# Belugas (*Delphinapterus leucas*) of the Barents, Kara and Laptev seas

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## ABSTRACT

This paper reviews published information on the white whale or beluga (*Delphinapterus leucas*) inhabiting the Barents, Kara and Laptev seas. Some data obtained during multi-year aerial reconnaissance of sea ice in the Russian Arctic are also included. Ice conditions, considered one of the major factors affecting distribution of belugas, are described. The number of belugas inhabiting the Russian Arctic is unknown. Based on analysis of published and unpublished information we believe that the primary summer habitats of belugas in the Western Russian Arctic lie in the area of Frants-Josef Land, in the Kara Sea and in the western Laptev Sea. Apparently most belugas winter in the Barents Sea. Although it has been suggested that a considerable number of animals winter in the Kara Sea, there is no direct evidence for this. Apparent migrations of animals are regularly observed at several sites: the straits of the Novaya Zemlya Archipelago, the waters north of the archipelago, and Vilkitskiy Strait between the Kara and Laptev seas. Calving and mating take place in summer, and the beluga mother feeds a calf for at least a year. Females mature earlier than males, and about 30% of mature females in a population are barren. Sex ratio is apparently close to 1:1. The diet of the beluga in the region includes fish and crustaceans and shows considerable spatial and temporal variations. However, polar cod (*Boreogadus saida*) is the main prey most of the year, and whitefish (*Coregonidae*) contribute in coastal waters in summer. Usually belugas form groups of up to 10 related individuals of different ages, while large aggregations are common during seasonal migrations or in areas with abundant and easily available food. Beluga whaling in Russia has a history of several centuries. The highest catches were taken in the 1950s and 1960s, when about 1,500 animals were caught annually in the Western Russian Arctic. In the 1990s, few belugas were harvested in the Russian Arctic. In 1999 commercial whaling of belugas in Russia was banned. Belugas can be caught only for research, cultural and educational purposes and for the subsistence needs of local people. With the absence of significant whaling, anthropogenic pollution seems to be the major threat for the species.

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## INTRODUCTION

The white whale or beluga (*Delphinapterus leucas*) is the most numerous cetacean inhabiting the Russian Arctic. Until the 1990s belugas were primarily considered a biological resource and most studies were aimed at increasing the efficiency of the utilisation of this resource. Now the beluga harvest in the Russian Arctic has all but ceased. At the same time there is rising interest in the species as a biological indicator of the status of Arctic marine ecosystems because it is a top consumer in the Arctic marine food chain, occurs in relatively large numbers, has a wide dis-

tribution and predominantly coastal occurrence, undertakes long seasonal migrations, and has a conspicuous appearance.

Heptner *et al*. (1976) distinguish two beluga populations inhabiting the Russian Arctic: the Karskaya population occupying the Barents, Kara and Laptev seas, and the Far-eastern population occupying the Chukchi Sea and northern part of the Pacific Ocean. At the same time data provided by the Aerial Reconnaissance of Sea Ice (ARSI) (Belikov and Boltunov 2002) and observations of marine mammals from coastal observation posts (Melnikov and Bobkov 1996) show that the range of the Far-eastern population includes the eastern part of the East-Siberian Sea. Obviously the populations are not completely separated from each other, and limited inter-population exchange is possible (Belikov *et al*. 1982). The location of the western limit of the Karskaya population range is not clear but may extend as far as Svalbard.

The existence of a separate population of belugas in the Laptev Sea has been postulated (Rutilevski 1939, Kleinenberg *et al*. 1964, Butorin 1966, Heptner *et al*. 1976) but not demonstrated. Taking this into consideration, we discuss the Karskaya beluga population of the Barents, Kara and Laptev seas. We presume that this population may itself consist of several stocks for which genetic and spatial identity is a matter for future research.

There are diverse opinions about the existence of separate populations of belugas in the White Sea. Ognetov (1981, 1986) disputed the identity of a separate population in the sea. However a recent long term study (1988-1997) of belugas in the area that applied a variety of methods (land based and vessel based video and acoustical monitoring, aerial survey), suggests the existence of a White Sea population including 5 local stocks (Belkovich 1995).

This paper reviews the information on occurrence, movements, feeding, reproduction and growth of belugas in the Barents, Kara and Laptev seas. When discussing seasonal distribution and movements of belugas, we refer to published information and the ARSI data (Belikov and Boltunov 2002). Most of the information has previously only been available in Russian.

## HABITAT CHARACTERISTICS (ICE CONDITIONS)

Sea ice cover is one of the major factors determining seasonal distribution and migrations of all Arctic marine mammals. Below is a brief description of ice conditions of the Barents, Kara and Laptev seas. It is based on published materials (Nazintsev 1971, Gudkovich *et al*. 1972, Chelingarov and Kadachigov 1981, Volkov 1981, Dobrovolskiy and Zalogin 1982) and material kindly given to us by Dr. Gorbunov (Arctic and Antarctic Research Institute, Saint Petersburg). This summary represents general conditions but there are wide annual fluctuations in the timing of ice formation and destruction, as well as in the thickness of ice and the extent of shore fast ice.

**The Barents Sea**

The inflow of great masses of Atlantic water usually keeps the Barents Sea ice free year round from the mainland coast up to 75º N (Fig. 1). Ice drift from the Kara Sea does not affect ice conditions in the Barents Sea. In the Barents Sea north of 75º N, ice formation in the north begins in September, in the central regions in October and in the southeastern regions in November. During spring and summer, the young ice rapidly melts. The melting and destruction of the ice cover begins in the southeastern areas of the sea. Almost the whole sea, with the exception of the regions adjacent to the Novaya Zemlya and Frants Josef Land, becomes ice-free by late summer.

**The Kara Sea**

In the Kara Sea, ice is present year round, and even in summer the surface water remains near the freezing point. In the southern part of the sea, sea surface temperature occasionally reaches 3 to 6° C in ice-free areas. The winter formation of recurrent polynias under the influence of off-shore winds is characteristic for the area outside of the fast ice zone. The new ice usually forms in the northern parts of the sea among the residual ice in mid-September, and gradually spreads towards the south and southwest. Ice

thaw starts in the southwest usually in late May. The process gradually expands towards the northeast and north. In the northern part of the sea, the ice usually begins to melt in late June. In summer, relatively ice-free areas include the area adjoining the Barents Sea, the estuary zones of the Ob and Yenisey rivers, and the recurrent polynias. In summer, pack ice remains in the northeastern part of the sea.

Three large ice massifs persist in the Kara Sea in summer: Novozemelskiy, Severozemelskiy, and Karskiy Northern (Fig. 1). The first lies near the eastern shore of Novaya Zemlya and disappears usually in August. The second stays year-round near the Severnaya Zemlya Archipelago and consists of broken shore-fast ice. Its size decreases by the end of summer due to ice melting. The third is a part of the oceanic ice massif and consists of one-year old thick ice in the northern part of the sea.

**The Laptev Sea**

The temperature of the surface water in most of the Laptev Sea is close to freezing point most of the year. In summer the sea surface can warm up to 3-5° C in the central part of the sea, and up to 10° C in southern coastal areas. New ice usually forms in the northern parts of the sea among the residual ice in the second half of September and gradually spreads southward. The other area of the new ice formation is the southern coastal waters which are under the influence of inflow from the Lena and Yana rivers. Because of lower salinity, young ice appears there by the end of September. In the rest of the sea, the ice formation begins by mid-October. Ice thaw begins in the areas adjacent to the mouths of the Lena and Yana rivers. It also starts in the area of recurrent polynias in the eastern and southern parts of the sea.

In summer, the Taimyrskiy and Yanskiy ice massifs occur in the Laptev Sea (Fig. 1). The first is a spur of the oceanic ice massif, and is situated near the eastern shore of the Taimyr Peninsula. In July it covers up to 70% of the western part of the Laptev Sea. By the end of September it covers only about one third of this area. The southern part of the massif consists of one year old ice, while its northern part contains a mixture of one year old and multi-year ice. The Yanskiy ice massif forms in the southern portion of the sea in July after the shore-fast ice is broken. It usually melts completely by the second half of August, although in some years it persists until the beginning of new ice formation.

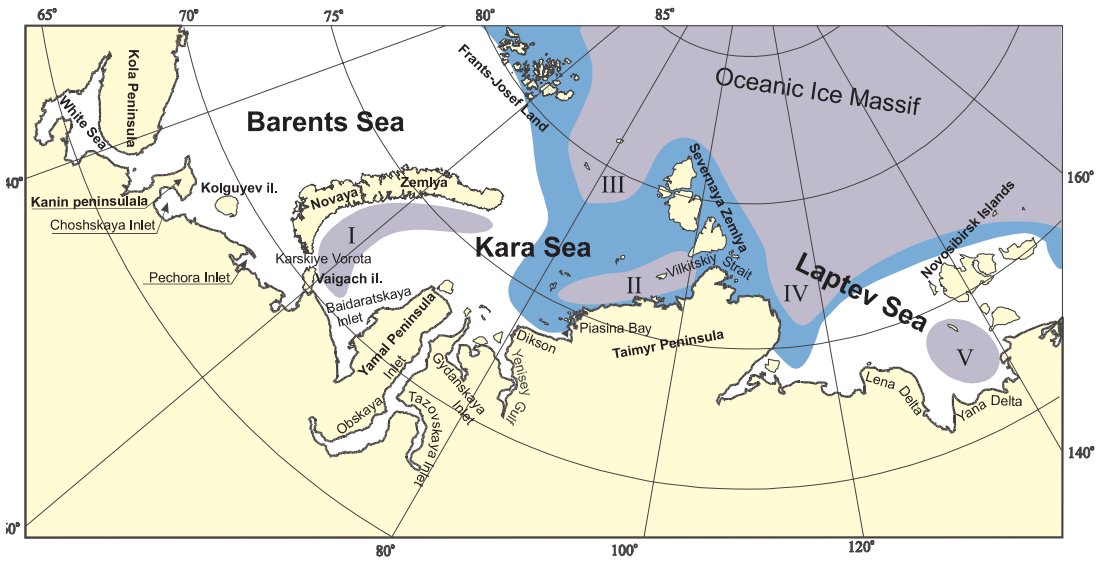


***Fig.1***
*Ice conditions in the Barents, Kara and Laptev seas in summer.*

## ABUNDANCE OF BELUGAS

No dedicated surveys have been conducted to estimate abundance of beluga stocks in the Russian Arctic. Klumov (1939) stated that 40,000 to 50,000 belugas inhabited the Barents, Kara and Laptev seas. This estimate was based upon the data provided by personnel of polar stations based on visual observations in autumn 1932 of mass inshore movements of belugas leaving the Kara Sea for the Barents Sea through Yugorskiy Shar and Karskiye Vorota straits and by Cape Zhelaniya. As an example Klumov (1939, page 19) cited a telegram from a polar station on Novaya Zemlya describing the run of belugas through the Yugorskiy Shar Strait occurring on the 10th of November: 'Belugas run all day without a break, at times they covered all the visible extent of the strait'. Klumov employed his own experience on counts of belugas in the Okhotsk Sea to derive rough estimates of the number of belugas passing an observation post at certain periods during mass inshore movements.

Ognetov and Stepakhno (1997) published another estimate of the population size. Quoting Ognetov (1987) they postulated that a total of 15,000 to 20,000 belugas inhabited the White, Barents, and Kara seas. However, the quoted work (Ognetov 1987) presents results of beluga counts in the White Sea only, and there are no data about abundance of the species in the other seas. According to the results of aerial surveys, summer numbers of belugas in the White Sea varied from 232 in 1975 to 2,500-3,000 in 1986 (Ognetov 1987).

## DISTRIBUTION AND MOVEMENTS

The distribution and movements of belugas depend on oceanographic conditions (primarily the dynamics of ice cover) and the distribution of primary prey species (Ostroumov 1935, Klumov 1939, Chapsky 1941, Kleinenberg *et al*. 1964, Ognetov and Potelov 1984, Belikov and Boltunov 2002). Wintering grounds (Fig. 2) and summer habitats (Fig. 3) can be distinguished in the range of the Karskaya beluga population. Most of the summer habitats lie far from the wintering sites, necessitating the long seasonal movements which are characteristic for the population (Chapsky 1941).

Available data on the seasonal distribution and movements of belugas in the western Russian Arctic (Ostroumov 1935, Klumov 1939, Rutilevski 1939, Kleinenberg *et al*. 1964, Heptner *et al*. 1976, Ognetov and Potelov 1984, Belikov and Boltunov 2002) lead us to define some sites as focal points of seasonal movements of animals in the region: Karskiye Vorota Strait, Yugorskiy Shar Strait, Matochkin Shar Strait, the area north of Novaya Zemlya, and Vilkitskiy Strait.

**Wintering grounds**

Numerous observations of large aggregations of belugas in winter in the southeastern part of the Barents Sea and near the western shore of Novaya Zemlya (Ostroumov 1935, Klumov 1936, 1939, Chapsky 1941, Kleinenberg *et al*. 1964) lead us to consider these areas as the wintering grounds for a considerable part of the population (Fig. 2). This speculation is supported by the fact that winter concentrations of polar cod (*Boreogadus saida*) are known to occur in the same areas (Ponomarenko 1968, Borkin 1995). It is known that some belugas of the Karskaya population winter in the White Sea, which they leave for the Barents Sea in late May (Kleinenberg *et al*. 1964, Ognetov 1975). Wintering of belugas in the central and western parts of the Barents Sea is indicated by regular approaches of the animals to the Murman shore of the Kola Peninsula in January–May (Klumov 1936, Heptner *et al*. 1976), and by spring eastward movement of belugas along this shore (Goriayev *et al*. 1998, Mishin *et al*. 1989).

The opinions of specialists regarding the possibility of the beluga's wintering in the Kara and Laptev seas are divided: some of them (Klumov 1939, Chapsky 1941, Tomilin 1957, Ognetov and Potelov 1984) believe that the majority of the animals leave these seas due to severe ice conditions and shortage of food in winter, while other authors (Rutilevski 1939, Kleinenberg *et al*. 1964, Butorin 1966, Heptner *et al*. 1976) suggest that the regular wintering of a considerable part of the population in these seas is possible. Although the ARSI data do not indicate any significant numbers of belugas wintering in the Kara and Laptev seas (Belikov and Boltunov 2002), further investigations are required.

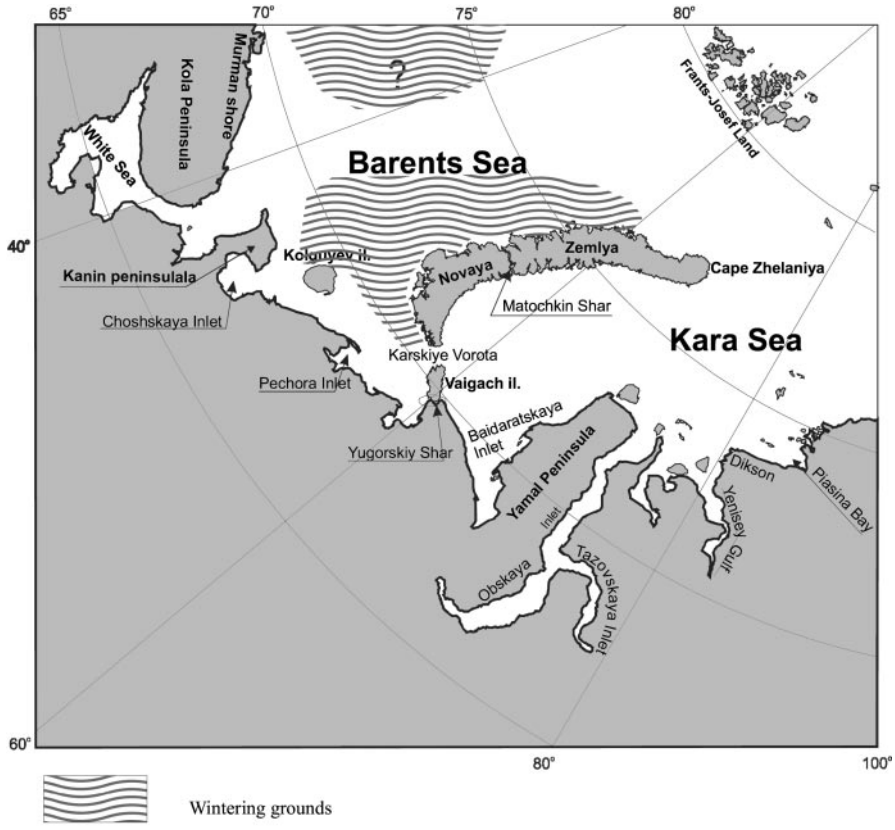


***Fig. 2***
*Winter distribution of belugas in the Barents, Kara and Laptev seas.*

**Summer habitats**

Klumov (1939) noted that primary feeding grounds, and areas where belugas occur less frequently or in lower numbers, can be distinguished in the summer range of the beluga population (Fig. 3). It is well known that the primary feeding grounds are situated near Frants Josef Land, in Obskaya Inlet, Yenisey Gulf, and in the part of the Kara Sea adjacent to the Taimyr Peninsula (Ostroumov 1929, 1935, Kovalev 1938, Rutilevski 1939, Klumov 1939, Chapsky 1941, Kleinenberg *et al*. 1964, Timo-

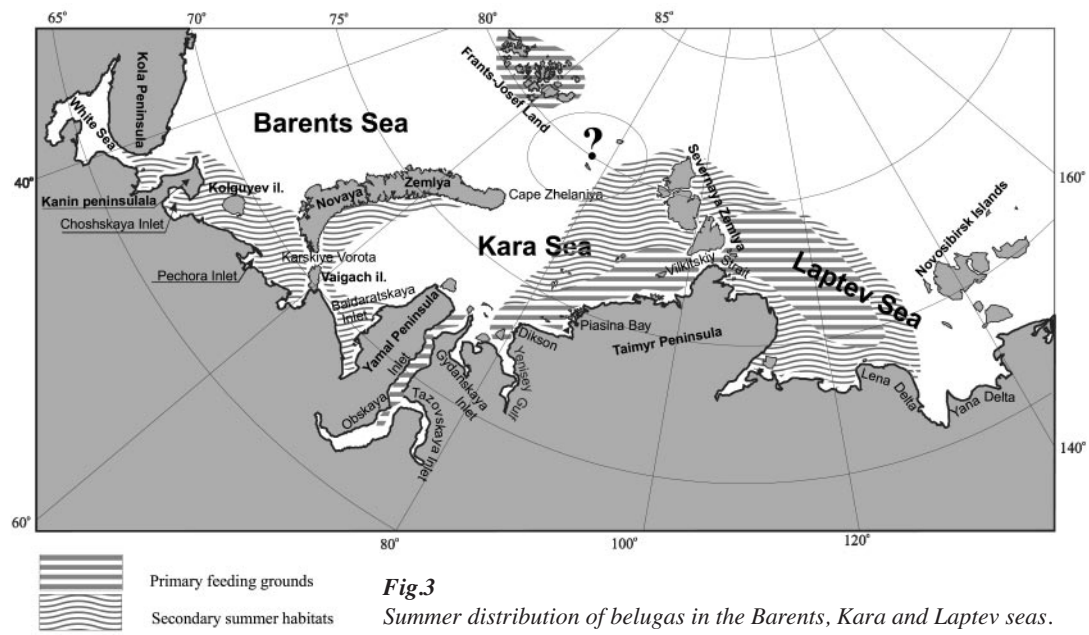


***Fig.3***
*Summer distribution of belugas in the Barents, Kara and Laptev seas.*

shenko 1967, Heptner *et al*. 1976, Ognetov and Potelov 1984). The regular appearance of belugas in these areas is likely related to the abundant food resources found there.

The area between the Frants-Josef Land, Novaya Zemlya and Severnaya Zemlya should also be considered an important feeding ground. There were comparatively frequent ARSI observations of belugas in this area (Belikov and Boltunov 2002), and it is known that polar cod concentrate there in the summer (Ponomarenko 1968, Borkin 1995). The ARSI data also suggest that important summer habitats lie in the western and southwestern parts of the Laptev Sea. In June-August, there were considerably more beluga observations by ARSI in this sea than in the Kara Sea (Belikov and Boltunov 2002).

Large numbers of belugas occur less regularly near Vaigach Island, in Baidaratskaya Inlet, near eastern Novaya Zemlya, western Severnaya Zemlya, eastern Taimyr Peninsula, and in some coastal areas of the southern Laptev Sea (Klumov 1936, 1939, Kleinenberg *et al*. 1964, Tarasenkov *et al*. 1966, Timoshenko 1967, Ognetov and Potelov 1984, Ushakov 1990). In summer in the Barents Sea, belugas appear near the northern shore of the Kanin Peninsula and in Choshskaya Inlet. Comparatively few animals regularly occupy the southeastern part of the Barents Sea (Chirkova and Folitarek 1930, Kleinenberg *et al*. 1964, Heptner *et al*. 1976).

Although Gydanskaya Inlet is situated between the Obskaya Inlet and Yenisey Gulf, which are famous for large aggregations of belugas, there is little indication that belugas occur there in significant numbers. Only Timoshenko (1967) mentions the inlet, and reported that belugas were not there seen during aerial survey done in the region on 7 August 1962.

**Movements**

Beluga movements can be divided into two types: local roaming and long-distance (Kovalev 1938, Kleinenberg *et al*. 1964). During long-distance movements, animals congregate into considerable gatherings, which are usually characterised by a certain structure (see Group Composition).

Heptner *et al*. (1976) believed that the major part of the population spent the winter in the Barents Sea, and moved to the Kara Sea in spring. Animals passing through the Karskiye Vorota and Yugorskiy Shar straits moved eastward, following the receding pack ice, and occupying the south-western part of the Kara Sea and the Ob-Yenisey region. Belugas rounding Novaya Zemlya from the north dispersed eastward along the pack ice edge or through the system of leads and occupied the eastern and southeastern parts of the Kara Sea.

Kleinenberg *et al*. (1964) believed that a considerable part of the Karskaya beluga population wintered in the northern and eastern parts of the Kara Sea and approached Obskaya Inlet, Yenisey Gulf and the Taimyr Peninsula in summer. Belugas, coming in spring and the beginning of summer from the Barents Sea to the Kara Sea, occupied the western part of the Kara Sea and Baidaratskaya Inlet.

Some researchers have proposed that a separate beluga population exists in the Laptev Sea, and that the animals stay in this sea all year round (Rutilevski 1939, Kleinenberg *et al*. 1964, Butorin 1966, Heptner *et al*. 1976). On the contrary, Klumov (1939) asserted that belugas occurred in the Laptev Sea only in the summer, and that they probably moved from the Kara Sea through the straits of the Severnaya Zemlya Archipelago and north of it. The ARSI data confirm that belugas occupy the Laptev Sea only in summer (Belikov and Boltunov 2002). We believe that the most likely route of spring penetration of belugas into the Laptev Sea is the area north of Severnaya Zemlya, as the straits of the archipelago and Vilkitskiy Strait are usually covered with fast ice until mid-July.

It is commonly believed that in the autumn, belugas leaving summer habitats for their wintering grounds go by the same routes that they used during the spring movements. However, there are no direct confirmations of this. Observations of large aggregations of belugas migrating through the same areas during spring and autumn are not sufficient evidence for such a conclusion. It is possible that belugas undertake "circular" annual migrations. For instance, animals coming in spring to the Laptev Sea

rounding Severnaya Zemlya from the north can leave the sea through the Vilkitskiy Strait in the fall.

One of the important factors determining the beluga's spatial distribution is thought to be the division of the population into relatively smaller stocks that occupy separate feeding grounds during the summer (Reimers 1991). The capacity of such grounds is obviously limited. Therefore, stocks arriving earlier occupy more favourable areas. This could explain the seasonal distribution pattern of belugas in Obskaya Inlet. According to Chapsky (1937), in summer the majority of the belugas stay in the central part of the inlet, where they arrive in July, often passing through ice covered areas. The northern part of the inlet is occupied a month later.

Based on the analysis of the available information, we propose the following scheme of beluga movements in the region. Apparently, the majority of the belugas winter in the Barents Sea. Animals appear first in the northern part of the Kara Sea, long before the intensive thaw and destruction of the pack ice, and stay in areas with polar cod aggregations. In the northeastern part of the sea, animals appear as early as May. In June belugas can appear in the southeastern Kara Sea and in the Laptev Sea (Belikov and Boltunov 2002). Early occurrence of the animals in the Kara Sea, when the straits south of Novaya Zemlya are still closed by solid fast ice, can be explained by the ability of the belugas to pass through areas covered with pack ice using networks of leads, channels and cracks. Belugas also have the ability to breath even through ringed seal (*Phoca hispida*) breathing holes, as was observed by whalers (Butorin 1966) and confirmed by Bobkov (1986). When Karskiye Vorota and Yugorskiy Shar straits become ice free, belugas move from the southeastern part of the Barents Sea to the southwestern Kara Sea and Baidaratskaya Inlet. Apparently animals of this wave move as far east as Obskaya Inlet.

In the second half of the summer Arctic cod approach the mainland shore of the Kara Sea (Ponomarenko 1968) which leads to a redistribution of belugas. With the beginning of the run of whitefish (*Coregonidae*), belugas appear near shore and enter rivers, bays and inlets. The last stocks come to the Kara Sea at the end of the summer and the beginning of autumn. Certain stocks occupy the feeding grounds in the Laptev Sea every year in June-August.

It is likely that belugas leave their summer habitats due to the decreasing availability of their primary prey. According to Ponomarenko (1968), at the end of September to the beginning of October, polar cod leave most parts of the Kara Sea for the Barents Sea. It is known that belugas leave the Kara Sea at the same time. Ice conditions probably do not influence beluga distribution directly until extensive solid ice fields prevent movements of the whales.

## BIOLOGY AND LIFE HISTORY

**Reproduction**

It is commonly accepted that mating and calving in belugas occur in spring and summer (Tomilin 1957, Kleinenberg and Yablokov 1960, Kleinenberg *et al*. 1964, Heptner *et al*. 1976). The peak time of mating is disputable; Heptner *et al*. (1976) assumed that it took place in late April and early May, and that only a few animals mated outside this period. Kleinenberg *et al*. (1964) suggested that mating peaks in spring and the first half of summer, based on analyses of the growth rate of beluga embryos.

A prolonged embryonic diapause seems not to be characteristic of the beluga (Kleinenberg *et al*. 1964). Most experts believe that pregnancy lasts for 11–12 months, and that the calving period, as well as the mating, is prolonged (Chapsky 1941, Tomilin 1957, Kleinenberg and Yablokov 1960, Kleinenberg *et al*. 1964, Heptner *et al*. 1976). Tomilin (1957) and Heptner *et al*. (1976) assumed that the calving period began early in spring and lasted for the three summer months, with its peak in midsummer or the second half of it. In addition, Tomilin (1957) suggested that the peak of mating and calving of belugas in the Russian Arctic shifted from the beginning to the end of summer from the west to the east of the region. According to Kleinenberg *et al*. (1964), spring and the first half of summer are the main calving times of the belugas inhabiting the Arctic seas.

A female usually gives birth to a single calf, and twin births are rare (Tomilin 1957, Kleinenberg *et al*. 1964, Heptner *et al*. 1976). Although a beluga can become pregnant immediately after calving, this does not occur in all females (Kleinenberg *et al*. 1964). Kleinenberg and Yablokov (1960) suggested that even if a female could become pregnant right after delivery, there would still need to be a period between these two events. These authors therefore expected that 4 to 5 annual deliveries would be followed by a period of barrenness, due to the annual shift of the calving time and female senescence. Based on this, Kleinenberg and Yablokov (1960) assumed that about of 20 - 25% of all mature female belugas would reproduce in a given year. A number of studies have examined reproductive tracts of belugas and have found that about 30% of adult females are pregnant in any given year (Khuzin 1961, Kleinenberg *et al*. 1964, Ognetov 1981).

Despite the availability of extensive data from whaling records, the sex ratio in the population is still inadequately known. Estimation of sex ratio is confounded by the known sex and age differentiation of the herds of beluga (*i.e*. presence of herds consisting of adult males and mixed groups of animals) and biased selection by whalers. In beluga embryos and newborn calves from the White and Kara seas, females (about 52%) prevailed over males in the embryos (n=75), while the percentage of males was higher (about 52%) in the newborn calves (n=29) (Ognetov MS 1999a). Data on the sex ratio in embryos and yearlings are also available from the Okhotsk Sea (Nikolskiy 1935). Thirty-five embryos out of 46 appeared to be males. The male:female ratio in the yearlings caught in the same region was 69:44. On the basis of these data, Nikolskiy (1935) considered sex ratio in the beluga population to approximate 60% males and 40% females. However we consider that these differences do not conclusively show that the sex ratio is not at or close to unity.

**Growth and development**

There is no common opinion regarding length of lactation. Some experts believed that the lactation period lasted for 6 months (Chapsky 1941, Kleinenberg *et al*. 1964). Heptner *et al*. (1976) considered that, as dentition occurred in the young animals at the age of 10 months, calves fed on milk at least up to that age. According to Tomilin (1957) yearlings feed independently. However belugas may continue to suckle their calves, at least occasionally, for up to 2 years (*e.g*. Wynne 1992). Beluga milk is very nutritious and contains 63.9% water, 22.6% fat, 12.6% protein, and 0.9% ash (Klumov 1939).

Body length in newly born belugas ranges from 116 to 182 cm and averages 150 cm. (Chapsky 1941, Kleinenberg *et al*. 1964, Heptner *et al*. 1976, Ognetov 1981). By the end of their first year, the animals reach an average length of 215 cm (Ognetov 1981). Annual growth slows abruptly when the animals get older (Kleinenberg *et al*. 1964, Ognetov 1981). Males and females begin to differ in their growth rates by the age of 3 to 4 years, when growth retardation is more pronounced in females. By the age of 7 years, females are, on average, 20 cm shorter than males (Ognetov 1981). Kleinenberg *et al*. (1964) believed that female belugas became physically mature when their body length reached 355 to 360 cm. This usually occurs at the age of 7 to 9 years. Ognetov (1981) assumed that females stopped growing and became physically mature at the age of 10 years at a body length of 354 to 412 cm, while growth terminated in males at the age of 11 or 12 years.

A beluga female can be sexually mature at the age of 2 (Kleinenberg *et al*. 1964, Ognetov 1981). In an analysis of 161 females, Ognetov (1981) showed that the age of sexual maturity varied considerably. Most of the females were sexually mature by the age of 5, while all beluga females were sexually mature by the age of 9 to 10. According to Kleinenberg *et al*. (1964), male belugas become sexually mature by the age of 5.

Belugas are unique in the extent of their colour change with age. Kleinenberg *et al*. (1964) described the colour of prenatal embryos and newly born calves as light grey with a brown tint. The colour of the growing calf darkens and turns into dark-grey or blue. Later on, the animals lighten in colour and the large whales are

completely white. According to Ognetov (1981), males change their colour more slowly than females. The colour of a beluga does not precisely indicate its age (Kleinenberg *et al*. 1964). However, approximate aging of the animals according to their colours has been widely practiced (Heptner 1930, Chapsky 1941, Dorofeev and Klumov 1935, Kleinenberg *et al*. 1964, Ognetov 1981).

In summary, beluga calves remain at least partially dependent on milk for nutrition for at least one year. The age of sexual and physical maturity varies considerably, but all female belugas are sexually mature by the age of 10, and some are mature by the age of 2. It should be noted that age estimation in the above-mentioned studies was based on counting growth layer groups (GLGs) in the dentine and cement of teeth obtained from harvested belugas. When interpreting the results of the enumeration of GLGs Russian researchers have followed Sergeant (1959) who suggested that two GLGs are deposited per year.

**Foraging**

Studies of the feeding of belugas have for the most part been based on examination of the stomach contents of the animals harvested in the whaling period (summer and autumn). Information on winter foraging can be obtained only from indirect evidence (*e.g*. the simultaneous approach to the western coasts of Novaya Zemlya by belugas and polar cod in winter) (Kleinenberg *et al*. 1964).

In the western part of the Russian Arctic, belugas feed on fish and crustaceans. Polar cod, Arctic cisco (*Coregonus autumnalis*), muksun (*C. muksun*), vendace (*C. sardinella*), herring (*Clupea harengus*), navaga (*Eleginus navaga*), Arctic char (*Salvelinus alpinus*), and crustaceans (*Mesidothea entomon, M. sabini, Gammaridae*) are the most prevalent food items (Heptner *et al*. 1976). The extensive range of belugas is indicative of a variable diet differing among particular parts of the range. However, schooling fish are preferred everywhere (Kleinenberg *et al*. 1964, Heptner *et al*. 1976).

In the Barents Sea, belugas feed primarily on polar cod, herring, navaga, and whitefish, and the animals foraging near the coasts of Novaya Zemlya eat mostly polar cod and Arctic char (Kleinenberg *et al*. 1964). Everywhere, crustaceans are a component of the beluga diet. Butorin (1966) reported that 5 to 10 kg of herring eggs and the remains of nets and herring bones were found in each of the stomachs of a few belugas caught in Choshskaya Inlet in May 1962. The belugas had apparently been feeding on fish eggs on the spawning grounds. In the period of mass spawning, herring lay their eggs not only on the seaweed, but also on the fishing nets.

In the Kara Sea, the diet of belugas consists primarily of polar cod. In addition to polar cod, the whales approaching the mainland coasts and entering Obskaya Inlet and Yenisey Gulf and the mouths of the other rivers feed on whitefish, primarily Arctic cisco (Klumov 1936, Kleinenberg *et al*. 1964).

Data on the diet of beluga in the Laptev Sea is scarce. It can be assumed that it is similar to that of the animals inhabiting the Kara Sea where polar cod is the primary food item (Butorin 1966).

A difference in feeding among animals of different age classes has been demonstrated for belugas of the Far East of Russia. According to Arseniev (1937), a calf switches from mother's milk to small fish and crustaceans at the end of the first year of its life. Growing animals begin to feed on larger food objects and gradually switch from benthic to pelagic foraging. Similar changes in the mode of foraging may be characteristic of belugas inhabiting the western part of the Russian Arctic.

Ognetov (1990) calculated a condition index for 503 belugas of both sexes and different ages caught in the White and Kara seas from 1977 to 1985. The index was expressed as the ratio of the weight of blubber and skin to the total weight of the animal. The study revealed no difference in the condition index between males and females or between females of different physiological status. At the same time, considerable annual fluctuation in the index was found. As the sample was composed of belugas caught only between June and September, it was not possible to evaluate seasonal changes

**Table 1.** Frequency of different group sizes of belugas in the Barents, White, Kara and Laptev Seas.

| Area | Group size frequency (%) | | | | Number of groups | Source |
|---|---|---|---|---|---|---|
| | 1 | 2-10 | 11-100 | >100 | | |
| The White, Barents and Kara seas | 16.1 | 54.9 | 25.8 | 3.2 | ? | Kleinenberg *et al*. 1964 |
| The White, Barents and Kara seas | 35.1 | 44.7 | 16.7 | 3.5 | 347 | Ognetov 1981 |
| The Barents, Kara and Laptev seas | 19 | 50 | 28 | 3 | 420 | Belikov and Boltunov 2002 |

in the animals' condition. However, Butorin (1966) asserted that beluga are fattest in April.

**Group composition**

Although solitary animals are sometimes observed, belugas usually form groups numbering from a few individuals to hundreds and even thousands. Kleinenberg *et al*. (1964) noted that the majority of solitary individuals observed either followed or preceded large herds. As a rule, all of them were large adult animals.

Mixed groups consisting of up to 10 individuals are observed most frequently (Table 1). Such groups usually include a white (adult) animal and 2 to 4 darker whales and represent family groups (a female with its calves of different ages) (Kleinenberg *et al*. 1964). Kleinenberg *et al*. (1964) considered such a group as the primary one. In their opinion, the herds numbering a few dozens to hundreds of individuals are only temporary associations formed in feeding areas and focal points of migrations. Small groups of belugas near the coasts and in the open sea are characteristic of spring and summer.

Belugas form the largest herds during migrations. These herds may number a few hundreds and even thousands of individuals. They differ in their sex and age composition. The following types of herds can be distinguished (Kovalev 1938, Kleinenberg *et al*. 1964, Ognetov 1975, 1990):

- mainly adult males with few adult females;
- mixed but structured. The leading part of the herd consists of the adult males, the rear part of it is mixed and consists primarily of adult males and females accompanied by immature animals.

## WHALING AND UTILIZATION

**History of whaling**

In the western part of the Russian Arctic, Russians traditionally harvested belugas. Indigenous peoples living at the coasts of the Barents, Kara and Laptev seas only occasionally hunted large marine mammals (the beluga and other cetaceans) (Chapsky 1941, Krupnik 1986). Whaling was practiced in the White Sea in the ninth century, when people inhabiting the Russian European North paid tribute with beluga skins. They used harpoons to kill the whales (Chapsky 1941). For more than 200 years, belugas have been harvested in the Choshskaya Inlet of the Barents Sea (Chirkova and Folitarek 1930). A beluga hunt was developed along the western coasts of Novaya Zemlya in the 19th century (Kleinenberg *et al*. 1964). In the Murman area (coastal area along the northern Kola Peninsula), belugas were harvested occasionally rather than regularly (Klumov 1936).

In the Kara Sea, belugas were traditionally harvested in Obskaya Inlet and Yenisey Gulf. The history of whaling there is as long as in the White Sea. According to Valikov (1936), more than 400 beluga were harvested annually in Obskaya Inlet in some years at the turn of the century. However, Chapsky (1937) reported there was no regular whaling in the inlet until 1931. Belugas were harvested primarily in the

central and southern parts of the inlet, near the juncture with Tazovskaya Inlet.

In Yenisey Gulf, whaling has been ongoing since the 19th century. Belugas were caught near Dikson Island in the 1860s and 1870s. Later, whaling was abandoned, and did not recommence for a long time (Kovalev, 1938). Up to the 1920s, no more than 30 animals were harvested annually in Yenisey Gulf. A fixed Norwegian sweep-net was used for the first time to catch belugas near Dikson Island in 1929. Seven whaling points along the eastern coast of the Yenisey Gulf were equipped with such nets in 1931. Afterwards, whaling expanded up to Dikson Island and the western part of Piasina Bay (Kovalev 1938).

Available data on beluga catches in the western Russian Arctic are given in Table 2. Heptner *et al*. (1976) noted that the whaling statistics were not complete and most of the presented data were approximate. Harvests were quite variable because of considerable variation in the timing of migration and in the number of whales approaching the coasts (Kleinenberg *et al*. 1964).

The harvest of belugas likely did not cause any significant damage to the population. The exception was whaling during the period between 1954 and 1966, when the annual harvests averaged 1,500 individuals with a maximum of 3,222 animals in 1960 (Table 2). This resulted in a dramatic decrease in number of beluga approaching Novaya Zemlya and entering the Baidaratskaya Inlet and Yugorskiy Shar Strait (Ognetov and Potelov 1982). This probably indicated a population decline by the mid-1960s. Fewer whales were harvested during the following decades.

In the 1990s few belugas were harvested in the Russian Arctic. Belugas were caught occasionally when other sea mammals were hunted (Belkovich pers. comm.). In recent years about 2,100 belugas were allocated for annual harvest in Russia, including northern and Far Eastern seas. In September 1999, all commercial catches of belugas in Russia were prohibited (see Conservation and Management). Supervising implementation of the ban, the State Committee of the Russian Federation on Environmental Protection (SCEP) is responsible for the collection of catch data. No catches were recorded by September in the Barents, White, and Kara seas in 1999.

Thus, beluga whaling in western Russian Arctic has practically ceased, while some belugas are hunted in the eastern seas. The decline of the beluga whaling industry has apparently been caused by low demand for its products in the domestic market.

**Whaling techniques**

Most beluga harvesting in the western part of the Russian Arctic has been done using nets (Kleinenberg *et al*. 1964). Fixed nets were used in a passive catching technique. The 'polovinki', an entangling net placed on the migration route of the beluga, is one of the oldest techniques for catching belugas. This method was used in the White Sea, near Novaya Zemlya, and in Obskaya Inlet and Yenisey Gulf (Kleinenberg *et al*. 1964). Polovinki were usually set in the period of dark nights, because the whales easily avoid nets in daylight. The mesh size was 40 to 45 cm, the length of the net was 25 to 30 m up to 150 m. The height of the net was dependent upon the depth of the place where the net was set, but usually ranged between 8 and 15 m (Chapsky 1941). The fixed nets were set in groups of 3 to 10 nets each.

A Norwegian fixed net is another example of a fixed net. They were also placed on the migration routes of the whales (Chapsky 1941). The Norwegian fixed nets were 300 to 600 m (sometimes up to 1,000 m) long and 3 to 12 m high, depending on water depth. The mesh size was less than 20 cm. After the animals entered a fixed net, they were locked in with an additional net and then killed using a gun, harpoon or lance.

Several types of sweep nets were used. A herd of belugas was surrounded with a sweep net thrown from special boats. Trapped whales were either killed in place, or transported to the shore and killed there. Such nets were about 1,500 m long (Kleinenberg *et al*. 1964).

There was some catch of belugas by sealers in the Barents and Kara seas in the 1950s. The an-

**Table 2.** Catch statistics[1] of belugas in the Barents, White, Kara and Laptev Seas.

| Year | White Sea | Barents Sea | Kara Sea | Total in the western Russian Arctic |
|---|---|---|---|---|
| 1902 | no data | 223 | no data | no data |
| 1905 | no data | 150 | no data | no data |
| 1911 | no data | 120 | no data | no data |
| 1915 | no data | no data | 5 | no data |
| 1916 | no data | no data | 25 | no data |
| 1917 | no data | 150 | 20 | no data |
| 1918 | no data | no data | 18 | no data |
| 1919 | no data | no data | 16 | no data |
| 1920 | no data | no data | 8 | no data |
| 1922 | no data | no data | 39 | no data |
| 1925 | no data | 71 | no data | no data |
| 1926 | no data | 11 | 40 | no data |
| 1927 | no data | no data | 75 | no data |
| 1928 | no data | 154 | 80 | no data |
| 1929 | no data | 39 | 137 | no data |
| 1930 | no data | no data | 421 | no data |
| 1931 | no data | 14 | 374 | no data |
| 1932 | no data | no data | 916 | no data |
| 1933 | no data | 220 | 870 | no data |
| 1934 | no data | 216 | 522 | no data |
| 1935 | no data | no data | 623 | no data |
| 1936 | no data | no data | 198 | no data |
| 1950 | no data | no data | no data | 96 |
| 1951 | no data | no data | no data | 53 |
| 1952 | no data | no data | no data | 287 |
| 1953 | no data | no data | 108 | 387 |
| 1954 | no data | no data | 209 | 776 |
| 1955 | no data | no data | 156 | 329 |
| 1956 | no data | no data | 77 | 600 |
| 1957 | no data | no data | 152 | 796 |
| 1958 | no data | no data | 41 | 2,103 |
| 1959 | no data | no data | no data | 1,945 |
| 1960 | 840 | 2,382 | 3,222 | |
| 1961 | 18 | 1,732 | 1,750 | |
| 1962 | 21 | 1,149 | 1,164 | |
| 1963 | 233 | 1,030 | 1,263 | |
| 1964 | 662 | 2,322 | 2,968 | |
| 1965 | 297 | 1,510 | 1,807 | |
| 1966 | 609 | 914 | 1,523 | |
| 1967 | 166 | no data | 108 | 274 |
| 1968 | 30 | no data | no data | no data |
| 1969 | 302 | no data | no data | no data |
| 1970 | 850 | no data | 140 | no data |
| 1971 | 499 | no data | 113 | no data |
| 1973 | 155 | 46 | 87 | 288 |
| 1973 | 155 | 46 | 87 | 288 |

Table 2. (continued)

| Year | White Sea | Barents Sea | Kara Sea | Total in the western Russian Arctic |
|---|---|---|---|---|
| 1974 | 146 | 9 | 39 | 194 |
| 1975 | 60 | 35 | 74 | 169 |
| 1976 | 272 | 30 | 170 | 472 |
| 1977 | 292 | 306 | 598 | |
| 1978 | 43 | no data | 20 | no data |
| 1979 | 126 | no data | 74 | no data |
| 1980 | 43 | 141 | 184 | |
| 1981 | 204 | no data | 90 | no data |
| 1982 | 73 | no data | 43 | no data |
| 1983 | 42 | 183 | 225 | |
| 1984 | 55 | 370 | 425 | |
| 1985 | 138 | no data | 110 | no data |
| 1986 | 172 | no data | 20 | no data |
| 1987 | 9 | no data | 6 | no data |
| 1988 | 7 | | | no data |
| 1989 | 27 | | | no data |
| 1990 | no data | no data | no data | no data |

[1] Sources: 1950-1959 from the Northern Basin Authority on the Protection and Recovery of the Fishery Resources (Arkhangelsk) and by the Northern Branch of the Polar Research Institute for Marine Fishery and Oceanography (SEVPINRO, Arkhangelsk); 1960-1990, Ognetov (MS 1999b); Barents Sea 1902-1934, Zhilinskiy (1925, 1934) and Klumov (1939); Kara Sea 1915-1956, Kovalev (1938), Chapsky (1937) and Khuzin (1961).

imals were actively chased into either steel or synthetic nets (Kleinenberg *et al*. 1964, Heptner *et al*. 1976, Ognetov and Potelov 1982).

**Utilisation**

The products of the beluga harvest in the Russian North have never been very important for the economy (Heptner *et al*. 1976).

A killed beluga was flensed and its skin removed with the blubber. The fat was then separated from the skin and processed into tallow. The skin was brined, cleaned of a thick layer of epidermis, and delivered to the tanneries. The rest of the carcass was processed into animal food or fertiliser. In places where no processing plants were available, the carcasses were utilised as food for fur farms. Tallow was used for technical purposes. Fat from the melon and the lower jaw was stored separately. Oil derived from this fat does not thicken at low temperatures and has been used in the preparation of special technical lubricants and medical ointments. Vitamin *A* was extracted from the liver (Tomilin 1957, Heptner *et al* 1976, Ognetov and Potelov 1982).

An average beluga yielded 250 kg of fat, 40 kg of skin and 250 kg of meat with bones. The weight of skin after the epidermis was removed was about 20 kg. About 50 % of the fat was lost during processing (Chapskiy 1941).

## CONSERVATION AND MANAGEMENT

State Fishery Committee of Russia (SFC) and its regional affiliates are in charge of beluga protection, usage and management. The SFC co-ordinates the activities of its regional affiliates, determines whaling quotas, establishes licensing regimes and promotes international co-operation in research, conservation and exploitation of the species. The regional affiliates of the SFC take part in the development and realisation of federal programs for the pro-

tection and sustainable exploitation of belugas and their habitats; develop territorial whaling rules and regulations fitting their terms of reference; grant rights for exploitation of the populations; co-ordinate the interests of the users of whale resources with the interests of users of other natural resources; design and conduct censuses and monitoring programs; and compile an inventory of the beluga populations.

The Law 'About the Animal World' (1995) is the legislative basis for conservation and exploitation of wildlife in Russia. According to Article 4 of the Law, the beluga is placed under federal jurisdiction, as it migrates through the territories of two or more subjects of the Russian Federation and inhabits the territorial sea, continental shelf and exclusive economic zone of the Russian Federation.

Fishery Research Institutions under the auspices of the SFC prepare annual stock assessments including recommendations for a total allowable catch (TAC). These TACs are reviewed by an Expert Commission organised by SCEP. The Expert Commission is comprised of more than 30 specialists and researchers from research institutes of the Russian Academy of Science, federal authorities, local and regional bodies for nature protection, and from public organizations. The expert conclusion of the Commission can be appealed only through the courts. The Government approves the TACs only if the recommendation of the Expert Commission is positive. TACs approved by the Government are shared among fishery enterprises based upon the decision of regional (basin) Fishery Councils.

The Russian Government issued a regulation in September 1999 prohibiting the commercial catch of belugas and the export of products of beluga whaling. Catching of belugas is presently allowed only for research, cultural and educational purposes and for the subsistence needs of local people.

The beluga is listed under Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Special permits issued by the SCEP are required for export and import of belugas and their parts and derivatives (*e.g.* for scientific purposes or for zoos and aquariums). For example, in 1998 and 1999, SCEP issued 3 and 5 permits and a total of 23 belugas were exported to different countries.

The conservation and exploitation of belugas and their habitats in the exclusive economic zone (EEZ) of Russia are under federal jurisdiction. The federal authorities (the Department of Fisheries and its regional affiliates in this case) are in charge of the following:

- control over the reasonable exploitation and conservation of belugas and protection of their habitats in the EEZ;
- ecological expertise and ecological control of the projects, programs, and other activities concerning the conservation and exploitation of the beluga populations in EEZ, and monitoring of the populations;
- establishment of 'zapovedniks' (nature reserves), 'zakazniks' (nature refuges), protected belts and other specially protected natural territories within the EEZ.

The beluga and its habitats are subject to special protection in protected natural areas (PNA), encompassing water areas, such as Ust-Lenskiy, Bolshoy Arkticheskiy (Great Arctic), Gydanskiy, Nenetskiy, and Kandalakshskiy 'zapovedniks' and Frants Josef Land and Severozemelskiy federal 'zakazniks'. PNAs are planned at Novaya Zemlya and the southeastern part of the Barents Sea and will be established in the near future. Outside the PNAs, particular attention should be paid to the regions of high concentration of the animals on the wintering grounds, the areas of summer feeding, and focal migration points.

## ANTHROPOGENIC IMPACT

In absence of significant hunting, pollution of the marine environment is likely the greatest anthropogenic threat to beluga in the Russian Arctic.

According to the Report on Status of the Arctic Environment (Anonymous 1998), persistent organic pollutants (POPs) are the most harmful anthropogenic contaminants for marine mammals due to their high liposolubility and bio-

magnification. High levels of PCBs are found in the Kara and Laptev seas, possibly due to their large river inflows (Anonymous 1998). Concentrations of PCBs and other POPs were high in some bays and river mouths in the southern part of the Barents Sea and around Svalbard. The highest levels of hydrocarbon contamination are found in the mouths of Pechora, Ob, and Yenisey rivers and in the Laptev Sea near the Lena delta. Considerable phenol contamination is found in the Laptev Sea in the mouths of the Lena and Yana rivers and in the adjacent marine areas. Matishov and Savinova (1996) also report similar contamination in the Laptev Sea. High phenol and oil contamination are found in some bays of the Barents Sea.

The level of radioactive contamination found in marine vertebrates east of Greenland and in the Barents Sea is relatively low (Anonymous 1998). High levels of radioactive contamination have been found only in sediments in Obskaya Inlet and near southern Novaya Zemlya (see also Matishov 1995). However, there is a high risk of radioactive contamination from about 11,000 containers with radioactive waste, 6 reactors from nuclear submarines, and a reactor screen from a nuclear icebreaker that are sunken in the Novaya Zemlya area (Matishov and Saviniva 1996).

Among heavy metals, lead is the most harmful to marine mammals. There are some indications of lead contamination in the Kara and Laptev seas and Pechora Inlet (Anonymous 1998).

Generally, however, pollutants are a potential threat to belugas only in a few restricted and mainly coastal areas of the Russian Arctic.

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