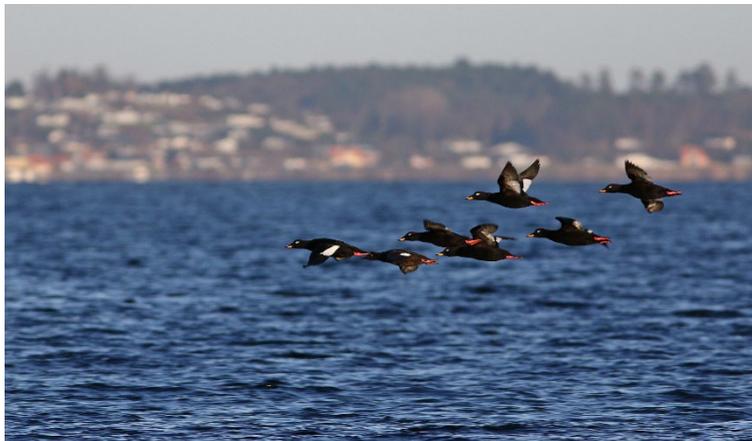


UTILITAS Saare-Liivi offshore wind farm site and diving ducks

Seaduck sensitivity to offshore wind farms

Scientific note from DCE – Danish Centre for Environment and Energy

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Front page photo: Flying Velvet Scoters (Photo by Rasmus Due Nielsen)

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1 Introduction

In July 2024 UTILITAS Wind, in Estonia approached Aarhus University, DCE (Danish Centre For Environment And Energy) for consultations regarding the potential impacts from offshore wind farms on diving ducks, particularly Long-tailed Duck and Velvet Scoter.

Here we present knowledge and experience about diving duck displacements from existing offshore wind farms. The memo does not provide an evaluation of the ornithological data collected at the Saare-Liivi site, as bird abundances and distributions in the Saare-Liivi area is unknown to DCE. It is also important to note that this is not an assessment of the potential impact on diving ducks from the establishment of the proposed wind farm.

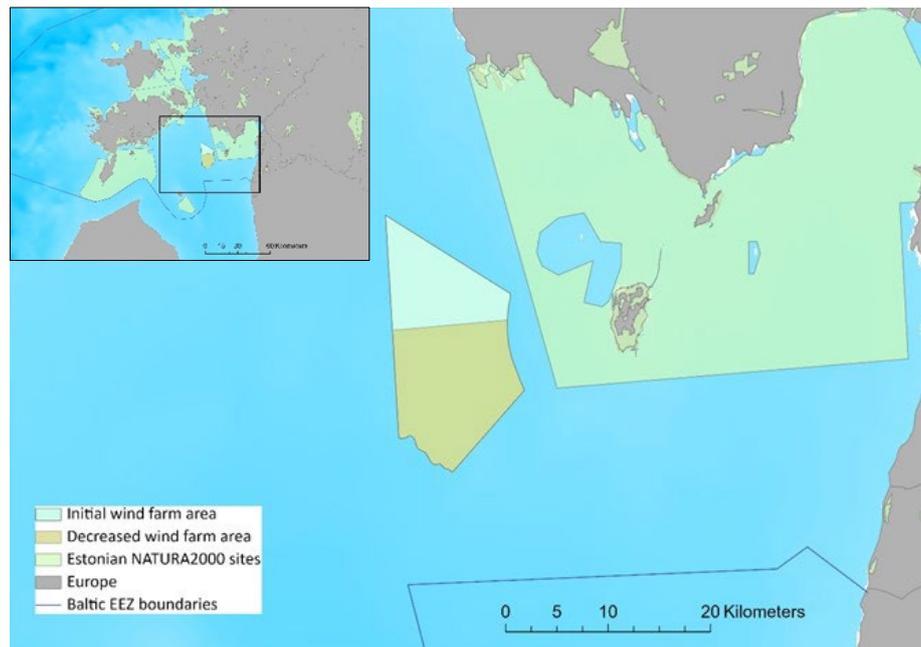
The memo will address the following topics:

- Methodological evaluation and guidance on quantification of the effect of habitat displacement on Long-tailed ducks and Velvet scoters on an appropriate scale of magnitude and time.
- Guidance on quantification of the negative population impact of habitat displacement on a relevant spatial scale, e.g. biogeographic, flyway and/or 'local' scale.
- Recent studies on habitat displacement: 1) Overview of post-construction monitoring studies of habitat displacement on arctic ducks in relation to offshore wind farms. 2) Selection of displacement distance (buffer zone) based on scientific literature and past project experience. 3) Selection of species-specific sensitivities (proportion of birds displaced within the 'accepted' buffer zones) based on literature and recent studies.

1.1 The Saare-Liivi offshore wind farm site

The Saare-Liivi wind farm site is situated in the Riga Bay, approximately 10 km west and southwest of Kihnu Island. The initial wind farm area is approximately 216 km², while a reduced wind farm site, representing the southern parts of the initial area, has an area of 136 km² (Figure 1.1). The depth of the reduced area is mainly between 6 and 25 meters, while the depth of the northern part of the initial area is generally between 25 and 30 meters of depth.

Figure 1.1 The Saare-Liivi off-shore wind farm site and the NATURA 2000 sites and other protected sites in the area. The Saare-Liivi wind farm site has an initial extension and a reduced extension (see legend).



The Saare-Liivi Special Protection Area (SPA) is situated west of the “Pärnu lahe” EU Birds Directive site (site ID EE0040346, <https://eunis.eea.europa.eu/sites/EE0040346>). The minimum distance between the initial wind farm site and the SPA is around 2 km, while the corresponding distance from the reduced wind farm site and the SPA is around 3 km.

1.2 The Pärnu lahe Birds Directive area

The Pärnu lahe SPA covers an area of 1,104 km², of which 96 % is marine. 41 bird species are designated for the area, of which 10 are diving ducks. The area is shown in Figure 1.1

The NATURA 2000 site has been designated for eight species of diving ducks according to their occurrence in the area during the non-breeding season, namely Tufted Duck, Scaup, Long-tailed Duck, Common Scoter, Velvet Scoter, Goldeneye, Goosander, Red-breasted Merganser (Table 1.1).

Table 1.1. List of the non-breeding species of diving ducks for which the Pärnu lahe EU Birds Directive site has been designated (Source: <https://eunis.eea.europa.eu/sites/EE0040346>).

Species	Minimum	Maximum
Tufted Duck	5,000	5,000
Scaup	57,000	57,000
Long-tailed Duck	270,000	270,000
Common Scoter	132,000	132,000
Velvet Scoter	70,000	70,000
Goldeneye	4,500	4,500
Goosander	50	50
Red-breasted Merganser	1,000	1,000

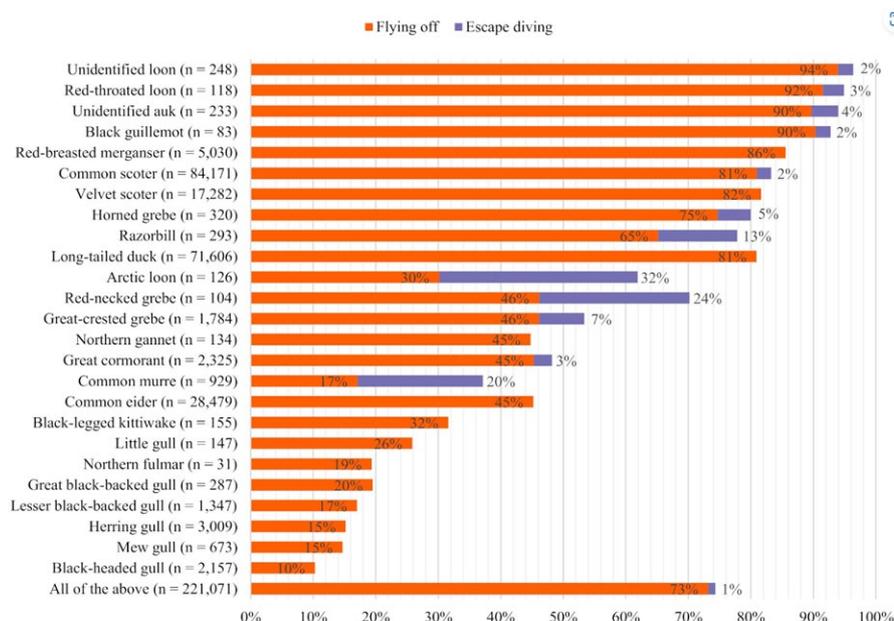
Of these eight species, Long-tailed Duck and Common Scoter are the most abundant. Velvet Scoter and Scaup are also present in the Birds Directive area in high numbers. Common Eider, another species of diving duck, is also on the designation list, but it is specifically designated for its breeding population and is therefore not relevant in this case.

2 Bird sensitivity to human disturbances

Sea ducks mainly forage on benthic bivalves in relatively shallow waters. The energetic costs of such feeding are directly proportional to the water depth and profitability of the food resources. As a result, they show less flexibility in habitat choice than, for instance, gull species which exhibit a more variable diet and can show greater flexibility in foraging behaviour, shifting to alternative food resources (Garthe & Hüppop 2004). These factors make sea ducks particularly vulnerable to disturbances displacing them from their optimal foraging areas. A study on the effects of regular ship traffic revealed that over 80% of the more than 70,000 Long-tailed Ducks flushed from approaching ships, displacing them from their preferred foraging areas and significantly increasing their energy expenditure due to unnecessary flight and relocation (Fliessbach et al. 2019). This analysis showed the species to be classified as the tenthly most susceptible to approaching ship traffic of the 25 species covered by the study (Figure 2.1, Fliessbach et al. 2019).

Velvet Scoter showed almost identical disturbance effects from approaching ships, with 82% of more than 17,000 observed birds flushed as a response to the approaching ship. This classified the species as the seventhly most affected of the 25 species covered by the study (Figure 2, Fliessbach et al. 2019).

Figure 2.1 Species-specific proportions of birds showing different disturbance responses in front of approaching research vessels in 2016 and 2017 (n = total number of individuals considered). From Fliessbach et al. 2019



When considering the effects of the presence of offshore wind farms on the distribution of Long-tailed Ducks and Velvet Scoters, we are currently unable to distinguish the effects caused by the wind turbines themselves and those resulting from related factors, such as maintenance ship traffic.

In the Nysted and Rødsand II offshore wind farms south of Lolland in Denmark bird distributions was monitored by use of aerial line transect surveys, both before and after construction of the wind farms (Petersen et al. 2006, 2011, 2018, Fox & Petersen 2019). The investigations were conducted during the following four phases:

- Phase A: Pre-construction of Nysted and Rødsand II offshore wind farms, 2000-2002.
- Phase B: Post-construction of Nysted and pre-construction of Rødsand II, 2003-2007.
- Phase C: Post-construction of Nysted and Rødsand II offshore wind farms, 2011.
- Phase D: Post-construction of Nysted and Rødsand II offshore wind farms, 2018.

The initial study utilized data gathered during phases A and B. It revealed a significant change of the distribution of Long-tailed Duck (Figure 2.2) with significant declines in bird density within the footprint of the Nysted offshore wind farm.

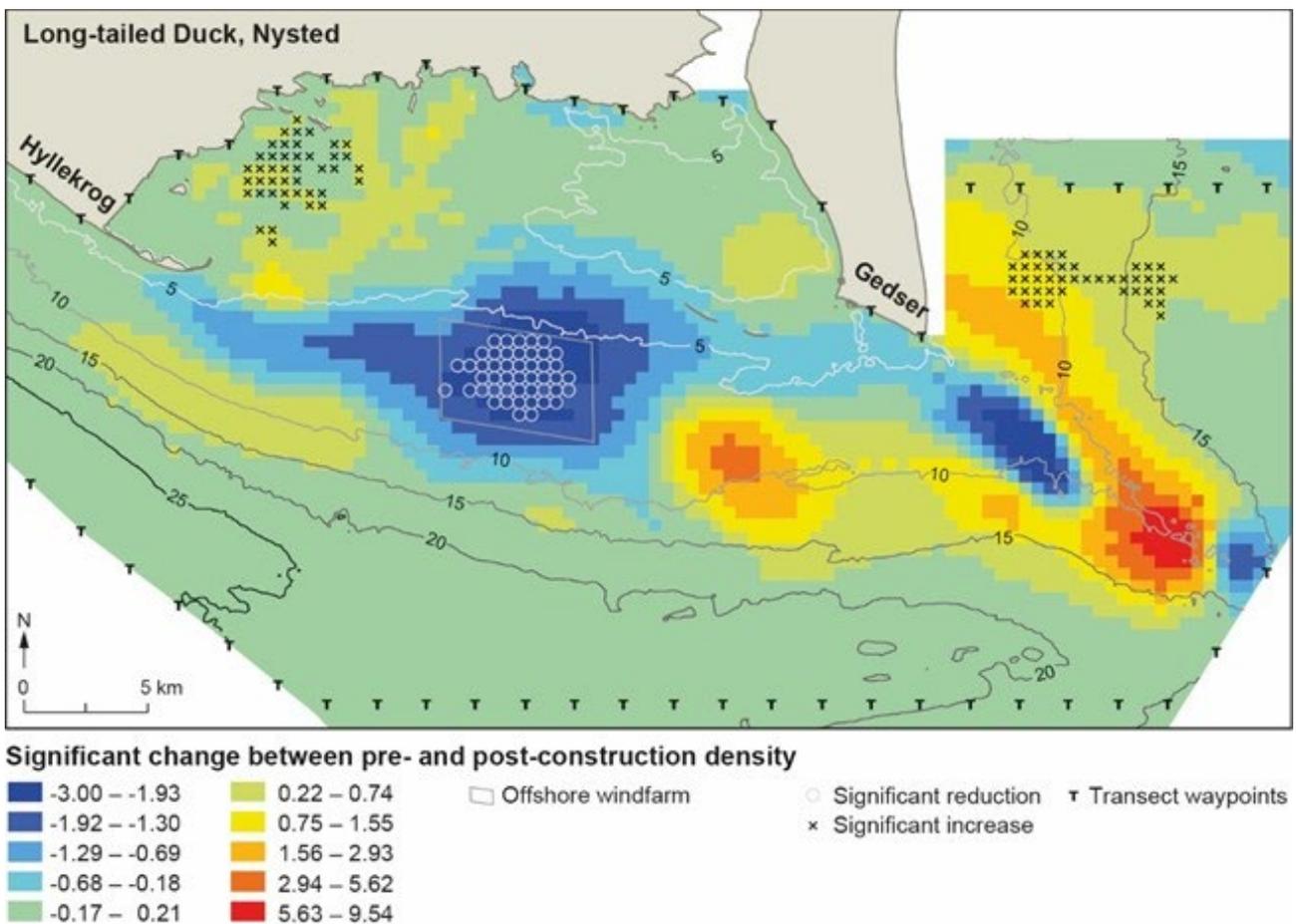
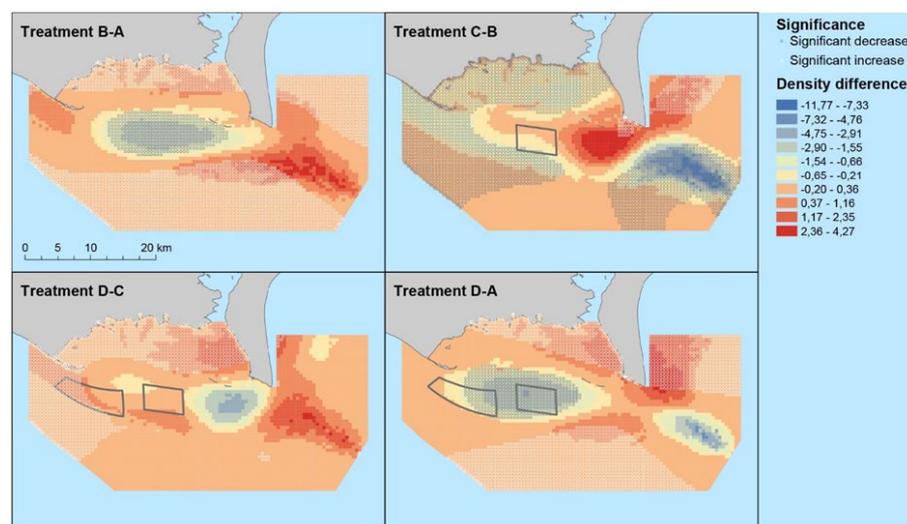


Figure 2.2 Map of the Nysted Offshore Windfarm study area showing estimated differences in Long-tailed Duck numbers within grid cells of 500 × 500 m distributed across the entire study site generated from a spatially-adaptive generalised additive model pre- and post-construction of the windfarm. Estimated abundances were derived from combined aerial survey data that counted birds along transects and adjusted abundance for detection probability. Negative differences (shades of blue) indicate fewer individuals in cells post-construction than prior, and positive differences (yellow-orange-red grid squares) indicate increased numbers post-construction. Black cross symbols indicate statistically significant increases, and open white circles indicate statistically significant decreases in these numbers when comparing pre- and post-construction abundance in these grid cells based on model estimates. Contour lines indicate depth intervals as labelled in metres. The ultimate position of the windfarm is identified by the light grey polygon outline and aerial transects waypoints are indicated by the T-symbols. After Petersen et al. 2011, Fox & Petersen 2019.

In 2018, the displacement of Long-tailed Ducks from the area south of Lolland was analyzed again, comparing data from the four phases, A through D. The analysis revealed that, even after 15 years of operation, bird densities had not returned to pre-construction levels when comparing Phase A with Phase D (Figure 2.3, "Treatment D-A"). However, a comparison of phases C and D, both post-construction of the wind farms, indicated an increase in bird densities, particularly in the western part of Rødsand II area, between 2011 and 2018. This may indicate some level of gradual habituation to the wind farms, although densities remained below pre-construction levels (Figure 2.3).

To our knowledge, no studies have specifically investigated changes in the distribution of Velvet Scoter before and after installation of a wind farm. However, investigations at Horns Rev on the west coast of Jutland, Denmark, provides relevant insights. The Horns Rev 2 offshore wind farm was constructed in an area with high numbers of wintering Common Scoters. By comparing ten aerial surveys conducted before the construction of the Horns Rev 2 wind farm with ten surveys conducted after it became operational, it was found that Common Scoters were present in lower abundances around the wind farm during the post-construction phase. This effect was gradually reduced with distance away from the wind farm, and densities returned to pre-construction levels at distances greater than five kilometres (Petersen et al. 2014). This distance is sometimes referred to as the "buffer zone".

Figure 2.3 Predicted differences in estimated duck counts (colour scale indicates numbers/grid cell of 0.25 km²) between phases A and B, B and C, C and D, and lastly, A and D. The grid of open grey circles represent grids with a significant decline in average numbers between the two phases and the grid of open white circles represent those areas with a significant increase in average numbers between the two phases. The black polygons indicate the location and extent of the wind farms, either under construction or constructed in each phase. After Petersen et al. 2018.



Changes in the distribution of Common Eiders in and around the Tunø Knob wind farm in central Kattegat, Denmark, were not found to be related to the presence of the ten small turbines (Guillemette et al. 1999). However, a ground-based survey at Sprogø, Storebælt, Denmark, indicated that Common Eiders utilized the area around a single row of ten turbines differently from the surrounding area (Jacobsen 2022). Common Eiders are generally less sensitive to human disturbances than for instance Long-tailed Duck and Common Scoter (Fliessbach et al. 2019). Furthermore, it is likely that the disturbance effect from a single line of turbines is less than from a wind farm covering a larger area. Therefore, these results regarding Common Eider may not be directly comparable to those of other species of diving ducks, such as Long-tailed Duck and Velvet Scoter.

2.1 Census of marine bird abundances and distributions

There are two main methods for censusing abundances and distributions of marine birds: ship-based surveys or aerial surveys. In most cases these methods include a sampling concept, under which surveys are performed using the Distance Sampling line transect method (Buckland et al. 2001). Aerial surveys can be conducted either by human observers or through image capture using aerial orthophotos (geo-referenced images). In the Baltic Sea, the method using human observers is most widely used. This method has a long-standing tradition in the Gulf of Riga, where it has been employed to develop quarterly models for various marine species (Aunins et al. 2012).

The human observer-based aerial survey method has also been used to assess displacement effects on Long-tailed Duck and Common Scoter in Denmark. The Distance Sampling method derives estimations of total abundances within the survey area. Subsequent use of spatial modelling tools provides detailed estimates of bird species density and abundance on a geographically fine grid, allowing for surface covering density estimates. An example of the use of the method is illustrated in the previous mentioned examples and is described in detail in for instance Petersen et al. (2022).

2.2 Mitigation measures or spatial planning

The mechanisms behind the effect of offshore wind farms on Long-tailed Duck and Common Scoter distributions is poorly known. It is unclear whether the displacement is primarily due to visual stimuli from the turbines, sound or light regimes, maintenance traffic, or other factors. For that reason, direct mitigation measures are difficult to identify. Although no data is available to demonstrate this, it is likely that the spacing between the individual turbines has an influence on the displacement effect on diving ducks. Greater spacing between the turbines could make the structure appear more as individual turbines rather than a clustered structure, potentially mitigating displacement.

A more effective measure may be spatial planning. For example, within the proposed Saare-Liivi Offshore wind farm site, situating the wind farm in areas with lowest diving duck abundance could promote the consenting process and minimize potential negative impacts on diving duck species.

3 Discussion

3.1 The impact on bird distribution from offshore wind farm

The studies of the distribution of Long-tailed Duck around the Nysted and Rødsand II offshore wind farms south of Lolland, Denmark, showed that although the species were observed between the turbines, the density of the species declined significantly within and around the wind farms post-construction (Petersen et al. 2006, 2011, 2018, Fox & Petersen 2019). A study at Kriegers Flak, west of the island of Møn in Denmark, also confirmed that birds can indeed be found within wind farm sites (Nielsen et al. 2023). Unfortunately, the study lacked pre-construction survey data, making it impossible to perform a before-and-after comparison. As a result, we cannot determine whether the presence of the wind farm has changed the distribution of the birds.

Quantifying the population-level impact of displacements caused by offshore wind farms, for example, is extremely challenging. While methods like those described can sometimes measure the number of displaced individuals, assessing the effects on the general flyway population is far more complex. Ideally, if the displaced birds encounter similar conditions - such as inter- and intra-specific competition, food availability, and predation/disturbance levels - at their new locations as they had at their original site, there should be no population-level impact. However, displacement is likely to affect their body conditions, potentially leading to minor adverse effects, such as slightly increased mortality or decreased reproduction rates.

Geographically explicit agent-based models could help analyze these impacts more effectively. Developing such models is challenging and labor-intensive and would benefit from international collaboration. These models could also address cumulative effects, as many bird species migrate across extensive geographical areas throughout the year. An international approach to assessing cumulative effects along migratory flyways could enhance the quality of future impact assessments. Given the current level of understanding, a precautionary approach should be adopted.

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