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HARBOUR PORPOISE POPULATON RESPONSE TO WINDFARM CONSTRUCTION, SERVICE TRAFFIC, AND CHANGES IN PREY AVAILABILITY

PrePARED Output Summary No. 8

Background

The construction and operation of offshore windfarms may influence the foraging behaviour of some species, which can ultimately affect their populations. Such population effects are difficult to determine through field observations, particularly for highly mobile and long-lived species, like the harbour porpoise. Simulation studies can offer insights by integrating a great variety of factors into predictions of future population developments.

The response of harbour porpoises to the construction and maintenance of the Moray Firth OWFs at the scales of the wind farm, the Moray Firth and the North Sea were simulated over a period of 60 years. We employed the DEPONS model (Nabe-Nielsen et al. 2018), a purpose-built agent-based model that simulates the individual movements and survival of thousands of virtual porpoises in a dynamic landscape. Porpoise agents react realistically to noise disturbance from WF construction and moving vessels by altering their movement patterns, and to WF-related changes in prey fish distributions by adapting their choice of foraging location. Changes in population dynamics emerge over the course of the simulation from the balance between reproduction and mortality related to competition for food.

Report 010: Study Aim

Assess the combined long-term effects of windfarm-related noise (piling, construction traffic, service traffic) and changes in prey availability at the Moray Firth offshore wind farm on the North Sea harbour porpoise population at multiple spatial scales

Data Collection

North Sea porpoise density estimates, derived from GAM models of observations combined with environmental covariates, were used as a proxy for prey density. The model map was created by merging the map used in Nabe-Nielsen et al. (2018) with updated estimates for the northern North Sea from a 2022 OSPAR report (Geelhoed et al. 2022) and higher-resolution data for the Moray Firth area (MOWF (East) Ltd. 2012). Monthly maps were generated from available seasonal maps using a sine interpolation. Bathymetry data were sourced from EMODNET, salinity and temperature data from Copernicus, and a sand grain size map was generated as described in Frankish et al. (2026) (App. 1). Piling noise representation for the Beatrice, Moray East and Moray West developments (until 30/04/2024) was based on published schedules, an estimate for an area-specific sound attenuation factor was provided by Bellmann et al. (2020), and a broadly applicable sound source level of 221.5 dB re 1 µPa SEL @1 m was based on

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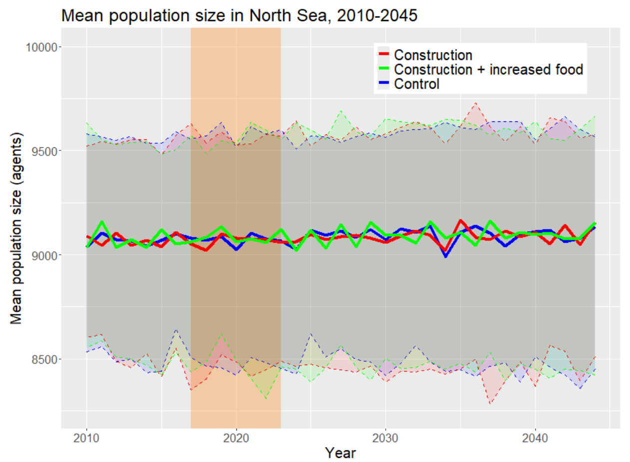
preliminary received sound levels for piling at Moray West.

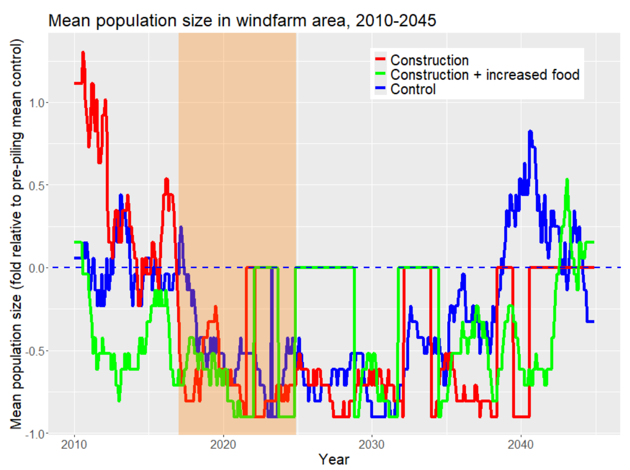
A model run of 60 yr consisted of 25 yr (1985–2009) of burn-in (to allow the population to stabilize; discarded in analysis), 7 yr (2010–2016) of pre-piling, 8 yr (2017–2024) of piling, and 20 yr (2025-2045) of post-piling conditions. Ship traffic was parameterized from AIS data purchased from commercial providers. Base traffic for the complete North Sea model area was created from a single-day record set for 01 /07 /2020 that was cycled for each simulation day. For the piling period, this was merged with 8 yr of recorded Moray Firth-only traffic, of which 6 missing months (1–3 & 10–12 /2022) were substituted with data from 2021. For the post-piling period, it was merged with OWF-related Moray Firth-only records extracted from 12 /2024–11 /2025 to represent hypothetical ongoing service traffic.

One hundred replicates were run for each of three scenarios: ***construction*** (WF piling, piling traffic, and future service traffic), ***construction + increased food*** (as above, but with increased prey biomass at WF sites during post-piling), and ***control*** (no WFs or associated traffic, base traffic only). The hypothetical prey biomass increase was represented by 3-fold increased food levels around pile foundations, declining to 1-fold over a 500-m radius, based on BRUV surveys at these sites (Bicknell et al. 2025, 2026). Simulations were initiated with 10,000 "super-individuals", each of which represents a large number of individuals in the real population.

Results

The simulation results suggest that cumulative noise disturbance from piling and ship traffic, or local changes in prey fish biomass, would have **no discernable impact on the long-term (annual to multi-decadal) dynamics of the wider North Sea harbour porpoise population (upper figure)**. Differences between scenarios were minimal relative to variation between replicates. At the smaller spatial scales, lower agent numbers introduced substantial stochastic variability, and apparent divergence between scenarios towards the start and end of the simulation period should be interpreted as random variation. Similar to the larger scale, there were **no discernable impacts at the scale of the OWF (lower figure) and the Moray Firth (not shown)**.





Figures show population size on 1 January of each year. Thick lines: mean across 100 replicates, shaded: 50% confidence intervals, orange bar: piling period

Conclusions

- Construction and traffic noise generated by the Moray Firth OWFs, as well as potential local changes in prey fish biomass, had no discernable long-term impacts on harbour porpoise populations at regional or global scales.
- This finding agrees with the conclusion of earlier environmental impact assessments that while short-term deterrence by OWF-related noise can be expected, long-term effects are unlikely.