norden

Action plan for seabirds in Western-Nordic areas

Report from a workshop in Malmö, Sweden,
4–5 May 2010

TemaNord 2010:587

Action plan for seabirds in Western-Nordic areas
Report from a workshop in Malmö, Sweden, 4–5 May 2010

TemaNord 2010:587

ISBN 978-92-893-2147-1

Print: Kailow Express ApS
Copies: 110

Printed on environmentally friendly paper
This publication can be ordered on www.norden.org/order. Other Nordic publications are available at www.norden.org/publications

Printed in Denmark

Nordic Council of Ministers
Ved Stranden 18
DK-1061 København K
Phone (+45) 3396 0200
Fax (+45) 3396 0202

Nordic Council
Ved Stranden 18
DK-1061 København K
Phone (+45) 3396 0400
Fax (+45) 3311 1870

www.norden.org

Nordic co-operation

Nordic co-operation is one of the world’s most extensive forms of regional collaboration, involving Denmark, Finland, Iceland, Norway, Sweden, and three autonomous areas: the Faroe Islands, Greenland, and Åland.

Nordic co-operation has firm traditions in politics, the economy, and culture. It plays an important role in European and international collaboration, and aims at creating a strong Nordic community in a strong Europe.

Nordic co-operation seeks to safeguard Nordic and regional interests and principles in the global community. Common Nordic values help the region solidify its position as one of the world’s most innovative and competitive.

Content

Preface

This report is an outcome of the cross-sectorial workshop which was held in Malmö, Sweden in May 2010, aimed at preparing a seabird action plan for Western-Nordic areas. This work received financial support from the Nordic Council of Ministers for the Environment.

The workshop was preceeded by a review of seabirds in the north-east Atlantic, their status and trends and the anthropogenic impacts. This review, along with the discussions at the workshop, provides the backbone of this report.

The project group would like to give acknowledge to all workshop participants. Special thanks to the contributing authors Morten Frederiksen, Denmark, and Inga Elisabeth Næss, Norway, and contributions to workshop planning from the cooperating bodies Joint Nature Conservation Committee, Norwegian Institute for Nature Research, and Scottish Natural Heritage.

The project was directed by the Norwegian Directorate for Nature Management.

Trondheim, October 2010

Janne Sollie
Director

Sigrun Einarson
Project manager

Executive Summary

Background

In 2008, the Nordic Council of Ministers for the Environment decided to support drawing up a cross-sectorial seabird action plan aimed at counteracting the declining trends in seabird populations in the Western-Nordic region. The background was a resolution adopted at a joint meeting of Nordic nature conservation NGOs in 2006, urging the Nordic Council to take coherent and strong measures in order to identify the causes for seabird populations decline and breeding failures, and to propose mitigating actions.

This report is an outcome of a workshop which was held in May 2010, aimed at preparing an action plan for seabirds in Western-Nordic areas including Scotland. The workshop was preceeded by a review of seabirds in the north-east Atlantic, their status and trends and the prevailing anthropogenic impacts.

Seabirds in the North East Atlantic: status, trends and anthropogenic impacts

Seabird status and trends

Since 2004, widespread breeding failures have been observed in seabird colonies. A number of species are declining in (nearly) all countries, or at least wherever the trend is known: black-legged kittiwake, Arctic tern, black-headed gull, Brünnich's guillemot, Arctic skua. Fewer species show generally increasing trends: northern gannet, great skua.

General impact factors – of importance to many species in large parts of the Western-Nordic area

- *Oil pollution.* All seabird species are vulnerable to oil spills, particularly because the waterproofing of their plumage is affected by even very small amounts of oil. Birds may also be exposed to toxic effects of oil spills due to ingestion of contaminated prey.
- *Competition with fisheries.* Many seabird species are completely dependent on small, energy-rich pelagic fish in order to raise offspring successfully. These fish are sometimes also exposed to large-scale human fisheries for fish meal and oil, e.g. sandeel, sprat, young herring and capelin. Lack of food caused by competition between seabirds and

fisheries is clearly an important cause for the problems experienced by many seabird populations.

- *Climate change – increasing sea temperatures*. Several studies have shown that breeding success and/or adult survival of seabirds is negatively correlated with sea temperatures. It is most likely that the mechanism behind this pattern is linked to declines in availability of fish food (complex ecological mechanisms and interactions with other factors may be involved). There is clear evidence that the abundance and distribution of many species of zooplankton that is important prey for juvenile stages of many fish species are affected by warming sea temperatures.

Specific impact factors – of importance to fewer species and/or in more local parts of the Wester-Nordic area

- *Bycatch*. Seabirds captured as bycatch in net fisheries is not well monitored, and the magnitude of the problem is thus uncertain. The available evidence suggests that the fishery for lumpsucker in Greenland, Iceland and Norway is particularly problematic and large numbers of northers fulmars are captured in long-line fisheries.
- *Introduced predators*. Most seabirds have few defences against ground-based predators, including the introduced American mink and brown rat. The biggest problems seem to occur in western Scotland, the Faroes and Iceland, and the most sensitive species are burrow-nesters such as storm-petrels, shearwaters and some auks, followed by ground-nesters such as terns and small gulls.
- *Contaminants*. Persistent and biomagnifying organic contaminants have the potential to affect seabirds through long-term sub-lethal toxic effects. Studies have shown population-level effects of contaminants on glaucous gulls in Norway, but it is possible that similar problems occur in other areas.

Local impact factors

- *Hunting*. In large parts of the study area seabird hunting has lost much of its traditional importance. However, in the Faroes, Iceland and Greenland seabird hunting is still important, at least locally. For some of the most popular quarry species, including Atlantic puffin in the Faroes and Iceland, and Brünnich’s guillemot in Greenland, the current harvest level may be unsustainable.
- *Disturbance*. In most cases, effects of disturbance caused by human activities are likely to be local, and impacts on regional populations likely to be small. Beach-nesting terns may be an exception to this, as recreational pressure on their habitat can be intense.

Action plan for seabirds in Western-Nordic areas

The outcome of the workshop was a total of 57 priority actions that would help reverse current declines in seabird populations in Western-Nordic areas including Scotland. These actions were categorized with respect to implementation cost (qualitative assessment only), time schedule and responsibility for implementation.

It is strongly emphasized that the workshop did not prioritise the recommended actions, and therefore all should be treated as of equal importance. Hence, the workshop did not suggest any tiered approach with respect to the implementation of the actions reported from the workshop. Still, it is considered highly important that some immediate actions are taken with a high potential for improving the status of seabird populations in the region.

Priority actions that are deemed feasible to implement at low/medium cost and within a time-frame of less than 3 years

Fisheries

- Establish observer schemes for bycatch
- Prepare National/European Community plans of action on seabird bycatch
- Establish controls in the lumpsucker fishery to reduce bycatch
- Include bycatch in “eco” labelling schemes
- Introduce reward scheme for ideas that lead to bycatch reduction
- Continue sandeel closures (Shetland and East Scotland) to address overharvesting of seabird food
- Use seabirds as indicators of environmental health including of fish stocks

Oil and pollutants

- Conduct review of regulatory framework efficiency in the Nordic region from a seabird management perspective
- Continue AMAP monitoring of seabird contaminants; include new contaminants and secure communication between seabird and contaminants research so most vulnerable species are included

Conflicting species

- Prepare handbook on how to handle introduced/invasive species
- Prevent/manage inappropriate vegetation

Seabird harvest

- Restrict egg collection to an early stage during breeding season
- Increase the level of understanding among the public of introducing hunting restrictions

Area management and disturbance

- Identify the risks of different activities on seabirds, and locations sensitive to seabirds
- Introduce area restrictions for particular activities, and adequate publicity, public awareness and enforcement
- Develop codes-of-conduct for more organised activities e.g. tourism
- Collate and share good practice from countries in monitoring, planning, and assessing area management and disturbance with respect to impacts on seabirds

Climate change

- Restrict fisheries on key stocks of forage fish
- Ensure that appropriate protection (national laws and international agreements) applies to new areas and times in cases of changes in seabird migration routes and times

Actions deemed feasible to implement at high cost within a time-frame of less than 3 years

Marine installations causing loss of habitats, disturbance, collision

- Execute spatial planning and environmental assessments taking seabirds management into account
- Improve and standardise methods for Environmental Assessment

The following actions would probably need more than 3 years to be implemented

Fisheries

- Introduce mitigation measures for bycatch on long-lines and (bottom-set) gillnets
- Use seabirds as indicators of environmental health including of fish stocks

Oil and pollutants

- Develop standard methods for assessing effects on seabirds of accidental and chronic oil spills
- Carry out public outreach/education to commercial shipping and small boats, and establish public hotline for reporting spills
- Ensure better enforcement and systems for collecting evidence leading to large fines
- Designate sailing shipping routes as far off from land/sensitive areas as possible

- Introduce regulations demanding the use of light fuel in sensitive areas (e.g. tourist ships)

Conflicting species

- Prevention and removal of introduced and invasive species (predators, parasites, diseases, competitors)
- Perform risk analysis/-assessments of area plans to be able to prioritise and identify problems with introduced species

Seabird harvest

- Introduce mandatory hunting proficiency test (mandatory course and a written exam)
- Ban hunting during breeding season
- Collect hunting and culling statistics, with verification control
- Prohibit lead ammunition – introduce alternative ammunition
- Restrict traffic by human activities during hunting

Prioritised research needs

- Seabird food availability and quality
- Seabirds and ecosystem studies
- Seabird ecology
- Impact of marine installations on seabirds
- Effects of culling on seabird populations

As to the responsibilities assigned to the priority actions, the workshop directed the majority of these at the public sector, both for implementation responsibility and funding. However, the private sector was assigned *joint responsibility* with the public sector in some areas, mainly fisheries/the fishing industry with regard to the interaction fisheries versus seabirds, and the sectors petroleum industry and shipping concerning oil spills and pollutants.

The workshop recommended international coordination and cooperation to address specific challenges, in particular implementation of mitigating actions on seabird bycatch. It is emphasized, however, that most priority actions presented may benefit from cooperation at international and/or Nordic levels.

The Nordic Council of Ministers was specifically assigned implementation responsibility to the following priority actions

- Introduce reward scheme for ideas that lead to bycatch reduction, and financial support for such schemes
- Prepare common Nordic guideline for oil spill drift models that includes maps of sensitive areas and seabird colonies

- Review the efficiency of the current regulatory framework that is relevant for oil spills in the Nordic region (emergency preparedness, remediation responsibilities, fines etc.)
- Establish Nordic seabird monitoring programme with standard methods and common guidelines for level of activities

It is evident that all the priority actions reported from the workshop need further detailed planning to succeed. To make targeted and effective use of conservation resources, it is particularly important to customise any action on seabirds to particluar *area* (the relevance of implementing actions at cross-national, national, or local level), seabird *species* (some seabirds species are significantly more affected by anthropogenic impacts than others), and type and severity of *impacts*. In addition, the value of monitoring is highly significant in order to provide relevant information for management.

Main recommendations

The workshop recommends that the Nordic Council of Ministers for the Environment discuss and decide on

1. mitigating actions with expected positive effects on seabird populations in the Nordic region within 3 years;
2. cross-national actions on seabird bycatch;
3. the priority actions specifically assigned to the Nordic Council;
4. planning of mitigating actions with estimated implementation period longer than 3 years;
5. seabird research priorities.

1. Introduction

Concerns over the well-being of seabird populations in the North East (NE) Atlantic have been growing over the last few years. Since 2004, widespread breeding failures have been observed in seabird colonies along the North Sea coasts of Scotland, including colonies and species which had otherwise shown success since the beginning of standardised monitoring. Similar observations were made in less well-monitored seabird colonies in the Faroes and south Iceland. It seemed clear that birds were unable to find sufficient, or sufficiently good, food to supply their growing chicks. These reports have led to an increased focus on the well-being of seabird populations.

In August 2006, the Nordic Council of Ministers for the Environment (MR-M) discussed the situation for seabirds in the western part of the Nordic area. The background was a resolution adopted at a joint meeting of Nordic nature conservation NGOs in 2006, urging the Nordic Council to take coherent and strong measures in order to identify the causes for seabird populations decline and breeding failures, and to propose mitigating actions. MR-M decided to support a seminar aimed at reviewing current knowledge on seabird populations, and to analyse causes behind population changes.

A Nordic workshop was arranged on the Faroe Islands in 2007. Seabird and marine experts and other interested parties from all the relevant countries were present, discussing three main topics: status, pressures and impacts, and challenges/conservation measures. The 2007 workshop concluded that climate related, complex ecological changes have disrupted the food web in Nordic waters. The numbers of fish-eating birds have decreased, and reproductive rates have drastically dropped since 2003. These changes underlined the need for a comprehensive approach addressing factors such as commercial fisheries, oil spills, seabird harvest and environmental pollutants, which influence seabird populations (Nordisk Ministerråd 2008).

Based on the 2007 workshop report, MR-M decided to support drawing up a cross-sectorial seabird action plan aimed at counteracting the declining trends in seabird populations in West Nordic region including Scotland.

On 4–5 May 2010, the cooperating insitutitions Danish Forest and Nature Agency; Faroese Marine Research Institute; Greenland Agency of Fisheries, Hunting and Agriculture; Icelandic Institute of Natural History; Norwegian Directorate for nature management; Marine Directorate, the Scottish Government and Lunds Universitet, Sweden hosted a workshop aimed at preparing a seabird action plan for Western-Nordic areas. The workshop brought together the public sectors environment, energy, fisheries, hunters organisations and science, and representatives from ICES and OSPAR. The following topics were discussed during the workshop: (1) Effects of fisheries; (2) Oil, pollutants and waste; (3) Conflicting species; (4) Seabird harvest; (5) Area management and disturbance; and (6) Climate issues and cumulative effects.

The workshop presented an updated review on status and trends of seabird populations, and an assessment of the relative importance of the previaling environmental and anthropogenic impact factors on the seabird populations. Participants took part in break-out sessions and plenary discussions with recommendations for a seabird action plan. The presentations and discussions held at the workshop serve as basis for the contents of this report, which has been subject to a hearing round among workshop particpants.

2. Seabirds and coastal people

By *Inga Elisabeth Næss, Norway* [1]

Coastal people have always lived in close proximity to seabirds, and the annual cycle of birds is an important part of our own seasonal rhythm. Clouds of puffins flying towards bird cliffs, the sound of seagulls following fishing-boats ashore, or flocks of eider ducks gathering in sounds, all contribute to the atmosphere of places near the sea.

2.1 An important resource

The ocean is a giant cauldron of food. People of the past settled along weather-beaten coasts to gain access to fish, sea mammals and seabirds. Archaeologists have found bones from seabirds in middens from Stone Age sites dating from 3–4000 years ago and at Viking and Medieval settlements. Owning a downery, or living in the neighbourhood of a bird cliff, was synonymous with affluence. Flesh, eggs, feathers, down, oil and fat were exploited – as exemplified by the inhabitants of the island St Kilda in Scotland, who used seabirds in their entirety.

In the spring bird flesh and eggs were vital sources of protein that could also be stored for winter use. Down and feathers used for filling coverlets were once an important export article. Seabird resources were also valuable as payment of land rent.

> Many a poor man here never eats any other kind of meat than from these birds. Nor did they have anything else to pay as tax than puffins, and they sell the feathers in exchange for fire-wood.
>
> Erich Hansen Sønnebøl: A Description of Lofoten and Vesterålen (1591)

2.2 Bird catching

The different methods employed to capture seabirds included pulling, clubbing, snaring and netting on land and sea. In earlier times birds were caught bare handed, by “pulling”. Puffins were pulled out of their nests with a special hooked stick. Later they were caught by placing nets put on the ground in front of entrances or in frames on the sea.

[1] Author and freelance journalist. Krangata 2, N – 7014 Trondheim, Norway.

A downery sometimes had several owners, and a bird cliff could be shared by an entire village. In such cases the cliff was divided into parts, and all members of the community participated in gathering eggs. The catch was distributed in shares according to the size of each farm. The oldest man in the village was responsible for the distribution. At Bleik in Vesterålen, Norway, this person was called "King of the Island".

When the aim of catching was purely subsistence and methods remained simple, stocks were generally maintained at a sustainable level. Common rules controlled the amount of eggs collected and the number of birds caught.

> On the island of Lovund in Norway, all landowners had rights to a part in the puffin cliff. The size of their landholding determined the extent of the share in the scree and the number of nets they were allowed to use. No man was free to decide over "his property". Everyone suffered when the puffin stock failed even for only one season.
>
> Tromsø Museum: Kystfolk og sjøfugl

2.3 Eider ducks as domestic animals

Catching birds and egg gathering are the most common ways of exploiting seabirds. However, in northern Norway the eider duck was kept as a domestic animal during the nesting season. This is the one of the best traditional examples of the close relationship between coastal people and seabirds. In downeries, the eider duck is still regarded as a "sacred" bird to be tended and protected and is never hunted. Downery landscapes are characterized by "eider duck architecture": stone nests, old boats turned upside down and wooden sheds provide shelter for many nests. During the nesting season the islanders protect the birds against predators. When the eider duck leave the nest, the down is harvested, cleaned by hand and made into filling for the best down coverlets in the world.

After down coverlets first came into use in the 16th century, eiderdown became an important article for export from Iceland and Norway. Somewhere between 60 and 70 nests are required to fill a duvet with one kilo of down. In the year 1900, one ton of cleaned down, representing the harvest from 60–70,000 nests, was produced in Nordland county in northern Norway.

2.4 Local identity

Seabirds play a significant role in the spiritual life and immaterial culture of coastal people as evidenced by names of islands, inlets and skerries. By observing the movements, flight and calls of different seabirds, people were even able to forecast the weather. Hunting traditions were a source of pride and a badge of local identity in maritime communities. Songs and sagas telling of the exploits of daring hunters dangling from ropes in steep bird cliffs are told from St Kilda in Scotland to Røst in Norway.

> “The hides of seals were cut into thongs often used for lowering bird-hunters over the cliffs. Around his waist would be tied a strong seal hide thong, the other end of which would be held by his trusted friends on the cliff-top above.
>
> Saturday Magazine. April 30th 1836

On the island of Lovund in northern Norway the return of the puffins on April 14th is annually celebrated. Local inhabitants and tourists go out to the bird cliff to welcome flocks of birds coming in from the ocean to breed in the scree.

2.5 Man as protector and enemy

Seabirds have always sought human contact for food and protection. Birds gather where fishermen gut their catches in harbours. Exploitation of seabirds and protection go hand in hand. Two good examples of practices which secured continual access to seabird resources were leaving a certain amount of eggs in nests and avoiding catching puffins returning to nests with herring sprats in their beaks. Rural depopulation and changes in ways of making a living have caused the disappearance of old ways and loss of knowledge about how to use natural resources. Modern technology provides a means of over-exploitation. Motorboats and modern firearms make seabird hunting much more effective and increase the risk of decimating stocks. In the worst case hunting pressure can lead to regional extinction of species. The consequences were catastrophic for the Great auk. Over-exploitation also led to extermination of the great cormorant in Denmark and the Faroe Islands.

Commercialised hunting may result in mass destruction. On the Russian island Novaya Zemlya, exploitation of bird colonies became a large scale trade, constituting 30 per cent of all export from the islands in the 1930’s. Hunters and trappers on Spitsbergen often ended the season by plundering eiderduck nests for down and eggs.

> Not only do they scrupulously rob both down and eggs, throwing away what they find useless, they also thoughtlessly shoot down every eider duck within range.
>
> Richard Ritter von Barry, 1884

Today the greatest threat to seabird stocks comes from human related environmental destruction. Changes in climate and overtaxation of fishery resources have led to food shortage for birds and threaten the reproduction of vulnerable species like cormorants and puffins. In 1980, 1,2 million puffins hatched in Røst in Lofoten. Ten years later the number was halved. In 2009, no birds successfully reproduced. Seabirds are vulnerable to oil pollution.

When the feathers of seabirds are fouled by oil they lose their insulating properties. Birds which spend a lot of time on sea, like eider ducks, razorbills and cormorants, are especially exposed. Imported land mammals also damage seabirds. Minks may extinguish an entire colony of eider ducks within a couple of days. When human populations move away from downeries leaving them derelict, birds are left exposed to predators. Increased boat tourism and hunting also create disturbances and can frighten birds off nests, giving predators ample opportunity to take eggs and chicks.

2.6 An important and obvious part

The use of seabirds as a resource is a distinctive aspect of the coastal culture which is rapidly becoming history. Seabird hunting is now forbidden in many countries. Laws and regulations have been introduced to limit exploitation. Seabird hunting is still important in some places around the North Atlantic. Many bird species are caught in Greenland, puffins are still caught in the Faroe Islands, and in Iceland seabird hunting is permitted. Scotland only allows the traditional gannet catching on Sula Sgeir, off the Hebrides.

Humans influence landscape and environment, landscapes and environment influence man. Seabirds are important for the diversity of nature and to the lives of coastal people: The playful presence of black guillemots in the harbour waters, the great cormorant drying its wings on a seamark are common sights in coastal areas. The trumpet blast from the black-legged kittiwake in the bird cliffs and the soft calls from eiders mating in early spring, are voices in a polyphonic choir. When one or two voices in the giant choir are silenced, we experience a loss, an empty space. When the seagulls seek towns for foods and the crowds of puffins do not return to the scree, the lack of balance in nature will affect us and influence our lives.

3. Seabirds in the North East Atlantic. Summary of status, trends and anthropogenic impact.

By *Morten Frederiksen*, National Environmental Research Institute, Aarhus University, Denmark [2]

This Chapter provides a summary of the status and trends of seabird populations breeding in the Nordic countries, including Scotland but excluding high-Arctic areas and the Baltic Sea. The summary is based on a full review (see Appendix 1) of the evidence for the impact of various anthropogenic factors on these populations.

The review covers thirty seabird species, with breeding populations ranging from a few hundred to several million. Status and trends were evaluated based on data supplied by country representatives. These data vary in quality: whereas some countries have long-established monitoring programmes and use them to derive quantitative estimates of trends, other countries have used irregular counts combined with expert judgement. The overall picture is nevertheless fairly clear. Several species are declining in all or almost all countries where they occur: Arctic skua, black-headed gull, black-legged kittiwake, Arctic tern, common and Brünnich's guillemot, and Atlantic puffin. Most of these species are regarded as sandeel feeders at least in the North Sea, although they may feed on other small fish in more northerly areas. Brünnich's guillemot breeds in the Arctic and feeds on a variety of invertebrates and small fish. Black-headed gull is an opportunistic species using both marine, freshwater and terrestrial habitats, and reasons for its widespread decline are unclear.

The assessment of factors affecting seabird populations was based on a wide-ranging, but non-exhaustive literature review. In addition, the potential importance of each of these factors as a threat to seabirds in the next decade was evaluated through a survey of expert opinion. A questionnaire form was sent out to a selection of highly experienced seabird researchers in the North Atlantic, and 12 completed forms were received. In the following, the most important threats are listed and explained.

[2] Morten Frederiksen is in the Department of Arctic Environment, National Environmental Research Institute, Aarhus University. Frederiksborgvej 399, DK – 4000 Roskilde, Denmark.

General threats – these are important to many species in large parts of the study area

- *Oil pollution.* Seabirds are extremely vulnerable to oil spills, particularly because the waterproofing of their plumage is affected by even very small amounts of oil. All species are potentially vulnerable, but diving species spending much time sitting on the sea surface are most at risk: auks, marine ducks, divers and cormorants. Oil pollution has two main sources: acute accidental spills from extraction or transport of crude oil, and chronic, often deliberate, releases from shipping. The former are mainly concentrated in or near operating oil fields, whereas the latter mainly occur along busy shipping lanes, including in wintering areas south of the study area. In addition to acute effects of plumage fouling, birds may also be exposed to long-term toxic effects due to ingestion of contaminated prey.

- *Competition with fisheries.* Many seabird species are completely dependent on sufficient availability of small, energy-rich pelagic fish in order to raise offspring successfully. These fish are sometimes also exposed to large-scale human fisheries for fish meal and oil, e.g. sandeel, sprat, young herring and capelin. There is thus a potential for competition between seabirds and fisheries, and several studies indicate that competition has occurred in practice. Lack of food is clearly an important cause of the problems experienced by many seabird populations, and human fisheries may in some cases contribute to this. All fish-eating seabirds are potentially vulnerable to competition with fisheries.

- *Climate change.* Another important factor contributing to lack of food for seabirds is climate change. There is clear evidence that the abundance and distribution of many species of zooplankton are affected by warming sea temperatures. In large parts of the North Atlantic, the most important of these species is the copepod *Calanus finmarchicus*, which is extremely abundant, and the most important prey for juvenile stages of many fish species, and which has been shown to be very sensitive to changing temperatures. Several studies have shown that the breeding success and/or adult survival of seabirds are negatively correlated with sea temperatures, and it is most likely that the mechanism behind this pattern is linked to declines in availability of fish food. Complex ecological mechanisms and interactions with other factors may be involved, and the consequences of increasing temperatures are not always easy to predict. All seabirds are potentially vulnerable to effects of climate change, but so far it appears that fish-eating species are most sensitive.

Specific threats – these affect fewer species and/or act more locally

- *Bycatch*. Seabirds are regularly captured as bycatch in some fisheries, and this is one of the most important threats facing seabirds worldwide. In the study area, the most problematic fishing activity is standing gear, particularly gillnets. These nets regularly capture diving seabirds of many species, including auks, marine ducks and cormorants. Bycatch in net fisheries is not well monitored, and the magnitude of the problem is thus uncertain (although likely to be high). However, the available evidence suggests that the fishery for lumpsucker in Greenland, Iceland and Norway is particularly problematic. Bycatch in long-line fisheries is probably less important in this part of the world, although large numbers of northern fulmars are captured in this fishery.

- *Introduced predators*. Most seabirds have few defences against ground-based predators, including the introduced American mink and brown rat. These species have, often through involuntary human assistance, spread to many inshore and offshore islands, with sometimes devastating effects on seabird populations. The biggest problems seem to occur in western Scotland, the Faroes and Iceland, and the most sensitive species are burrow-nesters such as storm-petrels, shearwaters and some auks, followed by ground-nesters such as terns and small gulls.

- *Contaminants*. Persistent and biomagnifying organic contaminants have the potential to affect many organisms, mainly through long-term sub-lethal toxic effects. Top predators and opportunistic feeders taking human refuse are most likely to be affected, i.e. particularly large gulls. Studies have shown population-level effects on glaucous gulls in Norway, but it is possible that similar problems occur in other areas.

Local threats – these are most important in certain parts of the study area

- *Hunting*. In large parts of the study area seabird hunting has lost much of its traditional importance, and in Denmark, Sweden, Norway and Scotland effects on seabird populations are likely to be minor. However, in the Faroes, Iceland and Greenland seabird hunting is still important at least locally, and some species may be exposed to overharvesting. Due to the typical seabird life history where reproduction is slow and adult mortality low, killing of adult breeders is particularly problematic and may have large negative impacts on populations. For some of the most popular quarry species, including Atlantic puffin in the Faroes and Iceland, and Brünnich's guillemot in Greenland, the current harvest level may be unsustainable. Hunting of the latter species also occurs in wintering areas off Newfoundland.

- *Disturbance*. Many human activities have the potential to create sufficient disturbance to affect seabird populations, either at the breeding colonies or at sea. The most sensitive species are probably beach-nesting terns, cliff-nesting auks and moulting concentrations of eiders. In most cases, effects of disturbance are likely to be local, and impacts on regional populations likely to be small. Beach-nesting terns may be an exception to this, as recreational pressure on their habitat can be intense.

4. Seabird action plan

4.1 Workshop format

The format of the workshop was conducted in plenary meetings and through work in small groups (see Appendix 3 for workshop programme).

The plenary introduction of the workshop presented an overview of the current situation for seabird populations, and review of impacts on seabird populations and existing actions and measures (see Chapter 3 and Appendix 1). Short communications from national representatives were also given. The workshop then split up into smaller groups, enabling the parallel sectors from all invitees to discuss mitigation measures.

For the purpose of the workshop, six thematic subjects had been identified by the project group and seabird experts from Joint Nature Conservation Committee, Norwegian Institute for Nature Research, and Scottish Natural Heritage:

1) Effects of fisheries
2) Oil, pollutants and waste
3) Conflicting species
4) Seabird harvest
5) Area management and disturbance
6) Climate issues and cumulative effects

The break-out groups worked and reported in accordance with a template modelled on *Logical Framework Approach* (Norad 1999) (see Appendix 3). In the final part of the workshop, the reports from the working groups were presented and discussed in plenary, providing the final input into the seabird action plan.

4.2 Action plan for seabirds in Western-Nordic areas

Section 4.2 summarizes the high and medium priority actions reported from the six working groups. Full versions of these reports, including low priority actions, are shown in Appendix 2.

4.2.1 Effects of fisheries

The management of marine ecosystems and fisheries in the North East Atlantic Ocean is in general based on the advice on conservation and management measures given by the ICES (International Council for the Exploration of the Seas). ICES gives i.e. advice on Total Allowable Catch (TAC) for the most important fish stocks, which aim to ensure sustainability and maximize long-term output.

Many fish stocks are shared between several coastal states and TAC of these stocks are decided on and shared between relevant states trough negotiations. Technical regulations, i.e. discard policy, mesh sizes, minimum size of fish etc., and regulations on control and surveillance, may be harmonized or differ between the coastal states.

The effects of fisheries on seabird populations can be summarized into four categories (see Table 4–1):

1) Bycatch of fishing operations
2) Overharvesting of seabird food
3) Effects of discard on the seabird populations
4) Ecosystem effects

As far as bycatch is concerned, the group recognized two different fisheries of special importance: (1) the long-line fisheries (the main impact in the region discussed within the scope of this report is probably on the fulmar); and (2) bycatch in gillnets, especially bottom-set ones. The lumpsucker gillnet fishery was specifically noted as this fishery is of short time duration but can have a large impact on certain seabird populations.

There are several measures available to mitigate the impacts of long-line fisheries (underwater line-setters, bird-scaring lines, good line weighting, night setting etc.). The only known mitigation measure for gillnets is a spatio-temporal closure of the fishery/change of gear, i.e. possible actions may have relatively high costs.

In view of the possible high costs for mitigation actions the group considers it of high priority to introduce bycatch observer schemes so that bycatch reduction actions could be targeted initally to high risk areas with specific fishing gear (long-lines and gillnets, especially lumpsucker nets) and high seabird usage. The group also discussed the possibility of providing incentives to fishers through some kind of "eco" labelling scheme, and systems of rewards for reducing bycatches.

EU has begun a public consultation on a proposed Action Plan to reduce incidental bycatches of seabirds in fishing gears that is of relevance alos to the Nordic area (EU 2010).

It is known that reductions in sandeel prey abundance have affected seabirds breeding in Shetland and east Scotland. In the latter case there is good reason to believe that sandeel harvesting has affected fish abundance and seabird breeding performance. These issues have been addressed through existing fisheries closures. These closures have likely helped other fish (and possibly fisheries) that are influenced by the size of sandeel stocks.

The impact of fisheries on ecosystems is primarily a research question. In general, a better understanding of the ecosystem effects of fishing interactions on seabirds is needed, and there is a need for better understanding of the effects on seabirds of fishery management changes such as the move to a "large fish" and Maximum Sustainable Yield (MSY) approach. In this connection, the use of seabirds as indicators of environmental health was also discussed by teh group.

Table 4–1. Priority actions reported on effects of fisheries

	High and medium priority actions	Costs	Time-schedule	Assigned responsibility
Bycatch				
1	Observer schemes.	Medium	Short	Public sector. Fishers.International co-ordination.
2	National/ European Community plans of action on seabirds (under FAO guidance).	Low	Short	National/ European authorities
3	Mitigation measures for bycatch on long-lines.	Low-medium	Medium	Public sector. Fishers.
4	Mitigation measures in (bottom-set) gillnet.	High	Medium	Public sector. Fishers.
5	Lumpsucker fishery control.	Medium	Short – medium	Public sector. Fishers.
6	Include bycatch in "eco" labelling schemes.	Low	Short – medium (ongoing)	Large (EU) retailers. Fisheries, supported by public sector. Private certification authorities.
7	Reward scheme for ideas that lead to bycatch reduction, and financial support for such schemes.	Low-medium	Short	Nordic Council. Fishers.
Overharvesting of seabird food				
8	Sandeel closures (Shetland and East Scotland) (note other closures for sandeel stock purposes may have same effect).	Low	Short (already in place)	Public sector. Fishers.
9	Better understanding of effects of overharvesting (- of fish) interactions.	Medium	Medium	Public funding
Discards				
10	Better understanding of discard interactions.	Medium	Short – medium	Public funding
Ecosystem effects				
11	Better understanding of ecosystem effects of fishing interactions on seabirds.	Medium	Medium – long	Research: public funding
12	Better understanding of the implications of moving to a "large fish" and MSY approach to fisheries management.	Low (once research done)	Medium – long	New policy: public funding
13	Use seabirds as indicators of environmental health including of fish stocks.	Low-medium	Medium (?) Some in existence	Linked to monitoring/ surveillance: public funding

4.2.2 Effects of oil, pollutants and waste

The area within the scope of this report has for decades been affected by extensive petroleum exploration and production activities. Such activities, as well as shipping, commercial fisheries and tourism, represent risks for accidental and chronic oil discharges and dumping of various categories of waste hazardous to seabirds. Furthermore, the ecosystems of the NE Atlantic are affected by long-range trans-boundary pollutants.

Group discussions on mitigating actions related to oil spills (see Table 4–2) focused on the need to improve baseline knowledge of distribution and migration routes of seabird populations, and to improve monitoring programmes for seabirds. This is particularly important in new areas where petroleum exploration activities are planned.

Table 4–2. Priority actions reported on oil, pollutants and waste.

	High and medium priority actions	Costs	Time-schedule	Assigned responsibility
Oil spills: minor and major accidental oil spills and chronic discharges from petroleum activities and shipping/traffic				
1	Map seabird populations and geographic distribution in time and space where petroleum exploration activities are planned.	High	Medium	Public and private sectors
2	Establish better information on seabird distribution and migration routes on open seas.	High	Long	Public and private sectors
3	Establish a Nordic seabird monitoring programme with standard methods and common guidelines for level of activities.	High	Medium	Public sector
4	Develop standard methods for assessing effects on seabirds of accidental and chronic oil spills.	Low – medium	Medium	Public sector
5	Prepare common Nordic guideline for oil spill drift models that includes maps of sensitive areas and seabird colonies.	Medium	Medium	Public and private sectors
6	Carry out public outreach/education to commercial shipping and small boats, and establish public hotline for reporting spills.	Low	Medium	Public and private sectors
7	Conduct review on regulatory framework efficiency in Nordic region.	Low	Short	Public sector
8	Ensure better enforcement and systems for collecting evidence leading to large fines.	Medium	Medium	Public sector
9	Designate sailing "highways" for shipping as far off from land/sensitive areas as possible; designate "emergency beaching areas", introduce mandatory use of Pilot, and surveilliance from satellite and airplane.	Low – medium	?	Public sector
10	Introduce regulations demanding the use of light fuel in sensitive areas (e.g. tourist ships).	Low	Medium	Private sector
Pollutants other than oil				
11	Continue AMAP monitoring of seabird contaminants; include new contaminants and secure communication between seabird and contaminants research so most vulnerable species are included.	Medium	Short	Public sector

Two Nordic standards are recommended, one for assessing the effects of oil spills on seabirds, and one for vulnerability mapping for oil spill response. Communication/outreach/education is recommended both for commercial shipping and for smaller boats to reduce illegal discharges of oil, and a public hotline for reporting any oil spills should be established.

The group recommended reviewing the efficiency of the current regulatory framework for oil spills (emergency preparedness, remediation responsibilities, fines etc.).

Two specific recommendations related to shipping activities were made, including designating shipping lanes way from land and sensitive areas, and mandatory use of light fuels by ships sailing near sensitive areas for seabirds (light fuels are considered less hazardous to seabirds than heavy crude oil).

The group recommended that for the Arctic area contaminants harmful to seabirds other than those caused by oil spills should be addressed by ongoing projects within the Arctic Council working group Arctic Monitoring and Assessment Programme (AMAP). No specific recommendations were given regarding the potential impacts of waste on seabirds.

4.2.3 Effects of conflicting species

The term "conflicting species" includes introduced and invasive species. A species is considered introduced when its transport into an area outside of its native range is the result of human action; either intentional or accidental. Invasive species are those non-indigenous species that adversely affect the habitats and bioregions they invade.

The group concluded that invasive species raise many of the same problems as introduced species, and that they should be handled similarly. Issues dealing with introduced species could therefore also be applied to invasive species.

The species conflicting most severely with seabirds in the NE Atlantic are the brown rat and mink. They are very serious threats to ground- and burrow-nesting seabirds as they take eggs, chicks and even full-grown birds, and they can cause local and regional population declines and extinctions. The main species affected are storm-petrels, Manx shearwaters, Atlantic puffins, black guillemots, terns and small gulls. Problems have occurred throughout the study area, but the largest effects in number terms have been in Scotland, the Faroes and Iceland.

To identify the problems with introduced species and to be able to prioritize, it is recommended that risk analysis/-assessments of area plans are carried out.

The group recognized that there is a need for national and international plans to be developed and implemented to restrict the introduction of predators to seabird breeding areas. Preventing introduction is in general much more cost effective than an eventual removal.

Introduced predators such as rats and and mink should be eradicated from islands where possible, and it is recommended to prepare a handbook on how to handle introduced species, with specific examples on methods. When introduced species are removed from an area, actions must be taken to prevent/restrict re-introduction (as for predator-free areas).

Natural predators like such as white-tailed sea eagle, great skua and the large gulls can cause problems for some smaller seabirds. This is natural, but human activities (such as discarding of fishery waste) can increase abundance and distribution of the larger birds, thus indirectly affecting the smaller seabirds adversely. Management of these human activities can control these adverse effects. The group considered any problems related to natural predators and ballast water as of low overall priority (see Appendix 2).

Table 4–3. Priority actions reported on conflicting species.

	High and medium priority actions	Costs	Time-schedule	Assigned responsibility
	Preventing introduced and invasive species			
1	Prevent predators.	Low-medium	Long	Public and private sectors
2	Prevent parasites and diseases.		Long	Public sector and ongoing international processes
3	Prevent competitors.	High	Long	Ongoing international processes
4	Prevent/manage inappropriate vegetation.	Low	Short	Dependent on ownership (local problem)
	Removal of introduced and invasive species			
5	Remove introduced predators – stage one: removal of introduced and invasive species. - Chronic species (like American mink, rats). - Acute problems (like hedgehogs).	High	Medium	Private and public sectors
	Remove introduced predators – stage two: prevent re-invasion of introduced and invasive species.	Medium	Long	Private and public sectors
	Risk analysis and guidance documents (handbook)			
6	Perform risk analysis/-assessments of area plans to be able to prioritise and identify problems with introduced species.	Low	Long	Public sector
7	Prepare handbook on how to handle introduced species, with specific examples.	Low-medium	Short	Public sectors and ongoing international processes

4.2.4 Effects of seabird harvest

Seabird harvest has a long tradition and is still an important, particularly in the more remote Arctic areas. Restrictions placed on harvesting vary within the area of interest, and the priority actions summarized in Table 4–4 may therefore not apply, or apply equally, to all the countries addressed in this report.

The effects of hunting adult birds can potentially be high on seabirds because of their life history that usually include low natural adult mortality. For this reason the group recognized that banning hunting during the breeding season, and introducing mandatory hunting proficiency tests (mandatory course and a written exam) is of great importance. This cannot be efficiently done, however, without explaining to the public why this is needed. Therefore it is important that information about the population status of seabirds and what may affect their dynamics is communicated to the public.

The group also recognized that disturbance by humans (also during hunting) can negatively affect seabird populations, and this type of impact emphasizes the need for establishing further protected areas.

In order to monitor the effects of culling and hunting it is necessary to be able to identify and partition the causes of any population changes. This will require some specific research and monitoring actitity.

Table 4–4. Priority actions reported on seabird harvest.

	High and medium priority actions	Costs	Time-schedule	Assigned responsibility
Hunting				
1	Introduce mandatory hunting proficiency test (mandatory course and a written exam)	Low	Medium	Public sector
2	Ban hunting during breeding season.	Low	Long	Public sector
3	Collect hunting and culling statistics, with verification control.	Medium	Long	Public sector
4	Prohibit lead ammunition – introduce alternative ammunition.	Low	Long	Public sector
5	Increase the level of understanding among the public of introducing hunting restrictions.	Medium	Short	Public sector
6	Restrict traffic by human activities during hunting.	Low	Long	Public sector
7	Restrict egg collecting to an early stage during breeding season.	Low	Short	Public sector
Protected areas				
8	Create more nature reserves/ conservation sites.	High	Long	OSPAR; WSSD; Public sector
9	Implement protection areas through action plans.	Medium	Long	Public sector
Research				
10	Population dynamics (monitoring of seabird populations).	High	Long	Public sector
11	Effects of culling.	Low	Short	Public sector

4.2.5 Effects of area management and disturbance

A variety of activities potentially affecting seabirds in relation to area management and disturbance were identified (see Table 4–5). The major activities potentially having a negative impact on seabirds were considered to be marine installations e.g. wind turbines, oil and gas platforms, wave and tidal devices, harbours, piers and bridges etc through the loss of (foraging) habitats, disturbance and/or collision risks. There is a need to consider the use of areas by seabirds, both in space and in time. Spatial planning, improved and standardised environmental impact assessments are key elements in reducing impacts on seabirds. Furthermore, research on the impact of marine installations on seabirds may help to improve spatial planning and impact assessments.

The group suggested collating and sharing good practice in monitoring, planning and assessment between countries. This would then be used as guidance.

Recreational use and tourism were also identified as factors that could potentially have negative impact on seabirds. Identifying sensitive areas and the risks from different activities, followed by appropriate mitigating steps such as area/activity restrictions, adequate publicity, public awareness raising, code-of-conducts for more organised activities and enforcement can reduce the impact of disturbance.

The group considered whether buildings/constructions on land were a potential threat. However, compared to marine installations the threats associated with these were considered low as existing measures and processes for spatial planning and environmental impact assessments were thought to be in place. However, the group did consider that there was still room for improvement in this field.

Aquaculture and mariculture were also considered in relation to disturbance and the risks of changing foraging habitats of seabirds, but were considered as having low overall priority (see Appendix 2).

Finally, ship routes in general, including ferries and hydrofoils, were considered to have an overall low disturbance on seabirds in the project area.

The group emphasized that although some of the above factors might have less impact on seabirds in the overall Nordic Sea area, they might be of far greater significance locally or regionally and cannot as such be disregarded as priorities in all circumstances.

Table 4–5. Priority actions reported on area management and disturbance.

High and medium priority actions	Costs	Time-schedule	Assigned responsibility
Marine installations causing loss of habitats, disturbance and/or collision			
1 Execute spatial planning and environmental assessments taking seabirds management into account.	High	Ongoing	Public and private sector
2 Improve and standardise methods for Environmental Assessment.	High	Short	Public sector
3 Research: impact of marine installations on seabirds.	High	Ongoing	Public sector
Recreational use and tourism causing disturbance			
4 Identify the risks of the different activities, and sensitive locations.	Low	Short	Public sector
5 Introduce area restrictions for particular activities, and adequate publicity, public awareness and enforcement.	Low – high	Long, ongoing	Public sector
6 Develop codes-of-conduct for more organised activities e.g. tourism.	Low	Short	Public sector
Good practices			
7 Collate and share good practice from countries in a) monitoring; b) planning, and c) assessment.	Low	Short	Public sector. NCM.

4.2.5 Effects of climate change and cumulative effects

According to guidance from the Nordic Council of Ministers, an emphasis was to be placed on the climate change dimension. This perspective on the challenges facing seabirds is interesting and important in itself, but also of high importance politically.

The group recognized that climate change will not be negative to all species in all locations. However the factors listed below are expressed as negative aspects of climate change. The group identified direct effects of climate change (1) and (2) but most factors identified are indirect effects of climate, factors (3) to (11).

1) Weather, defined as short term features within otherwise long-term patterns
2) Climate, defined as persistence or increased frequency of extreme weather conditions
3) Declines in food availability
4) Declines in food quality

5) Changes in species composition of food
6) Changes in abundance and species composition of zooplankton, a subset of factors (3) to (5)
7) Loss of breeding habitats from sea level rise
8) Increased ultraviolet (UV) radiation affecting primary production (or activation of contaminants such as Polyaromatic Hydrocarbons (PAH))
9) Ocean acidification
10) Changes in migratory behaviour (timing and location) affecting intensity of other pressures such as hunting and fishing
11) Some protected areas may no longer be appropriate, but new areas will emerge for target species as temperature zones move north

The prioritisation and evaluation of actions or mitigating measures (see Table 4–6) recognized that high overall priority was given to actions that addressed significant problems, needed to start immediately, or are practicable. Low overall priority (see Appendix 2) was given to actions that addressed potential, rather than actual, problems, and which were recognized as not needing an immediate start.

Although greater frequencies of direct impacts of climate change may affect seabirds temporarily, the indirect effects, of prolonged, are recognized as much more long-term and serious. Indirect effects can also be difficult to evaluate as effects may vary geographically, seasonally, with prey species, and bird species. It was recognized however that indirect effects were generally difficult to research and that long-term observations (monitoring) were critical as baseline information to inform further research into the effects or impacts of individual factors. Although cumulative effects are likely to occur it was recognized that research should, at first, be directed at understanding the effects of each factor individually.

It is clear from the ideas put forward by the workshop that much information is still needed on various aspects of changing climate. Direct actions at this stage are by and large international efforts to reduce CO_2 and greenhouse gas emissions. The responsibility for this lies primarily with governments. Increased research including monitoring also rests with governments, although universities and independent research institutes should take part in implementing the present action plan.

Special attention is drawn to the importance of monitoring seabird issues to improve baseline information. In this respect is important to note the ongoing biodiversity monitoring plan of the Conservation of Arctic Flora and Fauna (CAFF) working group of the Arctic Council (http://cbmp.arcticportal.org/). The Nordic countries are all members of the Arctic Council CAFF has an expert group (Cbird) on seabirds that includes all Arctic countries and the UK (http://caff.arcticportal.org/expert-groups/seabird-group-cbird). Cbird has agreed a monitoring plan for Arctic seabirds (Petersen *et al.* 2008), that has yet to be put into operation. Hence, many initiatives started and must continue but others have to begin, in the coordination of seabird monitoring in the Arctic, including the region dealt with in the current workshop report.

Table 4–6. Priority actions reported on climate issues and cumulative effects.

	High and medium priority actions	Costs	Time-schedule [3]	Assigned responsibility
Climate change				
1	Limit CO_2 and greenhouse gas emissions, as may be agreed internationally.	Low (no *additional* costs)	Immediate (will take a long time to see benefits)	Action for everyone. Implemented by public sector on the basis of international processes.
Climate change impacts				
2	Restrict fisheries on key stocks of forage fish	Medium	Immediate when the need arises	Public sector
3	Changes in migration routes and times: Ensure that appropriate protection (national laws and international agreements) applies to new areas and times.	Low	Immediate when the need arises	Public sector, with internationally coordinated action if necessary.
4	Develop a flexible and adaptable system for the establishment and review of protected areas.	Low	Immediate (periodic review over long term)	
Research				
5	Reasons for variations in sandeel and capelin (etc) abundance.	Medium	Immediate – needs to be done	Public sector, with internationally coordinated action if necessary.
6	Processes leading to variations in feed quality.			
7	Reasons for variations in species composition of forage species.			
8	To avoid reductions in the seabird food: research into food webs leading through secondary producers to prey species.			

4.3 Summary of priority actions and main recommendations

The outcome of the workshop was a total of 57 priority actions that would help reverse current declines in seabird populations in Western-Nordic areas including Scotland. These actions were categorized with respect to implementation cost (qualitative assessment only), time schedule and responsibility for implementation.

The workshop also reported a limited number of low priority mitigating actions (see Appendix 2). These actions are not further discussed in this Section, but may still be relevant in helping to improve seabird management in specific parts in the region.

[3] Indicate when the work should start.

It is strongly emphasized that the workshop did not prioritise the recommended actions, and therefore all should be treated as of equal importance. Hence, the workshop did not suggest any tiered approach with respect to the implementation of the actions (e.g. to prioritise implementation of actions categorized low cost/short timeframe versus action of high cost/long timeframe).

Still, as it is considered highly important that some immediate actions are taken with a high potential for improving the status of seabird populations in the region, all priority actions that are deemed feasible to implement at low/medium cost and within a time-frame of less than 3 years (and/or are ongoing) are summarized below. Research needs and cross-cutting issues are summarized separately.

Fisheries

- Establish observer schemes for bycatch
- Prepare National/European Community plans of action on seabird bycatch
- Establish controls in the lumpsucker fishery to reduce bycatch
- Include bycatch in “eco” labelling schemes
- Introduce reward scheme for ideas that lead to bycatch reduction
- Continue sandeel closures (Shetland and East Scotland) to address overharvesting of seabird food
- Use seabirds as indicators of environmental health including of fish stocks

Oil and pollutants

- Conduct review of regulatory framework efficiency in the Nordic region from a seabird management perspective
- Continue AMAP monitoring of seabird contaminants; include new contaminants and secure communication between seabird and contaminants research so most vulnerable species are included

Conflicting species

- Prepare handbook on how to handle introduced/invasive species
- Prevent/manage inappropriate vegetation

Seabird harvest

- Restrict egg collection to an early stage during breeding season
- Increase the level of understanding among the public of introducing hunting restrictions

Area management and disturbance

- Identify the risks of different activities on seabirds, and locations sensitive to seabirds

- Introduce area restrictions for particular activities, and adequate publicity, public awareness and enforcement
- Develop codes-of-conduct for more organised activities e.g. tourism
- Collate and share good practice from countries in monitoring, planning, and assessing area management and disturbance with respect to impacts on seabirds

Climate change

- Restrict fisheries on key foraging stocks
- Ensure that appropriate protection (national laws and international agreements) applies to new areas and times in cases of changes in seabird migration routes and times

The only actions deemed feasible to implement at *high* cost within a time-frame of less than 3 years are related to marine installations causing loss of habitats, disturbance and/or collision:

- Execute spatial planning and environmental assessments taking seabirds management into account
- Improve and standardise methods for Environmental Assessment

The following actions would probably need more than 3 years to be implemented:

Fisheries

- Introduce mitigation measures for bycatch on long-lines and (bottom-set) gillnets
- Use seabirds as indicators of environmental health including of fish stocks

Oil and pollutants

- Develop standard methods for assessing effects on seabirds of accidental and chronic oil spills
- Carry out public outreach/education to commercial shipping and small boats, and establish public hotline for reporting spills
- Ensure better enforcement and systems for collecting evidence leading to large fines
- Designate sailing shipping routes as far off from land/sensitive areas as possible
- Introduce regulations demanding the use of light fuel in sensitive areas (e.g. tourist ships)

Conflicting species

- Prevention and removal of introduced and invasive species (predators, parasites, diseases, competitors)

- Perform risk analysis/-assessments of area plans to be able to prioritise and identify problems with introduced species

Seabird harvest

- Introduce mandatory hunting proficiency test (mandatory course and a written exam)
- Ban hunting during breeding season
- Collect hunting and culling statistics, with verification control
- Prohibit lead ammunition – introduce alternative ammunition
- Restrict traffic by human activities during hunting

Summary of prioritised research needs reported from the workshop:

- Seabird food availability and quality
    - Discard interactions
    - Effects of overharvesting (- of fish) interactions
    - Implications of moving to a "large fish" and MSY approach to fisheries management
    - Variations in forage species (sandeel and capelin etc.)
    - Processes leading to variations in seabird prey quality
- Seabirds and ecosystem studies
    - Ecosystem effects of fishing interactions on seabirds
    - Food webs leading through secondary producers to prey species (to avoid reductions in the seabird food)
- Seabird ecology
    - Population dynamics
    - Distribution and migration routes on open seas, and in areas where petroleum exploration activities are planned
- Impact of marine installations on seabirds
- Effects of culling on seabird populations

The workshop reported a few cross-cutting issues of general relevance to nature management:

- Create more nature reserves/conservation sites/protected areas, and develop a flexible and adaptable system for the review of protected areas
- Prepare common Nordic guideline for oil spill drift models
- Limit CO_2 and greenhouse gas emissions, as may be agreed internationally
- Establish a Nordic seabird monitoring programme aimed at surveying population dynamics in such a way that the causes behind population declines can be identified and addressed

As to the responsibilities assigned to the priority actions, the workshop directed the majority of these at the public sector, both for implementation responsibility and funding. However, the private sector was assigned *joint responsibility* with the public sector in some areas, mainly fisheries/the fishing industry with regard to the interaction fisheries versus seabirds, and the sectors petroleum industry and shipping concerning oil spills and pollutants (see Section 4.2 and Appendix 2 for more information).

The workshop recommended international coordination and cooperation to address specific challenges, in particular implementation of mitigating actions on seabird bycatch. It is emphasized, however, that most priority actions presented may benefit from cooperation at international and/or Nordic levels.

The Nordic Council of Ministers was specifically assigned implementation responsibility to the following priority actions:

- Introduce reward scheme for ideas that lead to bycatch reduction, and financial support for such schemes
- Prepare common Nordic guideline for oil spill drift models that includes maps of sensitive areas and seabird colonies
- Review the efficiency of the current regulatory framework that is relevant for oil spills in the Nordic region (emergency preparedness, remediation responsibilities, fines etc.)
- Establish Nordic seabird monitoring programme with standard methods and common guidelines for level of activities

It is evident that all the priority actions reported from the workshop need further detailed planning to succeed. To make targeted and effective use of conservation resources, it is particularly important to customise any action on seabirds to particluar *area* (the relevance of implementing actions at cross-national, national, or local level), seabird *species* (some seabirds species are significantly more affected by anthropogenic impacts than others), and type and severity of *impacts*. The main general impacts on seabirds are oil pollution, climate change and competition with fisheries, the main specific impacts are bycatch, introduced predators and contaminants, while the main local impacts are hunting and disturbance. In addition, the value of monitoring is highly significant in order to provide relevant information for management.

The enclosed review of seabird status, trends and anthropogenic impacts (see Chapter 2 and Appendix 1) is a recommended source of updated information to be used when mitigating actions are planned.

Main recommendations

The workshop recommends that the Nordic Council of Ministers for the Environment discuss and decide on

1) mitigating actions with expected positive effects on seabird populations in the Nordic region within 3 years;
2) cross-national actions on seabird bycatch;
3) the priority actions specifically assigned to the Nordic Council;
4) planning of mitigating actions with estimated implementation period longer than 3 years;
5) seabird research priorities.

References

EU (2010), EU Action Plan for reducing incidental catches of seabirds in fishing gears. Public consultation. http://ec.europa.eu/fisheries/partners/consultations/seabirds/index_en.htm

Norad (1999), Logical Framework Approach: handbook for objectives-oriented planning. Norad Handbook.

Nordisk Ministerråd 2008. Vest-Nordiske sjøfugler i et presset havmiljø. Hva er status for sjøfuglbestandene i Norden? Hvilke påvirkningsfaktorer truer? Hvilke tiltak kan settes inn? Rapport fra en nordisk workshop Tórshavn, Færøyene 26.–29. september 2007. – TemaNord 2008:573. Nordisk Ministerråd, Copenhagen, 100 pp.

Petersen, A., Irons, D., Anker-Nilssen, T., Artukhin, Y., Barrett, R., Boertmann, D., Egevang, C., Gavrilo, M.V., Grant Gilchrist, Hario, M., Mallory, M., Mosbech, A., Olsen, B., Osterblom, H., Robertson, G., Strøm, H. (2008), Framework for a Circumpolar Arctic Seabird Monitoring Network. CAFF CBMP Report No.15. CAFF International Secretariat, Iceland.

5. Sammendrag

5.1 Bakgrunn

I 2008 bestemte Nordisk Ministerråd for miljø (MR-M) å støtte utviklingen av en tverrsektoriell handlingsplan for sjøfugl med målsetting om å motvirke de nedadgående trendene hos sjøfuglbestandene i Vest-Norden. Bakgrunnen var et vedtak fra et møte mellom de nordiske naturvernorganisasjonene i 2006 som oppfordret Nordisk Råd om å identifisere årsakene til bestandenes nedgang og feilslåtte hekking og for å foreslå avbøtende tiltak.

Denne rapporten er resultatet av en workshop holdt i mai 2010 for å forberede en handlingsplan for sjøfugl i Vest-Norden inkludert Skottland. I forkant av workshopen ble det laget en sammenstilling vedrørende sjøfugl i nordøst-Atlanteren som omhandler status og trendene og de rådende menneskelige påvirkningsfaktorer.

5.2 Sjøfugl i Nordøst–Atlanteren: status, trender og menneskelig påvirkning

Sjøfuglenes status og trender

Siden 2004 har vi sett en omfattende hekkesvikt hos sjøfugl. Der bestandstrendene er kjent er en rekke arter i nedgang i nesten alle land: krykkje, rødnebbterne, hettemåke, polarlomvi og tyvjo. Et fåtall arter viser generelt en økende trend: havsule og storjo.

Generelle påvirkningsfaktorer – av betydning for mange arter i store deler av Vest-Norden

- *Oljeforurensning.* Alle sjøfuglarter er sårbare for oljeutslipp, spesielt på grunn av at fjærdraktens vanntette egenskaper blir påvirket selv av små mengder olje. Fugler kan også bli eksponert for toksiske effekter av oljeutslipp ved at de spiser forurensete byttedyr.
- *Konkurranse med fiskeriene.* Mange sjøfuglarter er helt avhengig av små, energirike pelagisk fisk (som tobis, brisling, sild og lodde) for å være i stand til å fø opp unger. Disse fiskeartene er delvis også gjenstand for stor-skala menneskelige fiskerier for fiskemel og – olje. Matmangel forårsaket av konkurranse mellom sjøfugl og fiskerier er helt klart en viktig årsak for problemene mange sjøfuglbestandene står overfor.
- *Klimaendringer – økt sjøtemperatur*. Flere studier har vist at hekkesuksess og/eller voksenoverlevelse er negativt korrelert med

sjøtemperatur. Det er mest sannsynlig at mekanismene bak dette mønsteret er koblet til redusert tilgjengelighet av fisk (komplekse økologiske mekanismer og interaksjoner med andre faktorer kan også være involvert). Det er godt dokumentert at mengden og fordelingen av mange dyreplanktonarter som er viktig bytte for ungfiskstadier, er påvirket av varmere sjøtemperaturer.

Spesifikke påvirkningsfaktorer – av betydning for færre arter og/eller i mer lokale deler av Vest-Norden

- *Bifangst*. Sjøfugl som fanges gjennom bifangst i garnfiske er ikke godt overvåket, og problemets størrelsesorden er derfor usikkert. Studier tyder på at fiskeriene for rognkjeks på Grønland, Island og Norge er særlig problematisk og store antall av havhest fanges gjennom linefiske .
- *Introduserte predatorer*. De fleste sjøfuglene har lite forsvar mot bakkelevende predatorer, som den introduserte amerikanske minken og brunrotte. De største problemene ser ut til å være i Vest-Skottland, Færøyene og Island og de mest sårbare er hulehekkende arter som stormsvaler, lirer og noen alkefugler etterfulgt av bakkehekkende arter som terner og mindre måker.
- *Forurensning*. Persistente og biomagnifiserende organiske miljøgifter har potensial til å påvirke sjøfugl gjennom langvarige toksiske effekter. Studier har påvist effekter av miljøgifter på bestandsnivå hos polarmåke på Bjørnøya på Svalbard, Norge. Det er mulig at liknende problemer forekommer også i andre områder.

Lokale påvirkningsfaktorer

- *Jakt*. I store deler av studieområdet har jakt på sjøfugl mistet mye av sin tradisjonelle betydning. På Færøyene, Island og Grønland er sjøfugljakt imidlertid fortsatt viktig, iallfall lokalt. For noen av artene det drives jakt på, som lunde på Færøyene og Island og polarlomvi på Grønland kan dagens nivå på innhøstinga være lite bærekraftig.
- *Forstyrrelse*. Stort sett vil effektene av forstyrrelse forårsaket av menneskelige aktiviteter sannsynligvis være lokale og påvirkningene på regionale bestander er sannsynligvis små. Strandhekkende terner kan være et unntak da rekreasjonstrykket på deres habitat kan være stort.

5.3 Handlingsplan for sjøfugl i vestnorden

Resultatet av workshopen var 57 prioriterte tiltak som kan bidra til å reversere de nåværende nedgangene i sjøfuglbestander i Vest-Norden inkludert Skottland. Disse tiltakene ble kategorisert med hensyn til kostnader (kun kvalitativ vurdering), tidsramme og ansvarsområde for implementering.

Det understrekes at workshopen ikke prioriterte de anbefalte tiltakene og derfor bør alle behandles som om de er av lik betydning. Følgelig foreslo ikke workshopen noen trinnvis tilnærming med hensyn til implementering av tiltakene. Likevel er det svært viktig at tiltak med stort potensial for å bedre situasjonen for sjøfuglbestandene i regionen iverksettes så snart som mulig.

Prioriterte tiltak som er ansett som gjennomførbare for implementering ved lave/medium kostnader innenfor en tidshorisont på mindre enn 3 år:

Fiskeriene

- Etablere observatørordning for bifangst.
- Forberede nasjonale/EU handlingsplaner for bifangst av sjøfugl.
- Etablere kontroller i rognkjeksfisket for å redusere bifangst.
- Inkludere bifangst i "øko" merkeordning.
- Innfør belønningsordning for ideer som fører til at bifangst reduseres.
- Videreføre stenging i tobisfisket (Shetland og Øst-Skottland) for å fokusere på overbeskatning av mat for sjøfugl.
- Bruke sjøfugl som indikatorer på helsetilstanden til miljøet, inkludert fiskebestander.

Olje og forurensning

- Utføre en analyse av effektiviteten av reguleringsrammene i den nordiske regionen fra et sjøfuglforvaltnings perspektiv.
- Fortsette med AMAP overvåking av miljøgifter i sjøfugl; inkluder nye miljøgifter og sikre kommunikasjon mellom forskning på sjøfugl og miljøgifter slik at de mest sårbare artene er inkludert.

Konfliktarter

- Forberede en håndbok i hvordan man håndterer introduserte/invasjonsarter.
- Forhindre/takle uønsket vegetasjon.

Høsting av sjøfugl

- Begrense høsting av egg til et tidlig stadium i hekkesesongen.
- Øke forståelsen hos publikum for å innføre jaktrestriksjoner.

Områdeforvaltning og forstyrrelse

- Identifisere risikoen av forskjellige aktiviteter på sjøfugl og viktige sjøfuglområder.
- Innføre arealrestriksjoner for spesielle aktiviteter; tilstrekkelig publisitet, bevissthet blant publikum og håndhevelse.
- Utvikle et regelsett for mer organiserte aktiviteter, som f.eks. turisme.

- Samle og del god praksis fra land når det gjelder overvåking, planlegging og vurdering av områdeforvaltning og forstyrrelse med tanke på påvirkninger på sjøfugl.

Klimaendringer

- Begrens fisket på bestander av små pelagiske fisk som er viktig næring for sjøfugl.
- Sørg for at formålstjenelig beskyttelse (nasjonale lover og internasjonale avtaler) også gjelder nye områder og tidsperioder i tilfelle endringer av sjøfuglenes trekkruter og – tider.

Tiltak ansett som gjennomførbare for implementering ved høye kostnader innenfor en tidshorisont på mindre enn 3 år:

Marine installasjoner forårsaker tap av habitat, forstyrrelse, kollisjon

- Utfør romlig planlegging og miljøvurderinger der man tar høyde for sjøfuglforvaltning
- Forbedre og standardisere metoder for miljøvurderinger.

Følgende tiltak vil sannsynligvis trenge mer enn 3 år for å bli implementert:

Fiskeriene

- Introduser avbøtende tiltak for bifangst i linefiske og bunngarn.
- Bruk sjøfugler som indikatorer på miljøhelstetilstanden inkludert fiskebestander

Olje og forurensning

- Utvikle standardmetoder for vurdering av effekter av akutte og kroniske oljeutslipp på sjøfugler.
- Informer kommersiell skipsfart og småbåtbrukere og etabler en beredskapstelefon for å rapportere oljeutslipp.
- Sørg for bedre håndhevelse og systemer for å samle bevis som fører til store bøter.
- Etablere skipsleder så langt unna land/sårbare områder som mulig.
- Innfør reguleringer som krever bruk av lett drivstoff (tungoljeforbud) i sårbare områder (for eksempel turistbåter).

Konfliktarter

- Forebygging og fjerning av introduserte og invaderende arter (predatorer, parasitter, sykdommer, konkurrenter).
- Utfør risikoanalyser/-vurderinger i arealplaner for å kunne prioritere og identifisere problemer med introduserte arter.

Høsting av sjøfugl

- Innfør obligatorisk jegerprøve (obligatorisk kurs og skriftlig eksamen).

- Forby jakt i hekkesesongen.
- Innsamling av statistikk for jakt – og andre former for beskatning (som skadefelling osv.).
- Forby blyammunisjon – innfør alternative ammunisjon.
- Begrens menneskelige forstyrrelser under jakt.

Prioriterte forskningsbehov:

- Tilgjengelighet og kvalitet av næringsorganismer for sjøfugl.
- Studier av sjøfugl og økosystemer.
- Sjøfugløkologi.
- Påvirkningen av marine installasjoner på sjøfugl.
- Effekter av skadefelling på sjøfuglpopulasjoner.

Når det gjelder ansvarliggjøring av de prioriterte handlingene, rettet workshopen de fleste av disse til offentlig sektor, både ansvaret for implementering og finansiering. Privat og offentlig sektor ble imidlertid tilskrevet et felles ansvar på enkelte områder. Dette gjelder hovedsakelig fiskeriene/fiskeindustrien med tanke på interaksjonen mellom fiskeriene og sjøfugl, og petroleum- og skipsfartsektoren når det gjelder oljeutslipp og forurensning.

Workshopen anbefaler internasjonal koordinering og samarbeid for å adressere spesifikke utfordringer, særlig implementeringen av avbøtende tiltak i forbindelse med bifangst av sjøfugl. Det er imidlertid understreket at de fleste prioriterte tiltakene som er presentert her kan dra fordel av internasjonalt og/eller nordisk samarbeid.

Nordisk Ministerråd ble spesielt tildelt ansvaret for implementering av de følgende prioriterte tiltakene:

- Innfør belønningsordning for ideer som fører til at bifangst reduseres og finansiell støtte til slike ordninger.
- Forbered felles nordisk retningslinjer for driftmodeller av oljeutslipp som inkluderer kart over sårbare områder og sjøfuglkolonier.
- Evaluer effektiviteten av de nåværende reguleringsrammene som er relevant for oljeutslipp i den nordiske regionen (kriseberedskap, ansvaret for opprydning, bøter osv.).
- Etabler nordisk sjøfugl overvåkingsprogram med standard metoder og felles retnignslinjer for nivå på aktivitetene.

Det er tydelig at alle de prioriterte tiltakene fra workshopen trenger mer detaljert planlegging for å bli vellykket. For å kunne bruke naturforvaltningsressursene effektivt og målrettet er det spesielt viktig å tilpasse tiltakene for sjøfuglene til spesifikke *områder* (relevansen av implementering av tiltakene på internasjonalt, nasjonalt og lokalt nivå), *arter* (noen sjøfuglarter er betydelig mer påvirket av menneskelig påvirkning enn andre), og type og hvor alvorlig *påvirkningene* er. I tillegg er verdien av overvåking svært viktig for å kunne skaffe til veie relevant informasjon til forvaltningen.

5.4 Hovedanbefalinger:

Workshopen anbefaler at Nordisk Ministerråd for miljø diskuterer og tar stilling til følgende:

1) avbøtende tiltak med forventet positive effekter på sjøfuglbestandene i Norden innen tre år;
2) internasjonale tiltak på bifangst av sjøfugl;
3) de prioriterte tiltakene spesielt tildelt Nordisk Ministerråd;
4) planlegging av avbøtende tiltak med forventet implementeringsperiode lenger enn 3 år;
5) prioritert sjøfuglforskning.

Appendix 1: Seabirds in the North East Atlantic.

– A review of status, trends and anthropogenic impact.

By *Morten Frederiksen*, National Environmental Research Institute, Aarhus University, Denmark. May 2010.

Table of Contents

1. Preface

This review of the status, trends and factors affecting seabird populations in the North East (NE) Atlantic forms the scientific background paper for the workshop on a Nordic Action Plan for Seabirds in Malmö, Sweden on 4-5 May 2010. The work has been carried out during February-April 2010 as part of a contract between the National Environmental Research Institute, Aarhus University and the Norwegian Directorate for Nature Management, funded by the Nordic Council of Ministers.

1.1 Acknowledgements

Updates on status and trends were supplied by the members of the project group. Special thanks in this context go to David Boertmann, Thomas Bregnballe, Tycho Anker-Nilssen, Hallvard Strøm, Ævar Petersen, Arnþór Garðarsson, Ian Mitchell, Roddy Mavor and Matt Parsons.

The following helped with various advice, or supplied unpublished or otherwise inaccessible data or reports on factors affecting seabirds: Flemming Merkel, Bergur Olsen, Ævar Petersen, Sarah Wanless, Tycho Anker-Nilssen, Thomas Bregnballe, Martina Kadin, Paul Thompson, Anders Mosbech, Leif Nilsson, Frank Rigét and Mike Harris. Maria Lifentseva compiled terms of reference for ICES WGSE for all years, and provided access to old reports. David Boertmann, Anders Mosbech, Mark Tasker and Ian Davies provided helpful comments on earlier drafts of the review.

Thanks to Norman Ratcliffe, Mark Tasker, Mike Harris, Sarah Wanless, David Boertmann, Svein-Håkon Lorentsen, Hallvard Strøm, Tycho Anker-Nilssen, Rob Barrett, Arnþór Garðarsson, Anders Mosbech, Flemming Merkel and Bergur Olsen, who provided their expert opinion on the ranking of threats facing seabirds in the Nordic seas.

2. Introduction

2.1 Background

Concerns over the well-being of seabird populations in the NE Atlantic have been growing over the last few years. In 2004, widespread breeding failures were observed in seabird colonies along the North Sea coasts of Scotland, including colonies and species which had otherwise shown stable high success since the beginning of standardised monitoring. It seemed clear that birds were unable to find sufficient, or sufficiently good, food to supply their growing chicks. These poor conditions continued with some local variation until 2008, and in addition to low breeding success, large population declines were observed in some colonies, particularly in Shetland. Colonies on the west coast of Scotland were also hit in some years. The species mainly affected were sandeel specialists, both surface feeders such as black-legged kittiwakes and Arctic terns, and pursuit divers such as common guillemots and Atlantic puffins. The regular reports of seabird breeding failures received widespread media coverage in the UK. The problem coincided with a period of consistent recruitment failure and very low catches of sandeels in the North Sea, and also with a population explosion of the previously rare snake pipefish. All these events were speculatively linked to climate change, not least in the popular press.

Around the same time, consistent breeding failures were also observed in less well-monitored seabird colonies in the Faroes and south Iceland. Again, sandeel-dependent species were worst hit, with most focus on Atlantic puffins. Inspired by an initiative from nature conservation societies in the Nordic countries, the Nordic Council of Ministers funded a workshop in Tórshavn in the Faroes in September 2007, where experts discussed status, problems and potential management actions for seabirds. The proceedings of the workshop were published as a report (Nordisk Ministerråd 2008). Subsequently, a process towards a Nordic Action Plan for Seabirds was initiated by the Nordic Council of Ministers, and a working group with representatives from the Nordic countries plus Scotland was established. The working group felt that the process towards an action plan required a more thorough review of the existing evidence on the status and trends of seabird populations and the factors affecting them. In the present document, I attempt to provide such a review.

2.2 Objective and scope

In the terms of reference for this review, the objective is defined as: "*… to prepare a literature review covering (1) status and trends of seabird populations within a defined geographical area, (2) review of the prevailing environmental and anthropogenic impact factors on the seabird populations, and (3) assess the relative importance of these impact factors on the seabird populations, i.e. drivers and causes for the trends described*". Within the time available, I have attempted to cover each of these points as well as possible; however, it should be noted that the field of research is large and that the present review does not claim to be exhaustive.

The geographical scope of the review has been agreed through consultation with the members of the working group. Scotland, the Faroes, Iceland and mainland Norway are included in their entirety (see figure 2–1). In addition, the review covers the Danish and Swedish coasts of Kattegat and Skagerrak, the Danish North Sea coast N of the Wadden Sea, Bear Island, East Greenland up to the Arctic Circle and West Greenland up 70° N. Marine areas included are thus the Norwegian Sea, the northern North Sea including Skagerrak and Kattegat, the southern Barents Sea and Greenland Sea, the North Atlantic west of Scotland, around the Faroes and south of Iceland, the Denmark Strait, and the western parts of the Labrador Sea and Davis Strait. The high-Arctic regions of Greenland and Svalbard are thus not included, and neither is the brackish Baltic Sea. Finding a descriptive name for this area is difficult, and in the review I have variously used the terms "NE Atlantic", "Nordic seas" and simply "study area".

The review covers seabird populations breeding within this area. Species only occurring in the area during the non-breeding season (high-Arctic breeders such as ivory, Sabine's and Ross's gull, and southern hemisphere breeders such as great and sooty shearwater) are thus not included. On the other hand, some seabirds breeding in the study area winter outside the area, and I have as far as possible included threats occurring in these more southerly wintering areas.

It is also necessary to define a taxonomic scope – which species are included as seabirds? There is no universally agreed definition, and I have here adopted the same definition as used in the earlier report (Nordisk Ministerråd 2008). This implies that species are included which are dependent on marine food resources throughout the year, the exceptions being that some gulls and skuas also take food of terrestrial origin, and that cormorants and some terns also take freshwater fish. The major groups included are thus tubenoses (fulmars, shearwaters and storm petrels), pelecaniforms (gannets and cormorants), marine ducks (eiders), and charadriiforms (skuas, gulls, terns and auks).

A listing and ecological classification of the species included is given in Section 0. This definition thus excludes several groups of birds which are seasonally dependent on the marine environment and may be exposed to the same anthropogenic impacts as the species included here, notably divers, grebes, and diving ducks other than eiders. The reason for excluding these species is mainly practical; in particular, due to their freshwater breeding habitat, they are not covered by the same monitoring programmes as the "proper" seabirds, and indeed data on status and trends for this group of species are notoriously poor. They are also poorly studied in terms of impact factors, but can probably in many cases be regarded as sufficiently ecologically similar to eiders that their sensitivity to the various impacts is similar as well.

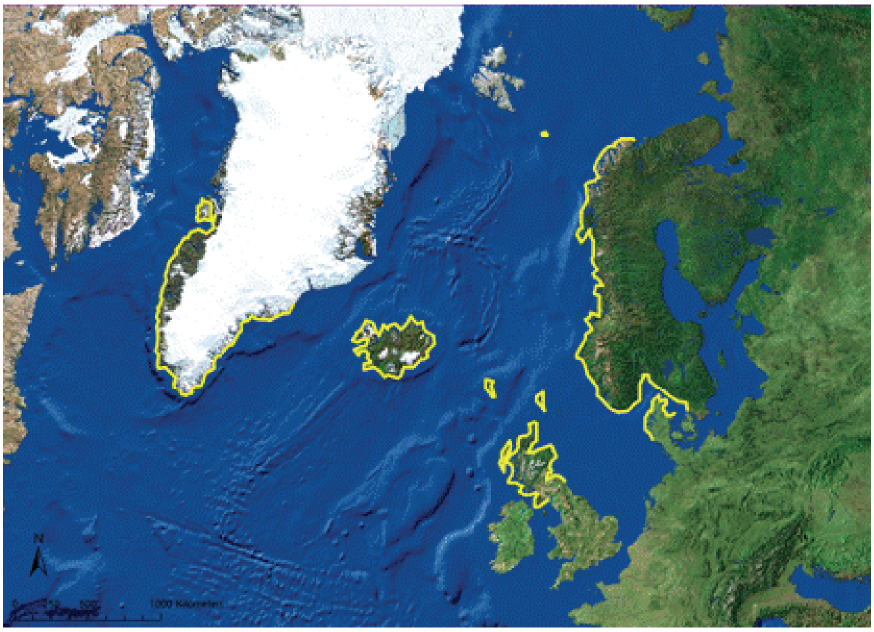

Figure 2–1. Approximate geographical scope of the review. Seabirds breeding along the sections of coast shown in yellow are included.

2.2 Glossary

The following list defines the most important ecological and other specialist terms used in this review.

Biomagnification: The phenomenon that the concentration of many fat-soluble contaminants increases with trophic level, so that predators show the highest concentration. Two mechanisms are involved: firstly, some fat-soluble contaminants are excreted slowly, and secondly most organisms metabolise these contaminants rather slowly. As a result, predators accumulate contaminants from their food and the concentrations of these substances can increase during a predator's lifetime.

Bottom-up control: The concept that the abundance of an organism is mainly controlled by the availability of resources, typically food (in contrast to top-down control by predation).

Demersal: Occurring at or near the sea floor.

Demographic models: Mathematical models which integrate knowledge about the average demographic performance of a given species or population, with the aim of projecting the growth rate of the population. These models can be used to predict the consequences of management actions or changes in the environment which affect mortality or fecundity.

Demographic performance: Measures of how well individuals perform under certain conditions in terms of producing offspring (breeding success) or surviving from year to year. Average values for demographic performance determine population dynamics, i.e. whether the population will increase, remain stable or decrease.

Ecological niche: The "role" a species plays in the ecosystem. This can be defined in many dimensions, including physical features (e.g. preferred temperature) and biological interactions (e.g. preferred prey), and in various degrees of detail. A given ecological niche requires a set of adaptations (including anatomy and physiology, as well as life history), which are shaped by evolution.

Ecosystem structure: A rather vague term indicating the make-up of ecosystems in terms of e.g. the relative abundance of species. As an example, human fisheries have changed the structure of marine ecosystems, so that they today contain fewer large fish (typically predators) than in the past.

Gadoids: Taxonomic group of fish including cod and its relatives (e.g. haddock, whiting, saithe).

Homeothermic: Physiologically able to maintain a constant body temperature despite variation in ambient temperature. Homeothermic organisms (birds and mammals) have high energy requirements and a wide temperature tolerance.

Kleptoparasitism: The habit of stealing prey from other birds. Skuas are specialist kleptoparasites and obtain a large proportion of their food in this way, but large gulls also habitually kleptoparasitise other birds.

Life history: The suite of characteristics which define the "way of life" of a certain species. This includes growth rate, age at maturity, typical lifespan, typical number of eggs produced etc. Certain characteristics generally occur together, for example in a typical seabird life history (see Section 0). Life histories are shaped by evolution, and reflect features of the environment and ecological niche of the species.

Pelagic: Of fish etc.: occurring in the open water column, i.e. well away from the sea floor. Of seabirds: occurring (or feeding) in the open sea, i.e. well away from the coast.

Phytoplankton: Minute algae which are the most important primary producers (i.e. at the lowest trophic level) in the open sea.

Poekilothermic: Having a body temperature determined by external conditions (ambient temperature and radiation). Poekilothermic animals (fish, reptiles, amphibians and all invertebrates) have low energy requirements and often a narrow temperature tolerance.

Piscivorous: Feeding mainly on fish.

Planktivorous: Feeding mainly on zooplankton, including e.g. copepods and krill.

Population dynamics: Fluctuations in the abundance of a species (or stock/population) over time. Driven by changes in demographic performance (survival and fecundity), and at the local scale also by emigration and immigration.

Recruitment: The process where young individuals join the breeding population of a species; a function of the production of young and their survival to breeding age. Central concept in fisheries biology.

Scavenging: In the context of seabirds, the habit of searching for any available food item at sea, often floating debris of various sorts. Scavenging seabirds are typically the primary exploiters of fishery discards.

Top-down control: The concept that the abundance of an organism is mainly controlled by predation, including e.g. human fisheries (in contrast to bottom-up control by food availability).

Trophic: Concerning the relationship between an animal and its food source.
Trophic level: A measure of where in the food web a certain species occurs (an aspect of the species” ecological niche). Primary producers (plants), which use sunlight and nutrients to produce organic matter, are at the lowest trophic level, while top predators such as polar bears are at the highest trophic level. Seabirds typically are at a high trophic level, because they feed

on fish, which again feed on zooplankton, which again feed on phytoplankton.

Wasp-waist control: The concept that fluctuations in the abundance of one or very few species of mid-trophic fish control the abundance of both their prey (zooplankton) and their predators (including seabirds). Many marine shelf ecosystems, particularly in colder waters, exhibit wasp-waist structure where diversity is much lower at the mid-trophic level than at lower and higher levels, but it is unclear how important wasp-waist control is.

Wing loading: The ratio of weight to wing area, a measure of how easy it is for a bird to remain airborne and thus how big a load it can carry. Birds with high wing loading have to fly fast and direct and can only carry a small load relative to their weight. Larger birds generally have a higher wing loading. Because diving places different demands on wing shape (small wings are advantageous), diving birds typically have very high wing loading and in extreme cases (penguins, great auk) have lost the power of flight.

Zooplankton: Small animals (from <1 mm up to ~2 cm) which feed on phytoplankton and are themselves eaten by larger zooplankton, pelagic fish, as well as some seabirds and marine mammals (including baleen whales). Some of the most important taxonomic groups are copepods and euphausiids (krill).

2.4 Seabird ecology and life history

Although they breathe air and breed on land, seabirds depend completely on food obtained at sea, and they are in effect marine organisms that happen to be more visible than e.g. fish. Two central constraints have shaped the evolution of seabird ecology and life history: 1) they are adapted to exploit resources that are widely scattered, highly dynamic and unpredictable in time and space, and 2) they are tied to land for breeding and thus need to combine the ability to fly between colonies and foraging areas with the ability to obtain food at or below the surface. The central features of seabird ecology are well described in several books (Furness & Monaghan 1987, Schreiber & Burger 2002, Gaston 2004).

Breeding seabirds are so-called central place foragers, meaning that they have to return periodically to the colony to either relieve an incubating/brooding mate or feed offspring. This restricts the area they can exploit during the breeding season, and is one of the factors promoting colonial breeding: the best sites within range of high-quality foraging areas are attractive to many individuals and species. Breeding seabirds typically have to travel considerable distances to obtain food and therefore feed their chicks at relatively low frequency. At the same time, seabirds (particularly diving species) have a high wing loading and thus can only transport a limited amount of food back to their offspring. These factors in combination place a premium on obtaining high-quality food with high energy content, typically lipid-rich pelagic fish.

Outside the breeding season, seabirds are much more free to follow the movements of their favourite prey. Some species become truly oceanic and may roam over the entire North Atlantic or further afield, while a few long-distance migrants spend the northern winter in the Southern Ocean. A few species (cormorants) have to roost on land and are thus tied to the coastline. Because birds can move with their resources, their requirement for high-energy food becomes less, although total energy requirements may increase with lower ambient temperatures. On the other hand, many of the favourite fish prey species become less available during the autumn and winter, as they move to deeper waters or bury in the sediment when phytoplankton productivity decreases. As a result, many seabirds switch diet outside the breeding season and feed more on invertebrates, including large zooplankton species.

The factors determining the breeding distribution of seabirds are not very well understood. Most species have fairly well-defined northern and southern range limits, which probably are ultimately shaped by climatic factors through the availability of favourite prey. Although most species show some flexibility in prey choice, many species require large concentrations of energy-rich pelagic fish near colonies during the breeding season, and this requirement may affect range limits. One of the best known examples concerns the little auk, which requires large lipid-rich crustaceans, e.g. copepods (*Calanus glacialis* and *C. hyperboreus*) or amphipods, for chick feeding. These species only occur at high density in high-Arctic waters, thus restricting the breeding range of this seabird.

Seabirds are adapted to an environment where conditions for raising offspring are difficult and uncertain (because of the requirement for sufficient high-quality food within range of colonies), whereas adults generally have few problems sustaining themselves. Their life histories reflect this, with investments in survival being much larger than in reproduction – when success is uncertain, it pays to distribute reproductive investments over many breeding seasons. A typical seabird life history accordingly includes long lifespan (i.e. low mortality of adults), delayed maturity (birds need to be several years old before they attempt to breed) and low fecundity (one or a few eggs laid annually). There is some variation around this theme, with the most pelagic species (having the longest commute between colony and feeding ground) typically being most long-lived. While many species produce no more than one offspring per year, some more coastal species can under optimal conditions produce three or four.

The consequence of this life history is that seabird populations in the short to medium term are much less sensitive to declines in breeding success than to declines in adult survival (Croxall & Rothery 1991). In other words, one or a few bad breeding seasons will have a small and delayed impact on population size in the following years, whereas increased mortality of adults will have an immediate and severe impact. However, a longer row of unsuccessful breeding seasons will lead to population decline, despite the often very long lifespan of the adults (see e.g. Section 0). Thus, population size will in most cases only change slowly as a consequence of an environmental impact, and will therefore be a very conservative indicator of the effect of environmental change. Breeding success is likely to react much faster to any deterioration in conditions (Cairns 1987), whereas adult survival in theory should only be affected when conditions are very poor.

2.4.1 Ecological classification of seabirds breeding in the Nordic seas

Seabirds can be classified into relatively few groups of ecologically similar species. The groups mainly reflect conditions during the breeding season; at other times of the year, they may be less accurate. The list below is adapted from Table 2 in Nordisk Ministerråd (2008), with the following changes:

- Arctic tern, common tern and little tern are here regarded as coastal surface feeders, as this better reflects their ecology during the breeding season.
- Conversely, lesser black-backed gull is regarded as a pelagic surface feeder.
- Sandwich tern has been added as a coastal surface feeder – this species was apparently forgotten in the preparations for the 2007 workshop.
- The exclusively high-Arctic breeding species king eider, ivory gull and Sabine’s gull are not included here.

A few species mentioned in the list only occur in small numbers or in a very limited part of the study area, and these species are covered in less detail: long-tailed skua, little gull, little auk.

Pelagic pursuit-diving	Razorbill Common guillemot Brünnich's guillemot Little auk Atlantic puffin
Pelagic surface-feeding (incl. plunge-diving and kleptoparasites)	Northern fulmar Manx shearwater European storm-petrel Leach's storm-petrel Northern gannet Arctic skua Long-tailed skua Great skua Lesser black-backed gull Black-legged kittiwake
Coastal benthic diving	Common eider
Coastal pursuit-diving	Great cormorant European shag Black guillemot
Coastal surface-feeding (incl. plunge-diving and kleptoparasites)	Iceland gull Glaucous gull Great black-backed gull Herring gull Common gull Black-headed gull Little gull Arctic tern Common tern Little tern Sandwich tern

2.5 Methods

2.5.1 Collecting evidence

In the terms of reference for this review, it is stated that "*The review shall be based on published scientific evidence*". Strict adherence to this principle would in my opinion be an unnecessary restriction of the evidence included, particularly because some subjects are poorly covered in the published literature. I have therefore interpreted the terms of reference more liberally and have included evidence presented in (published or unpublished) reports from e.g. ICES, CAFF and various research institutes in the involved countries. The review of factors affecting seabirds was thus based on a combination of a systematic literature search (using ISI Web of Science®), browsing reports from the Arctic Council's Conservation of Arctic Flora and Fauna (CAFF) and the ICES Working Group on Seabird Ecology (WGSE), web searches for published reports by other organisations, and contacts with researchers in the involved countries. Due to time limitations, the review cannot be regarded as exhaustive, but I believe that most major studies from the last twenty years or so are included. I have mainly used evidence from empirical studies in the study area, but in some cases it seemed relevant to refer to studies from other parts of the world, particularly as some aspects have not (yet) been studied in the NE Atlantic.

Furthermore, many data relating to recent updates on status and trends are not published at all, but held in databases, spreadsheets etc by a variety of organisations. Some countries publish more or less detailed (and more or less delayed) annual updates of status and trends (Mavor *et al*. 2008, JNCC 2009, Anker-Nilssen 2009, Lorentsen & Christensen-Dalsgaard 2009), but most of the involved countries do not. Thus, any overview of status and trends in the entire region based only on published evidence would inevitably be out of date. Here, I have therefore used all data available to me, i.e. what was submitted by the country representatives on the project group. These data constitute an update of the electronic Appendix to the report of the workshop in Tórshavn 2007 (Nordisk Ministerråd 2008).

2.5.2 Types and strength of evidence

Evidence for the impact of various anthropogenic factors on seabirds comes in various forms. The critical issue is whether the factor in question affects seabird populations (i.e. status and trends), but for many factors it is much easier to document impacts on individuals. In this report, I have tried to weight the available evidence according to its quality, reliability and generality. The most common types of evidence can be ranked in order of increasing strength:

- Anecdotal reports of mortality or reduced fecundity due to a given factor.
- Empirical (quantitative) evidence of mortality or reduced fecundity due to a given factor (e.g. number of birds drowned in nets). Studies covering larger areas are given more weight.
- Statistical evidence for a link between a given (quantified) factor and increases in mortality or reductions in fecundity at the population level.
- Demographic models translating statistical evidence for impacts on mortality/fecundity into population-level consequences (decline or reduced growth). Models based on theoretical considerations are given less weight.

2.5.3 Ranking the factors

No scientific studies (in the study area or elsewhere) have been able to simultaneously assess all the anthropogenic factors which can affect seabirds. Any overall assessment will therefore have to rely on expert opinion combined with a review of the available evidence. In order to provide a reasonably objective ranking of the importance of the various anthropogenic factors affecting seabirds in the study area, I decided to make use of the accumulated knowledge of a selection of researchers who between them have several hundred years of field experience working with seabirds in the North Atlantic (see list of contributors under Acknowledgements). I asked each expert to rank the expected threat over the next 10 years from each factor on each species (at the population level), on a scale from 0 to 3:

0) No threat
1) Minor threat
2) Moderate threat
3) Severe threat

3. Status and trends of seabirds in the NE Atlantic

3.1 Population status

The most recent data on the status (size) of breeding seabird populations in the Nordic countries (and the UK) were collated as part of the process leading up to the workshop in Tórshavn in September 2007, although the actual data were not included in the workshop report (Nordisk Ministerråd 2008). For this review, the national working group representatives were requested to update the spreadsheet produced in 2007, if new data were available. Furthermore, because the geographical scope differed from the earlier workshop, subsets of national data relevant to the present study area had to be extracted for Denmark, Sweden, Norway, Greenland and Scotland.

Numbers in the Table generally refer to breeding pairs. The exception is most of the auks (razorbill, common guillemot, Brünnich's guillemot, black guillemot), where numbers in some cases refer to individuals observed on the cliff or water. In the Table (next page), this is the case for Scotland, whereas the other countries have converted observed counts of individuals to numbers of pairs.

Thirty species of seabirds are included in Table 3–1 a-b. Of these, 13 species breed in Denmark (within the study area), 17 in Sweden, 26 in Norway, 20 in the Faroes, 23 in Iceland, 19 in Greenland, and 24 in Scotland. The most numerous seabird species in the NE Atlantic (excluding the high Arctic) are Atlantic puffin, northern fulmar, common guillemot and black-legged kittiwake, each of which has a total breeding population in the study area of more than 1 million pairs. At the other end of the scale, several species only occur in very low numbers (< 1000 pairs) close to their range edge: little gull, little tern and little auk. The roseate tern (not listed) could also be included in this group, as it has a tiny and irregular breeding population in Scotland.

Table 3-1a. Status of seabird populations in Denmark, Sweden, Norway and the Faroe Islands.

	Denmark[4]		Sweden[5]		Norway[6]		Faroes[7]	
	numbers	year	numbers	year	numbers	year	numbers	year
Northern fulmar					39,000	2005–06	600,000	1987
Manx shearwater							25,000	2002
European storm-petrel					1,000–10,000	1994	250,000	2002
Leach's storm-petrel					100–1,000	1994	1,000	2002
Northern gannet					4,500	2005	2,350	1995
Great cormorant	11,300	2009	3,050	2008	30,800	2005		
European shag			3	2007	24,000	2005	1,500	2002
Common eider	2,200	2008	30,000	2009	190,000	2005	6,000	2002
Arctic skua			50–75	2004–07	5–9,000	1994–95	900	2003
Long-tailed skua					1–5,000	1994		
Great skua					475	2005–06	500	2002
Iceland gull								
Glaucous gull					650	2006		
Great black-backed gull	1,200	2000	7,500	2000	53,000	2005	1,200	1981
Herring gull	17,000	2008	20,000	2000	233,000	2005	1,500	1981
Lesser black-backed gull	2,800	2008	9,800	2006	50,000	2005	9,000	1981
Common gull	5,600	2008	10,000	2000	135,000	2005	1,000	1981
Black-headed gull	16,000	2008	5,000	2002–06	1,000	1990s	150	1981
Little gull					0–10	1994		
Black-legged kittiwake	420	2005	32	2008	466,000	2005–06	160,000	1999
Arctic tern	1,300	2009	230	2008	35,000	2005–06	7,600	2003
Sandwich tern	2,200	2009	50	2008				
Common tern	130	2009	6,200	2008	11,000	2005		
Little tern	100	2009	55	2008				
Razorbill			6	2008	25,000	2005–06	4,500	1987
Common guillemot			11	2008	100,000	2005–06	100,000	1999
Brünnich's guillemot					130,000	2005–06		
Little auk					+	2006		
Black guillemot	1,300	2009	950	2008	35,000	2005–06	3,500	2002
Atlantic puffin					1,700,000	2005–06	550,000	1987

[4] Sources: NERI, K.T. Pedersen, U.M. Berthelsen & S. Asbirk, unpubl. data; Bregnballe & Eskildsen (2009); Lyngs (2008).

[5] Source: L. Nilsson, unpubl. data.

[6] Sources: Barrett *et al.* (2006); Strøm (2007).

[7] Source: B. Olsen, pers. comm.

Table 3–1b. Status of seabird populations in Iceland, Greenland and Scotland.

	Iceland[8]		Greenland[9]		Scotland[10]	
	numbers	year	numbers	year	numbers	year
Northern fulmar	1–2,000,000	1995	>25,000	1996	485,852	1998–2002
Manx shearwater	7–10,000	1995			141,701	1998–2002
European storm-petrel	50–100,000	1995			21,370	1998–2002
Leach’s storm-petrel	80–90,000	1995			48,047	1998–2002
Northern gannet	31,500	2006–08			182,511	2003–2004
Great cormorant	4,127	2008	5,000	2005	3,626	1998–2002
European shag	4,900	2007			21,487	1998–2002
Common eider	300,000	1995	6,000	2008	31,650[11]	1988–1991
Arctic skua	5–10,000	1995	<3,000	2008	2,136	1998–2002
Long-tailed skua			5–10	1994		
Great skua	5,400	1984–85			9,634	1998–2002
Iceland gull			50,000	2005		
Glaucous gull	8,000	1995	5,000	2005		
Great black-backed gull	15–20,000	1998	<5,000	2005	14,776	1998–2002
Herring gull	5–10,000	1995	<50	2008	72,130	1998–2002
Lesser black-backed gull	25,000	1995	1,000	2008	25,057	1998–2002
Common gull	700	2000			48,113	1998–2002
Black-headed gull	25–30,000	1995	5–50	1996	43,191	1998–2002
Little gull						
Black-legged kittiwake	630,000	1983–85	110,000	2008	282,213	1998–2002
Arctic tern	250–500,000	1995	65,000	2003	47,306	1998–2002
Sandwich tern					1,068	1998–2002
Common tern					4,784	1998–2002
Little tern					331	1998–2002
Razorbill	380,000	1983–85	2,600	2007	139,186[12]	1998–2002
Common guillemot	990,000	1983–85	<1,000	2007	1,167,841	1998–2002
Brünnich's guillemot	580,000	1983–85	15,000	2007		
Little auk			500	2007		
Black guillemot	10–15,000	1998	20,000	2007	37,505	1998–2002
Atlantic puffin	2–3,000,000	1995	3,000	2007	493,042	1998–2002

3.2 Population trend

For the 2007 report, participants also assessed the current trend (over the most recent 5 years) for each seabird species. For this review, national representatives were asked to update this information. In most cases, estimated trends were based on a combination of a few, possibly non-representative counts and expert judgement. However, for Scotland quantitative trends were estimated from annual sample counts in the Seabird Monitoring Programme whenever possible. Trends are categorised as increasing (i), probably increasing (i?), no overall trend (not), probably decreasing (d?), decreasing (d) or unknown (?), and in the Table below they are colour-coded accordingly from green to red. For Scotland, five-year trends >25% were

[8] Source: Petersen (2000), Garðarsson (1995, 1996, 2008a, 2008b), Garðarsson & Petersen (2009), Petersen & Thorstensen (2004)

[9] Sources: D. Boertmann unpubl. data; Boertmann (1994, 2006, 2008a, 2008b); Egevang & Boertmann (2003); Mosbech *et al.* (2009); Nyeland & Mathæussen (2004); Merkel *et al.* (2010); Merkel (2008); Labansen *et al.* (2010).

[10] Sources: Mitchell *et al.* (2004); Wanless *et al.* (2005b); unknown source for common eider.

[11] Refers to the entire UK.

[12] Refers to numbers of individuals

categorised as i, 11 to 24% as i?, -10 to 10% as not, -24 to -11% as d? and <-25% as d.

	Denmark	Sweden	Norway	Faeroes	Iceland	Greenland	Scotland
Northern fulmar			not	d	d	not	not[13]
Manx shearwater				?	d?		?
European storm-petrel			?	d	?		?
Leach's storm-petrel			?	d?	?		d
Northern gannet			i?	i	i		i[14]
Great cormorant	d	i	not?		i	i	d[133]
European shag		?	not	not	d		d[13]
Common eider	i	d	not	i	not	i	?
King eider			?				
Arctic skua		d	?	d	?	?	i?[13]
Long-tailed skua		?	?			not	
Great skua			i	not	d		i[13]
Iceland gull						i?	
Glaucous gull			?		d	not	
Great black-backed gull	i	not	not	not	d	i	d?[13]
Herring gull	not	d	not	not	i?	not	d[13]
Lesser black-backed gull	d	not	d?	d	d	i	i?[14]
Common gull	d	not	d	not	not		i[14]
Black-headed gull	d	d	?	d	d	not	d[14]
Little gull			i?				
Ivory gull			d?				
Black-legged kittiwake	not	not	d	d	d	d	d[13]
Sabine's gull			?				
Arctic tern	d	not	d?	d	d	d?	not[133]
Sandwich tern	not	d					d?[133]
Common tern	d		d?				not[13]
Little tern	not	not					not[13]
Razorbill		i	d?	d?	d?	not	i?[14]
Common guillemot		i	d	d	d	d	d?[13]
Brünnich's guillemot			d		d	d	
Little auk			?			d?	
Black guillemot	i	d	d?	i?	d	not	i[13]
Atlantic puffin			d	d	d	d	i[14]

Some overall patterns clearly emerge from this overview. Here, I comment briefly on the most obvious of these patterns. A number of species are declining in (nearly) all countries, or at least wherever the trend is known: black-legged kittiwake, Arctic tern, black-headed gull, Brünnich's guillemot, Arctic skua. Fewer species show generally increasing trends: northern gannet, great skua.

The black-legged kittiwake, Arctic tern and Arctic skua are surface feeders with high foraging costs, and they are regarded as very sensitive to fluctuations in prey abundance (Furness & Tasker 2000). In a large part of their range, they feed mainly on sandeels, and the wide-ranging and sustained breeding failures observed for these species in Scotland have been convincingly linked to a lack of this key prey species (Heath *et al*. 2009). Observed patterns are very similar in other countries and it is highly likely that lack of

[13] Quantitative trend estimated from Seabird Monitoring Programmeme
[14] Trend covers a 15-year period from 1985-88 to 1998-2002

food also occurs there. The underlying causes for the lack of sandeels and other small fish are less clear, but are probably linked to a combination of climate change and competition with fisheries, with some regional variation (see Section 4). Similar, but less widespread problems are observed for diving species relying on the same prey species, particularly European shag, common guillemot and Atlantic puffin.

The causes for the decline of the Brünnich's guillemot probably vary regionally. In Norway (and possibly Iceland), low food availability with potentially complex causes (similar to the scenario described above) is important, while a combination of hunting, bycatch and oil pollution (all three factors also operating in the winter quarters) is likely behind the decline observed in Greenland and Iceland. Bycatch and oil pollution may also be important in Norway.

To the best of my knowledge, the causes for the widespread decline of the black-headed gull are not understood. This species is a generalist and feeds in both marine, freshwater and terrestrial habitats, so it is difficult to pinpoint simple candidate explanations. Clearly, more research is needed in order to come up with relevant management actions.

The increase of the great skua is likely due to the widespread availability of fishery discards. With the recent decline of this food source, predation from great skuas has contributed to the problems experienced by other species, particularly the Arctic skua. Although the world population of the great skua still is fairly low (almost the entire population breeds in the present study area), this species thus has a large impact on sympatric seabirds. The availability of discards may also contribute to the continuing increase of the northern gannet, although this species may also still be recovering from past harvest and persecution.

3.3 Red list status

The following Table shows the official red list status of the seabird species treated here in each country, and internationally according to the International Union for the Conservation of Nature (IUCN)[15]. In the absence of input from national working group representatives, the red lists for Sweden[16] and UK[17] were obtained from web sources. The categories used are defined by IUCN, in decreasing order of threat: RE, regionally extinct; CR, critically endangered; EN, endangered; VU, vulnerable; NT, near threatened; LC; least concern. Higher threat categories are shown in redder colours. These categories are in principle objectively defined, but some room for interpretation exists. It is worth noting that:

---

[15] http://www.iucnredlist.org/, accessed 9 April 2010.
[16] http://www.artdata.slu.se/rodlista/, accessed 12 April 2010.
[17] Spreadsheet downloaded from http://www.jncc.gov.uk/page-1769, accessed 12 April 2010.

- Some lists are more up to date than others. For example, the Icelandic list dates from 2000 and is due to be updated soon.
- The UK does not use the IUCN criteria for birds. Instead, species are listed as red, amber or green. In the Table, I have loosely equated “red” with VU, “amber” with NT, and “green” with LC.
- The list given for Norway applies to the mainland. Svalbard (including Bear Island) has a separate red list, not shown here.

	Denmark	Sweden	Norway	Faroes	Iceland	Greenland	UK	IUCN
Northern fulmar			LC	LC	LC	LC	Amber	LC
Manx shearwater				VU	VU		Amber	LC
European storm-petrel			LC	LC	VU		Amber	LC
Leach's storm-petrel			NT	VU	VU		Amber	LC
Northern gannet			LC	VU	VU		Amber	LC
Great cormorant	LC	LC	LC	RE	LC	LC	Amber	LC
European shag		LC	LC	NT	LC		Amber	LC
Common eider	LC	LC	LC	NT	LC	VU	Red	LC
Great skua			LC	VU	LC		Amber	LC
Arctic skua		LC	NT	EN	LC	LC	Red	LC
Long-tailed skua			LC			LC		LC
Common gull	LC	LC	LC	NT	LC		Amber	LC
Great black-backed gull	LC	LC	LC	NT	VU	LC	Amber	LC
Glaucous gull					LC	LC		LC
Iceland gull						LC		LC
Herring gull	LC	LC	LC	NT	LC		Red	LC
Lesser black-backed gull	LC	VU	CR (ssp. *fuscus*)	NT	LC		Amber	LC
Black-headed gull	LC	LC	NT	VU	LC	VU	Amber	LC
Little gull	RE	LC	LC					LC
Black-legged kittiwake	NT	EN	VU	VU	LC	VU	Amber	LC
Sandwich tern	LC	VU					Amber	LC
Common tern	LC	LC	VU				Amber	LC
Arctic tern	LC	LC	LC	EN	LC	NT	Amber	LC
Little tern	NT	VU					Amber	LC
Little auk			LC		RE	LC		LC
Common guillemot	NT	LC	CR	EN	LC	EN	Amber	LC
Brünnich's guillemot			NT		VU	VU		LC
Razorbill	NT	LC	LC	EN	LC	LC	Amber	LC
Black guillemot	LC	LC	NT	NT	LC	LC	Amber	LC
Atlantic puffin		RE	VU	NT	LC	NT	Amber	LC

4. Environmental and anthropogenic factors affecting seabirds in the NE Atlantic

4.1 Fisheries-related factors

Human fisheries have profoundly altered the structure and function of marine ecosystems worldwide by selectively removing large fish with slow growth and late maturity (e.g. Pauly & Maclean 2003), and inevitably they affect seabirds in many ways (Tasker *et al*. 2000, ICES 2000, Furness 2003). These effects can broadly be categorised as follows: direct mortality from bycatch in fishing gear, decreased demographic performance (survival or fecundity) due to depletion of food stocks, provision of extra food in the form of discards, with associated direct and indirect effects, and indirect effects of altered ecosystem structure, where fisheries favour certain non-target species.

4.1.1 Bycatch

Unintentional capture of non-target organisms in fishing gear (bycatch) is widely recognised as a serious threat not only to seabirds, but also to e.g. sea turtles and marine mammals (Tasker *et al.* 2000, Lewison *et al*. 2004). Bycatch of large numbers of seabirds has been recorded in many types of fishing gear throughout the world, with long-lines and gillnets most often involved. A particularly dramatic example concerns albatrosses, where bycatch in long-line fisheries mainly in the Southern Ocean has led to large increases in mortality of adult breeders (e.g. Weimerskirch *et al.* 1997), with resulting declines in population size being so severe that 18 out of 22 extant species have now been red-listed as critically endangered, endangered or vulnerable[18].

Until recently, bycatch issues have received relatively little attention in the study area and in European waters in general, and there are few quantitative studies available. Useful overviews were given by Bakken & Falk (1998) for the circumpolar Arctic, by ICES WGSE for EU waters (ICES 2008), and by Christensen-Dalsgaard *et al.* (2008) for Norway. Few studies have tried to quantify bycatch (number of birds killed) on more than a local scale, and none of these have evaluated quantitatively the impact of bycatch on seabird popu-

[18] http://www.rspb.org.uk/supporting/campaigns/albatross/about/species/index.asp, accessed 4 February 2010.

lations (individual species or in general) in the study area, so the following review is based mainly on anecdotal evidence and expert opinion.

The only country in the study area currently conducting regular monitoring of seabird bycatch is Greenland, where all fishers are required to report bycatch to the national database. Bycatch statistics are thus available since 2004, although their reliability is unknown, and so far they have seen little use (F.R. Merkel, pers. comm.). In Norway, a sampling-based monitoring scheme for bycatch is under development (Christensen-Dalsgaard *et al.* 2008).

Worldwide, long-lining has generally been regarded as the most damaging fisheries practice in terms of bycatch, but the available evidence suggests that it is of less importance in the Nordic Seas, with only northern fulmars being caught regularly in large numbers (Dunn & Steel 2001). The magnitude of this bycatch is uncertain, but Dunn & Steel (2001) suggested that the Norwegian, Faroese and Icelandic long-lining fleets in total may catch up to 100,000 northern fulmars annually. This number has to be seen in the context of a population at risk that is very large (several million birds). The contrast between the North Atlantic and e.g. the Southern Ocean in terms of bycatch problems associated with long-lining is probably due to differences in the composition of seabird communities: albatrosses and large petrels are the most common victims of long-lining, and the northern fulmar is the only representative of this group breeding in the North Atlantic. Furthermore, mitigation measures are readily available (Dunn & Steel 2001, ICES 2008) and advantageous for fishers to use (because loss of bait to scavenging seabirds is minimised), so long-lining bycatch is unlikely to become a major conservation concern in the study area.

Some of the textbook examples of high bycatch of diving seabirds in drift or gillnets come from the study area. During 1965–75, an intensive salmon drift net fishery took place off West Greenland in autumn, and the annual bycatch of Brünnich's guillemots associated with this fishery in 1969–71 was estimated to 540,000 (Tull *et al.* 1972). In April 1985, cod gillnet fisheries in a small area of north Norway caught an estimated 200,000 mainly common guillemots (Strann *et al.* 1991). Nevertheless, bycatch in net fisheries has received little attention in the North Atlantic until very recently. A recent review (Žydelis *et al.* 2009) concluded that perhaps 100,000 – 200,000 birds (including e.g. ducks not included in this review) drown annually in gillnets in the Baltic and North Seas, although very few studies were available from the North Sea. If these findings can be extrapolated to the entire study area, bycatch in nets may be a significant conservation concern for at least some species. A few regional studies support this:

- Gillnets for cod and lumpsucker probably kill tens of thousands of birds annually in Iceland, primarily auks, cormorants and common eiders (Petersen 2002).

- Around Nuuk in West Greenland, drowning in lumpsucker nets caused substantial mortality of adult common eiders in spring (Merkel 2004b). Bycatch mortality was of the same order of magnitude as hunting, and 1500 – 2000 birds were estimated to drown annually in the Nuuk area alone.
- On the west coast of Sweden, Lunneryd *et al.* (2004) estimated that more than 2000 great cormorants and 300 – 400 common eiders and common guillemots drowned annually in nets.
- In northeast Scotland, 2400 common guillemots and razorbills were estimated to drown in salmon nets in 1992, although this number was considered trivial relative to the size of the breeding populations (Murray *et al.* 1994).
- Using ring recoveries, Bregnballe & Frederiksen (2006) showed that many (particularly first-year) Danish great cormorants drowned in nets in Kattegat and the western Baltic, but that the proportion drowned among all birds recovered declined as the population increased.

The review by Christensen-Dalsgaard *et al.* (2008) also concluded that the largest seabird bycatch problems in Norway were likely to be associated with gillnets for cod and lumpsucker. This conclusion can probably be generalised to the entire study area. The species most at risk are likely to be those foraging at or near the bottom at the time and place when fisheries take place, including auks (common guillemot, razorbill, black guillemot), cormorants (great cormorant, European shag) and seaducks (common eider). Although some recommendations for mitigation measures are available (e.g. Melvin *et al.* 1999), solutions which are also advantageous for fishers and thus likely to be widely adopted are less obvious than for long-lining (Bull 2007).

Trawl fisheries have generally been assumed to cause relatively little bycatch of seabirds. However, recent studies in the south Atlantic (e.g. Watkins *et al.* 2008) have shown that considerable numbers of large scavenging birds (e.g. albatrosses and gannets) drown after colliding with trawl warps and being dragged under. Consistent with this, the only available study from the North Atlantic (Pierce *et al.* 2002) found that northern gannets were the only species which was occasionally drowned in trawl fisheries around Scotland. Considering that trawl fisheries are very important and widespread in the study area, more surveys of seabird mortality seem warranted.

Conclusions: Bycatch in fisheries gear is most likely to be a serious conservation issue when intensive net fisheries coincide in time and space with concentrations of vulnerable species (see above). The largest problems can thus be anticipated year-round in Iceland, Norway and west Greenland, and in Kattegat and Skagerrak in autumn and winter when large numbers of auks are present. Bycatch on long-lines is likely to be a smaller problem in the study area.

4.1.2 Depletion of food stocks

Most seabirds in boreal and Arctic waters are highly dependent on a reliable supply of small, planktivorous, lipid-rich pelagic fish, at least for raising chicks successfully. In the Nordic seas, this ecological niche is occupied by a small number of species which can be extremely abundant. The most important species are European sprat (temperate, mainly North Sea), sandeel (boreal – low Arctic), young herring (mainly boreal), capelin (low Arctic) and polar cod (low – high Arctic), with typically only one or two species being important at any location. These mid-trophic pelagic fish often show very large fluctuations in abundance, which can have drastic effects on both lower and higher trophic levels, so-called wasp-waist control (Rice 1995, Cury *et al*. 2000). Planktivorous fish are generally too small to be of interest for human consumption despite their high abundance, and fisheries on these species consequently developed relatively late with the advent of fishmeal factories in the 1950s. The most important fishmeal fisheries in the study area are (or were) sandeel in the North Sea, European sprat in the North Sea, Blue whiting in the Norwegian Sea, herring in the Norwegian Sea, and capelin in the Barents Sea and around Iceland. Because many of these fisheries target the same stocks that many seabirds rely on for successful reproduction, they potentially compete directly with the birds for resources, and if fisheries deplete these stocks consequences for seabird populations can be severe (Furness 2003, Gislason 2003). This issue was reviewed twice by the ICES Working Group on Seabird Ecology (ICES 1994, 2000).

One of the best-documented examples of the effect depletion of fish stocks can have on seabird populations concerns the very large colony of Atlantic puffins on Røst in Lofoten in west Norway. At this colony, puffins are completely dependent on an adequate supply of young herring for successful reproduction (Barrett *et al*. 1987, Anker-Nilssen 1992). Overfishing of the previously very large stock of Norwegian spring-spawning herring in the 1960s led to a collapse (Hamre 1994), which in turn caused more or less complete breeding failure for puffins at Røst in most years during 1969–1987 (Anker-Nilssen *et al.* 1997). The long-term consequence was a 65% decline in the size of the breeding population (formerly approximately 2 million pairs) from 1979 to 1996 (Anker-Nilssen *et al.* 1997).

During the 1990s an intensive sandeel fishery occurred off the east coast of Scotland, within foraging range of large seabird breeding populations. Sandeels in this area belong to a separate aggregation showing different dynamics and life history characteristics than in other parts of the North Sea (Pedersen *et al*. 1999, Boulcott *et al*. 2007). Breeding success of black-legged kittiwakes was depressed during this period at the Isle of May (Frederiksen *et al.* 2004) and other colonies (Frederiksen *et al.* 2007c), while there was no suggestion of negative effects on breeding success or chick condition for four species of diving seabirds (Frederiksen *et al.* 2008b). A demographic model indicated that the black-legged kittiwake population was likely to decline if the local sandeel fishery is reopened, even if no further increases in sea temperature occur (Frederiksen *et al.* 2004). There are no long-term fisheries-independent data on sandeel abundance in the area, so it is not possible to document whether the local sandeel aggregation was depleted by the fishery. Black-legged kittiwakes are regarded as more sensitive to changes in food abundance than diving seabirds (Furness & Tasker 2000), so the observed pattern is consistent with a moderate depletion which would affect only the most sensitive species.

Conclusions: Lack of suitable prey is clearly one of the most serious problems facing seabirds in the Nordic seas, particularly during the breeding season when birds are spatially restricted and food requirements in terms of quantity and especially quality are higher. Large-scale fisheries targeting important seabird prey (small pelagic fish) potentially cause depletion of stocks, which can affect breeding seabirds severely. These problems are most likely to occur in areas with large fishmeal fisheries (e.g. North Sea, Barents Sea), and the worst-hit species will be surface feeders with access to only a small part of the total prey stock (black-legged kittiwakes, terns, skuas). However, fish abundance is often driven by a complex array of factors (including natural and anthropogenic variation in climate), and determining the exact contribution of fisheries to stock crashes can be exceedingly difficult (see Section 0). The role of fisheries should thus be evaluated on case-by-case basis, taking into account all available evidence on other contributing factors.

4.1.3 Discards

Fisheries for human consumption produce large amounts of discards, either in the form of unwanted non-target species, undersize or otherwise undesirable individuals of target species, or offal (livers and intestines) of fish cleaned at sea. In contrast, industrial fishmeal fisheries in principle produce no discards. Discards are primarily utilized by surface-feeding seabirds, often species with an opportunistic, scavenging life style. In the study area, the dominant species exploiting discards are typically large gulls (great black-backed, glaucous, herring and lesser black-backed), great skuas and sometimes northern gannets (Garthe *et al.* 1996). Northern fulmars are also numerous at discarding vessels, whereas smaller gulls (black-legged kittiwake, common gull, black-headed gull) due to their lower competitive ability mainly take discards when larger species are absent.

Discards and the birds exploiting this resource have been well studied in the North Sea (mainly through several EU-funded collaborative research projects), whereas there are very few studies from more northerly parts of the study area. The amounts of fish discarded in the North Sea in 1990 was estimated at 789,000 tonnes (or 22% of reported landings), in theory enough to supply the energetic needs of 5.9 million scavenging seabirds (Garthe *et al.* 1996). A much more difficult question is which effects the availability of this food, typically demersal fish species not normally available to surface feeding seabirds, has had on populations of the involved species. Fisher (1952) famously proposed that the huge expansion in range and population size by northern fulmars since the 17^{th} century was linked to exploitation of offal and discards. While the validity of this hypothesis is difficult to test, more recent studies indicate that fulmar at-sea distribution is more closely linked to oceanographic features than to availability of discards (Camphuysen & Garthe 1997), and that while discards constitute an important fraction of fulmar diet in some areas, they are rarely the most important food item (Phillips *et al.* 1999). It thus seems unlikely that the current range and population size of fulmars is limited by the availability of discards, and that current and future reductions in amounts of discards will have widespread negative effects on this species.

Although there are no quantitative studies to support this, it seems likely that populations of large gulls and great skuas in the study area have been artificially inflated through the provision of large amounts of discards (and domestic refuse for gulls). Recent changes in fishery landings and practices have led to declines in discard availability, which are likely to continue. These species are opportunistic generalists, and when one important food source disappears, they will try to compensate by increasing their consumption of other prey – which may include other seabird species. A well-studied example of this concerns great skuas in the Northern Isles of Scotland (home to 60% of the world population (Furness & Ratcliffe 2004)). Great skuas in this region are highly dependent on discards (Votier *et al.* 2008), and in years when the availability of both discards and sandeels (the most important alternative fish prey) is low, they turn their attention to chicks and adults of other seabirds (Votier *et al.* 2004). Predation by great skuas has had negative effects on populations of black-legged kittiwakes (Heubeck *et al.* 1997) and Arctic skuas (Jones *et al.* 2008b). Inflated populations of large gulls due to discards may also affect smaller seabirds such as terns negatively through increased nest predation and kleptoparasitism, as well as displacement from high-quality nest habitat (ICES 1997), although these problems may be more important in the southern North Sea, i.e. outside the study area.

Another potential effect of discards on seabirds is a change in the quality of food delivered to chicks. A large proportion of all discards consist of demersal fish, which are typically less lipid-rich and thus have lower energy content than schooling pelagic fish, the stable prey of most piscivorous seabirds. In South Africa, Grémillet *et al.* (2008) showed that Cape gannets raised very few chicks when stocks of pelagic prey were low, although discards of demersal fish were easily available. This issue has not been studied in the North Atlantic.

Conclusions: The availability of discards is highly likely to have allowed large population increases of scavenging species. Future reductions in the amount of discards may have negative consequences locally for both these species and other seabirds which may be exposed to increased predation pressure, but may in the longer term reduce populations of predators and thus limit potential predation.

4.1.4 Ecosystem effects

Historically, human fisheries have preferentially removed large fish (species and individuals) and have thus caused major changes in size distribution and ecosystem structure (Pauly *et al*. 1998, Pauly & Maclean 2003). The removal of large, slow-growing mainly predatory fish (primarily gadoids) may have benefitted the stocks of small, fast-growing planktivorous "forage" fish that most seabirds depend on (Sherman *et al.* 1981), and thus allowed positive growth of most seabird populations in the UK (and perhaps elsewhere in the NE Atlantic) during the 20th century (ICES 2000). Likewise, the almost total removal of large whales from North Atlantic ecosystems is likely to have had profound effects. Documenting such effects is extremely difficult, mainly because little or no data are available on stock size of forage fish in the past. We simply do not know how many e.g. sandeel or capelin there were before the start of the respective fishmeal fisheries, and evidence for an increase in these stocks as the intensity of human consumption fisheries increased during the first two thirds of the 20th century is difficult to come by.

Evidence for contemporary top-down control of forage fish stocks by predatory fish would provide indirect support for this scenario: if e.g. sandeel stocks are smaller in years when their predators are abundant, this might indicate that there were many fewer sandeels in the past when fish predator stocks were much larger. Around Shetland, there is a strong negative correlation between the size of the local sandeel stock and the spawning stock of herring in the North Sea (Frederiksen *et al.* 2007b), herring being an important predator of sandeel larvae. The recovery of the North Sea herring stock following overfishing in the 1970s may thus have contributed to the decline of the Shetland sandeel stock and consequent declines in seabird breeding success, although other factors almost certainly also have been involved (see Section 0).

Conclusions: Recovery of stocks of predatory fish may in some cases lead to decreases in the abundance of their fish prey, which could be detrimental to seabirds. However, such a mechanism is only expected to be important if forage fish abundance is mainly regulated by top-down control through predation, as opposed to bottom-up control through food availability.

4.2 Hunting and other types of intentional killing

4.2.1 Hunting

Hunting (harvest) of seabirds has a long tradition in the N Atlantic, and particularly in the more remote Arctic and maritime areas it is still an important activity, although recreational and cultural aspects are often more important than the nutritional or economic value. A useful overview of the history and current state of seabird harvest in the Arctic part of the region (Greenland, Iceland, Faroes, and northern Norway) is provided by Circumpolar Seabird Group (2008). A brief summary of the current state follows.

In Greenland, hunting pressure on seabirds was very high until fairly recently, when modern regulations were introduced starting in 2002, including shorter open seasons and prohibiting hunting during the breeding season with few exceptions (Merkel & Christensen 2008). Twelve species covered in this report can be hunted legally. Quite large numbers of birds are still taken, with Brünnich's guillemot as the most important, followed by common/king eider, little auk, black guillemot and black-legged kittiwake. In Iceland, most seabird species can be (and are) hunted; the numerically most important species are Atlantic puffin and common guillemot, while the highest hunting pressure in relation to population size occurs for European shag, great cormorant and the large gulls (Petersen 2008). Although decreasing in economic importance, seabird hunting is still widespread in the Faroes and most species can be hunted; the most important species are northern fulmar and Atlantic puffin (Olsen 2008). In Norway, few seabirds (6 species covered in this report) can be legally hunted, with common eider and great cormorant being the most popular (Strøm *et al.* 2008). Sweden only allows hunting of common eider and three gull species, and estimated numbers shot are low (Kindberg *et al.* 2009). Similarly, in Denmark only 4 species covered in this report can be hunted, of which only common eiders are taken in appreciable numbers (Noer *et al.* 2009). In Scotland, no seabirds can be legally taken as quarry, although an annual harvest of 2000 northern gannet chicks ("gugas") on the tiny island of Sula Sgeir is allowed by special dispensation (Murray 2008).

Bag statistics exist for most countries in the region. Registered hunters are typically required to submit data on how many birds they killed in the previous year in order to renew their annual license. Sweden implemented bag statistics in 1939 (not compulsory), Denmark in 1941, Norway in 1971 (compulsory from 2000), Greenland in 1993 and Iceland in 1995. Scotland and the Faroes have not implemented bag statistics.

While time series of the number of birds taken thus are available in several countries (e.g. Circumpolar Seabird Group 2008, Noer *et al.* 2009), there are very few empirical studies evaluating the impact of seabird hunting at the population level in this region. Historically, the traditional seabird harvest as carried out in e.g. the Faroes has been regarded as sustainable (Nørrevang 1986), although there is little empirical evidence to support this – other than the persistence of most exploited seabird populations over centuries. At the very general level, it is highly likely that the large increases in population size of most seabirds in the UK and elsewhere in Western Europe during the 20th century were at least partly due to increased protection from hunting and persecution (Ratcliffe 2004). The best evidence for population-level impacts of hunting in the region comes from Greenland, where hunting pressure at least historically has been considerably higher than in other countries, and where breeding populations of most seabirds declined dramatically throughout the 20th century in the more populated areas (e.g. Burnham *et al.* 2005).

Two of the main quarry species which have shown pronounced population declines in W Greenland are common eider (Merkel 2004a) and Brünnich's guillemot (Kampp *et al.* 1994). Before the change in legislation in 2002, hunting pressure on common eiders was very high and probably unsustainable (Gilliland *et al.* 2009). In the new regulations, the open season was shortened and the spring hunt was banned, leading to a ~ 70% decline in the hunting bag (F. Merkel pers. comm.). Extensive monitoring in northern W Greenland has documented a large (> 200%) population increase from 2000 to 2007 (Merkel 2008), supporting the role of hunting in limiting eider population growth. Hunting has almost certainly caused very large declines and local extinction of Brünnich's guillemot in large parts of W Greenland (Kampp *et al.* 1994, Falk & Kampp 2001). The new legislation in 2002 brought similar changes for Brünnich's guillemot as for common eider and a > 50% decline in the hunting bag (F. Merkel pers. comm.), but so far breeding populations have not been shown to recover (Mosbech *et al.* 2009). This may be due to intrinsic features of guillemot biology (long generation time and low maximum population growth rate), to insufficient monitoring, or to recovery being prevented by other factors acting on the population.

Conclusions: Hunting clearly is a potentially very important pressure on seabird populations, which can cause declines and local extinctions. Historically, the great auk was exterminated by overharvesting, and the combination of hunting and persecution caused regional extinctions of e.g. great cormorants in Denmark and the Faroes and of Brünnich's guillemots in parts of W Greenland. More recently, hunting pressure has decreased in most if not all countries, and the importance of this impact on seabird populations is clearly reduced. However, some species and populations are still affected by substantial hunting, which in combination with other factors may cause declines or limit recovery from earlier overharvesting. Examples include common eiders in Denmark, Atlantic puffins in the Faroes, great cormorants and European shags in Iceland, and Brünnich's guillemots in Greenland.

4.2.2 Culling and persecution

Some seabirds are notoriously unpopular, e.g. because they interfere with human activities, cause financial losses or have the potential to spread diseases. Such species are often killed either legally or illegally. In the N Atlantic, the species typically exposed to culling and persecution are cormorants and large gulls. Great cormorants are culled in Denmark, Sweden and Scotland, where conflicts with human fisheries and aquaculture are common. Gulls (mainly herring gulls, but also great and lesser black-backed gulls as well as glaucous gulls) are killed legally or illegally in most countries, e.g. because numbers are seen to be too high in urban areas, because of perceived collision risk at major airports, because of conflicts with other bird species of higher conservation concern (typically terns), or because of potential predation in managed eider colonies (Iceland).

Data on how many birds are killed by culling or persecution are typically poor or absent, partly due to the often illegal nature of these activities. It is therefore very difficult to evaluate the impact on seabird populations. For example, while it is well documented that populations of large gulls have declined in the more southerly parts of the region (Mitchell *et al.* 2004), it is unclear what role culling may have played in this. At the local scale, persistent culling has caused the abandonment of some colonies of lesser black-backed gulls, although the regional population increased at the same time (Calladine 2004). For great cormorants, the available data are somewhat better. In Denmark, the combination of egg oiling and culling (in Denmark as well as in the wintering areas) has probably led to a stabilisation of the population at a lower level than would otherwise have occurred (Bregnballe 2009). On a more local scale in western Jutland, effects of culling were less clear, probably because of immigration from areas with lower culling intensity (Bregnballe 2009).

Conclusions: Culling and persecution of "problem" species is mostly targeted at thriving and/or increasing populations, as these are most likely to come into conflict with human interests. At the same time, reducing thriving populations through culling is notoriously difficult, due to the demographic compensatory mechanisms (increased survival or lower age of recruitment) which are likely to be triggered when large numbers of birds are killed (Wanless *et al*. 1996, Frederiksen *et al*. 2001). In order to have a long-term impact on populations, culling thus needs to be extensive and persistent – and this is rarely the case in modern societies. Culling programmes for great cormorants in Denmark and other European countries have probably caused the population to stabilise at a lower level than would otherwise have occurred. In Iceland, eider farming is still widespread, and the associated persecution is likely to have reduced population growth rates of gulls and other potential predators.

4.2.3 Egg collection

Like harvesting of adults and young, the collection of seabird eggs for human consumption was traditionally carried out by coastal communities more or less everywhere in the N Atlantic. However, today egg harvest only takes place in relatively few areas. In Iceland, collection of eggs of most seabird species is allowed, and in rural areas substantial numbers of eggs are still collected, with black-legged kittiwake and common guillemot being the main target species (Petersen 2008). Legal egg collection on a limited scale also takes place in the Faroes (Olsen 2008) and Norway (Strøm *et al.* 2008).

In Greenland, egg harvesting used to be widespread; since 2002 a total ban has been in place for most species, although some illegal collection of Brünnich's guillemot eggs still occurs (pers. obs.).

Seabirds are much more sensitive to reductions in adult survival than in reproduction, so in most cases egg harvesting is unlikely to have a major impact on population growth, as long as birds are allowed to relay and only a fraction of each colony is targeted. However, if food is scarce birds may be unable to lay more than one clutch, and in such situation the impact will be more pronounced. World-wide, there are very few studies which evaluate the population-level impact of egg harvesting. A recent study on Arctic terns in Greenland showed that relaying propensity and success were high as long as harvest was carried out early in the season, and thus indicated that a properly regulated egg harvest could be sustainable (Egevang 2010). Nevertheless, intense egg harvesting could lead to reduced population growth rate and if persistent, to long-term declines. These findings can probably be generalised to many other seabirds.

Conclusions: It is unlikely that egg collection, as carried out today, has any major impacts on seabird populations in the N Atlantic. However, in years when food conditions are poor, egg harvest may contribute to complete breeding failures. Persistent egg harvesting in small, isolated population may contribute to long-term declines (e.g. Brünnich's guillemots in SW Greenland).

4.3 Pollution-related factors

4.3.1 Oil pollution

Oil pollution is one of the most high-profile threats to seabirds. Like other animals, birds are exposed to the toxic effects of oil in the environment, but in addition aquatic birds are highly vulnerable to loosing the waterproofing of their plumage. When birds are oiled, they will therefore very often take refuge on shore to avoid hypothermia. Dead oiled birds also wash up on shore, and in combination these factors make the immediate effects of oil spills on seabirds highly visible. Nevertheless, documenting and evaluating the long-term impact of oil pollution on seabird populations has been very difficult. The most important reason for this is probably that most spills take place during the non-breeding season, when birds often occur far from their breeding colonies and where individuals from widely dispersed colonies occur together. This both dilutes the impact of a given spill and makes it difficult to identify where the impact is largest. In a few recent cases, genetic analyses have been used in an attempt to pinpoint the origin of seabirds killed during major oil spills (Cadiou *et al.* 2004). In this context, it is also relevant to point out that seabirds breeding in the Nordic seas often winter further south, in areas where they may be exposed to oil pollution (e.g. in the southern North Sea, Bay of Biscay or off Newfoundland). Studies from these areas are therefore also reviewed here. The impacts of oil pollution on seabirds have been reviewed several times (e.g. ICES 2002, 2005, Boulinier & Riffaut 2008).

Acute mortality from oil spills occurs both when large amounts of oil are released during spill events, usually in connection with shipwrecks or other accidents, and as a consequence of the chronic and often deliberate release of small amounts of oil during tank cleaning operations. Relatively few large oil spills have occurred in the study area in recent decades, the most well-known being the *Stylis* in Skagerrak in December 1980 and the *Braer* off Shetland in January 1993. Major spills have been more frequent in more southerly areas, e.g. the *Erika* in December 1999 off Brittany, the *Prestige* in November 2002 off Galicia, and the *Tricolor* in January 2003 in the English Channel. While all of these spills have resulted in seabird deaths, there is no relationship between the size of the spill and the number of birds killed (ICES 2005). Indeed, the smallest of the spills (*Stylis*) resulted in the highest number of recorded (45,000) and estimated (200,000 – 300,000) deaths, while the much larger *Braer* spill only killed an estimated 5,000 birds. The number of birds killed after a spill thus depends to a large extent on how many birds are present in the area at the time, and also on weather and other factors. As mentioned above, documenting the impact of these spills on seabird populations has been difficult. While the *Braer* spill killed few birds, these were mainly local residents (European shags, black guillemots), making the assessment of population-level impact relatively simple. In the following years, local population declines were observed for both these species (Heubeck 1997). Taking a different approach, Votier *et al.* (2005) analysed long-term data from the colony Skomer in Wales and found that adult survival of common guillemots was reduced in winters when large oil spills occurred in areas where birds from this colony winter. Although this colony is outside the present study area, the wintering areas are shared with birds from more northerly colonies, and similar effects may have occurred in these populations. After the *Prestige* spill, the observed mortality of European shags was biased towards females, which could lead to disproportionate demographic effects (Martínez-Abraín *et al*. 2006); it is not known whether this phenomenon is local or occurs generally.

Chronic oil pollution, i.e. the regular illegal discharge of small quantities of oil from vessels, is increasingly seen as a potentially larger problem for seabird populations than the occasional large accidental spills. The magnitude and trend of the problem is monitored by beached bird surveys, both in Europe and North America (Camphuysen & Heubeck 2001, Wilhelm *et al*. 2009). The severity of this problem seems to be declining, as documented by observed declines in oiling rates and/or densities of oiled birds (ICES 2003, Larsen *et al*. 2007, Wilhelm *et al.* 2009). Nevertheless, the number of birds killed is probably still very large. Based on beached bird surveys and a mathematical model of the proportion of birds killed that were recorded, Wiese & Robertson (2004) estimated that 315,000 auks were killed annually by chronic oil pollution in Newfoundland, of which 67% Brünnich's guillemots. A demographic model indicated that a mortality of this magnitude could reduce the annual growth rate of the Canadian population of this species by approximately 2.5% (Wiese *et al*. 2004). Similar impacts could be expected for Greenlandic populations, which share wintering areas with the Canadian breeders. Unfortunately, a similar exercise has not been carried out for e.g. the North Sea. Chronic oil pollution also occurs during oil production at offshore platforms, but the magnitude of mortality due to this source is unknown (Wiese *et al*. 2001). Likewise, residual oil from large spills can continue to leak into the environment for many years, contributing to chronic oil pollution (Peterson *et al*. 2003).

Seabirds differ substantially in their vulnerability to the acute effects of oil pollution (Williams *et al*. 1995). The species most affected are typically those which spend most time sitting on the water, i.e. diving species such as eiders (and other sea ducks), auks and cormorants. Surface-feeding species, which spend most of their time in the air, are generally much less affected. In addition, those species which moult their flight feathers simultaneously and thus periodically lose the power of flight (sea ducks, auks) are extremely vulnerable during this time.

In addition to the acute effects of plumage fouling, oil also has long-term toxic effects on seabirds through direct ingestion or contaminated prey, although these effects are poorly understood (Golet *et al*. 2002, Peterson *et al*. 2003). Studies in Spain following the *Prestige* spill have shown sub-lethal toxic effects on yellow-legged gulls (Alonso-Alvarez *et al*. 2007), and similar effects can be expected whenever seabirds are exposed to oil in the environment over long periods. There are no published studies of long-term toxic effects in the NE Atlantic.

Conclusions: Acute accidental oil spills have long been regarded as one of the most serious threats to seabird populations. However, it is highly likely that chronic oil pollution from small-scale illegal discharges and from slow release of oil from large spills is a more serious threat, and in the most polluted regions (Newfoundland, southern North Sea) the magnitude of this problem may be sufficient to affect population growth of some populations (which may breed far from the affected areas) negatively. Nevertheless, accidental oil spills occurring during the breeding season near major colonies could have devastating effects, particularly if they take place in ice-covered waters of the high Arctic where clean-up is logistically very difficult. The likelihood of such a low probability – high impact event will increase with increasing shipping and offshore oil production in the high Arctic. The species most vulnerable to the acute effects of oil spills are eiders, auks and cormorants, whereas all seabird species are likely to be affected by long-term toxic effects, often mediated through the food web.

4.3.2 Contaminants

A wide variety of contaminants of anthropogenic origin are widespread in the marine environment, with widely varying toxic effects on organisms. The most problematic of these contaminants are those that are persistent, able to be transported over long distances and tend to biomagnify, particularly persistent organic pollutants (POPs) and heavy metals. Many studies over the years have documented that contaminants are present in seabirds and their eggs, and also that concentrations of many of the "legacy" POPs (e.g. DDT and its metabolites, PCBs) have been gradually decreasing while new chemicals (e.g. brominated flame retardants and fluorinated compounds) have appeared in increasing concentrations (e.g. AMAP 2009). Indeed, seabird eggs are often used to monitor trends in contaminant concentrations over time, as they are easy to collect, store and analyse. There are also many studies showing physiological effects of specific POPs in seabirds, typically endocrine disruption in some form (e.g. Verboven *et al*. 2010); this literature will not be reviewed here.

Population-level impacts of contaminants on seabirds are much less well-studied. Due to biomagnification, it is expected that the largest impacts are found for species at the highest trophic level, i.e. top predators. Research efforts have accordingly concentrated on large gulls, which due to their habit of feeding on eggs and chicks (and sometimes adults) of other seabirds have a higher trophic level than typical piscivorous seabirds (Hobson *et al*. 1994). The most detailed studies are of glaucous gulls on Bear Island. Here, Bustnes *et al.* (2003) found that both reproductive performance and adult survival were negatively related to blood concentrations of several POPs; the observed effect on survival was so large that impacts on population growth seem likely. These results were confirmed in a subsequent study, which also indicated that the effect on adult survival was mainly due to oxychlordane, a metabolite of the insecticide chlordane (Bustnes *et al*. 2005). Further studies along the mainland coast of Norway have also shown negative effects of organochlorines on adult survival of the lesser black-backed gull (Bustnes *et al*. 2008a), as well as on reproductive performance and survival of the great black-backed gull (Helberg *et al*. 2005, Bustnes *et al*. 2008b). There are no similar studies of other seabirds or from other parts of the NE Atlantic.

Conclusions: Contaminants with potentially deleterious effects are widespread in the marine environment and present in all seabirds in varying concentrations. Due to the lack of studies of demographic effects, it is very difficult to evaluate how strong impacts these contaminants have on seabird populations. However, it is likely that populations of top predators such as large gulls are negatively affected by contaminants, at least in the Barents Sea and along the Norwegian coast. Concentrations of many contaminants are higher in the Norwegian/Barents/Greenland Sea than e.g. in W Greenland (AMAP 2009), and impacts on seabirds can be expected to follow a similar pattern. Much less is known about contaminant concentrations and their trends outside the Arctic.

4.3.3 Other types of pollution

Plastic particles of various origins are often ingested by surface-feeding seabirds, particularly procellariiforms (albatrosses, petrels, shearwaters and storm petrels). In the N Pacific, this is regarded as a serious conservation problem, particularly for the Laysan albatross (Blight & Burger 1997, Young *et al*. 2009). In the NE Atlantic, this problem has only been recorded in northern fulmars, where plastic particles are found in the stomachs of beached individuals in the North Sea (van Franeker & Meijboom 2002). Indeed, the occurrence of plastic particles in fulmar stomachs has been suggested as a cost-effective way of monitoring plastic pollution (ICES 2002). There is currently no information on whether plastic particles represent a problem for northern fulmars in the Atlantic.

Eutrophication can alter the structure of aquatic ecosystems fundamentally, and could also be expected to have an impact on seabirds. However, in the present study area eutrophication is only likely to be important in coastal regions, primarily Kattegat and the eastern North Sea. There are apparently no studies of potential impacts on seabirds in this area, but it is certainly conceivable that food availability of e.g. mussel-feeding sea ducks or cormorants feeding on benthic fish can be affected by higher nutrient levels.

4.4 Predation

4.4.1 Natural predators

In general, seabirds are adapted to the presence of a variety of natural predators, and predation should normally not represent a threat to seabird populations. However, natural (indigenous) predators can be a problem for seabirds if they occur at inflated densities due to human activities (typically avian predators), or if they gain access to normally predator-free sites (typically mammalian predators). The problems occurring when densities of large gulls and skuas are artificially inflated due to human food provision (fisheries discards and/or domestic refuse), particularly when these anthropogenic food sources are suddenly reduced or eliminated, have already been mentioned. Briefly, this may lead to increased predation on eggs, chicks and adults of several seabird species, including terns, storm petrels and Atlantic puffins. Recovery of previously decimated populations of avian predators may cause disturbance, large-scale mortality and local population declines of seabirds, as has been observed for white-tailed eagles preying on black-legged kittiwakes in western Norway (T. Anker-Nilssen & S.-H. Lorentsen, pers. comm.), but it is debatable whether this represents a conservation problem or a return to a more “natural” state.

The main (and in some cases the only) adaptation seabirds show to mammalian predation is avoidance, i.e. nesting in inaccessible habitats such as cliffs and offshore islands. Therefore, when terrestrial predators gain access to these habitats, they can cause large problems, including complete breeding failures and widespread adult mortality (see also next Section). In the NE Atlantic, the most important indigenous mammalian predators are Arctic and red foxes. Fox predation can become a problem if foxes gain access to previously isolated islands through construction of dams or bridges, or if intense human disturbance forces birds to nest in habitats accessible to foxes. However, it appears that few if any studies of these potential problems exist.

Conclusions: Natural predators mainly cause problems for seabirds when their abundance or distribution is inflated due to various human activities. It is in my opinion most reasonable to view these problems as indirect and unintended consequences of the respective activities rather than as separate threats in their own right.

4.4.2 Introduced predators

On a worldwide scale, seabirds on islands are well known to be extremely vulnerable to the introduction of alien (primarily mammalian) predators, and this is regarded as one of the most severe threats to seabird populations, particularly on remote oceanic islands (Courchamp *et al.* 2003). The worst offenders are typically brown rats (Jones *et al.* 2008a) and feral cats (Ratcliffe *et al.* 2010), but even house mice have been shown to cause significant conservation problems for seabirds on e.g. Gough Island in the S Atlantic through predation on eggs and chicks (Wanless *et al.* 2007a). Seabirds are generally vulnerable because they have few if any defence mechanisms directed towards terrestrial predators, and because many species breed on the ground or in burrows. Cliff-nesting species are less vulnerable.

In the N Atlantic, the main impacts of introduced predators on seabirds are linked to brown rats and American mink. The mechanisms through which these two species spread to islands are very different. Rats are not strong swimmers and rely on human intervention to colonise new islands. However, they are ubiquitous in most harbours and are thus often transported inadvertently on ships and boats. They thus mainly occur on islands with (current or former) human habitation, also because they need other food when seabirds are absent, and human scraps and refuse are a reliable food source. Mink were originally introduced in Europe for fur farming, and the feral populations occurring in many countries descend from farm escapees. They are strong swimmers, and if present along the mainland coast they may cross to islands within a few kilometres of the shore.

Feral mink occur in Denmark, Sweden, Norway, Scotland and Iceland, and they are considered a conservation problem for seabirds in all these countries. However, few quantitative studies have been carried out. Mink can take eggs, young and adults of many seabird species, primarily ground- and burrow-nesters. In Iceland, mink predation has likely caused a decline in mainland populations of black guillemots and a shift in the distribution towards islands further offshore (Petersen 1981, Jóhannsson & Guðjónsdóttir 2007). The mink problem is relatively well studied in western Scotland, where mink predation has been linked with breeding failure, redistribution and long-term population declines of terns and small gulls (Craik 1997, Ratcliffe *et al*. 2008).

Rats are present in all countries in the region except Greenland, and they occur on most inhabited islands. They primarily take the eggs and young of ground- and burrow-nesting seabirds, and conservation concerns with such species are widespread. There is circumstantial evidence that rat predation has shaped the breeding distribution of some of the most vulnerable seabird species; for example, European and Leach's storm-petrels only occur on rat-free islands in Scotland (Ratcliffe 2004) and the Faroes (B. Olsen, pers. comm.). Worryingly, rats have very recently been observed on the otherwise predator-free Nólsoy in the Faroes, which houses one of the largest colonies of European storm-petrel in the world (B. Olsen, pers. comm.). Rats have also been linked to local extinction of Manx shearwaters and Atlantic puffins on Scottish islands (Ratcliffe 2004). Furthermore, rat eradication on Scottish islands (e.g. Ailsa Craig and Canna) has led to local recovery and recolonisation of several seabird species (Ratcliffe *et al.* 2009).

Conclusions: Introduced predators (mainly rats and mink) are a very serious threat to ground- and burrow-nesting seabirds on the islands where they occur. They can cause local and even regional population declines and extinctions. The main species affected are storm-petrels, Manx shearwaters, Atlantic puffins, black guillemots, terns and small gulls. Although a lack of studies in some countries precludes firm conclusions, the biggest problems seem to occur in Scotland, the Faroes and Iceland.

4.5 Disturbance

Human disturbance may cause e.g. lower breeding success of seabirds, either because birds desert their nests or because opportunistic predators take advantage of their temporary absence during a disturbance event. Disturbance is most typically linked to tourism and hunting (or in general recreational activities), but in principle any human presence, including e.g. construction and research activities, can have the same effect. An overview of the scale of the problem in Arctic areas was given by Chardine & Mendenhall (1998). Breeding seabirds (particularly cliff nesters) often show little or no behavioural response to human presence, but nevertheless effects such as nest desertion may occur. In the past, irresponsible behaviour at bird cliffs (e.g. shooting and sounding of boat's whistles) has occurred, and even today tourist operators and others often approach bird cliffs very closely e.g. in Greenland (F. Merkel, pers. comm.). There are few quantitative studies of the effect of disturbance on seabirds. Beale & Monaghan (2004) found that breeding success of black-legged kittiwakes and common guillemots at a

Scottish nature reserve were affected by the number of visitors and their distance from the nest, with the strongest effect for kittiwakes. The authors concluded that seabirds view humans as potential predators, and that the negative impact is likely due to this behavioural mechanism leading to increased heart rate and thus energy requirements. An impact of research activities on breeding success of black-legged kittiwakes was also found in northern Norway (Sandvik & Barrett 2001).

Certain ground-nesting species are likely to be much more sensitive to human disturbance than cliff-nesters, particularly beach-nesting terns. A study in southern Denmark found that population trends for Arctic and little terns were more positive on islands with access restrictions than on those without (Bisschop-Larsen 2003). It appears that no quantitative studies exist from the NE Atlantic.

Human disturbance may also affect foraging and roosting seabirds, but this aspect is even less studied. Merkel *et al.* (2009) found that foraging behaviour of common eiders in Greenland during winter was affected by boat traffic. In principle, e.g. moulting auks (which are flightless) should also be sensitive to disturbance, but as they occur highly dispersed at sea, any given disturbance event is likely to only affect few individuals while concentrations of moulting sea ducks seems to be very sensitive to disturbance (e.g. Mosbech & Boertmann 1999).

Conclusions: Effects of human disturbance on seabird breeding success are probably widespread, but difficult to quantify. In order to fully assess the impacts at a particular site, it is necessary to take into account the energetics and behaviour of the focal bird species, as well as the presence of natural predators and the expected number of human visitors (Beale 2007); modelling tools may be useful in such an assessment (Bennett *et al.* 2009). However, in most areas and for most species disturbance from tourism and other human activities is likely to affect only a small fraction of the total population, and the overall impact is thus likely to be small. The main exceptions are beach-nesting terns – in particular little terns are likely to be extremely vulnerable to human disturbance if access is not managed properly (Pickerell 2004) – and concentrations of moulting sea ducks.

4.6 Area use and management

4.6.1 Loss of nest and foraging habitat

Relatively few seabirds breed in locations that are of interest for construction and other developments, and their nest habitats are thus fairly secure. This is particularly the case for species nesting on cliffs and/or remote oceanic islands. However, ground-nesters such as gulls and terns often breed on beaches, salt marshes or dunes, locations which may also be attractive for e.g. construction of tourism facilities. Similar problems may occasionally occur for burrow-nesters. It is difficult to draw general conclusions about the impacts such developments may have on seabird populations, mainly because the consequences will depend on e.g. the size of the colony in question and the availability of alternative nest habitat and thus have to be evaluated case by case as part of Environmental Impact Assessments. However, for the most sensitive species (habitat specialists such as terns) the cumulative impact of development at several locations may be large, particularly because increased disturbance is likely to occur both during construction and once the facility is in use. For most countries in the study area this problem is relatively minor due to legal restrictions on physical development in the coastal zone.

Nest habitat for the same species may also be lost as a consequence of current or future sea level rise. This has been considered a problem in parts of both North America and Europe (e.g. Brinker *et al*. 2007), but to my knowledge no studies exist from the current study area.

Foraging habitat of some inshore-feeding species may be lost or degraded due to human activities, e.g. aquaculture, kelp harvest or mussel and scallop dredging. The potential impacts on seabird populations have received very little research attention and are difficult to predict.

Conclusions: Loss of nest habitat may be a problem locally for some species and should be assessed whenever coastal developments encroach on seabird breeding grounds, but at the larger scale it is unlikely that impacts on populations are severe. The impact of loss of foraging habitat is difficult to assess.

4.6.2 Offshore construction (wind farms, oil and gas extraction)

The large-scale development of offshore structures, particularly large wind farms, is a recent phenomenon and the impacts on seabirds and other features of the natural environment are still poorly understood. Indeed, there are probably more publications on how to assess these impacts than there are empirical studies (e.g. Fox *et al*. 2006). The field is thus unusual in that the theoretical aspects (i.e. which impacts are expected) are more developed than the associated empirical evidence (e.g. Drewitt & Langston 2006). Most of the few empirical studies have been carried out in the southern North Sea and the western Baltic Sea, around or S of the limit of the present study area. Impacts of wind farms on seabirds have been reviewed by WGSE on several occasions (ICES 2002, 2003, 2004).

The potential effects of wind farms on seabirds fall into four categories: 1) collisions resulting in mortality, 2) displacement due to disturbance (mainly temporary), 3) behavioural avoidance (barrier effects), and 4) habitat loss. There are few empirical studies of each of these potential effects, and even fewer assessments of population-level impacts. Clearly some birds collide with turbines and are killed (Newton & Little 2009), although radar observations have shown that many birds avoid flying through wind farms, and that barrier effects thus may be more important than collision mortality (Desholm & Kahlert 2005). For an onshore wind farm in Belgium, Everaert & Stienen (2007) concluded that the growth rate of a nearby mixed tern colony was reduced due to collision mortality, with common terns being most affected.

Two attempts have been made at an evaluation of which species are likely to be most sensitive to wind farm impacts. Garthe & Hüppop (2004) used mainly behavioural characteristics and concluded that e.g. divers (not covered here) and diving ducks (e.g. common eider) were most sensitive, fulmars and small gulls least sensitive, with e.g. auks being intermediate. In contrast, Desholm (2009) used demographic characteristics and concluded that e.g. common eiders were substantially more sensitive than divers. However, this study was specific to one wind farm in the western Baltic Sea and included few seabirds.

Offshore production platforms for oil and gas extraction have existed in e.g. the North Sea for much longer than marine wind farms, and are now being constructed in Arctic areas as well. Risks to seabirds are similar for these structures as for wind farms, although they typically occur more dispersed and e.g. barrier effects thus should be insignificant. However, in addition birds may be attracted to platforms due to night lighting and refuse disposal, collisions are more numerous due to night lighting, and birds are also killed by gas flares (Wiese *et al.* 2001), although this problem is declining as a result of stricter regulations. The impacts of individual platforms are thus probably more severe than for individual wind turbines, but have been even less studied, probably because offshore extraction developed before the introduction of environmental impact assessments. On the other hand, the number of wind turbines far exceeds the number of platforms, while the latter also tend to be located further offshore in areas with lower bird concentrations.

An important issue in relation to offshore construction (and other localised activities) is that the impact of a specific activity is likely to be rather small, but that many similar activities may be planned simultaneously over a larger area. Any assessment of the impact of e.g. wind farms should thus take into account the cumulative impact that large numbers of farms along e.g. a migration flyway may have (Masden *et al*. 2010).

Conclusions: Due to scarcity of empirical data, it is probably still too early to assess the population-level impacts of wind farms and other offshore construction activities. There are still very few offshore wind farms in the study area, but undoubtedly more will be constructed in the coming years. Impacts will increase with the number of structures, but more empirical studies are needed in combination with modelling exercises before overall impacts can be assessed. This is also true for offshore production platforms, the potential impacts of which are even less known.

4.7 Climate-related factors

Documenting and quantifying the relationship between climate and seabird populations requires observations under a range of different climatic conditions, and thus over a considerable span of years. Long-term data collected under standardised protocols are needed, both for seabirds and for the climate aspects under study. Investigations of seabird-climate links are therefore by their nature somewhat retrospective, and mainly document how seabirds have reacted to climate fluctuations in the past, e.g. whether warm years have tended to be good for breeding or vice versa. What we learn from these studies is thus how seabird populations are (or have been) affected by climate *variability*.

Generalising findings from such studies to conditions where directional climate *change* (with superimposed annual and/or decadal variation) is the norm requires some care, particular when extrapolating to conditions outside the observed range, and when the hypothesised causal relationships are complex and indirect. Climate effects on seabirds have been reviewed by ICES WGSE on several occasions (ICES 1998, 2004, 2007, 2008, 2009).

4.7.1 Direct effects of climate

Climate may affect organisms directly, i.e. by causing additional mortality of eggs, offspring or adults through e.g. overheating, chilling or flooding. In general, seabirds are well-insulated, homeothermic organisms and thus have a wide temperature tolerance, although their energy requirements for thermoregulation will increase under adverse weather conditions. Nevertheless, the dark plumage of many seabirds may cause them to overheat on hot sunny days. This phenomenon has been recorded in juvenile Cape gannets (Hochscheid *et al.* 2002), and in Arctic Canada elevated mortality of adult Brünnich's guillemots was found when birds were exposed to hot conditions combined with high mosquito densities (Gaston *et al.* 2002); there are no similar reports from the study area.

Although most seabirds have completely waterproof plumage and thus are well insulated when in the water, this is not the case for cormorants. As an adaptation allowing highly efficient diving, their plumage is only partially waterproof (Grémillet *et al.* 2005), and they need to dry out on land after foraging. Therefore, they are vulnerable to soaking by persistent rain and/or spray, which may cause chilling. Two studies in east Scotland showed that European shags may be severely affected by bad weather: Aebischer (1993) documented the effects of a spring gale on breeding success, and Frederiksen *et al.* (2008a) showed that large-scale mortality events were associated with periods of persistent rain and onshore winds in late winter, and used a demographic model to demonstrate that an increased frequency of such events could lead to population decline.

Flooding of nest burrows during heavy rainfall can be an important cause of breeding failure, although this potential problem has received surprisingly little attention. In west Scotland, hatching success of Manx shearwaters was depressed in years with frequent heavy rain, and lower in burrows more exposed to flooding (Thompson & Furness 1991). Anecdotal information confirms that flooding during heavy rain also causes egg or chick mortality for Atlantic puffins (M.P. Harris, pers. comm.) and likely for other burrow nesters.

Conclusions: It seems relatively rare that direct climate effects have a significant impact on seabird populations. Most of the documented cases are linked to extreme weather events, and if such events become more frequent in the future, risks to some seabird populations may increase.

4.7.2 Indirect effects of climate

It is generally acknowledged that the most serious and wide-ranging impacts of climatic fluctuations and directional change on seabird populations are likely to be indirect, i.e. mediated through trophic interactions. In other words, seabirds may suffer if the abundance of their main prey is reduced due to changes in climate. The specific mechanism may be complex (see examples below), but generally speaking poekilothermic organisms such as fish and plankton are more likely to have a narrow temperature preference and thus be directly affected by changes in temperature than homeothermic organisms such as seabirds. If seabird population trends are primarily affected by the abundance of their prey, this is a case of bottom-up control (as opposed to top-down control through predation). Seabird prey may in turn be exposed to bottom-up control from their respective food sources (mainly zooplankton), or may be directly affected by climatic conditions. Unravelling these complex mechanisms is very difficult and data-demanding, and there are only a few cases where the full scenario is well documented. However, the general principles are broadly accepted as valid, and therefore cases where e.g. a correlation between sea temperature and some aspect of seabird demographic performance is observed are often cited as evidence for an indirect climate effect, although the precise mechanism may be unknown.

Indirect climate effects on seabirds have received considerable research attention over the last ten years, and some of the best and most well-documented examples worldwide come from the study area, in particular Scotland and Norway. The comparative lack of relevant long-term seabird data sets and/or analytical expertise has hampered similar studies in other parts of the study area, particularly Iceland and the Faroes where widespread breeding failures have focused attention on this issue. Below, I summarise the evidence from the best-known cases and briefly review other empirical studies from the NE Atlantic.

Sandeels and seabirds in the North Sea: Most breeding seabirds in the North Sea are heavily dependent on sufficient stocks of sandeels for successful reproduction (Hamer *et al*. 1993, Furness & Tasker 2000, Frederiksen *et al*. 2006). During the period when organised seabird monitoring in Scotland has taken place, there have been two episodes of widespread breeding failures. The first affected Shetland in the late 1980s (Monaghan 1992, Hamer *et al.* 1993), and the second covered the entire North Sea coast in 2004–2008 (Heath *et al.* 2009). In both cases, there is strong evidence that lack of suitable food (i.e. sandeels) was the proximate cause of the breeding failures (Monaghan *et al*. 1994, Davis *et al*. 2005, Furness 2007, Wanless *et al*. 2007b), but it is less obvious what has caused the lack of sandeels (Frederiksen *et al.* 2007b). Sandeel recruitment is highly variable between years, and seems to be affected by climate either directly or through the availability of their favourite copepod prey, *Calanus finmarchicus* (Arnott & Ruxton 2002, Frederiksen *et al.* 2006, van Deurs *et al*. 2009). Studies on the Isle of May in east Scotland have shown that several aspects of seabird demographic performance were negatively correlated with sea temperature: breeding success of black-legged kittiwakes (Frederiksen *et al.* 2004), adult survival of Atlantic puffins (Harris *et al*. 2005, Grosbois *et al*. 2009) and black-legged kittiwakes (Frederiksen *et al.* 2004). For black-legged kittiwakes, the negative relationship between breeding success and sea temperature was consistent across colonies in E Scotland (Frederiksen *et al.* 2007c) and Orkney (Frederiksen *et al.* 2007a). Furthermore, for this species a demographic model indicated that the population is likely to continue to decline if mean sea temperature increases, even if the local sandeel fishery remains closed (Frederiksen *et al.* 2004).

In a further twist to the story, sandeels in the western North Sea have become substantially smaller over the last 35 years (Wanless *et al.* 2004); for 0-group (juvenile) fish this is equivalent to a 60% decline in mean energy content (M. Frederiksen, D. Elston & S. Wanless, unpubl. data). In 2004, 0-group sandeels had a much lower energy content than expected for their length, indicative of a near-zero lipid content (Wanless *et al*. 2005a). While the biological mechanism behind these observed patterns is unclear, the implications for birds carrying single prey to their chicks (e.g. common guillemots) are clear: they will have to work harder to supply their offspring with food, or alternatively give up their breeding attempt.

Herring and seabirds in the Norwegian Sea: The most important prey for breeding seabirds in the Norwegian Sea is the Norwegian spring-spawning herring. The extended breeding failure and consequent population decline of Atlantic puffins on Røst following overfishing of this stock has already been described (see Section 0). Long-term studies in this colony have shown that Atlantic puffin breeding success was tightly linked to the availability and size of young herring (Durant *et al.* 2003), and that this relationship again was tightly linked to ocean climate, with sea temperature having a positive effect (Durant *et al.* 2006). Adult survival of Atlantic puffins in this colony was also positively associated with sea temperature (Harris *et al.* 2005, Grosbois *et al.* 2009), again indicating a positive effect of warmer conditions on herring recruitment and thus food availability for puffins. A positive relationship between temperature and population growth was also found for lesser black-backed gulls in this region, again interpreted as an effect of improved recruitment of (unspecified) fish prey at higher temperatures (Bustnes *et al.* 2010).

Other studies: There are a few other studies of the relationships between seabird demography and climate in the study area, and all of these seem to point to indirect effects as being most important. A study of five seabird species at Hornøya in the Barents Sea showed generally weak negative relationships between adult survival and sea temperature, and interpreted these as indirect climate effects mediated through prey abundance, possibly in the wintering areas (Sandvik *et al.* 2005). In a circumpolar study, Irons *et al.* (2008) found that colonies of both common and Brünnich's guillemots tended to decrease following major changes (increases or decreases) in sea temperature, whereas they increased or remained stable when temperatures showed little change. Again, these findings are more consistent with indirect trophic effects of climate than with a direct physiological impact. Long-term studies of northern fulmars at Eynhallow in Orkney showed relationships between reproduction, recruitment and survival of this extremely long-lived species and an index of regional climatic variation, the North Atlantic Oscillation (Thompson & Ollason 2001, Grosbois & Thompson 2005). Fulmars forage over huge areas of ocean even during the breeding season (P.M. Thompson, pers. comm.), and it is perhaps not surprising that large-scale climate is a better predictor of demographic performance than local conditions for this species. However, the biological mechanisms behind these apparent effects remain unknown.

Conclusions: The importance of indirect climatic impacts on seabird populations is likely to vary strongly geographically and among species. The contrast between the situation in the North Sea, where seabirds perform best when sea temperatures are low, and the Norwegian Sea, where the opposite situation prevails, is probably related to the geographical position of these two regions relative to the distribution of *Calanus finmarchicus*, a keystone species in the NE Atlantic which is highly sensitive to temperature change (Helaouët & Beaugrand 2007), and which may be shifting its distribution northwards (Helaouët & Beaugrand 2009). Where it occurs, *C. finmarchicus* is generally the most important prey for at least the larval stages of the most important fish prey of seabirds. The Norwegian Sea is close to the northern range limit of *C. finmarchicus*, whereas the North Sea is at the southern range limit. A northward distribution shift due to increasing temperatures is thus likely to benefit piscivorous seabirds in the northern part of the Norwegian Sea (and potentially further north), whereas North Sea seabirds are likely to suffer. In the longer term, it is possible that the extensive breeding problems experienced by seabirds in Scotland and more recently in the Faroes and southern Iceland will spread north- and westwards as regional sea temperatures increase. The most heavily affected species are likely to be piscivorous specialists, i.e. those that at least locally tend to rely on one or a few key prey species. Examples include auks (guillemots, razorbills and puffins), kittiwakes, terns and Arctic skuas (cf. Furness & Tasker 2000). More generalist feeders such as gannets, cormorants and fulmars, and benthic feeders such as eiders are less likely to be affected. However, in the longer term further increases in sea temperature may also bring other as yet unpredictable changes in marine ecosystems, which could affect seabirds both positively and negatively.

It is worth noting that at the northern edge of the present study area in e.g. W Greenland, *Calanus finmarchicus* is in the process of replacing its high-Arctic congeners *C. hyperboreus* and *C. glacialis* (T.G. Nielsen, pers. comm.). This is predicted to benefit piscivorous seabirds while causing increasing problems for the planktivorous little auk, which relies on these large and lipid-rich copepods for successful breeding (Stempniewicz *et al.* 2007). Similar patterns have been observed in the Bering Sea, where there is a much higher diversity of planktivorous seabirds (Kitaysky & Golubova 2000, Hunt *et al*. 2002).

4.8 Combined and complex effects

As should be obvious from the preceding Sections, seabird populations are affected by a variety of factors, which rarely if ever operate in isolation. Assessing the total impact on populations thus requires an evaluation of how seabirds are affected by combinations of various factors. Two (or more) simultaneous factors may in theory be additive (the combined impact is simply the sum of the two), synergistic (the combined impact is larger than the sum) or antagonistic (the combined impact is smaller than the sum). In the two latter situations, interactions between the two effects occur, and these can in principle be detected through statistical analysis. However, studies of this type are very complex and data-demanding, and are therefore rare. Further difficulties arise if one or more of the involved effects are indirect, in which case interactions can occur at several stages. In the following, two case studies of combined and often complex effects are summarised, but it is worth noting that many other combinations may occur, although they have never been studied.

In the Barents Sea, many seabirds rely heavily on capelin as food for their young (Barrett & Krasnov 1996). From the seabirds” point of view, the causes for observed breeding failures (notably in the late 1980s, Vader *et al*. 1990) are thus simple: a lack of the preferred food, capelin. Capelin stocks in the Barents Sea have crashed several times in recent decades, with wide-ranging ecological effects (Gjøsæter *et al*. 2009). Capelin abundance is affected by both fishing and predation from other fish, notably cod and herring (Hjermann *et al*. 2004a). The herring stock involved here is the Norwegian spring-spawning herring, which for most of its life cycle occurs in the Norwegian Sea, although juvenile stages migrate into the Barents Sea and spend a couple of years there. In turn, the size of this herring stock is strongly linked to climate, as mentioned in Section 0, resulting in a strong statistical association between climate and capelin abundance (Hjermann *et al*. 2004b). Black-legged kittiwakes in this region are very sensitive to variation in capelin abundance, and although they will feed on herring when available, this does not represent a suitable alternative in terms of successful fledging of chicks (Barrett 2007). In accordance with this, the kittiwake population in the Barents Sea increased during the 1960s and 1970s, when herring stocks were reduced by overfishing and capelin stocks likely were high (Barrett & Krasnov 1996), and has declined since the 1980s during a period that includes three crashes in the capelin stock (Barrett 2007). Understanding fluctuations in seabird breeding success in the Barents Sea, and consequent changes in population size, thus requires knowledge of both fishery and climate impacts on herring stocks spending most of their life several hundred kilometres away in the Norwegian Sea.

The situation in Shetland is similarly complicated. Practically all breeding seabirds here rely on sandeels as their primary food. Widespread and almost total breeding failures were observed during the late 1980s for black-legged kittiwake, Arctic tern and Arctic skua, and these problems recurred during the 2000s. From 2004 onward, common guillemots, razorbills and Atlantic puffins were also hit, and populations of all these species have declined, for kittiwakes up to 85%. The main proximate cause of these problems is clearly lack of food (e.g. Hamer *et al.* 1993, Davis *et al.* 2005), although predation from great skuas has also played a part. However, it is much less clear what has caused the lack of sandeels. Intensive studies following the first crash in breeding success concluded that significant recruitment to the local sandeel stock around Shetland only occurred when larvae from the much larger Orkney stock were transported to Shetland by the Fair Isle Current (Wright 1996, Proctor *et al*. 1998). Thus, when this current failed (as happened in the late 1980s), sandeel abundance around Shetland crashed. To my knowledge, no explanation for the episodic failure of the Fair Isle Current has been found, but it seems likely that it is linked to climatic variation. Local sandeel fisheries around Shetland were considered too low intensity to affect food availability to seabirds, and have since been stopped. However, an alternative explanation of the lack of sandeels is predation from increasing stocks of North Sea herring, which have been recovering from overexploitation during the 1970s (Frederiksen *et al.* 2007b). The relative importance of these factors in controlling sandeel stock size has not been established conclusively.

Some authors have speculated that climate change may interact synergistically with other factors such as pollutants (Jenssen 2006), but the available evidence to date is insufficient to evaluate the potential importance of such interactions.

Conclusions: Marine ecosystems are extraordinarily complex, and in most cases declines in seabird populations are likely to be caused by several factors working at once. Understanding these complex effects is a major challenge. However, it is most likely that factors usually operate in a more or less additive fashion, so that the effect of addressing one threat does not change markedly with the level of other threats. Thus, although it may be necessary to address several threats to achieve a positive conservation outcome, efforts expended addressing one particular threat are not likely to be wasted.

5. Overall evaluation of threats to seabirds in the NE Atlantic

Evaluating and ranking the importance of the threats described in the previous Sections is a complex and difficult undertaking. There is no completely objective way of doing this, both because the scientific background knowledge is too limited and because the evaluation necessarily involves some extrapolation of current societal trends. Given this, informed judgement by experts is in my opinion the only way such an evaluation can be carried out. In order to support my own judgement, I requested input from a selection of highly experienced seabird experts in the various countries.

I received 12 completed questionnaires: 5 from Norway (4 regional and one general), 3 from Scotland, 3 from Greenland and 1 from Iceland. Subsequently, I also received input from the Faroes. Each researcher ranked the importance of each threat for each species on a scale from 0 (no threat) to 3 (severe threat). The biased geographical distribution, and the obviously different interpretations of threats used by the various experts, precluded any formal statistical treatment. Instead, I have chosen to combine the questionnaire contributions with my own assessment in an evaluation for each region and species group. In some cases, different researchers had widely different assessments of the same threats, probably partly because interpretations of the briefly named (and unexplained) threats differed, and because researchers considered the threats on different geographical scales. I emphasise that the overall evaluations presented below are my conclusions, based on contributions from other researchers as well as my own experience and reading of the literature. Note also that this evaluation is intended to cover threats facing seabirds in the NE Atlantic over the next ten years; thus, potential threats which have not yet materialised or been documented are also included. The completed questionnaires are reproduced in the Appendix.

5.1 Regional evaluation of threats by species groups

In order to reduce the complexity of this exercise and to make the results more accessible, I have divided the overall study area into 6 regions and grouped the seabird species into 10 categories according to taxonomical and ecological similarity. Different ways of structuring the material could also be used, but I hope that the present structure is helpful for management purposes. In the Tables below, the threats are ranked in the same way as in the questionnaires, i.e. from 0 (no threat) to 3 (severe threat), and colour-coded accordingly from green to red. These categorical ranks are obviously quite rough and should be regarded as relative rather than absolute. Furthermore, the rankings presented here are preliminary, and may well be adjusted following discussions at the workshop.

It is apparent that some threats are generally considered more important than others. Thus, hunting, oil pollution, bycatch, competition with fisheries and climate change are often regarded as important threats. However, there is a great deal of variation among regions and species groups, and some threats, although generally less important, are critical in specific cases (e.g. introduced predators for tubenoses in W Scotland and the Faroes). This extensive variation in the importance of threats needs to be taken into account in conservation and management strategies.

Also worth remembering is the fact that threats to seabird populations, and indeed the populations themselves, are not restricted by national boundaries. Some threats, although highly relevant for seabirds breeding in the NE Atlantic, occur outside the region. For instance, chronic oil pollution in wintering areas in the southern North Sea, Bay of Biscay and off Newfoundland may be a bigger problem for the seabird populations in question than that occurring inside the study area. Similar considerations apply to e.g. bycatch and hunting. Likewise within the study area, threats occurring in some countries may affect populations breeding in other countries. International cooperation is thus necessary to address these issues.

North Sea, Skagerrak and Kattegat

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	0	0	1	1	0	1	0	0	0	0
Egging	0	0	0	0	0	0	0	0	0	0
Discards	1	1	0	0	2	1	1	1	0	0
Bycatch	1	1	2	2	0	0	0	0	0	2
Competition with fisheries	1	1	1	1	1	1	0	2	1	1
Oil pollution	1	1	1	2	1	1	1	1	1	2
Contaminants	0	0	0	0	1	2	1	0	0	0
Plastics	2	1	0	0	0	0	0	0	0	0
Introduced predators	1	0	0	1	1	0	1	0	2	0
Disturbance	0	0	0	1	0	0	1	1	2	0
Developments	0	1	0	1	0	0	0	0	1	1
Climate change	1	0	1	0	1	0	1	3	2	2

Norwegian Sea

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	0	0	1	0	0	0	0	0	0	0
Egging	0	0	0	0	0	1	0	0	1	0
Discards	0	0	0	0	0	0	0	0	0	0
Bycatch	1	1	2	2	0	1	0	0	0	1
Competition with fisheries	1	1	1	0	1	1	0	3	2	2
Oil pollution	1	1	1	2	1	1	1	1	1	2
Contaminants	0	0	0	0	1	2	1	0	0	0
Plastics	2	1	0	0	0	0	0	0	0	0
Introduced predators	0	0	1	1	0	1	1	0	2	0
Disturbance	0	0	2	1	0	1	1	0	0	0
Developments	0	1	0	1	0	1	0	0	0	0
Climate change	1	0	0	0	0	1	0	3	2	2

Barents Sea

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	0	0	1	0	0	0	0	0	0	0
Egging	0	0	0	0	0	1	0	0	0	0
Discards	0	0	0	0	0	0	0	0	0	0
Bycatch	1	1	1	2	0	1	0	0	0	1
Competition with fisheries	1	2	1	0	2	2	0	3	2	3
Oil pollution	1	2	2	2	1	1	1	2	1	3
Contaminants	1	0	0	0	2	2	1	1	0	0
Plastics	2	1	0	0	0	0	0	0	0	0
Introduced predators	0	0	0	1	0	1	0	0	1	0
Disturbance	0	0	0	0	0	0	0	0	0	0
Developments	0	1	1	1	0	1	1	0	0	0
Climate change	2	0	0	0	0	1	1	3	2	2

Atlantic (N & W Scotland, Faroes)

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	1	1	1	0	0	1	0	1	0	2
Egging	0	0	0	0	0	0	0	0	0	0
Discards	1	1	0	0	2	2	1	1	1	0
Bycatch	1	1	1	2	0	0	0	0	0	1
Competition with fisheries	1	1	1	0	1	1	0	2	0	1
Oil pollution	1	1	1	1	1	1	1	1	1	1
Contaminants	0	0	0	0	1	1	0	0	0	0
Plastics	2	1	0	0	0	0	0	0	0	0
Introduced predators	3	0	0	1	1	0	1	0	2	2
Disturbance	0	0	0	0	0	0	1	0	2	0
Developments	0	1	0	0	0	1	0	0	0	0
Climate change	1	0	1	0	2	0	0	2	2	2

Iceland

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	1	2	2	0	1	2	1	0	0	2
Egging	0	0	0	0	0	1	0	1	1	1
Discards	0	0	0	0	0	0	0	0	0	0
Bycatch	2	0	1	1	0	0	0	0	0	2
Competition with fisheries	0	0	1	0	0	1	0	0	0	1
Oil pollution	1	1	1	2	1	1	1	1	1	2
Contaminants	0	0	0	0	1	1	0	0	0	0
Plastics	2	1	0	0	0	0	0	0	0	0
Introduced predators	2	0	0	1	0	0	0	0	0	2
Disturbance	0	0	1	1	0	0	1	1	1	0
Developments	0	0	0	0	0	0	0	0	0	0
Climate change	1	0	0	0	1	1	0	2	2	2

Greenland

	Tubenoses	Gannet	Cormorants	Eiders	Skuas	Large gulls	Small gulls	Kittiwake	Terns	Auks
Hunting etc	1	NA	1	2	1	1	NA	2	0	2
Egging	0	NA	0	1	0	1	NA	1	1	0
Discards	0	NA	0	0	0	0	NA	0	0	0
Bycatch	0	NA	1	2	0	0	NA	1	0	1
Competition with fisheries	0	NA	1	0	0	0	NA	1	1	2
Oil pollution	1	NA	1	2	1	1	NA	1	1	3
Contaminants	1	NA	0	0	1	2	NA	0	0	0
Plastics	1	NA	0	0	0	0	NA	0	0	0
Introduced predators	0	NA	0	0	0	0	NA	0	0	0
Disturbance	1	NA	1	2	0	0	NA	2	2	1
Developments	1	NA	1	1	0	0	NA	0	0	1
Climate change	1	NA	1	2	0	0	NA	1	2	2

6. Scientific names of species mentioned in the text

Birds

Common name	Alternative name	Scientific name
Atlantic puffin		Fratercula arctica
Arctic skua	Parasitic jaeger	Stercorarius parasiticus
Arctic tern		Sterna paradisaea
Black guillemot		Cepphus grylle
Black-headed gull		Larus ridibundus
Black-legged kittiwake		Rissa tridactyla
Brünnich's guillemot	Thick-billed murre	Uria lomvia
Cape gannet		Morus capensis
Common eider		Somateria mollissima
Common guillemot	Common murre	Uria aalge
Common gull	Mew gull	Larus canus
Common tern		Sterna hirundo
European shag		Phalacrocorax aristotelis
European storm-petrel		Hydrobates pelagicus
Glaucous gull		Larus hyperboreus
Great auk		Pinguinus impennis
Great black-backed gull		Larus marinus
Great cormorant		Phalacrocorax carbo
Great shearwater		Puffinus gravis
Great skua		Catharacta skua
Herring gull		Larus argentatus
Iceland gull		Larus glaucoides
Ivory gull		Pagophila eburnean
King eider		Somateria spectabilis
Laysan albatross		Phoebastria immutabilis
Leach's storm-petrel		Oceanodroma leucorhoa
Lesser black-backed gull		Larus fuscus
Little auk	Dovekie	Alle alle
Little gull		Larus minutus
Little tern		Sterna albifrons
Long-tailed skua	Long-tailed jaeger	Stercorarius longicaudus
Manx shearwater		Puffinus puffinus
Northern fulmar		Fulmarus glacialis
Northern gannet		Morus bassanus
Razorbill		Alca torda
Ross's gull		Rhodostethia rosea
Sabine's gull		Xema sabini
Sandwich tern		Sterna sandvicensis
Sooty shearwater		Puffinus griseus
White-tailed eagle		Haliaeëtus albicilla
Yellow-legged gull		Larus michahellis

Fish

Common name	Alternative name	Scientific name
Cod	Atlantic cod	Gadus morhua
Herring	Atlantic herring	Clupea harengus
Capelin		Mallotus villosus
European sprat		Sprattus sprattus
Sandeel	Lesser sandeel, sand lance	Ammodytes marinus
Lumpsucker	Lumpfish	Cyclopterus lumpus
Polar cod		Boreogadus saida
Snake pipefish		Entelurus aequoreus

Mammals

Common name	Alternative name	Scientific name
American mink	Mink	Mustela vison
Arctic fox		Alopex lagopus
Brown rat		Rattus norvegicus
Feral cat	Domestic cat	Felis catus
House mouse		Mus musculus
Red fox		Vulpes vulpes

7. References

Aebischer, N.J. (1993), Immediate and delayed effects of a gale in late spring on the breeding of the Shag *Phalacrocorax aristotelis*. Ibis 135: 225–232.

Alonso-Alvarez, C., Munilla, I., López-Alonso, M. & Velando, A. (2007), Sublethal toxicity of the Prestige oil spill on yellow-legged gulls. Environment International 33: 773–781.

AMAP 2009. Arctic pollution (2009), Arctic Monitoring and Assessment Programme, Oslo.

Anker-Nilssen, T. (1992), Food supply as a determinant of reproduction and population development in Norwegian puffins *Fratercula arctica*. DSc thesis, University of Trondheim.

Anker-Nilssen, T. (2009), Sjøfugl i N orge 2008. SEAPOP, Leaflet. 12 pp.

Anker-Nilssen, T., Barrett, R.T. & Krasnov, J.V. (1997), Long- and short-term responses of seabirds in the Norwegian and Barents Seas to changes in stocks of prey fish. Forage Fishes in Marine Ecosystems. Proceedings of the International Symposium on the Role of Forage Fishes in Marine Ecosystems, pp. 683–698. University of Alaska, Fairbanks.

Arnott, S.A. & Ruxton, G.D. (2002), Sandeel recruitment in the North Sea: demographic, climatic and trophic effects. Marine Ecology Progress Series 238: 199–210.

Bakken, V. & Falk, K. (1998), Incidental take of seabirds in commercial fisheries in the Arctic countries. CAFF International Secretariat, Akureyri, CAFF Technical Report no. 1. 50 pp.

Barrett, R.T. (2007), Food web interactions in the southwestern Barents Sea: black-legged kittiwakes *Rissa tridactyla* respond negatively to an increase in herring *Clupea harengus*. Marine Ecology Progress Series 349: 269–276.

Barrett, R.T., Anker-Nilssen, T., Rikardsen, F., Valde, K., Røv, N. & Vader, W. (1987), The food, growth and fledging success of Norwegian Puffin chicks *Fratercula arctica* in 1980–1983. Ornis Scandinavica 18: 73–83.

Barrett, R.T. & Krasnov, J.V. (1996), Recent responses to changes in stocks of prey species by seabirds breeding in the southern Barents Sea. ICES Journal of Marine Science 53: 713–722.

Barrett, R.T., Lorentsen, S.-H. & Anker-Nilssen, T. (2006), The status of breeding seabirds in mainland Norway. Atlantic Seabirds 8: 97–126.

Beale, C.M. (2007), Managing visitor access to seabird colonies: a spatial simulation and empirical observations. Ibis 149: 102–111.

Beale, C.M. & Monaghan, P. (2004), Human disturbance: people as predation-free predators? Journal of Applied Ecology 41: 335–343.

Bennett, V.J., Beard, M., Zollner, P.A., Fernández-Juricic, E., Westphal, L. & LeBlanc, C.L. (2009), Understanding wildlife responses to human disturbance through simulation modelling: A management tool. Ecological Complexity 6: 113–134.

Bisschop-Larsen, L. (2003), Bestandsudviklingen hos terner (*Sterna spp*., Aves) i Det Sydfynske Øhav. Flora og Fauna 109: 87–94.

Blight, L.K. & Burger, A.E. (1997), Occurrence of plastic particles in seabirds from the eastern North Pacific. Marine Pollution Bulletin 34: 323–325.

Boertmann, D. (1994), An annotated checklist to the birds of Greenland. Meddelelser om Grønland – Bioscience 38: 1–64.

Boertmann, D. (2006), Optælling af ridekolonier i Disko Bugt, Arfersiorfik Fjord og Nordre Strømfjord. Arbejdsrapport fra DMU, nr. 225.

Boertmann, D. (2008a), Grønlands Rødliste 2007. Grønlands Hjemmestyre og Danmarks Miljøundersøgelser, Nuuk.

Boertmann, D. (2008b), The lesser black-backed gull, *Larus fuscus*, in Greenland. Arctic 61: 129–133.

Boulcott, P., Wright, P.J., Gibb, F.M., Jensen, H. & Gibb, I.M. (2007), Regional variation in maturation of sandeels in the North Sea. ICES Journal of Marine Science 64: 369–376.

Boulinier, T. & Riffaut, L. (2008), What is the impact of oil pollution on seabirds? Oceanis 30: 577–598.

Bregnballe, T. (2009), Skarven. Hovedland, Aarhus.

Bregnballe, T. & Eskildsen, J. (2009), Danmarks ynglebestand af skarver i 2009. Danmarks Miljøundersøgelser, Aarhus Universitet, Nyhedsbrev fra Afdeling for Vildtbiologi og Biodiversitet. 3 pp.

Bregnballe, T. & Frederiksen, M. (2006), Net-entrapment of great cormorants *Phalacrocorax carbo* sinensis in relation to individual age and population size. Wildlife Biology 12: 143–150.

Brinker, D.F., Mccann, J.M., Williams, B. & Watts, B.D. (2007), Colonial-nesting seabirds in the Chesapeake Bay region: Where have we been and where are we going? Waterbirds 30 (Spec Issue 1): 93–104.

Bull, L.S. (2007). Reducing seabird bycatch in longline, trawl and gillnet fisheries. Fish and Fisheries 8: 31–56.

Burnham, W., Burnham, K.K. & Cade, T.J. (2005), Past and present assessments of bird life in Uummannaq district, West Greenland. Dansk Ornitologisk Forenings Tidsskrift 99: 196–208.

Bustnes, J.O., Anker-Nilssen, T. & Lorentsen, S.-H. (2010), Local and large-scale climatic variables as predictors of the breeding numbers of endangered Lesser Black-backed Gulls on the Norwegian Coast. Journal of Ornithology 151: 19–26.

Bustnes, J.O., Erikstad, K.E., Lorentsen, S.H. & Herzke, D. (2008a), Perfluorinated and chlorinated pollutants as predictors of demographic parameters in an endangered seabird. Environmental Pollution 156: 417–424.

Bustnes, J.O., Erikstad, K.E., Skaare, J.U., Bakken, V. & Mehlum, F. (2003), Ecological effects of organochlorine pollutants in the Arctic: A study of the Glaucous Gull. Ecological Applications 13: 504–515.

Bustnes, J.O., Fauchald, P., Tveraa, T., Helberg, A. & Skaare, J.U. (2008b), The potential impact of environmental variation on the concentrations and ecological effects of pollutants in a marine avian top predator. Environment International 34: 193–201.

Bustnes, J.O., Miland, O., Fjeld, M., Erikstad, K.E. & Skaare, J.U. (2005), Relationships between ecological variables and four organochlorine pollutants in an artic glaucous gull (*Larus hyperboreus*) population. Environmental Pollution 136: 175–185.

Cadiou, B., Riffaut, L., McCoy, K.D., Cabelguen, J., Fortin, M., Gélinaud, G., Le Roch, A., Tirard, C. & Boulinier, T. (2004), Ecological impact of the “Erika” oil spill: determination of the geographic origin of the affected common guillemots. Aquatic Living Resources 17: 369–377.

Cairns, D.K. (1987), Seabirds as indicators of marine food supplies. Biological Oceanography 5: 261–271.

Calladine, J. (2004), Lesser black-backed gull *Larus fuscus*. In: Mitchell P.I., Newton S.F., Ratcliffe N. & Dunn T.E. (eds) Seabird Populations of Britain and Ireland, pp. 227–241. T. & A.D. Poyser, London.

Camphuysen, C.J. & Garthe, S. (1997), An evaluation of the distribution and scavenging habits of northern fulmars (*Fulmarus glacialis*) in the North Sea. ICES Journal of Marine Science 54: 654–683.

Camphuysen, C.J. & Heubeck, M. (2001), Marine oil pollution and beached bird surveys: the development of a sensitive monitoring instrument. Environmental Pollution 112: 443–461.

Chardine, J. & Mendenhall, V. (1998), Human disturbance at Arctic seabird colonies. CAFF International Secretariat, Akureyri, CAFF Technical Report no. 2. 18 pp.

Christensen-Dalsgaard, S., Fangel, K., Dervo, B.K. & Anker-Nilssen, T. (2008), Bifangst av sjøfugl i norske fiskerier – eksisterende kunnskab og forslag til kartleggingsprosjekt. Norsk Institutt for Naturforskning, Trondheim, NINA Rapport 382. 62 pp.

Circumpolar Seabird Group (2008), Seabird harvest in the Arctic. Conservation of Arctic Flora and Fauna, CAFF Technical Report no. 16. 77 pp.

Courchamp, F., Chapuis, J.L. & Pascal, M. (2003), Mammal invaders on islands: impact, control and control impact. Biological Reviews 78: 347–383.

Craik, C. (1997), Long term effects of North American mink *Mustela vison* on seabirds in western Scotland. Bird Study 44: 303–309.

Croxall, J.P. & Rothery, P. (1991), Population regulation of seabirds: implications of their demography for conservation. In: Perrins C.M., Lebreton J.D. & Hirons G.J.M. (eds) Bird Population Studies: Relevance to Conservation and Management, pp. 272–296. Oxford University Press, Oxford.

Cury, P., Bakun, A., Crawford, R.J.M., Jarre, A., Quiñones, R.A., Shannon, L.J. & Verheye, H.M. (2000), Small pelagics in upwelling systems: patterns of interaction and structural changes in “wasp-waist” ecosystems. ICES Journal of Marine Science 57: 603–618.

Davis, S.E., Nager, R.G. & Furness, R.W. (2005), Food availability affects adult survival as well as breeding success of parasitic jaegers. Ecology 86: 1047–1056.

Desholm, M. (2009), Avian sensitivity to mortality: Prioritising migratory bird species for assessment at proposed wind farms. Journal of Environmental Management 90: 2672–2679.

Desholm, M. & Kahlert, J. (2005), Avian collision risk at an offshore wind farm. Biology Letters 1: 296–298.

Drewitt, A.L. & Langston, R.H.W. (2006), Assessing the impacts of wind farms on birds. Ibis 148 (s1): 29–42.

Dunn, E. & Steel, C. (2001), The impact of longline fishing on seabirds in the north-east Atlantic: recommendations for reducing mortality. Unpublished report to RSPB, NOF, JNCC and BirdLife International. 108 pp.

Durant, J.M., Anker-Nilssen, T. & Stenseth, N.C. (2003), Trophic interactions under climate fluctuations: the Atlantic puffin as an example. Proceedings of the Royal Society of London Series B-Biological Sciences 270: 1461–1466.

Durant, J.M., Anker-Nilssen, T. & Stenseth, N.C. (2006), Ocean climate prior to breeding affects the nestling period in the Atlantic puffin. Biology Letters 2: 628–631.

Egevang, C. (2010), Migration and breeding biology of Arctic terns in Greenland. PhD thesis, Center for Macroecology, Evolution and Climate, University of Copenhagen.

Egevang, C. & Boertmann, D. (2003), Havternen i Grønland. Danmarks Miljøundersøgelser, Faglig Rapport nr. 438. 69 pp.

Everaert, J. & Stienen, E.W.M. (2007), Impact of wind turbines on birds in Zeebrugge (Belgium): significant effect on breeding tern colony due to collisions. Biodiversity and Conservation 16: 3345–3359.

Falk, K. & Kampp, K. (2001), Lomvien i Grønland: mulige effekter af forskellige bestandspåvirkende faktorer, og praktiske grænser for ressourceudnyttelse. Grønlands Naturinstitut, Nuuk, Teknisk rapport nr. 38.

Fisher, J. (1952), The fulmar. Collins, London.

Fox, A.D., Desholm, M., Kahlert, J., Christensen, T.K. & Petersen, I.K. (2006), Information needs to support environmental impact assessment of the effects of European marine offshore wind farms on birds. Ibis 148 (s1): 129–144.

Frederiksen, M., Daunt, F., Harris, M.P. & Wanless, S. (2008a), The demographic impact of extreme events: stochastic weather drives survival and population dynamics in a long-lived seabird. Journal of Animal Ecology 77: 1020–1029.

Frederiksen, M., Edwards, M., Mavor, R.A. & Wanless, S. (2007a), Regional and annual variation in black-legged kittiwake breeding productivity is related to sea surface temperature. Marine Ecology Progress Series 350: 137–143.

Frederiksen, M., Edwards, M., Richardson, A.J., Halliday, N.C. & Wanless, S. (2006), From plankton to top predators: bottom-up control of a marine food web across four trophic levels. Journal of Animal Ecology 75: 1259–1268.

Frederiksen, M., Furness, R.W. & Wanless, S. (2007b), Regional variation in the role of bottom-up and top-down processes in controlling sandeel abundance in the North Sea. Marine Ecology Progress Series 337: 279–286.

Frederiksen, M., Jensen, H., Daunt, F., Mavor, R.A. & Wanless, S. (2008b), Differential effects of a local industrial sand lance fishery on seabird breeding performance. Ecological Applications 18: 701–710.

Frederiksen, M., Lebreton, J.D. & Bregnballe, T. (2001), The interplay between culling and density-dependence in the great cormorant: a modelling approach. Journal of Applied Ecology 38: 617–627.

Frederiksen, M., Mavor, R.A. & Wanless, S. (2007c), Seabirds as environmental indicators: the advantages of combining data sets. Marine Ecology Progress Series 352: 205–211.

Frederiksen, M., Wanless, S., Harris, M.P., Rothery, P. & Wilson, L.J. (2004), The role of industrial fisheries and oceanographic change in the decline of North Sea black-legged kittiwakes. Journal of Applied Ecology 41: 1129–1139.

Furness, R.W. (2003), Impacts of fisheries on seabird communities. Scientia Marina 67: 33–45.

Furness, R.W. (2007), Responses of seabirds to depletion of food fish stocks. Journal of Ornithology 148: S247–S252.

Furness, R.W. & Monaghan, P. (1987). Seabird ecology. Blackie, Glasgow.

Furness, R.W. & Ratcliffe, N. (2004), Great skua *Stercorarius skua*. In: Mitchell P.I., Newton S.F., Ratcliffe N. & Dunn T.E. (eds) Seabird Populations of Britain and Ireland, pp. 173–186. T. & A.D. Poyser, London.

Furness, R.W. & Tasker, M.L. (2000), Seabird-fishery interactions: quantifying the sensitivity of seabirds to reductions in sandeel abundance, and identification of key areas for sensitive seabirds in the North Sea. Marine Ecology Progress Series 202: 253–264.

Garthe, S., Camphuysen, C.J. & Furness, R.W. (1996), Amounts of discards by commercial fisheries and their significance as food for seabirds in the North Sea. Marine Ecology Progress Series 136: 1–11.

Garthe, S. & Hüppop, O. (2004), Scaling possible adverse effects of marine wind farms on seabirds: developing and applying a vulnerability index. Journal of Applied Ecology 41: 724–734.

Garðarsson, A. (1995), Svartfugl í íslenskum fuglabjörgum. Bliki 16: 47–65.

Garðarsson, A. (1996), Ritubyggðir. Bliki 17: 1–16.

Garðarsson, A. (2008a), Dílaskarfsbyggðir 1994–2008. Bliki 29: 1–10.

Garðarsson, A. (2008b), Súlutalning 2005–2008. Bliki 29: 19–22.

Garðarsson, A. & Petersen, Æ. (2009), Íslenski toppskarfsstofninn. Bliki 30: 9–26.

Gaston, A.J. (2004), Seabirds: a natural history. T. & A.D. Poyser, London.

Gaston, A.J., Hipfner, J.M. & Campbell, D. (2002), Heat and mosquitoes cause breeding failures and adult mortality in an Arctic-nesting seabird. Ibis 144: 185–191.

Gilliland, S.G., Gilchrist, H.G., Rockwell, R.F., Robertson, G.J., Savard, J.P.L., Merkel, F. & Mosbech, A. (2009), Evaluating the sustainability of harvest among northern common eiders *Somateria mollissima borealis* in Greenland and Canada. Wildlife Biology 15: 24–36.

Gislason, H. (2003), The effects of fishing on non-target species and ecosystem structure and function. In: Sinclair M. & Valdimarsson G. (eds) Responsible Fisheries in the Marine Ecosystem, pp. 255–274. Food & Agriculture Organization of the United Nations, Rome.

Gjøsæter, H., Bogstad, B. & Tjelmeland, S. (2009), Ecosystem effects of the three capelin stock collapses in the Barents Sea. Marine Biology Research 5: 40–53.

Golet, G.H., Seiser, P.E., McGuire, A.D., Roby, D.D., Fischer, J.B., Kuletz, K.J., Irons, D.B., Dean, T.A., Jewett, S.C. & Newman, S.H. (2002), Long-term direct and indirect effects of the “Exxon Valdez” oil spill on pigeon guillemots in Prince William Sound, Alaska. Marine Ecology Progress Series 241: 287–304.

Grémillet, D., Chauvin, C., Wilson, R.P., le Maho, Y. & Wanless, S. (2005), Unusual feather structure allows partial plumage wettability in diving great cormorants *Phalacrocorax carbo*. Journal of Avian Biology 36: 57–63.

Grémillet, D., Pichegru, L., Kuntz, G., Woakes, A.G., Wilkinson, S., Crawford, R.J.M. & Ryan, P.G. (2008), A junk-food hypothesis for gannets feeding on fishery waste. Proceedings of the Royal Society B-Biological Sciences 275: 1149–1156.

Grosbois, V., Harris, M.P., Anker-Nilssen, T., McCleery, R.H., Shaw, D.N., Morgan, B.J.T. & Gimenez, O. (2009), Modeling survival at multi-population scales using mark-recapture data. Ecology 90: 2922–2932.

Grosbois, V. & Thompson, P.M. (2005), North Atlantic climate variation influences survival in adult fulmars. Oikos 109: 273–290.

Hamer, K.C., Monaghan, P., Uttley, J.D., Walton, P. & Burns, M.D. (1993), The influence of food supply on the breeding ecology of Kittiwakes *Rissa tridactyla* in Shetland. Ibis 135: 255–263.

Hamre, J. (1994), Biodiversity and exploitation of the main fish stocks in the Norwegian – Barents Sea ecosystem. Biodiversity and Conservation 3: 473–492.

Harris, M.P., Anker-Nilssen, T., McCleery, R.H., Erikstad, K.E., Shaw, D.N. & Grosbois, V. (2005), Effect of wintering area and climate on the survival of adult Atlantic puffins *Fratercula arctica* in the eastern Atlantic. Marine Ecology Progress Series 297: 283–296.

Heath, M., Edwards, M., Furness, R., Pinnegar, J. & Wanless, S. (2009), A view from above: changing seas, seabirds and food sources. In: Baxter J.M., Buckley P.J. & Frost M.T. (eds) Marine Climate Change Ecosystems Linkages Report Card, pp. 24 pp. Marine Climate Change Impact Partnership, www.mccip.org.uk/elr/review.

Helaouët, P. & Beaugrand, G. (2007), Macroecology of *Calanus finmarchicus* and *C. helgolandicus* in the North Atlantic Ocean and adjacent seas. Marine Ecology Progress Series 345: 147–165.

Helaouët, P. & Beaugrand, G. (2009), Physiology, ecological niches and species distribution. Ecosystems 12: 1235–1245.

Helberg, M., Bustnes, J.O., Erikstad, K.E., Kristiansen, K.O. & Skaare, J.U. (2005), Relationships between reproductive performance and organochlorine contaminants in great black-backed gulls (*Larus marinus*). Environmental Pollution 134: 475–483.

Heubeck, M. (1997), The direct effect of the Braer oil spill on seabird populations, and an assessment of the role of the Wildlife Response Centre. In: Davies J.M. & Topping G. (eds) The Impact of an Oil Spill in Turbulent Waters: the Braer, pp. 73–90. The Stationery Office, Edinburgh.

Heubeck, M., Mellor, R.M. & Harvey, P.V. (1997), Changes in the breeding distribution and numbers of Kittiwakes *Rissa tridactyla* around Unst, Shetland, and the presumed role of predation by Great Skuas *Stercorarius skua.* Seabird 19: 12–21.

Hjermann, D.Ø., Ottersen, G. & Stenseth, N.C. (2004a), Competition among fishermen and fish causes the collapse of Barents Sea capelin. Proceedings of the National Academy of Sciences of the United States of America 101: 11679–11684.

Hjermann, D.Ø., Stenseth, N.C. & Ottersen, G. (2004b), Indirect climatic forcing of the Barents Sea capelin: a cohort effect. Marine Ecology Progress Series 273: 229–238.

Hobson, K.A., Piatt, J.F. & Pitocchelli, J. (1994), Using stable isotopes to determine seabird trophic relationships. Journal of Animal Ecology 63: 786–798.

Hochscheid, S., Grémillet, D., Wanless, S. & du Plessis, M.A. (2002), Black and white under the South African sun: are juvenile Cape gannets heat stressed? Journal of Thermal Biology 27: 325–332.

Hunt, G.L., Stabeno, P., Walters, G., Sinclair, E., Brodeur, R.D., Napp, J.M. & Bond, N.A. (2002), Climate change and control of the southeastern Bering Sea pelagic ecosystem. Deep-Sea Research II 49: 5821–5853.

ICES (1994), Report of the Study Group on Seabird-fish Interactions. International Council for the Exploration of the Sea, Copenhagen, ICES CM 1994/L:34. 72 pp.

ICES (1997), Report of the Working Group on Seabird Ecology. International Council for the Exploration of the Sea, Copenhagen, ICES CM 1997/L:3. 71 pp.

ICES (1998), Report of the Working Group on Seabird Ecology. International Council for the Exploration of the Sea, Copenhagen, ICES CM 1998/C:5. 40 pp.

ICES (2000), Report of the Working Group on Seabird Ecology. International Council for the Exploration of the Sea, Copenhagen, ICES CM 2000/C:04. 75 pp.

ICES (2002), Report of the Working Group on Seabird Ecology. International Council for the Exploration of the Sea, Copenhagen, ICES CM 2002/C:04. 72 pp.

ICES (2003), Report of the Working Group on Seabird Ecology. International Council for the Exploration of the Sea, Copenhagen, ICES CM 2003/C:03. 96 pp.

ICES (2004), Report of the Working Group on Seabird Ecology (WGSE). International Council for the Exploration of the Sea, Copenhagen, ICES CM 2004/C:05. 53 pp.

ICES (2005), Report of the Working Group on Seabird Ecology (WGSE). International Council for the Exploration of the Sea, Copenhagen, ICES CM 2005/G:07. 49 pp.

ICES (2007), Report of the Working Group on Seabird Ecology (WGSE). International Council for the Exploration of the Sea, Copenhagen, ICES CM 2007/LRC:05. 123 pp.

ICES (2008), Report of the Working Group on Seabird Ecology (WGSE). International Council for the Exploration of the Sea, Copenhagen, ICES CM 2008/LRC:05. 99 pp.

ICES (2009), Report of the Working Group on Seabird Ecology (WGSE). International Council for the Exploration of the Sea, Copenhagen, ICES CM 2009/LRC:10. 91 pp.

Irons, D.B., Anker-Nilssen, T., Gaston, A.J., Byrd, G.V., Falk, K., Gilchrist, G., Hario, M., Hjernquist, M., Krasnov, Y.V., Mosbech, A., Olsen, B., Petersen, A., Reid, J.B., Robertson, G.J., Strøm, H. & Wohl, K.D. (2008), Fluctuations in circumpolar seabird populations linked to climate oscillations. Global Change Biology 14: 1455–1463.

Jenssen, B.M. (2006), Endocrine-disrupting chemicals and climate change: a worst-case combination for Arctic marine mammals and seabirds? Environmental Health Perspectives 114: 76–80.

JNCC (2009), UK seabirds in 2008. Joint Nature Conservation Committee, Leaflet. 16 pp.

Jóhannsson, J.H. & Guðjónsdóttir, B. (2007), Áhrif minks á teistuvarp á Ströndum. Náttúrufræðingurinn 76: 29–36.

Jones, H.P., Tershy, B.R., Zavaleta, E.S., Croll, D.A., Keitt, B.S., Finkelstein, M.E. & Howald, G.R. (2008a), Severity of the effects of invasive rats on seabirds: A global review. Conservation Biology 22: 16–26.

Jones, T., Smith, C., Williams, E. & Ramsay, A. (2008b), Breeding performance and diet of Great Skuas *Stercorarius skua* and Parasitic Jaegers (Arctic Skuas) *S. parasiticus* on the west coast of Scotland. Bird Study 55: 257–266.

Kampp, K., Nettleship, D.N. & Evans, P.G.H. (1994), Thick-billed murres of Greenland: status and prospects. In: Nettleship D.N., Burger J. & Gochfeld M. (eds) Seabirds on Islands: Threats, Case Studies and Action Plans, pp. 133–154. Birdlife International, Cambridge, UK.

Kindberg, J., Holmqvist, N. & Bergqvist, G. (2009), Årsrapport 2007–2008: Viltövervakningen. Svenska Jägareförbundet, Viltforum #2/2009. 22 pp.

Kitaysky, A.S. & Golubova, E.G. (2000), Climate change causes contrasting trends in reproductive performance of planktivorous and piscivorous alcids. Journal of Animal Ecology 69: 248–262.

Labansen, A.L., Merkel, F., Boertmann, D. & Nyeland, J. (2010), Status of the black-legged kittiwake (*Rissa tridactyla*) breeding population in Greenland, 2008. Polar Research in press.

Larsen, J.L., Durinck, J. & Skov, H. (2007), Trends in chronic marine oil pollution in Danish waters assessed using 22 years of beached bird surveys. Marine Pollution Bulletin 54: 1333–1340.

Lewison, R.L., Crowder, L.B., Read, A.J. & Freeman, S.A. (2004), Understanding impacts of fisheries bycatch on marine megafauna. Trends in Ecology & Evolution 19: 598–604.

Lorentsen, S.-H. & Christensen-Dalsgaard, S. (2009), Det nasjonale overvåkningsprogrammet for sjøfugl. Resultater til og med hekkesesongen 2008. Norsk Institutt for Naturforskning, Trondheim, NINA Rapport 439. 58 pp.

Lunneryd, S.-G., Königson, S. & Sjöberg, N.B. (2004), Bifångst av säl, tumlare och fåglar i det svenska yrkesfisket. Fiskeriverket, Göteborg, F-info 2004:8. 20 pp.

Lyngs, P. (2008), Status of the Danish breeding population of Eiders *Somateria mollissima* 2000–2002. Dansk Ornitologisk Forenings Tidsskrift 102: 289–297.

Martínez-Abraín, A., Velando, A., Oro, D., Genovart, M., Gerique, C., Bartolomé, M.A., Villuendas, E. & Sarzo, B. (2006), Sex-specific mortality of European shags after the Prestige oil spill: demographic implications for the recovery of colonies. Marine Ecology Progress Series 318: 271–276.

Masden, E.A., Fox, A.D., Furness, R.W., Bullman, R. & Haydon, D.T. (2010), Cumulative impact assessments and bird/wind farm interactions: Developing a conceptual framework. Environmental Impact Assessment Review 30: 1–7.

Mavor, R.A., Heubeck, M., Schmitt, S. & Parsons, M. (2008), Seabird numbers and breeding success in Britain and Ireland, 2006. Joint Nature Conservation Committee, Peterborough, UK Nature Conservation Report No. 31. 113 pp.

Melvin, E.F., Parrish, J.K. & Conquest, L.L. (1999), Novel tools to reduce seabird bycatch in coastal gillnet fisheries. Conservation Biology 13: 1386–1397.

Merkel, F. & Christensen, T. (2008), Seabird harvest in Greenland. In: Circumpolar Seabird Group (ed) Seabird Harvest in the Arctic, pp. 41–49. Conservation of Arctic Flora and Fauna.

Merkel, F.R. (2004a), Evidence of population decline in common eiders breeding in Western Greenland. Arctic 57: 27–36.

Merkel, F.R. (2004b), Impact of hunting and gillnet fishery on wintering eiders in Nuuk, southwest Greenland. Waterbirds 27: 469–479.

Merkel, F.R. (2008), Bestandsstatus for ederfuglen i Ilulissat, Uummannaq og Upernavik kommuner, 2001 – 2007. Resultater fra overvågning gennemført af lokale optællere i samarbejde med Grønlands Naturinstitut. Pinngortitaleriffik, Grønlands Naturinstitut, Nuuk, Teknisk rapport nr. 73. 36 pp.

Merkel, F.R., Mosbech, A. & Riget, F. (2009), Common Eider *Somateria mollissima* feeding activity and the influence of human disturbances. Ardea 97: 99–107.

Merkel, F.R., Rasmussen, L.M. & Rosing-Asvid, A. (2010), Seabirds and marine mammals in South and Southeast Greenland, June 2008. Pinngortitaleriffik, Greenland Institute of Natural Resources, Nuuk, Technical Report No. 81. 57 pp.

Mitchell, P.I., Newton, S.F., Ratcliffe, N. & Dunn, T.E. (2004), Seabird populations of Britain and Ireland. T. & A.D. Poyser, London.

Monaghan, P. (1992), Seabirds and sandeels – the conflict between exploitation and conservation in the northern North Sea. Biodiversity and Conservation 1: 98–111.

Monaghan, P., Walton, P., Wanless, S., Uttley, J.D. & Burns, M.D. (1994), Effects of prey abundance on the foraging behaviour, diving efficiency and time allocation of breeding Guillemots *Uria aalge*. Ibis 136: 214–222.

Mosbech, A. & Boertmann, D. (1999), Distribution, abundance and reaction to aerial surveys of post-breeding king eiders (*Somateria spectabilis*) in western Greenland. Arctic 52: 188–203.

Mosbech, A., Merkel, F., Boertmann, D., Falk, K., Frederiksen, M., Johansen, K. & Sonne, C. (2009), Thick-billed murre studies in Disko Bay (Ritenbenk), west Greenland. National Environmental Research Institute, Aarhus University, Roskilde, NERI Technical Report no. 749. 60 pp.

Murray, D.S. (2008), The guga hunters. Birlinn, Edinburgh.

Murray, S., Wanless, S. & Harris, M.P. (1994), The effects of fixed salmon *Salmo salar* nets on guillemot *Uria aalge* and razorbill *Alca torda* in Northeast Scotland in 1992. Biological Conservation 70: 251–256.

Newton, I. & Little, B. (2009), Assessment of wind-farm and other bird casualties from carcasses found on a Northumbrian beach over an 11-year period. Bird Study 56: 158–167.

Noer, H., Asferg, T., Clausen, P., Olesen, C.R., Bregnballe, T., Laursen, K., Kahlert, J., Teilmann, J., Christensen, T.K. & Haugaard, L. (2009), Vildtbestande og jagttider i Danmark: Det biologiske grundlag for jagttidsrevisionen 2010. Danmarks Miljøundersøgelser, Aarhus Universitet, Faglig rapport fra DMU 742. 288 pp.

Nordisk Ministerråd (2008), Vest-Nordiske sjøfugler i et presset havmiljø. Nordisk Ministerråd, København, TemaNord 2008:573. 100 pp.

Nørrevang, A. (1986), Traditions of sea bird fowling in the Faroes: an ecological basis for sustained fowling. Ornis Scandinavica 17: 275–281.

Nyeland, J. & Mathæussen, H. (2004), Monitering af havfuglekolonier i Maniitsoq Kommune 2003. Grønlands Naturinstitut, Pinngortitalriffik, Nuuk, Teknisk Rapport nr. 59.

Olsen, B. (2008), Seabird harvest in the Faroe Islands. In: Circumpolar Seabird Group (ed) Seabird Harvest in the Arctic, pp. 30–35. Conservation of Arctic Flora and Fauna.

Pauly, D., Christensen, V., Dalsgaard, J., Froese, R. & Torres, F. (1998), Fishing down marine food webs. Science 279: 860–863.

Pauly, D. & Maclean, J. (2003), In a perfect ocean: the state of fisheries and ecosystems in the North Atlantic Ocean. Island Press, Washington, DC, USA.

Pedersen, S.A., Lewy, P. & Wright, P. (1999), Assessments of the lesser sandeel (*Ammodytes marinus*) in the North Sea based on revised stock divisions. Fisheries Research 41: 221–241.

Petersen, A. (1981), Breeding biology and feeding ecology of Black Guillemots. DPhil Oxford University.

Petersen, A. (2008), Seabird harvest in Iceland. In: Circumpolar Seabird Group (ed) Seabird Harvest in the Arctic, pp. 50–58. Conservation of Arctic Flora and Fauna.

Petersen, Æ. (2000), Vöktun sjófuglastofna. Náttúrufræðingurinn 69: 189–200.

Petersen, Æ. (2002), Fugladauði í veiðarfærum í sjó við Ísland. Náttúrufræðingurinn 71: 52–61.

Petersen, Æ. & Thorstensen, S. (2004), Vöktun stormmáfsstofnsins í Eyjafirði 1980–2000. Náttúrufræðingurinn 72: 144–154.

Peterson, C.H., Rice, S.D., Short, J.W., Esler, D., Bodkin, J.L., Ballachey, B.E. & Irons, D.B. (2003), Long-term ecosystem response to the Exxon Valdez oil spill. Science 302: 2082–2086.

Phillips, R.A., Petersen, M.K., Lilliendahl, K., Solmundsson, J., Hamer, K.C., Camphuysen, C.J. & Zonfrillo, B. (1999), Diet of the northern fulmar *Fulmarus glacialis*: reliance on commercial fisheries? Marine Biology 135: 159–170.

Pickerell, G. (2004), Little tern *Sterna albifrons*. In: Mitchell P.I., Newton S.F., Ratcliffe N. & Dunn T.E. (eds) Seabird Populations of Britain and Ireland, pp. 339–349. T. & A.D. Poyser, London.

Pierce, G.J., Dyson, J., Kelly, E., Eggleton, J.D., Whomersley, P., Young, I.A.G., Santos, M.B., Wang, J.J. & Spencer, N.J. (2002), Results of a short study on bycatches and discards in pelagic fisheries in Scotland (UK). Aquatic Living Resources 15: 327–334.

Proctor, R., Wright, P.J. & Everitt, A. (1998), Modelling the transport of larval sandeels on the north west European shelf. Fisheries Oceanography 7: 347–354.

Ratcliffe, N. (2004), Causes of seabird population change. In: Mitchell P.I., Newton S.F., Ratcliffe N. & Dunn T.E. (eds) Sea-

bird Populations of Britain and Ireland, pp. 407–437. T. & A.D. Poyser, London.
Ratcliffe, N., Bell, M., Pelembe, T., Boyle, D., Benjamin, R., White, R., Godley, B., Stevenson, J. & Sanders, S. (2010), The eradication of feral cats from Ascension Island and its subsequent recolonization by seabirds. Oryx 44: 20–29.
Ratcliffe, N., Craik, C., Helyar, A., Roy, S. & Scott, M. (2008), Modelling the benefits of American Mink *Mustela vison* management options for terns in west Scotland. Ibis 150: 114–121.
Ratcliffe, N., Mitchell, I., Varnham, K., Verboven, N. & Higson, P. (2009), How to prioritize rat management for the benefit of petrels: a case study of the UK, Channel Islands and Isle of Man. Ibis 151: 699–708.
Rice, J. (1995), Food web theory, marine food webs, and what climate change may do to northern marine fish populations. In: Beamish R.J. (ed) Climate Change and Northern Fish Populations. Canadian Special Publication of Fisheries and Aquatic Sciences 121, pp. 561–568. National Research Council of Canada, Ottawa.
Sandvik, H. & Barrett, R.T. (2001), Effect of investigator disturbance on the breeding success of the Black-legged Kittiwake. Journal of Field Ornithology 72: 30–42.
Sandvik, H., Erikstad, K.E., Barrett, R.T. & Yoccoz, N.G. (2005), The effect of climate on adult survival in five species of North Atlantic seabirds. Journal of Animal Ecology 74: 817–831.
Schreiber, E.A. & Burger, J. (eds.) (2002), Biology of marine birds. CRC Press, Boca Raton, Florida.
Sherman, K., Jones, C., Sullivan, L., Smith, W., Berrien, P. & Ejsymont, L. (1981), Congruent shifts in sand eel abundance in western and eastern North Atlantic ecosystems. Nature 291: 486–489.
Stempniewicz, L., Blachowiak-Samolyk, K. & Weslawski, J.M. (2007), Impact of climate change on zooplankton communities, seabird populations and arctic terrestrial ecosystem – A scenario. Deep-Sea Research II 54: 2934–2945.
Strann, K.B., Vader, W. & Barrett, R. (1991), Auk mortality in fishing nets in north Norway. Seabird 13: 22–29.
Strøm, H. (2007), Distribution of seabirds on Bjørnøya. In: Anker-Nilssen T., Barrett R.T., Bustnes J.O., Erikstad K.E., Fauchald P., Lorentsen S.-H., Steen H., Strøm H., Systad G.H. & Tveraa T. (eds) SEAPOP Studies in the Lofoten and Barents Sea Area in 2006. NINA Report 249, pp. 50–52. Norsk Institutt for Naturforskning, Trondheim.
Strøm, H., Anker-Nilssen, T., Barrett, R. & Ekker, M. (2008), Seabird harvest in Norway and Svalbard. In: Circumpolar Seabird Group (ed) Seabird Harvest in the Arctic, pp. 59–63. Conservation of Arctic Flora and Fauna.
Tasker, M.L., Camphuysen, C.J., Cooper, J., Garthe, S., Montevecchi, W.A. & Blaber, S.J.M. (2000), The impacts of fishing on marine birds. ICES Journal of Marine Science 57: 531–547.
Thompson, K.R. & Furness, R.W. (1991), The influence of rainfall and nest site quality on the population dynamics of the Manx shearwater *Puffinus puffinus* on Rhum. Journal of Zoology 225: 427–437.
Thompson, P.M. & Ollason, J.C. (2001), Lagged effects of ocean climate change on fulmar population dynamics. Nature 413: 417–420.
Tull, C.E., Germain, P. & May, A.W. (1972), Mortality of thick-billed murres in the West Greenland salmon fishery. Nature 237: 42–44.
Vader, W., Barrett, R.T., Erikstad, K.E. & Strann, K.B. (1990), Differential responses of Common and Thick-billed Murres to a crash in the capelin stock in the southern Barents Sea. Studies in Avian Biology 14: 175–180.
van Deurs, M., van Hal, R., Tomczak, M.T., Jónasdóttir, S.H. & Dolmer, P. (2009), Recruitment of lesser sandeel *Ammodytes marinus* in relation to density dependence and zooplankton composition. Marine Ecology Progress Series 381: 249–258.
van Franeker, J.A. & Meijboom, A. (2002), Marine litter monitoring by northern fulmars (a pilot study). Alterra, Green World Research, Wageningen, Alterra-rapport 401. 70 pp.
Verboven, N., Verreault, J., Letcher, R.J., Gabrielsen, G.W. & Evans, N.P. (2010), Adrenocortical function of Arctic-breeding glaucous gulls in relation to persistent organic pollutants. General and Comparative Endocrinology 166: 25–32.
Votier, S.C., Bearhop, S., Fyfe, R. & Furness, R.W. (2008), Temporal and spatial variation in the diet of a marine top predator – links with commercial fisheries. Marine Ecology Progress Series 367: 223–232.
Votier, S.C., Furness, R.W., Bearhop, S., Crane, J.E., Caldow, R.W.G., Catry, P.,

Ensor, K., Hamer, K.C., Hudson, A.V., Kalmbach, E., Klomp, N.I., Pfeiffer, S., Phillips, R.A., Prieto, I. & Thompson, D.R. (2004), Changes in fisheries discard rates and seabird communities. Nature 427: 727–730.

Votier, S.C., Hatchwell, B.J., Beckerman, A., McCleery, R.H., Hunter, F.M., Pellatt, J., Trinder, M. & Birkhead, T.R. (2005), Oil pollution and climate have wide-scale impacts on seabird demographics. Ecology Letters 8: 1157–1164.

Wanless, R.M., Angel, A., Cuthbert, R.J., Hilton, G.M. & Ryan, P.G. (2007a), Can predation by invasive mice drive seabird extinctions? Biology Letters 3: 241–244.

Wanless, S., Frederiksen, M., Daunt, F., Scott, B.E. & Harris, M.P. (2007b), Black-legged kittiwakes as indicators of environmental change in the North Sea: evidence from long-term studies. Progress in Oceanography 72: 30–38.

Wanless, S., Harris, M.P., Calladine, J. & Rothery, P. (1996), Modelling responses of herring gull and lesser black-backed gull populations to reduction of reproductive output: implications for control measures. Journal of Applied Ecology 33: 1420–1432.

Wanless, S., Harris, M.P., Redman, P. & Speakman, J. (2005a), Low energy values of fish as a probable cause of a major seabird breeding failure in the North Sea. Marine Ecology Progress Series 294: 1–8.

Wanless, S., Murray, S. & Harris, M.P. (2005b), The status of Northern Gannet in Britain & Ireland in 2003/04. British Birds 98: 280–294.

Wanless, S., Wright, P.J., Harris, M.P. & Elston, D.A. (2004), Evidence for decrease in size of lesser sandeels *Ammodytes marinus* in a North Sea aggregation over a 30-yr period. Marine Ecology Progress Series 279: 237–246.

Watkins, B.P., Petersen, S.L. & Ryan, P.G. (2008), Interactions between seabirds and deep-water hake trawl gear: an assessment of impacts in South African waters. Animal Conservation 11: 247–254.

Weimerskirch, H., Brothers, N. & Jouventin, P. (1997), Population dynamics of wandering albatross *Diomedea exulans* and Amsterdam albatross *D. amsterdamensis* in the Indian Ocean and their relationships with long-line fisheries: conservation implications. Biological Conservation 79: 257–270.

Wiese, F.K., Montevecchi, W.A., Davoren, G.K., Huettmann, F., Diamond, A.W. & Linke, J. (2001), Seabirds at risk around offshore oil platforms in the North-west Atlantic. Marine Pollution Bulletin 42: 1285–1290.

Wiese, F.K. & Robertson, G.J. (2004), Assessing seabird mortality from chronic oil discharges at sea. Journal of Wildlife Management 68: 627–638.

Wiese, F.K., Robertson, G.J. & Gaston, A.J. (2004), Impacts of chronic marine oil pollution and the murre hunt in Newfoundland on thick-billed murre *Uria lomvia* populations in the eastern Canadian Arctic. Biological Conservation 116: 205–216.

Wilhelm, S.I., Robertson, G.J., Ryan, P.C., Tobin, S.F. & Elliot, R.D. (2009), Re-evaluating the use of beached bird oiling rates to assess long-term trends in chronic oil pollution. Marine Pollution Bulletin 58: 249–255.

Williams, J.M., Tasker, M.L., Carter, I.C. & Webb, A. (1995), A method of assessing seabird vulnerability to surface pollutants. Ibis 137 (supplement): S147–S152.

Wright, P.J. (1996), Is there a conflict between sandeel fisheries and seabirds? A case study at Shetland. In: Greenstreet S.P.R. & Tasker M.L. (eds) Aquatic Predators and Their Prey, pp. 154–165. Fishing News Books, Oxford.

Young, L.C., Vanderlip, C., Duffy, D.C., Afanasyev, V. & Shaffer, S.A. (2009), Bringing home the trash: do colony-based differences in foraging distribution lead to increased plastic ingestion in Laysan albatrosses? Plos One 4: e7623.

Žydelis, R., Bellebaum, J., Österblom, H., Vetemaa, M., Schirmeister, B., Stipniece, A., Dagys, M., van Eerden, M. & Garthe, S. (2009), Bycatch in gillnet fisheries – An overlooked threat to waterbird populations. Biological Conservation 142: 1269–1281.

Appendix: Completed threat questionnaires

Norway (5 questionnaires)

Norway – questionnaire 1: SW Barents Sea – Bear Island	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Great Northern Diver	0	0	0	1	1	1	0	0	0	2	0	0	
White-billed Diver	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Red-necked Grebe	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Northern Fulmar	0	0	0	1	1	1	1	2	0	0	0	2	
Manx Shearwater													
Storm Petrel													
Leach´s Storm Petrel													
Northern Gannet	0	0	0	1	2	2	0	1	0	0	1	0	
Great Cormorant													*P.c.carbo*
European Shag													
Common Eider	0	0	0	2	0	2	0	0	0	0	0	0	
King Eider	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Steller's Eider	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Long-tailed Duck	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Velvet Scoter	-		-	-	-	-	-	-	-	-	-	-	Wintering pop.
Parasitic Jaeger	0	0	0	0	2	1	1	0	0	0	0	0	
Great Skua	0	0	0	0	2	1	2	0	0	0	0	0	
Iceland Gull													
Glaucous Gull	0	0	0	0	2	1	3	0	0	0	0	2	
Great Black-backed Gull	0	0	0	1	2	1	2	0	0	0	1	1	
Herring Gull	0	0	0	1	2	1	2	0	0	0	1	1	
Lesser Black-backed Gull	0	2	0	2	1	2	1	0	2	1	1	2	*L.f.fuscus*
Lesser Black-backed Gull													*L.f.intermedius*
Common Gull													
Black-headed Gull													
Little Gull													
Black-legged Kittiwake	0	0	0	0	3	2	1	0	0	0	0	3	
Arctic Tern	0	0	0	0	2	1	0	0	0	0	0	3	
Sandwich Tern													
Common Tern													
Little Tern													
Razorbill	0	0	0	1	3	3	0	0	0	0	0	2	
Common Guillemot	0	0	0	1	3	3	0	0	0	0	0	3	
Brünnich's Guillemot	0	0	0	1	3	3	0	0	0	0	0	3	
Little Auk	0	0	0	0	2	2	0	0	0	0	0	2	
Black Guillemot	0	0	0	0	1	2	0	0	0	0	0	2	
Atlantic Puffin	0	0	0	0	3	3	0	0	0	0	1	2	

Norway – questionnaire 2: Norwegian Sea	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Great Northern Diver	1		0	2	1	3	0	0	0	0	0	2	Wintering pop.
White-billed Diver	1		0	2	1	3	0	0	0	0	0	2	Wintering pop.
Red-necked Grebe	0		0	2	1	2	0	0	0	1	0	2	Wintering pop.
Northern Fulmar	0	0	0	1	1	1	1	2	0	0	1	2	
Manx Shearwater													
Storm Petrel	0	0	0	0	0	1	1	2	1	0	0	0	
Leach´s Storm Petrel	0	0	0	0	0	1	1	2	1	0	0	0	
Northern Gannet	0	0	0	1	2	2	0	1	0	0	1	0	
Great Cormorant	1	0	0	1	1	2	0	0	0	0	0	0	*P.c.carbo*
European Shag	1	0	0	1	2	2	0	0	0	0	0	0	
Common Eider	0	0	0	2	0	2	0	0	1	0	1	0	
King Eider	0		0	2	1	3	0	0	0	0	0	2	Wintering pop.
Steller's Eider													
Long-tailed Duck	0		0	2	1	2	0	0	0	0	0	1	Wintering pop.
Velvet Scoter	0		0	2	1	2	0	0	0	0	0	1	Wintering pop.
Parasitic Jaeger	0	0	0	0	1	1	1	0	0	0	0	0	
Great Skua	0	0	0	1	2	1	2	0	0	1	0	0	
Iceland Gull													
Glaucous Gull													
Great Black-backed Gull	0	0	0	1	2	1	2	0	0	0	1	1	
Herring Gull	0	0	0	1	2	1	2	0	0	0	1	1	
Lesser Black-backed Gull	0	2	0	2	1	2	1	0	2	1	1	2	*L.f.fuscus*
Lesser Black-backed Gull	0	0	0	1	1	1	1	0	0	0	1	1	*L.f.intermedius*
Common Gull	0	0	0	0	1	1	1	0	1	0	1	1	
Black-headed Gull	0	0	0	0	0	0	1	0	0	0	1	1	
Little Gull													
Black-legged Kittiwake	0	1	0	2	3	2	1	0	0	0	0	3	
Arctic Tern	0	2	0	0	2	1	0	0	0	0	0	3	
Sandwich Tern													
Common Tern	0	1	0	0	1	1	0	0	0	0	0	1	
Little Tern													
Razorbill	0	1	0	1	3	3	0	0	0	1	1	2	
Common Guillemot	0	2	0	1	3	3	0	0	1	1	1	3	
Brünnich's Guillemot	0	0	0	1	2	2	0	0	0	0	0	3	
Little Auk	0	0	0	0	2	1	0	0	0	0	0	2	
Black Guillemot	0	0	0	1	1	2	0	0	2	0	0	2	
Atlantic Puffin	0	0	0	0	3	3	0	0	0	0	1	2	

Norway – questionnaire 3: North Sea & Skagerrak	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Great Northern Diver	1		0	2	1	3	0	0	0	0	0	2	Wintering pop.
White-billed Diver	1		0	2	1	3	0	0	0	0	0	2	Wintering pop.
Red-necked Grebe	0		0	2	1	2	0	0	0	1	0	2	Wintering pop.
Northern Fulmar	0	0	0	1	1	1	1	2	0	0	1	2	
Manx Shearwater													
Storm Petrel	0	0	0	0	0	1	1	2	1	0	0	0	
Leach´s Storm Petrel	0	0	0	0	0	1	1	2	1	0	0	0	
Northern Gannet	0	0	0	1	2	2	0	1	0	0	1	0	
Great Cormorant	1	0	0	1	1	2	0	0	0	0	0	0	*P.c.sinensis*
European Shag	1	0	0	1	2	2	0	0	0	0	0	0	
Common Eider	1	0	0	2	0	2	0	0	1	0	1	0	
King Eider													
Steller's Eider													
Long-tailed Duck	0		0	2	1	2	0	0	0	0	0	1	Wintering pop.
Velvet Scoter	0		0	2	1	2	0	0	0	0	0	1	Wintering pop.
Parasitic Jaeger	0	0	0	0	1	1	1	0	0	0	0	0	
Great Skua	0	0	0	1	2	1	2	0	0	1	0	0	
Iceland Gull													
Glaucous Gull													
Great Black-backed Gull	0	0	0	1	2	1	2	0	0	1	1	1	
Herring Gull	0	0	0	1	2	1	2	0	0	1	1	1	
Lesser Black-backed Gull													*L.f.fuscus*
Lesser Black-backed Gull	0	0	0	1	1	1	1	0	0	1	1	1	*L.f.intermedius*
Common Gull	0	0	0	0	1	1	1	0	1	2	1	1	
Black-headed Gull	0	0	0	0	0	0	1	0	0	0	1	1	
Little Gull													
Black-legged Kittiwake	0	1	0	2	3	2	1	0	0	0	0	3	
Arctic Tern	0	2	0	0	2	1	0	0	0	0	0	3	
Sandwich Tern													
Common Tern	0	1	0	0	1	1	0	0	0	0	0	1	
Little Tern													
Razorbill	0	1	0	1	3	3	0	0	0	1	1	2	
Common Guillemot	0	2	0	1	3	3	0	0	1	1	1	3	
Brünnich's Guillemot	0	0	0	1	2	2	0	0	0	0	0	3	
Little Auk	0	0	0	0	2	1	0	0	0	0	0	2	
Black Guillemot	0	0	0	1	1	2	0	0	2	0	0	2	
Atlantic Puffin	0	0	0	0	3	3	0	0	0	0	1	2	

Norway – questionnaire 4: Barents Sea – Norwegian mainland	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Great Northern Diver													Wintering pop.
White-billed Diver				1									Wintering pop.
Red-necked Grebe													Wintering pop.
Northern Fulmar	0	0	0	1	1	1	1	2	0	0	0	2	
Manx Shearwater													
Storm Petrel													
Leach´s Storm Petrel													
Northern Gannet	0	0	0	1	2	2	0	1	0	0	1	0	Directly threatened by return of sea eagle
Great Cormorant	1	0	0	1	1	2	0	0	0	1	1	0	*P.c.carbo*
European Shag	1	0	0	1	1	2	0	0	0	0	1	0	
Common Eider	0	0	0	2	0	2	0	0	1	0	1	0	
King Eider				1	1	3						2	Wintering pop.
Steller's Eider				1	1	3						2	Wintering pop.
Long-tailed Duck				1	1	2						1	Wintering pop.
Velvet Scoter				1	1	2						1	Wintering pop.
Parasitic Jaeger	0	0	0	0	1	0	1	0	0	0	0	0	
Great Skua	0	0	0	0	2	0	2	0	0	0	0	0	
Iceland Gull													
Glaucous Gull					1	1	3					2	Wintering pop.
Great Black-backed Gull	0	0	0	1	1	1	1	0	0	0	1	1	
Herring Gull	0	0	0	1	1	1	1	0	0	0	1	1	
Lesser Black-backed Gull	0	2	0	2	1	1	2	0	2	1	1	2	*L.f.fuscus*
Lesser Black-backed Gull													*L.f.intermedius*
Common Gull	0	0	0	0	1	1	1	0	1	0	1	1	
Black-headed Gull	0	0	0	0	0	0	1	0	0	0	1	1	
Little Gull													
Black-legged Kittiwake	0	0	0	0	3	2	1	0	0	0	0	3	
Arctic Tern	0	0	0	0	2	1	0	0	1	0	0	3	
Sandwich Tern													
Common Tern	0	0	0	0	1	1	0	0	1	0	0	1	
Little Tern													
Razorbill	0	0	0	1	2	3	0	0	0	0	0	2	
Common Guillemot	0	0	0	1	3	3	0	0	0	0	0	3	But threatened on some colonies by return of sea eagle
Brünnich's Guillemot	0	0	0	1	2	3	0	0	0	0	0	3	
Little Auk						2						2	Migrating pop.
Black Guillemot	0	0	0	0	1	2	0	0	1	0	0	2	
Atlantic Puffin	0	0	0	0	3	2	0	0	1	0	0	2	

Norway – questionnaire 5	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Northern Fulmar	0	0	-	1(2)	1	0	-	2(3)	0	2(3)	0	-	Disturbance from sea eagles prevent breeding and impact breeding success for those who breed
Manx Shearwater	-	-	-	-	-	-	-	-	-	-	-	-	
Storm Petrel	-	-	-	-	-	-	-	-	-	-	-	-	
Leach´s Storm Petrel	-	-	-	-	-	-	-	-	-	-	-	-	
Northern Gannet	0	0	-	0	1	0	-	-	0	0	1	1	
Great Cormorant	1	0	-	2	1	1	-	-	1	2(3)	1	0	Severe disturbance in some colonies
European Shag	1	0	-	2	1	1	-	-	1	0	1	0	
Common Eider	1	0	-	2	0	2	-	-	2	2	1	1	
King Eider	-	-	-	1	-	2	-	-	-	-	0	-	
Parasitic Jaeger	0	0	-	0	0	0	-	-	-	-	-	-	
Great Skua	0	0	-	0	0	0	-	-	-	0	-	-	
Iceland Gull	-	-	-	-	-	-	-	-	-	-	-	-	
Glaucous Gull	-	-	-	-	-	-	-	-	-	-	-	-	
Great Black-backed Gull	0	1	-	0	0	0	-	-	-	1	-	-	
Herring Gull	0	1	-	0	0	0	-	-	-	1	-	-	
Lesser Black-backed Gull	0	1	-	0	1	0	-	-	-	1	1?	-	
Common Gull	0	1	-	0	0	0	-	-	-	1	-	-	
Black-headed Gull	0	0	-	0	0	0	-	-	-	-	-	-	
Little Gull	-	-	-	-	-	-	-	-	-	-	-	-	
Black-legged Kittiwake	0	0	-	-	0(1)	0	-	-	0	2(3)	-	2(3)	Disturbance by sea eagles
Arctic Tern	0	1	-	0	0	0	-	-	2	0(1)	1?	-	
Sandwich Tern	-	-	-	-	-	-	-	-	-	-	-	-	
Common Tern	0	1	-	0	0	0	-	-	2	0(1)	1?	-	
Little Tern	-	-	-	-	-	-	-	-	-	-	-	-	
Razorbill	0	0	-	1	0(1)	2	-	-	2	0	-	-	
Common Guillemot	0	0	-	2	0(1)	2	-	-	2	2(3)	-	-	Disturbance by sea eagles
Brünnich's Guillemot	-	-	-	-	-	-	-	-	-	-	-	-	
Little Auk	-	-	-	-	-	-	-	-	-	-	-	-	
Black Guillemot	0	0	-	1	0	2	-	-	2(3)	0	1?	-	
Atlantic Puffin	0	0	-	1	0(1)	2	-	-	1(2)	0	-	-	

Iceland (1 questionnaire)

	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)	
Northern Fulmar	1	1		2	0	1	3	3	0	0	0	1	
Manx Shearwater	0								2				Manx and the petrels are possibly threatened by house cats at Heimaey, Vestmanns.
Storm Petrel	0								2				
Leach´s Storm Petrel	0								2				
Northern Gannet	2	0	-		0			1	0	2	0	0	
Great Cormorant	1	0		1	1				0	2	0	0	Cormorants are shot at fish nurseries.
European Shag	1	0		1	0				0	1	0	0	
Common Eider	0	0		1	1	2			1	1	0		
King Eider													Eiders are potential competitors with mussel farms.
Parasitic Jaeger	2	0		0	0	0			0	1			
Great Skua	2	1			0				0	1			
Iceland Gull	0							1					
Glaucous Gull	1	1								1		1	
Great Black-backed Gull	3	1								3			
Herring Gull	3	1								1			
Lesser Black-backed Gull	3	1								1			
Common Gull													
Black-headed Gull	1	1								1			
Little Gull													
Black-legged Kittiwake	0	1						1		1			
Arctic Tern	0	1								1			
Sandwich Tern													
Common Tern													
Little Tern													
Razorbill	1	1		3		3							
Common Guillemot	1	1		3		3							
Brünnich's Guillemot	1	1		3		3						3	
Little Auk													
Black Guillemot	2	1		3		3			3				
Atlantic Puffin	2	0							2				

Greenland (3 questionnaires)

Greenland – questionnaire 1	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	1	1	1	2	0	1	2	2	1	1	1	2
Manx Shearwater												
Storm Petrel												
Leach´s Storm Petrel												
Northern Gannet												
Great Cormorant	1	0	0	1	2	2	1	0	1	1	1	2
European Shag												
Common Eider	2	1	0	2	0	2	1	0	2	1	1	2
King Eider	1	0	0	2	1	2	1	0	1	1	3	2
Parasitic Jaeger												
Great Skua							2					
Iceland Gull							1					
Glaucous Gull							2					
Great Black-backed Gull							2					
Herring Gull												
Lesser Black-backed Gull												
Common Gull												
Black-headed Gull												
Little Gull												
Black-legged Kittiwake	2	1	1	1	2	2	1	ni	2	2	1	3
Arctic Tern	1	2	1	0	0	1	1	ni	2	2	2	2
Sandwich Tern												
Common Tern												
Little Tern												
Razorbill	1	0	0	2	2	3	1	0	1	1	1	2
Common Guillemot	1	0	0	1	2	3	1	0	2	2	1	3
Brünnich's Guillemot	2	1	0	1	1	3	1	0	1	2	1	2
Little Auk	1	0	0	0	0	2	1	0	1	0	1	2
Black Guillemot	1	0	0	1	0	2	1	0	2	1	1	1
Atlantic Puffin	3	1	0	1	2	2	1	1	2	1	1	2

Greenland – questionnaire 2	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	0	0	0	0	0	1	1	1	1	1	1	1
Manx Shearwater												
Storm Petrel												
Leach´s Storm Petrel												
Northern Gannet	0	0	1	0	1	2	2	0	1	0	0	1
Great Cormorant	1	0	0	1	0	1	1	0	1	1	1	0
European Shag												
Common Eider	2	0	0	1	0	2	1	0	1	1	1	2
King Eider	1	0	0	0	0	2	1	0	0	2	0	2
Parasitic Jaeger	0	0	0	0	1	0	1	0	1	1	1	1
Great Skua	0	0	0	0	0	0	2	0	1	1	1	1
Iceland Gull	1	1	0	0	0	1	1	0	0	1	0	1
Glaucous Gull	1	1	0	0	0	1	2	0	0	1	0	1
Great Black-backed Gull	0	0	0	0	0	1	2	0	1	1	0	1
Herring Gull	0	0	0	0	1	1	1	0	1	1	0	1
Lesser Black-backed Gull	0	0	0	0	1	1	2	0	2	1	0	1
Common Gull	0	0	0	0	0	1	1	0	1	1	0	0
Black-headed Gull	0	0	0	0	0	1	0	0	1	1	0	0
Little Gull												
Black-legged Kittiwake	2	1	0	0	2	1	1	0	1	1	1	2
Arctic Tern	0	1	0	0	1	1	1	0	2	2	0	2
Sandwich Tern	1	0	0	0	2	1	2	0	3	3	0	1
Common Tern												
Little Tern	0	0	0	0	0	0	0	0	3	3	3	2
Razorbill	1	0	0	0	1	3	1	0	1	2	1	1
Common Guillemot	1	0	0	1	3	3	2	0	1	2	1	1
Brünnich's Guillemot	2	1	0	1	1	3	2	0	0	2	1	2
Little Auk	1	0	0	0	0	2	1	0	0	1	1	3
Black Guillemot	1	0	0	0	0	2	0	0	2	1	2	1
Atlantic Puffin	1	0	0	0	3	3	1	0	2	1	1	2

Greenland – questionnaire 3	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	0	0	0	0	0	1	0	0	0	0	0	0
Manx Shearwater	0	0	0	0	0	1	0	0	0	0	0	0
Storm Petrel												
Leach´s Storm Petrel												
Northern Gannet												
Great Cormorant	0	0	0	0	0	0	0	0	0	0	0	0
European Shag												
Common Eider	2	1	0	3	1	0	0	0	0	2	0	1
King Eider	1	0	0	2	1	0	0	0	0	2	0	1
Parasitic Jaeger	0	0	0	0	0	0	0	0	0	1	0	0
Great Skua	0	0	0	0	0	0	0	0	0	0	0	0
Iceland Gull	0	0	0	0	0	0	0	0	0	0	0	0
Glaucous Gull	0	2	0	0	0	0	0	0	0	1	0	0
Great Black-backed Gull	0	2	0	0	0	0	0	0	0	1	0	0
Herring Gull	0	1	0	0	0	0	0	0	0	0	0	0
Lesser Black-backed Gull	0	1	0	0	0	0	0	0	0	0	0	0
Common Gull												
Black-headed Gull												
Little Gull												
Black-legged Kittiwake	2	0	0	0	1	0	0	0	0	2	0	1
Arctic Tern	0	2	0	0	1	0	0	0	0	2	0	1
Sandwich Tern												
Common Tern												
Little Tern												
Razorbill	0	0	0	0	0	1	0	0	0	0	0	1
Common Guillemot	1	1	0	0	1	2	0	0	0	1	0	1
Brünnich's Guillemot	2	1	0	0	1	2	0	0	0	2	0	1
Little Auk	0	0	0	0	0	1	0	0	0	0	0	1
Black Guillemot	1	0	0	0	0	0	0	0	0	1	0	1
Atlantic Puffin	0	0	0	0	0	0	0	0	0	0	0	1

Scotland (3 questionnaires)

Scotland – questionnaire 1	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	1	-	2	2	0	1	0	1	1	0	0	0
Manx Shearwater	0	0	0	1	0	0	0	1	2	0	0	0
Storm Petrel	0	0	0	0	0	0	0	1	3	0	0	0
Leach´s Storm Petrel	0	0	0	0	0	0	0	1	2	0	0	0
Northern Gannet	0	1	2	1	1	1	0	1	1	0	1	0
Great Cormorant	1	1	0	1	0	1	0	1	1	0	0	0
European Shag	1	1	0	1	0	1	0	1	1	0	0	0
Common Eider	1	1	0	1	0	1	0	1	1	0	1	0
King Eider	0	0	0	1	0	1	0	0	1	0	0	0
Parasitic Jaeger	0	0	0	0	0	0	0	0	1	0	0	0
Great Skua	0	0	2	0	1	0	0	0	1	0	0	0
Iceland Gull	0	0	1	0	0	0	0	0	1	0	0	0
Glaucous Gull	0	0	1	0	0	0	0	0	1	0	0	0
Great Black-backed Gull	1	1	2	1	1	1	0	0	1	0	0	0
Herring Gull	1	1	2	1	0	1	0	0	1	0	0	0
Lesser Black-backed Gull	0	1	2	1	0	1	0	0	1	0	0	0
Common Gull	0	0	1	0	0	1	1	0	1	0	1	0
Black-headed Gull	0	0	1	0	0	1	1	0	1	0	1	0
Little Gull	0	0	0	0	0	0	0	0	1	0	0	0
Black-legged Kittiwake	0	0	2	0	1	1	0	0	1	0	0	0
Arctic Tern	0	0	0	0	1	0	0	0	2	2	0	0
Sandwich Tern	0	0	0	0	0	0	0	0	2	2	0	0
Common Tern	0	0	0	0	0	0	1	0	2	2	0	0
Little Tern	0	0	0	0	0	0	1	0	2	1	0	0
Razorbill	1	0	0	1	1	1	0	0	1	2	0	0
Common Guillemot	1	1	0	1	1	1	0	0	1	1	0	0
Brünnich's Guillemot	1	1	0	1	1	1	0	0	1	1	0	0
Little Auk	0	0	0	0	0	1	0	0	1	0	0	0
Black Guillemot	0	0	0	1	0	1	0	0	1	0	0	0
Atlantic Puffin	1	0	0	1	1	1	0	0	1	0	0	0

Scotland – questionnaire 2	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	0	0	2	1	0	0	1	1	1	0	0	2
Manx Shearwater	0	0	0	0	0	1	0	0	3	0	0	0
Storm Petrel	0	0	0	0	0	0	0	0	3	0	0	0
Leach´s Storm Petrel	0	0	0	0	0	0	0	0	3	0	0	0
Northern Gannet	0	0	2	1	0	0	1	0	0	0	1	0
Great Cormorant	0	0	0	1	0	1	0	0	0	0	0	0
European Shag	0	0	0	1	0	1	0	0	0	0	0	1
Common Eider	0	0	0	1	2	0	0	0	0	0	0	2
King Eider												
Parasitic Jaeger	0	0	0	0	1	0	0	0	0	0	0	2
Great Skua	1	0	0	1	1	0	1	0	0	1	1	2
Iceland Gull												
Glaucous Gull												
Great Black-backed Gull	1	0	2	1	0	0	1	0	0	0	1	0
Herring Gull	1	0	2	1	0	0	0	0	0	0	1	0
Lesser Black-backed Gull	1	0	2	1	0	0	0	0	0	0	1	0
Common Gull	0	0	0	0	0	0	0	0	0	0	0	0
Black-headed Gull	0	0	0	0	0	0	0	0	0	0	0	0
Little Gull												
Black-legged Kittiwake	0	0	1	0	1	0	0	0	0	0	0	2
Arctic Tern	0	0	2	0	1	0	0	0	2	2	1	2
Sandwich Tern	0	0	2	0	1	0	0	0	2	2	1	0
Common Tern	0	0	2	0	1	0	0	0	2	2	1	0
Little Tern	0	0	0	0	0	0	0	0	2	3	1	0
Razorbill	0	0	0	1	0	1	0	0	0	0	0	1
Common Guillemot	0	0	0	1	1	1	0	0	0	0	0	1
Brünnich's Guillemot												
Little Auk												
Black Guillemot	0	0	0	1	0	1	0	0	2	0	0	2
Atlantic Puffin	0	0	0	0	1	1	0	0	2	0	0	2

Scotland – questionnaire 3	Hunting (intentional killing)	Egging	Discards	Bycatch	Competition with fisheries	Oil pollution	Contaminants	Plastics	Introduced predators	Disturbance	Developments (e.g. wind farms)	Climate change (direct/indirect)
Northern Fulmar	1	_	2	1	0	0	1	2	1	0	0	1
Manx Shearwater	0	0	0	0	0	0	_	_	2	0	_	_
Storm Petrel	0	0	0	0	0	0	_	_	2	0	_	_
Leach´s Storm Petrel	0	0	0	0	0	0	_	_	2	0	_	_
Northern Gannet	1	0	1	0	1	0	_	_	0	0	2	1
Great Cormorant	1	0	0	0	2	0	_	0	0	1	0	_
European Shag	0	0	0	0	0	0	_	0	1	1	0	2
Common Eider	_	_	0	1	2	1	1	0	2	2	0	_
King Eider	_	_	_	_	_	_	_	_	_	_	_	_
Parasitic Jaeger	0	0	0	0	0	0	_	_	0	0	_	1
Great Skua	1	0	2	0	0	0	_	_	0	0	0	1
Iceland Gull	_	_	_	_	_	_	_	_	_	_	_	_
Glaucous Gull	_	_	_	_	_	_	_	_	_	_	_	_
Great Black-backed Gull	0	0	0	1	0	0	_	_	0	0	0	_
Herring Gull	0	0	1	0	0	0	_	_	0	0	0	_
Lesser Black-backed Gull	0	0	0	0	0	0	_	_	0	0	0	_
Common Gull	_	_	_	_	_	_	_	_	_	_	_	_
Black-headed Gull	_	_	_	_	_	_	_	_	_	_	_	_
Little Gull	_	_	_	_	_	_	_	_	_	_	_	_
Black-legged Kittiwake	1	0	1	0	1	0	_	_	1	0	1	2
Arctic Tern	0	0	0	0	0	0	_	_	1	1	1	1
Sandwich Tern	0	0	0	0	0	0	_	_	1	1	1	1
Common Tern	0	0	0	0	0	0	_	_	1	1	1	1
Little Tern	0	0	0	0	0	0	_	_	1	3	0	1
Razorbill	1	0	0	0	0	1	0	0	0	0	1	1
Common Guillemot	1	0	0	0	0	1	0	0	0	0	1	1
Brünnich's Guillemot	2	0	0	0	0	_	0	0	0	0	0	1
Little Auk	_	0	0	0	0	0	0	0	0	0	0	1
Black Guillemot	1	0	0	0	0	1	0	0	1	0	1	1
Atlantic Puffin	2	0	0	0	0	0	0	0	1	0	1	1

Appendix 2: Workshop working groups reports

Working group 1. Priority actions reported on effects of fisheries.

Overall priority is rated by gains for seabird conservation.

Priority actions	Cost	Time-schedule	Assigned responsibility	Overall priority
1 Bycatch				
1a) Observer schemes.	Medium	Short	Target initial effort on high risk areas with specific fishing gear (longlines and gillnets, particularly lumpsucker nets) and high seabird usage. Responsibility with public sector with fishing sector support. International co-ordination helpful (through ICES?).	High
1b) National/ European Community plans of action on seabirds (under FAO guidance).	Low	Short	National/European authorities; drafting can be based on existing Plans of Action. Implementation is included below.	High
1c) Mitigation measures for bycatch on longlines.	Low-medium	Medium	Public authorities (law, enforcement). Fishers (implementation). Good knowledge of mitigation “toolbox”, just need to be tuned to circumstance. Cost reliant on need.	Medium, exact priority depends on observer scheme results.
1d) Mitigation measures in (bottom-set) gillnets.	High	Medium	Public authorities (law, enforcement). Fishers (implementation). Relatively high cost due to only known mitigation measure is spatio-temporal closure of fishery/ change of gear.	Medium, exact priority depends on observer scheme results.
1e) Lumpsucker fishery control.	Medium	Short-medium	Public authorities (law, enforcement). Fishers (implementation).Relatively short-period shallow gillnet fishery, only known systems are bird scaring, area closures and change of gear. Further research may find new or improve existing mitigation. Costs more easily borne by (inshore) fishers if fish price was higher/more stable (needs actions more generally).	High
1f) Include bycatch in “eco” labelling schemes.	Low	Short-medium (ongoing)	Some consideration already made in schemes; biggest driver is from large (EU) retailers. Only applies if a fishery applies to be labelled (public authorities should encourage/support this). Private certification authorities; fishery funds certification (sometimes with public support). Scheme is low cost but may drive actions under c) – e) above (higher costs).	High

Priority actions	Cost	Time-schedule	Assigned responsibility	Overall priority
1g) Reward scheme for ideas that lead to bycatch reduction, and financial support for such schemes.	Low (-medium)	Short (for best effect)	Some schemes already in existence (e.g. WWF); Nordic Council reward would target Nordic Seas. Encourages fisher innovation, value to fisher is in recognition and possible future marketing of idea.	High
2 Overharvesting of seabird food				
2a) Sandeel closures (Shetland and East Scotland) (note other closures for sandeel stock purposes may have same effect).	Low	Short (but already in place)	Closures exist already; costs already factored into fishing. Closures elsewhere due to poor (sub-) stock conditions. Other fish stocks also depend on sandeel as prey, so gains for those stocks may offset costs to industry of closures.	High
2e) Better understanding of effects of overharvesting (of fish) interactions.	Medium	Medium	Modelling cheap; research at sea is higher cost. Needed to meet political commitments on ecosystem-based fishery management. Public funding.	Medium
3 Discards				
3a) Better understanding of discard interactions.	Medium	Short – medium	Aim is to understand value of discards to scavenging seabird community and how changes in discard policy might affect this. Good opportunity of experimental situation with three separate discard regimes in northern North Sea/Faroese waters currently. Public funding.	Medium
4 Ecosystem effects				
4a) Better understanding of ecosystem effects of fishing interactions on seabirds	Medium	Medium - long	Research on overall effects of past fishing on non-scavenging seabird populations; mostly by changing size structure of fish populations, but perhaps indirectly through habitat effects. Public funding.	Medium
4b) Need to understand the implications of moving to a "large fish" and MSY approach to fisheries management.	Low (once research done)	Medium-long (short if these policies are introduced in short-term)	Environmental impact assessment (of some sort) of new policy. These policies may be desirable for fish stock but may have unforeseen/ unintended consequences on other parts of the ecosystem including seabirds. Public funding.	High
4c) Use seabirds as indicators of environmental health including of fish stocks.	Low (medium)	Some in existence; others may be found (medium?)	Linked to monitoring/surveillance (see other group); some seabird demographic parameters are relatively tightly linked to state of some fish stocks (e.g. kittiwake breeding success and local sandeel stock; 1st year herring / capelin and puffin diet). Known examples are rare, there may be more)	Medium
4d) Recreate the great auk.	High	Long	Essential if we are to recover biodiversity; need further development of genetic amplification and other technology.	Medium

Working group 2. Priority actions reported on oil, pollutants and waste.

Priority actions	Cost	Time-schedule	Assigned responsibility	Overall priority
1 Oil spill				
1.1. Oil exploration & production and traffic: identification of key areas for planning and response, and baseline for impact studies				
Better mapping of seabird populations and geographic distribution in time and space is needed. Time series are very important, as well as mapping and colony monitoring, for example at Jan Mayen and other areas where oil activitites are coming up.	High	Medium	Public and private sectors	High
Studies to provide better information on seabird distribution and migration routes on open seas. Such information is essential for better planning of offshore acivities and response to oil spills. Should include surveys and tracking of seabirds and wintering areas.	High	Long	Public and private sectors	High
Common Nordic guidelines for operational oil spill drift models using maps with sensitive areas including sea bird colonies and important coastal and offshore areas (using information from the two action items above).	Medium	Medium	Private and public ongoing efforts	High
A Nordic seabird monitoring programme with standard methods and common guidelines for level of activities.	High	Medium	Public sector	High
Standard methods for assessing effects of accidental oil spills.	Low	Medium	Public sector	Medium
Rehabilitation of oiled seabirds. In relation to seabird populations the cost of rehabilitation is very high and no positive population effect can be expected. Other actions are likely to give better value for money. However, for very small and threatened populations it could be considered.	High		Private and public sectors	Low
1.2. Operational/chronic oil spills				
Better understanding of effect on seabird populations from operational/chronic oil spills. Standard methods among countries should be developed. Time series are very important.	Medium	Medium	Public sector	High
2 Prevention of oil spills				
2.1. Prevention of operational/chronic oil spills				
Public outreach/education to small boats and commercial shipping. Public hotline for rapporting spills.	Low	Medium	Public and private sectors	High
Conduct review on Nordic regulatory framework efficiency.	Low	Short	Public sector	High
Ensure better enforcement and systems for collecting evidence leading to large fines. Include education of enforcement system.	Medium	Medium	Public sector	High
2.2. Prevention of large accidental spills				
Designate sailing “highways” for shipping as far off from land/sensitive areas as possible; using internationally binding measures (IMO). Designate “emergency beaching areas” of low sensitivity. Introduce mandatory use of Pilot in sensitive areas. Introduce surveiliance from satellite and airplane.	Low/ medium		Public sector	High
Introduce regulations demanding the use of light fuel in sensitive areas (e.g tourist ships)	Low	Medium	Private sector	High
Enforce stricter regulation on runoff from land/ discharge from platforms (produced water from oil production platforms).	High	Long	Private sector	Low

Priority actions	Cost	Time-schedule	Assigned responsibility	Overall priority
3 Pollutants other than oil				
Continue AMAP monitoring of seabird contaminants. Include new contaminants and secure communication between seabird and contaminants research so most vulnerable species are included.	Medium	Short	Public sector	Medium

Working group 3. Priority actions reported on conflicting species.

Priority actions	Costs	Time-shedule	Assigned responsibility	Overall priority
1. Risk analysis/assessments area plans/prioritize and identify problems with introduced species.	Low (1000-10 000£)	Long	Public sectors (nature reserves; IBA). Private sectors (estates).	Medium
1.1. Handbook on handling introduced species (with specific examples, e.g. traps, poison, hunting, other solutions).	Low-medium (30-40 000 £)	Long	Public sectors. Ongoing international processes.	Medium
2.1. Removal of introduced predators – stage one: removal. - Chronic species like mink, rats. - Acute problems like hedgehogs.	High (removal of hedgehog Hebrides Islands: current annual cost is £300,000; total cost for removal of mink is £ 5 million).	Medium	Private sector (estate owners). Public sector (general management).	High (locally)
2.2. Removal of introduced predators – stage two: prevent re-invasion.	Medium (current annual cost in the Hebrides is £300,000-400,000)	Long		High (locally)
3.1. Prevention of introduction/invation of predators.	Low –Medium (10 000 £)	Long	See 1.1 above.	Medium
3.2. Introduced competitors, established.	High	Long	Ongoing international processes	Medium
4. Introduced competitors, before establishment (risk analysis, planning).	Medium	Long	Ongoing international processes	Medium
5. Introduced parasites and diseases, prevention.		Long	General management – public sector. Ongoing international processes	Low – medium
6. Introduced vegetation.	Low	Short	Dependent on ownership, local problem.	Priority dependent on the threat to seabird populations.
7. Natural predators.				Low
8. Ballast water.				Low

Working group 4. Priority actions reported on seabird harvest.

Priority actions	Costs	Time-shedule	Assigned responsibility	Overall priority
1. Hunting test.	Low	Medium	Public sector	High
2. Restrictions on traffic by human activities during hunting.	Low	Long	Public sector	Medium
3. Ban of hunting during breeding season.	Low	Long	Public sector	High
4. Collecting hunting statistics (with verification control).	Medium	Short	Public sector	High
5. Research on population dynamics.	High	Long	Public sector	High
6. Prohibition of lead ammunition, introducing alternative ammunition.	Low	Long	Public sector	High
7. Restrictions on egg collecting. Eggs should only be collected at an early stage during breeding season, quotas.	Low	Short	Public sector	Medium
8. Increasing the level of understanding among the public of introducing restrictions.	Medium	Short	Public sector	High
9. Creation of more nature reserves, conservation sites (RAMSAR, IBAs, SPAs a.o.).	High	Long	OSPAR member countries; WSSD; Public sector (especially international conventions).	High
10. Implementation of protection areas through action plans.	Medium	Long	Public sector	High
11. Culling statistics: research of effects of culling.	Low	Short	Public sector	High

Working group 5. Priority actions reported on area management and discturbance.

Priority actions	Cost	Time-schedule	Assigned responsibility	Overall priority
1. Recreational use and tourism causing disturbance.				Medium
1.1. Identify the risks of the different activities and sensitive locations (spatial planning).	Low	Short	Public sector	
1.2. Area restrictions for particular activities and adequate publicity (public awareness and enforcement).	Low- medium; high on enforcement.	Long (ongoing)	Public sector	
1.3. Codes-of-conduct (for more organized activities, eg. tourism).	Low	Short	Private sector	
2. Marine installations causing loss of habitats, disturbance and/or collision risk.				High, because of large scales of potential developments and impacts.
2.1. Spatial planning and environmental assessments to take account of seabirds.	High	(Ongoing	Public and private sectors	High
2.2. Improved and standardized methods for EA.	High (could deliver savings to individual assessments).	Short	Public sector	High
2.3. More research needed on the impact of marine installations.	High	(Ongoing)	Public sector	High
3. NCM to provide funding to collate and share good practice from countries in a) monitoring; b) planning, and c) assessment – for use as guidance (rather than prescription).	Low	Short	Public sector	High
4. Buildings/constructions on land causing loss of habitats.	Low-high, depending on the scale of building/ installation.			Low: covered by existing processes; but room for improvement.
4.1. Environmental Assessments (EAs).		(Ongoing)	Public and private sectors	
4.2. Improved and standardized methods for EA.		Short	Public sector	
5. Aquaculture and mariculture causing direct disturbance and changes to foraging habitat.		Short-medium		Low
5.1. License systems.	(Existing)		Public sector	
5.2. Spatial planning and environmental Assessments.	(Existing)		Private and public sectors	
5.3. Improved and standardized methods for EA.	High		Public sector	
6. Shipping (eg hydrofoils/ferries) causing disturbance/ mortality: spatial planning and environmental assessment.			Public-private sector	Low
6.1. Better understanding impacts.	Medium	Short-medium and ongoing thereafter		
6.2. Planning new routes. 6.3. Existing routes/changes in vessels.	Medium (if it can be based on existing knowledge).	Medium if via IMO. PSSA; short-medium term if national issues.		

Working group 6. Priority actions reported on climate issues and cumulative effects. High overall priority is given to actions that address recognised significant problems, need to start immediately, and are practicable. Low overall priority is given to actions that address potential problems, and which do not need to start immediately. E/N: Existing/New actions/ mitigating measures.

Priority actions	Costs	Time-schedule	Assigned responsibility	Overall priority
Limit CO_2 and greenhouse gas emissions, as may be agreed internationally (E/N).	Low (no additional costs)	Long term project to start immediately.	Action for everyone. Implemented by Governments on the basis of international processes.	High
Need research on reasons for variations in sandeel and capelin (etc) abundance.	Medium	Immediate – needs to be done.	Government, with international coordinated action if necessary.	High
Need research on processes leading to variations in feed quality.	Medium	Immediate – needs to be done.	Government, with international coordinated action if necessary.	High
Avoid reductions in the sea bird food. Research needed into food webs leading through secondary producers to prey species.	Medium	Immediate – needs to be done.	Government, with international coordinated action if necessary.	High
Restrict fisheries on key stocks of forage fish (E/N).	Medium	Immediate when the need arises.	Government. May need international processes if fisheries managtement is international (e.g EU).	Medium
Develop a flexible and adaptable system for the establishment and review of protected areas (N).	Low	Periodic review over long term.	Government, with international coordinated action if necessary.	Medium
Need research on reasons for variations in species composition of forage species.	Medium	Immediate – needs to be done.	Government, with international coordinated action if necessary.	Medium
Changes in migration routes and times.Ensure that appropriate protection (national laws and international agreements) applies to new areas and times.	Low	Immediate when the need arises. Currently no established examples in seabirds, but examples in other species (greylag geese etc). Needs a targeted monitoring programme to describe variation in distribution and detect changes from current situation. c.f. Working group 2 report.	Government, with international coordinated action if necessary.	Low – medium
Protect important breeding areas, eg. by building physical protection (N). Create new breeding areas above the area likely to be affected by flooding (N). Protect or restore other alternative habitats (no net loss idea) (E/N). Design or amend coast protection to maintain breeding areas (N). Take advantage of soft approaches to coast protection and maintainance of breeding space (E).	Low – medium	Long term project, but with early recognition of need to plan for these areas.	Government – public sector. Depends on who does the local planning.	Low

Appendix 3: Workshop programme and participants list

Programme: Action Plan for Seabirds in Western-Nordic Areas
Malmö, Sweden, 4–5 May 2010

Welcome!

Introduction

In August 2006, the Nordic Council of Ministers for the Environment (MR-M) discussed the situation for seabirds in the western part of the Nordic area. The background was a resolution adopted at a joint meeting of Nordic nature conservation NGOs in 2006, urging the Nordic Council of Minsters (NCM) to take coherent and strong measures in order to identify the causes for seabird populations decline and breeding failures, and to propose mitigating actions. MR-M decided to support a NCM project aimed at reviewing current knowledge on seabird populations, and to analyse causes behind population changes.

A Nordic workshop was arranged on the Faroe Islands in 2007. Seabird and marine experts and other interested parties from all the relevant countries were present, discussing three main topics: status, pressures and impacts, and conservation measures. The 2007 workshop concluded that climate related, complex ecological changes have disrupted the food web in Nordic waters. The number of fisheating birds has decreased, and reproductive rates have drastically dropped since 2003. These changes underline the need for a comprehensive approach addressing factors such as commercial fisheries, oil spills, seabird harvest and environmental pollutants, which influence seabird populations.

Following the 2008 report, MR-M decided to support a NCM project aimed at drawing up a seabird action plan, i.e. a proposal for mitigating measures. This project was initated in 2009, named ”Action plan for seabirds in Western-Nordic areas”.

Purpose

The objective with this workshop is to work out a cross-sectorial action plan aimed at counteracting the declining trends in seabird populations in Western- Nordic areas including Scotland. A final proposal for a seabird action plan will be reported in the NCM publication series (TemaNord), and communicated to NCM.

Format

The format of the workshop will be conducted in plenary meetings and work in small groups. The plenary introductory part of the workshop would be to get an overview of the current situation with regard to seabird populations, and review of impacts on seabird populations and existing actions and measures. On this basis, the workshop would split up into smaller groups, enabling the parallel sectors from all invited countries and other invitees to discuss mitigating measures. A template for the reporting from these break-out groups will be prepared.

For the purpose of this workshop, the following six break-out groups have been identified:

1. Effects of fisheries (overharvesting of seabird food, bycatch, etc.)
2. Oil, pollutants and waste
3. Conflicting species (alien species, naturalpredators, etc.)
4. Seabird harvest
5. Area management and disturbance
6. Climate issues and cumulative effects

In a final part of the workshop, the participants will come together in the plenary to present the results of the group discussions, and provide input into the drafting of a seabird action plan.

Participants

Participants for the workshop will be drawn from responsible institutions from the countries and sectors as shown below.

Countries	Sectors
Denmark	Fisheries
Faroe Islands	Environment
Greenland	Energy
Iceland	Hunters organisation
Norway	Science
Scotland	
Sweden	

Particpants registration and information

All particpants are requested to submit an online registration using this link: http://www.dirnat.no/seabirdsactionplan/. All registered workshop participants will receive participants information, covering

- Arrival
- Workshop Venue
- Accommodation
- Meals
- Refunding of Travelling Expenses and
- Accomodation
- Contact Information
- Maps

Organizers: Sigrun Einarson, Norwegian Directorate for nature management
e-mail: sigrun.einarson[at]dirnat.no
Phone (direct/mobile): (+47) 7358 0946

Ingeborg Einum, Norwegian Directorate for nature management
e-mail: ingeborg.einum[at]dirnat.no
Phone (direct/mobile): (+47) 7358 0802

Workshop programme

Tuesday 4 May

08.30 Registration at meeting venue Opening of workshop

09.00 Welcome address and background for workshop
Sigrun Einarson, Directorate for nature management, Norway

Seabird populations – situation overview in Western-Nordic areas

Chair: Niels Nilsen, Danish Forest and Nature Agency, Denmark
09.30 Seabird population status and trends
Morten Frederiksen, DMU, Denmark
10.00 Impacts on seabird populations
Morten Frederiksen, DMU, Denmark
10.30 Coffee/tea break and late registration
11.00 Impacts on seabird populations (cont.)
11.30 Overview of existing actions & measures

Consideration of national reports

11.30 Denmark
Niels Nilsen, Danish Forest and Nature Agency
11.40 Faroe Islands
Bergur Olsen, Faroese Marine Research Institute
11.50 Greenland
Jens Bagger, Agency of Fisheries, Hunting and Agriculture
12.00 Iceland
Aevar Petersen, Icelandic Institute of Natural History
12.10 Norway
Magnus Irgens, Directorate for nature management
12.20 Sweden
Leif Nilsson, Lund University
12.30 Scotland
David Mallon, Marine Directorate, The Scottish Government
12.40 Plenary discussion
13.00 Lunch

Group work – part I

Chair: David Mallon, Marine Directorate, The Scottish Government, Scotland
14.00 Introduction to group work
14.30 Group work – part I

Plenary

16.00 Plenary presentations & discussion of group work
18.00 Meeting adjourns

Wednesday 2, 5 May

09.00 Meeting convenes

Group work – part II

Chair: Aevar Petersen, Icelandic Institute of Natural History, Iceland
Co-chair: Leif Nilsson, Lund University, Sweden
09.00 Group work – part II
13.00 Lunch

Plenary

14.00 Plenary presentations of group work
16.20 Closing plenary session

16.50 Closing workshop address
Sigrun Einarson, Directorate for nature management, Norway
17.00 Workshop adjourns

NCM project group contact details

Denmark Niels Nielsen Head of Section	Skov og Naturstyrelsen/ Danish Forest and Nature Agency Haraldsgade 53, 2100 København Ø, Denmark Tel.: (+45) 72542427 e-mail: nin[at]sns.dk
Faroe Islands Bergur Olsen Biologist	Faroese Marine Research Institute Noatun 1, FO-100 Torshavn, Faroe Islands Tel.: (+298)352327 e-mail: berguro[at]hav.fo
Greenland Jens Bagger Head of Section	Agency of Fisheries, Hunting and Agriculture Postbox 680, 3900 Nuuk, Greenland Tel.: (+299) 345345 e-mail: JEBA[at]gh.gl
Iceland Ævar Petersen Chief scientist	Icelandic Institute of Natural History Hlemmur 3, P.O. Box 5320, 125 Reykjavik, Iceland Tel.: (+354) 5900500 e-mail: aevar[at]ni.is
Norway Sigrun Einarson Senior adviser	Norwegian Directorate for nature management Tungasletta 2, 7485-Trondheim, Norway Tel.: (+47) 73580946 e-mail: sigrun.einarson[at]dirnat.no
Norway Magnus Irgens Adviser	Norwegian Directorate for nature management Tungasletta 2, 7485-Trondheim, Norway Tel.: (+47) 73580707 e-mail: magnus.irgens[at]dirnat.no
Scotland David Mallon	Marine Directorate The Scottish Government Marine Planning & Policy, The Scottish Government, Area 1-A Victoria Quay, Edinburgh, Scotland, EH6 6QQ Tel.: 00 44 131 244 1560 e-mail: David.Mallon[at]scotland.gsi.gov.uk
Sweden Leif Nilsson Senior Researcher	Lund University Ecology Building, S-223 62 Lund, Sweden Tel.: (+46) 462223709 e-mail: leif.nilsson[at]zooekol.lu.se

Cooperating institutions contact details

Project group:

Denmark

Danish Forest and Nature Agency
Tel.: (+45) 7254 2000
E-mail: sns[at]sns.dk
Web: http://www.skovognatur.dk

Faroe Islands

Faroese Marine Research Institute
Tel.: (+298) 353900
E-mail: hav[at]hav.fo
Web: http://www.frs.fo

Greenland

Agency of Fisheries, Hunting and Agriculture
Tel.: (+299) 34 50 00
E-mail: info[at]gh.gl
Web: http://dk.nanoq.gl

Iceland

Icelandic Institute of Natural History
Tel.: (+354) 460 0500
E-mail: nia[at]ni.is
Web: http://www.ni.is/english

Norway

Norwegian Directorate for nature management
Tel.: (+47) 7358 0500
E-mail: postmottak[at]dirnat.no
Web: http://www.dirnat.no

Scotland

Marine Directorate
The Scottish Government
Tel.: +44 (0)8457 741 741 or
+44 (0)131 556 8400
E-mail: ceu[at]scotland.gsi.gov.uk
Web: http://www.scotland.gov.uk

Sweden

Lund University
Tel.: (+046) 222 0000
Web: http://www.lu.se

Other cooperatingbodies & donors:

Joint Nature Conservation
Committee (JNCC)
Tel.: 01733 562626
E-mail: comment[at]jncc.gov.uk
Web: http://www.jncc.gov.uk

Norwegian Institute for Nature Research (NINA)
Tel.: (+47) 73 80 14 00
E-mail: firmapost[at]nina.no
Web: http://www.nina.no

Scottish Natural Heritage (SNH)
Tel.: +44 (0)1463 725000
Web: http://www.snh.org.uk

Participants list

	Last name	First name	Workplace	Country	E-mail
1	Alexandersson	Hans	The County Administrative Board of Västra Götaland	Sweden	hans.alexandersson[at] lansstyrelsen.se
2	Bagger	Jens	Agency of Fisheries, Hunting and Agriculture	Greenland	JEBA[at]gh.gl
3	Blytmann	Aksel	Greenlandic Fisher and Hunter Association (KNAPK)	Greenland	aksel[at]knapk.gl
4	Buxton	Nigel	Scottish Natural Heritage	Scotland	nigel.buxton[at]snh.gov.uk
5	Danielsen	Levi	Faroese hunting society	Faroe Islands	led[at]kollnet.fo
6	Davies	Ian	Marine Scotland, Marine Laboratory	Scotland	daviesim[at]marlab.ac.uk
7	Einarson	Sigrun	Directorate for nature management	Norway	sigrun.einarson[at]dirnat.no
8	Einarsson	Kristinn	Ministry of Industry, Energy and Tourism	Iceland	ke[at]os.is
9	Einum	Ingeborg	Directorate for nature management	Norway	ingeborg.einum[at]hotmail.com
10	Frederiksen	Morten	National Environmental Research Institute	Denmark	mfr[at]dmu.dk
11	Gardarsson	Arnthor	University of Iceland, Reykjavik	Iceland	arnthor[at]hi.is
12	Heilmann	Johannes	Fisheries	Greenland	
13	Irgens	Magnus	Directorate for nature management	Norway	magnus.irgens[at]dirnat.no
14	Lilliendahl	Kristjan	Ministry of Fisheries	Iceland	klill[at]hafro.is
15	Lunneryd	Sven Gunnar	Institute of Coastal Research, Swedish Board of Fisheries	Sweden	sven-gunnar.lunneryd[at] fiskeriverket.se
16	Mallon	David	Marine Directorate The Scottish Government	Scotland	David.Mallon[at]scotland.gsi.gov.uk
17	Maltha Rasmussen	Lars	Greenlandic Nature Institute	Greenland	lara[at]natur.gl
18	Mortensen	Liv Kristine	Ministry of the Environment	Norway	Liv-Kirstine.Mortensen[at]md.dep.no
19	Mosbech	Anders	National Environmental Research Insititute	Greenland	amo[at]dmu.dk
20	Nilsen	Niels	Danish Forest and Nature Agency	Denmark	nin[at]sns.dk
21	Nilsson	Leif	University of Lund	Sweden	leif.nilsson[at]zooekol.lu.se
22	Olsen	Bergur	Faroese Marine Research Institute	Faroe Islands	berguro[at]hav.fo
23	Olsen	Jóhanna	The Environment Agency	Faroe Islands	johannao[at]us.fo
24	Overvik	Modulf	Directorate of Fisheries	Norway	modulf.overvik[at]fiskeridir.no
25	Petersen	Aevar	Icelandic Institute of Natural History	Iceland	aevar[at]ni.is
26	Rappe	Christina	Swedish Environmental Protection Agency	Sweden	christina.rappe[at] naturvardsverket.se
27	Reid	Jim	On behalf of ICES	Scotland	Jim.Reid[at]jncc.gov.uk
29	Stenløkk	Jan	Norwegian Petroleum Directorate	Norway	Jan.Stenlokk[at]npd.no
29	Systad	Geir Helge	Norwegian Institute for Nature Research	Norway	geir.systad[at]nina.no
30	Tasker	Mark	On behalf of OSPAR	UK	mark.tasker[at]jncc.gov.uk
31	von Buxhoeveden	Alexander	Swedish Coast Guard	Sweden	alexander.von.buxhoeveden[at] kustbevakningen.se

Break-out groups reporting format

Group work – part 1: Discuss & propose actions/mitigating measures
Break-out group no.: ____

The objective of group work – part 1 is to discuss environmental and anthropogenic factors affecting seabirds in the NE Atlantic, to consider existing actions/measures and propose relevant actions/mitigating measures, and to explain their significance.

Factors affecting seabirds	**Description of actions/mitigating measures** **Mark "E" if existing or "N" if new**	**Actions/mitigating measures significance** **Relative to all theme 1 statements: High-Medium-Low**	**Explanation of significance**
1 -			
2 -			
…			

Group work – part 2: Prioritize & evaluate actions/mitigating measures
Break-out group no.: ____

The objective of group work – part 2 is to bring the most significant actions identified in groupwork – part 1 forward, coming up with costs, time schedule, responsibility, and overall priority. This will form the basis for a full action plan.

Priority actions **Restricted to actions of high or medium significance from group work – part 1**	**Costs** **High** **Medium** **Low**	**Time-shedule** **Short (short term horizon 0–3 years)** **Medium (medium term horizon 3–5 years)** **Long (long term horizon > 5 years)**	**Assigned responsibility** **Public sector** **Private sector** **Ongoing** **international processes**	**Overall priority** **High** **Medium** **Low**
1 -				
2 -				
…				

Appendix 4: Seabirds – species names

English	Scientific	Danish	Faroese	Greenlandic	Icelandic	Norwegian	Swedish
Arctic skua	Stercorarius parasiticus	Almindelig kjove	Kjógvi	Isunngaq	Kjói	Tyvjo	Kustlabb
Arctic tern	Sterna paradisaea	Havterne	Terna	Imeqqutaalaq	Kría	Rødnebb-terne	Silvertärna
Atlantic puffin	Fratercula arctica	Lunde	Lundi	Qilanngaq	Lundi	Lunde	Lunnefågel
Black guillemot	Cepphus grylle	Tejst	Teisti	Serfaq	Teista	Teist	Tobisgrissla
Black-headed gull	Larus ridibun-dus	Hættemåge	Fransaterna	Nasalik	Hettumáfur	Hettemåke	Skrattmås
Black-legged kittiwake	Rissa tridactyla	Ride	Rita	Taateraaq	Rita	Krykkje	Tretåig mås
Brünnich's guillemot	Uria lomvia	Polarlomvie	Íslands-lomvigi	Appa	Stuttnefja	Polarlomvi	Spetsbergs-grissla
Common eider	Somateria mollissima	Ederfugl	Æða	Miteq siorar-tooq	Æðarfugl	Ærfugl	Ejder
Common guillemot	Uria aalge	Almindelig lomvie	Lomvigi	Appa sigguttooq	Langvía	Lomvi	Sillgrissla
Common gull	Larus canus	Stormmåge	Skatumási		Stormmáfur	Fiskemåke	Fiskmås
Common tern	Sterna hi-rundo	Fjordterne	Kriterna		Sílaþerna	Makrellterne	Fisktärna
European shag	Phalacrocorax aristotelis	Topskarv	Skarvur		Toppskarfur	Toppskarv	Toppskarv
European storm-petrel	Hydrobates pelagicus	Lille stormsvale	Drunnhvíti		Stormsvala	Havsvale	Stormsvala
Glaucous gull	Larus hyperboreus	Gråmåge	Valmási	Naajarujussuaq	Hvítmáfur	Polarmåke	Vittrut
Great black-backed gull	Larus marinus	Svartbag	Svartbakur	Naajarluk	Svartbakur	Svartbak	Havstrut
Great cormorant	Phalacrocorax carbo	Skarv	Hiplingur	Oqaatsoq	Dílaskarfur	Storskarv	Storskarv
Great skua	Stercorarius skua	Storkjove	Skúgvur		Skúmur	Storjo	Storlabb
Herring gull	Larus argentatus	Sølvmåge	Fiskimási		Silfurmáfur	Gråmåke	Gråtrut
Iceland gull	Larus glaucoides	Hvidvinget måge	Lítil valmási	Naajaannaq	Bjartmáfur	Grønlands-måke	Vitvingad trut
Ivory gull	Pagophila eburnea	Ismåge	Ísmási	Naajavaarsuk	Ísmáfur	Ismåke	Ismås
King eider	Somateria spectabilis	Kongeederfugl	Æðukongur	Miteq siorakitsoq	Æðarkóngur	Praktærfugl	Praktejder
Leach´s storm petrel	Oceanodroma leucorhoa	Stor storm-svale	Sýldur drunnhvíti	Tulugarnaasaq	Sjósvala	Stormsvale	Klykstjärtad stormsvala
Lesser black-backed gull	Larus fuscus	Sildemåge	Likka	Naajarlutsiaq	Sílamáfur	Sildemåke	Silltrut
Little auk	Alle alle	Søkonge	Fulkubbi	Appaliarsuk	Haftyrðill	Alkekonge	Alkekung
Little gull	Larus minutus	Dværgmåge	Dvørgmási		Dvergmáfur	Dvergmåke	Dvärgmås

English	Scientific	Danich	Faroese	Greenlandic	Icelandic	Norwegian	Swedish
Little tern	Sterna albifrons	Dværgterne	Fruntaterna		Dvergþerna	Dvergterne	Småtjärna
Long-tailed skua	Stercorarius longicaudus	Lille kjove	Snælduk-jógvi	Papikkaaq	Fjallkjói	Fjelljo	Fjällabb
Manx shear-water	Puffinus puffinus	Almindelig skråpe	Skrápur	Timmik	Skrofa	Havlire	Mindre lira
Northernfulmar	Fulmarus glacialis	Mallemuk	Havhestur	Qaqulluk	Fýll	Havhest	Stormfågel
Northern gannet	Morus bassanus	Sule	Súla		Súla	Havsule	Havssula
Razorbill	Alca torda	Alk	Álka	Apparluk	Álka	Alke	Tordmule
Sabine's Gull	Larus sabini	Sabinemåge	Ternumási	Taateraarnaq	Þernumáfur	Sabinemåke	Tärnmås
Sandwich Tern	Sterna sand-vichensis	Splitterne	Faksaterna		Þaraþerna	Splitterne	Kentsk tärna

Appendix 5: Workshop press release

2010-05-10 New action plan proposed for Nordic seabirds

A common action plan for Nordic seabirds could address population declines and help avoid harmful effects from fisheries, oil- and gas production, commercial shipping, marine installations and introduced species. This is the conclusion from a cross-sectoral workshop on seabirds in the Swedish city of Malmö. The workshop also points out that we need a better understanding of how climate change will affect our seabirds.

The purpose of the meeting was to work out a cross-sectoral action plan aimed at counteracting the declining trends in seabird populations in Western-Nordic areas including Scotland.

More than 30 representatives from the sectors of fisheries, environment, energy, science and also hunter-organizations took part in the workshop on May 4–5. Discussions were held both in smaller working groups and plenary sessions.

The action plan will point out mitigating measures that will help to reduce the negative impact factors identified in each sector.

A final proposal for a seabird action plan will be communicated to the Nordic Council of Ministers (NMC), for national implementation in each country. The proposal will be published in the NMC publication series (TemaNord) later this year.

The workshop was part of a Nordic Council of Ministers initiative started in 2006, due to a growing concern for the seabirds of the Nordic countries. The background was a resolution adopted at a joint meeting of Nordic nature conservation NGOs in 2006, urging the Nordic Council of Minsters to take coherent and strong measures in order to identify the causes for seabird populations decline and breeding failures, and to propose mitigating actions.

For more information, please contact:

(Contact information to the members of the project group)

Appendix 6: Abbreviations

AMAP	Arctic Monitoring and Assessment Programme (working group of the Arctic Council
CAFF	Conservation of Arctic Flora and Fauna (working group of the Arctic Council)
Cbird	CAFF seabird expert group
EA	Environmental Assessment
FAO	Food and Agriculture Organization of the United Nations
IBA	Important Bird Area
ICES	International Council for the Exploration of the Sea
ICES WGSE	ICES Working Group on Seabird Ecology
IMO	International Maritime Organization
IUCN	International Union for the Conservation of Nature
JNCC	Joint Nature Conservation Committee
MR-M	The Nordic Council of Ministers for the Environment
MSY	Maximum Sustainable Yield
NGO	Non-Governmental Organisation
NINA	Norwegian Institute for Nature Research
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAHs	Polycyclic Aromatic Hydrocarbons (some compounds have been identified as carcinogenic, mutagenic, and teratogenic)
POP	Persistent Organic Pollutant
PSSA	Particularly Sensitive Sea Area
RAMSAR	Wetlands Convention
SNH	Scottish Natural Heritage
SPA	Special Protected Area
TAC	Total Allowable Catch
WSSD	World Summit on Sustainable Development
WWF	World Wildlife Fund