Methods to Estimate Collision Risk and Behavioural Reponses of Seabirds around Wind Turbines in the Firth of Forth

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The study has been devised in collaboration with RSPB, NatureScot, Joint Nature Conservation Committee and Marine Scotland Science, and endorsed by the Forth and Tay Regional Advisory Group. A study of such scale and detail is a first in the UK.

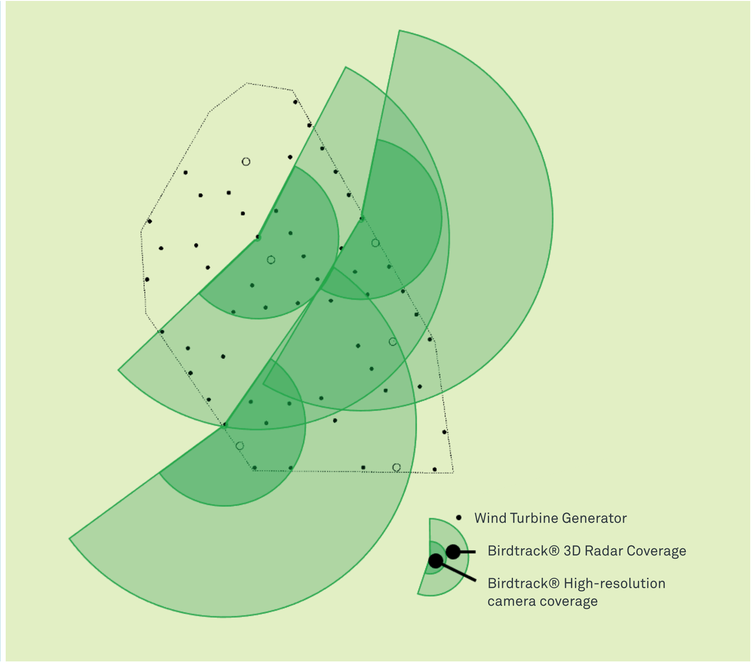
Motivation

Seabirds represent a key consenting risk for offshore wind farms. Crucial to quantifying the risk that an offshore wind farm development may present is to identify the underlying mechanisms of birds' behavioural responses to wind turbines, and reveal species, site and weather specific factors enhancing avoidance and thereby reducing collision risk.

This study will record seabird interactions with an operating wind farm at multiple scales. It will help inform the development of future offshore wind projects to minimize impacts on wildlife.

Study Area and Duration

Neart na Gaoithe offshore wind farm, 15.5km east of Fife Ness, in the outer Firth of Forth. Monitoring bird activity data for the 2024 and 2025 breeding and post-breeding seasons, from March to October.



Research questions

1. Does collision occur and are there empirical methods to record seabird collisions at offshore wind farms?

2. What are the collision rates?

3. What are the reactive behaviours of seabirds around turbines?

4. How can we accurately record reactive seabird behaviour close to operational offshore wind turbines?

5. At what distance does any behaviour change such as avoidance or reactive behaviour occur and is this the same for each focus species?

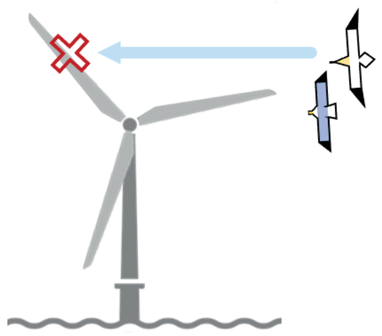
6. Can this information be used to understand collision risk to seabirds at offshore wind farms?

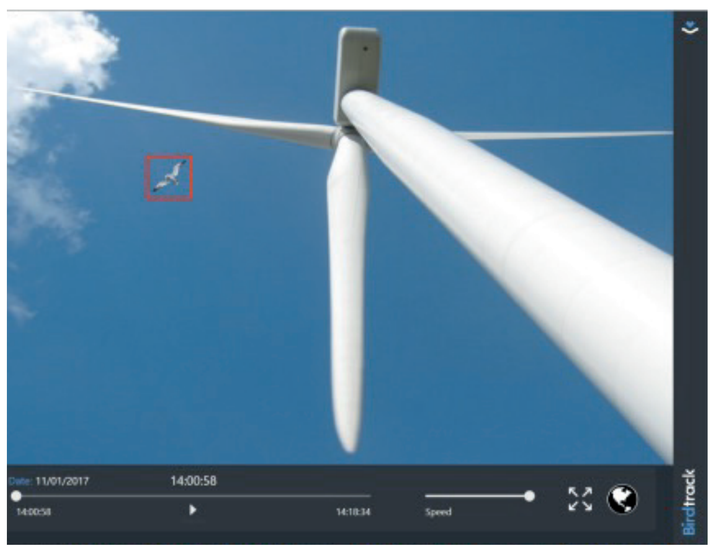
7. Do weather conditions and time of day affect avoidance or reactive behaviour?

8. Does behaviour change within and between seasons?

Estimating Collision Rate
[Research Goals 1-2]

Video analysis of collision events with rotating blades.

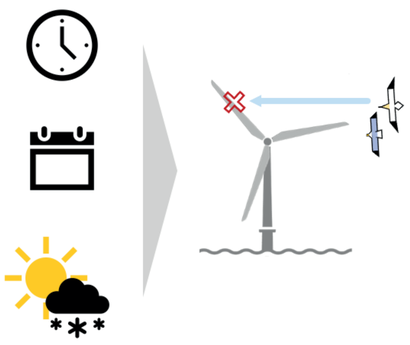




Influence of Variables on Collision Rates
[Research Goals 6-8]

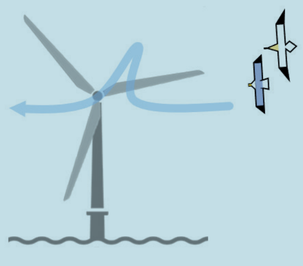
Modelling collision rates Using GAM to explore the influence of weather, season and other covariates on collision events.

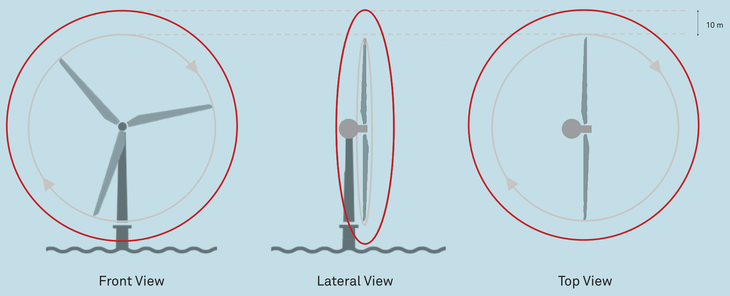
This will require analyses that specifically deal with rare events.



Estimating Micro-avoidance
[Research Goals 3-8]

Video analysis of evasive behavioural response within a 10 m buffer around the blade´s swept zone.





Power analysis

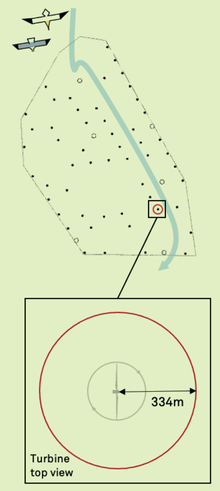
The table below shows the sample size required to obtain micro-avoidance estimates.

Micro-avoidance	Power	Sample size
0.95	0.80	8.70
0.95	0.95	14.40
0.85	0.80	10.86
0.85	0.95	17.99

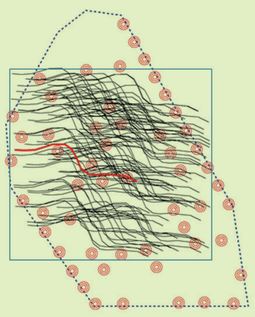
Estimating Meso-avoidance
[Research Goals 3-8]

Response of bird trajectories to the wind turbine by comparing the densities inside the turbine's area of influence with a hypothetical scenario in which the wind farm is absent. Density is quantified as the number of tracks per unit area and the length of tracks per unit area.

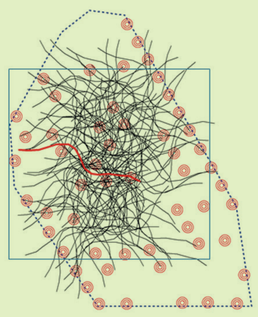
The measure of meso-avoidance for each trajectory is expressed by using the probability that each observed hypothetical trajectory will exhibit a total intersection length shorter than that of a random set of trajectories.



Random shifts



Random shifts & rotations



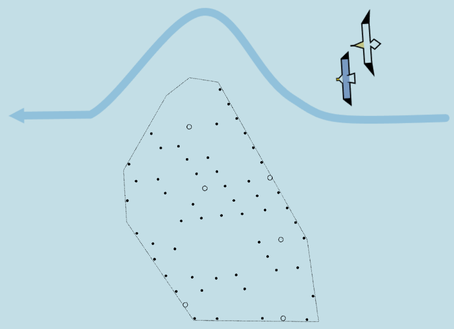
	Buffer size		
	100m	180m	260m
Traj 1	**0.947**	0.876	0.779
Traj 2	0.889	0.76	0.649
Traj 3	0.565	0.315	**0.150**
Traj 4	0.592	0.38	0.224
Traj 5	0.735	0.58	0.431

	Buffer size		
	100m	180m	260m
Traj 1	**0.942**	0.847	0.770
Traj 2	0.874	0.772	0.643
Traj 3	0.570	0.342	**0.188**
Traj 4	0.578	0.361	0.194
Traj 5	0.675	0.487	0.303

Meso-avoidance probability of no intersection among 999 random simulated trajectories

Estimating Macro-avoidance
[Research Goals 3-8]

Macro avoidance is measured as the number of tracks per unit area and the track length per unit area. The variability of the estimates will be determined through bootstrap resampling.



Repas-Goncalves M, Pina L, Barton C, Cardia P, Oliveira R, Perrow M, Segurado P, Tarrant P, Machado R, May R. Methods to estimate collision risk and behavioural responses of seabirds around wind turbines in the Firth of Forth. Poster presented at: CWW2023 Conference on Wind Energy and Wildlife Impacts; 18-22 Sep, 2023; Sibenik, Croatia. http://10.5281/zenodo.8372804