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Distribution and numbers of breeding ivory gulls *Pagophila eburnea* in Severnaja Zemlja, Russian Arctic

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The ivory gull *Pagophila eburnea* has a semi-circumpolar distribution with breeding sites in the High Arctic. Data about ivory gulls in the Severnaja Zemlja Archipelago (Siberia) were collected from 1991 to 1995. The numbers of breeding ivory gulls and their egg-laying period are correlated with the sea ice situation and weather during the first part of the summer. We estimate that the total potential breeding population of Severnaja Zemlja is about 2000 pairs, which makes up approximately 20% of the Russian and 14% of the world ivory gull breeding population. The percentage of the total breeding population which actually breeds varies annually. The most important breeding area of the ivory gull in Severnaja Zemlja is the Sedov Archipelago (A. Sedova) where a large colony (from 410 to about 1100 pairs in different years) was found on flat ground on Domašnij Island. Colonies from 10 to 100 breeding pairs, mostly on steep cliff faces, occur on O. Oktjabr'skoj Revoljucii and O. Bol'ševik. The ivory gull is included in the Red Data Book of Russia. Parts of Severnaja Zemlja, with important breeding sites, have become a nature reserve.

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Introduction

The ivory gull *Pagophila eburnea* has a semi-circumpolar distribution with breeding sites on High Arctic islands from the central Canadian Arctic Archipelago eastwards to Severnaja Zemlja (Blomquist & Elander 1981; Il'ičev & Flint 1988). In the Russian Arctic the ivory gull breeds in northern Novaja Zemlja (Antipin 1938; authors' observation, July 1995), on Victoria Island (Govorucha 1970; Vuilleumier 1995), in Franz Josef Land (Gorbunov 1932; Rutilevskij 1957; Tomkovič 1986; Uspenskij & Tomkovič 1986), in the islands in the Kara Sea (Dement'ev 1951; E. E. Syroečkovskij Jr., pers. comm. 1993; Syroečkovskij Jr., & Lappo 1994; Bangjord et al. 1994) and in Severnaja Zemlja (Dëmme 1934; Urvancev 1935; Ušakov 1951; Bulavincev 1984; Belikov & Randla 1987; de Korte & Volkov 1993; de Korte et al. 1995).

The first data about ivory gulls in Severnaja Zemlja were collected by Urvancev (1935) and Ušakov (1951) from 1931 to 1932, mainly in A. Sedova (abbrevations and meanings of geographical names in Severnaja Zemlja are given in Table 1), followed by Dëmme's (1934) observations from 1932 to 1934. Some data about the biology of this species were collected by Bulavincev (1984) in the southern part of O. Bol'ševik in 1982. Additional information about the distribution of ivory gulls in Severnaja Zemlja was also obtained by Belikov & Randla (1987) and by the staff of the polar stations on O. Domašnij, O. Golomjannyj, O. Bol'šoj, O. Malyj Tajmyr (Fig. 1)* and was summarised by M. V. Gavrilo (de Korte et al. 1995). From 1991 to 1995, Volkov and de Korte worked each summer in Severnaja Zemlja, mainly on O. Bol'ševik and in A. Sedova.

About 40% of the land area of the archipelago, about 37,600 km^2, is covered with glaciers up to an elevation of 985 m.(Fig. 1). From 1961 to 1991, at M. Pesčanyj on northern O. Bol'ševik, the average daily temperature was +0.9 °C in July (de Korte et al. 1995). From 1991 to 1995 the ice-cover of the Kara Sea near the southern part of

* Location name explanation: A. = Archipelag (Archipelago), B.= Buchta (Bay), F. = F'ord (Fjord), G. = Gora (Mountain), L. = Lednik (Glacier), M. = Mys (Cape), O. = Ostrov (Island), Oz. = Ozero (Lake), P. = Poluostrov (Peninsula), Pr. = Proliv (Strait), R. = Reka (River)

Table. 1. Breeding sites and possible breeding sites (?) of ivory gulls *Pagophila eburnea* in Severnaja Zemlja. F = colony on flat ground, C = colony on cliffs, I = colony with only ivory gulls, M = mixed colony with other seabird species. Numbers (location) correspond with breeding site numbers in Fig. 1.

Location	Observ. date	Type	Size	State	Source	
1.	O. Dlinnyj?	1931–1934	?	?	?	Laktionov 1936
2.	O. Srednij	22 July 1932	FI	25 nests	chicks	Dëmme 1934
		July 1992, '93, '94, '95		0		de Korte et al. 1995, authors' observ. 1995
3.	O. Domašnij	11 July 1933	FI	100 adults	first eggs	Dëmme 1934
		23 June 1948	FI	nests	first eggs	logbook polar station
		21 September 1949	FI	nests	flying young	logbook polar station
		28 June 1951	FI	nests	first eggs	logbook polar station
		15 July 1993	FI	700 nests	30% chicks	de Korte & Volkov 1993
		20 July 1994	FI	1100 nests	10% chicks	de Korte et al. 1995
		26 July 1995	FI	410 nests	20% chicks	authors' observ. 1995
4.	O. Golomjannyj	30 July 1931	FI	100 nests	eggs, chicks	Ušakov 1951
		31 July 1931	FI	nests	?	Ušakov 1951
		July 1932	FI	2000 adults	eggs, chicks	Urvancev 1935
		20 August 1934	FI	2 pairs	chicks	Dëmme 1934
		June 1939	FI	100 nests	eggs	Charitonovič 1940
		6 August 1992		0		de Korte et al. 1995
		5 August 1995	FI	11 nests	eggs, chicks	authors' observ. 1995
5.	B. Skrytaja?	?	C?	?	?	Belikov & Randla 1987
		1991		0		V. I. Bulavincev, pers. comm. 1991
		1993		0		authors' observ. 1993
		1995		0		A. Helbig, pers. comm. 1995
6.	O-va Diabazovye?	1931–1932	??	?	?	Laktionov 1936; Ušakov 1951
		1993, '94, '95		0		authors' observ. 1993, '94, '95
7.	M. Goristyj?	?	??	?	?	Ušakov 1951; Semënov 1971
		1993, '94, '95		0		authors' observ. 1993, '94, '95
8.	F. Matuseviča?	15 July 1993	C?	?	?	de Korte et al. 1995
9.	G. Bazarnaja?	?	C?	?	?	Ušakov 1951; Semënov 1971
		1993, '94, '95		0		authors' observ. 1993, '94, '95
10.	B. Skazočnaja	12 August 1985	CI	2 nests	chicks	M.V. Gavrilo, pers. comm. 1988
11.	P. Parižskoj Kommuny?	1931–1934	??	?	?	Laktionov 1936
		1983		0		Belikov & Randla 1987
		1985		0		Gavrilo 1988
12.	Oz. Izmenčivoe?	7 September 1983	C?	?	?	Belikov & Randla 1987
13.	G. Ploskaja	15 July 1993	C?	20–40 adults	?	de Korte et al. 1995
		20 July 1994	C?	20–40 adults	?	de Korte et al. 1995
14.	O. Bol'šoj?	1956	??	?	?	logbook polar station
15.	M. Massivnyj?	1931–1934	C?	?	?	Laktionov 1936; Ušakov 1951
		1993, '94, '95		0		authors' observ. 1993, '94, '95
16.	M. Olovjannyj?	19 June 1931	C?	empty nests	?	Ušakov 1951
		1993, '94, '95		0		authors' observ. 1993, '94, '95

17.	R. Studënaja?	?	C?	?	?	Bulavincev 1984; Belikov & Randla 1987
		1991–1995		0		authors' observ. 1991–1995
18.	R. Mušketova	August 1992	FI	1 nest	empty	de Korte et al. 1995
19.	Oz. Tvërdoe	21 July 1991	FI	1 nest	eggs	Volkov & Pridatko 1994
20.	M. Pesčanyj?	?	C?	?	?	Bulavincev 1984; Belikov & Randla 1987
		1991		0		authors' observ. 1991–1995
21.	R. Ostancovaja (tundra)	28 July 1991	FI	18 nests	70% chicks	Volkov & Pridatko 1994
		July 1992–1995		0		de Korte et al. 1995; authors' observ. 1995
22.	R. Ostancovaja (canyon)	28 July 1992	CM	24 nests	eggs, chicks	de Korte et al. 1995
		17 July 1993	CM	2 nests	eggs	de Korte et al. 1995
		22 July 1994	CM	17–20 nests	eggs	de Korte et al. 1995
		24 July 1995	CM	23 nests	eggs, chicks	authors' observ. 1995
23.	L. Vojcechovskogo	7 August 1991	CI	50 nests	90% chicks	Volkov & Pridatko 1994
		19 July 1992		0		de Korte et al. 1995
		21 July 1994	CI	20–40 adults	?	de Korte et al. 1995
		20 July 1995	CI	8 adults	?	authors' observ. 1995
24.	R. Šumnaja	29 July 1982	FI	40 nests	70% chicks	Bulavincev 1984
		10 August 1995		0		authors' observ. 1995
25.	O. Malyj Tajmyr?	?	F?	nests	?	A. Tjurjakov. pers. comm. 1988
		July 1993		0		authors' observ. 1993

the archipelago varied in summer between 100% and 10% (V. A. Spičkin, Arctic and Antarctic Research Institute, St. Petersburg, pers. comm. 1994; authors' observations 1991–1995).

The aim of our study was to survey the distribution of breeding sites and estimate the breeding population size of ivory gulls in Severnaja Zemlja.

Methods

From 19 July until 22 August 1991, Volkov & Pridatko (1994) worked in northwestern O. Bol'ševik near the station Prima. In 1992 we studied birds in the same area from 15 July until 6 August. From 14 to 19 July 1993 we searched by helicopter for bird colonies on all the large and on some of the small islands of the archipelago. This work was continued on O. Bol'ševik and O. Domašnij from 20 to 26 July (de Korte & Volkov 1993; de Korte et al. 1995). From 19 to 22 July 1994, we observed colonies of ivory gulls on O. Bol'ševik and O. Oktjabr'skoj Revoljucii from a helicopter and we landed on O. Domašnij and in R. Ostancovaja. From 19 July to 10 August 1995 we made reconnaissance flights by helicopter in the southern part of the archipelago. On the ground we visited R. Ostancovaja on 22 and 24 July, A. Sedova from 23 July to 9 August, and R. Šumnaja on 10 August.

From 1991 to 1995 we investigated yearly the same areas and thus had the opportunity to study the population changes of ivory gulls. In 1991 and 1992 we found colonies by walking. We covered an unglaciated area of about 440 km^2 in 1991, and 625 km^2 in 1992. In 1993, 1994 and 1995 we found colonies by surveys with a helicopter when we flew a total of 40 hours across and around all the large islands and O. Malyj Tajmyr, O-va Diabazovye and A. Sedova. In colonies up to 500 pairs we counted the number of pairs by counting the adult birds on the nest (one adult or two adults on a nest = one pair). If possible we noted also nests without adults. In larger colonies we counted an estimated percentage of the total colony and extrapolated the results to the whole colony.

For a study of the density of ivory gulls on land outside the colonies in 1991, we used the method of route census with a registration of length of route and distance from observer to each observed ivory gull on this route (Čelincev 1985). We investigated by walking all habitat types of

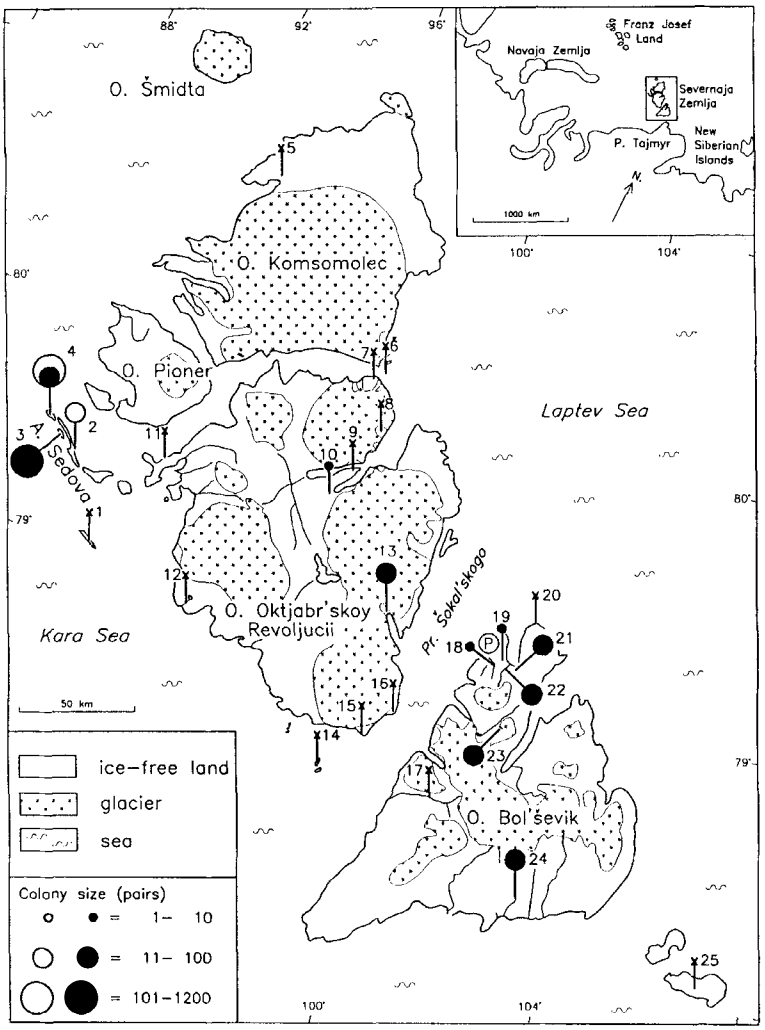

Fig. 1. Severnaja Zemlja with place names referred to in this paper and possible breeding sites of ivory gulls. Explanation: Open circle = breeding reported before 1980; Solid circle = breeding reported in and after 1980; X = doubtful reports on breeding; P = station Prima. Numbers on map indicate breeding sites:

1 = O. Dlinnyj
2 = O. Srednij
3 = O. Domašnij
4 = O. Golomjannyj
5 = B. Skrytaja
6 = O-va Diabazovye
7 = M. Goristyj
8 = F. Matusevièa
9 = G. Bazarnaja
10 = B. Skazočnaja
11 = P. Parižskoj Kommuny
12 = Oz. Izmenčivoe
13 = G. Ploskaja
14 = O. Bol'šoj
15 = M. Massivnyj
16 = M. Olovjannyj
17 = R. Studënaja
18 = R. Mušketova
19 = Oz. Tvërdoe
20 = M. Pesčëanyj
21 = R. Ostancovaja (tundra)
22 = R. Ostancovaja (canyon)
23 = L. Vojcechovskogo
24 = R. Šumnaja
25 = O. Malyj Tajmyr.

the area: coastal tundra (38 km route), lowland watershed tundra (28 km), foothill watershed tundra (79 km), and arctic deserts on mountains (44 km). Censuses were done during 20–31 July, when part of the ivory gull population still was incubating, and during 12–18 August, when all chicks had hatched.

Clutch sizes were investigated in the second half of July when all clutches had been completed. Egg mortality was only studied in the second half of the incubation period, and chick mortality only in the first half of the chick rearing period.

Results

Breeding distribution and numbers

Fig. 1 and Table 1 present the location of breeding places, probable breeding places and numbers of breeding pairs of ivory gulls in Severnaja Zemlja.

A colony of about 700 breeding pairs was found on the southeastern part of O. Domašnij in July 1993 (de Korte et al. 1995). This colony had about 1100 pairs in July 1994, and had 410 pairs in July 1995. From 1993 to 1995, the colony had moved

about 500 m. We found a colony with 11 pairs on O. Golomjannyj in August 1995. In 1993 and 1994 we saw a colony with several dozen pairs near a glacier on the cliffs of G. Ploskaja.

Our observations in 1993, 1994 and 1995 did not confirm reports by Urvancev (1935), Laktionov (1936), Ušakov (1951), Semënov (1971) about breeding on O-va Diabazovye, M. Goristyj, G. Bazarnaja, M. Massivnyj and M. Olovjannyj. Breeding of ivory gulls on P. Parižskoj Kommuny (Laktionov 1936) was not confirmed by field work performed in 1983 (Belikov & Randla 1987) and 1985 (Gavrilo 1988). Bulavincev (1984) and Belikov (Belikov & Randla 1987) found a colony with about 40 pairs in the basin of R. Šumnaja (O. Bol'ševik) in 1981, but in 1995 we did not see ivory gulls there. We found a colony with 18 nests on flat ground on the tundra about one kilometer east of R. Ostancovaja in 1991. This breeding place was not occupied from 1992 to 1995. In 1991 we also found a colony with about 50 nests on accessible rocks with a south-eastern exposure, about 100 m from L. Vojcechovskogo (Volkov & Pridatko 1994). Within one kilometer from this colony there were six other occupied nests on inaccessible rocks. The accessible breeding site was deserted in 1992 and 1995, but several dozen pairs bred there in 1994. The inaccessible site was occupied in 1995. In 1992 we found four small colonies with a total of 24 breeding pairs some hundreds of meters apart on cliffs in the canyon of R. Ostancovaja (de Korte et al. 1995). Ivory gulls bred there again in 1993 in one and in 1994 and 1995 in three of these four colonies (Table 2).

Table 2. Total numbers of seabird breeding pairs in four cliff colonies with breeding ivory gulls in R. Ostancovaja in different years.

	Pagophila eburnea	*Rissa tridactyla*	*Larus hyperboreus*	*Cepphus grylle*
1992	24	115	3	3
1993	2	30	2	some
1994	17-20	80-90	2	some
1995	23	45-50	7	2 - 3

Type of colonies

In Severnaja Zemlja ivory gulls breed on flat tundra and on cliffs, mostly in colonies, but also in single pairs (Table 1). In most colonies on flat ground we found only ivory gulls, but in a large colony of ivory gulls on O. Domašnij in 1993 we also saw a breeding pair of kittiwakes *Rissa tridactyla*. On the cliffs of R. Ostancovaja ivory gulls bred together with kittiwakes, black guillemots *Cepphus grylle* and glaucous gulls *Larus hyperboreus* in 1992 (Table 2). Nests were situated on narrow inaccessible ledges in the middle part of the cliffs, about 15 m from the cliff top. Most of the ivory gulls nested among the kittiwakes, but some pairs bred separately.

Colonies usually consisted of one group of nests, but on the tundra near R. Ostancovaja a colony had two groups of nests 600 m from each other. One group had four nests in a dry grass-moss-lichen tundra, the second had 14 nests on gravel in a small stream. The mean distances between the nearest nests in the two groups were 1.5 and 6 m respectively. On the cliffs of R. Ostancovaja there were four groups in 1992, with distances of 300 to 500 m between the groups. The colony on O. Domašnij consisted of one group in a dry gravel habitat in 1993 and 1994. It consisted of a large and a small group, 40 m apart in 1995, when it was located in and around the remains of a polar station.

The composition of the nest material is related to the vegetation in the colony area. In the cliff colony near L. Vojcechovskogo ivory gulls used mostly mosses. In the tundra colony near R. Ostancovaja nests consisted of vascular plants. In the colony on O. Domašnij, which in 1995 was situated in and around the remains of a polar station, the nests were made of mosses and small pieces of wood.

Breeding and breeding success

In the colony near L. Vojcechovskogo on 7 August 1991, about 10% of 50 pairs had eggs, 10% had down-covered chicks, 40% had chicks with small primaries and 40% had chicks with half-grown primaries. In the colony on O. Domašnij, we observed 70% of the nests with eggs and 30% with chicks of two to five days old on 15 July 1993; 30% of the pairs still had eggs, and 70% had chicks of less than 10 days old on 22 July 1993. On 26 July 1995, 20% of the nests had chicks, and on 5 August 80% of the nests had chicks. In these colonies the period of egg laying spanned three weeks or more, while 70–80% of the eggs had been laid within two weeks after the first egg-laying.

Table 3. Chick mortality in ivory gull colonies on Severnaja Zemlja.

Colony	Date	Breeding pairs (n)	Mean clutch brood size	Chicks (n)			
				% hatched	living	chick dead	mortality
R. Ostancovaja (tundra)	28 July 1991	18	1.6	70%	20	0	0%
	10 August 1991	18	1.6	95%	24	3	11%
O. Domašnij	23 July 1993	240 (1/3)	1.4	70%	360	90	38%
	20 July 1994	220 (1/5)	2.0	10%	40	?	?
	26 July 1995	306	1.4	20%	88	3	3%
	08 August 1995	306	1.4	95%	390	17	4%
L. Vojcechovskogo	07 August 1991	·50	1.4	90%	·60	?	?

Full clutches of ivory gulls had one to three eggs. Mean clutch size varied from year to year from 1.4 to 2.0 (Table 3). Clutches with one or two eggs were the rule. However, in the large colony on O. Domašnij, we found clutches with three eggs in 1993 (< 1%), 1994 (15%) and 1995 (< 1%). Chick mortality in the first weeks of life also varied from year to year with low mortality in 1991 and 1995, and relatively high mortality in 1993 (Table 3).

Non-breeding birds

In Severnaja Zemlja we saw outside the colonies only ivory gulls in completely white plumage. Data about the numbers of ivory gulls outside the colonies were collected during route counts on the northwest part of O. Bol'ševik. In 1991 on the eastern coast of Pr. Šokal'skogo we counted an average of four birds in flight per two-hour period, but in 1992 only one per two-hour period.

In 1991 we did not see groups of birds in the tundra outside the colonies. In 1992 such groups were recorded far from the coast and the station. Near a lake, 4 km from the coast, I. N. Safronova (pers. comm. 1992) observed a group of 72 birds on 23 July. In the upper part of R. Ostancovaja near a glacier, 20 birds were recorded on 2 August.

In 1991 we observed that on the tundra near Pr. Šokal'skogo density increased from 1.5 birds per km^2 in the last 10 days of July to 6.6 birds per km^2 in the middle of August. Further inland, non-breeding birds were rare.

Discussion

Breeding distribution

Severnaja Zemlja is the easternmost area in the Russian Arctic where ivory gulls have been proven to breed (Table 1, Fig. 1). Bannikov (1941) wrote about ivory gulls breeding on Wrangel Island, but without any specification. Uspenskij (1963) supposed breeding of this species on Bennett Island (De Long Islands in the New Siberian Islands), but he only observed adult birds during the breeding period and did not find nests. Breeding of the ivory gull on the New Siberian Islands and on Herald Island, without reference, mentioned by Løvenskiold (1964) was never confirmed by more recent field observations (Portenko 1973; Stišov et al. 1991). Stišov et al. (1991) mentioned breeding ivory gulls in the De Long Islands, but without any reference. On the western coast of Novaja Zemlja, Gorbunov (1929) saw ivory gulls but he did not prove breeding. A map of the breeding distribution of ivory gulls in the Russian Arctic by Judin & Firsova (1988) does not include Bennett Island and western Novaja Zemlja. A map with the world breeding distribution of ivory gulls by Grant (1986) indicates Bennett Island, and such a map by Haney (1993) indicates Bennett Island and western Novaja Zemlja.

Population size

The ivory gull is quite common in Severnaja Zemlja and 25 breeding sites have been located

(Table 1, Fig. 1). Among seabirds, only glaucous gulls, kittiwakes and black guillemots are more widespread (de Korte at al. 1995). It is difficult to estimate the size of the breeding population of the ivory gull on Severnaja Zemlja because ivory gull breeding densities in the same area differ considerably from year to year. For example, the total numbers of breeding pairs counted in the same areas on northern O. Bol'ševik was 69 in 1991, 24 in 1992, 2 in 1993, 30–40 in 1994, and 27 in 1995. On O. Domašnij, O. Srednij, O. Golomjannyj and perhaps O. Dlinnyj, ivory gulls bred on flat ground in the 1930s and 1950s (Dëmme 1934; Urvancev 1935; Laktionov 1936; Ušakov 1951; logbooks polar stations), but we did not find colonies of ivory gulls on O. Srednij from 1992 to 1995. M. V. Gavrilo found breeding pairs in 1985 in the southern part of B. Skazočnaja (de Korte et al. 1995). Belikov & Randla (1987) supposed that ivory gulls were breeding in 1983 on the river between Oz. Izmenčivoe and the sea. Our observations in 1993, 1994 and 1995 did not confirm reports by Urvancev (1935), Laktionov (1936), Ušakov (1951), Semënov (1971) about breeding on O-va Diabazovye, M. Goristyj, G. Bazarnaja, M. Massivnyj and M. Olovjannyj. Breeding of ivory gulls on P. Parižskoj Kommuny (Laktionov 1936) was not confirmed by field work performed in 1983 (Belikov & Randla 1987) and 1985 (Gavrilo 1988). Bulavincev (1984) and Belikov (Belikov & Randla 1987) found a colony with about 40 pairs in the basin of R. Šumnaja (O. Bol'ševik) in 1981, but in 1995 we did not see ivory gulls there. In the valley of R. Mušketova we found an old empty nest in 1992. Reports about ivory gulls breeding in R. Studënaja and at M. Pesčanyj (Bulavincev 1984; Belikov & Randla 1987) were not confirmed by our observations from 1991 to 1995. The staffs at the polar stations recorded ivory gulls breeding on O. Bol'šoj and O. Malyj Tajmyr (de Korte et al. 1995), but we did not find them when we visited those places. Reports of ivory gull colonies on the east coast of O. Komsomolec and B. Skrytaja (Belikov & Randla 1987) were not confirmed by our observations in 1991 and 1993 nor by A. Helbig in July 1995 (pers. comm. 1995).

The numbers of breeding ivory gulls and their egg-laying period seem to be correlated with the sea ice situation and weather during the first part of the summer. The relatively low numbers of ivory gulls in 1992 can perhaps be explained by solid pack ice in the Kara Sea in June and July (V. A. Spičkin pers. comm 1994; authors' observation). In that year we observed quite large concentrations of non-breeding ivory gulls on the tundra. According to P. S. Tomkovič (pers. comm. 1992), similar concentrations of ivory gulls were observed in 1981 near deserted colonies on Graham Bell Island (Franz Josef Land). In unfavourable years some birds occupy nests in the colony, but do not lay eggs. In 1992 pairs of ivory gulls were sitting on nests, without eggs or chicks, in a portion of the cliff colony in R. Ostancovaja which had not often been used in the past judging from the absence of nitrophilous lichens (*Xanthoria* spec. and *Caloplaga* spec.) near the nests. These lichens usually can be observed in cliff colonies, which have been occupied for decades, or centuries (Salomonsen 1979).

The estimated number of 100 pairs of breeding ivory gulls on the whole of O. Bol'ševik (Bulavincev 1984) is a minimum figure. We estimate that the total potential breeding population of Severnaja Zemlja is about 2000 pairs. The percentage of this population which actually breeds will vary annually. A total of about 8000 pairs may breed in other parts of the Russian Arctic: some thousands of pairs on the islands of Kara Sea (E. E. Syroečkovskij Jr., pers. comm. 1993; Bangjord et al. 1994; Syroečkovskij, Jr., & Lappo 1994); some thousands on Franz Josef Land (Uspenskij & Tomkovič 1986); and some hundreds on Victoria Island (Govorucha 1970; A. B. Junak, pers. comm. 1992; Vuilleumier 1995; Forsberg 1995). A total of about 4000 pairs may breed outside Russia, with less than 1000 pairs in Svalbard (Birkenmajer 1969; Mehlum & Bakken 1994), a maximum of 1000 pairs in Greenland (Evans 1984), and about 2400 breeding pairs in the Canadian Arctic (Thomas & MacDonald 1987).

Location of colonies

On Severnaja Zemlja, ivory gulls breed in colonies on cliffs or on flat ground. On large islands, cliff colonies were situated up to 20 km from the coast, but on the small island of O. Domašnij a flat ground colony was situated in some years less than 20 m from the coast. Colonies on cliffs were located in inaccessible sites in canyons (e.g. R. Ostancovaja) and on accessible sites near inland glaciers (e.g. L. Vojcechovskogo). In northern Novaja Zemlja a small ivory gull colony in a canyon was also recorded (authors' observation

July 1995). In Svalbard ivory gull colonies were recorded on cliffs near glaciers (Dalgety 1932; Bateson & Plowright 1959; Løvenskiold 1964; Flipse & de Roever 1964; Birkenmajer 1969; de Korte 1972), on cliffs facing the nearest coast (Malmgren 1863; Montague 1926; Dalgety 1928; authors' observation 1986), and on flat ground (Løvenskiold 1964). Cliff colonies and flat ground colonies have also been found in Franz Josef Land (Tomkovič 1986), Greenland (Salomonsen 1961; Wright & Matthews 1980) and Canada (Thomas & MacDonald 1987). Most colonies that we found constituted one coherent group of nests, but some colonies included separate groups of nests. This type of colony, with an example of six groups of nests, was also recorded on Franz Josef Land (Rutilevskij 1957).

Timing of egg-laying and breeding success

The timing of egg laying varies from year to year and perhaps also from site to site. On O. Domašnij the first eggs were reported between 23 June (1948) and 28 June (1951) (logbook of the polar station). On 15 July 1993 we saw chicks there, which judging from their size, were two to five days old. This means that egg laying had started before 20 June if we allow for an incubation period of 24 days (Judin & Firsova 1988). In the colony of R. Šumnaja, five to seven day old chicks were observed on 29 July 1982 (Bulavincev 1984), hence egg laying had started in the first days of July. Dëmme (1934) reported the beginning of egg laying on O. Srednij on 11 July 1933.

The period of egg laying in a colony can be prolonged. In 1991, in the colony on the tundra near R. Ostancovaja, we saw chicks of about ten days old with developing primaries on 28 July but some clutches were still being incubated on 10 August. In 1982 in a colony on R. Šumnaja, the first chicks hatched about 24 July, while on 13 August, two clutches were still being incubated (Bulavincev 1984).

In the five seasons (1991 to 1995) during which we did our observations, the timing of egg laying varied from the third week in June to the first days of July. According to 1981 data from Graham Bell Island in Franz Josef Land (Tomkovič 1986) and 1982 data from the southern part of O. Bol'ševik (Bulavincev 1984), egg laying began in the first days of July. In 1991 and 1993, with an early spring on O. Bol'ševik, egg laying began before 20 June. A similar early period of the beginning of egg laying was also recorded by the staff of the polar station on Rudolf Island in Franz Josef Land (20 June) (Rutilevskij 1957), where birds changed breeding place in the beginning of July and relaid. Dëmme (1934) recorded the beginning of egg laying in 1934 on 11 July, which is relatively late, implying that the earliest chicks would fledge in early September. It is possible that these were relaid. In Svalbard most juveniles fledge in late August (Løvenskiold 1994; de Korte 1972). The variation of the timing of egg laying and the relatively long period in which chicks can hatch and fledge successfully gives part of the ivory gull population a chance to reproduce also in unfavourable years because different timing gives different feeding opportunities.

The main factor that determines the egg production of ivory gulls is probably the possibility of finding food during the egg-laying period, part of which is synchronised with the primary moult (de Korte 1972). Food availability depends much on the distance from the breeding place to open water near sea ice (open leads and polynyas), where the birds can forage for amphipods and polar cod *Boreogadus saida*, which we found in the stomachs of two and seven dead chicks, respectively. In exceptional cases they may also eat collared lemming *Dicrostonyx torquatus* (Kaljakin et al. 1985). In the first part of the summers of 1991 and 1995, when there was open water in the Kara Sea near the southern part of Severnaja Zemlja, ivory gulls bred successfuly and most chicks survived the frequent unfavourable weather with strong winds, rain and snow. In 1993, when large areas of the Kara Sea were covered with unbroken ice, chick mortality was much higher, although the weather was much milder. In 1992 many ivory gulls did not breed, probably because the whole Kara Sea near the archipelago was covered with unbroken ice (V. A. Spičkin pers comm. 1994; authors' observations).

Predation and site fidelity

We did not record attacks from Arctic skuas *Stercorarius parasiticus*, pomarine skuas *Stercorarius pomarinus* and glaucous gulls *Larus hyperboreus* in colonies of ivory gulls. However, snowy owls *Nyctea scandiaca* which roam in small numbers to Severnaja Zemlja in years following a lemming year (de Korte et al. 1995) sometimes take chicks from colonies on flat ground (authors' observation 1995).

Around polar stations predation of eggs and chicks by dogs is possible; this was recorded on O. Domašnij in 1933 (Dëmme 1934). In 1939 about 300 eggs were collected on O. Golomjannyj by personnel of the polar station (Charitonovič 1940). At O. Trojnoj in the Kara Sea, the crew and dogs of the polar station took eggs in ivory gull colonies to a large extent in 1992 and 1994 (Syroečkovskij, Jr., & Lappo 1994; Bangjord et al. 1994).

In summer, mammalian predators (arctic fox *Alopex lagopus*, wolf *Canis lupus*, and polar bear *Ursus maritimus*) are rare on Severnaja Zemlja and they probably have only occasionally a significant direct influence on breeding success of the birds. On O. Trojnoj in the Kara Sea, a colony of ivory gulls was subject to heavy predation by arctic foxes and polar bears in the first week of July 1992, whereafter the ivory gulls changed breeding places and started to relay on 14 July (Syroečkovskij, Jr., & Lappo 1994).

Change or desertion of breeding sites is characteristic for ivory gulls (Dalgety 1928, 1932; Bateson & Plowright 1959; Birkenmajer 1969; de Korte 1972). Birds often nest near the breeding places of previous years. Previous-year nests near occupied colonies were found by Bulavincev (1984) in southern O. Bol'ševik, by Tomkovič (1986) in Franz Josef Land, and by us in 1991 near R. Ostancovaja. In 1993, on O. Domašnij at a distance of two kilometres from an occupied colony, we found four deserted colonies from previous years (de Korte & Volkov 1993). In 1994 the colony had moved about 100 m from the 1993 site, and again in 1995 by about 400 m. An accessible breeding site near L. Vojcechovkogo which had breeding birds in 1991 and 1994 had none in 1992 and 1995. This characteristic of ivory gull ecology is often observed when a colony is located in areas accessible for predatory mammals; it is possibly a strategy to avoid predation, preventing terrestrial predators from learning the exact location of the colony. Birds situated in inaccessible places tend to use use the same colonies each year, an example of which is the colony on the cliffs of R. Ostancovaja. According to Løvenskiold (1964), ivory gulls never breed in a breeding place where eggs or young had previously been taken. On O. Srednij, where a military station is situated, colonies of ivory gulls have disappeared; but on O. Golomjannyj, O. Trojnoj and Victoria Island where large polar stations were located, ivory gulls have continued to breed on flat ground colonies (Govorucha 1970; authors' observations 1995; Bangjord et al. 1994; A. B. Junak, pers. comm. 1992; Vuilleumier 1995; Forsberg 1995). If strong human disturbance disappears, the birds may reoccupy a breeding place that had previously been deserted. For instance, on O. Domašnij a colony disappeared after a station was build in 1930. The station was closed in 1954 and ivory gulls were again found breeding on the island in 1993, 1994 and 1995.

Threats and protection

Data about ivory gulls indicate changes in numbers in different parts of the breeding area. A decrease in the number of ivory gulls in Svalbard and a decrease in the area of distribution in the Canadian Arctic Archipelago were recorded in the 1960s for unknown reasons (Birkenmajer 1969; McDonald 1976). For the Russian Arctic we do not have much data about numerical fluctuations and changes in the area of distribution of the ivory gull. The number of breeding pairs in A. Sedova recorded in the 1930s is about the same as in the 1990s (about 1000).

The numbers of ivory gulls that breed in Severnaja Zemlja make up about 20% of the Russian and about 14% of the world breeding population. In Russia the ivory gull is a protected species and is included in the Red Data Book of Russia (But'ev 1983). The breeding places on the islands in the Kara Sea are included in the Great Arctic Reserve, which has the status of a Strict Nature Reserve, "Zapovednik" (Volkov & de Korte 1994). The whole of Franz Josef Land has the status of a Nature Reserve, "Zakaznik" (Huberth Hansen et al. 1994; Prokosch 1995). In 1996 part of Severnaja Zemlja has been given the status of a Nature Reserve, "Zakaznik" (Prokosch 1995). This means that a considerable part of the Russian population of ivory gulls is now breeding in protected nature areas.

From 1990 to 1995 the number of polar stations in the Russian High Arctic has severely decreased (de Korte et al. 1995; authors' observations 1995), thereby reducing the influence of human activity in these areas. However, extensive gold mining in open trenches in the southern part of O. Bol'ševik may have a negative impact on breeding places which have been reported in R. Studënaja and R. Šumnaja. In addition, the increasing scientific and tourist activities employing the use of heli-

copters in the High Arctic, including Severnaja Zemlja, Franz Josef Land and Victoria Island, could also have a negative effect on breeding places if these activities take place without any control (Vuilleumier 1995; Forsberg 1995; authors' observations 1992–1995).

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