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ORIGINAL ARTICLE

Satellite tracking of Ross's Gull *Rhodostethia rosea* in the Arctic Ocean

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Abstract Ross's Gull is one of the most emblematic Arctic birds and least known seabirds in the world; post-breeding movements and the use of sea-ice habitats have been long debated, but described only from scattered observations. We tracked two adults, a male and female, breeding in the Kolyma Delta, Russia, using the lightest (<5 g) satellite transmitters currently available: the transmitters provided data for 44 and 132 days for the female and male, respectively. After departing from the breeding area and reaching the nearby Laptev Sea at the beginning of July, both birds moved NW, and the male staged until the end of September in an area of scattered sea-ice (concentration 50–100 %), NE of Severnaya Zemlya archipelago, between 80 and 85° N. By mid-October, most likely escaping the polar night, this bird reached the coast of NW Alaska, and a few days later it arrived in the coastal wetlands of North Chukotka, where it remained until the transmitter stopped in early November.

Keywords Satellite tracking · Post-breeding migration · Staging area · Sea-ice · Rates of travel · Ross's Gull · Siberia

Zusammenfassung

Die Rosenmöwe gehört zu den emblematischsten Vögeln der Arktis, doch ist ihre Biologie und Ökologie kaum bekannt. Die bisherigen Erkenntnisse über ihre postnuptialen Wanderungen und die Nutzung von Packeis stützten sich auf lediglich einzelne Beobachtungen. Mit Hilfe der kleinsten derzeit verfügbaren Satelliten-Sender (<5 g) gelang es uns, ein Männchen und ein Weibchen, die beide im russischen Kolyma-Delta brüteten, während 132 und 44 Tagen zu verfolgen. Vom Brutgebiet aus gelangten sie Anfang Juli zunächst in die benachbarte Laptewsee. Anschließend flogen beide in Richtung Nordwesten an den Rand des Packeises. Das Männchen blieb bis Ende September zwischen 80 und 85° nördlicher Breite nordöstlich der Inselgruppe von Sewernaja Semlja, in einem Gebiet mit einer Eiskonzentration von 50–100 %. Mitte Oktober zog dieser Vogel an die Nordwestküste von Alaska, wohl um der Polarnacht zu entfliehen. Wenige Tage später erreichte er die küstennahen Feuchtgebiete im Norden Tschukotkas, wo er bis Anfang November, als der Sender ausfiel, blieb.

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Introduction

One of the most emblematic Arctic birds, the Ross's Gull *Rhodostethia rosea*, is also one of the least known. Most of its world population (ca. 25,000 pairs; Del Hoyo et al.

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1996) breeds in the remote tundra of central Siberia between the Taimyr Peninsula and the Kolyma river (Andreev 2006; Degtyarev 1991; Pavlov and Dorogov 1976), with a few pairs in Canada and Greenland (Egevang and Boertmann 2008; Maftei et al. 2012). Outside the breeding season, our knowledge of the ecology and the distribution is limited and speculative, based on direct observations from few localities (Vaughan 1992). Andreev (2006) suggested that Russian birds move northwards after the breeding season and disperse along the Siberian coast of the Arctic Ocean. Ross's Gulls are reported to arrive in the western Arctic Ocean mainly in July, with some penetrating as far west as northeast Greenland and north to 87°30′ (Meltofte et al. 1981; Hjort et al. 1997). In August and September they are believed to move southeast and eastwards, with large numbers crossing the Bering Strait and observed passing Point Barrow (Alaska) in September–October (Maftei et al. 2014; Murdoch 1885; Vaughan 1992). Finally, the birds return from the Beaufort Sea, and most are believed to spend the winter offshore in the Bering and Okhotsk Seas before returning to their breeding grounds in Spring using an inland flyway (Andreev 1985, 2006).

Using the lightest commercially available satellite-received platform terminal transmitters (PTTs), this pilot study aimed to (1) assess the efficacy of these transmitters in harsh polar environments and obtain information on (2) post-breeding movements and (3) habitat use of the Ross's Gull.

Methods

On 24 June 2013, three breeding adults (a pair and a female) were trapped with clap nets at a colony of 21 nests in the Kolyma Delta, Russia (69°N, 161°E). The birds were fitted with a <5 g PTT (Microwave Telemetry Inc, USA) attached with a Teflon ribbon chest harness (<2 g), which represented ca. 4.5 % of the body mass (Male = 150 g, Females = 146 g). When observed for 1.5 h the following day, both nests contained chicks and were attended by the male parents, one tagged and one untagged.

PTTs had a "10-hours-on/48-hours-off" duty cycle for signal transmission to provide Argos location estimates, with each location class (LC) denoting the estimated level of accuracy i.e., <250 m, <500 m, and <1500 m for LC3, LC2, and LC1, respectively (CLS 2014; but see Boyd and Brightsmith 2013). LC0, LCA, LCB, and LCZ have no error estimate, although LCA locations are sometimes believed to have similar accuracy than LC1 locations (Hays et al. 2001; Vincent et al. 2002). In our study we only used LC1, LC2, and LC3, except when selecting the "best daily positions" (BDP) when we also included a few LCA, LCB, and LC0 locations. BDP refers to the most accurate position collected during the 10 h of transmission that occurred at intervals of 58 h).

We used orthodromic distances to calculate distances between locations to estimate "rates of travel" (details in Gilg et al. 2013).

Daily maps of sea-ice concentration were provided by the Institute of Environmental Physics, University Bremen (Spreen et al. 2008; http://www.seaice.de).

Results

The three PTTs produced contrasting results, with data produced over a few hours only for the female #129362 (failed transmitter; not presented in this study), to 132 days for its male partner #129361 (24 June–03 November). Female #129363 was monitored for 44 days (24 June–07 August). Altogether, 1366 positions were obtained for these birds, including 24 % LC1-3, 40 % LC0, and 12 % LCA. The fate of the birds was unknown, but none of the PTTs had been stationary before they stopped transmitting (often the sign of a lost transmitter or a dead bird). Although the birds we trapped did not abandon their nests as in Maftei et al. (2015), it is likely that both nests failed after the young died, as the male and female left the area of the nesting colony 8 and 5 (or 6) days, respectively, after being caught and tagged (i.e. before their young could have fledged).

The female stayed within 3 km of the colony until 02 July. On 04 July, it was located 25 km away, and 2 days later it had left the breeding area and was found offshore 175 km from the mainland coast (Fig. 1). From there, it moved westward where it again reached wet coastal tundra on 09 July. From 11 to 31 July, it staged in open sea close to the New Siberian Islands, but always further than 45 km from the nearest land (Fig. 1).

The male stayed at the colony until at least 29 June, and in the Kolyma Delta region until 08 July, but moving as far as 200 km southwest of the colony, and then rapidly moving to the open sea, reaching 80° N on 10 July, only 2 days after leaving the mainland (minimum distance travelled in 48 h = 1300 km; minimum flight speed over this 48 h period = 27 km/h). From 10 July to 19 September it stayed in an area of scattered sea-ice in the Laptev Sea, northeast of Severnaya Zemlya (Fig. 1), at latitudes between 80 and 85°N (Fig. 2). After 3.5 weeks with no locations, it was located in active migration on 12–13 October 2000 km to the east. During a 4.5-h period, it covered a distance of 300 km southward with an average speed of 60 km/h, to approach the Alaskan coast north of Cape Lisburne (last position was ca. 100 km from land). Two days later (15 October), it was located at the mouth of Kolyuchin Bay, on the northern coast of the Chukotka Peninsula (Russia), where it remained for 1 week until 22 October. It then

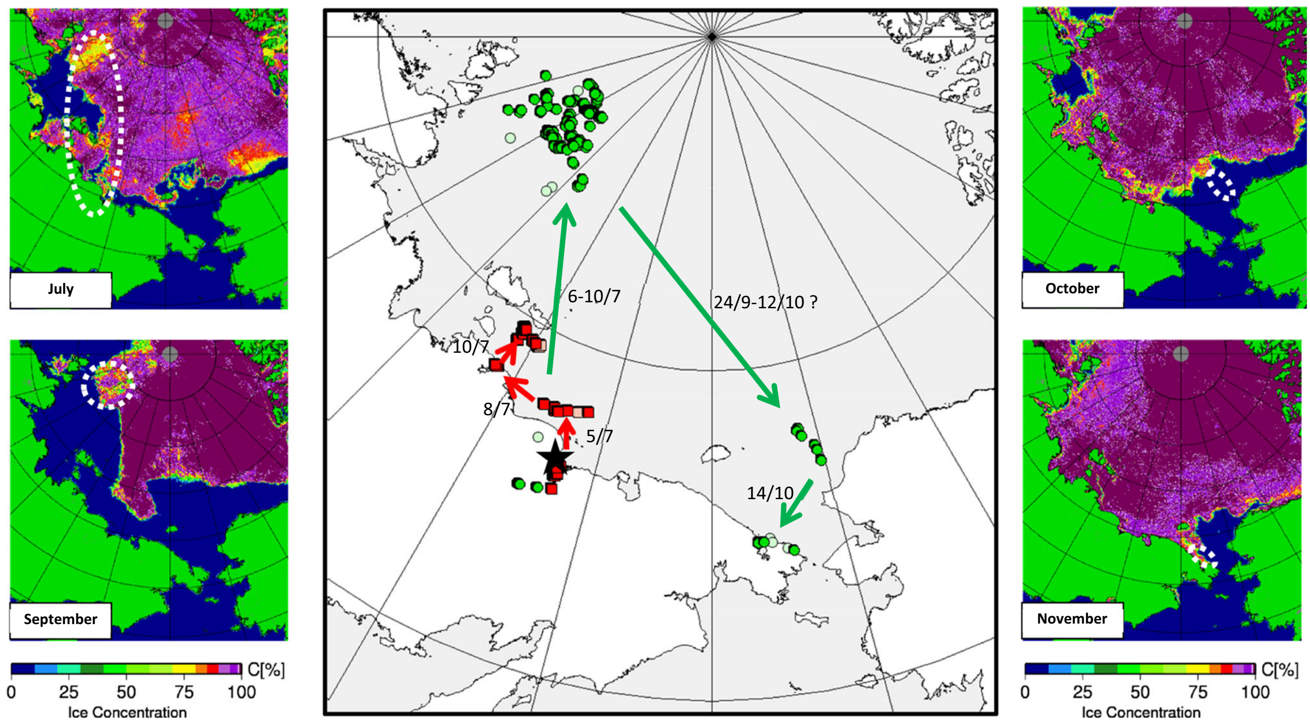


Fig. 1 Post-breeding movements of two Ross's Gulls monitored between 24 June and 03 November. *Central panel* female = *red symbols*, male = *green symbols*. Only the best daily positions (BDP) are shown on the figure. Densely coloured symbols were produced from high accuracy LC1, LC2, and LC3 ($n = 58$), *light colour symbols* from low accuracy LCA, LCB, and LC0 ($n = 13$). *Lateral panels* monthly distributions of Ross's Gulls (delimited with *white dotted lines*) compared to sea-ice distribution and concentration (as available for the 15th day of each month). The breeding site is localized by a *black star*, while the *arrows* show the main directions and dates of the post-breeding movements documented in this study

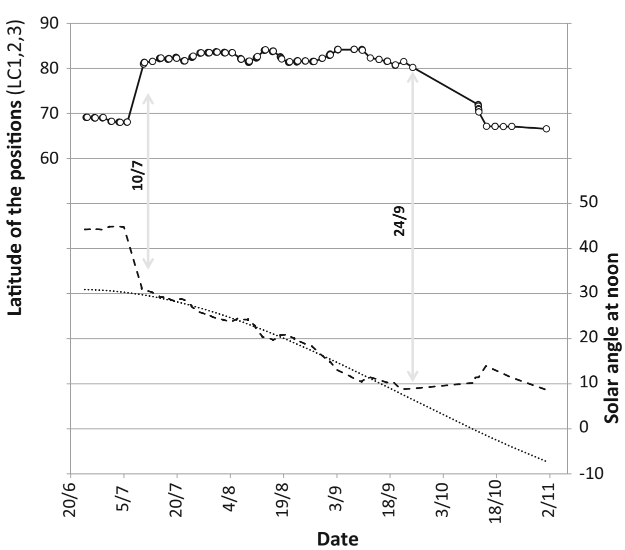


Fig. 2 Latitudinal movements of the male Ross's Gull (*upper part* of the figure) according to the solar angle at noon (*lower part*). The *dashed line* shows the solar angles at the bird's positions while the *dotted line* presents the solar angle at 82.5°N (average latitude of the area used by the gull from 10/7 to 24/9)

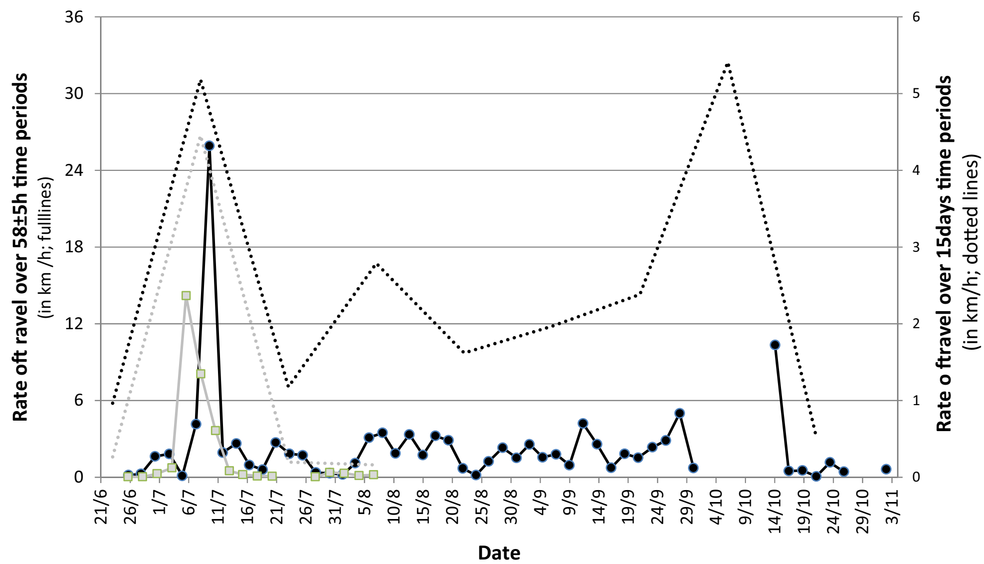
moved eastward where it was last located on 03 November off the coast 70–100 km NW of Cape Dezhnev.

Rates of travel calculated for every 58-h (±5) time period based on BDP clearly show the periods with highest movements (Fig. 3). High rates were documented for both birds between 05 and 10 July, when leaving breeding grounds to the northwest, and in October for the male when flying to the Bering Sea. The minimum distance travelled by these birds was 1777 km (over 44 days) for the female and 8254 km (over 132 days) for the male.

Discussion

Satellite tracking remains the best option to precisely monitor long distance movements for birds that cannot easily be recaptured. The 5 g PTT opens monitoring opportunities for several hundreds of new species in the range 100–250 g (Bridge et al. 2011; Meyburg et al. 2011). The 5 g solar PTTs have already been used on several species (http://www.microwavetelemetry.com), but only a few studies have yet been published, e.g., a female

Fig. 3 Rates of travel estimated from best daily positions (BDP) for male (*black symbols*) and female (*grey symbols*) Ross's Gulls. *Full lines* (values on the *y* axis) are estimates for time periods of 58 ± 5 h (with *lines* interrupted when no positions for more than 68 h), *dotted lines* (values on the *z* axis) are estimates for time periods of 15 days (i.e. average value based on the data points presented on the *full line*)



Eurasian Hobby *Falco subbuteo* was monitored in 2008–2010 (Meyburg et al. 2011), eight Common Cuckoos *Cuculus canorus* in 2010–2011 (Willemoes et al. 2014), and five Bulwer's Petrels *Bulweria bulwerii* in 2010 (Rodriguez et al. 2013), whilst an ongoing study of three Amur Falcons *Falco amurensis* has also been reported (Kasambe 2014). Together with the recent work from the Nearctic on the same species (Maftei et al. 2015), our study is the first using lightweight 5 g PTTs in a polar environment and one of the few that has succeeded in monitoring birds for several months. Interestingly, using the same 5-g transmitters, but a slightly different harness design (i.e. leg-loop harness compared with our chest harness), Maftei et al. (2015) monitored their two birds for longer periods than in our study (i.e. 130 and 534 days versus 44 and 132 days).

Compared to the Hobby study, our Russian Ross's Gulls produced more locations, i.e., 1366 during a cumulated 176-day monitoring period compared to ca. 2000 Hobby locations over 2 years, but of lower accuracy (49 % of positions were LC1-3 in the Hobby study compared to 24 % in our study). These contrasting results are not surprising given the conditions that prevail in the Arctic. The polar orbits of Argos satellites facilitates the reception of more signals than at lower latitudes, but cold ambient temperatures drains battery power, and although sunlight is permanent in summer at polar latitudes, the low angle of incidence reduces the efficacy of the solar panel to recharge the battery (also see Gilg et al. 2010). Overall, the results of all these studies using 5-g PTTs are relatively disappointing compared to similar studies using larger PTTs. For the Ivory Gull *Pagophila eburnea,* for example, a species using similar high-Arctic sea-ice habitats than the Ross's Gull, mounting larger PTTs (>10 g) with the same leg-loop or chest harnesses provided much better results, with a large fraction of the birds monitored for several years (Gilg et al. 2010; Spencer et al. 2014). It is still unclear whether the relatively low success of these studies using 5-g PTTs originates from technical or biological constraints.

From the Kolyma Delta, our two Ross's Gulls rapidly moved NW to the Arctic Ocean in early July, shortly after they had failed breeding (Figs. 1, 3). From 10 July to 24 September, the locations of the male, ca. 2000 km NW of the breeding colony, agreed with the suggested existence of a "post-breeding dispersal pattern" to the NW for the Russian population, towards a large offshore and ice-covered area in the Eurasian part of the Arctic Ocean (above 80° N) extending from 20° W to 160° E. Indeed, for the entire summer, the male staged ca. 1000 km east of the area in the northern Barents Sea where Meltofte et al. (1981) found large post-breeding concentrations of Ross's Gull in July 1980, and ca. 500 km from the route along which Hjort et al. (1997) regularly saw the species in 1996. Interestingly, and as in Maftei et al. (2015), both birds moved northward and mainly used sea-ice habitats after they had left their breeding grounds (Fig. 1, lateral panels). During the 6 weeks it spent above 80°N (Fig. 2), the male remained in an area of scattered sea-ice (concentration 50–100 %; Fig. 1), although open water and dense sea-ice habitats were available nearby. This area borders the eastern end of the late-summer nitrogen-rich ice-edge that runs along the northern Barents Sea (see Bluhm and Gradinger 2008; Gilg et al. 2010), thus the long summer staging may be explained by high planktonic productivity in this area. Empirical observations made in the same region of the Arctic Ocean (Hjort et al. 1997) suggest that the summer food of Ross's Gull probably consists of amphipods and small polar cod *Boreogadus saida* found in the open leads of the sea-ice.

When this male eventually started to move southward in late September-early October, the sun angle at noon was already below 10° at 80–85°N (the sun disappeared completely from this region in early October; Fig. 2). Hence, it is likely that the arrival of the Polar Night, rather than a change in sea-ice, was the main reason for this sudden and rapid southeastern movement in October (see similar pattern for Ivory Gull in Gilg et al. 2010). The bird had to choose to stay on sea-ice in the polar night or follow the daylight to the south over open water. The last positions for this individual further support the importance of the northern coast of Chukotka, and especially Kolyuchin Bay, for the conservation of rare and endangered Siberian species such as Emperor Goose *Anser canagicus* (Hupp et al. 2007), Steller's Eider *Polysticta stelleri* (Rosenberg et al. 2014), Ross's Gull (present study), and Spoon-billed Sandpiper *Eurynorhynchus pygmeus* (Zockler et al. 2010).

To follow up this study, we suggest (1) to monitor at least 10 adults in any new satellite tracking project, (2) to use a leg-loop harness instead of a chest harness to attach the transmitters, and if possible (3) to use smaller transmitters once ICARUS-like projects become operational (Bridge et al. 2011; http://icarusinitiative.org).

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References

Andreev AV (1985) Breeding success in the Ross's Gull and factors on which it depends [in Russian]. In: Litvinenko NM (ed) Rare and endangered birds of the far east. Far-eastern Department, U.S.S.R. Academy of Sciences Vladivostok, pp 110–131

Andreev A (2006) Between permafrost and drift ice: Ross's gull on the Kolyma breeding grounds (*in Russian*). In: Borodina OE (ed) To the centenary of S.A. Buturlin's Kolyma voyage. Corporation for the promotion of technologies, Magadan, pp 79–99

Bluhm BA, Gradinger R (2008) Regional variability in food availability for Arctic marine mammals. Ecol Appl 18:S77–S96

Boyd JD, Brightsmith DJ (2013) Error Properties of Argos Satellite Telemetry Locations Using Least Squares and Kalman Filtering. PLoS One 8:e63051. doi:10.1371/journal.pone.0063051

Bridge ES et al (2011) Technology on the Move: recent and Forthcoming Innovations for Tracking Migratory Birds. Bioscience 61:689–698. doi:10.1525/bio.2011.61.9.7

CLS (2014) Argos user's manual. CLS, Toulouse

Degtyarev AG (1991) A method of airborne census of Ross's gull (*Rhodostethia rosea*) in Yakut tundras USSR (In Russian). Zoologichesky Zhurnal 70:81–85

Del Hoyo J, Elliott A, Sargatal J (1996) Handbook of the birds of the world, vol 3. Hoatzin to Auks, Lynx Editions, Barcelona

Egevang C, Boertmann D (2008) Ross's Gulls (Rhodostethia rosea) breeding in Greenland: a review, with special emphasis on records from 1979 to 2007. Arctic 61:322–328

Gilg O, Strøm H, Aebischer A, Gavrilo MV, Volkov A, Miljeteig C, Sabard B (2010) Post-breeding movements of the northeast Atlantic ivory gull *Pagophila eburnea* populations. J Avian Biol 41:532–542. doi:10.1111/j.1600-048X.2010.05125.x

Gilg O et al (2013) Trans-equatorial migration routes, staging sites and wintering areas of a high-arctic avian predator: the long-tailed skua (*Stercorarius longicaudus*). PLoS ONE 8:e64614

Hays GC, Åkesson S, Godley BJ, Luschi P, Santidrian P (2001) The implications of location accuracy for the interpretation of satellite-tracking data. Anim Behav 61:1035–1040

Hjort C, Gudmundsson GA, Elander M (1997) Ross's gulls in the central arctic ocean. Arctic 50:289–292

Hupp JW, Schmutz JA, Ely CR, Syroechkovskiy JEE, Kondratyev AV, Eldridge WD, Lappo E (2007) Moult migration of emperor geese Chen canagica between Alaska and Russia. J Avian Biol 38:462–470. doi:10.1111/j.0908-8857.2007.03969.x

Kasambe R (2014) Doyang reservoir: a potential IBA in Nagaland. Mistnet 15:24–28

Maftei M, Davis SE, Jones IL, Mallory ML (2012) Breeding habitats and new breeding locations for Ross's Gull (Rhodostethia rosea) in the Canadian High Arctic. Arctic 65:283–288

Maftei M, Davis S, Uher-Koch B, Gesmundo C, Suydam R, Mallory M (2014) Quantifying fall migration of Ross's gulls (Rhodostethia rosea) past Point Barrow, Alaska. Polar Biol 37:1705–1710. doi:10.1007/s00300-014-1552-4

Maftei M, Davis SE, Mallory ML (2015) Confirmation of a wintering ground of Ross's Gull Rhodostethia rosea in the northern Labrador Sea. Ibis:n/a-n/a doi:10.1111/ibi.12261

Meltofte H, Edelstam C, Granstrom G, Hammar J, Hjort C (1981) Ross's gulls in the arctic pack-ice. Brit Birds 74:316–320

Meyburg B-U, Howey PW, Meyburg C, Fiuczynski KD (2011) Two complete migration cycles of an adult Hobby tracked by satellite. Brit Birds 104:2–15

Murdoch J (1885) Birds. In: Ray PH (ed) Report of the international polar expedition to point barrow, alaska. House of Representative, Government Printing House, Washington, D.C

Pavlov BM, Dorogov VF (1976) The Ross's gull (*Rhodostethia rosea*) in the Taimyr (In Russian). Ornitologiya 12:240–241

Rodriguez B, Bécares J, Martinez JM, Rodrigues A, Ruiz A, Arcos JM (2013) Satellite tracking of Bulwer's Petrels *Bulweria bulwerii* in the Canary Islands. Bird Study 60:270–274

Rosenberg DH, Petrula MJ, Schamber JL, Zwiefelhofer D, Hollmén TE, Hill DD (2014) Seasonal movements and distribution of Steller's Eiders (*Polysticta stelleri*) Wintering at Kodiak Island, Alaska. Arctic 67:347–359

Spencer NC, Gilchrist HG, Mallory ML (2014) Annual movement patterns of endangered ivory gulls: the importance of sea ice. PLoS ONE 9:e115231. doi:10.1371/journal.pone.0115231

Spreen G, Kaleschke L, Heygster G (2008) Sea ice remote sensing using AMSR-E 89-GHz channels. J Geophy Res Oceans 113: C02S03 doi:10.1029/2005jc003384

Vaughan R (1992) In search of Arctic birds. Poyser, London

Vincent C, McConnell BJ, Ridoux V, Fedak MA (2002) Assessment of Argos location accuracy from satellite tags deployed on captive gray seals. Marine Mammal Sci 18:156–166. doi:10.1111/j.1748-7692.2002.tb01025.x

Willemoes M et al (2014) Narrow-front loop migration in a population of the common Cuckoo *Cuculus canorus*, as revealed by satellite telemetry. PLoS One 9:e83515. doi:10.1371/journal.pone.0083515

Zockler C, Syroechkovskiy EE, Atkinson PW (2010) Rapid and continued population decline in the Spoon-billed Sandpiper Eurynorhynchus pygmeus indicates imminent extinction unless conservation action is taken. Bird Conserv Int 20:95–111. doi:10.1017/s0959270910000316