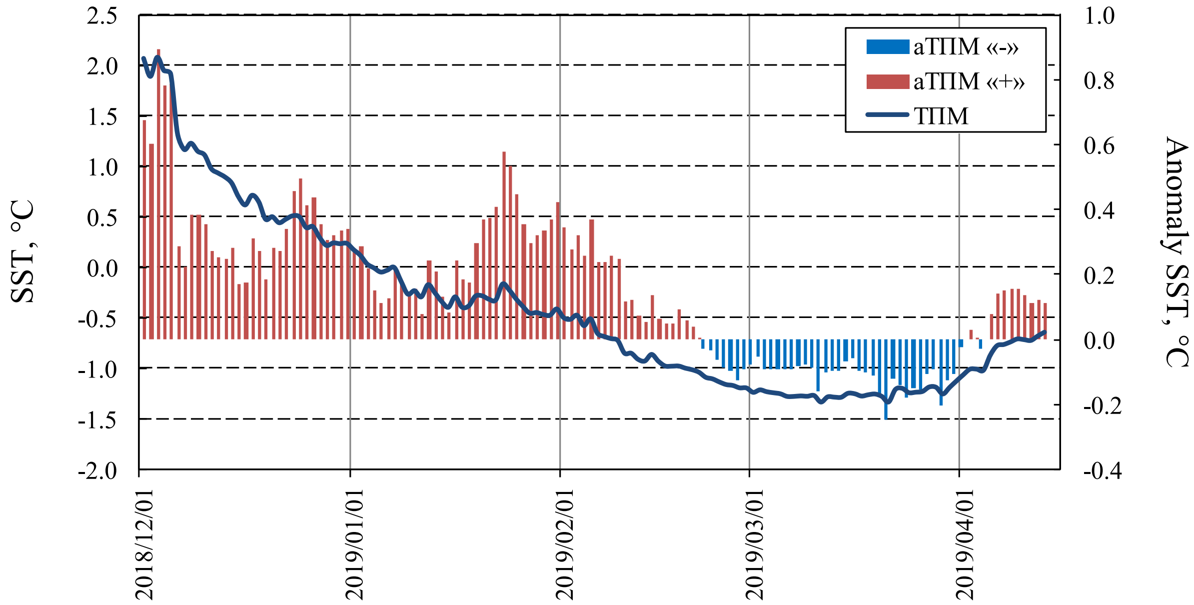


Fig. 4.19. Intra-seasonal variation of sea surface temperature (SST) and its anomaly (aSST) in the northeastern part of the Sea of Okhotsk during December 2018 – first ten-day period of April 2019

According to Fig. 4.1.10, the 2019 season was rather close to SST multi-year mean in terms of mean surface temperature in January – March, slightly exceeding it. Thus, its SST was –0.79°C versus its multi-year mean of –0.87°C. This is the second-highest value over the last five winters after 2015. If we consider a longer period, the winter of 2019 is comparable with the winters of 2006 and 2008.

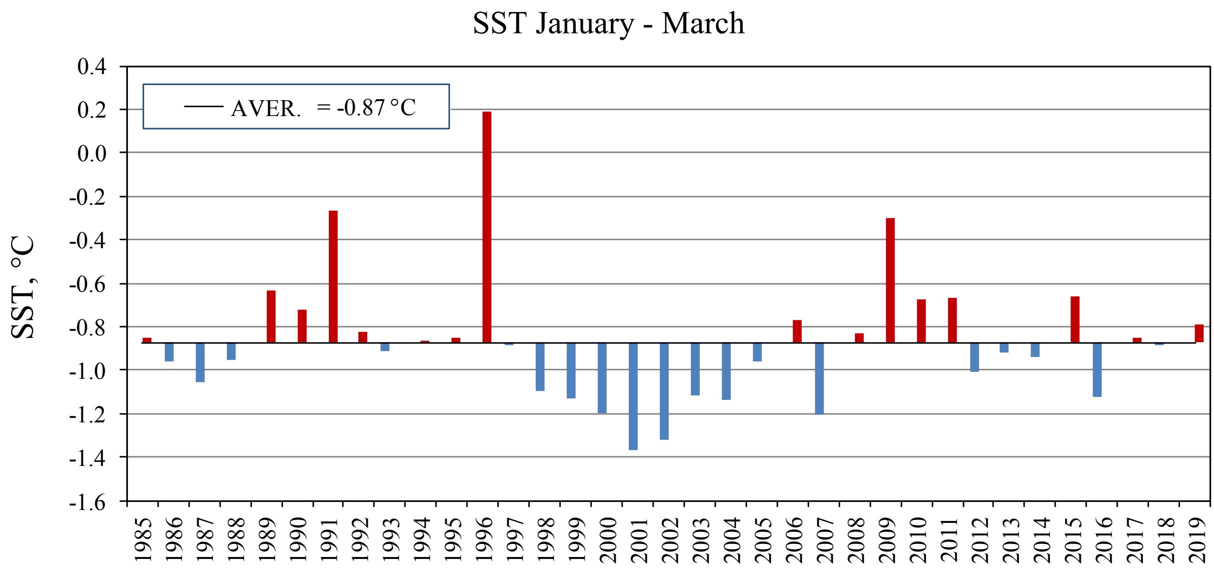


Fig. 4.1.10. Year-to-year variation of mean surface water temperature in January – March in the northeastern part of the Sea of Okhotsk in 1985–2019

4.2. A characteristic of pollock fishing season in 2019 versus 2018

In 2019, pollock TAC was **347.1 kt** in subzone 61.05.1, **347.1 kt** in subzone 61.05.2 and **269.8 kt** in subzone 61.05.4, which totals to **964.0 kt** for the northern part of the Sea of Okhotsk. Similarly to 2010–2018, quotas in subzones 61.05.2 and 61.05.4 in 2018 were combined in an aggregate TAC of **616.9 kt.**

With consideration for world prices for pollock products and as requested by fishing companies, the Industry Council for Commercial Fishing Forecasting under the Federal Fishery Agency continues setting the overall TAC for North Sea of Okhotsk pollock lower than its biologically justifiable value recommended by scientists and it has been remaining roughly at the same level of 966 kt since 2016.

Pollock catch by pelagic trawls in a commercial fishing mode in the RF EEZ (target fishery) by all vessels of the Sea of Okhotsk expedition totaled to about **817.2 kt** by April 10, 2019 (Table 4.2.1) which is more than a year before (788.2 kt). Another **23.8 kt** (36.6. kt in 2018) was produced by other fisheries, primarily the Danish seine fishery off West Kamchatka.

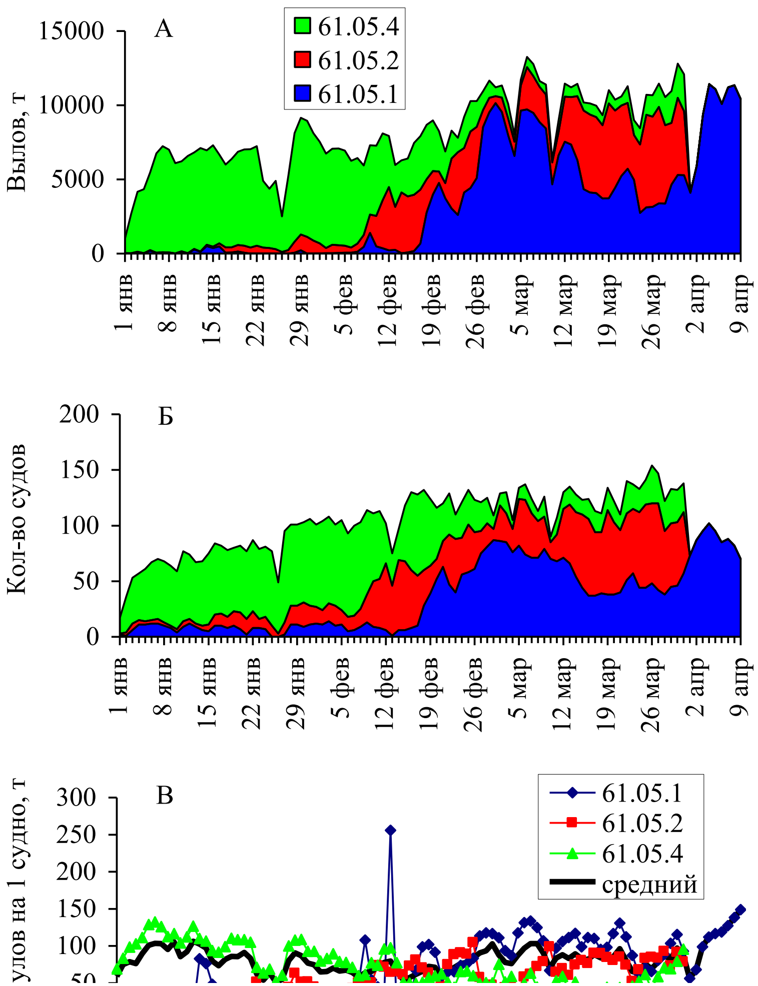
Total catch in combined subzones 61.05.2 and 61.05.4 in January – March 2019 was 524.0 kt or nearly 30 kt more than in the preceding year.

Total pollock catch in the Season A of 2019 was 841.1 kt (87.2% of TAC) compared with 824.8 kt (85.3% of TAC) during the same period in 2018.

Table 4.2.1 – Pollock TAC, yield and percentage of TAC use by fishing areas in the northern part of the Sea of Okhotsk in January – early April 2019

Subzone	TAC, kiloton	Ship-days in target trawl fishery	Number of hauls in target fishery	Total yield, kt		Percentage of TAC use by all fishing gear types since year's start, %
				trawls	all fishing gear types	
61.05.1	347.1	3069	8343	316,683	316,863	**91.3**
61.05.2	347.1	3112	7936	280,176	288,561	
61.05.4	269.8	3076	7824	220,362	235,628	**85.0**
Total	**964.0**	**9257**	**24103**	**817,221**	**841,052**	**87.2**

In January 2019, same as in 2018, pollock fishing activities were concentrated in Kamchatka-Kuril subzone (Fig. 4.2.1-2). Monthly catch in this subzone was about 130.6 kt (177.8 kt a year ago). Catch intensity in West Kamchatka and North Sea of Okhotsk subzones was low (0.7 and 26.0 kt respectively), with pollock harvested here as by-catch in herring and other fisheries. Total fleet number in all subzones was reaching 98 vessels with an average of 69. Last year's figures for the same period January were larger – 106 and 73 respectively. Mean catch per vessel was also lower than in January of 2018 – 72.4 tons versus 82.9 tons. The whole fleet's daily catch also differed. Is averaged at 5.2 kt in January 2019 and at 6.1 kt in January 2018. As a result, total pollock catch in the northern part of the Sea of Okhotsk in January 2019 was 157.3 kt versus 189.3 kt a year before. Therefore, yield was somewhat lagging behind the preceding year's yield already at the start of the fishing season.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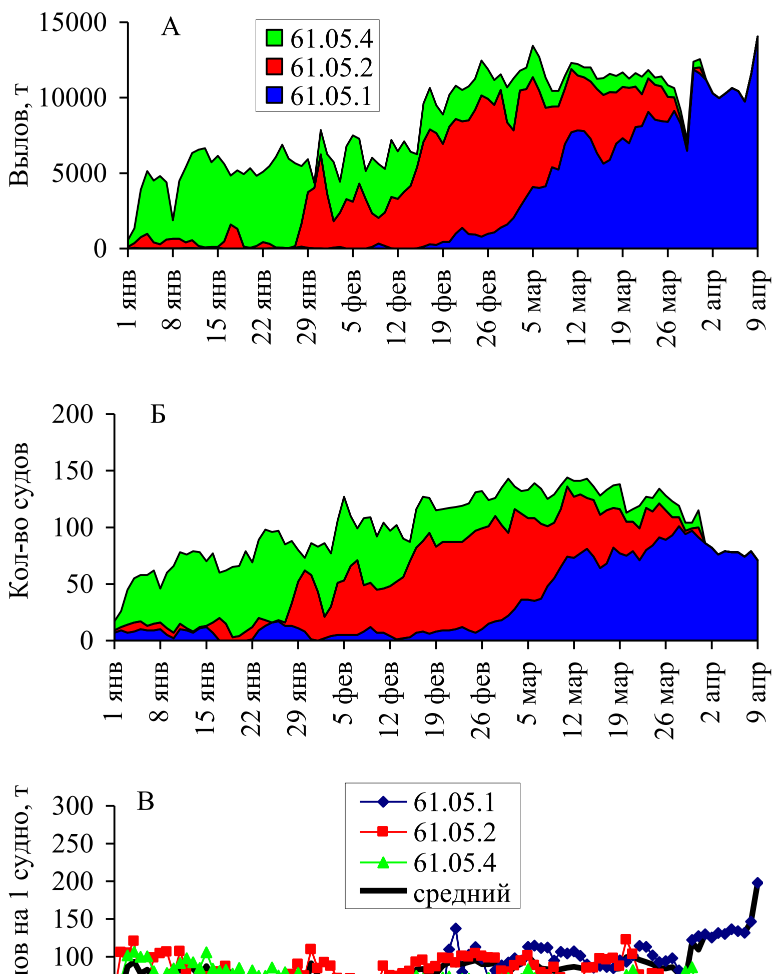
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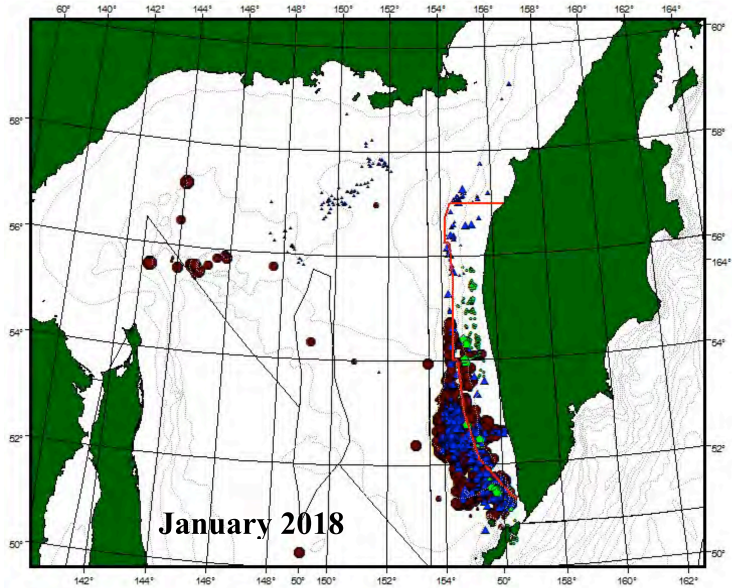
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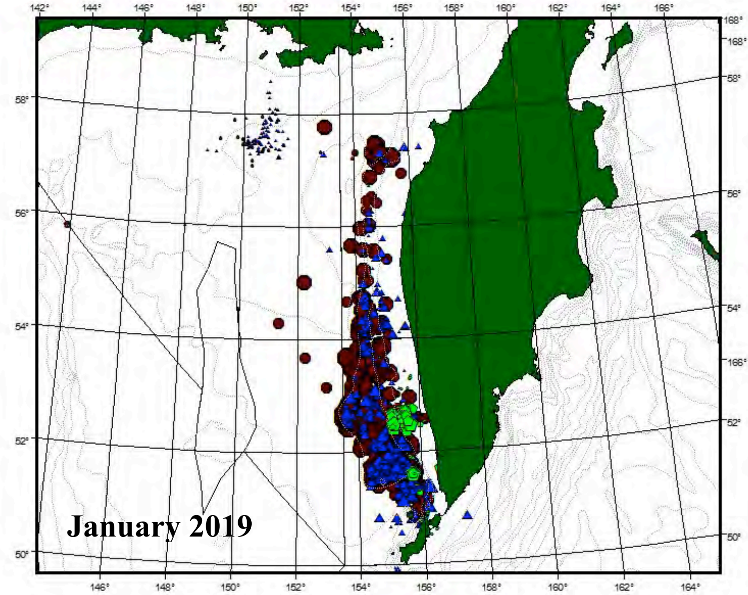
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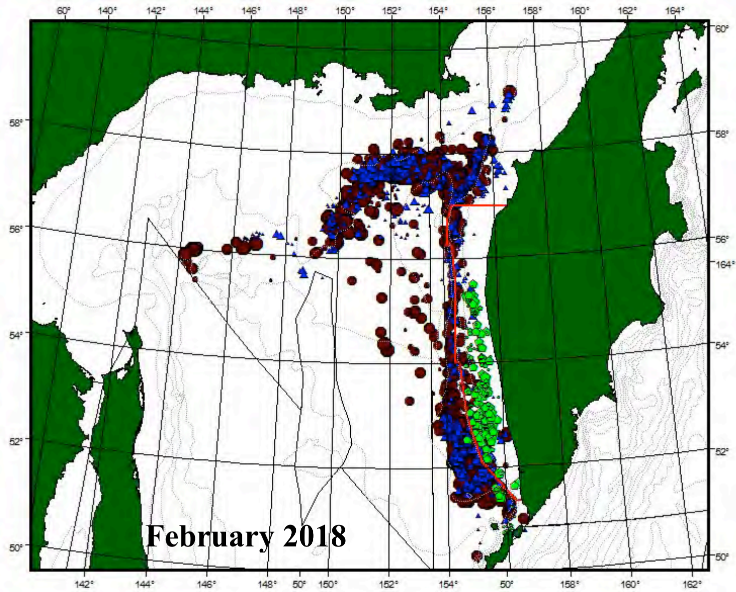
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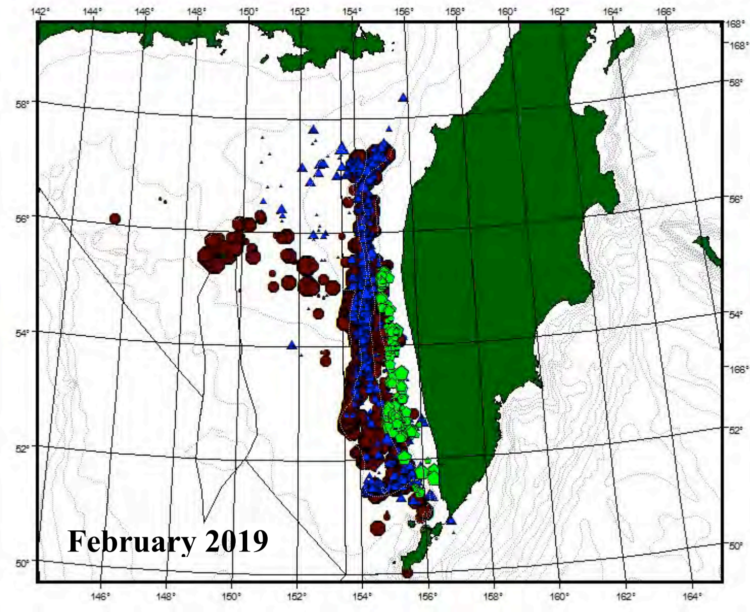
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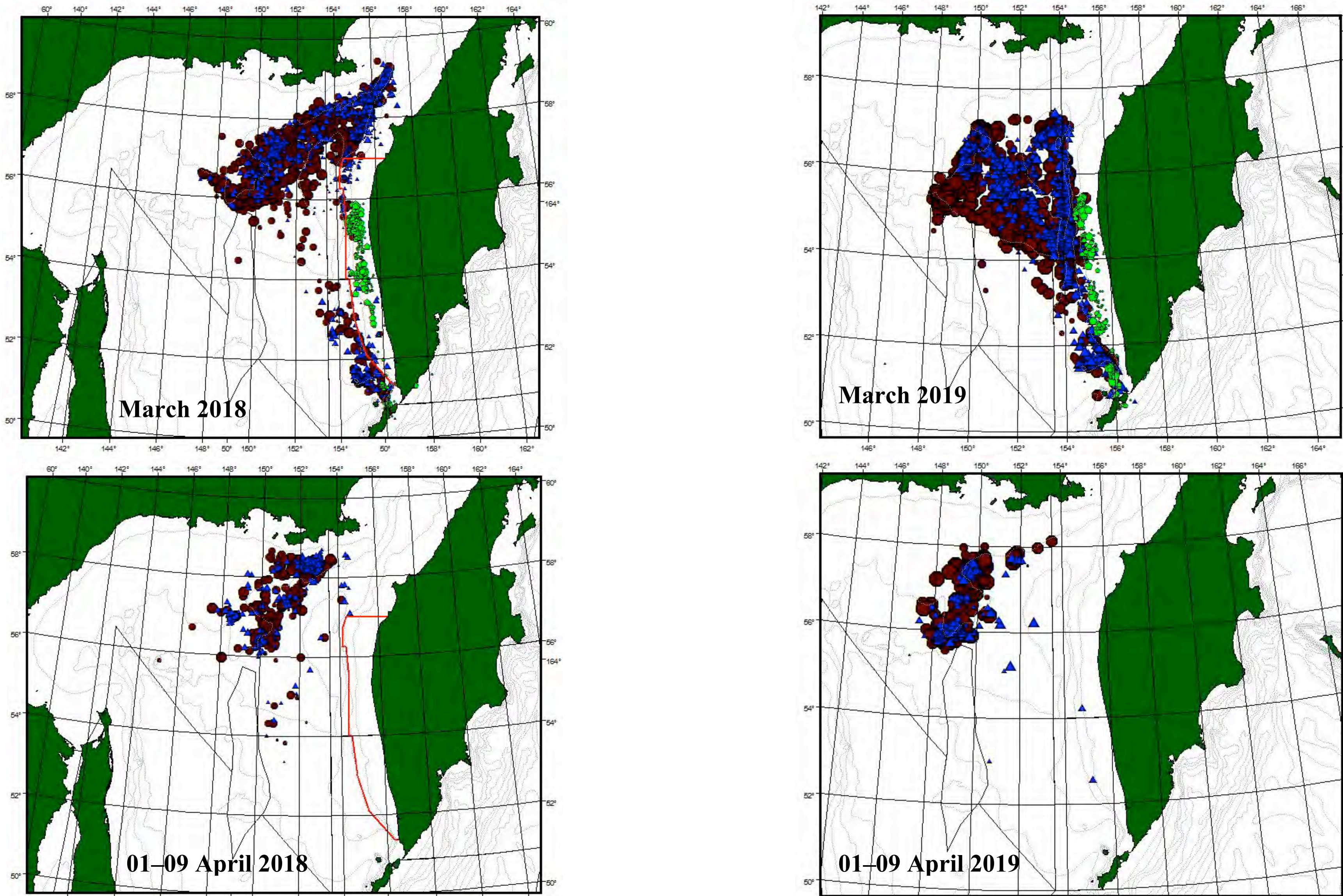

Fig. 4.2.2. Fleet distribution in the pollock fishery in the northern part of the Sea of Okhotsk in January – first 10-day period of April 2018 (left) and 2019 (right) (circles – large-tonnage fleet (trawls), blue triangles – medium-tonnage fleet (trawls), green rhombi – all ships (Danish seines))

In February, main pollock fishing gradually moved to West Kamchatka subzone (see Fig. 4.2.1–2). Monthly catch here was about 150.2 kt. For comparison, the bulk of catch in February 2018 was harvested in Kamchatka-Kuril subzone. It amounted to 104.0 kt in 2018 and only about 71.7 kt in February 2019. Up to 132 vessels of various types were operating in all three subzones, with an average number being 109. The last year's average was larger by 4 vessels. Mean catch per vessel was 74.7 tons in February 2019 and 69.7 tons in February 2018, with the whole fleet's total mean daily catch being 8.3 and 7.9 kt respectively. Total pollock catch in February was 232.7 kt which is more than in February 2018 (219.9 kt). Still, total cumulative catch since year's beginning remained almost 20 kt less than in the last year (389.9 kt and 409.2 kt respectively). As seen in Fig. 2, fleet distribution in February 2019 significantly differed from last year's distribution (see Fig. 4.2.2).

In March 2019, same as in 2018, pollock fishing activities were most intensive in North Sea of Okhotsk and West Kamchatka subzones (Fig. 4.2.1–2). Their catch was 207.1 kt and 112.4 kt respectively. For comparison, respective figures for last year's March were 184.2 kt and 115.6 kt. Monthly catch in Kamchatka-Kuril subzone was as low as about 33.4 kt in March 2019 and 30.6 kt in March 2018. The pollock fishing flotilla counted up to 144 vessels and averaged at 129 vessels. Last year's figures were 154 and 126 respectively. Mean catch per vessel was somewhat higher than a year ago and amounted to 88.3 tons (84.7 tons in 2018). As a result, total catch by the whole flotilla was 352.9 kt versus 330.4 kt in 2018. Similar to the preceding month, fleet locations were affected by ice conditions.

During 01–09 April 2019, pollock catch in the North Sea of Okhotsk subzone totaled 98.2 kt versus 84.9 kt in the last years (see Fig. 4.2.1–2).

In general, total daily pollock catch by all vessels in the northern part of the Sea of Okhotsk during the 2019 fishing season was gradually growing, as more catchers became engaged and more fishing operations were performed: from 0.6 kt in early January up to 6.6 kt in the middle of January (see Fig. 4.2.1). It remained roughly on the same level (about 5.9 kt) till mid-February. Then it abruptly rose to 10.6 kt and remained high till late March varying in the range of 7.2 to 13.4 kt and averaging at 11.2 kt. Largely due to a very high mean catch per vessel, the whole fleet's mean catch during April 01–09 remained at the level of 10.9 kt.

Mean daily catch over the fishing season was 8.5 kt while it was lower in the last year (8.3 kt).

4.3. Information about species composition and catches per unit effort (CPUE)

The species composition of trawl catches in the target pollock fishery in the northern part of the Sea of Okhotsk in January – first 10-day period of April included 43 fish species and 4 cephalopod mollusks (Appendix 3). Catches were absolutely dominated by pollock. Its catches were reaching 179.5 tons per haul

(82.2 tons on average) or 124.3 tons per one trawling hour (19.9 ton/hour on average). For comparison, last year's figures were 220 tons (61.6 tons on average) and 59.9 ton/trawling hour (12.2 tons on average) respectively. In weight terms, the percentage of pollock in some hauls reached 100% and generally averaged at 99.6%. The second-largest species in catches in occurrence terms was Pacific herring. Its catches reached 9.1 ton/haul (0.121 tons on average) or 2.7 ton/trawling hour (0.03 ton/trawling hour), with a maximum and mean percentage in catches being 7.0% and 0.14% respectively.

11 fish species and 1 squid species were found in catches in the target herring trawl fishery in the West Kamchatka subzone (Appendix 4). Herring catches were reaching 72 tons per haul (49.5 tons on average) or 32.7 and 19.8 tons respectively when converted to one trawling hour. The percentage of herring in catches was reaching 99.2% and averaged at 84.8%. Pollock was a by-catch species. Its catches varied in the range of 44.8 to 21.0 tons per haul (6.8 tons on average) or 0.18 to 14.00 tons/trawling hour (3.5 tons on average). Its mean percentage in catches was 15.2% in weight terms.

The averaged species composition in the Danish seine fishery off West Kamchatka included 28 fish species and 6 invertebrate species (Appendix 5). Pollock was dominating with its catches being up to 96.4 tons per seine shoot (=CPUE) or 17.9 tons on average. Pollock percentage in catches was reaching 93.8% and averaged at 50.8%. Considerable catches were registered for saffron cod, yellow-fin sole and cod.

4.4. Data on key biological parameters of pollock and by-catch species

As of this writing, information collected by scientific observers in the northern part of the Sea of Okhotsk during the 2019 fishing season is being processed. In addition, it is planned that primary data will be traditionally shared with other Far Eastern fishery research institutes. Brief information presented below is based on research findings obtained by KamchatNIRO observers only.

Fish length in the target pollock trawl fishery in January 2019 in Kamchatka-Kuril sub-zone – key fishing area in that month – varied from 23 to 71 cm and individuals of 41–45 cm size groups dominated (47.9%) (Fig. 4.4.1). The percentage of individuals shorter than the commercial length of 35 cm (37 cm according to Smitt) was low and averaged at 3.4%.

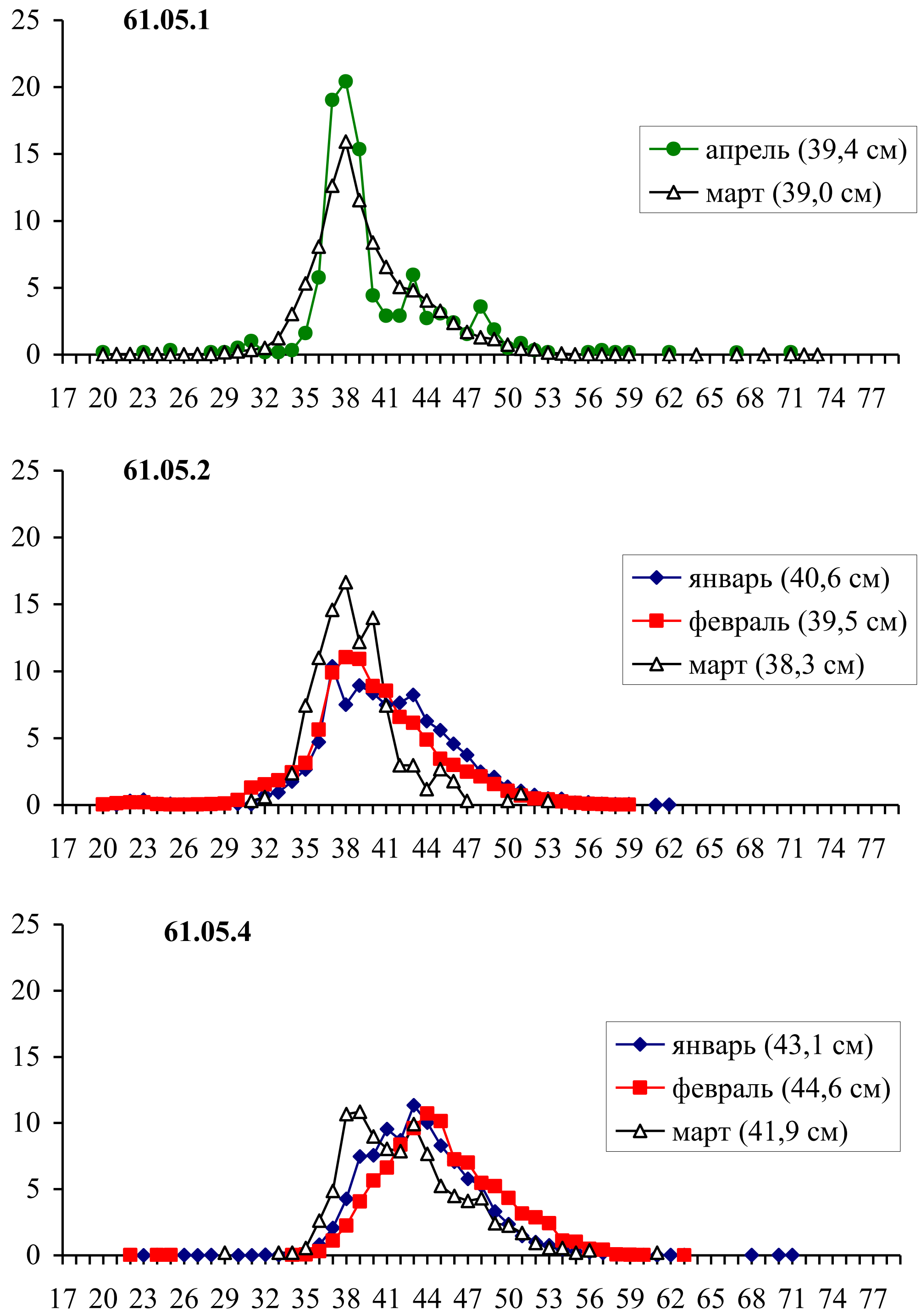

Fig. 4.4.1. Pollock size distribution in commercial trawl catches in January – first 10-day period of April 2019 in the northern part of the Sea of Okhotsk

Fish length in West Kamchatka subzone in January varied in the range of 21 to 62 cm, the bulk of catches being individuals 37–42 cm long (50.3%). The percentage of juveniles averaged at 22.3%.

One month later, pollock size distribution in trawl catches did not show any significant change in subzone 61.05.4. The bulk of catches was composed of individuals 42–45 cm long (39.8%). The by-catch of juveniles averaged at 1.1%.

As for subzone 61.05.2, its size distribution also changed insignificantly in this month compared with January. The bulk of catches was composed of individuals 37–41 cm long (49.3%). The by-catch of juveniles reached up to 80% in individual hauls and averaged at 27.1%. Virtually no changes were registered for pollock size distribution in subzone 61.05.4.

In March, pollock size distribution in trawl catches somewhat changed in Kamchatka-Kuril subzone compared with the preceding months. More juveniles appeared in catches. The bulk of catches was composed of individuals 38–43 cm size groups (56.4%). The by-catch of under-size pollock grew to 8.6%.

Individuals 36–40 cm long dominated in catches in West Kamchatka subzone in March (68.5%) and mean by-catch of juveniles was 36.3%.

A similar size distribution pattern was observed in the North Sea of Okhotsk subzone. Individuals 36–40 cm long dominated (56.6%) and mean by-catch of under-size fish was 31.9%.

In April, pollock size distribution in catches showed virtually no change in subzone 61.05.1. Mean by-catch of juveniles was 29.6%.

Pollock size distribution in Danish seine catches off West Kamchatka did not undergo any significant change in January – February. The bulk of catches was composed of individuals 41–46 cm long (55.6%) (Fig. 4.4.2).

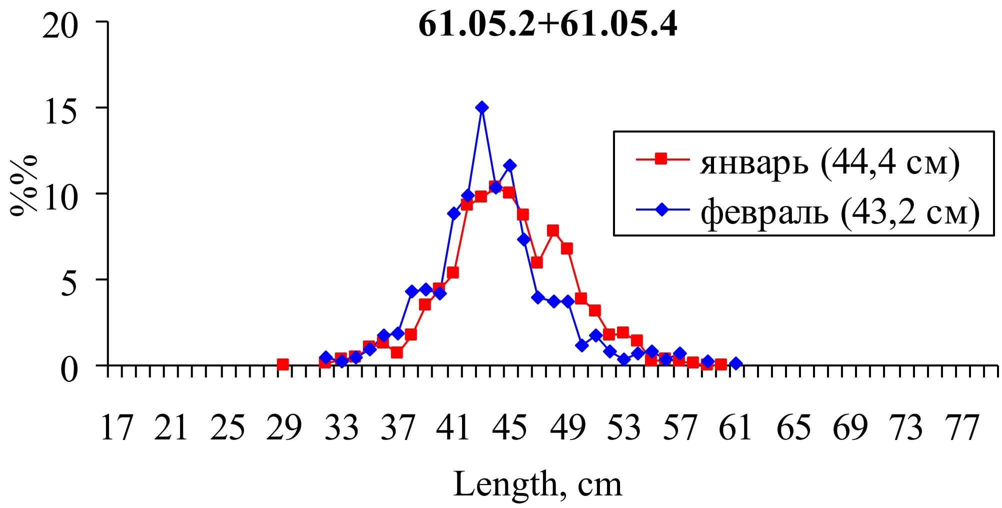

Fig. 4.4.2. Pollock size distribution in commercial Danish seine catches in January – February 2019 in the northern part of the Sea of Okhotsk

In summary, fishing conditions in the northern part of the Sea of Okhotsk were unfavorable in terms of qualitative composition of pollock catches in some areas of sub-zones 61.05.1 and 61.05.2.

The reason for increased by-catches of under-size pollock in this year is presence in recruitment of medium-strength year-classes of 2016–2014 with lengths of 20–38 cm, unusually widely distributed in the northeastern part of the Sea of Okhotsk due to this year’s hydrological and thermal specific features. Furthermore, the strong year-class of 2013 has fully joined the fishable stock this year. A portion of individuals belonging to this year class are under commercial size.

As for the timing of pollock spawning activities in 2019, it can be concluded, based on the dynamic of gonad maturation, that it was close to its multi-year mean, i.e. late March – early April.

By observers’ data, during the target herring fishery in April in West Kamchatka subzone, pollock occurred as by-catch. Fish length varied from 29 cm to 69 cm, with size groups of 38–41 cm dominating (55.2%) (Fig. 4.3.3).

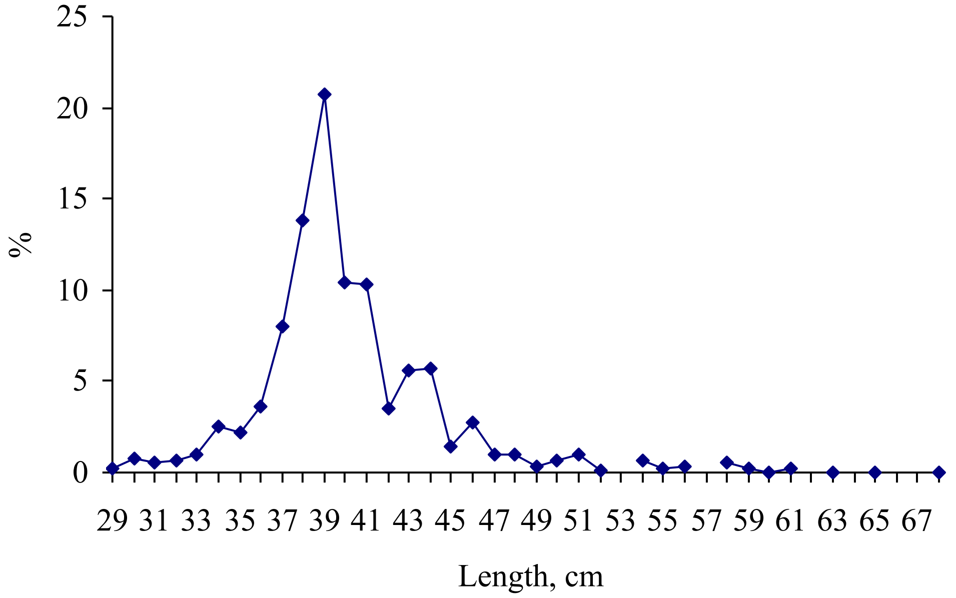

Fig. 4.3.3 Size distribution of pollock by-caught in the target herring fishery in West Kamchatka subzone in April 2019

Herring length during its target fishing in West Kamchatka subzone in April varied from 21 to 34 cm, with individuals of size groups 26–27 cm dominating (45.2%) (Fig. 4.3.4).

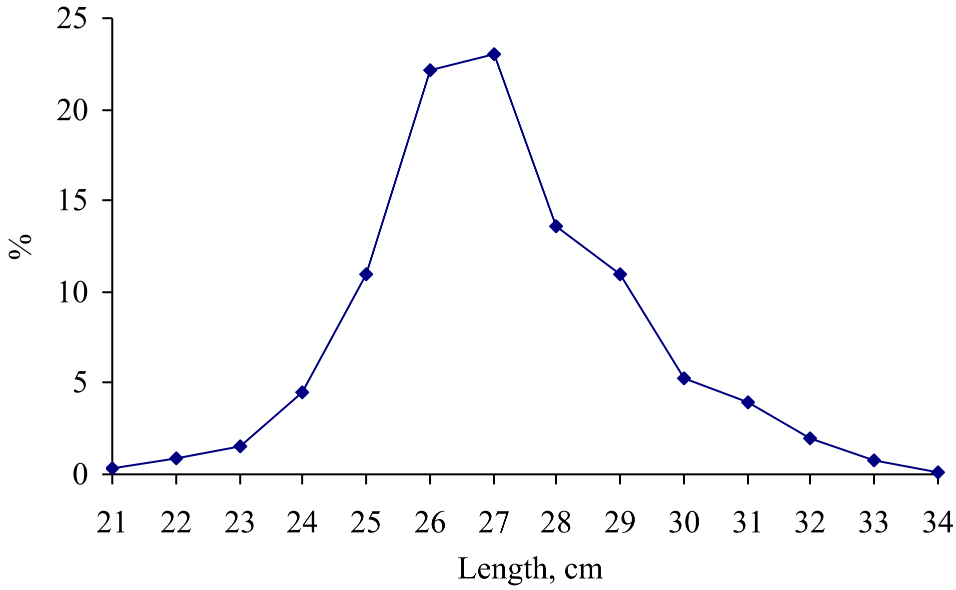

Fig. 4.3.4 Herring size distribution in commercial catches in West Kamchatka subzone in April 2019

Biological information about other commercial fish species is presented in respective voyage reports prepared by observers.

4.5. Information about marine mammal and seabird by-catch

No by-catch of seabirds and marine mammals was registered by observers during the fishing period.

4.6. Brief characteristic of the current state of North Sea of Okhotsk pollock stock

According to results of studies performed in 2018, the majority of indices declined from 2017. In particular, GLM-standardized CPUEi index somewhat reduced (Fig. 4.6.2). As seen on the same figure, its reduction discontinued in 2019 and it was roughly equal to its value in 2018.

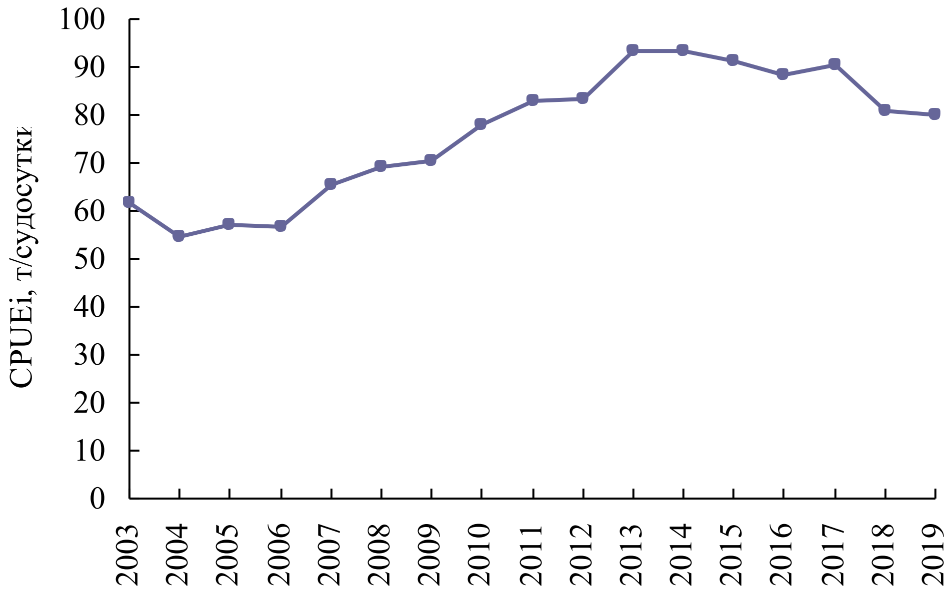

Fig. 4.6.2. Year-to-year dynamic of GLM-standardized catches per unit effort in the target pollock trawl fishery in the northern part of the Sea of Okhotsk

Some reduction of the North Sea of Okhotsk pollock stock was also registered by results of TINRO's count surveys (Table 4.6.1). New data on its stock condition will be obtained in the nearest future.

Table 4.6.1. Year-to-year dynamic of the total stock of North Sea of Okhotsk pollock based on three methods, spring of 2013–2018

Methods	Year	West Kamchatka		Shelikhov Bay		North Sea of Okhotsk		East Sakhalin		Total	
		mn of indiv.	kiloton	mn of indiv.	kiloton	mn of indiv.	kiloton	mn of indiv.	kiloton	mn of indiv.	kiloton
Ichthyo-planktonic	2013	9760	2861	2479	1134	12283	3945	230	80	24752	8019
	2014	12214	3404	2498	745	25506	4010	1829	644	42047	8803
	2015	9696	3113	88	17	16501	4926	543	241	26828	8296
	2016	9184	2452	1133	122	18289	4289	3644	891	32250	7754
	2017	10758	3549	1903	536	38662	8998	1409	373	52732	13456
	2018	12448	3979	2089	526	31473	6625	306	89	46316	11219
Trawling	2013	9016	2824	1985	842	13244	3843	1528	544	25773	8053
	2014	18284	5718	2119	437	38662	6144	2270	778	61295	13077
	2015	16814	5263	598	134	23987	5730	1761	738	43161	11864
	2016	16864	4678	5414	594	23400	5668	504	119	46181	11059
	2017	18246	5284	865	285	34876	6715	1735	417	55722	12701
	2018	17993	5914	980	265	28550	5392	-	-	47524	11571
Acoustic	2013	8989	3839	3114	1291	11634	3840	1414	507	25150	9477
	2014	7548	3112	3828	1131	21696	3382	1039	419	34111	8044
	2015	8647	2919	614	231	14544	4598	1338	590	25143	8338
	2016	9560	3012	3469	349	16244	3946	1007	292	30280	7599
	2017	8767	2941	1231	322	24884	4900	1631	699	36513	8862
	2018	9285	3274	1715	608	19218	3831	-	-	30218	7713

We would like to emphasize that all indices used in model-based calculations apply only to the current stock condition but not to forecasted one.

According to results of model-based calculations, total stock biomass of North Sea of Okhotsk pollock as of early 2018 was 9.65 million tons and its spawning stock biomass was 6.16 million tons which is somewhat less than a year before (9.92 and 6.39 million tons respectively) (Fig. 4.6.3). Therefore, the model adequately "reacted" to decreased indices. A short-time small reduction of the stock in 2018 is explained by withdrawal of the strong 2011 year-class while pollock belonging to other strong cohort of 2013 just started actively joining the fishable and spawning stock.

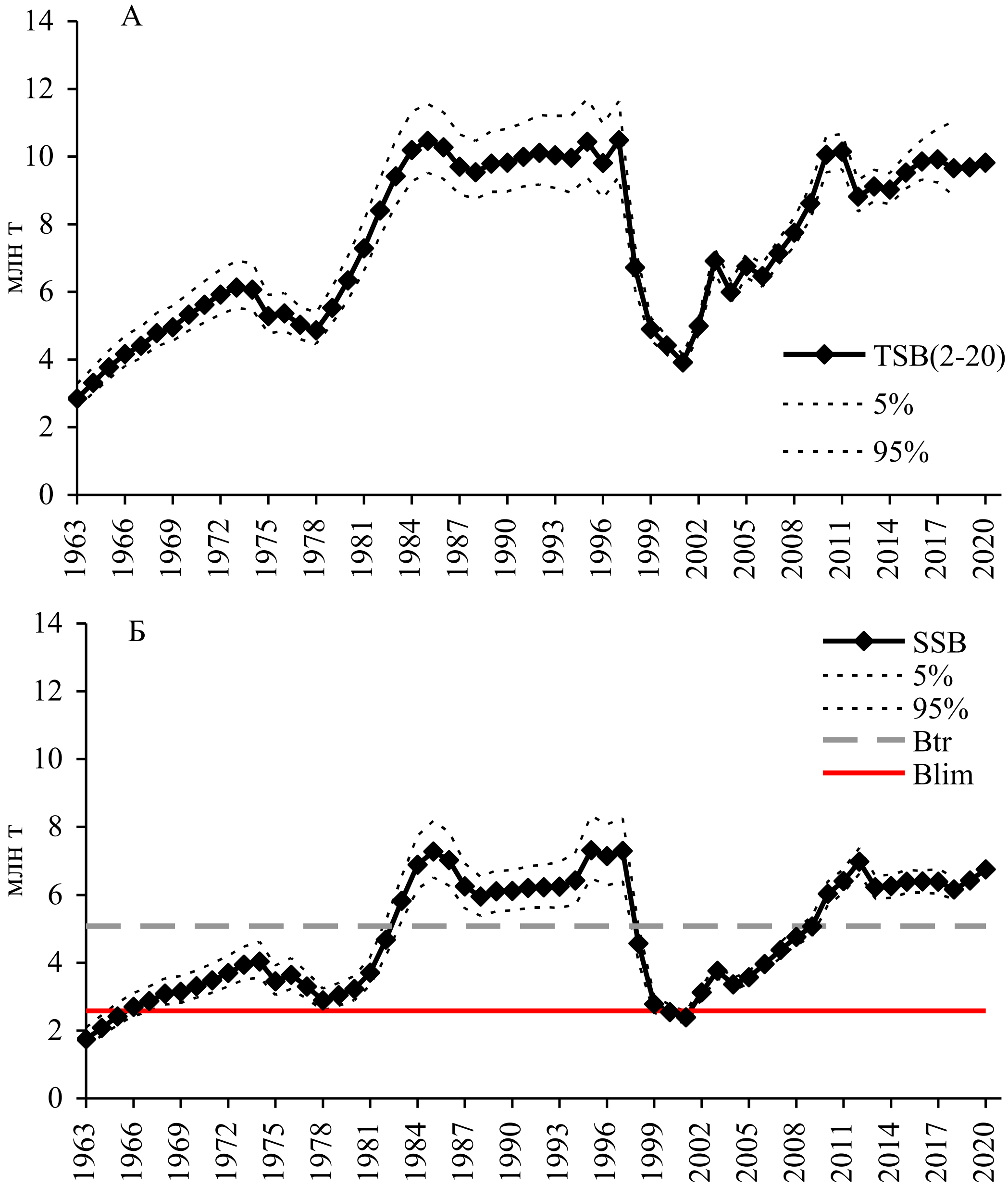

Fig. 4.6.2. Year-to-year dynamic of total (А) and spawning (Б) stock biomass of North Sea of Okhotsk pollock, percentile bootstrap

For forecasting purposes, of primary importance are data on qualitative composition of catches in the terminal year and recruitment forecast. Data on age composition of catches and age structure of the stock based on trawling survey data are indicative of rather high abundance of the 2014 year-class comparable with the 2013 year-class in abundance terms (Fig. 4.6.3). Furthermore, the next year-classes of 2015–2016 are assessed as medium-strength. All these facts allow for an optimistic outlook at the stock condition of North Sea of Okhotsk pollock in the nearest future.

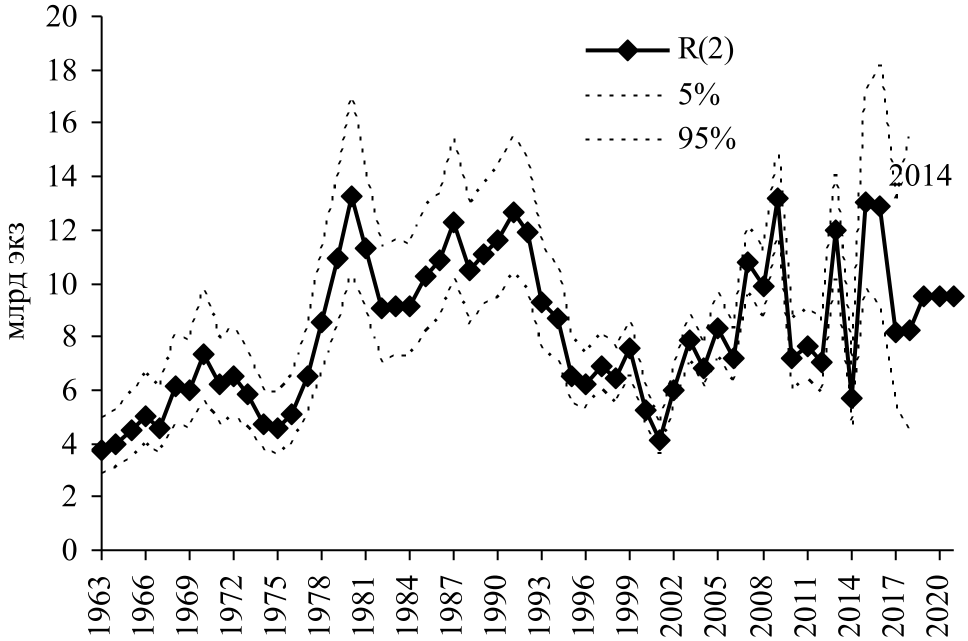

Fig. 4.6.3. Year-to-year dynamic of recruitment abundance and its percentile bootstrap

According to our forecasts, we assume that recruitment (2-year-old individuals) will be some 9.5 billion individuals and pollock stock will be growing. As of early 2020, total and spawning stock biomass will be 9.82 and 6.75 million tons respectively.

The 2019 fishing season basically confirmed our assumptions. Total pollock catch in the Season A of 2019 was 841.1 kt (87.2% of TAC) compared with 824.8 kt (85.3% of TAC) in the preceding year. Mean catch per vessel in January – early April was 84.2 tons compared with 82.2 tons during the same period a year before.

According the Harvest Control Rule (HCR), total pollock catch in the northern part of the Sea of Okhotsk in 2020 may be 1,232.4 kt. Given some uncertainty regarding recruitment of 2015–2016, specialists recommended to set the TAC value for 2020 at the level of the lower limit bottom of 95% confidence interval of potential yield, i.e. 1,064.0 kt.

Appendix 1

Information on monitoring activities performed by KamchatNIRO observers on SOO pollock fisheries during January-April 2019

Observer's name	Vessel	Fishing company	Period	No of vessel days	No of inspected trawls	Pollock biological analysis	Biological analysis of other species	Observation stations on sea birds and mammals
Mikhalytin	BATM «Mikhain Staritsyn» (trawl)	Fishing Kolkhoz Lenina	01.01–20.04.2019	109	285	18360	3418	145
Blokhin	MRKTM «Boris Trofimenko» (trawl)	Akros	17.12.2018–22.05.2019	127	301	27499	3889	153
Subbotin	BATM «Moskovskaya Olimpiada» (trawl)	Okeanrybflot	27.12.2018-20.04.2019	115	207	17594	132	147
Korobov	mothersihp «Zaliv Vostok» (trawl)	Fishing Kolkhoz Novyi Mir	23.01–10.04.2019	78	204	15731	251	89
Spirin	BATM «Polluks» (trawl)	Okeanrybflot	09.01–08.03.2019	59	131	16729	–	72
Kolybin	mothership «Victor Gavrilov» (Danish Seiner)	Fishing Kolkhoz Lenina	22.02–31.03.2019	38	41	1011	1939	52
Kalugin	STR «Ogni» (Danish seiner)	Kamchattralflot Ltd.	17.02–17.03.2019	29	22	1472	237	43
			TOTAL	**555**	**1191**	**98396**	**9866**	**701**

Appendix 2

Amount of collected biological information by KamchatNIRO observers during SOO pollock fisheries in January-April 2019

Specie	Subzone 61051	Subzone 61052	Subzone 61054	Total
Measuring				
Clupea pallasii	1409	5335		6744
Eleginus gracilis			1189	1189
Gadus macrocephalus				0
Gymnocanthus detrisus			52	52
Lepidopsetta polyxystra				0
Limanda aspera			681	681
Limanda sakhalinensis			188	188
Platichthys stellatus				0
Pleuronectes quadrituberculatus			23	23
Sebastes glaucus			6	6
Theragra chalcogramma	25832	30993	34881	91706
Subtotal	**27241**	**36328**	**37020**	**100589**
Full biological analysis				
Albatrossia pectoralis			8	8
Atheresthes evermanni			3	3
Clupea pallasii	155	650		805
Gadus macrocephalus		18	17	35
Glyptocephalus stelleri		3	2	5
Gymnocanthus detrisus				0
Hemilepidotus gilberti			3	3
Hemilepidotus jordani				0
Hippoglossoides elassodon	6	21	48	75
Laemonema longipes			1	1
Lepidopsetta polyxystra			18	18
Myoxocephalus polyacanthocephalus			2	2
Reinhardtius hippoglossoides matsuurae	1	2	14	17
Sebastes glaucus		6	1	7
Sebastolobus alascanus		1		1
Sebastolobus macrochir			3	3
Theragra chalcogramma	1914	2314	2462	6690
Subtotal	**2076**	**3015**	**2582**	**7673**
Grand total	**29317**	**39343**	**39602**	**108262**

Appendix 3

Average catch composition during mid-water trawl pollock fishery in the SOO in January-April 2019 (on data collected by KamchatNIRO observers)

Specie	Lenght, sm		Average mass, kg			Catch per operation, kg			CPUE, kg/effort			Share in catch by weight, %		
	min	max	min	max	av	min	max	av	min	max	av	min	max	av
Bathyraja maculata	97	97	3,450	3,450	3,450	0	20,700	0,167	0	3,450	3,450	0,03	0,03	0,02
Clupea pallasii	16	34	0,060	0,274	0,182	0	9100,000	121,392	0	2373,913	28,150	0,01	7,00	0,14
Alepisaurus ferox	128	128	6,522	6,522	6,522	0	6,522	0,053	0	6,522	6,522	0,02	0,02	0,03
Albatrossia pectoralis	45	57	0,292	0,475	0,354	0	9,500	0,159	0	1,947	0,354	0,00	0,04	0,00
Coryphaenoides cinereus	42	56	0,221	0,390	0,306	0	3,315	0,039	0	0,603	0,306	0,00	0,01	0,00
Laemonema longipes	28	28	0,075	0,075	0,075	0	0,375	0,003	0	0,083	0,075	0,00	0,00	0,00
Gadus macrocephalus	40	68	0,900	3,825	2,324	0	58,050	1,824	0	17,963	2,324	0,02	0,10	0,01
Theragra chalcogramma	**20**	**73**	**0,258**	**0,673**	**0,476**	**19860,4150**	**179589,060**	**82237,224**	**3572,9292**	**124285,719**	**19852,038**	**92,97**	**100,00**	**99,61**
Sebastolobus macrochir	33	37	0,725	0,895	0,800	0	8,700	0,145	0	2,373	0,800	0,01	0,01	0,00
Sebastolobus alascanus	25	25	0,175	0,175	0,175	0	1,750	0,014	0	0,226	0,175	0,00	0,00	0,00
Sebastes glaucus	24	44	0,530	0,805	0,668	0	16,100	0,156	0	2,077	0,668	0,00	0,03	0,00
Myoxocephalus polyacanthocephalus	43	68	2,638	4,000	3,319	0	158,280	1,857	0	24,992	3,319	0,11	0,20	0,02
Hemilepidotus papilio	34	36	0,473	0,473	0,473	0	8,514	0,069	0	2,003	0,473	0,01	0,01	0,00
Malacocottus zonurus	15	25	0,145	0,360	0,243	0	49,006	0,848	0	11,531	0,243	0,00	0,08	0,00
Dasycottus setiger	35	37	0,855	0,855	0,855	0	6,840	0,055	0	1,173	0,855	0,02	0,02	0,00
Aptocyclus sp.	31	36	1,091	1,091	1,091	0	19,638	0,158	0	13,092	1,091	0,02	0,02	0,01
Aptocyclus ventricosus	11	37	0,180	1,895	0,971	0	328,900	18,677	0	151,800	4,548	0,00	0,39	0,02
Eumicrotremus soldatovi	14	23	0,229	0,229	0,229	0	43,968	0,355	0	9,771	0,229	0,05	0,05	0,00
Eumicrotremus asperrimus	15	23	0,195	0,242	0,219	0	78,000	0,902	0	26,000	0,266	0,05	0,19	0,00
Liparis ochotensis	38	38	0,890	0,890	0,890	0	13,350	0,108	0	2,108	0,890	0,02	0,02	0,00
Careproctus roseofuscus	30	35	0,540	1,210	0,805	0	9,680	0,132	0	1,659	0,805	0,00	0,02	0,00
Careproctus rastrinus	21	39	0,145	1,290	0,866	0	39,600	1,082	0	6,393	0,866	0,00	0,06	0,00
Careproctus furcellus	36	36	0,740	0,740	0,740	0	7,400	0,060	0	0,955	0,740	0,01	0,01	0,00
Careproctus cyclocephalus	26	36	0,574	0,574	0,574	0	10,332	0,083	0	2,066	0,574	0,02	0,02	0,00
Lycogrammoides schmidti	19	38	0,049	0,510	0,249	0	12,900	0,501	0	2,100	0,249	0,00	0,02	0,00
Lycogrammoides nigrocaudatus	23	40	0,123	0,368	0,257	0	15,375	0,247	0	3,417	0,257	0,00	0,06	0,00
Lycogrammoides	20	25	0,045	0,078	0,062	0	2,700	0,041	0	1,157	0,062	0,00	0,00	0,00

microcephalus														
Lycodes soldatovi	51	73	0,735	1,316	1,026	0	4,410	0,046	0	1,707	1,026	0,00	0,01	0,01
Lycodes concolor	48	64	0,540	1,485	1,154	0	21,600	0,355	0	3,411	1,154	0,00	0,03	0,01
Bothrocara soldatovi	53	56	0,951	1,046	0,999	0	4,184	0,057	0	1,046	0,999	0,01	0,01	0,01
Bothrocarichthys microcephalus	19	41	0,093	0,408	0,178	0	18,360	0,439	0	2,899	0,178	0,00	0,02	0,00
Bothrocarina nigrocaudata	29	32	0,212	0,212	0,212	0	0,848	0,007	0	0,212	0,212	0,00	0,00	0,00
Bothrocarina microcephalus	23	34	0,085	0,108	0,098	0	3,060	0,051	0	0,583	0,098	0,00	0,01	0,00
Bothrocara brunnea	39	62	0,580	2,570	1,490	0	22,500	0,796	0	3,971	1,490	0,01	0,03	0,01
Bothrocara zestum	51	63	0,915	1,190	1,020	0	63,900	1,119	0	10,090	1,020	0,01	0,08	0,01
Boreoteuthis borealis	13	15	0,103	0,103	0,103	0	3,090	0,025	0	0,386	0,103	0,01	0,01	0,00
Stichaeopsis nevelskoi	37	37	0,160	0,160	0,160	0	0,800	0,007	0	0,178	0,160	0,00	0,00	0,00
Zaprora silenus	23	23	0,190	0,190	0,190	0	1,140	0,009	0	0,190	0,190	0,00	0,00	0,00
Hippoglossoides elassodon	24	45	0,183	0,665	0,385	0	208,824	4,876	0	35,798	0,951	0,00	0,52	0,00
Glyptocephalus stelleri	36,5	48	0,435	1,095	0,764	0	10,950	0,258	0	2,628	0,764	0,01	0,02	0,00
Atheresthes evermanni	40	67	1,308	2,515	2,021	0	50,300	0,591	0	8,623	2,021	0,02	0,13	0,01
Reinhardtius hippoglossoides matsuurae	58	85	1,805	4,037	2,571	0	80,940	1,287	0	12,780	2,571	0,00	0,10	0,01
Gonatopsis borealis	11	29	0,169	0,385	0,253	0	109,525	3,360	0	33,803	0,751	0,03	0,44	0,00
Gonatopsis sp.	16	25	0,305	0,366	0,336	0	86,925	0,760	0	19,681	0,336	0,03	0,12	0,00
Berryteuthis anonychus	10	18	0,106	0,149	0,128	0	20,264	0,199	0	3,242	0,128	0,01	0,03	0,00
Berryteuthis magister	7	23	0,069	0,935	0,154	0	246,750	20,447	0	94,982	4,466	0,00	0,42	0,02

Appendix 4

Average catch composition during mid-water trawl ***herring*** fishery in the SOO in January-April 2019 (on data collected by KamchatNIRO observers

Specie	Lenght, sm		Average mass, kg			Catch per operation, kg			CPUE, kg/effort			Share in catch by weight, %		
	min	max	min	max	av		min	max	min	max	av		min	max
Clupea pallasii	**21**	**34**	**0,205**	**0,229**	**0,216**	**16000,027**	**72000,087**	**49497,214**	**5333,342**	**32666,613**	**19782,227**	**52,45**	**99,92**	**84,79**
Theragra chalcogramma	21	76	0,115	0,597	0,303	44,775	20999,924	6804,497	17,91	13999,950	3544,540	0,08	47,53	15,19
Gadus macrocephalus	53	65	2,396	2,610	2,503	0	38,336	5,420	0	12,779	2,503	0,02	0,05	0,01
Sebastes glaucus	28,5	41,5	0,541	0,544	0,543	0	9,738	1,142	0	1,826	0,543	0,00	0,01	0,00
Hemilepidotus papilio	28	33	0,301	0,306	0,304	0	14,448	1,741	0	4,816	0,580	0,00	0,02	0,00
Hemilepidotus gilberti	35	36	0,408	0,408	0,408	0	1,632	0,181	0	0,544	0,408	0,01	0,01	0,00

Gymnocanthus detrisus	32	33	0,404	0,404	0,404	0	1,616	0,180	0	0,539	0,404	0,01	0,01	0,00
Eumicrotremus soldatovi	16	18	0,161	0,161	0,161	0	1,932	0,215	0	1,159	0,161	0,00	0,00	0,00
Aptocyclus ventricosus	22	24	0,323	0,323	0,323	0	5,814	0,646	0	2,492	0,323	0,01	0,01	0,00
Careproctus colletti	25	26	0,201	0,201	0,201	0	0,402	0,045	0	0,201	0,201	0,00	0,00	0,00
Limanda sakhalinensis	21	22	0,090	0,090	0,090	0	1,260	0,140	0	0,236	0,090	0,00	0,00	0,00
Gonatus kamtschaticus	47	47	1,854	1,854	1,854	0	1,854	0,206	0	1,854	1,854	0,01	0,01	0,01

Appendix 5

Average catch composition during Danish seiner pollock fishery in the SOO West Kamchatka shelf in JanuaryMarch 2019 (on data collected by KamchatNIRO observers

Specie	Lenght, sm		Average mass, kg			Catch per operation, kg			CPUE, kg/effort			Share in catch by weight, %		
	min	max	min	max	av		min	max	min	max	av		min	max
Mallotus villosus	14	16	0,010	0,010	0,010	0	0,060	0,006	0	0,060	0,010	0,00	0,00	0,00
Clupea pallasii	30	32	0,350	0,350	0,350	0	256,200	23,291	0	256,200	23,291	0,23	0,23	0,07
Osmerus mordax dentex	21	34	0,170	0,240	0,195	0	124,440	28,756	0	124,440	28,756	0,06	0,41	0,08
Eleginus gracilis	21	45	0,180	0,433	0,312	0	30047,870	5028,103	0	30047,870	5028,103	0,52	94,73	14,24
Theragra chalcogramma	32	74	0,460	1,280	0,685	126,72	96398,050	17922,396	126,72	96398,050	17922,396	0,69	93,75	50,77
Gadus macrocephalus	28	72	0,230	2,340	1,395	0	4492,020	527,260	0	4492,020	527,260	0,42	4,08	1,49
Sebastes glaucus	24	48	0,570	0,570	0,570	0	2494,840	226,804	0	2494,840	226,804	2,27	2,27	0,64
Pleurogrammus monopterygius	32	35	0,234	0,234	0,234	0	71,370	6,488	0	71,370	6,488	0,24	0,24	0,02
Hexagrammos stelleri	20	28	0,170	0,260	0,215	0	31,960	3,323	0	31,960	3,323	0,04	0,18	0,01
Gymnocanthus detrisus	22	36	0,220	0,500	0,325	0	3000,040	320,047	0	3000,040	320,047	0,38	17,29	0,91
Hemilepidotus jordani	28	48	0,290	1,100	0,603	0	348,170	53,443	0	348,170	53,443	0,20	2,84	0,15
Hemilepidotus gilberti	21	33	0,170	0,390	0,301	0	540,120	51,901	0	540,120	51,901	0,00	4,41	0,15
Triglops jordani	14	23	0,020	0,060	0,040	0	19,980	1,827	0	19,980	1,827	0,00	0,12	0,01
Myoxocephalus polyacanthocephalus	24	68	0,310	4,920	1,882	0	1808,400	422,732	0	1808,400	422,732	0,00	9,78	1,20
Myoxocephalus jaok	22	60	0,690	2,540	1,170	0	1859,280	534,576	0	1859,280	534,576	0,20	14,69	1,51
Hemitripterus villosus	41	47	1,230	1,230	1,230	0	29,520	2,684	0	29,520	2,684	0,59	0,59	0,01
Dasycottus setiger	30	36	0,690	0,690	0,690	0	505,080	45,916	0	505,080	45,916	0,46	0,46	0,13
Percis japonica	30	35	0,230	0,230	0,230	0	329,180	29,926	0	329,180	29,926	0,30	0,30	0,08
Podothecus sturioides	21	29	0,110	0,230	0,187	0	71,300	9,582	0	71,300	9,582	0,09	0,38	0,03
Glyptocephalus stelleri	25	30	0,170	0,170	0,170	0	248,710	22,610	0	248,710	22,610	0,23	0,23	0,06
Limanda aspera	19	41	0,130	0,520	0,284	0	6293,170	1209,453	0	6293,170	1209,453	1,39	59,86	3,43
Hippoglossoides sp.	22	42	0,280	0,570	0,436	0	4200,020	428,309	0	4200,020	428,309	0,32	22,71	1,21

Atheresthes evermanni	50	64	2,030	2,030	2,030	0	1485,960	135,087	0	1485,960	135,087	1,35	1,35	0,38
Lepidopsetta polyxystra	18	44	0,100	0,770	0,456	0	7905,590	1302,641	0	7905,590	1302,641	0,38	39,53	3,69
Limanda sakhalinensis	16	36	0,080	0,560	0,233	0	2100,000	308,170	0	2100,000	308,170	0,44	11,36	0,87
Platichthys stellatus	36	51	1,030	1,030	1,030	0	548,990	49,908	0	548,990	49,908	5,22	5,22	0,14
Pleuronectes quadrituberculatus	28	53	0,410	0,910	0,694	0	3700,400	446,571	0	3700,400	446,571	0,19	20,01	1,26
Hippoglossus stenolepis	32	50	0,050	1,720	1,150	0	119,000	17,511	0	119,000	17,511	0,00	0,59	0,05
Crossaster borealis ochotensis			0,020	0,020	0,020	0	8,860	0,806	0	8,860	0,806	0,01	0,01	0,00
Gorgonocephalus caryi			0,220	0,220	0,220	0	1,760	0,160	0	1,760	0,220	0,02	0,02	0,00
Octopus conispadiceus	8	14	0,080	0,080	0,080	0	0,630	0,057	0	0,630	0,080	0,00	0,00	0,00
Octopus sp.			2,000	2,000	2,000	0	10,000	0,909	0	10,000	2,000	0,20	0,20	0,01
Balanus sp.			0,070	0,140	0,105	0	299,920	27,316	0	299,920	27,316	0,01	0,27	0,08
Paralithodes camtschaticus			3,570	3,570	3,570	0	1385,160	125,924	0	1385,160	125,924	1,17	1,17	0,36