The Scottish Seabird Vulnerability Report

August 2025

Scottish Government
Riaghaltas na h-Alba

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Contents

Introduction

The Scottish Seabird Vulnerability Report describes the process undertaken to identify the key pressures acting on seabirds in Scottish waters and at coastal breeding colonies. It also provides a high-level evaluation of the measures already in place to combat these pressures and identifies gaps and opportunities for action, where more can be done. The Scottish Seabird Vulnerability Report provides the basis for the development of the Scottish Seabird Conservation Action Plan (herein referred to as the "Seabird CAP") which sets out our vision for Scotland's seabird colonies to 2045, working in collaboration to deliver action where our seabird conservation efforts are most needed and can be most effective.

Vulnerability assessments were conducted for twenty-four species of seabird regularly occurring in relatively high numbers in Scottish waters during the breeding and/or nonbreeding seasons (Table 1). Vulnerability is considered to be a combination of the sensitivity of a species to a particular pressure with the level of potential interaction (exposure) the species has to that pressure.

Species sensitivity assessments conducted by Rogerson et al. (2021) were used to provide the basis for the sensitivity assessments. All species-pressure combinations with a high or medium sensitivity score were then assessed to determine the degree to which each species is exposed to these pressures whilst in Scottish waters. The geographic area covered by the exposure assessments included all Scottish waters, out to the limit of the continental shelf (Figure 1). The sensitivity and exposure assessments were then combined to provide an overall vulnerability score for each species-pressure combination.

All pressures that resulted in a high or medium vulnerability score for any seabird species, and where there is supporting evidence demonstrating impacts, were identified as the main pressures that should be considered when prioritising coastal and marine seabird conservation actions in Scotland.

To gauge the extent to which these main pressures are already being addressed a review of current measures was conducted by a working group[1] with expert judgment used to highlight where progress was underway to deliver action that would be beneficial to seabirds, and where more could be done through the identification of gaps. A stakeholder workshop in February 2020 also provided an opportunity for gaps and conservation actions to be highlighted.

1 Working group members include representatives from The Scottish Government, NatureScot, the Joint Nature Conservation Committee (JNCC), the Royal Society for the Protection of Birds (RSPB) and the British Trust for Ornithology (BTO).

Table 1: Seabird species included in the vulnerability assessments.

Common name	Scientific name
Northern fulmar	*Fulmarus glacialis*
European storm-petrel	*Hydrobates pelagicus*
Leach's storm-petrel	*Oceanodroma leucorhoa*
Arctic skua	*Stercorarius arcticus*
Great skua	*Stercorarius skua*
Black-legged kittiwake	*Rissa tridactyla*
Little gull	*Hydrocoloeus minutus*
Lesser black-backed gull	*Larus fuscus*
Herring gull	*Larus argentatus*
Great black-backed gull	*Larus marinus*
Common gull	*Larus canus*
Black-headed gull	*Chroicocephalus ridibundus*
Little tern	*Sternula albifrons*
Sandwich tern	*Sterna sandvicensis*
Common tern	*Sterna hirundo*
Arctic tern	*Sterna paradisaea*
Manx shearwater	*Puffinus puffinus*
Northern gannet	*Morus bassanus*
European shag	*Gulosus aristotelis*
Great cormorant	*Phalacrocorax carbo*
Atlantic puffin	*Fratercula arctica*
Black guillemot	*Cepphus grille*
Common guillemot	*Uria aalge*
Razorbill	*Alca torda*

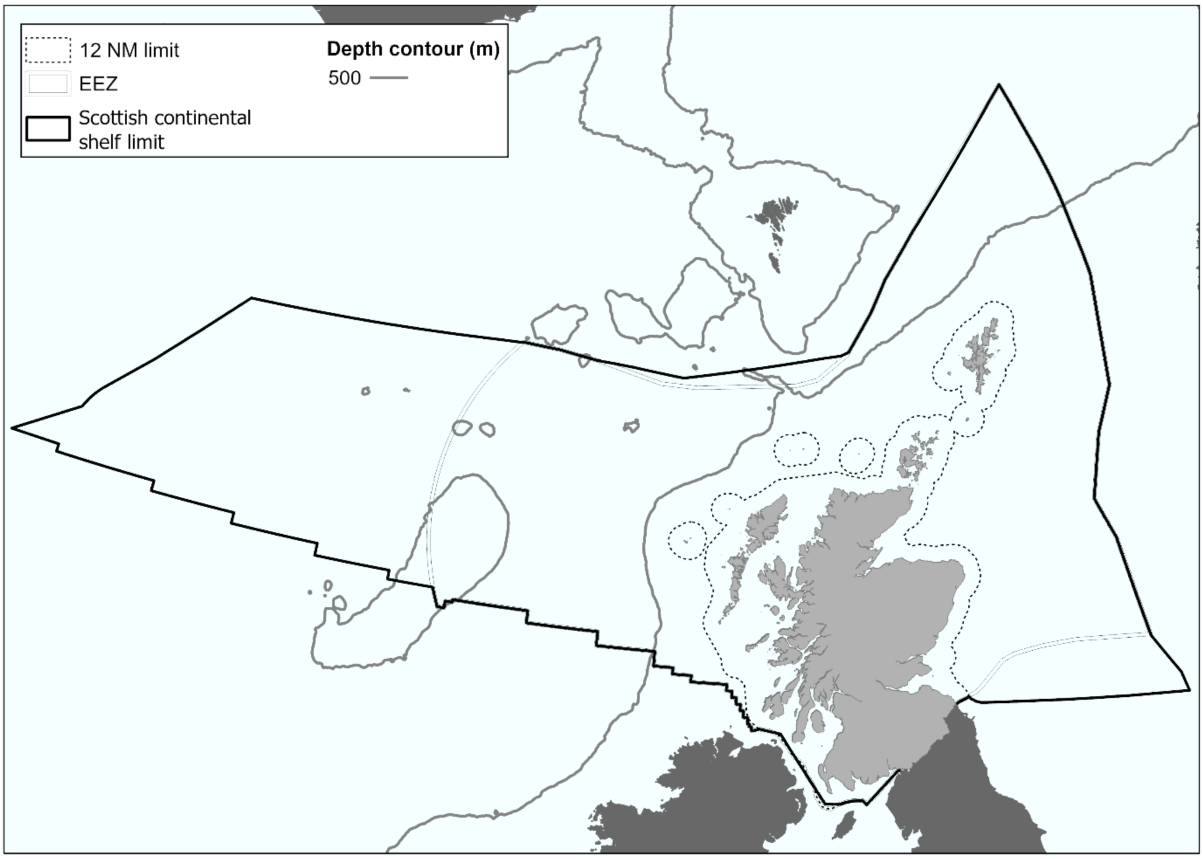

Figure 1: The spatial extent covered by the Vulnerability Report.

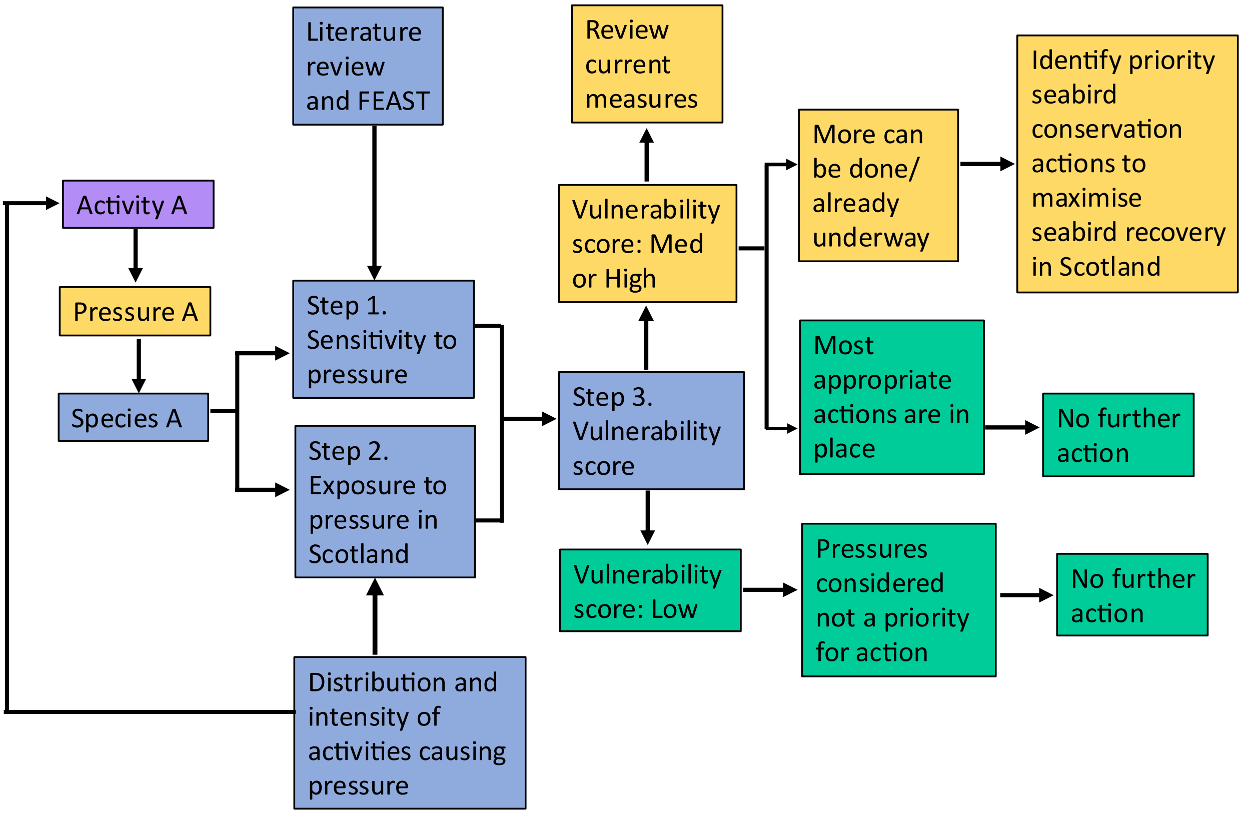

Figure 2: Process used to identify the main pressures impacting seabirds in Scotland and opportunities to do more.

Approach To Determining Species Vulnerability To Pressures

For the purpose of this report, species vulnerability is measured as the risk of impact to the Scottish population of each of the named seabird species from a known human-induced pressure acting at Scottish coasts and seas. Vulnerability is considered to be a function of the sensitivity of a species to a particular pressure combined with the level of potential interaction (exposure) the species has to that pressure. A three-step approach was used to determine species vulnerabilities:

Step 1: Assess species sensitivity to all marine pressures identified in the Feature Activity Sensitivity Tool (FeAST).

Step 2: Assess the level of exposure for each species to each pressure by overlapping seabird distribution data with mapped information on activities associated with pressures assigned a high or medium sensitivity score.

Step 3: Combine the sensitivity and exposure scores to determine the species vulnerability score to each species-pressure combination (see also Figure 3).

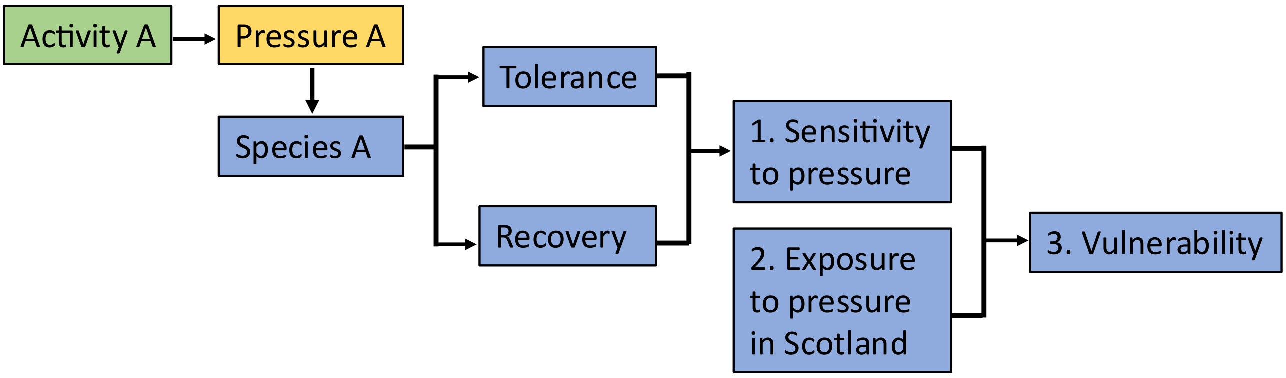

Figure 3: Determining the vulnerability of a named species to a pressure.

Step 1: Assessing Species Sensitivity

The sensitivity assessments of each species to each pressure, except bycatch (see below), are taken from Rogerson et al. (2021). Rogerson et al. completed a detailed literature review to provide an up-to-date evidence base for each species to each marine pressure listed in FeAST. Using this evidence base, Rogerson et al. followed the FeAST methodology to determine the sensitivity of each seabird species to pressures.

FeAST is a web-based application which allows users to investigate the sensitivity of marine features (habitats, species, geology, and landforms) in Scottish seas, to pressures arising from human activities. It has been used to underpin assessments in Scotland's Marine Assessment 2020, and for discussions on management requirements for Marine Protected Areas and Priority Marine Features.

FeAST includes 36 human induced pressures, each with a clear definition and impact benchmark (where possible) at which feature sensitivities are assessed. The benchmarks define the intensity at which the pressure is applied for the purpose of the assessment, e.g. it is being assessed if the sensitivity of a population to disturbance is high, medium or low at a defined benchmark level of disturbance. This ensures the assessments are consistent across all marine habitats and species. FeAST's marine pressures list is adapted from an inventory and prepared and agreed by the OSPAR Joint Assessment Monitoring Programme.

The FeAST assessment approach is based upon the methods originally developed by MarLIN and later adapted for use with highly mobile species by Pérez-Domínguez et al. (2016). In this method, sensitivity is defined as a combination of initial resistance (known as 'tolerance' in the FeAST) of a feature to a pressure, and its resilience (known as 'recovery' in the FeAST) from the impact of a pressure, both based on the perceived impact to the species population.

Species tolerance and recovery are assigned ‘low’, ‘medium’, or ‘high’ using standard criteria (Table A1.1 and A1.2) and based on available evidence. Sensitivity scores were then derived using the matrix shown in Table 2 combining tolerance and recovery scores. Further details on the criteria used by Rogerson et al. (2021) to assess tolerance, recovery and confidence (Table A1.3) in the overall sensitivity score are provided in Annex 1.

Table 2: Matrix for assessing sensitivity from scores of a species’ tolerance and recovery potential for a pressure (Rogerson et al. (2021).

Recovery Potential	Low tolerance	Medium tolerance	High tolerance
Low recovery	High	Medium	Low
Medium recovery	Medium	Medium	Low
High recovery	Low	Low	Low

Standard criteria were also used to determine the confidence in the overall sensitivity score (Annex 1) which is a combination of the confidence in both the tolerance and recovery scores with the lower of the two assigned as a precautionary approach. As a result, the seabird sensitivity assessments reflect the different degrees in confidence associated with the overall tolerance score confidence because all species recovery confidence scores were assigned a ‘high’ level of confidence.

While the sensitivity to most pressures was taken from Rogerson et al. (2021), seabird vulnerability assessments to bycatch in UK waters were taken from Bradbury et al. (2017) to ensure consistency in the use of vulnerability assessments that were already available. Bradbury et al. (2017) calculated a Seabird Sensitivity Index (SSI) by scoring known traits of conservation status, demography/ecology and behaviour. Each trait was scored by panel of nine experts and the median scores across experts were used to provide an overall index.

Those pressures with a sensitive or low sensitivity score, or where they could not be assessed due to lack of data (Table A1.4) were not considered further for assessment as actions to address activities associated with these pressures were considered not the most important and/or beneficial. All high and medium sensitivity scores resulting from the analysis conducted by Rogerson et al. (2021) were further sense checked through expert judgment to ensure the activities associated with these pressures were appropriate for focussed marine and/or coastal seabird conservation actions. Six additional pressures were excluded from further assessment at this stage due to the main source of pressure not being associated with coastal and/or marine activities, and/or birds experience the pressure only at a small scale in their extent (Table A1.5). These pressures were not considered to be the highest risks to seabirds in Scotland and therefore were not considered further.

All remaining pressures resulting in high or medium seabird sensitivities were identified as the main pressures impacting seabirds in Scottish water and at coastal colonies. These were taken forward to the exposure assessment.

Step 2: Assessing Exposure

To assess exposure, the distribution of activities associated with the main pressures resulting from the sensitivity assessments were compared to the coastal breeding colonies and at sea distributions in Scotland for each of the 24 seabird species covered by the Vulnerability Report.

Pressure-activity associations i.e. human-induced activities that are associated with producing a pressure were adopted from FeAST.

Data on Distribution

Seabird coastal breeding colony locations were taken from the Seabird Monitoring Programme[2] prior to publication of Seabirds Count[3] census. Seabird foraging distributions were mapped using data from Waggitt et al. (2019).

The pressure-activity associations helped to narrow-down appropriate sources of data to determine the extent of pressure distributions. There was substantial variation in the information available for distribution, scale, intensity and/or duration of each pressure. The sources for pressure-activity distribution information on each pressure/threat are listed in Table A2.1.

Assessing Seabird Distribution

Seabird species distributions in Scottish waters were categorised as having widespread, restricted or localised distributions through expert judgment. The criteria used to assign each species to a category were a combination of:

- at sea distributional maps (for example see Figure A2.1); and
- known coastal breeding colony locations.

The quality of data available for analysing seabird species distributions was variable and therefore confidence in the species distribution scores was categorised as ‘low’, ‘medium’, or ‘high’ through expert judgment. The criteria used to assign data confidence to a category were a combination of:

- the extent of regular breeding survey effort across the species range, along with the detectability of nests,

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[2] Seabird Monitoring Programme | BTO - British Trust for Ornithology
[3] Seabirds Count | JNCC - Adviser to Government on Nature Conservation

- how detectable the species is during at-sea or from digital aerial surveys, and;
- the amount of tracking data available and number of colonies targeted.

The results of the species distribution analysis and the data confidence scores are listed in Table A2.2.

Assessing Pressure Distribution

The distribution of key pressures resulting from the sensitivity assessments were analysed using distribution maps for activities associated with the main pressures (Figures Figure A2. 2: Marine renewables map used in analysis exposure to collision mortality, displacement and barrier to species movement from offshore windfarms and exposure to collision mortality from underwater turbines.

A2.2, A2.3, A2.4, A2.5), where this information was available. Where information on the spatial distribution of a pressure was not available (e.g. climate change, marine litter) a qualitative judgement utilising expert opinion was made on the likely distribution of the pressure.

The distribution of the activities and pressures for each threat/impact were categorised as 'widespread', 'restricted' or 'localised' following the same method as species distribution.

The quality of pressure data available for analysis was variable and therefore confidence in these scores was also categorised as 'low', 'medium', or 'high' through expert judgment. The criteria used to assign data confidence to a category were a combination of:

- whether data is available for all the main activities leading to a pressure;
- the spatial coverage of any data, whether it covers the whole of Scotland or certain regions only; and
- the relevance of the data available to the impact pathway identified between the relevant activities and seabird species.

The results of the pressure distribution categorisations and the data confidence scores are listed in Table A2.3.

Combining Species Distribution & Pressure-Activity Distribution Scores

A matrix (Table 3) was used to combine the respective results from the species and pressure-activity distribution analysis. Different combinations were assigned a relative score of 'high', 'moderate', 'low' or 'negligible' to identify the potential level exposure of each species to each potential impact/threat. These scores were predominantly based on the approximate spatial extent of the overlap between a species and a pressure, although where possible the intensity of the pressure was also considered.

The exposure scores were then sense checked through expert judgment, and where required, scores were revised to take account of the known or perceived degree of overlap between the distributions of each species and each pressure/activity (Table A2.4).

Where a species was considered to have no or negligible exposure to a pressure, these were classified as 'negligible' (e.g. little gull (non-breeding) and habitat loss & mortality from invasive predatory mammals).

Table 3: How exposure of a species to a pressure was scored (high, medium, low, negligible) from corresponding scores for the distribution of the species and of the relevant pressures-activity.

Species Distribution	Restricted pressure distribution	Localised pressure distribution	Widespread pressure distribution
Negligible	Negligible	Negligible	Negligible
Restricted	Low	Low	High
Localised	Low	Medium	High
Widespread	Low	Medium	High

Confidence in the exposure assessment was taken as the lowest score of confidence in either the species or pressure distribution data, according to the matrix in Table 4.

Table 4: How exposure confidence was scored (high, medium, low) from corresponding scores of species distribution data confidence and pressure distribution data confidence of a species to the impact or threat of a pressure.

Species data confidence	Low pressure data confidence	Medium pressure data confidence	High pressure data confidence
Low	Low	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

Step 3: Assessing Vulnerability

To assess vulnerability of a species to a threat/impact, another matrix (Table 5) was used to combine the respective results from the species and pressure-activity distribution analysis. Different combinations of the sensitivity scores from step 1 and the exposure scores from step 2 were assigned a relative score of 'high', 'moderate', 'low' or 'negligible' to identify the potential level of vulnerability of each species to each potential threat/impact.

Table 5: How vulnerability was scored (high, medium, low, negligible) from corresponding scores of sensitivity and exposure by a species to the impact or threat of a pressure.

Population Exposure	Low population sensitivity	Medium population sensitivity	High population sensitivity
Negligible	Negligible	Negligible	Negligible
Low	Low	Low	Medium
Medium	Low	Medium	High
High	Low	High	High

Confidence in the vulnerability assessment was taken as the lowest score of confidence from the sensitivity and exposure confidence scores (Table 6).

Table 6: How vulnerability confidence was scored (high, medium, low) from corresponding scores of sensitivity data confidence and exposure data confidence by a species to the impact or threat of a pressure.

Exposure data confidence	Low sensitivity data confidence	Medium sensitivity data confidence	High sensitivity data confidence
Low	Low	Low	Low
Medium	Low	Medium	Medium
High	Low	Medium	High

Vulnerability Assessment Results

Tables A3.1 to A3.11 give a summary of the scores for sensitivity, exposure and the resultant vulnerability, along with confidence, for each species with respect to each of the impacts/threats from pressures.

Tables A3.12 to A3.23 lists those species that are most vulnerable to each of the impacts/threats (i.e. with a vulnerability score of medium or high from Tables A3.1 to A3.11).

The resulting pressures with a medium and high vulnerability were further rationalised to assist with focusing actions on a specific activity associated with multiple pressures (i.e. collision, displacement and barrier effect pressures for marine energy where combined) or where distinct actions to address a specific pressure can be pragmatically separately out (i.e. separating ‘habitat loss’ from ‘invasive predatory mammals’).

The results from the vulnerability assessments indicated that the main pressures and threats acting on seabirds whilst at Scottish breeding colonies and in Scottish waters are:

- Climate change
- Reduction in prey availability
- Invasive predatory species
- Bycatch
- Collision, displacement and barrier effects
- Disturbance
- Pollution (marine litter and contaminants)
- Habitat loss
- Intentional taking/ destruction of adults/ eggs (control & harvesting activities)

These pressures act on seabirds in one of three main pathways; threats to plentiful food supplies; availability of safe breeding and foraging habitats; and threats leading to direct mortality. Climate change is the exception, as this can act on all three pathways.

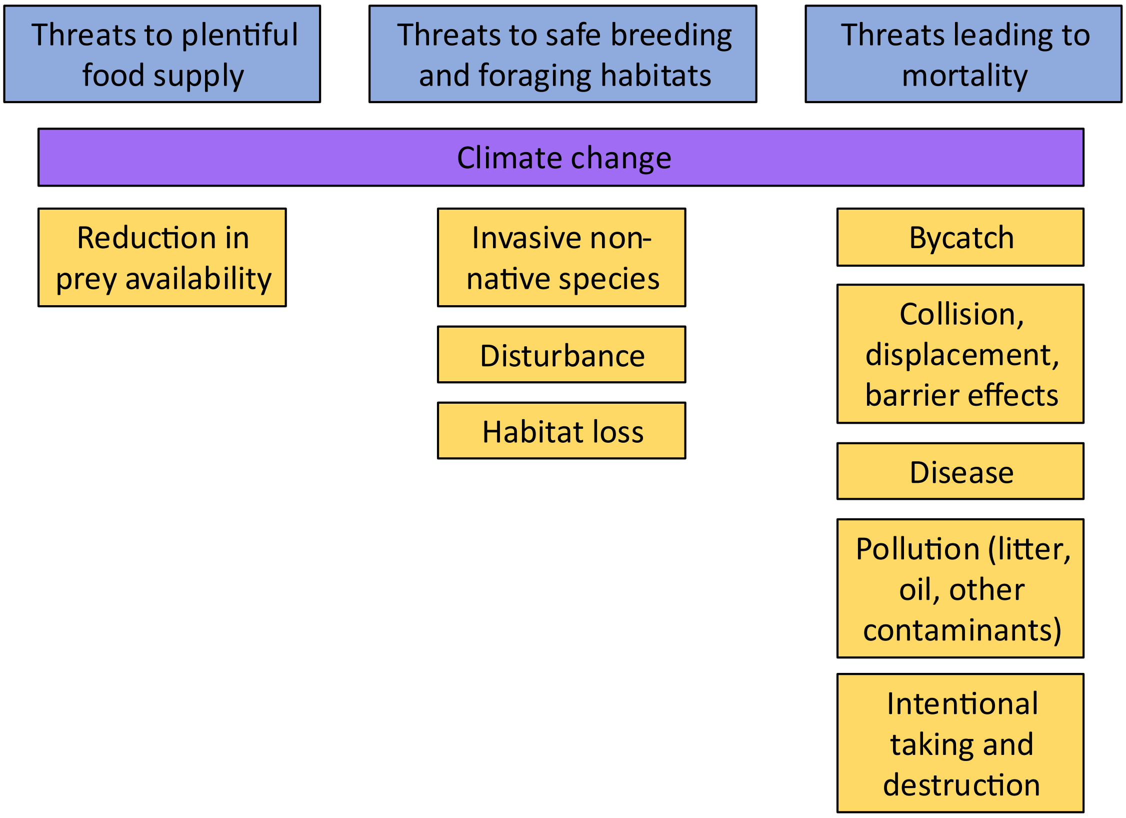

Figure 4 The main pressures and threats acting on seabirds in Scotland affecting the three themes.

Main Seabird Pressures and Threats

Climate Change

Climate change is a major driver of global biodiversity loss (IPBES, 2019) and poses a significant threat to seabirds. While there has been considerable research on its impacts, the effects are complex, often indirect, and operate at the ecosystem level, making them hard to separate from other pressures (Burton et al. 2023, Johnston et al. 2021, Mitchell et al. 2020).

Indirect Impacts:

Climate change impacts seabirds primarily through changes in the distribution, abundance and availability of fish prey (Daunt and Mitchell, 2013; Johnston et al., 2013; Pearce-Higgins, 2021). Rising sea temperatures reduce phytoplankton, affecting the food chain and seabirds (Heath et al., 2012), while warming has altered sandeel distribution (OSPAR, 2017a) and may shift fish species like sprat northward (Kjesbu et al., 2022).

Warming seas have been linked to lower breeding success in species such as kittiwakes and guillemots, with effects varying by species and location due to food chain dynamics and different foraging strategies (Burton et al., 2023). Additionally, changes in the timing of peak prey availability and high energy demands of seabirds due to rising temperatures may disrupt their synchronisation and lead to ‘trophic mismatches’ (Keogan et al., 2021, 2018). Ocean acidification and toxic algal blooms, predicted to increase with climate change, also pose threats to seabirds (Casero et al., 2022).

Direct Impacts:

Climate change can directly impact seabirds through exposure to extreme weather conditions. Severe weather can disrupt foraging, lead to poor body condition, and cause mass mortality events (e.g., Fullick et al., 2022; Morley et al., 2016). High winds increase energy expenditure during flight and foraging (Daunt et al., 2006; Frederiksen et al., 2008). Heavy rainfall and flooding during nesting can chill eggs, kill nestlings, and cause breeding failures (Aebischer, 1993). Rising sea levels threaten breeding sites for shore-nesting species like terns (Ivajnšič et al., 2017). Seabirds are also vulnerable to extreme heat, which can affect both them and their food sources (Choy et al., 2021; Piatt et al., 2020). These global impacts compound local threats, reducing species' ability to adapt (MCCIP 2020).

Threats To Plentiful Food Supplies

Reduction In Prey Availability

Seabird species are negatively impacted by reduced prey availability, either from lower prey density or decreased encounter rates (Mitchell et al., 2004; Cury et al., 201). Prey reduction may also arise as a result of removal and/or damage to prey supporting habitat such as sandbanks, seagrass meadows and kelp forests, rendering previously rich areas no longer suitable.

Prey reductions can lead to immediate loss of individual fitness and starvation, which can affect survival and can reduce numbers of birds attempting to breed (Springer et al., 1986). If food is scarce during the chick rearing period, breeding success can also be reduced or whole colonies may fail to produce any young. Prey availability is also constrained by seabird foraging ranges (during breeding) and dive depth, both of which vary greatly among species.

The three most important prey fish for seabirds foraging in Scottish waters are sandeel, sprat and herring (ICES., 1996). All of these, until recently, have been subject to commercial fisheries. In March 2024, fishing for sandeel was prohibited in all Scottish waters and the English part of the North Sea. It is anticipated as a result, that sandeel stocks will increase. Sprat and herring fisheries are focused on areas supporting the highest densities of fish, for sprat this is the southern North Sea, for herring, fisheries in recent years include locations such as the Firth of Forth, Moray Firth and the Clyde (Aires et al., 2014).

Threats To Safe Breeding & Foraging Seabird Habitats

Invasive Non-Native Species (INNS)

All seabird species, to varying degrees, are vulnerable to predation of chicks and eggs whilst at breeding colonies. As such, seabirds have strong tendencies to breed on islands free from land-based predators. While native predators like otters and great skuas are part of the natural food web, invasive non-native species (INNS) can devastate seabird populations. The presence of INNS at seabird colonies is the most significant cause of global bird extinctions over recent centuries (BirdLife International, 2017).

In Scotland, non-native predatory species include brown and black rats, American mink, domestic cats and house mice (Burnell et. al., 2023). On Scottish seabird islands, non-native predators can also include species that are native elsewhere in Scotland such as wood mouse, stoats, hedgehogs and red fox. The presence of mammalian predators on seabird islands can serve to eliminate and exclude breeding species, to alter behaviour and breeding habitat occupancy, and/or to suppress breeding numbers and distribution. Impact severity differs between species, with small burrow-nesting petrels and auks at particular risk.

INNS are introduced to islands through accidental transport on vessels, swimming from invaded areas, or even deliberate human actions (Russell et al., 2017).

Grazing animals such as deer, sheep, goats and rabbits can also potentially impact seabirds by altering habitats through over- or under-grazing and erosion. Similarly, non-native plant species such as tree mallow, can encroach breeding sites rendering them no longer suitable for breeding.

Disturbance

Breeding seabirds are vulnerable to disturbance from a wide range of activities at their colonies. Most breeding colonies are in remote or rural locations and so disturbance can be a marked change in conditions they are used to at the site. Seabird responses to disturbance varies greatly between species, with some species or species groups showing a high sensitivity to disturbance (e.g. terns) where others are much more tolerant (e.g. gulls) (Goodship and Furness, 2019 & 2022).

Noise or visual disturbance from the presence of people and/or anthropogenic activities at or close to a colony can cause adult birds to move off their nests, leaving chicks and eggs vulnerable to chilling or predation. Continued or severe disturbance can cause reduced breeding success, desertion of individual nests or colony abandonment. Even where there is no obvious escape response, physiological responses to stress from disturbance have been shown to reduce fitness in some species, and can affect immunity (Ellenberg et al., 2006).

Visual disturbance is also associated with artificial lighting on vessels and structures, as well as lighting from buildings on land close to the shore. Artificial light can cause disorientation to sensitive species, which can result in injury or death (Watson et al., 2014 and Deakin et al., 2022). The young of species that fledge at night, such as Atlantic puffin, Manx shearwater and storm-petrels are particularly susceptible to being disorientated by artificial light on land and at sea.

Breeding and non-breeding seabirds are vulnerable to vessel disturbance at sea, eliciting escape responses (birds taking flight or diving to avoid vessel) and potentially displacement of birds from foraging areas or other important areas. Escape responses and the potential requirement to have to travel further for food as a result of displacement increases energy expenditure and possible loss of fitness which can affect breeding success and survival.

Habitat Loss

Anthropogenic activities on land and at sea can result in the loss of breeding, wintering or foraging habitats for seabirds which in turn can adversely impact seabird populations, breeding success and behaviour. On the coast, infrastructure such as landfall for offshore cables and pipelines; ports and harbour development; coastal protection and flood defence works and laying of outfall and intake pipes, can result in the loss of intertidal foraging areas and nesting habitats for species such as terns and gulls.

At sea, offshore energy infrastructure and development can result in the displacement of birds from important foraging areas. When a bird is displaced to a location further from its source colony, it can cause increased flight time. This extended travel can deplete the bird's energy reserves and reduce the time it has available for essential foraging activities, potentially affecting its energy for attending to nests (Searle et al. 2018).

Threats Leading To Mortality

Bycatch

Seabirds can accidentally be caught and killed as bycatch in various types of fishing gear. Seabird bycatch is known to occur when birds target bait on long-line hooks; when birds swim into fixed nets when diving below the sea surface or when birds foraging for fish are caught in midwater trawls (Northridge et al., 2020). Less is known about seabird bycatch in other gear types and targeted monitoring is required to establish if seabird bycatch is an issue.

Long-Line Fisheries:

Seabirds captured in longline fisheries tend to be surface-feeders. They can be caught when attempting to take bait or when targeting caught fish as they are being hauled to the surface. Fulmar is the main species recorded as being bycaught in long-lines, along with gannet, and to a lesser extent Manx shearwater and some gull species (Dunn and Steel, 2001; Anderson et al., 2011; Northridge et al., 2020; Kingston et al., 2023). Long-lining tends to be concentrated along the edge of the continental shelf to the west and north of Scotland, with some coming further onto the shelf, including around the Shetland Isles.

Set Net Fisheries:

Set nets can be a hazard to birds that feed in the water column. This includes species that undertake plunge or pursuit diving such as auks (especially guillemots) but also cormorants, shags and gannets (Bærum et al., 2019, Northridge et al., 2020). Some surface-feeding species such as fulmar and gulls have also been reported as bycatch in set nets (Zydelis et al., 2013, Fangel et al., 2015, ICES, 2022). There is limited information on where set nets are used and there are a range of different types of netting in inshore waters, depending on the intended target species. Impacts are expected to be influenced by various factors including mesh size and soak time.

Midwater Trawl Fisheries:

It is mainly birds that feed in the water column, such as auks, that are at risk of occasional entanglement from midwater trawls (McCarthy et al., 2011). The majority of birds caught by UK vessels are guillemots, with fewer cormorants and razorbills (Northridge et al., 2020). Some gannets have been recorded as bycatch in the Scottish herring and mackerel fleets (Pierce et al., 2002). Surface-feeders may also be caught, for example gulls have been recorded in purse seine nets in Norway (Bradbury et al., 2017, Christensen-Dalsgaard et al., 2022). Pelagic fisheries are widely distributed across the continental shelf and beyond, with target species forming part of international stocks.

Aquaculture:

To a much lesser extent, some seabird species can also become accidentally entangled in nets, ropes and lines associated with aquaculture. Low numbers of seabirds, particularly gannets, gulls, cormorants, shags and skuas can be caught in finfish aquaculture top nets or side nets. Auks can be caught in the sub-sea nets of the cages (NatureScot, 2020). Fish farms are localised in distribution and limited mainly to the Northern Isles and west of Scotland.

Collision, Displacement & Barrier Effects

The next few decades are likely to see big changes to our climate. Moving to renewable energy, including offshore wind, will play a major role in cutting the emissions contributing to climate change.

However, seabird species have the potential to be impacted by marine renewable development, through both direct mortality and subtle non-lethal effects, which impact individual condition and demographic rates (e.g. survival and reproduction). Seabirds may be affected by three key effects: collision, displacement and barriers to movement, with vulnerability to these varying between species and across seasons. It is also dependent on the development characteristics and location.

Offshore windfarms may present a collision risk to commuting, feeding or migrating seabirds (Furness et al., 2013). Collision risk is assessed by combining the flight height of a given species and the ability of that species to avoid turbines. The flight height of some seabirds puts them at risk of death or injury from colliding with offshore wind farm structures, particularly large gulls, kittiwake, gannet, cormorant and shag (Furness et al., 2013, Johnston et al., 2014, Mendel et al., 2014, Johnston & Cook 2016). Some species appear to avoid flying through windfarms i.e. exhibit macro-avoidance. Evidence suggests there are species-specific responses to turbines and that to avoid collision, most birds adjust their flight paths at some distance from the turbines, rather than making last-second adjustments (Cook et al., 2018). However, some species such as shags and cormorants can be attracted to offshore developments by using structures to roost (Dierschke et al., 2016)

Some species are particularly sensitive to disturbance at sea, either from artificial structures such as wind turbines but also additional vessel traffic during wind farm construction (Jarrett et al., 2018, Fliessbach et al., 2019). This disturbance can lead to their displacement from important habitats (Searle et al., 2014, 2018, Warwick-Evans et al., 2017, Peschko et al., 2021, 2024, Lamb et al., 2024). Such displacements may incur greater energetic costs, which may ultimately affect survival or breeding success. In addition to simply causing birds to fly around a development and fly further than they otherwise would, the presence of offshore wind farms might have a greater impact by causing a barrier to movement, preventing birds from successfully migrating or accessing breeding colonies. Offshore wind developments may cause other impacts to seabirds such as changing prey populations and habitats (Grecian et al., 2010, Farr et al., 2021).

Exposure of seabirds to these pressures is likely to increase as the number of offshore wind farms increases and expands into waters in the North and West Scotland (Sectoral Marine Plan for Offshore Wind Energy, 2020[4]).

Diving seabirds such as auks and shag have the potential to be killed or injured by collision with tidal stream turbines below the surface (Furness et al., 2012). Exposure to threats or impacts from tidal or wave energy generation is localised, confined to a limited number of locations predominantly in NW Scotland and the Northern Isles. Currently, there is one operational tidal stream project in Scottish waters. Several more projects have now secured funding and are anticipated to progress to construction/ operation.

Disease

Seabirds are susceptible to several diseases and parasites, such as Puffinosis coronavirus, Newcastle disease, bacterial infections, avian botulism, gapeworm and ectoparasites. In addition, a new plastic-induced fibrotic disease; '*Plasticosis'* has also recently been described in seabirds (Hayley et al. 2023). However, none have been recorded as having such an immediate and acute impact on seabird populations in recent years as avian influenza (HPAI).

Between 2021 and 2023, an unprecedented outbreak of HPAI (predominantly H5N1 and other strains) impacted wild bird populations on a global scale. Breeding seabirds, including great skua, gannet, guillemot, kittiwake, tern and gull species, suffered particularly severe mortality attributed to HPAI in Scotland (Tremlett et al., 2024). Continued detection of infection in wild birds through 2023, 2024 and 2025 demonstrates that the virus was still circulating in wild bird populations. In 2023 and 2024, a new strain of HPAI was detected in the UK (H5N5), which potentially poses an ongoing threat to seabird populations.

The impact attributed to HPAI on Scottish seabird populations has been manifold, including;

- Severe reduction in breeding populations (for example an estimated decrease of 76% in great skua, and 22% in northern gannet populations (Tremlett et al., 2024);
- Impacts to species demographics; and
- Changes to seabird behaviour.

[4] Sectoral Marine Plan for Offshore Wind Energy

Pollution

Marine litter:

Some seabirds that feed on detritus and plankton at the sea surface can accidentally ingest small floating plastic particles (O'Hanlon et al., 2017). Ingesting these plastics is potentially harmful and can cause damage to internal organs (Lavers et al., 2019; Rivers-Auty et al., 2023) resulting in scar tissue formation (*Plasticosis* -see Disease). Petrels' are most at risk (Wang et al., 2021; Rivers-Auty et al., 2023). Unlike in other species of seabird, a specific anatomical feature of petrels' - a narrowing between the proventriculus and gizzard - prevents pellets containing indigestible material in the gizzard being regurgitated. This is also true for fulmar and means that ingested plastic remains and accumulates in the gizzard reducing the amount of food that they can digest, leading to reduced body condition and potentially starvation.

Seabirds can also become entangled in marine litter such as in Abandoned, Lost or otherwise Discarded Fishing Gear (ALDFG), in recreational nylon fishing line, occasionally in other types of plastic litter at sea, and in plastic waste incorporated into seabird nest material, leading to injury or death (Wilcox, 2015, O'Hanlon et al. 2017, Lavers et al., 2019).

Marine litter is discarded through a wide range of human activities conducted both at sea and on land. Exposure to threats from litter is considered to be widespread and is assumed to occur throughout Scottish waters.

Oil pollution:

Oil pollution in the marine environment that has caused seabird deaths largely stems from chronic and widespread release of fuel oil, impacting seabirds that typically spend time on the sea surface such as auks (Mitchell et al. 2004). Released oil will contaminate the surface of the water, water column and seafloor as well as having an immediate impact on seabirds. Fouling with oil alters feather microstructure, which results in loss of water-proofing; thermal insulation; buoyancy and can impair flight (Leighton, 1993, Jenssen, 1994). Ingestion of oil from preening can lead to organ failure. Birds contaminated at sea may therefore die from drowning, hypothermia, starvation, or dehydration (Helm et al., 2014).

Accidental spillage of large volumes of crude oil during extraction or transportation can also cause mass mortalities and profound effects on populations, in particular if occurring during the breeding season near colonies. The effects are relatively short-term and localised.

Intentional Taking & Destruction of Adults/ Eggs

The intentional taking and destruction of seabirds (either adults or eggs) is illegal under the Wildlife and Countryside Act (1981). Certain activities are, however, permitted under licence. In a limited number of circumstances, for example where seabirds pose a threat to aviation safety or are a risk to public health and safety, licenses can be issued for lethal control. Some taking of gull eggs for human consumption is also licensed at limited sites.

Each year, up to 2000 young gannets (guga), have been harvested from the island of Sula Sgeir for the purpose of human consumption, as permitted by The Wildlife and Countryside Act 1981. The harvest was voluntarily suspended between 2022 and 2024 due to the outbreak of HPAI.

Review Of Existing Measures, Actions Underway & Scope For More Potential Actions

There are existing overarching species and site protection legislation that provides protection for seabirds generally. Additionally, key strategies and policies increasingly recognise the fundamental importance of biodiversity to achieving broader environmental, economic and social objectives. There are also other multi-faceted areas of supporting work including research, monitoring, raising awareness and collaboration that provide crucial foundations and play an essential role in maximising the success of actions to directly address pressures. This report does not attempt to draw out all the relevant legislation, strategies, policies and multi-faceted areas of work that currently contribute to delivering conservation actions for seabirds.

To gauge the extent to which the main pressures identified through the vulnerability assessments are already being addressed, and the scope for additional or new pressure and/or species-specific potential action, a high-level review was conducted[5]. Expert judgment was used to highlight where the most appropriate actions were already in place or underway, where more could be done, and to identify where new action would be beneficial to seabirds. This work was complimented by a report on 'Potential actions to support recovery of seabird populations in Scotland' (Furness et al. 2024) to understand what adaptive responses may be appropriate to address different pressures.

A stakeholder workshop in February 2020 also provided an opportunity for gaps and potential conservation actions to be highlighted.

A summary of the high-level review findings is provided in Table A4.1 and was used to provide the basis for developing proposed priority actions in the Scottish Seabird Conservation Action Plan.

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5 Working group members include representatives from The Scottish Government, NatureScot, the Joint Nature Conservation Committee (JNCC), the Royal Society for the Protection of Birds (RSPB) and the British Trust for Ornithology (BTO).

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Annex 1: Assessing Sensitivity

Sensitivity criteria used by Rogerson et al. (2021) to score Tolerance, Recovery and Confidence.

Scoring Tolerance

Rogerson et al. (2021) assigned tolerance scores using the criteria in Table A1.1:

Table A1. 1: Criteria for assessing the tolerance potential of species

Tolerance score	Definition
None	A severe decline (>50%) in the estimated size of the local population as a result of increased mortality, reduced reproductive success, displacement or any other mechanism
Low	A significant decline (>10 and ≤50%) in the estimated size of the local population as a result of increased mortality, reduced reproductive success, displacement or any other mechanism.
Medium	A moderate decline (loss of up to 10%) in the estimated size of the local population as a result of increased mortality, reduced reproductive success, displacement or any other mechanism.
High	No population decline is expected. Effects affecting key functional and physiological attributes of the species (e.g. food intake rate, energy expenditure rate) may occur but are buffered from feeding through to changed rates of reproduction or mortality and hence population size by virtue of species' flexibility to respond to the pressure e.g. by redistribution, dietary shifts, increased foraging effort, etc.

If there was insufficient data within the assessment to determine a tolerance score as described above, but it was considered through expert opinion that there remained scope for potential impacts (of unknown magnitude) upon the species, a score of 'sensitive' was assigned. 'Not assessed' was assigned where there was no evidence available to allow an assessment of sensitivity.

Scoring Recovery

Scoring of recovery is determined by life history parameters indicative of the recovery potential of species (Table 2) and are detailed in Rogerson et al (2021).

Table A1. 2: Criteria for assessing the recovery potential of species

Life history parameters	Low recovery potential	Medium recovery potential	High recovery potential
Definition	Full recovery expected within 10-25 years.	Full recovery expected within 2-10 years.	Full recovery expected within 2 years.
Lifespan	Long- lived (10 years +)	Moderate lifespans (5-10 years)	Short-lived (up to 5 years)
Age at first maturity	Deferred maturity (first breeds when more than 3 years old)	First breeds when 2-3 years old	First breeds at one year of age
Adult mortality rate	Low natural mortality (<15%)	Moderate natural mortality rate (15-25%)	High natural annual mortality (>25%)
Fecundity / reproductive success	Low reproductive output (<2 chicks per pair per annum)	Moderate reproductive output (2-5 chicks per pair per annum)	High reproductive output (>5 chicks per pair per annum)

The framework for this was originally developed for a wider spectrum of bird species and consequently, all of the 22 seabird species covered by the Scottish Seabird Vulnerability Report fall into the low recovery category, hence, by default, the recovery score is low.

Confidence In Tolerance, Recovery & Sensitivity Scores

For each of the tolerance and recovery scores, confidence in the assessment was also scored, following a scoring system considering three confidence components (Table A1.3). For each of the components (quality of evidence, applicability of evidence and degree of concordance) a score was given and they were added up. The resulting confidence score falls between 3 and 15 points, and the degree of confidence is defined as:

- High confidence: total score >12;
- Medium confidence: total score 6 – 12; and
- Low confidence: total scores <6.

Table A1. 3: Definitions of confidence categories for assessments of tolerance, recovery and sensitivity

Confidence	Quality of information sources	Applicability of evidence	Degree of concordance
High (Score = 5)	Based on Peer Reviewed papers (observational or experimental) or grey literature reports by established agencies on the feature	Assessment based on the same pressures arising from similar activities, acting on the same type of feature in comparable areas (i.e. Ireland, UK)	Evidence agrees on the direction and magnitude of impact
Medium (Score = 3)	Based on some peer reviewed papers but relies heavily on grey literature or expert judgement on feature or similar features	Assessment based on similar pressures on the feature in other areas	Evidence agrees on direction but not magnitude of impact
Low (Score = 1)	Based on expert judgement, which is not clearly documented	Assessment based on proxies for pressures e.g. natural disturbance events	Evidence does not agree on concordance or magnitude

Table A1. 4: Seabird sensitivity to pressures not taken forward to the vulnerability analysis.

Key:

M=Medium, L=Low, S=Sensitive, NA= Not Assessed
Br=Breeding season only, Nbr=Non-breeding season only

1. Water clarity changes
2. Nitrogen & phosphorus enrichment
3. Under-water noise
4. Temperature changes - local
5. Water flow (tidal current) changes – local
6. Physical removal (extraction of sub-stratum)
7. Habitat loss from coastal infra-structure
8. Mortality or sub-lethal impacts of synthetic compounds (e.g. pesticides, antifoulants)
9. Mortality or sub-lethal impacts of non-synthetic compounds (e.g. heavy metals)

Species	1	2	3	4	5	6	7	8	9
Northern fulmar	L	S	L	NA	S	NA	S	S	S
Manx shearwater (Br)	L	S	L	NA	S	NA	S	S	S
European Storm-petrel (Br)	L	S	L	NA	S	NA	S	S	S
Leach's storm petrel (Br)	L	S	L	NA	S	NA	S	S	S
Arctic skua (Br)	L	S	L	NA	S	NA	S	S	S
Great skua	L	S	L	NA	S	NA	S	S	S
Great black-backed gull	L	S	L	NA	S	NA	S	S	S
Herring gull	L	S	L	NA	S	NA	S	S	S
Lesser black-backed gull	L	S	NA	NA	M	NA	S	S	S
Black-headed gull	L	L	L	NA	S	NA	S	S	S
Common gull	L	L	L	NA	S	NA	S	S	S
Little gull (Nbr)	L	S	L	NA	M	NA	S	S	S
Black-legged kittiwake	L	S	L	NA	S	NA	S	M	S
Little tern (Br)	S	M	L	NA	NA	NA	S	S	S
Common tern (Br)	M	M	L	NA	NA	NA	S	M	S
Arctic tern (Br)	L	M	L	NA	NA	NA	S	M	S
Sandwich tern (Br)	S	M	L	NA	NA	NA	S	S	S
Northern gannet	S	S	L	NA	S	NA	S	S	S
Great cormorant	S	S	S	NA	L	NA	S	S	M
European shag	S	S	S	NA	S	NA	S	S	S
Razorbill	S	M	S	NA	L	NA	S	S	S
Common guillemot	L	M	M	NA	L	NA	S	S	S
Black guillemot	S	S	S	NA	S	NA	S	S	M
Atlantic puffin	S	S	S	NA	L	NA	S	S	S

Table A1. 5: Pressures for which one or more seabird species show a ’medium’ sensitivity that were not taken forward to Step 2 (exposure analysis).

Pressure	Sensitivity	Reason for not considering pressure further
Water clarity changes	Common tern have a medium sensitivity to water clarity changes. Common tern have a high reliance on visually locating food from the air. Increased turbidity can reduce the ability of common tern to successfully catch prey.	In Scotland, common tern may experience this pressure to a small extent in highly localised situations and over a short time period.
Nitrogen & phosphorus enrichment	Terns, razorbill and common guillemot have a medium sensitivity to the effects of nitrogen and phosphorous	In Scotland, terns, razorbill and common guillemot may experience this pressure to some extent when enrichment

	enrichment. Indirect impacts of nitrogen and phosphorous enrichment resulting in algal blooms have been recorded as causing mass mortality of seabirds. Cormorants are negatively affected by fertilizer use most likely associated with run-off from inland and estuarine locations.	results in algal blooms. Nitrogen and phosphorous enrichment is mostly associated with run-off from inland and estuarine locations.
Underwater noise	Common guillemot have a medium sensitivity to underwater noise. Underwater noise may directly affect guillemot, being submerged for comparably long periods when diving in search for prey on the seabed. Guillemots have been found to show consistent reactions to underwater sound during controlled trials.	In Scotland, common guillemot may experience this pressure to a small extent. Limited evidence suggests a potential negative effect from underwater noise but the impact is expected to be temporary.
Water flow (tidal current) changes – local	Lesser black-backed gull and little gull have a medium sensitivity. Increases in water flow could increase energy expenditure of resting birds or birds diving for prey. It could also influence the availability of prey close to the water surface and species composition could be altered. These impacts could give rise to reduced body condition and therefore direct impacts. Lesser black-backed gulls are known to drift passively with the tidal current for several hours to rest. Water flow is reported to have a strong influence on little gull foraging.	In Scotland, lesser black-backed gull and little gull may experience this pressure to a small extent in localised situations.

Mortality or sub-lethal impacts of synthetic compounds (e.g. pesticides, antifoulants)	Kittiwake, common tern and Arctic tern have a medium sensitivity to impacts of synthetic compounds. Synthetic compounds can have impacts on seabird physiology such as hormone levels, breeding probability, hatching dates and even on genetics and behaviour. Evidence of impacts from synthetic contaminants on reproduction has been found in terns and impacts to time spent on eggs has been found in Kittiwake.	Legacy contaminants are expected to be in decline and recent studies have found declines in pollutant concentrations in colonies in the German Baltic Sea.
Mortality or sub-lethal impacts of non-synthetic compounds (e.g. heavy metals)	Cormorant and black guillemot have a medium sensitivity to impacts of non-synthetic compounds. Sub-lethal levels of heavy metal concentrations can lead to chronic diseases in seabirds and can have adverse effects on growth, development, reproduction, metabolism and behaviour. Bioaccumulation of mercury is known to occur in cormorants and black guillemot from their prey.	For cormorants, levels of non-synthetic compounds are very low and appear to not have any significant influence on the birds. Trends in mercury contamination have been seen to fall since 1993 and therefore this pressure is expected to be limited.

Annex 2: Assessing Exposure

Table A2. 1: The sources for exposure information on each impact/ threat.

Threat/ impact	Activity	Exposure information sources
Climate change	Multiple activities	Marine Climate Change Impacts Partnership (MCCIP)
Collision mortality, displacement and barrier to species movement.	Energy generation - Offshore wind: Operation and maintenance (Marine energy – Offshore wind)	Location of existing and planned offshore wind farms together with future planned areas for offshore wind developments identified through the Sectoral Plan for Offshore Wind Energy.
Underwater collision mortality	Energy generation - Tidal stream: Operation and maintenance Wave energy generation (Marine energy – wave and tidal)	Location of existing tidal developments known. (Tidal lease sites and tidal draft plan options, Marine Scotland - National Marine Plan Interactive (atkinsgeospatial.com))
Marine litter	Multiple activities	Some existing marine litter indicators are available (e.g. SCRAPBook[6], OSPAR Marine indicators[7], Great British beach clean[8]). Spatial extent currently unclear, especially at scale relevant to seabirds.
Habitat loss & mortality from invasive	Multiple activities	Exposure assessments use the UK Marine Strategy assessment of invasive predatory Mammals on seabird islands (Mitchell et al.

[6] Scotland's Coastal Rubbish Aerial Photography (SCRAPbook) | marine.gov.scot
[7] Plastic Particles in Fulmar Stomachs in the North Sea (ospar.org), Composition and Spatial Distribution of Litter on the Seafloor (ospar.org), Abundance, Composition and Trends of Beach Litter (ospar.org)
[8] State of beaches: Beachwatch report (2023) - Marine Conservation Society

predatory mammals		2018) along with distribution data and maps from Stanbury et al. (2017).
Reduction in prey by fishing	Fisheries	ICES Advice on fishing opportunities, catch, and effort for sandeels in the North Sea. The latest advice for each sandeel area adjacent to the Scottish Coast contains information on annual fishing pressure and landings up to 2018 and estimates of stock size up to 2019. For northern North Sea & Shetland see ICES (2019a) and for northern and central North Sea see ICES (2019b). No stock assessment data available that would enable a straightforward exposure assessment for fishing pressure on other prey species – sprat, juvenile herring, juvenile cod, whiting etc.
Disturbance	Recreation, tourism and transport activities	Data on vessel traffic (available from Marine Scotland via NMPi). The distribution of a wide range of recreational activities is recorded by the Scottish Marine Recreation & Tourism Survey[9] with associated maps by activity available from Marine Scotland via NMPi.
Intentional taking of adults/eggs	Licenced culling, control & harvesting	NatureScot licensing data.
Mortality from oil contamination	Multiple activities	Seabird Oil Sensitivity Index[10] (based upon seabird survey data collected from 1995-2015) aids planning and emergency decision making with regards to oil pollution, identifying areas at sea where seabirds are likely to be most sensitive to oil pollution. The UK Beached Bird Survey and SOTEAG[11], also undertake monitoring of oiled seabirds.

[9] Scottish Marine Recreation & Tourism Survey (2015)
[10] Seabird Oil Sensitivity Index (SOSI) | marine.gov.scot
[11] Seabird Monitoring – SOTEAG

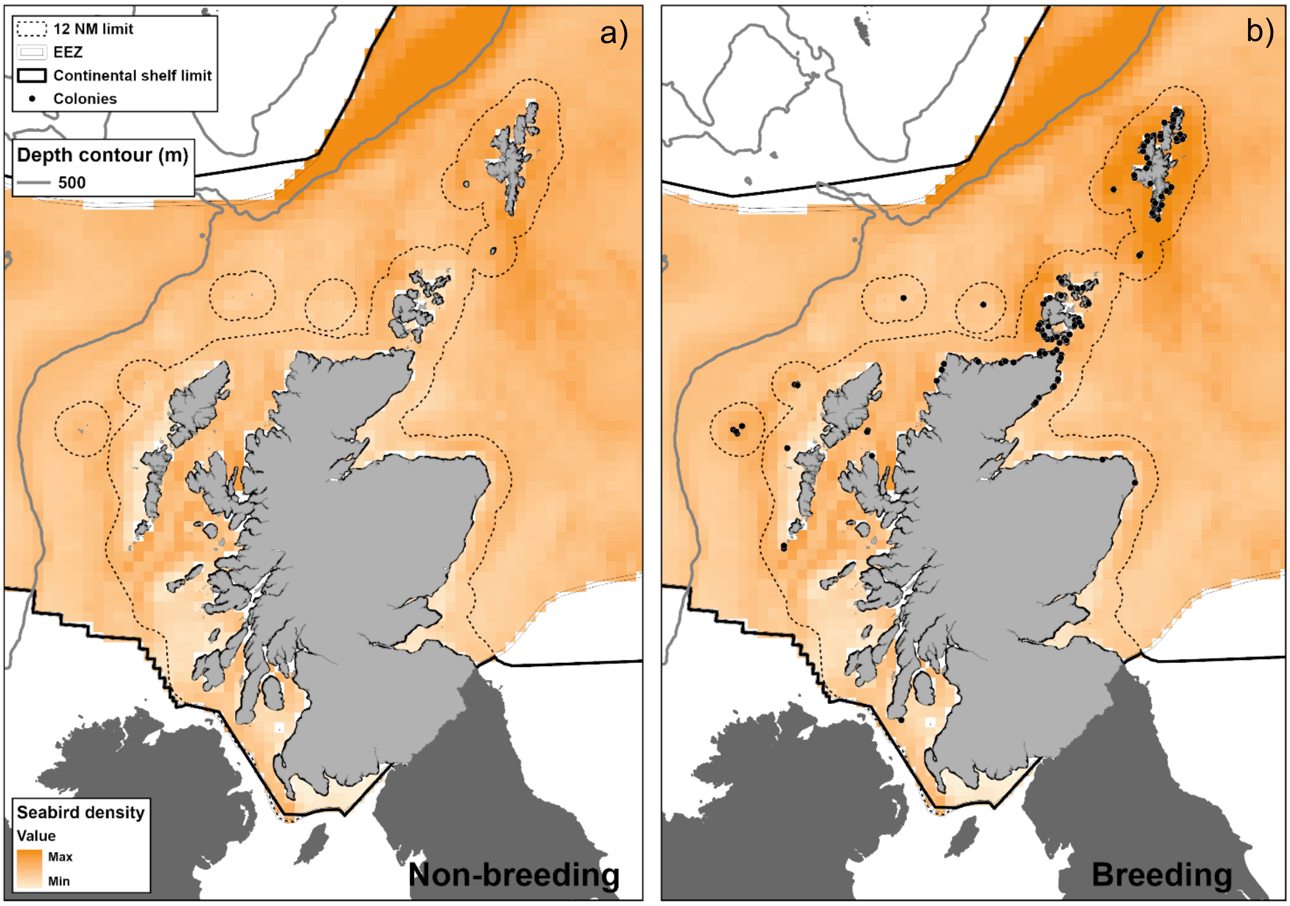

Figure A2. 1: Example of species distribution maps used in the exposure assessment.

a. Northern fulmar non-breeding distribution and b. Northern fulmar breeding distribution. Offshore distribution data taken from Waggitt et al. (2019). Dots indicate colonies which contain >0.01% of the Scottish breeding population based on Seabird Monitoring Program[12] data.

Table A2. 2: Species distribution categorisations and the data confidence scores used in the exposure analysis.

Br=Breeding season, Nbr=Non-breeding season

Common name	Distribution description	Distribution score	Data description	Data confidence score
Northern fulmar (Br)	Breeds throughout Scotland, but largest aggregations in	Widespread	Conspicuous at sea, extensive breeding survey	High

[12] http://archive.jncc.gov.uk/default.aspx?page=1550

	North and West, and vast foraging forages throughout Scottish waters.		effort and some GPS tracking data.	
Northern fulmar (Nbr)	Forages throughout Scottish waters, but in lower densities than breeding.	Widespread	Conspicuous at sea, extensive survey effort and some GLS tracking data.	High
Manx shearwater (Br)	Breeds in a small number of sites in the West of Scotland, with extensive foraging ranges and occurs on passage elsewhere.	Localised	Relatively conspicuous at sea. One well monitored colony (Rum) but limited regular breeding survey effort elsewhere. Tracking data from a single colony in Scotland.	Medium
European Storm-petrel (Br)	Breeds in the West and North of Scotland, with extensive foraging ranges and occurs on passage elsewhere.	Localised	Small size makes detection at sea challenging. Limited breeding survey effort in much of range, and limited tracking data from 2 colonies.	Low
Leach's storm petrel (Br)	Breeds in a small number of sites in the North and West of Scotland, foraging predominantly in offshore waters in West of Scotland, although on passage elsewhere.	Localised	Relatively challenging to observe at sea with limited breeding survey effort in much of range and tracking data from 1 colony.	Low
Arctic skua (Br)	Breeds predominantly in	Localised	Conspicuous at sea. Due to	Low

	the North and also West of Scotland, with foraging and passage throughout Scottish waters.		remote/expansive breeding, limited survey effort in much of range, and limited tracking data.	
Great skua (Br)	Breeds predominantly in the North and also West of Scotland, with foraging and passage throughout Scottish waters.	Localised	Conspicuous at sea. Due to remote/expansive breeding, limited survey effort in much of range, and no tracking data due to tagging effects.	Low
Great skua (Nbr)	Occurs throughout Scottish waters on passage but largely absent from majority of Scotland during winter period.	Restricted	Conspicuous at sea but low densities and no tracking data.	Low
Great black-backed gull (Br)	Breeds throughout Scotland but greatest breeding aggregations in North and West, foraging and passage throughout Scottish waters.	Widespread	Conspicuous at sea, extensive breeding survey effort but limited GPS tracking data due to tagging effects.	Medium
Great black-backed gull (Nbr)	Occurs throughout Scottish waters	Widespread	Conspicuous at sea, but no tracking data.	Medium
Herring gull (Br)	Breeds on throughout Scotland and forages throughout Scottish waters.	Widespread	Conspicuous at sea, extensive breeding survey effort but limited tracking data in Scotland.	Medium

Herring gull (Nbr)	Occurs throughout Scottish waters	Widespread	Extensive survey effort but no tracking data.	Medium
Lesser black-backed gull (Br)	Breeds on throughout Scotland (including many terrestrial sites in the central belt) and forages throughout Scottish waters.	Widespread	Conspicuous at sea, extensive survey effort and some tracking data in Scotland.	Medium
Lesser black-backed gull (Nbr)	Occurs throughout Scottish waters on passage but largely absent from majority of Scotland during winter period, although some individuals remain in the South.	Restricted	Conspicuous at sea and some tracking data.	Medium
Black-headed gull (Br)	Breeds on throughout Scotland (including many terrestrial sites) and forages throughout Scottish waters.	Widespread	Conspicuous at sea, extensive survey effort, no tracking data	Medium
Black-headed gull (Nbr)	Occurs throughout Scotland and generally inshore waters	Widespread	Conspicuous at sea, extensive survey effort, no tracking data	Medium
Common gull (Br)	Breeds on throughout Scotland (including many terrestrial sites) and forages throughout Scottish waters.	Widespread	Conspicuous at sea, extensive survey effort, no tracking data	Medium
Common gull (Br)	Occurs throughout Scotland and generally inshore waters	Widespread	Conspicuous at sea, extensive survey effort, no tracking data	Medium

Little gull (Nbr)	Small numbers, predominantly in waters in South-east of Scotland.	Restricted	Limited survey effort in Scotland and no tracking data.	Low
Black-legged kittiwake (Br)	Breeds on throughout Scotland and forages throughout Scottish waters.	Widespread	Extensive survey effort and GPS tracking data from numerous colonies in Scotland.	High
Black-legged kittiwake (Nbr)	Occurs throughout Scottish waters, but lower densities than during breeding.	Widespread	Extensive survey effort and GLS tracking data from colonies in Scotland.	High
Little tern (Br)	Localised coastal distribution close to small number of breeding locations. Absent during non-breeding season.	Restricted	Small and challenging to detect during at sea surveys due to low densities, remote/limited breeding survey effort in Scotland and no tracking data.	Low
Common tern (Br)	Largely coastal distribution throughout Scotland. Absent during non-breeding season.	Localised	Conspicuous during at sea surveys, some breeding survey effort and limited tracking data in Scotland.	Medium
Arctic tern (Br)	Largely coastal distribution throughout Scotland. Absent during non-breeding season.	Localised	Conspicuous during at sea surveys, some breeding survey effort and limited tracking data in Scotland.	Medium
Sandwich tern (Br)	Largely coastal distribution throughout Scotland. Absent	Localised	Conspicuous during at sea surveys, some breeding survey effort and no	Medium

	during non-breeding season.		tracking data in Scotland.	
Northern gannet (Br)	Several large breeding colonies (gannetries) distributed across Scotland and forages throughout Scottish waters.	Widespread	Large and conspicuous during at sea surveys, extensive breeding survey effort and tracking data from selected colonies in Scotland.	High
Northern gannet (Nbr)	Occurs throughout Scottish waters, but in lower densities compared to summer and a relatively short winter period.	Widespread foraging and	Large and conspicuous during at sea surveys, and some year-round tracking data from colonies in Scotland.	High
Great cormorant (Br)	Largely coastal breeding distribution in the south and east of Scotland.	Localised	Conspicuous and inshore during at sea surveys, good survey effort within more coastal areas but no tracking data in Scotland.	Medium
Great cormorant (Nbr)	Largely coastal foraging distribution throughout Scotland.	Localised	Conspicuous and inshore during at sea surveys, and no tracking data in Scotland.	Medium
European shag (Br)	Coastal breeding and foraging distribution throughout Scotland.	Localised	Conspicuous and inshore during at sea surveys, good survey effort within more coastal areas, GPS tracking data from selected colonies in Scotland.	Medium
European shag (Nbr)	Coastal distribution throughout Scotland, with	Localised	Conspicuous and inshore during at sea surveys, and	Medium

	partial non-breeding migration in some populations.		GLS tracking data from limited number of colonies in Scotland.	
Razorbill (Br)	Occurs and breeds throughout Scottish waters	Widespread	Conspicuous and during at sea surveys, extensive breeding survey effort and GPS tracking data from selected colonies in Scotland.	High
Razorbill (Nbr)	Occurs throughout Scottish waters, but in reduced numbers and more offshore than during breeding.	Widespread	Conspicuous during at sea surveys, and GLS tracking data from colonies in Scotland.	High
Common guillemot (Br)	Occurs and breeds throughout Scottish waters	Widespread	Conspicuous during at sea surveys, extensive breeding survey effort and GPS tracking data from selected colonies in Scotland.	High
Common guillemot (Nbr)	Occurs throughout Scottish waters, but in reduced numbers and more offshore than during breeding.	Widespread	Conspicuous during at sea surveys, and GLS tracking data from colonies in Scotland.	High
Black guillemot (Br)	Coastal foraging and breeding distribution to the North and West of Scotland.	Localised	Conspicuous and inshore during at sea surveys, good breeding survey effort and GPS tracking data from colonies in Scotland.	Medium
Atlantic puffin (Br)	Occurs throughout Scottish waters.	Widespread	Conspicuous during at sea surveys, extensive	High

			breeding survey effort, but limited GPS tracking data from selected colonies in Scotland due to tagging effects.	
Atlantic puffin (Nbr)	Occurs throughout Scottish waters, but in reduced numbers and more offshore than during breeding.	Widespread	Conspicuous during at sea surveys, and GLS tracking data from colonies in Scotland.	Medium

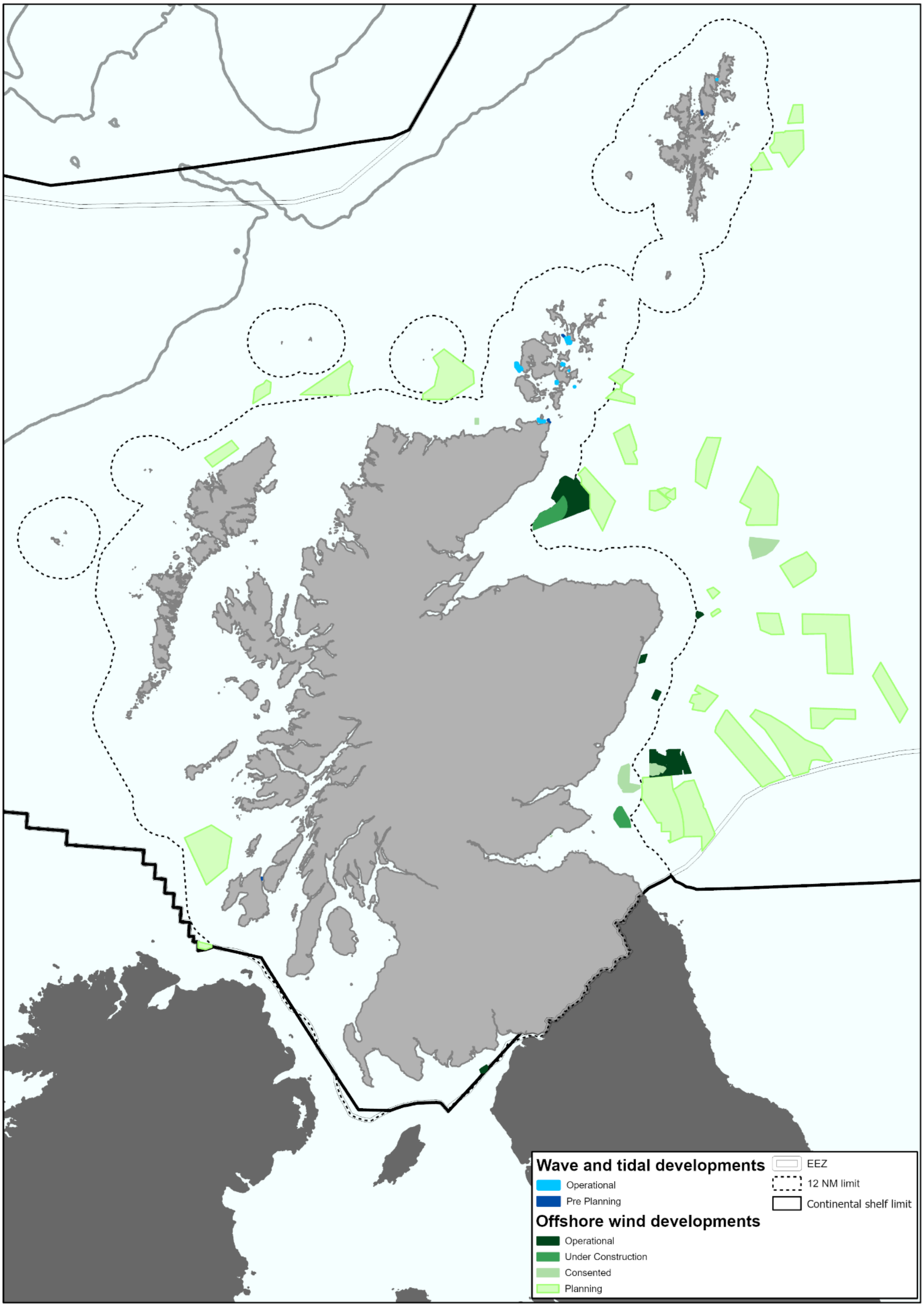

Figure A2. 2: Marine renewables map used in analysis exposure to collision mortality, displacement and barrier to species movement from offshore windfarms and exposure to collision mortality from underwater turbines.

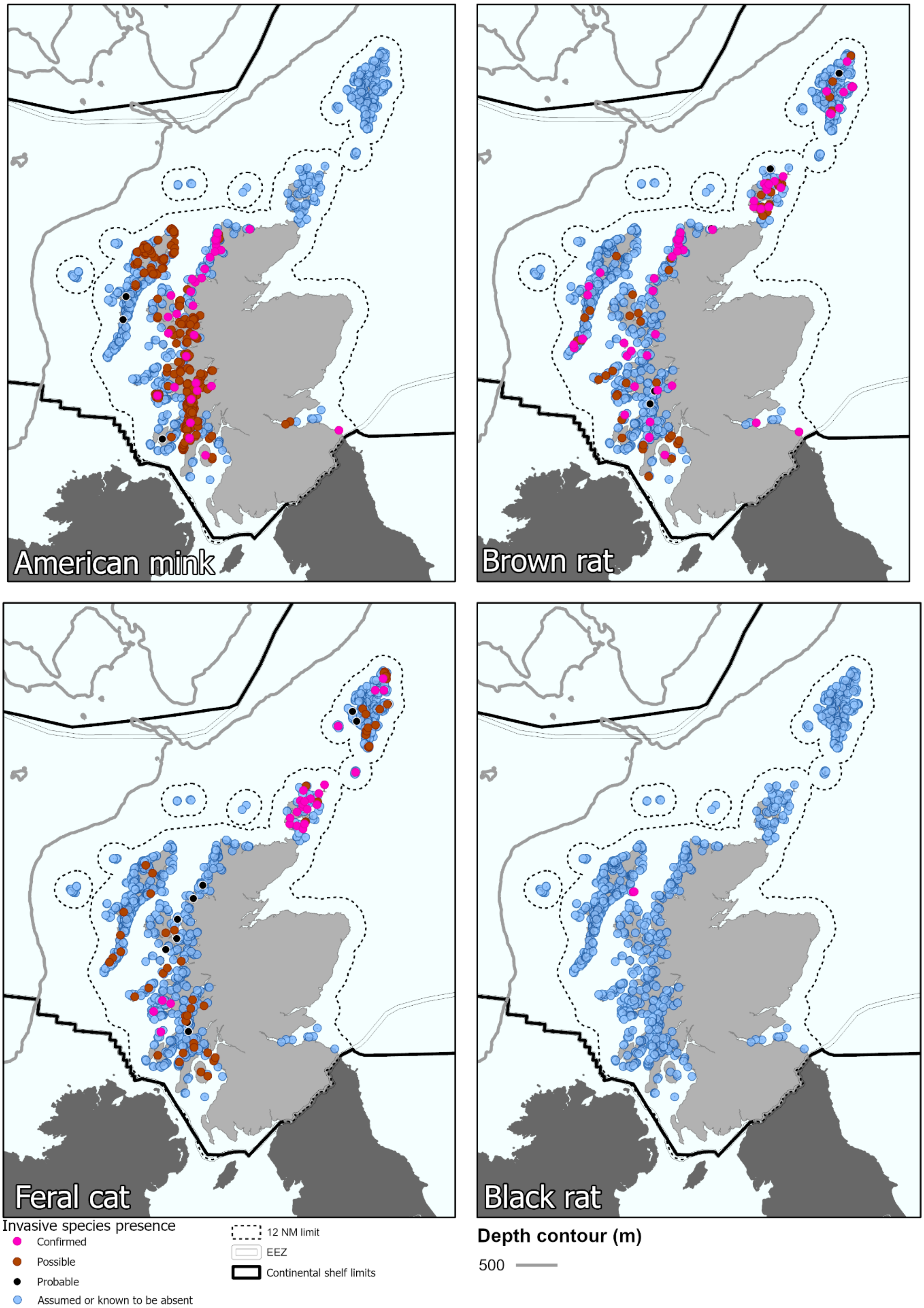

Figure A2. 3: Invasive species maps used to analysis exposure to mortality from invasive predatory mammals. Data taken from (Stanbury et al. 2017)

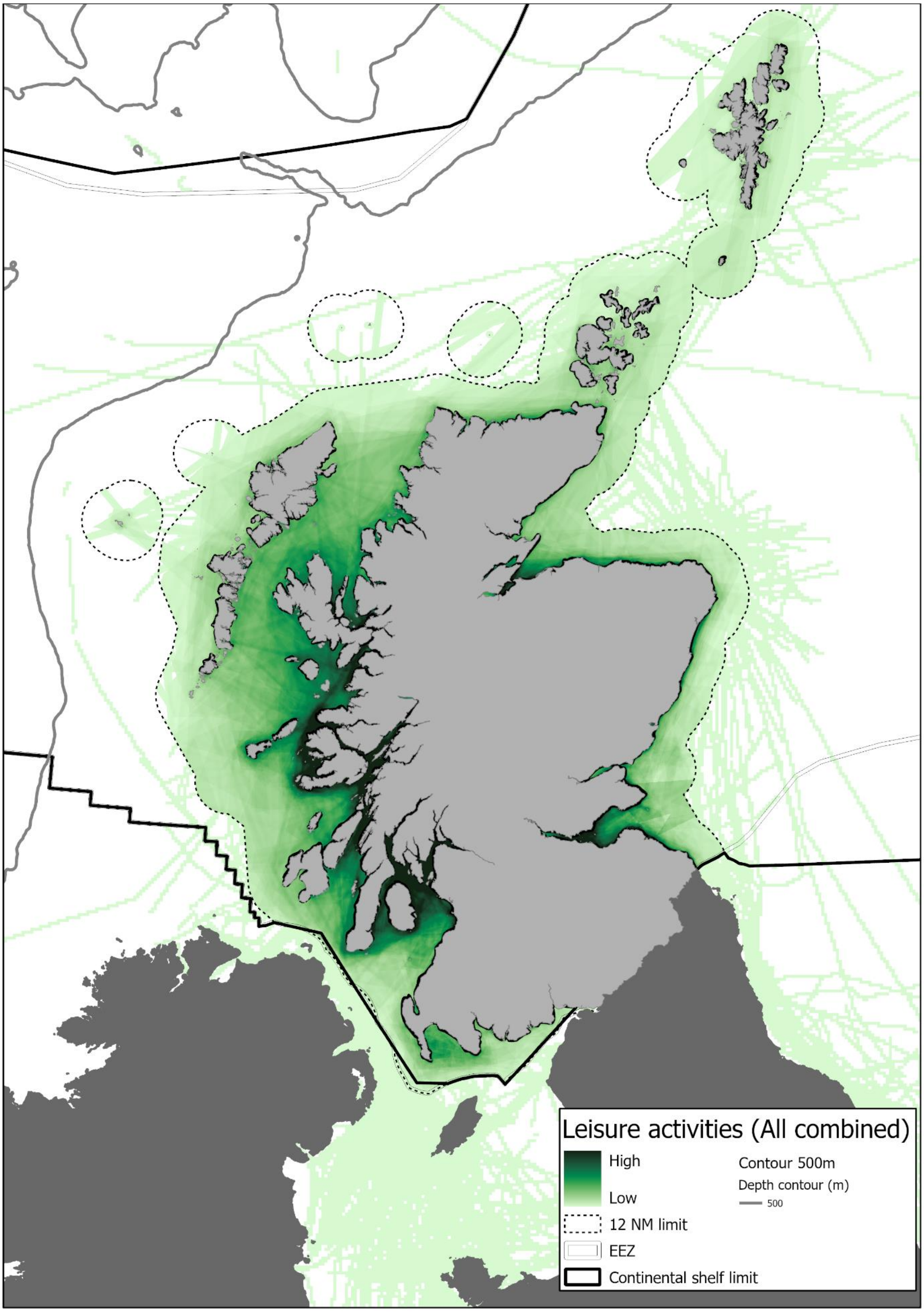

Figure A2. 4: Leisure vessel activity map used to analysis disturbance exposure from recreation, tourism and transport. Maps generated using Vessel Monitoring System (VMS) data owned by Marine Scotland.

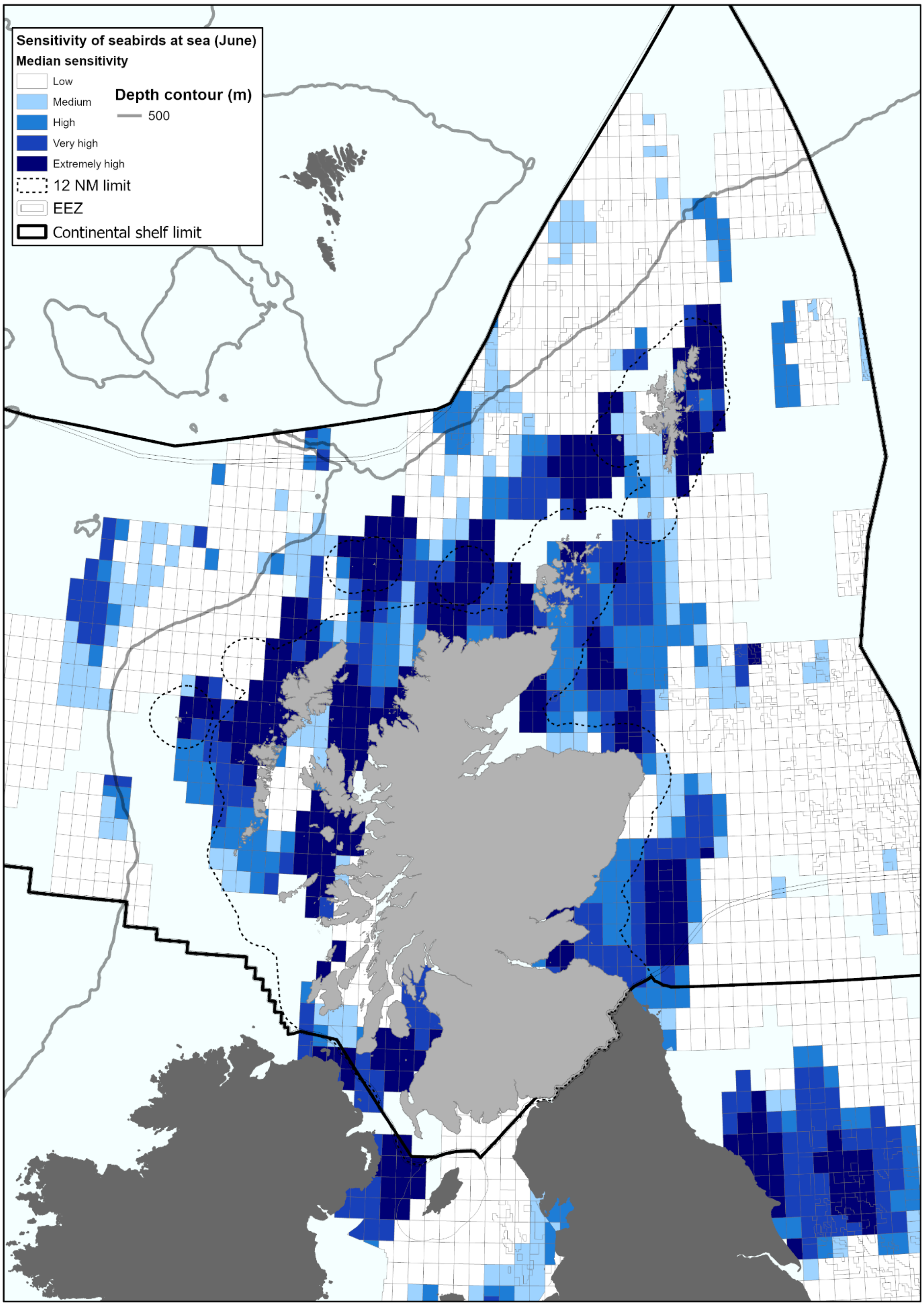

Figure A2. 5 Seabird Oil Sensitivity Index[13] used in analysis exposure to mortality from oil contamination.

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[13] Seabird Oil Sensitivity Index (SOSI) | JNCC - Adviser to Government on Nature Conservation

Table A2. 3: Pressure distribution scores used in exposure analysis

Pressure Name	Distribution Description	Distribution Score	Data Description	Data Confidence Score
Climate Change	There is increasing evidence of climate change impacting seabirds throughout Scotland, both through direct impacts of extreme weather events and indirect impacts on prey populations. While the impacts vary by location, they are widespread with high exposure for all species.	Widespread	While there is high confidence that climate change is and will affect seabirds, there is low confidence as to how and where this will occur.	Low
Wind turbine collision mortality; displacement by wind turbines; wind turbines as barrier to species movement	Currently, several discrete wind farms are located in the seas off Eastern Scotland and within 100km of shore. However, the Sectoral Marine Plan identifies several candidate areas for future development in both the West and North.	Localised	Locations of current sites known and plans identify candidate areas for future development.	High
Mortality by collision with underwater turbines etc	Limited number of locations in NW of Scotland and Northern Isles.	Restricted	Locations of current sites known and plans identify candidate areas for future development.	High

Marine litter	Widespread, but low level exposure throughout range.	Localised	Limited information available and data collected over limited spatial/ temporal scale which may not be relevant to seabirds.	Low
Habitat loss & mortality from invasive predatory mammals	Majority of mainland Scotland and numerous offshore islands. Predominantly an issue during breeding and restricted to land.	Localised	Historical data for large parts of Scotland and specific surveys of other locations. Regular monitoring at some seabird colonies.	High
Reduction in prey by fishing	The pressure occurs throughout Scottish waters, but the spatial extent of fisheries is limited and target fish species vary regionally	Localised	Stock assessment data routinely collected. Spatial scale of assessments may not be appropriate for some seabird species/ colonies, non-commercial prey species poorly covered.	Medium
Disturbance from recreation, tourism and	Predominantly within 10km of shore. Recreational disturbance	Localised	The survey data has wide coverage but the information is	Low

leisure and transport	generally more limited during winter		not necessarily directly relevant to the threat of these activities on seabirds. Intermediate for vessel traffic (vessels <12m length not tracked).	
Intentional taking of adults/ chicks/ eggs (licenced control & harvesting)	Occurs in small numbers throughout Scotland but affects limited species. Predominantly breeding season.	Localised	Locations of legal activities known.	High
Mortality from oil contamination	Widespread, but low level exposure throughout range.	Medium	Long term data from beached bird surveys and surveillance by Oil and Gas sector, but more limited data on discharges from shipping traffic.	Medium

Table A2. 4: Species for which matrix derived exposure scores were modified following expert review.

Br = Breeding season only, Nbr = Non-breeding season only.

Pressure Name	Exemptions	Justification
Wind turbine collision mortality	Northern fulmar	Low flight heights
	Great skua (Nbr)	Passage
	Lesser black-backed gull (Nbr)	Passage
	Little gull (Nbr)	Passage
	Little tern	Extreme coastal distribution
	Great cormorant	Extreme coastal distribution
	European shag	Extreme coastal distribution
	Razorbill	Low flight heights
	Common guillemot	Low flight heights
	Black guillemot	Low flight heights
	Atlantic puffin	Low flight heights
Displacement by wind turbines	Northern fulmar	Low flight heights & extensive foraging
	Manx shearwater	Low flight heights & extensive foraging
	European storm-petrel	Low flight heights & extensive foraging
	Leach's storm-petrel	Low flight heights & extensive foraging
	Little tern	Extreme coastal distribution
	Great cormorant	Extreme coastal distribution
	European shag	Extreme coastal distribution
	Black guillemot	Extreme coastal distribution
Wind turbines as a barrier to species movement	Northern fulmar	Extensive foraging distributions
	Manx shearwater	Extensive foraging distributions
	European storm-petrel	Extensive foraging distributions
	Leach's storm-petrel	Extensive foraging distributions
	Arctic skua	Extensive foraging distributions
	Great skua	Extensive foraging distributions
	Little tern	Extensive foraging distributions
Mortality by collision with underwater turbines etc	Great cormorant	Extreme coastal distribution
	European shag	Extreme coastal distribution
	Black guillemot	Extreme coastal distribution

Habitat loss & mortality from invasive predatory mammals	Northern fulmar (Nbr)	Largely at sea
	Great skua (Nbr)	Largely at sea
	Great black-backed gull (Nbr)	Largely at sea
	Herring gull (Nbr)	Largely at sea
	Lesser black-backed gull (Nbr)	Largely at sea
	Black-headed gull (Nbr)	Limited risk
	Common Gull (Nbr)	Limited risk
	Little gull (Nbr)	Largely at sea
	Black-legged kittiwake (Nbr)	Largely at sea
	Northern gannet (Nbr)	Largely at sea
	Great cormorant (Nbr)	Roosts on land throughout non-br
	European shag (Nbr)	Roosts on land throughout non-br
	Razorbill (Nbr)	Largely at sea
	Common guillemot (Nbr)	Largely at sea
	Atlantic puffin (Nbr)	Largely at sea
Intentional taking of adults/chicks/ eggs (licenced control & harvesting)	Great black-backed gull	Some licenced/unlicenced cull
	Herring gull	Some licenced/unlicenced cull
	Lesser black-backed gull	Some licenced/unlicenced cull
	Black-headed gull	Some licenced/unlicenced cull
	Common gull	Some licenced/unlicenced cull
	Northern gannet (Br)	Licenced harvest on Sula Sgeir
	Great cormorant	Some licenced/unlicenced cull

Annex 3: Vulnerability Analysis Components & Results

The following tables summarise species sensitivity, exposure, vulnerability and confidence to the impact or threat of key pressures.

Br = Breeding season only, NBr = Non-breeding season only, NA= not assessed, NE = not exposed/negligible

Table A3. 1 Species Summary: Climate Change.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	High	High	High	High
Manx shearwater	Medium	High	High	High
European Storm-petrel	Medium	High	High	High
Leach's storm petrel	High	High	High	High
Arctic skua	High	High	High	High
Great skua	High	High	High	High
Great black-backed gull	High	High	High	High
Herring gull	Medium	High	High	High
Lesser black-backed gull	Medium	High	High	High
Black-headed gull	High	High	High	High
Common gull	High	High	High	High
Little gull (Nbr)	High	High	High	High
Black-legged kittiwake	High	High	High	High
Little tern (Br)	High	High	High	High
Common tern (Br)	High	High	High	High
Arctic tern (Br)	High	High	High	High
Sandwich tern (Br)	High	High	High	High
Northern gannet (Br)	Sensitive	High	Sensitive	High
Northern gannet (Nbr)	Low	High	Low	High
Great cormorant (Br)	Low	High	Low	High
Great cormorant (Nbr)	Sensitive	High	Sensitive	High
European shag (Br)	Sensitive	High	Sensitive	High
European shag (Nbr)	High	High	High	High
Razorbill	High	High	High	High
Common guillemot	High	High	High	High
Black guillemot	High	High	High	High
Atlantic puffin (Br)	High	High	High	High
Atlantic puffin (Nbr)	Sensitive	High	Sensitive	High

Table A3. 2 Species Summary**:** Wind Turbine Collision Mortality[14].

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	Sensitive	Low*	Sensitive	Low
Manx shearwater	Medium	Medium	Medium	Medium
European Storm-petrel	Medium	Medium	Medium	Low
Leach's storm petrel	Medium	Medium	Medium	Low
Arctic skua	Medium	Medium	Medium	Low
Great skua (Br)	Medium	Medium	Medium	Low
Great skua (Nbr)	Medium	Medium*	Medium	Low
Great black-backed gull	High	Medium	High	Medium
Herring gull	High	Medium	High	Medium
Lesser black-backed gull (Br)	High	Medium	High	Medium
Lesser black-backed gull (Nbr)	High	Medium*	High	Medium
Black-headed gull	Medium	Medium	Medium	Medium
Common gull	Medium	Medium	Medium	Medium
Little gull (Nbr)	Medium	Medium*	Medium	Low
Black-legged kittiwake	Sensitive	Medium	Sensitive	Low
Little tern (Br)	Medium	Low*	Low	Low
Common tern (Br)	Medium	Medium	Medium	Medium
Arctic tern (Br)	Medium	Medium	Medium	Medium
Sandwich tern (Br)	Medium	Medium	Medium	Medium
Northern gannet	Medium	Medium	Medium	High
Great cormorant	Medium	Low*	Low	Medium
European shag	Medium	Low*	Low	Medium
Razorbill	Medium	Low*	Low	Medium
Common guillemot	Medium	Low*	Low	Medium
Black guillemot	Medium	Low*	Low	Medium
Atlantic puffin	Medium	Low*	Low	Medium

Table A3. 3 Species Summary: Displacement by Wind Turbines.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	Medium	Low*	Low	Medium
Manx shearwater	Medium	Low*	Low	Medium
European Storm-petrel	Medium	Low*	Low	Low
Leach's storm petrel	Medium	Low*	Low	Low
Arctic skua	Low	Medium	Low	Low
Great skua (Br)	Low	Medium	Low	Low
Great skua (Nbr)	Low	Low	Low	Low

[14] Sensitivity to collision above water was assessed generally for all activities and structures. Here we focus on exposure to collision with wind turbines

Great black-backed gull	Low	Medium	Low	Medium
Herring gull	Low	Medium	Low	Medium
Lesser black-backed gull (Br)	Low	Medium	Low	Medium
Lesser black-backed gull (Nbr)	Low	Low	Low	Medium
Black-headed gull	Low	Low	Low	Medium
Common gull	Low	Low	Low	Medium
Little gull (Nbr)	Medium	Low	Low	Low
Black-legged kittiwake	Medium	Medium	Medium	Medium
Little tern (Br)	Medium	Low*	Low	Low
Common tern (Br)	Medium	Medium	Medium	Medium
Arctic tern (Br)	Medium	Medium	Medium	Medium
Sandwich tern (Br)	Medium	Medium	Medium	Medium
Northern gannet	High	Medium	High	High
Great cormorant	Medium	Low*	Low	Medium
European shag	Medium	Low*	Low	Medium
Razorbill	Medium	Medium	Medium	High
Common guillemot	Medium	Medium	Medium	High
Black guillemot	Medium	Low*	Low	Medium
Atlantic puffin	Medium	Medium	Medium	Medium

Table A3. 4 Species Summary: Wind Turbines as a Barrier to Species Movement[15].

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	Medium	Low*	Low	Medium
Manx shearwater	Medium	Low*	Low	Medium
European Storm-petrel	Medium	Low*	Low	Low
Leach's storm petrel	Medium	Low*	Low	Low
Arctic skua	Low	Low*	Low	Low
Great skua	Low	Low*	Low	Low
Great black-backed gull	Low	Medium	Low	Medium
Herring gull	Low	Medium	Low	Medium
Lesser black-backed gull (Br)	Low	Medium	Low	Medium
Lesser black-backed gull (Nbr)	Low	Low	Low	Medium
Black-headed gull	Low	Low	Low	Medium
Common gull	Low	Low	Low	Medium
Little gull (Nbr)	Medium	Low	Low	Low
Black-legged kittiwake	Medium	Medium	Medium	Medium
Little tern (Br)	Medium	Low*	Low	Low

[15] Sensitivity to barrier to species movement was assessed generally for all activities and structures. Here we focus on exposure to wind turbines as a barrier to species movement

Common tern (Br)	Medium	Medium	Medium	Medium
Arctic tern (Br)	Medium	Medium	Medium	Medium
Sandwich tern (Br)	Medium	Medium	Medium	Medium
Northern gannet	High	Medium	High	High
Great cormorant	Medium	Medium	Medium	Medium
European shag	Medium	Medium	Medium	Medium
Razorbill (Br)	Medium	Medium	Medium	High
Razorbill (Nbr)	Medium	Medium	Medium	High
Common guillemot	Medium	Medium	Medium	High
Black guillemot	Medium	Medium	Medium	Medium
Atlantic puffin	Medium	Medium	Medium	Medium

Table A3. 5 Species Summary: Underwater Turbine Collision Mortality.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar (Br)	Low	Low	Low	Medium
Northern fulmar (Nbr)	Low	Low	Low	Medium
Manx shearwater	Low	Low	Low	Medium
European Storm-petrel	Low	Low	Low	Low
Leach's storm petrel	Low	Low	Low	Low
Arctic skua	Low	Low	Low	Low
Great skua (Br)	Low	Low	Low	Low
Great skua (Nbr)	Low	Low	Low	Low
Great black-backed gull (Br)	Low	Low	Low	Medium
Great black-backed gull (Nbr)	Low	Low	Low	Medium
Herring gull (Br)	Low	Low	Low	Medium
Herring gull (Nbr)	Low	Low	Low	Medium
Lesser black-backed gull (Br)	Low	Low	Low	Medium
Lesser black-backed gull (Nbr)	Low	Low	Low	Medium
Black-headed gull	Low	Low	Low	Medium
Common gull	Low	Low	Low	Medium
Little gull (Nbr)	Low	Low	Low	Low
Black-legged kittiwake	Low	Low	Low	Medium
Little tern (Br)	Low	Low	Low	Low
Common tern (Br)	Low	Low	Low	Medium
Arctic tern (Br)	Low	Low	Low	Medium
Sandwich tern (Br)	Low	Low	Low	Medium
Northern gannet	Medium	Low	Low	Medium
Great cormorant	Medium	Medium*	Medium	Medium
European shag	Medium	Medium*	Medium	Medium

Razorbill	High	Low	Medium	Medium
Common guillemot	High	Low	Medium	Medium
Black guillemot	High	Medium*	High	Medium
Atlantic puffin	High	Low	Medium	Medium

Table A3. 6 Species Summary: Marine Litter.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	High	Low	Medium	Low
Manx shearwater	High	Low	Medium	Low
European Storm-petrel	High	Low	Medium	Low
Leach's storm petrel	High	Low	Medium	Low
Arctic skua	Sensitive	Low	Sensitive	Low
Great skua	Sensitive	Low	Sensitive	Low
Great black-backed gull	High	Low	Medium	Low
Herring gull	High	Low	Medium	Low
Lesser black-backed gull	High	Low	Medium	Low
Black-headed gull	High	Low	Medium	Low
Common gull	High	Low	Medium	Low
Little gull (Nbr)	High	Low	Medium	Low
Black-legged kittiwake	High	Low	Medium	Low
Little tern (Br)	Sensitive	Low	Sensitive	Low
Common tern (Br)	Sensitive	Low	Sensitive	Low
Arctic tern (Br)	Sensitive	Low	Sensitive	Low
Sandwich tern (Br)	Sensitive	Low	Sensitive	Low
Northern gannet	High	Low	Medium	Low
Great cormorant	Sensitive	Low	Sensitive	Low
European shag	Sensitive	Low	Sensitive	Low
Razorbill	Sensitive	Low	Sensitive	Low
Common guillemot	Medium	Low	Low	Low
Black guillemot	Sensitive	Low	Sensitive	Low
Atlantic puffin	Sensitive	Low	Sensitive	Low

Table A3. 7 Species Summary: Habitat Loss and Mortality from Invasive Predatory Mammals.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar (Br)	High	Medium	High	Medium
Northern fulmar (Nbr)	High	NE*	NE	Medium
Manx shearwater	High	Medium	High	Medium
European Storm-petrel	High	Medium	High	Low
Leach's storm petrel	High	Medium	High	Low
Arctic skua	Sensitive	Medium	Sensitive	Low

Great skua (Br)	Sensitive	Medium	Sensitive	Low
Great skua (Nbr)	Sensitive	NE*	Sensitive	Low
Great black-backed gull (Br)	High	Medium	High	Medium
Great black-backed gull (Nbr)	High	NE*	NE	Medium
Herring gull (Br)	High	Medium	High	Medium
Herring gull (Nbr)	High	NE*	NE	Medium
Lesser black-backed gull (Br)	High	Medium	High	Medium
Lesser black-backed gull (Nbr)	High	NE*	NE	Medium
Black-headed gull	High	Medium	High	Medium
Common gull	High	Medium	High	Medium
Little gull (Nbr)	High	NE*	NE	Low
Black-legged kittiwake (Br)	Medium	Medium	Medium	Medium
Black-legged kittiwake (Nbr)	Medium	NE*	NE	Medium
Little tern (Br)	High	Low	Medium	Low
Common tern (Br)	High	Medium	High	Medium
Arctic tern (Br)	High	Medium	High	Medium
Sandwich tern (Br)	High	Medium	High	Medium
Northern gannet (Br)	Sensitive	Medium	Sensitive	Low
Northern gannet (Nbr)	Sensitive	NE*	Sensitive	Low
Great cormorant (Br)	Sensitive	Medium	Sensitive	Low
Great cormorant (Nbr)	Sensitive	Low*	Sensitive	Low
European shag (Br)	Medium	Medium	Medium	Medium
European shag (Nbr)	Medium	Low*	Low	Medium
Razorbill (Br)	High	Medium	High	Medium
Razorbill (Nbr)	High	NE*	NE	Medium
Common guillemot (Br)	High	Medium	High	Medium
Common guillemot (Nbr)	High	NE*	NE	Medium
Black guillemot	High	Medium	High	Medium
Atlantic puffin (Br)	High	Medium	High	Medium
Atlantic puffin (Nbr)	High	NE*	NE	Medium

Table A3. 8 Species Summary: Reduction in Prey by Fishing.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	Sensitive	Medium	Sensitive	Low
Manx shearwater	Sensitive	Medium	Sensitive	Low

European Storm-petrel	Sensitive	Medium	Sensitive	Low
Leach's storm petrel	Sensitive	Medium	Sensitive	Low
Arctic skua	High	Medium	High	Low
Great skua (Br)	High	Medium	High	Low
Great skua (Nbr)	High	Low	Medium	Low
Great black-backed gull	Medium	Medium	Medium	Medium
Herring gull	Medium	Medium	Medium	Medium
Lesser black-backed gull (Br)	Medium	Medium	Medium	Medium
Lesser black-backed gull (Nbr)	Medium	Low	Low	Medium
Black-headed gull	Medium	Medium	Medium	Medium
Common gull	Medium	Medium	Medium	Medium
Little gull (Nbr)	Sensitive	Low	Sensitive	Low
Black-legged kittiwake	High	Medium	High	Medium
Little tern (Br)	High	Low	Medium	Low
Common tern (Br)	High	Medium	High	Medium
Arctic tern (Br)	High	Medium	High	Medium
Sandwich tern (Br)	High	Medium	High	Medium
Northern gannet	Medium	Medium	Medium	Medium
Great cormorant	Sensitive	Medium	Sensitive	Low
European shag	Medium	Medium	Medium	Medium
Razorbill	High	Medium	High	Medium
Common guillemot	High	Medium	High	Medium
Black guillemot	High	Medium	High	Medium
Atlantic puffin	High	Medium	High	Medium

Table A3. 9 Species Summary: Disturbance from Recreation, Tourism & Transport

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	High	Low	Medium	Low
Manx shearwater	Medium	Low	Low	Low
European Storm-petrel	Medium	Low	Low	Low
Leach's storm petrel	Medium	Low	Low	Low
Arctic skua	Low	Low	Low	Low
Great skua	Low	Low	Low	Low
Great black-backed gull	Low	Low	Low	Low
Herring gull	Low	Low	Low	Low
Lesser black-backed gull	Low	Low	Low	Low
Black-headed gull	Low	Low	Low	Low
Common gull	Low	Low	Low	Low

Little gull (Nbr)	Low	Low	Low	Low
Black-legged kittiwake	Low	Low	Low	Low
Little tern (Br)	High	Low	Medium	Low
Common tern (Br)	High	Low	Medium	Low
Arctic tern (Br)	High	Low	Medium	Low
Sandwich tern (Br)	High	Low	Medium	Low
Northern gannet	Medium	Low	Low	Low
Great cormorant	High	Low	Medium	Low
European shag	High	Low	Medium	Low
Razorbill	Sensitive	Low	Sensitive	Low
Common guillemot	High	Low	Medium	Low
Black guillemot	Sensitive	Low	Sensitive	Low
Atlantic puffin	Medium	Low	Low	Low

Table A3. 10 Species Summary: Intentional Taking of Adults/ Eggs (Licenced Culling, Control & Harvesting).

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	Medium	NE	NE	Medium
Manx shearwater	Medium	NE	NE	Medium
European Storm-petrel	Sensitive	NE	Sensitive	Low
Leach's storm petrel	Sensitive	NE	Sensitive	Low
Arctic skua	Sensitive	NE	Sensitive	Low
Great skua	Sensitive	NE	Sensitive	Low
Great black-backed gull	High	Medium*	High	Medium
Herring gull	High	Medium*	High	Medium
Lesser black-backed gull	High	Medium*	High	Medium
Black-headed gull	Sensitive	Medium*	Sensitive	Medium
Common gull	Sensitive	Medium*	Sensitive	Medium
Little gull (Nbr)	Sensitive	NE	Sensitive	Low
Black-legged kittiwake	Medium	NE	NE	Medium
Little tern (Br)	Medium	NE	NE	Low
Common tern (Br)	Medium	NE	NE	Medium
Arctic tern (Br)	Medium	NE	NE	Medium
Sandwich tern (Br)	Medium	NE	NE	Medium
Northern gannet (Br)	Sensitive	Low*	Sensitive	Low
Northern gannet (Nbr)	Sensitive	NE	Sensitive	Low
Great cormorant	Medium	Medium*	Medium	Medium
European shag	Sensitive	NE	Sensitive	Low
Razorbill	Medium	NE	NE	Medium
Common guillemot	Medium	NE	NE	Medium

Black guillemot	Medium	NE	NE	Medium
Atlantic puffin	Medium	NE	NE	Medium

Table A3. 11 Species Summary: Mortality from Oil Contamination.

Species	Sensitivity	Exposure	Vulnerability	Confidence
Northern fulmar	High	Low	Medium	Medium
Manx shearwater	High	Low	Medium	Medium
European Storm-petrel	High	Low	Medium	Low
Leach's storm petrel	High	Low	Medium	Low
Arctic skua	High	Low	Medium	Low
Great skua	High	Low	Medium	Low
Great black-backed gull	Medium	Low	Low	Medium
Herring gull	Medium	Low	Low	Medium
Lesser black-backed gull	Medium	Low	Low	Medium
Black-headed gull	High	Low	Medium	Medium
Common gull	High	Low	Medium	Medium
Little gull (Nbr)	High	Low	Medium	Low
Black-legged kittiwake	High	Low	Medium	Low
Little tern (Br)	Sensitive	Low	Sensitive	Low
Common tern (Br)	Sensitive	Low	Sensitive	Low
Arctic tern (Br)	Sensitive	Low	Sensitive	Low
Sandwich tern (Br)	Sensitive	Low	Sensitive	Medium
Northern gannet	Medium	Low	Low	Medium
Great cormorant	High	Low	Medium	Medium
European shag	High	Low	Medium	Medium
Razorbill	High	Low	Medium	Medium
Common guillemot	High	Low	Medium	Medium
Black guillemot	Sensitive	Low	Sensitive	Medium
Atlantic puffin	High	Low	Medium	Medium

Species with Medium and High Vulnerability to Main Pressures

The following tables highlight the main pressures and threats identified as having a high and medium vulnerability to the named seabird species. The tables also include species that are considered ‘sensitive’ to these pressures.

Listed species refer to breeding populations only unless otherwise stated (i.e. Br/Nbr = breeding & non-breeding populations, Nbr = non-breeding populations only).

Table A3. 12 Climate Change

Species	Vulnerability
Arctic skua	High
Arctic tern	High
Atlantic puffin	High
Black-headed gull (Br/Nbr)	High
Black guillemot	High
Black-legged kittiwake (Br/Nbr)	High
Common gull (Br/Nbr)	High
Common guillemot (Br/Nbr)	High
Common tern	High
European shag	Sensitive
European shag (Nbr)	High
European storm petrel	High
Great black-backed gull (Br/Nbr)	High
Great cormorant (Nbr)	Sensitive
Great skua (Br/Nbr)	High
Herring gull (Br/Nbr)	High
Leach's storm petrel	High
Lesser black-backed gull (Br/Nbr)	High
Little gull (Nbr)	High
Little tern	High
Manx shearwater	High
Northern fulmar (Br/Nbr)	High
Northern gannet	Sensitive
Razorbill (Br/Nbr)	High
Sandwich tern	High

Table A3. 13 Reduction in prey availability

Species	Vulnerability
Arctic skua	High
Arctic tern	High
Atlantic puffin (Br/Nbr)	High
Black-headed gull	Medium
Black guillemot	High
Black-legged kittiwake (Br/Nbr)	High
Common gull	Medium
Common guillemot (Br/Nbr)	High
Common tern	High
European shag (Br/Nbr)	Medium
European storm petrel	Sensitive
Great black-backed gull (Br/Nbr)	Medium

Great cormorant (Br/Nbr)	Sensitive
Great skua (Br)	High
Great skua (Nbr)	Medium
Herring gull (Br/Nbr)	Medium
Leach's storm petrel	Sensitive
Lesser black-backed gull (Br)	Medium
Little gull (Nbr)	Sensitive
Little tern	Medium
Manx shearwater	Sensitive
Northern fulmar (Br/Nbr)	Sensitive
Northern gannet (Br/Nbr)	Medium
Razorbill (Br/Nbr)	High
Sandwich tern	High

Table A3. 14 Habitat loss & mortality from invasive predatory mammals

Species	Vulnerability
Arctic skua	Sensitive
Arctic tern	High
Atlantic puffin	High
Black-headed gull	High
Black guillemot	High
Black-legged kittiwake	Medium
Common gull	High
Common guillemot	High
Common tern	High
European shag	Medium
European storm petrel	High
Great black-backed gull	High
Great cormorant (Br/Non-br)	Sensitive
Great skua (Br/Non-br)	Sensitive
Herring gull	High
Leach's storm petrel	High
Lesser black-backed gull	High
Little tern	Medium
Manx shearwater	High
Northern fulmar	High
Northern gannet (Br/Non-br)	Sensitive
Razorbill	High
Sandwich tern	High

Table A3. 15 Bycatch[16]

Species	Vulnerability
Arctic tern	Medium
Atlantic puffin (Br/Nbr)	Medium
Black guillemot	Sensitive
Black-legged kittiwake (Br/Nbr)	Medium
Common tern	Medium
European shag ((Br/Nbr)	Medium
Great black-backed gull (Br/Nbr)	Medium
Great cormorant (Br/Nbr)	Medium
Herring gull (Br/Nbr)	Medium
Leach's storm petrel	Medium
Lesser black-backed gull (Br/Nbr)	Medium
Little gull (Nbr)	Medium
Little tern	Medium
Manx shearwater	Medium
Northern gannet (Br/Nbr)	Medium
Razorbill (Br/Nbr)	Medium
Sandwich tern	Medium

Table A3. 16 Collision mortality (by offshore wind energy)

Species	Vulnerability
Arctic skua	Medium
Arctic tern	Medium
Black-headed gull (Br/Nbr)	Medium
Black-legged kittiwake (Br/Nbr)	Sensitive
Common gull (Br/Nbr)	Medium
Common tern	Medium
European storm petrel	Medium
Great black-backed gull (Br/Nbr)	High
Great skua (Br/Nbr)	Medium
Herring gull (Br/Nbr)	High
Leach's storm petrel	Medium
Lesser black-backed gull	High
Little gull (Nbr)	Medium
Manx shearwater	Medium
Northern fulmar (Br/Nbr)	Sensitive
Northern gannet (Br/Nbr)	Medium
Sandwich tern	Medium

[16] Bradbury et al. 2017

Table A3. 17 Displacement (by offshore wind energy)

Species	Vulnerability
Arctic tern	Medium
Atlantic puffin (Br/Nbr)	Medium
Black-legged kittiwake (Br/Nbr)	Medium
Common guillemot (Br/Nbr)	Medium
Common tern	Medium
Northern gannet (Br/Nbr)	High
Razorbill (Br/Nbr)	Medium
Sandwich tern	Medium

Table A3. 18 Barrier to species movement (by offshore wind energy)

Species	Vulnerability
Arctic tern	Medium
Atlantic puffin (Br/Nbr)	Medium
Black guillemot	Medium
Black-legged kittiwake (Br/Nbr)	Medium
Common guillemot (Br/Nbr)	Medium
Common tern	Medium
European shag (Br/Nbr)	Medium
Great cormorant (Br/Nbr)	Medium
Northern gannet (Br/Nbr)	High
Razorbill (Br/Nbr)	Medium
Sandwich tern	Medium

Table A3. 19 Mortality by collision with underwater turbines etc

Species	Vulnerability
Atlantic puffin (Br/Nbr)	Medium
Black guillemot	High
Common guillemot (Br/Nbr)	Medium
European shag (Br/Nbr)	Medium
Great cormorant (Br/Nbr)	Medium
Razorbill (Br/Nbr)	Medium

Table A3. 20 Disturbance (from recreation, tourism and transport)

Species	Vulnerability
Arctic tern	Medium
Black guillemot	Sensitive
Common guillemot (Br/Nbr)	Medium
Common tern	Medium
European shag (Br/Nbr)	Medium

Great cormorant (Br/Nbr)	Medium
Little tern	Medium
Northern fulmar (Br/Nbr)	Medium
Razorbill (Br/Nbr)	Sensitive
Sandwich tern	Medium

Table A3. 21 Marine litter

Species	Vulnerability
Arctic skua	Sensitive
Arctic tern	Sensitive
Atlantic puffin (Br/Nbr)	Sensitive
Black-headed gull	Medium
Black guillemot	Sensitive
Black-legged kittiwake (Br/Nbr)	Medium
Common gull	Medium
Common tern	Sensitive
European shag (Br/Nbr)	Sensitive
European storm petrel	Medium
Great black-backed gull (Br/Nbr)	Medium
Great cormorant (Br/Nbr)	Sensitive
Great skua (Br/Nbr)	Sensitive
Herring gull (Br/Nbr)	Medium
Leach's storm petrel	Medium
Lesser black-backed gull (Nbr)	Medium
Little gull (Nbr)	Medium
Little tern	Sensitive
Manx shearwater	Medium
Northern fulmar (Br/Nbr)	Medium
Northern gannet (Br/Nbr)	Medium
Razorbill (Br/Nbr)	Sensitive
Sandwich tern	Sensitive

Table A3. 22 Mortality from oil contamination

Species	Vulnerability
Arctic skua	Medium
Arctic tern	Sensitive
Atlantic puffin (Br/Nbr)	Medium
Black-headed gull	Medium
Black guillemot	Sensitive
Black-legged kittiwake (Br/Nbr)	Medium
Common gull	Medium
Common guillemot (Br/Nbr)	Medium

Common tern	Sensitive
European shag (Br/Nbr)	Medium
European storm petrel	Medium
Great cormorant (Br/Nbr)	Medium
Great skua (Br/Nbr)	Medium
Leach's storm petrel	Medium
Little gull (Nbr)	Medium
Little tern	Sensitive
Manx shearwater	Medium
Northern fulmar (Br/Nbr)	Medium
Razorbill (Br/Nbr)	Medium
Sandwich tern	Sensitive

Table A3. 23 Intentional taking of adults/eggs (licenced culling, control & harvesting)

Species	Vulnerability
Arctic skua	Sensitive
Black-headed gull	Sensitive
Common gull	Sensitive
European shag (Br/Nbr)	Sensitive
European storm petrel	Sensitive
Great black-backed gull (Br/Nbr)	High
Great cormorant (Br/Nbr)	Medium
Great skua (Br/Nbr)	Sensitive
Herring gull (Br/Nbr)	High
Leach's storm petrel	Sensitive
Lesser black-backed gull (Br/Nbr)	High
Little gull (Nbr)	Sensitive
Northern gannet (Br/Nbr)	Sensitive

Annex 4: Review of existing measures in place

Table A4. 1 Summary of high-level review of measures already in place, actions underway and where more could be done to benefit seabirds.

Impact/threat	Existing Measures in place	Actions committed or underway	Opportunities for action
Reduction in prey availability	Closure of fishing for sandeel in Scottish waters Fisheries measures implemented in some non-seabird MPAs	Development of fisheries measures in seabird MPAs.	Scope for more actions that can enhance prey availability, such as managing other forage fish species, and enhancing/restoring prey supporting habitats such as spawning and nursery areas.
Invasive predatory species	Eradication of invasive predatory mammals from three key seabird islands – Canna, Ailsa Craig and the Shiant Isles.	Eradication of stoats on Orkney. Produced Biosecurity Plans for seabird islands and established three incursion response hubs.	Scope for more actions that can enhance safe breeding opportunities such as, removing and/or controlling invasive predatory mammals from seabird colonies where predation is an issue, securing long-term island biosecurity measures, managing grazing levels and vegetation composition/structure where these are damaging breeding habitats.
Bycatch	Voluntary use of mitigation	UK Bycatch Mitigation Initiative. Trials on the use of	Scope for more actions that can reduce incidental

	measures in some fleets.	streamers and altered buoyancy regimes are ongoing through the European LIFE funded project, CIBBRiNA and UK Bycatch Monitoring Programme.	bycatch mortality, such as developing and implementing technical and spatial measures to reduce seabird bycatch in the fishing sector and continuing to improve techniques to reduce entanglement in aquaculture nets.
Collision, displacement and barrier effects	Sectoral Marine Plan for Offshore Wind for ScotWind.	Minimising impacts of marine renewables development at strategic and project level through mitigation and where appropriate, compensation.	Scope for more actions that can reduce risk of incidental injury and/or mortality of seabirds from marine renewables and, development of appropriate actions to be considered for compensation.
Disease	Scottish Highly Pathogenic Avian Influenza Response Plan.	Ongoing review of the HPAI plan in wild birds response plan.	Be prepared for new and emerging wildlife disease threats to seabirds.
Disturbance	Scottish Outdoor Access Code and the Scottish Marine Wildlife Watching Code. Some information and site managers available on Nature Reserves. Scottish Seabird Centre – educational programmes		Scope to promote the Codes to raise awareness of the potential to cause disturbance and explore opportunities to minimise disturbance. Scope for additional visitor engagement, raising awareness and education.

Pollution	Industry standards on oil spill (including Oil Pollution Emergency Plans (OPEPs)) Scottish Marine Litter Strategy	Marine litter initiatives are underway from a wide variety of organisations.	Scope to reduce sources of marine litter through delivery of Scottish Marine Litter Strategy.
Habitat loss	Designated a network of Marine Protected Areas that include important seabird breeding and foraging sites.		Scope for marine and coastal habitat restoration and enhancement.
Intentional taking of adults/eggs (licenced culling, control and harvesting)	Removed gulls from the gull general licence. Gull licence guidance available.	Presumption against issuing gull licences. Review and analysis of licence returns.	Scope for additional pre-emptive guidance and engagement to reduce gull licence applications.

Annex 5: Glossary

A guide to terms and acronyms used across the document

- Bioaccumulation - The accumulation of substances, such as pesticides, or other chemicals in an organism.
- Bycatch - Incidental non-target species caught in commercial fishing gear.
- Br - Breeding
- Nbr - Non-breeding
- Marine Protected Area (MPA) - Area of sea protected by legislation
- UKMS - UK Marine Strategy
- OSPAR - The Convention for the Protection of the Marine Environment of the North-East Atlantic.
- PCBs - Polychlorinated biphenyls.
- PME - Post mortem Examination
- Special Protected Area (SPA) - A site designated under the EU Birds Directive. Often abbreviated to SPA.
- SMP - Seabird Monitoring Programme
- Statutory Nature Conservation Bodies - Body appointed by legislation to advise Governments on nature conservation issues.

Scottish Government
Riaghaltas na h-Alba

This publication is available at **www.gov.scot**

Any enquiries regarding this publication should be sent to us at

The Scottish Government
St Andrew's House
Edinburgh
EH1 3DG

ISBN: 978-1-83691-975-9 (web only)

Published by The Scottish Government, August 2025

Produced for The Scottish Government by APS Group Scotland, 21 Tennant Street, Edinburgh EH6 5NA
PPDAS1631814 (08/25)