

# NOCTURNAL FLIGHT ACTIVITY BY NORTHERN GANNETS *MORUS BASSANUS* IN RESPONSE TO PREDATOR DISTURBANCE

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## ABSTRACT

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The Northern Gannet *Morus bassanus* typically flies only during the day, with minimal flight activity following civil twilight. Here we document nocturnal flight activity by Northern Gannets in response to predation risk by Eastern Coyotes *Canis latrans*. Eight parental gannets were fitted with GPS/time-depth recorders on 15 July 2021 at mainland nest sites at Cape St. Mary's, Newfoundland, Canada. Previously, among 506 foraging trips in 2019 and 2020 that were investigated using biologging, only two were initiated at night, suggesting nocturnal departures for foraging are very rare at this colony. Then, however, killings of chicks by coyotes occurred within our study plot on 24 July 2021. From 24 July to 20 August 2021, we recorded 51 instances of nocturnal departures from the colony during which individuals rested on the water overnight and returned to the colony by the following morning without foraging, which we deem to be a response to predator disturbance. The predation and nocturnal anti-predator flight behaviour recorded in this study is indicative of the risks associated with mainland nesting by colonial seabirds.

**Key words:** Northern Gannet, *Morus bassanus*, nocturnal flight activity, predation, coyotes

## INTRODUCTION

Northern Gannets *Morus bassanus* are typically diurnal foragers during the breeding season. They usually exhibit minimal flight activity during civil twilight following sunset, and flight activity is negligible during nautical twilight, astronomical twilight, and night (Garthe *et al.* 1999, 2000, 2003, 2014; Hamer *et al.* 2000, 2007; Warwick-Evans *et al.* 2015, 2018; Furness *et al.* 2018).

Limiting their nesting sites to isolated islands and steep coastal cliffs is a strategy that gannets, like most seabird species, have apparently adopted in part to avoid mammalian predation (Clode 1993). However, the protection provided by these isolated refuges can be circumvented by introduced or invasive predators. For instance, canids such as foxes and coyotes have preyed on seabird colonies following their introduction or incursion to islands by swimming or travelling on sea ice (Sklepkovich & Montevecchi 1996, Burke *et al.* 2011, Mackinnon & Kennedy 2014, Montevecchi *et al.* 2019).

Eastern Coyotes *Canis latrans* arrived on the island of Newfoundland in 1985, likely via sea ice (Blake 2006). Their numbers subsequently increased, and they have recently become a threat to the gannet colony at Cape St. Mary's Ecological Reserve. During 2016 and 2018, coyotes killed adults and chicks nesting on mainland cliffs (Montevecchi *et al.* 2019).

The incursion of mammalian predators into a seabird colony can induce novel or atypical predator avoidance behaviour, as observed, for example, among Cape Gannets *Morus capensis* when the presence of predatory Cape fur seals *Arctocephalus pusillus* increased owing to the seals' population recovery (Courbin *et*

*al.* 2022). We documented nocturnal flight activity by Northern Gannets during the breeding season at Cape St. Mary's, which likely occurred in response to the presence of a nocturnally active predator, the Eastern Coyote.

## METHODS

### Study site

Cape St. Mary's Ecological Reserve, Newfoundland, Canada (46.81°N, 054.18°W), is home to approximately 15 000 breeding pairs of Northern Gannets (Chardine *et al.* 2013, d'Entremont *et al.* 2022). The gannets nest on an isolated sea stack known as Bird Rock, as well as on adjacent mainland cliffs. The mainland portion of the colony has increased steadily since an initial expansion in the 1980s (Montevecchi & Wells 1984), and approximately half of the breeding pairs at this colony are located on the mainland (S.I. Wilhelm pers. comm.). This mainland expansion has resulted in a portion of the colony being at risk of predation by terrestrial predators. For example, coyote predation occurred in 2016 (30 adults and 38 chicks killed) and in 2018 (20 adults and 22 chicks killed; Montevecchi *et al.* 2019).

### GPS tagging

We attached solar-powered GPS/time-depth recorders (GPS/TDR; URIA 300 LPS, Ecotone, Poland) to the innermost four rectrices of eight parental Northern Gannets on a mainland cliff site on 15 July 2021 using Tesa® tape and cable ties. The GPS units weighed 13.5 g and measured 36×22×12.5 mm. Once attached, they comprised < 0.5% of the average weight of the tagged gannets (3338 g ± 412 g, standard deviation) and 0.17% of their frontal area (Pennycuik

2008), where tag effects on animal behaviour are considered minimal (Geen *et al.* 2019). Tags were set to record GPS positions every 15 minutes and dive depth once per second while tags were submerged. An Ecotone base station was deployed at the colony within 100 m of tagged birds to allow for remote data collection. The tags also recorded when each tagged bird was in range of the base station, allowing for detection of departure and arrival times at the colony. Nocturnal departures associated with overnight absences in 2021 were compared with departure times of foraging trips by gannets nesting on the same ledges in 2020 and 2019, when coyote predation was not observed. Tag application followed the same protocols in those years (KJND & WAM unpubl. data).

### Observations

Killings of gannet chicks at our study site were first reported by staff at Cape St. Mary's Ecological Reserve on 24 July 2021 ( $n = 12$ ). Subsequent predation was reported on 25 July ( $n = 5$ ) and 28 July ( $n = 4$ ). Additionally, predated chicks were found above mainland nesting sites, ~200 m to the east of the tagging site on 24 July ( $n = 7$ ) and 28 July ( $n = 3$ ). Chicks were found with cranial puncture wounds near the back of the neck (Fig. 1A) and were cached, either singly or in groups, near the nesting sites on the mainland cliffs (Fig. 1B). The puncture wounds and caching behaviour are consistent with kills of adults and pre-fledgling chicks by coyotes observed at this location in 2016 and 2018 (Montevecchi *et al.* 2019). Though a red fox *Vulpes vulpes* den was near the reserve's interpretation centre in 2019, the remains of only Black Guillemots *Cephus grylle* and Common Murres *Uria aalge* were seen near the den (KJND pers. obs.), suggesting predation risk to gannets by foxes has been low. Coyote sightings were also reported in July 2021 on the road leading to the reserve, and several sheep were killed by coyotes ~10 km away in the village of St. Bride's (C. Mooney & W. Careen pers. comm.). By 28 July 2021, all eight GPS tagged parental gannets had lost their chicks due to predation. Though carcasses of 31 chicks were found, no adult kills were recorded.



**Fig. 1.** (A) A freshly killed Northern Gannet *Morus bassanus* chick with a cranial puncture wound near the back of the neck; (B) several freshly killed Northern Gannet chicks, some cached in small holes in the ground. Both photos were taken the morning of 28 July 2021 by Kyle d'Entremont.

### Data analysis

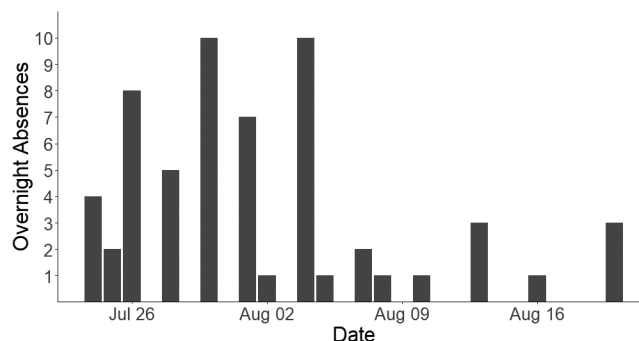
Overnight absences that were not associated with foraging were determined manually. GPS/TDR data were examined for excursions that did not involve plunge dives and that began within 30 minutes of sunset; during civil, nautical, or astronomical dusk; or at night. Overnight absences ended when a bird returned to the colony by the following morning without foraging. Foraging trips (e.g., trips away from the colony that involved plunge dives) that began with other overnight departures were also recorded. However, dives associated with these trips occurred only during daylight hours following their initial nocturnal departure. Eastern coyotes are most active from within an hour before sunset until an hour after sunrise (Andelt & Gipson 1979), so sudden departures by gannets at these times were likely due to coyote presence.

Departure times of all overnight absences from the colony were assigned as having occurred during daylight, daylight within 30 minutes from sunset, civil twilight, nautical twilight, astronomical twilight, or night using Time and Date (2022). The average maximum distance from the colony for each overnight absence was calculated for departures that occurred during each of these light phases. GPS locations were displayed using ArcGIS Pro version 2.7.0 (ESRI, USA).

### RESULTS AND DISCUSSION

From 24 July to 20 August 2021, we recorded 51 instances of overnight absences from the colony that began within the 30 minutes before sunset or later (Figs. 2, 3). These overnight absences were initiated on the first day that freshly killed gannet chicks were observed above the cliff site where parental gannets were tagged (24 July 2021). All birds rested on the ocean surface following departure during these absences. Each of the eight tagged individuals had at least four overnight absences from the colony during this time span.

Of the 51 overnight absences associated with predator presence, 2.0% departed during nautical twilight ( $n = 1$ ), 23.5% during civil twilight ( $n = 12$ ), 29.4% departed during daylight within ~30 min of sunset ( $n = 15$ ), and 45.1% departed during the night ( $n = 23$ ). Of these 51 overnight absences, 15.7% ( $n = 8$ ) ended during astronomical twilight, 66.7% ( $n = 34$ ) ended during nautical twilight, 13.7% ( $n = 7$ ) ended during civil twilight, and 3.9% ( $n = 2$ ) ended during daylight. The average maximum distance travelled from the colony during these absences varied depending on the light



**Fig. 2.** Counts of overnight absences by parental Northern Gannets *Morus bassanus* from a mainland nesting site at Cape St. Mary's, Newfoundland, Canada, from 24 July to 20 August 2021.

TABLE 1

**Synchronous departure times (NST = Newfoundland Standard Time, 24-hour clock) of overnight absences by six individual Northern Gannets *Morus bassanus* from mainland nesting cliffs at Cape St. Mary's, Newfoundland, Canada on 04 August 2021**

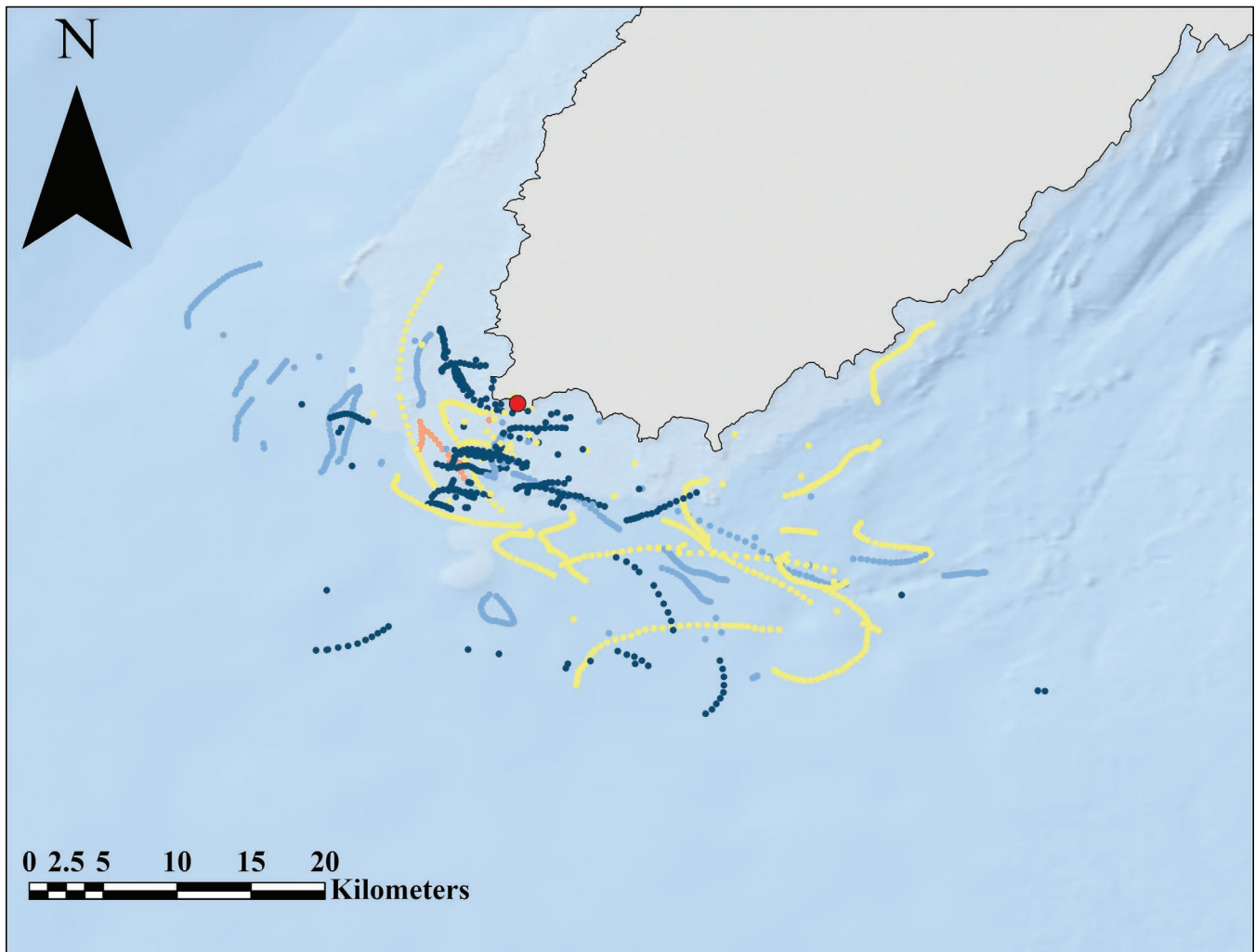
Individual	Departure Time (NST)
NEW02	2021-08-04 02:41:00
NEW08	2021-08-04 02:41:23
NEW04	2021-08-04 02:42:24
NEW03	2021-08-04 02:44:09
NEW05	2021-08-04 02:46:00
NEW06	2021-08-04 02:52:32

phase at departure: 15.1 km for daylight within 30 minutes from sunset, 13.5 km for civil twilight, and 7.4 km for night.

Departure times were typically synchronous among individuals, occurring within at least 30 minutes of one another. In one

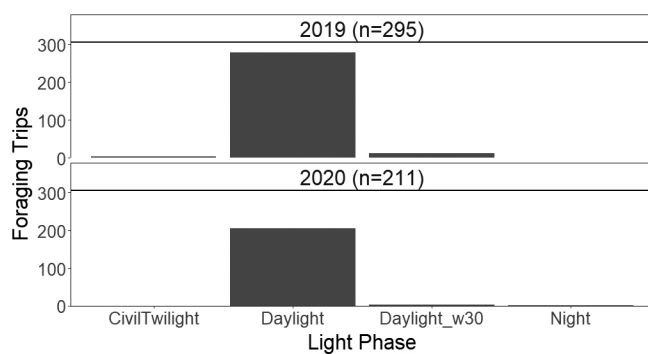
instance, six individuals fled the colony within 10 minutes of each other, at ~2:40 am Newfoundland Standard Time (Table 1). In addition to the overnight absences, we also recorded five foraging trips in which gannets departed synchronously during the night with other individuals engaging in non-foraging absences and rested on the ocean surface until daylight. This synchrony in nocturnal colony departure when gannets are typically at rest (Table 1), combined with the documented killings of gannet chicks when this behaviour began to arise, suggest a response to predation risk and to predator presence.

In response to the invasion of novel predators, seabirds need to alter their behaviour to avoid predation, which Cape Gannets did in their flight behaviour (e.g., Courbin *et al.* 2022). In this study, we have shown that Northern Gannets exhibit atypical nocturnal flight activity in response to predation risk from invasive Eastern coyotes. Though we recorded only eight individuals departing the colony at night, apparently due to predation risk, it is likely that many more individuals exhibited this behaviour—the site with our tagged birds was home to upwards of 50 breeding pairs, most of which had chicks that were predated by mid-August (KJND pers. obs.).



**Fig. 3.** GPS locations from all 51 non-foraging overnight absences recorded in 2021. GPS locations are color coded by the light phase at time of departure: dark blue = night, orange = nautical twilight, light blue = civil twilight, and yellow = daylight within 30 minutes of sunset (Daylight\_w30). The red dot signifies the location of Cape St. Mary's Ecological Reserve, Newfoundland, Canada.





**Fig. 4.** Recorded light phases at time of departure for all 506 foraging trips by parental Northern Gannets *Morus bassanus* ranging from Cape St. Mary's, Newfoundland, Canada, in 2019 and 2020.

The coincidence of our presence in the colony and the onset of predation by the coyotes suggests that researcher disturbance may have stimulated the incursion of coyotes in the area, as increased levels of human activity have been linked to increases in coyote presence (Lewis *et al.* 2021). However, prior coyote predation events in 2016 and 2018 occurred with minimal researcher presence at the colony (Montevecchi *et al.* 2019). Additionally, the ecological reserve is a major tourist attraction, with hundreds of tourists on site during the peak tourism season from July to September.

Across 506 recorded foraging trips by Northern Gannets ranging from Cape St. Mary's in 2019 and 2020, when predation of chicks or adults was not recorded during the breeding season, only two trips began during the night (Fig. 4). These two instances of overnight departures for foraging trips both occurred late in the breeding season (05 October 2019 and 26 September 2020) and could have been linked to colony detachment, as their chicks may have fledged by this point. Though no documented killings of gannets or their chicks were documented in 2019 and 2020, it is still possible that these overnight departures also could have been linked to undetected coyote presence and predation risk, as previous killings by coyotes have occurred at Cape St. Mary's in late September (Montevecchi *et al.* 2019). As seabirds have likely experienced selection pressure against nesting at mainland sites to avoid mammalian predators (Clode 1993), the anti-predator nocturnal flight behaviour documented in our study is indicative of risks for seabirds nesting in mainland colonies.

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## REFERENCES

- ANDELT, W.F. & GIPSON, P.S. 1979. Home range, activity, and daily movements of coyotes. *The Journal of Wildlife Management* 43: 944–951. doi:10.2307/3808278
- BLAKE, J. 2006. *Coyotes in Insular Newfoundland: Current Knowledge and Management of the Islands Newest Mammalian Predator*. St. John's, Canada: Newfoundland and Labrador Department of Environment and Conservation, Wildlife Division.
- BURKE, C.M., HEDD, A., MONTEVECCHI, W.A. & REGULAR, P.M. 2011. Effects of an Arctic Fox visit to a Low Arctic seabird colony. *Arctic* 64: 302–306.
- CHARDINE, J.W., RAIL, J.-F. & WILHELM, S. 2013. Population dynamics of Northern Gannets in North America, 1984–2009. *Journal of Field Ornithology* 84: 187–192.
- CLODE, D. 1993. Colonially breeding seabirds: Predators or prey? *Trends in Ecology and Evolution* 8: 336–338.
- COURBIN, N., PICHEGRU, L., SEAKAMELA, M. ET AL. 2022. Seascapes of fear and competition shape regional seabird movement ecology. *Communications Biology* 5: 208. doi:10.1038/s42003-022-03151-z
- D'ENTREMONT, K.J.N., GUZZWELL, L.M., WILHELM, S.I. ET AL. 2022. Northern Gannets (*Morus bassanus*) breeding at their southern limit struggle with prey shortages as a result of warming waters. *ICES Journal of Marine Science* 79: 50–60. doi:10.1093/icesjms/fsab240
- FURNESS, R.W., GARTHE, S., TRINDER, M., MATTHIOPOULOS, J., WANLESS, S. & JEGLINSKI, J. 2018. Nocturnal flight activity of Northern Gannets *Morus bassanus* and implications for modelling collision risk at offshore wind farms. *Environmental Impact Assessment Review* 73: 1–6. doi:10.1016/j.eiar.2018.06.006
- GARTHE, S., BENVENUTI, S. & MONTEVECCHI, W.A. 2000. Pursuit plunging by Northern Gannets (*Sula bassana*) feeding on capelin (*Mallotus villosus*). *Proceedings of the Royal Society B* 267: 1717–1722.
- GARTHE, S., BENVENUTI, S. & MONTEVECCHI, W.A. 2003. Temporal patterns of foraging activities of Northern Gannets, *Morus bassanus*, in the northwest Atlantic Ocean. *Canadian Journal of Zoology* 81: 453–461.
- GARTHE, S., GRÉMILLET, D. & FURNESS, R.W. 1999. At-sea activity and foraging efficiency in chick-rearing Northern Gannets (*Sula bassana*): a case study in Shetland. *Marine Ecology Progress Series* 185: 93–99.
- GARTHE, S., GUSE, N., MONTEVECCHI, W.A., RAIL, J.-F. & GRÉGOIRE, F. 2014. The daily catch: flight altitude and diving behaviour of Northern Gannets feeding on Atlantic mackerel. *Journal of Sea Research* 85: 456–462.
- GEEN, G.R., ROBINSON, R.A. & BAILLIE, S.R. 2019. Effects of tracking devices on individual birds—a review of the evidence. *Journal of Avian Biology* 50: e01823. doi:10.1111/jav.01823
- HAMER, K.C., HUMPHREYS, E.M., GARTHE, S. ET AL. 2007. Annual variation in diets, feeding locations and foraging behaviour of gannets in the North Sea: flexibility, consistency and constraint. *Marine Ecology Progress Series* 338: 295–305.
- HAMER, K.C., PHILLIPS, R.A., WANLESS, S., HARRIS, M.P. & WOOD, A.G. 2000. Foraging ranges, diets and feeding locations of gannets *Morus bassanus* in the North Sea: Evidence from satellite telemetry. *Marine Ecology Progress Series* 200: 257–264.

- LEWIS, J.S., SPAULDING, S., SWANSON, H. ET AL. 2021. Human activity influences wildlife populations and activity patterns: implications for spatial and temporal refuges. *Ecosphere* 12: e03487. doi:10.1002/ecs2.3487
- MACKINNON, C.M. & KENNEDY, A.C. 2014. Decline in breeding of the Great Black-backed Gull, *Larus marinus*, and the Herring Gull, *L. argentatus*, on Boot Island, Nova Scotia, 1986 to 2010. *The Canadian Field-Naturalist* 128: 165–172. doi:10.22621/cfn.v128i2.1581
- MONTEVECCHI, W., POWER, K., WHITE, E. ET AL. 2019. Eastern coyote *Canis latrans* predation on adult and pre-fledgling Northern Gannets *Morus bassanus* nesting on mainland cliffs at Cape St. Mary's, Newfoundland, Canada. *Marine Ornithology* 47: 39–42.
- MONTEVECCHI, W.A. & WELLS, J. 1984. Mainland expansion of the Northern Gannet colony at Cape St. Mary's, Newfoundland. *American Birds* 38: 259–262.
- PENNYCUICK, C.J. 2008. *Modelling the flying bird, 1st Edition*. London, UK: Academic Press.
- SKLEPKOVYCH, B.O. & MONTEVECCHI, W.A. 1996. Food availability and food hoarding behaviour by Red and Arctic Foxes. *Arctic* 49: 228–234.
- TIME AND DATE. 2022. *St. John's, Newfoundland and Labrador, Canada—Sunrise, Sunset, and Daylength*. Stavanger, Norway: Time and Date AS. [Accessed at <https://www.timeanddate.com/sun/canada/st-johns> on 19 January 2022.]
- WARWICK-EVANS, V., ATKINSON, P.W., GAUVAIN, R.D., ROBINSON, L.A., ARNOULD, J.P.Y. & GREEN, J.A. 2015. Time-in-area represents foraging activity in a wide-ranging pelagic forager. *Marine Ecology Progress Series* 527: 233–246.
- WARWICK-EVANS, V., ATKINSON, P.W., WALKINGTON, I. & GREEN, J.A. 2018. Predicting the impacts of windfarms on seabirds: an individual based model. *Journal of Applied Ecology* doi:10.1111/1365-2664.12996
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