Russian Academy of Sciences
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APPROVED
Director of KB PIG FEB RAS, Doctor of Biol.
__________________ A.M. Tokranov
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REPORT

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Organization of monitoring of presence, interaction with fishing gear and accidental by-catch of Steller sea lion and other marine mammal species in the pollock trawl fishery in the Sea of Okhotsk during 2014-2015 fishing season

Customer:
Noncommercial Organization "Pollock Catchers Association"

Head of Research Group:
Laboratory of Higher Vertebrate Animal Ecology
Senior Research Fellow, Cand. Sc. (Biol.) V.N. Burkanov

Prepared by:
Laboratory of Higher Vertebrate Animal Ecology
Junior Research Fellow I.A. Usatov
Laboratory of Higher Vertebrate Animal Ecology
Junior Research Fellow S.V. Fomin

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INTRODUCTION

Pollock is a key commercial species for Russian Far East fisheries and ranks first among other fish species in catch volume terms. The main pollock fishing area is the Sea of Okhotsk. The Sea of Okhotsk Pollock Fishing Expedition (SOPE) is one of the largest-scale fishing expeditions both in Russia and worldwide. Pollock is harvested in the Sea of Okhotsk by mid-water trawls. About 200 fishing vessels take part in the pollock fishery in recent years.

The bulk of pollock is caught in the Sea of Okhotsk by vessels holding membership in the Pollock Catchers Association (PCA), a noncommercial organization uniting 32 major fishing companies with a total catch volume of 1.5 million tons of seafood per annum (http://pollock.ru/assocziacziya/). PCA fleets include 145 state-of-the-art ships of which 111 ones are catchers. PCA accounts for more than 64% of Russia's and 34% of the world's pollock catch.

In September 2013, the pollock fishery operated by PCA was recognized sustainable and well managed and received international certification by the Marine Stewardship Council (MSC) (O'Boyle et al., 2013). All MSC certificate holders must perform regular studies to investigate impacts of their certified fishery on surrounding biota including accidental by-catch and death of other marine species.

Such studies of pollock trawl fishery impacts on marine mammals (MM) in the Sea of Okhotsk were initiated by PCA in 2014. This paper presents the findings of observations performed by researchers of the Kamchatka Branch of the Pacific Institute of Geography, Far Eastern Branch of Russian Academy of Sciences (KB PIG FEB RAS) in the pollock fishery in January – April 2015.

These studies were performed during the season "A" (January – April) by two observers based on large autonomous freezer trawlers (BMRT) engaged in fish catching and processing (*Baklanovo* and *Pilenga-2*). One observer was staying at sea beginning from 16 January (Usatov I.A.) and the second one (Fomin S.V.) beginning from 9 March. Both continued working till the end of the fishery. Additional information about encounters with MM and their capture in trawls was collected by another researcher from KB PIG FEB RAS (Artyukhin Yu.B.) who was performing studies on pollock fishery impacts on seabirds on board the BMRT *Moskovskaya Olympiada* during 16 January – 09 April 2015.

1. MATERIALS AND METHODS

BRIEF DESCRIPTION OF MARINE MAMMAL OBSERVER ACTIVITIES IN THE POLLOCK TRAWL FISHERY IN THE SEA OF OKHOTSK IN JANUARY – APRIL 2015

Activities on monitoring of marine mammals (MM) presence and by-catch in the pollock trawl fishery in the Sea of Okhotsk were performed in January – April 2015 by 3 observers from KB PIG FEB RAS (Table 1.1). Two observers departed from the port of Petropavlovsk-Kamchatsky on 15 January on large autonomous freezer trawlers (BMRT) *Baklanovo* and *Moskovskaya Olympiada* (owned by PJSC Okeanrybflot, Petropavlovsk-Kamchatsky city). Both vessels started pollock fishing on 17 January in Kamchatka-Kuril subzone (6105.4) and operated roughly in the same area till 02 February (17 days). After cargo transfer, both ships proceeded to West Kamchatka subzone (6105.2). The BMRT *Moskovskaya Olympiada* operated in this area till 05 March (Fig. 1.1). During 07-20 March, it operated in North Sea of Okhotsk subzone (6105.1). During 23-28 March, it was finishing remaining quotas in West Kamchatka and North Sea of Okhotsk subzones and after that moved to East Sakhalin subzone (6105.3) where operated during 28 Match – 08 April. After finishing its quota, the *Moskovskaya Olympiada* proceeded for cargo transfer to West Kamchatka coast and ended pollock fishing operations on 11 April. The *Baklanovo* was fishing for pollock in subzones 6105.2 and 6105.1 till the end of the pollock fishery on 01 April after which switched to herring fishery (Fig. 2). The third observer departed to the pollock fishery area from Pusan port on 01 March on board the *Korsakov* cargo ship and arrived on board the BMRT *Pilenga-2* (Poronai LLC, Yuzhno-Sakhalinsk) on 09 March. This trawler was operating at that time in subzone 6105.2 and stayed there till 25 March. Then it proceeded to subzone 6105.1 and was fishing there till 08 April. After cargo transfer, it operated in East Sakhalin subzone (6105.3) in vicinity of Iona Island and finished its operations in that area on 18 April (Fig. 3).

BRIEF INFORMATION ABOUT VESSELS ON WHICH OBSERVERS WERE BASED

All observers were based on large-tonnage vessels – large freezer/factory trawlers (BMRT), Project 1288 of *Pulkovsky Meridian* type intended for harvesting of various fish species using bottom and mid-water trawl; processing of main raw food materials into frozen products in processed and non-processed form; processing of by-catch and offal into fish meal; product storage and transfer to transport vessels in fishing area. Its main particulars are as follows: length overall 103.7 m; breadth overall 16.0 m; keel draft 5.7 m; depth to top deck 10.2 m; depth to lower deck 7.4 m; moulded midship draft 5.9 m; gross tonnage 4347 t; net tonnage 1304 t; mean speed 14.3 knots; main engine power capacity 2 × 2574 kW. Total design volume of three bins for catch pouring is 40 tons (15 tons in each of two side bins and 10 tons in the central bin). All bins are located in the after part of fish deck. Crew number is 98. Each vessel was equipped with a mechanized trawling complex, navigation, search and other equipment compliant with current navigation and fishing requirements.

Table 1. 1. Summarized data on MM observer activities in the pollock fishery in the Sea of Okhotsk in January – April 2015

Area	Pilenga-2		Moskovskaya Olympiada		Baklanovo		**TOTAL**	
	ship-days	number of haul-outs	ship-days	number of haul-outs	ship-days	number of haul-outs	ship-days	number of haul-outs
6105.2	18	57	39	88	45	88	102	233
6105.1	14	53	21	48	17	42	52	143
6105.4	0	0	17	54	17	42	34	96
6105.3	10	20	10	21	0	0	20	41
TOTAL	**42**	**130**	**87**	**211**	**79**	**172**	**208**	**513**

The vessels owned by PJSC Okeanrybflot were equipped with similar mid-water trawls of 154/1120 m type pr. 342 EKB (two trawls on each vessel). Trawls were operated by warp/trawling, cable and Gilson winches with various pulling force and speed characteristics, rope capacity, dimensions and weight. Two Ibercisa MAI-E/600/3200-32/IS electric winches are installed in the aft part of fish deck for trawl warp heave-out and haul-in. Their performance data are as follows:

- electric motor drive 360 hp, 660 rpm;
- rope capacity of drum 3200 m of wire Ø 32 mm;
- pulling force and drum rotational speed ratings:
- first layer (Ø 610 mm) – pulling force 42.5 t, speed 48 m/min,
- middle layer (Ø 1096 mm) – pulling force 24.9 t, speed 81 m/min,
- full drum (Ø 1582 mm) – pulling force 17.6 t, speed 115 m/min.

The BMRT *Pilenga-2* differed from two other vessels by its modernized processing plant with a capacity of up to 180 tons of frozen products per day which is thrice more than this ship's design capacity in frozen product output. In this connection, the volume of raw fish bins has also been increased. Total volume of four bins was 80 tons (twice more than on two other ships). Two bins had a holding capacity of 25 tons each and two bins – 15 tons each. Such more-than-double increase of processing plant capacity (frozen products) on the BMRT *Pilenga-2* leads to higher intensity of raw fish harvesting and, as a result, larger number of haul-outs. This vessel used 3 mid-water trawls (types 126, 158 and 172). It alternately operated two trawls. When trawling in ice, it used the capron trawl 158 more frequently (after this trawl was damaged, they started using the capron 126 trawl). When trawling in ice free waters, they used both 172 and 158 (later replaced by 126 trawl) trawls. Working parameters of all trawls were similar. Vertical opening is 60-65 m, horizontal opening is 100-110 m. Trawl opening was controlled by ship's speed, warp length and mass of weights installed on the trawl.

EQUIPMENT USED FOR OBSERVATIONS

For recording ship's route, all observers used portable GPS navigators (Garmin 78S) with a replaceable set of batteries (AA size). Canon and Nikon digital photo cameras of various modifications with a set of telescopic lenses with a focal distance in the range of 30 to 400 mm were used for photographing animals and fishing operations. Notebooks or portable voice recorders (Sony ISD-BX 140 or similar) were used to register events. Optical equipment included 8x30 binoculars of Nikon Monarch type or similar. Photo recorders of PlotWatcher PRO and Bushnell were used for monitoring of events taking place on fish deck, MM by-catch or recording of changing parameters of trawl control instruments (echo sounder and others). Observation data were stored in personal laptop computers.

The Client did not allocate any funds for acquisition of equipment and special clothes suitable for severe winter conditions. All equipment used for this work belonged to observers. They also purchased photo recorders for MM by-catch monitoring at their own expense.

PROTOCOL OF OBSERVATION OF MARINE MAMMAL PRESENCE AND BEHAVIOR IN THE OPERATING AREA OF FISHING VESSELS

Observations of MM presence around the fishing vessel were performed every day in the daylight period during randomly selected time intervals. The start of observations was fixed by a GPS navigator reading (coordinates and time). Weather conditions and nature of ship's operations (trawling, transit passage, lying adrift) were recorded in the observation log (or on voice recorder). Changes in weather and ship's operating mode were regularly recorded also using GPS receiver's readings and in the observation log. The essence of observations of MM presence near the ship was "scanning" of the water area at intervals of several minutes. If a MM was detected, coordinates and time of such encounter were fixed on the GPS navigator, approximate distance to the animal and direction from ship's course was visually determined. The following was specified using a binocular:

- species
- number of individuals
- sex and age composition
- behavior
- nature of interaction (if any) with ship or fishing gear.

The number of GPS receiver's fix and all relevant information was recorded in the observation log (or on voice recorder). If any animals were photographed, an according entry was made in the log. Breaks in observations (for taking meal or in case of short-time absence) and end of observations were also recorded in the GPS navigator. All photographs, GPS navigator data and data from the observation log or voice recorder (if it was used) were entered in the Access database on personal computer at the end of each day.

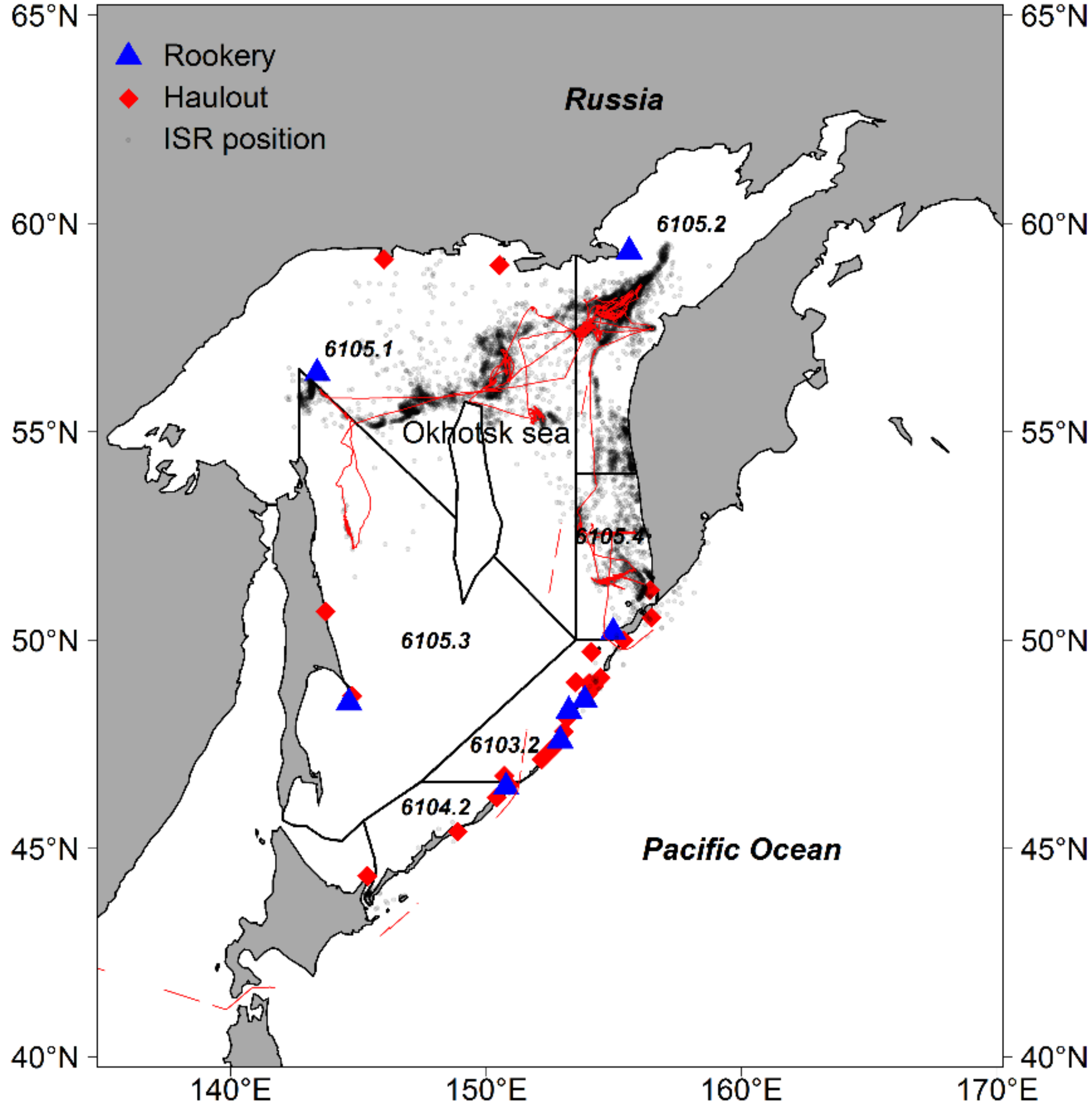

Fig. 1.1. Track record of the BMRT *Moskovskaya Olympiada* movements in the Sea of Okhotsk in January – April 2015.

Ship's track is shown by a red line; dark fill spots throughout the sea basin show SDR positions of ships operating in pollock fishery in the Sea of Okhotsk in January – April 2015 (all positions); intensity of fill shows fishing fleet concentration areas; blue triangles show Steller sea lion breeding rookeries; red rhombs show locations of non-breeding haul-out sites.

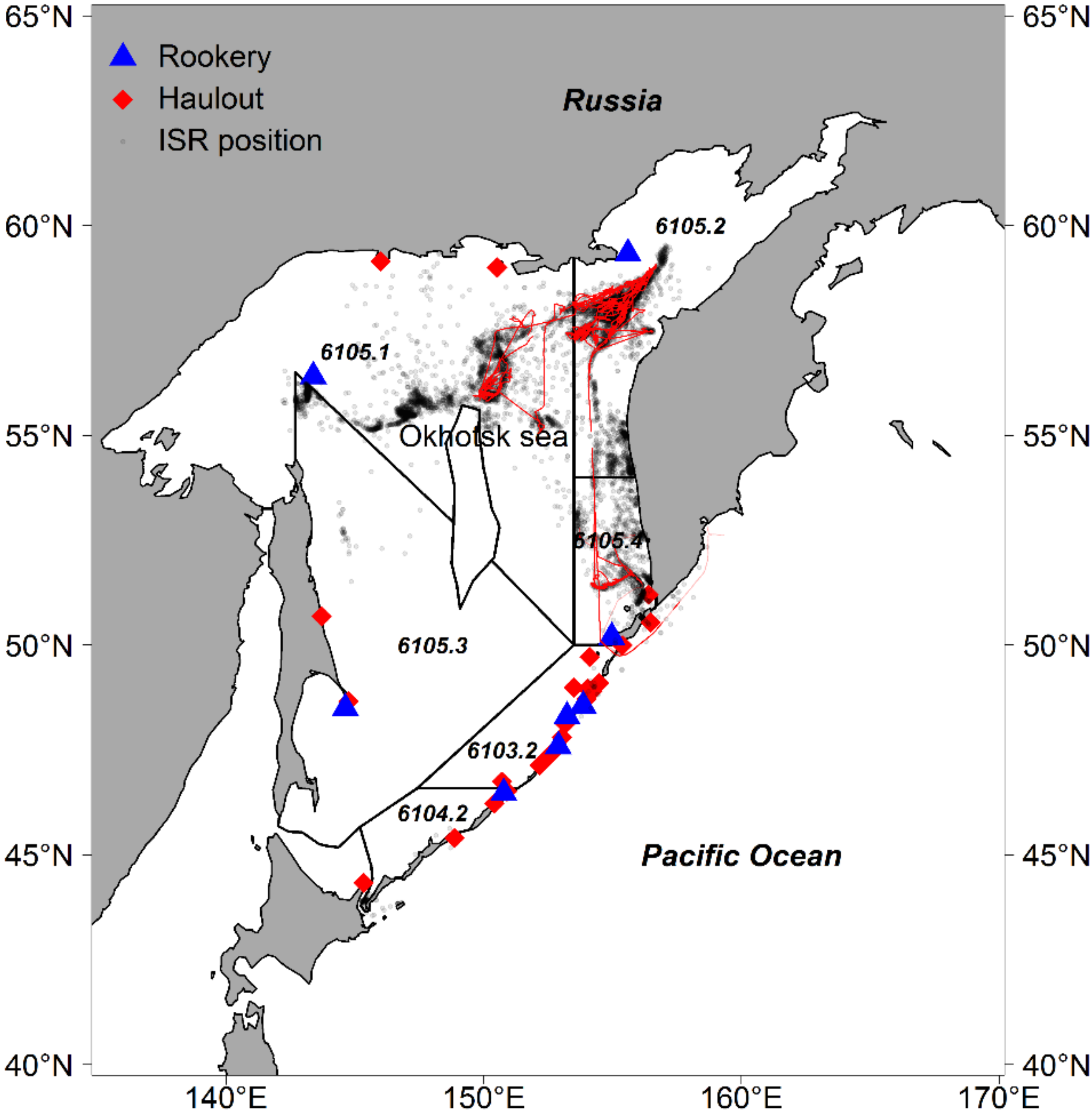

Fig 1.2. Track record of the BMRT *Baklanovo* movements in the Sea of Okhotsk in January – April 2015 (*legend is the same as in Fig. 1.1*).

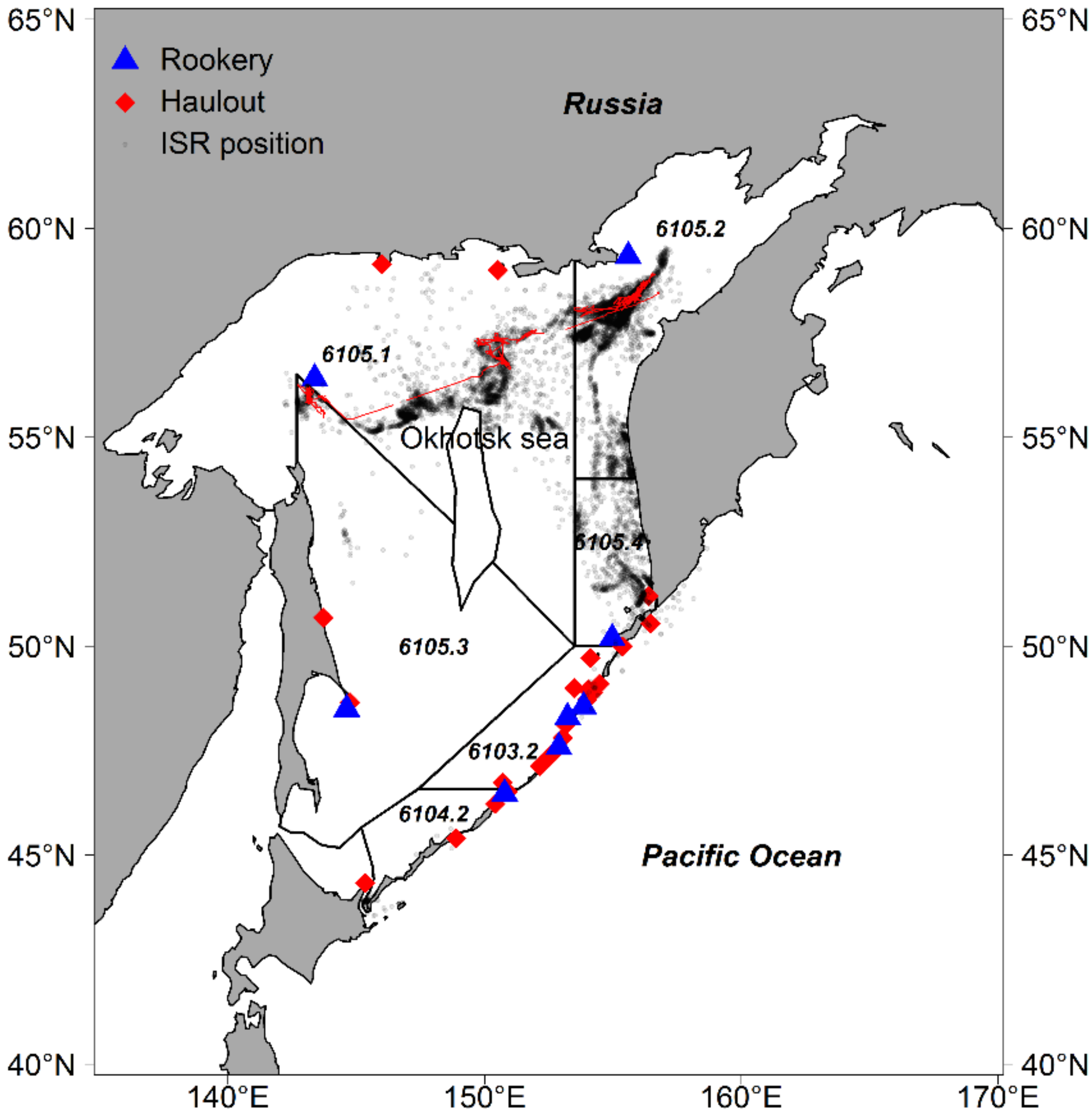

Fig. 1.3. Track record of the BMRT *Pilenga-2* movements in the Sea of Okhotsk during 8 March – 17 April 2015 (legend is the same as in Fig. 1.1).

PROTOCOL OF VERBAL AND RADIO INTERVIEWING OF FISHING VESSELS

Our observers interviewed deck officers of ships found within visibility limits from the observer's ship via VHF radio or during "Master's Hour" daily briefing radio conferences. The observer introduced himself, briefly described the purpose of MM by-catch monitoring studies and asked the following questions:

- if there were any encounters with MM; if yes, what MM species and number was;
- if there was any MM interaction with ship, its details and particular features;
- if there was any MM by-catch; if yes, the observer specified its location, species and number of animals, circumstances in which such by-catch had occurred.

Answers were registered in the notebook or on voice recorder.

REGISTRATION OF MARINE MAMMALS BY-CATCH IN TRAWLS

Accidental capture of marine mammals in a trawl can be detected only during catch pouring from its cod-end to reception bins. As trawling was performed on a 24-hour basis on all vessels, catch was poured to bins also on a 24-hour basis. Bins on the *Moskovskaya Olympiada* and the *Baklanovo* were capable of holding only 40 tons of catch and, if catch per one haul-out exceeded 40 tons of fish, it was poured during several hours. If ship operated in a steady state mode, catch was poured almost all day round. In this connection, observers had difficulties with inspecting the content of catches in cod-ends and were unable to inspect all catches even theoretically. The BMRT *Pilenga-2*'s bins had a holding capacity of 80 tons and the observer based on this vessel had more frequent opportunities for full inspection of the content of cod-ends. Autonomous photo recorders turned out to be very important and necessary for this purpose. During their stay on ships, observers tested two photo recorder types – PlotWatcher PRO and Bushnell. They were installed in different locations on board the ship and photographed the deck and all activities taking place on it, including catch pouring into bins, at different intervals (1 second to 5 minutes). As observers were busy with work on registration of MM and their interactions with fishing gear, they did not have enough time for viewing and interpretation of photographs during the voyage. This part of work was completed after the voyage in our laboratory.

Crew members whose job duties directly related to fishing or ship's navigation were well aware of observers' work and gave them assistance as appropriate.

PROTOCOL OF FISHING EFFORT REGISTRATION

MM are not target species in the pollock trawl fishery in the Sea of Okhotsk and get caught in trawls accidentally. Animals are often observed near fishing vessels but seldom in by-catch. Therefore, certain circumstances should arise for occurrence of such event (or several circumstances should coincide) depending on specific features of the fishing area, vessel type and size, trawl type and size and, which is most important in our opinion, trawling techniques. In order to determine the moment and events in case of which animals get captured in a trawl, we divided a trawling cycle into individual operations and measured their characteristics. Such degree of detail for fishing efforts was required to perform an integrated assessment of reasons for MM capture in trawls and determination of the moment or trawling phases when MM were found in the operating envelope of the trawl or trawl wires, or due to which crew's manipulations with the trawl animals turned out captured in it.

During the entire period of fishing, we performed visual observations of fishing operations. Events were recorded in time and space using a personal GPS navigator. Fishing operations were divided into permanent (not repeated during one trawling cycle) and variable (changing during trawling process). Permanent parameters included:

- vessel type and size;
- model of the trawl being used;
- "trawl out" – when a relevant command is given and the cod-end starts sliding from the stern ramp into the water;
- "otter boards out" – when otter boards are connected and command given for their launching;
- "otter boards up" – otter boards appeared on the water surface;
- start of cod-end lifting to board – the front part of the cod-end (determined by a seam) begins rising up the stern ramp;
- end of cod-end lifting to board – movement of the filled trawl on deck is stopped, trawling operation is completed.
- species and catch weight in tons.

Variable trawling parameters included:

- trawling depth (trawling horizon);
- depth under the keel;
- trawling speed;
- trawling course;
- density and depth of aggregations being trawled;
- ship's manipulations with the trawl during trawling:
    - "circulation" – ship's U-turn during trawling when the trawl is lifted from the trawling horizon to the surface water layer;
    - "cooler" – trawl towing ("trawling") in a small depth to preserve the catch awaiting free room on deck for the cod-end;
    - "incident" – various problems with trawl heaving out, hauling in or trawling (fouling, snagging, etc.).

Depth under the keel was determined by echo sounder readings. Trawling horizon was shown on the trawl control unit. Trawling speed was recorded using ship's satellite navigator readings or observer's personal navigator readings (if readings coincided). Density and depth of aggregations being trawled was determined by echo sounder (Furuno) readings and evaluated on a 10-point scale. Ship and trawl manipulations were determined visually and their parameters were specified using the trawl control unit and TrawlTec. Catch weight was taken from ship's fishing log.

After a trawling parameter was fixed on GPS, the content of this event was recorded on voice recorder. All navigator readings and voice records were transferred to a customized Access data base at the day's end.

COLLECTION OF BIOLOGICAL INFORMATION FROM ANIMALS CAPTURED IN TRAWLS (LIVE AND DEAD)

Observers evaluated the following parameters of MM captured in fishing gear:

- species, sex, age;
- physical condition and fatness;
- stomach, intestines and head (whole) were taken from dead animals;
- body was measured and weight was determined.

All specimens taken from dead animals were frozen in ship’s freezing hold and delivered for processing to KB PIG FEB RAS laboratory in Petropavlovsk-Kamchatsky.

2. FINDINGS.

2.1. SPECIES AND QUANTITATIVE COMPOSITION OF MARINE MAMMALS IN POLLOCK TRAWL FISHING AREAS IN THE SEA OF OKHOTSK IN JANUARY – APRIL 2015

Species composition and relative abundance. Three observers encountered with MM on 1,116 occasions in pollock trawl fishing areas in the Sea of Okhotsk in January – April 2015 (Fig. 2.1.1). Animals were met solo and in groups of 2 to 167 individuals. A total of 3,994 MM individuals were met. They belonged to 11 species (Table 2.1.1). MM species was not identified in 27 cases, of which 3 cases were cetaceans and 24 cases were true seals. The most frequently met and most numerous animal in pollock fishing areas was Steller sea lion (50.5% of encounters and 69.2% of total number of observed animals). It was followed by larga seal – 19.3% of encounters and 12.6% of total number of observed animals. Ribbon seal ranked third in occurrence rate (9.8%) and fourth in abundance terms – 4.1%. Fourth-largest in abundance terms was Dall's porpoise (6.6%) which ranked only sixth in occurrence rate (4.5%). Ribbon seal was followed by Northern fur seal (6.8%) and Minke whale in occurrence rate (5.0%). The remaining 5 species accounted for less than 1% both in terms of occurrence rate and abundance (Table 2.1).

Spatial distribution. Our observers were unable to alter ship's routes or duration of ship's stay in a particular area. They just passively registered encounters with animals in those locations where their ships was operating and only those periods of time during which their ships stayed in a particular area of the Sea of Okhotsk. In this connection, MM spatial distribution and relative abundance in pollock fishing areas was largely affected by ship's fishing activities. Dark places in Fig. 2.1.1 reflect both more frequent encounters with MM and duration of stay of ships with observers in this area. A more detailed description of encounters with individual MM species is given below.

PINNIPEDS–- PINNIPEDIA

4 pinniped species were found in pollock trawl fishing areas in the Sea of Okhotsk in January – April 2015. Two belong to the eared seal family (Otaridae) – Steller sea lion and Northern fur seal and two belong to the true seal family (Phocidae) – ribbon seal and larga seal.

Table 2.1.1. MM species composition and occurrence rate in the Sea of Okhotsk in January – April 2015

Item No.	English name	Latin name	Occurrence rate by number of encounters, %	Percentage of species, %
1	Dall's purpoise	*Phocoenoides dalli* (True, 1885)	3.9	5.9
2	Sperm whale	*Physeter macrocephalus* (Linnaeus, 1758)	0.2	0.1
3	Killer whale	*Orcinus orca* (Linnaeus, 1758)	0.3	0.6
4	Baird's beaked whale	*Berardius bairdii (*Stejneger, 1883)	0.1	0.2
5	Minke whale	*Balaenoptera acutorostrata* (Lacépède, 1804)	5.0	1.5
6	Fin whale*	*Balaenoptera physalus* (Linnaeus, 1758)	0.8	0.4
7	North Pacific right whale*	*Eubalaena japonica* (Lacépède, 1818)	0.1	0.0
8	Whale (not identified by species)	*Cetacea sp.*	0.3	0.1
9	Steller sea lion*	*Eumetopias jubatus* (Schreber, 1776)	51.4	70.0
10	Northern fur seal	*Callorhinus ursinus* (Linnaeus, 1758)	6.3	3.8
11	Ribbon seal	*Histriophoca fasciata* (Zimmerman, 1783)	9.9	3.8
12	Larga seal	*Phoca largha* (Pallas, 1811)	19.6	12.8
13	Seal (not identified by species)	*Pinnipedia sp.*	2.1	0.8

** - Species listed on the RF Red Data Book*

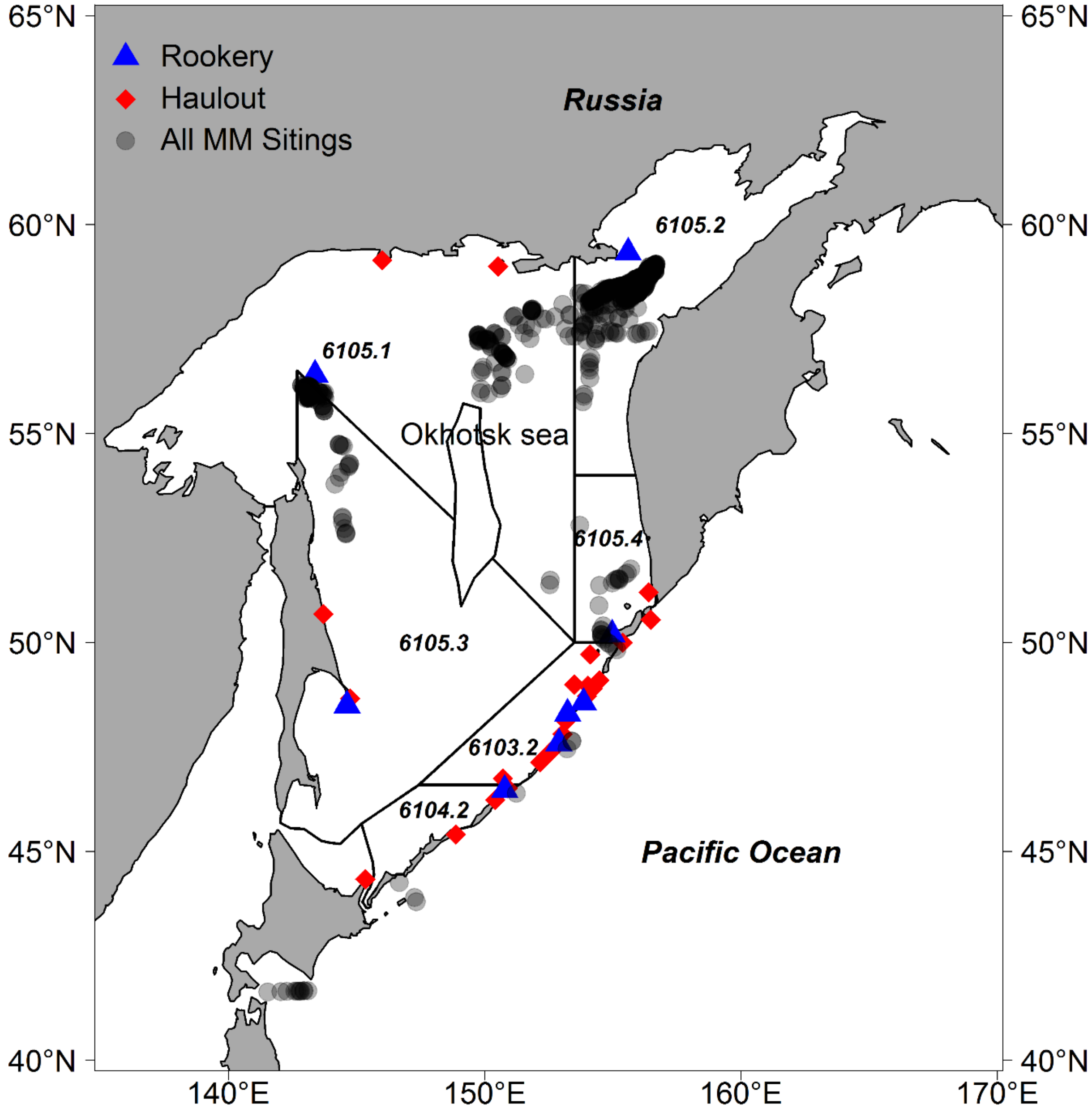

Fig. 2.1.1. Locations of encounters with MM (all species) in the Sea of Okhotsk in January – April 2015.

Intensity of the color of dots indicates at number of encounters. Animals were met more frequently in darker-colored places.

STELLER SEA LION. This species was met most frequently in the northern part of the Sea of Okhotsk in areas 6105.1 and 6105.2 (Fig. 2.1.2). A total of 564 animals were observed and only once (2 individuals) this animal was observed in Kamchatka-Kuril subzone (6105.4). Steller sea lion was observed in immediate vicinity of ships and at a distance, afloat in the water and during rest on ice floes. Roughly in half cases, this sea lion was met solo or in pairs. Groups included more than 4 individuals in 30% of cases. A maximum of 167 animals were simultaneously registered within observer's field of vision (21 March 2015). This happened in roughly 50 miles from this sea lion's large breeding rookery in Yamsky Islands. It should be noted that all Steller sea lions observed in groups of 10 individuals and more (12% of all encounters) were found either within 15-20 miles from their rookery on Iona Island or at a distance of no more than 100-150 miles from their rookery on Yamsky Islands (Fig. 2). The total number of sea lions in these groups was 1,380 individuals (35% of total number of observed Steller sea lions). It should be noted that ships with observers operated in one area for a long time and the same individuals animals might be repeatedly observed and included in the number of identified animals. Therefore, our figures should be perceived as data on relative abundance in pollock fishing area. They do not reflect the real number of Steller sea lions. Methods of collecting information about encounters with MM are not adequate for any calculations of Steller sea lion abundance estimates.

NORTHERN FUR SEAL. This species was met only in the northern part of the Sea of Okhotsk (areas 6105.1 and 6105.2) and once (two juveniles) off East Sakhalin (Fig. 2.1.3). In total, fur seals were met 69 times (a total of 151 individuals). The majority of observations occurred off West Kamchatka (6103.2) – 56 times or 81% of all occasions and 90% of total number of observed fur seals. Same as for Steller sea lion, fur seals were met solo in roughly half all cases (33 times or 48% of encounters), in pairs in roughly 1/3 of cases (20 occasions, 40 individuals) and in groups of more than 2 individuals in 16 cases. A maximum number of animals in groups was 10 (3 times in different areas and on different dates). Fur seals were observed on ice only in two cases. In all other cases, they were in the water.

RIBBON SEAL. This species was registered in three fishing areas (Fig. 2.1.4). It was observed more frequently off West Kamchatka (area 6103.2) at the entry to Shelikhov Bay – 61 times (56% of all encounters), less frequently off Northeast Sakhalin (6103.3) – 45 encounters (41%) and only 3 times in North Sea of Okhotsk area (6105.1) (3%). Solo animals were met more frequently (79 cases, 80% of encounters). Pairs were met less frequently – 23 times (21%) and groups counting more than 2 animals even less frequently. All ribbon seals were observed either on ice or in the water among ice.

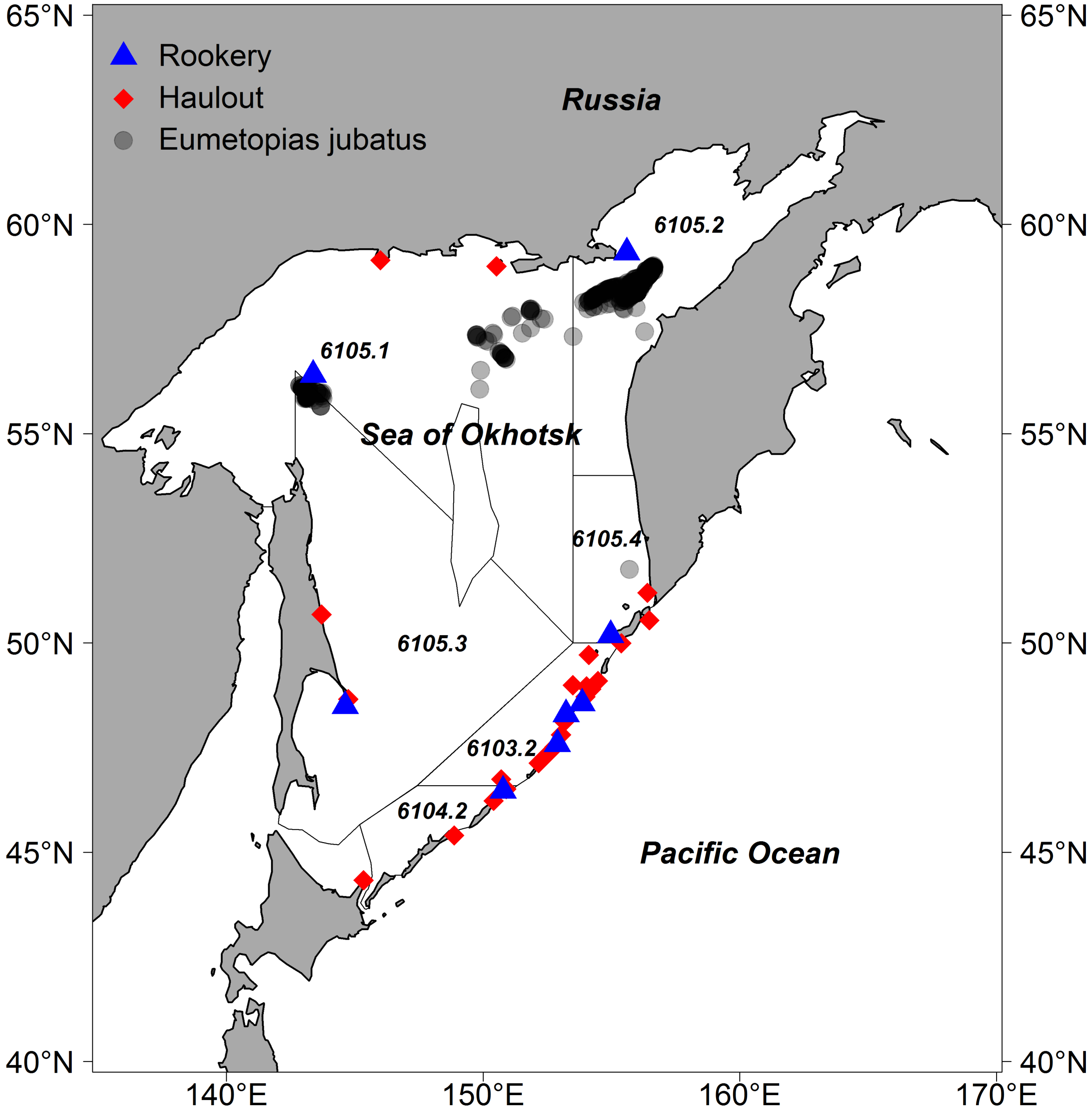

Fig. 2.1.2. Locations where Steller sea lion was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

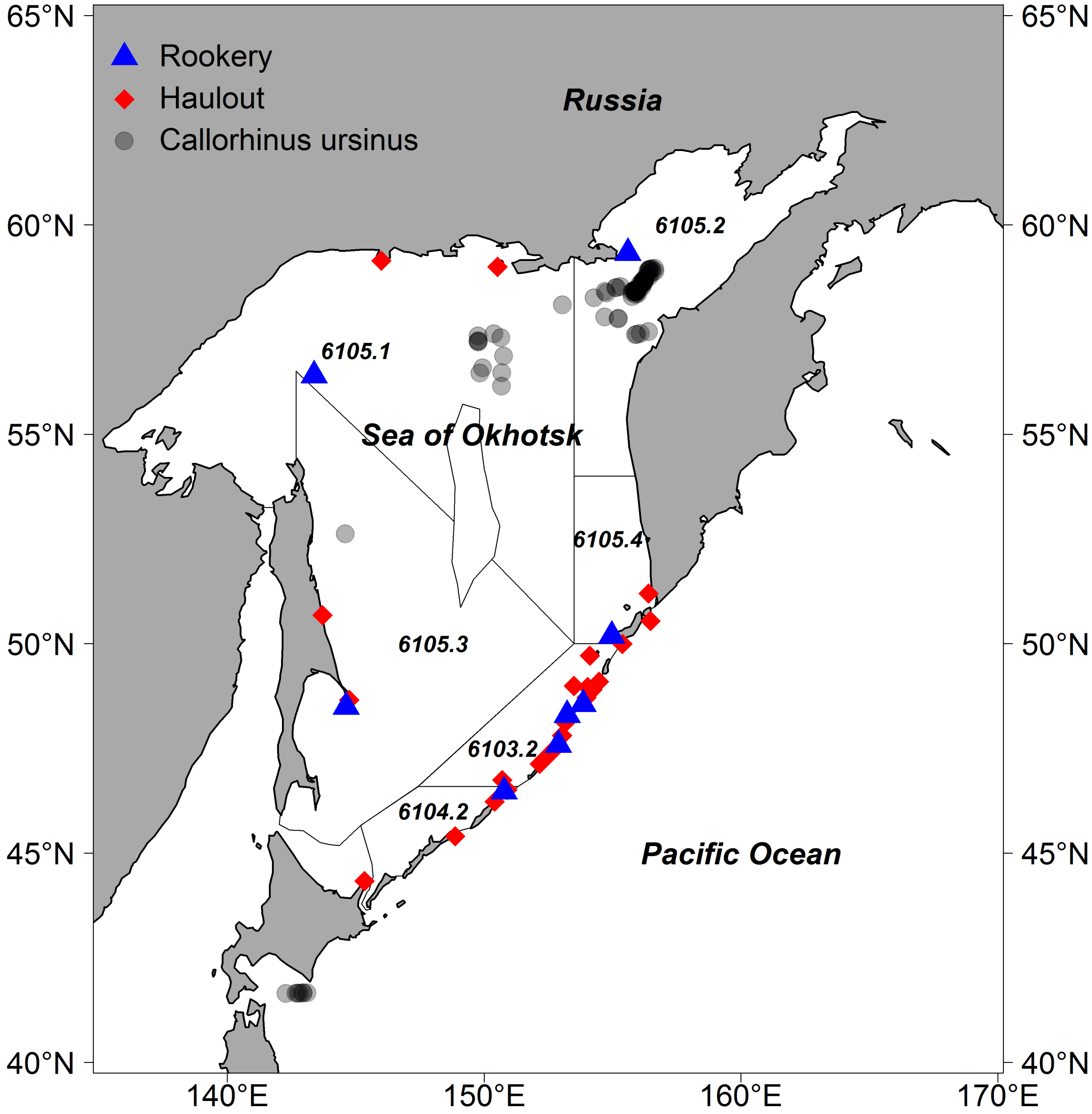

Fig. 2.1.3. Locations where Northern fur seal was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

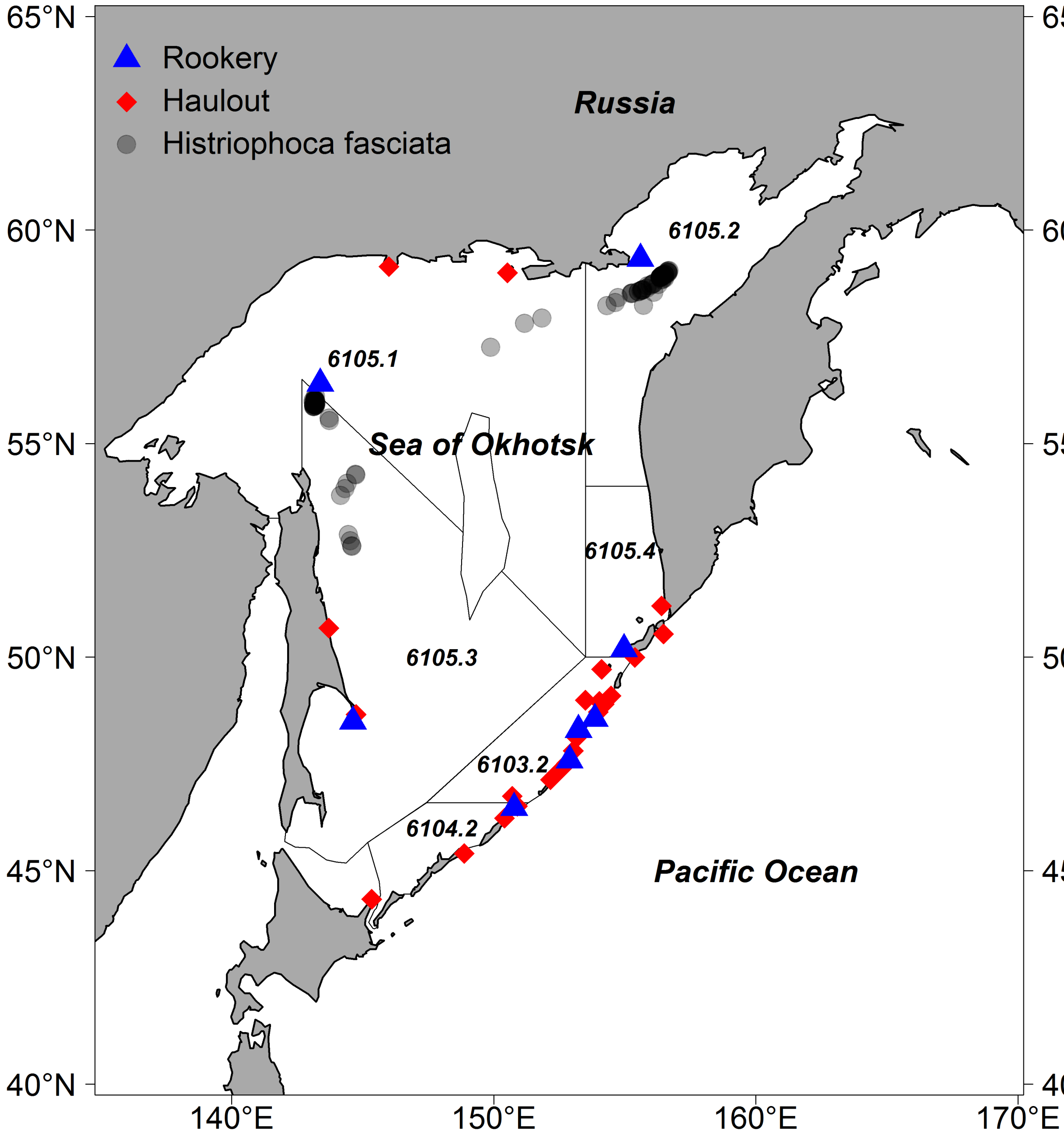

Fig. 2.1.4. Locations where ribbon seal was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

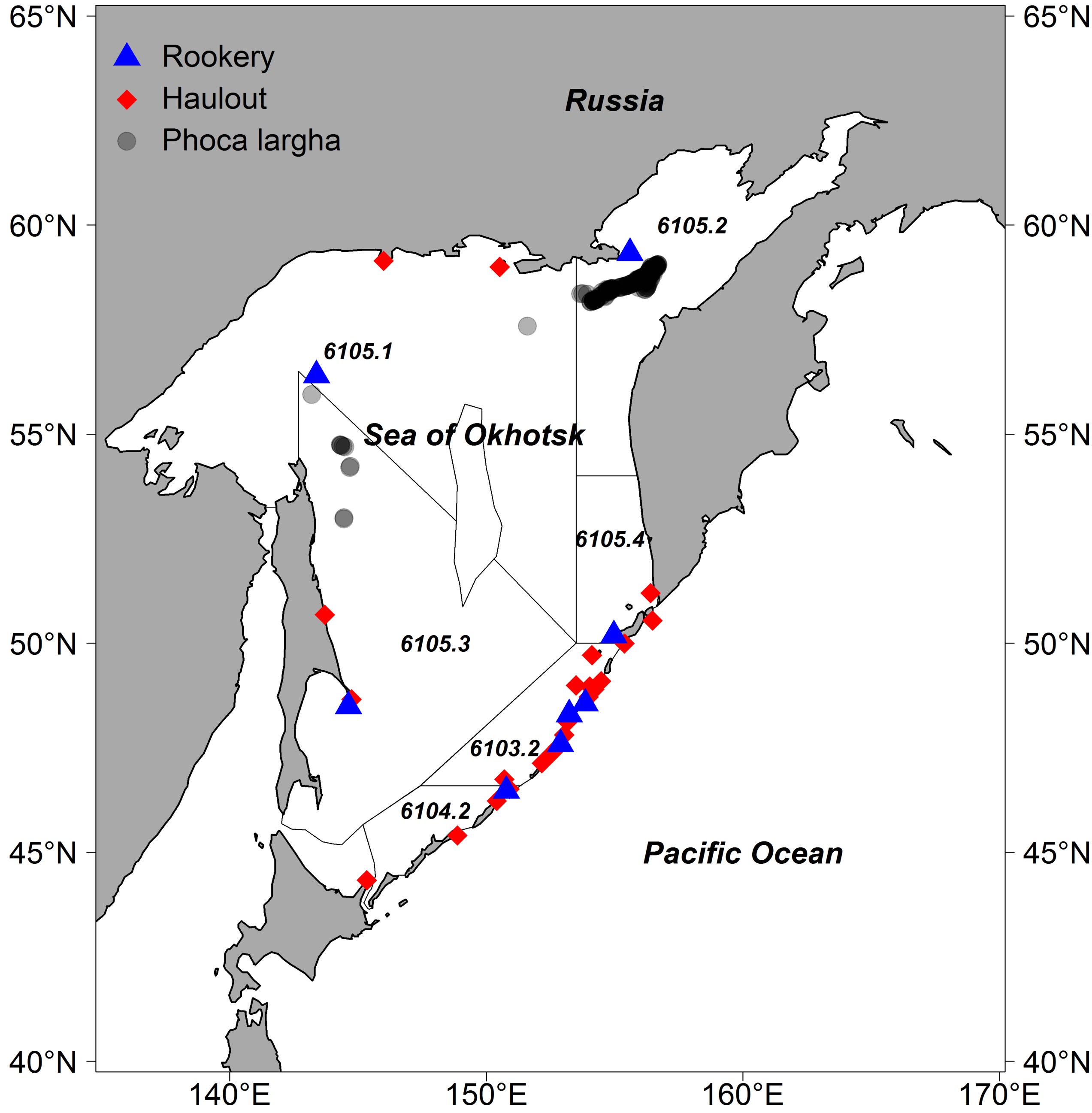

Fig. 2.1.5. Locations where larga seal was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

LARGA SEAL. The spatial distribution of larga seal in January – April 2015 was very similar to that of ribbon seal described above. Both species belong to ice forms of seals and gravitate toward dense strong ice in this period as they give birth to pups and nurse them on ice in March – April (Fig. 2.1.5). This animal was observed in the Sea of Okhotsk 215 times, of which 204 times (95%) it happened in West Kamchatka zone (6105.2). Only once one individual was observed in area 6105.1 and the rest 10 individuals (5%) – off Northeast Sakhalin island (Fig. 2.1.5). Solo animals were observed 64 times (30% of total number of encounters), pairs – 51 times (24%) and groups more than 2 animals – 100 times (47%). A maximum number of animals in groups was 11.

CETACEANS - CETACEA

7 cetacean species was observed in pollock trawl fishing areas in the Sea of Okhotsk in January – April 2015. Three species belong to baleen whales (Mysticeti) – Minke whale, fin whale and North Pacific right whale; and four species belong to toothed whales (Odontoceti) – Dall's porpoise, sperm whale, killer whale and Baird's beaked whale.

DALL'S PORPOISE. This species is the most frequently occurring and numerous cetacean species in pollock fishing areas in the Sea of Okhotsk (Fig. 2.1.6). It was met 43 times, of which it was observed off West Kamchatka (area 6105.2) 27 times (63%). It was occasionally observed in North Sea of Okhotsk area (6105.1) – 9 times (21% of all encounters) and in the south of Kamchatka-Kuril area (6105.4) – 7 times (16% of all encounters). A total of 231 individuals were registered. The size of groups varied from 2 to 22 individuals averaging at 5.4 individuals.

MINKE WHALE. This species ranks second in terms of the number of encounters following Dall's porpoise. It is one of widely distributed cetacean species. Its spatial distribution in the winter of 2015 reflects distribution of MM observation efforts (Fig. 2.1.7). It is in locations of maximum efforts (area 6105.2) that the largest number of encounters was registered. Of 55 cases in the Sea of Okhotsk in January – April 2015, West Kamchatka (6105.2) accounted for 37 cases (67%). Minke whale was met less frequently in North Sea of Okhotsk subzone (6105.1) (10 times) and Kamchatka Kuril subzone (6105.04) (8 times). In most cases, they were solo Minke whales (50 times or 91% of all encounters).

FIN WHALE. Fin whale was met 9 times during the whole observation period (Fig. 2.1.8). It was observed off West Kamchatka in seven cases, of which three times near the ice edge and four times south of the ice edge. Two observations were made in the southern part of Kamchatka-Kuril zone (6105.4). It was solo whales in four cases, pairs in other four cases and a group of 3 whales in one case. A total of 15 fin whales were observed.

KILLER WHALE, SPERM WHALE, BAIRD'S BEAKED WHALE AND NORTH PACIFIC RIGHT WHALE. These species were met in pollock fishing areas in the Sea of Okhotsk several times during the whole period (1 to 3 cases). Killer whale was observed once in the south of Kamchatka-Kuril zone (7 individuals, 7 March 2015) and two times – off West Kamchatka (6105.2) in groups of 10 and 8 individuals. Solo sperm whales were observed on two occasions (16

January and 07 March) near the southern boundary of Kamchatka-Kuril subzone (6105.4). Baird' beaked whale (group of 6 six individuals in subzone 6105.2 on 12 April) and North Pacific right whale (in Kamchatka-Kuril subzone northwest of Kambalny Bay on 23 January) were met on one occasion each.

SEX AND AGE COMPOSITION. Only observers with ample experience are capable of visually identifying MM sex and age by size, appearance and behavior. The accuracy of visual identification of sex and age for different age and sex groups may be different. For instance, adult Steller sea lion males are much larger than females and juveniles. Their identification in the water or on the shore normally poses no difficulty even for inexperienced observers. Identification is also easy for adult killer whale males (by dorsal fin height) or Northern fur seal bulls (by body size). Adult ribbon seal males and females are markedly different in the coloring of their hair. At the same, it is very difficult to distinguish between Steller sea lion or Northern fur seal female and juvenile animals even for experienced zoologists, particularly in limited visibility conditions or during short-time period of observation. Our observers' work in the Sea of Okhotsk was complicated by the circumstance that animals often approached their ships in dusk or in dark hours. Due to this reason, we indicate in our report data only on those MM species and groups whose sex or age composition was successfully identified.

STELLER SEA LION. Of 2,765 Steller sea lions met in the Sea of Okhotsk by observers, sex or age was identified for 929 animals (34%). Adult bulls were dominating (426 individuals, 46%). Half-bulls (subadult males at the age of 4-6 years) accounted for 24% and juvenile animals of unidentified sex accounted for 28%. Only 17 adults females were identified or 2% of all sea lions with specified sex and/or age. Thus, the majority of Steller sea lions in pollock trawl fishing areas in the Sea of Okhotsk were adult and subadult males which accounted for 70% of all Steller sea lions for whom sex and age was identified.

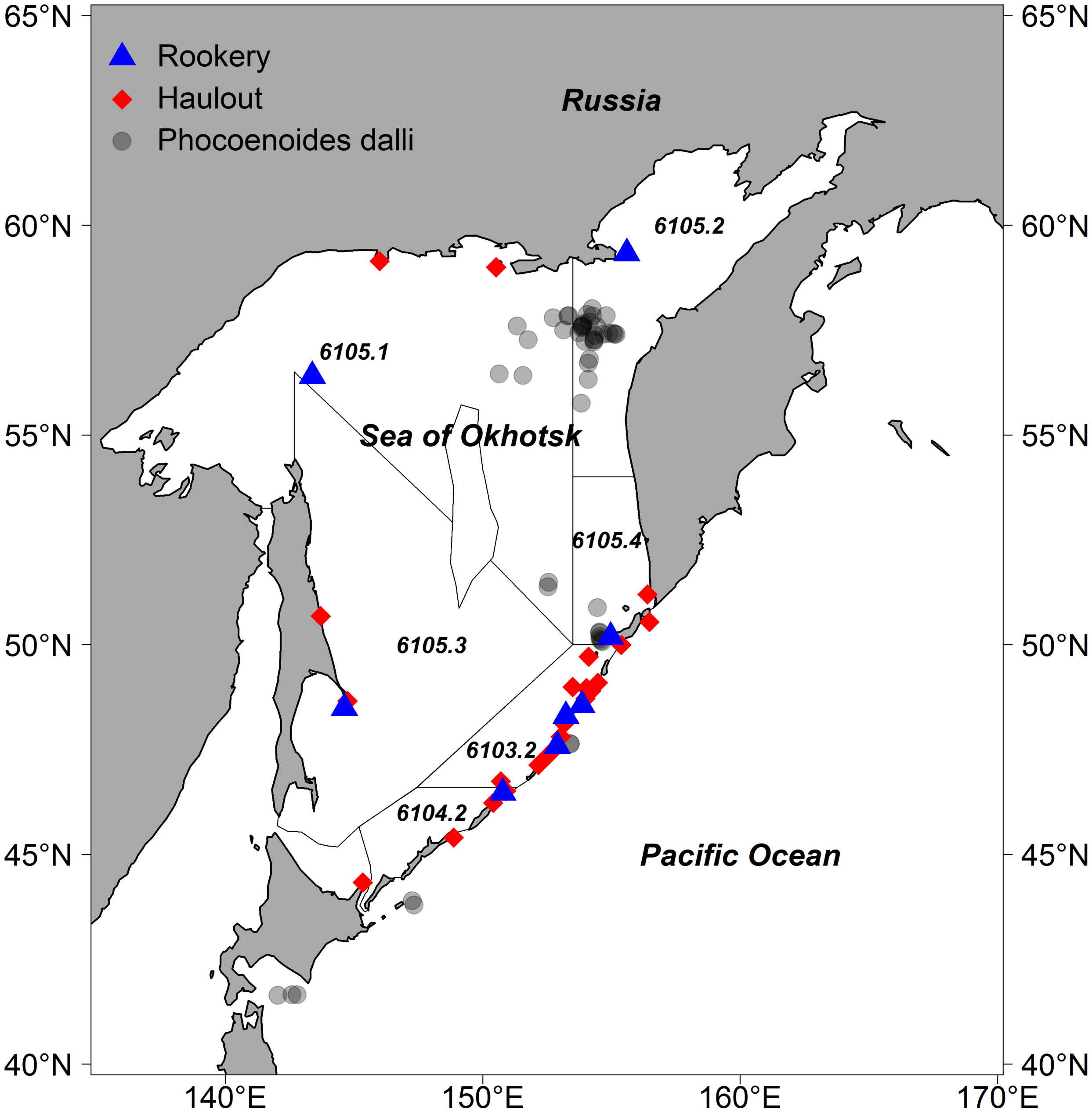

Fig. 2.1.6. Locations where Dall's porpoise was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

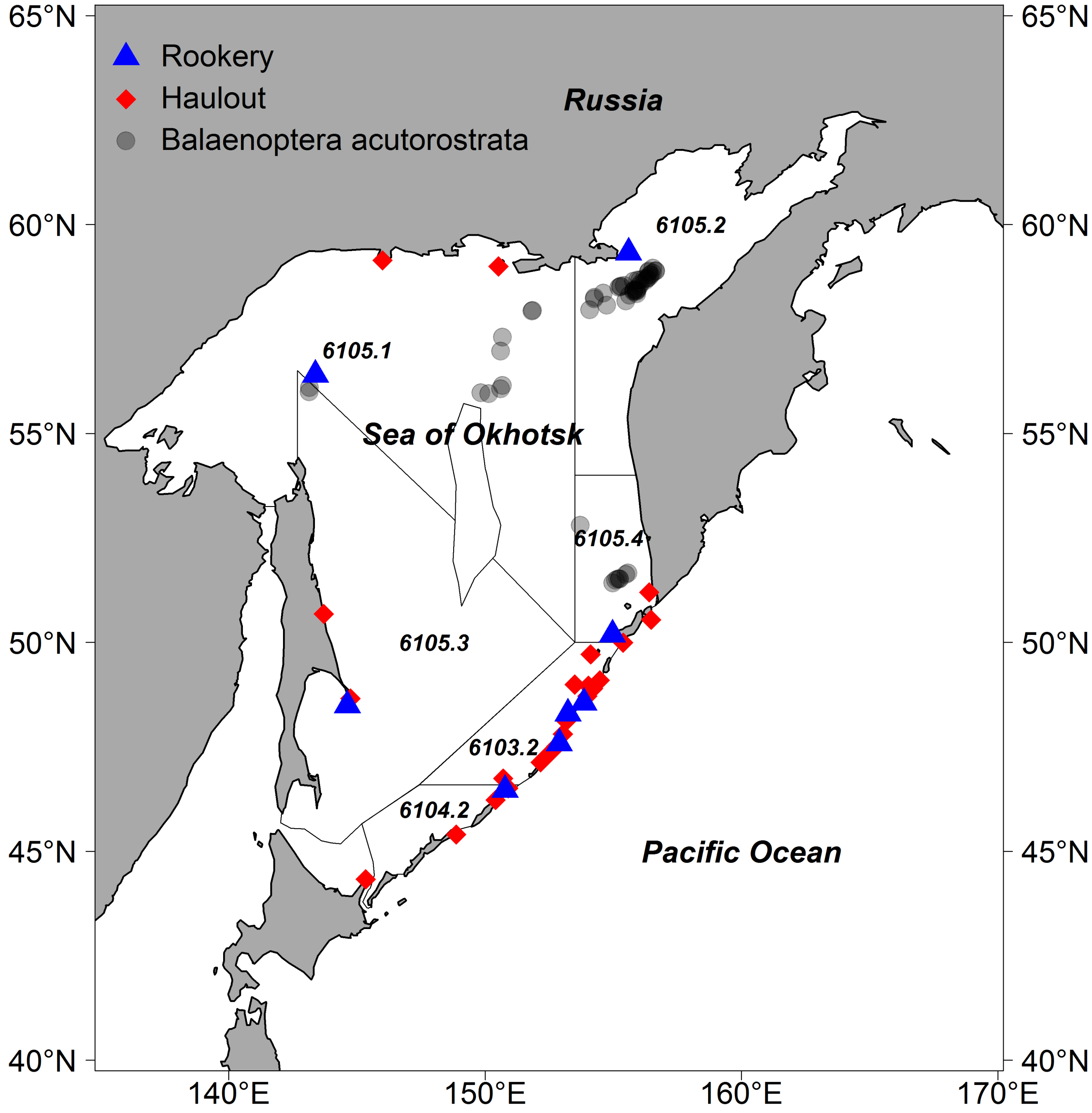

Fig. 2.1.7. Locations where Minke whale was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

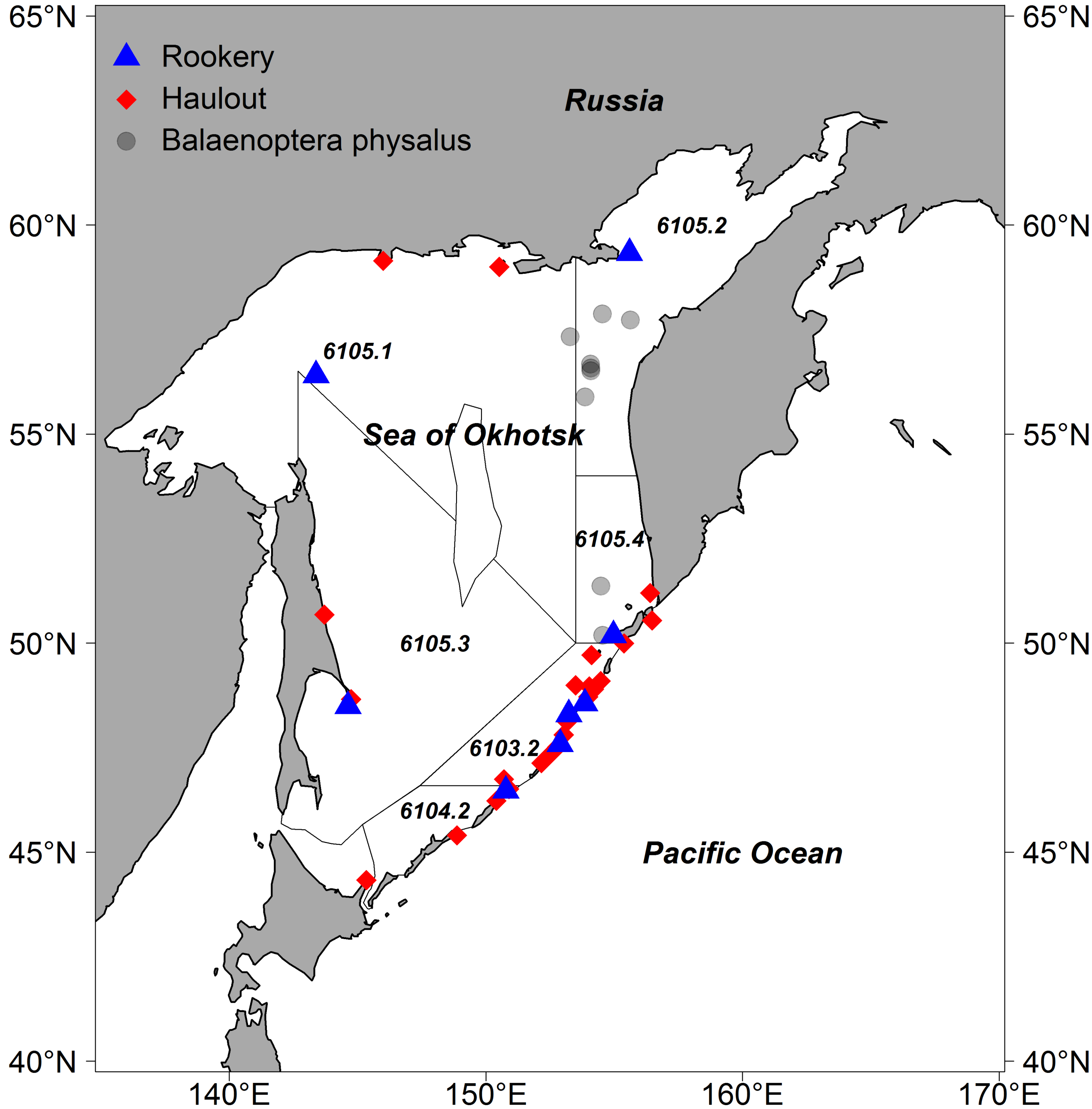

Fig. 2.1.8. Locations where fin whale seal was observed in the Sea of Okhotsk in January – April 2015. *Intensity of the color of dots indicates at number of encounters. Animals were observed more frequently in darker-colored places.*

Northern fur seal. Of 163 Northern fur seals met in the Sea of Okhotsk, sex and age were identified for 81 individuals (50%). Of this number, 77 animals (93%) turned out males older than 4-5 years. Four animals were referred to juveniles (under 4 years) and another four were referred to juveniles whose sex was not identified. Thus, this pinniped species in pollock trawl fishing areas in the Sea of Okhotsk was dominated by juvenile adults.

Larga seal. It is not possible to identify sex and age for solo seals of this species lying on ice or swimming in the water. March–April is a breeding season for larga seal – it gives birth to pups and females nurse their pups during one month after birth. Male normally stays in close vicinity of the pup and its mother. Such groups of seal are called family groups. Larga seal was observed 215 times in pollock fishing areas in the Sea of Okhotsk in March-April 2015, of which 123 cases were categorized as “family groups” (57%).

Ribbon seal. Adult animals are easily distinguished from juveniles and pups by their hair coloring and size. Of 150 ribbon seals met on ice in the Sea of Okhotsk, sex and age was identified for 47 individuals (31%). Of this number, 22 were males (47%), 14 were females (30%), 5 were juveniles (11%) and 6 were pups (13%). Unlike larga seal, breeding groups and pups of ribbon seal were met much less frequently.

Other species. Other MM species have no sex- and age-specific distinctive features or identification of their sex and age poses great difficulty even for experienced observers. Of all cetacean species, we successfully identified sex and age for 3 killer whale males (of 25 observed individuals).

occurrence rate. MM occurrence rate in the pollock fishing area was a highly variable parameter. MM were met much more seldom in January- February than in March-April (Fig. 2.1.9). Findings of individual observers differed by an order of magnitude (Table 2.1.2). This parameter broadly varied also for species, fishing areas and even within one area during the season. Such uneven occurrence is possibly explained by specific features of distribution and biology of MM living in pollock fishing areas as well as by specifics of observer performance on each ship. Such high variability of MM occurrence data leads to difficulties and brings uncertainty to evaluation of the by-catch of MM species. Even in one area, there may be no by-catch at all during a considerable portion of the season and then it may reach high values during a particular period of the season or in a particular fishing area. This circumstance affects calculations on the required number of observers on ships.

Table 2.1.2. Summarized data on MM observations in the Sea of Okhotsk in January – April 2015 from ships with observers (number of encounters)

Species	Moskovskaya Olympiada	Baklanovo	Pilenga-2	Total
Dall's porpoise	24	12	14	50
Sperm whale	2	-	1	3
Killer whale		2	2	4
Baird's beaked whale	1	-		1
Minke whale	5	28	23	56
Fin whale*	4	4	1	9
North Pacific right whale*	1	-	-	1
Whale, species not identified	*1*	-	*3*	*4*
Steller sea lion*	18	184	362	564
Northern fur seal	8	30	38	76
Ribbon seal	10	61	38	109
Larga seal	9	205	1	215
Seal, species not identified	-	-	*24*	*24*
TOTAL	**83**	**526**	**507**	**1116**
Start of observations	16-Jan-15	16-Jan-15	7-Mar-15	16-Jan-15
End of observations	13-Apr-15	20-Apr-15	18-Apr-15	20-Apr-15
Duration, days	87	94	42	223
Number of encounters with MM per day	0.95	5.60	12.07	5.00

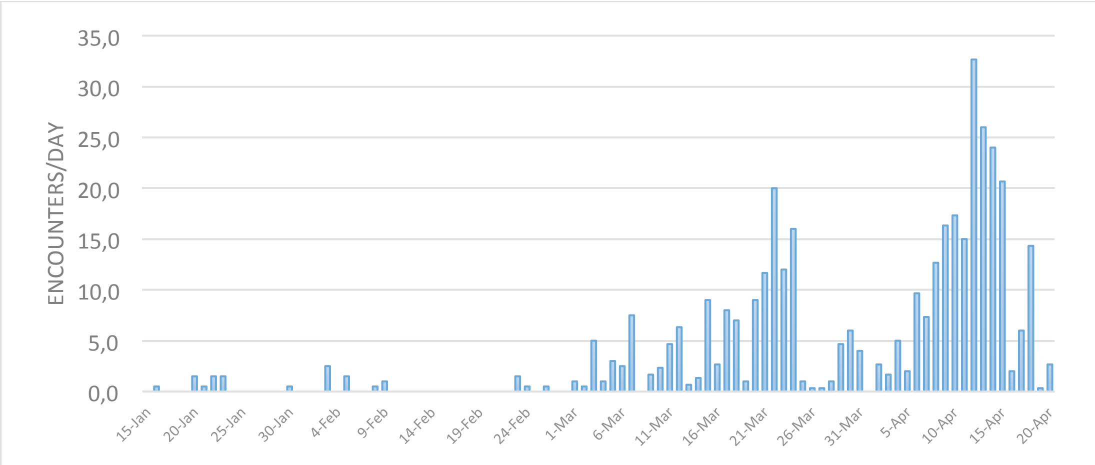

Fig. 2.1.9. Variation of MM occurrence rate in the Sea of Okhotsk in January – April 2015 (average number of encounters / day per one observer).

2.2. MARINE MAMMALS PRESENCE NEAR FISHING VESSELS, CAPTURE IN FISHING GEAR AND DEATH DURING POLLOCK TRAWL FISHERY IN THE SEA OF OKHOTSK IN JANUARY – APRIL 2015

2.2.1 PRESENCE AND BEHAVIORAL FEATURES OF MARINE MAMMALS NEAR FISHING VESSELS

Three observers based on different fishing vessels registered 11 MM species in January – April 2015 (Table 2.1.1). Some catch losses are unavoidable during fishing process (fish fall from trawl during trawling and hauling-in, off-grade fish rejection, processing waste, etc.). As a result, all animal species living in the ocean and staying in areas of man's fishing activities have an opportunity for relatively simple and easy access to food otherwise requiring much effort in a natural environment.

The vast majority of MM species met in the pollock trawl fishery in the Sea of Okhotsk did not show any reaction to or noticeable interest in operating fishing vessels neither during fish catching nor fish processing. MM can be brought into two groups in terms of interaction with vessels engaged in pollock trawl fishing – species which are neutral or indifferent to pollock fishing and species which are dependent on it or somehow interacting with it.

The first group may include the following 6 cetacean species: Dall's porpoise, killer whale, Baird's beaked whale, sperm whale, fin whale and North Pacific right whale. None of three MM observers working in the Sea of Okhotsk in January – April 2015 noticed any interactions between the above said MM species and ships or fishing gear. First of all, it should be noted that almost all cetacean species (except one species) were met extremely rarely – 1 to 9 times during the whole observation period. Detection of animals was not related to their interest in man's activities. The above said animals live in those areas of the Sea of Okhotsk where pollock is fished. Only Dall's porpoise was met near ships rather frequently. It was observed 43 times (3.9% of all observed MM). A typical common feature for all species was a short duration of the encounter and distance by far exceeding 100 m from ships. Dall's porpoises approached ships nearer than 100 m (7 times or 12% of all above said cetacean species), and only these animals altered their direction of movement and approached the ship. However, such behavior is typical of this species and was not related to the fact that the ship was engaged in fishing at that moment. Porpoises often approach ships (not only fishing ones) and accompany them for some time.

The group of MM dependent on or interacting with fishing vessels may include Steller sea lion, Minke whale, Northern fur seal, larga seal and ribbon seal. In January – April 2015, these animals showed interest in fishing vessels or reacted to their appearance in some way. As animal behavior and nature of their interaction with ships was specific for different animal species, we will briefly characterize these relationships below separately for each species.

MINKE WHALE. This whale was most frequently met near fishing vessels (55 times, 61 individuals). It was the only cetacean species obviously reacting to fishing vessels during pollock fishing and changed its behavior when doing so. It appeared in ship's immediate vicinity during trawling operations related to fish catching (trawl heaving-out, trawling or hauling-in) in 74% of cases. When watching this whale, one may normally see it on the water surface only one time and rarely two or more times. A specific feature of Minke whale's behavior near fishing vessels was that it followed the vessel for a long time (sometimes up to 15 minutes and more) behind the trawl or above the trawl and repeatedly surfaced roughly at the same distance from the vessel. Minke whale was several times registered in the place where fish processing waste was being discharged. It picked up slightly stunned or small fish falling out from the trawl or passing through its large meshes, filtered fish processing waste and fed on it. As a rule, they were solo animals, in 4 cases they were in pairs and in one case three whales were observed simultaneously. Our observers registered no adverse effects on these whales from fishing gear or ships (collisions, entanglement, injury, etc.) in January – April 2015. It should be specially stressed that all encounters with Minke whales occurred in the daylight. It was absolutely impossible to detect these animals, appearing on the surface for a few seconds only, in poor visibility conditions in dark hours.

Steller sea lion. It was the most numerous MM species during the pollock fishery in the Sea of Okhotsk in January – April 2015 both in terms of the number of encounters and number of individuals. It obviously showed increased interest in operating vessels which was reflected in its behavior. These animals purposefully approached vessels and regularly stayed near them feeding on fish falling out from trawls or on fish processing waste. None of MM met in the Sea of Okhotsk during the above said period showed such lively interest in fishing vessels as Steller sea lion. In the sampling selection of 130 trawling runs in the pollock fishery, viewed from the beginning to end, these sea lions were present near ship during 28 trawling runs (22%).

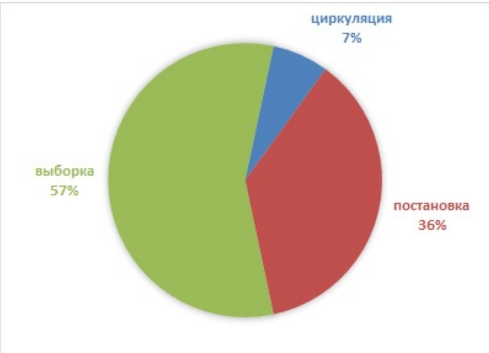

Fig. 2.2.1 Steller sea lion presence in ship's immediate vicinity depending on the nature of fishing operations (*n=30*).
циркуляция = circulation
выборка = hauling-in
постановка = heaving-out

According to visual estimates of our observers, the median of the distance at which Steller sea lions stayed from fishing vessels, was 1000 m (q_0=0, $q_{0.25}$=100, $q_{0.75}$=2000, q_1=4000; *n*=393). However, this figure reflects mostly the moment when an animal was observed first time after which the ship with the observer continued moving and approached animals or, quite frequently, animals approached the ship. Roughly in one quarter of all cases, sea lions were found in the ship's immediate vicinity at a distance of 1 to 100 m.

An average number of animals in groups was 3 to 4. Steller sea lions approached vessels both during any of fishing operations (heaving-out, trawling or hauling-in) and when vessels were adrift during catch processing. In the latter case, animals quite frequently stayed near the ship for several hours and even days. As for fishing operations, animals approached more frequently during trawl hauling-in (57%) or heaving-out (36%) and much less frequently during circulation maneuvers (7%). It should be noted that circulation maneuvers were performed rather seldom in 2015 (13% of trawling runs). In the process of trawling, when the ship started moving at a permanent speed after trawl setting, animals normally did not pursue it. If sea lions still followed the ship, they were keeping at a distance of 200-300 m from it (above the trawl) and then gradually fell behind.

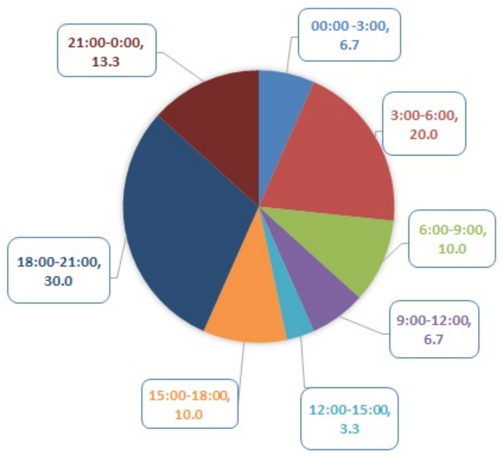

Fig. 2.2.2. Distribution of Steller sea lion presence near ship in the course of fishing operations during a 24-hour period (*n=30*).

Steller sea lions might be present near the ship in any time of the day. However, in most cases (70%) they approached the ship in the dusk or in the night. The ship performed fishing operations on a 24-hour basis and animals might stay near it also at any time of the day (Fig. 2.2.2). It is noteworthy that almost half of all cases of Steller sea lion observation near the ship occurred between 18:00 and midnight. In general, such pattern of this species' feeding behavior is consistent with the pattern of its feeding activities during the day and in the summer season (Burkanov et al., 2011). In daylight hours, animals normally take rest at rookeries and in the dusk they proceed to sea for feeding. Our observers noted during the pollock fishery that this sea lion's feeding activity was significantly lower in the daylight than in the dusk. In daylight hours, animals were frequently sleeping on ice and giving no attention to operating vessels.

Let's dwell on most typical features of Steller sea lion behavior near fishing vessels. As a rule, animals appeared near the ship at the moment when otter boards approached the stern or slightly later – at the time when the trawl bag was hauled in. Animals staying in 1-1.5 km from the ship were quite frequently seen, upon hearing the sound of a working warp winch, to change their course abruptly and head for this sound at a high speed (Fig. 2.2.3). Their behavior near the ship was similar in virtually all cases: they approached the location where the trawl emerged on the water surface and started feeding pulling fish from under its rim or picking up small fish falling out from it (Fig. 2.2.4).As hauling-in proceeded, animals were coming closer to the ship but in some cases they still kept at a significant distance from it. After the trawl was hauled in, animals stayed near the ship for some time picking up remaining fish. If the plant was in operation at that time and processed fish, sea lions quite frequently continued feeding near scuppers. If the next trawl heaving-out operation was performed and the trawl was thrown onto the water, animals also came to it and fed on fish from under its rim. They often were not present near the ship before trawl heaving-out and appeared near its board only after the warp winch started operating. Its sound is audible at a great distance and animals well distinguish it as it is a signal for them to start getting food. It is fish falling out from the trawl both during hauling-in and heaving-out that attracts animals.

An operating warp winch probably attracts Steller sea lions during ship's U-turns with its trawl in the water (circulation maneuver). We observed as sea lions staying at a distance of more than 1 km from the ship started moving at a high speed to the trawl after hearing the sound of the

Fig. 2.2.3. A group of Steller sea lions hurrying to the ship upon hearing the sound of the warp winch

Photo by I.A. Usatov

Fig. 2.2.4. Steller sea lions feeding on fish falling out from the trawl during hauling-in

Photo by Yu.B. Artyukhin

winch pulling the trawl to the surface for an U-turn. The trawl was at a depth of about 50 m during its U-turn. Upon reaching the trawl location, animals started diving and stayed 1 to 3 minutes under the water (up to 5 minutes in one case). They stayed above the trawl during the entire duration of its circulation maneuver and moved away from the ship only when circulation was finished and the trawl was lowered back to the trawling horizon. As trawling in the pollock fishery is performed at depths of 200-300 m, Steller sea lions are likely to be unable to dive deeply enough to reach the trawl at such depths and simultaneously follow it at a speed of 3-4 knots (ship's average speed during trawling). This can explain the fact that there were few Steller sea lions near the ship during trawling runs.

Steller sea lions also approached ships lying adrift to feed on catch processing waste or on off-grade fish. The duration of their stay near a ship lying adrift varied in a broad range from a few hours to several days. The presence of these sea lions near ships even when there are no fishing or fish processing activities under way (43% of cases of their presence near ships lying adrift) is explained, in fishermen's opinion, by their desire to warm up in the water flowing out of scuppers which is considerably warmer than sea water. As soon as the ship starts moving, animals stop following it and quickly disappear.

The sex and age composition of sea lions near ships is virtually identical to that in pollock fishing areas (see Chapter 2.1). Males (half-bulls and bulls) and juvenile animals were dominating. Females were observed rarely. It is worth reminding once again that it is sometimes extremely difficult to identify an animal's sex and age near ship as many encounters occurred in the night time. Probably, males' dominance is explained also by the fact that they are much larger and easier identifiable in the dusk and in the night.

NORTHERN FUR SEAL. In most cases (77%), fur seals stayed at a distance of 300 m or closer to fishing vessels. Although fur seal belongs to one family (Otaridae) with Steller sea lion and is its close relative, its behavior near fishing vessels was absolutely different. Fur seals were normally indifferent to presence of fishing vessels. Their behavior did not change nor depend on the nature of fishing operations performed by the ship. They were active in roughly 80% of cases – moved in the water, surfaced at different distances from the ship, stayed on the surface for a short time and dived again. They were never observed purposefully moving toward the ship or actively feeding on fish near the trawl or on offal near scuppers which is quite typical of Steller sea lions. Fur seals live in pollock fishing areas and pollock is common in their diet. However, they appear near ships accidentally, probably because their feeding areas coincide with pollock trawl fishing areas. Both man and animals use same fish aggregations for their purposes but no obvious and active interactions were observed between Northern fur seal and fishing vessels in January – April 2015.

LARGA SEAL. This seal was met 11 times (5% of all encounters) near fishing vessels during the pollock fishery (23 individuals). Animals stayed at a distance of 1-60 m and up to 1 km. All animals were on ice at the time of observation. Encounters with larga seal in the pollock fishery began in March or April when it goes out onto ice for breeding. In 89% of cases, animals were represented by family groups consisting of a male, female and pup or one of parents and pup (Fig. 2.2.5). Larga seals did not show any interest in operating vessels. However, fishing vessel operations in vicinity of their breeding areas noticeably disturbed them. When a ship approached them, animals became worried and escaped into the water. Normally, the male was the first to leave the ice floe and, when distance to the ship shortened, was followed by the female. The pup stayed on ice alone. If the ship moved onto the ice floe, the pup also escaped into the water (Fig. 2.2.6). The female normally stayed near the pup at all times.

Fig. 2.2.5. Two family groups of larga seals together with white coat pups

Photo by I.A. Usatov

We have met a small number of larga seals during the entire observation period. Nonetheless, the level of harassment by ships operating in this seal's breeding areas is very high. All animals found closer than 200 m from the ship normally started moving around the ice floe in panic and escaped into the water (Fig. 2.2.7). As scores of vessels engaged in pollock fishing repeatedly cross their haul-out locations, larga seals are continuously exposed to harassment. In March–April 2015, observers did not note any other adverse impacts on larga seal caused by fishing fleet operations (injuries due to collision with warps or ships, etc.). Only once they observed one emaciated larga seal pup but the reason for its emaciation might not be related to fishing fleet operations. In all other cases, pups and adult larga seals looked well-fed.

Fig. 2.2.6. A larga seal pup tries to escape into a crack fleeing from the ship advancing onto the ice floe. Photo by I.A. Usatov

Fig. 2.2.7. Panic escape into the water of a female larga seal after the ship approached to the ice floe on which its family group was staying. Photo by I.A. Usatov

RIBBON SEAL. This species was met 52 times (48% of all encounters) during the pollock fishery. Our observers detected these animals from a distance of up to 1.5 km. An average distance from animals to the ship at the moment of encounter was 555±6.4 m (n=46; median 500 m). Ribbon seal behavior was similar to that of larga seals. Both species were indifferent to ship's fishing operations. They were never observed feeding near scuppers or trawls. In quantitative terms, occurrence of family groups was noticeably lower for ribbon seals than for larga seals. White coat pups were observed only in 23% of cases. Solo animals escaped from ice into the water when a ship approached to a distance of 100 m or closer. Pups normally stayed on ice and were forced into the water when the ship made a contact with the ice floe or proceeded toward it (Fig. 2.2.8).

Fig. 2.2.8. A ribbon seal with its pup escaping into the water being disturbed by a passing ship towing a trawl. Photo by S.V. Fomin.

No cases of ribbon seal being injured due to interaction with ships or fishing gear were registered in 2015.

2.2.2. CAPTURE IN TRAWLS AND DEATH OF MARINE MAMMALS

MM observations in the pollock trawl fishery in the Sea of Okhotsk in 2015 were a first-ever effort of this kind. As no published data on MM by-catch in this type of fishery are available and the number of observers was very limited (3 persons), all of them were based in the first season on the PCA's most numerous vessel type – large-tonnage vessel group. MM by-catch registry was the key task assigned to MM observers during their work at sea.

3 vessels with observers on their board performed 522 trawl hauls during the entire fishing period. As illustrated in Fig. 2.2.9A, hauls were performed on a 24-hour basis. As the only observer on each ship was unable to work round the clock, it was recommended to choose hauls for MM by-catch monitoring such that they evenly covered during the day. Altogether, observers personally inspected 334 hauls (64%) during the entire fishing season, beginning from trawl heaving-out to the end of hauling-in and catch pouring.

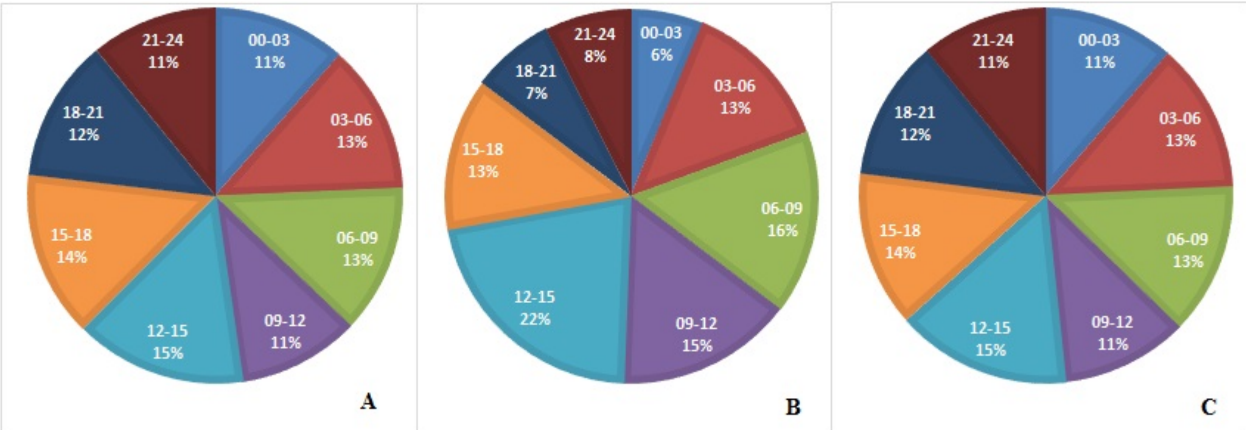

Fig. 2.2.9 Round-the-clock distribution of hauls and MM by-catch observations on three monitored ships during the pollock fishery in the Sea of Okhotsk in January – April 2015
***A** – distribution of hauls; **B** – distribution of direct observations of hauls; **C** – distribution of direct observations together with viewing of recorder data.*

The actual round-the-clock distribution of hauls is presented in Fig. 2.2.9B. In general, it can be stated that distribution of direct observations of hauls was sufficiently close to the frequency of actual hauls during a 24-hour period. Still, the intensity of observations was lower in the night time (from 18:00 to 03:00, Fig. 2.2.9B). The explanation is a high intensity of MM observations during daylight hours and need for documenting daylight observations in the evening.

As photo recorders were installed on all vessels and were in use during the greater portion of time, the frequency of haul inspections using photographs might be increased to 503 (96%) and their round-the-clock distribution might be very close to the frequency of actual hauls (Fig. 2.2.9C). Unfortunately, these recorders operated in a test mode and were not mounted in locations most optimal for MM by-catch monitoring. Camera locations on two ships were not suitable for reliable control of catch pouring (more details see below in Chapter 2.4, see also Fig. 2.4.3–2.4.7) and because of that capture and by-catch of small MM might remain unnoticed. It is due to this reason that we don't use photo recorder data for by-catch analysis in 2015.

During hauls covered by direct visual control on all 3 ships, one MM individual was captured in trawl and died – a ribbon seal (16 March 2015, the BMRT *Pilenga-2*). This animal was captured during trawling between 09:00 and 12:00. It was a juvenile animal (female, 1 year) of a small size. The animal passed together with fish into the accumulation bin during catch pouring from cod-end to bins and the observer did not notice it. As fish was processed and proceeded from the bin to the processing plant, the animal stuck in a narrow hole connecting the bin with the conveyor feeding catch to the processing plant and blocked fish supply to the plant. In order to unblock the hole, plant operators had to cut the carcass and extract it by pieces. The observer identified the animal by these pieces. No other cases of MM by-catch were registered by observers in the hauls controlled by them in 2015.

Up to 83 large-tonnage vessels were simultaneously operating in the pollock fishery in the Sea of Okhotsk in January – April 2015. Therefore, ship coverage by observers was 3.6%. Ship's daily catch reports were submitted by an average of 54±1.5 (n = 90, min = 4; max = 73) ships of BMRT, BATM, RTM, RKTS, RTMKS, RTMS and MRKT types. They performed a total of 14,693 hauls during the entire fishing season (data from the Industry Information System (IIS) "Monitoring" were provided on our request by the Kamchatka Branch of the Center for Fisheries Monitoring and Communication (KB CFMC). Our observers covered 334 hauls by direct visual observations which accounted for 2.3% of all hauls performed by large-tonnage fleets. Only one ribbon seal individual was observed in controlled hauls. Based on the assumption that ribbon seal capture in trawls is consistent with normal statistical distribution, we obtain the value of ribbon seal capture in trawl and death on large-tonnage vessels in 2015 at 0.00299 individuals per 1 haul. Upon referring this figure to all hauls performed by large-tonnage fleets, we obtain a mortality rate of 44 individuals for this species. Given that its abundance in the Sea of Okhotsk exceeds hundreds of thousands of individuals, we can conclude this species' by-catch by large-tonnage fleets in 2015 was insignificant.

In order to evaluate by-catch of other MM species, we should make provision for the fact that they were not observed in trawls of large vessels. Assuming once again that their capture is in line with statistical normal distribution laws, we can conclude that the rate of capture of other species during the 2015 fishing season in the Sea of Okhotsk was lower than that of ribbon seal. The estimated number of other species by-caught during the entire fishing season was smaller than the figure obtained by us for ribbon seal. Such mortality rate (i.e. less than 44 individuals) in the pollock trawl fishery in the Sea of Okhotsk would be insignificant even for Steller sea lion given its current estimated number of 25-28,000 individuals (Burkanov et. al., 2012).

Based on above said estimations, we might have concluded that the pollock trawl fishery in the Sea of Okhotsk does not have any significant effects on MM populations living in this area. However, we have to refrain from such conclusion because of a number of circumstances and above said assumptions.

First, not only large-tonnage vessels are engaged in pollock trawl fishing in the Sea of Okhotsk. 66 medium-tonnage vessels of various types (SDS, SRTM, SRTR, STR, TSM and custom-built) were also engaged in fishing in 2015. The average number of such ships operating per day was 35±1.5 (n = 89, min = 8; max = 56) and they performed 5505 hauls (data by CFMC). It should be specifically noted here that MM by-catch observations have never been performed on medium-tonnage vessels in the Sea of Okhotsk including the year of 2015. Because of that, we are unable to make even a preliminary estimate of MM direct mortality rate due to impacts from this group of ships.

Second, the vessels covered by observations in 2015 used only four trawl types – mid-water trawl 154/1120 m pr. 342 EKB (BMRT *Moskovskaya Olympiada* and *Baklanovo*), mid-water trawl 126/800 m pr. 091 NBAMR Fishing Gear Factory, mid-water trawl 158/880 m Podyapolsk settlement Fishing Gear Factory, Primorsky region and mid-water trawl 126/800 m pr. 091 NBAMR Fishing Gear Factory. Three latter types were used by one ship – BMRT *Pilenga-2*. By CFMC data, large-tonnage vessels alone were using 26 mid-water trawl types in January – April 2015. Different trawl types have different efficiency of target species capture and, consequently, MM accidental by-catch in different fishing gear may also be different.

Furthermore, medium-tonnage vessels used 9 trawl types in the pollock fishery in the Sea of Okhotsk in 2015 (data by CFMC). Therefore, we need to know information about animal capture in different trawl types and on different vessel types to make any substantiated conclusions on MM accidental by-catch and mortality in the pollock trawl fishery. Such assessment of MM by-catch in fishing gear has never been performed for the pollock trawl fishery in the Sea of Okhotsk.

Third, as was said above, we assumed, when calculating MM capture frequency, that this value is consistent with statistical laws for normal distribution. In reality, this is not so. In most cases, the distribution of data on MM capture in fishing gear significantly differs from normal distribution. Therefore, use of the arithmetic mean and other normal distribution parameters for evaluation of MM by-catch in the pollock trawl fishery in the Sea of Okhotsk may lead to incorrect results. Marine animals get captured in fishing gear in an extremely uneven pattern. During a lengthy portion of the fishing season, no animals at all or few animals are captured in fishing gear. At some moment of the fishing season (or in case of particular fishing gear types, vessel types, fishing areas, weather conditions, etc.), MM by-catch becomes high and even extremely high. Some fishermen report exactly such pattern of Steller sea lion capture in trawls in the pollock fishery (see Chapter 2.3 Fishermen Interviewing). Therefore, one observation cycle is absolutely insufficient for understanding of trends in MM capture in trawls in the pollock fishery in the Sea of Okhotsk, because it controlled less than 3% of vessels and less than 2% of hauls (collectively for large- and medium-tonnage vessels).

In summary, we cannot make any substantiated conclusion on the degree of direct impacts of the pollock trawl fishery on MM being based only on MM by-catch and mortality observations in in the Sea of Okhotsk in January – April 2015.

2.3. ASSESSMENT OF POTENTIAL FOR COLLECTION OF INFORMATION ABOUT MARINE MAMMALS BY FISHING VESSEL CREWS

Analysis of Marine Stewardship Council (MSC) logs. In 2014, PCA prepared special logs for registry of MM and bird by-catch to be kept by fishing vessel crews in fishing areas. These logs were disseminated to ships together with recommendations on record keeping procedures. The key purpose of this effort was to obtain information about MM and bird capture in trawls from fishermen themselves. Provided that crews perform this duty conscientiously, such data may become important additional materials and assist in evaluations of MM and bird by-catch.

Such logs had been delivered to ships in the beginning of the fishing season. In June 2015, KB PIG FEB RAS received from PCA logs from 12 ships. We were also informed that such logs had been kept by two more vessels but were lost during delivery to PCA. Ship masters reported only that no cases of MM and bird capture in trawl and by-catch had been registered. Thus, we had MSC logs from 12 ships and 'no by-catch' information from 2 ships for analysis.

94 PCA ships took part in the pollock fishery during "A" season in 2015. Thus, this study covers 15% of ships holding membership in PCA. The timing and duration of each ship's operations are presented in Table 2.3.1. All 12 PCA ships submitting MSC logs in 2015 used mid-water or pelagic trawls for pollock fishing in the Sea of Okhotsk. Two ships owned by Tikhrybcom LLC used an "RT/TM mid-water trawl" missing in the fishing gear list available in IIS "Monitoring" in 2015. This means that, according to SDR data, ships did not use this trawl type in the pollock fishery in the Sea of Okhotsk in 2015. A mid-water trawl 210/720 m is indicated in logs submitted by 10 ships owned by PAO NBAMR. According to statistical information in IIS "Monitoring", this trawl was used only by 4 ships in the pollock fishery in the Sea of Okhotsk in 2015. Although all ships received same logs and same record keeping instructions, they filled in them differently. For instance, MSC logs from 10 ships owned by PAO NBAMR contained only entries with fishing start and end dates, trawl name and master's name. The rest fields in the log were empty. These logs contain no information about animal or bird capture in the trawl or about intervals in catching (harvesting) of aquatic living resources due to some reasons (bad weather conditions, equipment repair, receipt of supplies, etc.) as specified in log keeping recommendations. We may assume only that no cases of animal by-catch or death were registered in all these ships. One ship (MRTM *Sea Hunter*, Tikhrybcom LLC) entered fishing coordinates in its log every day during the entire fishing period with a comment that no by-catch was registered. Only one ship provided data on bird capture (MFT *Morskoy Volk*, Tikhrybcom LLC). It was glaucous-winged gull in 4 cases and fulmar in one case. All birds were alive and released. There were no additional data on bird capture in the logs.

Table 2.3.1. Information about duration of operations and timing of MSC log keeping by PCA ships.

Ship	**Start of log keeping**	**End of log keeping**	**Total days in fishery**
MRTM *Sea Hunter*	2-Jan-15	10-Apr-15	98
BMRT *Alexander Belyakov*	7-Jan-15	5-Apr-15	88
BMRT *Ardatov*	6-Jan-15	2-Apr-15	86
BMRT *Astronom*	27-Jan-15	6-Apr-15	69
BMRT *Aeronavt*	3-Jan-15	4-Apr-15	91
BMRT *Ilya Konovalov*	3-Jan-15	4-Apr-15	91
BMRT *Kapitan Maslovets*	28-Jan-15	8-Apr-15	70
BMRT *Kapitan Faleev*	3-Jan-15	7-Apr-15	94
BMRT *Mekhanik Bryzgalin*	13-Jan-15	4-Apr-15	81
BMRT *Nikolai Chepik*	17-Jan-15	4-Apr-15	77
BMRT *Pelagial*	22-Feb-15	7-Apr-15	44
MFT *Morskoy Volk*	1-Jan-15	5-Apr-15	94

In logs from 10 ships, fishing areas were indicated in the form of an arbitrary abbreviation consisting from letters but not as FAO codes as required by the record keeping instruction.

In total, 12 MSC logs contained information about 5 cases of seabird capture. No cases of MM capture or interaction with fishing gear were registered.

Fishing vessel crews have potentially ample opportunities for collection of information relevant to monitoring of pollock trawl fishery interactions and impacts on other biota species of the Sea of Okhotsk including MM and birds. Fishermen control their ship and all mechanisms used for fish catching on a 24-hour basis and they grade and process catches. In fact, no capture in trawl or injury of MM and even birds can remain unnoticed by at least one crew member. It is on this assumption that the idea of a special log for bird and animal by-catch registration by ship crews was based.

Unfortunately, analysis of received MSC logs and actual data collected by observers working in the same season and in the same fishing areas as well as data of IIS “Monitoring” shows that fishermen were completing these logs for the sake of appearances only. Only one log contained data on bird capture but no circumstances were specified. It is doubtful that birds could be captured in trawls and lifted to deck alive. More likely, they turned out on deck after striking against ship’s side or equipment (wires, aerials, etc.) rather than due to capture in trawl. Data on fishing gear indicated in MSC logs do not match fishing gear codes specified in IIS “Monitoring” (two ships owned by Tikhrybcom LLC) or are in contravention with data contained in this system.

There may be several reasons for fishermen’s inattentive attitude to PCA recommendations on MSC log keeping. First, the psychological factor plays an important role. Fishermen intuitively fear for adverse results of such information disclosure. These results may include unexpected penalties or ban on fishing or other sanctions leaving them without work or making their work much less effective in economic terms. Secondly, there are no unoccupied persons on a fishing vessel. Every crewman's duties are strictly regulated and his time is distributed between watches. All crew members perform their direct job duties during the greater portion of their work time. They are short of time even for rest to say nothing of observations and regular registration of animals and birds capture, injury and death. The third reason for such attitude to MSC log keeping is full lack of any interest, either financial or any other, in collection and recording of required information because, by their words, no incentives are provided for this additional work.

FISHERMEN INTERVIEWING. Fishermen were interviewed at sea by 3 observers. This method included collection of information through radio exchanges, filling of questionnaires during personal contacts and obtaining data from crews of ships which voluntarily agreed to perform observations and provide information about encounters with MM and their capture in fishing gear.

The attempt to collect information through radio interviews totally failed. Ships operating nearby obviously revealed no enthusiasm in discussing MM by-catch issues by radio. Success of an interview largely depends on respondent's trust in interviewer. It was just impossible to make an informal contact with interviewees by radio. In most cases, answers to questions about MM encounters and by-catch were 'no such cases' and radio interviews normally ended in a promise to collect requested information and forward it to our observer at the end of the voyage.

Fishermen interviewing during personal meetings turned out to be a more effective method. Unfortunately, it was limited to questioning crewmen of ships on which our observers were based and of cargo ships on which they proceeded to/from the fishing area. If our observers managed to pass to other ships during a cargo transfer operation, they discussed this issue with their crewmen as well. A total of 33 persons were interviewed. Of this number, 4 persons provided extremely general and non-informative data. Data received from these interviewees were omitted in further analysis. Thus, results of 29 interviews were eventually used in our analysis. All respondents fall under 5 groups by their job duties: ship masters, ship officers (deck officers and production staff), trawl masters, winch operators and sailors. The proportion of their professions is shown in Fig. 2.3.1. 28 interviewees were based on large-tonnage vessels of BATM, BMRT, RTMS and other types in their 1 or 2 preceding voyages. Only one person worked on board a medium-tonnage vessel ("schooner") which was engaged in fish catching only.

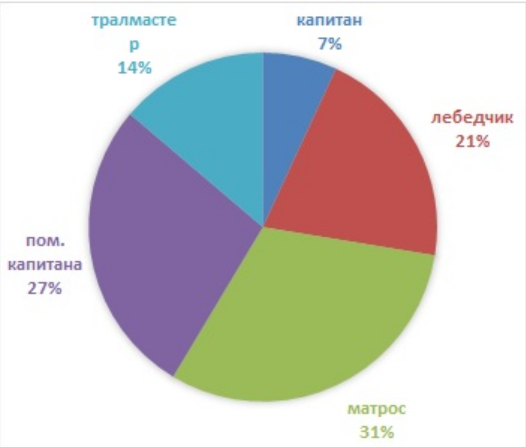

Fig. 2.3.1. Professions of interviewees *(n=29)*.
Тралмастер = trawl master, капитан = ship master, пом. капитана = deck officer,

лебедчик = winch operator, матрос =sailor

Mid-water wire trawls pr. 154/1120 or similar were used as fishing gear. The interviewees were unable to provide more detailed data on used trawls. A Danish seine was used on the above medium-tonnage vessel for pollock fishing. The interviewees were asked questions about pollock fishing in the Sea of Okhotsk in their previous voyages in 2013-2014. The majority of them (86%) did participate in the pollock fishery in previous years. When asked whether they had met Steller sea lions during pollock fishing in the Sea of Okhotsk, the vast majority (86%) said "yes" and as for this animal's occurrence rate they said "often" or "very often". Two persons (7%) could not answer this question and two (7%) said "no". When asked about Steller sea lion relative spatial distribution, all interviewees answered that during pollock fisheries it is met more frequently in the north of the Sea of Okhotsk (in ice-covered area) and much less frequently in the south – in Kamchatka-Kuril sub-zone. When asked about fishing operations during which Steller sea lions approached ships most frequently, the majority answered "during trawl hauling-in and/or trawling", two answers were "sea lions approached when the ship was adrift" and one answer was "any operations".

When asked about Steller sea lion by-catch in trawl, 11 interviewees (38%) (all from large-tonnage vessels) said "yes", 15 ones (52%) said "no" and 3 persons (10%) were unable to answer this question (Fig. 2.3.2).

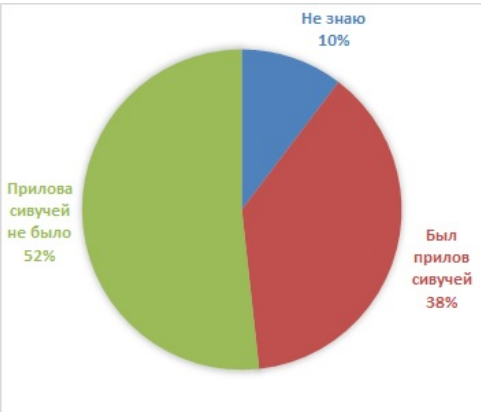

Fig. 2.3.2. Distribution of answers to question "Were there any cases of Steller sea lion by-catch in trawl?" (*n=29*).
Не знаю = I don't know, Прилова сивучей не было = No Steller sea lion by-catch, Был прилов сивучей = Yes, there was Steller sea lion by-catch

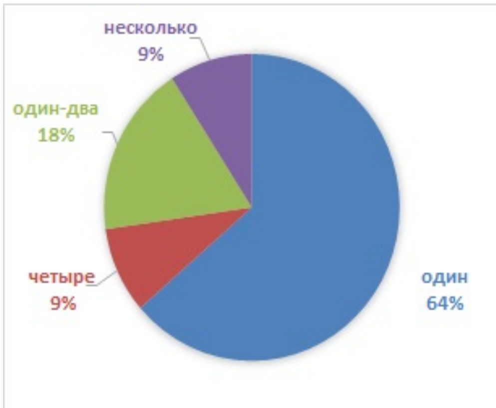

Fig. 2.3.3. Distribution of answers to question "How many were there cases of Steller sea lion capture in trawl per voyage?" (*n=11*).
Несколько = several, один-два = one or two, четыре = four, один =one

One interviewee who had worked on a medium-tonnage vessel with a Danish seine answered "no" to the question about by-catch in 2013-2014 but added that Steller sea lions were captured in trawl in earlier years. It is interesting to note the breakdown by profession of interviewees who said "yes" to this question: of 11 persons, 3 (27%) were deck officers and all others (73%) trawling watch members. Of 15 persons who answered "no" to the question about Steller sea lion capture in trawl in one or two latest voyages, 4 explained that sea lions had been captured earlier, "a few years ago", "in other fishing areas" "when fishing for other target species (squid, herring)". These 4 persons were also trawling watch members. 5 persons (45%) of remaining 11 who answered that they had had no experience of Steller sea lion capture in their fishing practices or were unable to answer this question, turned out to be ship masters of deck officers. If we take interviewed officers only (ship masters and deck officers), 7 persons (70%) from this group of 10 interviewees answered “no” to the question about by-catch or were unable to answer it. And, vice versa, of 19 interviewed trawling watch members, only 7 persons (37%) answered “no” or were unable to answer the question about Steller sea lion capture in trawls. The reason for such contrast in distribution of answers may be both lower awareness of navigating bridge personnel of animal capture facts and lower degree of officers’ trust in the interviewer. Ship officers more often deal with “inspections” of various kinds and may withhold (“unable to answer”) or negate animal capture facts to avoid any unpleasant consequences due to accidental by-catch of Steller sea lions.

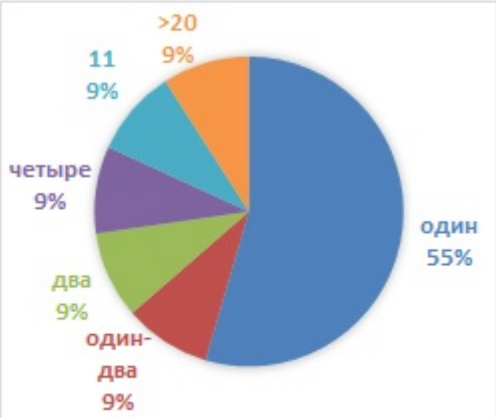

Fig. 2.3.4. Distribution of answers to question “How many Steller sea lions were accidentally captured in trawl during voyage?” (*n=11*). Четыре = four, два = two, один-два = one or two, один =one

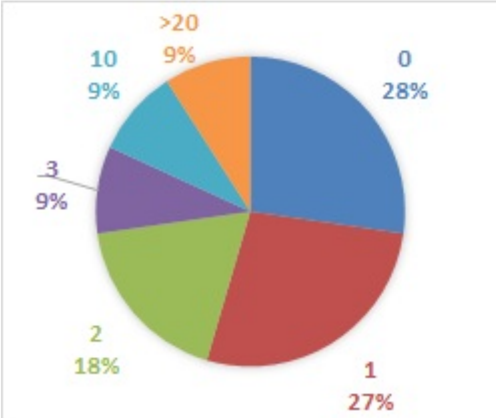

Fig. 2.3.5. Distribution of answers to question “How many Steller sea lions captured during voyage were dead?” (*n=11*).

When asked how many cases of Steller sea lion capture in trawl occurred per voyage, 7 persons (64%) of 11 interviewees who answered “yes” to the preceding question said that there was only one case per voyage, 2 persons (18%) said that there were one or two cases and one person each said: “four” and “several” (Fig. 2.3.3).

When asked how many Steller sea lions were accidentally captured in trawl per voyage, 6 persons said “one”. The rest 5 persons answered differently: “one or two”, “two”, “four”, “eleven” and “more than 20” (Fig. 2.3.4). When asked how many Steller sea lions captured during voyage were dead, 3 persons said that all sea lions were alive, three persons said that only 1 sea lion was dead and one person each said that 3, 10 and more than 20 sea lions died in by-catch during voyage. The interviewee who said about death of more than 20 sea lions specified that fishing was performed in the autumn near Iona Island (“the island was seen from our ship”) and off the northern half of the eastern coast of Sakhalin Island.

When asked what trawling method was used and at what moment of the trawling operation (heaving-out, trawling, circulation, hauling-in) animals were captured, the majority of interviewees had difficulty in answering. Two persons said that animals are captured during hauling-in when trawl slows down and it is “easier” for them to enter into it. One interviewee explained that Steller sea lions hardly get into trawl during circulation because this maneuver is rather “tough” and it is much harder for animals to enter into trawl at this moment than during hauling-in.

Answers to the question about the size of captured animals were distributed almost evenly in the range from small “pups” to large “mature” bulls. Therefore, we may conclude that juvenile and adult Steller sea lions are captured in trawl. Fishermen were unable to characterize the ratio of small and large individuals among encountered animals because they did not pay attention to that.

All interviewees pointed out that live animals were released back into the sea after being extracted from trawl. When doing so, crewmen met difficulty both in extraction and release of live sea lions particularly large bulls. Animals did not wish to go to the water through the stern ramp although, in fishermen's opinion, it was the shortest, safest and free way of escape. They tried to drive animals by sticks or water from fire hoses, put a rope, cod-end or even part of the trawl under them to force them away from deck and used even electric welding sparks. Sometimes it took more than hour to drive the animal from deck. All interviewees pointed out that animals always left the ship by jumping over its side and never escaped via the stern ramp.

22 persons answered the question on capture of other MM species. Only one of them said "yes" but added that it was a long time ago (not during one or two previous voyages) and there were 2 species in by-catch – Northern fur seal and larga seal. The rest interviewees answered "no" to this question.

In summary, based on results of interviews with fishermen on fishing vessels in the Sea of Okhotsk, we can make the following conclusions:

- Steller sea lions live in all pollock fishing areas in the Sea of Okhotsk but fishermen meet them more frequently in its northern part, particularly in vicinity of floating ice at the entrance to Shelikhov Bay, along the northern coast, near Iona Island and off the eastern coast of Sakhalin. These sea lions are observed less frequently off the western coast of Kamchatka, particularly near its southern half. Our ship-based observers also noted this trend in January – April 2015. Probably, such distribution pattern in the Sea of Okhotsk and in fishing areas may be explained by fact that it is much easier to notice these dark-colored animals on ice than afloat in the water. It is also possible that Steller sea lions may gravitate toward ice and use ice floes for rest during intervals between foraging rounds. Both fishermen and MM observers noted this circumstance.
- Fishermen cannot distinguish Steller sea lions by sex and age. In this connection, we tried to assess these parameters based on the size of animals (juveniles and females are much smaller than mature males). Fishermen report that they meet animals of different sizes during pollock fishing in the Sea of Okhotsk, ranging from small "pups" to big "mature" animals. However, it was not practicable to evaluate the ratio of age groups or sex composition of animals by so vague indicators. The majority of interviewees paid little attention to the size of animals and could not say which animals had been more numerous during encounters – small or large.
- Steller sea lions regularly approach fishing vessels during fishing operations. This happens more frequently during trawl hauling-in and less frequently during trawling but there are also fishermen's observations that Steller sea lions approach ships during any operations and follow ships for some time. Groups of several scores of animals sometimes stay near the ship for a long time when it lies at anchor or is adrift, particularly when the ship is processing catch on waste from which they feed.
- Fishermen say that Steller sea lions are captured in trawls as by-catch. This happens regardless of the crew's willingness or actions. It is not practicable to evaluate the occurrence rate of animal capture in trawls based on a small sampling selection of interviews with

fishermen. We can only conclude that this phenomenon is rather common than rare as nearly 40% of interviewees confirmed Steller sea lion by-catch on ships on which they had worked during one or two previous pollock fishing voyages. The vast majority of them had been based at that time on large-tonnage vessels.

- Quantitative data on Steller sea lion by-catch (number of captures per voyage, number of animals per capture, number of animals captured per voyage, etc.) broadly varied in fishermen's answers. The majority of fishermen who confirmed Steller sea lion by-catch noted one capture in trawl per voyage and only one captured animal. But there were also cases of more than one capture and capture of 10 and even more than 20 individuals per voyage. Obviously, Steller sea lion by-catch in pollock trawl fishing is an extremely variable parameter. A large number of animals in by-catch is a rare case. Fishermen were unable to indicate reasons for sea lion capture in trawls. In most cases, they remembered the fact of animal by-catch but could not remember any details.
- Fishermen noted both live and dead Steller sea lions in by-catch. The number of dead sea lions found in trawls obviously exceeds the number of live ones (approximate proportion is 1:3). Fishermen describe the condition of live sea lions as a stress. They lose orientation and virtually never leave the ship on their own. They have to be driven away and this poses much difficulty for crews.
- Other MM species get captured in trawls much less frequently than Steller sea lions. The interviewed fishermen indicate at occasional capture of Northern fur seal and larga seal.

2.4. ASSESSMENT OF POTENTIAL FOR AND DEVELOPMENT OF AUTOMATIC PHOTO AND VIDEO RECORDING METHODS FOR BY-CATCH OF MARINE MAMMALS

Automatic photo and video recorders are widely used for man's economic purposes and in households in recent years. Their quality and reliability improves from year to year while prices go down. There are affordable models of self-sustained and automatic recorders currently available in the market which may be suitable for MM by-catch monitoring purposes. Use of automatic photo or video recorders on PCA fishing vessels in pollock trawl fishery in the Sea of Okhotsk may essentially reduce costs of MM accidental by-catch and death monitoring, improve reliability of collected information and comply with MSC certification requirements.

In January – April 2015, KB PIG FEB RAS researchers tested on 3 PCA vessels photo and video recorders of two types: PlotWatcher PRO manufactured by Days 6 Outdors, LLC (http://www.day6outdors.com) and Bushnell 436 manufactured by Bushnell (http://www.bushnell.com). Unfortunately, PCA had only limited funds for financing of MM by-catch studies in the pollock trawl fishery in the Sea of Okhotsk in 2015 and KB PIG FEB RAS did not have any funds available for equipment purchases either. Due to these reasons, observers spent their own money to buy several recorders of both types. Both camera models had an autonomous power source from Ni-Mn batteries of AA type (8 pieces 2500 mAh). Photographs were recorded on a standard memory card SD 16 or 32 Gb. The set also included a battery charger and software for record copying and viewing on a computer.

Cameras were used first time for such work. Our observers mounted them in different locations on the ship to select a better point for photographing: in the wheelhouse near the window overlooking working deck, on the stern portal and in winch operator's cabin (Fig. 2.4.1 – 2.4.7). All mounting locations were preliminary agreed with the ship master.

Cameras were also tested for registration of trawling parameters to investigate the reasons for and details of trawling runs resulting in Steller sea lion capture. Captured animals are found in by-catch already after the trawl is lifted to ship's board when it is often impossible to recover details of this trawling operation (speed, depth, ship and trawl's maneuvers, fish aggregation records, etc.). A photo recorder allows for full recovery of details of the trawling operation resulting in animal capture and this information may help understand the reason for and circumstances of such cases.

Shooting intervals were tested as follows: 1, 5, 10, 15 and 60 seconds for cameras intended for working deck photographing, and 1to 5 minutes for cameras monitoring trawling control instruments.

Table 2.4.1. Performance data of photo recorders used for MM by-catch observations in the pollock fishery in the Sea of Okhotsk in 2015

Parameters	Bushnell 436	PlotWatcher PRO
General view		
File Format:	Picture, Video	AVIformatwithTLVextension
Image Sensor	5 Megapixel Color CMOS	n/a
Maximum Pixel Size	3264x2448 (8MP)	n/a
Lens	F = 3.1; FOV=50°; Auto IR-Cut-Remove (at night)	Zoom and Wide Angle
Display Screen	Std B&W Display: 24x32mm(1.5”) ; Color Display: 32x42mm (2”)	2.7” TFT LCD
Memory Card	SD or SDHC Card, Maximum capacity 32GB	SD or SDHC Card, Maximum capacity 32GB
Picture Size	8MP = 3264x2448; 5MP = 2560x1920; 3MP = 2048x1536	n/a
Video Size	720x480/30 fps, 640x480/30fps, 320x240/30fps	720P HD Video (1280 x 720)
Operation	Day/Night	Light-based, Time-based, Always On
Triggering Interval	1sec. - 60min. programmable	1, 2, 3, 5, 10, 20, 30 seconds 1, 3, 5, 10, 20, 30, 60 minutes
Video Length	5-60sec. programmable	
Power Supply	8xAA recommended, 4xAA as emergency power	8xAA recommended, 4xAA as emergency power
Stand-by Current	< 0.3 mA(<7mAh/day)	About 0.05 mA(<1.2 mAh/day)
Duration work	About 4 day with interval 1 minute, power Supply-8xAA	About 40 day with interval 1 minute, power Supply-8xAA
User Interface	LCD display	LCD display
Interface	TV out (NTSC/PAL); USB; SD card holder; 6V DC external	5.5mm x 2.1mm DC Power Plug
Operating Temperature	"-20 - 60°C (Storage temperature: -30 - 70°C)"	"-28,89°C to 43,33°C (limited display below -9,44°C)"
Operating Humidity	5% - 90%	n/a

RESULTS OF RECORDER TESTING ON THE BMRT *MOSKOVSKAYA OLYMPIADA*.

One recorder of PlotWatcher PRO model was tested during the voyage. It was installed in the beginning of the voyage on 18 January and operated on a 24-hour basis till the end of pollock fishing on 8 April. Initially (till 27 January), records were made at 10-second intervals and after that and till the end of the voyage – every 5 seconds. Total volume of archived data obtained during the recorder's operating time was 95 Gb.

The recorder was installed on trawl master's bridge at a height of 4 m from fish deck level. As camera was not updated for observations during pollock fishery, it was mounted using a collar from a double strip of galvanized tin 25 mm wide with a rubber backing strip. In order to ensure required position of the camera, we welded a 30-cm-long piece of tubing to the lamp stand on the front edge of the bridge at an appropriate angle (Fig. 2.4.1). The camera lens covered the whole width of fish deck at the level of three catch hopper covers including the area on front of the stern ramp (Fig. 2.4.2). It took about 4 hours to install the camera including clamp fabrication and welding works. Photo recorder installation and operation was agreed with the ship master and crewmen assigned by the master assisted in its installation. Its location was discussed with trawl team members such that no deck operations might affect and damage the installed camera. Battery changing and record copying was normally performed during each cargo transfer operation – we did not wait for memory card filling and battery outage. All records were regularly viewed to detect marine mammals in catch during trawl hauling-out and catch pouring.

RESULTS OF RECORDER TESTING ON THE BMRT *PILENGA-2*.

There were 3 cameras available on this ship: two PlotWatcher PRO units and one Bushnell 436 unit. One PlotWatcher PRO recorder was mounted in the wheelhouse with a view on fish deck (Fig. 2.4.3 and 2.4.4). It was operating 24 hours a day during 31 ship-days. Without any difficulty, this camera allowed for recording of the duration of fishing operations on deck (trawl heaving-out, duration of trawling, hauling-in and catch pouring) and for approximate determination of the catch volume per each haul based on how much the cod-end was filled. Due to this camera's remoteness from fish receiving bin hatches and low resolution of images, it was problematic to register MM by-catch from this shooting point. While it would be possible to register capture of Steller sea lion adult males or cetaceans using this camera, small animals (juvenile sea lions or true seals) would hardly be detectable on photographs. At least, this camera failed to register ribbon seal's capture occurring on this ship in this voyage. Along with remoteness from working deck, another problem is condensation on wheelhouse windows due to which images made by the camera become illegible.

The second PlotWatcher PRO camera was tested during 4 days on the stern portal. Pictures were taken at intervals of 1 sec and 5 sec. The camera was mounted such that to cover the fish deck area with hatches of both fish receiving bins (Fig. 2.4.5). In this case, any captured animals might be reliably registered by the camera either during catch pouring from cod-end to bins or at

Fig. 2.4.1. PlotWatcher PRO photo recorder location on BMRT *Moskovskaya Olympiada*.
1 – recorder mounted on the front edge of trawl master bridge by a nipple welded to the lamp stand; 2 – winch operator's cabin (recommended location for the second recorder).

Photo by Yu.B. Artyukhin

Fig. 2.4.2. An example of a picture taken by PlotWatcher PRO» from trawl master bridge. BMRT *Moskovskaya Olympiada*, 19 January, 14:06.

the moment of animal lifting from bin to deck. Unfortunately, this camera was not mounted yet on the day when a ribbon seal was captured in the trawl (March 16, 2015). This camera was also tested in the wheelhouse for recording of readings on trawl control displays. At operating intensity of one photo per 5 seconds, the camera creates a 1.5–2.2-gigabyte file and at intensity of one photo per second the file with records occupies 3–3.5 Gb of free space on the data carrier. In case of continuous photographing, the camera creates one file with all photographs during a day.

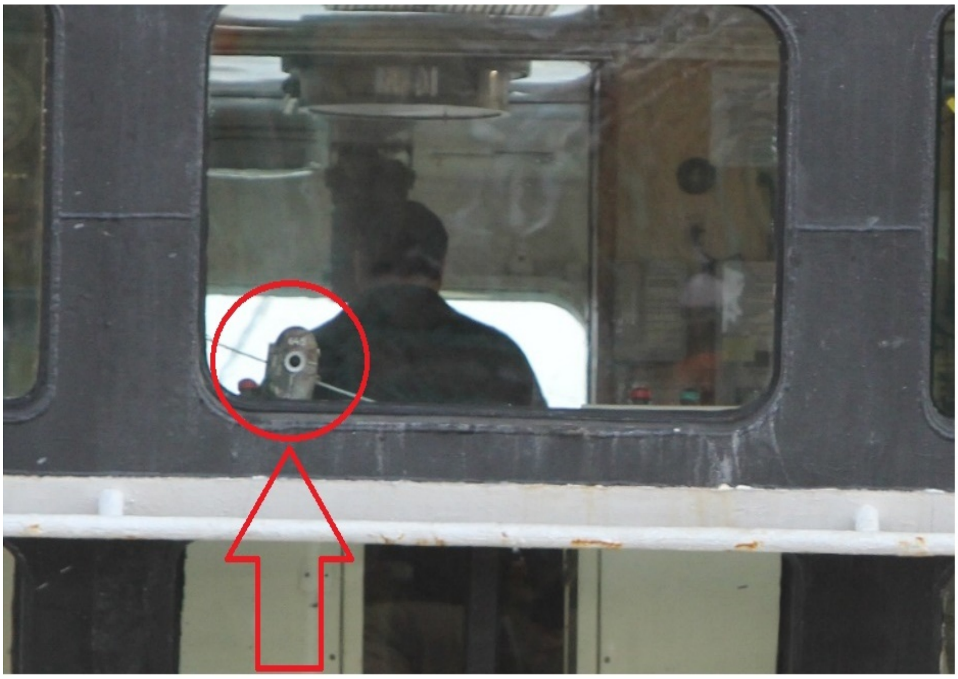

Fig. 2.4.3. PlotWatcher Pro camera location in the wheelhouse. Photographing is done from the wheelhouse window looking onto working deck. BMRT *Pilenga-2*. Photo by S.V. Fomin

Fig. 2.4.4. View of fish deck from PlotWatcher PRO camera mounted near the window in the wheelhouse. BMRT *Pilenga-2*, April 12, 2015, 12:41.

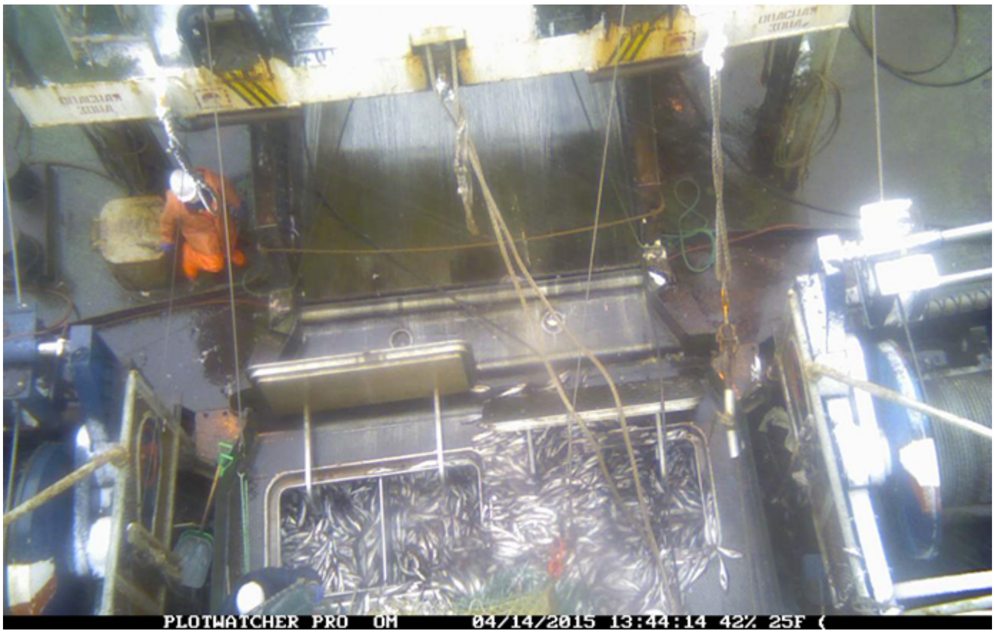

Fig. 2.4.5. Image from PlotWatcher PRO camera located on the stern portal. BMRT *Pilenga-2*, April 14, 2015, 13:44.

Fig. 2.4.6. View on fish deck. This image was made by Bushnell 436 photo recorder mounted on winch operator's cabin. BMRT *Pilenga-2*, March 31, 2015, 13:05.

Bushnell 436 camera was tested in two locations – in the wheelhouse for recording of trawl control instrument readings and in winch operator's cabin with a view opening toward the stern (Fig. 2.4.6). This camera did not have a high-speed shooting feature as PlotWatcher PRO camera did. A minimum triggering interval was 1 minute. This camera consumes much more energy and service time of one battery set did not exceed 3 to 5 days. Its only advantage was a better matrix sized 5 megapixels which resulted in better-quality images. A disadvantage of its location in winch operator's cabin was a low height of shooting point. Because of this, a blind area emerged in vicinity of receiving bin hatches at the moment of cod-end lifting to board which might result in a failure to register small-sized MM.

RESULTS OF RECORDER TESTING ON THE BMRT *BAKLANOVO*.

Both recorder types were tested on this ship as well. Same as on the *Pilenga-2*, PlotWatcher PRO was mounted in the wheelhouse in front of the window overlooking work deck (Fig. 2.4.7). The only difference was that an additional glass allowing for double magnification of the image was installed on the recorder lens on the *Baklanovo*.

Fig. 2.4.7. Photo taken by PlotWatcher PRO photo recorder through the wheelhouse window. An additional 2x glass was installed on the recorder lens. BMRT *Baklanovo*. January 31, 2015, 06:21.

The Bushnell 436 camera was used only for recording of trawl operating parameters. The PlotWatcher PRO camera was mounted and activated on the first day of fishing and operated on a 24-hour basis during the entire pollock fishing period (17 January – 31 March) and further herring fishing period (1-18 April). The camera allowed for exact recording of all fishing operations performed in working deck. However, because of its remoteness from receiving bins, this shooting point was not reliable enough for registry of by-catch of small MM. There is one advantage in camera installation in this location. If animals are captured in trawl at the end of trawling or in process of hauling-in, they turn out in the beginning of the cod-end. Normally, they stay alive and are found by fishermen immediately after being lifted to board (before catch pouring) and released from the trawl by cutting the front part of the cod-end found roughly in the middle of work deck. In this case, the wheelhouse camera will reliably register these events. A Steller sea lion was captured in the trawl of the BMRT *Baklanovo* during herring fishing on 4 April. It was dead, stayed in the middle of the cod-end and was found only during catch pouring (Fig. 2.4.8 and 2.4.9). It was a large male who blocked entrance holes of receiving bins and stopped catch pouring. Animal by-catch was reliably registered by the camera mounted in the wheelhouse.

Fig. 2.4.8. A Steller sea lion is being extracted from the cod-end during catch pouring.
PlotWatcher PRO recorder, BMRT *Baklanovo*, 4 April 2015, 02:54. Sea of Okhotsk, herring fishery.

Fig. 2.4.9. A Steller sea lion on the cod-end with catch.
PlotWatcher PRO recorder, BMRT *Baklanovo*, 4 April 2015, 02:56. Sea of Okhotsk, herring fishery.

In summary, photo recorders of two types – simple, inexpensive and readily available in the market – were tested in January – April 2015. The following conclusions on their application have been made:

- Upon comparison of two recorders, it was stated that PlotWatcher PRO camera has a whole number of advantages over Bushnell 436 camera, namely:
  - Simple and easy operation. Camera installation on board the ship poses no particular difficulty if a prefabricated collar is available. Setup of recording parameters on the camera

is simple and clear. Periodic inspection of the camera, change of batteries and data storage elements takes little time. Software allows for quick viewing of records on computer.

  - Highly autonomous operation. Battery charge is consumed in an economic manner: for instance, the level of charge in 4 Ni-Mn batteries reduced from 61% to 42% during 15 days of continuous operation (6-21 March) at below-zero temperatures. An effective algorithm of photo information recording to a magnetic data carrier allows for high-speed photographing – at intervals of 1 sec and more. The volume of a full-day record (17,280 shots in a single file) made with 5-second intervals was normally less than 2 Gb.
  - Informative content of its display. The recorder's display shows the battery charge level and remaining volume on the memory card which allows for easy control of the time of their replacement. A convenient interface allows for quick and easy tuning-up of the camera for the object of photographing.
  - Due to a high resolution of images, all cases of MM capture in trawl are reliably recognized and their species composition is identified.
- At the same time, a number of disadvantages were noted for this model:
  - The process of image recording to file was sometimes disrupted and because of that image hanging occurred. Although the camera continues shooting, the photograph on the display does not change ("is hanging"). This was detected only when viewing images on the computer. Such problem was found in two cameras, mostly during shooting at 1 sec intervals and only in files exceeding 2 Mb (some of such files). The reason is possibly related to the quality of the camera fabrication or its software. When the camera shoots at 5 sec intervals, resulting files are smaller and image hanging during playback occurs much less frequently. All files sized under 2 Gb are played back without any problems.
  - Low quality of the protective glass covering the lens from the front. It is exposed to sea salt for a long time and easily scratched during removal of splash, snow and soot. This glass has become opaque by the end of the voyage and sharpness of records deteriorated (this glass has to be replaced after the voyage).
  - During a heavy wet snowfall, the lens becomes covered with snow and part of records may turn out totally unreadable until the snow film disappears or the glass is covered.
  - As there is no external lens hood, the lens (or, more exactly, its safeguarding outer glass) is not protected against snow and splash; furthermore, intervals occur during recording in back solar lighting on which quality of image declines because of exposure.
  - Resolution is sufficient to detect animals of Steller sea lion size on records. However, it is unclear whether it will be high enough to read the animal's mark number when quality of image is worse (more granular) due to dim lighting than in the daylight.
- As for the location of cameras, it was found that there is no such point on ships being tested (all observers were based on the same ship type – BMRT) that would satisfy all important conditions for recorder performance: coverage of the entire work deck and high reliability of by-catch registration, accessibility for maintenance, protection of the camera against precipitation or moving equipment (wires, warps, derricks, etc.).
- The most suitable mounting locations for the camera are trawl master's bridge, winch operator cabin and wheelhouse (near the window overlooking work deck). Each of these locations has its merits and demerits. In order to improve reliability of MM by-catch registration to 100%, 3 recorders are needed – one in each of the above said locations. Camera redundancy would essentially improve monitoring efficiency in case of a failure of one camera (permanent failure in case of a malfunction or temporary failure in case of snow sticking to the lens, condensation on glass, etc.).

RECOMMENDATIONS ON USE OF PHOTO RECORDERS ON VESSELS

1. The following set of materials and equipment is required per one BMRT-type ship for autonomous collection of MM by-catch information:
   - 3 PlotWatcher PRO photo recorders;
   - 3 x 8 x 2 (for replacement) = 48 rechargeable batteries of AA type with a charging device for them;
   - memory cards sufficient for operation of 3 recorders during the entire voyage (3 x 6 cards = 18 cards);
   - a set of lens cleaning materials (1 set per ship);
   - recorder operating manual in Russian language(1 per ship).
2. It is more reliable to use 3 recorders simultaneously which are to be mounted in proven locations: trawl master bridge, winch operator cabin and navigating bridge. No guys and wires moving during fishing operations and cargo handling works shall interfere with the mounted camera. A free and safe access to the recorder shall be provided for its regular inspection and maintenance.
3. A broad metal collar shall be fabricated in advance for rigid securing of the camera during its entire operating period. The collar width may be taken according to the size of slots on the camera (25 mm) and its diameter should be suitable for mounting on pipes Ø40-60 mm. A rubber gasket should be laid on the inner side of the collar along its entire length. These collars shall be fixed by one or two long (to be suitable for mounting on pipes of different diameters) bolts with nuts passing via through holes.
4. The camera should be installed in a high point such that its lens was directed at a downward angle. This will allow for partial protection of the lens against snow, splash and soot. It is strongly recommended to fabricate a protective casing for the camera which will also function as a lens hood for protection against precipitation and image exposure by the low sun.
5. The shooting mode should be enacted 24 hours a day to avoid any gaps in trawling runs, register all activities with each hauled trawl on deck from its haul-out to the end of catch pouring and next heaving out, reliably fix all MM by-catch cases. A minimum shooting interval shall be 5 seconds.
6. A set of cleaning aids is required to remove soot, snow and salt from the lens protective glass with least possible damage (brushes, swabs, liquids or wet napkins suitable for use at freezing temperatures
8. The condition of cameras should be monitored and camera lens should be regularly cleaned during the voyage, particularly during lasting snowfalls; proper attention should be given to the level of battery charge and remaining free space on the memory card for timely replacement.
9. When MM by-catch monitoring is performed by crewmen, records should not be downloaded to computer but a sufficient number of memory cards should be provided for replacement when they become full.

10. Cameras should be installed on the ship by a specialist experienced in use of cameras for MM monitoring purposes. Camera performance should be checked on computer after their installation on the ship by making trial records prior to the beginning of fishing. Before the voyage, persons responsible for cameras should be given detailed consultations by a specialist on installation and operation of similar equipment, specific operating features of Ni-Mn batteries and software, etc.

It should be noted in conclusion that use of PlotWatcher PRO photo recorders, inexpensive (price per one camera was 200-250 U.S. dollars as of this writing), simple in installation and operation, may noticeably simplify observer's activities at sea and improve quality of information required for MM by-catch assessment in the pollock trawl fishery in the Sea of Okhotsk and, which is also essential, considerably reduce costs of collecting such information.

2.5. ANALYSIS OF STATISTICAL DATA ON POLLOCK FISHERY IN THE SEA OF OKHOTSK TO ASSESS ITS IMPACT ON POPULATIONS OF STELLER SEA LION AND OTHER MARINE MAMMAL SPECIES

Fishing, even on a commercial scale, is frequently unpredictable. To improve fishing efficiency, fishermen use various fishing gear types and various ship types. An additional complicating element in fishermen's activities is existing fishing rules which impose restrictions on timing, fishing areas, use of ships and fishing gear. It is widely known and undisputable that various fishing gear types have different catching efficiency. It may vary during the fishing season or when changing the area of fishing operations. It is also well known that some ship masters are lucky fishermen and some are not. All this is explained by the fact that fishing is a very dynamic process depending both on many known factors and on circumstances that are extremely hard to foresee. All above said may be applied, in a certain degree, to accidental by-catch including MM by-catch. There is a scientific basis, existing during many years and continuously updated, for fish harvesting while MM by-catch in fishing gear has never been specifically addressed in Russia. There is no available scientific information for its assessment at the present time, even for such important species as pollock of the Sea of Okhotsk.

When considering conditions in which MM by-catch occurs, it should be noted that in most cases MM capture in fish catching gear is an event totally uncontrolled by fishermen. Still, certain conditions are required for such event to happen. Therefore, MM by-catch studies should first of all address the circumstances (vessel types, fish catching gear types, fishing areas, timing, trawling technique, etc.) and occurrence rate of MM capture and death in trawls. It is only upon obtaining these data that we will be able to assess impacts of this type of man's business activity on MM populations living in the Sea of Okhotsk.

MM by-catch and mortality may be affected by such indicators as fishing efforts, fishing areas and fishing seasons.

FISHING EFFORTS.

Fishing efforts are an indicator of catch intensity per unit of time – day, week, month, season or year. It can be measured by different values rather closely correlating with each other. They are number of ships in fishery, number of ships engaged in fishing, number of hauls, catch volumes, product output, etc. In general, there will be some relation between MM by-catch and any of the above said indicators but correlation ratios will doubtlessly be different. In this connection, we need to determine which of these indicators will most precisely reflect MM by-catch. Proper attention should be given to simplicity of its measurement. Let's consider each of these indicators in more detail.

FISHING VESSELS. Different vessel types have different water displacement, different power capacity of engines and trawling machinery and use different fishing gear. All this taken together affects their performance – fish catch – and MM by-catch parameters. In this connection, it is necessary to assess the composition of fleets operating in the pollock trawl fishery in the Sea of Okhotsk and determined the occurrence rate of MM by-catch for different vessel types. At first, we grouped ships into two large categories – large-tonnage and medium-tonnage ships. The first group included ships with main engine power of 1500+ kW and displacement of 2000+ tons (BATM, BMRT, RKTS, RTM, RTMKS, RTMS, SRTM pr. FVS-419, SRTM pr. R-8830, TSM and UPB). The second group included ships with main engine power of 300 to 1000 kW and displacement of 500 to 2000 tons (MKRTM, MRTR, SDS, SRTM, SRTR, STR).

An average of up to 191 ships (min 158, max 200) participated in the pollock fishery in last 5 years, of which 110 ones were large-tonnage ships and 81 ones were medium-tonnage ships (Tables 2.5.1. and 2.5.2). 17 types of large-tonnage ships were registered in the IIS “Monitoring” database in 2010-2014. Half of them were ships of two types similar in size and main engine power – BMRT of “Prometheus” type and BMRT of “Pulkovsky Meridian” type pr. 1288 (lines 4 and 5 in Table 2.5.1). The rest 15 types were annually represented by 1 or 2 or 3 units only.

60% of 11 medium-tonnage ship types were ships of two types – STR pr. 503 and STR pr. 420. Another 20% was customized SRTM ships (Table 2.5.2).

Roughly same picture was observed in the number of ship-days with reported catch (ship-days when fishing) – the same ship types dominated in each group of ship types (Tables 2.5.3 and 2.5.4).

Such great diversity of trawling fleets is a factor complicating MM by-catch assessment. When planning observer activities, it is important to obtain information about animal capture on four basic ship types and, also, obtain data from more than 20 other ship types. Unexpectedly high Steller sea lion by-catch data in the Sea of Okhotsk reported by fishermen may be associated with one or several ship types not belonging to four basic groups.

Table 2.5.1. Basic types and number of large-tonnage ships participating in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	Ship types	2010	2011	2012	2013	2014	Mean
1	BATM customized	2	2	2	2	3	**2**
2	BMRT customized	7	8	8	8	6	**7**
3	BMRT of Ivan Bochkov type pr. V-408	9	9	8	9	7	**8**
4	BMRT of Prometheus type	12	10	10	11	10	**11**
5	BMRT of Pulkovsky Meridian type pr. 1288	47	45	45	44	44	**45**
6	BMRT of Sotrudnichestvo type pr. D-1305	0	0	2	1	1	**1**
7	NIS of Professor Marti type pr. 833	3	4	3	4	2	**3**
8	RKTS of Antarctida type pr. 16080	3	3	3	3	3	**3**
9	RTM customized	4	7	9	8	4	**6**
10	RTM of Atlantic type	2	2	1	0	0	**1**
11	RTMKS of Moonzund type pr. 488	2	2	2	2	0	**2**
12	RTMS customized	4	4	4	4	4	**4**
13	SRTM of Mys Korsakova type pr. FVS-419	0	3	4	4	4	**3**
14	SRTM of Sterkoder type pr. R-8830	8	11	11	9	9	**10**
15	TSM customized	1	1	1	1	0	**1**
16	TSM of Orlenok type pr. 333	5	4	4	1	0	**3**
17	UPB of Victoria type	0	0	1	1	1	**1**
	TOTAL:	**109**	**115**	**118**	**112**	**98**	**110**

Table 2.5.2. Basic types and number of medium-tonnage ships participating in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	Ship types	2010	2011	2012	2013	2014	Mean
1	MKRTM of Laukuva type pr. 12961	2	3	5	3	0	**3**
2	MRTR of Girulyai type pr. 1296	0	0	0	2	2	**1**
3	SDS	6	6	7	5	2	**5**
4	SRTM customized	15	16	16	16	17	**16**
5	SRTM of Valery Maslakov type	2	2	2	2	2	**2**
6	SRTM of Vasily Yakovenko type pr. 502EM	6	5	6	4	4	**5**
7	SRTM of Zhelezny Potok type pr. 502E	6	5	4	2	2	**4**
8	SRTR of Barents Sea type pr. 1332	3	3	3	3	2	**3**
9	STR customized	4	4	4	4	4	**4**
10	STR of Alpinist type pr. 503	38	34	30	28	25	**31**
11	STR of Nadezhny type pr. 420	19	20	21	17	9	**17**
	TOTAL	**91**	**89**	**89**	**76**	**60**	**81**

Table 2.5.3. Number of ship-days with catch in the pollock fishery in 2010-2014 by large-tonnage ship types

Item No.	Ship types	2010	2011	2012	2013	2014	Mean
1	BATM customized	79	82	69	58	99	77
2	BMRT customized	636	548	517	337	322	472
3	BMRT of Ivan Bochkarev type pr. V-408	688	660	641	603	592	637
4	BMRT of Prometheus type	967	693	576	649	634	704
5	BMRT of Pulkovsky Meridian type pr. 1288	3825	3563	3216	3147	2776	3305
6	BMRT of Sotrudnichestvo type pr. D-1305	0	0	67	73	70	70
7	NIS of Professor Marti type pr. 833	149	135	87	75	59	101
8	RKTS of Antarctida type pr. 16080	182	334	350	265	383	303
9	RTM customized	208	210	335	241	109	221
10	RTM of Atlantic type	85	35	42	0	0	54
11	RTMKS of Moonzund type pr. 488	146	103	111	111	0	118
12	RTMS customized	221	280	273	248	264	257
13	SRTM of Mys Korsakova type pr. FVS-419		211	161	219	104	174
14	SRTM of Sterkoder type pr. R-8830	518	654	799	659	581	642
15	TSM customized	77	54	79	41	0	63
16	TSM of Orlenok type pr. 333	240	87	127	34	0	122
17	UPB of Victoria type	0	0	7	74	64	48
	TOTAL:	**8021**	**7649**	**7457**	**6834**	**6057**	**7204**

Таблица 2.5.4. Number of ship-days with catch in the pollock fishery in 2010-2014 by medium-tonnage ship types

Item No.	Ship types	2010	2011	2012	2013	2014	Mean
1	MKRTM of Laukuva type pr. 12961	1	13	20	12	0	12
2	MRTR of Girulyai type pr. 1296	0	0	0	3	1	2
3	SDS	376	295	326	135	67	240
4	SRTM customized	1042	957	879	720	811	882
5	SRTM of Valery Maslakov type	1	15	8	18	13	11
6	SRTM of Vasily Yakovenko type pr. 502EM	346	244	152	54	29	165
7	SRTM of Zhelezny Potok type pr. 502E	163	44	46	29	45	65
8	SRTR of Barents Sea type pr. 1332	98	184	99	50	27	92
9	STR customized	116	207	183	84	100	138
10	STR of Alpinist type pr. 503	2308	1699	1124	919	860	1382
11	STR of Nadezhny type pr. 420	848	555	524	295	194	483
	TOTAL:	**5299**	**4213**	**3361**	**2319**	**2147**	**3468**

FISHING GEAR. Every ship type uses fishing gear specially designed and fabricated for its technical performance characteristics. A larg number of trawl models is available for each ship type. Using different fishing gear types, a ship may have different catches. It can be supposed that MM by-catch in different trawl types will be different as well.

In the pollock fishery in the Sea of Okhotsk in 2010-2014, all ships used 121 trawl types (data from IIS “Monitoring”). Large-tonnage and medium-tonnage ships used 72 and 49 trawl types respectively (see Tables 2.5.5 – 2.5.8). It should be kept in mind that one ship may have several trawl types on its board. If different trawl types were used during the fishing season, all of them were included in the IIS “Monitoring” report. Therefore, number of ships participating in the fishery and number of trawl types they used will differ. Of 72 trawl types used by large-tonnage ships, 9 types (12.5%) were used on the vast majority of ships (Table 2.5.5). They were indicated in reports by 96 ships participating in the fishery. The rest 63 trawl types were used at a much smaller number of ships (each type was used by 1 to 3 ships and not in each season) but this circumstance results in great diversity of trawl types, thus significantly complicating MM by-catch assessment.

A similar picture is observed when we analyze the number of hauls performed by large-tonnage ships using different trawl types – 9 basic trawl types account for more than 73% of all hauls performed during the year (Table 2.5.6).

Of 49 trawl types used in 2010-2014 by medium-tonnage ships, roughly half of them used 5 types only (Table 2.5.7). These trawl types accounted for more than 60% of hauls (Table 2.5.8).

In summary, a large number of various trawl types are used in the pollock fishery in the Sea of Okhotsk. If we assume that information about the number of hauls performed by different trawl types in the IIS “Monitoring” reflects real data, the greater portion of hauls is performed by 9 trawl types only on large-tonnage ships and by 5 trawl types on medium-tonnage ships

A real picture of use of different trawl types may be obtained through direct observations at sea only. Ships may use several trawl types during one season and even during one day. Therefore, when allocating MM observers between ships for by-catch assessment activities, it is important to give attention to the number and types of trawls available on their board and planned for use during the fishery. It is recommended to send observers to ships having more different trawl types on their board. In this case, MM by-catch data will more precisely reflect the real picture of MM by-catch in the pollock fishery.

Table 2.5.5. Basic types and number of trawls used by large-tonnage ships in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	**Trawl name**	**Years**					**Mean number of trawls per year**	**%**
		2010	**2011**	**2012**	**2013**	**2014**		
1	m/water trawl 112/784 m pr. 279 KEB	11	13	12	4	5	9.0	6.3%
2	m/water trawl 116/640 m pr. 180 FOL NBAMR	13	21	19	20	19	18.4	13.0%
3	m/water trawl 118/620 m pr. 009 OD BAMR	10	9	2	1	1	4.6	3.2%
4	m/water trawl 126/800 m pr. 091 FOL NBAMR	2	4	5	4	6	4.2	3.0%
5	m/water trawl 154/1120 m pr. 342 EKB	13	12	16	15	16	14.4	10.1%
6	m/water trawl 158/880 m pr. OD KRP	2	4	4	4	5	3.8	2.7%
7	m/water trawl 99/624 m pr. 280 KEB	11	11	12	7	5	9.2	6.5%
8	m/water trawl 991	7	7	4	4	3	5.0	3.5%
9	m/water trawl not reg. NPO PR	20	29	33	31	28	28.2	19.9%
TOTAL for all trawls*		**129**	**151**	**158**	**145**	**125**	**141.6**	**100%**

* this figure includes all 72 trawl types

Table 2.5.6. Number of hauls performed by basic trawl types of large-tonnage ships in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	**Trawl name**	**Years**					**Mean number of hauls per year**	**%**
		2010	**2011**	**2012**	**2013**	**2014**		
1	m/water trawl 112/784 m pr. 279 KEB	1.689	1.396	1.150	401	492	1,026	5.9%
2	m/water trawl 116/640 m pr. 180 FOL NBAMR	1.781	2.420	1.771	1.959	2.197	2,026	11.6%
3	m/water trawl 118/620 m pr. 009 OD BAMR	1.167	910	343	167	13	520	3.0%
4	m/water trawl 126/800 m pr. 091 FOL NBAMR	442	746	772	992	1.605	911	5.2%
5	m/water trawl 154/1120 m pr. 342 EKB	1.572	1.405	1.639	1.764	1.471	1,570	9.0%
6	m/water trawl 158/880 m pr. OD KRP	357	438	688	855	1.085	685	3.9%
7	m/water trawl 99/624 m pr. 280 KEB	1.599	1.156	936	711	467	974	5.6%
8	m/water trawl 991	1.483	1.369	572	528	313	853	4.9%
9	m/water trawl not reg. NPO PR	3.727	3.715	5.545	4.493	3.284	4,153	23.9%
TOTAL for all trawls*		**27,605**	**24.727**	**22.547**	**19.585**	**18.588**	**17.401**	**100%**

* this figure includes all 72 trawl types

Table 2.5.7. Basic types and number of trawls used by medium-tonnage ships in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	Trawl name	Years					Mean number of trawls per year	%
		2010	2011	2012	2013	2014		
1	m/water trawl 111/786 m pr. 279 NPO PR	5	6	7	3	1	4.4	6.0%
2	m/water trawl 100/460 m pr. 222 KEB KRP	17	13	8	4	2	8.8	12.0%
3	m/water trawl 80/520 m pr. 073 OD BAMR	18	14	14	7	6	11.8	16.0%
4	m/water trawl 99/624 m pr. 280 KEB	5	6	6	6	8	6.2	8.4%
5	m/water trawl not reg. NPO PR	4	5	7	5	5	5.2	7.1%
TOTAL for all trawls*		**87**	**81**	**80**	**62**	**58**	**36.4**	**100%**

* this sum includes all 49 trawl types

Table 2.5.8. Number of hauls performed by basic trawl types of medium-tonnage ships in the pollock fishery in the Sea of Okhotsk in 2010-2014

Item No.	Trawl name	Years					Mean number of hauls per year	%
		2010	2011	2012	2013	2014		
1	m/water trawl 111/786 m pr. 279 NPO PR	655	507	614	245	243	453	8.7%
2	m/water trawl 100/460 m pr. 222 KEB KRP	2251	1730	362	129	100	914	17.6%
3	m/water trawl 80/520 m pr. 073 OD BAMR	1315	801	912	265	201	699	13.4%
4	m/water trawl 99/624 m pr. 280 KEB	589	579	668	669	756	652	12.5%
5	m/water trawl not reg. NPO PR	306	568	745	526	365	502	9.6%
TOTAL for all trawls*		**8,183**	**6,601**	**4,943**	**3,126**	**3,194**	**5,209**	**100%**

* this sum includes all 49 trawl types

FISHING AREAS AND DURATION.

MM distribution in the Sea of Okhotsk is extremely uneven – one species dominate in some areas and other species dominate in other areas. MM abundance also greatly varies by areas. Therefore, operating area of ships will be an important variable parameter in MM by-catch assessment.

The mosaic pattern of fishing efforts by years, fishing areas and fishing seasons can be vividly illustrated by maps in Fig. 2.5.1 – 2.5.2. They show the number of hauls performed by all ship types and all mid-water trawl types during the fishing season referred to 1,000 sq. km (1 box ~ 0.3° of the map format). In "A" season during last 6 years, fishing intensity was gradually moving from south (from Kamchatka-Kuril subzone and south of West Kamchatka subzone) to northwest (northern half of West Kamchatka subzone) of the Sea of Okhotsk. This picture is also well seen when analyzing efforts by the number of ship-days with catch and in different months on a year-to-year basis (Table 2.5.9). While basic fishing efforts in January – February were observed in Kamchatka-Kuril subzone in 2010-2011, they dropped more than twice in this area in recent years but grew 4 to 8 times in West Kamchatka subzone. We don't have any data even on relative abundance of MM species in different fishing areas of the Sea of Okhotsk in different months of "A" season but it is quite obvious that any change in the number of fishing efforts will have significant effects on MM by-catch in the areas under consideration.

Therefore, fishing areas and fishing timing are very dynamic indicators. To obtain representative data on MM by-catch, all operating areas and fishing periods shall be covered by observations.

FISHING SEASON.

The pollock trawl fishery in the Sea of Okhotsk takes place during two seasons: "A" season – January–April and "B" season – October–December. Fishing intensity by months is subject to broad variation which is reflected in all parameters – number of participating ships, number of hauls and fish catch volume (Tables 2.5.1 – 2.5.9 and Fig. 2.5.1 – 2.5.5).

MM distribution in the Sea of Okhotsk is subject to broad variation on a season-to-season basis. For instance, increased aggregations in their breeding areas are observed during the breeding season for all pinniped animals (Geptner et al., 1976). Steller sea lions and Northern fur seals aggregate in this season in their breeding rookeries. Ice forms of true seals (ribbon seal, larga seal, ringed seal and bearded seal) aggregate in haul-outs on ice. Their breeding areas are not so fixed in spatial terms and largely depend on ice cover conditions in the sea. Eared seals (fur seals and Steller sea lions) breed in the summer and true seals breed in March – April. MM abundance in fishing areas is very dynamic on a month-to-month basis during the year as well.

All above said factors show that MM accidental by-catch will be likely to vary noticeably on a month-to-month basis. This circumstance should be taken into account when assessing MM by-catch in the pollock fishery in the Sea of Okhotsk.

There is absolutely no data on MM by-catch and even encounters in pollock fishing areas in "B" season. However, these data are required for an overall assessment of the impact of the pollock trawl fishery in the Sea of Okhotsk on MM.

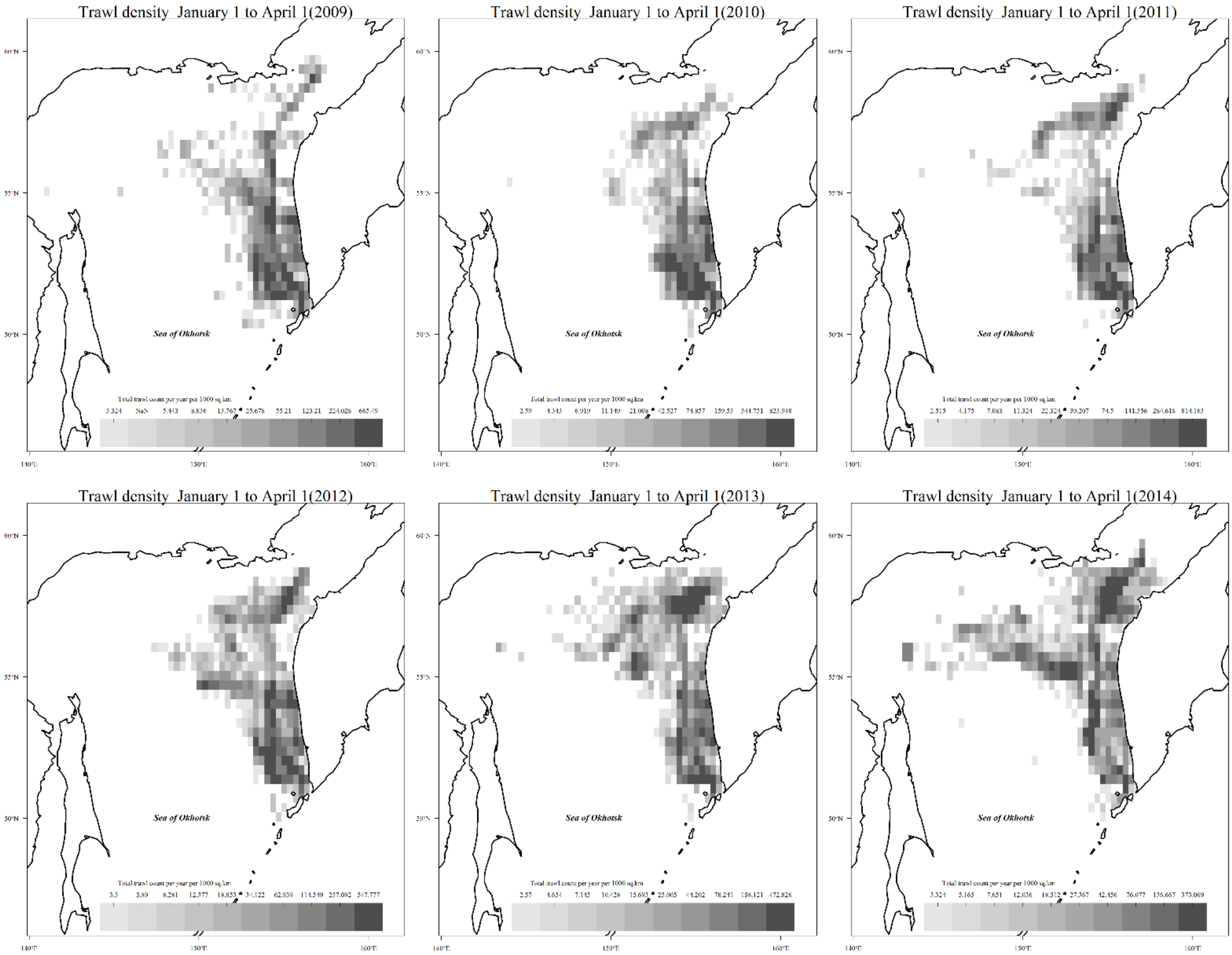

Fig. 2.5.1. Variation of trawling intensity by areas and years during 2009-2014 in the pollock fishery in the Sea of Okhotsk in “A” season (January – April) according to data contained in SDR of IIS “Monitoring”.

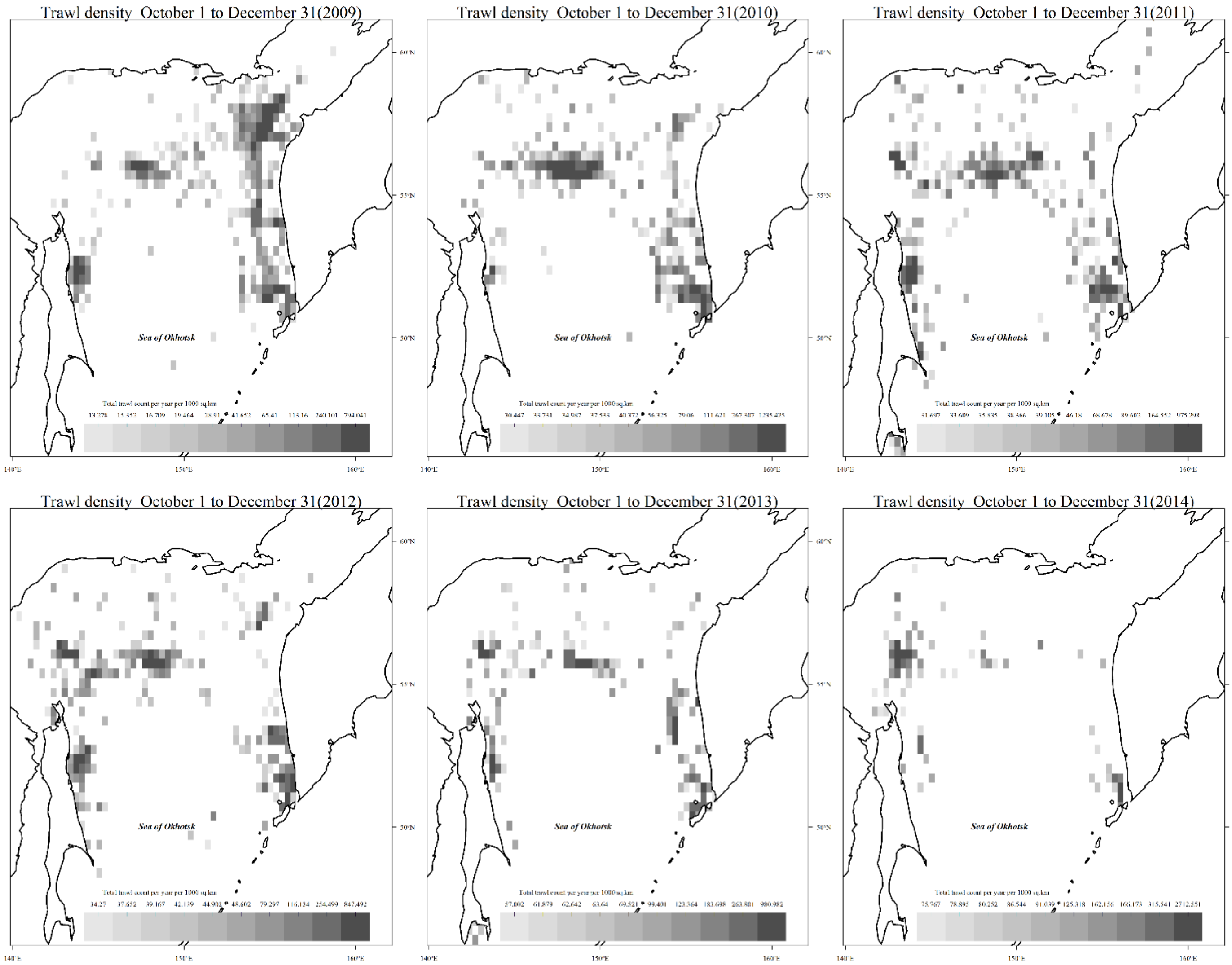

Fig. 2.5.2. Variation of trawling intensity by areas and years during 2009-2014 in the pollock fishery in the Sea of Okhotsk in “B” season (October – December) according to data contained in SDR of IIS “Monitoring”.

Table 2.5.9. Variation of pollock fishing intensity by month in four basic fishing subzones in 2010-2014 (number of ship-days with catch)

Kamchatka-Kuril:

Month	2010	2011	2012	2013	2014
January	1814	1500	1301	785	715
February	2183	1668	1456	586	257
March	1555	904	425	158	45
April	8	6	5	3	4
October	0	0	0	0	0
November	118	62	10	12	19
December	211	150	108	86	8
TOTAL	**5889**	**4290**	**3305**	**1630**	**1048**

West Kamchatka:

Month	2010	2011	2012	2013	2014
January	230	94	217	459	810
February	228	251	575	1513	1667
March	899	1521	1566	1396	1089
April	7	4	1	3	1
October	0	0	0	0	0
November	23	21		5	2
December	21	11	41	8	1
TOTAL	**1408**	**1902**	**2400**	**3384**	**3570**

North Sea of Okhotsk:

Month	2010	2011	2012	2013	2014
January	164	378	47	24	52
February	761	708	688	321	370
March	1170	1067	1244	1371	1467
April	1614	842	640	680	349
October	80	39	31	28	4
November	357	144	77	39	27
December	257	128	123	46	0
TOTAL	**4403**	**3306**	**2850**	**2509**	**2269**

East Sakhalin:

Month	2010	2011	2012	2013	2014
January	0	0	0	5	66
February	0	0	0	0	2
March	0	0	0	0	14
April	121	163	114	240	236
October	20	201	191	113	31
November	8	107	95	57	196
December	4	65	40	22	30
TOTAL	**153**	**536**	**440**	**437**	**575**

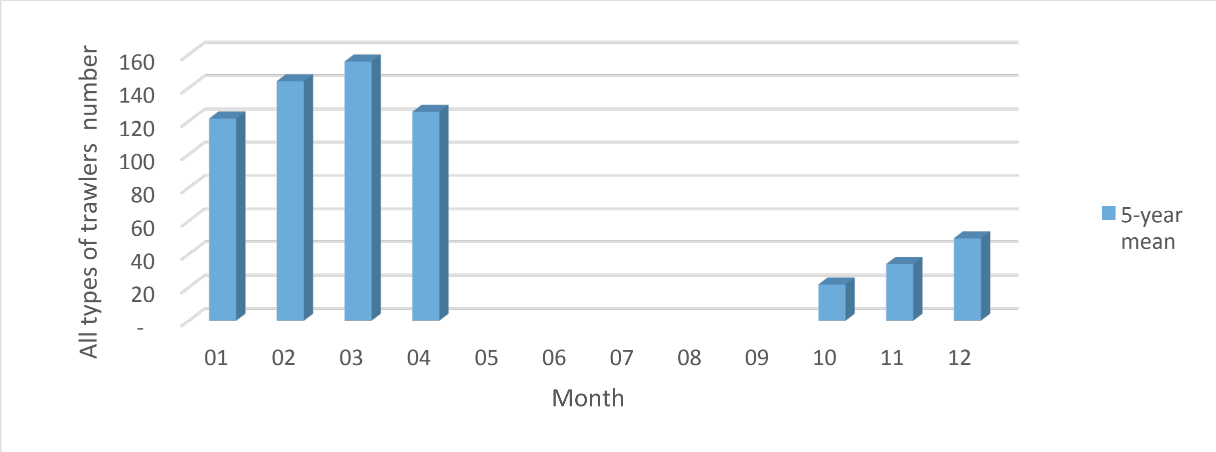

Fig. 2.5.3 Variation of the number of trawlers by month in the pollock fishery in the Sea of Okhotsk (average data for 2010-2014)

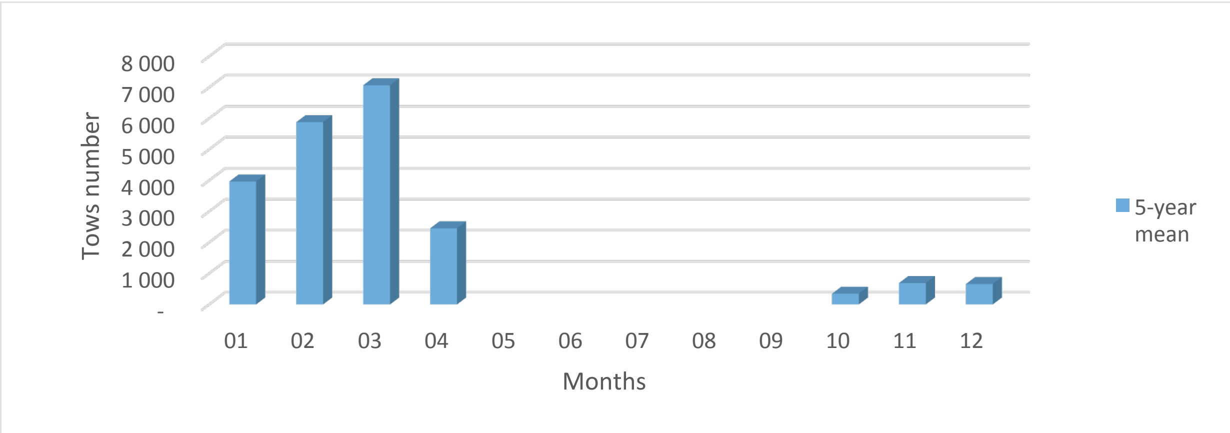

Fig. 2.5.4. Variation of the number of hauls by month in the pollock fishery in the Sea of Okhotsk (average data for 2010-2014)

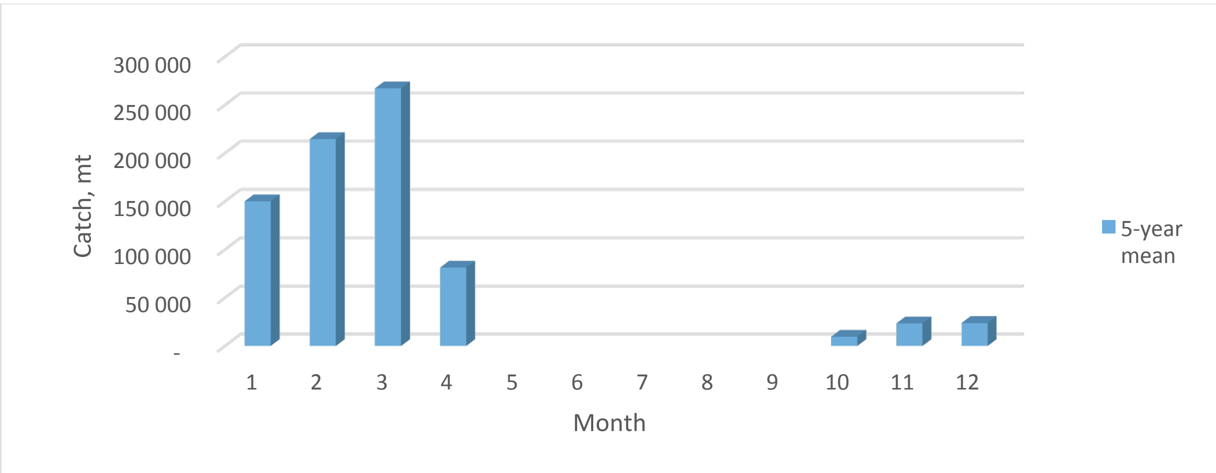

Fig. 2.5.5. Total pollock catch (tons) by trawling fleets by month (average data for 2010-2014)

* * *

The current abundance of the majority of pinniped species in the Sea of Okhotsk (larga seal, bearded seal, ringed seal, ribbon seal and Northern fur seal) is estimated at hundreds of thousands of individuals (Fedoseev, 1984; Kuzin, 1999; Chernook et al., 2014; and others). The adopted level of concern about MM mortality in fishing gear at 1% of their estimated abundance (Northridge and Thomas, 2003) in absolute units is expressed for the above species in the Sea of Okhotsk in thousands of individuals (varying from 2,000 for larga seal to more than 6,000 for ringed seal (Artyukhin et al., 2010). Based on the findings of observations on fishing vessels and fishermen verbal interviewing in 2015, we can tentatively conclude that the level of by-catch of the above said pinniped species in the pollock trawl fishery in the Sea of Okhotsk is likely to be considerably lower than the level of concern about this problem.

According to the study results obtained in the pollock trawl fishery in the Sea of Okhotsk in 2015, the only species raising concern is Steller sea lion. The estimated number of its Asian population being 25-28 thsd individuals (including pups), injury and death in trawls of 250 to 280 individuals (1% of its population) will raise concern for its population status. Our observers on 3 large-tonnage ships did not register any cases of Steller sea lion by-catch during this period in 2015, although interviewed fishermen reported regular capture and death of Steller sea lions in trawls (Chapter 2.3). They pointed out that the occurrence rate of such capture (both in terms of the number of cases and number of animals per capture) broadly varies. In some cases, it reaches 20 and more individuals per 1 ship. Such uneven pattern of Steller sea lion by-catch results in additional difficulty in assessing its mortality in the pollock trawl fishery.

Unfortunately, we did not manage to obtain reliable data on the level of Steller sea lion by-catch in the pollock trawl fishery in the course of our studies performed in 2015. The number of observers turned out extremely insufficient. Our observations were performed on one large-tonnage ship type only (BMRT of Pulkovsky Meridian type) of 12 ship types participating in the fishery. The ships with observers used only three trawl types of 24 types used in the fishery in this season. No observations at all were performed on medium-tonnage ships which vary by ship and trawl types as broadly as large-tonnage ships do.

Given such great diversity of fishing vessels, fishing gear, vast operating area and duration of the pollock fishing season (6 months) as well as such important circumstance as permanent presence of Steller sea lions in the fleet operating area and in immediate vicinity of fishing vessels, studies to obtain objective and precise information about Steller sea lion capture and death in the pollock trawl fishery in the Sea of Okhotsk are obviously necessary and need for such studies raises no doubt.

RECOMMENDATIONS ON ORGANIZATION OF WORK TO EVALUATE STELLER SEA LION BY-CATCH IN THE POLLOCK TRAWL FISHERY IN THE SEA OF OKHOTSK.

As there is no baseline information about Steller sea lion by-catch frequency, it is not possible to assess the nature of statistical distribution of cases of animal capture in trawls. Without such information, it is impossible to make a statistical calculation to determine the number of observers, required and sufficient for by-catch monitoring. In a situation when MM by-catch monitoring is to be performed first time ever for a particular fishery (as in our case) and frequency of animal capture in fish catching gear is unknown (as in our case), recommended coverage of fishing efforts (ships, hauls, etc.) should be 20-35% of actual efforts in this fishery (Barlow 1989, Northridge and Thomas, 2003). Such coverage of ships by observations normally allows for obtaining representative data on the indicator being considered.

Therefore, if an average of up to 190 trawlers (80 medium-tonnage and 110 large-tonnage ships, Tables 2.5.1 and 2.5.2) annually participate in the pollock trawl fishery in the Sea of Okhotsk during 5 years (2010-2014), 57 observers need to be trained and sent to the sea to ensure the required level of observations (30% of the planned number of ships).

When planning observer activities, it is important to give proper attention to diversity of trawling fleets. Observers should be assigned to ships proportionately to existing ship and fishing gear types. By-catch monitoring should be performed proportionately to fishing areas and during the entire season.

We believe that such intensive observations need to be made only once in order to obtain credible data on animal capture frequency. If the by-catch level will turn out below the level of concern about the population status of this species in the Sea of Okhotsk (1% of total number or 250-280 individuals in Steller sea lion case), the intensity of further observations may be reduced. It is not unlikely that such observations will not be needed every year. The findings of such work will allow for a substantiated calculation of the required and commensurate number of observers and of observation frequency by years.

It is strongly recommended to use automatic and autonomous photo recorders for such work. On some ships they can even replace observers, although full replacement is impossible. Still, photo recorders will in any case be of much help for observers on ships, substantially increase the volume and improve quality of information required for calculations.

2.6. ASSESSMENT OF POSSIBILITY FOR STUDY OF STELLER SEA LION NATURAL FEEDING HABITS IN THE SEA OF OKHOTSK IN WINTER

There are many methods for study of the diet of pinnipeds: analysis of the content of their stomachs and intestinal tract sampled from captured or dead animals (hunting, special scientific shooting, by-catch in fishing gear, collision with ships or fishing gear, washing ashore of dead animals, etc.); study of non-digested food remnants in feces or regurgitation (feces collection on the shore, on ice, in other locations where animals haul out for rest) and attachment of various instruments measuring movements in 3-D space; depth, number and duration of dives; registration of temperature changes in the animal's stomach and even video recording of their feeding under the water (Olivier et al., 2009, 2011, Waite et al., 2012a, 2012b, Skinner et al., 2012, and others). However, any of these methods can be applied only in particular conditions. Thus, access to dead seals is required for assessment of the species and quantitative composition of their diet by the content of their stomachs. Opportunities for collection of feces in animals' rest areas are required for study of non-digested food remnants. In order to attach any telemetric transmitters to live animals, they need to be captured or instruments need to be attached from a distance.

During their work at sea, observers assessed use of all above said methods for study of Steller sea lion natural feeding habits in the Sea of Okhotsk in the winter period. Let's dwell in more detail on each of them.

Study of the content of stomach and intestinal tract. Cases of animal by-catch and death in trawls are registered in the pollock fishery in the Sea of Okhotsk. Biological samples can be taken from such animals – their stomachs and intestinal tracts can be collected and frozen. There is no technical difficulty in collection of gastrointestinal tracts from dead animals, their storage on ships at sea and further delivery to scientists for research. The problem is that observers are not present on all ships and animals may be found in by-catch on ships having no observers on their board. Therefore, it is necessary to create conditions for fishermen (trawling watch members) such that they would be interested and agree to perform autopsy of dead animals, extract their gastrointestinal tracts, correctly label them, put in a plastic bag or container, freeze it and hand over them to scientists at the end of the voyage for further research. During the voyage, our observers asked fishermen their opinion of such work and received positive answers provided that collection of samples will be paid.

This method has one limitation in its application. Data on Steller sea lion diet obtained from samples taken from animals which died in trawls may wrongly reflect their natural diet. Easier conditions for foraging near ships may distort the real picture. Only comparative studies of their nutrition by other methods may confirm or refute this. We will address these methods below.

Coprological analysis. A considerable portion of the water surface is covered with ice in all fishing areas during the main season of pollock fishing in the Sea of Okhotsk (January – April). Both observers and fishermen point out that Steller sea lions often use ice for rest (Fig. 2.6.1). Non-digested food remnants discharged onto ice in the form of feces are widely used for studies of Steller sea lion diet (Merrick et al., 1997; Sinclair and Zeppelin, 2002; Waite and Burkanov, 2006; and others). Fishing vessel-based observers experienced in feces collection in rookeries in the summer believe that it will be no much difficulty to organize collection of feces samples from ice by trained persons. When fishing is good, fishing vessels often stay adrift for several hours while processing their catch. This time could be used for sampling by persons experienced in working on ice provided that weather conditions are good. This report's authors are ready to provide on request a detailed program of such work together with fishing vessels.

Feces samples could be collected in different fishing areas of the Sea of Okhotsk and yield data on animal feeding habits from different locations. To obtain data on their natural diet or assess impact of fleet operations on the species composition of this diet, feces sample collection could be performed at different distances from the areas of intensive fish catching operations.

A very attractive aspect in this method of Steller sea lion diet studies is that samples might be collected by observers engaged in MM by-catch monitoring on fishing vessels which would greatly reduce costs of this work.

USE OF TELEMETRY METHODS. It is theoretically possible to catch Steller sea lions in open waters or on ice to attach telemetric instruments to them but no appropriate methods have been developed to date. However, as Steller sea lions get captured in trawls and some of them stay alive when lifted to deck, it is possible to attach transmitters to such accidentally caught animals. In this way, we might be able to investigate several aspects related to assessment of pollock fishery impacts on Steller sea lion population in the Sea of Okhotsk. First, we could obtain data on this species' feeding behavior (diving depth, duration of stay under the water, feeding efficiency, etc.). Second, we could investigate the relationship between animal behavior and fishing fleet operations (whether they follow fishing vessels or stay in the same areas even if fishing vessels move). Third, we could obtain information about survival rate of Steller sea lions captured in trawls but staying alive. Satellite tags allow for tracking of animal movements and condition during several months after being captured in trawl.

In summary, we can confidently state that there is a real opportunity to study Steller sea lion feeding habits in a natural environment during the pollock fishery in the Sea of Okhotsk by several methods. The simplest and least expensive methods are study of the content of gastrointestinal tracts of dead animals and feces collection on ice by observers experienced in such work. There are no problems with technical aspects of this work. There is an organizational problem. Crewmen of fishing vessels will hardly agree to collect gastrointestinal tracts of dead Steller sea lions without any payment or other incentives.

Fig. 2.6.1. Steller sea lions taking rest on ice. Sea of Okhotsk, March 2015
Dark spots on ice are feces which can be used for nutrition studies. Photos by S.V. Fomin and I.A. Usatov

CONCLUSION

- Three observers based on three different ships registered 11 MM species in four fishing subzones (6105.01, 6105.02, 6105.03 and 6105.04) in pollock fishing areas in the Sea of Okhotsk during "A" season in 2015. Steller sea lion ranked first in terms of occurrence (51% of all encounters) and number of animals (69% of all individuals). It was followed in descending order by larga seal, ribbon seal, Dall's porpoise, Northern fur seal, Minke whale, fin whale, killer whale, sperm whale, Baird's beaked whale and North Pacific right whale. Three MM species – Steller sea lion, fin whale and North Pacific right whale – are rare protected species listed on the Red Data Book of Russia. The rest 8 species are common and their abundance or population status raises no concern.

- MM spatial (over the sea basin) and temporal (during the season) distribution was extremely uneven. The vast majority of encounters (more than 90%) occurred in March–April in the northern part of the Sea of Okhotsk (subzones 6105.02, 6105.03 and 6105.01). However, this distribution was greatly affected by duration of stay of ships in each of fishing areas. In Kamchatka-Kuril subzone (6101.4), ships operated only 2-3 weeks in the beginning of the fishery and in the northern part of the Sea of Okhotsk they operated all the rest time till the end of the fishery (90% of all time). Animals were more frequently met near the edge of ice cover and some species (larga and ribbon seals) were registered on ice only.

- Four out of eleven MM species observed in fishing areas interacted with fishing vessels engaged in pollock fishing. Two species – Steller sea lion and Minke whale – showed obvious interest in fishing vessel operations: when meeting a ship, these animals changed their course, approached the moving or drifting ship, followed it during hauling-in or trawling, fed on fish falling out from its trawl or catch processing waste and stayed near the ship for some time. Two other species – larga and ribbon seals – were indifferent to fishing operations by vessels but fishing fleet activities in vicinity of the edge of ice cover noticeably disturbed them. Ice forms of true seals (larga seal, ribbon seal, ringed seal and bearded seal) gather in breeding aggregations on ice during their breeding period (March–April). The density of their haul-outs in fleet operating areas was low and, possibly due to this circumstance, no cases of seal injury or death from ship's collision with ice and animals staying on it were registered. In case of a high density of animal haul-outs or large number of ships in seal breeding areas, such incidents may occur. The rest MM species showed no reaction to operating fishing vessels. We believe that their presence in this area was not related to fishing fleet operations. These animals live in this area and possibly feed on same pollock aggregations that are fished by fishermen.

- Up to 83 large-tonnage and 66 medium-tonnage ships operated in the Sea of Okhotsk during "A" season in 2015. Our observers were based only on 3 large-tonnage ships of one type (BMRT of Pulkovsky Meridian type) (3.6% of large-tonnage ships or 2% of all ships engaged in the fishery). All observers controlled 334 hauls from beginning to end or 2.3% of all hauls performed by large-tonnage ships (14693 hauls) or 1.7% of all hauls performed in the Sea of Okhotsk during "A" season with account for hauls performed by medium-tonnage ships (5497 hauls). Ships with observers used 4 trawl types out of 24 types used in the fishery. One ribbon seal individual was found in catch. No other MM species were found in by-catch. Unfortunately, it is not possible to make any justified conclusions on MM by-catch based on results obtained by three observers based on one type of ship (of 25 types participating in the fishery) who were able to control less than 3% of ships and less than 2% of hauls. The available sampling selection is too small for substantiated assessment of this parameter. We can only make our expert judgment that by-catch in trawls of common MM species (ice forms of seals, Northern fur seal, cetaceans) is likely to be low and hardly reaches the level of concern about this issue. One protected MM species – Steller sea lion – raises some concern. Its abundance is not high and the nature and intensity of its interaction with ships engaged in pollock fishing is extremely high. With account for information received from interviewed fishermen, there is a reasonable concern that Steller sea lion by-catch and death in trawls may have significant effects on the condition of its population in the Sea of Okhotsk. This issue needs to be addressed in a dedicated study. Activities on MM (particularly Steller sea lion) by-catch monitoring in the pollock trawl fishery in the Sea of Okhotsk should be continued.

- Upon analysis of statistical information about the pollock trawl fishery in the Sea of Okhotsk in 2010-2014, we obtained detailed data on ship and trawl types used for pollock fishery, intensity of fleet operations (number of ship-days when fishing, number of hauls, duration of work in different fishing areas by ship and trawl types, etc.). We found out that the pattern of fishing fleet operations is highly mosaic by fishing area, seasons, years and particularly fishing vessel types engaged in the fishery and trawl types used by them. Pollock catching efficiency greatly varies between different ship and trawl types, and by-catch may also be different for all of them. Such diversity of fleets and fishing gear considerably complicates work on Steller sea lion by-catch assessment and requires a much larger number of observers to obtain a representative sampling selection. The recommended number of Steller sea lion by-catch observers should be at least 25-35% of the number of ships and hauls performed by them, with observations evenly covering all ship types and fishing gear types. The data obtained by us are very important for planning work on assessment of Steller sea lion by-catch in the pollock fishery in the Sea of Okhotsk.

- In 2014, PCA prepared special logs for registry of MM and bird by-catch in trawls to be kept by fishing vessel. According to PCA data, 94 PCA ships took part in the pollock fishery in 2015. MSC logs were disseminated to 20 ships as an experiment (15% of all ships participating in the fishery). 12 ships returned these logs after the end of the fishery. It was found upon their analysis that 10 logs contained only general information about fishing start and end dates, ship name, master's name and trawl type used for pollock fishing (one type on all ships). The rest fields in these logs were empty. One log stated 5 cases of bird capture in trawls. It is surprising that birds were alive in all cases. No cases of bird capture in trawls, to say nothing of live bird lifting to board, were registered on all three ships on which KB PIG observers were based. In general, information in these logs turned out to be not informative and, to some degree, doubtful (by-catch of live birds).

- All attempts to involve fishermen in collection of data on MM distribution and accidental by-catch through radio interviewing turned out low effective as well. More information was obtained in the course of personal contacts between observers and fishermen. Upon interviewing 29 persons, it was found that Steller sea lion is the most frequently met MM species in the pollock fishery in the Sea of Okhotsk. Fishermen reported about cases of Steller sea lion capture in trawls (38% of interviewees). A larger portion of interviewees reported capture of one animal per voyage but cases of capture of 11 and even more than 20 individuals by one ship during the voyage were also reported. A curious feature of these interviews was that trawling watch members reported Steller sea lion capture in trawls twice more often than ship masters and deck officers.

- Two types of automatic and autonomous photo recorders – PlotWatcher PRO and Bushnell 436 – were tested in the process of MM by-catch monitoring in 2015. Due to a very limited scope of financing of these studies, these recorders were purchased by observers for their own money. Testing was very successful. Use of photo recorders may significantly improve quality of information for assessment of MM by-catch in the pollock trawl fishery and reduce monitoring costs. Recommendations on photo recorder installation and maintenance have been provided.

- During the voyage, MM observers explored possibilities for studies of Steller sea lion natural feeding in pollock fishing areas. Recommendations on such studies based on observation results have been provided.

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