ARCTIC
VOL. 71, NO. 1 (MARCH 2018) P. 76–88
https://doi.org/10.14430/arctic4703

Nesting of Barnacle Goose (*Branta leucopsis*) in the Russian Part of the Gulf of Finland

Sergei Kouzov,[1] Elmira Zaynagutdinova,[1,2] Rustam Sagitov[1] and Anna Rychkova[3]

(*Received 5 July 2017; accepted in revised form 31 December 2017*)

ABSTRACT. Until the end of the 1980s, the Barnacle Goose (*Branta leucopsis*) was an extremely rare migrating species in the Russian part of the Gulf of Finland, but in recent years it has become one of the mass migrants there. The first nest of a Barnacle Goose in the region was found on Dolgy Reef Island close to the Russian-Finnish border in 1995. Barnacle Geese then started expanding onto the islands in the eastern part of the Gulf of Finland. They occupied islands mostly in the northern part of the gulf, but nests were found in its central parts and close to the southwest coast as well. Barnacle Geese nested mostly on small, rocky, forest-free islands. By 2006, the size of the breeding population of this species had increased to 31 pairs. Forty nests were found in 2014, and an explosive population growth to 76 nests was observed in 2015. In 2010, Barnacle Geese started to breed on Ladoga Lake, and in 2015 the first nest was found on Onega Lake. Until 2010 Barnacle Geese had nested in the eastern part of the Gulf of Finland almost exclusively on the islands lying at a distance of 2.4–10.1 km from the coast. The population growth that occurred in subsequent years was due primarily to the birds' breeding on islands closest to the coast, no farther than 2 km away from the shore. After hatching, broods from inshore islets moved to feed on coastal meadows, but nonbreeding birds and failed breeders generally remained on offshore islands for the molting period. Further expansion of the Barnacle Goose in the eastern part of the Gulf of Finland is expected. However, expansion could ultimately be restricted by the limited food resources for broods and molting birds.

Key words: Baltic Sea; Barnacle Goose; *Branta leucopsis*; wildfowl; geese; breeding; population growth; expansion; population size; distribution; landscape; habitat

RÉSUMÉ. Jusqu'à la fin des années 1980, la bernache nonnette (*Branta leucopsis*) était une espèce migratrice extrêmement rare dans la partie russe du golfe de Finlande, mais ces dernières années, elle est devenue l'une des espèces migratrices importantes de l'endroit. Le premier nid de bernache nonnette dans la région a été trouvé sur l'île Dolgy Reef près de la frontière finno-russe en 1995. Ensuite, la bernache nonnette a commencé à s'étendre sur les îles de la partie est du golfe de Finlande. Elle occupait principalement des îles de la partie nord du golfe, bien que des nids aient été trouvés dans les parties centrales et à proximité de la côte sud-ouest. La bernache nonnette faisait surtout son nid sur les petites îles rocheuses dépourvues d'arbres. Vers 2006, la taille de la population reproductrice de cette espèce avait augmenté pour s'établir à 31 paires. Quarante nids ont été repérés en 2014, puis en 2015, on a assisté à une croissance explosive de la population, qui s'est établie à 76 nids en 2015. En 2010, la bernache nonnette a commencé à se reproduire au lac Ladoga, puis en 2015, un premier nid a été trouvé au lac Onega. Jusqu'en 2010, la bernache nonnette avait fait son nid dans la partie est du golfe de Finlande, presque exclusivement sur les îles se trouvant à une distance allant de 2,4 à 10,1 km de la côte. La croissance de population à laquelle on a assisté au cours des années qui ont suivi était principalement attribuable à la reproduction des oiseaux sur les îles se situant plus près de la côte, pas plus loin qu'à deux kilomètres de la rive. Après l'éclosion, les nichées des îlots côtiers se sont déplacées pour se nourrir dans les prés côtiers, mais les oiseaux n'étant pas en reproduction et les reproducteurs en échec sont restés généralement sur les îles au large pendant la période de mue. On s'attend à ce que la bernache nonnette s'étende davantage dans la partie est du golfe de Finlande. Cependant, sa croissance pourrait finir par être restreinte par les ressources alimentaires limitées convenant aux oiseaux de nichées et aux oiseaux en période de mue.

Mots clés : mer Baltique; bernache nonnette; *Branta leucopsis*; gibier à plumes; bernaches; reproduction; croissance de la population; étendue; taille de la population; distribution; paysage; habitat

Traduit pour la revue *Arctic* par Nicole Giguère.

[1] St. Petersburg State University, Universitetskaya emb. 7/9, St. Petersburg, Russia
[2] Corresponding author: e.zainagutdinova@spbu.ru
[3] Sechenov Institute of Evolutionary Physiology and Biochemistry, Russian Academy of Sciences, pr. Torez 44, St. Petersburg, Russia

АННОТАЦИЯ. Белощекая казарка, бывшая до конца 1980-х гг. исключительно редким мигрирующим видом в российской части Финского залива, стала одним из массовых мигрантов в настоящее время. Первое гнездо белощекой казарки в регионе было найдено на острове Долгий Риф недалеко от границы с Финляндией в 1995 г. Затем казарки начали расселяться по островам восточной части Финского залива. Они занимали острова в основном в северной части залива, однако гнезда также были найдены на островах в центральной части залива, а также у юго-западного побережья. Белощекие казарки гнездились исключительно на небольших безлесных островах. К 2006 г. количество гнездящихся в регионе птиц достигло 31 пары. В 2014 г. было найдено 40 гнезд. Взрывной рост численности до 76 гнездящихся пар наблюдался в 2015 г. В 2010 г. казарки начали гнездиться на Ладожском озере, а в 2015 г. первое гнездо вида было найдено на Онежском озере. До 2010 г. белощекие казарки на востоке Финского залива гнездились на островах, удаленных от берега более, чем на 2.4 км. В последующие годы рост гнездовой популяции происходил за счет пар, гнездящихся на островах, удаленных от побережья не более, чем на два км. Выводки с прибрежных островов перемещались на приморские луга на побережье, в то время как неразмножающиеся особи на период линьки оставались на островах в открытой части залива. В дальнейшем ожидается продолжение расселения белощеких казарок в восточной части Финского залива, однако оно может быть ограничено лимитированными пищевыми ресурсами для выводков и линных птиц.

Ключевые слова: Балтийское море, Белощекая казарка, *Branta leucopsis*, водоплавающие птицы, гуси, размножение, рост численности, расселение, размер популяции, распространение, ланшафт, биотоп

INTRODUCTION

In recent decades, climate change and human activities have significantly sped up changes in the natural environment. One of the habitats especially sensitive to these changes is the shores of large waterbodies of the boreal, Subarctic, and Arctic zones. Studies of wildfowl adaptations to the changes within their environment are thus of particular interest. In particular, such adaptations include changes in bird distribution and migration that lead to completely new types of nesting habitats.

For most of the 20th century, Barnacle Goose (*Branta leucopsis*) bred only on the islands of the High Arctic: on the northeastern coast of Greenland, on Spitsbergen and Vaygach Islands, and on the southern island of the Novaya Zemlya Archipelago (Ptushenko, 1952; Cramp and Simmons, 1978; Ganter et al., 1999). At that time, most of the birds nested on the coastal rocky cliffs (Menzbir, 1895; Ptushenko, 1952).

A severe decline of this species was observed in the middle of the last century (Borodin et al., 1984). In the 1950s, the Arctic-breeding Russian population of Barnacle Geese was estimated at 10 000 individuals (Boyd, 1961). The nuclear weapon testing actions carried out by the Soviet Union in the Novaya Zemlya archipelago from the 1950s to the 1990s had a serious impact on the biota of the Arctic. In the 1950s and 1960s, numerous atmospheric nuclear tests, including the most powerful nuclear explosion in world history, were done on the southwestern part of the North Island, near the South Island of Novaya Zemlya (Khalturin et al., 2005). The main colonies of the eastern European population of Barnacle Geese were located there at that time. It is obvious that terrestrial and sea ecosystems and their components, including polar bears (*Ursus maritimus*) and huge seabird colonies, suffered heavily from the blasts and excessive radiation there (Borodin et al., 2001). The catastrophic decline of the Atlantic herring (*Clupea harengus*) population can also be associated with these nuclear tests because feeding grounds of this species are located in the eastern part of the Barents Sea close to the archipelago (Krysov, 2000).

The early 1970s saw intensive growth in the numbers of wintering and migrating Barnacle Geese in the western Baltic, and small groups of birds began to stay on the coasts of the Baltic Sea during the summer (Owen, 1997; Ganter et al., 1999). The first nesting in this region was registered on a small island near Gotland Island (Sweden) in 1971 (Larsson et al., 1988; Black et al., 2014). Later, breeding Barnacle Geese appeared on the western islands of Estonia and southern Finland (Leito, 1996), as well as in the Danish Archipelago (Olsen, 1992; Mortensen and Hansen, 1999). Nesting colonies of Barnacle Geese were found in the Netherlands in the early 1980s (Meininger and van Swelm, 1994; Ouweneel, 2001; Voslamber et al., 2007) and on the coast of Germany in the late 1980s (Koop, 1998; Kruckenberg and Hasse, 2004). The number of colonies of the species grew rapidly, and in the early 2000s the nesting population of Barnacle Geese in Western Europe reached 25 000 birds in the North Sea and 21 000 in the Baltic Sea (Voslamber et al., 2007; Feige et al., 2008).

Economic activity, climate change, and nature protection measures in the regions far from the Arctic can have a significant impact on Arctic ecosystems because of migrating animals. Moreover, long-distance Arctic migrants can lead to changes in non-Arctic ecosystems. In the 20th century, the expansion of farmlands and intensive use of fertilizers allowed many species of Arctic herbivore birds to feed on plants more nutritious than their natural diet during migration and winter periods, while the spread of pesticides and natural habitat shrinkage decreased the number of carnivorous mammals and avian predators such as White-tailed Eagle (*Haliaeetus albicilla*). At the same time, hunting restrictions and other nature protection measures were introduced in Europe and North America. All these factors have driven population growth in a number of Arctic species and also made breeding at

temperate latitudes energetically feasible for some of them (van der Jeugd et al., 2009). However, different species and populations showed different trends. The size of the Russian European population of the White-fronted Goose (*Anser albifrons albifrons*) has increased significantly. At the same time, the size of Greenlandic populations (*A. a. flavirostris*) of this species has decreased (Fox et al., 2010). Greater Snow Geese (*Chen caerulescens atlantica*) in North America have not only increased in number, but also changed the areas of wintering and migratory stops (Gauthier et al., 2005). In some northern regions, the growth of the population of the Lesser Snow Goose (*C. c. caerulesens*) has led to overgrazing and catastrophic degradation of the Arctic ecosystems (Kerbes et al., 1990). The population of Canada Goose (*Branta canadensis*) has also increased, and the Giant Canada Goose (*B. c. maxima*) has established sedentary populations in urban areas in the temperate zone, causing inconvenience to local residents (BirdLife International, 2016). The population of the Dusky Canada Goose (*B. c. occidentalis*) has declined over the past 30 years because Canada Geese of five other subspecies now occupy the Cooper River delta on the south-central coast of Alaska, where the Dusky was formerly dominant (Bromley and Rothe, 2003). European Bewick's Swan (*Cygnus columbianus bewickii*) and Bean Goose (*Anser fabalis*) actively use farmlands in winter; however, their populations are of conservation concern because their numbers are in decline (Fox et al., 2010; Rees and Beekman, 2010). The Barnacle Goose populaton has increased significantly; moreover, this Arctic species has colonized new habitats not only in the Arctic, but also in the temperate zone. These Barnacle Goose populations have substantial colonization flexibility. Positive and negative consequences for the newly settled ecosystems need to be studied. Gathering data on such population trends in Arctic animals is also important in connection with the impact of global climate change on the Arctic and other regions.

Many Arctic sea birds, such as Velvet Scoter (*Melanitta fusca*), Common Eider (*Somateria mollissima*), Arctic Tern (*Sterna paradisaea*), Ruddy Turnstone (*Arenaria interpres*), Ringed Plover (*Charadrius hiaticula*), Razorbill (*Alca torda*), and Black Guillemot (*Cepphus grylle*), are widely spread and breed in the eastern part of the Gulf of Finland and in the Baltic Sea (Cramp and Simmons, 1978; Malchevsky and Pukinsky, 1983; Bubyreva et al., 1993; Noskov et al., 1993; Iovchenko et al., 2002; Shilin et al., 2014; Cherenkov et al., 2016). Most of these species in the Baltic Sea are probably relics of the last glacial period (Malchevsky and Pukinsky, 1983). In contrast to this group of birds, for Barnacle Geese there is no evidence of breeding in the Baltic Sea in previous centuries. It is therefore probable that the recent establishment of the Barnacle Goose represents an introduction of the species into an entirely new region.

The nesting and migration of Barnacle Geese in the Russian part of the Gulf of Finland and in the other territories of northwestern Russia have been discussed in several papers (Kouzov and Kravchuk, 2008; Sagitov et al., 2010, 2011, 2012, 2013, 2014; Hohlova and Artemiev, 2015; Agafonova, 2016); however, the overall coverage of this issue remains quite fragmented. In this paper, we present a new detailed study of Barnacle Goose nesting patterns in the Russian part of the Gulf of Finland.

METHODS

Data on nesting Barnacle Geese were obtained during the long-term studies of waterfowl in the eastern part of the Gulf of Finland conducted in 1987–2016 by the authors of this paper together with their colleagues from St. Petersburg State University, the Zoological Institute of the Russian Academy of Sciences, and the Baltic Fund of Nature. The research expeditions covered the Soikinsky and Kurgalsky Peninsulas; the archipelagos of Seskar, Virginy, Dolgy Reef, Dolgy Kamen, and Bolshoy Fiskar; and the islands of Moshchny, Maly, Vigrund, Gogland, Rodsher, Maly Tyuters, Bolshoy Tyuters, Sommers, Nerva, Ryabinnik, Maly Fiskar, Gusiny, and Stoglaz. Khitomatala and other islets, including Kurgalsky Reef, Tiskolovsky Reef, Vigrund, Vestgrund and Vikkala, were also covered. Note that until the late 1980s, a strict border regime in all these territories prevented any ornithological research.

The Kurgalsky Peninsula was studied in 1987–99 and then later from 2005 to 2016. Detailed surveys of nesting birds and broods on the inshore islands (Dolgy Reef, Bolshoy Fiskar Archipelago, Maly Fiskar, Tuman) of the coast were usually conducted at least two times per summer season. Initial information about the birds on the islands of the Gulf of Finland was obtained during the short-term expeditions of the St. Petersburg State University conducted in 1991–92 and 1994–2015 (Noskov et al., 1993; Buzun, 1997; Iovchenko et al., 2002). In 2005–08, Anna Rychkova conducted stationary surveys of nesting and migrating birds in May–July on Seskar Island (Rychkova, 2014) and on Bolshoy Fiskar.

In the remaining areas of the Gulf of Finland, research was conducted as part of ship expeditions with short-term landings on the islands. In 2005–06, these studies were carried out by the St. Petersburg State University expeditions. In 2010–14, two ship expedition teams organized by the Baltic Fund of Nature and St. Petersburg State University made counts of nesting birds on islands (Sagitov et al., 2010, 2011, 2012, 2013, 2014, our data). During these years, three expeditions lasting 6–12 days were usually conducted between the end of May and the end of July covering all the island areas of the eastern part of the Gulf of Finland. In 2015, during the period from 19 May to 25 June, three expeditions investigated the islands of the northern coast of the Gulf of Finland, Bolshoy Tyuters Island, and the Seskar Archipelago. The duration of these trips ranged from 3 to 14 days.

In 2016, during the period from 28 May to 31 June, two expeditions counted nests, broods, and nonbreeding

TABLE 1. Nests of Barnacle Geese on the islands of the eastern part of the Gulf of Finland in 1995–2015.

Islands	1995	2005	2006	2010	2011	2012	2013	2014	2015	Total
Rodsher	–[1]	–	–	1	0	0	0	0	0	1
Dolgy Reef	1	–	22	1	5	4	1	5	8	47
Zapadny Greben	0	0	–	–	0	0	0	0	2	2
Vostochny Greben	0	0	–	–	0	0	0	5	6	11
Kamennaya Zemlya	0	0	–	–	0	0	0	2	3	5
Galochy	0	0	–	–	3	–	1	3	5	12
Malaya Otmel	0	0	–	–	6	–	3	10	14	33
Ryabinnik	0	0	–	–	4	1	2	6	10	23
Bolshoy Fiskar Archipelago:										
Fiskar	0	0	1	0	0	1	1	1	1	5
Kivimaa	0	0	2	0	0	1	1	1	1	6
Mannonen	0	0	1	1	1	1	0	2	2	8
Bolshoy Zapadny	0	0	0	0	0	1	1	1	2	5
Tuman	0	0	0	0	0	0	0	0	4	4
Maly Fiskar	0	3	5	2	6	2	3	4	12	37
Nerva	0	–	–	–	0	2	2	2	3	9
Stoglaz	–	–	–	–	0	0	–	0	3	3
Reymosar	0	0	1	0	0	0	0	0	0	1
Total	1	3	32	5	25	13	15	42	76	212

[1] The dash indicates no data.

birds on the islands of Moshchny, Vigrund, Maly Tyuters, Rodsher, and on the Virginy Archipelago. The dense zigzag total count was conducted on smaller islands with areas of 1–12 hectares. Only the coastal strip was inspected in detail on the large islands (Bolshoy and Maly Tyuters, Moshchny, and Maly).

RESULTS

Barnacle Geese Settlement in the Region

Until the end of the 1980s, birds belonging to the Arctic-breeding Russian population of Barnacle Geese were rarely observed migrating through the Leningrad region and Karelia (Putkonen, 1940; Neufeldt, 1970; Malchevsky and Pukinsky, 1983). Their migration was also hardly ever observed in the Arkhangelsk region in the mid-20th century (Belopolsky, 1956). However, beginning in the 1960s, researchers started to observe intensive autumn migrations of the species at various sites along the coast of the White Sea: in the White Sea straits, on the eastern shore of the Onega Peninsula (Kishchinsky, 1979), and on the southwestern shore of Onega Bay (Kumari, 1963).

The number of migrating Arctic-breeding Barnacle Geese began to increase in the eastern part of the Gulf of Finland in the late 1980s (Bubyreva et al., 1993; Kouzov, 1995). In the following decade, this species became a mass migrant in the area (Buzun, 1998; Kouzov, 1995; Vasiljeva, 2002; Kontiokorpi and Rusanen, 2014). During these years, mass spring migratory stopovers of Arctic-breeding Barnacle Geese started to form in the vicinity of the town of Olonets in South Karelia, on the north coast of Ladoga Lake (Zimin et al., 2002; Lapshin et al., 2016), and at the mouth of the Northern Dvina River by the White Sea (Andreev, 2005). In recent years, the Barnacle Goose has become one of the greatest mass migrants in the eastern part of the Gulf of Finland (Kouzov, 2009, 2010; Kouzov and Kravchuk, 2010; Kouzov and Loseva, 2014), in South Karelia (Artemiev et al., 2009, 2011), and on the Onega Peninsula of the White Sea (Volkov et al., 2015).

On 22 June 1995, a Barnacle Goose nest with a clutch of six eggs was found on Dolgy Reef Island on the northern coast of the Gulf of Finland near the Russian-Finnish border (Gaginskaya et al., 1997). Some birds might have begun to nest in the region earlier, but as the islands of the Russian part of the Gulf of Finland were under a strict military regime, it was extremely hard to study all the islands regularly before the 1990s.

By 2006, the breeding population of this species on the northern coast of the Gulf of Finland had increased to 31 pairs. Nests were found on the islands of Maly Fiskar, Dolgy Reef, and on the Bolshoy Fiskar Archipelago (Table 1). Several dozen nonbreeding individuals were observed there as well. In 2006, one Barnacle Goose pair also bred on Reymosar Island on the western coast of the Kurgalsky Peninsula, on the southern shore of the Gulf of Finland (Kouzov and Kravchuk, 2008).

In 2010–12, the number of Barnacle geese nesting in the Russian part of the Gulf of Finland varied from five to 25 pairs (Sagitov et al., 2010, 2011, 2012, 2013, 2014; our data). Not all islands were visited in 2010, so some nests could have been missed on unvisited islands. However, some expansion of the nesting area was noted. In 2010, nesting of this species was noted on Rodsher Island in the central part of the Gulf of Finland, 16 km to the west of Gogland Island. In 2011, nesting pairs of Barnacle Geese were first found on Ryabinnik, Malaya Otmel, and Galochy Islands on the northern coast of the Gulf of Finland. In 2012, two pairs bred on offshore Nerva Island (Table 1).

In 2014–15, largely the same group of islands was observed as in 2011–13 (Sagitov et al., 2010, 2011, 2012,

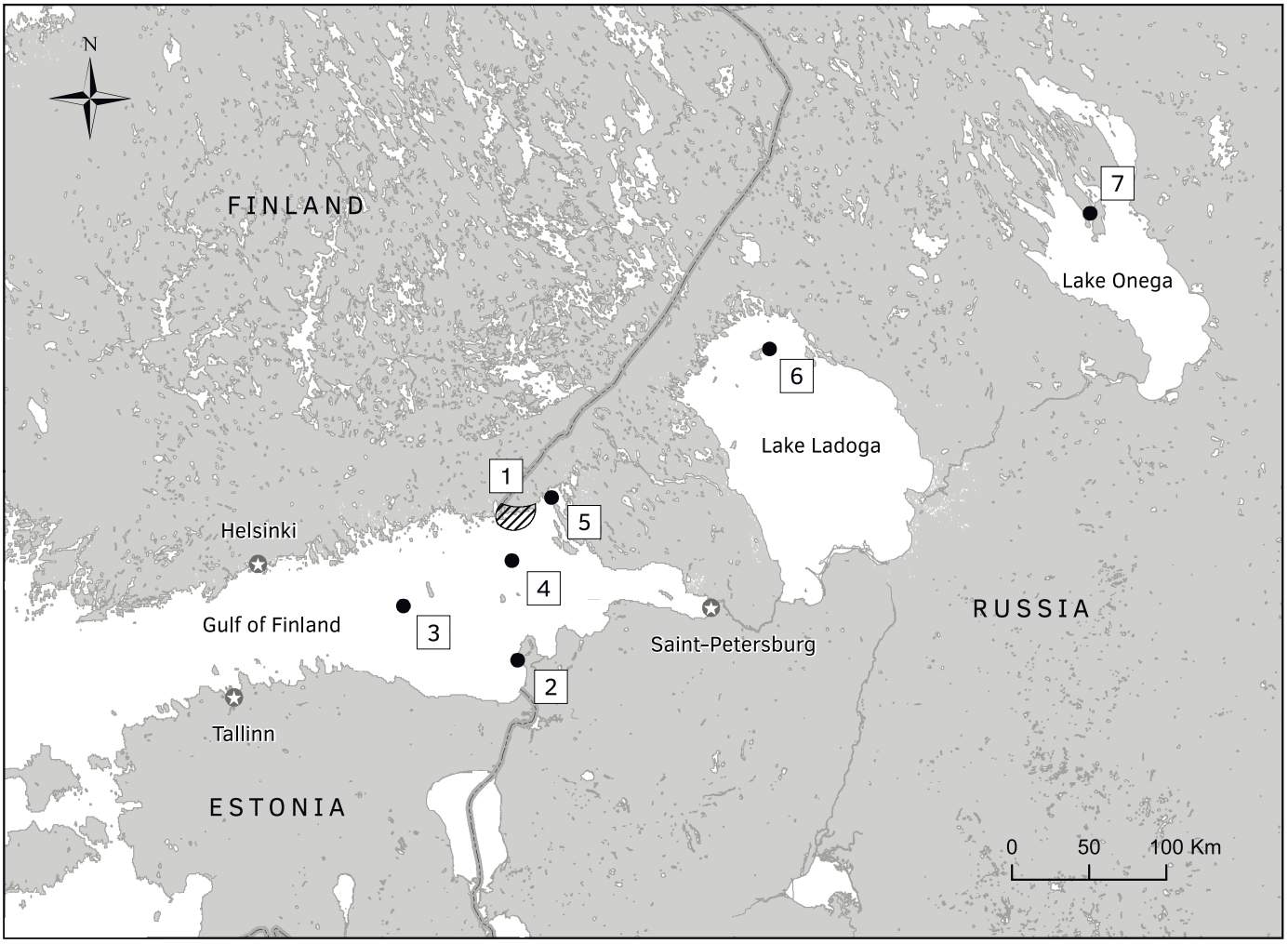

FIG. 1. Distribution of Barnacle Goose nests in the eastern part of the Gulf of Finland in 1995–2015. 1 – Islands near the northern coast of the Gulf of Finland (Dolgy Reef, Bolshoy Fiskar Archipelago, Galochy, Malaya Otmel, Kamennaya Zemlya, Vostochny Greben, Zapadny Greben, Ryabinnik, Maly Fiskar, Tuman), 2 – Reymosar, 3 – Rodsher, 4 – Nerva, 5 – Stoglaz, 6 – Valaam Archipelago, 7 – Kizhi Archipelago.

2013, 2014; our data) (Table 1) using the same methods. The islands are small, and all goose nests on each island visited were found. An explosive growth in the number of nesting Barnacle Geese was observed in 2014–15 in the eastern part of the Gulf of Finland; 40 nests were found in 2014 and 76 in 2015 (Table 1). In these years a further expansion of the nesting area in the northern part of the Gulf of Finland was observed. In 2014, Barnacle Geese started to reproduce on Vostochny Greben and Kamennaya Zemlya Islands, and in 2015 on Zapadnyy Greben, Tuman, and Stoglaz Islands (Khrabryi and Baibekova, 2016; our data) (Figs. 1, 2).

In 2010, Barnacle Geese started to breed on large lakes located to the east of the Baltic Sea. The first nesting of two pairs of this species on Ladoga Lake was recorded on the islands of the Valaam Archipelago. The number of breeding birds in the area was constantly growing: in 2013 as many as five pairs were nesting there (Agafonova et al., 2016). In 2015, the first nesting was recorded on Dedova Plesh Island in the southwestern part of the Kizhi Archipelago (Onega Lake) (Hohlova and Artemiev, 2015).

Spatial and Landscape Distribution of Nesting Birds

All known cases of nesting Barnacle Geese in the boreal zone of northwest Russia are confined to the three largest waterbodies of the region, namely the eastern part of the Gulf of Finland and Ladoga and Onega Lakes. The majority of nests were found in the northern parts of these waterbodies on the border of the Baltic crystalline shield. These are regions with predominantly esker landscapes smoothed by glacial granite rocks, characterized by a heavily rugged shoreline and numerous coastal islands (skerries).

In these areas, Barnacle Geese nest mostly on rocky, forest-free islands. The size of these islands is 0.7–9.4 hectares, with an elevation of 3–12 m, and the distance to the mainland is 0.4–28.3 km (Table 2). Because of the sharp depth depression, the shallow zone around these islands is largely absent. The prevailing depths in the Gulf of Finland near these islands vary from 5–10 m to 10–40 m (Table 2).

The majority of the nests were recorded on Dolgy Reef Island, as well as on Maly Fiskar Island and the Bolshoy

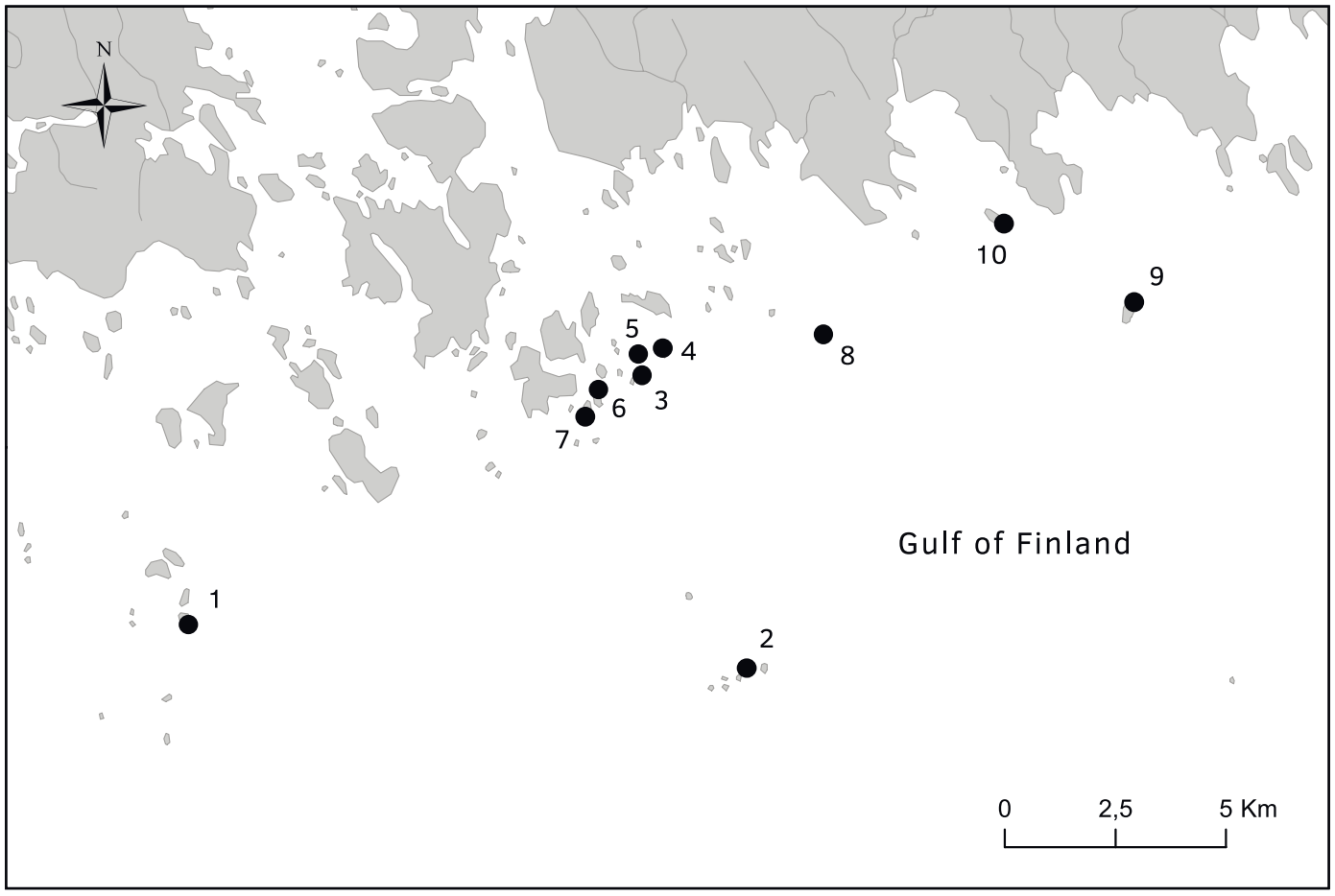

FIG. 2. Distribution of Barnacle Goose nests on the islands near the northern coast of the Gulf of Finland in 1995–2015. 1 – Dolgy Reef, 2 – Bolshoy Fiskar Archipelago, 3 – Galochy, 4 – Malaya Otmel, 5 – Kamennaya Zemlya, 6 – Vostochny Greben, 7 – Zapadny Greben, 8 – Ryabinnik, 9 – Maly Fiskar, 10 – Tuman.

Fiskar Archipelago (Tables 1 and 2). On Dolgy Reef Island, the first nest was found in 1995, on the Maly Fiskar in 2005, and on the archipelago Bolshoy Fiskar in 2006 (Table 1).

In the Russian part of the Gulf of Finland over the past 25 years, only two cases are known of nesting outside the landscape zone described above, and they are clearly an exception to the rule. In 2006, one pair nested on Reymosar Island, a boulder-sand moraine island on the southern coast of the Gulf of Finland, and in 2010 a pair nested on Rodsher Island, a boulder-pebble moraine island at the center of the Gulf of Finland, 17.7 km southwest of Gogland Island. In the following years the birds did not breed there.

On the Valaam Archipelago of Ladoga Lake and on the Kizhi Archipelago of Onega Lake, all Barnacle Goose nests were also found on smaller high rocky islands (Hohlova and Artemiev, 2015; Agafonova et al., 2016). On the Valaam Archipelago, birds occupied only rocky forest-free islets, or *ludas* (Agafonova et al., 2016). However, there were several pines on Dedova Plesh Island on Onega Lake, where reproduction of Barnacle Geese was observed in 2015 (Hohlova and Artemiev, 2015).

As can be seen from Tables 1 and 2, until 2010 Barnacle Geese nested in the eastern part of the Gulf of Finland almost exclusively on the islands lying at a distance of 2.4–10.1 km from the coast. In subsequent years, the population growth was primarily due to the birds inhabiting the islands closest to the coast, no farther than 2 km from the shore (Fig. 3). In 2014–15, 48% of all breeding birds in the area nested on inshore islands. Nesting density was also higher there. In 2015, the nesting density on offshore islands, that is, those lying at a distance of more than 2 km from the coast, was 1 nest per ha, and density on inshore islands, located within 2 km of the shore, was 2.6 nests per ha ($t = 2.38$, N1 = 8, N2 = 9, $p < 0.05$). The average sizes of the inshore and offshore islands were 3.5 ha and 4.2 ha, respectively. The sizes did not differ significantly ($t = -0.43$, N1 = 8, N2 = 9, $p > 0.05$).

Distribution of Nests in Microhabitats

Almost all nests of Barnacle Geese (n = 137) described in detail in 2010–15 in the eastern part of the Gulf of Finland were located in the interior parts of the islands, far from the oversplash zone. Depending on the size of the island, the distance from the nest to the shoreline varied from 12 to 40 m (mean 23, SD 7 m). The elevation of the nest locations varied from 1.7 to 11 m above the water (mean 3.4, SD 1.9 m).

TABLE 2. Characteristics of the islands in the eastern part of the Gulf of Finland, where Barnacle Geese nested in 1995–2015.

Island	Total number of nests in 1995–2015	Landscape	Area (ha)	Elevation (m)	Distance to the mainland coast or large forest island (km)	Average depth near the island (m)
Rodsher	1	Moraine boulder-pebble island	2.1	3.5	17.7	30–40
Dolgy Reef	47	Esker rock with low grass meadows and scattered bushes in the center of the island	7.7	6.0	4.8	5–15
Zapadny Greben	2	Esker rock with low grass meadows and scattered bushes in the center of the island	1.2	3.5	0.8	5–10
Vostochny Greben	11	Esker rock with low grass meadows and scattered bushes in the center of the island	2.3	3.5	1	5–10
Kamennaya Zemlya	5	Esker rock with small low grass patches in the center of the island	0.9	3.5	1.6	5–10
Galochy	11	Esker rock with small low grass patches in the center of the island	1.6	4.0	1.3	5–10
Malaya Otmel	33	Esker rock with low grass meadows, bushes, and trees in the center of the island	3.7	5.5	1.8	5–10
Ryabinnik	23	High esker rock with low grass meadows and scattered bushes in the center of the island	4.0	4.5	2.62	5–20
Bolshoy Fiskar Archipelago:						
Fiskar	5	Esker rock with small low grass and medium grass patches in the center of the island	1.4	5.5	10.1	10–40
Kivimaa	6	Esker rock with small low grass and medium grass patches in the center of the island	1.6	5.5	10.1	10–40
Mannonen	8	High esker rock with low grass and medium grass meadows and scattered bushes and trees in the center of the island	3.6	12.0	10.1	10–40
Bolshoy Zapadny	5	Esker rock with sparse grasses in the rock cracks	2.7	6.0	10.1	10–40
Tuman	4	Esker rock with sparse grasses in the rock cracks and bushes and trees in the center of the island	0.7	6.5	0.7	5–15
Maly Fiskar	37	Esker rock with low grass and medium grass meadows and scattered bushes and trees in the center of the island	5.1	6.5	2.43	10–35
Nerva	9	Esker rock with sparse grasses in the rock cracks	9.4	7.5	28.3	10–35
Stoglaz	3	Esker rock with sparse grasses in the rock cracks and bushes and trees in the center of the island	4.9	5.2	0.4	5–10
Reymosar	1	Moraine boulder-sand island with meadows of various types and reeds	12.5	1.5	1.34	1–5

In all the years of research, only two nests (1.4%, n = 137) were found within the lower level of the rock base. Most nests (77%, n = 137) were located at the middle level of cliffs. Only 21% of all nests were located at the upper level of rocks.

All nests found at the upper level of rocks were located on smooth plateaus and were uncovered, residing in the microdepressions of the substrate on the bare rocky ground or among scarce low-level vegetation (Table 3). All nests in the middle level were found in relief depressions in the inner area of the islands. Most of these nests were located in wide valleys or on wide ledges between rocky banks (65% of such nests, n = 110). Only about one-third of all nests (35% of nests, n = 110) were found in narrow rock depressions (width 2–5 m) of the middle rock level. Two nests at the lowest level of rocks were, on the contrary, found on microelevations of the relief (Table 3).

The most common nesting microhabitats were various shelters under trees or bushes, or in high grass. These microhabitats hosted 72% (n = 137) of all nests overall and up to 97% (n = 108) of all nests at the middle level of rocks. By contrast, at the upper rock level and the lowest rock level, vegetation was scarce or even lacking.

Broods and Molting Flocks

Shortly after hatching, most families with broods left the nesting islands to feed along the mainland coast. On most of the islands where nests were found, the broods recorded were mostly up to five days old. The counts made at the end of June and in July indicated that some of the older broods from islands located no farther than 5 km from the coast were widely dispersed along the mainland coast and along large inshore islands. In 2013–15 some families of Barnacle Geese were found on the northern coast of the Gulf of Finland and on large, wooded inshore islands, at a distance of 4–5 km from the nearest known nesting place. On the islands located more than 10 km from the coast (the Bolshoy Fiskar Archipelago and Nerva Island), broods stayed until fledging, which most often occurred in the first 10 days of August.

Molting flocks were encountered exclusively on the islands. In 2013 small molting flocks of Barnacle Geese were first observed on the Nerva (10–12 individuals) and Dolgy Reef Islands (12–20 individuals), and Bolshoy Fiskar Archipelago (8–35 individuals). The birds stuck to the rocky capes, the ones that jutted out the farthest into the sea.

DISCUSSION

The expansion of the Baltic population of Barnacle Geese began much later in the boreal zone of northwestern Russia than in the western parts of the Baltic region. The first Barnacle Geese were observed breeding in the Baltic Sea on Gotland Island in Sweden (Larsson et al., 1988;

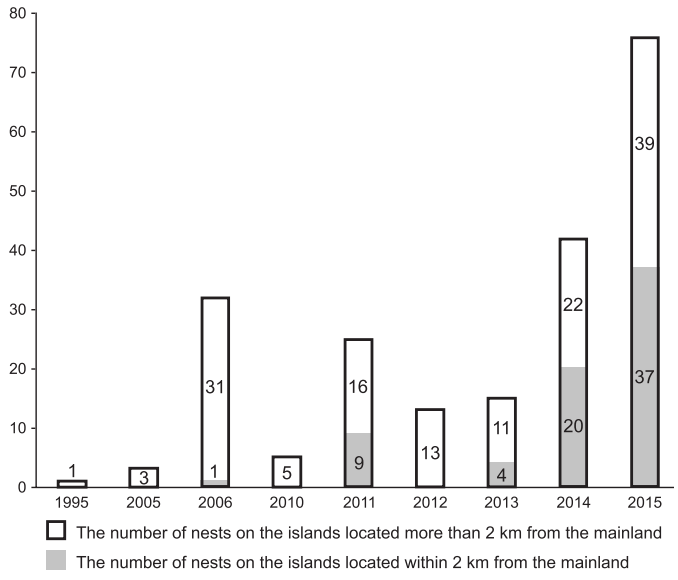

FIG. 3. The number of nests found on the islands located within 2 km of the mainland and on the islands lying farther than 2 km from the mainland.

Black et al., 2014), and then birds started settling in the eastern and western directions. As a part of this expansion process, the appearance of Barnacle Geese in the Russian area of the Baltic Sea is expected after the settlement of Finnish and Estonian territories. The subsequent appearance of breeding birds on Onega and Ladoga Lakes is a continuation of the process of species expansion. Moreover, it appears that this process is far from being completed.

Just as in the western Baltic regions and in the North Sea (Kruckenberg and Hasse, 2004; Feige et al., 2008; van der Jeugd et al., 2009), nesting in the eastern part of the Gulf of Finland was preceded by observations of migrating and summer staging birds.

Whereas in the Netherlands Barnacle Geese can nest not only on the islands but also on the mainland, in the Baltic Sea the birds prefer to nest exclusively on the islands (Feige et al., 2008). This pattern, which is also typical for the eastern part of the Gulf of Finland, is due to the fact that the islands are generally free from terrestrial predators. In the Russian part of the Baltic Sea, Barnacle Geese nest mostly on small forest-free islands with areas of 0.9–12.5 ha. Barnacle Geese inhabit islands of the same size in the other parts of the Baltic as well. In Estonia, Barnacle Geese nest on islands of 2–5.5 ha (Leito, 1996). In Germany, they inhabit mostly small islands with an area of less than 0.02 ha (Feige et al., 2008), while in Sweden, the colonies are located both on small islands and on islands of up to 300 ha (Ganter et al., 1999).

Barnacle Geese in the boreal zone of northwestern Russia nest almost exclusively in smoothed rock landscapes. Almost all known nesting cases were on the rocky skerries of the northern coasts of the Gulf of Finland, Ladoga and Onega Lakes, in places where the Baltic crystalline shield crops out at the surface. A similar picture is observed in more western parts of the Gulf of Finland. At present, about 3000–3500 pairs of Barnacle Geese breed on the skerry archipelagoes along the coast of Finland (Valkama et al., 2011).

Most of the birds inhabited flat platforms and hollows at the middle level of the rocks in areas with well-developed grass vegetation or under bushes. Nesting areas on Onega and Ladoga Lakes were also very similar to the maritime landscapes. This type of nesting of Barnacle Geese was dominant in the Arctic during the period of strong decline in numbers and nesting area in the mid-20th century (Uspensky, 1951; Bauer and Glutz, 1968; Cramp and Simmons, 1978; Syroechkovsky, 1995). Russian Arctic-breeding Barnacle Geese have begun to inhabit flat coastal tundra and flat inshore islands only in the last 40 years as the population growth commenced (Kalyakin, 1986; Gavrilo, 1991; Filchagov and Leonovich, 1992; Syropechkovsky, 1995; Volkov and Chuprin, 1995; Kondratyev et al., 2013). Near the southern coast of the Gulf of Finland, there is a fairly large number of small flat moraine islands with abundant grassy vegetation, which are actively used for nesting by other herbivorous wildfowl: Mute Swan (*Cygnus olor*), Greylag Goose (*Anser anser*), and Gadwall (*Anas strepera*); however, Barnacle Geese have not yet established themselves there.

A tendency to settle on the islands closest to the mainland shore is an adaptation of Barnacle Geese that allows them to nest in rocky habitats with poor food. After hatching, broods disperse widely along the coast. Barnacle Geese obviously breed on the islands that are closest to the mainland so that the broods have to cover only a short distance to get to the feeding habitats. In Russia, nearly half of the nests of Barnacle Geese are located on islands lying no more than 2 km away from the coast. In the Netherlands, Barnacle Geese cross a similar distance to the coast: 70–1500 m. In Germany this distance is even smaller: 10–400 m to the coast. However, in some areas of the Baltic Sea, broods travel more than 3000 m from the colony to the shore (Feige et al., 2008). The first single pairs of birds in the initial years of settling in the eastern part of the Gulf of Finland sought to occupy the islands most remote from the coast, which provided them with better protection from terrestrial predators. Low intraspecific food competition in those years allowed the broods to feed on the same island until fledgling. With the increase in the number of breeding pairs, the only way to optimize the use of space and food resources was to develop colonies on the islands closest to the shore or on large archipelagoes that would provide food resources for broods.

Barnacle Geese of the North Sea and Baltic Sea regions leave nesting sites after hatching takes place and usually head for the protein-rich plants of agricultural landscapes or even lawns and parks in the cities (Feige et al., 2008; Väänänen et al., 2011). In the eastern Gulf of Finland, as well, geese with broods usually leave nesting areas after hatching and move to the mainland. There are no agricultural areas near the seacoast in the Russian Baltic

TABLE 3. Microhabitat distribution of Barnacle Goose nests on the islands of the eastern part of the Gulf of Finland in 2010–15 according to the data on the nests described in detail (n = 137).

Rock level	Microrelief	Microhabitat	Number of nests
Upper rock level	Smooth plateaus	Uncovered in a microdepression on a bare rock	7
		Uncovered on a thin sand deposit on a rock with rare low grass vegetation	8
		Low grass meadow patch on the rock base	8
		Under bushes of willow, rowan, alpine currant or under low rock pine	6
Middle rock level	Wide valleys and ledges between rocky banks	Medium grass meadow patch on the rock base	14
		High grass meadow patch on a small rock depression on a plateau	22
		Under bushes of willow, rowan, alpine currant or under low rock pine	33
	Deep narrow rock depressions	High grass meadow patch in a deep rocky hollow	16
		Under bushes of willow, rowan or alpine currant in a deep rocky hollow	21
Lower rock level	Wide ledges	Tussocks of dense grasses on clumps of boulders lying on rocky surface	2

region, however: these shores are mostly covered by forests and bulrushes. Sea meadows are very narrow, and marshes are mostly absent. Local birds in prebreeding, nesting, and brood-rearing periods do not have the same food supplies that they would get in agricultural fields or marshes. Moreover, increased predation risk in these narrow feeding habitats near the forest influences the time and energetic budget of the feeding birds. Gulls, Hooded Crows (*Corvus corone cornix*) and White-tailed Eagles substantially reduce the success of nesting in the islands. Gull colonies are present on most of the islands where Barnacle Geese nest, and at least six pairs of White-tailed Eagles nest in the coastal areas of the Leningrad region (Pchelintsev, 2006). Foxes can stay on the islands and predate all the nests there, but no foxes were found on the islands observed. The pressure of predators and hunting is probably less intensive on offshore islands than on inshore ones. However, as the bird population grows, food resources become inadequate, and then the colonization of inshore islands begins. Thus the population growth of Barnacle Geese in the Russian part of the Baltic Sea is slow now in comparison with the western temperate populations, even Finnish populations that are situated very close by (Väänänen et al., 2011). The Helsinki area is special because geese can use city parks that offer good grazing grounds and safety from predators. In nearby Estonia, population growth of Barnacle Geese since establishment has been slow, as in our study area (Leito, 1996). The future growth of these nesting populations should be less significant than in the western areas of the Baltic Sea and the North Sea.

Most of the breeding areas of Barnacle Geese in the Baltic and North Sea regions are protected areas (Feige et al., 2008). However, in the Russian Baltic Sea, almost none of the goose nesting areas have protected status. In Sweden, half of the nesting areas of Barnacle Geese are protected, and the other half are located in areas formerly used for military purposes (Feige et al., 2008). In the east of the Gulf of Finland, in Russia, Barnacle Geese breed mainly within a closed border zone, where the level of disturbance is low. However, with the removal of borderline restrictions, a significant increase in the tourist flow and disturbance of birds may take place. Therefore, the establishment of protected areas is of crucial importance for the conservation of bird populations nesting on islands in the Gulf of Finland. Since the 1990s, work has been underway to establish a nature reserve, which would include most of the islands important for nesting of waterfowl in the eastern part of the Gulf of Finland. On 21 December 2017, the "East of the Gulf of Finland Reserve" was established. This reserve will help to preserve the unique conditions for the nesting of geese and other waterfowl on the islands of the eastern part of the Gulf of Finland.

ACKNOWLEDGEMENTS

Ornithologists from St. Petersburg State University and the Zoological Institute of the Russian Academy of Sciences, Alexander Kondratyev, Vadim Vysotsky, Vladimir Fedorov, Valery Buzun, Sergey Rezvyi, Anna Gaginskaya, Natalia Iovchenko, and Georgy Noskov, took part in the expeditions and collected data in the Gulf of Finland. We gratefully acknowledge the support of the studies in 2010–14 by the company Nord Stream AG. We would like to thank the Baltic Fund for Nature and project manager Vera Ovcharenko for organizing these expeditions. Special thanks go to the teams of the yachts *Centaurus-II*, *Mirabel*, *Manyana*, *St. Nicholas*, and boat *SMN*.

REFERENCES

Agafonova, E.V., Mikhaleva, E.V., and Sokolovskaya, M.V. 2016. Гнездование канадской *Branta canadensis* и белощёкой *B. leucopsis* казарок на островах Валаамского архипелага Ладожского озера [Nesting of the Canada Goose *Branta canadensis* and Barnacle Goose *Branta leucopsis* on the islands of the Valaam Archipelago of the Ladoga Lake]. Russian Ornithological Journal 25(1257):801–802.

Andreev, V.A. 2005. Экологические особенности миграций гусеобразных в устьевой части Северной Двины [Ecological features of migrations of Anseriformes in the estuary of the Northern Dvina River]. PhD thesis, Moscow State Pedagogical University.

Artemiev, A.V., Zimin, V.B., Lapshin N.V., and Simonov S.A. 2009. Особенности динамики весенних скоплений гусеобразных птиц Anseriformes на Олонецких полях Карелии в 2009 году [Characteristics of dynamics of spring aggregations of Anseriformes on Olonets fields in Karelia in 2009]. Russian Ornithological Journal 18(522):1891–1899.

Artemiev, A.V., Zimin, V.B., Lapshin, N.V., Simonov, S.A., and Loginov, I.I. 2011. Особенности динамики весенних скоплений гусеобразных Anseriformes на Олонецких полях Карелии в 2010 и 2011 годах [Characteristics of dynamics of spring aggregations of Anseriformes on Olonets fields in Karelia in 2010 and 2011]. Russian Ornithological Journal 20(706):2293–2300.

Bauer, K.M., and Glutz von Blotzheim, U.-N. 1968. Handbuch der Vogel Mitteleuropas [Handbook of the Birds of Central Europe]. 2. Anseriformes. Frankfurt un Main. Akademische Verlagsgesellschaft.

Belopolsky, L.O. 1956. Некоторые данные о пролете птиц осенью 1954 г. на побережье Белого моря и перспективы организации наблюдений за миграцией птиц в Карело-Финской ССР [Some data on the flight of birds in the fall of 1954 on the coast of the White Sea and the prospects for organizing observations of bird migrations in the Karelo-Finnish SSR]. Yearbook of the Society of Naturalists at the Academy of Sciences of the Estonian SSR 49:65–73.

BirdLife International. 2016. *Branta canadensis*. The IUCN red list of threatened species. http://www.iucnredlist.org/details/22679935/0

Black, J.M., Prop, J., and Larsson, K. 2014. The Barnacle Goose. London: T & AD Poyser.

Borodin, A.V., Bannikov, A.G., Sokolov, V.E., Vasiljev, N.G., Vinogradov, V.N., Giljarov, M.C, Gorlenko, M.V., et al., eds. 1984. Красная книга СССР. Редкие и находящиеся под угрозой исчезновения виды животных и растений [Red data book of the USSR: Rare and endangered species of animals and plants]. Vol. 1, 2nd ed. Moscow: Forest Industry.

———, eds. 2001. Красная книга Российской Федерации (животные) [Red data book of the Russian Federation: (Animals)]. Russian Academy of Sciences. Moscow: Astrel. 862 p.

Boyd, H. 1961. The number of Barnacle Geese in Europe 1959–1960. Wildfowl Trust Annual Report 12:116–124.

Bromley, R.G., and Rothe, T.C. 2003. Conservation assessment for the Dusky Canada goose (*Branta canadensis occidentalis* Baird). General Technical Report PNW-GTR-591. Portland, Oregon: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 79 p.

Bubyreva, V.A., Buzun, V.A., Volkovich, N.M., Kouzov, S.A., Shapovalova, O.V., and Schukin A.K. 1993. Report of Kurgalsky expedition of the St. Petersburg Naturalists Society. The field season 1992. Vestnik St. Petersburg State University, Series 3, Biology. Vol. 10:111–117.

Buzun, V.A. 1997. Остров Сескар (восточная часть Финского залива). Материалы первого семинара по программе "Изучение состояния популяций мигрирующих птиц и тенденций их изменений в России" [The Seskar Island (eastern part of the Gulf of Finland). Materials of the first seminar on the program "The study of the state of populations of migratory birds and the trends of their changes in Russia"]. St. Petersburg, Tuscarora. 42–49.

———. 1998. Данные о миграции птиц на острове Сескар (Финский залив, Балтийское море) весной 1997 г. Материалы второго семинара по программе "Изучение состояния популяций мигрирующих птиц и тенденций их изменений в России" [Data on migration of birds on the Seskar Island (Gulf of Finland, Baltic Sea) in the spring, 1997. Materials of the second seminar on the program "The study of the state of populations of migratory birds and the trends of their changes in Russia," 18–20 February 1998, Moscow. 47–69.

Cherenkov, A.E., Kouzov, S.A., Semashko, V.Y., Tertitski, G.M., and Semashko, E.V. 2016. Present status of Razorbills *Alca torda* in Russia: Occurrence, population and migrations. Marine Ornithology 44(2):207–213.

Cramp, S., and Simmons, K.E.L., eds. 1978. Handbook of the birds of Europe, the Middle East and North Africa: The Birds of the Western Palearctic, Vol. 1: Ostrich to Ducks. Oxford: Oxford University Press.

Feige, N., van der Jeugd, H.P., van der Graaf, A.J., Larsson, K., Leito, A., and Stahl, J. 2008. Newly established breeding sites of the Barnacle Goose *Branta leucopsis* in north-western Europe–an overview of breeding habitats and colony development. Vogelwelt 129: 244–252.

Filchagov, A.V., and Leonovich, V.V. 1992. Breeding range expansion of Barnacle and Brent Geese in the Russian European North. Polar Research 11(2):41–46. https://doi.org/10.1111/j.1751-8369.1992.tb00411.x

Fox, A.D., Ebbinge, B.S., Mitchell, C., Heinicke, T., Aarvak, T., Colhoun, K., Clausen, P., et al. 2010. Current estimates of goose population sizes in western Europe, a gap analysis and an assessment of trends. Ornis Svecica 20:115–127.

Gaginskaya, A.R., Noskov, G.A., and Rezvy, S.P. 1997. О находке гнезда белощёкой казарки на Финском заливе [About the discovery of a nest of Barnacle Goose on the Gulf of Finland]. Kazarka – Bulletin of the Working Group on the Anseriformes of North Eurasia 3:111–112.

Ganter, B., Larsson, K., Syroechkovsky, E.V., Litvin, K.E., Leito, A., and Madsen, J. 1999. Barnacle Goose *Branta leucopsis*: Russia/Baltic. In: Madsen, J., Cracknell, G., and Fox, A.D., eds. Goose populations of the Western Paleartic. A review of status and distribution. Wetlands International Publication No. 48. Wageningen, The Netherlands Wetlands International; Rönde, Denmark: National Environmental Research Institute. 270–283.

Gauthier, G., Giroux, J.-F., Reed, A., Béchet, A., and Bélanger, L. 2005. Interactions between land use, habitat use, and population increase in greater snow geese: What are the consequences for natural wetlands? Global Change Biology 11(6):856–868. https://doi.org/10.1111/j.1365-2486.2005.00944.x

Gavrilo, M.V. 1991. Белощекая казарка на острове Колгуеве [Barnacle Goose on the Island of Kolguev]. Materials of the 10th All-Union Ornithological Conference. Minsk. Vol. 2:128.

Hohlova, T.Yu., and Artemiev, A.V. 2015. Первая регистрация гнездования белощёкой казарки *Branta leucopsis* на Онежском озере [The first registration of the nesting of Barnacle Goose *Branta leucopsis* on Lake Onega]. Russian Ornithological Journal 24(1152):2021–2024.

Iovchenko, N.P., Gaginskaya, A.R., Noskov, G.A., and Rezvy, S.P. 2002. Результаты орнитологического обследования островов Финского залива в 1994–1995 годах [Results of the ornithological survey of the islands of the Gulf of Finland in 1994–1995]. Птицы и млекопитающие Северо-Запада России [Birds and mammals of northwestern Russia]. Proceedings of the Biological Research Institute 48:100–120.

Kalyakin, V.N. 1986. О распространении и экологии белощекой казарки на Острове Вайгач и Югорском полуострове. Актуальные проблемы орнитологии [About the distribution and ecology of Barnacle Goose on Vaigach Island and the Yugopskiy Peninsula. Actual problems of ornithology]. Moscow, Science. 93–103.

Kerbes, R.H., Kotanen, P.M., and Jefferies, R.L. 1990. Destruction of wetland habitats by Lesser Snow Geese: A keystone species on the west coast of Hudson Bay. Journal of Applied Ecology 27(1):242–258.

Khalturin, V.I., Rautian, T.G., Richards, P.G., and Leith, W.S. 2005. A review of nuclear testing by the Soviet Union at Novaya Zemlya, 1955–1990. Science and Global Security 13:1–42. https://doi.org/10.1080/08929880590961862

Khrabryi, V.M., and Baibekova, S.A. 2016. Гнездование белощёкой казарки *Branta leucopsis* в Выборгском заливе (Ленинградская область) [Nesting of Barnacle Goose *Branta leucopsis* in the Vyborg Bay (Leningrad region)]. Russian Ornithological Journal 25(1235):80–81.

Kishchinsky, AA. 1979. Миграции белощекой казарки – *Branta leucopsis* (Bechst) [Migration of Barnacle Goose – *Branta leucopsis* (Bechst). In: Миграции птиц Восточной Европы и Северной Азии (Аистообразные – Пластинчатоклювые) [Migration of the Birds of Eastern Europe and Northern Asia (Ciconiiformes – Anseriformes)]. Moscow, Science. 1–229.

Kondratyev, A., Zaynagutdinova, E., and Kruckenberg, H. 2013. Barnacle Goose *Branta leucopsis* abundance on Kolguev Island–current status and history of population growth. Wildfowl 63:56–71.

Kontiokorpi, J., and Rusanen, P. 2014. Survey of springtime Arctic bird migration in Vyborg in 1988–2008 and in Kurortny District in 1992–2001. Reports of the Finnish Environment Institute 39. Helsinki: Finnish Environment Institute.

Koop, B. 1998. Die Brutansiedlung und Bestandentwicklung der Weiswangengans *Branta leucopsis* in Schleswig-Holstein [The breeding and population trends of the Barnacle Goose *Branta leucopsis* in Schleswig-Holstein]. Limicola 12:72–76.

Kouzov, S.A. 1995. Новые сведения о некоторых видах казарок в Восточной части Финского залива [New information about some species of geese in the eastern part of the Gulf of Finland]. Geese Study Group Bulletin of Eastern Europe and Northern Asia 1:174–177.

———. 2009. Летне-осенние скопления и транзитные миграции водно-болотных птиц на Кургальском полуострове в 2007 г. [Summer–autumn aggregations and transit migrations of waterfowl on the Kurgalsky peninsula in 2007]. Изучение динамики популяций мигрирующих птиц и тенденций их изменений на Северо-Западе России [Study of the dynamics of populations of migratory bird populations and its trends in northwestern Russia], Vol. 6:71–87. St. Petersburg.

———. 2010. Весенняя миграция водно-болотных птиц на Кургальском полуострове в 2008 г. [Spring migration of waterfowl on the Kurgalsky peninsula in 2008]. Изучение динамики популяций мигрирующих птиц и тенденций их изменений на Северо-Западе России [Study of the dynamics of populations of migratory bird populations and its trends in northwestern Russia], Vol. 7:42–59. St. Petersburg.

Kouzov, S.A., and Kravchuk, A.V. 2008. Первый случай гнездования белощёкой казарки *Branta leucopsis* на Кургальском полуострове [The first case of nesting of Barnacle Goose *Branta leucopsis* on the Kurgalsky peninsula]. Russian Ornithological Journal 17(423):908–910.

———. 2010. Миграционные скопления водно-болотных птиц на северном побережье Невской губы и в плавнях острова Котлин весной 2009 г. [Migratory aggregations of waterfowl on the northern coast of the Neva Bay and in the floodplains of the Kotlin Island in the spring of 2009]. Изучение динамики популяций мигрирующих птиц и тенденций их изменений на Северо-Западе России [Study of the dynamics of populations of migratory bird populations and its trends in northwestern Russia], Vol. 8:89–94. St. Petersburg.

Kouzov, S.A., and Loseva A.V. 2014. О локальных путях пролета и миграционных стоянках морских птиц в восточной части Финского залива по результатам судовых учетов 2010–2013 гг. [About local ways of migration and migratory stops of seabirds in the eastern part of the Gulf of Finland according to the results of ship surveys 2010–2013]. Herald of Hunting Science 11(2):204–210.

Kruckenberg, H., and Hasse, T. 2004. Nonnengänse (*Branta leucopsis*) als Brutvögel an der Unterems [Barnacle goose (*Branta leucopsis*) as breeding bird in Lower Saxony]. Vogelkundliche Berichte aus Niedersachsen 36:83–88.

Krysov, A.I. 2000. Динамика численности атлантическо-скандинавской (норвежской весенне-нерестующей) сельди (*Clupea harengus harengus* L.) в раннем онтогенезе [Dynamics of the number of Atlantic-Scandinavian (Norwegian spring-spawning) herrings (*Clupea harengus harengus* L.) in early ontogenesis. PhD thesis, Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk.

Kumari, E. 1963. Number dynamics of some migrating seabirds on the White Sea and in the eastern part of the Baltic Sea. Communications of the Baltic Committee for the Study of Bird Migration 2:67–80.

Lapshin, N.V., Artemiev, A.V., and Simonov, S.A., 2016. Численность белощекой казарки Branta leucopsis (Bechst) на весенних стоянках и ее статус в южной Карелии [The number of Barnacle Goose *Branta leucopsis* (Bechst) in spring stopovers and its status in southern Karelia]. Proceedings of the Karelian Research Center of the Russian Academy of Sciences, Vol. 7:85 – 92.

Larsson, K., Forslund, P., Gustafsson, L., and Ebbinge B.S. 1988. From the High Arctic to the Baltic: The successful establishment of a Barnacle Goose *Branta leucopsis* population on Gotland, Sweden. Ornis Scandinavica 19(3):182 – 189.

Leito, A. 1996. The Barnacle Goose in Estonia. Estonia Maritima 1. 103 p.

Malchevsky, A.S., and Pukinsky, Y.B. 1983. Птицы Ленинградской области и сопредельных территорий: История, биология, охрана [Birds of the Leningrad Region and adjacent territories: History, biology, protection], Vol. 1. Leningrad: Leningrad University Press. 480 p.

Meininger, P.L., and van Swelm, N.D. 1994. Brandganzen *Branta leucopsis* als broedvogel in het Deltagebied [Barnacle geese *Branta leucopsis* as breeding birds in the Delta area, SW-Netherlands]. Limosa 67(1):1 – 5.

Menzbir, M.A. 1895. Птицы России [The birds of Russia], Vol. 1. Moscow. 836 p.

Mortensen, C.E., and Hansen, M. 1999. Ynglefugle på Saltholm 1998 – 1999 [Breeding birds of Saltholm 1998 – 1999]. In: Københavns Amt og Københavns Lufthavne: Naturforvaltningsrapport 32 [Copenhagen County and Copenhagen Airports: Nature Conservation Report 32]. 49.

Neufeldt, I.A. 1970. Обзор орнитологических исследований в Карелии [A review of ornithological research in Karelia]. Proceedings of the Zoological Institute of the Academy of Sciences of the USSR, Vol. 47:67 – 110.

Noskov, G.A., Fedorov, V.A., Gaginskaya, A.R., Sagitov, R.A., and Buzun, V.A. 1993. Об орнитофауне островов восточной части Финского залива [Ornithofauna of the islands of the eastern part of the Gulf of Finland]. Russian Ornithological Journal 2(2):163 – 173.

Olsen, K.M. 1992. Danmarks fugle – en oversigt [Danish birds – an overview]. Copenhagen: Dansk Ornitologisk Forening.

Ouweneel, G.L. 2001. Snelle groei van de broedpopulatie Brandganzen *Branta leucopsis* in het Deltagebied [Rapid increase of the breeding population of Barnacle geese *Branta leucopsis* in the Delta area]. Limosa 74:137 – 146.

Owen, M. 1997. *Branta leucopsis*. In: Hagemeijer, W.J.M., and Blair, M.J., eds. The EBCC atlas of European breeding birds: Their distribution and abundance. London: T & AD Poyser. 76 – 77.

Pchelintsev, V.G. 2006. Distribution and abundance of some raptor species in the Leningrad region. In: Koskimies, P., and Lapshin, N.V., eds. Status of raptor populations in eastern Fennoscandia. Proceedings of the Workshop, Kostomuksha, Karelia, Russia, 8 – 10 November 2005. Petrozavodsk: Karelian Research Centre, Russian Academy of Sciences. 120 – 124.

Ptushenko, E.C. 1952. Отряд Гусеобразные. Подсемейство Гусиные [Order Anseriformes. Subfamily Anserinae]. In: Dementyev, G.P., and Gladkov, N.A., eds. Птицы Советского Союза [Birds of the Soviet Union]. Moscow, Soviet Science. 247 – 344.

Putkonen, T.A. 1940. Tiedonantoja (*Chlidonias n. nigra*, *Locustella naevia*, *Branta leucopsis*, *Tadorna tadorna*). Information (*Chlidonias n. nigra*, *Locustella naevia*, *Branta leucopsis*, *Tadorna tadorna*). Ornis Fennica 17(1):8 – 9.

Rees, E.C., and Beekman, J.H. 2010. Northwest European Bewick's Swans: A population in decline. British Birds 103:640 – 650.

Rychkova, A.L. 2014. Орнитофауна острова Сескар (Финский залив) [Ornithofauna of Seskar Island (Gulf of Finland)]. Russian Ornithological Journal 23(1054):3063 – 3064.

Sagitov, R., Vysotskiy, V., Kondratiev, A., Buzun, V., Fedorov, V., and Ovcharenko, V. 2010. Project report: Ornithological investigations on the islands of the Russian part of the Gulf of Finland included into the area of "Ingermanlandsky" State Nature Reserve. St. Petersburg.

Sagitov, R., Vysotskiy, V., Zaynagutdinova, E., Fedorov, V., and Ovcharenko, V. 2011. Project report: Ornithological monitoring on the islands of the Russian part of the Gulf of Finland included into the area of "Ingermanlandsky" State Nature Reserve. St. Petersburg.

Sagitov, R., Buzun, V., Gaginskaya, A., Rezvyi, S., Zaynagutdinova, E., Glazkova, E., Kovalchuk, N., et al. 2012. Complex biological monitoring on the islands of the Russian part of the Gulf of Finland included into the area of "Ingermanlandsky" State Nature Reserve (currently under establishment). St. Petersburg.

Sagitov, R., Buzun, V., Zaynagutdinova, E., Glazkova E., Bamburov, I., and Ovcharenko, V. 2013. Continuation of complex biological monitoring on the islands of the Russian part of the Gulf of Finland included into the area of "Ingermanlandsky" State Nature Reserve (currently under establishment). St. Petersburg.

Sagitov, R., Kouzov, S., Sendek, D., Glazkova E., Loseva, A., and Ovcharenko, V. 2014. Continuation of complex biological monitoring on the islands of the Russian part of the Gulf of Finland included into the area of "Ingermanlandsky" State Nature Reserve (currently under establishment). St. Petersburg.

Shilin, M., Chusov, A., Lednova, J., and Kouzov, S. 2014. Variety and vulnerability of waterbird community in the eastern part of the Gulf of Finland in the zone of «Nordstream» marine gas pipeline. Measuring and modeling of multi-scale interactions in the marine environment: IEEE/OES Baltic International Symposium 2014. Baltic 2014 6: 6887863.

Syroechkovsky, E.E. 1995. Новое в гнездовом распространении белощеких казарок в России [New breeding of Barnacle Geese in Russia]. Geese Study Group Bulletin of Eastern Europe and Northern Asia, Vol. 1:39 – 46.

Uspensky, S.M. 1951. Гнездовья белощекой казарки на Новой Земле. Охрана природы [Nests of the Barnacle Goose on the Novaya Zemlya Islands. Protection of Nature]. Moscow. 124 – 127.

Valkama, J., Vepsäläinen, V., and Lehikoinen, A. 2011. The third Finnish breeding bird atlas. Helsinki: Finnish Museum of Natural History and the Ministry of the Environment. http://atlas3.lintuatlas.fi/english/

van der Jeugd, H.P., Eichhorn, G., Litvin, K.E., Stahl, J., Larsson K., van der Graaf, A.J., and Drent, R.H. 2009. Keeping up with early springs: Rapid range expansion in an avian herbivore incurs a mismatch between reproductive timing and food supply. Global Change Biology 15(5):1057–1071. http://doi.org/10.1111/j.1365-2486.2008.01804.x

Vasiljeva, N.A. 2002. Материалы к летней орнитофауне архипелага Сескар в восточной части Финского залива [Materials on the summer avifauna of the Seskar archipelago in the eastern part of the Gulf of Finland]. Berkut 11(1):18–26.

Volkov, A.E., and Chuprin, I.I. 1995. Новые сведения о гнездовании белощекой казарки (*Branta leucopsis*) на острове Колгуев [New information on the nesting of the Barnacle Goose (*Branta leucopsis*) on the island of Kolguev]. Geese Study Group Bulletin of Eastern Europe and Northern Asia, Vol. 1:47–50.

Volkov, A.E., Bragin, A.V., Pokrovskaya, I.V., and Volkova, E.V. 2015. Весенний пролёт гусей и лебедя-кликуна на Онежском полуострове в 2014 г. [Spring migration of geese and Whooper Swan on the Onega peninsula in 2014]. Kazarka – Bulletin of the Working Group on the Anseriformes of North Eurasia 18:91–103.

Voslamber, B., van der Jeugd, H., and Koffijberg K. 2007. Antallen, trends en verspreiding van overzomerende ganzen in Nederland [Numbers, trends and distribution of breeding goose populations in the Netherlands]. Limosa 80(1):1–17.

Väänänen, V.-M., Nummi, P., Lehtiniemi, T., Luostarinen, V.-M., and Mikkola-Roos, M. 2011. Habitat complementation in urban Barnacle Geese: From safe nesting islands to productive foraging lawns. Boreal Environment Research 16(Suppl. B):26–34.

Zimin, V.B., Artemyev, A.V., and Lapshin, N.V. 2002. Survey of spring bird migrations and stopovers in the Olonets fields in Karelia. Study of the Status and Trends of Migratory Bird Populations in Russia 4:18–28.