Compensations Measures

Note subject

Danish Energy Agency

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Contents

1 Introduction

The Appropriate Assessment of the draft Plan for North Sea I concluded an Adverse Effect on Integrity (AEoI) for displacement effects on red-throated *Gavia stellata* and black-throated diver *Gavia arctica* populations as features of the Special Protection Area (SPA) 113, Sydlige Nordsø. The AEoI is associated with offshore wind farm projects in the Danish and German North Sea, primarily as a result of the southern component of North Sea I and therefore a derogation from the Habitat Directive is likely required for permitting of development of wind farms in that area.

If a future EIA assesses there will be an adverse effect on SPA 113, and thereby a derogation may be needed, there will be a need to consider compensation measures for the bird species designated for SPA 113, Sydlige Nordsø. The SPA 113 has been expanded in 2023 but the latest plan for the Natura 2000-area is from 2023 (Miljøstyrelsen Sydjylland, 2023). In this the designation is red- and black-throated diver and little gull *Hydrocoloeus minutus*. The latter two is not present in the SPA and therefore suggested removed from the designation but this is not ratified yet. In the expansion decision two species is mentioned as designation for SPA 113; red-throated diver and common scoter *Melanitta nigra* (MST, 2023). Therefore at the moment SPA 113 is designated for the mentioned four species and the following sections of this report present possible compensation measures in the form of an 'idea catalogue' of measures.

This idea catalogue is produced by adapting a proven and accepted process used in the UK[1] to Danish legislation and practice. The idea catalogue consist of three parts; general knowledge about red- and black-throated diver, common scoter and little gull (the literature study), a longlist (as an appendix to this report) and a shortlist of suitable compensation measures.

2 Methods

The process starts with the undertaking of a literature study to inform the idea catalogue as an initial background description of red- and black-throated diver, common scoter and little gull biology and information related to key life stages with regard to conservation. Thereafter, based on this description and the literature study a longlist of feasible 'like for like' compensation measures is prepared. Like for like measures refer to compensation measures which benefit the same feature affected by the development of wind farms, so there is no net loss to that feature. In the longlist only measures outside the wind farm development area is considered. This is due to the nature of the impact (displacement) identified in the Strategic Environmental Assessment of the plan for the wind farm development area (COWI, 2024). As displacement is an effect of the presence of the wind turbine and associated activities, it is assumed in the longlist that any measures within the windfarm is project-specific for the wind farm project and therefore should be regarded as mitigation measures in a future Environmental Impact Assessment (EIA). As such measures are already considered before it is potentially concluded in the EIA that the wind farm has adverse effect on the designation of the SPA (and this effect cannot be sufficient mitigated) the same measures cannot be used as compensation measures.

The longlist provides a robust and fully encompassing foundation to develop compensation options for red- and black-throated diver, common scoter and little gull. Once measures are identified, they are investigated to understand their suitability and alignment with relevant compensation guidance. To evaluate the potential compensation measures in a robust and transparent manner, each of the options are scored against the

[1] NIRAS UK has developed and tested the method in several projects including at a strategic level.

compensation criteria NIRAS believe are of significant importance for reaching a successful outcome. The criteria are described in full in **Table *2.1***.

Each compensation measure identified was scored according to a scale (described below) depending on the weight of the criteria (with 1 being the minimum score) for each of the criteria identified (**Table *2.1***). The differences in potential highest scores is due to an intentional weighting of the different criteria as it is assessed that some criteria has higher impact on the success of the feature being effective. An overall score of all the criteria was then calculated for each potential measure (highest score = 26). Detail behind the scoring of each measure is provided in Appendix A.

The longlist draws on existing information on compensation measures, such as options from previous project proposals, published scientific literature, grey literature, relevant guidance on compensation options, and expert knowledge and experience held by NIRAS ornithologists. Those measures scoring highest will form the shortlist for more detailed discussion.

Table 2.1 Screening criteria applied for Like for Like longlist compensation measures

Criterion	Description	Score
Preference	Initial preference hierarchy based on the British DEFRA guidance[1]	4 = Address the specific impact in the same location.
		3 = Provide the same ecological function as the impacted feature; if necessary, in a different location.
		2 = Comparable ecological function in the same location.
		1 = Comparable ecological function in a different location.
Location	Measures should be in a location where they will be most effective at maintaining the overall coherence of the Natura 2000 network. Delivering compensation at the affected SPA, or other protected site, should be considered the most effective and will score higher.	4 = Option can be utilised by species from the protected site.
		3 = Species within a protected site can be affected by the option.
		2 = Species can be affected by option and species is within the biogeographic region.
		1 = Option can be reached by species and is located within the wider biogeographic region.
Technical Feasibility	Compensation options must be technically feasible to allow implementation. This criterion will be	5 = Technical delivery of option is well evidenced, achievable without any substantial challenges and there is certainty in the outcomes.

[1] https://consult.defra.gov.uk/marine-planning-licensing-team/mpa-compensation-guidance-consultation/supporting_documents/mpacompensatorymeasuresbestpracticeguidance.pdf

	decided based on evidence of challenges to implementation, with options supported by evidence and with limited barriers to delivery gaining a higher score.	4 = Technical delivery is evidenced but some challenges with delivery and some uncertainty in the outcomes.
		3 = There is some evidence of delivery and some uncertainty regarding outcomes.
		2 = Little to no evidence of delivery and considerable uncertainty in outcomes.
		1 = Compensation will not be in place, functioning and contributing to the coherence of the Natura 2000 network before impact occurs.
Functional Feasibility	Compensation options must be functional feasible to allow implementation. This criterion will be decided based on evidence of effect of implementation, with options supported by evidence and with limited barriers to delivery gaining a higher score.	4 = Function delivery of option is well evidenced, achievable without any substantial challenges and there is certainty in the outcomes.
		3 = There is some evidence of delivery and some uncertainty regarding outcomes.
		2 = Little to no evidence of delivery and considerable uncertainty in outcomes.
		1 = Compensation will not be in place, functioning and contributing to the coherence of the Natura 2000 network before impact occurs.
Timing	Compensation should be secured before the species is impacted. High scoring compensation options in this category will be those which can be in place, functioning and contributing to the coherence of the Natura 2000 network before any impact occurs. Higher scores are also awarded to those with higher certainty associated with their timelines.	4 = High degree of certainty compensation will be in place, functioning and contributing to the coherence of the Natura 2000 network before impact.
		3 = Some certainty compensation will be in place, functioning and contributing to the coherence of the Natura 2000 network before impact occurs.
		2 = Low certainty compensation will be in place, functioning and contributing to the coherence of the Natura 2000 network before impact occurs.
		1 = Compensation will not be in place, functioning and contributing to the coherence of the Natura 2000 network before impact occurs.
Additionality	Compensation must be additional to the normal practices required for the protection and management of the Protected Site. Any measures	2 = Confidence that measure will exceed what is considered 'normal' site management.

	that will already be undertaken by Government bodies to ensure that sites or species are in favourable condition should not be considered.	1 = Unlikely that measure will exceed what is considered 'normal' site management.
Scale	Compensatory measures should address the impact of the activity at a scale sufficient to deliver the required ratio of compensation	3 = Potential for high numbers of birds, eggs or nest sites to be provided per year (100s) from option.
		2 = Potential for moderate numbers of birds, eggs or nest sites to be provided per year (10s) from option.
		1 = Potential for low numbers of birds, eggs or nest sites to be provided per year (<10) from option.

3 Description of species

3.1 Red-throated diver

3.1.1 Biology

The global population size of red-throated divers is estimated at 200,000 to 600,000, with 80–90% of the population in northern Eurasia and 7–20% in North America (Rizzolo, et al., 2020). The red-throated divers' breeding population in Eurasia is 42,000–93,000 pairs with the largest numbers in western Russia (30,000–50,000 pairs) and Norway (3,000–6,000 pairs) (Rizzolo, et al., 2020). The breeding distribution is circumpolar with highest densities in open, flat tundra and coastal regions. Red-throated divers are solitary breeders and typically nest on the shores of freshwater lochs, lakes, and ponds or on small islands (del Hoyo *et al.*, 1992). They reach sexual maturity after three years and generally lay one clutch of two eggs each breeding season (BTO, 2023). The annual productivity varies spatially and temporally but in general, it ranges between 0.35 and 0.81 fledged chicks per pair with a chick survival rate of 0.40 to 1.0 (Rizzolo, et al., 2020). The adult survival rate is 0.84 (Hemmingsson *et al.*, 2002).

Red-throated divers migrate to their wintering habitat where they remain predominately at sea from October to April along inshore waters, close to sheltered coasts. (del Hoyo *et al.*, 1992). The wintering population in western Eurasia is estimated to be 42,000-44,000 individuals, with the highest numbers in the United Kingdom (17,000 individuals), followed by the Netherlands (10,000 individuals) and Germany (6,800 individuals) (Rizzolo, et al., 2020). Scandinavian red-throated divers winter in the Baltic Sea, the North Sea and southwards to France (Eriksson, 2000).

Red-throated divers forage by first scanning underwater and then diving from the surface and swimming. They feed on pelagic fish as well as crustaceans, molluscs, and other benthic invertebrates (del Hoyo *et al.*, 1992). In the North Sea, wintering red-throated divers eat mostly marine fish. One study concluded that cod (3–25 cm) constituted > 50% of total food intake and was found in 70% of 203 individuals. Other prey included gobies (Gobius spp.), stickleback, and herring. Stomach contents of ≥ 80% of birds contained only one fish species. However, molecular analysis of feces from red-throated divers wintering in the German Bight of the North Sea indicated a diverse diet, including 19 taxa dominated by five groups: clupeids, mackerel, gadoids, flatfish, and sandeels. (Kleinschmidt, Burger, & Dorsch, 2019)

3.1.2 Threats

At their breeding grounds, the key threats faced by red-throated divers are changes in water level, predation, and disturbance. Fluctuating water levels can reduce the number of suitable nesting sites in and around lakes and ponds, and excessive rainfall or wind can flood nests, decreasing the survival rate of eggs and chicks (Okill, 2004). On the other hand, if there is a drought and water levels drop, nests are more accessible to predators such as Arctic foxes, mink, gulls, and skuas (del Hoyo *et al.*, 1992; Okill, 2004). Disturbance from walkers or photographers can also flush nesting birds, exposing their nest to predation. In some locations, chick and egg mortality to Arctic foxes can be as high as 70% (Rizzolo, et al., 2020).

During migration and wintering, red-throated divers are particularly vulnerable to bycatch mortality in fisheries that overlap with their resting and feeding areas. For example, intense gillnet fisheries in the Baltic Sea are reported to entangle hundreds of divers annually, particularly in Sweden, Latvia, Lithuania, Poland, and Germany (Žydelis *et al.*, 2009). One study found that over the course of 12 consecutive winters, 370 red-throated divers were caught in nets in a small area of the German Baltic Sea (Schirmeister, 2003). Fisheries have also restricted the food supply of nesting and wintering birds. Commercial fisheries have depleted stocks of pelagic fish, such as sandeels, and limited the supply of common red-throated diver prey (Okill, 2004).

By spending most of their wintering period in large groups, red-throated divers are also susceptible to oil pollution in the North and Baltic Seas. During a winter survey of beached birds along the German North Sea coast, it was found that 84% of beached red-throated divers were covered in oil (Fleet *et al.*, 2003).

Studies have shown that red-throated divers are also sensitive to displacement by human activities. They have exhibited flight distances of up to 2 km from boats and tend to avoid highly trafficked areas (Bellebaum *et al.*, 2006). Given that red-throated divers fly at low altitudes, they are one of the highest ranked birds for collision risk with wind turbines (Bradbury *et al.*, 2014; Garthe and Hüppop, 2004). They have been observed avoiding wind farms in the North Sea by significant distances (more than 10 km) and are not believed to habituate to turbines, making them vulnerable to habitat loss from displacement (e.g., Petersen *et al.*, 2004; Petersen *et al.* 2008)).

3.2 Black-throated diver

3.2.1 Biology

The global population of black-throated diver is estimated to be between 275,000–1,500,000 individuals. The population in Russia has been estimated at 100–10,000 breeding pairs, and approximately 1,000–10,000 wintering individuals. The European population is estimated at 53,800–87,800 pairs, which equates to 108,000–176,000 mature individuals (BirdLife, 2024a).

The black-throated diver breeds in solitary pairs across northern Eurasia from the northern British Isles and Scandinavia eastward across Arctic Russia to eastern Siberia. They mainly breed near to deep, productive freshwater lakes in the boreal and taiga zone (del Hoyo *et al.*, 1992). Black-throated diver reach sexual maturity after three years generally lay one clutch of two eggs each breeding season (BTO, 2023b). In Arctic plains, variation in hatching success appears to be related to interannual differences in hunting activity by Arctic foxes. Productivity ranges from 0.4 to 0.7 young/km^2 and is highest in the years when fox activity is lowest (Bergman and Derksen, 1977). In Scotland, productivity averages 0.2 to 0.3 chicks fledged per pair with failure determined more frequently by nest flooding (Bundy, 1979) The adult survival rate is 0.89 (Nilsson, 1977).

Black-throated divers form flocks of ca. 50 individuals to migrate to their wintering habitat. They commonly winter from October to April along sheltered coasts inshore as well as large, inland lakes (del Hoyo *et al.*, 1992). Black-throated divers can regularly be found wintering in the Atlantic Ocean, the Baltic Sea, and the North Sea coasts of Europe from northern Norway to the Bay of Biscay. Birds also winter in the Adriatic, Aegean, Black, and Caspian Seas (Birdlife, 2024a).

Much like the red-throated diver, the black-throated diver is a pursuit diver and visual feeder, and while foraging, birds willoften look below the water surface for prey. Their diet consists predominantly of fish, although they may also consume aquatic invertebrates such as molluscs and crustaceans (del Hoyo *et al.*, 1992). At breeding and wintering grounds, water depth dictates foraging technique. In shallow water, birds forages from the surface and capture invertebrates by head-dipping; in deeper water, they dive for fish. Individuals foraging from the surface may occasionally attempt to expose benthic organisms by disturbing bottom sediments with the bill (Volcano, 2021).

3.2.2 Threats

Black-throated divers share many of the same threats as red-throated divers. Black-throated divers also nest directly adjacent to water and are subsequently susceptible to changes in the water level and nest flooding during heavy rainfall. Black-throated diver chicks and eggs are known to be predated by foxes, mink, otters, corvids, and gulls (del Hoyo *et al.*, 1992). The birds will also flush within 50 m of human disturbance, directly influencing chick survival rate (Bundy, 197). One study found that no pairs of black-throated divers were successful in rearing a chick on a small loch recreationally fished on a regular basis, whereas a loch without disturbance to divers had a 70% fledging rate suggesting that high nest attendance is important for egg and chick survival (Bundy, 1979).

Similar to red-throated divers, black-throated divers are susceptible to bycatch and have been recorded becoming entangled in gillnets and drowned in Baltic Sea fisheries along Sweden, Latvia, Lithuania, Poland and Germany (Žydelis *et al.*, 2009). Fisheries are also responsible for competing with divers for pelagic fish stocks, and putting strain on black throated divers' prey supply (Okill, 2004).

When wintering, black throated divers are as vulnerable as red-throated divers to oil pollution and vessel traffic disturbance (BirdLife, 2023a). They are also one of the highest ranked birds for wind farm sensitivity and are particularly at risk for collision and displacement due to turbines (Garthe and Hüppop, 2004; Bradbury *et al.*, 2014).

3.3 Common scoter

3.3.1 Biology

The global population of common scoter is estimated at 1,600,000 individuals (Delany *et al.*, 2006). However, this estimation is based on the common scoters wintering in west Palearctic, and up to 150,000 moult in Wadden Sea, 50,000 in Danish Kattegat, 10,000–15,000 in France and >10,000 in Britain. The population is Europe is estimated between 107,000-131,000 pairs or 214,000-263,000 mature individuals (BirdLife, 2024b).

Common scoter reach sexual maturity after two years and breed in eastern Greenland, Iceland, northern United Kingdom, and across Scandinavia and northern Russia (del Hoyo *et al.*, 1992). They breed on freshwater pools, small lakes, slow-flowing rivers and streams, and bogs in the tundra or northern taiga, where there is adequate vegetation to line their nest and provide cover (Collinson *et al.*, 2006). Females exhibit strong site fidelity with 77–93% of surviving birds returning to same area to breed in consecutive seasons. Productivity and chick survival varies spatially. In Iceland, nesting success was 57–89%, but in Ireland success was just 44%, principally due to corvid predation. The annual adult survival rates of common scoter is not well studied, but in Iceland, female survival rate averaged 78%.

Shortly after breeding, male common scoters leave the females and begin migrating in small groups. Females will migrate after their chicks have fledged, typically in September (Madge and Burn, 1988). Common scoters visit freshwater wetlands during migration, but they winter in shallow inshore waters in locations such as the Baltic Sea, on the Atlantic coast of Europe and North Africa, and in the West Mediterranean (Collinson *et al.*, 2006).

During the breeding season, a common scoter's diet consists mostly of molluscs (30 different spp.), aquatic invertebrates (crustaceans, worms, insects), small fish, and some plant material (seeds, roots, tubers). Choice of prey is most likely determined by prey abundance, and accessibility (Collinson *et al.*, 2006). Birds feeds almost exclusively by diving, typically between 1-3.7 m, although dives of up to 30 m have been recorded. During the wintering season, diet comprises of saltwater molluscs, typically just below the surface. While common scoter can form large, dense flocks at sea and on passage, they generally feed in smaller, looser groups, and may raft with other species of sea duck (Scottish Wildlife Trust, 2013).

3.3.2 Threats

In their breeding grounds, common scoter are susceptible to predation, which has been exacerbated with climate change. The lemming, a small rodent also found in arctic tundra where common scoter breed, have seen stark declines in their population as a consequence of global warming. As a result, predation pressure from snowy owls, arctic foxes, and skuas has increased on the common scoter to compensate for the decline in lemmings (Bellebaum *et al.*, 2012). Another predator of common scoters is humans, as hunting scoter is legal across many European countries, including Denmark where approximately 2,800-5,200 are killed annually (Bregnballe *et al.*, 2006).

Climate change is also believed to be contributing to habitat degradation of common scoter breeding grounds. The shrinkage and disappearance of wetlands and lakes in Siberia and decreasing snow cover in North American boreal habitats have both been linked to declines in their respective common scoter populations (Smith *et al.*, 2005; Drever *et al.*, 2012). While increasing water levels in wetlands and flooding from intense precipitation is not listed as one of the primary threats to common scoter, those that nest on or directly adjacent to bodies of water would also be susceptible to nest flooding.

Fisheries have had both a direct and indirect effect on common scoters. Common scoters are directly vulnerable to bycatch in gillnets, and are part of the 'sea ducks' family, which forms the majority of birds caught in gillnets in the Baltic Sea. Common scoter are most frequently reported as bycatch along Germany and Poland (Žydelis *et al.*, 2009). Indirectly, common scoter are forced to compete with commercial shellfish fisheries for prey such as molluscs, thus restricting their source of food (Kear, 2005). Bivalves in the Baltic Sea have also been diminished due to sand and gravel extraction and increasing winter water temperatures, furthering the strain placed on the common scoter's food supply (Mendel *et al.*, 2008).

Similar to red-throated divers and black-throated divers, common scoter that winter in the Baltic Sea are vulnerable to being exposed to oil pollution and displacement from vessel traffic. Among sea ducks, common scoters exhibit the longest duration of habitat displacement from approaching ships, with no evidence of habituation (Schwemmer *et al.*, 2011). Displacement is also a potential outcome of wind farms. Common scoters migrate mainly at night, putting them at high risk for turbine collision, and have been documented avoiding wind farms in the North and Baltic seas (Garthe and Hüppop, 2004; Bradbury *et al.*, 2014; Dierschke and Garthe, 2006).

3.4 Little gull

3.4.1 Biology

The global population of little gulls is estimated at c. 97,000–270,000 individuals. The European population is estimated at 23,700–45,200 pairs, which is equal to 47,400–90,500 mature individuals, but the population is declining. The largest European subpopulations are in Russia and Finland, with most of remainder in Sweden, Norway and the Baltic States (BirdLife, 2024c).

Little gulls reach sexual maturity after two years and produces a clutch of two or three eggs each year (Birdfact, 2024). In Europe, breeding is concentrated in northern Scandinavia, the Baltic States, Belarus, Russia and Siberia. Little gulls typically breed in mixed-species colonies (gull sp. and tern sp.), with up to 2,000 individuals, but may breed in solitary pairs (del Hoyo *et al.*, 1996). They form their nests in shallow freshwater lakes, bogs, and marshes with extensive vegetation such as cattail, bulrush and bur reed (del Hoyo *et al.*, 1996). Most studies record low productivity, 0-0.2 chicks fledged per pair. The mortality of adults is largely unstudied, but adult survival rate is estimated at 0.8 (Garthe and Hüppop, 2004).

Although little gulls are fully migratory, the routes are not well understood. Birds breeding in Europe tend to overwinter in the Mediterranean Sea, North Sea and Baltic Sea, as well as in the Atlantic off of western Europe and north-west Africa. Little gulls prefer to winter along shores, near to sandy and muddy beaches or at the mouths of rivers (del Hoyo *et al.*, 1996).

Little gulls are recorded foraging most often at the water surface and nearshore in wetlands, lakes, rivers, sewage treatment ponds, or along marine coasts. No systematic censuses of little gulls in open water has been done, so the extent of offshore foraging is unknown (del Hoyo *et al.*, 1996). Little gulls are mainly insectivorous (dragonflies, beetles, midges, mayflies and stoneflies) during the breeding season, but supplement their diet with small marine fish and invertebrates during the winter (del Hoyo *et al.*, 1996; Birdfact, 2024). A study in the Baltic found that all of little gull stomachs contained insects, while only 4% contained fish. Little gulls usually forage over water similar to terns or small petrels by dipping down to the surface periodically to catch prey at or just below the surface. They will also pick insects from the water surface while swimming, although some have been observed catching insects up to 20 m above ground. In some cases, little gulls will opportunistically take fish offal and bread thrown from small fishing boats (Ewins and Weseloh, 2020; Johnston, 1984).

3.4.2 Threats

The threats faced by little gulls are not well studied. Their breeding grounds are vulnerable to natural causes, such as flooding, as well as destruction and disturbance from humans. Little gull eggs and chicks are predated by muskrats, weasels, mink, and other species of gull, while adults are more commonly predated by owls and peregrine falcons (Bauer *et al.,* 2005; Birdfact, 2024)

Much like other birds that winter in the Baltic sea, little gulls form large flocks where there are susceptible to oil pollution and shipping traffic, although to what extent is not known. Little gulls are also reported as possible bycatch in Baltic Sea gillnet fisheries, although the exact impact on little gulls specifically has not been studied (Žydelis *et al.,* 2013).

Little gulls have also been reported as displaced due to windfarms and are at a moderate risk for collision with turbines (Garthe and Hüppop, 2004; Bradbury *et al.*, 2014). One study found that the displacement effect of wind farms on little gulls extended up to approximately 1.5 km, disrupting the resting and feeding habitat of the birds (Welcker and Nehls, 2016).

4 Results

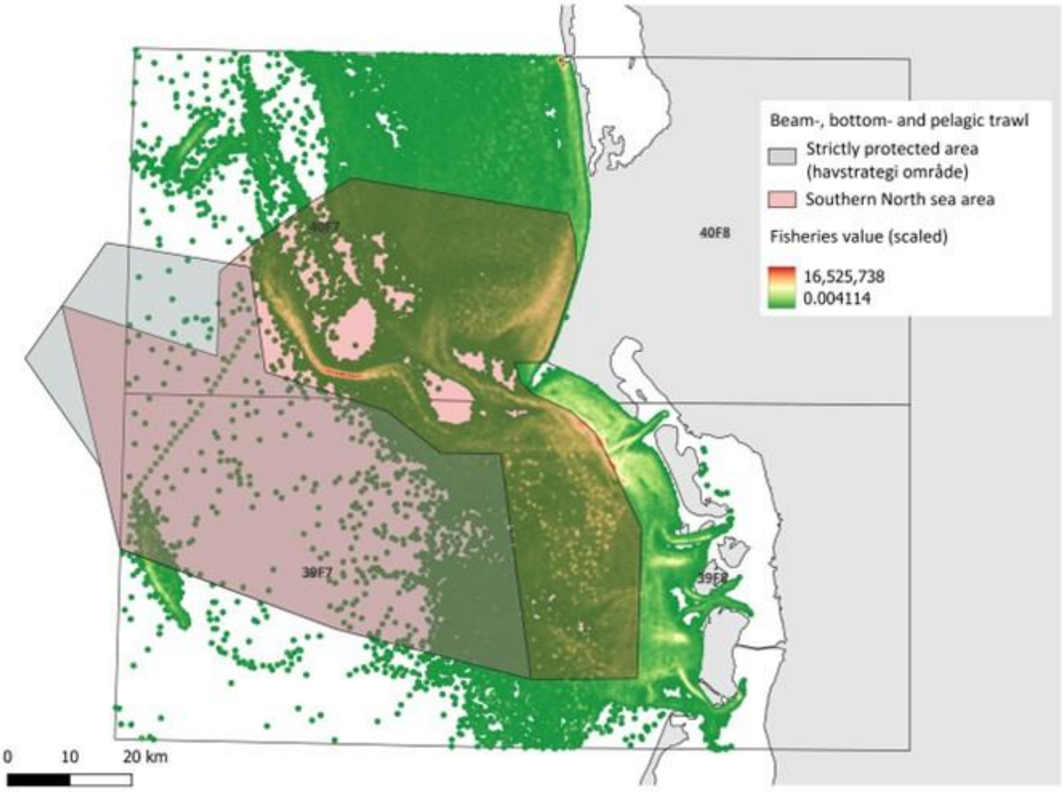
The result of the longlisting exercise for compensation measures can be found in Appendix A. The longlist is ordered in descending scoring order and is commented with why the different measures score as they do. The longlist considered the following compensations measures grouped in four compensations types:

- Habitat re-creation; creation or re-creation of habitats for the birds to use during their lifecycle in particular through protected species.
  - Designation of both onshore and offshore SPAs
- Rights acquisition; methods to compensate by acquiring rights for natural resources (e.g. fishing quotas).
  - Purchase of fishery quota
- Species recovery; Any measure that work towards directly increasing the numbers of birds.
  - Fishery closure
  - Fishery exclusion zone
  - Diversionary feeding for predators
  - Supporting habitat
  - Supplementary feeding
  - Aviation predator management
  - Predator eradication/exclusion
  - Hazedous plastic/nets removal
  - Other fisheries based measures
  - Redusing fisheries quota
  - Enhance breeding success by improving existing nesting locations
  - Alternative aquaculture netting
  - Funding sandeel alternative research
  - Provision of nesting material
  - Artificial nesting structures
- Threat reduction: Reduction of threats towards the species to compensate the potential effect of the wind farm area.
  - Hunting
  - Reduction of recreational activity disturbance
  - Seabird bycatch reduction
  - Gravel extraction prevention
  - Reduction of shipping disturbance
  - Management of marine litter
  - Reduce threats at non-DK sites
  - Biosecurity at important seabird colonies
  - Warden funding
  - Increasing environmental education
  - Pollution prevention and management

The longlist resulted in a subsequent shortlist consisting of the recommendations scoring highest. These measures mainly consist of restrictions in fisheries and hunting and are discussed further below. For many of the other compensation measures they scored low as they are practically difficult to implement as the measure need to be implemented in very large, inaccessible areas of the arctic in Russia, Scandinavia and Greenland. It was also considered to combine two or more measures to improve the combined score of the compensation measures but this is a very hard exercise and the considered compensation measures did not result in additional gains when combined.

Fishery closure and fishery exclusion zone:

In order for the displacement of red-throated and black-throated diver to have an adverse effect on the SPA the displacement has to lead to increased competition within the SPA. As the divers is displaced outside and within the SPA by the wind farm the displaced birds need to survive in the rest of the SPA in order for the designation to still be effective. The displacement will therefore lead to increased competition in the SPA for both space and food. For the effect to have adverse impacts on the SPA, food directly or through spatial competition has to be a limiting factor on the diver population in the SPA. As the densities of divers in the SPA is relatively low with ca. 0.5-1.0 divers/km^2 (Petersen, Nielsen, & Clausen, 2019) and the daily consumption of diver is between 200 and 300 g of fish per day (Rizzolo, et al., 2020; Kleinschmidt, Burger, & Dorsch, 2019) it is uncertain if the density of divers in the SPA (and the rest of the North Sea) is restricted by available prey. But in this idea catalogue food limitations is assumed. Therefore an effective compensation is reducing the competition for food or increasing the availability of food. For divers the only practically sound solution is to reduce the fishery in the area for pray species. This will mainly be the fishery for smaller pelagic fish as Atlantic herring, sprat, and sandeel. Therefore restrictions on these fisheries is likely to be effective measures but also fisheries that have these species as by-catch. In the German Bight divers mainly prey on cod during the winter but only cod smaller than is fished commercially. Similar restrictions have been implemented on sandeel fishery in British waters to improve the marine environment and general prey resources responsible for declines in key seabird species, primarily for black-legged kittiwake population.



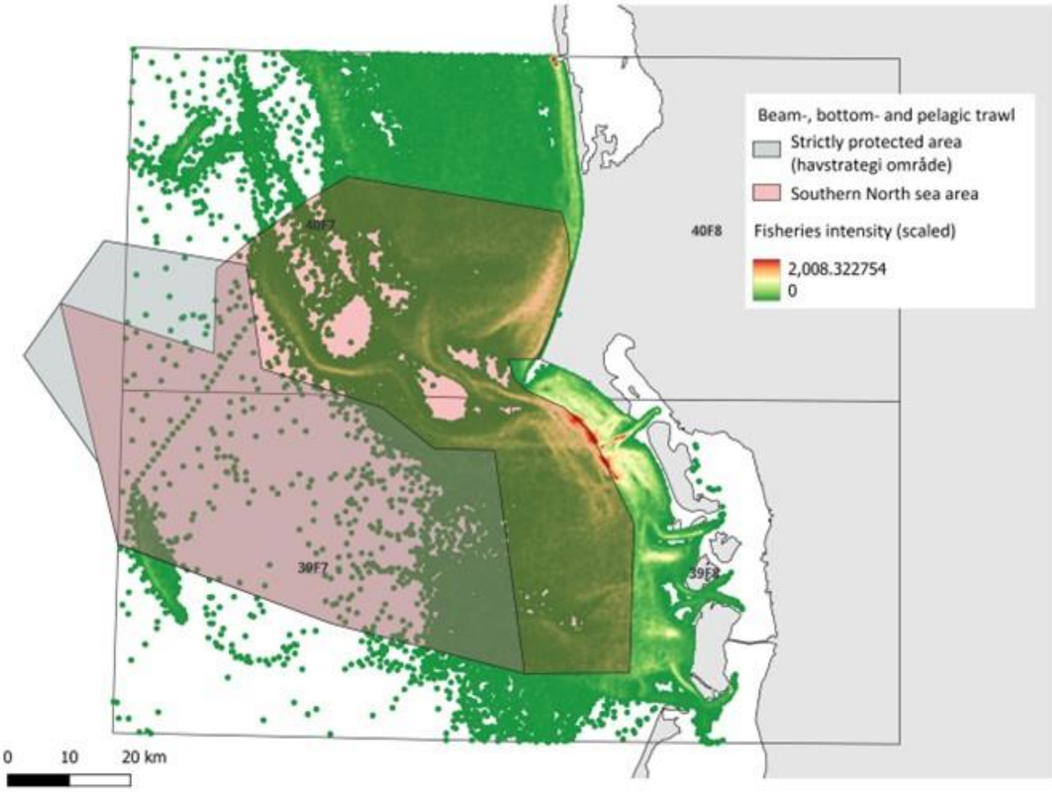
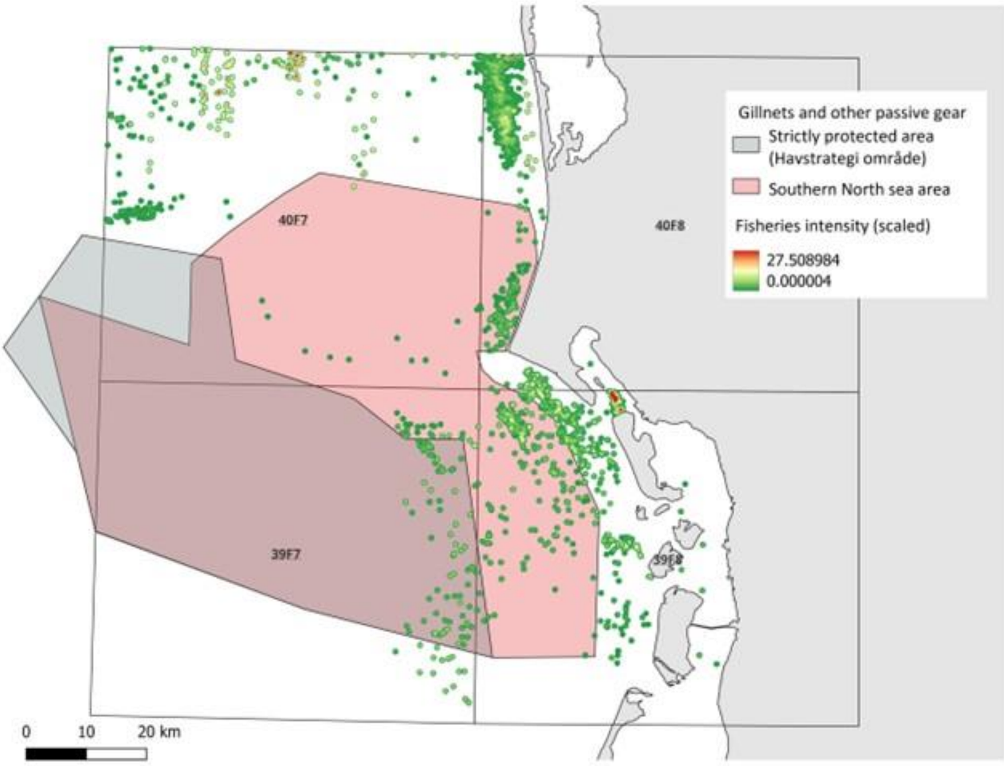


Figure 4.1 Value (top) and intensity (below) of trawls with indication of the SPA and strictly protected maritame strategy areas (Havstrategiområde).



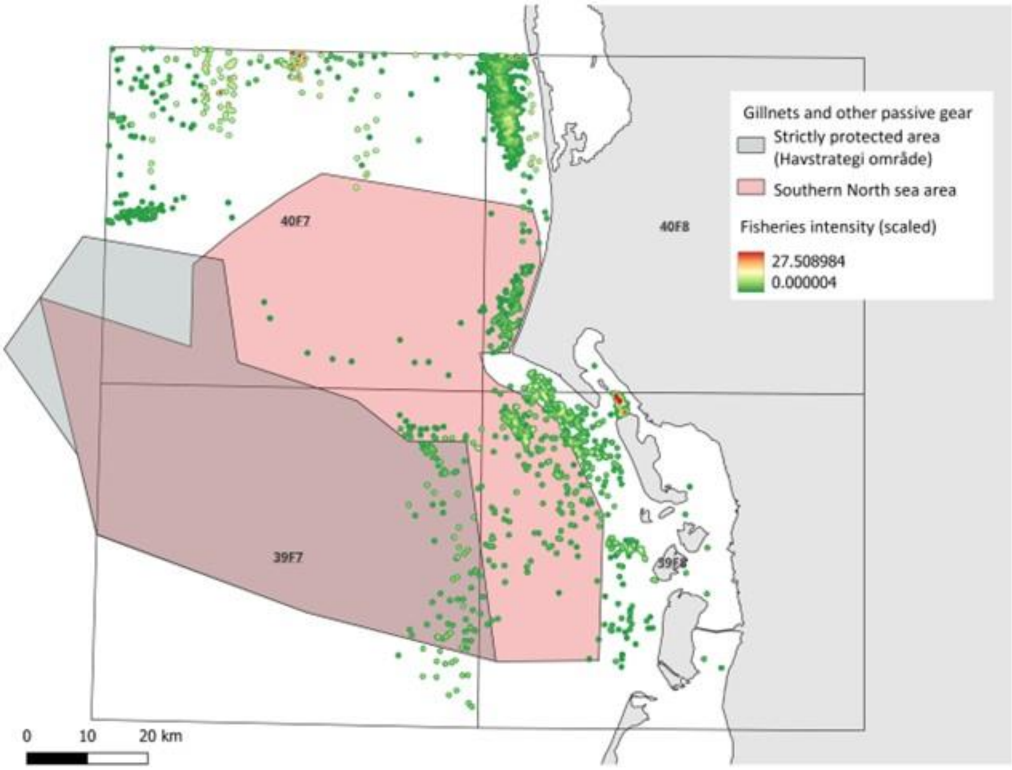


Figure 4.2 Value (top) and intensity (below) of standing nets with indication of the SPA and strictly protected maritame strategy areas (Havstrategiområde).

As can be seen on Figure 4.1 and Figure 4.2 a large part of the SPA is fished with trawls. This fishery is mainly after sandeel (Ammodytidae) especially around Horns Rev. The scrimp fisheries north of Horns Rev is does also have a large by-catch of species suitable for divers.

For common scoter similar restrictions on mussel fishery in the SPA would likely have an effect. The importance of this fishery is only a small part of the total fishery in the area. But a broader restriction would likely be most effective due to the connectivity of the populations within SPAs and outside. This is also true for the diver populations.

The measure would, though, be reliant on government power to exclude fishery. Excluding a fishery in one area could displace fishing effort to other regions to achieve the same quota. Exclusion of a fishery from the SPA could be considered a management measure, as it is suggested to prevent by-catch of harbour porpoise in the SPA Sydlige Nordsø, but it has not been used to provide more food for designated species. Therefore it is not used as a management measure for birds. If it were it would not provide additionality. This is particularly the case if fisheries pressures are listed as a contributor to species decline across the Danish SPA network. However, for an SPA where this measure is not being taken or taken in a reasonable timeframe it could provide additionality and it would also be acceptable outside an SPA.

Hunting restriction:

Common Scoter is the only of the species that is legal hunting on in Denmark. Therefore, it is possible to compensate any increased mortality by restrictions on hunting in Denmark. A total ban on hunting of common Scoter in Denmark will result in a potential compensation equal to the yearly hunting numbers of common scoters of 2,461 (2023). Most of the birds is, though, bagged in the inner Danish waters.

Reduction of recreational activity disturbance and shipping disturbance:

Both divers and common scoter are fairly sensitive to disturbance from recreational activities on water and shipping, with disturbance distances reported to exceed 5 km. Therefore restrictions in these activities are likely to reduce the impact locally and thereby increasing the available habitat for the birds. In the SPA the recreational activities are very costal so the effect might be relatively small. Similarly the shipping in the area is restricted by depths and access to the port of Esbjerg and to a less degree access to the existing windfarms on Horns Rev and in German waters. Restriction in this shipping could potentially have some effect but at the same time the shipping is necessary for the operations of the port and wind farms and therefore the compensation measure is hard to implement with great effects as a result.

Seabird bycatch

Bycatch in net of the seabird have a very direct impact on the survival of the populations in the SPA. The bycatch numbers in the area are though very low and the potential gain of the measure is therefore very limited locally. At the same time this measure would be negated if further restrictions are placed on fishery in the SPA.

Supplementary feeding

For little gull supplementary feeding can be very beneficial both as direct feeding or by returning bycatch to the sea. As little gull takes food from the surface of the sea both measures would supply additional food. It might also work for divers but their displacement from boats is likely to negate this measure and it is also unsure if they take dead fish offered this way.

Supplementary habitat

For common scoter supplementary habitat in the form of additional banks of mussels. It has the last 20 years been evident that the increased distribution of common scoter on Horns Rev is due to the increase in the distribution of Atlantic jackknife clam (*Ensis leei*). Therefore additional mussel banks outside the impact area of the wind farm would likely provide food for the common scoter and compensate any potential impact.

5 References

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6 Appendix A