Strategic Compensation Studies

Reducing Pressures from Avian Predators: A Potential Strategic Compensation Measure

THE CROWN ESTATE

Offshore Wind Industry Council

SCS

Offshore Wind Evidence + Change Programme

Contents

List of Tables

List of Figures

Acronyms

Acronym	Term
BoCC	Birds of Conservation Concern
Defra	Department for Environment, Food and Rural Affairs
HPAI	Highly Pathogenic Avian Influenza
IUCN	International Union for Conservation of Nature
LoSCM	Library of Strategic Compensation Measures
NEEOG	North East and East Ornithology Group
OW	Offshore Wind
OWEC	Offshore Wind Evidence and Change
OWF	Offshore Wind Farm
OWIC	Offshore Wind Industry Council
RSPB	Royal Society for the Protection of Birds
SCS	Strategic Compensation Studies
SoS	Secretary of State
SPA	Special Protection Area

Glossary

Term	Definition
Adaptive Management	A structured learning process which provides a framework for flexible and optimal decision-making in the face of ecological complexity. Adaptive management involves the implementation of evidence-based management decisions, the monitoring of the impact and evaluating of the outcome of those decisions, and the appropriate adjustment of management actions (Defra, 2024).
Library Of Strategic Compensation Measures	Measures developed through the Collaboration on Offshore Wind Strategic Compensation and approved by the Defra Secretary of State as appropriate strategic compensation measures for relevant offshore wind activities under certain circumstances.
Avian predator	Birds of prey or predatory birds, that for the purpose of this document prey on seabirds
Depredate	To prey upon or make prey of

Term	Definition
Diversionary feeding	The use of food to divert the activity or behaviour of a target species from an action that causes a negative impact, without the intention of increasing the density of the target population.
Highly Pathogenic Avian Influenza	A highly contagious viral disease that affects both domestic and wild birds.
Indirect predation control	Management methods undertaken to attempt to manage factors that have resulted in avian predator numbers being so high that there are significant impacts to target species.
Inter-specific competition	Interspecific competition is the competition between individuals of different species.
Intraguild predation	Intraguild predation occurs when two species that share a host or prey (and therefore may compete) also engage in a trophic inter-action with each other (parasitism or predation)
Kleptoparasatism	Kleptoparasitism is a form of feeding in which one animal deliberately takes food from another.
Procellariiform	Any of the group of seabirds that includes the albatrosses (family Diomedeidae); shearwaters, fulmars, prions, and large petrels (Procellariidae); storm petrels (Hydrobatidae); and diving petrels (Pelecanoididae).
Seabirds of OW compensation concern	Seabird species for which there is currently/may be a future compensation requirement in relation to OW development.
Top-down control	Top-down control is where the populations of the organisms lower trophic levels are controlled by the organisms at the top. This approach is also called the predator-controlled food web of an ecosystem.
Translocation	The intentional movement of individuals from one area to another for conservation purposes

Document Control

Revision	Author	Checked	Approved	Date	Description of change/ status
0.1	E.Goodman	A.Tarbet		25/02/2025	Technical review
0.2	E.Goodman	K.Route-Stephens		07/03/25	Manager review
0.3	E.Goodman	A.Cook		31/03/25	Technical review
1.0	E.Goodman	K.Route-Stephens	J.Cooper	02/04/25	Final approval

Reference: OWIC (2025). Reducing Pressures from Avian Predators: A Potential Strategic Compensation Measure. OWEC SCS Report No. 01
A report produced by OWIC for the OWEC Strategic Compensation Studies (SCS) project.

Acknowledgements: We would like to acknowledge the support from Aonghais Cook, Principal Marine Biodiversity Specialist and ornithological expert, for undertaking a technical review of this report before publication.

About OWEC SCS Project: The Strategic Compensation Studies (SCS) is a £3.5 million project running until the end of 2027 which forms part of the Offshore Wind Evidence and Change programme (OWEC), led by The Crown Estate (in partnership with the Department for Energy Security and Net Zero and Department for Environment, Food & Rural Affairs). Alongside the OWEC programme funding, the SCS project is supported through financial and in-kind contributions from participating Offshore Wind Industry Council (OWIC) members.
Further information can be found via the Strategic Compensation Studies webpage.

Purpose of this Report: This report forms part of the SCS predator reduction work package and aims to identify the scale of opportunity for reducing pressures from avian predators as a strategic compensation measure, either in isolation, or as part of a package of measures in the UK.

Executive Summary

The offshore wind (OW) sector is set to expand significantly to meet ambitious Government targets under Clean Power by 2030 and achieving net zero. It is recognised that the scale and location of future developments will mean that the derogation process[1] is increasingly likely to be triggered, hence there is a need for industry-scale consideration of how future-proof compensation will be delivered.

The OWIC-led Strategic Compensation Studies (SCS) project, funded by the Offshore Wind Evidence and Change (OWEC) programme, within which this piece of work is being delivered, aims to investigate the effectiveness of certain potential strategic compensation measures through desk-based studies and practical pilots to increase confidence in measures, and provide compensation options for OW plans and projects.

This report forms part of the SCS predator reduction work package and aims to identify the scale of opportunity for reducing pressures from avian predators as a strategic compensation measure either in isolation or as part of a package of measures in the UK. Previous work indicates there is currently limited support for avian predator control to be used as a strategic compensation measure, except as an additional or adaptive management tool or to accompany an approved primary measure. However, in light of the limited number of approved strategic measures and the increasing need for projects and plans to secure ecologically sound, cost-effective compensation, the SCS project aims to ensure that all relevant aspects are fully considered prior to the measure being disregarded as a strategic option.

The report focuses on seabirds which are of current OW compensation concern, including black-legged kittiwake *Rissa tridactyla*, Northern gannet *Morus bassanus*, common guillemot *Uria aalge*, razorbill *Alca torda*, lesser black-backed gull *Larus fuscus*, red-throated diver *Gavia stellata*, Atlantic puffin *Fratercula arctica* and Sandwich tern *Thalasseus sandvicensis*. Consideration has also been given to species which may require compensation in the future such as Procellariiforms (shearwater and petrel

[1] Under the Conservation of Habitats and Species Regulations 2017 as amended (known as the Habitats Regulations).

species). This review of the literature has shown that the current volume of evidence for avian predation is limited and varies between both avian predator species and species that are of OW compensation concern. The impact from avian predation on species of OW compensation concern also varies, with some species experiencing limited negative impacts whereas others suffering reduced breeding performance, nest failure and in some cases colony failure as a result.

The report concludes that there is merit in progressing additional assessment of several of the different avian predator management methods given the current limited evidence of their effectiveness for seabirds. The recommendations are centred around practical trials of non-lethal interventions such as habitat modification/nest cover and refuges, artificial burrows and nest boxes and deterrence measures such as bamboo canes and bioacoustics. This would enable the methodologies to be further developed, monitored for effectiveness and considered as strategic compensation measures for species impacted by OW.

This could encompass the following:

1. Reducing pressures from avian predators as a standalone measure that incorporates a number of control methods that are deemed most effective for a particular avian predator and/or species of OW compensation concern.

2. Reducing pressures from avian predators could be implemented alongside other strategic measures, such as mammalian predator control or disturbance reduction. The delivery of two (or more) approved measures together would likely lead to increased effectiveness of the compensation and reduce levels of uncertainty. The identified measures could then be implemented via a strategic scheme at scale.

1 Scope of this report

The offshore wind (OW) sector is set to expand significantly to meet ambitious Government targets around net zero. It is recognised that the scale and location of future developments will mean that the derogation process is increasingly likely to be triggered, hence there is a need for industry-scale consideration of how future-proof compensation will be delivered.

The OWIC-led Strategic Compensation Studies (SCS) project, funded by the Offshore Wind Evidence and Change (OWEC) programme, within which this piece of work is being delivered, aims to investigate the effectiveness of certain strategic compensation measures through desk-based studies and practical pilots to increase confidence in measures, and provide compensation options for OW plans and projects.

The SCS project will provide more confidence in different measures by carrying out practical trials and collating evidence to help fill data gaps, ensuring that OW projects can be consented/conditions discharged in a timely way and that the relevant frameworks and mechanisms are in place for compensation delivery. The SCS project also aims, where possible, to promote additional measures for approval into the library of strategic compensation measures (LoSCM) to support the acceleration of OW delivery in the UK.

The SCS project includes six technical work packages, as follows:

- Work package 1 – artificial nesting structures;
- Work package 2 – predator reduction;
- Work package 3 – habitat creation;
- Work package 4 – infrastructure removal;
- Work package 5 – delivery mechanism and overarching actions; and
- Work package 6 – supporting measures.

This report forms part of the SCS predator reduction work package and aims to identify the scale of opportunity for reducing pressure from avian predators to form a strategic compensation measure either in isolation or as part of a package of measures in the UK.

In comparison with mammalian predator control, there has been limited consideration of reducing pressure from avian predators as a strategic compensation measure and the work that has been undertaken has primarily been in a Scottish context. This report aims to identify the scale of opportunity for reducing pressure from avian predators as a strategic compensation measure either in isolation or as part of a package of measures in the UK. Previous work indicates there is currently limited support from stakeholders for avian predator control to be taken forward as a strategic compensation measure, except as an additional or adaptive management tool to accompany mammalian predator control. However, in light of the limited number of options for strategic measures and the ever-increasing need to secure ecologically sound, cost-efficient compensation, the SCS project seeks to, where possible, ensure that all relevant aspects are considered prior to the measure being disregarded as a strategic option.

This literature review summarises the current state of knowledge relating to the evidence of avian predation on relevant seabird species of OW compensation concern in the UK, reviews the current evidence on the effectiveness of various methods to reduce pressures from avian predation and the potential for this to form a strategic compensation measure. Where possible, this report builds on previous work undertaken in this area and identifies recommendations for further work. Upon completion of the literature review the SCS project will review the information collated and consider whether any further work will be undertaken to progress reducing pressures from avian predators as a potential compensation measure.

2 Avian predator control

2.1.1 Background

Predation is a natural phenomenon that plays a key role in maintaining healthy ecosystem. However, in cases where predator numbers are too high (Roos *et al.*, 2018) this may result in seabird colony declines and even failure (Clode, 1993). The benefits of mammalian predator control on seabirds are generally well understood, as reflected in the approval of the measure into the LoSCM by the Defra Secretary of State (SoS) in February 2024. Seabirds are however also vulnerable to predation from avian predators such as large gulls, raptors and corvids. Avian predators may take eggs, chicks and even adults directly or can have indirect impacts such as disturbance or kleptoparasatism (whereby the avian predator steals/competes for prey of the individual).

The remote location of many seabird colonies coupled with the very short-lived nature of predation attempts, make it difficult to monitor and quantify these events. Past studies aiming to observe avian predation events include visual observations undertaken intermittently at optimum stages throughout the breeding season (e.g. Walsh *et al.*, 1995) as well as the use of remote time-lapse cameras (e.g. Collins *et al.*, 2014). Collins *et al.* (2014) suggested that the use of remote time-lapse cameras could play an important role in quantifying the impact and ensuring that avian predation is sufficiently considered as a factor that may impact colony productivity.

Due to the fact that avian predation has the potential to result in colony declines and failure, there has been interest in reducing pressures from avian predators as a potential strategic compensation measure for the OW industry. Thus far, avian predation control has only been implemented as a compensation measure at project-level for one OW project located off the coast of France, although is undertaken for other purposes through licence control, both of which are discussed further in section 2.1.2.

There are multiple types of avian predation which occur in varying locations and at different points in a seabird's life cycle. A summary of the types of avian predation and where and when the type of predation occurs is provided in Table 2.1.

Table 2.1: Summary of types of avian predation with information on location and timings of predation occurring

Type of predation	Location and timing of predation
Egg predation	Occurs at the nest site only during pre-hatching period
Chick predation	Dependant on species, this may be limited to nest site, or, for species with more mobile chicks (e.g. lesser black-backed predation may occur elsewhere in the colony as chicks start moving around
Adult predation	May occur on nests whilst parents are incubating, close to coast when birds are returning from foraging

Type of predation	Location and timing of predation
	trips, or offshore whilst birds are foraging
Kleptoparasitism	May occur when adults are returning to colony with prey, or further offshore after adults have captured prey items during foraging

2.1.2 Avian predator control to date

Saint Brieuc Offshore Wind Farm

Saint Brieuc is an Offshore Wind Farm (OWF) developed off Brittany, France commissioned in 2024. In 2012, Ailes Marine (a subsidiary of Iberdrola) implemented a compensation measure to limit predation on common guillemot *Uria aalge* and black-legged kittiwake *Rissa tridactyla* nests by carrion crows *Corvus corone* (hereafter, crows). The measure was implemented by the Syndicat Mixte Grand Site Cap d'Erquy on the cliffs of Cap Fréhel. The location of the avian predator control measures in relation to the OWF is shown in Figure 2.1. The measures implemented included various crow regulation operations and resulted in the capture of nine crows on Cap Fréhel, although detailed information is limited.

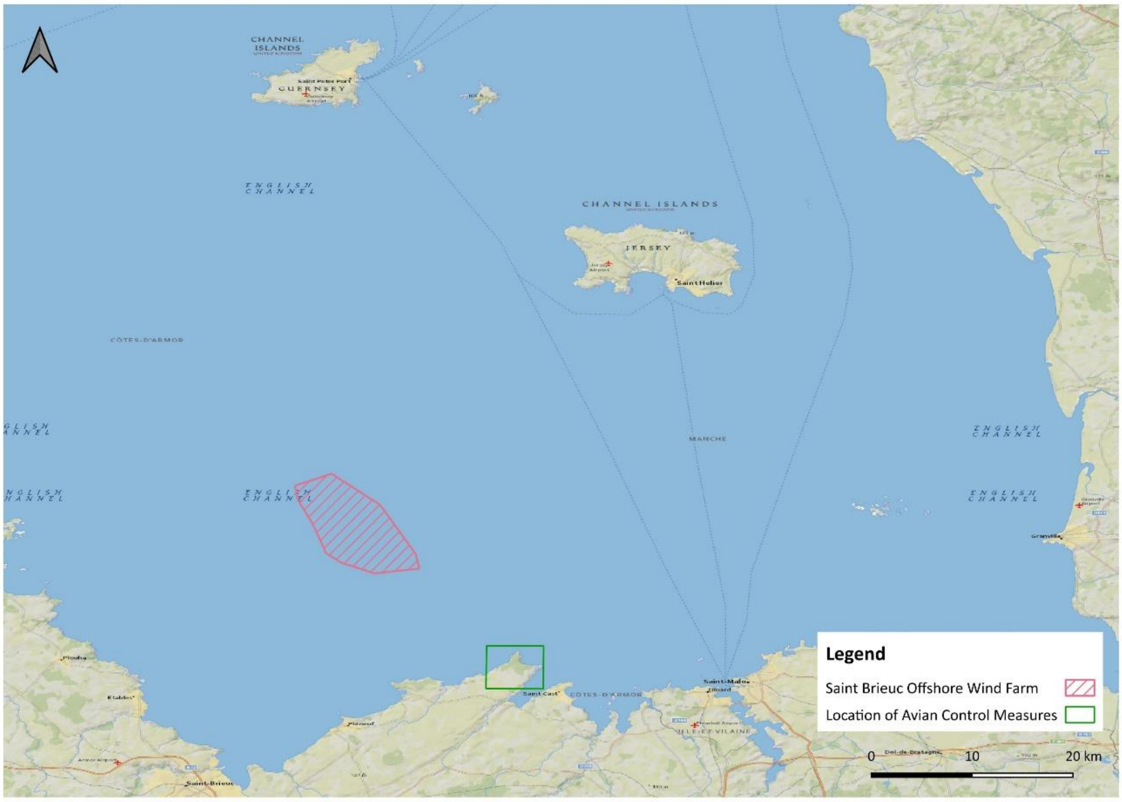

Figure 2.1: Location of Saint Brieuc Avian Predator Compensation Measures

The compensation measure will continue annually for 10 years and then, if necessary, every two years until the end of the life of the OWF. Post-implementation monitoring has demonstrated that the measure has been successful in increasing the number of nesting pairs of relevant bird species. The black-legged kittiwake breeding population is at its highest recorded level in history with 305 breeding pairs (an increase from 87 pairs in 2019). The population has been increasing almost constantly since the first crow control operations. For both common guillemot *Uria aalge* and razorbill *Alca torda*, results indicate population recovery with more than 500 pairs of common guillemot and 52-55 breeding pairs of razorbill recorded in 2019.

Licence Control

In the UK, the RSPB carries out licensed control of herring gulls *Larus argentatus*, lesser black-backed gulls *Larus fuscus* and great black-backed gulls *Larus marinus* to protect breeding terns from predation pressures at specific reserves. Herring gull and lesser black-backed gulls are currently in unfavourable conservation status and any lethal control should not endanger the species at a population level. Licence conditions do not require submission of records in regard to numbers of animals controlled, however RSPB publishes these for transparency. In 2011-12, 76 large gull nests were destroyed (mostly lesser-black-backed gull) and three adult lesser black-backed gulls were shot on RSPB reserves. RSPB have also published more recent records for gull management at roseate tern *Sterna dougalli* and Sandwich tern *Sterna sandvicensis* colonies. In 2022, the RSPB reported that it had carried out control of herring gull at one site where 23 eggs were destroyed and one adult bird was shot. For lesser black-backed gull, two sites were managed in 2022 with one bird shot and 16 eggs destroyed, and three sites managed in 2021 with three birds shot and 148 eggs destroyed. In 2022 greater black-backed gull were also controlled at one site with three eggs destroyed, no management was undertaken for this species in 2021 (RSPB, 2023).

2.1.3 Reducing pressures from avian predators as strategic compensation

In comparison with mammalian predator control, there has been limited consideration of avian predator control as a strategic compensation measure and the work that has been undertaken has primarily been in a Scottish context. For example, avian predator control was considered in the "Ornithology Regional Compensation Measures" report by several stakeholders[2] (Royal Haskoning DHV, 2023). The report concluded that there was weak evidence that avian predator management could lead to population-level benefits with respect to Northern gannet *Morus bassanus*, common guillemot and razorbill, and moderate evidence for black-legged kittiwake, puffin *Fratercula arctica* and other seabird species. It was not considered a viable strategic measure when considered in isolation however there may be occasions in which this could be useful as an additional/adaptive management tool alongside mammalian predator management or eradication.

A report commissioned by Scottish Government and authored by RSPB (Scottish Government, 2024), identified a list of potential strategic

[2] Project Team (Royal HaskoningDHV and HiDef), developers, Scottish Renewables, NatureScot; Scottish Government; Marine Directorate Licencing Operations Team, Marine Directorate Renewables & Ecology, Crown Estate Scotland, RSPB, Centre for Ecology & Hydrology and Defra

compensation measures and evaluated their ecological and practical feasibility, with avian predator management being one of the measures assessed. The report concluded that avian predator management, had a low–medium level of ecological efficacy and a low overall feasibility score. The low score was attributed to high uncertainty and a paucity of evidence regarding its potential benefit for seabirds, also that types of management would be location specific. The report further concluded that management of avian predators would likely be relatively low cost but may present challenges when delivering at scale.

3 Species of concern

This section focuses on the seabird species for which the OW industry is currently often required to compensate for, and species which may require compensation in the future (hereby referred to as species of OW compensation concern), and the avian predator species of concern.

The SCS project aims to take a proactive approach to identifying potential future compensation requirements, so that this can be approved and secured in a timely manner. In this way, this report also considers seabird species which may potentially require compensation as a result of future offshore leasing rounds, such as the Celtic Sea. There is the potential (noting that this is not currently evidenced in the literature) for OW development to result in the need for compensation for some Procellariiforms (shearwater and petrel species). For this reason, section 3.1.9, considers other seabird species, including Procellariiform species which are present in the UK (and abroad for additional context where evidence for UK species is lacking).

A list of species of OW compensation concern is provided below:

- Black-legged kittiwake;
- Northern gannet;
- Common guillemot;
- Razorbill;
- Lesser black-backed gull;
- Red-throated diver *Gavia stellata*;
- Atlantic puffin;
- Sandwich tern; and
- Procellariiforms.

Also of relevance to this report are the key UK species that are considered avian predators, and which could be controlled through avian predator management.

Table 3.1 outlines these species, notes their distribution within the UK and their predation preferences.

Table 3.1: Key UK avian predators

Species	Distribution	Predation type
Great black-backed gull	UK wide	May predate eggs, chicks and adult birds.
Herring gull	UK wide	May predate eggs and chicks
Lesser black-backed gull	UK wide	May predate eggs and chicks
Common gull *Larus canus*	Breeding Common Gulls are found mostly in the north and west of both Scotland and Ireland	May predate eggs
Carrion crow	UK wide	May predate eggs and young chicks
Eurasian magpie *Pica pica*	UK wide	May predate eggs and young chicks
Common raven *Corvus corax*	UK wide	May predate eggs and young chicks
Eurasian jackdaw *Corvus monedula*	UK wide	May predate eggs and young chicks
Great skua *Stercorarius skua*	Breed on northern islands in summer breeding season. Present UK wide outside of breeding season	May predate eggs, chicks and adult birds
Peregrine falcon *Falco peregrinus*	UK wide but primarily in North and South West England, Wales and Scotland	May predate chicks and adult seabirds
White tailed eagle *Haliaeetus albicilla*	Outer Hebrides, Wester Ross, Skye and the Small Isles, and north Argyll centred on Mull with	May predate eggs, chicks and adult birds.

Species	Distribution	Predation type
	attempts underway to reintroduce the species to southern England.	
Short-eared owl *Asio flammeus*	Nests on uplands in the north of the UK. Winters in the lowlands of central and southern England and Wales, particularly around the coast.	May predate chicks and adult seabirds
Mediterranean gull *Larus Melanocephalus*	Largest breeding colonies are found in the south and south-east of England, with more scattered breeding records elsewhere in the UK, including Northern Ireland.	May predate eggs and young chicks

3.1 Evidence of avian predation

This section summarises the evidence available for the key species of OW compensation concern (species as outlined in section 3). Evidence of avian predation on the key species is discussed alongside the findings of any studies where avian predator control has been implemented.

3.1.1 Black-legged kittiwake

Predation on black-legged kittiwake colonies by avian predators may occur at varying scales depending on geographic location. For example, evidence from the UK and Alaska shows that colonies may lose only few offspring to predators such as large gulls, ravens, or crows (Maunder and Threlfall, 1972; Murphy *et al.,* 1991) and that the impact of avian predators on the species breeding success or survival tends to be local and mostly evident at small or declining colonies (Natural England, 2023; Oro and Furness 2002). Whereas at other colonies, such as in Norway and Canada, avian predation may occur on a much greater scale (Barrett and Runde 1980; Maccarone 1992).

Larger gull species (such as herring gulls) may predate black-legged kittiwake eggs and chicks (Galbraith 1983; Harris and Wanless 1997) as do peregrine falcons which have been recorded predating large chicks or fledglings at a small number of colonies (Collins, 2014; Furness, 2013). A remote time lapse camera on Puffin Island in 2013 recorded a peregrine falcon depredating chicks at two out of four nests monitored and resulted in failure of all four nests (Collins, 2014).

There is also evidence of great skua predation affecting adult black-legged kittiwake survival rates and being associated with colony declines (Heubeck *et al.*, 1997; Phillips *et al.*, 1999; Votier *et al.*, 2008). Any such effects are however limited to the Northern Isles and possibly other parts of north and north west Scotland due to the presence and distribution of great skua during the breeding season (see Table 3.1). Predation of black-legged kittiwake in this region may be of particular relevance in the context of the future expansion of offshore wind associated with ScotWind and innovative oil and gas leasing rounds.

In a study conducted by Anker-Nilssen and Aervak (2009) on white-tailed eagles in North Norway, data was collected over 26 years on both white-tailed eagle numbers and the population trends and breeding success at three black-legged kittiwake colonies. Two of the colonies were on cliffs, whilst the other was located on buildings and was not visited by eagles. Findings showed that the number of breeding pairs at the main cliff colony, decreased steadily from about 25,000 to 9,300 during the study and that breeding success was 42% lower where predation by eagles was taking place. The colony located on the buildings without eagle presence, however, increased from 131 to 633 pairs over the same period. Later work by Anker-Nilssen *et al.* (2023) investigated how the increase in white-tailed eagles in northern Norway, over a 42-year period has led to black-legged kittiwake colony extinction. Population modelling undertaken showed that the increased abundance of eagles sped up the elimination of the colony by many years.

On Gull Island, Canada, great black-backed gull and herring gull took approximately 43% and 30% of all black-legged kittiwake offspring in 1998 and 1999, respectively (Massaro *et al.* 2000). There is evidence to suggest that the size of sub-colonies and nest density may affect the survival of black-legged kittiwake offspring in relation to predation by large gulls. For example, Massaro *et al.*, (2001) quantified the relationship between black-legged kittiwake nest-site characteristics and risk of predation by great black-backed and herring gulls at Gull Island, Newfoundland, Canada, during 1998 and 1999. The study investigated which nest sites were predated by herring or great black-backed gulls during both calm and windy conditions. Irrespective of wind conditions both gull species were more likely to attack nests located on upper sections of cliffs than nests on lower sections. Whereas, during calm conditions, nest sites located on narrow ledges were less likely to be attacked by great black-backed gulls (Massaro *et al.,* 2001).

3.1.2 Northern gannet

Predation is not generally considered to be a huge threat to Northern gannets, which are large and will behave aggressively to predators that approach their breeding areas (Mowbray, 2002). There are occasional reports of eggs being taken by species such as great black-backed gulls, herring gull and common ravens and chicks may be taken from nests by these species.

Barrett (2008) suggested that white-tailed eagle harassment and predation on adults and/or chicks could have led to a decline in colony numbers and movement to new breeding sites in the Lofoten/Vesteralen area of Norway. The European white-tailed eagle population has been increasing steadily since the late 1960s after a sharp decline during the twentieth century. The impact of white-tailed eagle predation on Northern gannets in this region has not yet been recorded or quantified but observations of predation on chicks and deceased adults have been found within colonies since 1997 (Barrett, 2008).

3.1.3 Common guillemot

Common guillemots nest on broad ledges of cliffs, on rocky platforms, or under large boulders at the foot of cliffs. The highest densities of nests are often located on ledges which could make them vulnerable to predation by avian predators due to increased accessibility. Predation of eggs by ravens, crows, gulls and great skuas is widely reported and both great black-backed gulls, and great skuas may also take fledglings and chicks from nests (Furness, 2021).

A study by Camphuysen (2002) investigated the post-fledging dispersal of young and adult common guillemot and effects of predator presence and prey availability at sea along the east coast of England and Scotland. The avian predators assessed were great skua and great black-backed gull, as they were the only seabirds within the study area that had been observed predating on common guillemot chicks and triggering alarm calls. Herring gull were not included within the study, as although their presence triggered alarm calls and avoidance by common guillemot chicks it is considered that they are not able to catch/kill grown common guillemot chicks at sea (Camphuysen, 2002). The study found that most adult guillemots from North Sea colonies guided their offspring away from the colony. They moved rapidly through a coastal area with abundant prey resources but high predation risk and travelled several hundreds of kilometres into the open sea where there were very few avian predators, but prey resource was low and variable, although in some cases prey resources were predictable (Camphuysen, 2002).

In seabird monitoring undertaken at Canna in the Sea of the Hebrides, the number of ringed birds which have been predated annually are recorded (Swan *et al.*, 2016). The predation of common guillemot is primarily attributed to gull species, with numbers of birds predated varying year by year (Table 3.2). It is thought that the high number of adults predated in 2013 was likely linked to the observed high nest failure rates (Swan *et al.*, 2016). A high number of common guillemot eggs were also predated by gulls.

Table 3.2: Number of ringed predated adult common guillemot found in colonies according to year (taken from Swan *et al.*, 2016).

Year	Number of ringed adult birds
2000	8
2001	30
2002	13
2003	28
2004	23
2005	10
2006	17
2007	23
2008	4
2009	16
2010	20

Year	Number of ringed adult birds
2011	11
2012	13
2013	30

3.1.4 Razorbill

Furness (2021) reported that predation of razorbill eggs by ravens, crows, gulls and skuas is widespread, while species such as great black-backed gulls and great skuas are reported to take fledging razorbill chicks and some chicks from nest sites. Razorbills will have one chick per season which corresponds to the number of eggs laid. A study of the breeding biology of Razorbill was carried out on Skokholm (South Wales) during 1971-73 (Lloyd, 1979). The number of razorbill eggs laid was observed and of those laid, 30% were lost. Of this total 73% was attributed to predation by herring gulls and jackdaws. Razorbills may be less vulnerable to egg predation by avian predators than common guillemots due to their nesting preferences, hidden nests in crevices and cavities under boulders rather than on cliff ledges (Furness, 2021).

In seabird monitoring undertaken at Canna in the Sea of the Hebrides, the number of ringed birds which have been predated annually are recorded (Swan *et al.*, 2016). The predation of razorbill is primarily attributed to gull species, with numbers of birds predated varying year by year (Table 3.3).

Table 3.3: Number of ringed predated adult razorbill found in colonies according to year (taken from Swan *et al.*, 2016).

Year	Number of ringed adult birds
2000	1
2001	1
2002	2
2003	2
2004	7
2005	24
2006	14
2007	0
2008	0
2009	2

Year	Number of ringed adult birds
2010	4
2011	3
2012	5
2013	12

3.1.5 Lesser black-backed gull

Over the last 18 years there have been declines of lesser black-backed gull on Horsvær, Norway from approximately 400 to 200 pairs across nine sub-colonies (Bustnes *et al.*, 2022). Research on Horsvær showed that nest predation was happening on a large scale and was the cause of failure of a well-functioning sub-colony. The key nest predator was the common raven, with a single pair breeding in or near to a colony of lesser black-backed gulls found to have significant impacts on reproduction (Bustnes *et al.*, 2022).

Another study by Bardsen and Bustnes (2022) found that nest predation by ravens may be the direct cause of reproductive failure and indirectly link to declines in lesser black-backed gull. The study was also undertaken at Horsvær and aimed to assess the population viability of a threatened population of the lesser black-backed gull under different scenarios for nest predation and environmental conditions (Bardsen and Bustnes, 2022). The study found that from 2011 to 2016 the most common egg predators were breeding ravens but also observed one pair of hooded crows *Corvus cornix* predating on eggs in 2015. Throughout the study period, an average of 95% of the eggs were predated which resulted in the production of only 0.031 fledglings per nest when the ravens were breeding.

A study looking into predation of lesser black-backed gull by herring gull in the Gulf of Finland over a period of 14 years (Hario *et al.*, 1994) found that predation by herring gull was one of the major causes of death among lesser black-backed gull chicks. Prior to culling operations, 17% of chick deaths were attributed to predation by neighbouring herring gulls in the study colony. Culling these proven predators (2 pairs) lowered the predation rate to 2% and improved the fledging result significantly (Hario *et al.*, 1993).

3.1.6 Red-throated diver

Red-throated diver breed on lakes and freshwater lochs throughout the north and west of Scotland, the Hebrides, Orkney and Shetland, as well as some locations across the sub-arctic Arctic, Asia and North America. Red-throated diver productivity is impacted by a range of factors including food availability, disturbance, mammalian and avian predation as well as distances to foraging areas and fluctuations in water levels. Predation specifically is considered to be a common cause of decreased breeding performance, although identifying the predator species responsible is often difficult (Hulka, 2010; Dewar and Lawrence, 2023).

Predation was noted as a current cause of decline in red-throated diver populations on Shetland which reported predation from species such as great skua and large gulls (Okill, 2004). Avian predators of red-throated diver eggs on Shetland include hooded crow, common raven, arctic skua, great black-backed gull, lesser black-backed gull, herring gull and common gull. Whereas predators of chicks are primarily great skua and great-black-backed gull (Bundy, 1976; Gomersall, 1986; Okill, 2004).

Across breeding areas in Scotland reported avian predators of red-throated diver nests included common gull, herring gull, and great black-backed gull, (Bundy, 1978; Dewar and Lawrence, 2023). In Sweden and other Arctic areas predators include species such as common cranes *Grus grus* and white-tailed eagles (Ollson *et al.*, 2021), glaucous gull *Larus hyperboreus*, long tailed skua *Stercorarius marinus*, arctic skua and snowy owl *Nyctea scandiaca* (Bergman and Derksen 1977; Dickson 1992, 1993; Eberl and Picman 1993).

3.1.7 Atlantic puffin

It is reported that Atlantic puffin numbers can be depleted at a local scale by predation from great skuas and gulls, especially great black-backed gulls which kill adult Atlantic puffins at many colonies (Furness, 2021).

Gulls have been observed to frequently predate eggs and young of Atlantic puffins during the breeding season, which has led to the requirement for gull control programmes at many colonies. A study on the Isle of May, carried out gull control over a 23-year period (1975-1998) (Finney *et al.*, 2003). The study found that the breeding population of Atlantic puffins increased from 3,000 to approximately 19,000 breeding pairs during the period of gull control (1972-

1989). Adult herring gulls and lesser black-backed gulls were culled and gull nests destroyed, reducing the Isle of May population from 17,000 to 2,500 pairs. Following the end of the control in 1989 (and an increase in gull population to 4,100 pairs), the Atlantic puffin population continued to increase, reaching 42,000 pairs in 1998. Atlantic puffin recruitment between 1989 and 1998 was significantly higher in areas with low gull density, or that were maintained as gull-free through the destruction of nests.

Finney *et al.* (2001) aimed to assess the effectiveness of different gull management options including maintaining gull-free areas and delaying gull breeding. The study found no significant difference between gull-free and gull-occupied habitat on Atlantic puffin chick growth or survival, although Atlantic puffins nesting in gull-free habitat did have a higher rate of provisioning of chicks and lower risk of kleptoparasatism. Delaying of gull breeding by three weeks was found to have no impact on Atlantic puffin chick growth or survival.

A later study on the Isle of May by Langois Lopez *et al.* (2023) used population viability analysis to quantify under what predation pressure the Atlantic Puffin population may decline and become locally extinct over a three-generation period. The predation level for 2017 was estimated at 1120 Atlantic puffins per year which was not thought to be sufficient to result in a population decline. It was concluded that predation of approximately 3000 Atlantic puffins per year would be required to cause a population decline, and >4000 to drive the population to quasi-extinction (Langois Lopez *et al.* 2023).

A similar study was also undertaken on the English Channel Island of Burhou investigating whether increased numbers of Larus gulls were restricting or endangering the island's Atlantic puffin population. The study indicated that of the three gull species investigated (herring gull, lesser black-backed gull and great black-backed gull) only great black-backed gull preyed directly on Atlantic puffin. Their direct predation on the reduced population of Atlantic Puffins was a considerable addition to adult mortality rates, although kleptoparasitic attacks, were likely too infrequent and too unsuccessful to affect Atlantic Puffin breeding success (Soanes *et al.*, 2010).

An Atlantic puffin translocation programme in 1973-1981 (Kress and Nettleship, 1988) found that almost all the 774 Atlantic puffin nestlings moved from

Newfoundland, Canada, to Maine, USA, survived. To improve the likelihood of survival, predator management was also undertaken in 1974-1875 and included culling and destroying the nests of herring gulls and great black-backed gulls.

3.1.8 Tern species

In Eastern Egg Rock, Maine USA, great black-backed gull and herring gull populations were managed using lethal control measures from 2003 to 2005. Social attractants (Arctic tern *Sterna paradisaea* decoys and sound recordings of non-aggressive tern vocalisations) were used to re-establish breeding Arctic terns, to the former nesting site (Donehower *et al.*, 2009). After the first summer of predator management herring gull populations were significantly reduced and great black-backed gulls were significantly reduced after three summers of control by poisoning, shooting, egg and chick destruction and human disturbance. In the first year of using social attractants, tern sightings nearly doubled in frequency and in the third year, Arctic terns and common tern *Sterna hirundo* nested in the immediate vicinity of the decoys and playback speaker. In 1981 Roseate terns *Sterna Dougallii* became established and by 1982 Eastern Egg Rock supported the largest common tern colony in Maine. However, the relative importance of gull control, decoys, and sound recordings could not be determined from this study.

A study at a former gravel pit in Kent, England (Akers and Allcorn 2006), found that the number of common terns and black-headed gulls *Chroicocephalus ridibundus* declined on gravel islands, despite attempts to remove the nests and eggs of large gulls (e.g. herring gulls) in the 1990s and early 2000s. Whilst work on an island in Lake Onatario, Canada (Morris *et al.* 1980) found that the fledging success of common terns was significantly higher in May and June 1976 (0.44 chicks/egg laid for 66 eggs) when ring-billed gull *Larus delawarensis* nests were destroyed and vegetation manually removed from the site, than in May and June 1975, when no gull removal was used (0.18 chicks/egg laid for 217 eggs). Despite the increases, only three pairs of terns returned to the site in 1977. Later studies during 1977-1989 at a common tern colony in Lake Ontario, Canada (Morris *et al.*, 1992), found the nesting population increased at one colony but decreased at another following several interventions, including the control of particular ring-billed gulls that were predating common tern eggs.

Arctic Tern colonies on Rockabill in Ireland, were shown to have poor productivity over a 15-year monitoring period with breeding pairs ranging from 20 to 360, which was attributed to nest predation by various gull species (Burke *et al.*, 2022).

In Sands of Forvie, northeast coast of Scotland, Fuchs (1977) identified black-headed gulls as the main predators on Sandwich terns' eggs, whilst herring gulls were the primary predator on Sandwich tern chicks. The study concluded that avian predation by these two species were major factors influencing the breeding success of Sandwich tern at the study area. Post fledging young Mediterranean Gull families are often located in and around the black-headed gull and Sandwich tern colonies. The Mediterranean gulls have been recorded ambushing the Sandwich tern adults returning to the colony after foraging and stealing prey items (Fuchs, 1977). Another study investigated the feeding ecology of Sandwich Terns in the presence of kleptoparasitising black-headed gulls on the Isle of Griend, The Netherlands, between 1992 and 1998. Approximately 30% of all of the food the parents transported to the colony was lost, through kleptoparasitism by black-headed gulls (Steinan *et al.*, 2001).

3.1.9 Other Seabird Species

Manx Shearwater

It has been reported that breeding Manx shearwaters are especially vulnerable to predation events by brown rat *Rattus norvegicus*, although avian predators, specifically the great black-backed gull, and great skua may also impact on breeding populations (Brooke, 1990; Newton *et al.* 2004). Dietary assessments from Lundy Island, in the Bristol Channel, also indicate that Manx Shearwater alongside other seabirds, such as herring gull, are the primary food source for the resident peregrine falcons (Sutton 2016; Sutton *et al.* 2017). A later study by Sutton and Loram (2021) then quantified the diet of five breeding pairs of peregrine falcon over four breeding seasons. Manx Shearwater was found to be the primary prey species, accounting for 47.3 % by frequency and 40.8 % by biomass.

There is also anecdotal evidence of great black-backed gull predating Manx shearwater on Skokholm, Wales although the predation rates had not previously been quantified. In 2017, a study was undertaken to quantify the diet of great black-backed gulls on Skokholm through the collection of regurgitate pellets of indigestible prey items. The study was undertaken across a twomonth period and revealed that the prey of the 26 breeding pairs of great black-backed gulls sampled consisted of 48% of other bird species, of this Manx Shearwater contributed 83.5%, followed by unidentified auk species (Atlantic puffin, razorbill, or common guillemot: 10.2%), European storm petrel (0.4%), other prey items identified included common pheasant *Phasianus colchicus*, unidentified passerine, unidentified gull, and unidentified bird (Westerberg *et al.*, 2019).

Petrels

On Elliðaey Island, Iceland a study was undertaken to investigate the prey of herring gulls and lesser black-backed gulls from 25 – 29 June 2018. The study targeted a population of approximately 160 gulls in mixed colonies and dissected 191 pellets. Findings showed that gulls fed primarily on avian prey, insects and molluscs and that the total consumption of Leach's Storm-petrels by all gulls in the colonies amounted to approximately two individuals per day, over the 4 day period. European storm petrels were not preyed upon in high quantity during the study period, with a minimum of one individual depredated within a four-day study period, which was attributed to the later breeding season of this species (Hey *et al.*, 2019).

A study aiming to investigate how reveal how the diet of great skuas has changed in Northern Scotland also analysed pellets and otoliths (Church *et al.*, 2018). Due to difficulties in differentiating among bird prey species, the most frequently occurring seabird remains in pellets were allocated into one of five categories one of which included storm-petrel (mostly European storm-petrel). The presence of storm-petrel within the diet of great skua has been low but consistent over the study period (1973 – 2017), (Church *et al.*, 2018).

Whereas, on Benidorm Island predation by yellow-legged gulls accounted for a large percentage of mortality of storm-petrels (up to 33%). The study undertook two methodological approaches including the analysis of pellets and multistate capture–recapture models to estimate separately adult storm-petrel survival and a minimum probability of being killed by gulls. It was confirmed that predation was carried out by specialist gulls, and that neither the size of the gull colony nor its food availability influenced predation on petrels (Oro *et al.*, 2005).
Storm-petrels are also vulnerable to predation by a variety of owl species, including Little Owl *Athene noctua* (Lockley, 1947), short-eared owl and long-

eared owl *Asio Otis* (Bried, 2003). In some locations such as Ramsey, Pembrokeshire predation by breeding owls may contribute to storm-petrel population decline or hinder attempts to establish new colonies (M. Bolton pers. obs.). Although no owl species breed at Scottish storm petrel colonies, short-eared owls occur as regular migrants at colonies such as St Kilda and Mousa but are not thought to cause population-level impacts (The Scottish Government, 2022.).

Other species

A study on Alborán Island, in southern Spain (Paracuellos and Nevado 2010), found that the population of Audouin's gulls *Larus audouinii* increased from an average of 181 pairs in 1997-2000 to 626 pairs in 2009, following the control of yellow-legged gulls *Larus michahellis* from 2000 to 2009.

Unlike common guillemot, black guillemot nest in burrows or crevices, with nest boxes having been shown to be successful for the species at Copeland Bird Observatory and on Strangford Lough (British Trust for Ornithology, 2024). Black guillemots have shown to be vulnerable to avian predators such as hooded crow (Foster, 2011; Hario 2001;) and great skua (Furness, 1987). A study undertaken by Johnston *et al.* (2019) used camera traps to investigate predation on breeding black guillemots. Hooded Crows were identified in 557 photographs, with one instance of a chick being predated on North Ronaldsay from a single chick nest. Although no direct interaction or predation was recorded, other avian predators recorded on the cameras included great black-backed gulls (56 sightings), and great skuas (four sightings) (Johnston *et al.,* 2019). Herring Gull predation on black guillemot has also been observed, with gulls pulling both sitting adults and chicks from nesting holes (BTO, 2024).

Significant declines have been observed in monthly counts of Eurasian Oystercatchers *Haematopus ostralegus* within the Exe Estuary in comparison with the wider region of southwest England. These findings suggested that there were site-specific pressures leading to these declines which was investigated by Custard *et al.* (2024). It was found that an unexplained increase in the frequency of kleptoparasitism (whereby carrion crows and European herring gulls were stealing mussels (the preferred prey) from oystercatchers). The study concluded that this increased kleptoparasitism led to reduced foraging success, leading to a decrease in over winter survival and a reduction in immature birds using the site over winter (Custard *et al.*, 2024).

3.1.10 Summary

If reducing pressures from avian predators is progressed as a strategic compensation measure, understanding the key avian predators for each of the seabird species of OW compensation concern is crucial. Methods implemented to control avian predators would need to be tailored to the relevant species in order to be ecologically effective. Understanding the spatial nature of avian predation would also be key if the measure were to be implemented on a strategic scale. This is set out in table 3.4 below.

Table 3.4: Summary of the primary avian predators for each seabird species of OW compensation concern and the region where predation has been recorded

Seabird species requiring compensation	Avian predators	Region where predation has been recorded
Black-legged kittiwake	Peregrine falcon[3]	Puffin Island, North Wales
	White-tailed eagle[4]	Norway
	Great skua[5]	Northern Isles and north and north west Scotland.
	Great black-backed gull[6]	Newfoundland, Canada
	Herring gull[7]	
Northern gannet	Great black-backed gull	Not specified
	Herring gull	Not specified
	Common raven	Not specified
	White-tailed eagle[8]	Lofoten, Norway
Common guillemot	Great skua[9]	East coast of England and Scotland
	Great black-backed gull[9]	
Razorbill	Herring gull[10]	Skokholm, Wales
	Eurasian jackdaw[10]	

[3] Collins, (2014); Furness, (2013)
[4] Anker-Nilssen and Aervak (2009), Anker-Nilssen *et al.* (2023)
[5] Heubeck *et al.* (1997); Phillips *et al.* (1999); Votier *et al.* (2008)
[6] Massaro *et al.* (2001)
[7] Galbraith (1983), Harris and Wanless (1997)
[8] Barrett (2008)
[9] Furness (2021), Camphuysen (2002)
[10] Lloyd (1979)

Seabird species requiring compensation	Avian predators	Region where predation has been recorded
	Great black-backed gull[11]	Not specified
	Great skua[11]	Not specified
	Common raven[11]	Not specified
	Crows[11]	Not specified
Lesser black-backed gull	Common raven[12] [13]	Norway
	Hooded crow[13]	Norway
	Herring gull[14]	Finland
Red-throated diver	Great skua[15]	Shetland
	Hooded crow[16]	Shetland
	Common raven[16]	Shetland
	Herring gull[16]	Scotland Shetland Finland
	Great black-backed gull[16]	Scotland Shetland
	Lesser black-backed gull[16]	Shetland
	Common gull[16]	Shetland Scotland
	Common crane[17]	Sweden and other Arctic areas
	White-tailed eagle[17]	Sweden and other Arctic areas
	Glaucous gull[18]	Sweden and other Arctic areas
Atlantic puffin	Herring gull[19]	Isle of May Newfoundland, Canada

[11] Furness (2021)
[12] Bustnes *et al.* (2022)
[13] Bardsen and Bustnes (2022)
[14] Hario *et al.*(1994), Hario *et al.* (1993)
[15] Okill (2004)
[16] Bundy (1978); Dewar and Lawrence (2023)
[17] Ollson *et al.* (2021)
[18] Bergman and Derksen (1977)
[19] Finney *et al.* (2003)

Seabird species requiring compensation	Avian predators	Region where predation has been recorded
	Lesser black-backed gull[19]	Isle of May
	Great black-backed[20]	Newfoundland, Canada
Sandwich tern	Black-headed gull[21] Mediterranean gull[22]	Scotland The Netherlands
Manx shearwater	Peregrine falcon[23]	Lundy Island, Bristol Channel
	Great black-backed gulls[24]	Skokholm, Wales
	Great skua[25]	Not specified

[20] Soanes *et al.* (2010)
[21] Fuchs (1977), Steinan *et al.*, (2001)
[22] Fuchs (1977)
[23] Sutton (2016); Sutton *et al.*, (2017)
[24] Brooke (1990), Westerberg *et al.* (2019)
[25] Newton *et al.* (2004)

4 Wider considerations

4.1 Global and UK declines in bird numbers

The UK hosts breeding assemblages of seabird species of global importance; however, seabirds are facing an ever increasing range of threats such as climate change, changes in prey availability, bycatch, impacts from offshore activities including renewable energy and impacts to breeding success due to mammalian predators and diseases such as Highly Pathogenic Avian Influenza (HPAI). As a result of these pressures, many of the UK seabird species are now in decline, including both species considered to be avian predators and those of OW compensation concern examined within this document.

In an addendum to the fifth Birds of Conservation Concern (BoCC) in the United Kingdom, Channel Islands and Isle of Man and second International Union for Conservation of Nature (IUCN) Red List assessment of extinction risk for Great Britain (UK BoCC5a) Stanbury *et al.* (2024) added five seabird species to the Red List[26] (including Leach's storm-petrel, common gull, great black-backed gull, Arctic tern and great skua), see Table 4.1. The total number of Red-listed seabird species has now increased to 10, from six species when last assessed whilst those on the amber list[27] changed from 19 to 14 species (Stanbury *et al.*, 2024).

[26] BoCC Red-list key criteria: IUCN: Globally threatened; historical decline in the breeding population and severe breeding population decline over 25 years/longer term (see Stanbury *et al.* (2024) for further information on criteria.

[27] BoCC Amber-list key criteria: threatened in Europe and moderate breeding population decline over 25 years/longer term (see Stanbury *et al.* (2024) for further information on criteria.

Table 4.1: Species assessments for breeding seabirds for UK BoCC5a and GB IUCN2a addendum (IUCN threat status categories: Critically Endangered (CR), Endangered (EN), Vulnerable (VU), Near Threatened (NT) and Least Concern (LC))

Species	UK BoCC5a assessments	GB IUCN2a species assessment	Vulnerability index in the context of collision risk (Furness *et al.*, 2013)	Vulnerability index in the context of disturbance or habitat displacement (Furness *et al.*, 2013)
European storm-petrel	Amber	LC	91	2
Leach's storm-petrel	Red	CR	85	2
Northern fulmar	Amber	CR	48	2
Manx shearwater	Amber	CR	0	2
Northern gannet	Amber	LC	725	3
Black-legged kittiwake	Red	EN	523	6
Herring gull	Red	EN	1306	3
Lesser black-backed gull	Amber	LC	960	3
Sandwich tern	Amber	LC	245	9
Little tern	Amber	VU	212	10
Roseate tern	Red	[EN]; CR	175	9
Common tern	[Green] Amber	[NT]; VU	229	8
Arctic tern	Red	EN	198	10

Species	UK BoCC5a assessments	GB IUCN2a species assessment	Vulnerability index in the context of collision risk (Furness *et al.*, 2013)	Vulnerability index in the context of disturbance or habitat displacement (Furness *et al.*, 2013)
Arctic skua	Red	CR	327	3
Great skua	[Amber] Red	[LC]; VU	320	3
Atlantic puffin	Red	CR	27	10
Common guillemot	Amber	VU	37	14

4.2 Ethical considerations

One of the key issues with implementing avian predator control is centred around ethical concerns. Particularly with regard to lethal control and the unintended impacts of non-lethal control on both the conservation of the target species and other non-target species. Avian predator control undertaken to date has been highly contentious and met with high levels of opposition by certain conservation groups and the public, whereas vermin/rat eradication is more often widely accepted. However, as outlined in section 2.1.2 avian predator control has been previously carried out as a compensation measure in Europe and is also carried out by RSPB and there therefore needs to be a balance of these interests.

Avian predator management is particularly controversial when the target species are themselves protected, of high ecological value, of conservation concern, or vulnerable to the impacts of offshore wind farms. In many cases, selective management (i.e. the targeted removal of individuals predating on a seabird colony) is considered to be more acceptable than large-scale culling (Doherty and Ritchie, 2016). Furthermore, studies such as Westerberg *et al*. (2019) indicate that the removal of a relatively small number of specialist individuals may be an effective control measure to reduce impacts. This approach still remains contentious however and may result in difficult decisions needing to be made over the relative importance of different species and the appropriateness of management actions when considering the UK's declining seabird populations.

Key avian predators associated with seabird colonies in UK waters include gull species, which have experienced severe population declines themselves in recent years. Gulls are subject to multiple pressures including disease, predation, disturbance, legal and illegal control, and changes in food availability, including from fishing practices and landfill activities (Burnell *et al.*, 2023). Further information on the status and threats facing gull species (greater black-backed gull, lesser black-backed gull and herring gull) which are considered to be key predators of seabirds of OW compensation concern is provided in Table 4.2 below.

Finally, many avian predator species highlighted in this report, are actively being reintroduced. For example, sea eagles and other birds of prey (Table 3.1). Measures to reduce or limited numbers of these species could appear to contradict reintroduction programmes, so both must be carefully considered before being actioned.

Table 4.2: Overview of status and threats facing gull species (greater black-backed gull, lesser black-backed gull and herring gull) including declines in breeding abundance recorded by the Seabird Monitoring Plan from 2000-223 (Harris et al, 2024)

Species	Decline in breeding abundance	Key threats and potential sources of decline (Harris *et al.,* 2024)
Great black-backed gull	45%	• Reduction in food availability due to legal restrictions on fishery discards could impact their populations (Reeves and Furness 2002; Reid 2004; Wilhelm *et al.* 2016) • Chemical pollution from dichloro-diphenyltrichloroethane (DDT) in the marine environment (Burnell *et al.,* 2017) • Predation from terrestrial mammals such as American mink *Neovision vison* (Nordström *et al.*, 2003) • Bycatch (Billerman 2020; Christensen-Dalsgaard *et al.*, 2022) • Collision with OW turbines (Bradbury *et al.* 2014; Furness *et al.,* 2013)
Lesser black-backed gull	78%[4]	• Reduction in food availability due to legal restrictions on fishery discards (Bicknell *et al.,* 2013; Furness, *et al.*, 1992; Oro 1996; Ross-Smith *et al.*, 2014). • Diseases such as botulism (Macdonald and Standring 1978) and HPAI has led to a decrease of 25% in breeding populations at selected UK natural-nesting sites (Tremlett *et al.,* 2024). • Predation from mammalian predators such as red foxes, American mink and European badgers *Meles meles* (Davis *et al.,* 2018) • Collision with OW turbines (Thaxter *et al.,* 2019) • There is potential for some declines to be attributed to emigration from natural nests to urban areas (Rock 2005), likely driven by reduction in natural nesting habitat and sea level rise (Lock *et al.* 2022; Ross-Smith *et al.,* 2015) or increases in food availability in urban areas.

Species	Decline in breeding abundance	Key threats and potential sources of decline (Harris *et al.,* 2024)
Herring gull	46%[28]	• Impacts from HPAI have led to a decrease of 7% in the herring gull breeding populations at selected UK natural-nesting sites respectively, according to a comparison of pre- and post-HPAI counts (Tremlett *et al.,* 2024). Other threats and potential causes of decline include diseases such as botulism (Coulson 2017; Macdonald and Standring 1978;), changes in food availability such as ban of fishery discards (Bicknell *et al.,* 2013; Foster *et al.* 2017; Furness *et al.* 1992) and improvement in waste management (Coulson, 2015; Madden and Newton, 2004) predation from mammals such as American ,mink (Craik, 2015), and collision risk with OW turbines (Bradbury *et al.*, 2014).

[28] It should be noted that abundance trends for lesser black-backed gulls and herring gulls are currently only produced for natural nesters (gulls breeding on moors, cliffs, marshes, beaches) rather than on buildings in urban areas. This is due to feasibility and inherent uncertainty associated with monitoring birds and nests in urban environments. The trends presented above, therefore may not reflect the overall trend of the UK population.

5 Methods for reducing pressures from avian predators

5.1 Legal context

All wild birds are given full protection, in the UK under the Wildlife and Countryside Act 1981 (as amended), noting that parts of the Act apply differently in Scotland. Subject to certain exceptions, it is an offence to:

- Intentionally kill, injure or take any wild bird;
- Intentionally take, damage or destroy the nest of any wild bird while it is in use or being built;
- Intentionally take or destroy the egg of any wild bird;
- Possess wild birds (dead or alive) and their eggs; or
- Use traps, poison or similar items to kill, injure or take wild birds.

The above legislation does, however, allow exemptions for certain species of wild birds to be killed, providing all other alternatives have been explored, with licences issued by the relevant authority on behalf of the government. These exemptions may be for purposes such as preserving air safety, public health, preventing damage to livestock or for conservation.

Due to their poor conservation status, herring gulls and lesser black-backed gulls were taken off the general licence list in 2019 (Defra, 2020). Individual licences can still be applied for in order to control these species, however it was deemed that demand for gull licences for conservation purposes in 2021 would likely be in excess of that which could be allowed to support the recovery of these species. Individual licence applications for herring gull and lesser black-backed gull therefore need detailed evidence of the requirement to limit detrimental effect on vulnerable gull populations (Defra, 2020).

5.2 Non-lethal control measures

5.2.1 Habitat modification/nest cover and refuges

Interactions between predation and habitat quality of the prey species means that habitat management may be used as a tool to reduce predation levels. One of the most successful habitat modification methods is the creation of areas of cover or other refuges which result in predators being less likely to detect the target species. Cover and refuge methods may include the provision of tall ground cover or shrubs. For example, previous studies show that common guillemots nesting in areas with artificial cover installed over the cliff tops produced twice as many eggs (Parish and Paine 1996). The RSPB (2024) also suggested that providing an appropriate level of vegetation in front or around Atlantic puffin burrows, could aid in protecting pufflings and potentially reducing levels of kleptoparasitism from gulls. However, scrub management has also been proposed as a potential method to increase puffin nesting as large amounts of vegetation may prevent access to or visibility of burrows and could increase predation by mammalian predators such as rats (Outer Dowsing, 2025).

Kim and Monaghan (2005a) examined the potential sheltering effect of nest vegetation on the behaviour and breeding performance of herring gulls on Walney Island Cumbria. Whilst there was no evidence that vegetation cover influenced predation rate of eggs and chicks at this colony, predation rate was very low once the individuals completed their clutches and started incubation. In the same location, Kim and Monaghan (2005b) undertook similar work for lesser black-backed gull. a positive relationship between hatching success and nest vegetation, indicating the potential importance of nest vegetation in incubation. Findings demonstrated a positive relationship between hatching success and nest vegetation and suggested that nest vegetation can contribute to the provision of an appropriate microclimate for successful development of embryo and to protect eggs from predators (Stauffer and Best 1986; Bekoff *et al.,* 1989; Saliva and Burger 1989).

For reducing predation on wetland birds, vegetation management has included the creation of island refuges in reedbeds and other wetlands (Carter and Bright 2003) and maintenance of a high-water table throughout the breeding season for wading birds to reduce access and therefore predation by red fox (Bellebaum and Bock 2009).

Habitat management may be undertaken to indirectly control predator numbers. Specifically, habitat management may be used to reduce edge effects and actions may also be undertaken to reduce high populations of other typical prey species for predators, such as voles and rabbits, to indirectly reduce predator numbers (Kortland, 2006).

5.2.2 Artificial burrows, nest boxes and rafts

Artificial burrows or nest boxes can be installed at sites for ground/burrow nesting species where nesting is limited by ground conditions or to protect ground-nesting birds from larger avian predators such as gulls (Swinnerton *et al.,* 2008).

The provision of artificial nest boxes has been shown to be effective in providing protection for common tern nestlings from gull species (Burness and Morris, 1992). The study tested small chick shelters in Ontario, Canada which were designed to reduce predation from gulls. Prior to shelter placement predation on tern chicks had been regularly observed, with observations reducing to zero after placement.

Several studies have observed Roseate tern species preference for artificial nesting structures over natural nest sites on the ground or in crevices (Grinnell, 2010; Spendelow, 1982) which is at least partly attributed to shelter from avian predators. Similarly, Burke and O'Connell (2022) reported that Roseate terns show a preference for nest boxes and that birds nesting in nest boxes on Rockabill in Ireland performed better than those using open nest sites. On Rockabill, Larus gulls[29] are the most important predator of Roseate tern nests (Cabot, 1996; Casey *et al.*, 1995; Fink *et al.*, 2021), requiring wardens to monitor the study area to ward off gulls which attempted to predate nests whilst parents were away from the nest. Nest boxes are also used at other tern colonies, such as Lady's Island Lake (Ireland), Coquet Island (England) and Île aux Moutons and Île de La Colombière in Brittany, France (Burke and O'Connell, 2022).

A study was undertaken aiming to increase the availability of secure nest sites at a Madeiran storm petrel *Oceanofroma castro* colony. The colony was located on an Islet in the Azores that was free from introduced predators and showed evidence of inter-specific competition (Bolton *et al.*, 2004). The study introduced nest boxes that were designed to exclude larger species which resulted in a 12% increase in the breeding population after a year and a 28% increase in the overall colony size in the second year. Results from over three breeding seasons, showed that the breeding success of storm petrels using

[29] Larus is a large genus of gulls with worldwide distribution, and includes species such as herring gull, great black-backed gull and lesser black-backed gull.

nest boxes averaged 2.9 times greater than that of storm petrels at natural sites (Bolton *et al.*, 2004).

Meanwhile, in Benidorm, Spain a study carried out from 1997-2001 by De León and Mínguez (2003) found that European storm petrels in artificial nest boxes had significantly higher nesting success than birds in natural nests. The nest boxes included small tunnels which prevented access by larger yellow-legged gulls (known predators of storm petrel at this location), although the exact reasons for increased breeding success were not concluded. A later study by Libois *et al.* (2012) investigated the effectiveness of nest boxes for Mediterranean storm petrel *Hydrobates pelagicus melitensis* at Benidorm Island (Spain). The study found evidence of higher survival rates and breeding success for birds breeding in artificial nests than at natural sites. It concluded that the increase in survival rate and breeding success was likely due to increased protection from gull predation.

Red-throated diver productivity has also been shown to increase following provision of artificial nesting rafts in Scotland (Rheinallt *et al.* 2007; Furness 2013) and Finland (Nummi *et al.*, 2013). This is most likely the result of reduced nest flooding from fluctuating water levels and reductions in impacts of human disturbance and predation by mammalian predators. However, in areas where avian predators are impacting productivity (i.e. Scotland), open nesting rafts may only provide limited increased nest survival. For North Falls OWF, the primary compensation measure proposed for red-throated diver is the provision of artificial nesting rafts in Shetland or along the north mainland of Scotland. The provision of rafts with roofs may be considered as part of the adaptive management plan if productivity is not sufficiently increased by provision of standard rafts (North Falls, 2024). Similarly, nesting rafts may also be used as a management tool, including reducing pressures from avian predators for common terns (e.g. Dunlop et al 1991; Coccon *et al.*, 2018).

Whilst there is evidence that artificial nests have been used to successfully protect nesting birds from avian predators (e.g. Bolton *et al.*, 2004; Libois *et al.*, 2012) they may also have other positive impacts such as establishing new colonies, increasing established colony size, and improved breeding success, clutch sizes and adult survival (Priddel and Carlile 1995; Carlile *et al.* 2012; Fontaine and Martin, 2006, Sherley *et al.* 2012; Bedolla-Guzman *et al.* 2016). These observed benefits may be due to factors such as lowered incubation effort resulting from shelter from wind (Hilde *et al.,* 2016). The use of artificial burrows/nest boxes may be combined with other management measures such as translocation (Miskelly and Taylor 2004, Priddel and Carlile, 2006), supplementary feeding (Priddel and Carlile, 2001) and the use of decoys and recorded vocalisations to attract target bird species to the location (Podolsky and Kress, 1989, Cruz and Cruz, 1996, Bolton *et al.*, 2004).

5.2.3 Deterrence

Avian deterrents may be auditory, visual or chemical depending on the target species and location. Examples of different deterrents used for deterring pest birds from urban environments, farms, fisheries, airfields and landfill sites are detailed in Appendix A and are taken from NRW, 2024.

Visual deterrents

In addition to those listed by NRW, bamboo canes can be used as an additional form of visual deterrent to reduce predation by gulls on ground – nesting birds (Boothby *et al.*, 2019). The study placed bamboo canes in four breeding sites of Arctic Tern to test effectiveness as a deterrent, and observed fewer predation attempts in the caned areas than in the control areas. However, if a predation attempt did take place, the presence of canes did not reduce the probability of predation success. The study highlighted that further research is required to test the effectiveness across several breeding seasons and study sites, and to investigate the potential for habituation (Boothby *et al.*, 2019).

Other potential methods to divert avian predators away from important seabird breeding areas include laser-hazing, where laser beams were pointed at avian predators to discourage predation on prey species. This has been carried out at tern colonies, however, the efficacy of this method has been inconclusive due to not enough avian predators being successfully deterred and inconclusive findings on the effects of hazing on predation attempts and success (RSPB unpubl.data). This method is challenging to deliver due to the labour-intensive nature of hazing individual predators at scale and over long time periods, and therefore unlikely to be feasible at a strategic scale.

Anti-perching devices are often used in urban locations where wire coils, gels or spikes are used to deter bird presence through removal of perches. As seabird colonies are often located in remote locations, there would likely be limited locations for avian predators to perch although in some cases the removal of trees could be beneficial.

Auditory deterrents

A recent study by Scottish Government Marine Directorate (2024) suggested that further work should be undertaken to understand the deterrence of target avian predators in urban environments as these can offer useful insights into effective methods. For example, methods such as falconry, robots, pyrotechnics, and the playback of distressed calls have been shown to successfully deter gulls from certain areas (Baxter and Allan, 2006; Baxter and Robinson, 2007; Cook *et al.*, 2008; Soldatini *et al.*, 2008; Storms *et al.*, 2022; Thieriot *et al.*, 2015).

Recordings of bird alarm or distress calls may be effective when used on the same species of bird as the one recorded, or one that is taxonomically related (NRW, 2024). Research has shown them to work for gulls and corvids, but they may be less effective against species which do not produce readily identifiable distress calls (NRW, 2024). Further information on this measure and other measures used to deter birds in urban environments is included in

A key consideration when using deterrent methods to control avian predators, is to avoid unintended impacts on the target species themselves or predators moving to other undesirable locations. There is also evidence that suggests that gulls (Stickley *et al.* 1995) and other seabird species (Ronconi and St. Clair 2006, Soldatini *et al.* 2008) can become habituated to deterrents over time.

5.2.4 Diversionary feeding

Diversionary feeding is defined as "the use of food to divert the activity or behaviour of a target species from an action that causes a negative impact, without the intention of increasing the density of the target population" (Kubasiewicz *et al.*, 2016). Diversionary feeding can be carried out when natural food is limited, however it may also be effective when natural food is not limited as to divert avian predators to areas away from the target species. Diversionary feeding is most effective when carried out during the breeding season, when highest levels of predation on seabird nests occur (Smart and Amar, 2018).

Diversionary feeding allows both predator and prey to successfully raise chicks without harm to either species which reduces potential conflicts when controlling a species that is protected in its own right (Berwick Bank, 2022). Berwick Bank OWF derogation case noted that diversionary feeding would likely only be required for short period of time (a few weeks) whilst the chicks of the species of OW compensation concern are present, therefore predators would forage naturally for the remainder of the year. The report also stated that diversionary feeding would only be required for a small number of specialist pairs or individuals of the target predator species, and on this basis would not be expected to cause an increase in predator populations (Berwick Bank, 2022).

Berwick Bank OWF received advice from NatureScot that diversionary feeding could be effective as a project level compensation measure for peregrine falcons (where nest sites are accessible) (Berwick Bank, 2022). Although noting it is currently unknown how much predation on kittiwakes is due to peregrine falcons and diversionary feeding has not yet been trialled for this species. The potential for diversionary feeding to be used as a compensation option for great black-backed gull and herring gull was deemed not to be feasible on the basis that many birds nest colonially. Key concerns from stakeholders were centred around potential impacts on predator populations. Diversionary feeding was not taken forward as a measure and no further work was undertaken.

In a study conducted by Redpath *et al.* (2001) diversionary feeding of hen harriers *Circus cyaneus* reduced the number of grouse chicks taken from broods by 64%-94%, although this was not reflected in increases in grouse density in autumn. Similar findings were also recorded in a later study by Ludwig *et al.* (2018) where diversionary food was made available to all hen harrier broods on Langholm Moor between 2008 and 2015 as part of the Langholm Moor Demonstration Project. The number of grouse chicks predated by hen harrier broods in each year (from 2008-2015) represented 0-6% of grouse chicks produced per year. This was 34-100% lower than would be expected without diversionary feeding. However, the combination of diversionary feeding and grouse moor management did not increase the grouse density enough to support driven grouse shooting (Ludwig *et al.*, 2018).

Other examples include the diversionary feeding of common kestrels *Falco tinnunculus* which resulted in reduced predation on little tern *Sternula albifrons* chicks in Norfolk. Over a period of 6 years predation on little tern decreased by 88%, which resulted in little tern productivity doubling (Smart and Amar, 2018). In a study conducted by Mason *et al.* (2021) diversionary feeding of red kite *Milvus milvus* to reduce predation of Northern lapwing *Vanellus vanellus*, resulted in lapwing productivity increasing two-fold in years when diversionary feeding took place.

More recently, Bamber *et al.* (2024), evaluated diversionary feeding as a management tool to reduce predation on nests of Western capercaillies *Tetrao urogallus* in Scotland. The predators in the area included mammalian and avian species such as European badger *Meles meles*, red fox, European pine marten *Martes martes*, carrion crow, common buzzard *Buteo buteo* and ten scarcer raptor species. Diversionary feeding resulted in a marked decrease in predation on artificial nests and was reflected in an 82.5% increase in predicted nest survival over 28 days of incubation. It should however be noted that the main capercaillie nest predator in the region was deemed to be European pine marten.

5.2.5 Translocation

Translocation of avian predators, whereby the avian predator is captured, transported and released in a new location (away from important breeding areas for target species) could present a potential method for controlling avian predators on a strategic scale (Ackerman *et al.*, 2014). However, the feasibility and likely success of this method is likely to be species specific and very expensive to deliver (Marine Directorate, 2024). However, it is important that translocation programmes reduce the breeding numbers of the target species at the metapopulation level, and emigration of birds to neighbouring colonies to ensure that issues are not transferred to other sites (e.g., Bosch *et al.*, 2000).

In San Francisco Bay, California, a managed relocation programme of California gull *Larus californicus* colony was carried out over a two-year period (Ackerman *et al.*, 2014). Prior to relocation, gulls were found to be the predominant predator of Forster's tern Sterna *forsteri* chicks, potentially causing 54% of chick deaths. After the gull colony relocation, tern chick survival increased 900% at the closest colony (<1 km) but did not significantly change at a more distant tern colony (>3.8 km). At 19 tern nesting islands, fledging success was higher when gull abundance was lower at nearby colonies and when gull colonies were farther from the tern colony. The study concluded that the managed relocation of gull colonies away from nesting areas of sensitive waterbirds can improve local reproductive success, but this method could result in the shift of gull predation pressure to other areas or species (Ackerman *et al.*, 2014).

Translocation of black-billed magpies *Pica pica* was undertaken in Paris over a three-year period (Chiron and Julliard, 2007). After removal of magpies, the number of juvenile blue tits *Parus caeruleus* increased by 40% and the number of adult long-tailed tits *Aegithalos caudatus* increased 50 fold, with no corresponding increase in control sites where magpies were not removed. However, a 70% reduction in the number of adult blackcaps *Sylvia atricapilla* was also observed. There was no change in the number of juveniles or adults in seven other species monitored. The increase in blue tit juveniles observed after magpie density reduction was not anticipated as blue tits nest in cavities and are thus protected from avian predation. It was therefore concluded that a reduction in predation on fledglings was the primary explanation for the resulting increase in numbers (Chiron and Julliard, 2007).

Translocation may also occur where target species are transferred to a new location away from predators. For example, Young *et al.* (2023) translocated 110 Hawaiian petrel *Pterodroma sandwichensis* and 86 Newell's shearwater *Puffinus auricularis newelli* to a 2.5-ha predator-free enclosure on Kauai, Hawaii between 2015-2020. Prior to translocation, 76 artificial burrows were installed, along with removal of invasive plants and restoration of native plants. It was reported that all Newell's shearwater and 96% of Hawaiian petrel chicks survived to fledging, with multiple individuals returning to the translocation site as adults (Young *et al.*, 2023). This particular method of translocation is however likely to be challenging in the context of ensuring that species' populations within SPAs are maintained in favourable conservation status.

5.2.6 Indirect predation control

In some cases, management methods may be undertaken to manage factors that have resulted in avian predator numbers being at a level where there are significant impacts to target species.

When undertaking these methods to indirectly control the number of predators it is important to consider any potential negative effects on other non- target species. For example, reducing numbers of vole could impact other species which rely on them for food and which may often be protected in their own right. Therefore, the potential benefits and dis-benefits of indirect predator management should be carefully considered.

5.2.7 Intraguild predation

Intraguild predation occurs when two species that share a host or prey (and therefore may compete) also engage in a trophic interaction with each other (parasitism or predation) (Rosenheim *et al.*, 1995). Intraguild predation may be used as a tool in controlling certain predator numbers, whereby other predators play a role in predating on or competing with the target predator species, (Janssen *et al.*, n.d). This would involve the introduction or increase in presence of larger, more dominant predator in order to reduce or control the numbers of smaller (target) predators. This may be through either direct predation, competition for prey, habitat or resources or avoidance behaviour.

Although intraguild predation is a growing area of interest amongst ecologists and conservationists, there are limited studies documenting these complex interactions. Sergio and Hiraldo (2008), however suggested that Eurasian goshawk *Accipiter Gentilis* may reduce common buzzard density and breeding success as well as preying on corvids. There is also evidence that golden eagle *Aquila chrysaetos* could naturally limit hen harrier numbers on grouse moors (Fielding *et al.*, 2003). A study by Masson and Gallarado (2017) also recorded two events of intraguild nest predation involving Southern Caracaras *Caracara plancus*, Long-winged harriers *Circus buffoni*, and Roadside Hawks *Rupornis magnirostris* in Buenos Aires Argentina.

There is limited understanding of complex predator-prey relationships, making it difficult to develop the use of intraguild predation as a practical predator management tool. However, in the context of increasing numbers of some predatory species the role of top predators and meso-predators in controlling prey species populations due to their effect on more efficient lower predators should be considered and further studied (Bodey *et al.*, 2009).

5.2.8 Physical exclusion

Fencing, nets and wires may be used for predator control in areas of high densities of ground nesting birds. Electric fencing is becoming a commonly used method for terrestrial mammal control and exclusion on nature reserves. However, due to the mobile nature, ecology and foraging preferences of many seabird species it is unlikely that physical exclusion would be effective in controlling predation from avian predators without unintended impacts on the target species themselves. Access to colonies of cliff nesting species would also likely present logistical challenges.

In 1976 Ice Island, Ontario Canada previously supported 121 nests of common tern, by 1989 the island had been completely taken over by 181 pairs of nesting ring-billed gulls. During the breeding season from 1990-1993, Blokpoel *et al.* (1997) installed monofilament lines (to prevent gulls from landing and nesting), together with the repeated removal of gull nests, and the placement of wooden tern decoys was found to increase tern numbers of common terns. However, other studies such as Morris *et al.* (1992) and Scopel and Diamond (2017) did not find this method to be effective.

5.2.9 Public education

Public education alone is unlikely to be a successful measure for controlling avian predators, however, could be an effective tool when carried out alongside other control measures. Measures could be implemented in the locality of existing breeding seabird colonies to educate the public and businesses not to feed gulls and to dispose of food waste in an appropriate manner. These measures can help to keep gull numbers lower if there are less scavenging opportunities (NatureScot, 2025).

5.3 Lethal control measures

Lethal control involves the trapping, shooting, poisoning or otherwise killing of target avian predators to reduce their abundance or remove them from important breeding areas. Lethal control can be an effective strategy in reducing nest predation rates (e.g. Smith *et al.*, 2010) but can also be ethically and politically contentious and can result in unintended impacts on non-target species (Doherty and Ritchie, 2017; Bodey *et al.*, 2009).

Shooting and trapping are considered the most common methods of avian predator control, although the licence holder should consider the least impactful permitted method available in the circumstance.

The key lethal control measures are further explained in section 5.3.1 to 5.3.3 below.

5.3.1 Shooting

Shooting is generally only carried out on a small enough scale that it would not result in an overall impact on the population. One approach to lethal control involves removing 'problem individuals' which may be impacting breeding colonies. There is strong evidence that some individuals may develop specific predatory behaviours and that removal of these individuals can be very effective in controlling overall predation rates (Swan *et al.*, 2017). In urban environments shooting can be effective as an aid to scaring, but only when used as part of a wider bird scaring programme.

5.3.2 Egg destruction

Egg destruction may also be carried out carried out under licence for certain species and purposes. Methods typically include the replacement of the avian predator's eggs with dummy eggs and then chilling removed eggs (to make them unviable) before placing back in the nest. Returning the eggs to the avian predator's nest increases the likelihood that the birds will continue sitting on the eggs rather than laying a new clutch. Pricking and oiling eggs are generally not carried out due to concerns around the effectiveness with the procedure, chicks developing with abnormalities as well as issues around oil rubbing off on parent bird's feathers (NRW, 2025).

5.3.3 Trapping

Live-capture cage trapping and dispatch is widely considered to be a humane control method. Traps should be of permitted design, i.e. to capture birds alive, and to reduce the likelihood of entrapment or harm to non-target species. Permitted trap designs include the following:

- walk in multi-catch cage trap;
- Larsen trap;
- Larsen mate trap;
- Larsen pod trap; and

- pigeon trap.

Multi-catch cage trap

Multi-catch cage traps are large, covered in mesh and often have a narrow ladder or funnel in the top which birds can enter but are unable to fly back through. Carrion crow, hooded crow, Eurasian jackdaw and Eurasian magpie may be used as a decoy to catch target species in a multi-catch cage trap.

Larsen trap

A Larsen trap is a small portable cage with a spring activated trap door at the top or side that will close behind any bird heavy enough on entering the trap. Either bait or a live decoy bird can be used to attract target birds into the trap, with decoy birds often greatly increasing the effectiveness of the trap (Kirchmeir *et al.,* 2019). Only a single live decoy can be used, and it must be in a separate closed compartment within the cage. At the time of writing, only Carrion crows, hooded crows or Eurasian magpies are permitted as decoy birds in Larsen traps that are set under the general licence for the conservation of wild birds. The use of any other species as a decoy (e.g. a pigeon) is an offence.

6 Conclusions

Previous studies have found that the control of avian predators can have a positive impact on seabird populations during the breeding season, although with varying levels of effect (Royal Haskoning DHV, 2023; Marine Directorate, 2024). The potential effectiveness of avian control and, therefore viability as a strategic compensation measure, is dependent on several factors including the species of avian predator involved, the species of OW compensation concern, the site and type of management undertaken. Combined these factors make this measure difficult to implement on a strategic scale, and there is a need to better understand which avian control measures are best suited to both different avian predator species and species of OW compensation concern.

Non-lethal predator control and management may be considered more favourable ethically and is often a less labour-intensive alternative than lethal control (Doherty and Ritchie, 2017). For example, non-lethal control is likely to be effective against multiple predators (both avian and mammalian) at the same time. Non-lethal measures may also be better received by the general public and conservation organisations than lethal measures. Most importantly, non-lethal control is likely to be a more sustainable and less time-consuming form of predator management to deliver in the long term, key considerations for determining the suitability of strategic compensation measures.

In light of the limited number of strategic compensation measures currently available for OW development, there is merit in progressing additional assessment of several of the avian predator management methods outlined in this report to enable these to be developed and implemented as a package of measures for specific species of OW compensation concern.

This work could encompass the following:

1. As a standalone measure that incorporates a package of avian control methods that are deemed most effective for a particular avian predator or species of OW compensation concern.

2. Reducing pressures from avian predators could be implemented alongside other strategic measures, such as mammalian predator

control or disturbance reduction. The delivery of two (or more) measures together would likely lead to increased effectiveness of the compensation and reduce levels of uncertainty. These identified measures methods could then be implemented through a strategic scheme at scale.

In order for reducing pressures from avian predators to be implemented as part of a package of measures for a given species of OW compensation concern, there is a need to undertake further investigation of all those control methods identified as having potential given the current limited evidence base. Table 6.1 lists the methods for which further work is recommended.

Recommendations are centred around undertaking practical trials of non-lethal work such as habitat modification/nest cover and refuges, artificial burrows and nest boxes and deterrence measures such as bamboo canes and bioacoustics. This would enable the methodologies to be further developed, monitored for effectiveness and considered as strategic compensation measures.

If the above routes to enabling reducing pressures from avian predators to be approved to the LoSCM as a standalone or package measure are not successful, there is still the potential for reducing pressures from avian predators could be used as an adaptive management measure. This would likely be best suited to instances where mammalian predator control was deemed to not result in adequate compensation return for the relevant species but could also be used for other strategic compensation measures.

Table 6.1: Summary table of various avian control methods, species they may be relevant to both avian predators and those of OW compensation concern, the applicability to strategic compensation, the key issues associated with the methods and recommendations for further work

Avian control measure	Potential relevant avian predators	Potential relevant species of OW compensation concern	Applicability to strategic compensation	Key issues /uncertainties	Recommendations for further work
Non-lethal					
Habitat modification/nest cover and refuges	Could be relevant to all avian predator species but further investigation required	• Common guillemot • Razorbill • Manx shearwater • Atlantic puffin	Success of this measure is likely to be site/species specific	Feasibility of accessing nest sites in remote locations	Practical pilots could be undertaken to investigate the effectiveness of nest cover for relevant species.
Artificial burrows/nest boxes/rafts	Could be relevant to all avian predator species but further investigation required	• Manx shearwater • Atlantic puffin • Storm petrel • Tern species • Red-throated diver	• May be relevant to species of conservation concern (such as shearwaters and petrels) in relation to the Celtic Sea leasing round. • Inexpensive • Durable • May have multiple beneficial effects such as increasing availability of suitable nest sites, protecting from predation and promoting population increases in colonies.	• Feasibility of accessing nest sites in remote locations • Likely only applicable for burrowing/ground nesting species • Success may be linked to other factors such as shelter from extreme weather	Practical pilots could be undertaken to investigate the effectiveness of nest cover for relevant species.
Deterrence - bioacoustics	Could be relevant to all avian predator species, however further investigation would be required	Could be used to reduce predation on all species of conservation concern, however further investigation would be required	Bioacoustics could be potentially useful bird alarm or distress calls could be targeted at specific avian predators	• Could cause disturbance to other non-target species • Type of alarm/distress call used would be dependent on species of avian predator present and therefore would be site-specific to an extent. • Feasibility of technology needed to play bioacoustics in remote locations would need to be considered	Practical pilots could be carried undertaken to investigate the effectiveness of bioacoustics for relevant species.

Avian control measure	Potential relevant avian predators	Potential relevant species of OW compensation concern	Applicability to strategic compensation	Key issues /uncertainties	Recommendations for further work
				• Risk of habituation by avian predator species	
Deterrence – bamboo canes	Gull species	Ground nesting birds such as terns	• Evidence of some reduction in predation events • May be effective for other species of compensation return	• Limited evidence of effectiveness • Risk of habituation by avian predator species	Practical pilots could be carried undertaken to investigate the effectiveness of bioacoustics for relevant species.
Physical exclusion	Gull species	• Common tern	Limited evidence of a positive effect further investigation would be required but technical feasibility also likely to be very challenging to implement on a strategic scale.	• Feasibility of accessing nest sites in remote locations • Limited evidence of a positive effect	Further work could be carried out to progress as part of a package of measures.
Public education	Gull species	• Any species	• May be useful if undertaken alongside other control methods Inexpensive and easy to implement at relevant sites	• Compensation return would be very limited • Many seabird colonies are not located in areas where public have access	Further work could be carried out to progress as part of a package of measures
Diversionary feeding	Peregrine falcon	• Kittiwake • Manx shearwater	Would be very difficult to carry out on a strategic scale due to the highly site-specific nature of this method	• Labour intensive • Expensive • Could introduce avian predators at other undesirable locations • Previously there has been limited support from stakeholders. • Indirect impacts on the avian predators themselves	No further work recommended.
Translocation	No evidence for UK species	No evidence for UK species	Would be very difficult to carry out on a strategic scale due to the highly site-specific nature of this method	• Labour intensive • Expensive • Could introduce avian predators at other undesirable locations	No further work recommended.
Indirect control	None identified	None identified	• Limited compensation return • Hard to quantify compensation return	Potential negative effects on other non- target species	No further work recommended.

Avian control measure	Potential relevant avian predators	Potential relevant species of OW compensation concern	Applicability to strategic compensation	Key issues /uncertainties	Recommendations for further work
Intraguild predation	None identified	None identified	• Limited compensation return • Hard to quantify compensation return	Potential negative effects on other non- target species	No further work recommended.
Lethal					
Shooting	Could be feasible for all avian predator species	Potentially all species other than those that nest in burrows	Unlikely to be accepted by all relevant stakeholders	Ethical concerns around killing wild birds and particularly those of conservation concern	No further work recommended.
Egg destruction	Could be feasible for all avian predator species	Potentially all species other than those that nest in burrows	Unlikely to be accepted by all relevant stakeholders	Ethical concerns around killing wild birds and particularly those of conservation concern	No further work recommended.
Trapping	Could be feasible for all avian predator species	Potentially all species other than those that nest in burrows	Unlikely to be accepted by all relevant stakeholders	Ethical concerns around killing wild birds and particularly those of conservation concern	No further work recommended.

7 References

Anker-Nilssen, T., and Aarvak, T. (2009). Effects of white-tailed eagles on the reproductive performance of black-legged kittiwakes; indications from a 26-year study in North Norway. *VLIZ* Special Publication 42 (E. Stienen, et al. (Eds.)), 3.

Ackerman, J. Herzog, M. Hartman, C. and Herring G. (2014) Forster's tern chick survival in response to a managed relocation of predatory California gulls. *Journal of Wildlife Management*, 78, pp. 818-829.

Anker-Nilssen, T., and Aarvak, T. (2009) Effects of white-tailed eagles on the reproductive performance of black-legged kittiwakes; indications from a 26-year study in North Norway. *VLIZ Special Publication* (42) pp.3.

Anker-Nilssen, T. Fayet, A.L, and Aarvak, T. (2023) Top-down control of a marine mesopredator: Increase in native white-tailed eagles accelerates the extinction of an endangered seabird population. *Journal of Applied Ecology*, 60(3), pp. 445–452.

Bamber, J. (2024) Evaluating diversionary feeding as a method to resolve conservation conflicts in a recovering ecosystem. *Journal of Applied Ecology*, 61(8), pp. 1968–1978.

Bårdsen, B., and Bustnes, J. O. (2022) Multiple stressors: Negative effects of nest predation on the viability of a threatened gull in different environmental conditions. *Journal of Avian Biology*, 2022, e02953.

Barrett, R. T., and O. J., Runde. (1980) Growth and survival of nestling kittiwakes Rissa tridactyla in Norway. *Ornis Scandinavica* 11 (3), pp. 228-235.

Barrett, R. (2008) Recent establishments and extinctions of Northern Gannet Morus bassanus colonies in North Norway, 1995-2008. *Ornis Norvegica.* 31.

Baxter, A.T., and Allan, J. (2006) Use of raptors to reduce scavenging bird numbers at landfill sites. *Wildlife Society Bulletin* 34, pp. 1162-1168.

Baxter, A., and Robinson, A.P. (2007) A comparison of scavenging bird deterrence techniques at UK landfill sites. *International Journal of Pest Management* 53, pp. 347-356.

Bekoff M., Scott A.C., Conner D.A. (1989) Ecological analysis of nesting success in evening grosbeaks. *Oecologia* 81: pp.67–74

Bedolla-Guzman, Y., Masello, J., Aguirre-Muñoz, A., and Quillfeldt, P. (2016) A wood-concrete nest box to study burrow-nesting petrels. *Marine Ornithology* 44, pp. 249–252.

Bellebaum, J., and Bock, C. (2009) Influence of ground predators and water levels on Lapwing *Vanellus van*ellus breeding success in two continental wetlands. *Journal of Ornithology* 150, pp. 221–230.

Bergman R.D., and Derksen D.V. (1977) Observations on Arctic and Red-throated Loons at Storkersen Point, Alaska. *Arctic*, 30, pp. 41-51.

Berwick Bank (2022) Berwick bank wind farm derogation case colony compensatory measures evidence report. Available at: https://berwickbank-eia.com/supporting-documents/derogation-case-compensation-measures-eia-report/ Accessed February 2025.

Bicknell, A.W.J., Oro, D., Camphuysen, J.C., and Votier, S.C. (2013) Potential consequences of discard reform for seabird communities. *Journal of Applied Ecology,* 50, pp. 649—658.

Bodey, T.W., McDonald, R.A. and Bearhop, S. (2009). Mesopredators constrain a top predator: competitive release of ravens after culling crows. *Biology Letters*, 5(5), pp.617–620.

Bolton, M., Medeiros, R., Hothersall, B., and Campos, A. (2004) The use of artificial breeding chambers as a conservation measure for cavity-nesting procellariiform seabirds: A case study of the Madeiran storm petrel Oceanodroma Castro, *Biological Conservation*, 116(1), pp. 73–80.

Bradbury, G., Trinder, M., Furness, B., Banks, A.N., Caldow, R.W.G., and Hume, D. (2014) Mapping Seabird Sensitivity to Offshore Wind Farms. *Plos One*, 12(1)e0170863.

Bried, J. (2003). Impact of vagrant predators on the native fauna: a Short-eared Owl (Asio flammeus) preying on Madeiran Storm Petrels (Oceanodroma castro) in the Azores. Arquipélago. Life and Marine Sciences 20A: pp.57-60.

Boothby, C., Redfern, C., Schroeder, J., (2019) An evaluation of canes as a management technique to reduce predation by gulls of ground-nesting seabirds. Ibis 161, 453-458.

Brooke, M. (1990) The Manx Shearwater. London: T and Ad Poyser, Academic Press Ltd.

BTO (2024) Black guillemot nest boxes. Available at: https://www.bto.org/about-bto/national-offices/bto-northern-ireland/our-work-northern-ireland/black-guillemot Accessed: January 2025.

Bukacinski, D., Bukacinska, M., and Spaans, A.L. (1998) Experimental evidence for the relationship between food supply, parental effort and chick survival in the Lesser Black-backed Gull Larus fuscus. *Ibis,* 140, pp. 422-430.

Bundy, G. (1978) Breeding biology of the Red-Throated Diver, *Bird Study*, 23(4), pp. 249–256.

Burke, B., O'Connell, D. P., Kinchin-Smith, D., Sealy, S., and Newton, S. F. (2022) Nestboxes augment seabird breeding performance in a high-density colony: Insight from 15 years of monitoring data. *Ecological Solutions and Evidence*, 3(3).

Burness, G. P., and Morris, R. D. (1992) Shelters decrease gull predation on chicks at a Common Tern colony. *Journal of Field Ornithology*, 63(2), pp. 186–189.

Bustnes, J.O., Helberg, M., and Bardsen, B. (2022) Reproductive success of threatened northern lesser black-backed gulls (Larus fuscus fuscus) in relation to nest predation by ravens (Corvus corax).' *Ornis Fennica*, pp.0.

Cabot, D. (1996). Performance of the Roseate Tern population breeding in North-west Europe: Ireland, Britain and France, 1960–94. Biology and Environment: Proceedings of the Royal Irish Academy, 96B(2), pp. 55–68.

Camphuysen, Cornelis & Fox, A. & Leopold, Mardik & Petersen, Ib. (2004). Towards standardised seabirds at sea census techniques in connection with environmental impact assessments for offshore wind farms in the U.K.. 10.1314

Casey, S., Moore, N., Ryan, L., Merne, O. J., Coveney, J. A., & Del Nevo, A. (1995). The Roseate Tern conservation project on Rockabill, Co. Dublin: A six-year review 1989–1994. Irish Birds, 5, pp. 251–264.

Carlile, N., Priddel, D. and Madeiros, J. (2012) 'Establishment of a new, secure colony of Endangered Bermuda Petrel Pterodroma cahow by translocation of near-fledged nestlings,' *Bird Conservation International*, 22(1), pp. 46–58.

Carter, S.P., and Bright, P.W. (2003) Reedbeds as refuges for water voles (Arvicola terrestris) from predation by introduced mink (Mustela vison). *Biological Conservation*, 111(3), pp. 371-376.

Chiron, F.O., and Julliard, R. (2007) Responses of songbirds to magpie reduction in an urban habitat. *Journal of Wildlife Management*, 71, pp. 2624-2631.

Christensen-Dalsgaard, S., Ytrehus, B., Langset, M., Wiig, J.R., and Bærum, K.M. (2022). Seabird beachcast events associated with bycatch in the Norwegian purse seine fishery. *Marine Environmental Research*, 177, pp. 105625.

Church, G.E., Furness, R.W., Tyler, G., Gilbert, L. and Votier, S.C. (2018). Change in the North Sea ecosystem from the 1970s to the 2010s: great skua diets reflect changing forage fish, seabirds, and fisheries. *Ices Journal of Marine Science*, [online] 76(4), pp.925–937.

Clode (1993) Colonially breeding seabirds: Predators or prey? *Trends in Ecology and Evolution*, 8(9), pp 336 -338.

Coccon, F., Borella, S., Simeoni, N. and Malavasi, S. (2018). Floating rafts as breeding habitats for the Common tern, Sterna hirundo. Colonization patterns, abundance and reproductive success in Venice Lagoon. *Rivista Italiana di Ornitologia*, 88(1), pp.23–32.
Collins, P.M., Green, J.A., Dodd, S., Shaw, P.J.A, Halsey, L.G. (2014) Predation of Black-legged Kittiwake Chicks Rissa tridactyla by a Peregrine Falcon Falco

peregrinus: Insights from Time-lapse Cameras. Wilson Journal of Ornithology 126, pp. 158–161.

Cook, A., Rushton, S., Allan, J., Baxter, A., (2008) An evaluation of techniques to control problem bird species on landfill sites. *Environmental Management* 41, pp. 834-843.

Cruz, J.B., and Cruz F. (1996) Conservation of the dark-rumped petrel Pterodroma phaeopygia of the Galápagos Islands, 1982-1991. *Bird Conservation International*, 6, pp. 23-32.

Doherty, T and Ritchie, E. (2016) Stop Jumping the Gun: A Call for Evidence-Based Invasive Predator Management. *Conservation Letters*. 10. 10.1111/conl.12251.

Dunlop, C.L., Blokpoel, H. and Jarvie, S. (1991). Nesting Rafts As A Management Tool for a Declining Common Tern (Sterna hirundo) Colony. *Colonial waterbirds*, 14(2), pp.116–116.

Goss-Custard, John & Austin, G.E. & Frost, Teresa & Sitters, H.P. & Stillman, R.A.. (2024). Decline in the Numbers of Eurasian Oystercatchers Haematopus ostralegus on the Exe Estuary Special Protection Area. *Ardea*. Pp. 112.

Davis, S., Brown, A., Lock, L., Sharps, E., Bolton, M., and Wilson, L. (2018) Productivity of herring gulls Larus argentatus and Lesser Black-backed Gulls L. fuscus in relation to fox predation risk at colonies across northern England and Wales in 2012. RSPB Centre for Conservation Science, Bedfordshire.

De León A., and Mínguez E. (2003) Occupancy rates and nesting success of European storm-petrels breeding inside artificial nest-boxes. *Scientia Marina*, 67, pp. 109-112.

Defra (2020) New general licences for the control of wild birds Available at: https://www.gov.uk/government/news/new-general-licences-for-the-control-of-wild-birds Accessed: 23 January 2025.

Dewar, R., and Lawrence, S. (2023) The status of breeding Red-throated Divers Gavia stellata and Black-throated Divers Gavia arctica in Kintyre, Scotland, 2016–2020. *Bird Study*, 70(4), pp. 269-281.

Fuchs, E. (1977) Predation and anti-predator behaviour in a mixed colony of terns Sterna sp. And Black-headed Gulls Larus ridibundus with special reference to the Sandwich Tern Sterna sandvicensis. Ornis Scand. 8, pp.17-32.

Dickson, D.L. (1992) The Red-throated Loon as an indicator of environmental quality. Occasional paper. Canadian Wildlife Service.

Dickson D.L. (1993) Breeding biology of Red-throated Loons in the Canadian Beaufort Sea region. *Arctic*, 46, pp 1-7.

Dixon, Nick and Drewitt, Edward. (2018) A 20-year study investigating the diet of Peregrines, Falco peregrinus, at an urban site in south-west England (1997–2017). *Ornis Hungarica*. 26. pp. 177-187.

Donehower, C.E., Bird, D.M., Hall, C.S., Kress, S.W., (2007) Effects of Gull Predation and Predator Control on Tern Nesting Success at Eastern Egg Rock, Maine. *Waterbirds* 30, pp. 29-39.

Eberl, C., and Picman, J. (1993) Effect of Nest-Site Location on Reproductive Success of Red-Throated Loons (Cavia Stellata). *The Auk*, 110(3), pp. 436-444.

Fielding, A.H., Haworth, P.F., Morgan, D.H., Thompson, D.B.A. and Whitfield, D.P. (2003) The impact of golden eagles on a diverse bird of prey assemblage. In Thompson, D.B.A., Redpath, S.M., Fielding, A.H., Marquiss, M., Galbraith, C.A. (Eds.). Birds of Prey in a hanging Environment. The Stationery Office, Edinburgh. pp. 221-244.

Fink, A., Fitzgerald, M., Tiernan, E., & Newton, S. (2021). Rockabill tern report 2021. Unpublished BirdWatch Ireland seabird conservation report.

Finney, Suzanne and Wanless, Sarah and Harris, Michael and Monaghan, Pat. (2001) The impact of gulls on puffin reproductive performance: An experimental test of two management strategies. *Biological Conservation*. 98. pp. 159-165.

Fontaine, J. J., and Martin, T. E. (2006). Parent birds assess nest predation risk and adjust their reproductive strategies. *Ecology Letters*, 9(4), pp. 428–434.

Foster, A. (2011) BBC News - Hoodie havoc among bird life on Bangor harbour

Furness (2013) Evidence review to support the identification of potential conservation measures for selected species of seabirds. Report to Defra/

Furness, R. (1987) The Skuas. Poyser, London.

Furness, R., Ensor, K., and Hudson, A. (1992) The use of fishery waste by gull populations around the British Isles. *Ardea* 80 : pp. 105—113.

Furness, R.W., Wade, H.M. and Masden, E.A. (2013) Assessing vulnerability of marine bird populations to offshore wind *Journal of Environmental Management* 119, pp. 56-66

Furness, B., 2021. Report to Crown Estate Scotland and SOWEC: HRA Derogation Scope B - Review of seabird strategic compensation options, MacArthur Green.

Galbraith, H. (1983) The diet and feeding ecology of breeding kittiwakes Rissa tridactyla. *Bird Study* 30, pp. 109–120.

Gomersall, C. (1986) Breeding performance of the red-throated diver Gavia stellata in Shetland. *Holarctic Ecology*, 9 (4), pp. 277-284.

Grinnell, C. (2010) Behaviour and habitat use of roseate terns (Sterna dougallii) before and after construction of an erosion control revetment. Unpublished MSc Thesis. University of Massachusetts Amherst. Available at: https://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1490&context=theses Accessed: February 2025.

Hario, M. (1994) Reproductive performance of the nominate lesser black-backed gull under the pressure of herring gull predation. *Ornis Fennica*, 71, pp. 1-10.

Hario, M. (2001) Chick growth and nest departure in Baltic Black Guillemots Cepphus grylle. *Ornis Fenn*ica 78, pp. 97–108.

Harris, M., and Wanless, S. (1997) Breeding success, diet, and brood neglect in the kittiwake (Rissa tridactyla) over an 11-year period. *ICES Journal of Marine Science*. Oxford University Press, pp. 615–623.

Hey, J., Hansen, E. and Bolton, M. (2020). Gull Predation on Leach's Hydrobates leucorhous and European Storm-petrels H. pelagicus on Elliðaey Island, Iceland. *Seabird Journal*, [online] 32, pp.59–71.

Hilde, C.H., Pélabon, C., Guéry, L., Gabrielsen, G. W., and Descamps, S. (2016) Mind the wind: Microclimate effects on incubation effort of an arctic seabird. *Ecology and Evolution*, 6(7), pp. 1914–1921.

Huebeck, M., Mellor R.M., Harvey, P. (1997). Changes in the breeding distribution and numbers of kittiwakes Rissa tridactyla around Unst, Shetland and the presumed roles of predation by great skuas Stercorarius skua. *Seabird*, pp. 12–21.

Hulka, S. (2010) Red-throated diver breeding ecology and nest survival on Shetland. PhD thesis, University of Glasgow.

Janssen, A., Montserrat, M., HilleRisLambers, R., Roos, A. M. de, Pallini, A., and Sabelis, M. W. (n.d.). Intraguild Predation Usually does not Disrupt Biological Control. *Trophic and Guild in Biological Interactions Control*, pp. 21–44.

Johnston, Daniel and Furness, Robert and Robbins, Alexandra and Tyler, Glen and Masden, Elizabeth. (2020) Camera traps reveal predators of breeding Black Guillemots Cepphus grylle. 32. pp. 72-83.

Kim, S.-Y. and Monaghan, P. (2005a). Effects of vegetation on nest microclimate and breeding performance of lesser black-backed gulls (Larus fuscus). *Journal of Ornithology*, 146(2), pp.176–183.

Kim, S.-Y. and Monaghan, P. (2005b). Interacting effects of nest shelter and breeder quality on behaviour and breeding performance of herring gulls. *Animal Behaviour*, 69(2), pp.301–306.

Kirchmeir, A., Uhl, F., Bugnyar, T., and Schwab, C. (2019). Catching crows: seasonality, techniques and the influence of social behaviour. *Ringing and Migration*, 34(1), pp. 1–7.

Kortland, K., (2006) Forest management for capercaillie: an illustrated guide for forest managers. Capercaillie biodiversity action plan steering group.

Kubasiewicz, L. M., Bunnefeld, N., Tulloch, A. I. T., Quine, C. P., and Park, K. J. (2016) Diversionary feeding: An effective management strategy for conservation conflict? *Biodiversity and Conservation*, 25(1), pp. 1–22.

S. Langlois Lopez, F. Daunt, J. Wilson, N.J. O'Hanlon, K.R. Searle, S. Bennett, M.A. Newell, M.P. Harris, E. Masden (2023) Quantifying the impacts of predation by Great Black-backed Gulls Larus marinus on an Atlantic Puffin Fratercula arctica population: Implications for conservation management and impact assessments *Mar. Environ. Res.*, 188 (2023), Article 105994

Libois, E., Gimenez, O., Oro, D., Mínguez, E., Pradel, R., and Sanz-Aguilar, A. (2012) Nest boxes: A successful management tool for the conservation of an endangered seabird. *Biological Conservation*, 155, pp. 39–43.

Lloyd, C. S. (2008) Factors Affecting Breeding Of Razorbills Alca Torda On Skokholm*. Ibis, 121(2),* pp. 165–176.

Lock, L., Donato, B., Jones, R. and Macleod-Nolan, C. (2022) England's breeding seabirds: A review of the status of their breeding sites and suggested measures for their recovery. RSPB and Natural England report. Available at: https://www.projectlote.life/uploads/1/3/5/6/135667366/seabird_colony_assessment_lote.pdf Accessed February 2025.

Lockley, R. 1947. I know an Island, London, George G Harrap and Co. Ltd.

Ludwig, S.C., McCluskie, A., Keane, P., Barlow, C., Francksen, R.M., Bubb, D., Roos, S., Aebischer, N.J., and Baines, D. (2018) Diversionary feeding and nestling diet of Hen Harriers Circus cyaneus. *Bird Study*, 65: pp. 431-443.

Maccarone, A. D. (1992) Predation by Common Ravens on cliff-nesting Black-legged Kittiwakes on Baccalieu Island, Newfoundland. *Colonial Waterbirds* 15 (2), pp. 253-256.

MacDonald, S., and Standring, K.T. (1978) An outbreak of botulism in gulls on Firth of Forth, Scotland. Biological Conservation, 14 (2), pp. 149-155.

Mason, L. R., Green, R. E., Hirons, G. J. M., Skinner, A. M. J., Peault, S. C., Upcott, E. V., Wells, E., Wilding, D. J., and Smart, J. (2021). Experimental diversionary feeding of red kites Milvus milvus reduces chick predation and enhances breeding productivity of northern lapwings Vanellus vanellus. *Journal for Nature Conservation,* 64, 126051.

Massaro, M., J. W. Chardine, I.L. Jones, And G. J. Robertson. (2000) Delayed capelin (Mallotus vi llosus) availability influences large gull predatory behaviour on Black-legged Kittiwakes (Rissa tri dactyla), causing a reduction in kittiwake breeding success. *Canadian Journal of Zoology* 78, pp. 1588-1596.

Masson, D. A., and Gallardo, J. C. (2017). Observations of Intraguild Nest Predation Involving Three Species of Raptors in Argentina. *Journal of Raptor Research*, 51(4), pp. 485–488.

Maunder, J. E. and W. Threlfall. (1972) The breeding biology of the Black-legged Kittiwake in Newfoundland. Auk 89, pp. 789-816.

Miskelly C.M. and Taylor G.A. (2004) Establishment of a colony of common diving petrels (Pelecanoides urinatrix) by chick transfers and acoustic attraction. *Emu*, 104, pp. 205-211.

Morris, R., Kirkham, I., Chardine, J.W., (1980) Management of a declining Common Tern colony. The Journal of Wildlife Management 44, pp. 241-245.

Morris, R.D., Blokpoel, H. and Tessier, G.D. (1992) Management efforts for the conservation of Common Tern Sterna hirundo colonies in the Great Lakes: two case histories. *Biol. Cons*. 60, pp. 7–14.

Mowbray, T, Poole, A and Gill, F. (2002) Northern Gannet (Morus bassanus) The Birds of North America Online. Available at: https://www.researchgate.net/publication/240792857_Northern_Gannet_Morus_bassanus Accessed February 2025.

Murphy, E. C., A. M. Springer and D. G. Roseneau. (1991) High annual variability in reproductive success of kittiwakes (Rissa tridactyla L.) at a colony in western Alaska. *Journal of Animal Ecology* 60, pp. 515-534.

Natural England (2023) Definition of Favourable Conservation Status for kittiwake Available at: https://publications.naturalengland.org.uk/file/5346241970700288#:~:text=This%20document%20sets%20out%20Natural,thrive%20sustainably%20in%20the%20future . Accessed February 2025.

Nature Scot (2025) Planning and implementing a strategy to help tackle gull problems. Available at: https://www.nature.scot/doc/guidance-gull-management . Accessed February 2025.

Newton, S.F., Thompson, K. and Mitchell, P.I. (2004) Manx Shearwater Puffinus Puffinus. In: Mitchell, P.I., Newton, S.F., Ratcliffe, N and Dunn, T.E. *Seabird Populations Of Britain And Ireland*. T. and A. D. Poyser, London, pp. 63-80.

Nordström, M., Högmander, J., Laine, J., Nummelin, J., Laanetu, N. and Korpimäki, E. (2003). Effects of feral mink removal on seabirds, waders and passerines onsmall islands in the Baltic Sea. Biological Conservation 109(3), pp359-368.

North Falls Offshore Wind Farm (2024) Habitats Regulations Assessment Appendix 3 Red Throated Diver Compensation Document Available at: https://www.northfallsoffshore.com/wp-content/uploads/2023/05/004290164-04_HRA-In-Principle-Compensation-Review.pdf Accessed February 2024.

NRW (2025) Deterring birds from farms, fisheries, airfields, landfill sites and urban environments Available at: https://naturalresources.wales/media/675823/deterring-birds-fact-sheet.pdf Accessed February 2025.

Nummi, P, Väänänen, V-M, Pakarinen, R & Pienmunne, E 2013, 'The Red-throated Diver (Gavia stellata) in human-disturbed habitats – building up a local population with the aid of artificial rafts', *Ornis Fennica*, vol. 90, pp. 16-22.

O'kill, J.D., (1994) Ringing recoveries of red-throated divers Gavia stellata in Britain and Ireland, *Ringing and Migration*, 15:2, PP. 107-118,

Oldatini, C., Albores-Barajas, Y.V., Torricelli, P., Mainardi, D., (2008) Testing the efficacy of deterring systems in two gull species. *Applied Animal Behaviour Science* 110, pp. 330-340.

Olsson C, Petterson J and Johansson F (2021) Breeding biology of the Red-throated Loon Gavia stellata on the Holmöarna Archipelago, Northern Sweden. *Ornis Svecica* 31, pp. 1–18.

Oro, D. and Furness, R.W. (2002) Influences of food availability and predation on survival of kittiwakes, *Ecology*. 83(9), pp 2516 – 2528.

Oro, D., León, A. de, Minguez, E. and Furness, R.W. (2005). Estimating predation on breeding European storm-petrels (Hydrobates pelagicus) by yellow-legged gulls (Larus michahellis). *Journal of Zoology*, [online] 265(4), pp.421–429.

Oro, D. (1996) Effects of trawler discard availability on egg laying and breeding success in the lesser black-backed gull Larus fuscus in the western Mediterranean. *Marine Ecology Progress Series* 132 , pp. 43—46.

Outer Dowsing (2025) https://infrastructure.planninginspectorate.gov.uk/wp-content/ipc/uploads/projects/EN010130/EN010130-001613-7.7.5%20Predator%20Control%20Evidence%20Base%20and%20Roadmap.pdf

Paracuellos, M, Nevado, J (2010) Culling Yellow-legged Gulls Larus michahellis benefits Audouin's Gulls Larus audouinii at a small and remote colony *Bird Study* 57, pp.26–30.

Phillips, R.A., Thompson D.R., Hamer K.C. (1999) The impact of great skua predation on seabird populations at St Kilda: A bioenergetics model. *Journal of Applied Ecology* 36, pp. 218–232.

Podolsky, R.H. and Kress, S.W. (1989) Factors affecting colony formation in Leach's storm-petrel. *The Auk*, 106, pp.332-336.

Priddel, D., and Carlile, N. (1995) An artificial nest box for burrow-nesting seabirds. *Emu*, 95, pp. 290-294.

Priddel, D., and Carlile, N. (2001) A trial translocation of Gould's petrel (Pterodroma leucoptera leucoptera). *Emu*, 101, pp. 79-88.

Redpath, S.M., Thirgood, S.J., and Leckie, F.M. (2001) Does supplementary feeding reduce predation of red grouse by hen harriers?. *Journal of Applied Ecology*, 38: pp. 1157-1168.

Reeves, S.A., and Furness, R.W. (2002) Net loss–seabirds gain? Implications of fisheries management for seabirds scavenging discards in the northern North Sea.

Reid, J.B. (2004) Great Black-backed Gull Larus marinus. In: Mitchell, P.I., Newton, S.F., Ratcliffe, N. and Dunn, T.E. (eds). 2004.
Rheinallt, T., Craik, J.C.A., Daw, P., Furness, R.W., Petty, S.J. & Wood, D., eds. (2007) Birds of Argyll. Argyll Bird Club, Lochgilphead, UK.

Rock, P. (2005) Urban gulls: problems and solutions. *British Birds* 98, pp. 338—355

Ronconi, R.A. and St. Clair, C.C. (2006) Efficacy of a radaractivated on-demand system for deterring waterfowl from oil sands tailings ponds. *Journal of Applied Ecology*. 43, pp. 111–119.

Rosenheim, J.A. (1995) Intraguild predation among biological-control agents: Theory and evidence, Biological Control, 5(3), pp. 303–335.

Ross-Smith, V.H., Johnston, A. and Ferns, P.N. (2015) Hatching success in Lesser Black-backed Gulls Larus fuscus — an

Ross-Smith, V.H., Robinson, R.A., Banks, A.N., Frayling, T.D., Gibson, C.C. and Clark, J.A. (2014) The Lesser Black-backed Gull Larus fuscus in England: how to resolve a conservation conundrum. *Seabird Journal* 27, pp. 41—61.

Royal Haskoning DHV and HiDef (2024) Development of Ornithology Regional Compensation Measures Available at: https://broadshorewind.co.uk/wp-content/uploads/2024/06/Development-of-Ornithology-Regional-Compensation-Measures.pdf Accessed February 2025.

RSPB (2023) The conservationist's dilemma - an update on the science, policy and practice of the impact of predators on wild birds Available at: https://community.rspb.org.uk/ourwork/b/actionfornature/posts/the-conservationist-s-dilemma---an-update-on-the-science-policy-and-practice-of-the-impact-of-predators-on-wild-birds-10 Accessed February 2025

L Soanes, Ratcliffe, N., Booker, H., Atkinson, P. and Michel, C. (2010). Is an increase in gull numbers responsible for limiting Atlantic Puffin Fratercula arctica numbers on Burhou, Channel Islands? *Seabird Journal*, 23, pp.91–103.

Langlois Lopez, S., Daunt, F., Wilson, J., O'Hanlon, N.J., Searle, K.R., Bennett, S., Newell, M.A., Harris, M.P., Masden, E. (2023) Quantifying the impacts of predation by Great Black-backed Gulls Larus marinus on an Atlantic Puffin Fratercula arctica population: implications for conservation management and impact assessments *Mar. Environ. Res.*, 188 (2023), Article 105994

Billerman., S.M., Keeney, B.K., Rodewald, P.G., and Schulenberg, T.S.(eds). (2022) Birds of the World. Cornell Laboratory of

Saliva J.E., Burger J. (1989) Effect of experimental manipulation of vegetation density on nest-site selection in sooty terns. *Condor* 91: pp. 689–698

Scopel, L.C., and Diamond, A.W. (2017) The case for lethal control of gulls on seabird colonies. *J. Wildl. Manag*. 84, pp. 572–580.

Sergio, F. and Hiraldo, F. (2008) Intraguild predation in raptor assemblages: a review. *Ibis* 150 (Suppl. 1), pp. 132–145.

Sherley RB, G Barbara, J Barham, PJ Barham, TM Leshoro and LG Underhill (2012) Artificial nests enhance the breeding productivity of African Penguins (Spheniscus demersus) on Robben Island, South Africa. *Emu* 112, pp. 97-106.

Smart, J., and Amar, A. (2018) Diversionary feeding as a means of reducing raptor predation at seabird breeding colonies. *Journal for Nature Conservation*, 46, pp. 48–55.

Soldatini, C., Albores-Barajas, Y.V., Torricelli, P. and Mainardi, D. (2008) Testing the efficacy of deterring systems in two gull species. *Appl. Anim. Behav. Sci*. 110, pp. 330–340.

Spendelow, J. A. (1982) An analysis of temporal variation in, and the effects of habitat modification on, the reproductive success of Roseate Terns. *Colonial Waterbirds*, 5, pp. 19–31.

Stanbury, A.J., Burns, F., Aebischer, N.J., Baker, H., Balmer, D., Brown, A.F., Dunn, T., Lindley, P., Murphy, M., Noble, D.G., Owens, R. & Quinn, L. (2024) The status of the UK's breeding seabirds: an addendum to the fifth Birds of Conservation Concern in the United Kingdom, Channel Islands and Isle of Man and second IUCN Red List assessment of extinction risk for Great Britain British Birds Volume: 117.

Stauffer D.F, Best L.B. (1986) Nest-site characteristics of opennesting birds in riparian habitats in Iowa. *Wilson Bull* 98: pp.231– 242.

Stienen, E.W.M., Brenninkmeijer, A. and Geschiere, C.E. (2001). Living with Gulls: The Consequences for Sandwich Terns of Breeding in Association with Black-Headed Gulls. *Waterbirds: The International Journal of Waterbird Biology*, 24(1), p.68.

Stickley, A.R., Mott, D.F., and King, J.O. (1995) Short-term effects of an inflatable effigy on cormorants at catfish farms. *Wildl. Soc. Bull*. 23, pp. 73–77.

Storms, R.F., Carere, C., Musters, R., van Gasteren, H., Verhulst, S., Hemelrijk, C.K., (2022) Deterrence of birds with an artificial predator, the RobotFalcon. *Journal Of The Royal Society Interface* 19 (195).

Sutton, L.J. and Loram, S.W. (2021) Diet specialisation in an insular population of coastal Peregrine Falcons. *Bio One* 110(2), pp.137-144.

Sutton, L.J. (2016) Status of the Peregrine Falcon Falco peregrinus on Lundy: Breeding ecology and prey spectrum. *Journal of the Lundy Field Society* 5: pp. 75–88.

Sutton, L.J., Burrell, R.A. and Loram, S. (2017) Spatio-temporal trends in the predation of large gulls by peregrine falcons (Falco peregrinus) in an insular breeding population. *Raptor Journal* 11: pp. 103–109.

Swann, R.L., Aiton, D.G., Call, A., Foster, S., Graham, A., Graham, K. and Young, A. (2016) Canna seabird studies 2013. JNCC Report No. 474j. JNCC, Peterborough.

Swinnerton, K.J., Young, H.G., and Sangan.P. (2018) Options for the recovery of nesting seabirds on Jersey, Channel Islands. Report to Durrell Wildlife Conservation Trust.

Thaxter, C.B., Ross-Smith, V.H., Bouten, W., Clark, N.A., Conway, G.J., Masden, E.A., Clewley, G.D., Barber, L.J. and Burton, N.H. (2019) Avian vulnerability to wind farm collision through the year: Insights from lesser black-backed gulls (Larus fuscus) tracked from multiple breeding colonies. *Journal of Applied Ecology* 56 : pp. 2410—2422.

The Scottish Government (2022). *Offshore wind developments - collision and displacement in petrels and shearwaters: literature review*. [online] Gov.scot. Available at: https://www.gov.scot/publications/review-inform-assessment-risk-collision-displacement-petrels-shearwaters-offshore-wind-developments-scotland/documents/ Accessed April 2025.

Thieriot, E., Patenaude-Monette, M., Molina, P., Giroux, J.-F., (2015) The Efficiency of an Integrated Program Using Falconry to Deter Gulls from Landfills. *Animals* 5, pp. 214-225.

Tremlett, C.J., Morley, N. and Wilson, L.J. (2024) UK seabird colony counts in 2023 following the 2021—22 outbreak of Highly Pathogenic Avian Influenza. RSPB Research Report No. 76. RSPB Centre for Conservation Science, RSPB, The Lodge, Sandy, Bedfordshire.

Votier, S.C., Heubeck, M, Furness R.W., (2008) Using inter-colony variation in demographic parameters to assess the impact of skua predation on seabird populations. *Ibis* (Lond 1859) 150, pp.45–53.

Walsh, P.M., Halley, D.J., Harris, M.P., del Nevo, A., Sim, I.M.W. & Tasker, M.L. 1995. Seabird monitoring handbook for Britain and Ireland. JNCC / RSPB / ITE / Seabird Group, Peterborough.

Westerberg, K., Brown, R., Eagle, G., and Votier, S.C., (2019) Intra-population variation in the diet of an avian top predator: generalist and specialist foraging in Great Black-backed Gulls *Larus marinus*. *Bird Study*, *66*(3), 390–397.

Wilhelm, S.I., Rail, J.F., Regular, P.M., Gjerdrum, C. and Robertson, G.J. (2016) Large-scale changes in abundance of breeding herring gull (Larus argentatus) and Great Black-Backed Gulls (Larus marinus) Relative to Reduced Fishing Activities in Southeastern Canada. Bio One, 39(1), pp 146-142.

Young, L.C. (2023) 'Successful translocation of Newell's shearwaters and Hawaiian petrels to create a new, Predator Free Breeding Colony', *Frontiers in Conservation Science*, 4.

Appendix A Auditory, visual and chemical deterrents used for deterring pest birds from urban environments, farms, fisheries, airfields and landfill sites (Source: NRW,2024)

Deterrent	Description	Applicability to strategic compensation
Auditory		
Gas cannons	Can be effective if the timing and location of firing is varied, but they cause a noise nuisance if used close to housing or areas frequented by the public.	Not applicable, likely to cause disturbance to other non-target seabird species.
Pyrotechnic cartridges	Produce a bang and flash of light and are fired from rockets or modified pistols / shotguns. Rope fire-crackers are relatively inexpensive alternatives but can cause a fire hazard. Both methods are effective in areas where the noise is considered acceptable.	Not applicable, likely to cause disturbance to other non-target seabird species.
Bioacoustics	Recordings of bird alarm or distress calls, which are effective when used on the same species of bird as the one recorded, or one that is taxonomically related. Research has shown them to work for gulls, herons and corvids in particular. They may be less effective against pigeons and Canada geese, which do not produce readily identifiable distress calls.	Could be a viable measure for strategic compensation but would require further investigation to ensure there are not unintended impacts on non-target species.
Ultrasonic devices	Not thought to be effective against birds, as most are unable to hear in the ultrasonic range. They	Not applicable.

Deterrent	Description	Applicability to strategic compensation
	could also cause unacceptable disturbance to bats.	
Sonic devices	Sonic devices and high intensity, artificial sounds, are less effective and birds can become habituated to them unless they are varied regularly. The noise they generate may be considered unacceptable by the public.	Not applicable.
Visual		
Lasers	Effective against cormorants, in particular, when light levels are low. However, they are expensive and should not be pointed at the human eye.	Not applicable, as could not be carried out at scale as a long-term measure.
Dogs	Are one of the best deterrents, especially when trained working dogs, such as border collies, are used. Birds do not become habituated to a trained dog which responds well to commands and can pursue them off the site.	Not applicable, as could not be delivered in remote areas where colonies would be located, could not be easily delivered at scale or as a long-term measure and likely to cause disturbance to other non-target seabird species
Humans	Can be very effective, especially if mock 'wing beats' are made. The person should stand in full view of the birds, silhouetted against the sky, raising and lowering straight arms at a rate of around 25 beats per minute.	Not applicable, as not deliverable at scale as a long-term measure.

Deterrent	Description	Applicability to strategic compensation
Scarecrows	Tend to be useful for a limited time only, although their efficacy increases if they are dressed in loose-fitting clothing with streamers that move noisily in the wind.	Not applicable, likely to cause disturbance to other non-target seabird species.
Raptor models	Can be very useful, particularly if they are animated and frequently moved.	Not applicable, likely to cause disturbance to other non-target seabird species.
Replica or real corpses	Replica or real corpses of the target bird can deter others, if they mimic dead or injured birds. Real corpses only work whilst in good condition.	Not applicable, likely to cause disturbance to other non-target seabird species.
Balloons	Cheap but only work in the short-term. Their effectiveness increases if they are painted with a pair of 'eye-spots' consisting of bright concentric rings.	Not applicable, likely to cause disturbance to other non-target seabird species.
Kites and kite-hawks	May only be effective over a small area and for a short time.	Not applicable, likely to cause disturbance to other non-target seabird species.
Falconry	Method works well, especially when falcons are used (rather than hawks), as they are specialist predators of birds and will pursue them until they are chased off the site.	Not applicable, potential to predate on other non-target seabird species.
Radio-controlled model aircraft	Have been used successfully to scare cormorants and herons from water bodies. Raptor-shaped models are particularly effective.	Not applicable, as not deliverable at scale as a long-term measure.
Lights	Are not generally useful deterrents during daylight hours, although powerful strobes will affect pigeons	Not applicable, likely to cause disturbance to other non-target seabird species.

Deterrent	Description	Applicability to strategic compensation
	and lapwings in particular. They should not be used where they would cause a nuisance.	
Mirrors and reflectors	Very cheap and work against waterfowl, gulls and some herons. Foil pie-dishes suspended from twine are simple, efficient deterrents that can easily be moved from one place to another to prevent habituation.	Not applicable, likely to cause disturbance to other non-target seabird species.
Tapes/flags/rags/streamers	including hazard warning tape and Mylar tape, can combine visual, auditory (as they 'hum' in the wind) and physical exclusion, increasing their efficacy. are cheap and simple. They are most effective when partially hidden, when they are perceived as a potential threat. Black flags made from 60x90cm sheets of plastic are the most effective type against waterfowl.	Not applicable, likely to cause disturbance to other non-target seabird species.
Dyes and colourants	are easy to apply to water and can be useful for deterring water birds. Orange appears to be the colour most strongly avoided.	Not applicable, likely to cause disturbance to other non-target seabird species.
Chemical		
Aluminum ammonium sulphate	Chemical deterrents may be used in crop and forestry protection.	Not applicable, likely to impact other non-target seabird species.