Satellite tagging and seasonal distribution of harp seal (juveniles) of the White sea-Barents sea stock

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Abstract

Harp seal pups (4 ind.) were caught and marked with satellite telemetry transmitters (STT) in the White Sea in March-April 2010, the average tenure of STT was 226 ± 51.7 (103.6) days. In April the seals on the growth stage of "beater" left the White Sea on the drifting ice. In the Barents Sea the seals migrated north through the eastern part of the Barents Sea. Seals came to the northernmost point of their migration route, *i.e.* edge of the pack ice in the August – October period. One seal came out to the Greenland Sea. Seals' return migration was in winter along the Novaya Zemlya to the south-eastern part of the Barents Sea. Result data of marking showed harp seal juveniles during the first seasonal migration may leave the traditional feeding areas, and during the return migration may not come to molt to the White Sea. According to satellite telemetry data the Czech Bay (Barents Sea) can be one of the molt areas of harp seal juveniles.

Key words: *migration routes, harp seal, white-sea population, pups*

***Abbreviations*:** STT - satellite telemetry transmitter, CLS - Collecte Localization Satellites, PTT - Platform Terminal Transmitter, MapInfo GIS system - geographic information system

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Introduction

Harp seal (*Phoca groenlandica*) is the most abundant species among the true seals in the North Atlantic. Species includes three populations, named after a district of breeding: (1) Newfoundland (Northwest Atlantic, the hall of St. Lawrence), (2) Jan-Mayen (Greenland Sea, Jan Mayen) and (3) White-sea (the White, Barents and Kara Sea) population. The number of species is estimated at 8.5 - 9 million pcs. The number of the White-sea population according to aerial surveys of pups de-

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creased significantly in 12 years from 2 to 1.2 million pcs. (Svetochev et Svetocheva 2012a; anonymous 2001, 2004, 2006a,b, 2009, 2011, 2013, 2014).

It is known that harp seals of the White-Sea population are found in Greenland, Norwegian, Barents and Kara seas during seasonal migrations. This is confirmed by observations, pups rotary marking (Øritsland et Øien 1995), and satellite marking (STT) of adult seals in the White Sea in 1995-1997 (Nordøy et al. 2008).

The goal of our research was to determine migration routes of young harp seals (the first year of pups) in the Barents Sea, as well as their return migration routes. In April 2010, pups in the White Sea were tagged for the first time, and data on their seasonal migration was obtained.

Material and Methods

Experimental species

Harp seal pups (growth stage beater) were caught on the White Sea ice at the end of March 2010 with the help of MI-8 helicopter. Then pups molted during two weeks in the open-air cages on the coast of the White Sea (Onega Bay). Pups changed juvenile white hair to short pelage (Svetochev et Svetocheva 2009a,b, 2014).

Russian-made satellite tags «Pulsar», working in the Argos system, had been applied to beater back (Svetochev et Svetocheva 2012b). Method of attaching tags on seal back with glue was performed for the first time. The method based on the method of Canadian and Norwegian researchers (Nordøy et al. 2008, Folkow et Blix 1999, Andersen et al. 2009).

Tag technical specifications

The tag body cast from epoxy can withstand pressure at a depth of 2000 m. The tags used in this study were equipped with sensors to turn on and off, as well as sensor «wet» / «dry», responding to surfacing and diving. Weight of tag with fastening ranged from 288 to 290. The transmitter was powered by a battery with a capacity of 75000 in gear, sampling frequency radiation 44 seconds. In order to test and extend the lifetime of tags, they specially programmed: № 84578 and № 97601 - 10 days of continuous operation, then the scheduled 4 hours / 4 hour rest period; № 97602 and № 97603 - 10 days of continuous operation, then the scheduled 6 hours operating/ 6 hours of rest. Collecte Localization Satellites (CLS Argos, Toulouse, France) provided location information with different accuracy classes. Argos is a pioneer satellite-based system which has been operating since 1978. The Argos system collects data from Platform Terminal Transmitters (PTTs), and distributes sensor and location data to the final users. Argos helps the scientific community to better monitor and understand our environment, but also enables industry to comply with environmental protection regulations implemented by various governments.

Upon receipt of 4 signals from the tag per 1 flight of satellite the system was able to evaluate and assign each received coordinate the relevant accuracy class. The class «0» - shows that the accuracy of determination the coordinates was more than 1500 m. Class «1» - had positioning accuracy of less than 1500 m, the class «2» - had positioning accuracy of less than 500 m, and the class «3» - had positioning accuracy less than 250 m. Upon reception of the three signals from the tag per one flight of satellite the system determined the position of the tag, but did not assess the accuracy of observation, such data is

assigned class «A». Upon reception of the two signals the system also determined the position of the tag, but did not determine the accuracy of observation, such data is assigned class «B» (Svetochev 2013).

The tags were mounted on the seals back with special glue (quick solidifying two-component resin). Congelation point of the glue was monitored with a thermo-couple «Digital Multimetre M838». Net bags were used for fixing seals. Then seals were again placed in the open-air cages to test the tags. On April 8, 2010, the seals with tags were released on drifting ice in the White Sea (Fig. 1).

The average tenure of the tags was 226 ± 51.7 days, high accuracy classes amounted 26.9 - 63.1%, the last tag stopped May 7, 2011, so the total work time was 13 months - more than 1 year (Tab. 1). Ice conditions in the Barents and Norwegian Seas for the relevant time range were obtained from the website of the Technical University of Denmark (*www.seaice.dk*). Migration schemes were built using MapInfo GIS system.

STDs number	Sex of seal	Coordinates where the seals were released	Start of STD transmission	Stop of STD transmission	Time of STD work, day
84578	male	66° 10′ 28′′ N/ 40° 10′ 17′′ E	08.04.2010	14.09.2010	159
97601	male	66° 10′ 28′′ N/ 40° 10′ 17′′ E	08.04.2010	03.02.2011	301
97602	male	66° 10′ 28′′ N/ 40° 10′ 17′′ E	08.04.2010	04.11.2010	210
97603	male	66° 10′ 28′′ N/ 40° 10′ 17′′ E	08.04.2010	07.05.2011	394

Table 1. Information about the tags during transmission STT (Svetochev 2013).

Fig. 1. Harp seal (stage of growth «beater») with STT at the back. White Sea, Onega Bay, April 2010.

Results

White Sea

Seals with an STT, released in the White Sea in the Gorlo area remained on the ice for a week passively drifting at the annual ice. Beaters commonly migrate immediately after molting under the influence of currents and southern winds (Dorofeev 1960, Popov 1966).

The first information from the STT has shown that within 7-8 days beaters have been drifting to island Morgovez (Gorlo, or Voronka). During this time, the ice was within range of powerful the White-sea current, which starts from Cape Zimnegorsky and, heading north to the island Sosnovec, goes to the Barents Sea (Fig 2.) ([1]). In the middle of April seals actively started going into the water and headed north within the currents. Migration way for each seal had specific features. Seal with tag № 84578 reached Konushin cape with Mezensky current in the end of April, then moved to the north and came into the Barents Sea in early May (*see* Fig. 2). Seal № 97602 repeated the way of beater № 84578, falling behind 2- days, and did not return back to the White Sea.

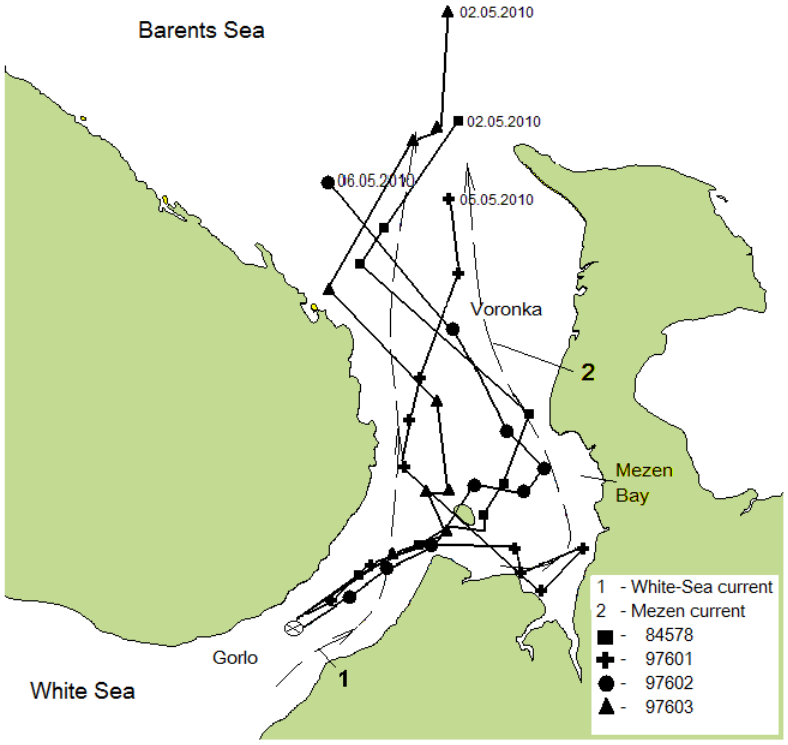

Fig. 2. The migration of harp seal (stage of growth beater) in the White Sea, April-May 2010. *Designations*: 1 – White-Sea current, 2 – Mezen current, № 84578, 97601, 97602, 97603 – tags number.

Seal № 97601 was located inside the Mezen Bay in the end of April. Strong tidal currents in this shallow bay lead to compression of pack ice, which can be dangerous for young seals. Decreased activity of signals from the STT is supposed to mean that the seal was staying in polynyas in the southern part of the bay and most of the time spent under water. This seal also left to the northwest within the White-sea current and left the White Sea in early May (*see* Fig. 2). Seal № 97603 left the White Sea sooner than the others apparently because of remaining within strong a White-sea current. On April 22th, the seal was abeam Konushin cape, and was reached the Barents Sea on April 30th.

Barents Sea

Seals began their first migration when left the White Sea in early May. Adult harp seals run along the Kola Peninsula, then went north to Bear Island to the ice edge. This direction is called «western way» (Nordøy et al. 2008, Nilssen et al. 1996). Seals with the STT in May 2010 chose «eastern way», they went north to the edge of the pack ice in the eastern part of the Barents Sea. «Eastern way» migration coincides with the Kanin and Novaya Zemlya currents in the Barents Sea.

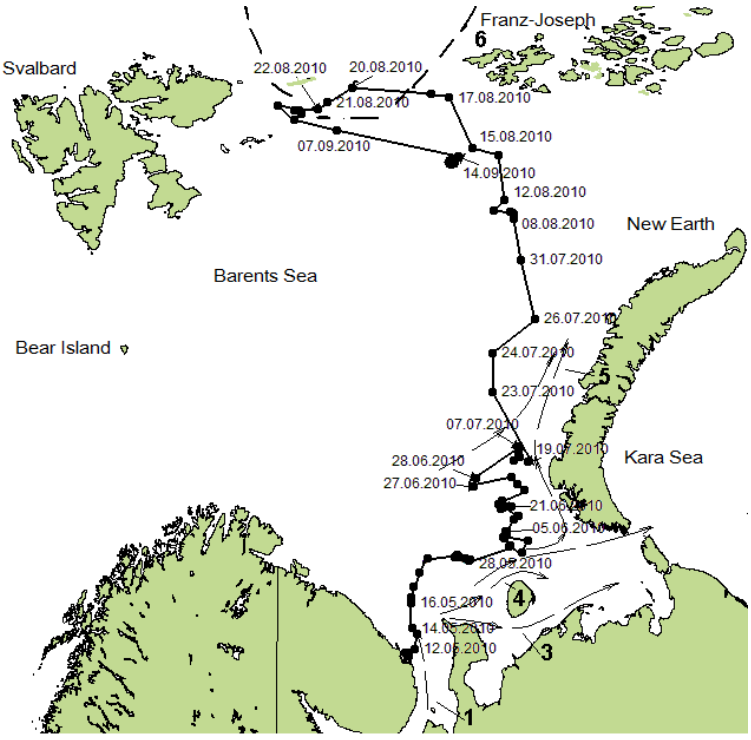

Fig. 3. The «eastern way» migration of harp seal № 84578 in the Barents Sea during 12.05-14.09.2010. The border of ice edge is specified on 01.08. 2010. *Designations*: 1 – White-Sea current, 3 – Kanin current, 4 – Kolguuev-Pechora current, 5 – Novaya Zemlya current, 6 – edge of pack ice ([2]).

In the end of May, seal № 84578 moved along the on «eastern way» in the Kanin current; he reached the northern slopes of Kanin-Kolguev shallow waters, where stayed for 1 month (Fig. 3). The migration to the north continued in mid-July. By the end of July, the seal was located on the 74° N. In late August, the seal came to the edge of the pack ice between the islands of Franz Josef Land and Svalbard, where he remained until the middle of September (the tag no longer transmitted signals).

Seal № 97601 began to migrate along the «western way» in Murmansk shallow water, and then went east to 40° E (Fig. 4). In summer, the seal was in the 74° N and 32° - 48° E. In early August, the seal moved east actively almost to 54° E. In late August, the seal reached 76° N, and in September he went to the western part of the Perseus Hill. During the return migration seal came to the Cape of Desire (Novaya Zemlya). In late November, it was on the ice in the Strait of Matochkin Shar. In early December, the seal was on annual ice between the islands Kolguev and the Novaya Zemlya (New Earth), where he stayed till the beginning of February 2011.

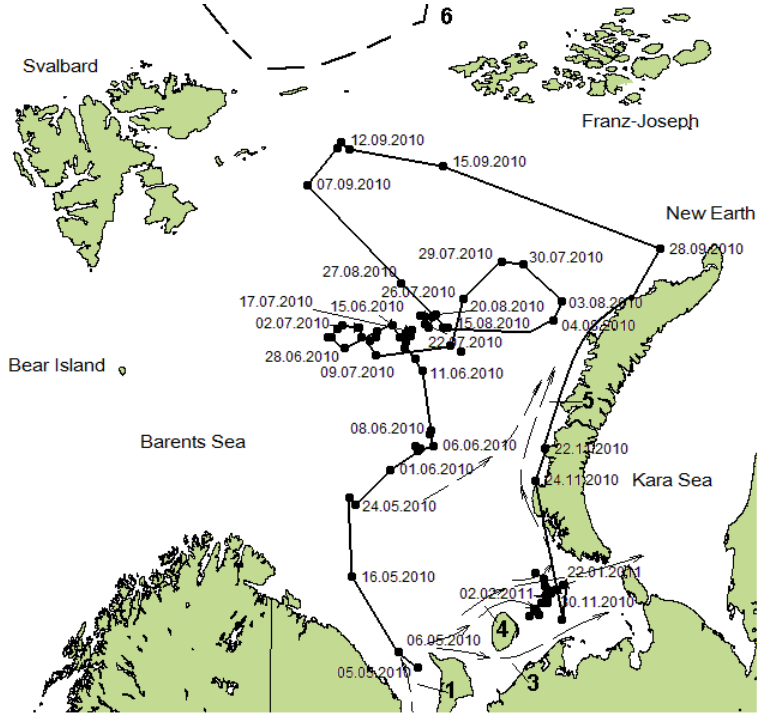

Fig. 4. The migration of harp seal № 97601in the Barents Sea during 05.05.2010-03.02.2011. The border of an ice edge is specified on 09.01.2010.

Seal № 97602 left the White Sea in early May, and went to the west along the coast of the Kola Peninsula quickly using a «western way» (Fig. 5). However, in mid-May, it turned to the northeast, and came to the western slopes of the Goose Bank, in the area of warm currents, in early June. A month later, the seal moved to the north-

east and came to 76° N near the island of the Franz Josef Land mid-July. However, the seal did not come to the ice edge. In early September, the seal turned to the southeast to the Novaya Zemlya, and in mid-September, it returned to the Goose Bank. In late September, the seal went to the northeast of the Franz Josef Land, and it went to the pack ice in mid-October, where remained until the end of the tag work 04.11.2010.

Among the tagged seals, the seal № 97603 passed the longest migration route. The individual left the White Sea earlier than the other seals, *i.e.* - in late April. The seal has chosen the «eastern way», but at the end of the summer turned to the northwest. At the beginning of November, the seal went to the north to reach the ice edge. Then, the seal remained between the islands of Svalbard and Franz Josef Land to the end of 2010 (*see* Fig. 6). In mid-January, the seal came to the Atlantic near the west coast of Svalbard (Greenland Sea), where he stayed for almost a month. In mid-February, the seal went back east along the ice edge, and came to the north of Novaya Zemlya in the middle of April (*see* Fig. 7). Then the seal moved south along the fast ice near the islands of Novaya Zemlya. On April 28th the seal came to the southeast of the Barents Sea, (Kanin-Kolguev shallow water), where remained on ice until 7 May. By this time the seal began to molt and likely lost the tag.

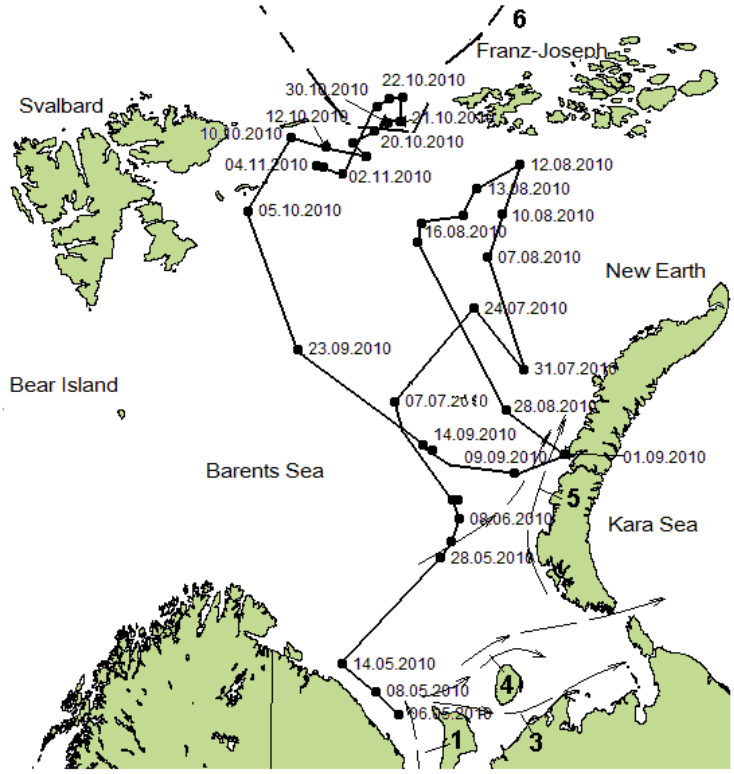

Fig. 5. The migration of harp seal № 97602 in the Barents Sea during 08.05-04.11.2010. The border of ice edge is specified on 01.10.2010.

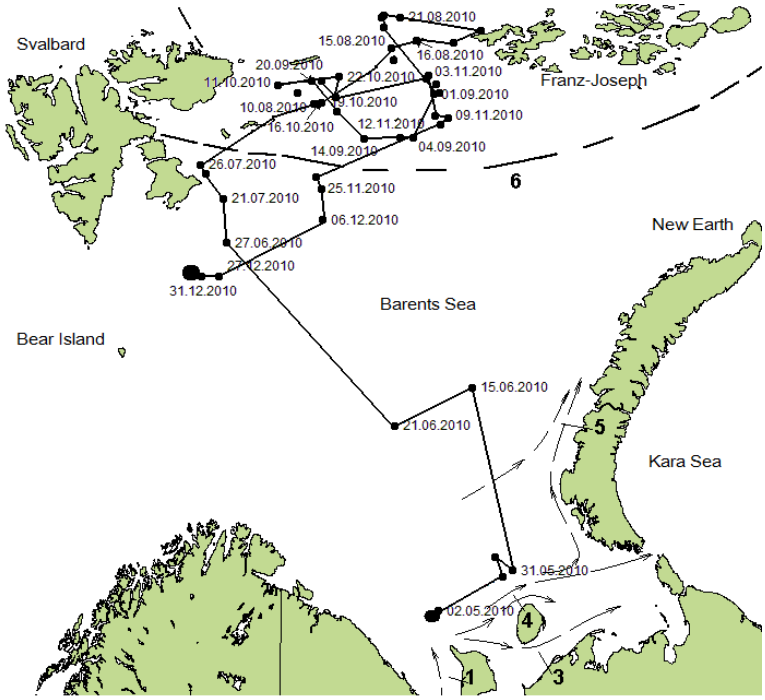

Fig. 6. The migration of harp seal № 97603 in the Barents Sea during 02.05.-31.12.2010. The border of ice edge is specified on 01.11.2010.

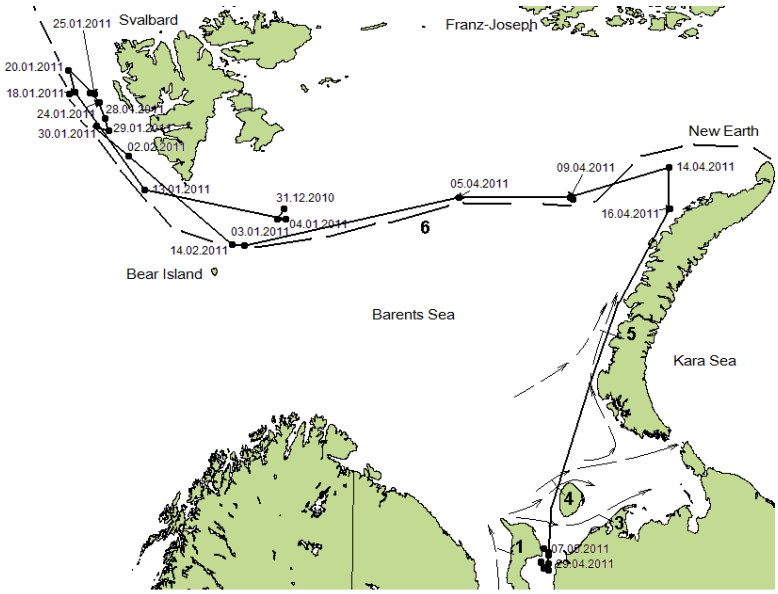

Fig. 7. The return migration of harp seal № 97603 (31.12.2010-07.05.2011) in the Barents Sea. The border of ice edge is specified on 01.02.2011.

Discussion

The rate of ice removal in the White Sea in March and April is the determining factor of harp seal pups survival. If young seals leave the White Sea in the late April - to early May period, they meet optimal conditions for a successful migration to feeding areas (Svetochev 2013, Matishov et al. 2011). An important age-related aspect is that young seals on the stage of growth «beater» begin to feed themselves in water yet in the White Sea, where the basis of diet consists of pelagic invertebrates. Intensity of the feeding, however, is rather small (Svetochev et Svetocheva 2005, Svetocheva et Svetochev 2008, Svetochev et Svetocheva 2009c). Moreover, we can assume that the seals dive to a depth not exceeding 30 m (Nordøy et al. 2008). However, the delay of leaving the White Sea because of unfavorable winds can lead to starvation and death (Svetochev 2000).

In our study, the observations of tagged seals showed that after molting, beaters had been drifting from Gorlo of the White Sea to the Barents Sea for almost a month, avoiding areas of ridging and actively swimming (and feeding?) in stationary polynyas of the Mezen Bay and Gorlo (*see* Fig. 8). In May-July period, the tagged seals migrated «eastern way», stopping in the most productive areas - such as Goose Bank, Hill Perseus, *etc*. Adult harp seals migrate faster through the western part of the Barents Sea (western way) and thus may come to the edge of the pack ice in the Barents sea in July (Nordøy et al. 2008).

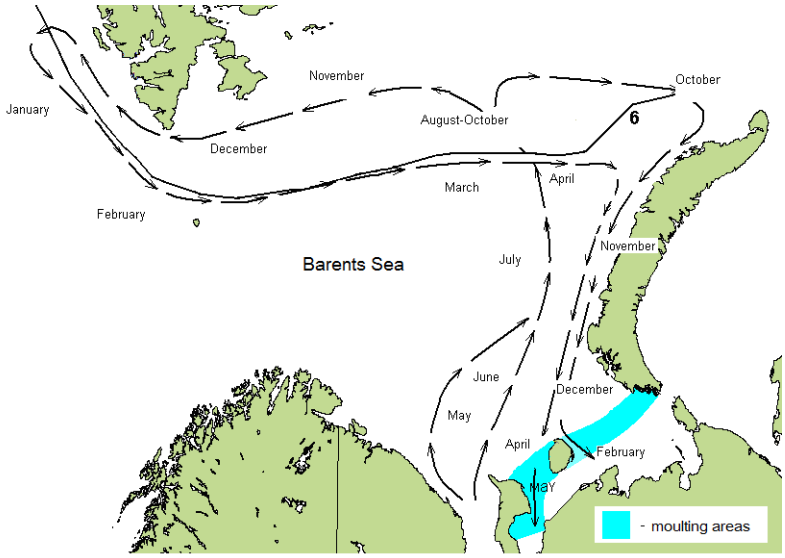

Fig. 8. The migration of harp seals (juveniles) in the Barents Sea according to STT per 2010-2011. Border of ice edge is specified on 01.02.2011 (Svetochev et Svetocheva 2012b).

In August - October period, young seals were feeding in the open part of the Barents Sea, which is typical for adult seals (Nordøy et al. 2008). However, they reached the edge of the pack ice between the archipelago of Svalbard and Franz

Josef Land some 2-3 months later than usually adult harp seals do. The reason of it might be the distribution of juvenile capelin in the Barents Sea in the summer of 2010, coinciding with the distribution of young seals ([3]).

Return migration time of young seals is likely to depend on the availability and abundance of forage at the edge of pack ice where the diet consists of Arctic cod and hyperiids (*Temisto libellula*) (Nordøy et al. 2008, Svetochev 2010). Only two tags worked in the November – to February period. One of the young seals made a traditional migration which is also typical of adult harp seals route. The seal had passed from the edge of the pack ice to the southeastern part of the Barents Sea in about 12 days, moving along the west coast of Novaya Zemlya. He remained in the area of habitual residence of adult harp seals for over a month, until the tag stopped working. Adult seals gather on southeast of the Barents Sea to go into the White Sea in winter. Such behavior has repeatedly been described previously (Nordøy et al. 2008, Dorofeev 1960, Beloborodov 1971, Potelov 1998). In the south-east of the Barents Sea capelin and herring could possibly be the objects of winter diet (Stasenkova 2009).

The second working tag showed the most interesting and long migration of a young seal. Instead of getting away from the edge of the pack ice to the southeast Barents Sea, the seal turned west and came to the west coast of Svalbard. Thus, the seal has got into the area Jan Mayen harp seal population. In April the seal returned to the Barents Sea and did not stay there to molt. Instead of staying there, the seal went the southeast sea. This happened very quickly, just in two weeks. It is a fact that the seal did not go to molt in the White Sea, as it was in the Czech Bay in early May. In this location, the sensor stopped after 13 months of uninterrupted work. The subject of food for seals in this area can be a Czech-Pechora herring (Stasenkova 2009).

Results got in this study of harp seals have provided unique information about the first seasonal migration of young individuals. Obviously, the migration routes of juvenile's seals differ from those of adult seals (Fig. 8). Young seals prefer the «eastern way». In fact, they remain in the feeding areas for a longer time than adult seals and come to the margin of pack ice later (or don't go there at all). Return migration has shown that young harp seals may return different ways to the areas of breeding and molting. They can stay in the north of the Barents Sea, to go out into the Atlantic and not return to the White Sea. Our study showed that the Czech Bay is a promising molting area for juvenile's seals. This information was received for the first time and is very promising for future studies. This variety of behavior during the first seasonal migration ensures the survival of juvenile's harp seal in the changing conditions of the Arctic seas.

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