Chapter 26: Passive acoustics pilot study: nocturnal avian migration in the mid-Atlantic

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Chapter 26 Highlights

Using passive acoustic sensors to document bird species migrating offshore

Context[1]

Little is known about the offshore migratory movements of songbirds in the northwestern Atlantic Ocean. Large bodies of water can act as migratory barriers to birds, but many are also crossed regularly by migrants in North America and Europe. Past research has suggested that songbirds likely migrate over the Atlantic—leaving from the northeastern United States and traveling to the Caribbean or South America—but we have limited information about which species conduct these movements or how often these movements occur.

As a complement to Chapter 27, where we document large-scale patterns of offshore migration and what conditions promote it, this chapter focuses on a pilot effort to identify some of the species that conduct these migratory journeys. Here, we use passive acoustic sensors deployed on a survey boat to detect the vocalizations that birds make during migration and determine what species are migrating over the mid-Atlantic Outer Continental Shelf.

Study goal/objectives

Determine whether passive acoustic sensors can be used in the offshore environment to identify bird species that migrate over the Atlantic Ocean.

Highlights

- The deployment of a passive acoustic sensor from a survey vessel was effective for detecting nocturnal migrants.
- While most acoustic surveys did not detect any songbird migrants, one survey 40 km off the coast detected 123 individual calls in one night.
- The most commonly detected songbirds were Yellow-rumped Warblers (*Setophaga coronata*) and American Redstarts (*S. ruticilla*); both of these species are forest-breeding insectivores.
- Many finches and thrushes were also detected, but species-level identification was not possible.
- Several species of sandpipers were also detected in these surveys.

Implications

Acoustic surveys have not always been successful in the marine environment, but this technique was effective in a pilot study. Migratory landbirds appear to be using this area at least on occasion. The effects of offshore developments on migratory passerines are not often considered and are poorly understood, and more research is needed on landbird migrations in this environment.

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[1] For more detailed context for this chapter, please see the introduction to Part VI of this report.

Abstract

Passive acoustic detectors can be useful for documenting nocturnal migration of low-flying songbirds and shorebirds. Many of these taxa produce species-diagnostic calls during migratory flight, which can be used to identify the species composition of migrants in an area and the relative migratory activity. To test the utility of this technology in the offshore environment, and to determine what species are flying over the mid-Atlantic Outer Continental Shelf (OCS), we deployed a passive acoustic detector on the project's 55' survey boat. When the boat stayed overnight on the water (seven total occasions over two years) we documented the birds passing overhead. No flight calls were heard on five of the seven nights, but on one night in early September, we documented 123 calls at a location over 40 km away from shore. Our limited sampling effort makes inference difficult, but the large number of species documented suggests that a diverse range of landbirds migrate over the mid-Atlantic OCS at low altitudes, at least on occasion. A long history of radar studies and incidental songbird observations aboard research vessels suggest that overwater migration by terrestrial species may be fairly common. The deployment of passive acoustic detectors from mobile platforms in the offshore environment appears to be a viable approach for detecting such events and identifying species that are migrating offshore.

Introduction

Oceans and other large bodies of water can act as barriers to migrating birds. Some species will not pass over these obstacles, however, many will stop over to rest and refuel before making long overwater flights (Delingat et al. 2008; Faaborg et al. 2010). Large bodies of water like the Mediterranean Sea or the Gulf of Mexico are regularly crossed by even small songbirds (Bruderer and Liechti 1999; Gauthreaux and Belser 1999). Within the study area for this project, Cape May and Delaware Bay are both known areas where large numbers of migrants stop over during migration (Clark et al. 1993; Moore et al. 1995). While there is some evidence of passerine migration over the northwestern Atlantic for some species (Faaborg et al. 2010; DeLuca et al. 2015), oceanic flyways and migrant use of offshore regions of the mid-Atlantic are poorly known and overwater migrations are thought to be only achieved by certain species (e.g., the Blackpoll Warbler, *Setophaga striata*).

Many bird species migrate at night and emit short vocalizations during flight ("flight calls"; Farnsworth 2005; Evans 2012). As songbirds are typically inactive at night during the non-migratory season, the combination of time of year, time of day, and flight call vocalizations provide strong evidence that the detected individuals are migrating. These flight calls are thought to be a form of communication between individuals, or possibly serve as a type of "echolocation," helping birds determine their altitude or navigate during periods of poor weather (Farnsworth 2005; Evans 2012). Many bird species can be identified by their vocalizations, so nocturnal acoustic monitoring stations can provide species-specific presence-absence data and indices of activity for birds that vocalize during migration.

The objective of this study was to determine if boat-based acoustic monitoring of nocturnal migrants was effective in describing the magnitude and complexion of offshore migration and, if so, to determine what species are moving through the offshore environment. We used an acoustic recording unit on the *Stormy Petrel II*—the boat survey platform—to passively monitor for nocturnal migrants when the boat was at sea between survey days. Here, we describe the species detected in these seven survey nights, where these calls were found, and what these data suggest about the future of this technique for measuring offshore migration.

Methods

During the infrequent nights spent at sea in boat surveys, a Song Meter 2 acoustic recording setup (Wildlife Acoustics, Inc.) was deployed with a weatherproof microphone designed for recording distant night flight calls in the sky. The setup was operated atop a 3 m tall pole on the upper deck of the survey vessel (placing the microphone approximately 5 m above sea level), and operated nonstop between nautical sunset and nautical sunrise to record flight calls of nocturnally migrating birds. The vessel was anchored at variable locations at sea (between 25 and 46 km offshore on any given survey). Resulting flight call data were analyzed to identify bird species (when possible) and provide information on the timing and intensity of nocturnal migration activity.

Bird acoustic analysis was conducted using Program RAVEN (Cornell Lab of Ornithology). Flight call files were identified via visual analysis of audio spectrograms by experienced BRI ornithologists. Calls were identified to species or to a complex of species with similar calls (Evans 2012; Murray 2004); calls that were not definitively identified to species or species grouping but were confirmed as birds were labeled as "no ID," and were used in analyses of nightly migratory activity (Evans 2012).

Results

We recorded seven nights of data (every night which the survey vessel spent offshore, rather than in port). We collected nighttime acoustic data on the May, June, August, September, and November 2012 and the June and August 2013 boat surveys, primarily from areas offshore of Maryland (Figure 26-1). No data were collected in winter and early spring surveys due to short daylight hours and poor weather. Most days had fewer than three detections, with the exception of one night in early September 2012 that had 123 detections (Table 26-1). Detections of non-migratory calls from seabirds (gulls, terns, storm petrels, etc.) were common, and are not presented here. Flight calls from at least 15 species of migrants were detected offshore during the seven nights of monitoring, including at least seven different warbler species.

On the night where 123 calls were detected the boat was located 30 km offshore of Virginia. Finch species accounted for the greatest proportion of identified calls (28 total detections; Table 26-2). Other commonly identified species or species groups were thrushes (14), Yellow-rumped Warblers (*Setophaga coronata*; 14) and American Redstarts (*Setophaga ruticilla;* 8). Non-passerines were present as well with 7 Least Sandpipers (*Calidris minutilla*) and 3 Semipalmated Sandpipers (*Calidris pusilla*). On this evening most calls either occurred within 1-5 hours after sunset or 9-11 hours after sunset.

Qualitatively, recording quality overall was good enough to identify passerine flight calls (Table 26-1). Recording quality on the April 2012 survey was hampered by weather and boat engine interference and was less than ideal. With this exception, recording conditions were generally favorable, with minimal overlap in frequencies between flight calls and wind and wave action against the boat.

Discussion

This pilot study represents one of the first times that avian passive acoustic detectors have been deployed from a moving platform in the offshore environment to monitor migratory songbirds and shorebirds. Nocturnal acoustic detectors proved to be an effective means to monitor the number and type of avian species that migrate offshore. Listening conditions were frequently above average, and after some initial adjustments to the monitoring setup to minimize engine noise, species were as identifiable as in similar projects documenting terrestrial migration. Detections of non-migratory calls from seabirds (gulls, terns, storm petrels, etc.) were common, and migratory flight calls from at least fifteen species including loons, passerines and shorebirds were also detected. These results suggest that the surveys can detect migrants, and that songbirds and shorebirds are migrate offshore at least occasionally.

Songbird flight calls were only detected on two of the seven nights monitored, both occurring during early fall migration. The low frequency of our acoustic surveys prevents us from making broader ecological inferences about how many species consistently migrate over the ocean in the mid-Atlantic. Offshore migration could be intentional (thus a common strategy) or a product of wind drift (an unintentional and perhaps less common strategy). It is unclear why birds are migrating offshore in this area and how often it occurs in a season, though other studies of nocturnal avian migration over the ocean (as well as over land) have suggested that migratory activity is highly episodic and appears to be largely driven by variations in weather (Hill et al. 2014). Most acoustic detections occurred within four hours of either sunrise or sunset, indicating that there may be more migratory activity at the beginning or end of a migratory flight (or perhaps when birds are most vocal). Overwater migration in the mid-Atlantic has historically been thought to be a relatively low probability event, since wintering grounds are accessible via terrestrial migration routes in the Americas. These data and results from Chapter 27 suggest that songbirds could use overwater migratory routes more than previously thought on the Atlantic seaboard, perhaps even preferentially over terrestrial routes (Faaborg et al. 2010; DeLuca et al. 2015).

The aural quality of the acoustic surveys in this study was relatively high. We were able to minimize the effect of engine noise and wave action by placing the detector on a tower above the boat. While acoustic surveys were effective on this offshore vessel, similar tests on other larger ships have been less successful (BRI unpubl. data), with large amounts of interference coming from the ships' navigation systems. Even once this basic technical bar is passed, nocturnal acoustic surveys still have limitations. Birds migrating over the station could remain undetected due to several factors: (1) they migrated outside of the detectable zone around the detector, or (2) they did not emit a flight call while they were inside the detectable zone. While our survey clearly can detect migrants, we are underestimating the number of species and total migratory activity in all of our surveys. Hierarchical models could be useful for disentangling these effects, and are an area of needed future research for this methodology in general.

The effect of offshore development on migratory animals is commonly considered where migratory corridors have been described. Landbird migration may occur across broad geographic areas, rather than in narrow "flyways" as have been described for some waterbirds (Faaborg et al. 2010). While there may be fewer overwater migrants in the mid-Atlantic as compared to smaller ecological barriers such as the Gulf of

Mexico, there still appears to be both songbird and shorebird migration in the region. This may be particularly true during fall migration; evidence for a variety of species (including bats as well as landbirds) suggests that overwater migration in the northwestern Atlantic is much more common in fall than in spring, when animals presumably migrate preferentially over land due to consistent tailwinds from the northwest (e.g., Morris et al. 1994; Hatch et al. 2013; DeLuca et al. 2015; Chapter 23; Chapter 25). Overwater migration might not be restricted to a few species in the mid-Atlantic either; perhaps many species migrate facultatively over water as they move down the coast, when weather and physiological conditions are ideal. Offshore structures, particularly those with full-spectrum nighttime lighting, have been known to cause mass mortality events to migrating passerines in low visibility weather conditions (Hüppop et al. 2006). More data are required to understand offshore migration in this region (see Chapter 27), but these limited acoustic samples suggest that it is occurring. Until a more accurate estimate of migratory activity is ascertained, we suggest caution when making assumptions about a lack of songbird migratory activity in the region.

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Figures and tables

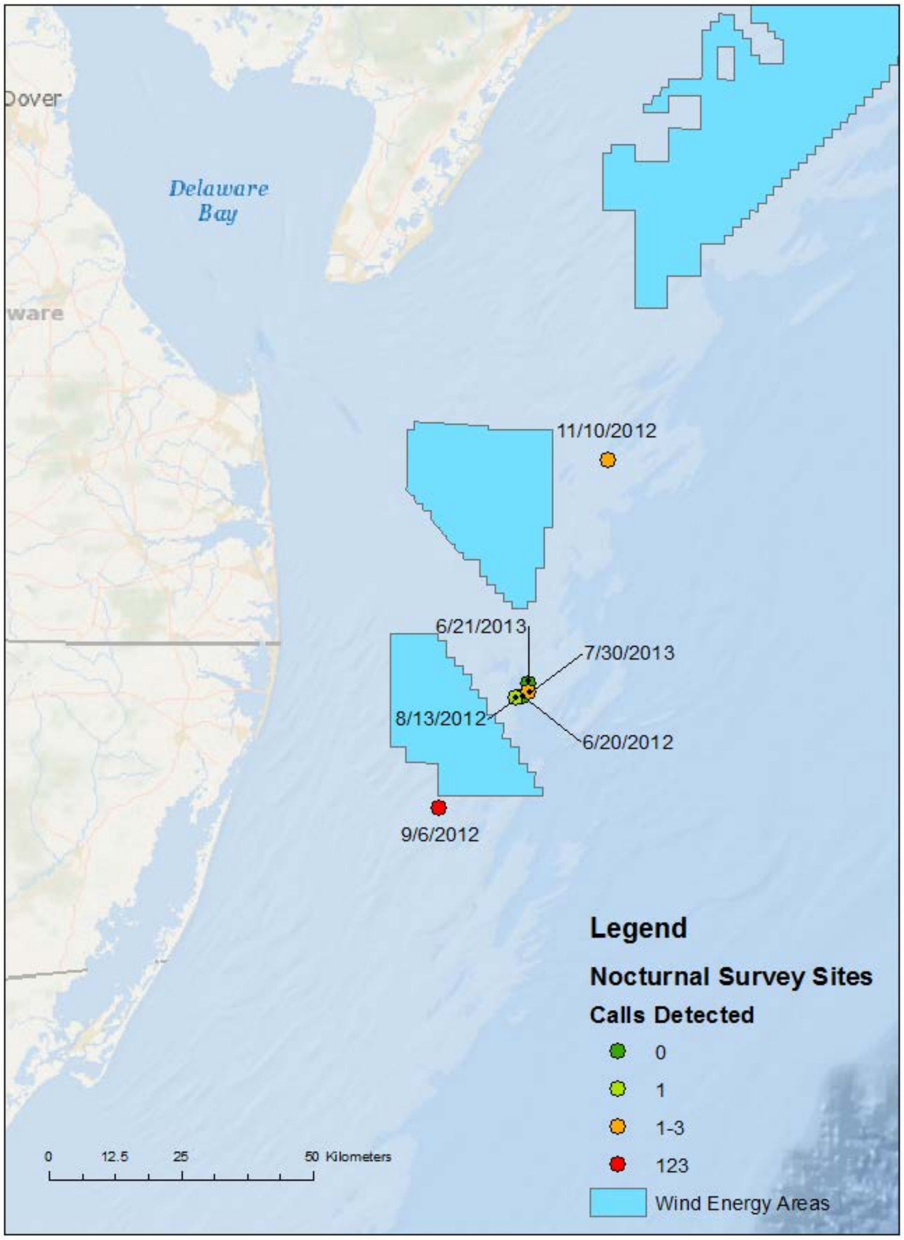

Figure 26-1. Map of the study area with 6 of the survey locations plotted with the Wind Energy Areas for reference. The 4/28/2012 survey was not plotted due to the boat drifting during the survey. The color of the point describes how many flight calls were detected at each of the surveys.

Table 26-1. Summary of migratory flight calls detected during offshore acoustic surveys to date.

Date of Survey	# of calls detected	# of calls identified to spp. or spp. group	Conditions for recording	Comments
4/28/2012	1	1	Poor	Common Loon
6/18/2012	0	0	Good	No flight calls detected
8/13/2012	1	1	Excellent	Sparrow spp.
9/06/2012	123	95	Fair	See Table 26-2 for species summary
11/11/2012	3	2	Good	Dunlin
6/21/2013	0	0	Fair	No flight calls detected. Some wind and wave noise.
7/30/2013	2	2	Fair	Wind and wave noise throughout the file. Least Sandpiper detected twice.

Table 26-2. Migratory flight calls detected during the September 2012 acoustic survey.

Species or Group	Flight Calls Detected
American Redstart	8
Canada Warbler	1
Cape May Warbler	1
Common Yellowthroat	2
Northern Waterthrush	3
Yellow-rumped Warbler	14
Ovenbird	2
Warbler spp.	1
Song Sparrow	2
Chipping Sparrow	1
Sparrow spp.	6
Least Sandpiper	7
Semipalmated Sandpiper	3
Shorebird spp.	1
American Goldfinch	1
Finch spp.	28
Thrush spp.	14
Unknown	28
Total flight calls detected:	**123**