ЗИМОВКИ ПТИЦ / WINTERING BIRDS

SATELLITE TELEMETRY UNCOVERS IMPORTANT WINTERING AREAS FOR SNOWY OWLS ON THE KOLA PENINSULA, NORHWESTERN RUSSIA

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Introduction

The snowy owl (*Bubo scandiacus*)** is one of the main avian predators of the Arctic tundra. It is known to specialize on lemmings *Lemmus* and *Dicrostonyx* sp. in the breeding season. The breeding areas are mainly associated with treeless tundra and mountainous regions in Fennoscandia, Russia, Alaska, Canada and Greenland (Portenko, 1972; Cramp, 1985).

Recoveries of ringed snowy owls in North America showed that individuals may migrate southwards to regular wintering areas in the prairie landscape (Oeming, 1957; Follen, Leupke, 1980; Kerlinger et al., 1985; Holt et al., 2015). Later studies revealed that many individuals also winter in the Canadian Arctic (Robertson, Gilchrist, 2003; Therrien et al., 2011, 2014; Doyle et al., 2017). The formerly limited information from ring recoveries has been considerably improved as satellite tracking of a small number of birds tagged in the breeding areas revealed high mobility of this species (Fuller et al., 2003; Dunn et al., 2009; Solheim et al., 2014; Therrien et al., 2011, 2014; Doyle et al., 2017).

The snowy owl is special in the sense that various authors seem unable to fit it in any specific category of migratory strategy. Parkin and Knox (2010) describe it as «nomadic and migratory, but movements unpredictable (HBW), probably dependent on availability of prey. Irruptive in Nearctic, but less so in Palearctic; wanders widely, if sparsely, through N Eurasia». Similarly, Newton (2010) describes the snowy owl as nomadic in search for microtine rodents for breeding and irruptive in winter areas with a cyclicity following small mammal three-to-five year fluctuations.

In Northern Eurasia, however, very little is known about the post-breeding movements, winter distribution and winter ecology of snowy owls. According to older literature, snowy owls breeding in Northern Russia migrate southwards to wintering areas in bush-tundra and steppe areas in Kazakhstan and southwest Siberia (Buturlin, Dementiev, 1936; Ryabov, 1950; Dement'ev et al., 1966; Portenko, 1972; Potapov, Sale, 2012). Knowledge on the breeding distribution of snowy owls in Arctic Russia is limited (Kharitonov et al., 2005; Lappo, 2005; Morozov, 2005; Potapov, Sale, 2012), but even less is known about winter areas of snowy owls breeding in Eurasia. Dement'ev et al. (1966) described the species as partly residential, but chiefly nomadic, movements irregular, differing in extent and distances covered according to local snow conditions, available food etc. They stated that snowy owls wintered in the Arctic based on the abundance of lemmings, and that the species was observed in the north during winter on Wrangel Island, in Anadyr, along the Indigirka and Kolyma rivers, on Novaya Zemlya, Kanin and Kola peninsulas. According to these authors, the majority of snowy owls abandoned the Arctic to winter in the open country, woody tundra and steppes in more southerly parts of Eastern Europe and Siberia north to 50ºN,

with regular wintering in the Volga region, Western Siberia, Kazakhstan steppes, southeast Transbaikalia, Amur river lands, Manchuria and northern Japan. They further described isolated observations in Western Europe and large-scale nomadism, especially during the 1920's, and wrote that snowy owls arrives at winter quarters in October and remained there until April.

As the movements of snowy owls in Eurasia seemed to be unpredictable, we assumed that they should use remote areas in much of their annual cycle, and that their location during winter was unknown. Satellite transmitters were thus the only suitable equipment to reveal winter movements and wintering areas of snowy owls breeding in Northern Fennoscandia. The far northern latitude put additional constraints in terms of low or absent sunlight levels outside the breeding season. Battery powered satellite transmitters were thus chosen for full year tracking, even though these rely on ARGOS/Doppler effect tracking with intermediate location accuracy not suitable for fine scale habitat studies as are solar panel powered GPS-transmitters / loggers (Bridge et al., 2011). Some other individuals were instrumented with solar panel GPS / ARGOS transmitters to get high quality location data outside the wintering season, when these were expected to go dormant due to insufficient charging of the internal battery due to lack of sunlight. Results from these were not used here.

Based on available literature, we predicted that the instrumented snowy owls would either migrate south-eastwards to steppe areas for wintering as described from Russian literature, or alternatively stay during winter in the Arctic, either on the tundra (Dement'ev et al., 1966; Potapov, Sale, 2012), or on polynyas in the sea ice, or in semi-open waters hunting seaducks as described from tracking studies on snowy owls breeding in Arctic Canada (Therrien et al., 2011).

Material and methods

Study area — breeding site in Norway

In Northern Norway, peaks in lemming densities were documented in 2007, 2011 and 2015. We located breeding snowy owls in several geographically separated areas. Our main field work was carried out in one area in Western Finnmark, North Norway (study area A — 70°N, 24°E) and one area in Northern Troms, North Norway (study area B — 69°N, 22°E), each area covering approx. 50 km^2 of Arctic tundra/mountain plateau. Study area A is an elevated mountain plateau with several lake basins divided by mountain tops, whereas study area B is made up of gently rolling hills with river valleys and lakes. None of the areas were known as important breeding areas for snowy owls prior to our study, but both are prime breeding habitats for snowy owls and Norway lemmings (*Lemmus lemmus*) (see Solheim et al., 2008; Jacobsen et al., 2012; Øien et al., 2016 for details).

Field work and methods

From 13 to 15 July 2007 we captured one adult male and two adult female snowy owls from three different pairs at their nests in study area A, using a trap consisting of a metal grid with multiple nooses. All birds were captured when all eggs had already hatched and the oldest young had started to wander away from the nest. We fitted two females with Microwave Telemetry 35 g solar PTTs and the male with a Microwave 35 g battery powered PTT (Jacobsen et al., 2008; Solheim et al., 2008).

In 2011, between 26 June and 10 July, we caught 9 females and three male snowy owls on the nests by bow-net traps with remote radio-controlled release mechanisms. Three individuals were equipped with 30 g Microwave Solar GPS PTTs, whereas both individuals in two pairs and five additional adult females were equipped with Geo-Trak 30 g battery PTTs. The owls were caught after at least one young had hatched (Jacobsen et al., 2012).

In 2015, we caught six female snowy owls in study area B and one in a mountainous region to the south of this area between 24 June and 2 July, of which four females were equipped with 30 g Microwave Solar GPS PTTs and three females with Geo-Trak 30 g battery PTTs (Øien et al., 2016).

We attached satellite transmitters as backpacks using 8 mm tubular Teflon tape harnesses. Two silver rings were used to strap together the harness, one at the top and one at the bottom of the sternum, to avoid interference with the bird's wing and leg muscles. In 2015, silver rings were replaced by joints made of small (15 × 15mm) leather patches. The Microwave 35 g battery powered ARGOS PTT was programmed to maximize the life time as to cover the full lemming cycle of 4–5 years, and was set to transmit every 9 days throughout the year. Similarly, the GeoTrak 30 g battery powered PTTs were programmed to transmit every 8 days.

We received locations of instrumented snowy owls via the ARGOS system (Collecte Localisation Satellites 2011). For the present study only location accuracy classes of 3, 2 & 1 were selected, with accuracy given as: 1= < 1000 m, 2 = < 350 m, 3= < 150 m. All movement parameters were analysed using ArcView 3.3 and the Animal movement extension by Hooge and Eichenlaub (1997).

Snowy owls breeding in Eurasia were formerly believed to winter mainly in steppe/agricultural habitats to the south of the tundra zone (Dement'ev et al., 1966). In such habitats small mammals are supposedly the most important prey animals. Small mammals may reproduce even in winter (Stenseth, Ims, 1993), thus possibly making up a steady food supply for wintering raptors. Under such conditions, snowy owls should be expected to make winter movements of limited distances. When analysing the tracking data, we defined medium-distance movements as > 10 km and long-distance movements as > 100 km. As analyses

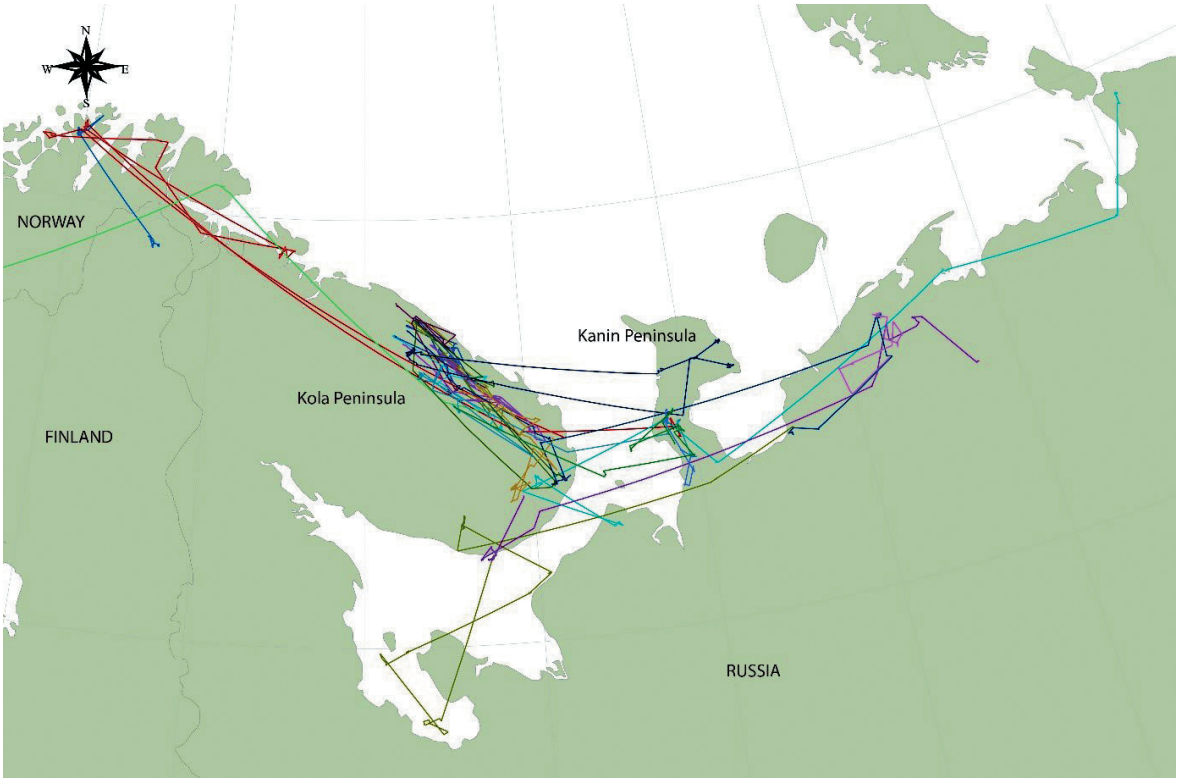

Figure 1. Movements during 21 individual winter periods of 9 snowy owls, equipped with satellite transmitters in Northern Norway in 2007, 2011 and 2015. Each winter track is shown with independent colour.

Рис. 1. Перемещения 9 белых сов, помеченных спутниковыми передатчиками на севере Норвегии в 2007, 2011 и 2015 гг. (в общей сложности 21 «индивидуальный» период зимовки). Разными цветами показаны пути перемещения разных особей.

progressed and movements during winters turned out to be many, we also classified each individual winter period as either «stable» (small territory, no long distances moved), «restless» (several movements > 10 km, but within defined areas) or «nomadic» (long distances moved, >100 km, between areas/regions or countries).

To assess spatial distribution during winter and pinpoint the most important wintering areas, a heat map (Fig. 2) with 10 equal kernels (bilinear interpolation) was produced with ArcMap 10.5.1 software (ESRI Inc., Redlands, CA, USA). The lowest class was deleted so the map shows 90% distribution, with increasing importance from blue to red colour.

Results

Thirteen out of the 22 instrumented snowy owls were provided battery operated transmitters and nine of these were successfully tracked at least throughout the first winter after catching. Of these, eight were tracked further for the second full winter cycle, while three continued for the third full winter and one for the forth. Two transmitters are still active working on their third winter by the end of January 2018. Altogether we received data from 21 full individual winter periods of these nine individuals. Further details on the technical operation of transmitters and the likely cause of the termination of transmissions for each transmitter is provided by Heggøy et al. (2017). Two of the snowy owls for whom we have wintering data used in the present study, have been observed alive after transmitters stopped functioning (Heggøy et al., 2017).

Temporal and spatial distribution of snowy owls in wintering areas

After the period of post-breeding movements during late summer and autumn, snowy owls arrived at their wintering grounds on average on 10 November (range: 29 September — 25 December) and stayed until 13 April (range: 28 March — 30 April), when pre-breeding movements in search of suitable breeding areas with high densities of small mammal prey started. The duration of the wintering period ranged from 93 to 206 days and the average number of days spent wintering was 152.4 (*se* = 6.3, *n* = 18).

After arriving at the area for wintering, nine snowy owls that we could follow during winter did not stay on one established winter territory for the whole winter as expected. Rather, they made several medium- (>10 km) and long-distance (>100 km) movements during winter. The number of medium-distance movements ranged from 2 to 20 for individual owls for one winter (mean 9.1 movements, *SE* = 1.1, *n* = 19)

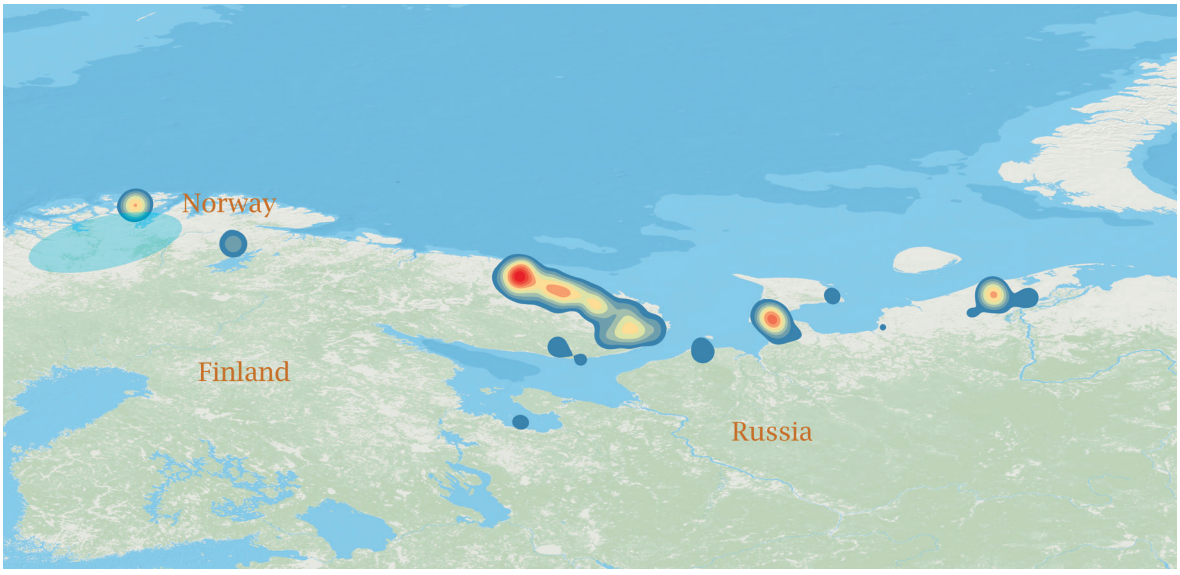

Figure 2. Snowy owl winter distribution shown as density estimates of all satellite locations during 21 individual winter periods of 9 snowy owls, equipped with satellite transmitters in Northern Norway in 2007, 2011 and 2015. The kernels are in increments of 25, 50, 75 and 95% kernels.

Рис. 2. Распределение белых сов зимой, представленное как оценка плотности всех спутниковых локаций 9 сов, помеченных спутниковыми передатчиками на севере Норвегии в 2007, 2011 и 2015 гг., за 21 «индивидуальный» период зимовки. Шаг «ядер» — 25, 50, 75 и 95%.

and the number of long-distance movements ranged from 0 to 6 (mean 1.9, *SE* = 0.5, *n* = 19). Most of the movements during winter fell into these two categories (average 78.3 % of all movements).

The sum of distances travelled by an individual during the winter period ranged from 295 to 2729 km (mean 896 km) for 18 fully covered individual winter periods.

Only three individual winter periods were classified as stable, while 12 were restless and six were nomadic.

Geographical location of wintering areas

The locations of wintering sites ranged from Western Finnmark in Norway and Northern Finland in the west to the Nenetsk Autonomous Okrug in the East. The majority (7) of snowy owls fitted with battery-operated satellite transmitters moved eastwards from the breeding areas in Northern Norway to the Russian Arctic during late summer and autumn, and wintered from the Kola Peninsula in the west through the Bolshe- and Malozemelskaya tundras to Amderma in the east. In most of the individually tracked winter periods (*n* = 12), snowy owls moved intermediate distances within defined areas, especially in the northern regions of the Kola Peninsula (Fig. 1).

All nine instrumented owls spent either the whole, or parts of at least one of their winter periods in the northern and/or eastern part of the Kola Peninsula. The single male tracked in this study spent three consecutive full winters on the Kola Peninsula, while in the fourth winter he returned to his former breeding area in Finnmark, Norway (study area A) in late November and settled there for winter. Five of the eight females spent 100% of one of their winters on the Kola Peninsula and two females spent one whole winter on the Bolshezemelskaya Tundra and Kanin Peninsula, respectively (see Figures 1 and 2). Other winter periods were divided between the Kola Peninsula and other wintering areas such as the Kanin Peninsula, Bolshezemelskaya Tundra, Norway and Finland. One female migrated south-westwards during her second winter and attempted to stay in more temperate mountain areas in Trøndelag County, Mid-Norway in mid-winter (see Fig. 1). Tracking of this bird ended there, and recovery of the carcass proved she had starved to death (Heggøy et al., 2016).

Two of the females spent part of their winter periods on the sea ice in the White Sea. One of them stayed on the ice in the period between 13 January and 28 March during the second winter (76 days) and in two shorter periods of altogether 10–20 days on 25 January — 19 February in her third winter. The other female spent 2–3 weeks on the ice during her second winter.

On average 53.3 % of the wintering time (*n* = 18 individual wintering periods) was spent on the Kola Peninsula, particularly in its interior northern and eastern parts (Figures 1 and 2). The average time spent there by individual owls (*n* = 9) was 59.4% (*n* = 18, *SE* = 23.6%).

Discussion

Older Russian literature suggests that the majority of snowy owls in Northern Russia migrate

southwards to overwinter in open steppe areas. However, Rogacheva (1998, 2005) claimed that some snowy owls wintered on the forest tundra in Northern Russia, where the main wintering habitats of willow ptarmigans (*Lagopus lagopus*) are located. Potapov and Sale (2012) reported snowy owls to be accidentally killed by the Arctic Fox (*Alopex lagopus*) traps in the Russian tundra zone during January and February in the Lower Kolyma region and on Taymyr (see also Ellis, Smith, 1993; Vereshagin, 1999). Snowy owls have been also found in winter on the Putorana Plateu (Romanov, 2004), Wrangel Island (Portenko, 1972) and Yamal, in the latter area especially in years with high numbers of willow ptarmigans (Danilov et al., 1984). Ptarmigans are also common winter prey in North America (Doyle et al., 2017, Holt et al., 2015, Potapov, Sale, 2012).

Our tracking studies suggest that snowy owls breeding in northwestern Eurasia undertake medium- and long-distance post-breeding movements mostly in the east-west direction, and that the owls mainly winter in the Russian and Fennoscandian Arctic. This is supported by older data on ring recoveries from Sweden where more than one hundred snowy owl nestlings were ringed in 1978. Some of them were later recovered far to the east in Russia, with the easternmost recovery at the mouth of the Yenissei River, about 2.500 km from the ringing site (Fransson et al., 2008). Our telemetry studies show that the main post-breeding movements indeed follow this east-west direction and suggest that the snowy owls breeding in Fennoscandia spend most, if not all, of their life cycle in the Arctic.

Our tracking data further show that long-distance movements in this nomadic species are not confined to pre- and post-breeding migratory movements in spring and autumn, but also take place during mid-winter. Snowy owls regularly undertake long-distance movements between alternative wintering sites. We suggest that the choice of wintering sites is a response to prey availability, and as the majority of owls stayed for relatively short time in each of their wintering sites in individual winters, we believe that snowy owls exploit food sources that are not evenly available over the entire winter within one area.

Therrien et al. (2011) nine adult female snowy owls breeding on Bylot Island in Nunavut in the Canadian Arctic with satellite transmitters and found out that the majority of these birds overwintered at high latitudes in the eastern Canadian Arctic, and eight of them spent several weeks (up to 101 days) on the sea ice between December and April. The owls gathered around open water patches in the ice used by many wintering seabirds, potential prey species. Our satellite tracking results indeed show that such a strategy is exploited also by snowy owls breeding in the Western Eurasian Arctic. During three individual wintering periods, two out of the eight tracked females spent a significant part of the winter (up to 76 days) on the sea ice in the southern (Onega Bay) and northern (between the Kola and Kanin peninsulas) parts of the White Sea. Most abundant wintering seabirds in these areas are common eiders (*Somateria* mollissim)a and long-tailed ducks (*Clangula hyemalis*), but aerial surveys confirmed that Steller's eider (*Polysticta stelleri*) also winter in smaller numbers in the polynyas of the White Sea (Aarvak et al., 2009). During the periods spent by snowy owls on the ice, the area was almost completely ice-covered.

The most important wintering area in our study, accounting for more than 50 % of the time spent wintering during 21 individual winter periods, was the eastern and northern parts of the Kola Peninsula. Staying for the whole winter in a limited area and establishing a winter territory is a common strategy for raptors dependent on small mammals during winter, and this is also true for snowy owls wintering in the prairie areas of Canada and USA (Boxall, Lein, 1982; Keith, 1963). Our results, however, show that snowy owls in northwestern Eurasia mainly settle for winter in prime habitat for willow ptarmigans. Ptarmigans do not breed in winter. Snowy owls could therefore be forced to move to new winter sites after local flocks of ptarmigans have been exploited. Flocks may be deprived and migrate in an attempt to escape snowy owl predation pressure. Movements of snowy owls could also be a response to medium- or long-distance movements of ptarmigan flocks during winter (Fuglei et al., 2017).

A satellite transmitter study by Doyle et al. (2017), who tracked four female snowy owls breeding on Herschel Island, Yukon in western Canadian Arctic in 2008, showed that these snowy owls wintered in open habitat with relatively high abundance of boreal prey species, like snowshoe hares and ptarmigans. However, one of the snowy owls stayed on the ice in the Beaufort Sea for 8 days. Satellite transmitters fitted to two snowy owls provided data during two consecutive winters. These owls revisited their previous winter area for shorter periods and stayed most of the winter far from it. The lack of regular site fidelity to winter areas has also been demonstrated by Fuller et al. (2003).

In 2017, snowy owls were included as Vulnerable (VU) in the IUCN Red List of Threatened Species (IUCN, 2017), because previously published population estimates appeared to be too high. Nomadic behaviour of the species and subsequent double and triple counting could be the reasons for population overestimates.

The high degree of winter mobility in this species revealed by this study further emphasise the importance of securing winter survival of snowy owls in order to conserve this globally threatened species in the future. As we suggest that ptarmigans are the most important prey during winter in northwestern Eurasia, a sustainable management of ptarmigan population is

crucial for conserving snowy owls. In Norway, both willow and rock ptarmigans are listed as vulnerable on the most recent national Red List (Henriksen, Hilmo, 2015).

Migrating snowy owls are well known to be encountered throughout the Kola Peninsula, and in some years they are found breeding in the coastal tundra belt (Krasnov, 1985, 2003; Bianki, 2005). The knowledge of their occurrence in the inland areas of Kola Peninsula, even in summer, is however limited, as snowy owls were not reported breeding in the mountain tundra areas of the peninsula by Semyonov-Tyan-Shansky and Guylyazov (1991). Several individuals were however encountered near Lake Enozero in June 2001 by Timonen and Tolvanen (2004), and nested in the surroundings of Lake Paukovoje, interior Kola Peninsula, in the last two decades (three nests were found — Nikolai Eliseev, pers. comm.). Information about occurrence in winter is equally scarce, but Potapov and Sale (2012) reported that museum skins of snowy owls were collected from Yokanga on the Kola Peninsula in February 1920. This is in line with the view of Pleske (1928), who considered that snowy owls occasionally wintered on the Kola Peninsula.

Analyses of museum collections of snowy owl skins allowed Priklonskiy (1993) to conclude that only 8–27% of the snowy owl population wintered in the tundra zone. However, this material is probably severely biased, because of great differences in the sampling effort in summer and winter, as well as in the lower and higher latitudes due to such factors as accessibility, degree of winter darkness, and density of human settlements. Our findings regarding the Kola Peninsula as the most important wintering area for snowy owls breeding in Fennoscandia are new and surprising. This information would be useful for the nature management authorities on the Kola Peninsula, since it is important for conservation of this globally threatened species.

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References

Aarvak T., Øien I.J., Krasnov Y., Gavrilo M.V., Shavykin A.A. 2009. The European wintering population of Steller's Eider *Polysticta stelleri* reassessed. — Bird Conservation International: 1–7.

Bianki V.V. 2005. Owls of Murmansk Region. — Owls of the Northern Eurasia (eds. Volkov S.V., Morozov V.V., Sharikov A.V.). Moscow, p. 43–46. (in Russian with English summary)

Bridge E.S., Thorup K., Bowlin M.S., Chilson P.B., Diehl R.H., Fléron R., Hartl P., Kays R., Kelly J.F., Robinson W.D., Wikelski M. 2011. Technology on the Move: Recent and Forthcoming Innovations for Tracking Migratory Birds. — BioScience, 61 (9): 689–698. Available from: 10.1525/bio.2011.61.9.7

Boxall P.C., Lein M.R. 1982. Feeding Ecology of Snowy Owls (*Nyctea scandiaca*) wintering in Southern Alberta. — Arctic, 35: 282–290.

Cramp S. (ed.). 1985. Handbook of the birds of Europe, the Middle East, and North Africa. The birds of the Western Palearctic. Vol. 4. Cambridge, U.K., 960 pp.

Danilov N.N., Ryzanovskiy V.N., Ryabitsev V.K. 1984. Birds of Yamal. Moscow, 334 pp. (In Russian)

Dement'ev G.P. 1936. Suborder Owls *Striges*. — Comprehensive guide to the birds of the USSR (eds. Buturlin S.A., Dement'ev G.P.). Vol. 3. Moscow-Leningrad, p. 101–129. (In Russian)

Dement'ev G.P., Gladkov N.A., Ptushenko E.S., Spangenberg E.P., Sudilovskaya A.M. 1966. Birds of the Soviet Union. Vol. 1. 1966. Moscow–Washington, 704 pp.

Doyle F.I., Therrien J.F., Reid D.G., Gauthier G., Krebs C.J. 2017. Seasonal Movements of Female Snowy Owls Breeding in the Western North American Arctic. — Journal of Raptor Research, 51 (4): 428–438.

Dunn E.H., Brewer A.D., Diamond A.W., Woodsworth E.J., Collins B.T. 2009. Canadian Atlas of bird banding. Volume 3: Raptors and Waterbirds, 1921–1995. Canadian Wildlife Service, 202 pp.

Ellis D.H., Smith D.G. 1993. Preliminary report of extensive Gyrfalcon and Snowy Owl mortality in northern Siberia. — Raptor Link, 1: 3–4.

Follen D. Sr., Luepke K. 1980. Snowy Owl recaptures. — Inland Bird Banding, 52 (4): 60.

Fransson T., Österblom H., Hall-Karlsson S. 2008. Svensk ringmärkningsatlas. Vol. 2. Stockholm. 216pp.

Fuglei E., Blanchet M.-A., Unander S., Ims R.A., Pedersen Å.Ø. 2017. Hidden in the darkness of the Polar night: a first glimpse into winter migration of the Svalbard rock ptarmigan. — Wildlife Biology, 1 (2017): wlb.00241 DOI10.2981/wlb.00241.

Fuller M., Holt D.W., Schueck L. 2003. Snowy Owl movements: variation on the migration theme. — Avian migration (eds. Berthold P., Gwinner E., Sonnenschein E). Berlin and Heidelberg, p. 359–366.

Heggøy O., Aarvak T., Øien I.J., Jacobsen K.-O., Solheim R. 2017. Effects of satellite transmitters on survival in Snowy Owls *Bubo scandiacus*. — Ornis Norvegica, 40: 33–38. doi: 10.15845/on.v40i0.1309.

Henriksen S., Hilmo O. (eds.) 2015. Norsk rødliste for arter 2015. Artsdatabanken, 193 pp.

Holt D.W., Larson M.D., Smith N., Evans D.L., Parmelee D.F. 2015. Snowy Owl (*Bubo scandiacus*). The birds of North America (ed. Rodewald P.G.). Ithaca, NY,

U.S.A. https://birdsna.org/Species-Account/bna/species/snoowl1 (last accessed 2018-01.26).

Hooge P.N., Eichenlaub B. 1997. Animal movement extension to ArcView, Version 1.1.: Alaska Science Center — Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA.

IUCN 2017. The IUCN Red List of Threatened Species 2017-3. http://www.iucnredlist.org Downloaded on 2018-01.25.

Jacobsen K.-O., Solheim R., Øien I.J. 2008. Snøuglas vandringsmønster og habitatvalg. Årsrapport 2007. — NINA Minirapport, 217, 24 s.

Jacobsen K.-O., Øien I.J., Solheim R., Aarvak T. 2012. Snøuglas bestandsforhold, vandringsmønster og habitatvalg. Årsrapport 2011. — NINA Rapport, 813, 20 s.

Keith L.B. 1963. A Note on Snowy Owl Food Habits. — Wilson Bulletin, 75 (3): 276–277.

Kerlinger P., Lein M.R., Sevick B.J. 1985. Distribution and population fluctuations of wintering snowy owls (*Nyctea scandiaca*) in North America. — Canadian J. Zool., 63: 1829–1834.

Kharitonov S.P., Bublichenko A.G., Korkina S.A. 2005. Snowy Owl breeding pattern at the north-western Taimyr Peninsula: comparison with the lemming cycle phases and spatial distribution. — Owls of the Northern Eurasia (eds. Volkov S.V., Morozov V.V., Sharikov A.V.). Moscow, p. 23–31. (in Russian with English summary)

Krasnov Yu.V. 1985. The biology of snowy owls in eastern Murmansk Region. — Birds of prey and Owls in the Nature reserves of the Russian Federation (ed. Krever V.G.). Moscow, p. 110–116. (in Russian).

Krasnov Yu.V. 2003. Snowy Owl *Nyctea scandiaca*. — Red Data Book of the Murmansk Oblast (eds. Mun K., Konstantinova N., Koryakin A., Makarova O). Murmansk, p. 331–332. (in Russian)

Lappo E.G. 2005. The long-term dynamics of Snowy Owl breeding range at Taimyr. — Owls of the Northern Eurasia (eds. Volkov S.V., Morozov V.V., Sharikov A.V.). Moscow, p. 32–35. (in Russian with English summary)

Morozov V.V. 2005. Snowy Owl in the eastern part of Bolshezemelskaya tundra and Yugorsky Peninsula. — Owls of the Northern Eurasia (eds. Volkov S.V., Morozov V.V., Sharikov A.V.). Moscow, p. 10–22. (in Russian with English summary)

Newton I. 2010. Bird migration. — Hong Kong, 598 pp.

Oeming A.F. 1957. Notes on the barred owl and the snowy owl in Alberta. — Blue Jay, 15: 153–156.

Øien I.J., Jacobsen K.-O., Aarvak T., Solheim R., Kleven O. 2016. Snøuglas økologi og forekomst i Norge i 2015. — NOF-Report. Rapport 4-2016, 30 pp. (In Norwegian)

Parkin D.T., Knox A.G. 2010. The status of birds in Britain and Ireland. London, 440 pp.

Pleske Th. 1928. Birds of the Eurasian Tundra. — Memoirs Boston Soc. Nat. Hist., vol. 6, N 3. Boston, 485 pp.

Portenko L.A. 1972. Die Schnee-Eule — *Nyctea scandiaca*. Magdeburg, 232 s.

Potapov E., Sale R. 2013. The Snowy Owl. London, Ltd. 304 pp.

Priklonskiy S.G. 1993. Snowy Owl — Nyctea scandiaca (linnaeus, 1758). — Birds of Russia and adjoining regions: Pterocliformes, Columbiformes, Cuculiformes, Strigiformes. Moscow, pp. 258–270. (In Russian)

Robertson G.J., Gilcrist G. 2003. Wintering Snowy Owls feed on seaducks in the Belcher Islands, Nunavut, Canada. — J. Raptor Research, 37 (2): 164–166.

Romanov A.A. 2004. Ornithofauna of the Putorana Plateau. — Vertebrate fauna of Putorana Plateau (ed. Romanov A.A.). Moscow, p. 92–299. (in Russian with English summary)

Rogacheva H. 1992. The Birds of Central Siberia. Husum, 737 pp.

Rogacheva E.V. 2005. Owls of the northern part of Central Siberia. — Owls of the Northern Eurasia (eds. Volkov S.V., Morozov V.V., Sharikov A.V.). Moscow, p. 369–384p. (in Russian with English summary)

Ryabov V.F. 1950. Contributions to the knowledge of the birdlife of the steppes. — Scintific notes of the Stalingrad pedagogical institute, issue 2. Stalingrad, p. 179–226. (in Russian)

Semyonov-Tyan-Shansky O.I., Guylyazov A.S. 1991. Birds of Lapland. Moscow, 288 pp. (in Russian)

Solheim R., Jacobsen K.-O., Øien I.J. 2008. Snøuglenes vandringer. Ett år, tre ugler og ny kunnskap. — Vår Fuglefauna, 31: 102–109.

Solheim R., Jacobsen K.-O., Øien I.J., Aarvak T., Stoffel M., Wiebe K., Zazelenchuk D. 2014. International efforts to unravel mysteries of movement patterns of Snowy Owls. — Blue Jay, 72 (3): 140–148.

Stenseth N.C., Ims R.A. 1993. The biology of lemmings. London, 683 pp.

Therrien J.-F., Gauthier G., Pinaud D., Bêty J. 2014. Irruptive movements and breeding dispersal of snowy owls: a specialized predator exploiting a pulsed resource. — Journal of Avian Biology, 45 (6): 536–544.

Therrien J-F, Gauthier G., Bêty J. 2011. An avian terrestrial predator of the Arctic relies on the marine ecosystem during winter. — Journal of Avian Biology, 42: 363–369.

Timonen S., Tolvanen P. 2004. Field survey of Lesser White-fronted Goose at the Kola Peninsula, northwestern Russia, in June 2001. —Fennoscandian Lesser White-fronted Goose conservation project (eds. Aarvak T., Timonen S.). Report 2001-2003. WWF Finland Report No 20 & Norwegian Ornithological Society, NOF Rapportserie Report No 1–2004: pp. 30–32.

Verestchagin N.K. 1999. Extermination of snowy owls *Nyctea scandiaca* in Russian Arctic regions. — The Russian Journal of Ornithology, express issue, 80: 22–23. (in Russian)

СПУТНИКОВАЯ ТЕЛЕМЕТРИЯ ОТКРЫВАЕТ ВАЖНЫЕ РАЙОНЫ ЗИМОВОК БЕЛЫХ СОВ НА КОЛЬСКОМ ПОЛУОСТРОВЕ, СЕВЕРО-ЗАПАД РОССИИ

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Резюме

В 2007, 2011 и 2915 гг. мы пометили спутниковыми передатчиками ARGOS, работающими на аккумуляторах, 9 белых сов в Норвегии. Целью исследования было выявление районов зимовки и отслеживание зимних перемещений белых сов, гнездящихся на севере Фенноскандии. Получены данные общей сложностью для 21 «индивидуального» периода зимовки; каждый их 9 передатчиков проработал хотя бы один полный зимний сезон. Белые совы появлялись в местах зимовки в среднем 10 ноября и оставались там до 13 апреля; среднее число дней, проведённое совами в районах зимовки, — 156. Птицы довольно широко кочевали: каждая из них в каждый из зимних периодов преодолевала в среднем 991 км, совершая перемещения на средние и большие расстояния. Мы обнаружили достаточно большую пластичность в выборе зимних местообитаний, что связано, на наш взгляд, с различиями в обилии корма в разных местах (мы полагаем, что зимой белые совы питаются в основном куропатками). Все помеченные передатчиками совы провели хотя бы часть одной зимы на севере и востоке Кольского полуострова, а 6 из 9 сов оставались только там на протяжении как минимум одной зимы. Больше половины времени из 21 «индивидуального» периода зимовки птицы провели во внутренних северных и восточных частях полуострова. Поскольку, по современным данным, белая сова — вид, находящийся под угрозой исчезновения, результаты настоящего исследования важны для планирования мероприятий по его охране.

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