Distribution and migrations of cetaceans in the Russian Arctic according to observations from aerial ice reconnaissance

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ABSTRACT

This paper is based on 748 observations of belugas (*Delphinapterus leucas*) and 382 observations of baleen whales in the Russian Arctic, the majority of the data provided by aerial reconnaissance of sea ice (ARSI). Although the data are not suitable for the estimation of the number and density of the animals, they represent a multi-year (1958-1995) range of observations to update our knowledge on the seasonal distribution and migrations of the species. Belugas inhabit not only shelf waters but also the zone of the shelf slope and the abyssal zone of the Arctic Ocean, where the animals appear mostly in summer. In winter belugas were observed only in the Barents Sea. In June-August, the frequency of beluga observations was highest in the Laptev Sea, which has previously been believed to have considerably lower numbers of beluga than the Kara and Barents seas. Patterns of seasonal distribution and ice cover suggest the existence of a natural border preventing or reducing population exchange between belugas inhabiting the western and eastern parts of the Russian Arctic. A brief review of available data on distribution of the narwhal (*Monodon monoceros*) in the Russian Arctic is also given. Two species of baleen whales were frequently seen in the Russian Arctic: the bowhead whale (*Balaena mysticetus*), and the grey whale (*Eschrichtius robustus*). The majority of such observations were made in the southeastern part of the East-Siberian Sea and the southern part of the Chukchi Sea. In the Bering Sea baleen whales were usually seen near the Chukotka Peninsula, in Anadyr Bay and southeast of it. Whales were usually seen in ice-free water: observations of whales among rarefied ice and near the ice edge were rare. There were considerable annual and seasonal variations in distribution and migrations of baleen whales in the region, probably caused mainly by the dynamics of ice conditions.

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INTRODUCTION

The study of the seasonal distribution and migrations of Arctic marine mammals has always been a complicated task due to the large area of the region, the severe climate, long periods of darkness, and, as a result, the high costs of field research. In addition, long migrations are characteristic for many Arctic marine mammals. That is why any additional information on the seasonal distribution of these species is of special value. The most common species of cetaceans in the Russian Arctic are the beluga (*Delphinapterus leucas*), narwhal (*Monodon monoceros*), bowhead whale (*Balaena mysticetus*), and grey whale (*Eschrichtius robustus*).

The beluga occupies or makes seasonal incursions into arctic and sub-arctic seas. Belugas in-

habit both deep waters and shallow coastal zones including river estuaries and mouths. Although in Russia the beluga is a game species, there has been almost no commercial hunting of it since the beginning of 1990s. A few animals are caught annually by local people for subsistence needs, mostly in Chukotka.

The narwhal is another cetacean species with a High Arctic distribution. In the Russian waters narwhals are rare and occur mostly in the area of Frantz-Josef Land. This species has never been subjected to whaling in Russia, and since 1983 it is has been listed in the Red Data Book of Russia.

The distribution of baleen whales in the Russian Arctic is limited to the western and eastern parts of the region. All the species with the exception of the minke whale (*Balaenoptera acutorostrata*) are listed in the Red Data Book of Russia. Special attention is paid to development of measures for conservation and sustainable use of the species. Whaling is prohibited throughout the Russian Arctic, except for the grey whale and the bowhead whale, which are harvested by indigenous people of Chukotka. Between 110 and 130 grey whales and 1 and 5 bowhead whales are harvested annually. Bowhead whales (50 to 60 annually) are also hunted by indigenous people of Alaska.

This work presents an analysis of seasonal distribution and movements of belugas, narwhals, and baleen whales in the Russian Arctic. The analysis is mainly based on the data collected by multi-year aerial reconnaissance of sea ice (ARSI). Data obtained by the drifting stations "North Pole", and questionnaire data are also included. Partial analysis of some of the data was done earlier (Belikov *et al*. 1982, 1984a, 1984b, 1989). These data do not allow us to speculate on the number and density of the species, but give a valuable range of multi-year observations, useful for illustrating the seasonal distribution and movements of belugas and other whales.

MATERIALS AND METHODS

Aerial reconnaissance of sea ice

ARSI was conducted for more than 40 years to monitor the state of sea ice cover in the Russian Arctic (Fig. 1). Figure 2 shows as an example the flight paths used by ARSI flights from 1982. Performing ARSI hydrologist-observers also recorded sightings of marine mammals, mainly

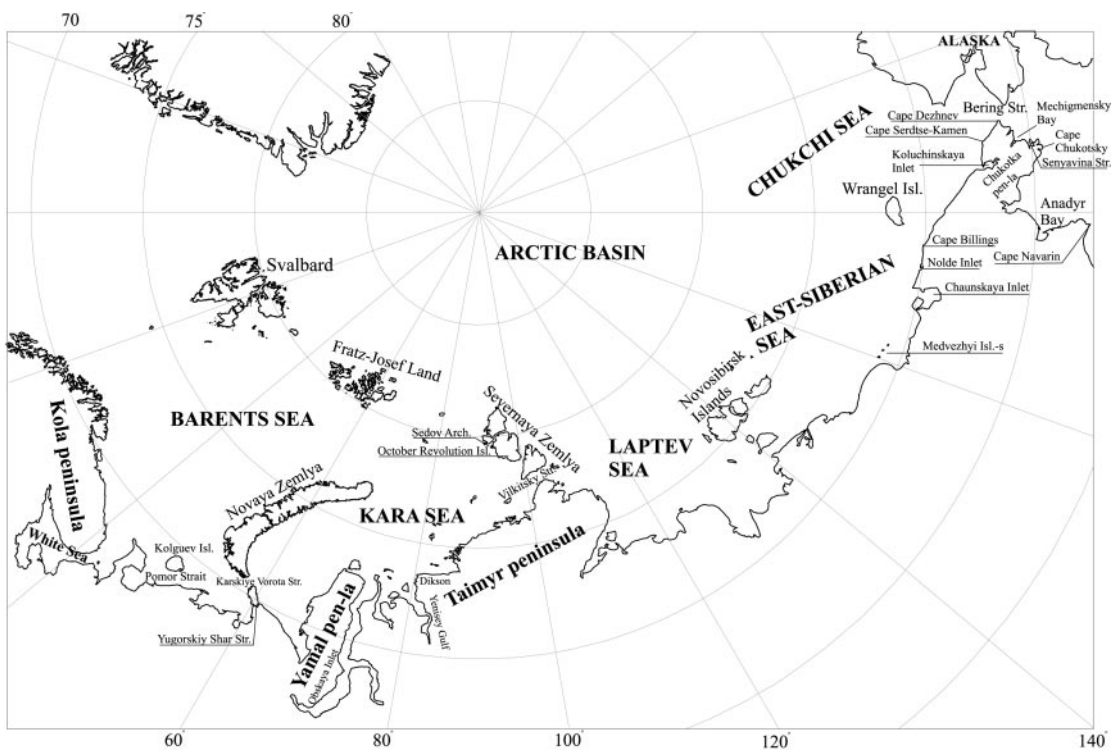

Fig. 1. *The Russian Arctic, showing place names used in the text.*

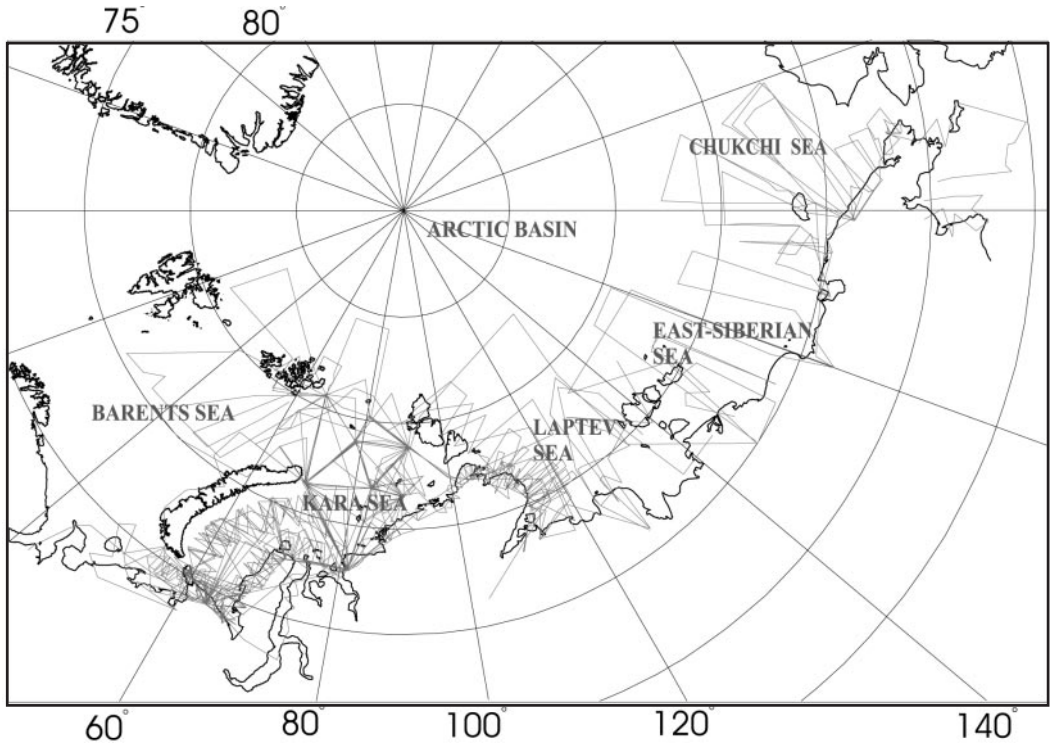

Fig. 2.
Flight paths of ARSI in 1982.

whales, walruses (*Odobenus rosmarus*), and polar bears (*Ursus maritimus*). Recording of marine mammals was an integral part of the ARSI, however observers differed in experience in making such observations.

Three types of ARSI can be distinguished according to their purposes (Volkov 1981): observing (research), operative, and special. Observing ARSI was conducted at standard routes, which were sometimes slightly altered according to changes in ice conditions. In winter it was performed monthly, in summer, three times per month. Operative and special ARSI were organised for assisting navigation. They were not regular, and covered smaller areas than observing ones did. The total effort of these ARSI is comparable with the effort of observing ARSI. The Kara Sea has the busiest shipping routes in the Russian Arctic, a situation that led to a relatively high proportion of operative and special ARSI compared with observing ones (Yu.A. Gorbunov, pers. comm.). During operative and special ARSI, the observers had less opportunity to observe animals.

ARSI was conducted using mostly Il-14 fixed-wing aircraft. More rarely an An-26 airplane or a Mi-8 helicopter was used. ARSI flights were performed at an altitude of 100 to 300 m at a speed 180 to 300 km/h, depending on the type of aircraft used. Locations where animals were observed, species and number of the animals were recorded on maps of ice conditions. The number of animals in big groups was estimated roughly, because precise counting was impossible due to the high speed of the flights. Since 1989, ARSI has been conducted primarily by instrumental means from high altitude. Visual observations of ice cover, although seldom carried out, are conducted using the Mi-8 helicopter or the An-26 airplane.

Other Data Sources

We also include information from marine mammal observations from the "North Pole" research stations that were installed on drifting ice platforms from 1954 to 1991. Animals were observed in the direct vicinity of the stations. Occasionally, when a helicopter was used for scientific work, observations were conducted away from the station.

Data from other sources include opportunistic observations of marine mammals from transport aircraft, transport vessels and icebreakers.

Treatment of Data

Maps of ice conditions made during ARSI and observation logs of "North Pole" drifting stations are stored in the archives of Arctic and Antarctic Research Institute (AARI), St. Petersburg. Within the framework of the project "Marine mammals" of the International Northern Sea Route Programme (INSROP), a project was carried out to create a database and a set of maps of the distribution of marine mammals (Belikov *et al*. 1995, Wiig *et al*. 1998). The database contains the species and number of observed animals, and co-ordinates and dates of the observations. For some observations ice conditions at the place of the observation are also given. In addition, the database contains descriptions of the ARSI flights with records of the date, path, duration, altitude and speed of a flight, visibility conditions, and co-ordinates of turning points on a route.

The database contains descriptions of 748 observations of belugas and 382 observations of baleen whales for 1958 to 1995. The major part of these observations is provided by ARSI (Table 1). Although description of the routes in the database has not yet been completed and at present covers only the period 1982-1991, even these data show the unevenness of the ARSI effort across the seas. The ARSI effort is the highest in the Kara Sea with more than five times the effort allocated there than in the other seas (Fig. 3).

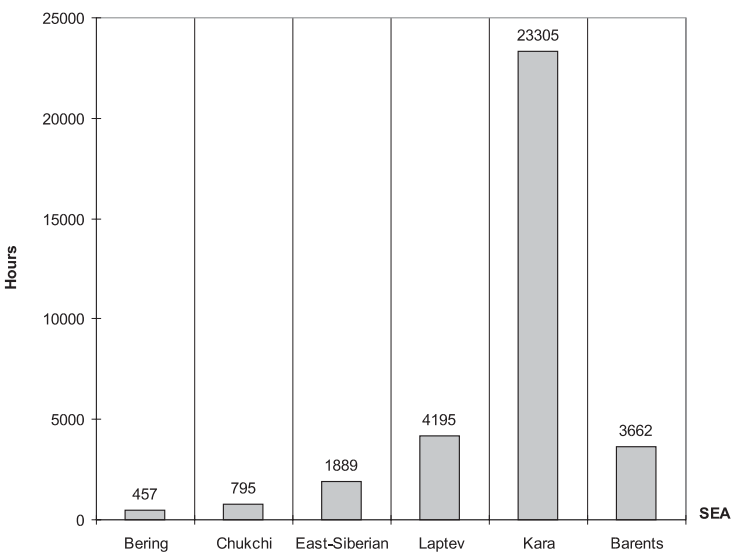

Fig. 3. *Distribution of ARSI effort (flight hours) in different seas, 1982-1991.*

Table 1. Number of observations of belugas and baleen whales, 1958 to 1995

	ARSI	Other	Total
Beluga	735	13	748
Baleen whales	351	31	382

The annual number of animal observations varied considerably (Fig. 4) and obviously depended on the annual frequency of ARSI flights. In the given range of observations for 1982 to 1991 a positive correlation ($r = 0.464$) was found between the annual number of ARSI flights and frequency of observations of belugas.

The most complete information on ARSI conducted from 1982 to 1991 exists for the Barents, Kara and Laptev seas (Table 2). To describe the relative frequency of observing belugas in these seas we derived a sighting index (Fig. 5) for the period 1982-1991, equal to the relation N/T, where N is the known total number of beluga observations in a certain sea, and T is number of hours of ARSI flights in the same sea.

DISCUSSION

Belugas

Belugas were seen in the eastern part of the East-Siberian Sea (Fig. 6), while none were observed in the central and western parts of the sea. Observations of belugas in the eastern part of the Laptev Sea adjacent to the Novosibirsk Islands were rare.

Only 12 observations of belugas were recorded for the East-Siberian Sea, although the ARSI effort in the sea was comparable with that in the Laptev and Barents seas (Fig. 3). Comparison of these ARSI data, as well as the data from ARSI observations of other marine mammals, with the materials on ice conditions in the East-Siberian Sea leads us to conclude (Belikov *et al*. 1982) that the central part of the sea presents a barrier to migrating marine mammals. This barrier is the Ayon ice massif, a year-round area of solid ice with a significant presence of multi-year ice. In the winter it extends from the Arctic Basin to the shore fast ice; in the summer, almost to the mainland shore.

However in abnormally warm years, when at the end of summer the most southern part of the

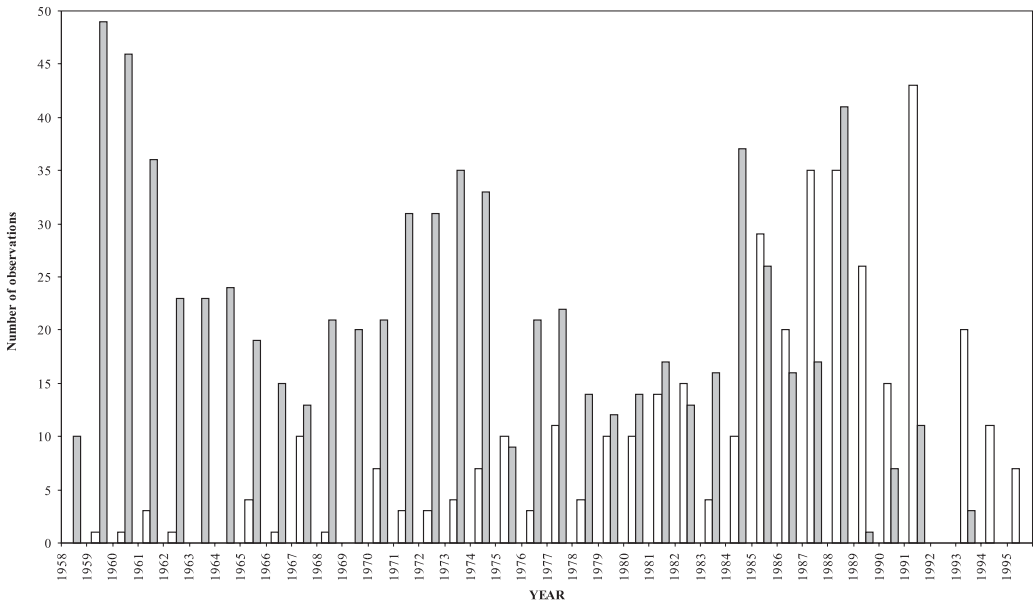

Fig. 4. *Annual numbers of observations of beluga and baleen whales, 1958-1995.*

East-Siberian Sea is ice-free, marine mammals migrating from the Chukchi Sea to the west or from the Laptev Sea to the east, could penetrate far into the East-Siberian Sea. Thus, inter-population exchange is potentially possible. For example: a group of 6 belugas of different ages was seen on June 15 1964 at 74° 50'N, 167° 30'E; in September 1977 a single animal was seen at 72° 05' N, 169° 00' E, and two belugas were seen at 72° 05'N, 167° 40' E. Several cases of appearances of solitary animals and small groups of belugas are mentioned by Kleinenberg *et al*. (1964), in the most western part of the East-Siberian sea, near the Medvezhyi Islands and in the region of mouth of the Kolyma River. Fedoseev (1966) reported observations of solitary belugas in the coastal zone from the mouth of the Kolyma River to Chaunskaya Inlet. These observations confirm the possibility of the exchange between belugas of eastern and western parts of the Russian Arctic.

Table 2. Duration of ARSI flights and summarised monthly numbers of beluga observations (*N*) in the Barents, Kara and Laptev seas, 1982-1991

Month	Barents Sea		Kara Sea		Laptev Sea		Total	
	Hrs	*N*	Hrs	*N*	Hrs	*N*	Hrs	*N*
Jan.	286	0	1,556	0	0	0	1,842	0
Febr.	288	0	1,880	0	227	0	2,395	0
March	258	1	2,440	0	320	0	3,018	1
April	661	2	2,467	2	272	0	3,400	4
May	620	1	2,509	1	125	0	3,254	2
June	273	1	2,014	2	109	1	2,396	4
July	315	1	2,318	9	541	20	3,174	30
Aug.	310	0	2,261	8	1,124	7	3,695	15
Sept.	230	0	1,660	5	782	2	2,672	7
Oct.	133	0	1,571	7	544	1	2,248	8
Nov.	63	0	1,142	0	94	0	1,299	0
Dec.	225	0	1,487	0	57	0	1,769	0
Total	3,662	6	23,305	34	4195	31	31,162	71

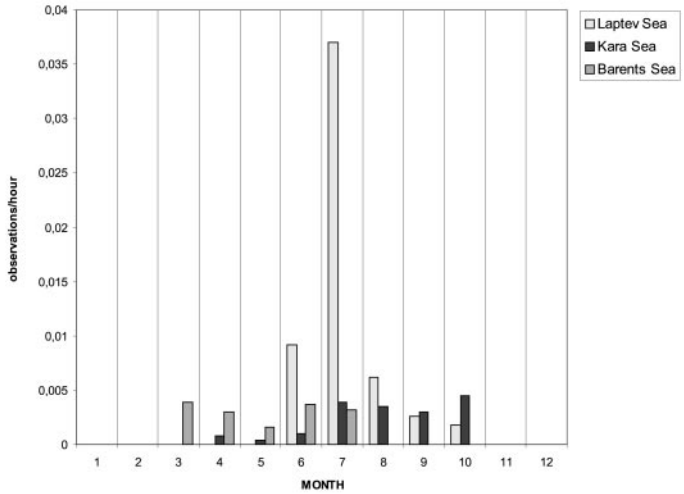

Fig. 5. *Monthly sighting index for belugas in the Barents, Kara and Laptev seas, 1982-1991.*

Nevertheless, our data confirm the delineation of belugas in the Russian Arctic into at least two largely discrete populations: the Karskaya population and Far-Eastern population.

Karskaya population

The ARSI data and the published data on the distribution of belugas in the Kara Sea (Klumov 1939, Ognetov and Potelov 1984), as well as our observations during field research on polar bears in April-May from 1993 to 1995 do not confirm the opinion of some researchers (Kleinenberg *et al*. 1964, Heptner *et al*. 1976, Mishin *et al*. 1989) that considerable numbers of belugas regularly winter in the Kara Sea. In the period of maximum extent of ice cover (January - April), belugas were observed only in the Barents Sea (Fig. 7a). The only exceptions were several observations of beluga in the Kara Sea at the eastern shore of Novaya Zemlya and in the north-western part of the sea adjacent to the Barents Sea.

In winter belugas were observed in most of the ice-covered Barents Sea (Fig. 7a). Rarely, belugas were found to the north of Svalbard and Franz-Joseph Land, where, as it was believed earlier, the animals could be seen only until the beginning of winter (Kleinenberg *et al*. 1964). In January-February, observations of belugas were rare because of poor visibility during the polar night and the lower frequency of ARSI flights. However, according to Ognetov (MS 1999), large aggregations of animals (up to 2000 to 3000) may be found in the Pomor Strait south of the Kolguev Island. In April the majority of observations of belugas were from the central and northeastern parts of the Barents Sea. This may indicate a spring re-distribution

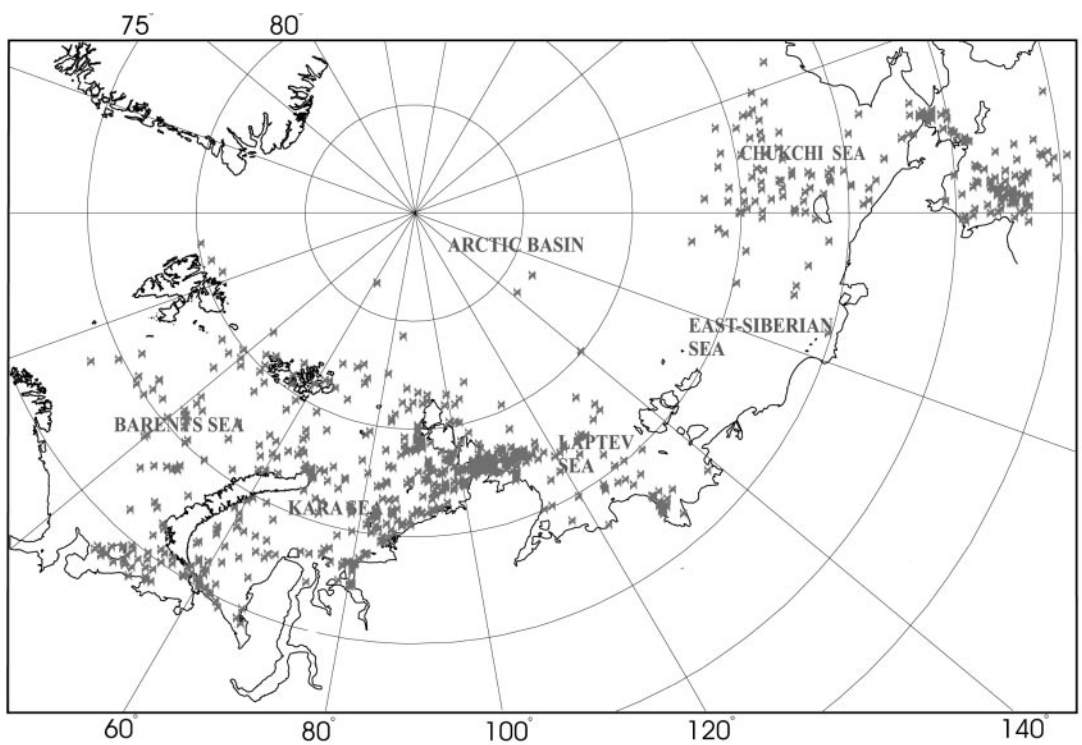

Fig. 6. *Observations of belugas from ARSI, 1958-1995.*

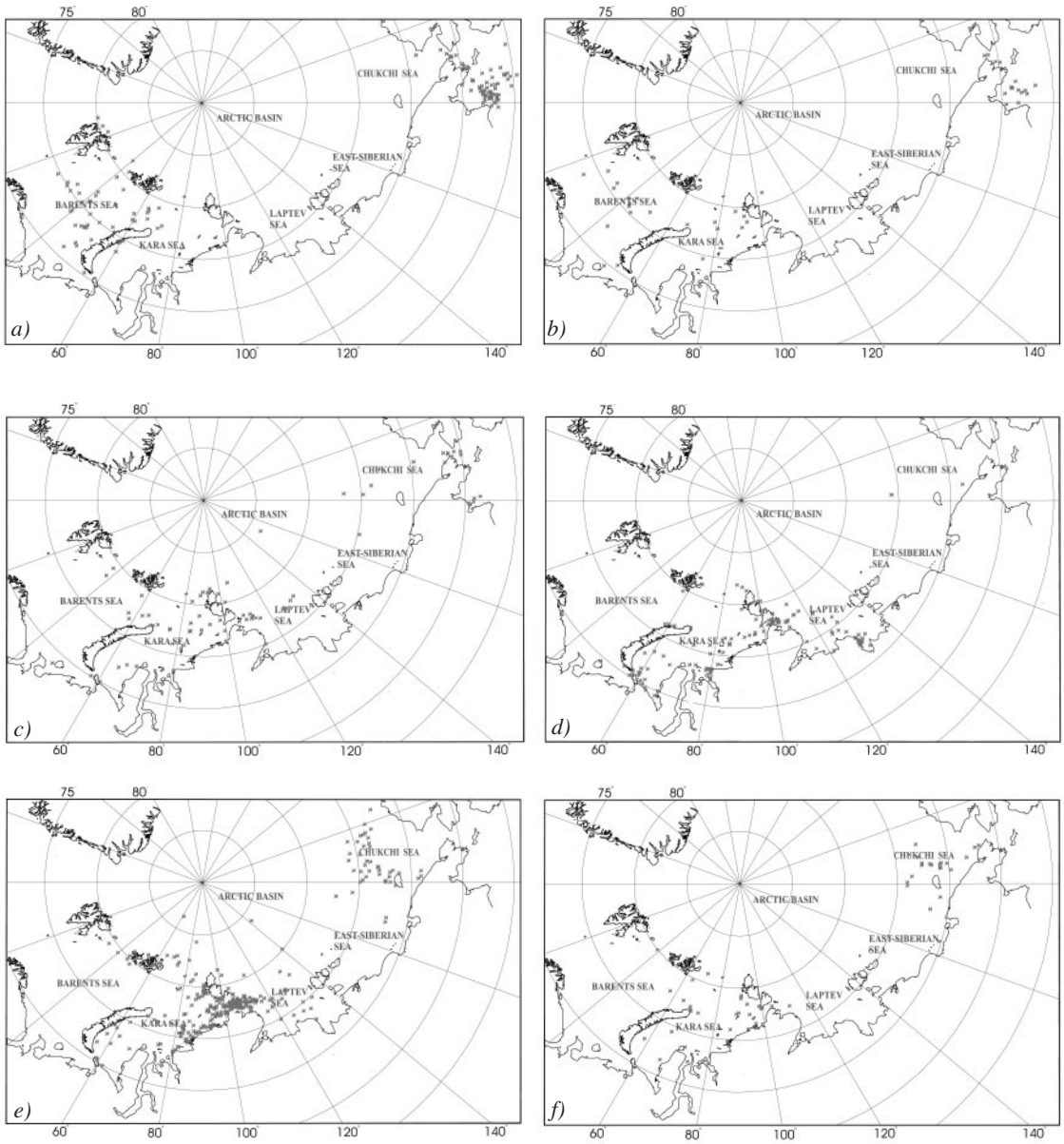

Fig. 7. *Observations of belugas from ARSI throughout the year:*
a) Jan.-April
b) May
c) June
d) July
e) Aug. - Sept.
f) October.

of belugas prior to the beginning of their migration to the Kara Sea. It is also known (Borkin and Zhuravleva 1995) that along the western shore and at the southern end of Novaya Zemlya, mass spawning of the polar cod (*Boreogadus saida*), one of the main prey species of the beluga, takes place.

Spring movement of belugas to the Kara Sea, as it can be derived from publications (Klumov 1939, Kleinenberg *et al*. 1964, Heptner *et al*. 1976) and the observations from ARSI, goes by two major paths: to the north of Novaya Zemlya and through the straits Yugorskiy Shar and Karskiye Vorota. It is believed (Kleinenberg *et al*. 1964, Heptner *et al*. 1976, Ognetov and Potelov 1984) that the spring migration of belugas to the east begins in the second half of May and continues through June. However, in May (Fig. 7b) belugas were seen by the ARSI observers in the northern and northeastern parts of the Kara Sea, and in one case, in the northwestern part of the Laptev Sea. The animals in the Laptev Sea likely penetrated through a system of leads. In early May 1991, 50 to 70 km south of the Sedov Archipelago (a small island group near the western coast of Severnaya Zemlya), participants of an international expedition, in-

cluding one of the authors of this report, observed several small groups of belugas in a lead in 40% to 60% one-year-old ice cover.

From the above data, we postulate that the eastward movement of belugas through the northern route begins earlier than previously thought. This may occur because animals migrating along the western coast of Novaya Zemlya do not encounter a dense ice pack, as the Western-Novaya Zemlya polynia occurs there at this time of year.

In June belugas were observed in the eastern and southeastern Kara Sea and near the northern point of the Severnaya Zemlya Archipelago (Fig. 7c). Few observations of belugas were recorded in the western and central parts of the Laptev Sea. According to the observations from ARSI, movement of belugas from the Barents Sea to the Kara Sea through the southern route begins no earlier than June.

In the second half of May and into June, shore fast ice breaks up rapidly and the edge of drifting ice in the southwestern part of the Kara Sea recedes to the north, northeast and east. Belugas can then move to the Kara Sea through the straits south of the Novaya Zemlya. According to several authors (Klumov 1939, Kleinenberg *et al*. 1964, Ognetov and Potelov 1984) movement takes place in May - June and its timing depends on the ice conditions of the specific year. Movement of animals through the Karskie Vorota Strait is usually more intensive than through the Yugorsky Shar Strait because ice breaks up later in the latter (Ognetov and Potelov 1984).

In July in the Kara Sea (Fig. 7d), belugas were observed most often in its southern part and in the Vilkitsky Strait. In some cases animals were observed near the northwestern coast of Novaya Zemlya. Klumov (1939) and Kleinenberg *et al*. (1964) also reported the occurrence of a few belugas in this area in July. In the Laptev Sea in July, belugas were seen in the western, southern and central parts.

There is a common belief that belugas are considerably less abundant in the Laptev Sea than in the Kara Sea (Klumov 1936, Chapsky 1941, Heptner *et al*. 1976). However, ARSI observations in the summer months demonstrate that the sighting index of belugas in the Laptev Sea is much higher than in the Kara Sea, with the difference being greatest in July (Fig. 5). This indicates that the beluga densities in these seas in the summer are at least comparable. However, there was a much higher proportion of operative and special ARSI relative to observational ARSI conducted in the Kara Sea than in the Laptev Sea. As a result, observations of animals in the Kara Sea were less effective than in the Laptev Sea, partially accounting for the relatively low sighting index there. Observations of belugas in the eastern part of the Laptev Sea were scarce.

In August-September (Fig. 7e) the frequency of beluga observations increased significantly near the northwestern shore of Taimyr Peninsula, in the Vilkitsky Strait and in the waters adjacent to the strait. Concentration of the animals in these regions at the end of summer and the beginning of autumn has been noted previously (Rutilevski 1939, Chapsky 1941, Kleinenberg *et al*. 1964, Timoshenko 1967). These authors believed that the reason for the concentration of belugas was food abundance: aggregations of whitefish (*Coregonidae*) and polar cod. Belugas were also observed near the eastern coast of Novaya Zemlya.

The ARSI data do not provide information on the summer distribution of belugas in the Barents Sea. In this period ARSI was not conducted over most of the sea because of the absence of ice. It is generally believed that in summer the majority of belugas leaves the sea (Ostroumov 1935, Ognetov MS 1999). In the region of Frantz-Josef Land, where ARSI was conducted all year round because of the presence of ice, belugas were observed in summer. Belugas were also observed in this area in August 1996: 3 groups of beluga, of 4, about 100 and 150 animals (Wiig and Boltunov 1997).

In the eastern Laptev Sea, observations of belugas by the ARSI were rare. Observations done from the research vessel "Polarstern" from 28 July to 18 August 1998 also confirm the rarity of belugas in this area. According to Pozdnyakov

(pers. comm.) in the area 73° 30'– 78° 04' N, 128° 14' – 133° 49' E only a few walruses, ringed and bearded seals and polar bears were seen.

ARSI observations demonstrate that practically all belugas leave the Laptev Sea by October (Fig. 7f). Apparently they leave for the Kara Sea, where belugas are still common in October.

Far eastern population

According to Fedoseev (1966), in the period of maximum extent of ice cover, groups of belugas in the northern part of the Bering Sea stay among rarefied broken ice and near the ice edge. According to other researchers (Melnikov and Bobkov 1996) belugas stay in a zone of coastal polynias and leads near the eastern Chukotka Peninsula. Berzin *et al*. (1996) reported observing small groups of belugas and solitary animals near Cape Navarin (southeast of Anadyr Bay) in winter 1983/84. Animals were seen mostly in leads and channels in the ice and sometimes in small polynias. According to questionnaire data presented by Berzin *et al*. (1996), about 500 belugas annually winter in pack ice of the Anadyr Bay.

A regular presence of belugas in the Chukchi Sea near Cape Serdtse-Kamen in winter, reported by Kleinenberg *et al*. (1964), is confirmed neither by observations from ARSI, nor by any other published data. Apparently, the occasional beluga entrapment in the winter ice of Koluchinskaya Inlet in the Chukchi Sea (Fedoseev 1986) should be considered as exceptional.

ARSI data suggest that in the period of maximum extent of ice cover (Fig. 7a) belugas occupy the Bering Strait at the eastern coast of Chukotka Peninsula, and most often the Bering Sea north and northeast of the Cape Navarin. Spring movement of belugas to the Chukchi Sea becomes apparent only in June (Fig. 7c). In years with especially light ice conditions at the end of June, separate groups of belugas reach the northern portion of the Chukchi Sea and adjacent waters of the Arctic Basin. Observations of marine mammals from coastal points (Melnikov and Bobkov 1996) support the conclusion of Kleinenberg *et al*. (1964) that a part of the belugas moving in spring from the Bering Strait move to the west of the Chukchi Sea along the northern coast of the Chukotka Peninsula.

In July ARSI observations of belugas in the eastern Russian Arctic were scarce (Fig. 7d). In August-September (Fig. 7e) the majority of animals were seen in the northern part of the Chukchi Sea, mainly along the ice edge, and in only a few cases in August, near the northern coast of the Chukotka Peninsula. Similarly, belugas were not seen from the coastal observation posts near the eastern and northern coasts of the Chukotka Peninsula in July-September 1991 to 1994 (Melnikov and Bobkov 1996). On September 2 1994 a single beluga was observed in the northern part of the Senyavina Strait.

ARSI data suggest that belugas begin to move toward the Bering Strait in October (Fig. 7f). However, in this month, animals were sometimes observed in the East-Siberian Sea and in the western Chukchi Sea. Thus, on October 10 1991, one animal was recorded west of Chaunskaya Inlet (70° 08' N, 163° 38' E), and on October 15 1979, a group of 50 animals was seen in the eastern part of the East-Siberian Sea (Inlet (70° 50' N, 176° 00' E). Fedoseev (1966, 1981) noted several other occurrences. The autumn migration of belugas from their feeding grounds to the Bering Sea continues from the second half of October through November (Fedoseev 1986, Melnikov and Bobkov 1996).

In the East-Siberian and Chukchi seas, ice conditions are more severe than in the Bering Sea where in winter numerous leads, channels, and cracks appear in the ice cover. According to Fedoseev (1986), belugas are forced out of the eastern Russian Arctic to the Bering Sea by rapidly forming ice in the fall. Analysis of the ARSI observations of marine mammals and the ice cover in the Chukchi Sea during spring-summer-autumn period of 1971-1979 (Belikov *et al*. 1984a) supports this conclusion.

Observations of belugas in the Arctic Basin

ARSI observations and the data collected by "North Pole" drifting stations show that in the summer belugas penetrate deep into the Arctic Basin. There are documented observations of

Table 3. Ice conditions at the locations of beluga observations (n = 308)

Ice conditions	Frequency of beluga observations (%)
Leads, channels, polynias	15.5
Edge of pack ice	7.5
Ice free water	77.0

belugas north of 83° N. For example on June 14 1955, 2 belugas in ice cracks were observed from the drifting station "North Pole – 5" at 83° 51' N, 151° 44' E. On August 18 1972, a solitary beluga was seen at 86° N. This is the most northern known observation of belugas in the Arctic Basin.

Belugas in the Arctic Basin were observed mainly in waters adjacent to the Chukchi Sea (Fig. 6). Usually they were seen there at the end of the summer, especially in years when the pack ice edge receded far to the north. The animals were observed both near the ice edge and in leads in the ice. As a rule, these were solitary animals or small groups. Herds of more than 100 animals were observed only in four cases.

In the period of maximum ice extent, belugas were seen in the Arctic Basin only in April near Svalbard and Frantz-Josef Land (Fig. 7a). For example, on April 24 1971 in leads to the north of Svalbard, ARSI registered 1 beluga, and on April 24 1974 in the same region 7 belugas were seen. On April 12, 1978, 5 belugas were observed in a zone of gray-white ice northwest of Frantz-Josef Land.

These observations indicate that belugas seasonally occupy not only the Arctic seas but also the region of continental slope and the abyssal zone of the Arctic Ocean. It should be noted that in the Arctic Basin ARSI was conducted significantly less intensively than in the seas. Because of this it is likely that belugas are more common in the Arctic Basin than is apparent from ARSI data. The ability of belugas to live in deep-water Arctic regions has been confirmed by satellite telemetry (Martin *et al*. 1993).

Association with ice

The majority of belugas were observed in ice-free water (Table 3). One-year old and young ice prevailed in those cases when animals were seen in ice (Table 4).

Table 4. Ice age at the locations of beluga observations (n = 74)

Ice age	Frequency of beluga observations (%)
Young ice	37
First-year ice	52
Old ice	11

Narwhals

Observations of narwhals in the Russian Arctic are not numerous and most are from the region of Frantz-Josef Land, which is reflected in both the published and unpublished (Table 5) information.

There have been numerous observations of narwhals in the area of Frantz-Josef Land dating from the first half of the 20th century. In July 1930 a group of 30 to 40 narwhals was observed near the ice edge between Scott-Kelti and Hooker islands; in autumn 1930 near Tikhaya Bay (Hooker Island), a large narwhal herd (about 100 animals) was encountered; and in spring 1931 group of 30 to 50 animals was seen (Kondakov and Zyryanov 1994). Kondakov and Zyryanov (1994) reported that in the 1930s at Franz-Joseph Land, solitary animals and groups of up to 10 narwhals were seen in polynias and leads from mid-May to the beginning of September. However the source of these data is not clear from their description.

Large groups of narwhals were met by the "FRAM" expedition between Frantz-Josef Land and Severnaya Zemlya in the summer of 1896 (Tomilin 1957). Rarely narwhals have also been seen in other regions of the Russian Arctic such as near Novaya Zemlya, at the Murmansk coast of the Kola Peninsula, and in the White Sea (Sokolov *et al*. 1963, Kondakov and Zyryanov 1994). The most recent documented observation of the species in the Russian Arctic is also from the Frantz-Josef Land area. In August 1996 two groups of about 5 and 50 animals were observed north of Jackson Island, and two groups of about 5 to 7 animals each were seen west of George Land Island (Wiig and Boltunov 1997).

Table 5. Observations of narwhals in the Russian Arctic from unpublished data

Year	Number of animals	Region
ARSI		
19/06/65	1	Part of the Arctic Basin north of the East-Siberian Sea (75° 00' N, 175° 00'E)
31/08/66	2	Northwest of Svalbard (81° 09' N, 5° 00' E)
24/04/71	3	Near northwestern Frantz-Josef Land (80° 55' N, 45° 40' E)
24/04/71	1	Near northwestern Frantz-Josef Land (80° 57' N, 44° 30' E)
19/08/76	2	Part of the Arctic Basin north of the Kara Sea (84° 15' N, 85° 02' E)
21/08/77	3	Western part of the Laptev Sea (80° 18' N, 116° 00' E)
24/04/80	1	North of Svalbard (82° 21' N, 24° 00' E)
20/03/88	2	The Kara Sea (76° 34 N, 70° 50' E)
20/03/88	4	The Kara Sea (76° 44 N, 69° 25' E)
24/08/89	40	Frantz-Josef Land, Notingale Strait
??(summer)	1	Frantz-Josef Land
Drifting Stations		
26/07/56	1	84° 39' N, 72° 30' E
30/07/56	2 (Ad + calf)	84° 25' N, 73° 00' E
10/08/56	1	83° 54' N, 74° 45' E
18/09/56	1	84° 42' N, 70° 01' E
Questionnaire data		
Late 1950s	10	Frantz-Josef Land, Rotsa Strait
1968 summer	1	Frantz-Josef Land
1971	4	Western Frantz-Josef Land
1974 summer	1	Frantz-Josef Land
1976 autumn	1	About 100 nm south of Frantz-Josef Land
Late 1970s, summer	8	About 110 nm east of the de Longa Islands (East-Siberian Sea)
April 1980	3	Northwestern Frantz-Josef Land
1980 spring	1	North of the Severnaya Zemlya (Arctic Basin)
1987 June	10	Frantz-Josef Land

In the past the range of the narwhal apparently differed from that seen at present, as suggested by bone remains found on the Russian Arctic islands and on the mainland shore (Tomilin 1957). On October Revolution Island (Severnaya Zemlya), a narwhal "cemetery" with 7 practically complete skeletons and numerous bones and tusks was found. This place is situated on a high paleo-terrace (45 m above the present sea level) in the Ozernaya River valley. The age of the bones as determined by radiocarbon dating is about 43,000 ±1,000 years (Bolshiyanov and Makeev 1995).

Baleen whales

During ARSI, observations were conducted by hydrologists-observers, who usually were not able to identify whales to species, except for narwhals and belugas. The majority of ARSI observations of baleen whales were from the eastern Russian Arctic; sightings were much less common in the western sector of the region. Solitary and small groups of whales prevailed in the observations (Fig. 8). North of 70° N only solitary animals and small groups of whales were observed, and north of 72° N only solitary animals were seen.

Eastern Russian Arctic

Our review of the recent (past 17 years) literature, and the review by Belikov *et al* (1984b), suggest that the grey whale and bowhead whale are the most common baleen whale species in the eastern Russian Arctic. Observations of ma-

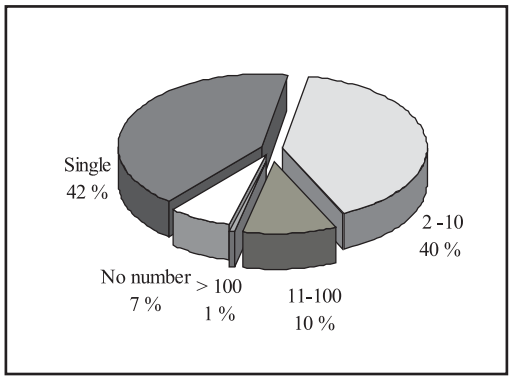

Fig. 8. *Proportions of different sized groups of baleen whales in 382 observations*

rine mammals performed from coastal observation points during seasonal migrations of the animals in the region in 1990-1996 (Melnikov 1995, Melnikov and Bobkov 1996) support this conclusion. Melnikov and Bobkov (1996) concluded that the grey whale is the most common baleen whale in the region in the summer-autumn period.

The ARSI data show that, in some years, spring movement of the whales along the eastern coast of the Chukotka Peninsula can begin as early as April (Fig. 9a). At this time, solitary whales or small groups of whales prevailed in the observations from the area east and southeast of Anadyr Bay and in the Bering Strait. As the ice edge recedes, some whales move from the Bering Strait to the northeast along the coasts of Alaska while others go to the northwest or to the west along the Chukotka Peninsula (Fig. 9b).

Observations from ARSI and from coastal observation posts (Melnikov and Bobkov 1996) show that the timing of the whale movement along the western migration path depends on the ice conditions near the northern Chukotka Peninsula. In some years with especially light ice conditions a narrow area of open water (a shore lead) forms as early as June. In such years, whales reach the region adjacent to Cape Serdtse-Kamen in June-July, and can move as far west as Nolde Inlet in the East-Siberian Sea. For example, in July 1985, ARSI recorded whales near Cape Schmidt, and in July 1986 near Cape Billings. Heavy ice conditions in the Chukchi Sea can delay the westward migration. In years with very heavy ice conditions, as in 1983, for example, there was almost no whale movement to the west along the Chukotka Peninsula.

In May-July near the northern coast of Chukotka Peninsula, whales were observed most often near Serdtse-Kamen Cape, and at the eastern coast, in the Bering Strait (Fig. 9b). In these months grey whales are common near the eastern coast of the Chukotka Peninsula, and in some regions (for example, in Mechigmensky Bay) they are numerous (Blokhin 1990, 1995). During the period of minimum ice cover (August-September) the majority of whales were observed in coastal waters from Kolyuchinskaya Bay in the east to Nolde Inlet in the west (Fig. 9c).

In years of light ice conditions in the East-Siberian Sea, when in September the southern part of the sea is ice-free, whales can move very far to the west. Numerous observations of grey and bowhead whales have been reported from the eastern part of the East-Siberian Sea (Bogoslovskaya *et al*. 1982, Marguette *et al*. 1982, Miller *et al*. 1985). On September 23 1990 one whale (most probably a bowhead) was observed by ARSI in open water near Bennet Island (Novosibirsk Islands) (Fig. 9c). Tomilin (1937) asserts that bowhead whales can reach the Laptev Sea in the warmest years.

The results of aerial observations carried out in 1993 by Bogoslovskaya (1995) confirm the occurrence of bowhead whales throughout the entire Russian Arctic. The observed groups of whales comprised animals of different size and age. Whales were usually observed at systems of recurring polynias.

Spring-summer movement of whales from the Bering Strait to the region of Wrangel Island and further northward becomes possible as the ice melts under the influence of the Herald branch of the warm Pacific current. In years with light ice conditions all the northern part of the Chukchi Sea becomes ice-free in the summer. In such years whales penetrate far to the north. For example, in October 1979 one bowhead whale was observed north of Herald Island at 74° N. However, observations of whales in the northern part of the sea are rare, and all the animals observed there (most likely bowhead whales) were solitary. Fedoseev (1966) reported that bowhead whales (their number was not given) were observed on October 12 1960 during an aerial cen-

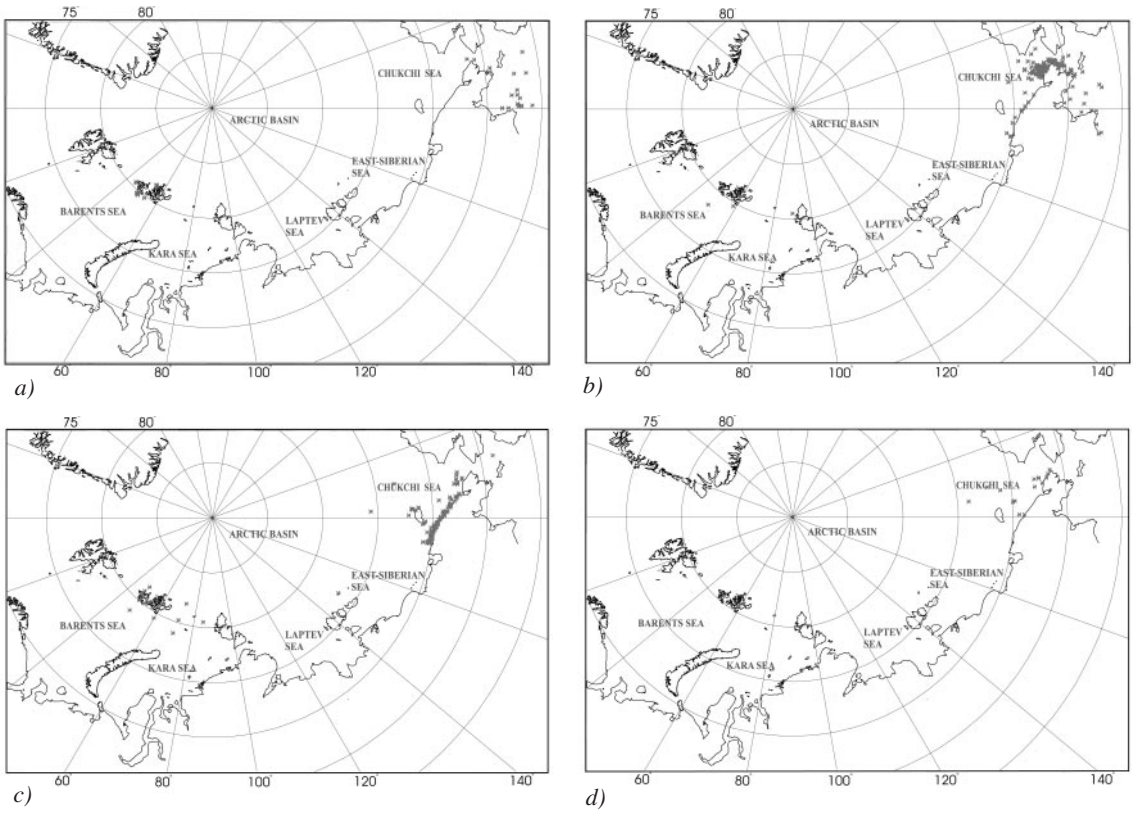

Fig. 9. *Observations of baleen whales from ARSI throughout the year. a) April b) May - July c) Aug.- Sept. d) October*

sus of marine mammals in the northern part of the Chukchi Sea (about 73° N, 175° E). The animals were seen in leads at the southern ice edge.

The autumn movement of whales to the Bering Strait occurs from the end of September through November. In October, when the pack ice expands southward, whales leave the East-Siberian Sea (Fig. 9d), and in the Chukchi Sea they were seen more rarely than in August-September. As in the spring, the timing of the autumn migration depends on ice conditions in the Chukchi and East-Siberian seas. As the process of ice formation proceeds in these seas, whales retreat toward the Bering Strait. In the strait and in the adjacent waters of the Chukchi Sea, whales were observed as late as November. By December all whales have left the Chukchi Sea for their wintering grounds.

In summary, the majority of the baleen whale observations in the Russian Eastern Arctic were from 2 regions: Nolde Inlet in the west to Koluchinskaya Bay in the east, and from Cape Serdtse-Kamen in the west to Cape Dezhnev in the east (Fig. 10). In the first area, whales were observed mostly in coastal waters, while in the second they were seen in a broader zone, up to approximately 68° 30' N. The data at our disposal confirm that in the eastern Russian Arctic whale aggregations occur not only in the Chukchi Sea but also in the southeastern part of

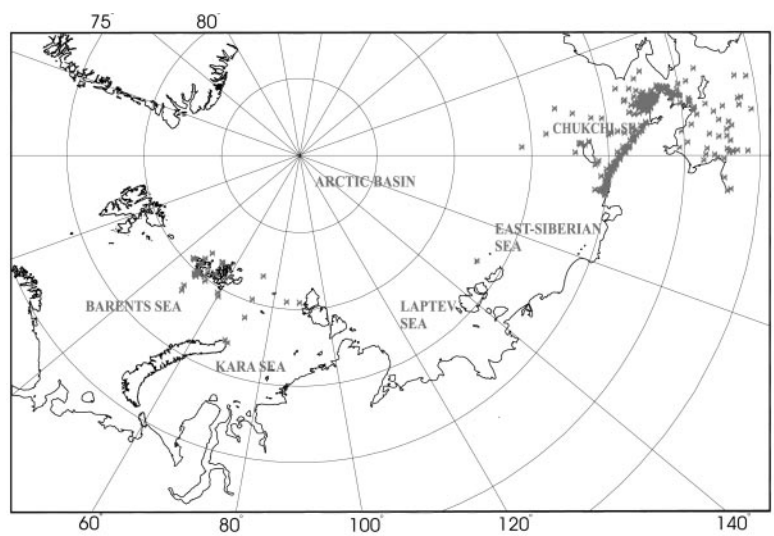

Fig. 10. *Observations of baleen whales, 1958-1995.*

the East-Siberian Sea. In the Bering Sea baleen whales occur mainly along the coast of the Chukotka Peninsula (from cape Dezhnev to Cape Chukotsky) and in Anadyr Bay and the waters southeast of it.

Western Russian Arctic
Observations of whales in the western Russian Arctic (the Barents and Kara seas, Fig. 10) were rather scarce to support speculations about their seasonal movements. In the period of maximum ice cover (January-April), observations of whales were especially rare in the region. According to published data (Belikov 1985, Belikov *et al*. 1989, Wiig 1991, Kondakov and Zyryanov 1994) the number of large baleen whales in spring and summer in the region of Frantz-Josef Land has been very low in the past 10 to 15 years.

In some years, in spring and summer, solitary animals and small groups of whales reach the northern part of the Kara Sea (Fig. 10). Three bowhead whales were observed in April 1988 300 to 350 km north of Severnaya Zemlya (questionnaire data). In the Laptev Sea and in the western part of the East-Siberian Sea, baleen whales were not observed by ARSI with the exception of the above-mentioned observation of a whale near Bennet Island. According to the questionnaire data (Belikov *et al*. 1989) one whale was observed in the western part of the Laptev Sea (about 80° N).

Association with ice
Whales were usually observed in open water and more rarely near the edge of pack ice. Observations of whales in leads, channels, and cracks were rare. As a rule whales avoided multi-year ice and were seen in first-year and young ice.

In the winter-spring period in the northern part of the Bering Sea baleen whales (likely bowhead whales) were observed near the edge of the pack ice, in recurring polynias, and also in leads free from ice or covered with young ice. The whales always had access to the northern part of the sea through the numerous channels and leads which are a common feature of the first-year ice in this area.

In summer in the Chukchi and East-Siberian seas, where ice conditions are much more severe than in the Bering Sea, whales were found mainly in open water or in zones of rarefied ice. There were only a few observations of whales in dense ice. We believe the animals may occur in such situations because of sudden changes in ice conditions.

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