Seabirds During Arctic Polar Night: Underwater Observations from Svalbard Archipelago, Norway

Authors: Ostaszewska, Kaja, Balazy, Piotr, Berge, Jørgen, Johnsen, Geir, and Staven, Robert

Source: Waterbirds, 40(3) : 302-308

Published By: The Waterbird Society

URL: https://doi.org/10.1675/063.040.0301

Seabirds During Arctic Polar Night: Underwater Observations from Svalbard Archipelago, Norway

Kaja Ostaszewska[1,*], Piotr Balazy[1], Jørgen Berge[2,3], Geir Johnsen[3,4] and Robert Staven[4]

[1]Institute of Oceanology, Polish Academy of Sciences, Powstańców Warszawy 55, 81-712, Sopot, Poland

[2]Department of Arctic and Marine Biology, UiT The Arctic University of Norway, 9037, Tromsø, Norway

[3]University Centre in Svalbard, Pb 156, 9171 Longyearbyen, Norway

[4]Department of Biology, Norwegian University of Science and Technology, 7491 Trondheim, Norway

[*]Corresponding author; E-mail: kajao@iopan.pl

Abstract.—Visually-oriented predators, such as seabirds, are highly light dependent, and thus their presence and activity under continuously dark conditions of Arctic polar night pose a number of questions about the strategies and mechanisms they use to find prey. Here, opportunistic observations of the behaviors of Thick-billed Murres (*Uria lomvia*; *n* = 4) and juvenile Black Guillemots (*Cepphus grylle*; *n* = 5) were made in the ocean around Spitsbergen Island, Svalbard Archipelago, off the coast of Norway. These observations were made between 15-23 January 2014-2017 during the darkest period of the polar night. Underwater observations recorded on 23 January 2014 and 19-20 January 2015 revealed that individual birds seemed to be attracted to artificial light. They actively foraged in the sea within the beam of scuba diver lights and harbor lamps indicating that artificial light may create additional feeding opportunities for seabirds present in the area. Other observations of Dovekies (*Alle alle*; *n* = 2) made on 15-16 January 2016 may indicate that not all seabird species exhibit such an adaptable behavior. Various seabird reactions might be caused also by different age and intra-specific variation among individuals; however, due to the limited number of observations, future studies are needed to increase our understanding of these behaviors.
Received 30 March 2017, accepted 19 June 2017.

Key words.—*Alle alle*, Arctic polar night, Black Guillemot, *Cepphus grylle*, Dovekie, light attraction, opportunistic foraging behavior, Spitsbergen, Thick-billed Murre, *Uria lomvia*.

Waterbirds 40(3): 302-308, 2017

The ambient light regime (irradiance, spectral composition and day length) plays an important role in the behavior of seabirds, affecting activities such as feeding, migration or reproduction (Wiese *et al.* 2001; Montevecchi 2006). For visual predators, the efficiency of foraging is strongly influenced by the level of available light, which is important for the detection of prey (Jetz *et al.* 2003). In other studies involving seabirds, light-limited foraging patterns were recorded for five penguin species (Wilson *et al.* 1993), Imperial Shags (*Phalacrocorax atriceps*) and European Shags (*P. aristotelis*) (Wanless *et al.* 1999).

In contrast to these observations, Grémillet *et al.* (2005) found that Great Cormorants (*Phalacrocorax carbo*) are able to forage in the dark and do not modify their foraging rhythms according to light levels. Some seabird species have learned to use nocturnal light (moonlight and starlight) and frequently perform foraging dives at night (Regular *et al.* 2011). For example, Swallow-tailed Gulls (*Creagrus furcatus*) maximize their foraging activity during darker periods of the lunar cycle (Cruz *et al.* 2013) in response to the availability of their prey, which migrates toward deeper water during the day and to the surface at night (a phenomenon called diel vertical migrations; Zaret and Suffern 1976). Red-legged Kittiwakes (*Rissa brevirostris*) also concentrate their foraging during nighttime since their main prey, lanternfish (Myctophidae), are available at the surface during this period (Kokobun *et al.* 2015).

Even night foraging seems to be at least partially visually guided (Regular *et al.* 2011). Nocturnal birds have eye shapes that are maximized for visual sensitivity (Hall and Ross 2007) and are considered to be highly light sensitive (Montevecchi 2006). In addition to using moonlight, starlight (Johansen *et al.* 2001; Regular *et al.* 2011) or bioluminescence (Imber 1975) to detect their prey, seabirds are also known to exploit foraging grounds exposed to artificial light (Montevecchi 2006).

The continuous darkness lasting over 3 months during the Arctic polar night offers a perfect natural situation for observations and studies on light attraction in seabirds. Perception of polar ecosystems during the polar night has changed. Many of the ecosystem components remain active and ready for the reappearance of the sun (Berge *et al.* 2015a). Among these are seabirds – an important link in energy transfer in polar ecosystems (Zmudczyńska-Skarbek *et al.* 2015). The presence and activity of seabirds during Arctic polar night was reported for the first time only recently (Table 1). The objective of this paper is to report on opportunistic observations of seabirds foraging under artificial light conditions during the Arctic polar night.

METHODS

Study Area

Spitsbergen (78° 45′ 0″ N, 16° 0′ 0″ E) is the largest Island of the Svalbard Archipelago, located off the coast of Norway (Fig. 1). The western fjords of the island are under the influence of two current systems: 1) the warm, salty West Spitsbergen Current that branches off the North Atlantic Current; and 2) the colder nutrient-poor waters originating in the Arctic Ocean carried by the East Spitsbergen Current (Loeng 1991). The salinity regime in the surface water varies from 28 Practical Salinity Units (PSU) to 34 PSU (Nilsen *et al.* 2008), while the sea temperature ranges from -1.4 °C to +7 °C (Włodarska-Kowalczuk *et al.* 1999). The surface inshore fjord waters of the West Spitsbergen Shelf typically freeze for a few months in winter (November-May), while the outer part of the fjord remains generally ice free (Svendsen *et al.* 2002; Nilsen *et al.* 2008). In 2014-2017, the sea did not freeze in the study area. There is apparent darkness starting from November through February on Spitsbergen at latitudes above 78° N, while in northern Norway (69° N) and West Greenland (69° N), where foraging behavior of wintering Great Cormorants was observed (Johansen *et al.* 2001; Grémillet *et al.* 2005; Table 1), there is still considerable ambient light during the daytime (Berge *et al.* 2015b).

Observations

Seabird observations were made while performing other tasks in the field and thus were opportunistic. All of the observations took place during the darkest period and the middle of the polar night (15-23 January) in four consecutive years (2014-2017; Table 2). In the first two years, underwater observations were done while shallow diving (0-7 m, consisting of approximately 10 40- to 45-min dives each year) in Kongsfjorden in the vicinity of Ny-Ålesund harbor (78° 55′ 43.95″ N, 11° 56′ 00.96″ E; Fig. 1). In 2014, seabird behavior was recorded on video camera (see Acknowledgments section for details), while in 2015 it was captured on still photographs (Fig. 2). On each occasion, the two-diver teams were equipped with strong video lights visible on the surface and underwater from a distance of several meters. Apart from the light originating from divers, there were some other artificial light sources from harbor buildings. In 2016, seabirds were observed from on-board R/V Helmer Hanssen in an uninhabited area of Smeerenburgfjorden (79° 43′ 41.23″ N, 10° 58′ 16.68″ E; Fig. 1) with no artificial light sources except those of the ship. In 2017, observations were made in Isfjorden from the boat (M/S Farm) moored inside the Longyearbyen harbor (78° 14′ 23.00″ N, 15° 32′ 37.45″ E; Fig. 1). The sea water was lit by a hand flashlight and harbor lamps.

RESULTS

Both underwater and land observations indicated that Thick-billed Murres in 2014 (n = 1) and 2016 (n = 3) and Black Guillemots in 2015 (n = 2) and 2017 (n = 3) (Table 2) were foraging in the beam of artificial light (divers' lamps, flashlights, harbor lamps). During one of the 10 dives in 2014, an individual Thick-billed Murre was observed. It approached divers and dived around them near the sea surface and up to 3-5 m depth catching larger zooplankton organisms (krill, *Thysanoessa* spp.) that were easily visible in the illuminated water. On 19-20 January 2015, a juvenile Black Guillemot (n = 2) was observed during two of the 10 dives. The individual followed the divers and the beams of light for 2-3 min, diving several times to a depth of ~6-7 m searching for prey and catching small fish within the seaweed. Between 15-19 January 2017, juvenile Black Guillemots (n = 3) were observed from the boat moored in the harbor. These individuals appeared to be attracted by the boat lights/flashlights, approached and started to forage on plankton (Common Clione, *Clione limacina*) when the water was illuminated. During observations in Smeerenburg on 15-16 January 2016, Thick-billed Murres (n = 3) were attracted by light, but Dove-

Table 1. Literature summary of seabird observations during Arctic polar night (December-January). n/a = not applicable.

Date	Time	Location	Species (sample size)	Age	Observation Type	Behavior	Reference
Middle of Dec 1996 and Jan 1997	Day Night	Sørfjord, Norway, 69° N	Great Cormorant (n = 30)	n/a	From land	Actively foraging at sea	Johansen *et al.* 2001
Dec 2002-Jan 2003	Night Twilight Day	Disko Island, West Greenland, 69° N	Great Cormorant (n = 10)	n/a	Diving activity revealed by data loggers	Actively foraging at sea	Grémillet *et al.* 2005
19-20 Jan 2010	Mid-day	Kongsfjorden, Spitsbergen, Norway, 78° N	Dovekie (n = n/a) Black Guillemot (n = n/a) Northern Fulmar (n = n/a) Black-legged Kittiwake (n = n/a) Thick-billed Murre (n = n/a)	No data	From boat	Actively foraging at sea	Berge *et al.* 2012
21-23 Jan 2014	Mid-day Evening	Kongsfjorden, Spitsbergen, Norway, 78° N	Dovekie (n = 3) Northern Fulmar (n = 1) Glaucous Gull (n = 1) Thick-billed Murre (n = 3)	Adult	From boat	Actively foraging at sea Food content in stomachs	Berge *et al.* 2015a
23, 25 Jan 2015	Mid-day	Kongsfjorden, Spitsbergen, Norway, 78° N	Dovekie (n = 2) Black Guillemot (n = 1)	Juvenile	From boat	Actively foraging at sea Food content in stomach	Berge *et al.* 2015a

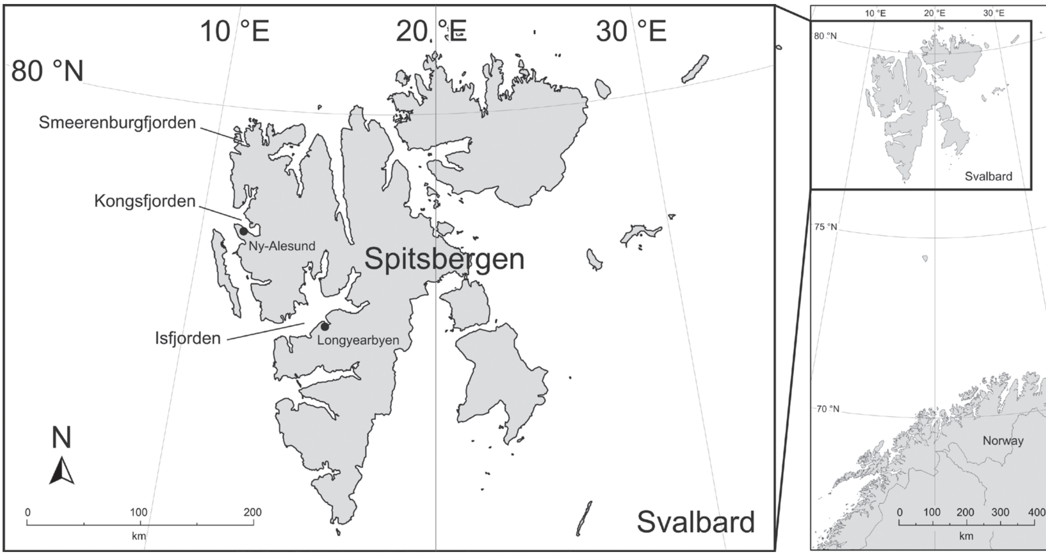

Figure 1. Locations of opportunistic observations of seabirds foraging under artificial light conditions during the Arctic polar night in the ocean around Spitsbergen Island, Svalbard Archipelago, Norway.

kies ($n = 2$) appeared to actively keep their distance and were always out of the range of the light. All of the birds (Black Guillemots, Thick-billed Murres and Dovekies) were recorded in Spitsbergen under continuously dark environmental conditions (Berge *et al.* 2012, 2015a, 2015b) (Table 2).

Discussion

Observations have indicated that artificial lights create additional feeding opportunities for both Thick-billed Murres and Black Guillemots (Montevecchi 2006). However, to date, the effect of light on Arctic seabirds has remained generally unknown (Humphries and Huettmann 2012), and no direct underwater observations of these species actively foraging during the darkest period of polar night had been conducted. Feeding in areas exposed to artificial nocturnal lighting is generally considered favorable for seabirds as this enhances food supply by attracting fish and zooplankton to the surface waters where it can be easily caught (Burke *et al.* 2005; Montevecchi 2006). It also provides sharp contrast against the completely dark environment that helps to target the prey.

Factors such as weather, season, ambient solar light conditions and lunar phase strongly influence attraction to sources of light. It is stronger, for example, during the night or at times of low cloud cover, and weaker on bright clear nights with a full moon (Telfer *et al.* 1987; Montevecchi 2006). Artificial lights would thus be expected to act as an especially intense stimulant for seabirds during polar night. The positive reaction of the seabirds to light could be explained by the need to detect bioluminescent prey items (Berge *et al.* 2012); seabirds feeding at night on vertically migrating bioluminescent prey are photosensitive, being attracted to light points in the sea (Imber 1975). Indeed, in studies on light-induced seabird strikes on vessels in Southwest Greenland (Merkel and Johansen 2011), a higher frequency of bird strikes was found during the darkest mid-winter period with reports of small numbers of Black Guillemot and Thick-billed Murre being killed in this way.

While attraction to artificial light has been observed in many different bird species (Harris *et al.* 1998; Rodríguez and Rodríguez 2009; Miles *et al.* 2010), not all seabirds respond positively to light. Dovekies, which were thought to be light at-

Table 2. Study observation summary of seabirds during Arctic polar night (January).

Date	Time	Location	Species (sample size)	Age	Observation Type	Behavior
23 Jan 2014	Evening	Ny-Ålesund harbor, Kongsfjorden, Spitsbergen, Norway, 78° N	Thick-billed Murre (n = 1)	Adult	While SCUBA diving, 0-5 m depth	Approaching scuba divers, diving and actively feeding in the beam of artificial light (diver's lamp, neighboring harbor)
19-20 Jan 2015	Mid-day	Ny-Ålesund harbor, Kongsfjorden, Spitsbergen, Norway, 78° N	Black Guillemot (n = 2)	Juvenile	While SCUBA diving, 0-7 m depth	Approaching scuba divers, diving and actively feeding in the beam of artificial light (diver's lamp, neighboring harbor)
15-16 Jan 2016	Mid-day	Smeerenburgfjorden, Spitsbergen, Norway, 78° N	Dovekie (n = 2) Thick-billed Murre (n = 3)	Adult	From boat (R/V Helmer Hanssen), stomach analysis	Thick-billed Murres attracted by light but not Dovekies, both species had food content in their stomachs
15-19 Jan 2017	Evening	Longyearbyen harbor, Isfjorden, Spitsbergen, Norway, 78° N	Black Guillemot (n = 3)	Juvenile	From boat (M/S Farm) moored in the harbor	Diving and actively feeding in the beam of artificial light (hand flashlights, ship's lights)

tracted (Wiese *et al.* 2001), seemed to actively avoid artificial light during our two observations. However, due to the limited number of observations, additional studies are needed to confirm this behavior. It is likely that there is some contribution from behavioral variation among individuals influencing their interactions with the environment (Roche *et al.* 2016). Individuals among one species can differ in personality and degree of behavioral plasticity (Roche *et al.* 2016). Age can also influence the attraction of birds to light. Some fledgling auks (Alcidae) are possibly more attracted to artificial light than adults (Montevecchi 2006). Older individuals may have learned to avoid artificial light sources, associating them with threats, while immature birds may be confused by incorrect visual orientation (Telfer *et al.* 1987) or environmental inexperience (Montevecchi 2006). Further studies could resolve this with more observations of a greater number of individuals. Interestingly, in the area where both the Dovekies and Thick-billed Murres were seen, food was found in their stomachs even though no other artificial light sources were present (Berge *et al.* 2015a; this study). This leaves open the question as to how these birds obtain their food and what strategies are used to survive in the unfavorable conditions of the Arctic polar night.

ACKNOWLEDGMENTS

The video of Thick-billed Murre behavior recorded in 2014 is available at http://youtu.be/Kq8TqQ_Ckqs. This study was performed according to and within the regulations enforced by the Norwegian Animal Welfare authorities, and no specific permissions were required, except for hunting of seabirds in 2016, which was conducted with permission from the Governor of Svalbard, given in accordance with the environmental protection regulations for Svalbard. The authors are grateful to Jakub Szuster, who assisted in diving, and two anonymous reviewers whose comments led to an improved manuscript. The Research Council of Norway (Marine Night, 226417) and the Polish Ministry of Science and Higher Education (W157/Norway/2013) provided funding. Kaja Ostaszewska has been supported as a Ph.D. student by the Centre for Polar Studies, KNOW - Leading National Research Centre, Poland.

Figure 2. Actively feeding juvenile Black Guillemot in the beam of a diver's lamp in January 2015 in the Ny-Ålesund harbor on Spitsbergen Island, Svalbard Archipelago, Norway. The same individual is shown on both photographs. Photos by Piotr Balazy.

LITERATURE CITED

Berge, J., A. S. Båtnes, G. Johnsen, S. M. Blackwell and M. A. Moline. 2012. Bioluminescence in the high Arctic during the polar night. Marine Biology 159: 231-237.

Berge, J., M. Daase, P. E. Renaud, W. G. Ambrose, Jr., G. Darnis, K. S. Last, E. Leu, J. H. Cohen, G. Johnsen, M. A. Moline and others. 2015a. Unexpected levels of biological activity during the polar night offer new perspectives on a warming Arctic. Current Biology 25: 2555-2561.

Berge, J., P. E. Renaud, G. Darnis, F. Cottier, K. Last, T. M. Gabrielsen, L. Seuthe, J. M. Weslawski, E. Leu, M. Moline and others. 2015b. In the dark: a review of ecosystem processes during the Arctic polar night. Progress in Oceanography 139: 258-271.

Burke, C. M., G. K. Davoren, W. A. Montevecchi and F. K. Wiese. 2005. Surveys of seabirds along support vessel transects and at oil platforms on the Grand Banks. Pages 587-614 *in* Offshore Oil and Gas Environmental Effects Monitoring: Approaches and Technologies (S. L. Armsworthy., P. J. Cranford and K. Lee, Eds.). Batelle Press, Columbus, Ohio.

Cruz, S. M., M. Hooten, K. P. Huyvaert, C. B. Proaño, D. J. Anderson, V. Afanasyev and M. Wikelsk. 2013. At-sea behavior varies with lunar phase in a nocturnal pelagic seabird, the Swallow-Tailed Gull. PLOS ONE 8: e56889.

Grémillet, D., G. Kuntz, C. Gilbert, A. J. Woakes, P. J. Butler and Y. le Maho. 2005. Cormorants dive through the polar night. Biology Letters 1: 469-471.

Hall, M. I. and C. F. Ross. 2007. Eye shape and activity pattern in birds. Journal of Zoology 271: 437-444.

Harris, M. P., S. Murray and S. Wanless. 1998. Long-term changes in breeding performance of Puffins *Fratercula arctica* on St Kilda. Bird Study 45: 371-374.

Humphries, G. R. W. and F. Huettmann. 2012. Global issues for, and profiles of, Arctic seabird protection: effects of big oil, new shipping lanes, shifting baselines and climate change. Pages 217-245 *in* Protection of the Three Poles (F. Huettmann, Ed.). Springer Japan, Tokyo, Japan.

Imber, M. 1975. Behavior of petrels in relation to the moon and artificial lights. Notornis 22: 302-306.

Jetz, W., J. Steffen and K. E. Linsenmair. 2003. Effects of light and prey availability on nocturnal, lunar and seasonal activity of tropical nightjars. Oikos 103: 627-639.

Johansen, R., R. T. Barrett and T. Pedersen. 2001. Foraging strategies of Great Cormorants *Phalacrocorax carbo carbo* wintering north of the Arctic Circle. Bird Study 48: 59-67.

Kokobun, N., T. Yamamoto, D. M. Kikuchi, A. Kitaysky and A. Takahashi. 2015. Nocturnal foraging by Red-legged Kittiwakes, a surface feeding seabird that relies on deep water prey during reproduction. PLOS ONE 10: e0138850.

Loeng, H. 1991. Features of the physical oceanographic conditions of the Barents Sea. Polar Research 10: 5-18.

Merkel, F. R. and K. L. Johansen. 2011. Light-induced bird strikes on vessels in Southwest Greenland. Marine Pollution Bulletin 62: 2330-2336.

Miles, W., S. Money, R. Luxmoore and R. W. Furness. 2010. Effects of artificial lights and moonlight on petrels at St. Kilda. Bird Study 57: 244-251.

Montevecchi, W. A. 2006. Influences of artificial light on marine birds. Pages 94-113 *in* Ecological Consequences of Artificial Night Lighting (C. Rich and T. Longcore, Eds.). Island Press, Washington, D.C.

Nilsen, F., F. Cottier, R. Skogseth and S. Mattsson. 2008. Fjord-shelf exchanges controlled by ice and brine production: the interannual variation of Atlantic Water in Isfjorden, Svalbard. Continental Shelf Research 28: 1838-1853.

Regular, P. M., A. Hedd and W. A. Montevecchi. 2011. Fishing in the dark: a pursuit-diving seabird modifies foraging behaviour in response to nocturnal light levels. PLOS ONE 6: e26763.

Roche, D. G., V. Careau and S. A. Binning. 2016. Demystifying animal 'personality' (or not): why individual variation matters to experimental biologists. Journal of Experimental Biology 219: 3832-3843.

Rodríguez, A. and B. Rodríguez. 2009. Attraction of petrels to artificial lights in the Canary Islands: effects of moon phase and age class. Ibis 151: 299-310.

Svendsen, H., A. Beszczynska-Møller, J. O. Hagen, B. Lefauconnier, V. Tverberg, S. Gerland, J. B. Ørbek, K. Bischof, C. Pappucci, M. Zajaczkowski and others. 2002. The physical environment of Kongsfjorden-Krossfjorden, an Arctic fjord system in Svalbard. Polar Research 21: 133-166.

Telfer, T. C., J. L. Sincock, G. V. Byrd and J. R. Reed. 1987. Attraction of Hawaiian seabirds to lights: conservation efforts and effects of moon phase. Wildlife Society Bulletin 15: 406-413.

Wanless, S., S. K. Finney, M. P. Harris and D. J. McCafferty. 1999. Effect of the diel light cycle on the diving behaviour of two bottom feeding marine birds: the blueeyed shag *Phalacrocorax atriceps* and the European shag *P. aristotelis.* Marine Ecology Progress Series 188: 219-224.

Wiese, F. K., W. A. Montevecchi, G. K. Davoren, F. Huettmann, A. W. Diamond and J. Linke. 2001. Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin 42: 1285-1290.

Wilson, R. P., K. Pütz, C. A. Bost, B. M. Culik, R. Bannasch, T. Reins and D. Adelung. 1993. Diel dive depth in penguins in relation to diel vertical migration of prey - whose dinner by candlelight? Marine Ecology Progress Series 94: 101-104.

Włodarska-Kowalczuk, M., M. Szymfeling and L. Kotwicki. 1999. Macro-and meiobenthic fauna of the Yoldiabukta glacial bay (Isfjorden, Spitsbergen). Polish Polar Research 20: 367-386.

Zaret, T. M. and J. S. Suffern. 1976. Vertical migration in zooplankton as a predator avoidance mechanism. Limnology and Oceanography 21: 804-813.

Zmudczyńska-Skarbek, K., P. Balazy and P. Kuklinski. 2015. An assessment of seabird influence on Arctic coastal benthic communities. Journal of Marine Systems 144: 48-56.