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Remote-sensing technology for monitoring seabird predators – monitoring the presence of predators and kleptoparasites in two contrasting Black Guillemot colonies in Northern Ireland

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Birds Science People

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Remote-sensing technology for monitoring seabird predators — monitoring the presence of predators and kleptoparasites in two contrasting Black Guillemot colonies in Northern Ireland

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EXECUTIVE SUMMARY

1. Offshore islands are important breeding habitats for the UK and Ireland's seabird populations but are disproportionately affected by introduced mammalian predators such as rats and mice.
2. Populations of burrow- and crevice- nesting seabirds such as Black Guillemots (*Cepphus grylle*) are especially vulnerable to invasive mammal predation due to the accessibility of their nests. Black Guillemots breed on Rathlin Island Special Protection Area (SPA), County Antrim, which hosts Northern Ireland's most significant seabird assemblage.
3. The Rathlin Acting for Tomorrow (LIFE Raft) partnership project (2021–2026) has been working to eradicate invasive Brown Rats (hereafter 'Rat', *Rattus norvegicus*) and Ferrets (*Mustela furo*) for the benefit of Rathlin Island SPA's internationally important seabird colonies and to enable wider native species recovery.
4. Because disturbance and mortality to seabirds caused by predators is likely to occur when human observers are absent, they are challenging to detect and monitor. Added to this, the often remote and difficult terrain of seabird colonies increases the challenge of making consistent direct observations. Hence, motion-triggered camera traps (hereafter, 'camera traps'), which can be left in the field to passively collect observations of predators, can be useful in monitoring the effectiveness of eradication programmes in seabird colonies.
5. To complement the aims of the LIFE Raft project, this study trialled the use of camera traps to assess predator presence in two Black Guillemot colonies to inform the conservation management of this seabird species. Study areas included the colony on Lighthouse Island (part of the Copeland Islands SPA), which is free from non-native mammals and where active nest sites were confirmed; and the Church Bay colony on Rathlin Island, pre-eradication where cameras were deployed before active nest sites were confirmed.
6. Remote cameras were effective in capturing potential conflict species (hereafter 'conflict species'), regarded as species which may cause mortality or injury to adults or chicks based on previous literature. These species were observed on 98% of the total study days, with nine species observed on Lighthouse Island and five on Rathlin.
7. Conflict species including Hooded Crow (*Corvus cornix*), Herring Gull (*Larus argentatus*), Raven (*Corvus corax*), Magpie (*Pica pica*), Otter (*Lutra lutra*), and Rat were captured investigating Black Guillemot nest sites, predating on Manx Shearwaters (*Puffinus puffinus*), and interacting with Black Guillemots through kleptoparasitism (food theft).
8. No predation of Black Guillemot adults, eggs or chicks was observed with camera traps, suggesting that in the focal locations in this pilot, direct predation may not occur frequently enough to be recorded using the methodology deployed here, or may not be observable using the current methodology.
9. Rathlin's distinct colony topography led to a different camera installation method as compared to Lighthouse Island. As a result, fewer conflict species were observed on Rathlin, as no active nests were captured on the deployed cameras.
10. Traditional monitoring in combination with nest checks, installation of cameras with a larger field of view, closer to confirmed active nests and minimising the probability of non-target species presence may help to record more informative data on predation pressures on Black Guillemots in further studies.

1. Background and aims

Offshore islands provide particularly important breeding habitats for the UK's globally significant seabird populations. In Northern Ireland, islands support the majority of the country's total populations of some cliff-nesting species, including Common Guillemot (hereafter 'Guillemot', *Uria aalge*), Razorbill (*Alca torda*), Shag (*Gulosus aristotelis*) and burrow-nesting species such as Manx Shearwater (*Puffinus puffinus*) and Atlantic Puffin (hereafter 'Puffin', *Fratercula arctica*), based on the Northern Ireland Seabird Report data (El Haddad & Upton 2025). However, island ecosystems are disproportionately affected by invasive alien species, which are the primary driver of island extinctions (Bellard *et al.* 2016, Blackburn *et al.* 2004, Doherty *et al.* 2016). Consequently, eradication programmes of introduced mammal species on islands can be an effective management tool with long-term benefits to seabird populations (Brooke *et al.* 2018, Cooper *et al.* 1995, Jones *et al.* 2016, Medina *et al.* 2011, Ratcliffe *et al.* 2010, Robinson 2015).

Rathlin Island Special Protection Area (SPA) is home to Northern Ireland's largest seabird colony, supporting the UK and Ireland's largest Guillemot colony and third-largest Razorbill colony (Burnell *et al.* 2023, El Haddad & Upton 2025). Despite its national importance, Rathlin Island hosts populations of introduced Brown Rats (hereafter, 'Rats' *Rattus norvegicus*) and Ferrets (*Mustela furo*), which can reduce seabird breeding success through the predation of eggs, chicks and adults (Bodey *et al.* 2011, Challies 2015, Ratz *et al.* 1999). Burrow- and crevice-nesting species are particularly vulnerable to mammal predation, because their nests are often located in low-lying areas which are easily accessed by small mammals (Ewins 1985, Johnston *et al.* 2020, Jones *et al.* 2008, Lock 2006, Zonfrillo 2002). Recent data from Rathlin indicates a stable Puffin population, record numbers of Black Guillemots (El Haddad & Upton 2025) and confirmed breeding of Manx Shearwaters on Rathlin for the first time since 1988 (Baldwin 2013, Brooke 2010, Else pers. comm.), although these may be due to increased survey effort and coverage. Predation pressure can directly impact breeding success (Lambert *et al.* 2021), survival (Johnston *et al.* 2020) and reduce nest site availability (Nordström & Korpimäki 2004), hence understanding the source of this pressure can have direct implications for developing conservation measures.

The Rathlin Acting for Tomorrow (LIFE Raft) project is a partnership between the Royal Society for the Protection of Birds (RSPB) Northern Ireland, Rathlin Development and Community Association, Causeway Coast and Glens Borough Council, Causeway Coast and Glens Heritage Trust, and the Department of Agriculture, Environment and Rural Affairs (DAERA). This project is funded by EU LIFE [**LIFE20 NAT/UK/00LIFE20 NAT/UK/0003490349**]; National Lottery Heritage Fund, and DAERA. Launched in 2021, LIFE Raft partners have been working to eradicate introduced Rats and Ferrets from Rathlin Island over a period of five years (LIFE RAFT 2021). This eradication programme is expected to lead to increases in the populations of Rathlin SPA breeding seabirds, especially ground-nesting species which are most vulnerable to terrestrial predators, such as Razorbill, Manx Shearwater, Puffin, Guillemot, Black Guillemot and several gull species. It is unknown whether the Rathlin Black Guillemot population is impacted by Rats and Ferrets, whether native predator presence is a driver of population change and consequently whether predator eradication will provide a benefit to the Black Guillemot colony on Rathlin. As only invasive alien species (Rats and Ferrets) have been targeted by the LIFE Raft project, native predators of Black Guillemots will remain present but potentially undetected in seabird colonies. Black Guillemots in Northern Ireland are vulnerable to native predators including Herring Gull (*Larus argentatus*), Hooded Crow (*Corvus cornix*) and Otter (*Lutra lutra*), and invasive alien species such as American Mink (hereafter 'Mink', *Neogale vision*) among others (Craik 1995, Ewins 1985, Foster 2011, Hario 2001, Nordström *et al.* 2002). Wildlife monitoring during and post-eradication is vital to provide evidence of the effectiveness of introduced predator eradication as a conservation method, which has important ethical considerations regarding the justification of culling one species in favour of another (Woinarski 2019), and the associated concerns over animal welfare (Cowan & Warburton 2011). Quantitative studies assessing the effectiveness of eradications, especially concerning native species' responses to eradication programmes, have often been limited because monitoring data can be resource intensive and difficult to obtain (Bird *et al.* 2019). This is often due to the type of nesting site, e.g. for species nesting in burrows and crevices which are more difficult to monitor, and the inaccessibility of many colonies e.g. on remote offshore islands (Frederiksen *et al.* 2025). A potential solution to this problem may be the use of remote-sensing technologies (Frederiksen *et al.* 2025).

Motion-triggered remote cameras (hereafter, 'camera traps') have become more commonly used for seabird monitoring in recent years (Cutler & Swann 1999, Edney & Wood 2021, Glover-Kapfer *et al.* 2019). Camera traps are particularly useful in monitoring predator presence in seabird colonies (Rendall *et al.* 2014) and to directly observe nest predation by native and invasive mammals and birds (Bird *et al.* 2021, Black 2018, Edney & Wood 2021, Johnston 2019, Johnston *et al.* 2020, Jones *et al.* 2018). This non-observer-based method may reduce time and monetary investment and disturbance to colonies (Frederiksen *et al.* 2025). The camera traps' infra-red lighting also provides an opportunity to capture activity of nocturnal predators not typically detected during daytime observations (Dilley *et al.* 2013, Johnston *et al.* 2020). Systematic monitoring of predator activity during the LIFE Raft project is essential to evaluate its effectiveness and to optimise remote-sensing techniques for future monitoring.

Therefore, this study tests the use of camera traps in the Church Bay Black Guillemot colony, located near the Rathlin harbour (55.294073 N, -6.206249 W; Figure 2b), to assess the presence and potential interactions of predators on Rathlin Island SPA. This approach complements traditional monitoring for introduced mammalian predators during the LIFE Raft project, namely wax blocks (for gnaw marks) and a grid of camera traps targeting areas outside of seabird colonies, allowing for a comparison of the efficacy of these methods. Camera traps were also deployed on Lighthouse Island (54.695228 N, -5.5221480 W; Figure 2a), part of the Copeland Islands SPA, which also hosts a colony of Black Guillemots, mainly nesting in easily accessible, ground-level artificial nest boxes. Lighthouse Island was selected as a comparative site to Rathlin as it does not host non-native predators and therefore can be used to contrast the extent of predation exposure arising from native predators only.

This project aims to: (1) use camera traps to monitor predator presence within the Black Guillemot colony on Rathlin Island, (2) collect concurrent data in a colony free from non-native mammalian predators on Lighthouse Island, to better understand native predation exposure in a well-established Black Guillemot colony in Northern Ireland and (3) compare and contrast the effectiveness of the monitoring methodologies between the two island colonies.

2. Methods

2.1. Camera deployment

Browning Recon Force Elite HP4 trail cameras fitted with SanDisk Extreme 256 GB memory cards were mounted on wooden stands at a height of approximately 75 cm. Seven cameras were deployed on Lighthouse Island on 14 May 2023 and six on Rathlin Island on 15 May 2023 (Figure 1). Camera settings were as follows: operation mode – trail cam; photo quality – default; photo delay – one second; multi shot mode – three photos three seconds apart (single shot mode on Lighthouse Island until 17 June); motion detection – normal; trigger speed – fast (0.1 seconds). Cameras were deployed initially on Lighthouse Island with a single-shot mode. However, after discussion with RSPB NI staff on Rathlin Island, Rathlin cameras were set to three-shot mode, and the Lighthouse Island cameras were adjusted accordingly at the earliest available opportunity. It is not expected that this will affect the proportional frequency of triggers much, however it may result in some faster trigger events being missed early in deployment for the Lighthouse Island cameras. Deployments targeted June and July which encompass incubation and chick rearing, when nests are vulnerable to predation. After preliminary observation of the colony to establish the location of potential nests and pinch-points for ground predator access, cameras were mounted with views over potential nest sites. Due to logistical constraints, cameras were deployed at both sites prior to egg-laying, and therefore the status of focal nest sites was unknown. The positioning of the cameras differed between Rathlin Island

and Lighthouse Island, due to the different topographies of the two colonies (Figure 2). Due to the presence of invasive mammals, Black Guillemots on Rathlin Island primarily nest within cliff fissures, making the observation of nests more difficult. Because of this, installation of cameras was limited to one area of the colony that was readily accessible on foot and cameras were trained on ground level areas close to the cliff (Figure 3a) to capture passing wildlife. Where possible, cameras were positioned overlooking areas observed to include, or be close to, former Black Guillemot Apparently Occupied Sites (AOS), as assessed on a reconnaissance visit in July 2021, or near crevices deemed potentially suitable as Black Guillemot nest sites. As a result, cameras on Rathlin did not capture active nest sites. On Lighthouse Island, where the majority of Black Guillemots nest in well-known crevices and artificial nest boxes, cameras were positioned to include multiple nest sites, in areas known to frequently contain active nests (Figure 3b).

Figure 1. Map of the study sites, Rathlin Island and Lighthouse Island (Northern Ireland) labelled in red.

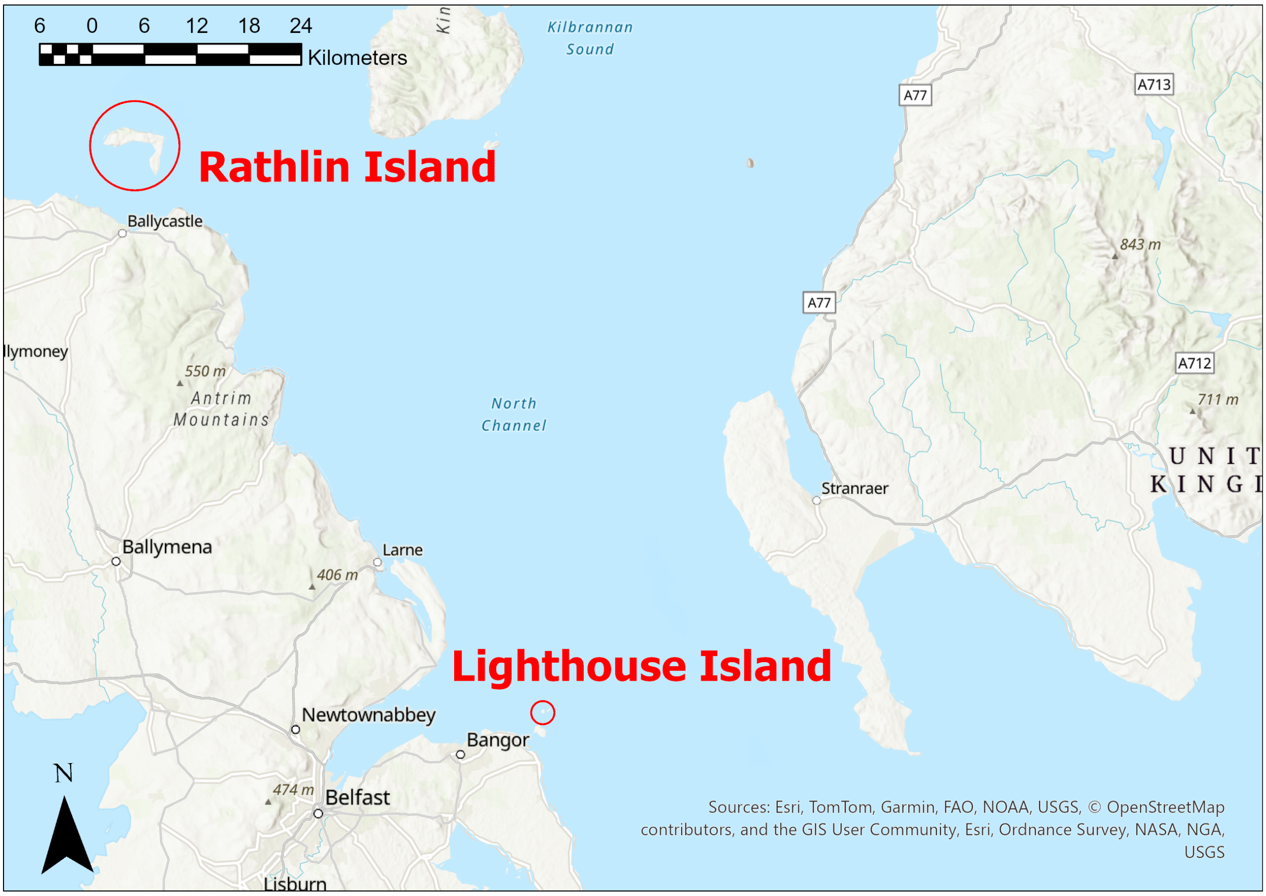
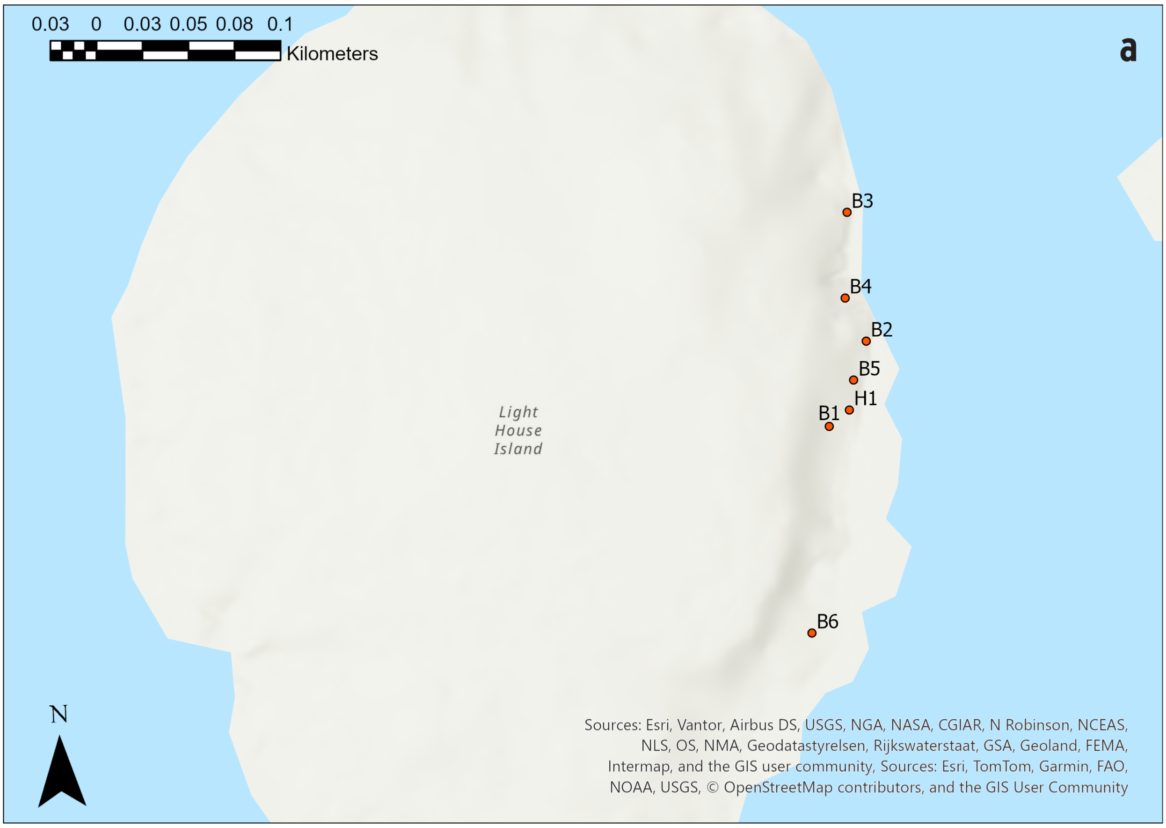


Figure 2. Locations of five camera traps installed on (a) Rathlin Island, and (b) seven camera traps on Lighthouse Island, Copeland Islands.



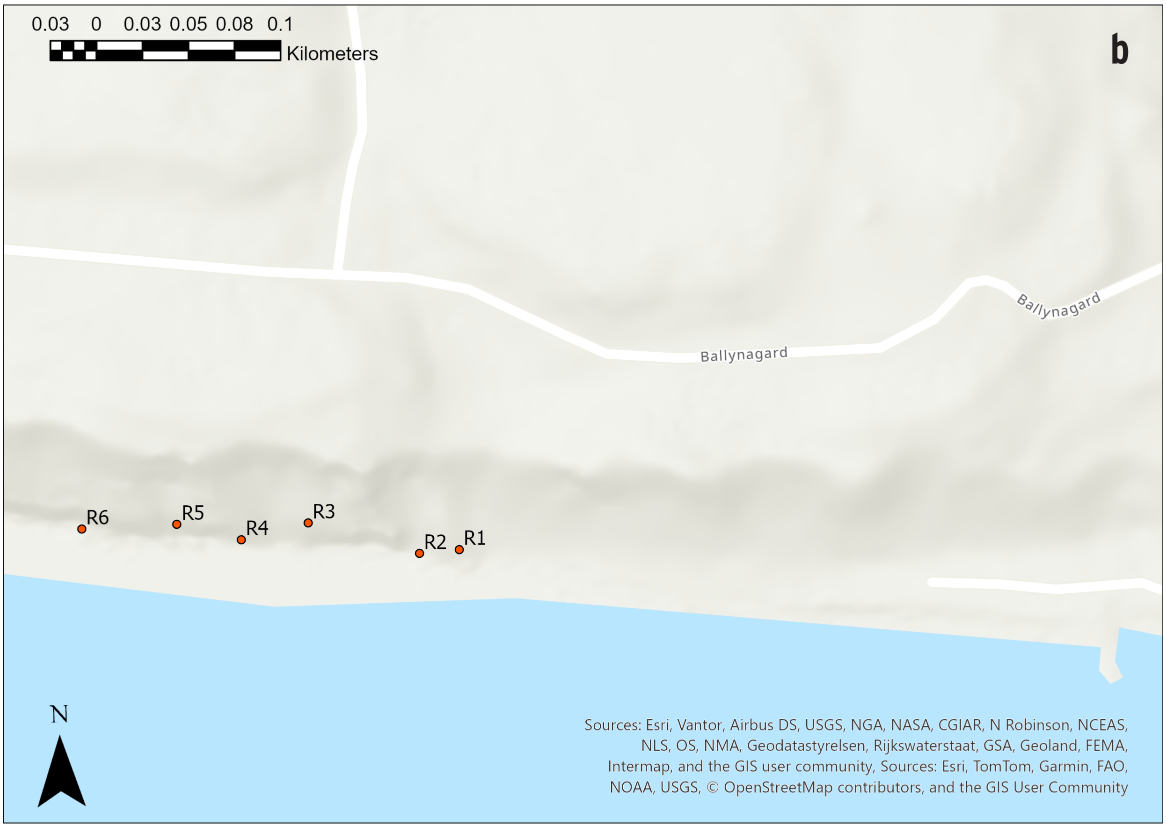


Figure 3. Example set ups of (a) Camera R3 on Rathlin Island and (b) Camera B5 on Lighthouse Island.

2.2. Image analysis

Images were assessed manually by two experienced observers, to maintain consistency of recording across the images. Vegetation growing in front of Camera B5 on Lighthouse Island obstructed the view of 131,757 photos, so these were removed during analysis. Where the image contrast in night-firing events obscured the target (especially on Rathlin Island, where the reflectance from the cliff limestone caused the background of the image to be very dark), images were edited in GIMP version 2.10.34 (The GIMP Development Team 2026) to improve the visibility of the trigger target. For each individual image, the date and time were extracted, and images were categorised by 'Activity' (Table 1). This category defines images by trigger, with the following options: Black Guillemot, human, camera operation, other species, multiple species. When 'other species' or 'multiple species' were recorded, images were further categorised by the species triggering the image. When there was more than one non-Black Guillemot species in shot, up to one additional species was recorded with priority given to species with potential to: predate Black Guillemot adults or nests, kleptoparasitise provisioning Black Guillemots, cause disturbance to Black Guillemot adults or nests, or to the species that triggered the camera first, in that order or priority. The general behaviours of non-Black Guillemot species were recorded, but behaviours of Black Guillemots were not recorded for this study.

Table 1. Categories of activities and behaviours identified within image analysis.

Category	Option	Description
Activity	Black Guillemot	One or more Black Guillemot present in frame
	Camera operation	Triggers associated with camera set up or maintenance
	Human	Human
	Other species	One or more single species (non-Black Guillemot, non-Human) present in frame
	Multiple species	Two or more species present in frame, including Black Guillemot or Human
Other species behaviour	Loafing/Foraging	Resting, preening, exploring, foraging
	Passing	Actively transitioning through frame without engaging in other behaviour
	Visiting potential nest	Target species is in close proximity to a potential Black Guillemot nest site (e.g. nest box, suitable crevice)
	Nest investigated	Target species appearing to look into potential Black Guillemot nest
	Confirmed feeding	Target species observed feeding
	Unconfirmed feeding	Target species observed potentially feeding, but view obscured
	Predation	Predation event observed
	Birds harassed/conflict	Conflict interaction between species
	Neutral interaction	Non-conflict interaction between species
	Scavenging	Target species observed with potentially scavenged food item
	Other	Other (see notes column in dataset for further details)

2.3. Data analysis

All analyses were performed in R version 4.5.2 (R Core Team 2025). Data wrangling was carried out using the dplyr (Wickham *et al.* 2023), readxl (Wickham & Bryan 2025) and tidyverse (Wickham *et al.* 2019) packages. Graphs were generated with the ggplot2 package (Wickham 2016); maps were made in ArcGIS Pro software version 3.4.2 (Esri 2025).

Frequencies of the species detected were counted by the number of photographs they appeared in, and separate visits were classed based on consecutive photos featuring the same species. A new separate visit was classified if the species pictured changed or if there was a time gap of more than five minutes between photographs. Species were assigned as neutral or potential conflict species (hereafter 'conflict species', defined as species which may cause mortality or injury to adults or chicks) based on previous literature. These include Hooded Crow, Herring Gull, Raven (*C. corax*), Magpie (*Pica pica*), Lesser Black-backed Gull (*L. fuscus*), Great Black-backed Gull (*L. marinus*), Black-headed Gull (*Chroicocephalus ridibundus*), Common Gull (*L. canus*), Otter, Brown Rat, Wood Mouse (*Apodemus sylvaticus*), Domestic Dog (*Canis lupus familiaris*) and Domestic Cat (*Felis catus*). Gaps between sightings of species were calculated by grouping chronological days by camera and counting the number of hours since last detection, summarised as mean gaps per individual camera.

For three of the cameras deployed on Lighthouse Island, the timestamp was set incorrectly, therefore the date and time of each image was calculated post-hoc using the timestamp of the location record as a reference. This is estimated to be correct within 30 minutes. Camera R5 on Rathlin experienced constant interference from Domestic Goats (*Capra hircus*, hereafter 'Goats') and was pushed down rendering subsequent footage unusable for predator presence detection. It was later moved to a nearby location to prevent being dislodged again. Therefore, data from Camera R5 were excluded from further species composition and frequency analyses to avoid skewing the data towards Goat presence.

3. Results

In total 426,909 images were taken over a total of 92 days by six cameras on Rathlin and seven cameras on Lighthouse Island. From 15 May to 2 August, 96,450 photos were taken on Rathlin, and 330,459 were taken on Lighthouse Island from 14 May to 13 August. In total, 88% of analysed photos (259,274) were taken in June and July, when Black Guillemot nests are most vulnerable to predation and kleptoparasitism. This camera trap trial was effective in observing predator presence in colonies, with conflict species captured on 90 out of 92 days (98%) across both islands. Predator presence rates were similar between the islands, with conflict species observed on 77 out of 79 days (97%) on Rathlin, and on 84 out of 92 days (91%) on Lighthouse Island. Mean gaps between sightings of conflict species were low on all cameras except for Camera R2 on Rathlin, which had the highest mean gap of two days (Figure 4).

Cameras on Lighthouse Island recorded a higher species richness than on Rathlin Island (38 species and 20 species respectively; Table 2), of which nine and five were classified as conflict species respectively. Lighthouse Island hosted a higher diversity of avian predators compared to Rathlin, including Raven, Hooded Crow, Magpie, Herring Gull, Lesser Black-backed Gull, Common Gull, Great Black-backed Gull and Black-headed Gull. All except for the Herring Gull were absent from the footage taken on Rathlin, which was in contrast dominated by mammalian species including Goat, Rat, Wood Mouse, Domestic Dog and Domestic Cat, although no Ferrets were captured in the footage. It's worth noting that 9,977 images of Puffins were captured, which is a new species to Lighthouse Island. Footage showed Puffins engaging in pre-breeding behaviours, such as collecting nesting material and investigating potential nest sites. Puffins were first confirmed to breed on Lighthouse Island in 2015, following a successful conservation project that used sound lures and decoys to encourage the establishment of a new Puffin colony (Wolsey & Smyth 2017).

No direct predation events on Black Guillemot adults, chicks or eggs were observed on either island. All predation events recorded were of Manx Shearwater adults, with six occurrences of Otter predation (Figure 5), and one by Raven, all on Lighthouse Island. On one occasion, Hooded Crows were observed to carry and leave a presumed chick of an unidentified gull species on Lighthouse Island, which was later predated by a Raven. More instances of conflict species visiting potential nests were observed on Lighthouse Island, including visits by Hooded Crow (103), Herring Gull (90), Raven (40), Magpie (32), Lesser Black-backed Gull (14), Common Gull (7), Otter (5), and Great

Black-backed Gull (3). On Rathlin Island, five instances of investigation of potential nest sites were recorded, two involving Rats (Figure 8) and three involving Goats, and no conflicts were observed. As active breeding sites were only observed directly within the camera view on Lighthouse Island, interactions between Black Guillemots and conflict species could only be observed there and involved native avian predators. Seven instances of kleptoparasitism of Butterfish (also known as Rock Gunnel, *Pholis gunnellus*) involved Herring Gulls (Figure 6) and one involved a Hooded Crow, similarly Ravens and Hooded Crows were observed in antagonistic interactions with Black Guillemots, causing them to leave the nest area. In total eight conflicts were recorded, and Black Guillemots returned to the colony within a maximum of 31 minutes of these interactions.

An unexpected behaviour pattern was observed almost exclusively on Camera B5 on Lighthouse Island. In total 40 individual events were recorded of birds (mostly corvids) perching and/or interacting with the camera trap or the post it was mounted on (Figure 7). This behaviour was observed only on Lighthouse Island, with 39 events recorded by Camera B5 (Figure 3b) and one event by Camera H1, installed nearby (Figure 2a). While many birds perching on the camera could not be identified, the majority that exhibited this behaviour were Hooded Crows, with a mean continuous perching duration of 2.2 minutes, and a maximum time of 37 minutes spent perching in one instance.

Figure 4. Mean gap (hours) between sightings of conflict species for each camera with standard error bars. Cameras installed on Lighthouse Island and on Rathlin Island are coloured in blue and green respectively.

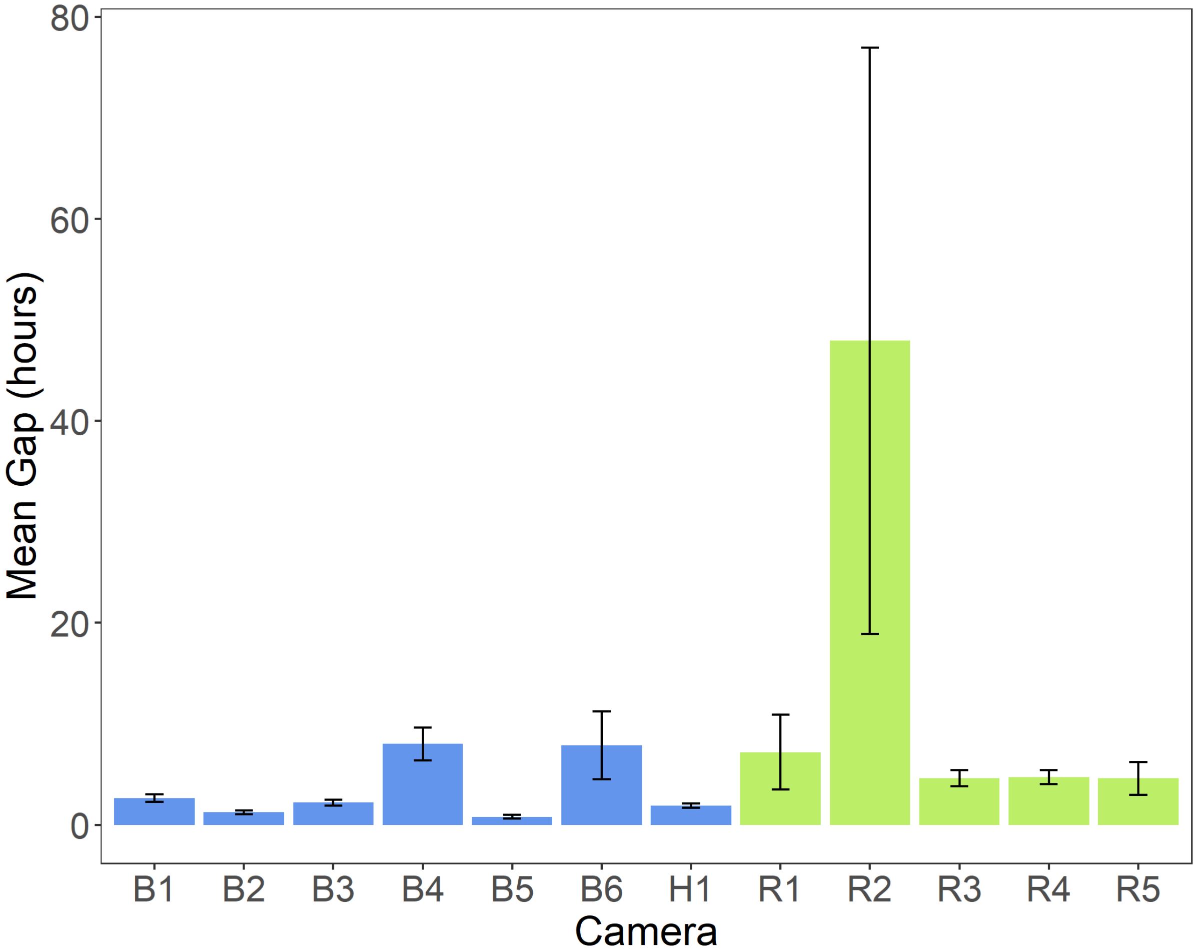


Figure 5. Camera trap photograph of Otter predation of a Manx Shearwater on Lighthouse Island.

Figure 6. Camera trap photographs of Herring Gull engaging in kleptoparasitism of Butterfish with an adult Black Guillemot on Lighthouse Island.

Figure 7. Camera trap photograph of a Raven interacting with the B5 Camera and/or post on Lighthouse Island.

Figure 8. Camera trap photograph of a Rat approaching a potential Black Guillemot nesting crevice on Rathlin Island.

Table 2a. Composition and frequency of species recorded on Lighthouse Island, possible conflict species are highlighted in pale orange.

Common name	Scientific name	Photos	Visits
Black Guillemot	*Cepphus grylle*	143,091	*
Puffin	*Fratercula arctica*	9,977	12
Rabbit	*Oryctolagus cuniculus*	8,385	62
Starling	*Sturnus vulgaris*	4,857	11
Hooded Crow	*Corvus cornix*	3,926	74
Woodpigeon	*Columba palumbus*	3,762	11
Unidentified passerine	Passeriformes *sp.*	1,713	15
Stock Dove	*Columba oenas*	1,613	21
Herring Gull	*Larus argentatus*	1,534	19
Raven	*Corvus corax*	1,325	12
Magpie	*Pica pica*	966	15
Unidentified bird		857	25
Unidentified pigeon/dove	*Columba* sp.	964	6
Unidentified animal		842	10
Unidentified gull	Laridae sp.	830	7
Oystercatcher	*Haematopus ostralegus*	709	8
Lesser Black-backed Gull	*Larus fuscus*	509	11
Common Gull	*Larus canus*	375	9
Rock Pipit	*Anthus petrosus*	226	17
Juvenile large gull	Larus sp.	197	4
Otter	*Lutra lutra*	127	10
Eider	*Somateria mollissima*	83	2
Pheasant	*Phasianus colchicus*	67	3
Manx Shearwater	*Puffinus puffinus*	63	24
Human	*Homo sapiens*	54	1
Great Black-backed Gull	*Larus marinus*	51	5
Feral Pigeon	*Columba livia domestica*	20	2
Dunnock	*Prunella modularis*	13	3
Skylark	*Alauda arvensis*	13	1
Shag	*Gulosus aristotelis*	10	1
Red Admiral	*Vanessa atalanta*	7	1
Pied Wagtail	*Motacilla alba yarrellii*	6	3
Bumblebee	Bombus sp.	5	2
Unidentified corvid	Corvus sp.	5	1
Blackbird	*Turdus merula*	4	2
Unidentified auk	Alcidae sp.	4	1
Water Rail	*Rallus aquaticus*	4	1
Black-headed Gull	*Chroicocephalus ridibundus*	3	2
Robin	*Erithacus rubecula*	3	1
Unidentified mammal	Mammalia sp.	3	3

Fulmar	*Fulmarus glacialis*	2	1
Shelduck	*Tadorna tadorna*	2	1
Swift	*Apus apus*	2	1
Butterfly	Lepidoptera sp.	1	1
Razorbill	*Alca torda*	1	1
Wren	*Troglodytes troglodytes*	1	1

Table 2b. Composition and frequency of species recorded on Rathlin Island, conflict species highlighted in pale red.

Species	Scientific name	Photos	Visits
Black Guillemot	*Cepphus grylle*	155	*
Domestic Goat	*Capra hircus*	39,477	491
Brown Rat	*Rattus norvegicus*	1,192	348
Rabbit	*Oryctolagus cuniculus*	870	105
Rock Pipit	*Anthus petrosus*	381	92
Wood Mouse	*Apodemus sylvaticus*	289	99
Herring Gull	*Larus argentatus*	159	37
Pied Wagtail	*Motacilla alba yarrellii*	116	30
Domestic Dog	*Canis lupus familiaris*	66	7
Blackbird	*Turdus merula*	63	4
Unidentified rodent	Muridae sp.	34	8
Shag	*Gulosus aristotelis*	33	1
Shelduck	*Tadorna tadorna*	17	1
Oystercatcher	*Haematopus ostralegus*	15	4
Domestic Cat	*Felis catus*	12	2
Unidentified passerine	Passeriformes sp.	10	4
Pygmy Shrew	*Sorex minutus*	6	2
Wren	*Troglodytes troglodytes*	6	2
Goldfinch	*Carduelis carduelis*	3	1
Grey Wagtail	*Motacilla cinerea*	3	1
Starling	*Sturnus vulgaris*	3	1
Wheatear	*Oenanthe oenanthe*	3	1

*Unique visits of individual Black Guillemots could not be accurately estimated due to the presence of multiple individuals in most photographs which flew away and returned frequently.

4. Discussion

Monitoring is essential to understand the impact of invasive mammal eradication programmes (Bird *et al.* 2019). This trial of using camera traps to provide baseline data on predator presence within the Rathlin Black Guillemot colony to support the LIFE Raft eradication programme on Rathlin Island was effective in detecting predator presence, capturing conflict species almost every day. The methodology was also effective on Lighthouse Island, despite differences in terrain and vegetation cover between the two sites. While the rates of predator presence between Rathlin Island and Lighthouse Island were similar, the species assemblage and behaviour differed significantly. A higher diversity of conflict species was observed on Lighthouse Island, especially in the assemblage of native avian predators, which is likely due to the proximity of camera traps to active nests on Lighthouse Island, and potentially due to differences in vegetative cover between the two locations. Conflict species were captured predating on Manx Shearwaters, interacting with Black Guillemots through kleptoparasitism, and investigating nest sites. No predation of Black Guillemot adults, eggs or chicks was observed with camera traps at either study site, suggesting that in the focal locations studied in this pilot, direct predation may not occur frequently enough to be recorded using the methodology deployed, or may not be observable using the current methodology.

4.1. Differences in assemblage of conflict species between Rathlin Island and Lighthouse Island colonies

Predator activity on Rathlin is expected to be different from that of Lighthouse Island, owing to the presence of non-native mammal species on Rathlin during this trial. Lighthouse Island, which is free from introduced mammal species, hosted a higher diversity of avian conflict species compared to Rathlin, which was in contrast dominated by mammalian conflict species, both introduced and domesticated. This was likely partially due to the difference in colony topography and in camera installation methodologies between the islands. Firstly, the Church Bay Black Guillemot colony on Rathlin is mostly located at height, within an inaccessible limestone cliff with a largely vegetation-free boulder-field between the cliff and the sea. The nest boxes and natural cavities of the Lighthouse Island colony are set along a ground-level rocky coast with stony outcrops that is well vegetated with campion, bracken and small elder trees. It is therefore likely that the more diverse habitat surrounding the Lighthouse Island colony, and the deployment of cameras at accessible, confirmed nest sites led to a greater diversity of bird species, particularly of generalist foragers, being captured on Lighthouse Island. Species such as Hooded Crows, Ravens and large gulls are commonly observed on Rathlin Island, so their absence from the footage collected in this study may be due to cameras being installed at potential nest sites before they were confirmed to be active and/or because of camera deployment at ground-level (away from high nests) to capture passing wildlife. Opportunistic omnivorous species such as corvids and gulls are more likely to congregate around active nest sites or find food sources elsewhere. Hence it is possible that corvids and gulls were present in Rathlin's Church Bay colony, but were not observed in the footage due to the difficulty of installing cameras close to active Black Guillemot nests in the cliff face. This demonstrates that while camera traps can in some cases alleviate issues common to traditional monitoring practices, such as visiting effort, disturbance and accessibility issues, the terrain and location of focal subjects are also important to consider with respect to the aims of the study. Hence, the topographical differences in camera installation between the islands may explain the relative lack of predator (especially avian) presence and activity on Rathlin.

Surprisingly, no Ferrets were observed on camera trap footage from Rathlin Island, despite being one of the main targets of the LIFE Raft project and the fact that the present study was carried out before the Ferret eradication on Rathlin Island. It is possible that Ferrets were present at low densities in the Church Bay Black Guillemot colony, but camera traps failed to capture them. Mustelids are considered difficult to monitor even with passive camera traps, because they are small and fast-moving (Glen *et al.* 2013). Some studies show that camera trap-based detection of mustelids can be improved by using scent-lured and enclosed camera traps, although the success of capture using these methods differs by mustelid species (Croose *et al.* 2025, Otte *et al.* 2025). It is also possible that Ferrets were not captured in the current trial because they concentrate their activity in areas with greater vegetation cover (Ragg & Moller 2000) and therefore avoid open cliff- and beach-based habitats, where cameras were installed in this study. The low number of Ferrets trapped in the aforementioned habitats during the Ferret eradication in winter of 2021 on Rathlin (Else pers. comm.) supports the possibility of low Ferret activity near Black Guillemot nesting areas.

The differences in predator assemblage between the two islands are important to consider when designing conservation mitigations for Black Guillemots and other burrow-nesting species. Avian predators and native mammals such as Otters are less likely to have catastrophic effects on nesting seabirds because they are less able to access most crevice nests unlike smaller predators such as Mink and Rats (Johnston *et al.* 2020). Camera traps were effective at capturing Rat activity in the Rathlin colony with 348 separate visits recorded. Therefore, repeating the methodology from this pilot after the eradication would contribute to evaluating the effectiveness of the LIFE Raft eradication programme in reducing or removing Rats from the colony area. However, evidence to support Rat eradication as an effective conservation measure from within the UK is often correlative or anecdotal. While a global review of 112 studies found a 25.3% increase in seabird productivity after predator removal, eradication did not ensure the reversal of the predicted population declines for more than half of the bird species considered (Lavers *et al.* 2010), suggesting that external factors such as food availability can have major impacts on seabird breeding success, as observed on Rathlin in 2025 (Else *et al.* 2025). Evidence for the effectiveness of eradication programmes is mixed, with some studies observing no significant benefits to seabird productivity (Côté & Sutherland 1997, O'Hanlon & Lambert 2016). For example, Lambert *et al.* (2021) found that in areas of the Isle of Rum where rodenticide was applied to reduce Rat presence, the negative impact of Wood Mouse on Manx Shearwater breeding success increased, reducing the positive impact of removing Rats. Despite this, evidence suggests that ground-, crevice- and burrow-nesting seabird species are particularly vulnerable to mammalian, and specifically Rat predation (Bell *et al.* 2011, 2019, Buxton *et al.* 2015, Goodwin 2021, Hobson *et al.* 1999, RSPB England 2019), and hence are most likely to benefit from Rat eradication. Overall, while the removal of predators from seabird colonies may reduce adult and chick mortality, therefore increasing colony resilience (Alexander *et al.* 2025), other conservation strategies are necessary in combination with predator eradication to ensure population recoveries (Lavers *et al.* 2010).

4.2 Predation and conflicts observed between Black Guillemots and other species

While direct predation of Black Guillemots was not detected, Otters were observed predating on Manx Shearwaters on Lighthouse Island on six occasions throughout this study. Individual Otters are opportunistic and may favour specific food items depending on their seasonal abundance (Reid *et al.* 2013), including nesting seabirds during the breeding season. While Otters occasionally take Black Guillemots (Ewins 1985), they predominantly hunt at night (Penteriani *et al.* 2025), so the nocturnal and relatively immobile on land Manx Shearwaters may make for more accessible prey when they return to their nests at night (Deakin *et al.* 2022, Reid *et al.* 2013, Riou & Hamer 2008) than the diurnal Black Guillemots (Hildén 1994). Another possibility is that the depredated Manx Shearwaters captured by camera traps in this trial were near-fledging juveniles, which are difficult to distinguish from adults (Harris 1966) and are vulnerable to nocturnal predators while the parents forage at sea (Gillies *et al.* 2021). Manx Shearwaters nest in soil burrows (Riou & Hamer 2008), which can be excavated by Otters (Stuntz & Orben 2025), whereas Black Guillemots on Lighthouse Island nest in rocky crevices, which tend to suffer little Otter predation (Quinlan 1983), or in nestboxes which roosting Black Guillemot parents can aggressively defend from predators. For these reasons Manx Shearwaters are more vulnerable to predation by Otters than Black Guillemots, as observed on the neighbouring island of Mew, Copeland, where an individual Otter predated on an estimated 325 Manx Shearwaters versus 11 Black Guillemots while raiding their nests in the spring of 2011 (Leonard 2011, Reid *et al.* 2013). This still contributed to the reduction of Black Guillemot reproductive success from 70–80% in the previous year to 21.4% (Leonard 2011, Reid *et al.* 2013). Therefore, Otters have the potential to impact both the Black Guillemot and the Manx Shearwater populations on Lighthouse Island, especially if the seasonal predation observed in the current study continues in the future.

Most conflict incidents with Black Guillemots involved Herring Gulls, which were observed stealing Butterfish, attacking adult Black Guillemots and investigating potential nests. Large gulls often displace smaller seabirds from their nesting habitat (Crowell & Crowell 1946, Howes & Montevecchi 1993, Nisbet *et al.* 2013, Scopel & Diamond 2017) and may affect reproductive success by predating on seabird eggs and young chicks and through kleptoparasitism (Brockmann & Barnard 1979, Furness 1987). Kleptoparasitism can reduce reproductive success through the loss of food provisioned to the chick and due to increased energetic costs in adults caused by avoidance and escape behaviours (Finney *et al.* 2001). In the past, Herring Gulls were controlled on Lighthouse Island, however this has since ceased as they are now a conservation priority species in Ireland (Amber-listed in the Birds of Conservation Concern in Ireland, Gilbert *et al.* 2021) due to breeding population declines caused by Avian botulism in the late 1980s (El Haddad & Upton 2025, Lynas *et al.* 2007) and are Red-listed in the UK because of declines in their non-breeding population (Stanbury *et al.* 2024). Despite this, Herring Gull numbers have been steadily increasing locally on Lighthouse Island and the surrounding areas, with the County Down population rising by 222% since the Seabird 2000 census (Burnell *et al.* 2023, Mitchell *et al.* 2004). Therefore, the presence of Herring Gulls is important to consider as an increasing pressure on Black Guillemot populations on predator-free offshore islands such as Lighthouse Island.

4.3 Limitations and recommendations for future research

This camera trap trial was effective in monitoring the presence of predators in the colonies but failed to record nest predation events of Black Guillemot adults or chicks, indicating that either the predation risk is low for Black Guillemots across both islands, or that there were limitations to the methodology that made detecting predation challenging. Firstly, Lighthouse Island cameras were initially set up with single shot mode and later switched to three shot mode, therefore some species and/or events may have been missed by the cameras. Secondly, due to logistical constraints, cameras were deployed prior to egg-laying based on previous nesting locations, meaning that not all sites may have been active nests, affecting the amount of nest predation that could potentially be observed. This is further supported by camera traps recording very little footage of animals visiting or investigating potential nests on Rathlin compared to Lighthouse Island. Because of the lack of active breeders in the camera views on Rathlin, conflict species were less likely to investigate potential nests and therefore depredate them, as they are usually attracted to the smell and calls of chicks in active nests. Therefore, deploying cameras on active nests or confirming whether the nest is active through subsequent nest checks may provide more accurate data of predator presence and/or predation in seabird colonies. However, it is important to balance research aims and the potential impacts to the study species through disturbance, as the installation of camera traps during the most sensitive periods of bird reproduction may delay the laying date, therefore affecting breeding success (López-López 2022). Secondly, confirming predation events may require regular nest checks in combination with the camera-trap monitoring, unless nest contents can be reliably captured on camera. For example, Johnston *et al.* (2020) observed an Otter close to the nest site in several photographs but were only able to confirm predation after a chick was subsequently found to be missing during a nest check. Predator identity can also be confirmed through the visual inspection of seabird remains during nest checks (e.g. wing remains from Otter predation). In future research, incorporating regular nest checks in the camera trap monitoring may improve detection of Black Guillemot nest predation.

Another aspect that should be considered in future research is the possible effect of camera trap presence on animal behaviour and breeding success. There were frequent observations of avian predators (mostly corvids) perching on or interacting with the camera mounts for a maximum of 30 minutes at one time, meaning the equipment may have created an artificial perch. This can negatively affect Black Guillemot breeding success as it creates a viewpoint for predators to hunt from and may increase the time that conflict species spend around the nest, possibly resulting in a higher risk of nest predation. This was demonstrated by an experiment in the Arctic tundra, where trail cameras attracted corvids and caused a significant increase in the rate of predation on artificial nests in comparison to nests without cameras installed (Henden *et al.* 2025). Corvids are generalist predators with good learning skills (Sonerud & Fjeld 1987) and may be attracted to any new anthropogenic structures as they signal availability of human food subsidies (Henden *et al.* 2025). Furthermore, there is often a lack of suitable perches available for predators such as corvids on offshore islands. Because perching behaviour was mostly observed on one camera on Lighthouse Island (Camera B5), it may suggest that the problem lies not within the study design itself, but in the location and surrounding habitat of that particular camera. Camera B5 was installed next to a tree, which could have provided a preferable cover for corvids and increased their activity in the area around the camera trap. More evidence is needed to elucidate possible causes of the observed perching behaviour on Camera B5. While in this case no predation was observed, it is recommended that future studies monitor the success of nests with and without camera traps installed, to evaluate possible effects on Black Guillemot breeding, and that appropriate adjustments are put in place to minimise predation risk.

Finally, the presence of Goats on Rathlin Island resulted in many issues pertaining to camera operation, footage analysis and the behaviour of the study species. Some cameras in particular experienced a lot of interference by Goats (e.g. Camera R5), which obstructed the camera view, tilted the cameras downwards and triggered thousands of photographs. This required additional visits to be implemented to fix and/or relocate cameras, increased the time taken for footage analysis and potentially obscured the view of smaller mammals commuting. High levels of Goat activity may have also deterred predators from the area, as shown by the uniquely high mean gap between sightings of conflict species on Camera R2, which was positioned in an active Goat walkway. The extensive presence of Goats can cause the disappearance of breeding seabirds, especially ground and burrow-nesting species (Coffey & Collier 2021), through nest disturbance and trampling (Bell 1995, Carlberg *et al.* 2022, Coffey & Collier 2021, Hata *et al.* 2019), degradation of nesting habitat from overgrazing (García *et al.* 2012, Peacock & Sherman 2010) and potential nest predation. Grazers such as Sheep (*Ovis aries*) have been documented eating seabird and wader eggs (Beintema & Müskens 1987, Fuller 1996, Pennington 1992) and while evidence of Goat nest predation was not found in this study and is largely anecdotal, it is important to consider Goats as a potential source of additional pressure on seabird reproductive success on Rathlin Island. Avoiding installation of cameras in areas with high Goat activity in the Church Bay Black Guillemot colony is not feasible because the only part of the colony accessible for deploying cameras is also accessible to Goats. To address the issue of Goat-triggered footage, future monitoring and conservation could make use of machine learning technology. Recent advances in machine learning technology allow for automatic extraction of species and behavioural information from camera trap footage (Norouzzadeh *et al.* 2018, Tabak *et al.* 2019, van Lunteren 2023). By taking advantage of these methods, footage of non-target species, such as Goats, can be automatically detected and filtered out, therefore reducing the time and costs associated with camera-trap projects on inhabited offshore islands such as Rathlin Island.

4.4 Conclusion

Monitoring of seabird colonies during ongoing eradication programmes of non-native mammals is essential to evaluate their effectiveness and detect unanticipated ecological outcomes. Camera traps are a useful tool in monitoring both native and non-native predator activity in seabird colonies undergoing mammal eradication, for which data are not readily available in published literature. This camera trap trial was effective in observing predator presence in Black Guillemot colonies on Rathlin and Lighthouse Islands, finding marked differences in predator assemblages between a colony inhabited by non-native mammals and one free from introduced mammalian predators. Camera traps recorded the presence of conflict species almost every day, which were observed predating on Manx Shearwaters, engaging in kleptoparasitism, and investigating Black Guillemot nest sites. However, improvements to the methodology may be required to more effectively record confirmed predation of Black Guillemot adults and nests, which was not observed in the present study. These include confirming predation events with nest checks, installing cameras with a larger field of view, and quantifying possible effects of the research on the behaviour and nesting success of the study species. Along with these recommendations, this study contributes to understanding of predator presence in seabird colonies in the UK and Ireland, and the most effective methods for collecting it. With proposed developments in offshore wind generation in Northern Ireland anticipated within the next 5–10 years, monitoring of seabird colonies has become crucial for informing accurate environmental impact assessments and developing effective mitigation measures required for wind farm planning and construction.

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Front cover: Black Guillemot nest, by Hugh Insley / BTO. Back cover: Black Guillemot, by Sarah Kelman / BTO

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This report details a study that trialled the use of camera traps to assess predator presence in two Black Guillemot colonies to inform the conservation management of this seabird species.

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