Barnacle Geese, © Axel Schulz

Birds and offshore wind farms – a double-edged sword?

Scenarios predicting a loss of biodiversity through global warming are among the most convincing arguments why man-kind should be drastically cutting carbon emissions. Offshore wind power holds great promise for climate change mitigation. However, as offshore wind farms increase, so do concerns that wind turbines could pose a threat to the marine environment, including birds. Researchers are beginning to answer basic questions about what may happen to migratory birds crossing the open sea. The sheer abundance and diversity of birds combined with their unrivalled abilities to fly and migrate mean that there is hardly a spot on the globe where no birds are found. From the wilderness of the polar regions, across arid deserts and vast oceans, over the highest mountain tops, into the centres of our cities – birds, especially migrants, are adapted to an amazingly wide range of environmental conditions.

Bird migration has evolved under the influence of seasonal fluctuations in food availability, resulting in behavioural routines and physiological adaptations that perfectly match the timing of the seasons and the geography of suitable habitats. Human-caused climate change is rapidly altering this delicate balance. Migratory birds are particularly sensitive indicators of climatic change. In fact, advances in the timing of spring migration, as witnessed on the island of Heligoland in the North Sea, are among the best documented biotic responses to recent climate change, and mismatches between migratory birds and their prey are becoming evident in some breeding populations. The combined effects of changes in resource availability and spatio-temporal changes in species distributions will determine the viability of populations and species as global warming continues.

Climate change concerns and the need to reduce carbon emissions are driving considerable growth in the renewable energy sector, spurring plans for large-scale offshore wind farms. At the same time, there is growing awareness that offshore wind turbines will affect birds in one way or the other.

Birds crossing or inhabiting the open sea may be affected by offshore wind farms in three basic ways:

1. Collision – Birds may be injured or killed by colliding with wind turbines. The risk of birds colliding with vertical structures is predicted to be higher in environments that lack anticipatory visual cues. Birds crossing the open sea may be particularly prone to collisions at night when visibility is low. Because searching for carcasses beneath wind turbines is unfeasible under offshore conditions, most impact assessments are based on indirect measures of collision probability. Moreover, conventional visual, acoustic and radar-based surveys do not accurately account for the number potentially affected individuals at the species level, which is decisive information for assessing species-specific vulnerabilities and population effects.

2. Avoidance/Displacement – Migratory birds may avoid flying through wind farms, resulting in longer flight routes, which can incur higher energetic costs. Radar surveys have shown that marine ducks may circumvent offshore wind farms, but the energetic consequences and cumulative effects remain to be investigated. The avoidance of wind farms by staging or wintering water birds is termed displacement. Displacement can be temporary (e.g. during construction) or permanent.

3. Attraction: Nocturnal migrants may become attracted to artificial lights on wind turbines, leading to a higher collision risk. Moreover, staging water birds may be attracted by habitat changes, e.g. through improved food availability in wind farms.

Empirical evidence for the order of magnitude of these effects is still circumstantial, and many open questions remain to be answered.

Most birds migrate at night. To assess avian collision risk in an offshore setting, birds need to be quantified within the rotor swept zone and set into proportion to overall migration rates. A dedicated avian radar system funded by the Federal Ministry for the Environment, Nature Conservation and Nuclear Safety (BMU) and installed on the research platform FINO 1 next to Germany's first offshore wind farm in the North Sea (and on FINO 2, near the second Baltic wind farm) operates on the basis of defined detection volumes, allowing continuous quantification of different groups of night-migrating birds. The design of this ongoing long-term study includes alternating measurements within and outside the wind farm, enabling the analysis of avoidance rates and phototactic aggregations of migrants under various weather situations. The presence and performance of birds within the rotor swept zone can be detected with motion-controlled infrared cameras system mounted onto the nacelle of a wind turbine. Through this approach, disoriented birds can be ground-proofed and set in relation to migration rates detected by radar. First results combining data collected by radar and night-vision cameras show that birds may get attracted by wind farms at night when visibility is low. However, these events seem to be relatively rare. Moreover, this phototactic attraction seems to be offset to some extent by micro-avoidance in response to running turbines. More long-term data are needed to test the effectiveness of mitigation measures such as operational controls (shutting down wind turbines during peak migratory periods) to limit potential impacts on birds.

Unbiased, reliable information is a powerful tool for promoting acceptance of renewable energy technologies. Station-based surveillance of birds' presence in conjunction with information on bird signals derived from large-scale weather radar networks has the potential to create base-line data that can be effectively used to inform policy makers and to improve planning, approval and mitigation processes. However, without a detailed picture of bird migration throughout the annual cycle and an in-depth understanding of migratory connectivity, we will not be able to predict how human activities will impact populations. It is likely that mortality of birds caused by collisions with offshore wind turbines will rarely exceed mortality caused by other generally accepted human activities (e.g. traffic, agriculture) and structures (e.g. windows, power lines). Nevertheless, new wind farms need to be carefully planned to minimize additional pressure on wildlife in a rapidly changing world.

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BirdScan radar at wind park alpha ventus, © Timothy Coppack

Migrating cranes, © IfAÖ GmbH