ORJIP Bird avoidance behaviour and collision impact monitoring at offshore wind farms

Henrik SKOV[1], Stefan HEINÄNEN[1], Tim NORMAN[2], Robin WARD[2], Sara MÉNDEZ ROLDAN [2]

[1] DHI, Agern Alle 5, 2970-DK, Hørsholm, Denmark. hsk@dhigroup.com

[2] NIRAS Consulting Ltd, St. Giles Court, 24 Castle Street, UK-CB3 0AJ, Cambridge, United Kingdom

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Résumé

Le programme ORJIP d'étude du comportement des oiseaux dans les parcs éoliens offshore, initié en 2014, est un projet industriel coordonné par Carbon Trust au Royaume-Uni et financé par dix promoteurs de parcs éoliens offshore et deux régulateurs au Royaume-Uni. NIRAS (Royaume-Uni) et DHI (Danemark) ont été chargés de développer les technologies de détection et le cadre d'analyse nécessaires à l'amélioration de la base de données sur les comportements des oiseaux de mer et les collisions dans les zones des parcs éoliens offshore. Le projet est maintenant dans sa phase finale avec la publication des résultats attendue en avril 2018. Ce document présente le dispositif de mesure et les technologies innovantes développées ainsi que les méthodes d'analyse mises en œuvre. Les principaux résultats de l'étude ORJIP en termes de taux d'évitement spécifiques aux espèces à l'échelle macro, méso et micro seront disponibles dans le cadre du rapport final et du document scientifique associé[1].

Abstract

The Offshore Renewables Joint Industry Programme (ORJIP) Bird Collision Avoidance (BCA) study, which started in 2014 is a joint industry project managed by Carbon Trust, United Kingdom (UK) and funded by 15 parties. NIRAS (UK) and DHI (Denmark) have been in charge of developing the sensor technologies and analytical framework necessary to improve the evidence base for seabird avoidance behaviour and collisions around offshore wind farms in order to offer better support to consenting applications for the offshore wind industry. The project is now in its final stage with publication of results due in April 2018. This paper presents the setup, technology innovation and analytical methods. The main results of the ORJIP study in terms of species-specific avoidance rates at macro, meso and micro scale will be available as part of the final report and associated scientific paper[1].

Motivation – purpose

The risk of seabirds colliding with turbine blades during operation is potentially one of the most significant environmental impacts related to the development of offshore wind energy. In order to quantify bird collision risk, collision risk models (CRM) are used and parametrised with technical specifications of the turbines, seabird densities, morphology and flight behaviour of existing seabird populations on site. The collision risk is subsequently corrected to take account of behavioural avoidance responses of birds to the presence of wind farms (*i.e.* avoidance). However, there is considerable uncertainty over the scale of such impacts due to the relatively few monitoring studies undertaken offshore so far. As the number of offshore wind farm projects increases, it is widely recognised that in order to minimise consenting risks of future project applications, further robust evidence on the level of avoidance behaviour of seabirds is required to inform CRM and environmental impact assessments.

Methodology

The ORJIP project consists of four main tasks:

i) **Development of a bird monitoring system**, that allows detecting and tracking seabird movements at the species level in and around an operational offshore wind farm, including development of new sensor technology based on integrated radar-camera recordings under a wide range of weather and visibility conditions;

ii) **Monitoring of seabird behaviour** at Thanet offshore wind farm (UK), deploying a multiple

[1] Skov, H., Heinänen, S., Norman, T., Ward, R.M., Méndez-Roldán, S. & Ellis, I. 2018. ORJIP Bird Collision and Avoidance Study. Final report – April 2018. The Carbon Trust. United Kingdom. 247 pp.

sensor monitoring system partly operated by experienced seabird observers (laser rangefinders and radar equipment), and partly automated through the radar-camera system, with a focus on five target species: Northern Gannet, Black-legged Kittiwake, Lesser Black-backed Gull, Herring Gull and Great Black-backed Gull;

iii) **Development of an appropriate methodology for quantifying avoidance behaviour**, based on existing research and equipment / data limitations;

iv) **Formulation of recommendations on the use of project data in support of collision risk assessments** in offshore wind planning applications.

Development of a seabird monitoring system

The Study 's monitoring system was designed to collect reliable data on bird avoidance behaviour at the three different spatial scales into which seabird avoidance behaviour can be broken down:

- macro avoidance, defined in this Study as seabird avoidance responses to the presence of the wind farm occurring beyond its perimeter up to 3 km, resulting in a redistribution of seabirds. Data used to inform macro avoidance have been collected by experienced seabird observers from two different turbines located at the corner and along the periphery of the wind farm using radar equipment for bird detection and tracking, and laser rangefinders for flight height measurements and tracking.

- meso avoidance, defined in this Study as seabird avoidance responses within the wind farm footprint to individual turbines (considering a 10 m buffer around the rotor swept zone), resulting in a redistribution of the birds within the wind farm footprint. Data used to inform meso avoidance have been collected from two different turbines located inside the wind farm, using 24/7 automated radars for bird detection connected to visual-thermal cameras that record bird movements. The development of software for integration of radar and camera tracking has been a major component of this Study, tested and validated at test sites before deployment at Thanet.

- micro avoidance, defined as bird avoidance responses to single blade(s) within the rotor swept zone (including a 10 m buffer), it is considered as the bird's 'last-second' action taken to avoid collision. As in the case of meso avoidance, data used to inform micro avoidance has relied on data collected by the automated radar-camera systems, which have also been able to record collision events.

Monitoring of seabird behaviour

The monitoring system was installed at Thanet during the summer of 2014, when data collection at the macro scale commenced and continued up to April 2016, with a total of 230 survey deployment days achieved (Figure 1). Automated tracking by the radar-camera system commenced in October 2014 and continued up to June 2016, when all equipment was decommissioned. Observers operating the radars located at the corner periphery of the wind farm collected a total of 1,555 tracks for the five target species, of which 1,205 were collected using the SCANTER radar; while 1,818 tracks were collected using the laser rangefinders, allowing to quantify macro avoidance at the species level. The radar-camera system collected a total of 12,131 daylight videos showing bird movements within the wind farm.

At the meso scale, video evidence and associated radar data have allowed to quantify meso avoidance at the species level, with the exception of Lesser Black-backed Gull. At the micro scale, due to the limited number of birds approaching the rotor, it has only been possible to quantify behaviour for all seabird species as a whole, and for large gulls as a group. Although a total of 459,164 videos were also collected during night time, only a sample of 48,000 night videos has been processed, finding that only very few had recorded birds, and therefore limiting analysis of nocturnal seabird avoidance.

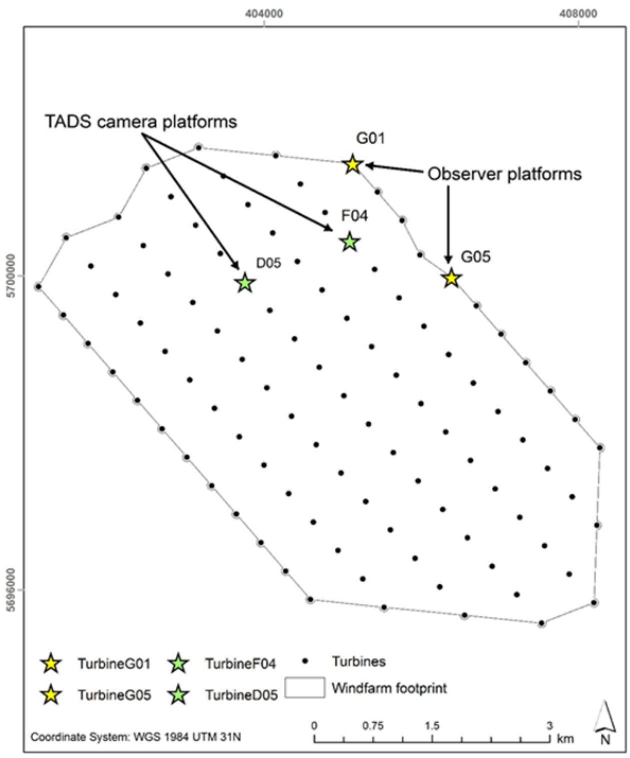

Figure 1. Sketch of installed monitoring system at Thanet offshore wind farm

Development of an appropriate methodology for quantifying empirical avoidance behaviour

The overall empirical avoidance behaviour is composed of combining empirical avoidance behaviour at the three different spatial scales mentioned above:

- macro avoidance, quantified by comparing the observed distribution of bird track density (measured as track length per unit area) inside the wind farm area with a hypothetical situation in the absence of the wind farm, in which the same total track length would have been observed, but with the same bird density inside and outside the wind farm (up to 3 km).
- meso avoidance, quantified by comparing the observed distribution of bird track density (measured as track length per unit area) inside the rotor swept zone (considering a 10 m buffer) within the wind farm, with an hypothetical situation in the absence of the wind farm, in which the same total track length would have been observed, but with the same bird density across the whole area (inside and outside to rotor swept zone and buffer).
- micro avoidance, quantified by calculating the proportion of birds adjusting or not to the presence of blades, considering bird movement in relation to the rotor, represented as a dynamic ellipse, surrounded by a 10 m buffer that changes its orientation with the wind direction (Figure 2).

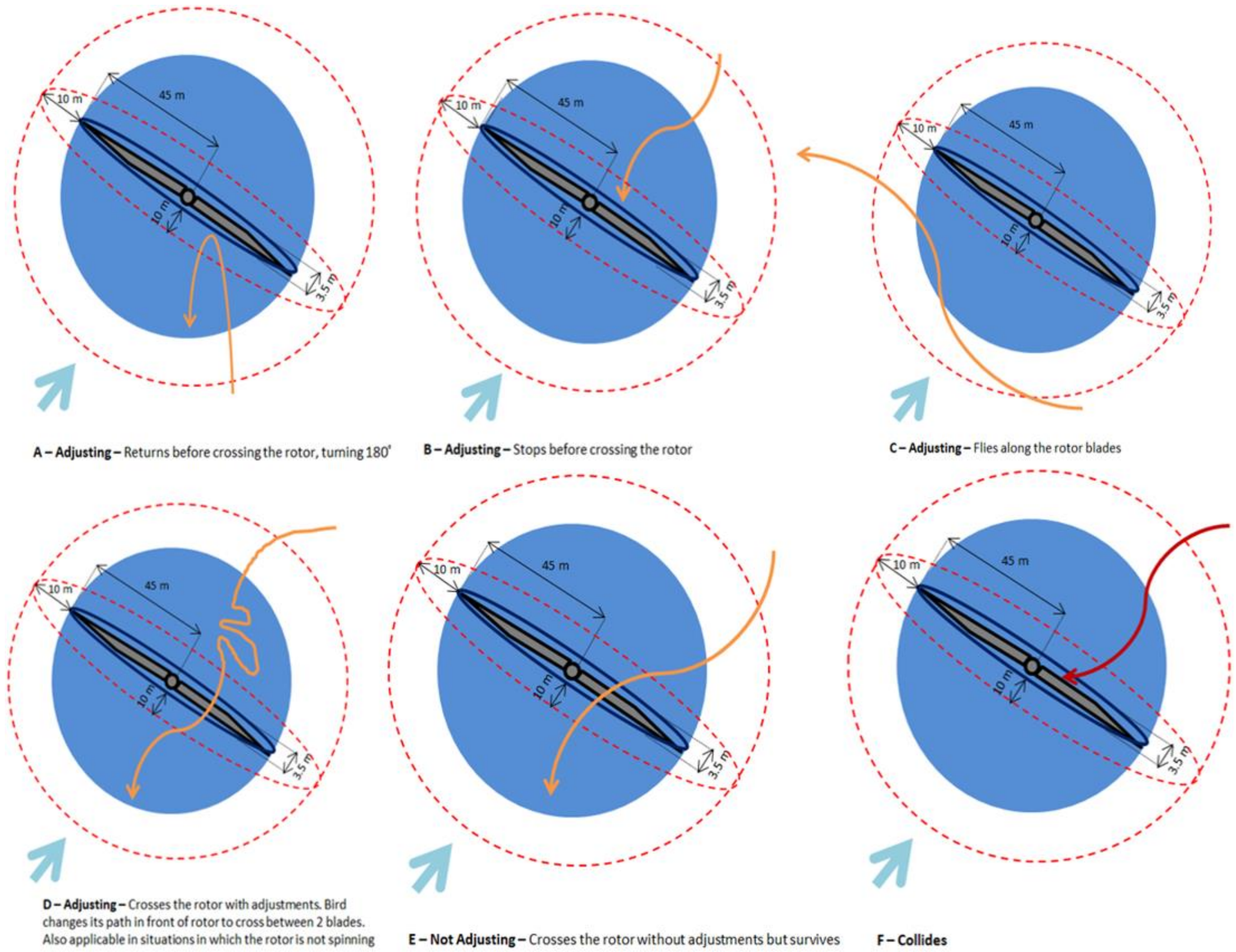

Figure 2. Illustration of micro avoidance concept and approach to analysis considered in this Study. Within the rotor-swept zone (blue circle) + 10 m buffer (red circle), arrows represent bird movement in relation to the rotor (dark blue ellipse + 10 m buffer (red ellipse). The light blue arrow represents wind direction. Birds have been observed to adjust their flight in order to avoid individual blades or not to adjust but survive when crossing the rotor (orange arrow) or in rare occasions collide (red arrow).

The methodology used for the assessment of avoidance behaviour at macro and meso avoidance scales has been developed through the course of the Project, considering different options for the treatment and analysis of radar and rangefinder data. The original methodology based on the comparison of track counts in avoidance areas was revised to account for the size of areas compared, *i.e.* quantification of track densities. In order to avoid results to be influenced by dissimilarity in the size (and geometry) of areas compared, these were analysed by dividing them into units of same size, and track density calculations were approached by measuring the length of bird tracks within each unit area.

While at the macro scale the availability of full radar and rangefinder tracks has allowed to calculate track lengths easily, the absence of real tracks at the meso scale, for which only radar trigger points were collected, required the estimation of mean track lengths classified according to behaviour observed in video evidence, corrected using flight speed data outside the wind farm to ensure these were as close to reality as possible.

Outputs summary

The main results of the ORJIP study in terms of species-specific avoidance rates at macro, meso and micro scale will be available as part of the final report and associated scientific paper due early 2018.

Interpretation, findings, prospects and possible developments

The ORJIP Bird avoidance behaviour and collision impact monitoring at offshore wind farms study will significantly advance understanding CRM inputs, including species-specific data on flight speed and track speeds that can inform the estimation of more realistic fluxes of seabirds. In addition, data on nocturnal night activity was collected, as well as detailed data on the frequency of flight heights that can inform improved generic flight height distributions. The study has generated the most extensive dataset of observations of seabird behaviour in and around an operational offshore wind farm that is currently available.

Acknowledgements

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