Seabirds in the North-East Atlantic
Climate Change Vulnerability and Potential Conservation Actions

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Ducks and Phalaropes

(Anatidae and Scolopacidae)

An assessment of climate change vulnerability and potential conservation actions for ducks and phalaropes in the North-East Atlantic

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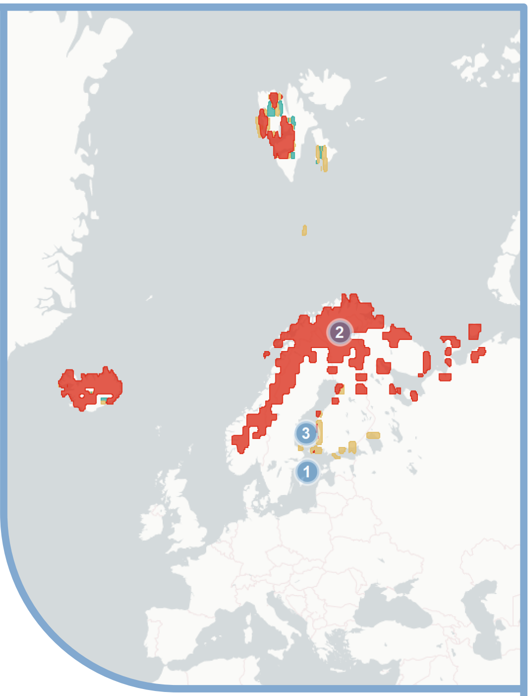
1 Long-tailed Duck (*Clangula hyemalis*)



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (89% of current range).

Current breeding area that is likely to remain suitable (8%).

Current breeding area that is likely to become more suitable (3%).

1.1.2 Current impacts attributed to climate change:

1 **Negative Impact:** Wintering populations in Europe have declined due to climate change-driven changes in predation in breeding areas outside of Europe.

2 **Negative Impact:** Range expansion of red foxes following milder winters has led to predation of ducks much further north than previously, and may be threatening the viability of northern populations.

3 **Neutral Impact:** Competition with non-native gobies has caused long-tailed ducks to switch prey, though there has been no observed change in mortality or condition. Goby invasion may have been assisted by climate change, though currently this is speculative.

1.1.3 Predicted changes in key prey species:

No key prey assessment was carried out for this species.

1.2 Sensitivity

- This species is numerous and has a large circumpolar range, but surveys suggest it is declining rapidly especially in the Baltic, most likely due to heavy bycatch. Any additional pressure from climate change is likely to exacerbate these declines.
- Several populations of long-tailed ducks are strongly reliant on *Mytilus edulis* for much of the year. *Mytilus* spp. are known to be sensitive to climate change, and warmer conditions are likely to result in lower quality prey. The consequences for long-tailed ducks are uncertain, but are very likely negative.
- Key wetland breeding habitats across the Arctic are rapidly disappearing or changing. The overall impact on long-tailed duck populations is unknown, but very likely to be negative.
- Species is known to be sensitive to changes in sea temperature, fluctuations in NAO, and, in particular, the presence of sea ice. A decline in sea ice is likely to result in a range shift of wintering populations, and it is possible that such a redistribution has already occurred in the Baltic.
- Long-tailed ducks often nest on low-lying areas near water, so are sensitive to flooding due to increased rainfall or wave-action. Any increase in intensity or frequency of storms is likely to impact breeding populations.
- Long-tailed ducks tend to winter in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.

1.3 Adaptive capacity

- Populations will mix during non-breeding season and there is low differentiation between populations. This may make populations more resilient to climate change, as immigration to support populations is more likely.
- Species has a very broad diet that varies depending on season and population. In the Baltic they have rapidly adjusted their diet in response to changes in prey availability. The loss of one prey species is unlikely to impact populations, though note that some populations may still be reliant on one or a few key species at some times of the year.
- Long-tailed ducks either abandon or skip breeding in particularly unsuitable years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding conditions.
- Female long-tailed ducks generally have high site fidelity and are unlikely to shift breeding areas quickly in response to climate change.

2 Harlequin Duck (*Histrionicus histrionicus*)

1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (95% of current range).

Current breeding area that is likely to remain suitable (2%).

Current breeding area that is likely to become more suitable (4%).

1.1.2 Current impacts attributed to climate change:

1 **Neutral Impact:** Population has redistributed, with some populations growing and others shrinking, most likely due to shifts in prey species caused by climate change.

1.1.3 Predicted changes in key prey species:

No key prey assessment was carried out for this species.

1.2 Sensitivity

- Harlequin ducks are sensitive to stream flow strength and variability during the breeding season; changes in freshwater flow can disrupt foraging and wash away nests. In parts of its range where temperature and precipitation patterns are likely to change, impacts could be significant.
- Harlequin ducks heavily rely on specific mollusc communities (e.g. *Mytilus* spp.), especially during the non-breeding season. Many marine mollusc species

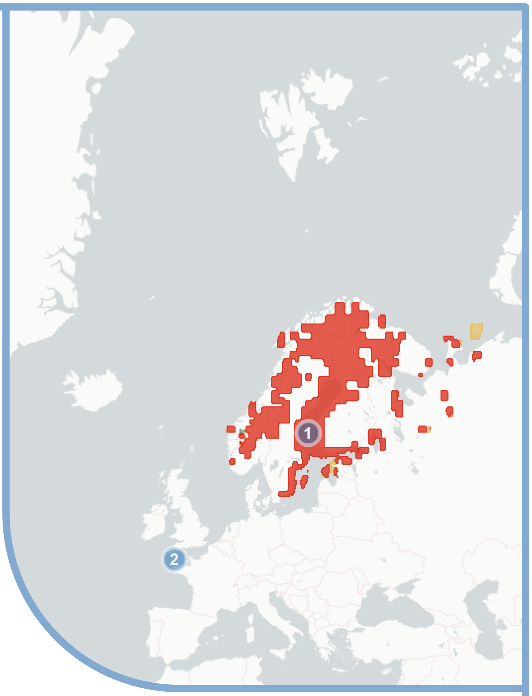
are known to be sensitive to climate change, and warmer conditions are likely to result in reduced abundance of key prey species.

- Harlequin ducks tend to winter in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.

1.3 Adaptive capacity

- Fidelity to moulting and wintering locations is very high, less high to breeding sites. This makes the species vulnerable to changes in wintering sites, particularly to extreme events.
- The species changes breeding sites readily, as determined by local conditions. Redistributing in response to climate change could potentially buffer negative impacts.

3 Velvet Scoter (*Melanitta fusca*)



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (96% of current range).

Current breeding area that is likely to remain suitable (4%).

Current breeding area that is likely to become more suitable (0%).

1.1.2 Current impacts attributed to climate change:

1 **Neutral Impact:** Scoters are starting their autumn migration significantly later in response to changing climate.

2 **Neutral Impact:** Wintering populations have redistributed, most likely due to lack of prey caused at least partly by climate change.

1.1.3 Predicted changes in key prey species:

No key prey species are predicted to decline for this species.

1.1.4 Climate change impacts outside of Europe

- Climate change has contributed to declines of scoter populations in North America. Earlier spring snow melt has likely led to a trophic mismatch and lower breeding success in scoters.

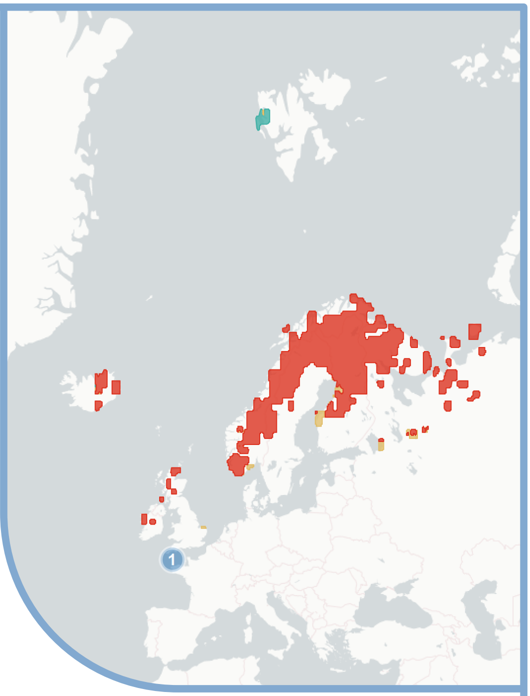
1.2 Sensitivity

- The species is numerous and has a large breeding range, but has suffered rapid declines since 1970. Particularly sensitive during non-breeding season as it gathers in high concentrations in relatively small areas (>90% of the global population winters in the Baltic). Additional pressure from climate change is likely to accelerate these declines.
- Many populations of velvet scoters rely on several key mollusc species for much of the year, many of which are known to be sensitive to climate change. Warmer conditions and ocean acidification are likely to result in reduced abundance of key prey species.
- Scoters, long tailed ducks and eiders have shown declines during historical regime shifts in marine ecosystems; they are likely sensitive to future changes in marine ecosystems.
- Key wetland breeding habitats across the Arctic are rapidly disappearing or changing. The overall impact on velvet scoters is unknown, but very likely to be negative.
- Often nests on low-lying areas near water, so is sensitive to flooding due to increased rainfall or wave-action. Any increase in intensity or frequency of storms is likely to impact breeding populations.
- Velvet scoters tend to winter in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.
- Recent observations and anecdotes have reported large groups of non-breeding scoters in the Baltic, many in poor condition. This may indicate high levels of stress or lack of high-quality prey. As this has not been observed previously, this may be a result of climate change. Further research is needed to clarify the cause of this and the long-term impact on the species.

1.3 Adaptive capacity

- Analyses of laying dates show there is little plasticity in response to changes in temperature, but there is some variation across and within populations.
- Species has shown flexibility in wintering sites in North America, in part predicted by year-to-year changes in sea temperature and fluctuations in NAO. Species is likely to shift wintering sites in response to climate change, and therefore buffer negative effects.

4 Common Scoter (*Melanitta nigra*)



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (94% of current range).

Current breeding area that is likely to remain suitable (5%).

Current breeding area that is likely to become more suitable (1%).

1.1.2 Current impacts attributed to climate change:

1 **Neutral Impact:** Wintering populations have redistributed, most likely due to lack of prey caused at least partly by climate change.

1.1.3 Predicted changes in key prey species:

No key prey species are predicted to decline for this species.

1.1.4 Climate change impacts outside of Europe:

- Climate change has contributed to declines of scoter populations in North America. Earlier spring snow melt has likely led to a trophic mismatch and lower breeding success in scoters.

1.2 Sensitivity

- There is some evidence that populations in the Baltic have declined substantially, but these are unsubstantiated and may instead indicate population shifts to the North Sea. If the species is indeed declining, climate change is likely to exacerbate these declines.

- Many populations of common scoters rely on several key mollusc species for much of the year, many of which are known to be sensitive to climate change. Warmer conditions and ocean acidification are likely to result in reduced abundance of key prey species.
- Scoters have shown declines during historical regime shifts in marine ecosystems, they are likely sensitive to future changes in marine ecosystems.
- Key wetland breeding habitats across the Arctic are rapidly disappearing or changing. The overall impact on scoter populations is unknown, but is very likely to be significant.
- Often nests on low-lying areas near water, so is sensitive to flooding due to increased rainfall or wave-action. Any increase in intensity or frequency of storms is likely to impact breeding populations.
- There are records of common scoters in recent wrecks along the coast of the UK. The extent and severity of these wrecks is unknown, but may suggest that common scoters are vulnerable to extreme climate events, and may be significantly impacted by more frequent, or more extreme, storms.
- Recent observations and anecdotal reports have reported large groups of non-breeding scoters in the Baltic, many in poor condition. This may indicate high levels of stress or lack of high-quality prey. As this has not been observed previously, this may be a result of climate change. Further research is needed to clarify the cause of this and the long-term impact on the species.

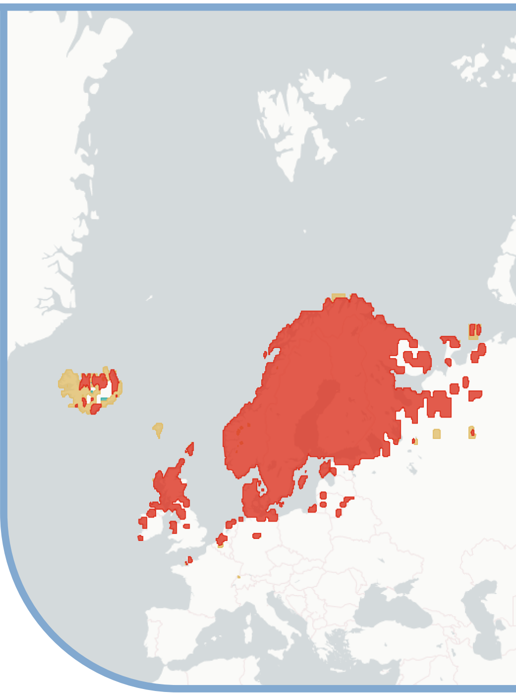
1.3 Adaptive capacity

- If suitable habitat is available, common scoters have on occasion either temporarily or permanently colonised new areas. However, in general they have high site fidelity and are unlikely to shift breeding areas quickly in response to climate change.
- There is some evidence the wintering population in the Baltic is redistributing to the North Sea. However the extent of this shift is uncertain and the cause is unknown.
- Very varied diet which varies by population and by year. Most likely to be determined by prey abundance. The loss of one or a few prey species is unlikely to have a significant impact.

5 Red-breasted Merganser

(*Mergus serrator*)

1.1 Evidence for exposure



1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (92% of current range).

Current breeding area that is likely to remain suitable (7%).

Current breeding area that is likely to become more suitable (1%).

1.1.2 Current impacts attributed to climate change:

We did not identify any current impacts of climate change for this species.

1.1.3 Predicted changes in key prey species:

No key prey species are predicted to decline for this species.

1.2 Sensitivity

- Red-breasted mergansers have low lying nests, which are vulnerable to flooding. Sea level rise or increased wave action from storms could impact breeding populations.

1.3 Adaptive capacity

- Red-breasted mergansers are capable of establishing or re-establishing colonies if conditions are suitable. Breeding range seems to be slowly expanding south in western Europe.

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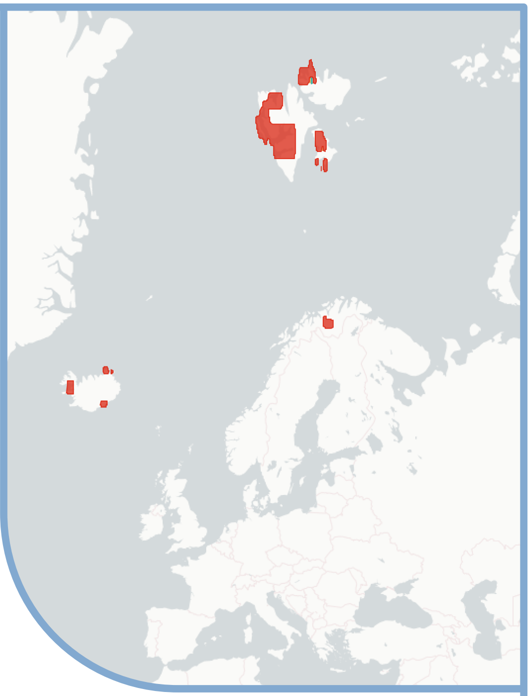
6 Red Phalarope (*Phalaropus fulicarius*)



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (93% of current range).

Current breeding area that is likely to remain suitable (6%).

Current breeding area that is likely to become more suitable (1%).

1.1.2 Current impacts attributed to climate change:

We did not identify any current impacts of climate change for this species.

1.1.3 Predicted changes in key prey species:

No key prey assessment was carried out for this species.

1.1.4 Climate change impacts outside of Europe:

- In Alaska red phalaropes now lay smaller eggs on average, presumably due to lower condition. This is likely due to delayed snow melt due to higher precipitation, despite the general warming trend.
- Across California red phalaropes have declined across their wintering areas. This is likely due to changes in ocean currents and declines in prey abundance.
- Populations around Alaska have declined in some areas, or possibly redistributed, due to changes in sea ice cover and in key copepod prey species.

1.2 Sensitivity

- The species is sensitive to changes in Arctic tern (*Sterna paradisaea*) populations. It relies on predator alarm warning from breeding Arctic terns, and localised populations have decreased rapidly in some breeding colonies in Greenland in the absence of Arctic terns. Any climate change impacts on Arctic terns (which are documented) are likely to have an impact on phalaropes.
- The species is restricted to high-latitude wet tundra areas, which are predicted to considerably decrease in area over the next century. In some parts of its range, such habitat is already disappearing.
- Some recent mortalities in populations outside Europe have been linked to unusually warm weather, and this could be exacerbated by climate change.
- Population sizes, trends and threats are not well understood. Probably largest threats are climate change, predation by foxes and pollution. Any change in population size or impacts are not likely to be detected rapidly. Carrying out conservation action is likely to be challenging.
- Species is sensitive to many threats, including disturbance by forestry work, ship traffic, bycatch, wind farms and heavy tourism. Nest abandonment is common when disturbed. Conservation intervention may therefore be difficult.
- Phalaropes frequently gather in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.

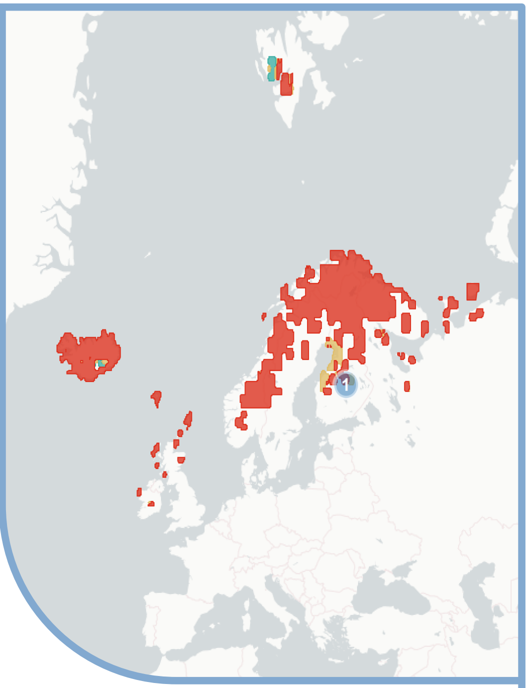
1.3 Adaptive capacity

- Phalaropes in Alaska are known to change their laying date in response to changes in snow melt. No known study on phenology in Europe.
- Species has low site fidelity overall; red phalaropes readily change breeding sites depending on conditions. Species could potentially shift breeding sites in response to climate change.
- Red phalaropes either abandon or skip breeding in particularly poor years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding conditions.

7 Red-necked Phalarope

(*Phalaropus lobatus*)

1.1 Evidence for exposure



1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (91% of current range).

Current breeding area that is likely to remain suitable (7%).

Current breeding area that is likely to become more suitable (2%).

1.1.2 Current impacts attributed to climate change:

1 **Neutral Impact:** Red-necked phalaropes have shifted north in Finland, the most southerly populations are declining while northerly populations are increasing. This shift is in correlation with climate change, but the underlying mechanism is not certain.

1.1.3 Predicted changes in key prey species:

No key prey assessment was carried out for this species.

1.1.4 Climate change impacts outside of Europe:

- A study in Alaska found that phalaropes have changed their laying date in response to changes in snow melt.
- Phalaropes have responded to changes in oceanic patterns in the Indian ocean and changed their foraging areas and patterns in response.

1.2 Sensitivity

- Very little is known about several aspects of this species' ecology. The status and trends of populations are largely unknown, and so any impacts of climate change will be difficult to identify, and effective conservation action will be challenging.
- Historical changes in weather patterns caused severe population crashes across America, Europe and Asia, many populations suffered enormous mortality and local near-extinctions. Impact was likely due to heavy depletion of plankton prey species.
- Phalaropes appear to have limited capacity to change prey species, and are heavily dependent on some key high-energy species during the breeding period. However, this is likely to vary depending on the population.
- Key wetland breeding habitats across the Arctic are rapidly disappearing or changing. The overall impact on phalaropes is unknown, but very likely to be negative.
- Phalaropes frequently gather in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.
- The species is sensitive to changes in Arctic tern (Sterna paradisaea) populations. It relies on predator alarm warning from breeding Arctic terns, and localised populations have decreased rapidly from some breeding colonies in Greenland in the absence of Arctic terns. Any climate change impacts on Arctic terns (which are documented) are likely to have an impact on phalaropes.

1.3 Adaptive capacity

- Phalaropes are known to change their laying date in response to environmental change, including recent changes in climate.
- Phalaropes undergo long migrations, which are energetically demanding. Different populations use different migration strategies and have adapted for different migration challenges. This may mean the species is flexible in its migration strategy and may respond to climate change, but also that the process is highly optimised. Changes in e.g. wind direction or strength could have large impacts.
- Red-necked phalaropes either abandon or skip breeding in particularly unsuitable years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding conditions.
- Species has low site fidelity overall; red-necked phalaropes readily change breeding sites depending on conditions. Species could potentially shift breeding sites in response to climate change.

8 Steller's Eider *(Polysticta stelleri)*

1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

While this species does occasionally breed in Europe, recent assessments have concluded these populations are not permanent and are generally at very low densities. As such, no habitat suitability assessment was carried out.

1.1.2 Current impacts attributed to climate change:

1 **Neutral Impact:** Many Steller's eiders have changed wintering area from the Baltic to the White Sea, most likely due to decreases in sea ice. This may also be associated with an overall population decline, but this is uncertain.

1.1.3 Predicted changes in key prey species:

No key prey species are predicted to decline for this species.

1.2 Sensitivity

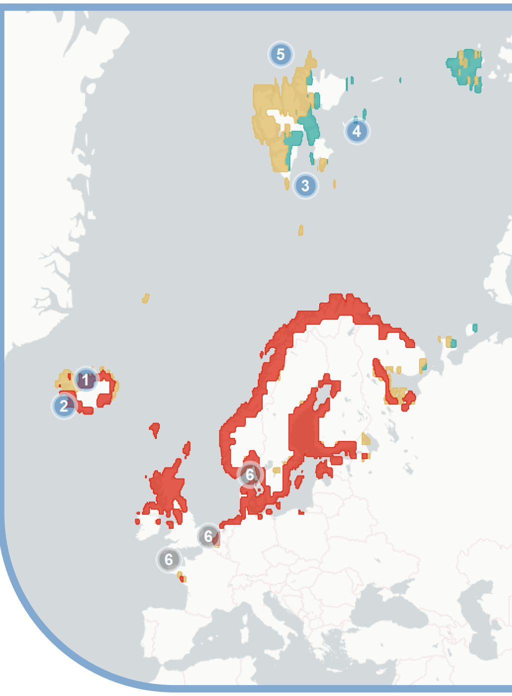
- This species has a large population and a large range, but is declining globally. In Europe the overall trend is unclear, there have been drastic declines in the Baltic, but this may be due to redistributions to other areas, in particular the north coast of Russia. Any existing declines are likely to be exacerbated by climate change.

- Eiders have shown declines during historical regime shifts in marine ecosystems, they are likely to be sensitive to future changes in marine ecosystems.
- Eiders are ground-nesters and vulnerable to predation by foxes and other mammals. Other eider species have suffered increased predation as a result of climate change. While this has not been observed in Steller's eiders, any increase in predation could have significant impacts on populations.
- Many of the species' key life-history traits are unknown. Many impacts to the population are unlikely to be detected quickly, and conservation action is likely to be challenging.
- Eiders form large rafts especially in the non-breeding season, making them particularly vulnerable to mass mortality events. Even localised climate change impacts may have large consequences on the population as a whole.
- Key wetland breeding habitats across the Arctic are rapidly disappearing or changing. The overall impact on eider populations is unknown, but very likely to be negative.
- Eiders have a varied diet of invertebrates but many populations are strongly reliant on *Mytilus* spp. and gastropods for much of the year. *Mytilus* spp. and gastropods are known to be sensitive to climate change, and warmer conditions are likely to result in reduction of key prey species. In addition, eiders show a preference for foraging in kelp beds, and any impacts to these may have severe negative consequences for foraging eiders.

1.3 Adaptive capacity

- While the species is generally considered to have high site fidelity to moulting and wintering sites, it has demonstrated range shifts in response to climate change. Large numbers have redistributed to northern Russia as sea ice has decreased over recent decades.
- Eiders either abandon or skip breeding in particularly unsuitable years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding condition.

9 Common Eider *(Somateria mollissima)*



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (80% of current range).

Current breeding area that is likely to remain suitable (18%).

Current breeding area that is likely to become more suitable (2%).

1.1.2 Current impacts attributed to climate change:

1 **Positive Impact:** Milder winter and summer weather have resulted in better average adult condition, and therefore better breeding success. In some areas this has resulted in local populations increases.

2 **Neutral Impact:** Eiders have shifted their phenology in response to milder winters and lay earlier.

3 **Negative Impact:** Due to a lack of sea ice driven by climate change, polar bears are becoming more numerous around bird colonies during the summer and are more heavily predating on eider populations.

4 **Positive Impact:** Earlier melt of sea ice in spring has resulted in a decrease in predation by Arctic foxes, as they cannot access breeding colonies without the presence of sea ice.

5 **Positive Impact:** Earlier melt of sea ice in spring has resulted in an increase in eider population density, as eiders have earlier and longer access to high-quality prey.

1.1.3 Predicted changes in key prey species:

6 Key prey species are likely to decline in abundance along the coast of Brittany, the coast of Belgium and along the south coast of Norway and Sweden.

1.1.3 Predicted changes in key prey species:

- Common eiders suffer increased predation from Arctic foxes due to prey switching following a collapse in lemming breeding cycles in northern Canada.
- In addition Canadian populations have suffered due to changes in weather in the breeding season, especially increased rain, either directly through exposure or indirectly through changes in predation.

1.2 Sensitivity

- This species has a large population and a large range, but is declining in several parts of its range. Known to be decreasing rapidly in the Baltic, climate change could be one of the underlying causes but this is uncertain.
- High precipitation and wind intensity reduce chick survival, likely through direct mortality from exposure and due to increased foraging difficulty. Precipitation is predicted to increase with climate change across northern Europe, and therefore likely to heavily affect chick survival.
- Often nests on low-lying coasts, so is sensitive to flooding due to increased rainfall or wave-action. Any increase in intensity or frequency of storms is likely to impact breeding populations.
- Eiders have a varied diet of invertebrates but many populations are strongly reliant on *Mytilus edulis* for much of the year. *Mytilus* spp. are known to be sensitive to climate change, and warmer conditions are likely to result in lower quality prey. The effect of this on eiders is uncertain, but is very likely negative.
- Eiders tend to winter in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.
- Eiders have shown declines during historical changes in sea temperature and fluctuations in weather patterns, particularly affecting the survival and distribution of wintering populations. They are likely sensitive to future changes in marine ecosystems.
- Eiders are particularly sensitive to disease outbreaks, bad years can claim up to 99% of offspring, and outbreaks seem to have a long term effect on female survival rate. Any change in disease dynamics due to climate change is likely to

have significant impacts.

- Warmer and calmer winters, with earlier break-up of sea ice, typically result in better condition adults and more adults committing to breeding in the following year. Many wintering areas (particularly in the Baltic and Svalbard) are likely to become milder due to climate change, which may benefit eider populations. However, sea ice also provides important resting areas for eiders during the winter, so a drastic reduction in sea ice may have counteracting negative effects.
- While climate change may have some positive impacts for common eiders, it does not mean that populations will necessarily increase in response to climate change. Recent research has found other pressures, in particular predation by native and non-native predators, may essentially override the positive effects of climate change, which appear to be small overall.
- This species has a long generation length (>10 years), which may slow recovery from severe impacts and increase population extinction risk.

1.3 Adaptive capacity

- Eiders either abandon or skip breeding in particularly unsuitable years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding conditions.
- There is low migratory connectivity between many populations in Europe (though this is not universal), and many populations will mix in the non-breeding season. This could be adaptive, as low connectivity is associated with greater flexibility and higher responsiveness to change.
- Female common eiders are typically highly faithful to breeding sites; extreme breeding philopatry of female ducks means it is unlikely populations will shift in response to climate change.
- Historically eiders have expanded their range, and colonised new areas such as Ireland and NW England in the early 20th century. This suggests if populations grow and conditions are suitable then eiders can colonise new areas.
- While some populations appear to have changed their phenology, other studies have found changes in laying date are not related to weather conditions. Plasticity seems to vary between populations.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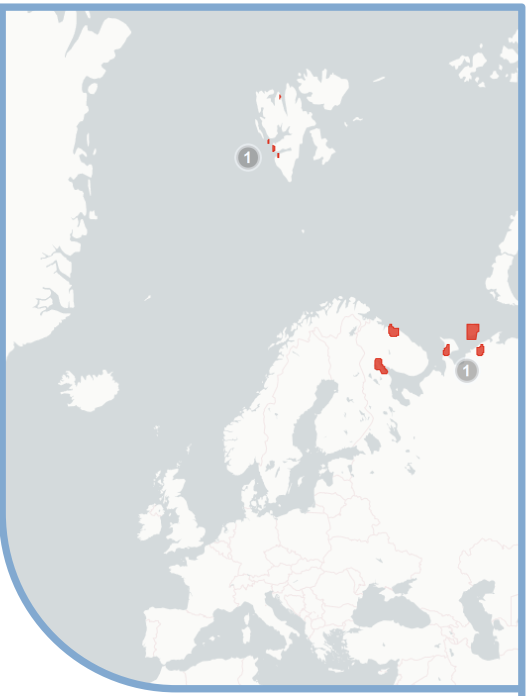
10 King Eider (*Somateria spectabilis*)



1.1 Evidence for exposure

1.1.1 Potential changes in breeding habitat suitability (by 2100):

Current breeding area that is likely to become less suitable (100% of current range).

Current breeding area that is likely to remain suitable (0%).

Current breeding area that is likely to become more suitable (0%).

1.1.2 Current impacts attributed to climate change:

We did not identify any current impacts of climate change for this species.

1.1.3 Predicted changes in key prey species:

1 Key prey species are likely to decline in abundance on the west coast of Svalbard and around the Kanin Peninsula and the south Barents Sea.

1.1.4 Climate change impacts outside of Europe

- Increase in ice break-up, and increased variability of break-up, caused by climate change has resulted in significant damage to benthic prey and has caused local shifts in prey availability. Currently this has only a small impact on king eiders, but impacts could become significant in the future.

1.2 Sensitivity

- Eiders have shown declines during historical regime shifts in marine ecosystems, they are likely sensitive to future changes in marine regimes.

- Wetlands provide important breeding grounds for this species. Remote sensing and imaging has shown fluctuations in lakes in Siberia, with many lakes disappearing and others appearing. The impact on populations is unknown, as the area is difficult to study but the potential impact is very large.
- King eiders tend to winter in large groups in relatively small areas, so are vulnerable to mass mortality through extreme events. Even localised climate change impacts may have large consequences on the population as a whole.
- King eiders are vulnerable to mass mortality, particularly during migration. Hundreds of thousands of eiders have been recorded dying following unexpected re-freezing of sea ice. Change or variability of conditions during migration period could have significant impacts on the population.
- King eiders may be sensitive to the loss of sea ice, as it provides important roosting sites during winter and supports marine algae and benthic invertebrate prey. While impacts of the loss of sea ice have not been observed on eiders so far, it is a potential future impact.
- This species has a long generation length (>10 years), which may slow recovery from severe impacts and increases population extinction risk.

1.3 Adaptive capacity

- Very low site fidelity to breeding areas (especially in males), but also few documented examples of breeding in novel areas, and no documented records of permanent colonisation. It seems unlikely this species will shift their range rapidly in response to climate change. High site fidelity to wintering areas, and even local changes to these sites may have significant impact on populations.
- King eiders have a varied diet, and can dive to greater depths than many other marine ducks. They likely could switch to alternative prey or foraging strategies if climate change changes availability of prey.
- King eiders have varied migration pathways and strategies which vary between individuals and between years. This plasticity likely provides some resilience to climate change, as eiders could change their migration strategy in response to local conditions.
- King eiders have low migratory connectivity (populations will mingle during non-breeding season), and a weak genetic structure. This may be advantageous in response to climate change, as local adaptation is low and migration plasticity is high in king eiders which may allow them to respond rapidly to change.
- Eiders either abandon or skip breeding in particularly unsuitable years, preserving resources. This could be adaptive if conditions become more variable and ameliorate the impact of poor breeding conditions.

Potential actions in response to climate change: Ducks and Phalaropes (Anatidae and Scolopacidae)

In this section we list and assess possible local conservation actions that could be carried out in response to identified climate change impacts. This section is not grouped by species, but by identified impacts. If an impact or action is specific to one or a few species, this information is included in the action summary or in the footnotes. Effectiveness, relevance, strength and transparency scores are based on the available evidence we collated (see Appendix 2), and therefore all statements regarding limited or a lack of evidence relate to the collated evidence base, and does not infer that no such studies exist.

1 Impact: Increase in mammal predation

Summary:

Invasive mammals are a major threat to many seabird populations, and as such there is a well-established literature on mammal exclusion, management and eradication detailing effective methods and case studies. However, there are more limited options when the mammalian predator in question is itself a conservation target, or is not easily managed. Nevertheless, for many situations there are several, well-researched, actions available that can benefit seabird populations effectively.

Intervention	Evidence of Effectiveness	R	S	T
Manage/ eradicate mammalian predators	Strong evidence that predator management can assist seabird populations under heavy predation pressure, if carried out effectively. Various sea ducks have been shown to benefit from predator control, especially targeting rodents and mustelids. Larger predators, such as bears and foxes, are more difficult to deter, and other actions are more likely to be viable and/or effective.	2	5	3

Physically protect nests with barriers or enclosures	Trialled extensively on many seabird groups, mostly with success, though depends on the species and the design of the barrier. Some trials on ducks have shown limited benefits, but generally quite minor and for limited species. Given the remote, dispersed nature of many duck and phalarope nesting sites, it may be difficult to carry this out at scale.	2	4	4
Reduce predation by translocating predators	Few trials on seabirds, and none for ducks and phalaropes. Existing evidence suggests this action can be beneficial and reduce egg/chick predation, and could be a possible action if other forms of predator management are not viable or permitted.	2	4	3
Repel predators with acoustic, chemical or visual deterrents	This is a hypothetical action. We found no records of this action's effectiveness for seabirds.	NA	NA	NA
Use supplementary feeding to reduce predation	Very few trials on seabirds, and none on ducks and phalaropes. No studies have shown this action is effective.	1	4	3

Green = Likely to be beneficial. Red = Unlikely to be beneficial, may have negative impact. Orange = contradicting or uncertain evidence. Grey = Limited evidence.
R = relevance rating. **S** = strength rating. **T** = transparency rating. All ratings on a scale of 1 to 5, where 5 is the highest.

Details:

Manage/eradicate mammalian predators

Relevance (R): 1 study in the evidence base focusses on ducks and phalaropes, 45 on other seabirds and 3 on other birds. Strength (S): The evidence base was comprised of 52 studies. Of these 44 were considered to have a good sample size, and 34 had a clear metric for effectiveness. Transparency (T): 52 studies included were published and peer-reviewed, of which 5 were literature reviews or meta-analyses, 0 were from the grey literature, and 0 were anecdotal. Of the studies included, 24 had a published methodology, and 28 justified their rationale.

Physically protect nests with barriers or enclosures

Relevance (R): 0 studies in the evidence base focus on ducks and phalaropes, 12 on other seabirds and 6 on other birds. Strength (S): The evidence base was comprised of 18 studies. Of these 16 were considered to have a good sample size, and 12 had a clear metric for effectiveness. Transparency (T): 17 studies included were published and peer-reviewed, 0 were from the grey literature, and 0 were anecdotal. Of the studies included, 11 had a published methodology, and 12 justified their rationale.

Reduce predation by translocating predators

Relevance (R): 0 studies in the evidence base focus on ducks and phalaropes, 2 on other seabirds and 2 on other birds. Strength (S): The evidence base was comprised of 4 studies. Of these 4 were considered to have a good sample size, and 3 had a clear metric for effectiveness. Transparency (T): 4 studies included were published and peer-reviewed, 0 were from the grey literature, and 0 were anecdotal. Of the studies included, 2 had a published methodology, and 3 justified their rationale.

Use supplementary feeding to reduce predation

Relevance (R): 0 studies in the evidence base focus on ducks and phalaropes, 1 on other seabirds and 3 on other birds. Strength (S): The evidence base was comprised of 4 studies. Of these 4 were considered to have a good sample size, and 4 had a clear metric for effectiveness. Transparency (T): 4 studies included were published and peer-reviewed, 0 were from the grey literature, and 0 were anecdotal. Of the studies included, 1 had a published methodology, and 4 justified their rationale.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