APP4SEA
Seabirds and oil
April 2020

Environmental Research Institute
North Highland College – UHI
Thurso, Scotland

APP4SEA

ARCTIC PREPAREDNESS PLATFORM
FOR OIL SPILL AND OTHER ENVIRONMENTAL ACCIDENTS

Seabirds and oil

The risk of oil spills to marine bird species in the northeast Atlantic

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Northern Periphery and Arctic Programme
2014–2020

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The 21st century brought unprecedented interest in the Arctic resources, turning the region from the world's unknown periphery into the center of global attention.

Within the next 50 years, local coastal communities, their habitual environment and traditional lifestyle will undergo severe changes, starting from climatic perturbations and ending with petroleum industrial intervention and increased shipping presence.

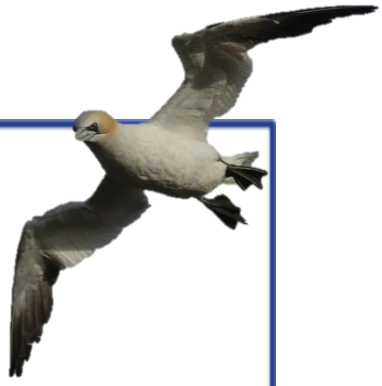
The APP4SEA project, financed by the Northern Periphery and Arctic Programme will contribute to environmental protection of the Arctic waters and saving the habitual lifestyle of the local communities. It will improve oil spill preparedness of local authorities and public awareness about potential oil tanker accidents at sea.

Background

Over the last century, Arctic ice cover and thickness have decreased, especially during the summer months, and is likely to decrease further as predicted global annual surface temperatures continue to rise with climate change. The increased melting of sea-ice in the Arctic increases the opportunities for marine access to this region, opening new shipping trade routes and access to unexploited oil and gas resources. With this exploration comes potential threats to the Arctic environment and the wildlife that live there.

Seabirds and Oil

Seabirds are particularly vulnerable to oil pollution, which can cause mass mortality events, with even minor oil spills causing problems. In severe spills, such as Deepwater Horizon in the Mexican Gulf (in 2010) or Exxon Valdez off Alaska (in 1989), tens if not hundreds of thousands of birds die. Although large oil spills and disasters can affect and kill large numbers of individuals, persistent oil pollution, for example from cleaning oil tanks at sea or continuous leakages from pipes, is thought to have the greatest impact on seabirds. Following a spill, seabirds frequently come in to contact with crude oil floating on the sea's surface, which can affect individuals in many direct and indirect ways. In colder water, such as around the Arctic, seabirds may be even more vulnerable as oil can persist for longer at these cooler temperature, and seabirds already have to deal with colder temperatures.



How oil affects seabirds:

- Suffocation
- Hypothermia (or hyperthermia)
- Ingestion of oil and associated toxins
- Increase energy use during flight
- Damages marine habitats where seabirds forage
- Cause mortality of their prey species
- Longer-term effects such as reduced breeding success
- Low survival rates of rehabilitated oiled birds

Due to their ecology, some seabird species are more likely to be affected by oil than others. For example, species that dive from the surface in search for food, such as seaducks and auks, will be more likely to come in to contact with oil than species such as gulls and terns, which spend less time of the sea surface. Therefore, we can estimate the vulnerability of different seabird species to oil by taking into account their behaviour and life history characteristics. This method allows us to create an index for the sensitivity of seabirds to oil – Oil Vulnerability Index (OVI).

To calucate this index for individual species we need to know information about:

1. How likely are individuals of this species to be affected by oil due their behaviour
   i.e. do they spend a lot of time on the sea surface where they may come into contact with oil
2. How vulnerable is the species
   i.e. is the species in decline and therefore of high conservation concern. If so, an oil spil may cause further declines to this species populations.
3. How quickly will the species recover from an oil incident
   i.e. if a species lays lots of eggs and fledges lots of young the population will recover more quickly than if they only fledge a single chick.

To establish the Oil Vulnerability Index (OVI) scores of seabirds in the eastern North Atlantic we collected information from the literature on six factors (below) for 62 species (see pages 6-8).

Determining the vulnerability of seabirds to oil:

- Proportion of time spent sitting on the water
- Percentage of tideline corpses contaminated with oil
- Habitat flexibility
- IUCN Red List Category
- Potential annual productivity
- Adult survival rate

These six factors are scorded on a scale of 0.2 – 1.0 in increments of 0.2, reflecting low to high vulnerability.

1. Proportion of time spent sitting on the water (using European Seabird at Sea data from 1995 to 2015). Species that spend more time on the ocean's surface are at greater risk of oiling and therefore have a higher score.

2. Percentage of tideline corpses contaminated with oil. Species with higher oiling rates (where a high percentage of tideline corpses are contaminated with oil) are assumed to be more sensitive to oil pollution and have a higher score.

3. Habitat flexibility, defined as the range of habitats a species uses, scored from 0.2 (high habitat flexibility: tend to forage over large marine areas with little known association with particular marine features) to 1 (low habitat flexibility: tend to feed on very specific habitat features, such as shallow banks with bivalve communities, or kelp beds).

4. Listing on the IUCN Red List; a measure of how vulnerable a species is to global extinction. Species listed as Least Concern were scored as 0.2, Near Threatened as 0.4, Vulnerable as 0.6, Endangered as 0.8 and Critically Endangered as 1.

5. Potential annual productivity, scored based on maximum and mean clutch size & age at first breeding. A high score reflects a small maximum and mean clutch size with a high age of first breeding, whilst a low score reflects a large maximum and mean with a low age of first breeding. Species with high scores are expected to recover from an oil incident more slowly.

6. Adult annual survival rate, also a measure of how quickly a species may recover from an oil incident, with species with high scores (reflecting high annual survival rates) expected to take longer to recover from an oil incident.

The values from the six factors are included in the following equation to provide an OVI value for each seabird species (pages 6-8).

$$OVI = (F_1 \times F_2)^{1-\frac{F_3}{F_3+0.5}} \times F_4^{1-\frac{\left(\frac{F_5+F_6}{2}\right)}{\left(\frac{F_5+F_6}{2}\right)+0.5}}$$

[a] This calculation is based on the Seabird Oil Sensitivity Index (SOSI) developed by Webb et al. (2016). Sensitivity of Offshore Seabird Concentrations to Oil Pollution around the United Kingdom: Report to Oil & Gas UK.

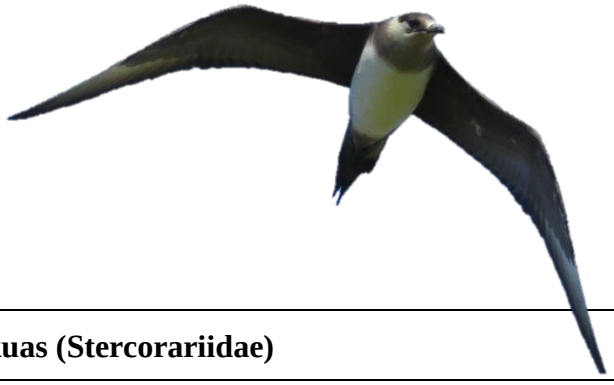
Common Name	Scientific Name	2019 IUCN Red List	OVI Score
Loons/divers (Gaviidae)			
Red-throated Loon	*Gavia stellata*	Least Concern	0.511
Arctic Loon	*Gavia arctica*	Least Concern	0.538
Common Loon	*Gavia immer*	Least Concern	0.563
Yellow-billed Loon	*Gavia adamsii*	Near Threatened	0.703

Grebes (Podicipedidae)			
Red-necked Grebe	*Podiceps grisegena*	Least Concern	0.300
Great Crested Grebe	*Podiceps cristatus*	Least Concern	0.300
Horned Grebe	*Podiceps auritus*	Vulnerable	0.570
Black-necked Grebe	*Podiceps nigricollis*	Least Concern	0.336

Petrels, shearwaters (Procellariidae)			
Northern Fulmar	*Fulmarus glacialis*	Least Concern	0.282
Cory's Shearwater	*Calonectris borealis*	Least Concern	0.203
Great Shearwater	*Ardenna gravis*	Least Concern	0.211
Sooty Shearwater	*Ardenna grisea*	Near Threatened	0.266
Manx Shearwater	*Puffinus puffinus*	Least Concern	0.333
Balearic Shearwater	*Puffinus mauretanicus*	Critically Endangered	0.592
Northern storm-petrels (Hydrobatidae)			
European Storm-petrel	*Hydrobates pelagicus*	Least Concern	0.089
Leach's Storm-petrel	*Hydrobates leucorhous*	Vulnerable	0.133
Gannets (Sulidae)			
Northern Gannet	*Morus bassanus*	Least Concern	0.282

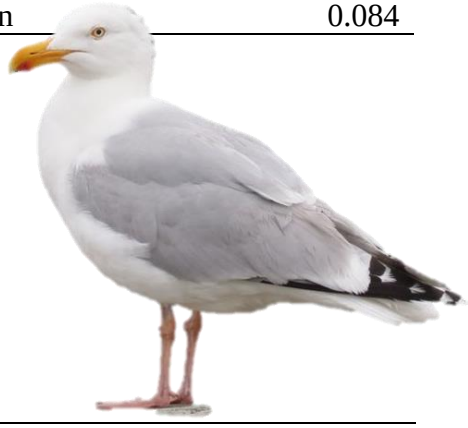
Common Name	Scientific Name	2019 IUCN Red List	SOSI Score
Cormorants (Phalacrocoracidae)			
Great Cormorant	*Phalacrocorax carbo*	Least Concern	0.345
European Shag	*Phalacrocorax aristotelis*	Least Concern	0.435

Ducks (Anatidae)			
Common Eider	*Somateria mollissima*	Near Threatened	0.542
King Eider	*Somateria spectabilis*	Least Concern	0.420
Steller's Eider	*Polysticta stelleri*	Vulnerable	0.570
Harlequin Duck	*Histrionicus histrionicus*	Least Concern	0.336
Long-tailed Duck	*Clangula hyemalis*	Vulnerable	0.570
Common Scoter	*Melanitta nigra*	Least Concern	0.336
Velvet Scoter	*Melanitta fusca*	Vulnerable	0.657
Common Goldeneye	*Bucephala clangula*	Least Concern	0.300
Goosander	*Mergus merganser*	Least Concern	0.260
Red-breasted Merganser	*Mergus serrator*	Least Concern	0.270
Greater Scaup	*Aythya marila*	Least Concern	0.287
Phalaropes (Scolopacidae)			
Red-necked Phalarope	*Phalaropus lobatus*	Least Concern	0.041
Red Phalarope	*Phalaropus fulicarius*	Least Concern	0.048



Skuas (Stercorariidae)			
Pomarine Jaeger	*Stercorarius pomarinus*	Least Concern	0.203
Arctic Jaeger	*Stercorarius parasiticus*	Least Concern	0.255
Long-tailed Jaeger	*Stercorarius longicaudus*	Least Concern	0.255
Great Skua	*Catharacta skua*	Least Concern	0.319

Common Name	Scientific Name	2019 IUCN Red List	SOSI Score
Gulls, terns (Laridae)			
Mediterranean Gull	*Larus melanocephalus*	Least Concern	0.231
Little Gull	*Hydrocoloeus minutus*	Least Concern	0.161
Sabine's Gull	*Xema sabini*	Least Concern	0.194
Black-headed Gull	*Larus ridibundus*	Least Concern	0.255
Mew Gull	*Larus canus*	Least Concern	0.272
Lesser Black-backed Gull	*Larus fuscus*	Least Concern	0.239
European Herring Gull	*Larus argentatus*	Least Concern	0.227
Yellow-legged Gull	*Larus michahellis*	Least Concern	0.227
Iceland Gull	*Larus glaucoides*	Least Concern	0.138
Glaucous Gull	*Larus hyperboreus*	Least Concern	0.138
Great Black-backed Gull	*Larus marinus*	Least Concern	0.299
Ross's Gull	*Rhodostethia rosea*	Least Concern	0.121
Black-legged Kittiwake	*Rissa tridactyla*	Vulnerable	0.436
Ivory Gull	*Pagophila eburnea*	Near Threatened	0.254
Sandwich Tern	*Thalasseus sandvicensis*	Least Concern	0.171
Roseate Tern	*Sterna dougallii*	Least Concern	0.195
Common Tern	*Sterna hirundo*	Least Concern	0.205
Arctic Tern	*Sterna paradisaea*	Least Concern	0.162
Little Tern	*Sternula albifrons*	Least Concern	0.198
Black Tern	*Chlidonias niger*	Least Concern	0.084



Auks (Alcidae)			
Common Murre	*Uria aalge*	Least Concern	0.585
Thick-billed Murre	*Uria lomvia*	Least Concern	0.585
Razorbill	*Alca torda*	Near Threatened	0.721
Black Guillemot	*Cepphus grylle*	Least Concern	0.563
Little Auk	*Alle alle*	Least Concern	0.563
Atlantic Puffin	*Fratercula arctica*	Vulnerable	0.843

Mapping seabird oil vulnerability

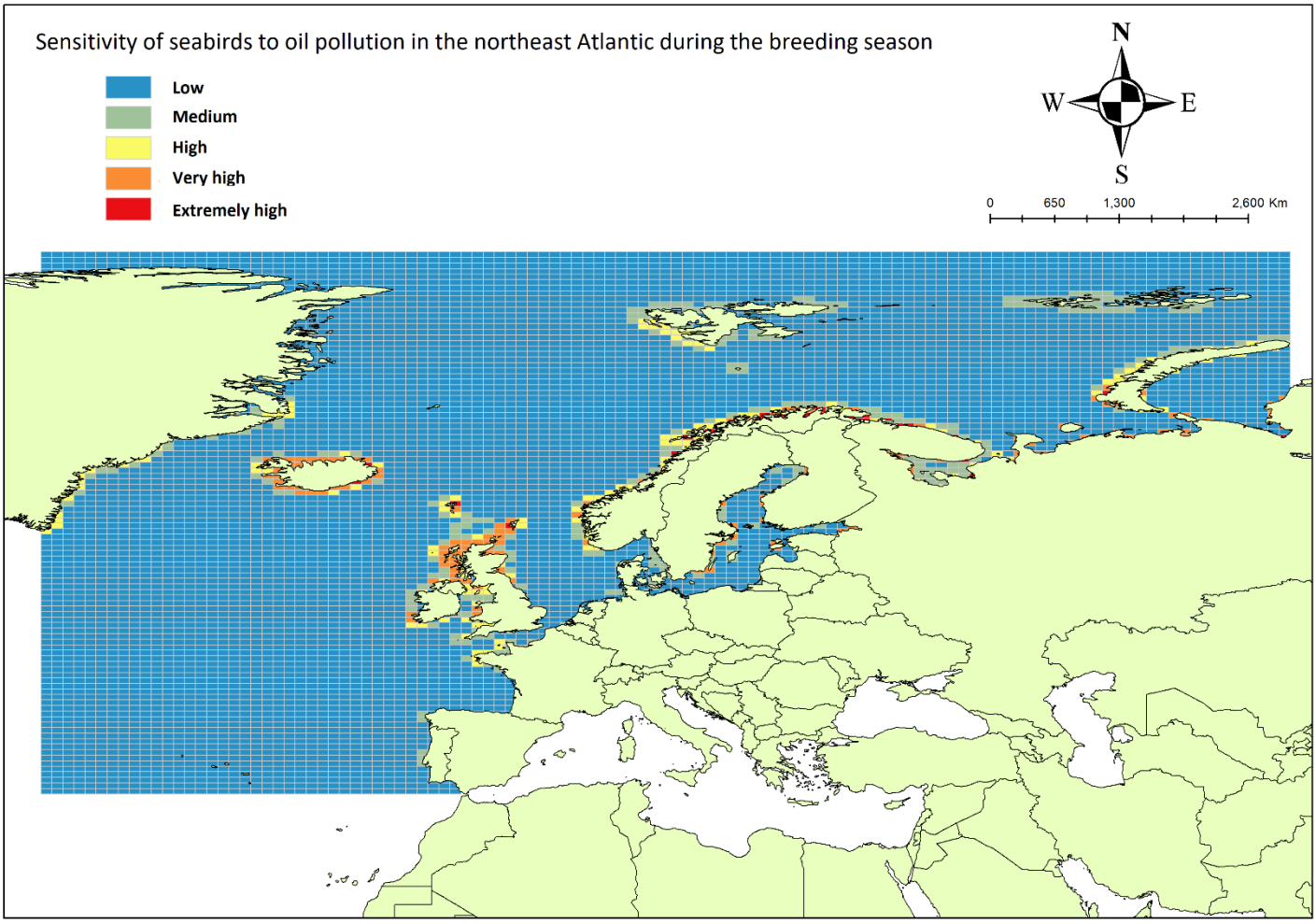
To estimate where in the eastern North Atlantic seabirds are most vulnerable to oil pollution in the event of an oil incident, we combined the species-specific OVI values with that species Birdlife International distribution map for the breeding and non-breeding season. The eastern North Atlantic region of interest was divided into ICES (International Council for the Exploration of the Sea) rectangles. For both the breeding and non-breeding season, the SOSI values for all species that occur in a rectangle were summed to give an overall SOSI scores for all seabird species which may be present in that rectangle during that season. As the timing of the breeding season can vary depending on the species and where they breed, the broad breeding and non-breeding timing, by month, for each seabird species can be found on pages 10-12. Based on the overall summed OVI values for all seabird species present within each ICES rectangles, each rectangle was categorised as being locations of low to high sensitivity for seabirds to oil pollution (see maps for the breeding and non-breeding season on page 13, or explore these maps on the APP4SEA map). For example, an ICES rectangle categorised as low sensivity indicates an area where fewer species occur and / or species with lower vulnerability to oil, whilst those categorised as extremely high sensivity indcate areas where many seabird species occur, especailly those with higher vulnerability to oil.

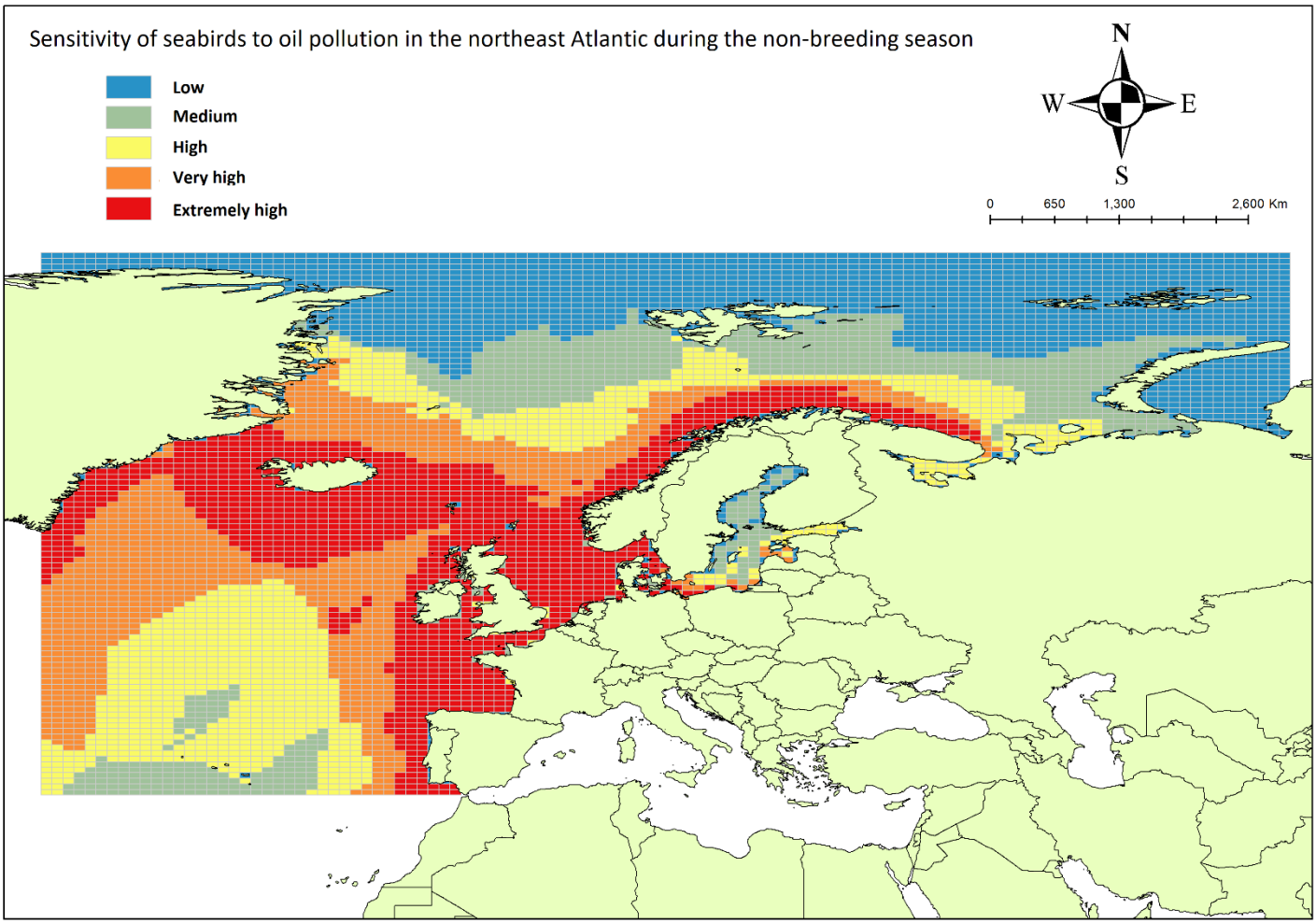
Broad breeding (B) and non-breeding (NB) timings for the target seabirds within the eastern North Atlantic

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Red-throated Loon Gavia stellata	NB	NB	NB	NB	B	B	B	B	B	NB	NB	NB
Arctic Loon Gavia arctica	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Common Loon *Gavia immer*	NB	NB	NB	NB	B	B	B	B	B	NB	NB	NB
Yellow-billed Loon *Gavia adamsii*	NB	NB	NB	NB	NB	B	B	B	B	NB	NB	NB
Red-necked Grebe *Podiceps grisegena*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Great Crested Grebe *Podiceps cristatus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Horned Grebe *Podiceps auritus*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Black-necked Grebe *Podiceps nigricollis*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Northern Fulmar *Fulmarus glacialis*	NB	NB	B	B	B	B	B	B	B	NB	NB	NB
Cory's Shearwater *Calonectris borealis*	NB	NB	B	B	B	B	B	B	B	B	B	NB
Great Shearwater *Ardenna gravis*	B	B	B	B	B	NB	NB	NB	B	B	B	B
Sooty Shearwater *Ardenna grisea*	B	B	B	B	B	NB	NB	NB	B	B	B	B
Manx Shearwater *Puffinus puffinus*	NB	NB	NB	B	B	B	B	B	B	B	NB	NB
Balearic Shearwater *Puffinus mauretanicus*	B	B	B	B	B	B	NB	NB	B	B	B	B
European Storm-petrel *Hydrobates pelagicus*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Leach's Storm-petrel *Hydrobates leucorhous*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Northern Gannet *Morus bassanus*	NB	NB	B	B	B	B	B	B	B	NB	NB	NB
Great Cormorant *Phalacrocorax carbo*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
European Shag *Phalacrocorax aristotelis*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Common Eider *Somateria mollissima*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
King Eider *Somateria spectabilis*	NB	NB	NB	NB	NB	B	B	B	B	NB	NB	NB
Steller's Eider *Polysticta stelleri*	NB	NB	NB	NB	NB	B	B	B	B	NB	NB	NB
Harlequin Duck *Histrionicus histrionicus*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Long-tailed Duck *Clangula hyemalis*	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB	NB
Common Scoter *Melanitta nigra*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Velvet Scoter *Melanitta fusca*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Goldeneye *Bucephala clangula*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Goosander *Mergus merganser*	NB	NB	B	B	B	B	B	B	NB	NB	NB	NB
Red-breasted Merganser *Mergus serrator*	NB	NB	NB	B	B	B	B	B	B	B	NB	NB
Greater Scaup *Aythya marila*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Red-necked Phalarope *Phalaropus lobatus*	NB	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB
Red Phalarope *Phalaropus fulicarius*	NB	NB	NB	NB	NB	B	B	B	B	NB	NB	NB
Pomarine Jaeger *Stercorarius pomarinus*	NB	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB
Arctic Jaeger *Stercorarius parasiticus*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Long-tailed Jaeger *Stercorarius longicaudus*	NB	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB
Great Skua *Catharacta skua*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Mediterranean Gull *Larus melanocephalus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Little Gull *Hydrocoloeus minutus*	NB	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB
Sabine's Gull *Xema sabini*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Black-headed Gull *Larus ridibundus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Mew Gull *Larus canus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Lesser Black-backed Gull *Larus fuscus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
European Herring Gull *Larus argentatus*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Yellow-legged Gull *Larus michahellis*	NB	NB	NB	B	B	B	B	NB	NB	NB	NB	NB
Iceland Gull *Larus glaucoides*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Glaucous Gull *Larus hyperboreus*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Great Black-backed Gull *Larus marinus*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Ross's Gull *Rhodostethia rosea*	NB	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB
Black-legged Kittiwake *Rissa tridactyla*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Ivory Gull *Pagophila eburnea*	NB	NB	NB	B	B	B	B	B	B	NB	NB	NB
Sandwich Tern *Thalasseus sandvicensis*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Roseate Tern *Sterna dougallii*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Common Tern *Sterna hirundo*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Arctic Tern *Sterna paradisaea*	NB	NB	NB	NB	B	B	B	B	B	NB	NB	NB
Little Tern *Sternula albifrons*	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB	NB
Black Tern *Chlidonias niger*	NB	NB	NB	NB	B	B	B	NB	NB	NB	NB	NB
Common Murre *Uria aalge*	NB	NB	NB	NB	u	B	B	B	NB	NB	NB	NB
Thick-billed Murre *Uria lomvia*	NB	NB	NB	NB	NB	B	B	B	B	NB	NB	NB
Razorbill *Alca torda*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Black Guillemot *Cepphus grylle*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB
Little Auk *Alle alle*	NB	NB	NB	NB	B	B	B	B	NB	NB	NB	NB
Atlantic Puffin *Fratercula arctica*	NB	NB	NB	B	B	B	B	B	NB	NB	NB	NB

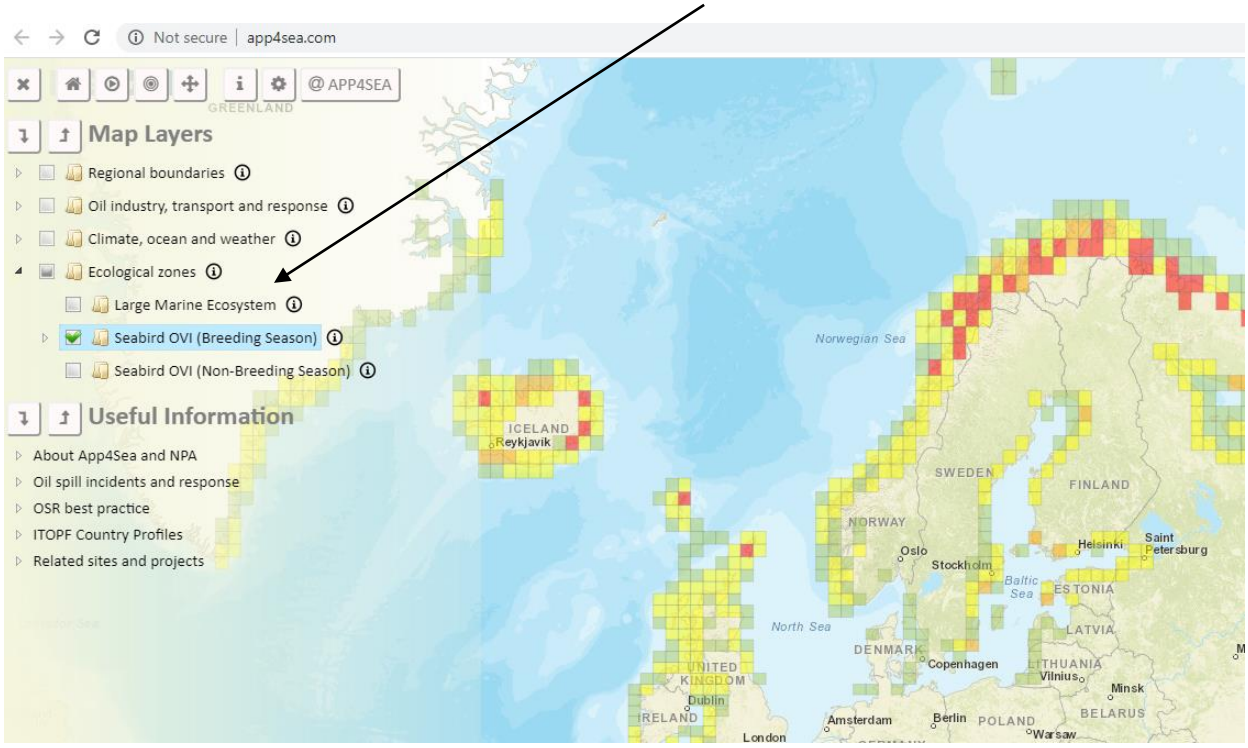

Sensitivity of seabirds to oil pollution in the northeast Atlantic during the breeding season
Low
Medium
High
Very high
Extremely high
N
W
E
S
0
650
1,300
2,600 Km


Sensitivity of seabirds to oil pollution in the northeast Atlantic during the non-breeding season
Low
Medium
High
Very high
Extremely high
N
W
E
S
0
650
1,300
2,600 Km

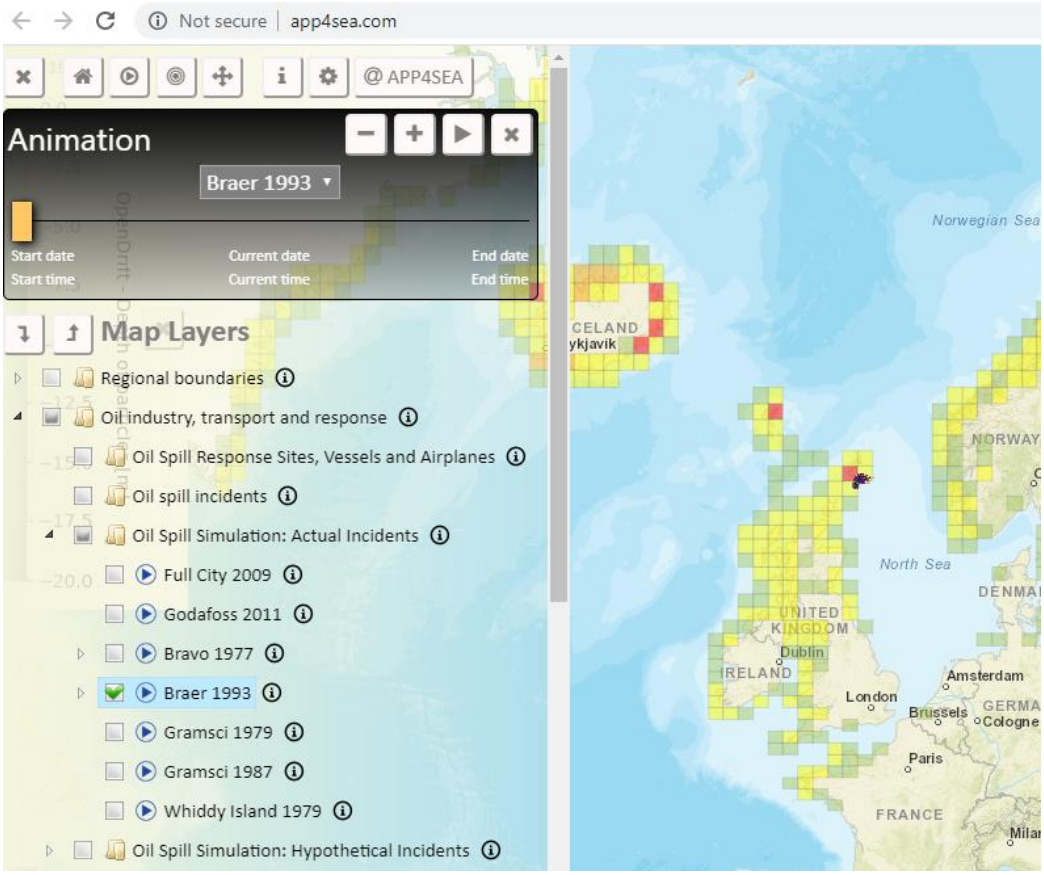
APP4SEA Seabird Oil Vulnerability Map Guide

You can explore the above Seabird Oil Vulnerability Maps on the APP4SEA map at

http://www.app4sea.com/ under the Ecological zones Map Layer



You can also explore hypothetical and actual oil incidents to see if they overlap with areas where seabirds may be vulnerable to oil pollution during the breeding and non-breeding season.



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