The physical **location** of offshore turbines in relation to staging areas in the **USA**, the **Caribbean**, and **Central and South America** can influence the birds and bats that encounter those turbines. A multi-year study using cameras, bird and bat acoustics, and VHF tag receivers (**ATOM™**) recorded **~60** species of birds including Caribbean-wintering migrant **palm and Cape May warblers**, South American-wintering migrant **blackpoll warbler and bobolink**, Cuban-wintering **northern flicker,** and North Carolina and Florida-wintering **winter wren and brown creeper.** Differences among species detected and identified in each sensor confirms that a **multi-sensor approach** for monitoring is beneficial.

There were **no observed collisions**; two individuals (1 bird and 1 bat) suffered air displacement, but they recovered and continued flying. **ATOM** also collected novel data on insects, tracking over 7,000 insects around the turbine rotor swept zone and revealed foraging behavior in ~35% of detections. Offshore wind turbines thus provide potential sites for **perching and foraging**. Although these turbine sites provide a new opportunity to feed, which may be beneficial for insectivores and omnivores in enabling them to reach migration destinations in better condition, the consequences of a potentially delayed arrival are unknown (positive, negative, or neutral). Additionally, limited refugia for migratory birds may increase exposure to predators such as peregrine falcons.

Our data show that **foraging activity** appears to be conducted with an **awareness** of the **moving blades** and in safe zones close but parallel to blade movements.

Location of offshore wind turbines influences migrant bird species composition and behavior

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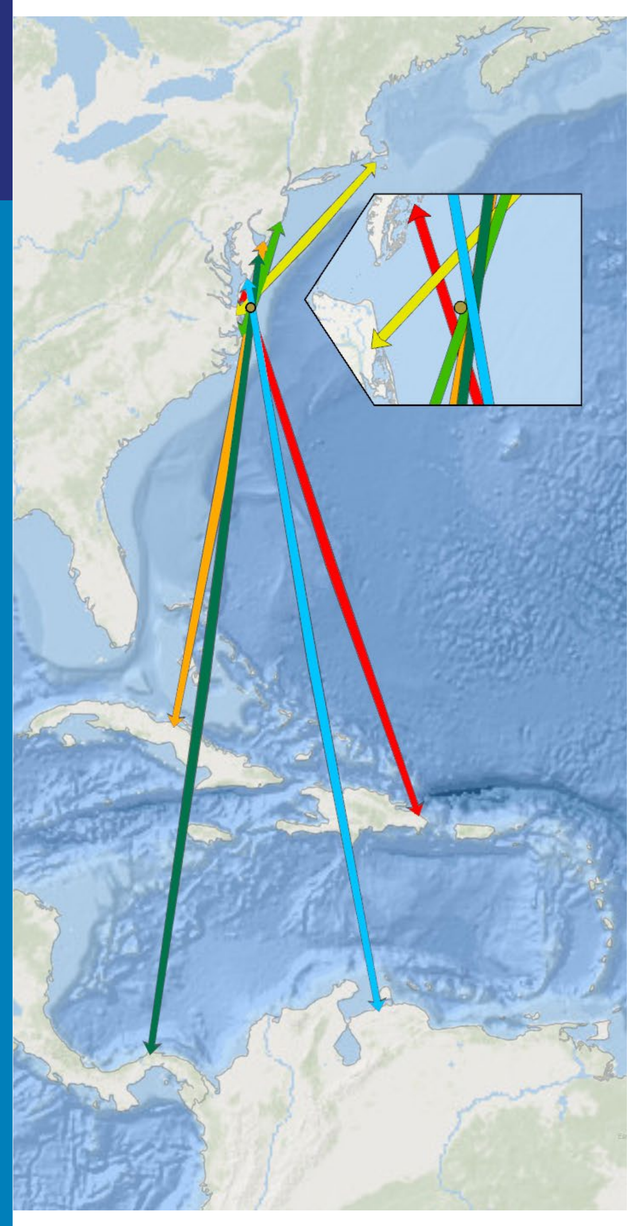


Introduction

Knowledge of bird and bat movement and behavior around turbines in the offshore marine environment is critical for assessing the environmental impacts of offshore wind developments in the eastern USA. During both construction and operation, offshore wind developments may impact bird populations directly through mortality from collisions and indirectly through displacement or attraction, which may affect population fitness (Furness et al. 2013; Vanermen et al. 2015). Bird collisions with offshore wind turbines appear to be rare (Skov et al. 2018), but relevant studies are very limited due to logistical difficulties, and consequently, very little is known about collision impacts on small bird species.

Methods

We designed a multi-sensor system to record bird observations and behavior at offshore turbines. Two Acoustic and Thermographic Offshore Monitoring (ATOM™) systems were deployed on wind turbines 27 miles off the coast of Virginia, USA. The systems were operational during the day and night. Behaviors around the turbines were identified as:

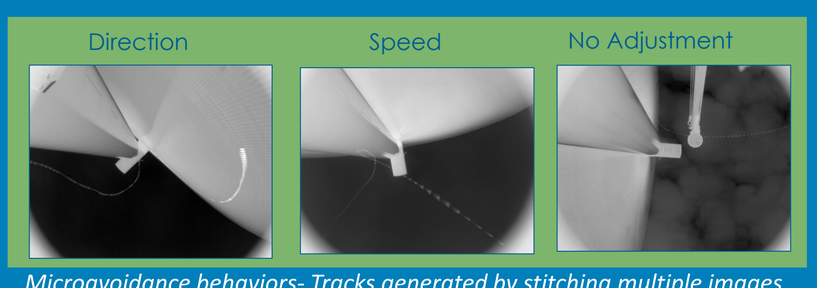
- Attraction (comes to check-out turbine then continues)
- Hawking (sallies from perch on short flights to capture flying insects)
- Microavoidance (blade interactions when blades are moving)
- Perching
- Aerial foraging (prolonged continuous flight capturing prey items)
- Low patrol (direct flight below the rotor-swept zone [RSZ])
- High patrol (direct flight within or above the RSZ)
- Flyover (very high flight visible above turbine, usually large birds for detection reasons)
- Thermaling (no flapping)
- Monopole gleaning (taking insects off the monopole)

Results

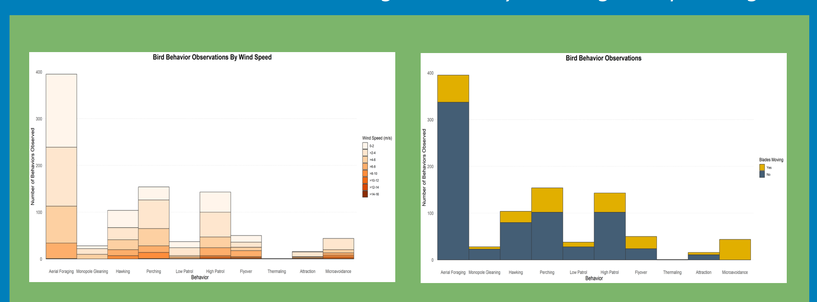
- ATOM™ recorded ~60 species of birds including Caribbean-wintering migrants, South American-wintering migrants, Cuban-wintering migrants, and North Carolina and Florida-wintering migrants.
- Observations of microavoidance from ~20 species/species groups with moving blade interactions.
- There were no observed collisions.
- Most prolonged passerine activity occurred in the day; although, most migrant call activity was recorded between 11 pm and 5 am.
- Bird detections reduced significantly when windspeeds exceeded 5 m/s.
- Over 7,000 insect macrofauna were recorded likely representing 5% of the total number of insects at the turbine, including 7 species of Lepidoptera.
- Insect activity continued consistently into higher windspeeds than bird activity.

Discussion

- The physical location of offshore turbines in relation to staging areas can influence the birds that encounter those turbines.
- Unexpectedly high numbers of insects likely drives activity around the turbines.
- Long-distance migrations over the ocean have been documented in a number of insect species, especially among relatively large species in the orders Lepidoptera, Orthoptera, and Odonata.
- Most bird migration occurred between 11 pm and 5 am and individuals remained to forage through the ensuing day.



Microavoidance behaviors- Tracks generated by stitching multiple images



Activity associations with windspeed, and turbine blade movements

Common Name	Scientific Name
Peregrine Falcon	*Falco peregrinus*
Hirundine species	
Brown Creeper	*Certhia americana*
Winter Wren	*Troglodytes hiemalis*
Wren species	
American Robin	*Turdus migratorius*
Blue-winged Warbler	*Vermivora cyanoptera*
Black-and-white Warbler	*Mniotilta varia*
American Redstart	*Setophaga ruticilla*
Cape May Warbler	*Setophaga tigrina*
Magnolia Warbler	*Setophaga magnolia*
Bay-breasted Warbler	*Setophaga castanea*
Blackburnian Warbler	*Setophaga fusca*
Palm Warbler	*Setophaga palmarum*
Pine Warbler	*Setophaga pinus*
Yellow-rumped Warbler	*Setophaga coronata*
Setophaga species	
Parulidae species	
Rose-breasted Grosbeak	*Pheucticus ludovicianus*
Passerine species	
Unidentified bird species	
Eastern Red Bat	*Lasiurus borealis*
Bat species	

List of species and species groups seen foraging in video

REFERENCES

Furness, R. W., H. M. Wade, and E. A. Masden. 2013. Assessing vulnerability of marine bird populations to offshore wind farms. Journal of Environmental Management 119:56–66.

Skov, H., S. Heinänen, T. Norman, R. Ward, S. Méndez-Roldán, and I. Ellis. 2018. ORJIP bird collision and avoidance study. Final report – April 2018. The Carbon Trust, United Kingdom.

Vanermen, N., T. Onkelinx, W. Courtens, M. V. de walle, H. Verstraete, and E. W. M. Stienen. 2014. Seabird avoidance and attraction at an offshore wind farm in the Belgian part of the North Sea. Hydrobiologia 756:51–61.

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