

**Long-term Bat Monitoring on
Islands, Offshore Structures,
and Coastal Sites in the Gulf of
Maine, mid-Atlantic, and
Great Lakes—Final Report**



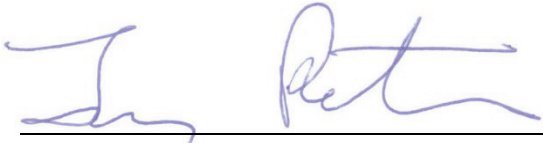
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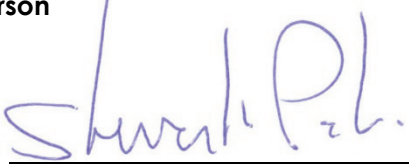
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Sign-off Sheet

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Executive Summary

To better understand seasonal and spatial distribution of bats offshore, the Department of Energy (DOE) funded an acoustic survey of bat activity on islands, offshore structures, and coastal sites in the New England Gulf of Maine, mid-Atlantic coast, and Great Lakes regions from 2012 – 2014 (Award Number DE-EE005378). The primary purpose of the study was to enhance understanding of when and where bats occur offshore (here defined as waters beyond 3 nautical miles from land), with the underlying objective of assessing potential impacts to bats from offshore wind energy development. This effort built upon a pilot acoustic study conducted by Stantec Consulting Services Inc. (Stantec) in the Gulf of Maine between 2009 and 2011, and supported an expanded survey effort in the Gulf of Maine, mid-Atlantic coast, and Great Lakes regions. This report combines data from the 2009 – 2011 Gulf of Maine pilot study as well as the 2012 – 2014 expanded study.

Although our ultimate goal was to assess bat activity offshore, current logistical constraints on long-term acoustic monitoring require that we base inferences regarding bat presence and activity over large expanses of open water on the results of surveys conducted at islands, coastal sites, and offshore structures where equipment can be more readily and reliably deployed. In some cases, remote offshore structures such as isolated weather buoys and ships provided a unique opportunity to directly measure bat activity above open water. However, monitoring bat activity at remote islands is still informative, as bats must travel considerable distances offshore to reach the islands. The broad spectrum of coastal sites, islands, and offshore structures included in this study, combined with the long-term nature of the project, allow for analysis of bat activity patterns across a number of spatial and temporal gradients.

We successfully monitored acoustic bat activity at sites in the Great Lakes ($n = 6$), Gulf of Maine ($n = 24$), and mid-Atlantic ($n = 8$) coastal regions for between 1 – 6 years per site. Survey site categories included 7 coastal locations, 9 large islands (>200 ha), 8 medium islands (15 – 200 ha), 6 small islands (<15 ha), 8 offshore structures (weather buoys, platforms, navigational aids) with island/structure sites ranging from ~ 4 – 42 km from the mainland. Detectors were deployed in lighthouse towers, trees, temporary towers, and other structures as available. In addition to these sites, we monitored bat activity on 3 different research vessels.

We detected a total of 565,158 bat passes (defined as a series of 2 or more echolocation pulses) during a total of 17,730 detector nights, recording bat activity at every site monitored. Although recorded bat passes do not indicate the number of bats present within a given period of time, as individual bats cannot be distinguished acoustically, the metric still remains a useful measure of bat activity. Bat activity levels calculated during the period from 15 July – 15 October, when 86% of bat passes occurred, ranged from 0 – 542.9 passes per night per site. The mean number of passes per night among annual datasets in this study by category was 4.96 (range 0.0 – 26.3) at offshore structures, 25.2 (range 0.2 – 138.1) at small islands, 95.6 (range 0.2 – 400.2) at medium

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islands, 35.5 (range 0.8 – 255.4) at large islands, and 112.6 (5.2 – 542.6) at coastal sites (mainland locations on or near the shoreline). For comparison, overall detection rates derived from 34 publicly available acoustic studies conducted at terrestrial wind projects ranged from 0.3 – 106.7 among studies, with an overall mean of 15.2 passes/night.

In addition to these coastal, island, and offshore sites, data from research vessels also contributed to our understanding of bat activity offshore, though the data represent a much smaller survey effort and were subject to high equipment failure rates. The offshore vessels did yield detections of bats up to 130 km from land (east of New Jersey). Of the 5 ship-based datasets (105 total nights of monitoring), bats were detected from only one ship, which made several distinct voyages along the mid-Atlantic coast between mid-July and the end of September, 2014. During the 52 nights surveyed aboard this ship, 35 bats were detected at distances of 5.3 – 129.6 km (mean 60.3 km) from the nearest point of land. Bat passes were detected during 7 out of 52 nights (13.5%) when the ship was under way at sea. All but 2 of the 35 offshore bat detections occurred during 2 separate voyages along the mid-Atlantic coast during the month of September. No bats were detected during 19 nights when the ship was at sea between mid-June and early August. No bats were detected during the remaining 4 ship-based datasets, although 2 of these remaining datasets were very brief and none spanned the late summer/early fall period of higher bat activity.

For the most part, the highest bat activity levels occurred at coastal sites or, in some cases, islands where detectors were in close proximity to forest edges. In some cases, unusually high activity levels can be explained by circumstances at certain sites. These include higher-than-expected activity levels at small, remote islands lacking vegetation, which may have been related to a small number of bats inhabiting the lighthouse or structure where bat detectors were deployed. In another case, the lighthouse where the detector was deployed was constantly illuminated, likely concentrating insect and bat activity and explaining unusually high activity levels. Acoustic detectors at several sites were also deployed in trees or located near forested edges, and microhabitat surrounding detectors appeared to have substantial influence on acoustic bat activity levels. Accordingly, we included percent forest within 150 m of detectors as a covariate in quantitative models of bat activity to at least partially account for potential microhabitat effects.

At certain sites, periods of prolonged absence of bats also illuminated patterns of offshore bat activity. At small islands and offshore sites where detectors were placed on focal points of the landscape, a lack of acoustic detections over an extended period of consecutive nights was interpreted as true absence of bats, rather than detection failure. Nightly summary of data between April and October identified periods of no bat activity lasting up to 126 consecutive nights at a site. Of the 12 datasets with periods of inactivity greater than 40 consecutive nights within this period, none spanned the entire month of August, 2 spanned the entire month of September (and October), and 7 spanned the entire month of July.

Bat activity patterns were highly seasonal in all regions and across species, with detection rates peaking in late summer and early fall and a high percent of bat passes occurring within a limited

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number of nights. Additive modeling of nightly bat presence versus season and weather variables, calculated on a regional level, indicated a bimodal influence of Julian Day on the regional distribution of bats, with increased bat activity during spring and fall relative to mid-summer. Regional mean nightly temperature and mean nightly wind speed also contributed significantly to variation in bat activity levels: bat activity occurred disproportionately during warmer temperatures and lower wind speeds within each region. Bats were absent for extended periods at certain remote sites during mid-summer: one remote offshore structure reported 126 consecutive nights (early April – early August) without bat activity, and 12 datasets showed over 40 consecutive nights without bat activity during summer.

We categorized 346,327 bat passes to species or species group (the remainder were categorized as high frequency or low frequency unknown). The *Myotis* genus was the most frequently detected species group, representing 43% of all identified bat passes, although only 9 *Myotis* passes were identified from all sites in the mid-Atlantic region. Although *Myotis* were most numerous at sites on or near the coast, they were also detected at the most remote sites. Occurrence of *Myotis* species (and overall *Myotis* activity levels) declined dramatically at most sites in the Gulf of Maine region after 2011 or 2012, likely due to region-wide impacts of White Nose Syndrome. Eastern red bats (*Lasiurus borealis*) were the most widespread species, occurring at 97% of surveyed sites and accounting for 40% of passes overall. Eastern red bats were also the most commonly identified species at offshore structures, comprising 89.8% of 3,684 passes identified to species that were recorded at offshore structures. Silver-haired bats (*Lasionycteris noctivagans*) and hoary bats (*Lasiurus borealis*) accounted for small percentages of overall activity, but occurred at 89% and 95% of sites respectively. Big brown bats (*Eptesicus fuscus*) comprised a large proportion of bat activity at certain coastal sites and large islands, but were rarely detected at isolated sites or offshore structures. Tri-colored bats (*Perimyotis subflavus*) were the least frequently detected species, present at 53% of sites.

Regional patterns in wind speed and temperature affected patterns in acoustic bat activity. Increases in nightly mean wind speed had a negative effect on bat activity, although the shape of this relationship differed slightly among regions based on additive modeling. Temperature had a positive effect on bat activity, particularly in the range between ~10° and ~20°C. The effect of wind speed and temperature on bat activity may also change with season. During summer, nightly bat activity is likely driven primarily by foraging behavior, and cold temperatures or high winds are likely to reduce prey availability, particularly offshore. During fall migration, however, bats may take advantage of favorable tailwinds or be more likely to fly during colder weather, such that overall relationships between mean temperature and wind speed may change. Wind direction, changes in barometric pressure, and other factors may also play different roles during spring and fall migration versus summer.

Species differed in seasonal activity patterns: eastern red bats occurred at high levels during a relatively wide range of dates between July and October and hoary bats at highest levels in mid-August. Silver-haired bats appeared to move through regions during a narrower period in early September. *Myotis* species tended to either be active throughout the season at island sites

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that appeared to have a resident population or else occurred sporadically during the fall migration period, although they were occasionally present at even the most remote sites.

We evaluated the effect of site isolation (represented by distance from the mainland and percent land within a 3 nautical mile radius) and habitat (represented by percent forest within a 150 meter (m) buffer of detectors) on 3 distinct but related measures of bat activity including the number of passes per detector night, the percent of nights with bat activity, and an index of consistency among nights. Linear mixed effects models indicated that each measure of activity was significantly affected by distance from the mainland and amount of forest. The percentage of land covered by forest within 150 m of a given site had a significant positive effect on the number of bat passes per night. Accounting for the positive effect of forest cover, bat activity declined in magnitude, occurred with less frequency, and was more inconsistent at greater distances from the mainland in all regions. The magnitude of this effect was somewhat less in the Gulf of Maine than in other regions, possibly due to the large number of islands mediating the effects of distance from the mainland. The effect of distance from the mainland also varied among species and was greatest for big brown bats and least for silver-haired bats and *Myotis* species. Percent land area within 3 nautical miles contributed less to variation in the 3 measures of bat activity among sites than distance from the mainland or percent forest within 150 m of detectors, although our models did not necessarily separate contributions of distance from the mainland versus percent land area. Species-specific model results were subject to greater variance than those based on total bat activity, and we suspect that certain outlier sites may have contributed to the unexpected result that *Myotis* species were minimally affected by distance from shore, particularly because they were detected so infrequently at remote offshore structures.

At most sites, bat activity increased rapidly during the first hour past sunset and then declined steadily for the rest of the night (as defined in 2015 as sunset to sunrise). However, at certain isolated sites such as Matinicus Rock and Mount Desert Rock in the Gulf of Maine, daytime bat activity represented a disproportionately high percentage of total activity: 13.9% and 10.9% of bat activity at those sites occurred between sunrise and sunset, respectively. Bats can be detected acoustically up to a maximum distance of approximately 30 meters, meaning that acoustic bat detectors can sample only a small proportion of the vast available air space in the sites and regions we were monitoring. Nevertheless, this method proved reliable and enabled us to document consistent spatial, seasonal, and temporal patterns in bat activity across multiple large regions.

Assessing the potential magnitude of offshore bat activity using acoustic survey results depends in part on the extent to which bats may be attracted to monitoring sites. Some degree of attraction could reasonably be expected, either due to sites serving as migratory stopovers, concentrations of insect prey, or novel features in an otherwise uniform habitat. As such, bat activity documented at islands and structures likely represents a concentration of bats from a surrounding area. The size of this area would depend on foraging patterns of bats in the vicinity, the sensory limits of bats, or possibly on long-established migratory routes.

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Paradoxically, the assumption that bats are highly attracted to offshore structures and islands could suggest that very few bats are present offshore, despite higher-than-expected detection rates. However, this would also suggest that offshore wind projects could be similarly attractive to bats, increasing risk of impacts. Alternatively, if no attraction or concentration is occurring and acoustic activity at islands simply represents detection of a smaller proportion of bats on unmodified flight trajectories, one would have to assume that substantially higher numbers of bats are present offshore given a certain level of activity, considering the very small collective volume air space sampled by acoustic bat detectors.

While knowing the density of bats present offshore would certainly aid in understanding the magnitude of potential offshore wind impacts, a more important question when assessing potential impacts to bats from offshore wind projects may be to characterize conditions during which bats occur offshore, how frequently such conditions occur, and whether turbines are operating during such conditions. Because the seasonal window during which bat activity levels are highest at offshore islands and structures is brief, and because the offshore environment lacks structure or refugia for bats that could moderate higher winds and colder temperatures, conditions of higher risk are presumably less frequent offshore than at terrestrial sites. As such, potential risk of turbine-related impacts could be readily managed through turbine feathering programs proven effective at terrestrial sites, with such actions necessary during a narrow set of conditions and a brief seasonal period.

Whether such measures will be necessary for offshore wind projects is uncertain until activity patterns and associated risk can be documented at an operational offshore wind project. Establishing thresholds at which turbine curtailment is necessary is less a biological question than a policy question given uncertainty surrounding population sizes of long-distance migratory species. However, based on the widespread detection of bats at offshore structures and remote islands, we recommend that acoustic methods similar to those used in this study be used at nacelle height at a subset of turbines constructed at the first several offshore wind projects constructed along the Atlantic Outer Continental Shelf, as well as in the Gulf of Mexico, Great Lakes, and Pacific coast regions. Such methods could enable analysis of conditions under which bats are actually active in the rotor zone, allowing a more precise characterization of risk patterns and evaluation of the need for, and potential effectiveness of various measures and devices to reduce impacts on migrating bat populations.

Ultimately, without information on movements of individual bats, we do not know the fate of bats detected at offshore acoustic sites. This lack of data raises questions regarding the seasonal migratory patterns of individual species, whether bats fly offshore “strategically” to follow more direct migratory paths, whether they seek out potential resources such as floating wrack lines or exploit a particular offshore food source, and whether bats purposely navigate to known offshore islands as planned stopovers during migration. Combined with acoustic datasets generated by this study and potential future studies, recent developments in radio telemetry technology permitting the tracking of bats offshore could help determine migratory behavior such as flight speed and stopover behavior, which would greatly improve our ability to predict patterns of risk associated with offshore development.

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1.0 INTRODUCTION

Although bats are capable of flying long distances over open water, little is known about the species composition, distribution, and behavior of bats offshore (waters beyond 3 nautical miles [nm] from land). To better understand distribution of bats offshore, the Department of Energy (DOE) funded an acoustic survey of bat activity on islands, offshore structures, and coastal sites in the New England Gulf of Maine, mid-Atlantic coast, and Great Lakes regions from 2012 – 2014 (Award Number DE-EE005378).

Acoustic bat surveys use specialized bat detectors to record the ultrasonic echolocation calls of bats passing within range of a detector (typically up to 30 meters [m] depending on species and conditions). Bat detectors can be deployed to operate passively for long periods of time and currently provide the only practical method available to remotely monitor bat activity patterns and species composition. Although individual bats cannot be distinguished acoustically, the number of bat calls recorded per unit of time provides a measure of the amount of bat activity at a site. Acoustic data can also be analyzed to determine seasonal patterns in activity, nightly patterns in timing, and conditions during which bats are active. If a sufficient number of detectors are deployed, acoustic surveys can also document large-scale spatial patterns in bat activity.

This study expanded upon an initial pilot study conducted by Stantec Consulting Services Inc. (Stantec) in the Gulf of Maine from 2009–2011 (Pelletier et al., 2013, Peterson et al. 2014). The pilot study attempted to quantitatively assess distribution and activity patterns of bats over open water based on monitoring conducted at coastal sites, offshore structures, and remote islands up to 40 kilometers (km) from the mainland. This report integrates results of the 2012–2014 offshore monitoring with those of the 2009–2011 pilot study, providing an opportunity to assess bat activity patterns over a 6-year period and across 3 large regions.

Objectives of the study included:

1. Enhancing the understanding of seasonal offshore bat migration activities;
2. Deploying and refining acoustic monitoring equipment configurations on Integrated Ocean Observing System (IOOS) infrastructure and other available coastal and remote offshore locations; and
3. Expanding monitoring of seasonal bat activities along the East Coast and to the Great Lakes to produce regional datasets.

The underlying context for the study is the potential for offshore wind energy developments to affect bats through turbine related mortality. Similar to land-based wind project sites, turbine-related mortality and/or injury to bats could also be of concern at offshore wind facilities. A previous analysis of existing information on offshore bats funded by the Bureau of Ocean Energy Management (BOEM) found that presence of bats and numbers of bats detected in regional

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acoustic surveys did not differ between offshore and inland survey sites, based on compilation of datasets available at the time and references reporting presences of bats at a variety of offshore locations (Pelletier et al. 2013). Given the apparently regular, seasonal presence of bats offshore, a more detailed understanding of seasonal and spatial patterns of bat distribution and species composition offshore will help developers, agencies, and stakeholders to assess potential risk to bats from offshore wind energy projects and to manage such risks through project siting and operational measures. The regional offshore dataset generated by this study provides a baseline for comparison when evaluating the results of targeted surveys of proposed energy development sites and future surveys of offshore bat activity.

1.1 STUDY AREA

BOEM manages energy leases in the Atlantic Outer Continental Shelf (Atlantic OCS), which is generally defined as submerged lands outside of state jurisdiction (i.e., beyond 3 nm out to at least 200 nm of the coast) between Maine and Florida (Pelletier et al. 2013). Within the Atlantic OCS, Stantec focused its coastal and offshore acoustic survey efforts on the Gulf of Maine region and mid-Atlantic coastline region from Delaware south to Virginia (mid-Atlantic). Stantec also surveyed bat activity at locations in Lake Superior and Lake Erie (Great Lakes). These broadly defined regions include a wide range of coastal sites, islands, and offshore structures, and are distinct in several potentially important ways with respect to potential offshore bat activity. The Gulf of Maine's coastline consists of numerous peninsulas, narrow bays, and estuaries and includes hundreds of vegetated and barren rock islands of varying sizes and distances from the mainland. By comparison, the mid-Atlantic coast is relatively linear, with most islands existing as part of a long coastal barrier system that parallels the mainland shoreline. The Great Lakes region is the largest and most geographically diverse region, with 5 large and distinct freshwater lakes distributed across a wide range of landscapes, including certain geographic pinch points offering distinct north-to-south migratory opportunities.

Bird migration patterns are known to vary among these regions, with well-known fall migration concentrations occurring at Point Pelee on the north shore of Lake Erie; Cape May, New Jersey; and in the Bay of Fundy along the Maine and New Brunswick coasts. The Great Lakes region also includes spring bird migration concentration points such as Presque Isle State Park on the south shore of Lake Erie (noted for raptors and songbirds) and the Keweenaw Peninsula in Michigan's Upper Peninsula (noted for raptors). We selected monitoring sites with such bird migration patterns in mind, anticipating some similarities between geographic patterns in bird and bat migration.

Eight bat species are presumed to occur in all 3 regions we surveyed, including the little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), eastern small-footed bat (*Myotis leibii*), tri-colored bat (*Perimyotis subflavus*), big brown bat (*Eptesicus fuscus*), silver-haired bat (*Lasionycteris noctivagans*), eastern red bat (*Lasiurus borealis*), and hoary bat (*Lasiurus cinereus*). Additionally, the Indiana bat (*Myotis sodalis*) may occur in the Great Lakes and mid-Atlantic states, and the evening bat (*Nycticeius humeralis*) and Mexican free-tailed bat (*Tadarida brasiliensis*), could occur in portions of the mid-Atlantic region. Prior surveys have

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documented relatively low incidence of *Myotis* species along the coastal plain in the mid-Atlantic (Johnson et al. 2011a). Johnson and Gates (2008) documented 5 bat species (eastern red bat, big brown bat, hoary bat, tri-colored bat, and silver-haired bat) in an acoustic bat survey on Assateague Island on the mid-Atlantic coast in 2005 and 2006. They also documented Seminole bats (*Lasiurus seminolus*) at the island in a 2005 netting study (Johnson and Gates 2008). Year 2009 – 2011 acoustic monitoring in the Gulf of Maine documented the same 5 species as well as at least one *Myotis* species (Peterson et al. 2014). Of these species, Indiana bats are federally endangered, northern long-eared bats are federally threatened, and several species are considered as rare, threatened, or endangered by certain states within the northeast.

Although our goal was to assess bat activity offshore, logistical constraints of long-term acoustic monitoring required that we sample bat activity primarily at fixed structures. As such, we have based inferences regarding bat presence and activity over large expanses of open water on the results of surveys conducted at islands, coastal sites, and offshore structures where bats can be more readily and reliably monitored. In some cases, remote offshore structures such as isolated weather buoys and ships provided a unique opportunity to directly measure bat activity above open water, while in other cases monitoring bat activity at remote islands proved useful as the bats were required to travel considerable distances over open water to reach the islands. The broad range of sites included in this study, combined with the long-term nature of the project, allow for analysis of bat activity patterns across a number of spatial and temporal gradients.

2.0 METHODS

2.1 SITE SELECTION AND DEPLOYMENT

Stantec identified a series of potential coastal and offshore acoustic survey locations in the Gulf of Maine, mid-Atlantic, and Great Lakes regions. A broad variety of organizations, individuals, or agencies responsible for these sites were subsequently contacted to determine feasibility of deploying long-term acoustic bat monitoring equipment. A primary goal was to select survey remote sites lacking suitable bat habitat and most closely resembling remote offshore locations where wind projects would likely be sited, while ensuring that sites could be accessed safely and reliably. We prioritized remote islands and offshore structures, although surveyed a series of shoreline and larger island sites in areas lacking more remote options. Locations of each site were reviewed and approved in advance by the local state historic preservation organization and DOE for historical/cultural significance prior to deploying equipment as part of a larger National Environmental Policy Act (NEPA) analysis.

Following site selection and access approval by site stakeholders and the DOE, we deployed an acoustic bat detector array consisting of 1 or 2 ultrasonic bat detectors mounted on customized brackets, pulley systems, temporary towers, or other mounting configurations to suit the needs of

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particular locations. Survey sites included lighthouses, towers, bridges, offshore platforms, navigational aids, buoys, and shoreline trees as conditions required. We recorded each survey location using Global Positioning Systems (GPS) and calculated the area of each island, the linear distance of each detector to the nearest mainland location, and the percent land area within a 3 nm (5.6 km) radius of each survey site based on the National Oceanic and Atmospheric Administration (NOAA) Medium Resolution Shoreline datalayer (NOAA 2000) using ArcGISTM Software (ESRI, Redlands, CA). The distance of 3 nm was chosen based on BOEM's definition of "offshore" mentioned previously. We also calculated the percent of forested area within 150 m of each detector, based on the U.S. Geological Survey (USGS) National Land Cover Datalayer (Homer et al. 2015) or using satellite imagery in cases where the landcover data were not available, to quantify the microhabitat surrounding survey sites. For certain descriptive summaries, we categorized sites as "coastal" (mainland locations), small islands (<15 hectares [ha]), medium islands (15–200 ha), large islands (>200 ha), offshore "structures" (buoys, bridges, offshore platforms lacking natural habitat), or ships (Figure 2-1, Figure 2-2).



Figure 2-1. Examples of acoustic bat detectors deployed at offshore "structures" including NERACOOS Buoy A (left), the Chesapeake Light Tower (center), and Albermarle ATON (right). Yellow arrows highlight bat detector locations.

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Figure 2-2. Rock of Ages Lighthouse (left) and Matinicus Rock (right) are examples of sites categorized as "small islands." Yellow arrows indicate detector placement.

Selecting sites that were sufficiently remote to represent offshore bat activity but were still accessible was a challenge, but we received tremendous support from partnering agencies, island caretakers, and a variety of stakeholders to select locations where equipment could be safely deployed for long periods of time. These same groups provided essential assistance in accessing sites to deploy, monitor, and recover equipment, in some cases deploying equipment on Stantec's behalf where we could not reach sites. We accessed sites via hiking, driving, helicopter, and a variety of vessels operated by the U.S. Fish and Wildlife Service (USFWS), National Park Service (NPS), U.S. Coast Guard (USCG), universities, commercial fishermen, and private charters.

2.2 ACOUSTIC BAT DATA COLLECTION

We used acoustic Anabat SD1, SD2, or Anabat II/CFzcaim bat detectors (Titley Scientific, Queensland, Australia) or Wildlife Acoustics SM2Bat+™ detectors during the 2009 – 2014 survey period. Acoustic detectors were deployed at heights ranging from 3 – 30 m above ground level (AGL). The maximum detection range depends on the orientation of a bat relative to the microphone, volume and frequency of the echolocation signal, and atmospheric conditions, although typically is 30 m or less. As such, acoustic detectors sample a relatively limited volume of air space relative to that available or to the rotor zone of modern offshore wind turbines. Nevertheless, acoustic detectors have proven a reliable means of monitoring bat activity across a wide variety of location types in terrestrial studies and are one of the only available means of remotely monitoring bat activity.

A backup detector was deployed at most locations to increase the likelihood of collecting valid data in the harsh offshore marine environment during extended periods. Detectors were powered by 12-volt batteries charged by solar panels. Initially, the same battery was used to power both primary and backup detectors, although we modified the design in 2013 and 2014 to use separate power supplies for backup detectors where they were present. Anabat

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detectors were deployed in weatherproof housings, which directed bat calls to the detector's microphone via a 90-degree PVC elbow such that the system would detect bats in a horizontal cone (Figure 2-3). We modified this setup for buoy deployments, connecting the microphone to detector via a 3 m extension cable, mounting the microphone inside PVC tube, and sealing both the microphone and detector/battery enclosures with marine caulking. The SM2Bat+ units included weatherproof microphones, which were not modified for these surveys. The microphone sensitivity for both units is estimated to reliably detect bats to a distance of at least 10 m.

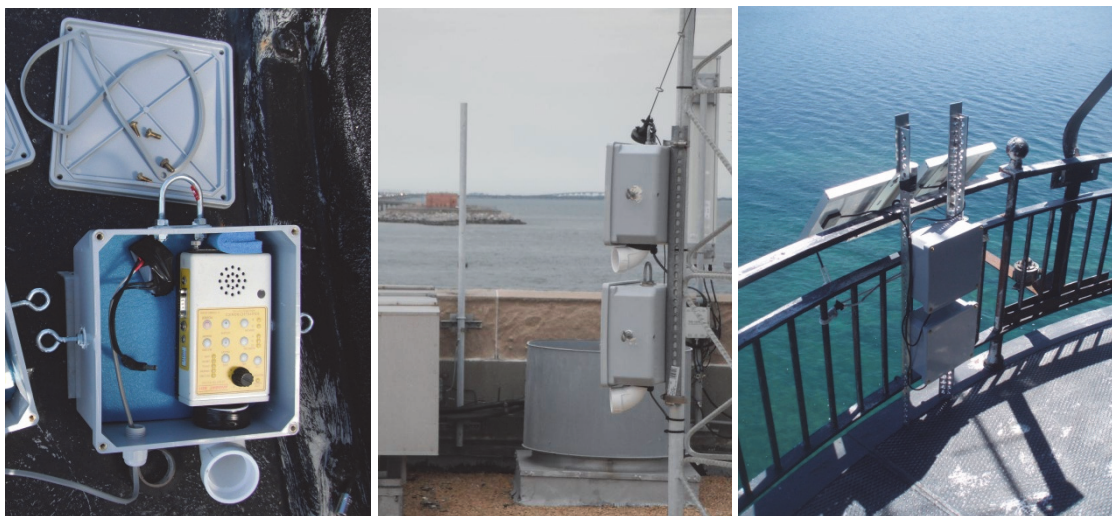


Figure 2-3. Waterproof enclosure for deploying bat detectors offshore (left) and as mounted on an antenna at the Chesapeake Bay Bridge Tunnel (center) and Rock of Ages Lighthouse (right).

Acoustic detectors were operated in frequency division mode using a factor of 16, converting the ultrasonic frequency into an audible range and then converting the sound to frequency-time plots through a process known as zero-crossing. This method requires very little digital memory to store large quantities of bat passes and was ideal for long-term, unattended monitoring. We conducted a thorough evaluation of all bat detectors and microphones prior to deployment, and tested microphones before and after deployment, using a single detector and a source of ultrasound (Bat Chirp, Nevada Bat Technology, Las Vegas, NV), to ensure that microphones were comparable. We adjusted sensitivity of Anabat detectors manually in the field at deployment to maximize detection range while limiting ambient background noise and interference. Usually, sensitivity was set to a value from 6.25 – 7.0 (~1 unit below the level at which the detector generates constant noise).

In 2009 – 2012, we programmed detectors to operate from 1800 – 0800 (14 hours per night) in all but a few cases to survey the period from 30 minutes before sunset to 30 minutes after sunrise. This sampling period was increased to 1200 through 1100 (23 hours per night) or 1600 through 1000 (18 hours per night) in 2013 based on recent incidental observations of offshore daytime flight activity of eastern red bats (Hatch et al. 2013). However, the expanded schedule resulted

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in recording substantial amounts of non-bat “static” from a variety of sources, causing data loss in several cases when memory cards filled to capacity prematurely. Because little or no activity was recorded during daytime despite substantial daytime effort in 2013, we returned to the 1800 – 0800 schedule for most sites in 2014. This schedule allowed us to more effectively record the full period from sunset to sunrise plus a 30 minute buffer during April – October.

When possible, we visited study sites periodically to check the condition of the detectors, although we were able to access most sites only 1 – 2 times per year. During site visits, we inspected equipment and downloaded data to laptop computers using appropriate software (CFCread 4.3r – 4.4n software [Corben 2009a] for Anabat detectors). We reviewed system status files and samples of recorded data in the field to evaluate system performance and establish the period during which detectors were functioning properly. We then redeployed the system (replacing any malfunctioning components and/or detectors when necessary), redeployed the same system, or removed the system for the winter, depending on the status of equipment and time of year. In a few cases, we left equipment in place over the winter, programming detectors to begin recording data the following March or April.

2.3 DATA ANALYSIS

We visually inspected all recorded call files to determine whether a bat pass had been detected and to determine whether the file was of sufficient quality for identification. Each potential call file consists of a brief (generally less than 15 seconds) time-stamped time/frequency plot that can be analyzed visually in Analook 3.7w software (Corben 2009b). To be considered a bat pass, we required a call file to contain at least 2 discrete “pulses” in the ultrasonic range suitable for bats in the region and having the appearance of a bat call. Files with only static or other non-bat “noise” were excluded from further analysis. In certain cases where detectors recorded large numbers of noise files, we created customized filters using Analook software to eliminate non-bat files, visually checking that no bat call files were accidentally filtered out of the dataset.

We categorized all passes with fewer than 5 pulses as either high frequency unknown (HFUN) if the minimum frequency of bat pulses was greater than 33 kilohertz (kHz) or low frequency unknown (LFUN) if the minimum frequency of pulses was less than 33 kHz. Passes with greater than 5 pulses were identified to species or “guild” based on qualitative inspection of call parameters and comparison to reference libraries of known calls as in Johnson et al. (2011b). Guild and species categories used in this report are summarized in Table 2-1.

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Table 2-1. Guilds used in categorizing acoustic call sequences. Species-specific codes in parentheses were used in cases where calls could be identified to species.

Guild	Potential Species
BBSH	Big brown bat (EPFU), silver-haired bat (LANO)
LACI	Hoary bat (LACI)
MYSB	<i>Myotis</i> species (little brown bat, northern long-eared bat, eastern small-footed bat, Indiana bat)
RTEB	Eastern red bat (LABO), tri-colored bat (PESU), evening bat (NYHU)
UNKN	High-frequency unknown (HFUN), low-frequency unknown (LFUN)

2.4 DATA SUMMARY AND ANALYSIS

We summarized the extent of successful survey effort for each site, documenting site metadata and dates surveyed for each site/detector/year combination, then determined the time and date ("night of") each bat pass based on the time-stamped filename logged by acoustic detectors. We determined nightly sunset times for each site using Anasun software (Corben 2009b) and determined the time past sunset of each bat pass, allowing nightly and hourly analyses of bat activity. We generated a file-level summary of each bat pass and created a nightly tally of bat passes by species/guild in Excel software, then imported data into R software (R Core Team 2014) for subsequent summary, analysis, and graphing.

2.4.1 Measures of Bat Activity

The number of bat passes detected at individual sites during a particular time period is perhaps the most direct measure of acoustic bat activity, but typically fluctuates widely over time and is affected by a number of factors including detector placement and habitat immediately surrounding the detector. Importantly, numbers of recorded bat passes do not necessarily indicate the number of bats within range of the detector, as individual bats can be detected repeatedly. Considering possible biases of passive acoustic survey results, we calculated several different measures of bat activity to analyze patterns in bat activity, including;

- Number of bat passes per detector night;
- Percent of sampled nights/hours with bat activity; and
- Consistency of bat activity among surveyed nights per season and among hours within nights (Gini coefficient).

Bat activity follows distinct seasonal patterns, coinciding with spring emergence from hibernacula, summer roosting/pup rearing period, and fall migration and swarming. Survey effort, although concentrated on late summer and fall, occasionally included continuous

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monitoring from 1 January through 31 December. To limit seasonal bias, we calculated the above measures of bat activity for nights (sunset to sunrise) between 15 July and 15 October for site-level analyses. We calculated nightly percent of hours with activity and nightly consistency of activity only for entire hours surveyed between sunset and sunrise.

The number of passes per detector night, one of the most commonly reported measures of bat activity, is most susceptible to bias from repeated detections of a small number of bats and is therefore highly influenced by detector placement. However, it is also the most sensitive indicator of overall bat activity among sites. Percent of nights/hours with bat activity, although closely related to the number of passes per night, is unaffected by repeated detections of the same bats within nights and may therefore be a less biased measurement of bat activity among sites.

We quantified the consistency of bat activity among nights using an index known as the Gini coefficient. This coefficient, originally developed by economists to measure distribution of income, has also been applied by demographers to indicate population concentrations (Shryock and Siegel 1980) and provides a convenient metric of consistency of bat activity among nights. To calculate the Gini coefficient for each site, we sorted the nightly (15 July – 15 October) recorded passes for each acoustic dataset, plotted the cumulative distribution of bat activity versus survey effort, and calculated the area beneath this curve (represented by blue line in Figure 2-4) using trapezoidal approximation. By subtracting this area from 0.5 (the area indicating uniformly distributed activity) we derived the value for A in Figure 2-4, which is multiplied by 2 to obtain the Gini coefficient. Gini coefficients range from 0, representing even distribution of bat activity, to a maximum of 1, which would indicate that bats were detected during only 1 sampling unit. By quantifying the degree to which bat activity was concentrated in a small number of survey nights versus evenly distributed across time, this index provides a useful indicator of how sporadic bat activity was at each site.

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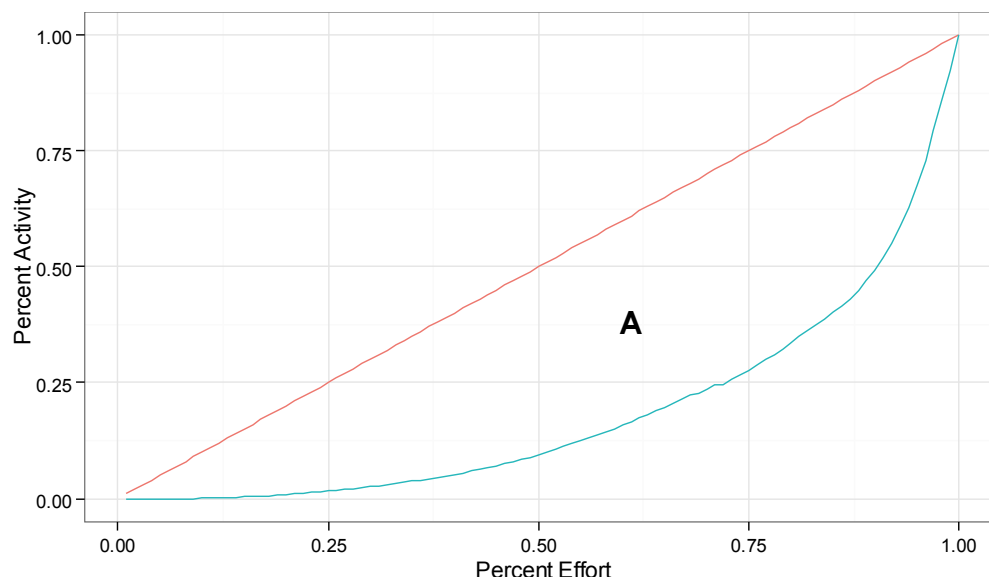


Figure 2-4. The Gini coefficient is calculated by multiplying the area A (the difference between the areas beneath curves denoting uniform distribution [red line] and the distribution of bat activity measured at a particular site [blue line]) by 2 such that the coefficient ranges from 0 (evenly distributed activity) to 1 (all activity during 1 night).

2.4.2 Measures of Site Isolation and Habitat

While the focus of our monitoring was on bat activity offshore, surveys occurred at islands of varying size and remoteness, offshore structures, and coastal sites. Distance between island survey sites and the mainland was the primary measure of site isolation, but does not account for the amount of land area present in the surrounding area (e.g., island size or presence of other nearby islands), which may mediate the effects of site isolation, nor does it include potential effects of microhabitat. We therefore quantified site isolation and habitat using multiple variables, including;

- Distance from the detector to the nearest mainland;
- Percent of land area within a 3 nm radius;
- Percent forest (any type) within 150 m of detectors.

Evaluation of multiple measures of site isolation enabled more informative inferences regarding bat activity offshore recognizing the fact that detectors were typically deployed on land-based structures that could themselves serve as potential bat roosting habitat. Also, differences in larger biogeographical patterns among regions (such as the numerous islands and long peninsulas on the Maine coastline) could mean that the importance of distance from shore

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could also vary among regions. Together, these metrics encompass island size, distance from mainland, and microhabitat, all of which likely affect likelihood and amount of bat activity.

2.4.3 Statistical Analysis

We analyzed spatial patterns of bat activity on several scales to address potential management objectives related to project siting and operation. We first analyzed effects of temperature, wind speed, and time of year on nightly patterns in bat activity on a regional scale, implementing general additive models in R software (R Core Team 2014) using package “mgcv” (Wood 2011). These models apply smoothing functions to variables and can be useful for fitting nonlinear relationships such as seasonal patterns. Additive models also lend themselves well to graphical interpretation and visualizing relationships among variables. We modeled the nightly percent of hours with bat activity as a function of Julian Day, mean nightly temperature, and mean nightly wind speed, using a separate additive model for each region and not including interaction terms. We calculated the percent of hours per night during which bat activity occurred across all sites and years within each region by Julian Day. To limit the influence of individual sites, we conducted this analysis using a subset of nights for each region during which 4 or more sites were monitored simultaneously during a particular year. We obtained weather data from 3 widely spaced weather stations within each region and calculated the mean nightly (sunset to sunrise) temperature and wind speed for each region. These weather stations included Stannard Rock, Lake Superior (STDM4), Fairport, OH (FAI01), and South Bass Island, OH (SBI01) in the Great Lakes region, Northeastern Regional Association of Coastal and Ocean Observing Systems (NERACOOS) Buoys E, F, and I in the Gulf of Maine, and the Chesapeake Bay Bridge Tunnel, VA (CBBV2), Hatteras, NC (HCGN7), and the Chesapeake Light Tower, VA (CHLV2) in the mid-Atlantic region.

We evaluated the effect of site isolation/habitat on the 3 measures of bat activity described above using a subset of annual datasets from sites with more than 30 nights sampled between 15 July and 15 October, summarizing bat activity per site for each year. The total number of passes per detector night (rounded to the nearest whole number), percent of nights with activity, and Gini coefficient were modeled separately using linear mixed effects models, assigning region, distance from the mainland, percent land area, and percent forest within 150 m as fixed effects (allowing an interaction between region and distance), and year as a random effect with fixed slope. Mixed effects modeling was chosen to account for inter-year variance in bat activity (by specifying year as a random effect), while focusing on the effects of site isolation and habitat. We assumed a Poisson distribution for the rounded number of passes per detector night and normal distribution of the percent of nights with activity and Gini coefficient. Models were implemented in R using the package “lme4” (Bates et al. 2015). To enable direct comparison of effect sizes from model results, we first standardized units of distance from shore, percent land area, and percent forest within 150 m (Schielezeth 2010). Prior to standardization, we also square-root transformed land area and percent forest to minimize skew in predictor variables. We evaluated the resulting models using graphical interpretation of predicted values and 90% confidence intervals and calculation of conditional and marginal

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pseudo- R^2 according to methods recommended in Nakagawa and Schielzeth 2013 and using the R packages AICcmodavg (Mazerolle 2015) and MuMIn (Multi-Model Inference; Barton 2015).

To determine whether the effect of distance from the mainland on bat activity differed among species, we modeled the number of passes per night (rounded to the nearest whole number), percent nights with activity, and Gini coefficient, calculated separately for each identified species and genus *Myotis*, using linear mixed effects models. Region and species were each allowed to interact with distance from shore, percent forest and land area were included as fixed effects, and year was included as a random effect with random intercept and fixed slope. We plotted the predicted effect of distance from the mainland on each measure of bat activity for each species, setting the percent of forest within 150 m and percent land area within 3 nm to zero for the purposes of examining patterns with minimal influence of terrestrial habitat.

Rather than using a model selection criteria or hypothesis testing framework, we focused our analysis on the direction and magnitude of effect sizes and their associated precision based on a single, relatively simple model structure. This model structure allowed the effect of distance from the mainland on bat activity to vary among regions while accounting for variation due to the amount of land in the surrounding area and the microhabitat immediately surrounding the detector. We did not allow the effect of land area or forest to vary among regions, partly to reduce model complexity, and partly because we consider the relationships between these variables and bat activity less likely to vary among regions compared to distance. By applying the same model structure to multiple measures of activity, we also can evaluate the consistency, or lack thereof, in model predictions based on distinct but related measures of bat activity.

3.0 RESULTS

3.1 SURVEY EFFORT AND SITE DATA

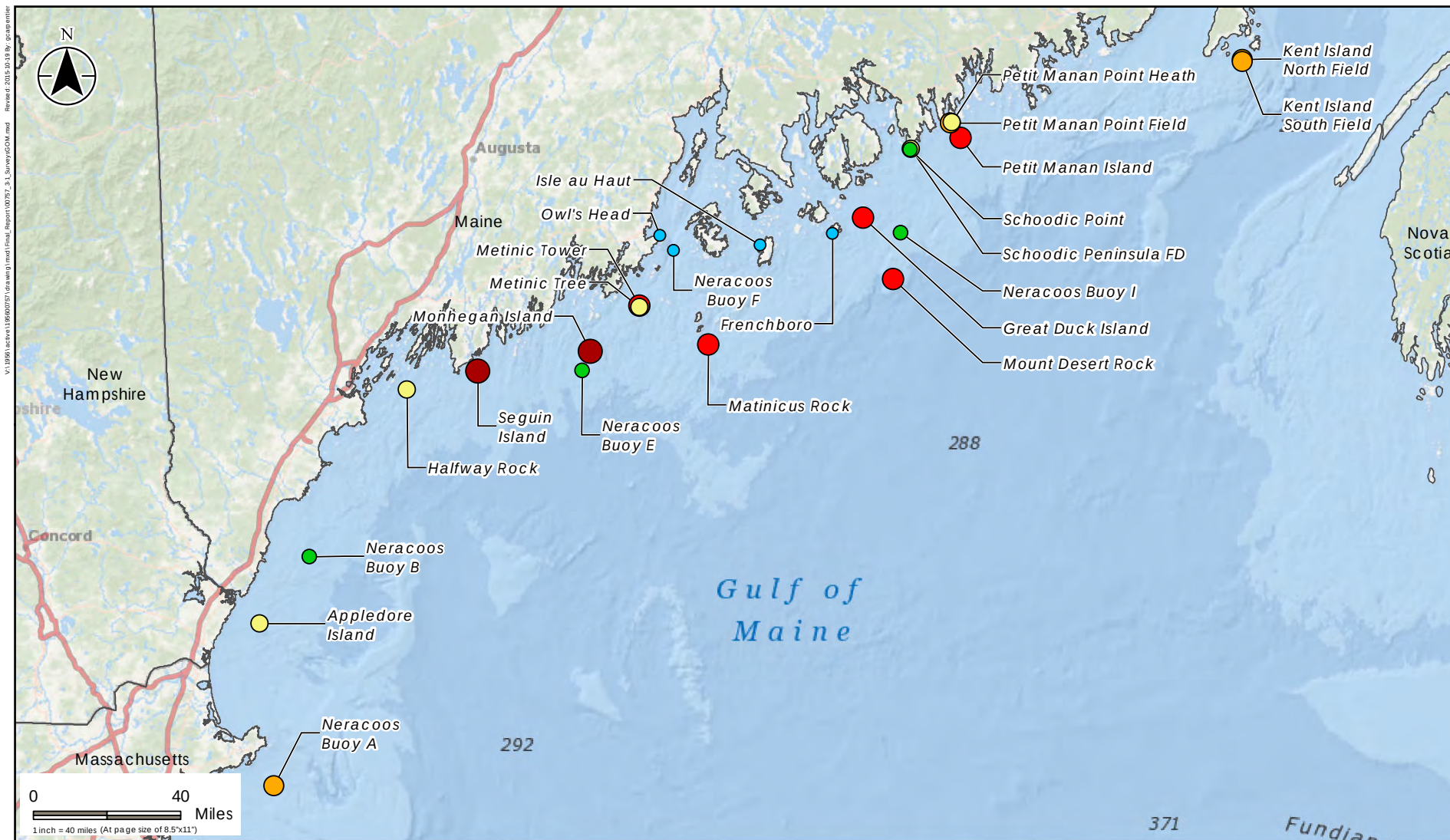
We deployed bat detectors at a cumulative total of 39 sites between 2009 and 2014; 7 in the Great Lakes, 8 in the mid-Atlantic, and 24 in the Gulf of Maine. The number of sites surveyed successfully varied among years, with each site surveyed between 1 and 6 years (Figure 3-1, Figure 3-2, Figure 3-3). Detectors functioned properly for at least a portion of the attempted survey period at every site except Toledo Light (Great Lakes region), where detectors failed to operate properly for any nights. We also deployed detectors on 3 research vessels that traveled throughout the Atlantic OCS in 2012 – 2014 (Figure 3-4).

Survey effort focused on summer and early fall, although we sampled throughout the entire year on several occasions (Figure 3-5). Four of the detectors in the Gulf of Maine were located in close proximity (~200 – 500 m) to another detector (i.e., paired), although we treated data from each detector as a separate site in such cases. We successfully monitored 7 coastal sites, 9 large islands, 8 medium islands, 6 small islands, 8 offshore structures, and 3 ships at some point between 2009 and 2014. The 8 offshore structures included 5 NERACOOS weather buoys, a fixed

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navigational aid, an offshore research platform, and a tunnel platform. Island sites ranged in size from 0.1 – ~231,000 ha and were located between 4 and 41.6 km from the mainland, with monitoring sites including lighthouses, temporary towers, and trees or other structures. Coastal sites also included a variety of lighthouses, buildings, and other structures (Table 3-1).



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Prepared by GAC on 2015-04-21
Reviewed by TSP on 2015-04-23

00757_3-1_SurveysGOM.mxd

Survey Sites Number of Years Surveyed

- 1
- 2
- 3
- 4
- 5
- 6

Client/Project
Offshore Acoustic Bat Study
US Department of Energy

Figure No.
3-1

Title

Gulf of Maine Survey Effort
10/19/2015



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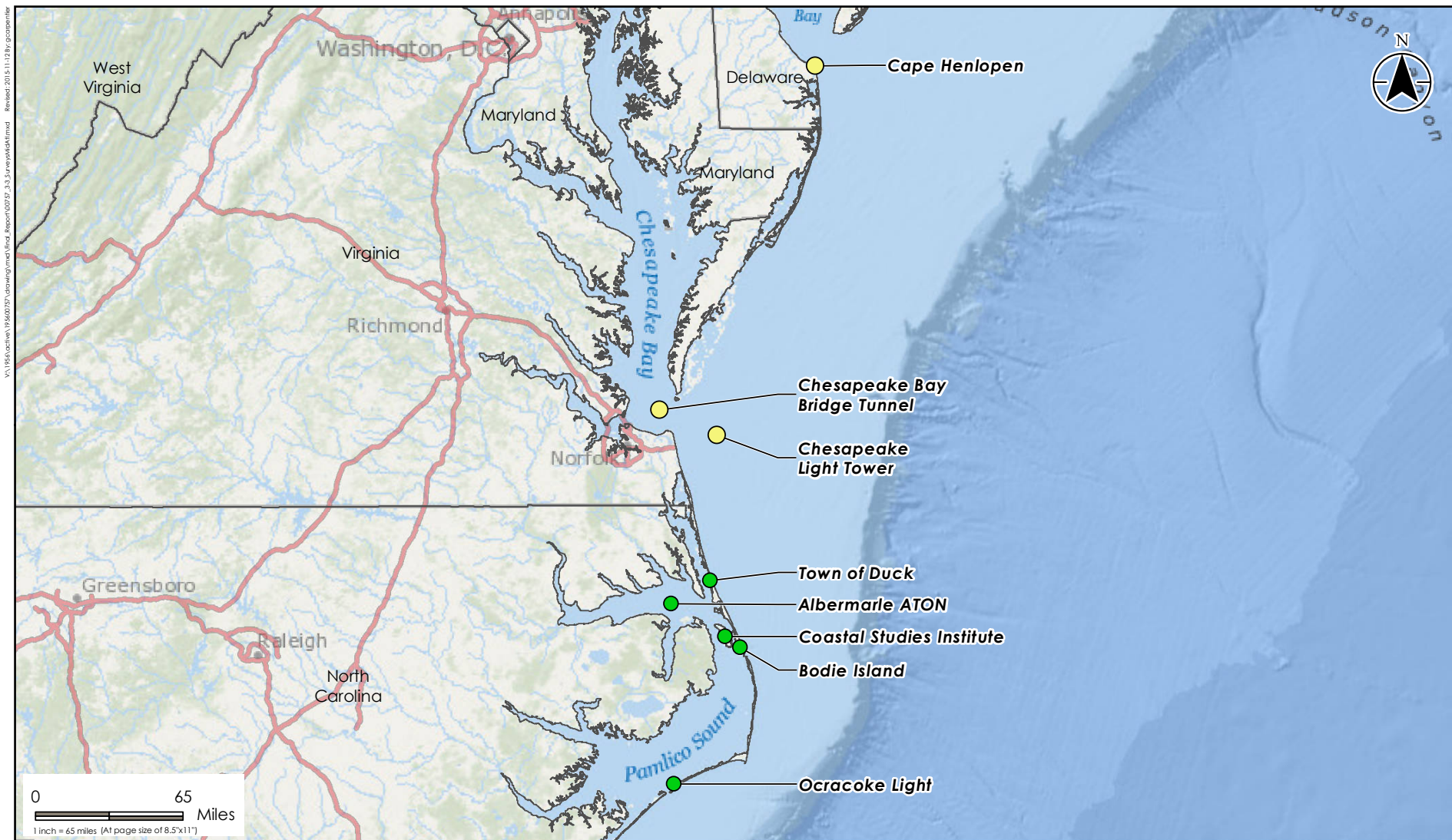
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Survey Sites
Number of Years Surveyed
○ 0
● 1
● 2
● 3

Client/Project
Offshore Acoustic Bat Study
US Department of Energy

Figure No.
3-2

Title
Great Lakes Survey Effort
10/19/2015



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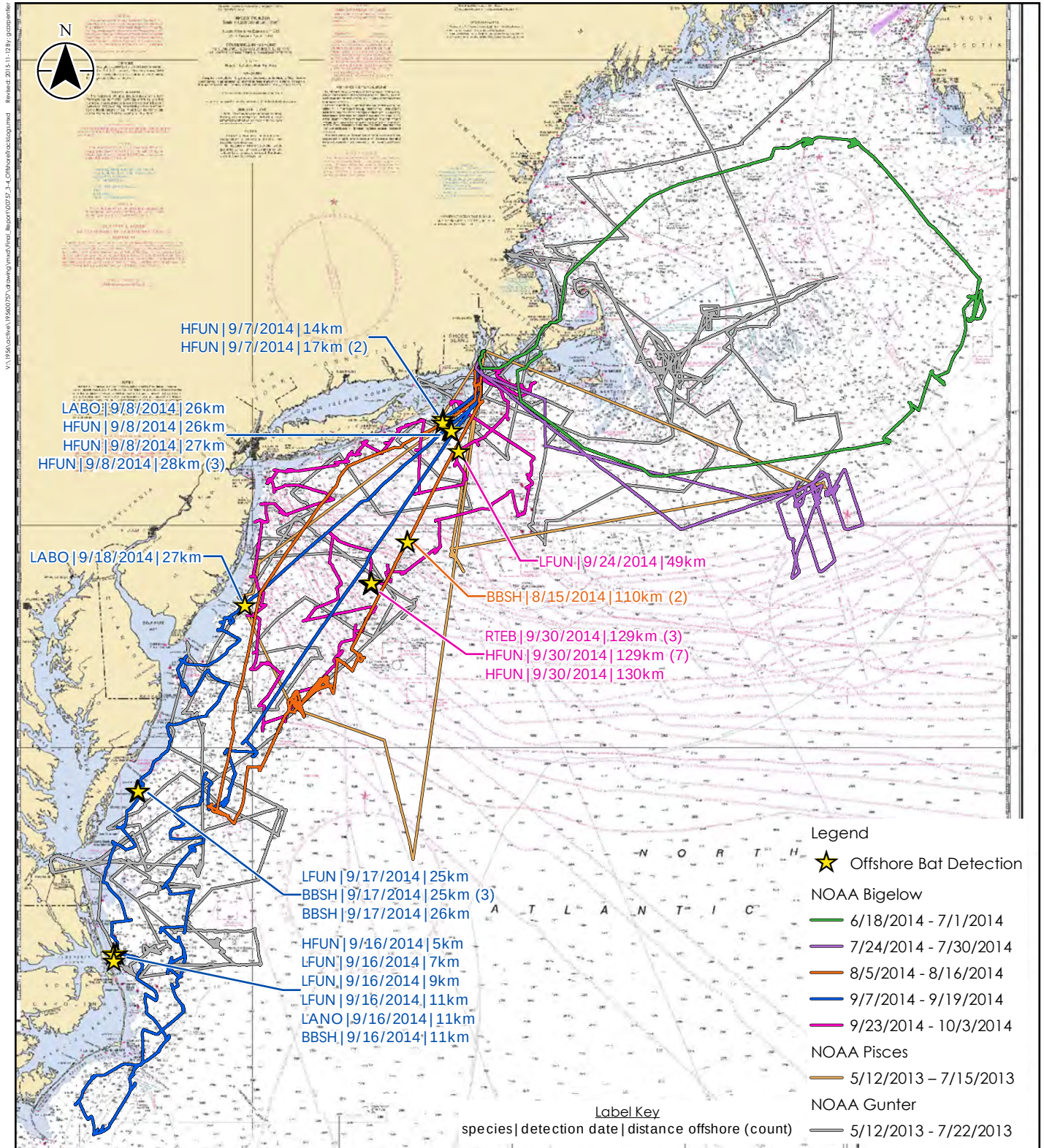
00757_3-3_SurveysMidAtl.mxd

Survey Sites
Number of Years Surveyed
● 2
● 3

Client/Project
Offshore Acoustic Bat Study
US Department of Energy

Figure No.
3-3

Title
Mid-Atlantic Survey Effort
11/12/2015



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Prepared by GAC on 2015-11-10
 Reviewed by TSP on 2015-11-11

00757_3-4_OffshoreTrackLogs.mxd

0 112 Miles
 1 inch = 112 miles (At page size of 8.5x11")

Client/Project
 Offshore Acoustic Bat Study
 US Department of Energy

Figure No.
 3-4

Title
 Offshore Bat Detection on
 NOAA Research Vessels
 11/12/2015

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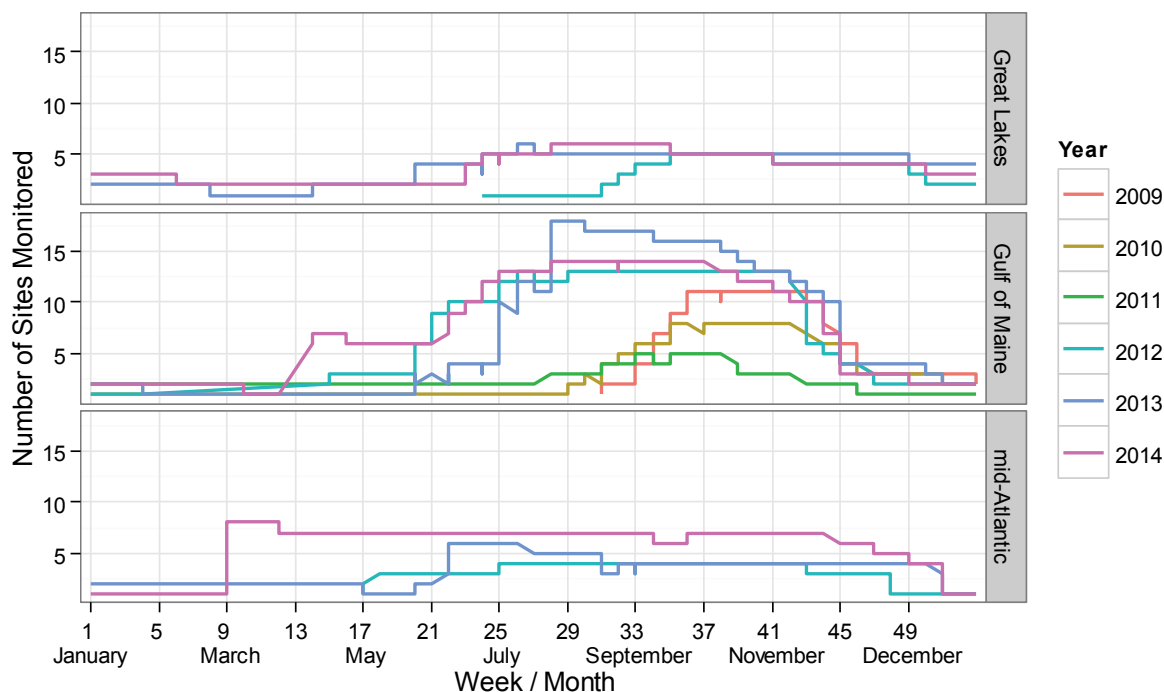


Figure 3-5. Weekly survey effort across regions and years during 2009 through 2014 acoustic bat monitoring.

We deployed ~120 unique Anabat detectors and 6 SM2 detectors over the course of the combined DOE and pilot study, surveying a total of 23,471 “successful” (where detectors functioned properly) detector nights. Of these, 5,741 detector nights were from backup detectors (redundant) and were not analyzed, so the final dataset used for analysis consisted of 17,730 detector-nights including all data from 2009 – 2014. Data loss occurred for a variety of reasons during the study, including discharged batteries, seawater entering the battery and/or detector enclosure or damaging the microphone, physical damage to units from ice and/or wave action, and memory cards that prematurely filled to capacity. Additionally, data loss occurred as a result of corrupt memory cards or apparent incompatibility between detector firmware and rapidly evolving software to process acoustic detector data. Notably, although nearly every detector array mounted on weather buoys was destroyed from exposure to seawater (buoys can be entirely submerged during storms) at some point during deployment, we recorded 1,600 detector nights from buoys during the study. The detector deployed on NERACOOS Buoy E functioned properly for 312 consecutive nights between April 2012 and February 2013. None of the SM2 detectors deployed on buoys functioned properly for any nights due to apparently immediate microphone failure upon contact with seawater. The microphone elements of these detectors were apparently more susceptible to seawater damage than those of Anabat detectors.

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We visually analyzed 3,460,818 potential bat call files recorded by acoustic detectors during 17,730 detector nights throughout the complete 2009 – 2014 study, and classified 565,158 of these files as bat passes. The total number of passes recorded annually per site ranged from 0 – 49,009, with bats detected at every site monitored during at least one of the years of monitoring. The total number of passes, calculated per night between 15 July and 15 October, ranged from 0.1 – 414.3 among sites, aggregating data across years. Of the 38 sites successfully surveyed (excluding ships), 20 (52%) had overall activity rates of less than 20 bat passes per night within this period, and 12 sites (32%) had rates of fewer than 5 bat passes per night (Figure 3-6, Figure 3-7, Figure 3-8, Figure 3-9). We detected at least 1 bat pass during 7,380 of the 17,730 surveyed nights (42%) overall, with the percent of nights with activity (15 July – 15 October) ranging from 0 – 100% among sites (Figure 3-6). Gini coefficients were most often between 0.70 and 0.85, with only 3 sites having coefficients less than 0.5 (Figure 3-6). Appendix A includes detailed summaries of results from each individual site surveyed between 2009 and 2014.

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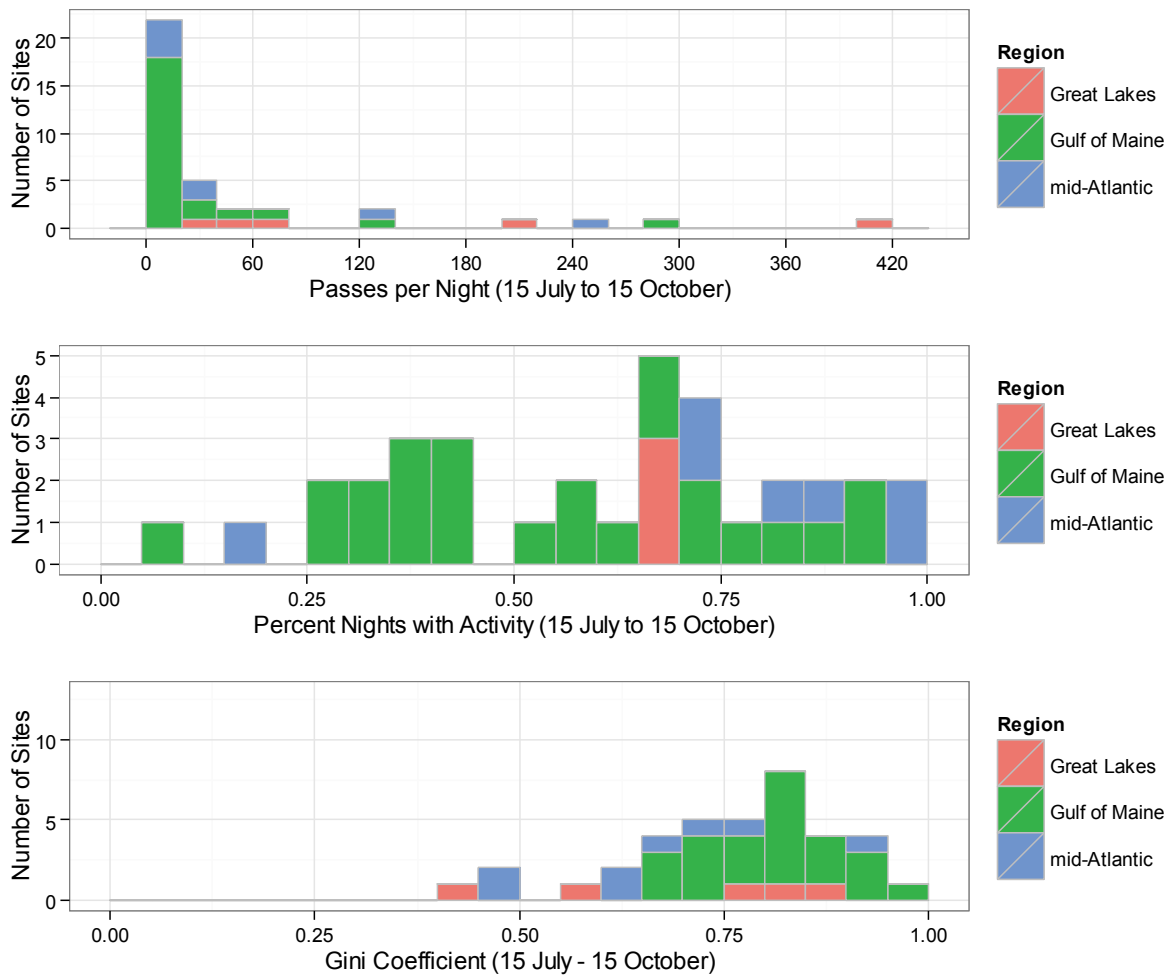
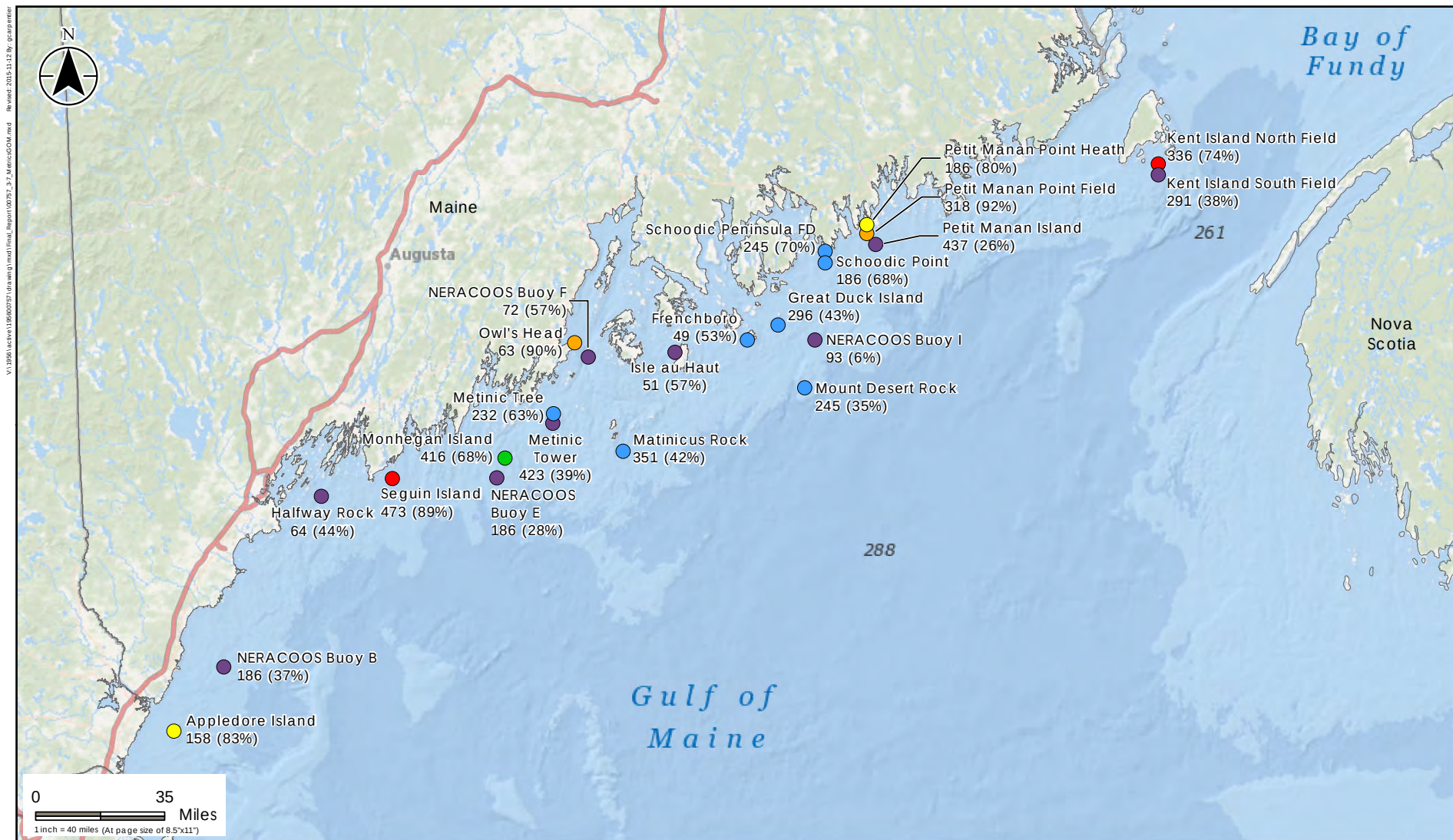


Figure 3-6. Number of bat passes per night (top), percent nights with activity (middle), and Gini coefficient (bottom) among sites, between 15 July and 15 October, combining years.



30 Park Drive
Topsham, ME USA 04086
Phone (207) 729-1199

Prepared by GAC on 2015-11-09
Reviewed by TSP on 2015-11-10

00757_3-7_MetricsGOM.mxd

195600757

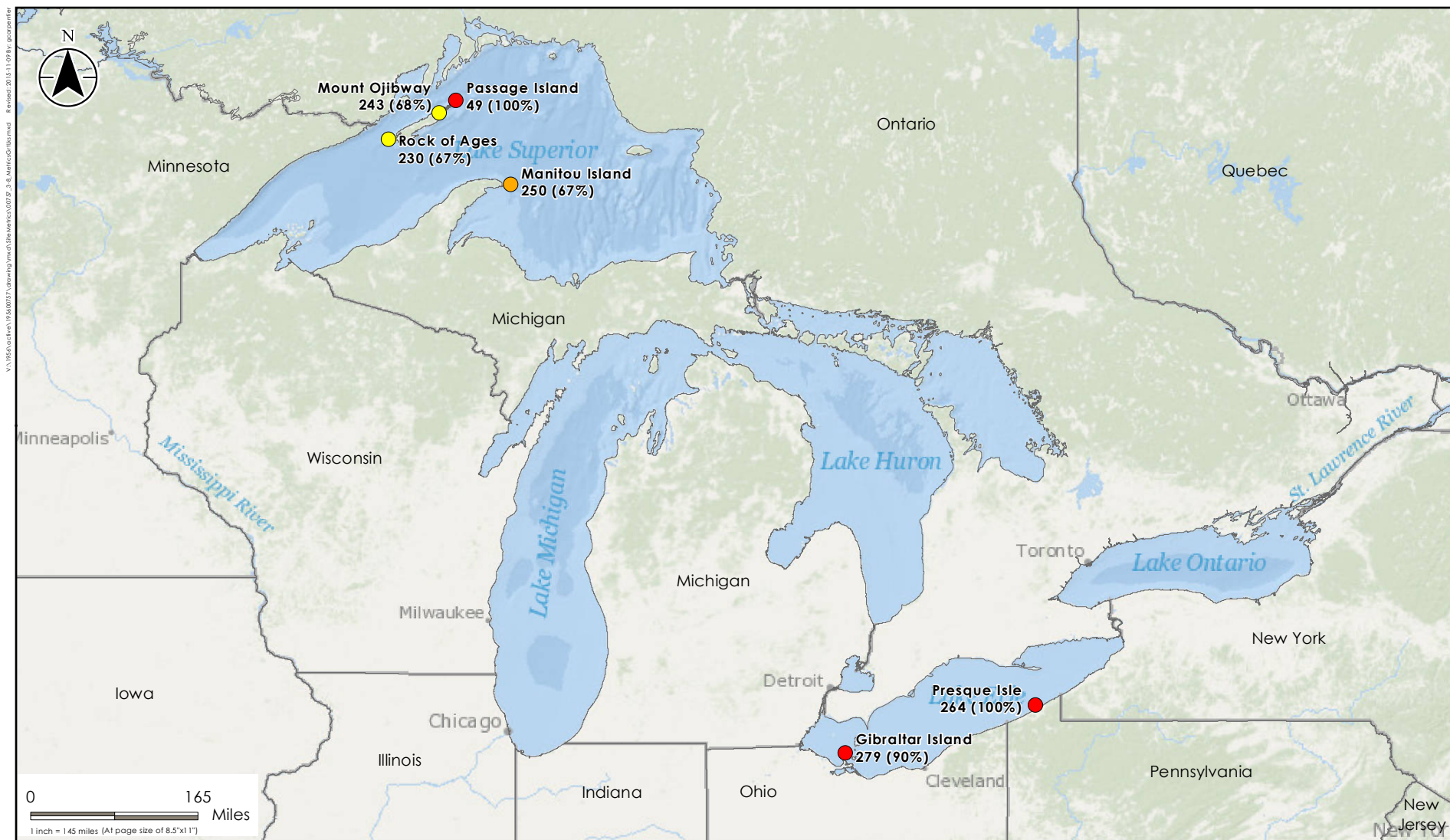
Client/Project
Offshore Acoustic Bat Study
US Department of Energy

Figure No.
3-7

Title

Overall Bat Activity Levels By Site
in the Gulf of Maine Region

11/12/2015



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195600757



30 Park Drive
Topsham, ME USA 04086
Phone (207) 729-1199

Prepared by GAC on 2015-11-09
Reviewed by TSP on 2015-11-10

00757_3-8_MetricsGrfLks.mxd

Legend

Passes per Night

- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 20.0
- 20.1 - 50.0
- 50.1 - 100.0
- >100

Label Key

Site Name
X (Y)

where:

X = Number of Nights Surveyed

Y = Percent of nights with bat activity

Client/Project

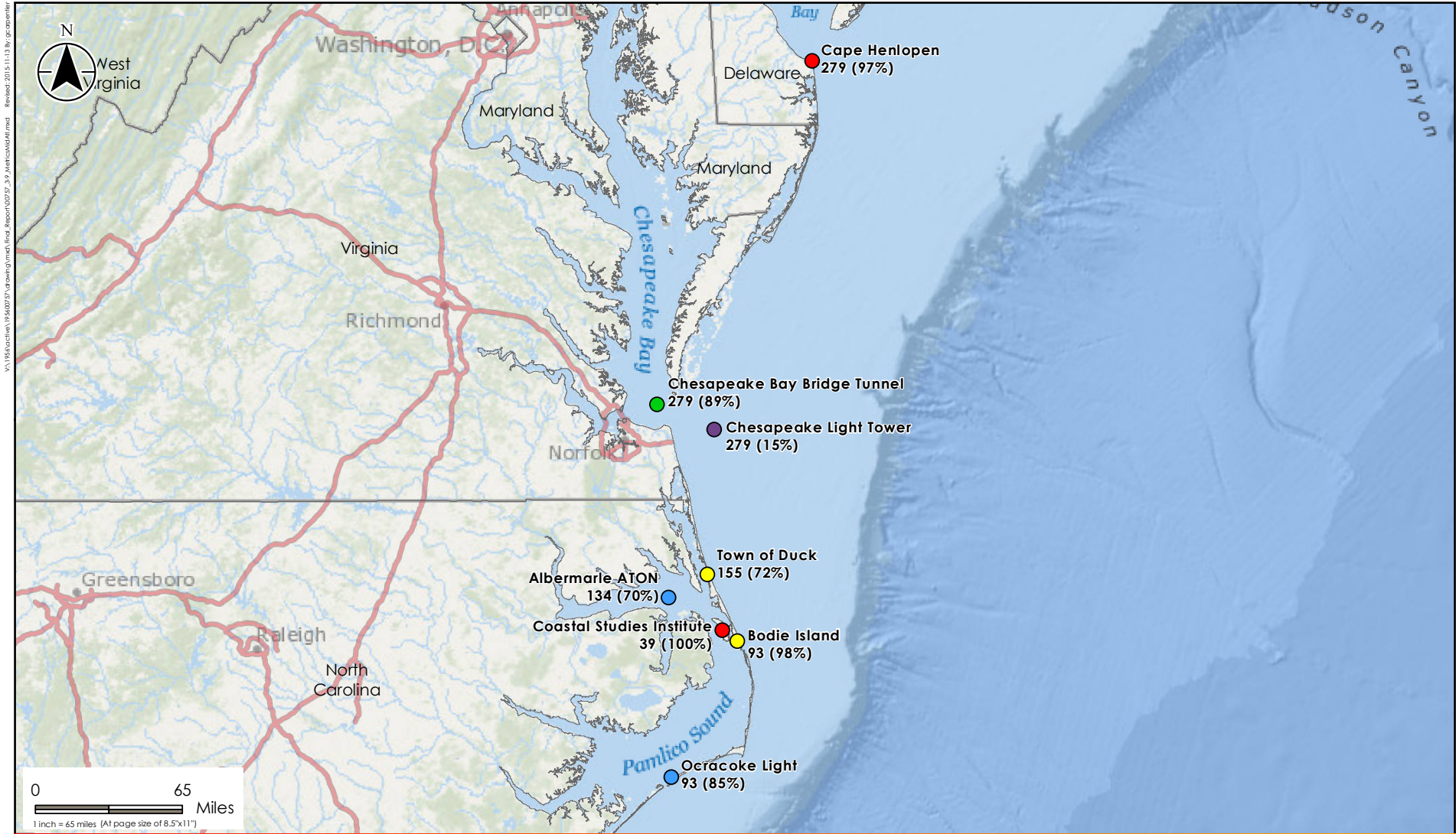
Offshore Acoustic Bat Study
US Department of Energy

Figure No.

3-8

Title

Overall Bat Activity Levels By Site
in the Great Lakes Region
11/9/2015



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195600757



30 Park Drive
Topsham, ME USA 04086
Phone (207) 729-1199

Prepared by GAC on 2015-11-09
Reviewed by TSP on 2015-11-10

00757_3-9_MetricsMidAtl.mxd

Legend

Passes per Night

- 0.1 - 5.0
- 5.1 - 10.0
- 10.1 - 20.0
- 20.1 - 50.0
- 50.1 - 100.0
- >100

Label Key

Site Name
X (Y)

where:

X = Number of Nights Surveyed

Y = Percent of nights with bat activity

Client/Project

Offshore Acoustic Bat Study
US Department of Energy

Figure No.

3-9

Title

Overall Bat Activity Levels By Site
in the Mid-Atlantic Region

11/13/2015

LONG-TERM BAT MONITORING ON ISLANDS, OFFSHORE STRUCTURES, AND COASTAL SITES IN THE GULF OF MAINE, MID-ATLANTIC, AND GREAT LAKES—FINAL REPORT

January 15, 2016

Table 3-1. Characteristics of acoustic bat survey sites monitored from 2009 – 2014.

Site		Years Surveyed	Latitude	Longitude	Category	Island Size (ha)	Distance to Mainland (km)	% Land within 3 nm	% Forest within 150 m	Sampling Location	Height (m)	Habitat Surrounding Detector
Gulf of Maine	Appledore Island	2010, 2012, 2014	42.98706	-70.61533	Medium	40.0	10.2	0.7	62.0	Observation Tower	18	Tower on high island point in complex of buildings surrounded by dense shrubby vegetation
	Frenchboro	2009	44.09820	-68.36732	Large	594	10.5	7.7	28.6	Tree	2	Edge of coniferous forest at outer shoreline point of land
	Great Duck Island	2009 – 2012, 2014	44.14209	-68.24573	Medium	86	9.8	1.3	0.2	Lighthouse	5	Lighthouse tower at edge of field along outer shoreline point of land; scattered nearby structures
	Halfway Rock	2009, 2010, 2013	43.655994	-70.0369	Small	0.9	8.3	0.7	0.0	Lighthouse	23	Wave-swept rock with no woody vegetation
	Isle au Haut	2009	44.06474	-68.65132	Large	2,753	16.7	31.8	17.6	Lighthouse	12	Short lighthouse on rocky shoreline bordered by coniferous forest
	Kent Island North Field	2011 – 2014	44.58659	-66.75620	Medium	98.5	30.2	2.0	82.0	Tree	3	Small gap in mixed forest
	Kent Island South Field	2011 – 2014	44.58139	-66.75531	Medium	98.5	30.2	2.0	10.0	Temporary Tower	5	Mowed grassy field with stunted spruce trees
	Matinicus Rock	2009 – 2010, 2012 – 2014	43.78383	-68.85500	Small	10.3	32.9	0.7	0.0	Lighthouse	14	Wave-swept rock with no woody vegetation' adjacent structure
	Metinic Tower	2009 – 2010, 2012 – 2014	43.87959	-69.12707	Medium	139.8	8.7	1.6	0.0	Temporary Tower	6	Grassy open field island peninsula with scattered shrubs; coniferous forest edge ~400m distant.
	Metinic Tree	2012 – 2014	43.88254	-69.12709	Medium	139.8	8.7	1.6	23.6	Tree	2	Edge of coniferous forest
	Monhegan Island	2009 – 2014	43.76477	-69.31628	Large	207.6	17.1	2.3	9.8	Lighthouse	14	Lighthouse on high island point with numerous nearby structures, maintained lawns, surrounded by spruce-fir
	Mount Desert Rock	2009 – 2011, 2013 – 2014	43.96869	-68.12820	Small	0.8	41.6	0.0	0.0	Lighthouse	17	Wave-swept rock with no woody vegetation; house and out buildings
	NERACOOS Buoy A	2011 – 2014	42.52000	-70.56000	Structure	n/a	10.5	0.0	0.0	Buoy	2	Offshore buoy
	NERACOOS Buoy B	2012 – 2013	43.17000	-70.42000	Structure	n/a	14.1	0.0	0.0	Buoy	2	Offshore buoy
	NERACOOS Buoy E	2012 – 2013	43.71	-69.35	Structure	n/a	18.8	0.0	0.0	Buoy	2	Offshore buoy
	NERACOOS Buoy F	2013	44.05	-68.99	Structure	n/a	5.9	1.2	0.0	Buoy	2	Offshore buoy
	NERACOOS Buoy I	2013 – 2014	44.1	-68.1	Structure	n/a	26.2	0.0	0.0	Buoy	2	Offshore buoy
	Owl's Head	2009	44.09190	-69.04403	Coastal	n/a	n/a	19.1	18.7	Temporary Tower	2	Shrubs and herbs on steep bank 20 m above rocky shoreline
	Petit Manan Island	2009 – 2010, 2012 – 2014	44.36757	-67.86412	Small	6.3	4	1.5	4.8	Lighthouse	30	Mowed grassy field, occupied buildings, scattered shrubs
	Petit Manan Point Field	2010, 2012 – 2014	44.408454	-67.9036	Coastal	n/a	n/a	23.4	72.2	Tree	2	Deciduous forest with short canopy surrounding a mowed field
	Petit Manan Point Heath	2013 – 2014	44.41002	-67.89878	Coastal	n/a	n/a	23.3	24.2	Tree	2	Coniferous trees surrounded by scrub/shrub marsh
	Schoodic Peninsula FD	2009, 2013 – 2014	44.33676	-68.05799	Coastal	n/a	n/a	18.6	25.3	Building Rooftop	6	Coniferous forest, mowed lawns
	Schoodic Point	2013 – 2014	44.33330	-68.06206	Coastal	n/a	n/a	16.7	36.0	Tree	4	Coniferous forest, rocky shoreline
	Seguin Island	2009 – 2014	43.70750	-69.75807	Medium	25.6	4.1	4.2	31.5	Lighthouse	16	Mowed grassy field on island high point, occupied residence, low-mid-sized shrubs

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Site		Years Surveyed	Latitude	Longitude	Category	Island Size (ha)	Distance to Mainland (km)	% Land within 3 nm	% Forest within 150 m	Sampling Location	Height (m)	Habitat Surrounding Detector
Great Lakes	Gibraltar Island	2012 – 2014	41.65858	-82.82024	Small	2.6	8.0	9.4	23.1	Stone Tower	11	Shoreline stone tower on historic structure surrounded by deciduous trees and landscaped residential properties
	Manitou Island	2012 – 2014	47.41922	-87.58730	Large	423.2	9.4	4.4	30.3	Lighthouse	15	Mixed forest with small open patches
	Mount Ojibway Firetower	2012 – 2014	48.10843	-88.60724	Large	54,400	26	66.5	78.8	Firetower	20	Rocky ridge near center of large island dominated by spruce/fir dominated forest
	Passage Island	2013 – 2014	48.22354	-88.36588	Medium	88.2	25.3	0.9	9.4	Lighthouse	10	Rocky shoreline, coniferous forest
	Presque Isle	2012 – 2014	42.16576	-80.11540	Coastal	n/a	n/a	19.4	27.3	Lighthouse	11	Stone lighthouse tower near sand beach and surrounded by deciduous trees
	Rock of Ages	2012 – 2014	47.85508	-89.32665	Small	<1	21.0	0.2	0.0	Lighthouse	45	Wave-swept rock with no woody vegetation
	Toledo Light #2	n/a	41.81829	-83.19980	Structure	n/a	13.7	0.0	0.0	Lighthouse	15	Lighthouse tower and associated building on stone structure with no natural habitat
mid-Atlantic	Albermarle ATON	2012 – 2014	36.04506	-76.00140	Structure	n/a	7.9	0.0	0.0	Offshore Structure	3	Fixed concrete navigation aid surrounded by open water
	Bodie Island	2013 – 2014	35.82024	-75.56252	Large	1,599	14.8	20.1	0.0	Boardwalk	3	Inland saltwater pond surrounded by emergent marsh and low coniferous (pitch pine) forest
	Cape Henlopen	2012 – 2014	38.77037	-75.08500	Coastal	n/a	n/a	38.0	11.1	Temporary Tower	2	Scattered mid-low canopy pitch pine trees along fenceline behind a sand barrier beach
	Chesapeake Bay Bridge Tunnel	2012 – 2014	37.03667	-76.07665	Structure	n/a	12.1	0.4	0.0	Stone Structure	15	Concrete/stone structure at entrance to tunnel surrounded by open water and connected to mainland via bridge and underwater tunnel
	Chesapeake Light Tower	2012 – 2014	36.90972	-75.70970	Structure	n/a	24.8	0.0	0.0	Offshore Platform	36	Top deck roof location of offshore steel research platform surrounded by open water
	Coastal Studies Institute	2013 – 2014	35.87598	-75.6615	Large	3,291	8.0	40.0	47.3	Boardwalk	2	Forested shoreline
	Ocracoke Light	2013 – 2014	35.10894	-75.98590	Large	1,190	28.5	12.3	33.5	Lighthouse	20	Emergent marsh and residential development with deciduous forest
	Town of Duck	2013 – 2014	36.16441	-75.75492	Large	4,985	6.0	11.9	0.0	Boardwalk	2	Open water with developed shoreline, deciduous trees
Ship	R/V Bigelow (NOAA)	2013 – 2014	n/a	n/a	Ship	n/a	n/a	n/a	n/a	Research Vessel	10	Top deck, mid-ship rail location; Roving transects between coastal Massachusetts and North Carolina
	R/V Gordon Gunter (NOAA)	2013	n/a	n/a	Ship	n/a	n/a	n/a	n/a	Research Vessel	10	Top deck, mid-ship rail location; Roving transects between Bay of Fundy and Norfolk, VA
	R/V Pisces (NOAA)	2012 – 2013	n/a	n/a	Ship	n/a	n/a	n/a	n/a	Research Vessel	10	Top deck, mid-ship rail location; Roving from Providence, RI to coastal MD

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Table 3-2. Summary of acoustic bat survey effort and results for 2009 – 2014 offshore acoustic bat surveys.

Site	Region	Year	Dates	Detector Nights	Total Passes	Max. Passes per Night	% Nights w/ Activity*	Detection Rate*	Gini Coefficient**
Albermarle ATON	mid-Atlantic	2012	20 June – 31 December 2012	195	647	67	72.0	6.14	0.72
		2013	1 January – 2 August 2013	183	51	24	36.8	1.74	-
		2014	28 February – 31 December 2014	137	279	33	65.9	4.54	0.70
Appledore Island	Gulf of Maine	2010	10 August – 31 December 2010	144	360	31	70.1	5.18	0.63
		2012	17 July – 1 November 2012	108	4,753	1,128	92.3	49.07	0.74
		2014	10 July – 6 August 2014	28	31	10	39.1	1.35	-
Bodie Island	mid-Atlantic	2013	29 May – 29 June 2013	32	83	14	--	-	-
		2014	28 February – 17 December 2014	293	6,422	611	97.8	39.70	0.66
Cape Henlopen	mid-Atlantic	2012	28 April – 27 November 2012	214	18,912	430	100.0	136.94	0.37
		2013	27 May – 15 December 2013	203	15,377	499	94.6	129.55	0.47
		2014	1 March – 17 December 2014	292	14,846	477	95.7	115.01	0.56
Chesapeake Bay Bridge Tunnel	mid-Atlantic	2012	26 April – 26 November 2012	215	3,115	234	100.0	26.25	0.57
		2013	17 May – 18 December 2013	216	1,777	133	82.8	16.10	0.64
		2014	1 March – 15 December 2014	290	1,474	84	82.8	11.02	0.65
Chesapeake Light Tower	mid-Atlantic	2012	29 April – 25 October 2012	180	165	144	4.3	0.01	0.99
		2013	1 January – 31 December 2013	365	71	13	20.4	0.62	0.90
		2014	1 January – 30 November 2014	326	103	42	20.4	0.94	0.92
Coastal Studies Institute	mid-Atlantic	2013	5 August – 12 August 2013	8	2,455	651	87.5	306.88	0.45
		2014	1 March – 22 August 2014	175	16,643	800	100.0	255.38	
Frenchboro	Gulf of Maine	2009	28 August – 3 November 2009	68	302	98	53.1	5.98	0.85
Gibraltar Island	Great Lakes	2012	13 June – 11 December 2012	182	7,716	401	69.9	50.70	0.66
		2013	15 May – 31 December 2013	231	21,676	1,028	100.0	138.05	0.49
		2014	1 January – 8 December 2014	221	13,555	423	98.9	104.48	0.47
Great Duck Island	Gulf of Maine	2009	17 August – 20 October 2009	65	954	153	50.0	15.87	0.83
		2010	27 August – 15 December 2010	111	269	63	50.0	5.26	0.78
		2011	1 January – 31 May 2011	151	2	2	--		
		2012	21 June – 24 October 2012	126	1,423	278	63.4	13.87	0.78
		2014	16 June – 16 October 2014	123	36	11	14.0	0.37	0.93
Halfway Rock	Gulf of Maine	2009	13 August – 31 December 2009	141	287	60	43.8	4.20	0.85
		2010	1 January – 24 February 2010	55	0	0	--		
		2013	31 May – 1 July 2013	32	3	1	--		
Isle au Haut	Gulf of Maine	2009	26 August – 11 November 2009	78	237	97	56.9	4.59	0.84
Kent Island North Field	Gulf of Maine	2011	26 July – 20 September 2011	57	14,368	1,274	80.7	252.05	0.61
		2012	15 May – 20 October 2012	159	27,667	1,666	96.8	294.43	0.68
		2013	13 May – 27 October 2013	168	1,199	128	81.7	11.20	0.67
		2014	28 May – 29 October 2014	155	598	208	37.6	6.43	0.89
Kent Island South Field	Gulf of Maine	2011	3 July – 18 August 2011	47	97	18	57.1	2.69	0.72
		2012	15 May – 20 October 2012	159	478	35	58.1	5.00	0.73
		2013	13 May – 22 October 2013	163	57	8	30.1	0.58	0.80
		2014	30 May – 22 September 2014	116	11	2	12.9	0.16	0.89
Manitou Island	Great Lakes	2012	13 August – 31 December 2012	141	260	130	28.1	4.00	0.93
		2013	1 January – 31 December 2013	320	9,634	619	74.2	72.80	0.71
		2014	1 January – 31 December 2014	365	11,431	1,104	87.1	96.6	0.72

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Site	Region	Year	Dates	Detector Nights	Total Passes	Max. Passes per Night	% Nights w/ Activity*	Detection Rate*	Gini Coefficient**
Matinicus Rock	Gulf of Maine	2009	2 September – 14 September 2009	13	102	44	53.8	7.46	0.84
		2010	5 August – 31 October 2010	88	178	24	31.9	2.44	
		2012	22 June – 23 October 2012	124	1,495	326	67.7	12.66	
		2013	25 June – 4 November 2013	133	441	161	34.4	4.51	
		2014	4 April – 31 December 2014	272	111	21	31.2	0.86	
Metinic Tower	Gulf of Maine	2009	29 July – 27 October 2009	91	209	29	45.6	2.56	0.77
		2010	16 July – 16 October 2010	92	213	21	56.0	2.33	0.71
		2012	24 May – 25 October 2012	155	333	51	48.4	2.73	0.80
		2013	19 June – 19 September 2013	93	64	16	29.9	0.94	0.85
		2014	11 June – 4 December 2014	177	33	5	14.0	0.33	0.91
Metinic Tree	Gulf of Maine	2012	24 May – 25 October 2012	155	2,802	122	74.2	15.31	0.70
		2013	18 June – 30 September 2013	105	272	33	64.1	3.04	0.66
		2014	11 June – 13 September 2014	95	184	28	44.3	2.89	0.78
Monhegan Island	Gulf of Maine	2009	16 September – 27 December 2009	103	27	5	43.3	0.83	0.70
		2010	19 July – 4 September 2010	48	1,157	197	95.8	24.08	0.61
		2011	12 August – 31 December 2011	142	1,452	235	81.5	22.14	0.73
		2012	1 January – 23 November 2012	200	1,926	151	84.9	18.32	0.66
		2013	12 July – 31 December 2013	173	247	33	57.0	2.65	0.71
Mount Desert Rock	Gulf of Maine	2014	1 January – 9 October 2014	204	154	36	44.8	1.69	0.80
		2009	17 August – 31 December 2009	137	597	168	30.0	9.63	0.90
		2010	26 August – 31 December 2010	128	277	92	41.2	5.04	0.90
		2011	1 January – 17 September 2011	260	366	133	41.5	3.28	0.90
		2013	9 July – 23 July 2013	15	7	7	0.0	0.00	0.92
Mount Ojibway	Great Lakes	2014	8 August – 27 October 2014	81	336	77	27.5	4.61	
		2012	10 August – 31 December 2012	144	4,985	773	73.1	74.40	0.78
		2013	1 January – 31 December 2013	365	1,109	101	69.9	7.00	0.69
NERACOOS Buoy A	Gulf of Maine	2014	1 January – 5 October 2014	278	599	63	61.4	4.81	0.80
		2011	1 June – 15 October 2011	137	84	9	31.2	0.86	0.82
		2012	14 April – 2 July 2012	80	7	3	--	1.06	0.86
		2013	18 June – 18 August 2013	62	41	20	40.0		
NERACOOS Buoy B	Gulf of Maine	2014	1 April – 17 April 2014	17	0	0	--	3.83	0.77
		2012	11 April – 31 December 2012	265	411	32	46.2		
NERACOOS Buoy E	Gulf of Maine	2013	1 January – 17 December 2013	203	93	11	28.0	0.99	0.83
		2012	11 April – 31 December 2012	265	378	44	54.8	3.96	0.77
NERACOOS Buoy F	Gulf of Maine	2013	1 January – 10 December 2013	218	7	4	1.1	0.04	0.99
		2013	17 June – 24 September 2013	100	233	22	56.9	3.03	0.71
NERACOOS Buoy I	Gulf of Maine	2013	24 June – 31 December 2013	191	9	3	6.5	0.05	0.96
		2014	1 January – 3 March 2014	62	0	0	--	1.62	0.81
NOAA Bigelow	Ship	2013	8 April – 21 April 2013	14	0	0	--		
		2014	17 June – 30 September 2014	106	127	26	38.5	0.00	-
NOAA Gunter	Ship	2013	12 May – 22 July 2013	72	19	4	0.0	0.00	-
NOAA Pisces	Ship	2012	10 September – 24 September 2012	15	0	0	0.0	0.00	-
		2013	12 May – 15 July 2013	65	6	2	0.0	0.00	-
Ocracoke Light	mid-Atlantic	2013	28 May – 28 July 2013	62	397	197	78.6	21.50	-
		2014	28 February – 1 November 2014	247	1,368	159	84.9	7.63	0.61
Owl's Head	Gulf of Maine	2009	11 August – 14 November 2009	93	3,208	397	90.5	50.48	0.71
Passage Island	Great Lakes	2013	26 June – 4 July 2013	9	3,133	820	--	-	-
		2014	13 June – 26 August 2014	74	11,338	1,661	100.0	205.88	0.55

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Site	Region	Year	Dates	Detector Nights	Total Passes	Max. Passes per Night	% Nights w/ Activity*	Detection Rate*	Gini Coefficient***
Petit Manan Island	Gulf of Maine	2009	28 July – 29 October 2009	94	117	36	31.3	1.46	0.88
		2010	30 July – 11 November 2010	105	94	27	16.7	1.18	0.93
		2012	30 June – 17 November 2012	141	746	494	51.6	7.71	0.91
		2013	11 July – 5 November 2013	118	52	13	17.2	0.56	0.91
		2014	1 April – 29 October 2014	212	25	5	14.0	0.20	0.91
Petit Manan Point Field	Gulf of Maine	2010	7 September – 4 November 2010	59	4,659	978	87.2	119.38	0.72
		2012	25 May – 7 November 2012	167	9,530	1,143	90.3	89.42	0.66
		2013	11 July – 6 November 2013	119	7,343	573	96.8	77.47	0.63
		2014	1 April – 7 November 2014	221	4,467	342	89.2	46.84	0.58
Petit Manan Point Heath	Gulf of Maine	2013	11 July – 6 November 2013	119	3,313	320	88.2	34.10	0.62
		2014	1 April – 7 November 2014	221	2,302	349	71.0	9.40	0.77
Presque Isle	Great Lakes	2012	30 July – 5 December 2012	129	43,462	1,575	100.0	542.60	0.43
		2013	16 May – 31 December 2013	230	36,140	1,097	100.0	292.32	0.43
		2014	4 June – 31 December 2014	211	49,009	1,468	100.0	428.73	0.41
Rock of Ages	Great Lakes	2012	28 August – 10 October 2012	44	3,132	1,113	63.6	71.05	0.87
		2013	12 June – 6 December 2013	178	5,671	922	69.9	37.84	0.73
		2014	10 July – 31 December 2014	175	3,979	604	65.6	42.71	0.82
Schoodic Peninsula FD	Gulf of Maine	2009	18 August – 31 October 2009	75	314	49	64.4	5.29	0.75
		2013	10 July – 6 November 2013	120	616	54	81.7	5.76	0.57
		2014	1 April – 7 November 2014	221	510	116	62.4	5.24	0.79
Schoodic Point	Gulf of Maine	2013	10 July – 6 November 2013	120	526	52	69.9	5.46	0.67
		2014	1 April – 7 November 2014	221	645	75	66.7	6.15	0.72
Seguin Island	Gulf of Maine	2009	25 August – 11 November 2009	79	19,820	2,492	80.8	380.60	0.70
		2010	15 July – 23 October 2010	101	20,203	1,989	90.3	217.15	0.67
		2011	27 August – 8 November 2011	74	19,447	1,775	82.0	388.78	0.60
		2012	18 May – 17 October 2012	153	25,774	2,301	93.5	254.18	0.80
		2013	10 May – 14 October 2013	153	37,389	1,877	91.3	400.18	0.57
		2014	25 May – 31 December 2014	221	21,988	1,443	87.1	234.97	0.68
Town of Duck	mid-Atlantic	2013	15 August – 14 December 2013	122	118	42	33.9	1.81	0.86
		2014	1 March – 16 November 2014	261	3,409	643	96.8	34.56	0.65
*Percent nights with activity and detection rate (number of passes per night) are calculated for the subset of datasets between 15 July and 15 October.									
**Gini coefficient calculated only for sites with 30 or more nights sampled between 15 July and 15 October.									

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3.2 SPECIES COMPOSITION

We categorized 346,327 bat passes (61% of total) to species group, and identified 258,623 of these (46% of total) to species (treating bats within the genus *Myotis* as a single species) (Table 3-3). The remaining passes were categorized as high frequency or low frequency “unknown” but were included in analyses of overall bat activity. MYSP were the most commonly detected species overall and accounted for 43% of passes identified to species, despite their near absence in the mid-Atlantic region. LABO were the most widespread in terms of occurrence among sites, present at 97% of surveyed sites (Table 3-3). EPFU were detected at high levels at certain sites, contributing to high overall numbers, although they were detected at few sites relative to other species. By contrast, long-distance migratory LACI and LANO accounted for relatively low overall numbers of passes, but occurred at a high percent of sites across all regions. PESU were detected infrequently, accounting for low numbers of overall passes and occurring at 53% of sites monitored overall (Table 3-3). Species composition was relatively consistent among years in the Gulf of Maine and mid-Atlantic regions, although the rate of MYSP activity declined sharply in the Great Lakes region between 2012 and 2014, driven largely by a pronounced decline at the Presque Isle site (Figure 3-10). At the same time, rate of EPFU activity increased during the same period.

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Table 3-3. Bat passes identified to species (n = 258,558) by region (data from ships excluded), pooling results among surveyed sites (n = 38). EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = Myotis species, PESU = tri-colored bat.

Species	Region	# Passes (% in Region)	# Sites (% Region)
EPFU	Great Lakes	22,172 (20%)	6 (100%)
	Gulf of Maine	3,300 (3%)	14 (58%)
	mid-Atlantic	5,327 (14%)	6 (75%)
	<i>Total</i>	<i>30,799 (12%)</i>	<i>26 (68%)</i>
LABO	Great Lakes	22,784 (20%)	6 (100%)
	Gulf of Maine	48,727 (46%)	23 (96%)
	mid-Atlantic	31,139 (81%)	8 (100%)
	<i>Total</i>	<i>102,650 (40%)</i>	<i>37 (97%)</i>
LACI	Great Lakes	2,331 (2%)	6 (100%)
	Gulf of Maine	2,229 (2%)	23 (96%)
	mid-Atlantic	372 (1%)	7 (88%)
	<i>Total</i>	<i>4,932 (2%)</i>	<i>36 (95%)</i>
LANO	Great Lakes	5,075 (4%)	6 (100%)
	Gulf of Maine	1,329 (1%)	21 (88%)
	mid-Atlantic	1,156 (3%)	7 (88%)
	<i>Total</i>	<i>7,560 (3%)</i>	<i>34 (89%)</i>
MYSP	Great Lakes	60,349 (53%)	6 (100%)
	Gulf of Maine	50,961 (48%)	23 (96%)
	mid-Atlantic	9 (<1%)	5 (63%)
	<i>Total</i>	<i>111,319 (43%)</i>	<i>34 (89%)</i>
PESU	Great Lakes	991 (1%)	4 (67%)
	Gulf of Maine	39 (<1%)	9 (38%)
	mid-Atlantic	268 (1%)	7 (88%)
	<i>Total</i>	<i>1,298 (1%)</i>	<i>20 (53%)</i>

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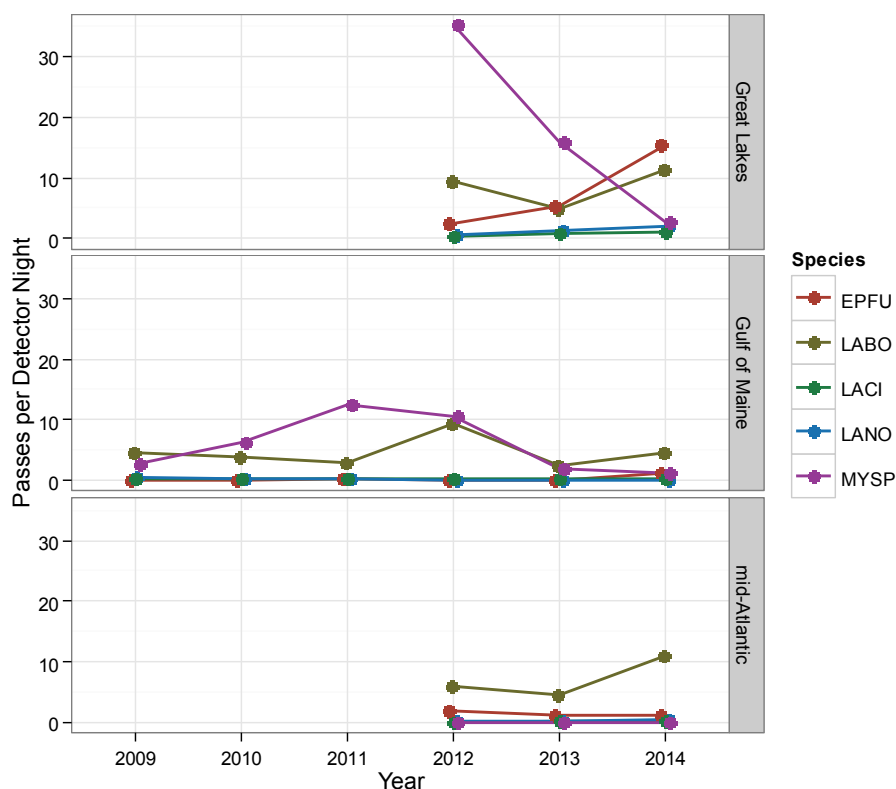


Figure 3-10. Yearly activity levels (passes per detector night) by species, pooled at the regional level, among years. EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* spp.

Overall species composition varied substantially among sites, regions, and site categories. In the Gulf of Maine, while *Myotis* species comprised a large portion of identified bat passes at coastal and medium island sites, few *Myotis* passes were detected at structures, ships, small islands, and large islands (Figure 3-11). *Myotis* species comprised a large proportion of bat passes recorded at small islands in the Great Lakes region. Of the 3,684 bat passes recorded at offshore structures that could be identified to species or species group, eastern red bats ($n = 3,308$; 89.8%), hoary bats ($n = 176$; 4.8%), and silver-haired bats ($n = 113$; 3.1%) were by far the most frequently detected species, and *Myotis* species comprised less than 1% of activity ($n = 23$).

Bat species composition varied seasonally at individual sites as well as the regional scale. Although generally recorded in relatively small numbers, migratory silver-haired bats occurred most frequently during June in the Great Lakes, September in the Gulf of Maine, and October in the mid-Atlantic (Figure 3-12). Eastern red bats and hoary bats occurred most frequently during August in all regions. Most species were more active in the Great Lakes during spring than in the other regions, with the exception of eastern red bats, which occurred frequently in the mid-Atlantic during spring. Numbers of recorded passes per species followed generally similar

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patterns, although the highest number of passes for *Myotis* species and eastern red bats were recorded during September in the Gulf of Maine (Figure 3-12).

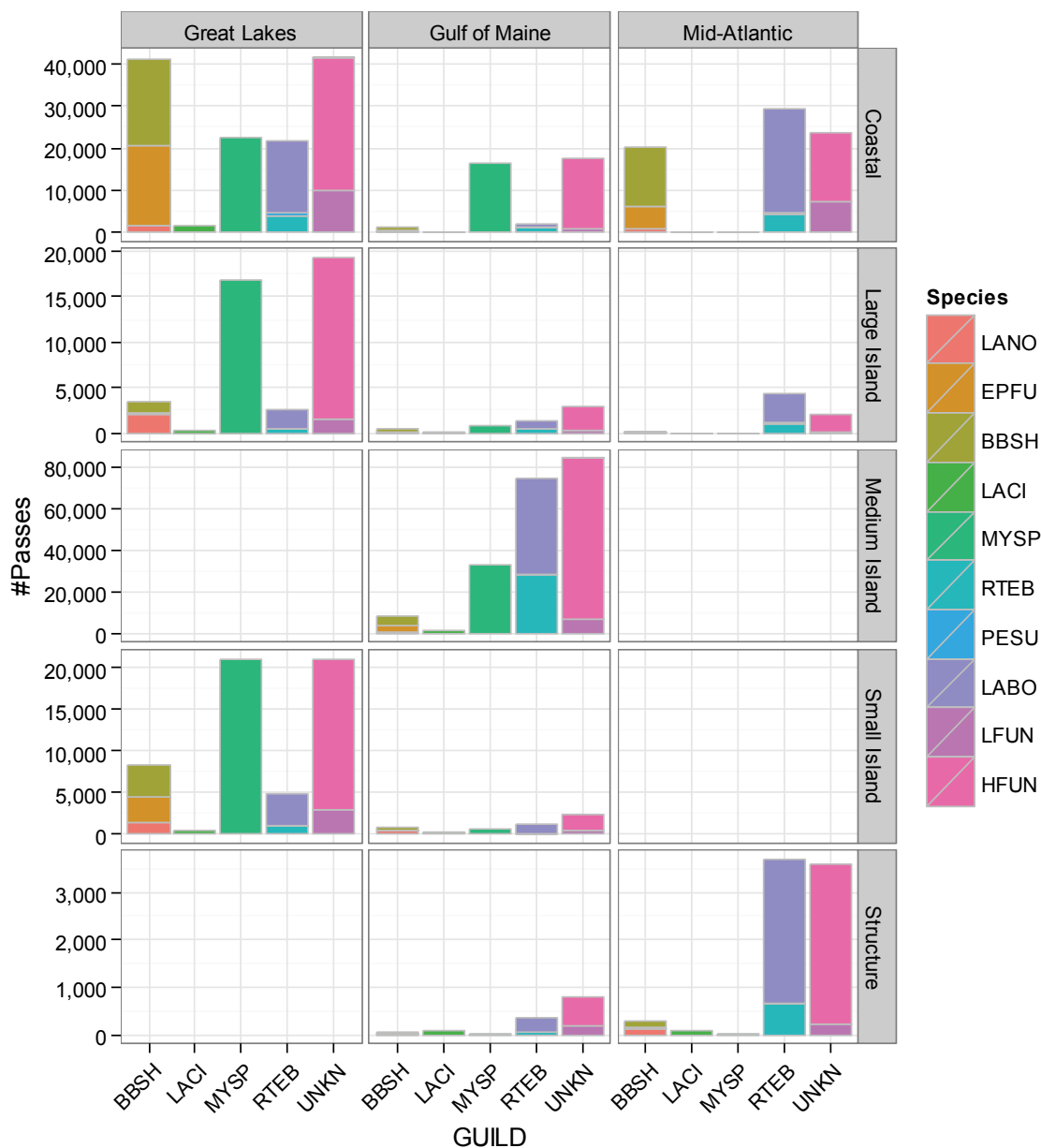


Figure 3-11. Overall species composition by region and site category, pooled among sites and years. EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* spp, PESU = tri-colored bat, BBSH = big brown/silver-haired group, RTEB = eastern red/tri-colored/evening bat group, LFUN = low frequency unknown, HFUN = high frequency unknown, UNKN = unknown group.

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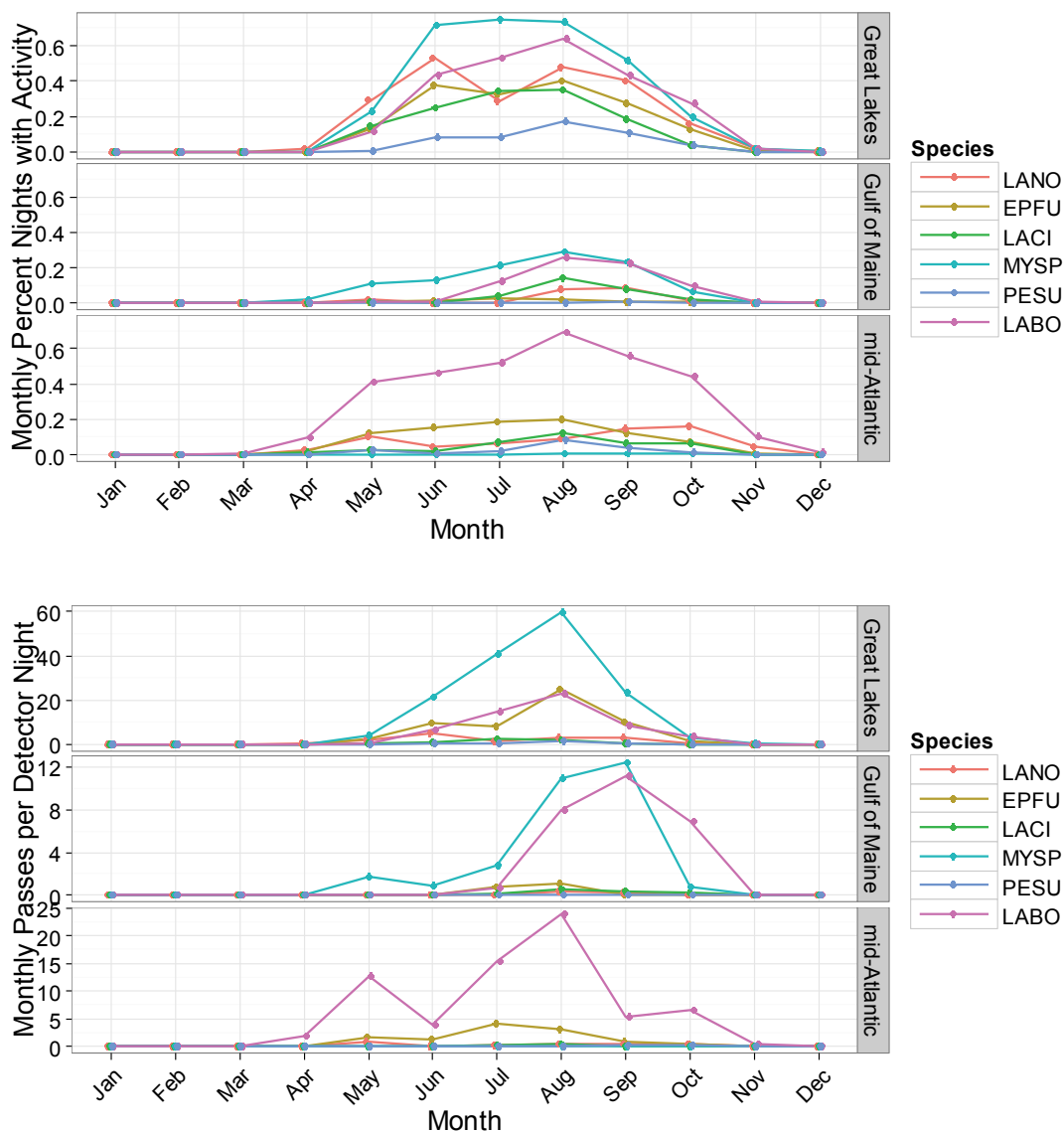


Figure 3-12. Monthly percent surveyed nights with activity (top) and passes per detector night (bottom) by species and region, pooled among sites and years. EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* spp, PESU = tri-colored bat.

As was the case for total bat activity levels, weeks 34 or 35 were most often the busiest weeks for each species, although the distribution of weeks with peak activity varied somewhat among species (Figure 3-13). Distribution of weeks with highest numbers of recorded silver-haired bats in particular was concentrated during weeks 34 – 37 (mid-August to mid-September).

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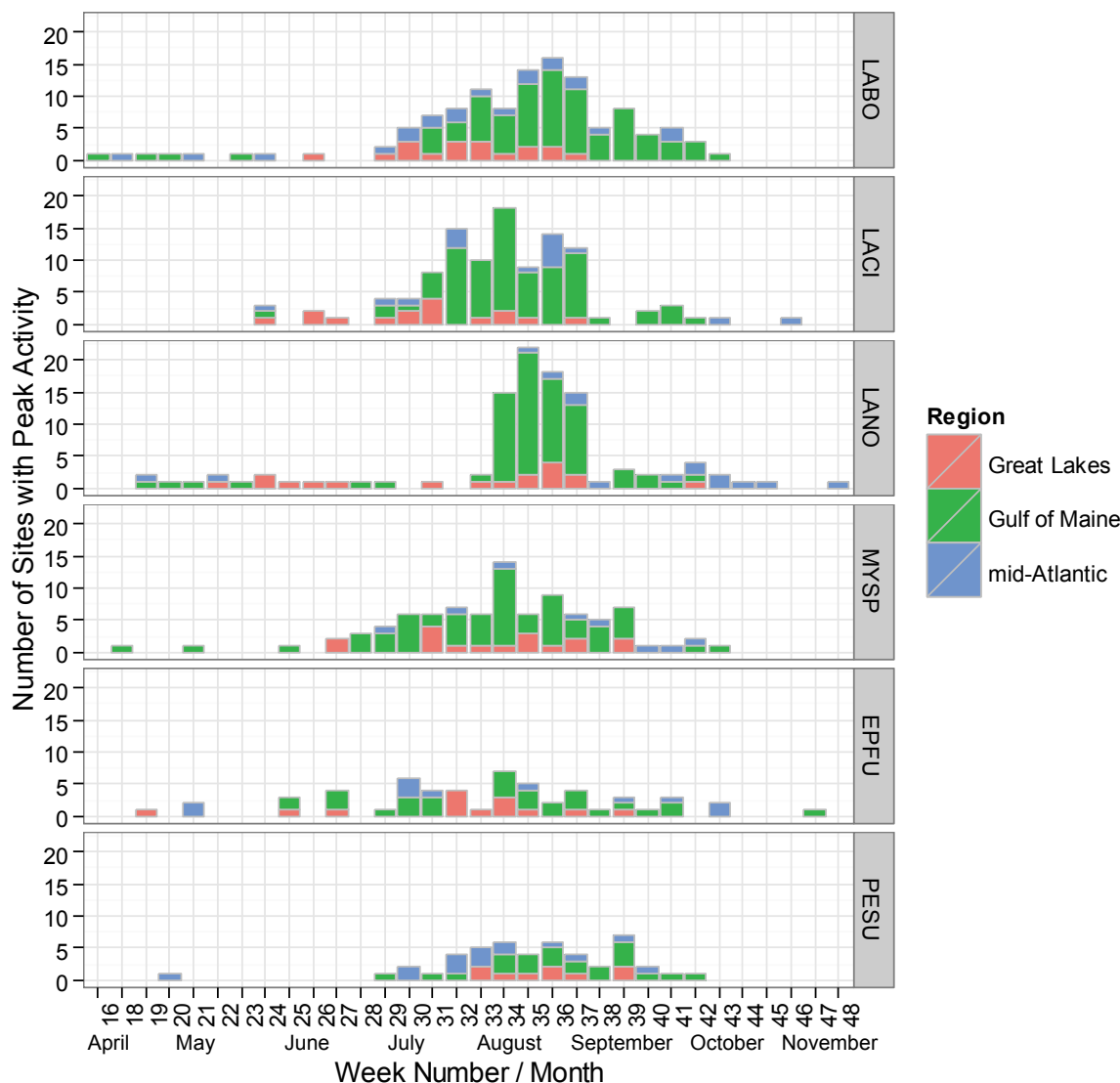


Figure 3-13. Distribution of weeks with highest number of bat passes by species among annual datasets from fixed sites (n = 119).

3.3 SEASONAL PATTERNS AND REGIONAL WEATHER

Bat activity occurred between 13 January and 9 December at sites in the Great Lakes region, between 13 April and 27 November in the Gulf of Maine region, and between 12 March and 7 December in the mid-Atlantic region. The bat pass recorded in the Great Lakes region (at Gibraltar Island) on 13 January was the only pass recorded at any site between 9 December and 12 March. Overall, 85.3% of bat passes occurred between 15 July and 15 October. Weekly passage rates ranged from 0 – 7,620 per site. The busiest week of bat activity occurred between week numbers 18 (mid-April) through 42 (mid-October) for individual sites during particular years

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of the study. Weeks 34 and 35 (mid- to late August) were consistently the busiest weeks overall among site/year datasets (Figure 3-14).

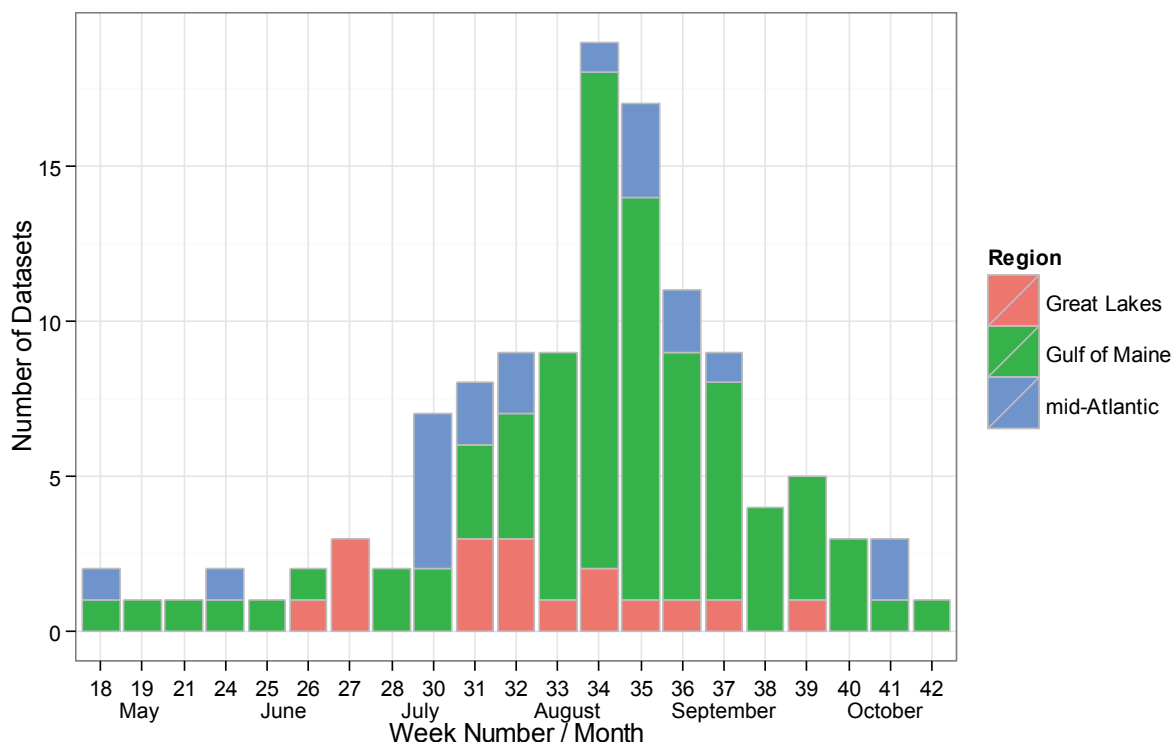


Figure 3-14. Distribution of weeks with highest number of bat passes for all species combined and by species/species group across site/year datasets from fixed sites between 2009 and 2014 (n = 119).

Bats were most active during August and September across regions and years, although high levels of bat activity occurred over a longer period in the Great Lakes region compared to the Gulf of Maine and mid-Atlantic regions (Figure 3-15). Peak monthly activity, combining sites, was highest in August or September during most years in each region (Figure 3-16). Bats were active for a longer period of the year at coastal and island sites than offshore structures, where monthly number of passes was also substantially lower (Figure 3-16). Although the number of recorded bat passes fluctuated widely among sites and nights throughout the study, seasonal timing of activity at most sites followed a similar pattern with the highest rate of bat passes occurring during August or September during roughly 80% of site/year datasets.

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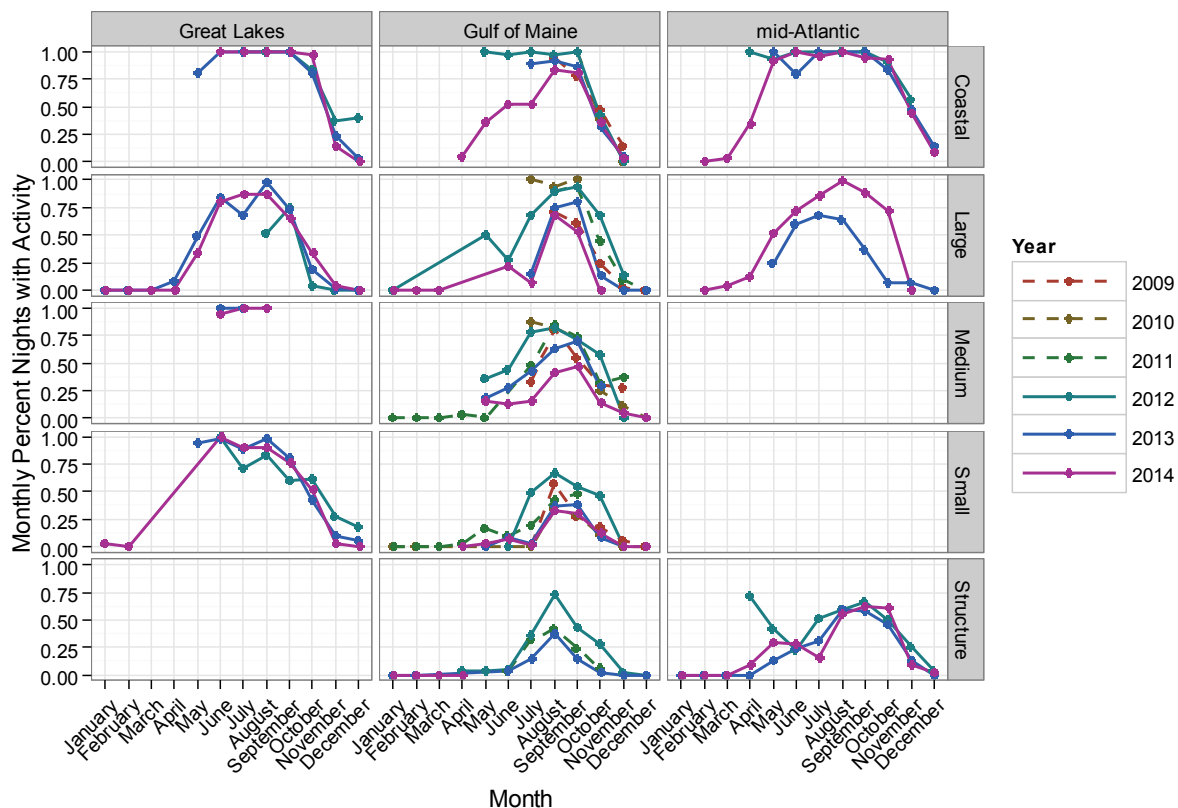


Figure 3-15. Monthly proportion of nights with bat activity (1 or more recorded bat pass) by region and category during 2009 – 2014 acoustic surveys.

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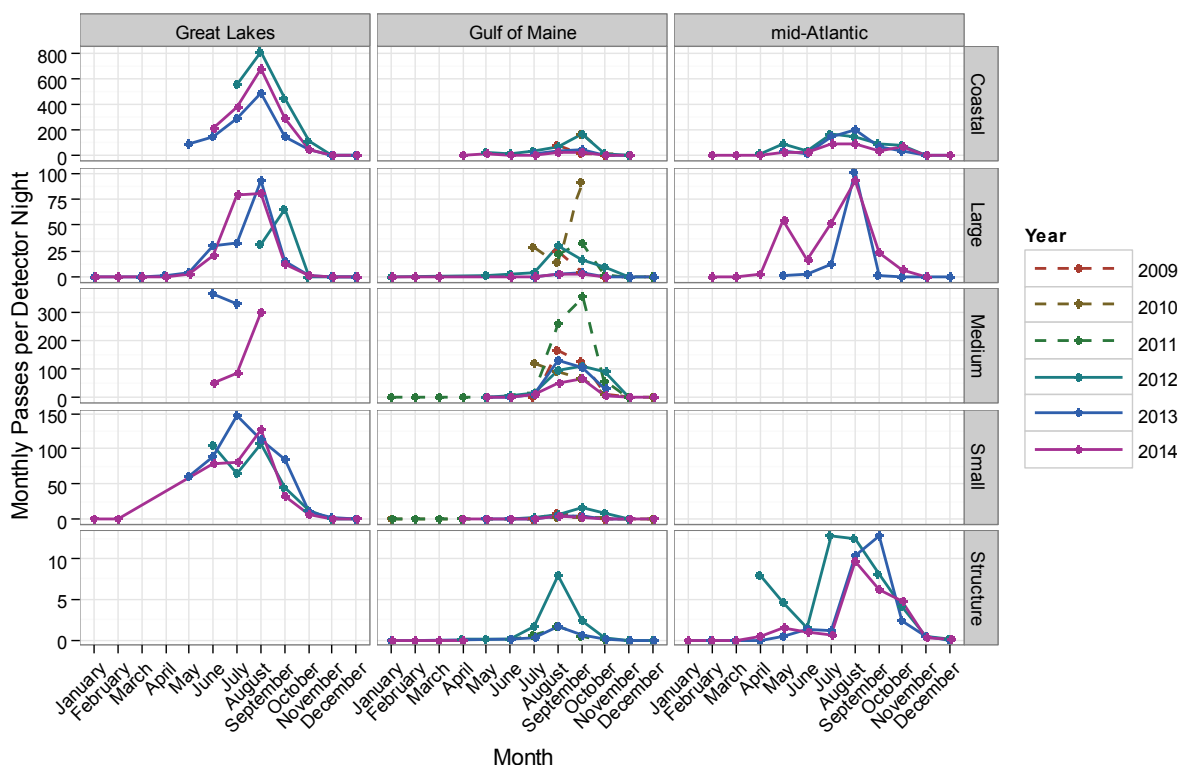


Figure 3-16. Monthly number of bat passes per detector night by region and category during 2009 – 2014 acoustic surveys. Note varying scale limits on the y-axes.

The subset of nightly data used for regional modeling of bat activity versus season and regional weather included 531 nights in the Great Lakes region, 876 nights in the Gulf of Maine region, and 617 nights in the mid-Atlantic region. Four or more sites per region were monitored simultaneously during each of these nights. Average nightly wind speeds and temperatures varied among regions, with overall warmer temperatures and lower wind speeds in the mid-Atlantic and a wider range in temperature and wind speed in the Great Lakes versus the other 2 regions. Bat activity occurred disproportionately during warmer temperatures and lower wind speeds within each region (Figure 3-17).

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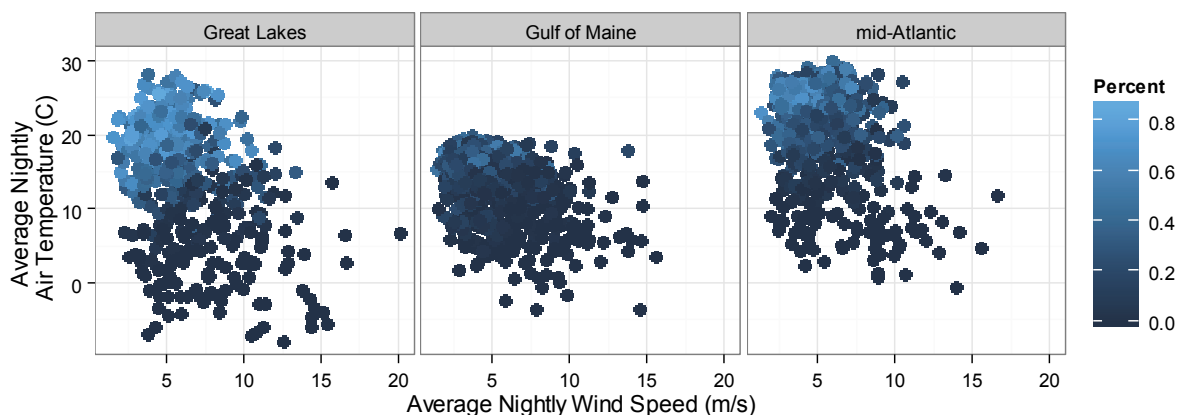


Figure 3-17. Nightly distribution of bat activity (expressed as a nightly percent of hours with activity across all sites within a region) versus average nightly wind speed and air temperature.

Additive models indicated varying effects of temperature, wind speed, and seasonality on bat activity among regions. In the Great Lakes region, the model assigned significant smoothing functions for nightly wind speed, mean nightly air temperature, and Julian Day, indicating their contribution to variation in bat activity. Mean nightly wind speed had a negative effect on activity up to ~10 m/s ($F = 7.0$, $p < 0.001$), and bat activity increased between nightly air temperatures ~7 and 20°C ($F = 7.4$, $p < 0.001$). Activity peaked at approximately Julian Day 225 (mid-August) in the Great Lakes region ($F = 70.2$, $p < 0.001$) (Figure 3-18). Each variable was also significant in the Gulf of Maine region, with wind speed having a negative effect on activity up to ~10 m/s ($F = 22.2$, $p < 0.001$), temperature having a positive effect on activity above ~12°C ($F = 11.9$, $p < 0.001$), and Julian Day having a variable effect with peaks centered at ~250 days (7 September) and 140 (20 May) ($F = 44.1$, $p < 0.001$) (Figure 3-18). Smoothing functions were also significant in the mid-Atlantic region, with wind speed ($F = 28.4$, $p < 0.001$) and temperature ($F = 5.3$, $p < 0.001$) following similar relationships as in the Gulf of Maine. The smoothing function for Julian Day ($F = 46.9$, $p < 0.001$) peaked at days ~140 (20 May) and 230 (19 August) as in the Gulf of Maine (Figure 3-18). Together, these parameters explained 88.9% of deviance in bat activity in the Great Lakes, 63.7% of deviance in the Gulf of Maine, and 78.5% of deviance in the mid-Atlantic region.

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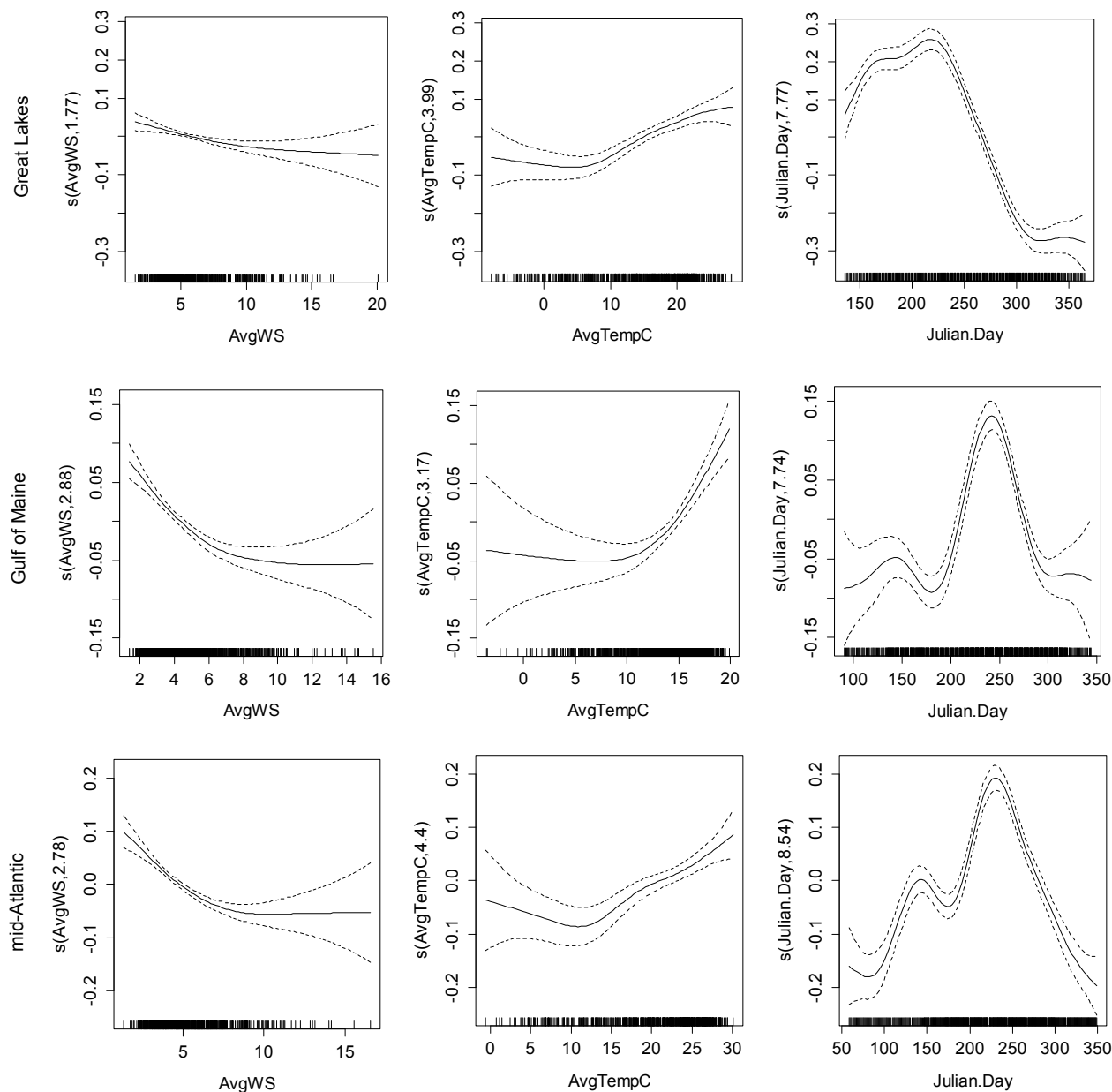


Figure 3-18. Smoothing functions of additive models of the effect of mean nightly wind speed (left column), temperature (center column), and season (Julian Day; right column) on percent of hours with bat activity on a regional basis in the Great Lakes region (top row), Gulf of Maine region (middle row), and mid-Atlantic region (bottom row). The vertical axis shows the contribution of the smoothing function to the fitted values of distribution of bat activity, with dashed lines indicating 95% confidence intervals.

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3.4 SPATIAL ANALYSES

Survey sites were between 0 km (coastal sites) and 41.6 km from the mainland, while the percent land area within a 3 nm radius ranged from 0 – 66.5% and the percent forested habitat within 150 m of detectors ranged from 0 – 82.0% (Figure 3-19). Of these measures, land area and percent forested habitat had the highest correlation (0.51), whereas distance was poorly correlated with land area (-0.21) and percent forested habitat (-0.06). As such, it was appropriate to include each of the terms as fixed effects when modeling effects of site isolation and habitat on bat activity.

The number of bat passes recorded per night, percent of nights with activity, and Gini coefficient varied substantially among sites, but were generally consistent among years at individual sites. Downward trends in passes per night and percent nights with activity and upward trends in Gini coefficient (indicating less consistent activity) relative to increasing distance from the mainland are apparent, with the positive effect of percent forest in the microhabitat surrounding detectors evident in certain outlier sites (Figure 3-20).

A generalized mixed effects model (assuming a Poisson distribution) demonstrated that distance from the mainland had a significant negative effect on the total number of passes per night while the percent of forest within 150 m had an approximately equal but opposite effect on activity (Table 3-4). Unexpectedly, land area within 3 nm also had a significant negative effect on the total number of passes, although the effect size was substantially less than those for distance and percent forest and this may have been related to an influential outlier in the Great Lakes region. The effect of distance on the number of passes differed significantly among regions, with the strongest negative effect documented in the mid-Atlantic and the weakest negative effect documented in the Gulf of Maine (although distance had a negative effect in all regions; Figure 3-21). The marginal and conditional pseudo- R^2 values for the fitted model were 0.488 and 0.502 respectively, indicating that the random effect year explained little of the overall variance in number of bat passes per night.

Distance from the mainland and percent forest within 150 m had significant and opposing effects on the percent of nights with activity, while land area within 3 nm had no effect (Table 3-4). The effect of distance varied significantly among regions, with the greatest negative effect occurring in the mid-Atlantic region and the weakest negative effect occurring in the Gulf of Maine (Figure 3-22). Marginal and conditional pseudo- R^2 values were 0.482 and 0.487, respectively, for the fitted model, indicating that the random effect of year explained little of the overall variance.

Gini coefficients increased significantly with distance from the mainland and decreased with percent forest within 150 m, indicating less consistent bat activity patterns among nights at sites more distant from the mainland and with less surrounding forest (Table 3-4). As was the case for percent nights with activity, land area did not have an effect on Gini coefficient and the effect of distance on Gini coefficient was weakest in the Great Lakes region (Figure 3-23). Marginal

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and conditional pseudo- R^2 values were both 0.524 for the fitted model, indicating that the random effect of year explained none of the overall variance in Gini coefficient.

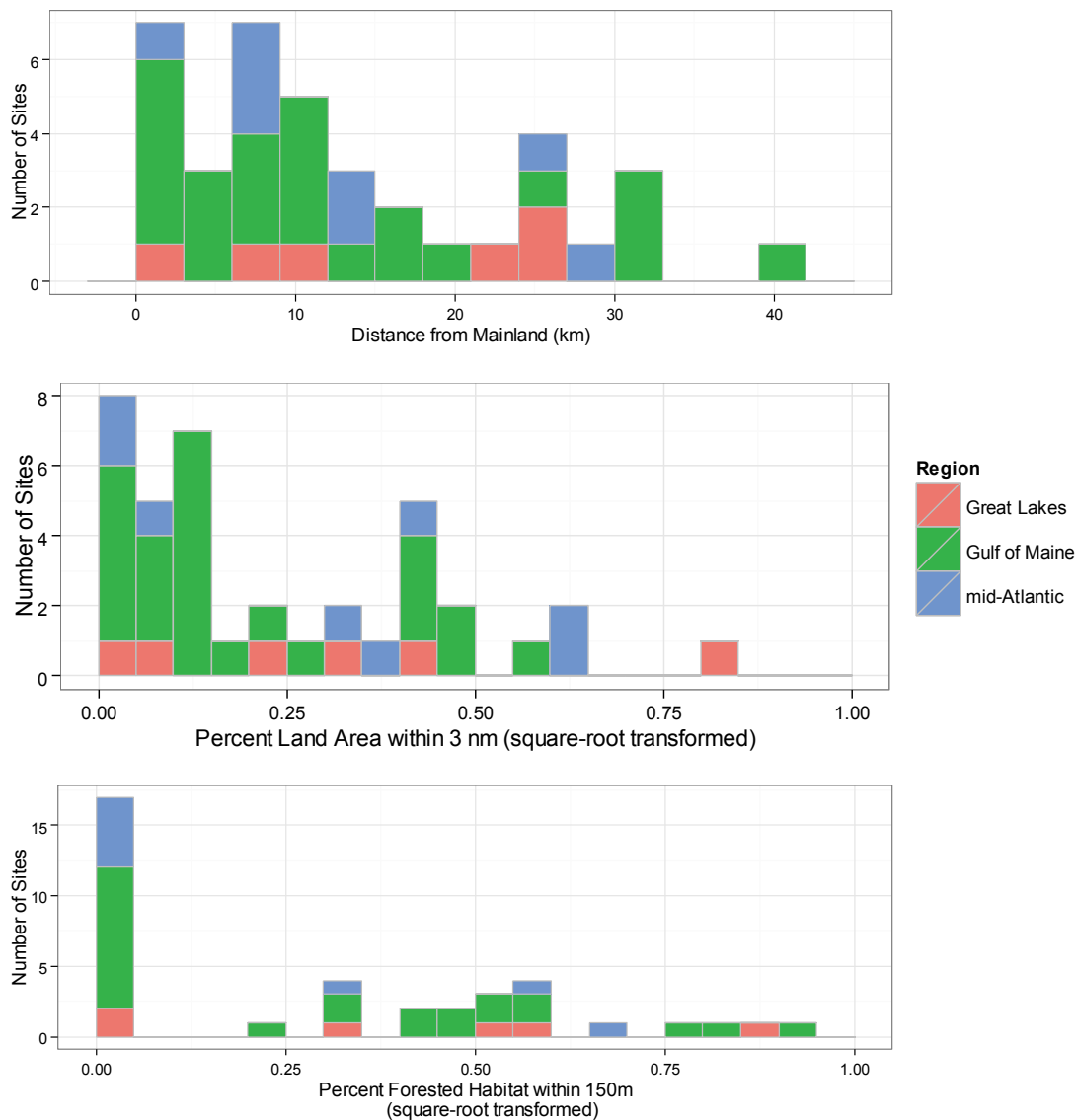


Figure 3-19. Distribution of sites by region, according to distance from the mainland (top), percent land area within 3 nautical miles (middle), and percent forested habitat within 150m (bottom).

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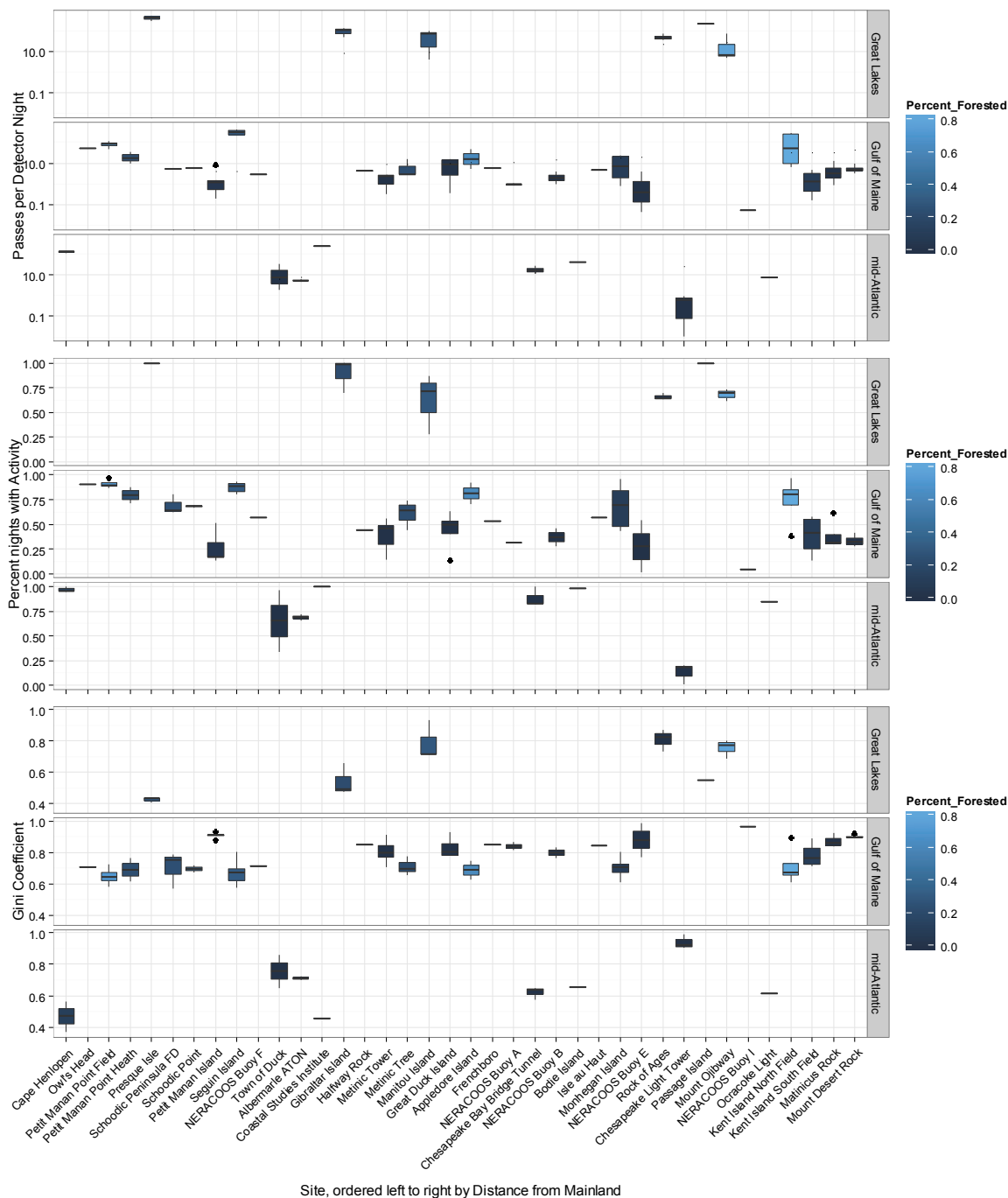


Figure 3-20. Bat passes per detector night (top), percent nights with activity (middle), and Gini coefficient (bottom) per site, calculated annually for the period between 15 July and 15 October.

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Table 3-4. Estimated coefficients of fixed effects for linear mixed effects models of bat activity versus region and spatial/habitat predictors. P-values based on Type II/III analysis of variance.

Bat Activity Measure	Fixed Effect	Estimate	Standard Error	p-value
Passes per Night	Intercept (Great Lakes)	4.95	0.22	<0.001
	Region (Gulf of Maine)	-1.85	0.04	
	Region (mid-Atlantic)	0.25	0.07	
	Distance	-1.69	0.05	<0.001
	Land Area	-0.61	0.03	<0.001
	Percent Forest	1.66	0.04	<0.001
	Distance:Gulf of Maine	0.70	0.06	<0.001
	Distance:mid-Atlantic	-0.76	0.13	
Percent Nights w/ Activity	Intercept (Great Lakes)	0.68	0.10	<0.001
	Region (Gulf of Maine)	-0.22	0.10	
	Region (mid-Atlantic)	0.21	0.13	
	Distance	-0.15	0.10	<0.01
	Land Area	0.00	0.04	0.92
	Percent Forest	0.21	0.04	<0.01
	Distance:Gulf of Maine	0.07	0.11	<0.05
	Distance:mid-Atlantic	-0.21	0.15	
Gini coefficient	Intercept (Great Lakes)	0.61	0.05	<0.001
	Region (Gulf of Maine)	0.21	0.05	
	Region (mid-Atlantic)	-0.03	0.06	
	Distance	0.19	0.05	<0.001
	Land Area	-0.01	0.02	0.53
	Percent Forest	-0.08	0.02	<0.001
	Distance:Gulf of Maine	-0.16	0.05	<0.001
	Distance:mid-Atlantic	0.00	0.07	

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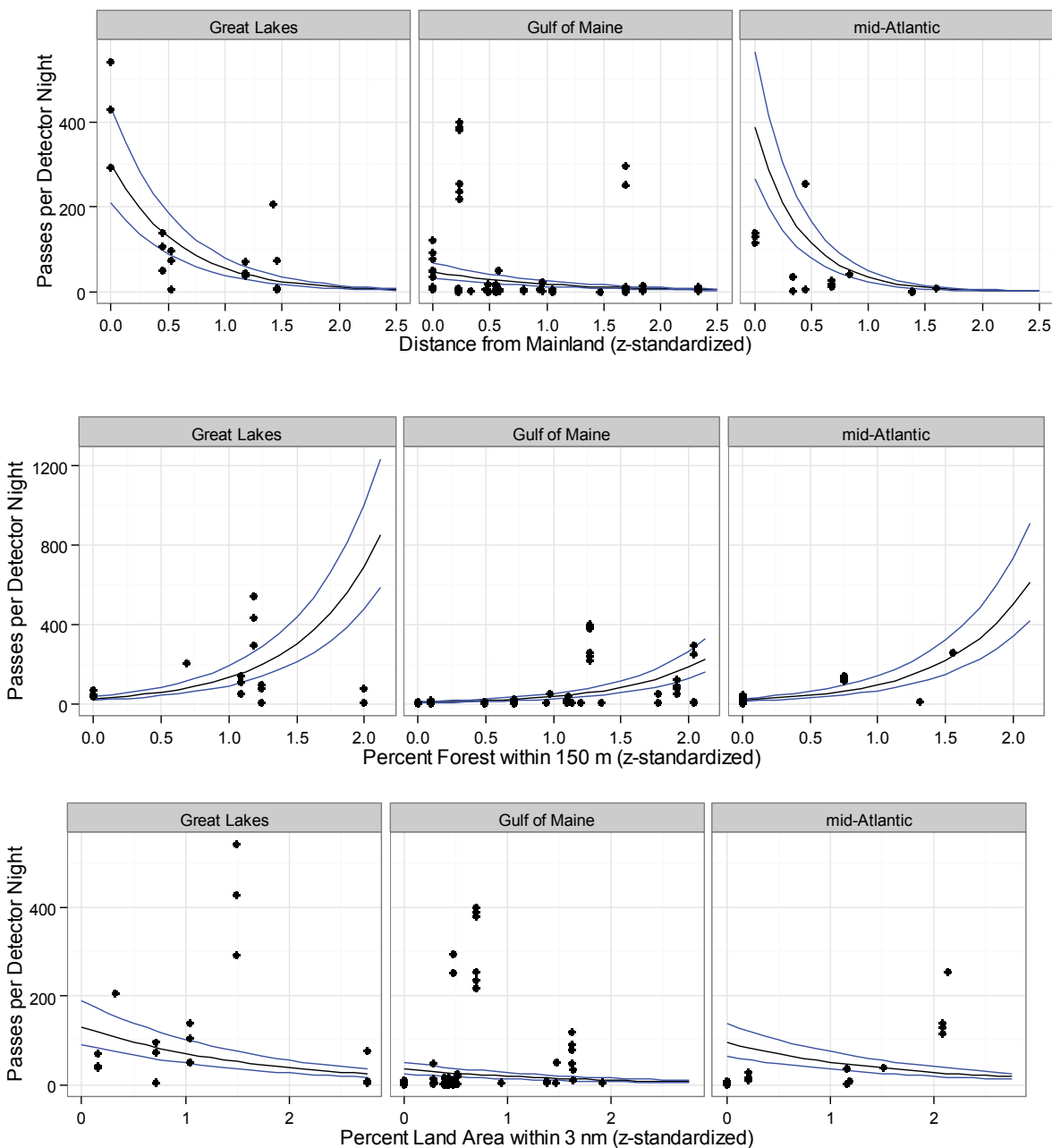


Figure 3-21. Predicted values of bat passes per detector night according to fixed effects distance from mainland (top), percent forest (middle), and percent land area within 3 nm radius (bottom), each estimated separately based on mean values of the other variables. X-axes are z-standardized across range of each variable and therefore unitless.

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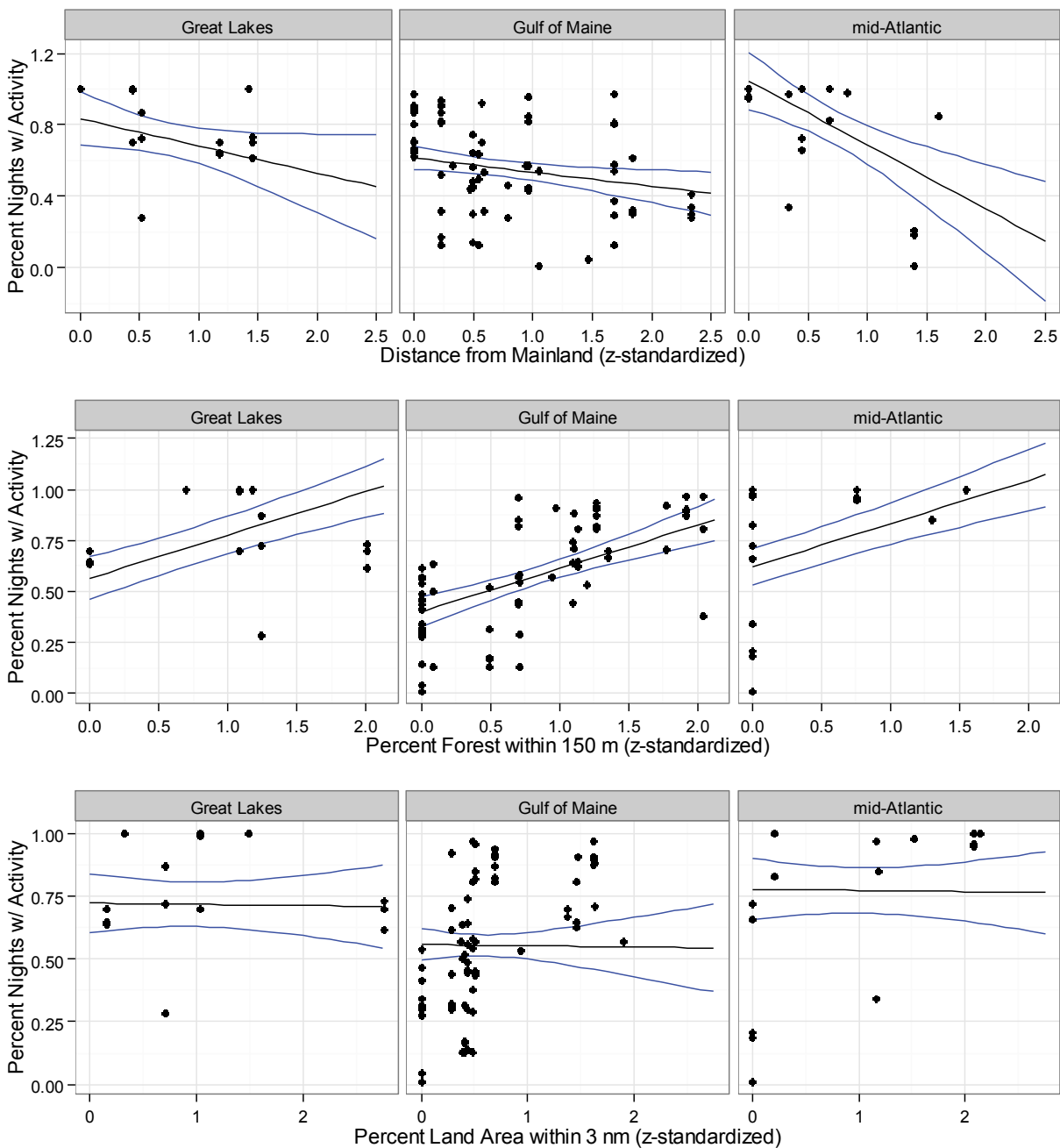


Figure 3-22. Predicted values of percent nights with activity according to fixed effects distance from mainland (top), percent forest (middle), and percent land area within 3 nm radius (bottom), each estimated separately based on mean values of the other variables. X-axes are z-standardized across range of each variable and therefore unitless.

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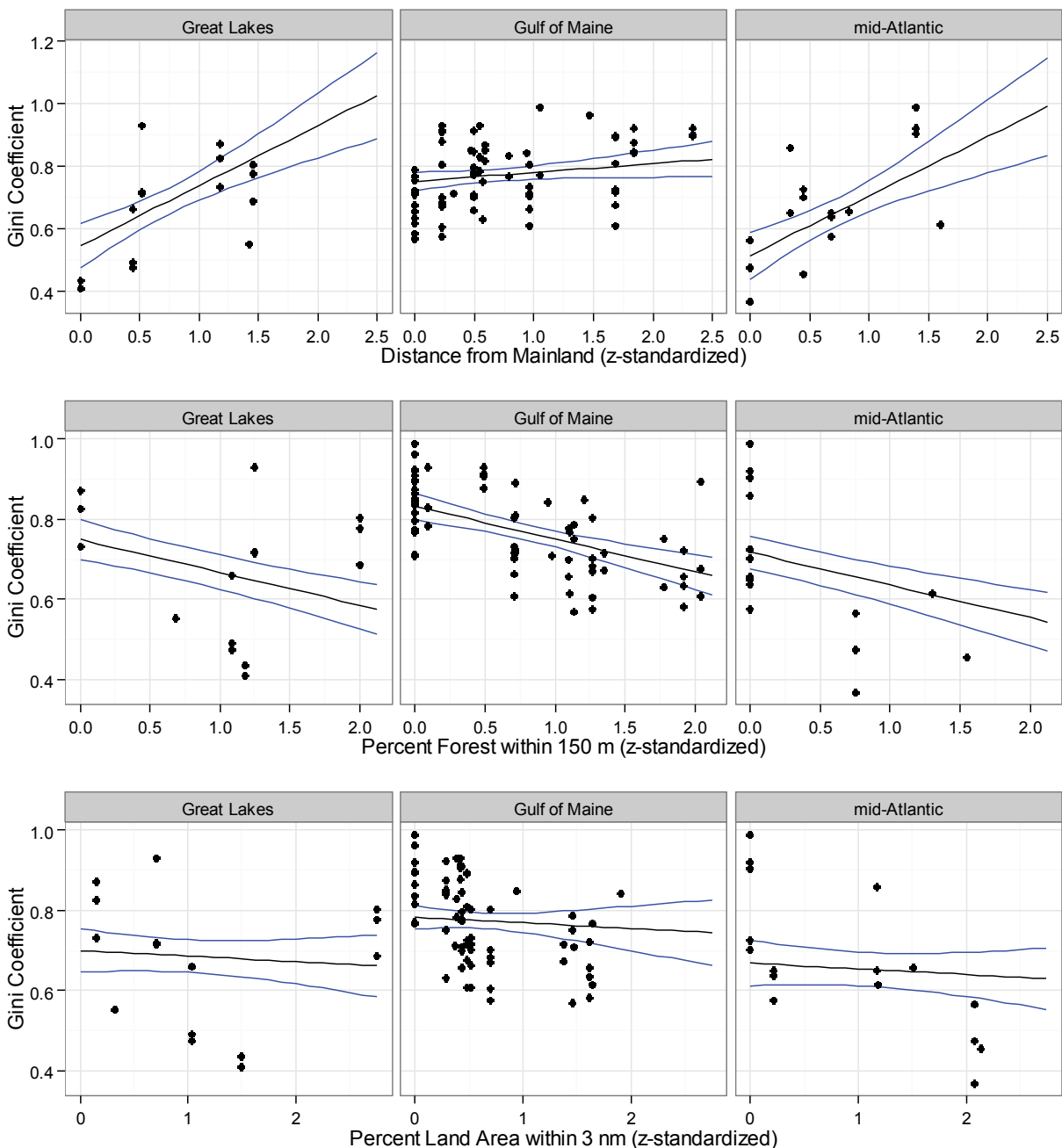


Figure 3-23. Predicted values of Gini coefficient according to fixed effects distance from mainland (top), percent forest (middle), and percent land area within 3 nm radius (bottom), each estimated separately based on mean values of the other variables. X-axes are z-standardized across range of each variable and therefore unitless.

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Species models indicated the same overall pattern of distance on each measure of activity among regions as the models based on combined bat activity, although the effect of distance from the mainland varied significantly among species for each measure of activity (Figure 3-24). We were required to remove the random effect of year when modeling the number of bat passes on a per species level to obtain a converging model, but were able to retain year as a random effect for models with percent of nights with activity and Gini coefficient. Silver-haired bats were least affected by distance from the mainland across regions for in terms of the percent of nights with activity and Gini coefficient overall, although *Myotis* species were affected to the same extent in terms of the number of passes per detector night. Big brown bats were most affected by distance from the mainland across regions for each measure of bat activity (Figure 3-24). Tri-colored bat activity responded to distance less than other species as well, although had the lowest predicted activity levels (and associated larger standard error around estimated effect sizes).

3.5 TIMING OF ACTIVITY

Timing of bat activity varied among sites and nights, although it generally followed a consistent overall pattern at most sites with activity increasing rapidly during the first hour past sunset, then declining steadily for the remainder of the night (Figure 3-25). Although sampling effort focused on documenting night-time bat activity, a sufficient amount of survey effort occurred during daytime to demonstrate that daytime activity was infrequent. Of the 565,158 recorded call sequences, 1,162 (0.21%) occurred before sunset of which only 66 of these passes occurred more than 1 hour before sunset. A total of 887 call sequences (0.16%) occurred after sunrise, 600 of which occurred during the first hour past sunrise. Daytime bat activity represented a disproportionally high percent of total bat activity per site at certain isolated sites such as Matinicus Rock, where 324 passes (13.9% of total passes recorded at the site) occurred before sunset or after sunrise, and Mount Desert Rock, where 172 passes (10.9%) occurred either before sunset or after sunrise.

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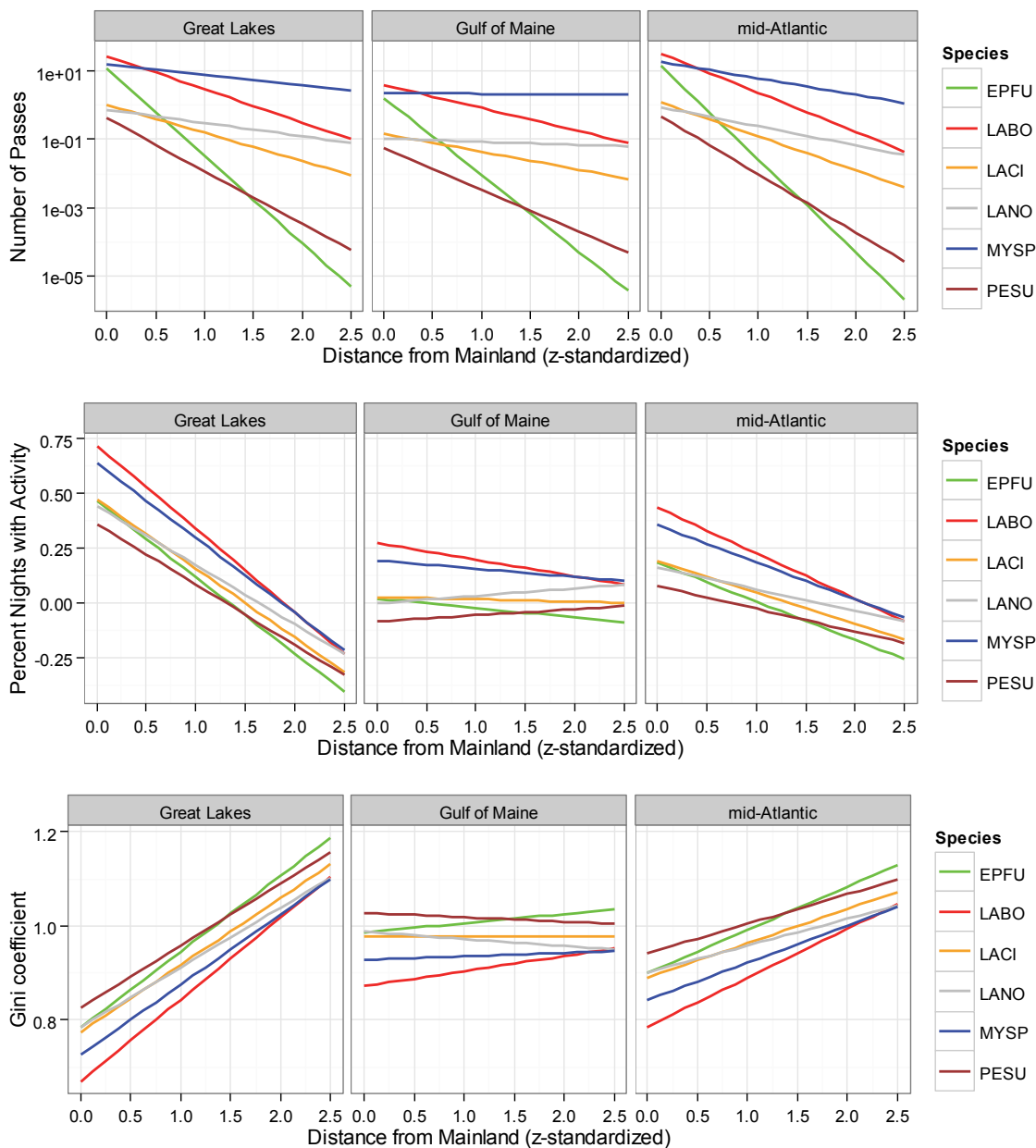


Figure 3-24. Predicted effect of distance on number of bat passes per night (top), percent nights with activity (middle), and Gini coefficient (bottom) by species and region, setting the amount of land area and percent forest to zero. Slope of line indicates relative magnitude of effect of distance. EPFU = big brown bat, LABO = eastern red bat, LACI = hoary bat, LANO = silver-haired bat, MYSP = *Myotis* species, PESU = tri-colored bat. X-axes are z-standardized across range of each variable and therefore unitless.

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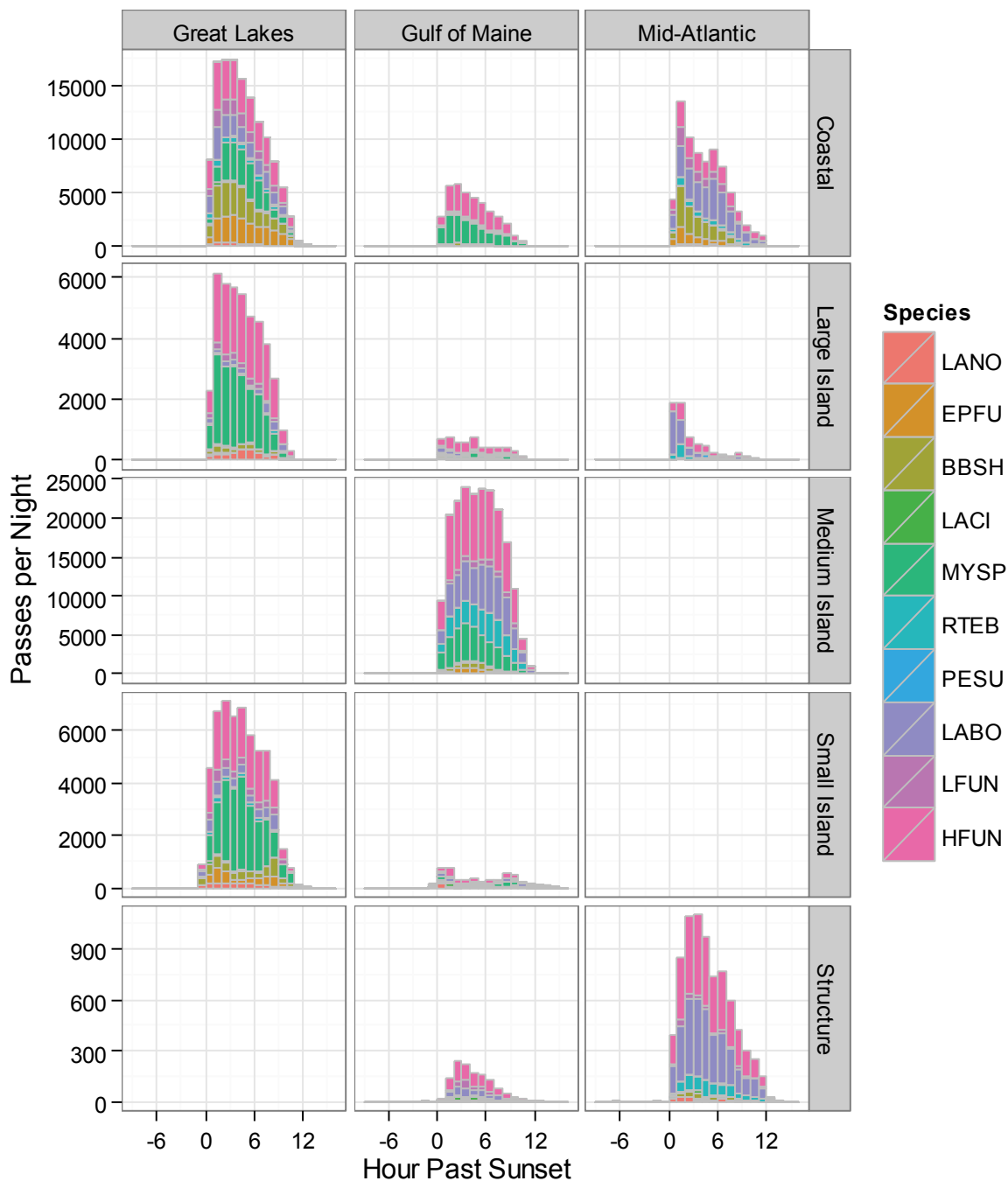


Figure 3-25. Hourly timing of bat activity relative to sunset by region and site category, combining years.

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3.6 NOTEWORTHY OBSERVATIONS

While this study focused on documenting offshore bat activity patterns on a regional scale, this section summarizes a subset of results from certain sites or groups of sites that bear attention due to their habitat, isolation, or unusual results. Appendix A includes detailed summaries of results of each site.

3.6.1 Buoy Data

The 2009 – 2014 dataset included a total of 1,600 nights of acoustic bat survey data from 5 offshore weather buoys in the Gulf of Maine. Although buoys ranged from 5.9 – 26.2 km from the mainland, and only 1 buoy (Buoy F) had any land within a 3-nm radius, we detected bats at every buoy that was monitored between 15 July and 15 October. Overall, we detected bats during 211 of 1,417 nights (15%) surveyed between 15 July and 15 October, with frequency of detection ranging from 1 – 57% among buoys and nightly passage rates ranging from 0.04 to 3.96 passes per night during this period (Table 3-2). Acoustic data from buoys followed relatively similar patterns to those documented at other sites in the study, with weekly activity peaking in early fall (weeks 31 – 34; Figure 3-26, Figure 3-27). Of the 372 passes recorded at buoys that were identifiable, 271 (73%) were eastern red bats, 81 (22%) were hoary bats, 14 (4%) were *Myotis* species, 5 (1%) were silver-haired bats, and 1 was a big brown bat (<1%).

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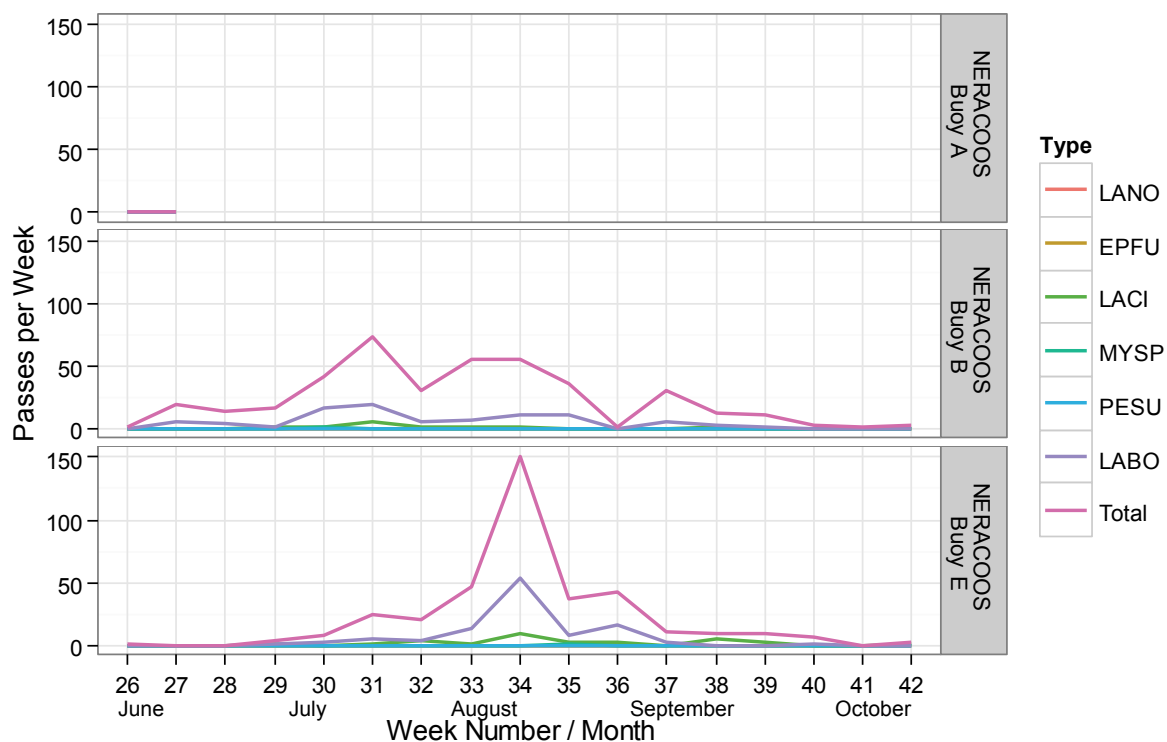


Figure 3-26. Weekly number of bat passes recorded at buoys in the Gulf of Maine during 2012 monitoring.

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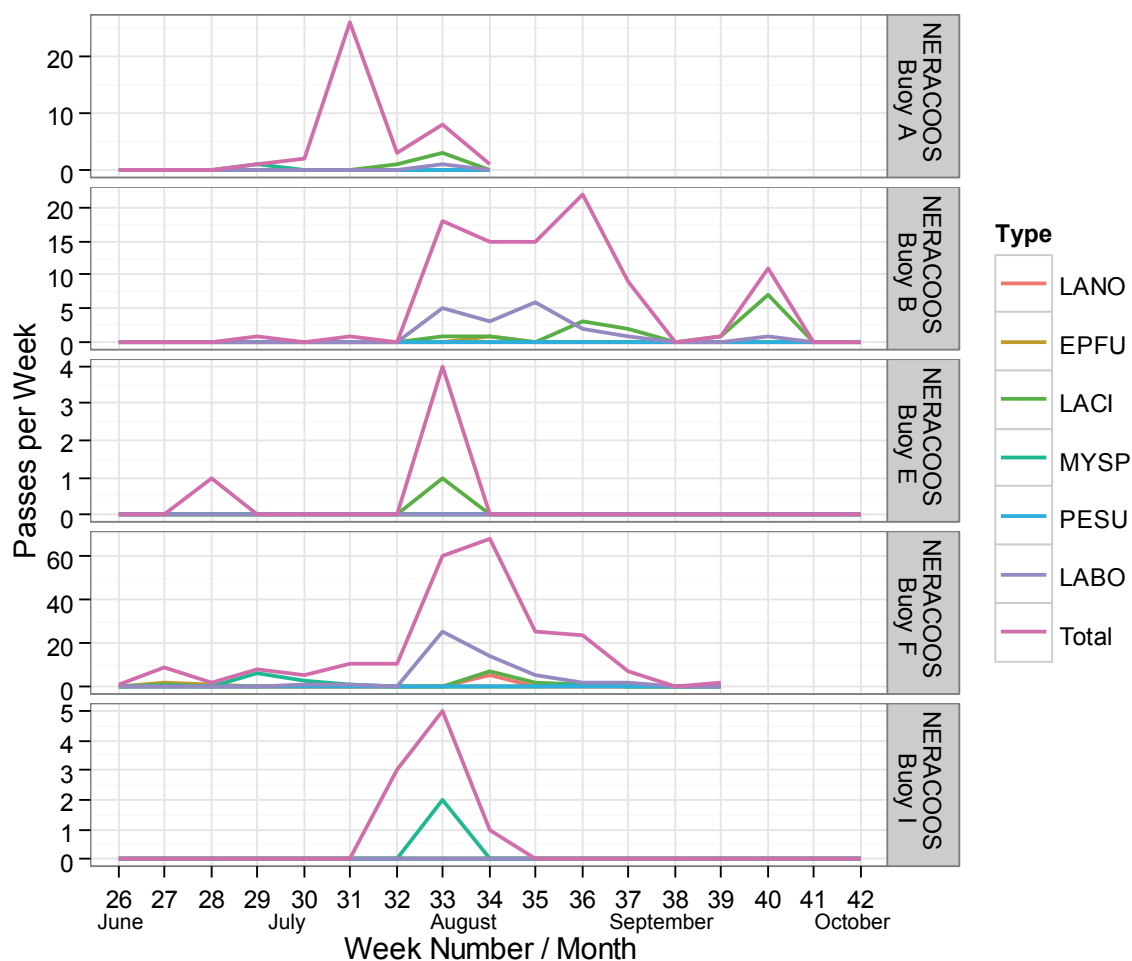


Figure 3-27. Weekly number of bat passes recorded at buoys in the Gulf of Maine during 2013 monitoring.

3.6.2 Ship Data

A limited amount of data from research vessels also contributed to our understanding of bat activity offshore, though represent a much smaller survey effort and were subject to high equipment failure rates. The offshore vessels did yield detections of bats up to 130 km from land (east of New Jersey). In 4 of the datasets, which totaled 53 nights of monitoring while the ships were at sea, no bats were detected, although 2 of these datasets were very brief and none spanned the late summer/early fall period of higher bat activity. The one ship-based dataset where bats were detected offshore consisted of 52 nights of monitoring during several distinct voyages between mid-July and the end of September, 2014. During these nights, 35 bats were detected at distances of 5.3 – 129.6 km (mean 60.3 km) from the nearest point of land. Bat passes were detected during 7 out of 52 nights (13.5%) when the ship was under way at sea. All but 2 of the 35 offshore bat detections occurred during 2 separate voyages along the mid-Atlantic coast during the month of September. No bats were detected during 19 nights when

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the ship was at sea between mid-June and early August. Of the 35 recorded bat passes, 7 were identified as BBSH (either silver-haired or big brown bat), 3 were identified as RTEB (eastern red bat or tri-colored bat), 2 were identified as eastern red bats, and the remaining 21 were classified as either high frequency unknown (17) or low frequency unknown (5). The ship was in port in Middletown, RI for the remaining 54 of these nights, during which an additional 92 bat passes were detected during 23 (42.6%) nights.

3.6.3 Absence of Activity

Although our analysis focused on detection of bats, the prolonged absence of bats from certain sites also helps understand patterns of offshore bat activity. For sites where detectors were placed on focal points on the landscape of a very small island or offshore structure, we interpret lack of acoustic detections during an extended period of consecutive nights as true absence of bats, rather than detection failure. Nightly summary of data between April and October during periods where detectors were confirmed to be operational identified periods of consecutive nights with no bat activity up to 126 nights. Of the 12 datasets with periods of inactivity greater than 40 consecutive nights within this period, none spanned the entire month of August, 2 spanned the entire month of September (and October), and 7 spanned the entire month of July (Table 3-5).

Table 3-5. Datasets with 40 or more consecutive nights between 1 April and 31 October with no bat activity.

Site	Distance from Mainland (km)	Region	Year	Dates	# Nights
Chesapeake Light Tower	24.8	mid-Atlantic	2013	1 April – 4 August	126
NERACOOS Buoy E	18.8	Gulf of Maine	2012	11 April – 29 June	80
NERACOOS Buoy E	18.8	Gulf of Maine	2013	17 August – 31	76
NERACOOS Buoy I	26.2	Gulf of Maine	2013	20 August – 31	73
Kent Island South	30.2	Gulf of Maine	2014	30 May – 7 August	70
Kent Island North	30.2	Gulf of Maine	2014	28 May – 31 July	65
Chesapeake Light Tower	24.8	mid-Atlantic	2014	1 April – 3 June	64
Matinicus Rock	32.9	Gulf of Maine	2014	4 June – 3 August	61
Chesapeake Light Tower	24.8	mid-Atlantic	2014	18 June – 5 August	49
NERACOOS Buoy I	26.2	Gulf of Maine	2013	24 June – 8 August	46
Mount Desert Rock	41.6	Gulf of Maine	2011	11 June – 25 July	45
NERACOOS Buoy A	10.5	Gulf of Maine	2013	22 June – 19 July	43

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3.6.4 White Nose Syndrome

The 2009 – 2014 study spanned the arrival of White Nose Syndrome (WNS) in the Northeast. This disease has led to precipitous declines in populations of cave-hibernating bat species in the region and federal listing of the northern long-eared bat, although the disease is not known to affect long-distance migratory bats. While we continued to detect *Myotis* species through 2014, a decline in the amount of *Myotis* species activity relative to that of other species was apparent at several sites in the Gulf of Maine. In the Great Lakes, the number of passes identified as *Myotis* species declined dramatically at Presque Isle, the easternmost site in the region, but *Myotis* species remained among the most commonly identified species at other sites in the region through 2014 monitoring.

Pronounced declines in the amount of *Myotis* activity across years were apparent at several sites in the Gulf of Maine and occurred primarily between 2012 and 2013. Such declines were particularly apparent at Kent Island North Field, Metinic Island Tree and Tower, Monhegan Island, and Seguin Island (see Appendix A summaries). The Kent Island North Field site in particular showed a marked decline in bat activity over the study period, with overall activity levels declining from 294 passes per night (activity during 97% of nights) in 2012 to 6.4 passes per night (activity during 37% of nights) in 2014 (see Table 3-2). At Seguin Island, *Myotis* species were the most commonly detected species in 2011 ($n = 3,537$ passes), but declined steadily through 2014, when no *Myotis* passes were recorded. During the same period, the number of passes identified as big brown bats increased from 134 in 2011 to 2,632 in 2014 (see Appendix A). *Myotis* activity levels remained high through 2014 at only 2 sites in the Gulf of Maine (both on Petit Manan Point), where *Myotis* continued to be the most commonly identified species and overall activity levels remained roughly consistent.

4.0 DISCUSSION

4.1 UTILITY OF ACOUSTIC SURVEYS IN OFFSHORE ENVIRONMENT

4.1.1 Equipment

Although acoustic bat detectors are capable of sampling only a small proportion of the vast available air space in the sites and regions we were monitoring, we were able to document consistent spatial, seasonal, and temporal patterns in bat activity among species using acoustic survey methods. Acoustic bat detectors were proven a reliable method to passively monitor bat activity offshore over long periods of time, provided that detectors are adequately protected from weather and powered with a sufficiently large external battery and solar charging system. Despite these measures, a relatively large percent of equipment was damaged or destroyed during the study, and use of backup detectors improved our overall sampling success considerably. Detector types vary in their suitability for long-term deployments (power consumption, data storage requirements, etc.), as do microphone elements in their ability to

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withstand exposure to seawater, so selecting appropriate equipment for offshore monitoring is an important consideration. Proper adjustment of detector sensitivity is also critical to avoid recording excessive amounts of static, which can fill memory cards to capacity and cause data loss despite other aspects of the detectors working properly.

Choice of equipment and characteristics of individual detectors can have a profound effect on results of acoustic monitoring. We attempted to minimize these effects by using the same type of detector and weatherproofing system across sites and qualitatively standardizing detector sensitivity at deployment. However, detector sensitivity can change during a long-term study due to gradual or sudden degradation of microphone elements, and detection range also varies with conditions (Hayes 2000). As such, potential effects of varying detector sensitivity and conditions are always possible when comparing results among sites and cannot be fully accounted for using calibration techniques. We did not attempt to quantify partial degradation of equipment over this long-term regional study, and categorized each attempted survey night as binary success or failure when evaluating detector function. However, deploying backup detectors allowed us to select the data from the detector that was operating most reliably and distinguish between long periods with no bat activity versus detector malfunction. Further, while detector sensitive may have varied among sites, such differences are unlikely to have introduced bias in this regional, long-term study as detectors were routinely replaced at all sites, analysis focused on large-scale patterns across numerous sites, and detector malfunctions did not occur systematically among sites.

4.1.2 Analysis Methods

A variety of methods now exist to analyze acoustic bat survey data including visual analysis, customized filters to identify passes meeting certain pre-defined criteria, and fully automated software packages that distinguish between static and bat files and identify passes to species and/or species group. We performed visual analysis of all recorded data for this project, in part because available options for automated analysis were limited when the study began, but also because we consider visual analysis to presently be the most reliable means of distinguishing bat echolocation pulses from environmental noise. We minimized potential subjectivity or errors associated with manual identification methods by following standardized identification procedures, categorizing poor quality calls as high or low frequency unknowns, and reviewing all identifications through a QAQC process where multiple individuals viewed each identified bat pass.

4.1.3 Measures of Activity

We summarized acoustic survey data using several methods including calculating the rate of bat passes per detector night, the percent of surveyed nights with activity, and the evenness of activity across sampled nights (Gini coefficient). We also obtained data from a sufficient number of sites to calculate detection rates and frequencies among sites on a nightly basis for certain regional analyses. While the nightly rate of activity is one of the most common metrics of bat activity, it is important to remember that the number of passes does not equate directly to the

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number of bats detected, as individual bats can be detected repeatedly. Alternative metrics of activity such as percent of hours/nights with activity are less affected by repeated detection of the same individuals and provide a useful alternative to the number of passes per night.

We are not aware of other acoustic bat studies employing indices of consistency of activity such as the Gini coefficient. However, this metric appears to be a useful indicator to quantify the consistency in bat activity among sites by distilling the distribution of activity across a wide season to a single index and enabling straightforward analysis of bat activity on a regional basis. Gini coefficients were the most stable measure of bat activity among years at individual sites, suggesting that they may provide a reasonable metric for comparisons among sites. Gini coefficients are somewhat limited for making inferences about rarely detected species, because the coefficient will necessarily be close to 1 (indicating unevenness), even if the lack of activity is unrelated to a particular covariate in question.

Importantly, linear models of each measure of activity produced consistent results, providing a more robust analysis of bat activity than would be possible using only one measure of bat activity. The number of bat passes per night is subject to greater variance among nights and sites than the other two measures and requires more specialized modeling techniques to account for non-normal distributions. The Poisson distribution produced adequate results for our purposes, although data were substantially overdispersed, indicating greater variance than could be accounted for using this distribution. Diagnostic plots of residuals from models based on the percent nights with activity and the Gini coefficient suggested that our chosen model structure was most appropriate for the Gini coefficient, which was more normally distributed relative to predictor variables than the other metrics of activity. Ultimately, rates of passes per night, percent of nights with activity, and indices of evenness of activity are highly related, and can all be useful in describing activity patterns of bats at individual sites and across larger regions.

Our results also highlight the importance of analyzing long-term acoustic data on an individual species basis when sample sizes allow, as certain seasonal and spatial patterns differ among species and would otherwise be masked in overall summaries. Bat species likely utilize offshore habitats differently and would therefore be subject to varying levels of risk of impact from offshore wind projects. Also, while aggregated measures of activity calculated over a long period of time are suitable for assessing the effect of site isolation and habitat on bat activity on a large scale, they may not be reliable predictors of the types of impacts that could be expected at offshore wind projects. Results from studies at terrestrial wind projects have indicated that activity levels (such as passes per detector night) are poor predictors of resulting mortality patterns (Hein et al. 2013). However, this lack of predictive power using aggregated site metrics does not mean that acoustic data are unable to predict conditions or times of year/night when risk of impacts would be highest. Acoustic data provide excellent temporal resolution and can be aligned with weather observations to identify specific conditions during which bats of particular species are present in the air space of proposed (or existing) turbines, enabling forecasting of the extent of “higher risk” conditions at particular sites. In this study, results of such an analysis performed on a regional scale aligned with studies from terrestrial sites,

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indicating that bat activity occurred disproportionately during warmer, calmer conditions (see below in Section 4.3.3).

4.2 EFFECTS OF HABITAT TYPE

Habitat immediately surrounding a detector can profoundly affect results of acoustic bat surveys (Frick 2013). Bats cue in on certain habitat types and structural features during foraging and roosting, and are therefore more or less likely to be recorded in particular habitat types. Structure of the habitat surrounding a detector (canopy height, type and density of vegetation “cluttering” the air space) also affects characteristics of bat echolocation such as frequency and pulse rate, as does the volume of air space that a detector can effectively monitor. The potential effects of microhabitat must be taken into consideration when comparing acoustic survey results among sites.

We attempted to minimize inter-site variability in habitat by deploying detectors on tops of towers and other high elevation structures that were in exposed locations away from surrounding trees and where detectors were sampling a similar volume of air space. However, at certain sites, the only available monitoring sites were near forest edges or even with the height of the surrounding forest canopy. The 4 sites with the highest number of recorded bat passes (Seguin Island, Presque Isle, Gibraltar Island, and Cape Henlopen), accounted for 365,314 passes combined, or 67.9% of passes recorded at all sites combined. Presque Isle and Cape Henlopen were both coastal sites at which detectors were positioned near a forest edge along a sandy shoreline, which likely concentrated bat foraging activity. The detector at Gibraltar Island was also even with the height of surrounding forest canopy, likely contributing to unusually high bat activity.

Further evidence of the effect of habitat surrounding detectors was particularly apparent at Kent Island, New Brunswick, where the “north field” detector recorded between 21 and 93 times higher activity levels than the “south field” detector during each of the 4 years where both sites were monitored. The sites were separated by 0.6 km, but the north field detector was in small a gap in a mixed forest whereas the south field detector was in an open field on a temporary tower (see Appendix A). Pronounced differences in rates of bat passes and species composition between these sites are likely attributable to the habitats immediately surrounding detectors, as both sites were on the same island.

We attempted to account for habitat effects by including the percent of forest within 150 m of detectors in our linear models of bat activity, and this metric had a significant, positive effect on bat activity across all regions. However, the influence of habitat at certain sites (such as Kent Island North Field) was still apparent in our analyses despite inclusion of this variable and likely contributed to certain unexpected results (such as the minimal effect of distance from shore on *Myotis* species activity levels).

Characteristics of the structures on which we deployed detectors also appeared to affect survey results in certain cases. Seguin Island is the only lighthouse site we surveyed where the

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light is continuously illuminated. Resident island caretakers reported observing bats foraging regularly around the light, which likely attracted insects and therefore concentrated bat activity. Other sites may have had resident bat populations living within the structures where detectors were deployed, contributing to unexpectedly high activity levels. This may have been the case at Rock of Ages lighthouse in the Great Lakes, an isolated rock island where we detected thousands of *Myotis* species and unexpectedly high activity levels (see Appendix A). Although the island lacked any vegetation, the lighthouse on which the detector was positioned likely contained numerous opportunities for bats to roost. Similarly, the Chesapeake Bay Bridge Tunnel had consistently high levels of bat activity and the tunnel and associated structures may have provided suitable day-roosting opportunities for bats.

The 1,600 nights of surveys conducted at 5 weather buoys in the Gulf of Maine as well as results from the Albermarle ATON and Chesapeake Light Tower in the mid-Atlantic may provide some of the most relevant information on bat activity at offshore wind turbines, as these sites lack natural habitat of any kind. Despite their isolation, we recorded bat activity at each of these sites, detecting bats during an unexpectedly high percent of nights. Detection rates, however, were lowest for this category of sites, and Gini coefficients were among the highest we documented, indicating that bat activity was sporadic.

Year 2014 monitoring on the NOAA vessel Bigelow also yielded detection of bats up to 129 km from shore, the farthest documented acoustic detection of a bat from the mainland in our study. This vessel was well positioned during September 2014 to sample bat activity in the mid-Atlantic OCS, and detected bats during multiple nights, with results similar to those from the Chesapeake Light Tower and weather buoys. We are unable to determine the extent to which the structures themselves or the ship attracted nearby bats, or whether bats may seek out such structures as temporary roosts to rest during the night (see Section 4.3.2. for a more detailed discussion of potential attraction to offshore structures). We did not detect activity patterns suggestive of opportunistic roosting at these sites, although this would have been difficult to distinguish.

4.3 SPATIAL PATTERNS

While sites varied considerably in species composition, detection frequencies and detection rates, several regional patterns were apparent in our results, including pronounced seasonal patterns and strong influence of weather variables. Our results suggest these patterns are not distinct from similar patterns documented in terrestrial studies and align with studies documenting large-scale migratory patterns of long-distance migratory species in North America (e.g., Cryan et al. 2014, Johnson et al. 2011b).

Despite the potentially confounding effects of habitat and site characteristics such as lighthouse illumination and potential roost habitat near detectors, we were able to document a pronounced, statistically significant, and ecologically relevant negative effect of distance from the mainland on the overall magnitude, frequency, and consistency of bat activity across three widespread regions. Inter-region differences highlight the potential importance of coastline

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geography, distribution of islands, and position relative to large-scale bat migratory patterns. Similar patterns were apparent using each of 3 distinct measures of bat activity.

4.3.1 Seasonal Patterns

Bats occurred with higher frequency and at increased detection rates during late summer or early fall at nearly every site we monitored across regions. Exceptions occurred in some cases, and not all datasets spanned this period, but overall bat activity was highest during late summer and fall (mid-August to mid-September). The smoothing functions of additive modeling aligned with these patterns in the Gulf of Maine and mid-Atlantic but indicated slightly increased activity during spring in the Great Lakes. The shape of the smoothing curves for the Gulf of Maine and mid-Atlantic regions also indicated peak activity in fall, a slight increase in activity during spring, and a drop in activity during summer.

Seasonal patterns varied among species. Silver-haired bats occurred at sites more often and at higher levels during June in the Great Lakes and during late August and early September in the Gulf of Maine and mid-Atlantic regions. Hoary bats and eastern red bats were most frequently detected during a broader seasonal period, with hoary bats tending to appear slightly earlier than eastern red bats. Eastern red bats were detected over a longer period across regions than either of the other 2 species, often occurring regularly throughout the summer and fall. We also detected non-migratory *Myotis* species most often during late summer at most sites, although they were consistently present at certain sites throughout much of the summer and fall. Big brown bats occurred occasionally throughout the spring, summer, and fall across sites, and tri-colored bats, the least common species at offshore sites, occurred primarily during late summer and fall.

A point of uncertainty in previous regional acoustic studies has been the relative absence of bat activity in spring versus fall (e.g., Johnson et al. 2011b). Our results generally followed the same pattern but may have identified sites where spring migration of certain bat species occurs. Gibraltar Island and Presque Isle are both located on the south shore of Lake Erie, where spring migration of songbirds and raptors have been documented, and Manitou Island is located at the tip of the Keweenaw Peninsula, which extends out into Lake Superior, and may provide a point of departure for spring migration across the lake. Additive modeling also indicated a bimodal relationship between Julian Day and activity in the Gulf of Maine and mid-Atlantic regions, suggesting potential spring activity. A similar pattern was not apparent in the Great Lakes, although our subset of data used in the additive models did not include spring dates for the Great Lakes region, as fewer than 4 sites were monitored simultaneously during that period.

Seasonal patterns from several remote islands and offshore structures also documented a pronounced absence of bat activity for extended periods during summer, suggesting very low levels of offshore activity outside of migratory periods. The longest periods of inactivity during summer occurred at weather buoys, the Chesapeake Light Tower, and some of the more remote islands.

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4.3.2 Site Isolation

We detected bats at every fixed site surveyed across regions, with bats occurring at unexpectedly high frequencies at even the most remote sites and offshore structures. Occasionally we recorded large numbers of passes at such isolated sites, possibly suggesting stopover behavior, movement of multiple bats past a site, or at the very least, several individual bats spending a considerable amount of time in close proximity to a detector. Despite the occasional high bat activity levels documented at certain sites, magnitude, frequency, and consistency of bat activity were all significantly lower at more isolated sites.

The effect of distance from the mainland on bat activity also varied significantly among species. Silver-haired and hoary bats, although detected at low levels across sites, occurred at high percentages of sites and were consistently less affected by distance from shore than other species such as big brown bats. Eastern red bats, the most widespread species in our study, showed pronounced declines in activity with increasing distance from shore, although were still one of the more frequently detected species across all sites. Unexpectedly, *Myotis* species were the most frequently identified species overall, were present at the most remote sites we monitored, and were less affected by distance from the mainland than long distance migratory eastern red bats. However, we suspect that certain remote islands where detectors were within forested areas likely contributed disproportionately to this result as they documented very high levels of *Myotis* activity. Also, uneven distribution of *Myotis* species in particular among sites and regions causes busy sites to disproportionately affect species-specific model predictions. We also caution that species-specific models were based on substantially less data than models using all bat activity. Indeed, confidence intervals surrounding species-specific model predictions, although not shown in Figure 3-24, were substantial.

4.3.3 Weather Conditions

On a regional basis, increasing nightly mean wind speed had a negative effect on bat activity, with a linear relationship in the Great Lakes and an inflection point at ~10 m/s in the other regions above which further increases in wind speed had little effect and confidence intervals of the smoothing function grew large. Temperature had a positive effect on bat activity, particularly in the range between ~10°C, below which activity did not decrease further, and ~20°C, above which further increases in activity leveled off slightly. These relationships suggest potential inflection points in the relationships between temperature and wind speed on bat activity on a regional scale.

Bats adjust their behavior according to a variety of biotic and abiotic factors, and individual parameters such as wind speed or temperature are likely not sufficient to explain activity patterns on a local or regional scale. Studies at terrestrial wind projects have found temperature and wind speed to explain relatively small amounts of the variability in bat activity levels (e.g., Erickson and West 2002, Horn et al. 2008). Presumably, availability of prey would strongly influence bat activity levels. Nevertheless, the relationship between bat activity and temperature suggests that these variables may be useful in predicting distribution of bats

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offshore on a regional scale. Time of year, linked closely with weather variables, will also be an important factor in any effort to project the distribution of bats offshore.

The effect of weather may also change with season. During summer, nightly bat activity is likely driven primarily by foraging behavior, and cold temperatures or high winds are likely to reduce prey availability, particularly offshore. During fall migration, however, bats may take advantage of favorable tailwinds or be more likely to fly during colder weather, such that overall relationships between mean temperature and wind speed may change. Wind direction, changes in barometric pressure, and other factors may also play different roles during spring and fall migration versus summer. Weller and Baldwin (2012) found that multiple weather parameters including wind speed and temperature affected bat activity levels at a terrestrial wind project in California, noting that models that allowed changes in relationships between weather variables across seasons more accurately predicted presence of acoustic bat activity. Presumably, factors that lead to heightened risk of turbine related impact at terrestrial projects (namely low winds and warmer temperatures) would also affect risk patterns at offshore wind projects, although the number of bats potentially affected cannot be established in either case using acoustic results.

4.3.4 White Nose Syndrome

Our objectives did not include monitoring the spread of WNS on a regional scale, although effects of the decline were apparent for cave-hibernating bats at several of the sites we monitored. While *Myotis* species were among the most commonly detected species early in the study in the Gulf of Maine (2009 – 2011), their relative frequency declined dramatically after 2011 or 2012 at most sites, with high levels of *Myotis* activity remaining only at a handful of sites. In the Great Lakes region, *Myotis* activity dropped dramatically at the Presque Isle site between 2009 and 2012, with big brown bats increasing during the same period. Although levels of *Myotis* activity declined dramatically in certain cases (e.g., Petit Manan Point, Maine), declines did not occur at all sites, suggesting that WNS had not yet affected bat populations in the Great Lakes within our survey period.

Myotis species were essentially absent from sites in the mid-Atlantic region throughout 2012 – 2014, although we did not have any pre-WNS data for comparison in this region. Previous studies in the mid-Atlantic have not detected *Myotis* species frequently, although a previous study offshore in the region found that *Myotis* comprised 7% of acoustic activity (Sjollema et al. 2014). Several other acoustic studies have documented substantial shifts in species composition following arrival of WNS in the northeast (e.g., Johnson et al. 2012, Jachowski et al. 2014).

4.4 COMPARISON WITH TERRESTRIAL STUDIES

Acoustic bat surveys following similar methods to this study have occurred at numerous proposed and existing terrestrial wind projects, providing a large dataset of similar results to which this coastal and island-based study can be compared. We compiled results of 34 publicly available studies conducted by Stantec at proposed or existing terrestrial wind projects in the

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northeast between 2009 and 2014 (Appendix B). Stantec conducted each of these studies using Anabat detectors and following the same visual analysis method used herein. Although specific dates of monitoring were not necessarily uniform among these surveys, most occurred between April and November. Combined, these surveys occurred at 19 sites in 5 northeastern states, representing a total of 21,898 detector nights of survey effort between 2009 and 2014. The number of recorded bat passes per night ranged from 0.3 – 106.7 among studies, with an overall mean of 15.2 passes/night. Most surveys (59%) documented fewer than 10 passes per night (Figure 4-1). An independent summary of 15 pre-construction acoustic surveys at proposed terrestrial wind projects in the northeast documented mean bat activity ranging from 1.24 – 141.70 passes per detector night with an overall mean of 25.2 passes per detector night (Hein et al. 2013). For comparison, the mean number of passes per night among datasets in this study by category was 4.96 at offshore structures, 25.2 at small islands, 95.6 at medium islands, 35.5 at large islands, and 112.6 at coastal sites (60.1 overall; see Figure 3-6).

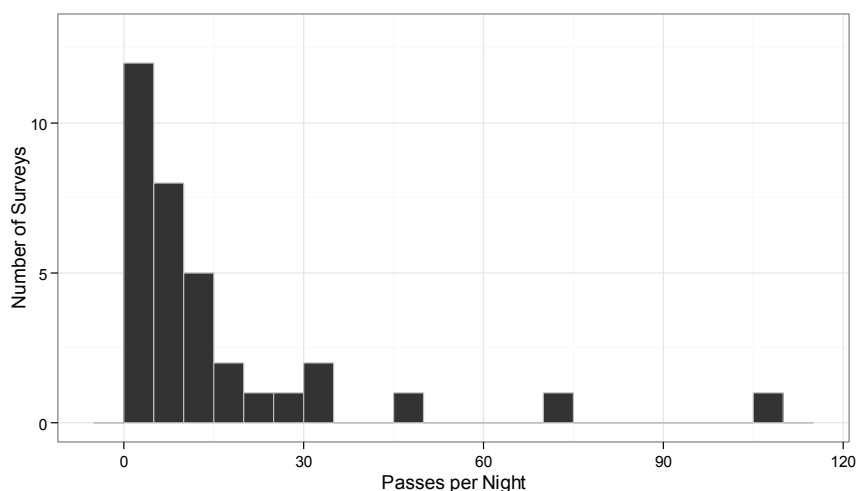


Figure 4-1. Number of passes per night among 34 acoustic bat surveys conducted at existing or proposed terrestrial wind projects in the northeast between 2009 and 2014.

This comparison of results indicates that levels of bat activity at small, remote islands have been relatively to those documented at terrestrial sites. Prior statistical analyses also failed to detect significant differences in bat activity levels at island versus terrestrial sites (Pelletier et al. 2013). While overall acoustic activity levels are not necessarily indicative of levels of risk of turbine-related impacts, the fact that bats are detected at remote islands and offshore structures with some regularity raises questions about the number of bats present offshore, particularly during periods of heightened risk such as the fall migratory period.

Number of bat passes does not indicate number of bats at a site. Unexpectedly high bat activity levels documented at focal points (e.g. lighthouses) on small islands could be the result of a small number of resident bats repeatedly flying past the detector due to lack of alternative available habitats (assuming that land provides better foraging habitat compared to water).

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While repeated detection of individual bats also occurs at terrestrial sites, bat activity over land is presumably less spatially concentrated than it would be on small islands. Therefore, despite similar or even higher acoustic activity levels documented at offshore islands relative to mainland sites, our results do not indicate similar densities of bats offshore compared to over land.

4.5 ATTRACTION TO ISLANDS AND OFFSHORE STRUCTURES

Assessing the magnitude of offshore bat activity using acoustic surveys depends in part on the degree to which bats may be attracted to islands and offshore structures. Interpreting results of acoustic surveys at offshore structures and islands assuming differing levels of attraction could help conceptualize patterns of risk. Islands and associated fixed structures (e.g. lighthouses) could provide stopover habitat for bats during migration. Stopover behavior has long been observed on the Farallon Islands, 48 km west of San Francisco, with peak numbers of bats observed in mid-September (Cryan and Brown 2007). As such, islands could be known waypoints along migratory routes, attracting bats from long distances. Also, islands and offshore structures could attract bats that happen to be foraging or flying in the vicinity, either as opportunistic roost habitat, concentration of insect prey, or simply a novel feature in an otherwise uniform and inhospitable habitat.

While acoustic detection of bats at some islands does not prove migratory stopover behavior, evidence of attraction and/or concentration of bat activity could reasonably be assumed at certain sites such as Seguin Island, where bat activity levels orders of magnitude higher than other similar sites could likely be explained by the presence of a constantly illuminated lighthouse. Offshore structures such as weather buoys, navigational aids, and offshore platforms had substantially lower activity levels than even the most remote islands with lighthouses, and likely have more limited range of potential attraction than tall lighthouses and islands. However, bat activity documented at islands and structures likely represents some concentration of bat activity from a surrounding area, the size of which would depend on foraging patterns of bats in the vicinity, the sensory limits of bats, or possibly long-established migratory routes.

Paradoxically, the assumption that bats are highly attracted to offshore structures and islands could suggest that very few bats are present offshore, despite higher-than-expected detection rates. However, this would also suggest that offshore wind projects could be similarly attractive to bats, increasing risk of impacts. Alternatively, if no attraction or concentration is occurring and acoustic activity at islands simply represents detection of a smaller proportion of bats on unmodified flight trajectories, one would have to assume that substantially higher numbers of bats are present offshore given a certain level of activity, considering the very small collective volume air space sampled by acoustic bat detectors. Recent studies of bat behavior at terrestrial wind projects using thermal videography indicate that bats appear to investigate turbines and lend support to prior hypotheses that bats are attracted to turbines (Cryan et al. 2014), although the range at which such attraction occurs is unknown.

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While knowing the density of bats present offshore would certainly help understand magnitude of potential impacts, no available method can address this question. However, this question is also currently unanswerable for terrestrial sites, for which population estimates, spatial densities, and migratory patterns of the most vulnerable species (the long-distance migratory hoary bat, silver-haired bat, and eastern red bat) are unknown. A more important question when assessing potential impacts to bats from offshore wind projects may be under what conditions bats occur offshore, how frequently such conditions occur, and whether turbines are operating during such conditions.

5.0 MANAGEMENT IMPLICATIONS AND RECOMMENDATIONS

Because no suitable roost habitat exists for bats offshore, bats can only occur offshore while foraging or migrating. However, this study has documented widespread and seasonally predictable presence of multiple bat species at even the most remote sites we monitored, demonstrating the ability if not the tendency for bats to fly considerable distances offshore during migration. While the number of bats present offshore cannot be determined through acoustic surveys, their presence during certain times of year and conditions suggests potential risk of turbine-related impacts at offshore wind projects.

Terrestrial studies have established that risk to bats can be effectively managed by feathering turbines during conditions when bats are active (namely low wind speeds and colder temperatures) although there has been little quantitative focus on identifying specific conditions leading to higher risk. Acoustic methods provide an excellent way to quantify periods of higher risk based on multiple factors (Weller and Baldwin 2012). Because the seasonal window during which bat activity levels are highest at offshore islands and structures is brief, and because the offshore environment lacks structure or refugia for bats that could moderate higher winds and colder temperatures, conditions of higher risk are presumably less frequent offshore than at terrestrial sites. As such, potential risk of turbine-related impacts could be readily managed through turbine feathering programs proven effective at terrestrial sites, with such actions necessary during a narrow set of conditions and a brief seasonal period.

Whether such measures will be necessary for offshore wind projects is uncertain until activity patterns and associated risk can be documented at an operational offshore wind project. Establishing thresholds at which turbine curtailment is necessary is less a biological question than a policy question given uncertainty surrounding population sizes of long-distance migratory species. Potential risk to federally or state-listed species currently drives avoidance and minimization measures for terrestrial sites. We did not attempt to determine presence/absence of federally listed northern long-eared bats or Indiana bats at sites monitored in this study, although the large number of *Myotis* species passes documented at a wide range of sites in the Gulf of Maine and Great Lakes suggests that certain members of this genus frequently undertake relatively long distance (at least ~40 km) offshore flights. Ongoing mist netting surveys

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at coastal sites in the northeast have also indicated relatively high numbers of northern long-eared bats post-WNS compared to other areas in the northeast. *Myotis* species appear to occur very infrequently in the mid-Atlantic region, so presumably risk to Indiana bats or northern long-eared bats would be negligible at offshore wind projects in that region.

Based on the widespread detection of bats at offshore structures and remote islands, we recommend that acoustic bat monitoring using methods similar to those used in this study occur at nacelle height at a subset of turbines constructed at the first several offshore wind projects constructed along the Atlantic OCS. Results of such monitoring would be appropriate to determine activity patterns of bats potentially at risk of turbine-related impacts and identify conditions associated with higher activity/risk. Mounting detectors on turbine nacelles enables accurate weather conditions to be monitored in the air space sampled by the acoustic detectors, improving precision of such analyses.

Conducting regional acoustic surveys in the Gulf of Mexico and along the Pacific coast, as well as expanding coverage in the large Great Lakes coast region, would also greatly improve understanding of larger-scale patterns in offshore bat distribution as well as longer-term trends in bat activity and species composition. Passive acoustic detectors provide a relatively reliable and efficient means of monitoring bat activity over long periods of time in remote locations. As detector technology improves, so should the ability to transfer data remotely and monitor the status of equipment.

Ultimately, without information on movements of individual bats, we do not know the fate of bats detected at offshore acoustic sites. This lack of data raises questions regarding the seasonal migratory patterns of individual species, whether bats fly offshore “strategically” to follow more direct migratory paths, whether they seek out potential resources such as floating wrack lines or exploit a particular offshore food source, and whether bats purposely navigate to known offshore islands as planned stopovers during migration. The answers to each of these questions will influence the potential risks posed to bats from offshore wind energy development.

Recent advances in passive radio telemetry survey equipment and coded “nanotag” transmitters have enabled unprecedented regional studies of songbird migrations in the Canadian Maritimes and Gulf of Maine, which have recently expanded into the Great Lakes and other regions. In line with these avian research efforts, several ongoing efforts to deploy nanotags on bats along the Gulf of Maine coast have successfully tracked coastal movements of individual bats, and highlight the unique value and opportunities available through multi-disciplined collaborative studies events (see site description for Petit Manan Point Field in Appendix A) (Peterson et al. 2015). This technology enables small wildlife such as bats to be tracked passively over long-distances (range depending primarily on fixed antenna configurations but exceeding 15 – 20 km), with current transmitters lasting for up to 4 weeks. Unlike passive acoustic data, which provides excellent temporal coverage and generates large, regional datasets, nanotag telemetry provides detailed information on movements of a small number of tagged individuals. However, supplementing regional acoustic information with telemetry records would greatly enhance understanding of the behavior of bats offshore,

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enabling better prediction and management of potential impacts associated with offshore wind development.

Documenting turbine-related impacts at offshore wind projects will not be possible using traditional methods applied at land-based projects. However, turbines themselves will provide an excellent opportunity to deploy acoustic detectors, nanotag receiving towers, and other technologies allowing remote, long-term monitoring of bats that may be at risk of impacts, as well as the opportunity to test potential deterrent devices. These sources of data would enable analysis of conditions under which bats are actually active in the rotor zone, allowing a more precise estimation of mortality rates and evaluation of the need for, and potential effectiveness of, various measures and devices to reduce impacts.

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Appendix A SITE DATA SUMMARIES

Albermarle ATON, North Carolina

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

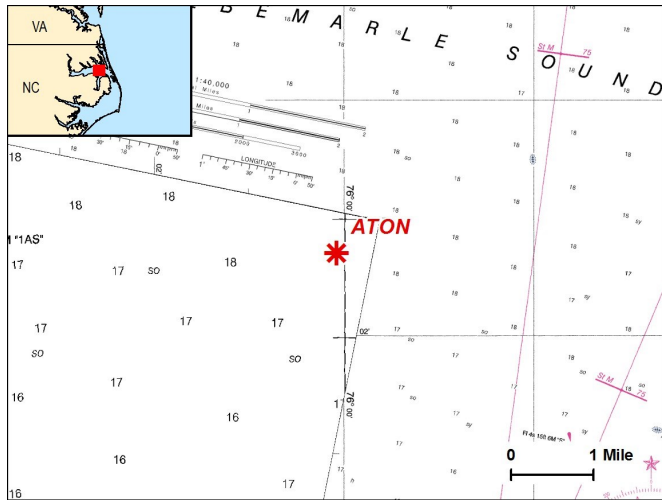


Table 1. Site Information

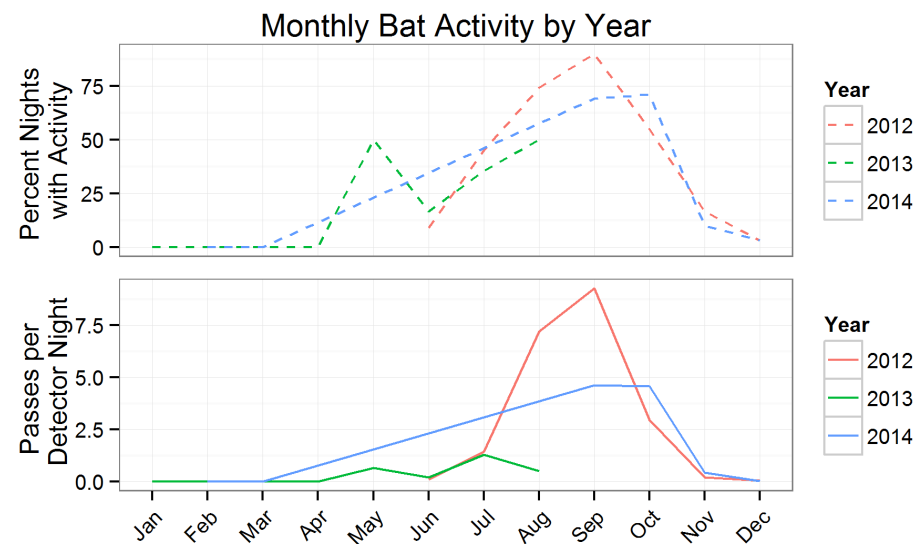
Region	mid-Atlantic
Category	Structure
Lat/Long	36.04506, -76.0014
Area (hectares)	n/a
Distance from Mainland (km)	7.9
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Offshore Structure
Detector Height (m)	3
Distance from Shore (km)	7.9

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	20 Jun – 31 Dec	195	647	67	0.72	6.14	0.72
2013	1 Jan – 2 Aug	183	51	24	0.37	1.74	-
2014	28 Feb – 31 Dec	137	279	33	0.66	4.54	0.70

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

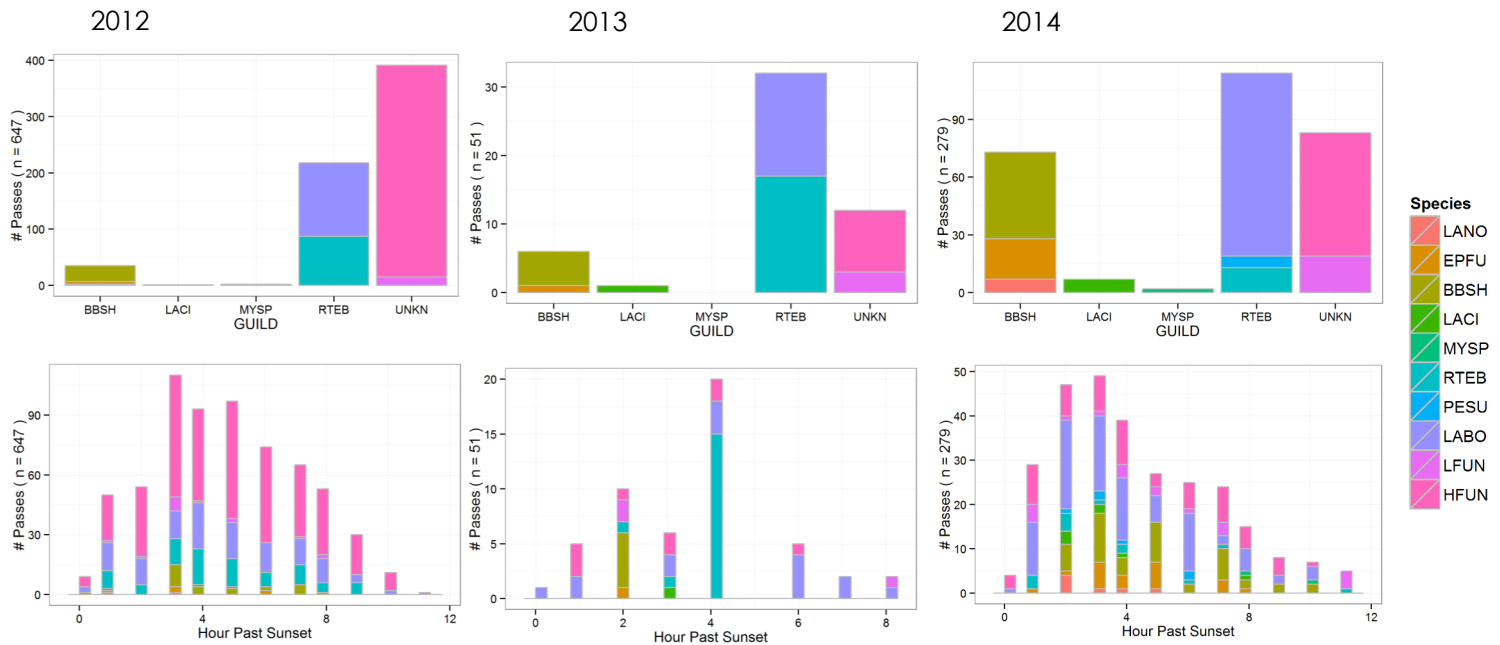


Bat surveys at this site spanned the entire period between 1 January and 31 December, although did not occur continuously during each year. Peak activity and frequency of presence occurred in September, although a small peak in activity also occurred in May. No activity occurred between 4 December 2012 and 27 May 2013 although the detector operated continuously during this period.

Albermarle ATON, North Carolina

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats were the most frequently identified species, comprising 81.4% of the 296 passes identified to species combining results from 2012, 2013, and 2014. Only 4 passes were categorized as *Myotis* species at this site.



View of detector mounted on ATON structure in 2012 (left) and when demobilized in December 2013 (right). This fixed, concrete structure is centrally positioned (7.9 km from shore) in Albermarle Sound, a relatively protected bay on the east coast of North Carolina.

Appledore Island, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

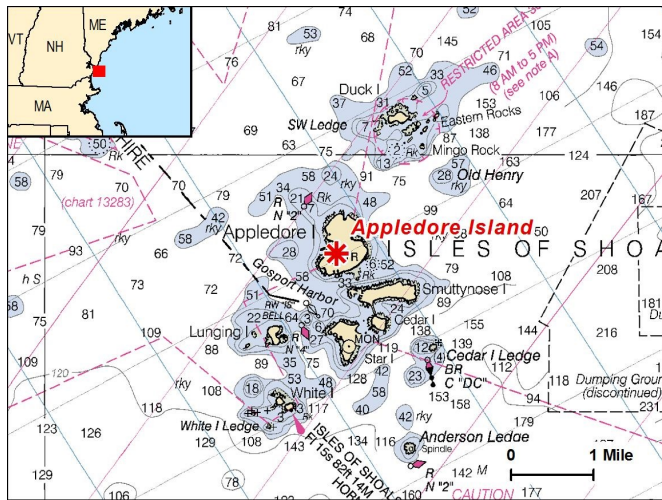


Table 1. Site Information

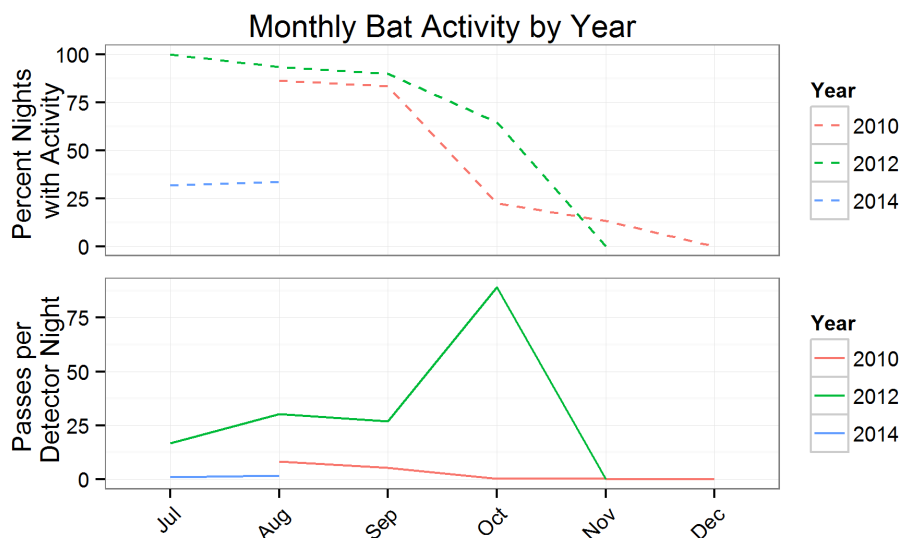
Region	Gulf of Maine
Category	medium
Lat/Long	42.987061, -70.615326
Area (hectares)	40.0
Distance from Mainland (km)	10.2
% Land in 3 nm buffer	0.7
% Forest in 150 m buffer	62.0
Detector Location	Observation tower
Detector Height (m)	18
Distance from Shore (m)	117

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2010	10 Aug – 31 Dec	144	360	31	0.70	5.18	0.63
2012	17 Jul – 1 Nov	108	4,753	1,128	0.92	49.07	0.74
2014	10 Jul – 6 Aug	28	31	10	0.39	1.35	-

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

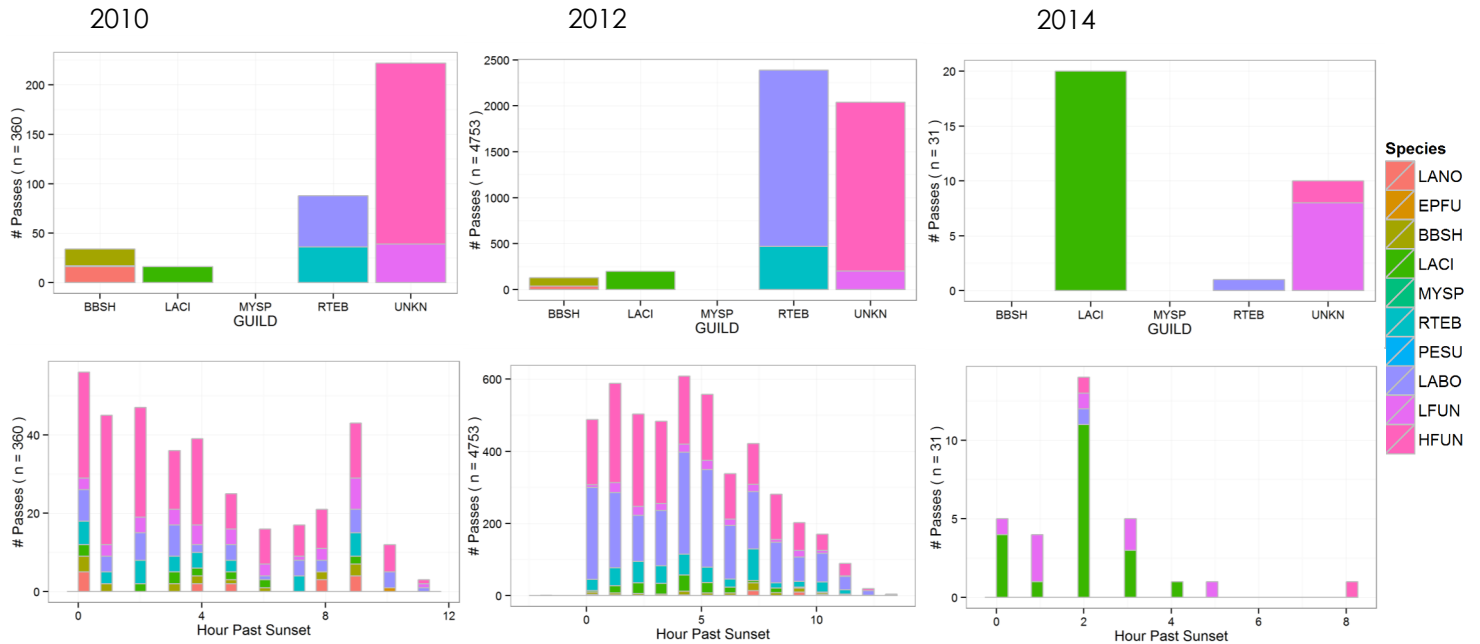


Peak activity at this site occurred in October 2012, driven largely by eastern red bat activity. This peak in activity occurred later at Appledore Island than at most sites in the region. Although rate of passes per night peaked in October, bats were detected most frequently in July and August. Activity levels were substantially lower in 2010, when the highest levels of activity were in August, and 2014 monitoring occurred for only a brief window in July and August.

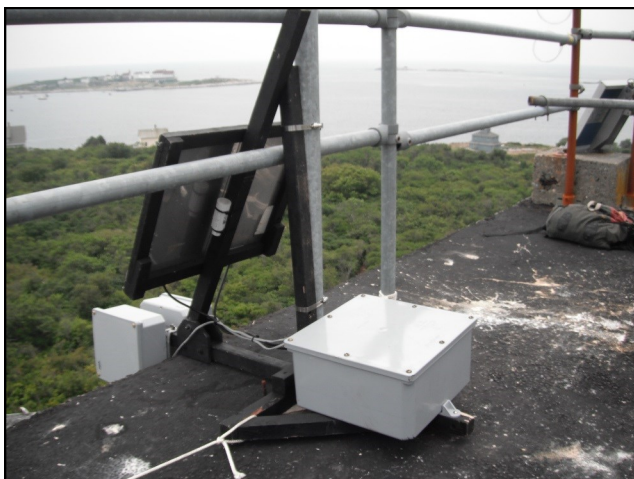
Appledore Island, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Species composition varied considerably among years, with high levels of eastern red bat activity in 2012 relative to the other years. Hoary bats were the most commonly identified species in 2014, although overall number of passes was substantially lower in 2014. No *Myotis* species were identified at this site during any year, which was unusual compared to other sites in the Gulf of Maine. Activity was highest in the first few hours past sunset overall, although activity (n = 55 passes) occurred up to 3 hours past sunrise on several nights between late July and early October 2012.



View of detector looking southwest (left) and of the tower from the ground (right). This 40 hectare island is 10.2 km from the mainland and lacks trees, although dense shrubs and manmade structures are present. The acoustic detector was deployed at the top of a concrete observation tower and oriented southward.

Bodie Island, North Carolina

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

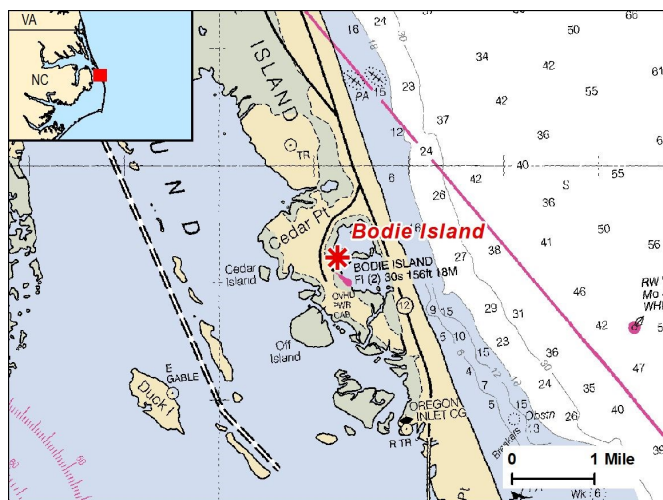


Table 1. Site Information

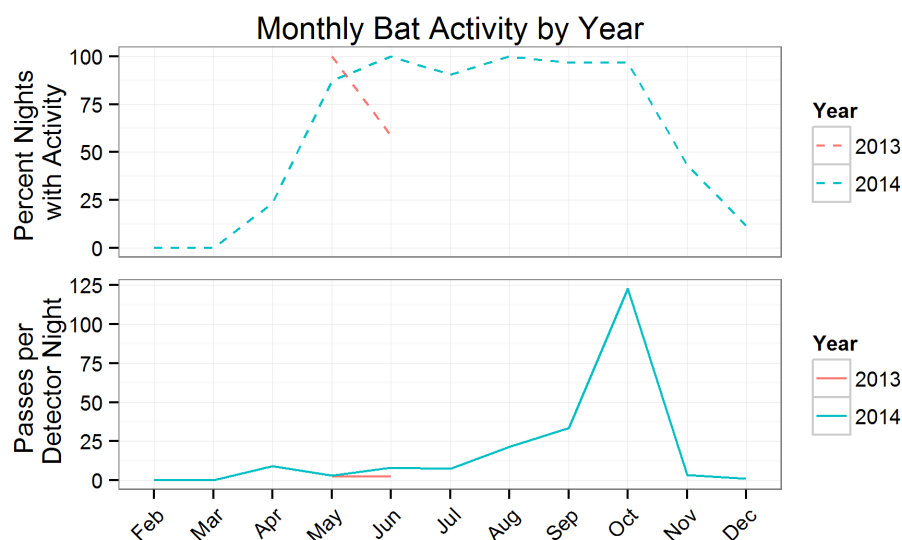
Region	mid-Atlantic
Category	Coastal
Lat/Long	35.820235, -75.562517
Area (hectares)	1589.6
Distance from Mainland (km)	14.8
% Land in 3 nm buffer	20.1
% Forest in 150 m buffer	0.0
Detector Location	Boardwalk
Detector Height (m)	3
Distance from Shore (m)	620

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	29 May – 29 Jun	32	83	14	-	-	-
2014	28 Feb – 17 Dec	293	6,422	611	0.98	39.70	0.66

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

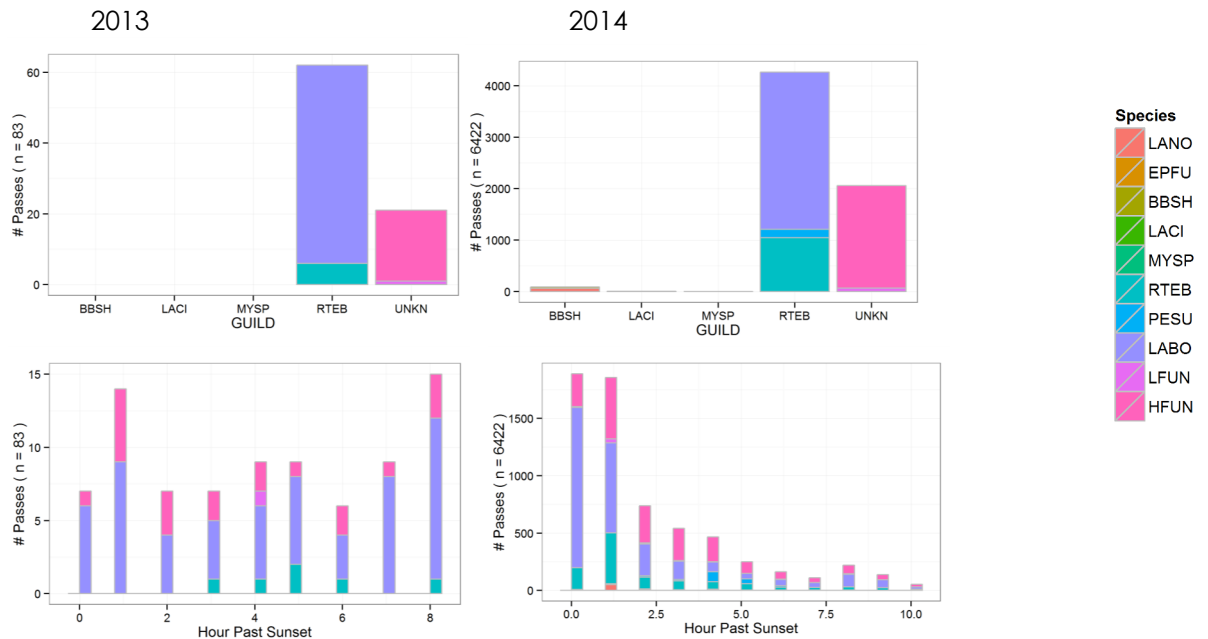


Although bats were present during most surveyed nights between June and October, activity levels peaked in October 2014, driven by a large number of eastern red bat passes recorded between 5 and 21 October. A small peak in red bat activity also occurred on 10 April 2014, possibly indicating spring migration activity.

Bodie Island, North Carolina

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats dominated bat activity recorded at this site in 2013 and 2014. Tri-colored bats were detected during only 3 nights 30 September—2 October 2014 (n = 165 passes) and 53 of 64 (83%) silver-haired bat passes at this site occurred on 10 September 2014. Most activity occurred in the first 2 hours past sunset at this site in 2014. Only 1 pass was categorized as a *Myotis* species at this site.



View of detector looking north (left) and of the boardwalk structure (right). The acoustic detector was deployed on an observation platform on a saltwater pond on the outer banks of North Carolina. The detector is approximately 15 m from the edge of the pond.

Cape Henlopen, Delaware

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

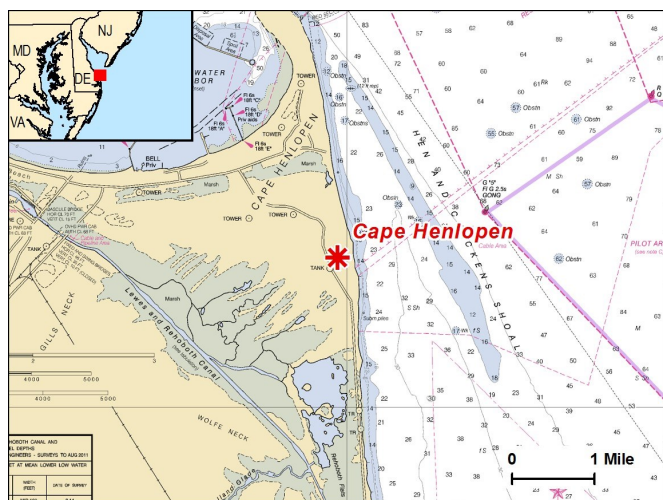


Table 1. Site Information

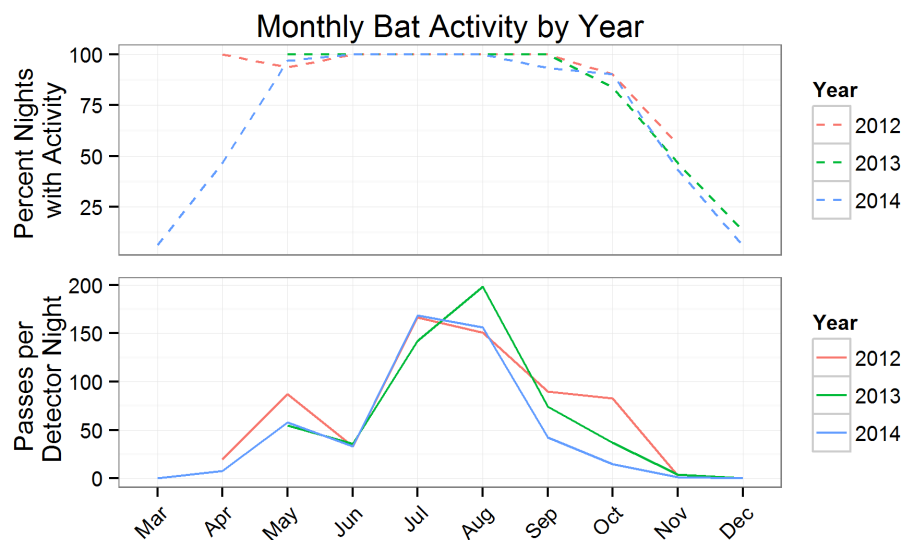
Region	Mid-Atlantic
Category	Coastal
Lat/Long	38.770365, -75.084997
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	38.0
% Forest in 150 m buffer	11.1
Detector Location	Temporary tower
Detector Height (m)	2
Distance from Shore (m)	150

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	28 Apr – 27 Nov	214	18,912	430	1.00	136.94	0.37
2013	27 May – 15 Dec	203	15,377	499	0.95	129.55	0.47
2014	1 Mar – 17 Dec	292	14,846	477	0.96	115.01	0.56

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

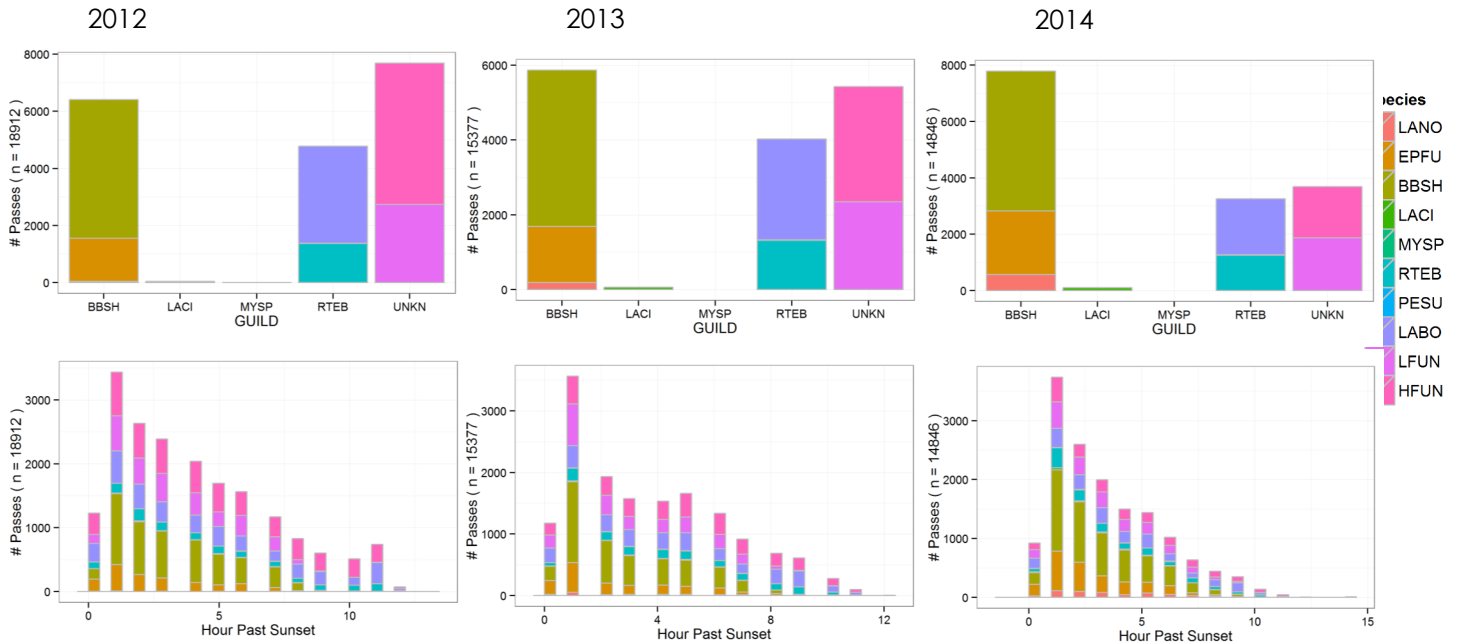


Bats were active at this site for nearly 100% of nights surveyed between May and September during each year of monitoring, suggesting presence of a local bat population throughout the summer. Detection rates peaked in July or August depending on the year. Although apparent local eastern red and big brown bat activity dominated overall patterns, migratory silver-haired and hoary bats also were present consistently during the spring and fall migration periods.

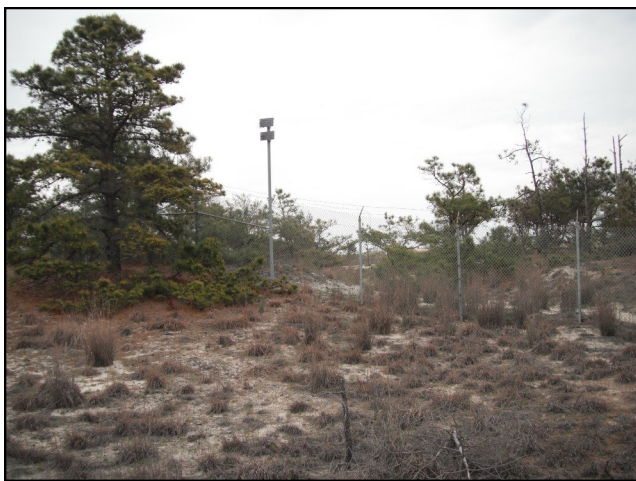
Cape Henlopen, Delaware

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Overall species composition and nightly timing were consistent at this site overall between 2012 and 2014. Eastern red bats (n = 8,062) and big brown bats (n = 5,279) were the most frequently detected species, occurring regularly between late April and Silver-haired bat activity (n = 784) occurred consistently in May and between mid September and mid October each year, with lower activity levels and frequency of detection in summer. Most hoary bat activity (n = 213) occurred in early August at this site. We identified 10 tri-colored bats and categorized only 2 passes as *Myotis* species.



View of detector looking east towards beach. This site is within a pine-barren habitat located along a fencerow parallel to the beach. The acoustic detector was deployed in a temporary tower and oriented eastward towards a sand beach.

Chesapeake Bay Bridge Tunnel, Virginia

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

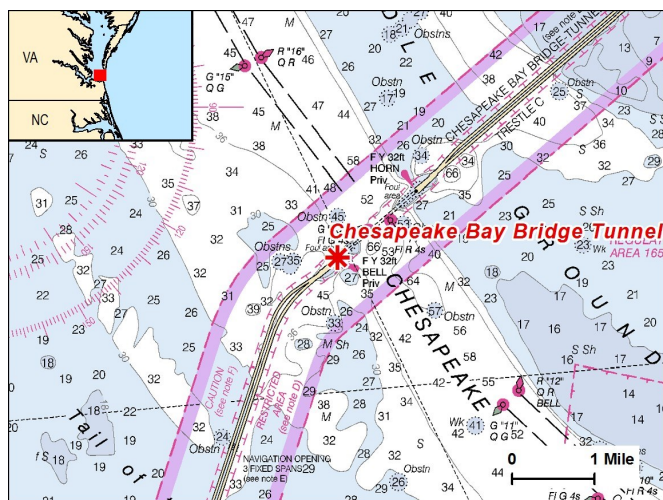


Table 1. Site Information

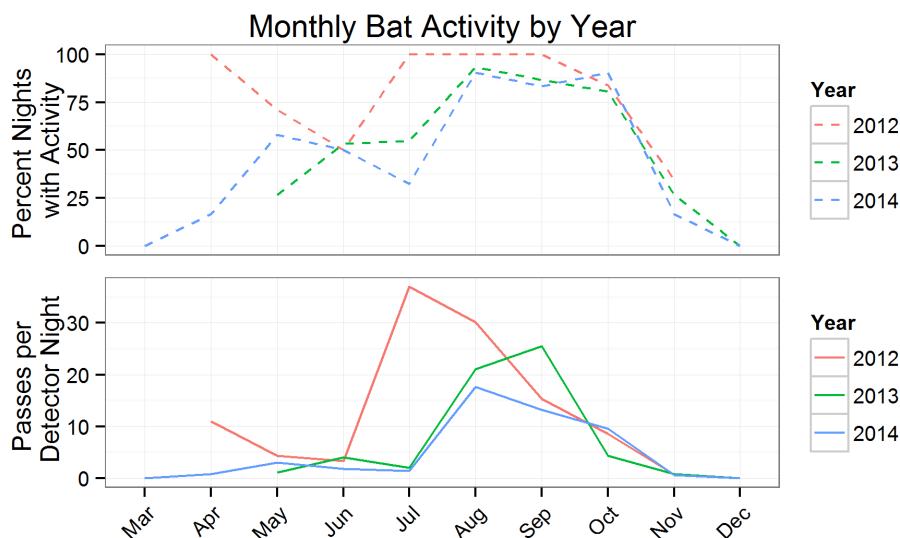
Region	mid-Atlantic
Category	Structure
Lat/Long	37.036669, -76.076649
Area (hectares)	n/a
Distance from Mainland (km)	12.1
% Land in 3 nm buffer	0.4
% Forest in 150 m buffer	0.0
Detector Location	Stone structure
Detector Height (m)	15
Distance from Shore (m)	10.4

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	26 Apr – 26 Nov	215	3,115	234	1.00	26.25	0.57
2013	17 May – 18 Dec	216	1,777	133	0.83	16.10	0.64
2014	1 Mar – 15 Dec	290	1,474	84	0.83	11.02	0.65

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

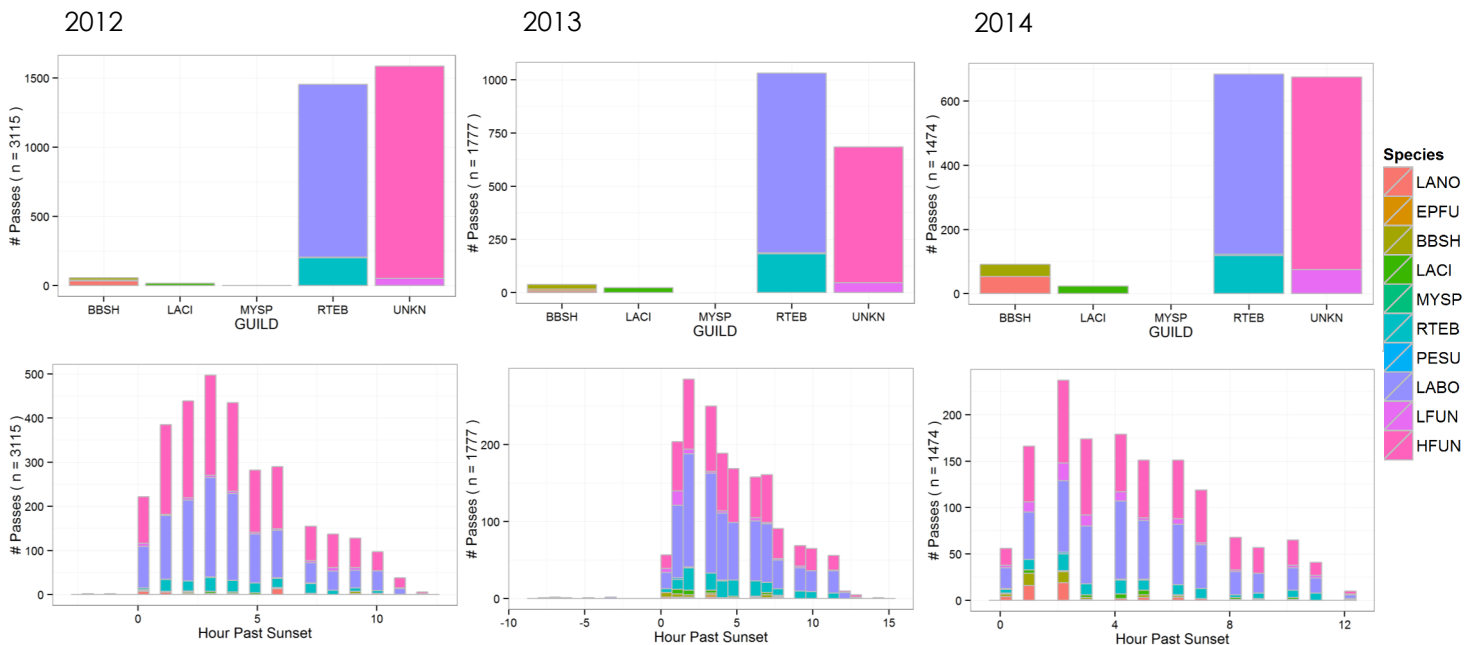


Bat activity levels were higher and at this site than any other "structure" sites in the 2012–2014 study, with consistent bat activity documented between July and October. The relatively low Gini coefficient indicates that activity was evenly distributed among nights rather than concentrated in a few very busy nights. Seasonal trends were driven primarily by eastern red bats, which were the most commonly detected species.

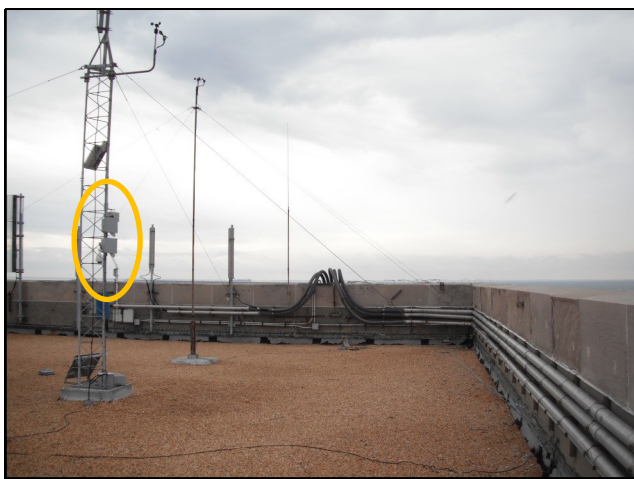
Chesapeake Bay Bridge Tunnel, Virginia

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats were the most frequently identified species at this site ($n = 2,655$). Silver-haired bat activity ($n = 95$) occurred primarily during October, and hoary bat activity ($n = 63$) occurred primarily during late August and early September. Big brown ($n = 14$), tri-colored ($n = 13$) and Myotis species ($n = 1$) were also detected at low levels. Overall activity peaked 3 to 4 hours past sunset although bats were recorded throughout the night. Several bat passes were also detected up to 8 hours before sunset ($n = 11$) and up to 3 hours past sunrise ($n = 102$), many of which occurred in early September.



View of rooftop detector (inside circle) looking southwest (left) and northeast (right). The acoustic detector was deployed atop a maintenance building on a ~ 2 hectare manmade "3rd Island" near the midpoint of the ~ 24 kilometer bridge/tunnel through Chesapeake Bay. No vegetation or natural habitat is present at this location.

Chesapeake Light Tower, Virginia

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

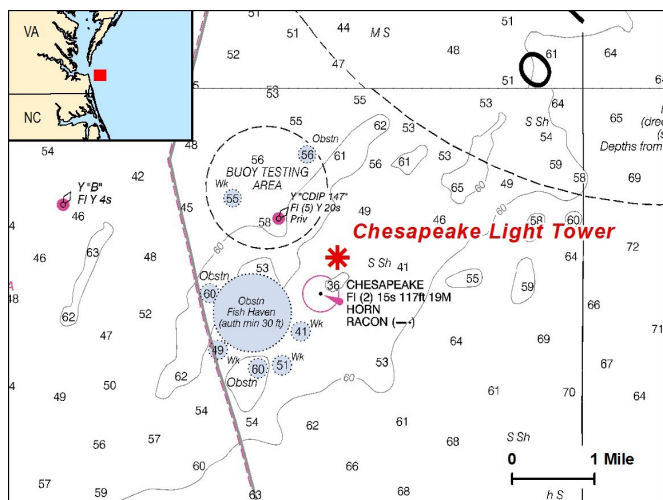


Table 1. Site Information

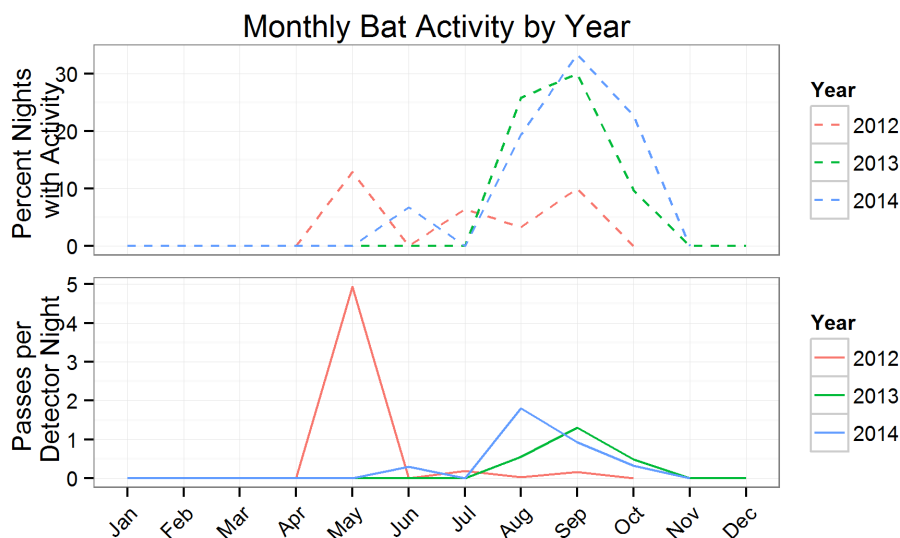
Region	Mid-Atlantic
Category	Structure
Lat/Long	36.90972, -75.7097
Area (hectares)	n/a
Distance from Mainland (km)	24.8
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Offshore platform
Detector Height (m)	36
Distance from Shore (m)	n/a

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	29 Apr – 25 Oct	180	165	144	0.04	0.01	0.99
2013	1 Jan – 31 Dec	365	71	13	0.20	0.62	0.90
2014	1 Jan – 30 Nov	326	103	42	0.20	0.94	0.92

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

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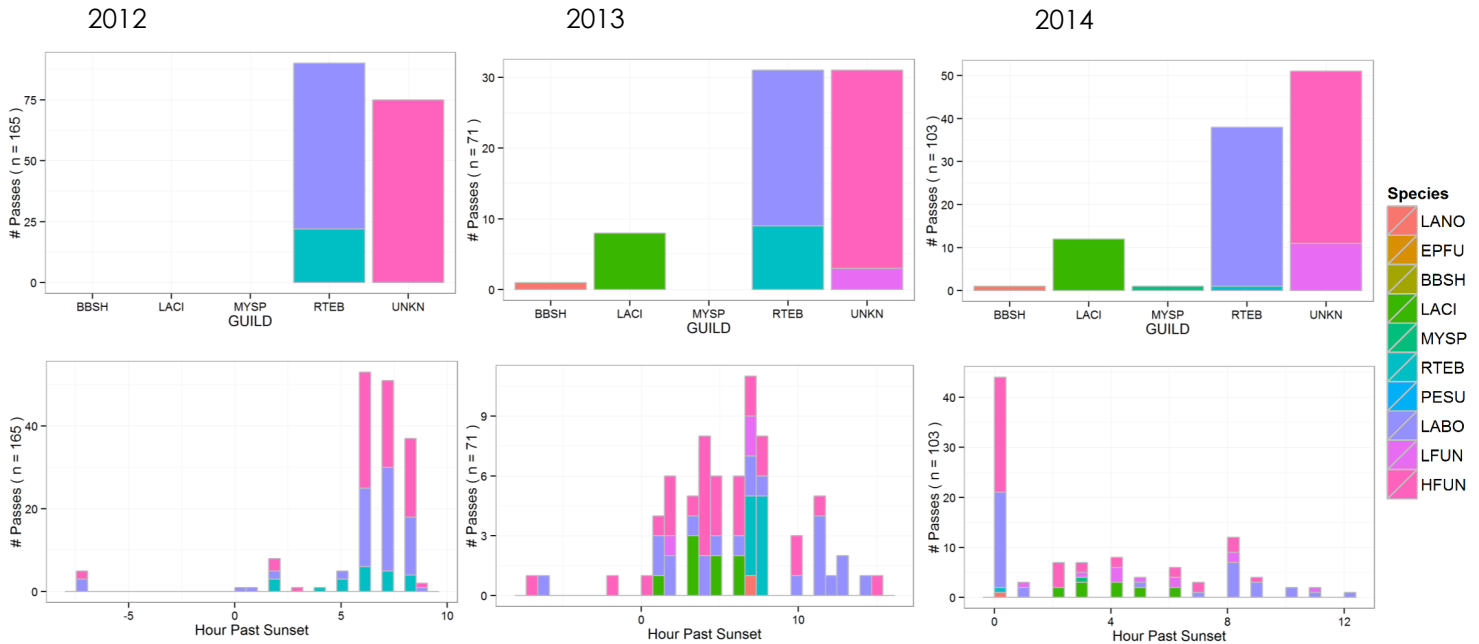


This was the most remote sites we monitored in the mid-Atlantic region. Although bat activity levels were among the lowest of any site we surveyed, bat activity occurred during 20% of surveyed nights in 2013 and 2014. Red bats activity drove the seasonal patterns observed at the site, with the busiest single night occurring 2 May 2012. Other than this peak, activity occurred most frequently in August and September.

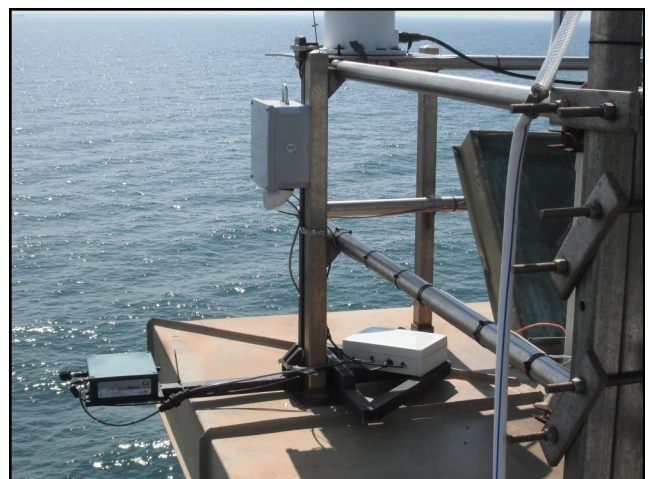
Chesapeake Light Tower, Virginia

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats were the most frequently detected species at this site (n = 127). Other species identified included hoary bats (n = 20), silver-haired bats (n = 2), and *Myotis* species (n = 1). But occurred irregularly. Timing of activity was very irregular at this site, with bats detected up to 7 hours before sunset (n = 8) and 5 hours past sunrise (n = 11). Most daytime detections occurred between 15 August and 15 September 2012 and 2013.



View of detector (orange circle) looking northeast (left) and as mounted on the tower structure (right). The acoustic detector was deployed at the top of the Chesapeake Light Tower and oriented southeast. This manmade structure is over 20 km from the nearest land (Virginia Beach) and lacks natural habitat.

Coastal Studies Institute, North Carolina

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

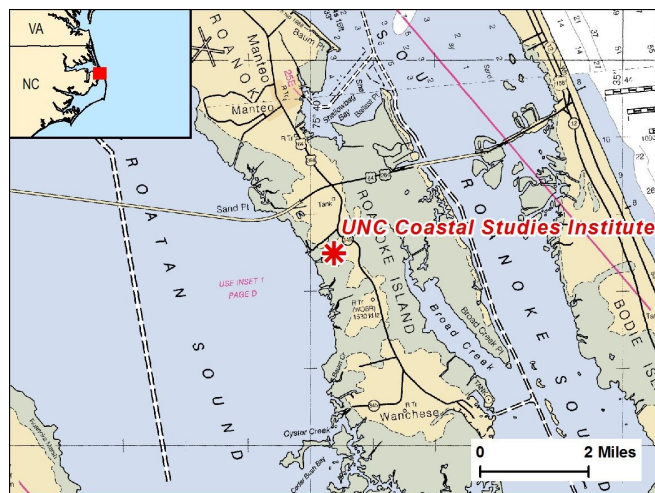


Table 1. Site Information

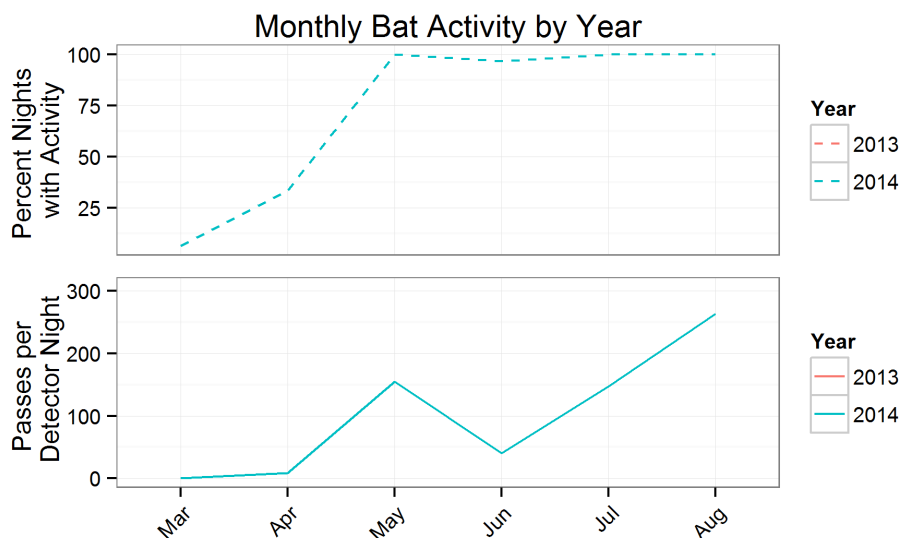
Region	mid-Atlantic
Category	Large Island
Lat/Long	35.87598, -75.6615
Area (hectares)	3291
Distance from Mainland (km)	8
% Land in 3 nm buffer	40.0
% Forest in 150 m buffer	47.3
Detector Location	Dock
Detector Height (m)	2
Distance from Shore (m)	0

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	5 Aug – 12 Aug	8	2,455	651	0.88	306.88	-
2014	1 Mar – 22 Aug	175	16,643	800	1.00	255.38	0.45

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

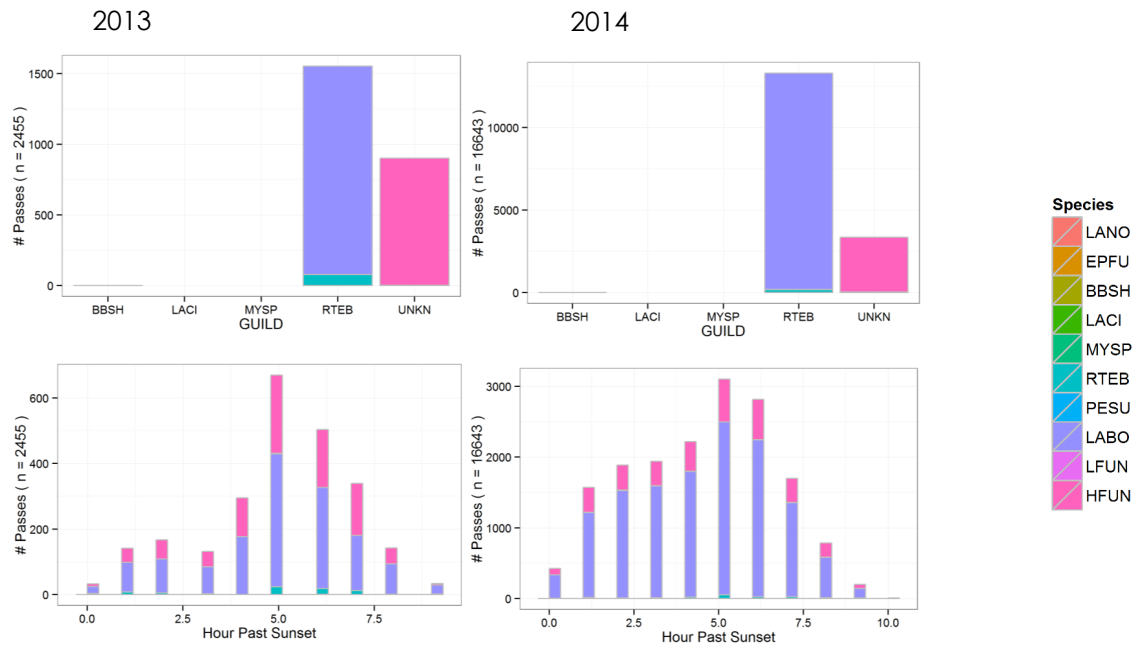


Surveys at this site documented high rates of eastern red bat activity between May and August, although surveys did not span the full season monitored at other sites. The low Gini coefficient indicates that activity was evenly distributed among survey nights.

Coastal Studies Institute, North Carolina

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Only 2 species were identified at this site, with eastern red bats (n = 14,580) comprising the vast majority of passes. Tri-colored bats (n = 6) were also present during a small number of nights in 2014. Overall timing peaked 5 hours past sunset, later than most sites, and no activity occurred before sunset or after sunrise.



View of detector looking southeast (left) and west (right). This detector was deployed on a boardwalk along a tidal river on the west side of Roanoke Island, a 3,291 hectare island in Croatan Sound, between Bodie Island and the mainland.

Frenchboro, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

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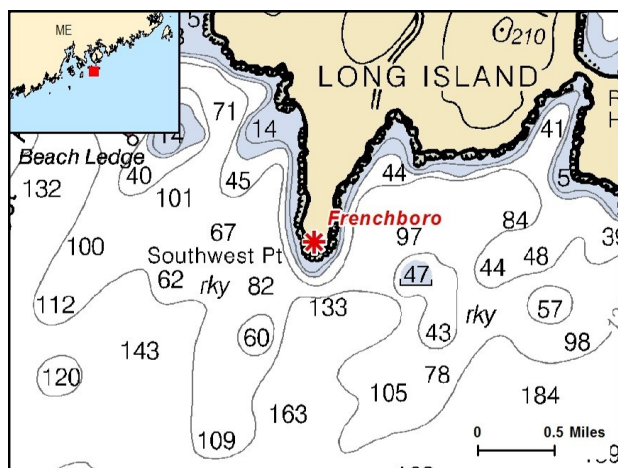


Table 1. Site Information

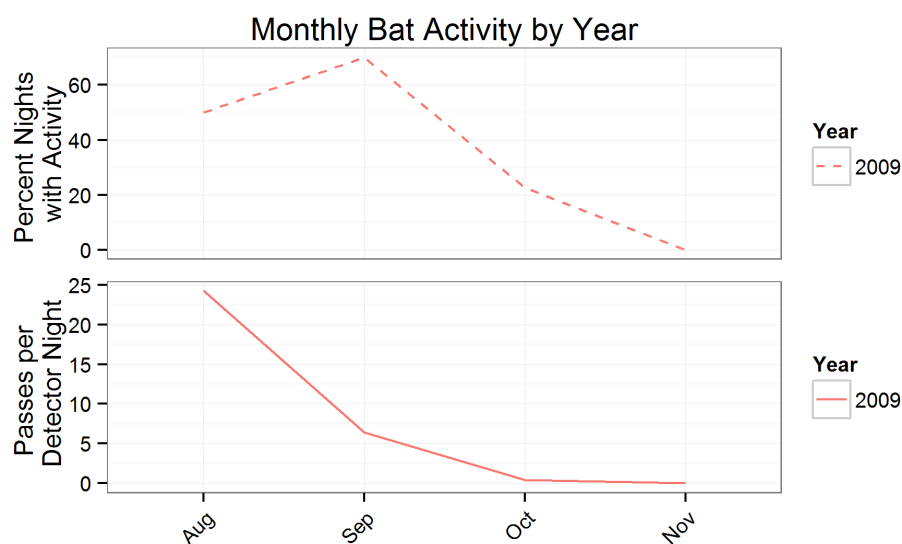
Region	Gulf of Maine
Category	Large Island
Lat/Long	44.098196, -68.367317
Area (hectares)	594
Distance from Mainland (km)	10.5
% Land in 3 nm buffer	7.7
% Forest in 150 m buffer	28.6
Detector Location	Tree
Detector Height (m)	2
Distance from Shore (m)	20

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	28 Aug – 3 Nov	68	302	98	0.53	5.98	0.85

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



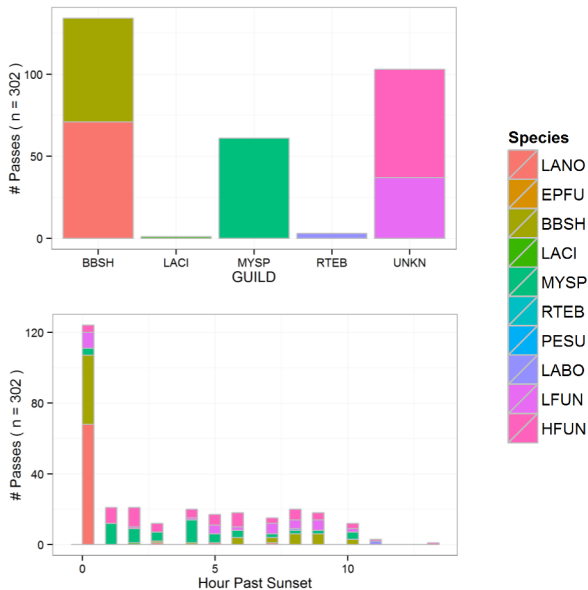
We detected high levels of acoustic activity at this site in late summer, although did not begin surveys until late August. Frequency of activity was highest in September and declined steadily thereafter, with no activity detected past 23 October 2009.

Frenchboro, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown

2009



Silver-haired bats were the most commonly detected species at this site (n = 71), occurring primarily between 28 August and 5 September 2009. We detected *Myotis* species activity regularly between late August and mid October (n = 61) and also recorded 1 hoary bat. Most activity occurred during the first hour past sunset. We detected 4 passes after sunset, with daytime activity occurring on 3 mornings between late August and mid October.



This detector was suspended in a dead coniferous snag along the shoreline of a large forested island (left). A group of local schoolchildren as interested in the project and helped set up the site (right).

Gibraltar Island, Ohio

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

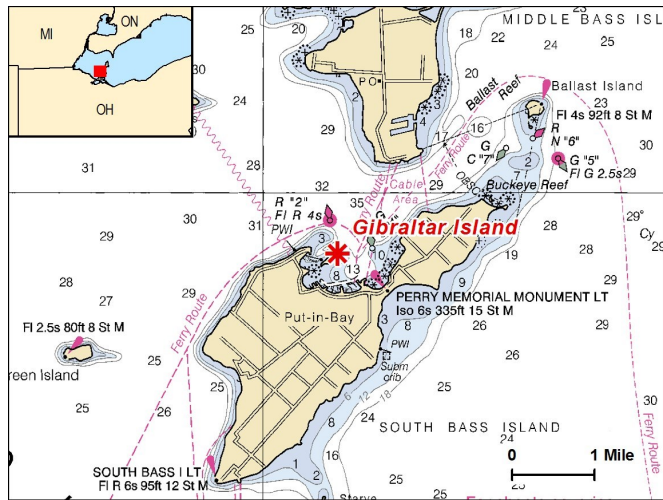


Table 1. Site Information

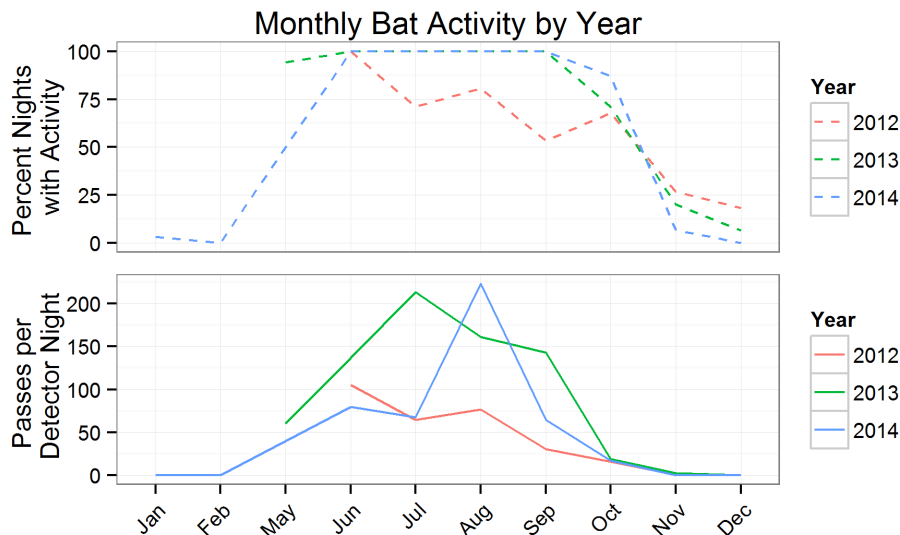
Region	Great Lakes
Category	Small Island
Lat/Long	41.658583, -82.820235
Area (hectares)	2.6
Distance from Mainland (km)	8
% Land in 3 nm buffer	9.4
% Forest in 150 m buffer	23.1
Detector Location	Stone tower
Detector Height (m)	11
Distance from Shore (m)	45

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	13 Jun – 11 Dec	182	7,716	401	0.70	50.70	0.66
2013	15 May – 31 Dec	231	21,676	1,028	1.00	138.05	0.49
2014	1 Jan – 8 Dec	221	13,555	423	0.99	104.48	0.47

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

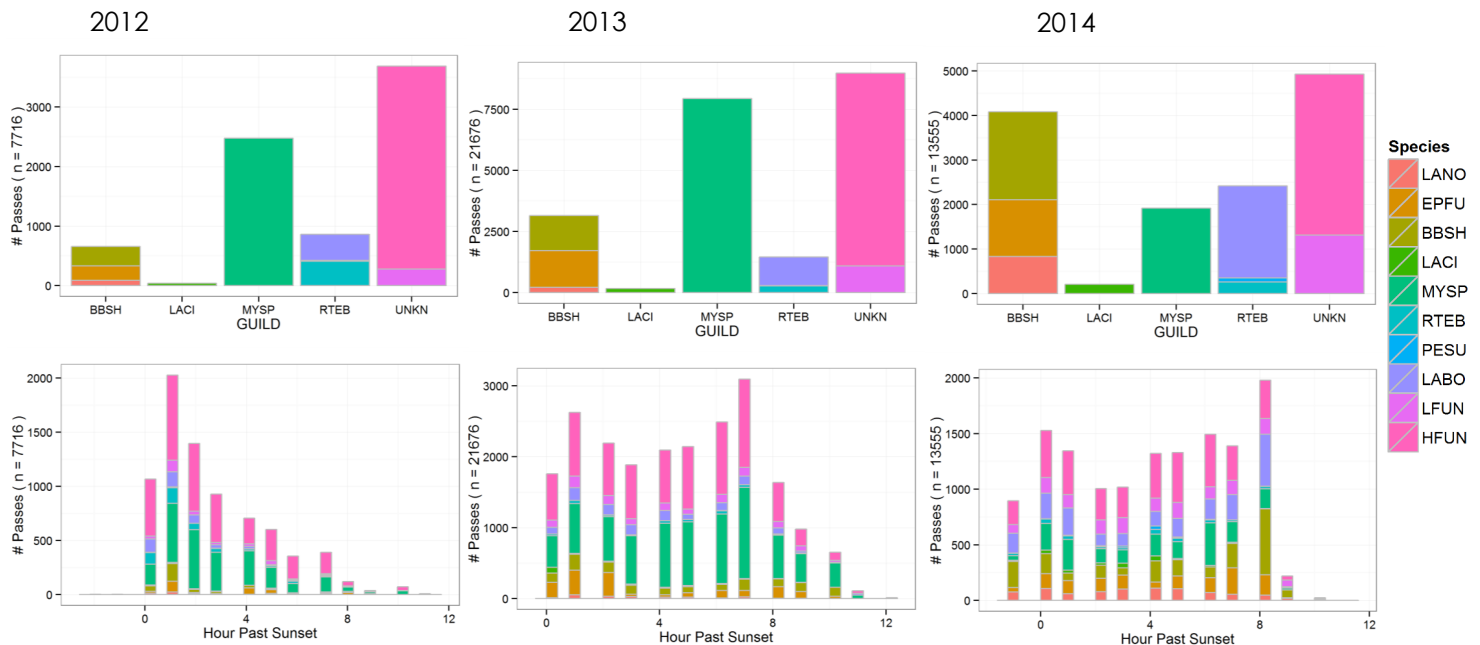


Bats were consistently present at this site between June through October, with annual peak rates occurring in June 2012, July 2013, and August 2014. We detected bat activity as late as 7 December, and also detected one bat on 13 January 2014.

Gibraltar Island, Ohio

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most commonly identified species group in 2012 and 2013 and overall (n = 12,328), although numbers declined slightly in 2014 relative to other species. Eastern red bats (n = 3,670) and big brown bats (n = 3,025) were also common. Silver-haired bats (n = 1,129) were detected most frequently in April, June, and September and hoary bats (n = 418) were most commonly detected in late August. Tri-colored bats (n = 112) occurred periodically throughout the survey period, with highest levels documented in late September 2014. Most activity occurred between sunset and sunrise, although we detected 900 passes in the hour before sunset in 2014, with pre-sunset activity distributed among many nights between early June and early November.



View of detector looking north (left) and of the solar panel and battery (right). This 2.7 hectare, inhabited island is part of an archipelago of islands approximately 8 km from the mainland. The acoustic detector was deployed in a tower on a historic home surrounded by scattered deciduous trees and maintained lawns.

Great Duck Island, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

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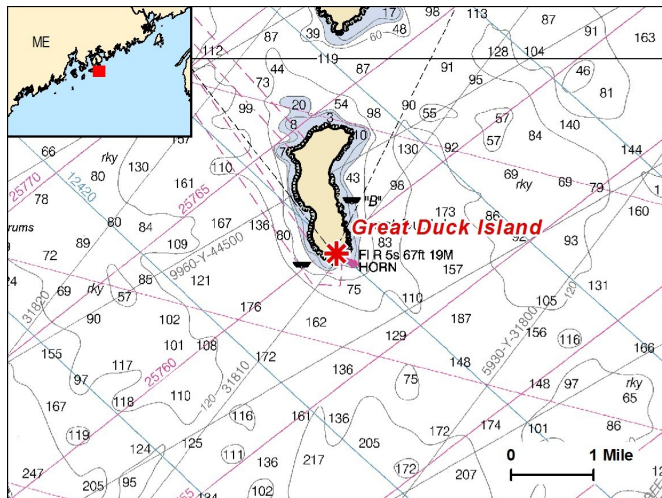


Table 1. Site Information

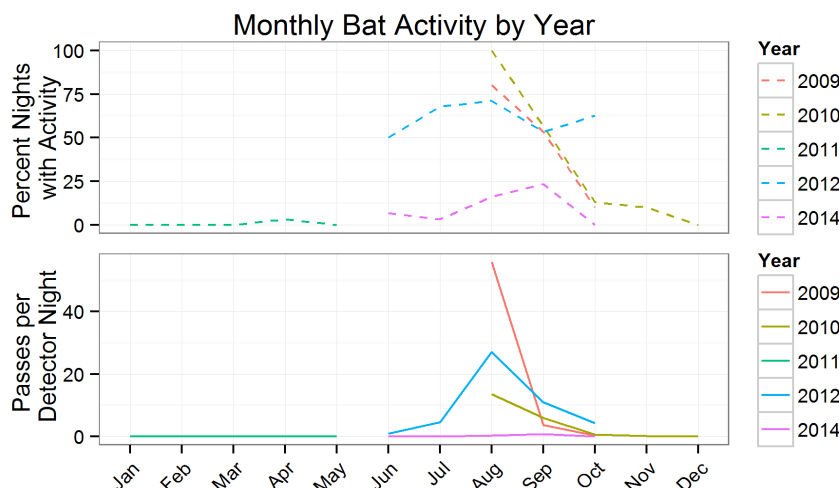
Region	Gulf of Maine
Category	Medium Island
Lat/Long	44.142092, -68.24573
Area (hectares)	86
Distance from Mainland (km)	9.8
% Land in 3 nm buffer	1.3
% Forest in 150 m buffer	0.2
Detector Location	Lighthouse
Detector Height (m)	5
Distance from Shore (m)	60

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	17 Aug – 20 Oct	65	954	153	0.50	15.87	0.83
2010	27 Aug – 15 Dec	111	269	63	0.50	5.26	0.78
2011	1 Jan – 31 May	151	2	2	-	-	-
2012	21 Jun – 24 Oct	126	1,423	278	0.63	13.87	0.78
2014	16 June – 16 Oct	123	36	11	0.14	0.37	0.93

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

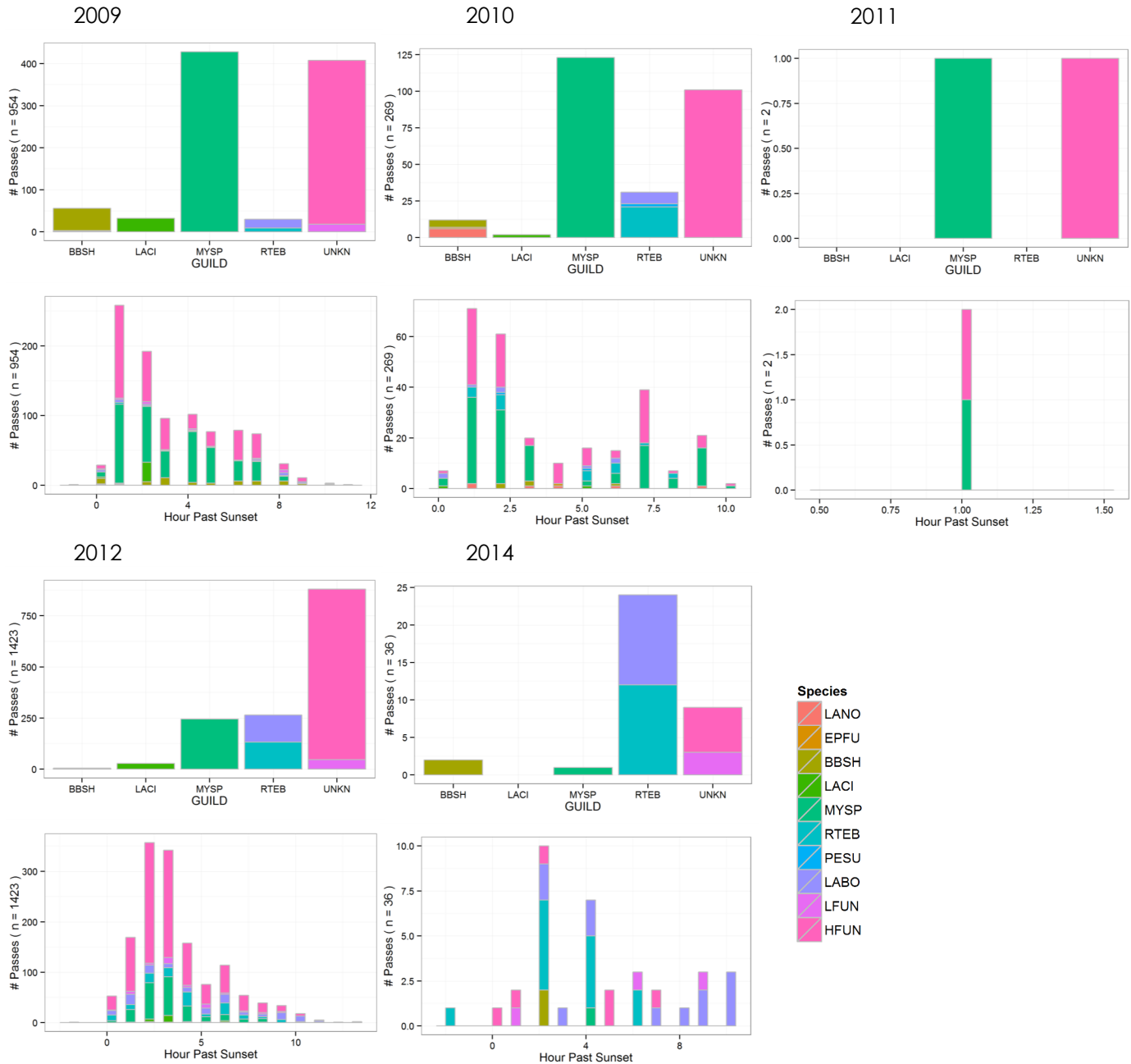


Dates surveyed varied among years, although bats occurred most often and at highest levels during August during 2009, 2010, and 2012 and September in 2014. Activity levels were substantially lower in 2014 than previous years, and also more sporadic, indicated by a higher Gini coefficient.

Great Duck Island, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most commonly identified group at this site overall (n = 798), although activity levels dropped substantially between 2012 and 2014, when only 1 was detected. Other species occurred irregularly at the site including hoary bats (n = 62), detected mostly in late August, and eastern red bats (n = 173), detected primarily between late August and mid September, silver-haired bats (n = 10), big brown bats (n = 3) and tri-colored bats (n = 2).

Great Duck Island, Maine



View of detector looking mounted on the lighthouse tower (upper left), looking southeast (upper right), southwest (lower left), and of the surrounding field (lower right). This 85.8 hectare island is 9.8 km from the mainland and supports a nesting seabird colony. The acoustic detector was oriented southward and deployed in a lighthouse tower located at the southern end of the island in a grassy field.

Halfway Rock, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

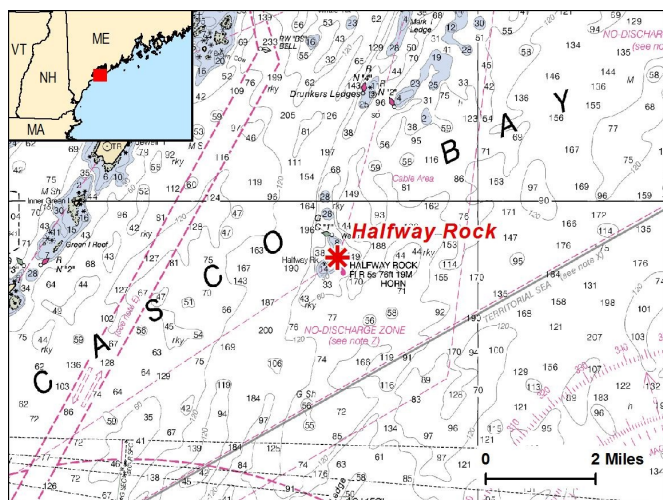


Table 1. Site Information

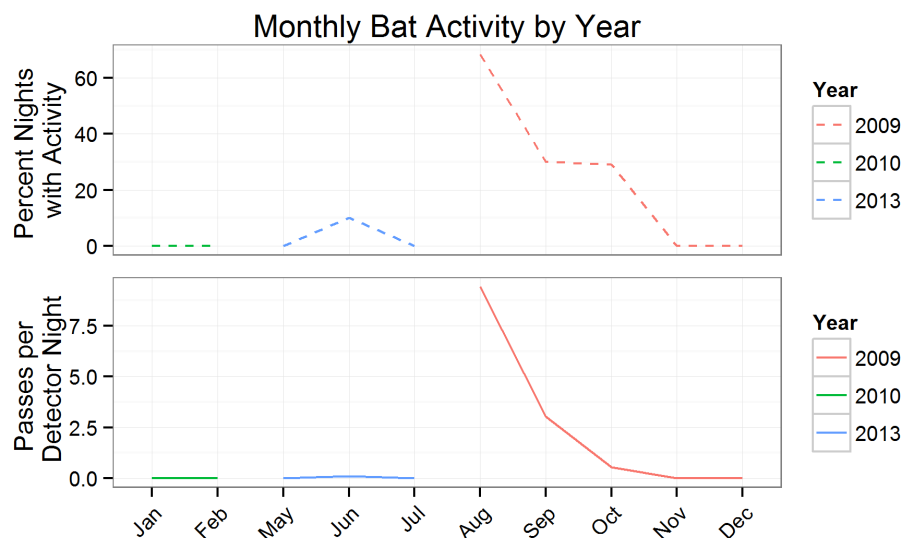
Region	Gulf of Maine
Category	Small Island
Lat/Long	43.655994, -70.0369
Area (hectares)	0.9
Distance from Mainland (km)	8.3
% Land in 3 nm buffer	0.7
% Forest in 150 m buffer	0.0
Detector Location	Lighthouse
Detector Height (m)	23
Distance from Shore (m)	48

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	13 Aug – 31 Dec	141	287	60	0.44	4.20	0.85
2010	1 Jan – 24 Feb	55	0	0	-	-	-
2013	31 May – 1 Jul	32	3	1	-	-	-

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

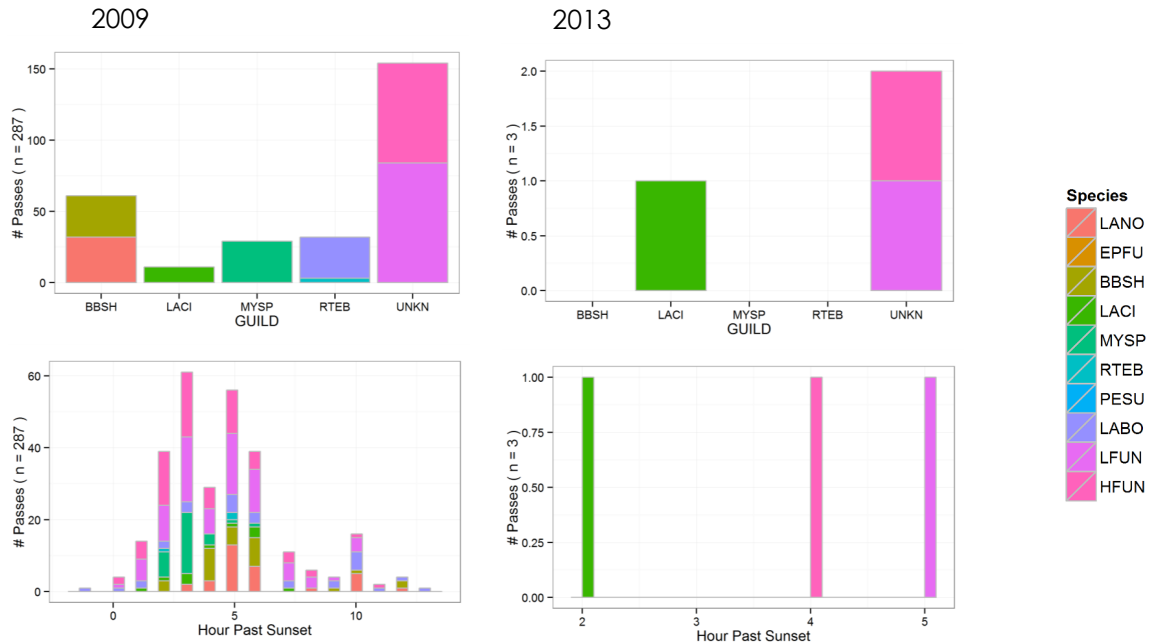


This site was monitored most intensively in 2009, when detection rate and frequency were highest in August, declining steadily through October (the last bat was detected on 25 October). Few passes were recorded during early summer surveys in 2013.

Halfway Rock, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Silver-haired bats (n = 32), eastern red bats (n = 29) and Myotis species (n = 29) occurred with relatively even proportions, and we also detected 12 hoary bats. Of the 32 silver-haired bat passes, 24 (75%) occurred during the night of 5 September 2009. One pass occurred in the hour before sunset and 12 passes occurred up to 2 hours after sunrise.



Halfway Rock is a waveswept rock lacking vegetation on the outskirts of Casco Bay, Maine, half way between Cape Small and Cape Elizabeth (right). The detector was deployed in the top of the stone lighthouse tower, facing south (left).

Isle au Haut, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

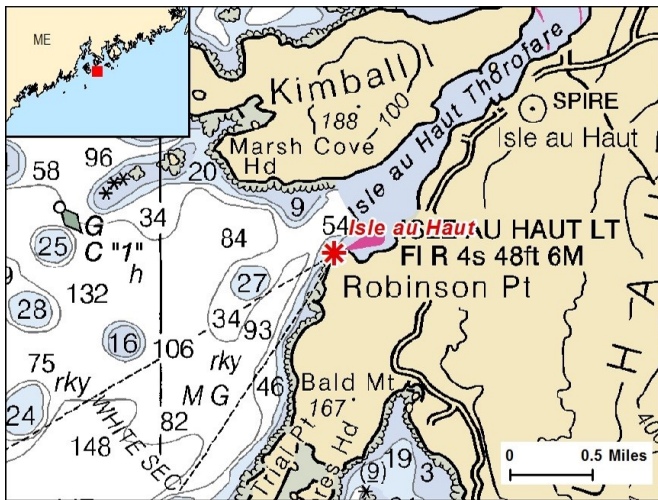


Table 1. Site Information

Region	Gulf of Maine
Category	Large Island
Lat/Long	44.06474, -68.651319
Area (hectares)	2,753
Distance from Mainland (km)	16.7
% Land in 3 nm buffer	31.8
% Forest in 150 m buffer	17.6
Detector Location	Lighthouse
Detector Height (m)	12
Distance from Shore (m)	0

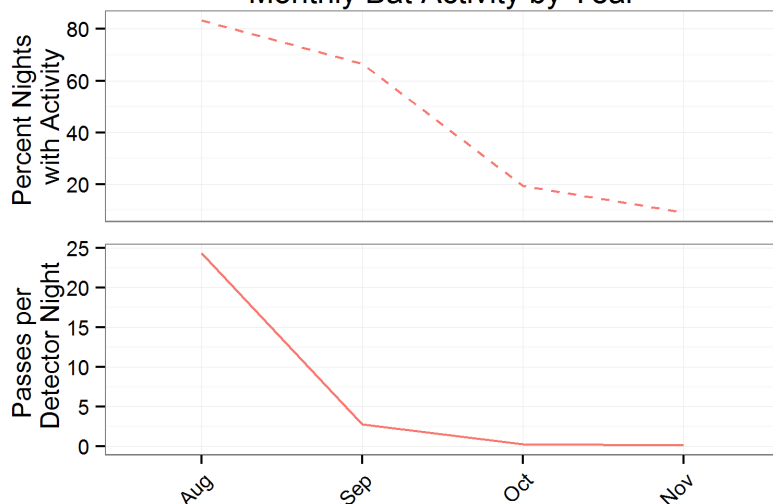
Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	26 Aug – 11 Nov	78	237	97	0.57	4.59	0.84

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

Monthly Bat Activity by Year



Year
-- 2009

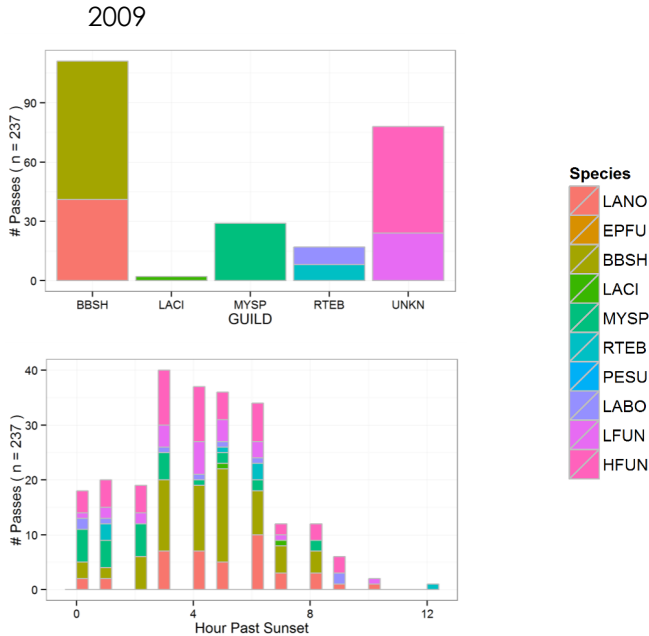
Detection rates were highest at this site in August and declined steadily through November. No bat activity occurred after 26 October 2009.

Year
— 2009

Isle au Haut, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Silver-haired bats (n = 41) were the most frequently detected species, followed by *Myotis* species (n = 29). We also detected eastern red bat (n = 9) and hoary bat (n = 2) passes. No activity occurred before sunset or after sunrise, and overall activity peaked 3 hours past sunset.



The detectors were positioned in the lighthouse tower platform, oriented along the rocky shoreline of this large, forested island.

Kent Island North Field, New Brunswick

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

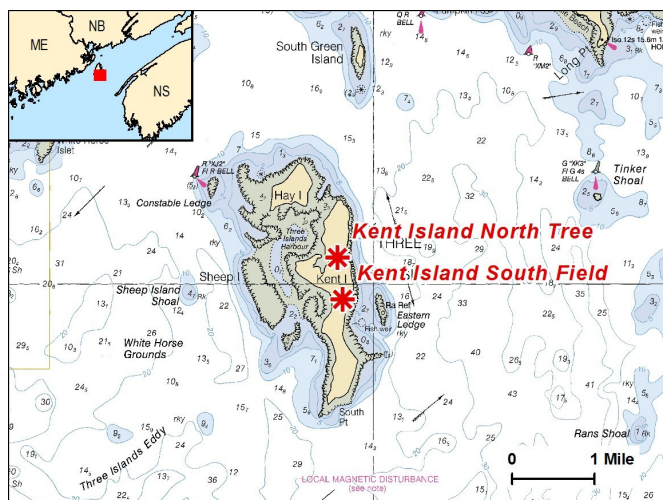


Table 1. Site Information

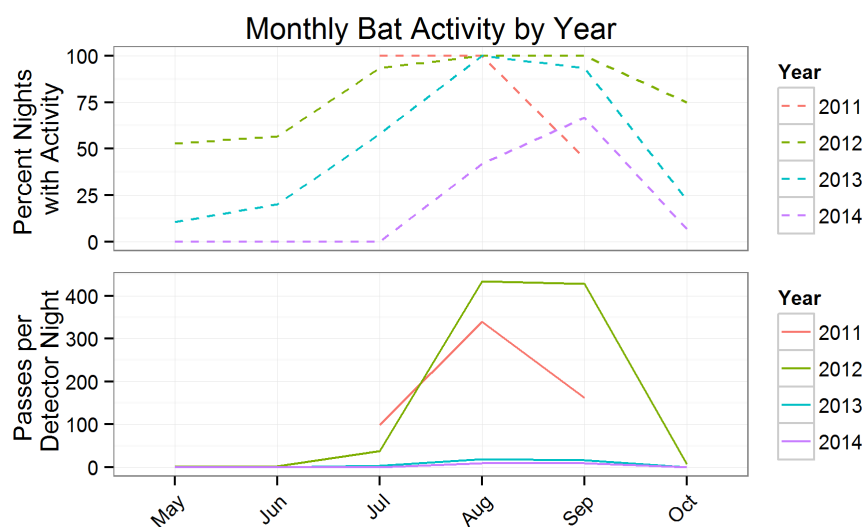
Region	Gulf of Maine
Category	Medium
Lat/Long	44.586585, -66.7562
Area (hectares)	98.5
Distance from Mainland (km)	30.2
% Land in 3 nm buffer	2.0
% Forest in 150 m buffer	82.0
Detector Location	Tree
Detector Height (m)	3
Distance from Shore (m)	130

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2011	26 Jul – 20 Sep	57	14,368	1,274	0.81	252.05	0.61
2012	15 May – 20 Oct	159	27,667	1,666	0.97	294.43	0.68
2013	13 May – 27 Oct	168	1,199	128	0.82	11.20	0.67
2014	28 May – 29 Oct	155	598	208	0.38	6.43	0.89

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

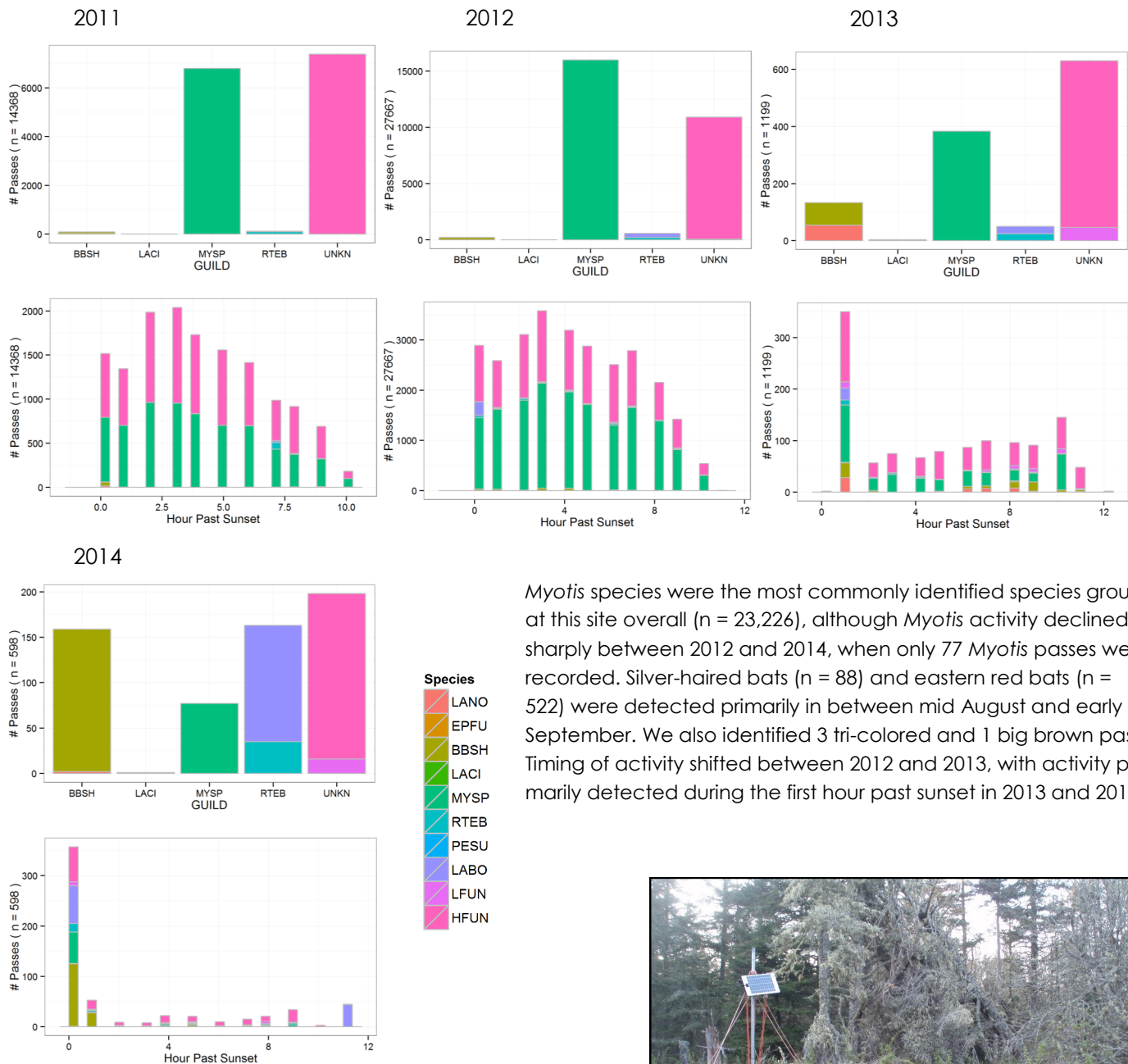


Bat activity was consistently high at this site between July and September, 2011–2012, but declined dramatically in 2013 and 2014, to the point where bats were not detected for 65 consecutive nights in 2014. Detection rates were 21 to 93 times higher at this site than the nearby South Field detector.

Kent Island North Field, New Brunswick

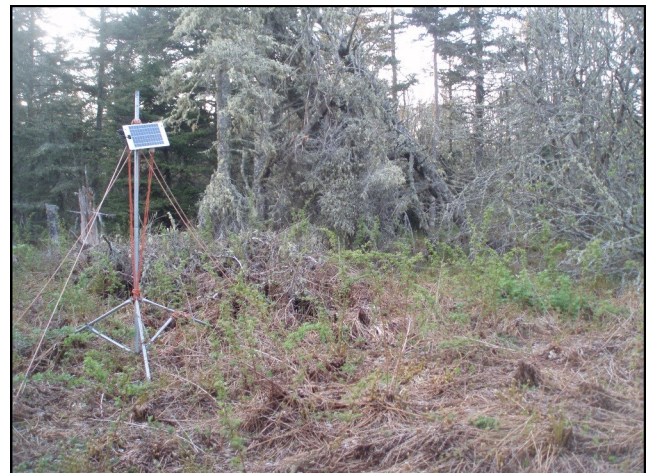
Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most commonly identified species group at this site overall (n = 23,226), although Myotis activity declined sharply between 2012 and 2014, when only 77 Myotis passes were recorded. Silver-haired bats (n = 88) and eastern red bats (n = 522) were detected primarily in between mid August and early September. We also identified 3 tri-colored and 1 big brown pass. Timing of activity shifted between 2012 and 2013, with activity primarily detected during the first hour past sunset in 2013 and 2014.

View of acoustic detector in small clearing. The acoustic detector was deployed in a temporary tower within a 20-meter diameter clearing surrounded by forest dominated by red-spruce (*Picea rubens*) and mountain ash (*Sorbus americana*). This site was 0.6 km north of the Kent Island South Field site.



Kent Island South Field, New Brunswick

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

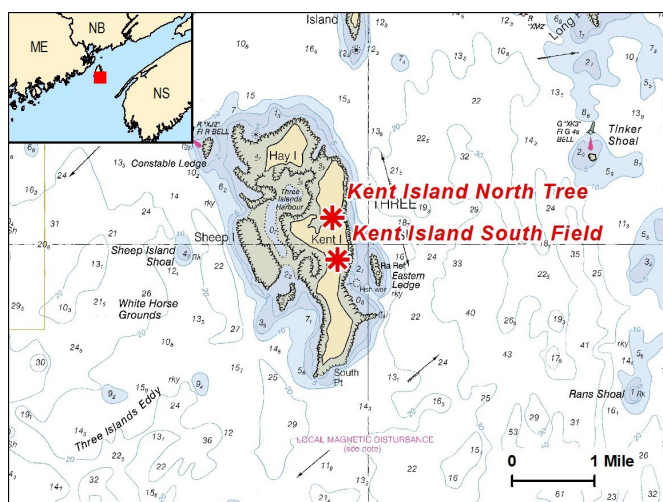


Table 1. Site Information

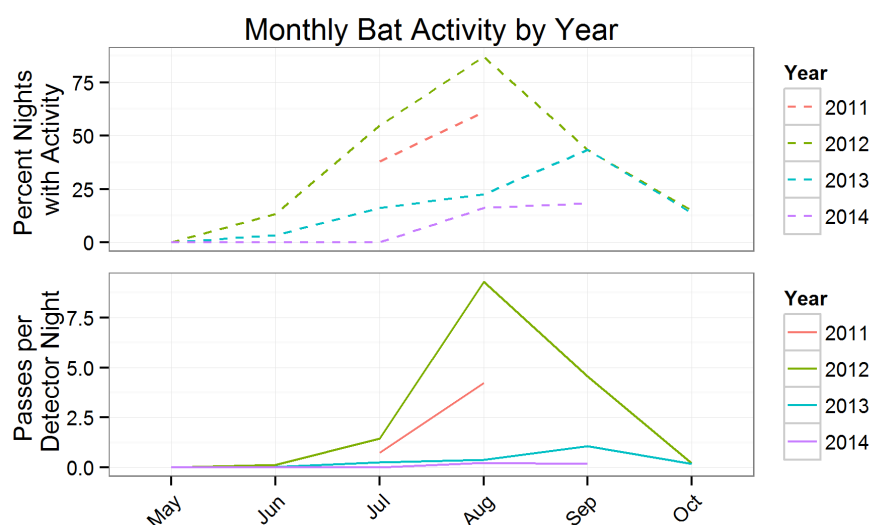
Region	Gulf of Maine
Category	Medium Island
Lat/Long	44.58139, -66.755308
Area (hectares)	98.5
Distance from Mainland (km)	30.2
% Land in 3 nm buffer	2.0
% Forest in 150 m buffer	10.0
Detector Location	Temporary tower
Detector Height (m)	5
Distance from Shore (m)	110

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2011	3 Jul – 18 Aug	47	97	18	0.57	2.69	0.72
2012	15 May – 20 Oct	159	478	35	0.58	5.00	0.73
2013	13 May – 22 Oct	163	57	8	0.30	0.58	0.80
2014	30 May – 22 Sep	116	11	2	0.13	0.16	0.89

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

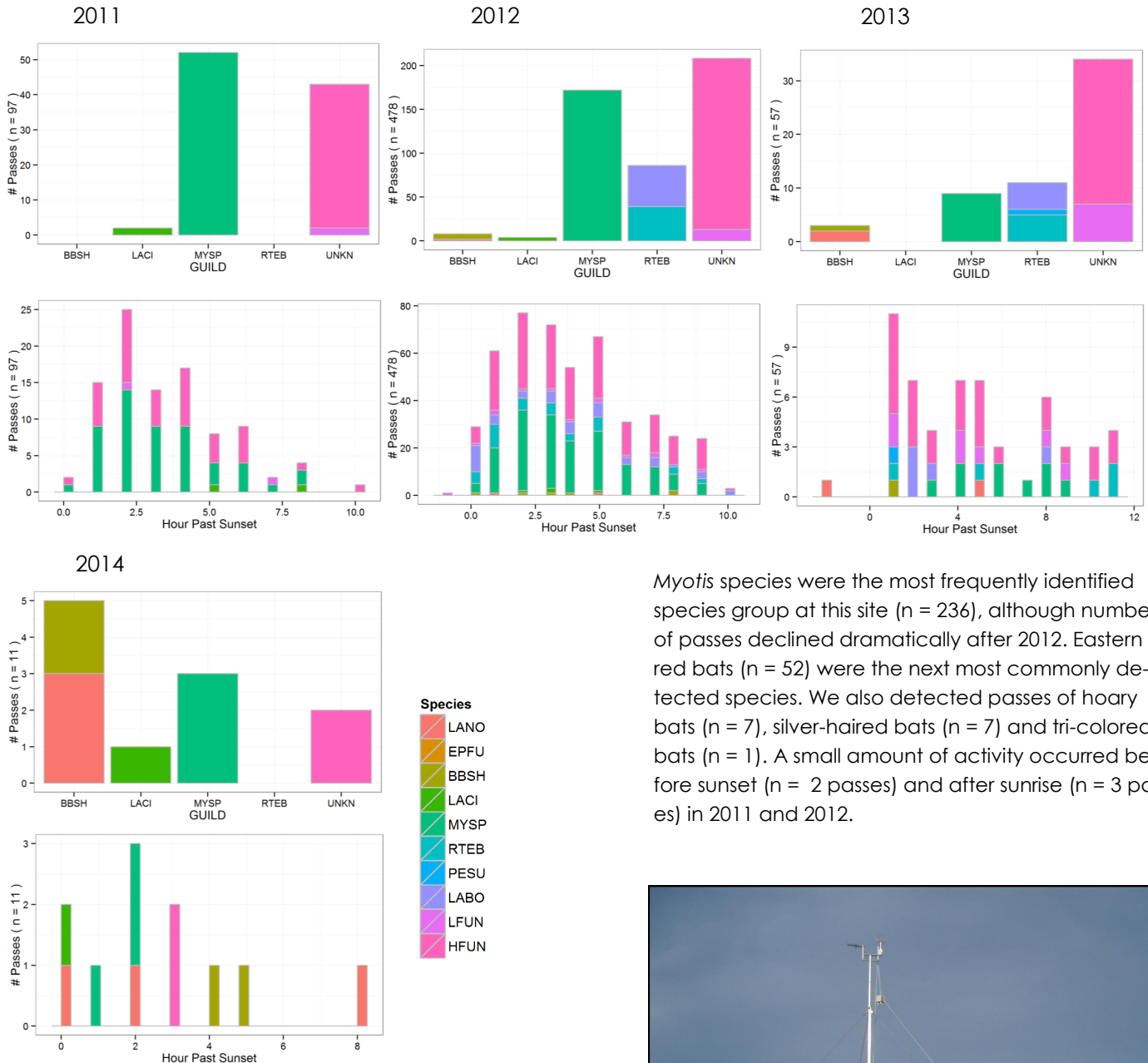


Detection rates were low at this detector throughout the study period, particularly relative to the nearby North Field detector. Rates and frequency of detection declined steadily at both Kent Island detectors between 2011 and 2014. Gini coefficients also increased during this period, indicating that activity became more sporadic. No bats were detected for a period of 70 nights between 30 May and 7 August 2014.

Kent Island South Field, New Brunswick

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most frequently identified species group at this site (n = 236), although number of passes declined dramatically after 2012. Eastern red bats (n = 52) were the next most commonly detected species. We also detected passes of hoary bats (n = 7), silver-haired bats (n = 7) and tri-colored bats (n = 1). A small amount of activity occurred before sunset (n = 2 passes) and after sunrise (n = 3 passes) in 2011 and 2012.

View looking east towards detector. The acoustic detector was deployed in a weather station tower and oriented westward. The large field complex surrounding the tower covers the southern half of the narrow, 98.5-hectare island and is 30.2 km from the mainland. This detector was 0.6 km south from the Kent Island North Field detector.



Manitou Island, Michigan

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

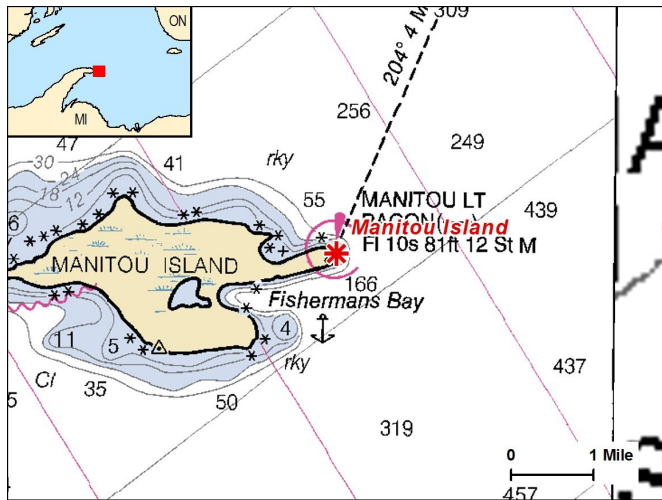


Table 1. Site Information

Region	Great Lakes
Category	Large Island
Lat/Long	47.419215, -87.5873
Area (hectares)	423.2
Distance from Mainland (km)	9.4
% Land in 3 nm buffer	4.4
% Forest in 150 m buffer	30.3
Detector Location	Lighthouse
Detector Height (m)	15
Distance from Shore (m)	15

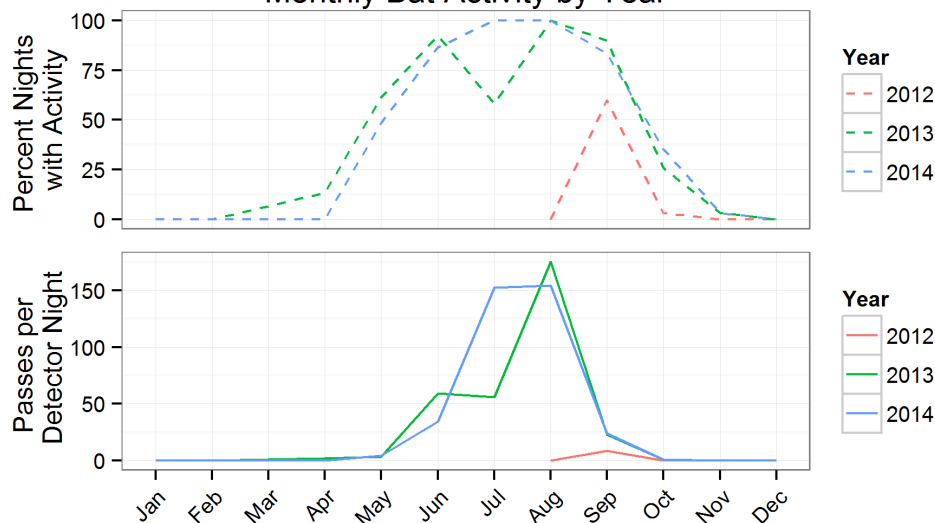
Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	13 Aug – 31 Dec	141	260	130	0.28	4.00	0.93
2013	1 Jan – 31 Dec	320	9,634	619	0.74	72.80	0.71
2014	1 Jan – 31 Dec	365	11,431	1,104	0.87	96.6	0.72

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

Monthly Bat Activity by Year

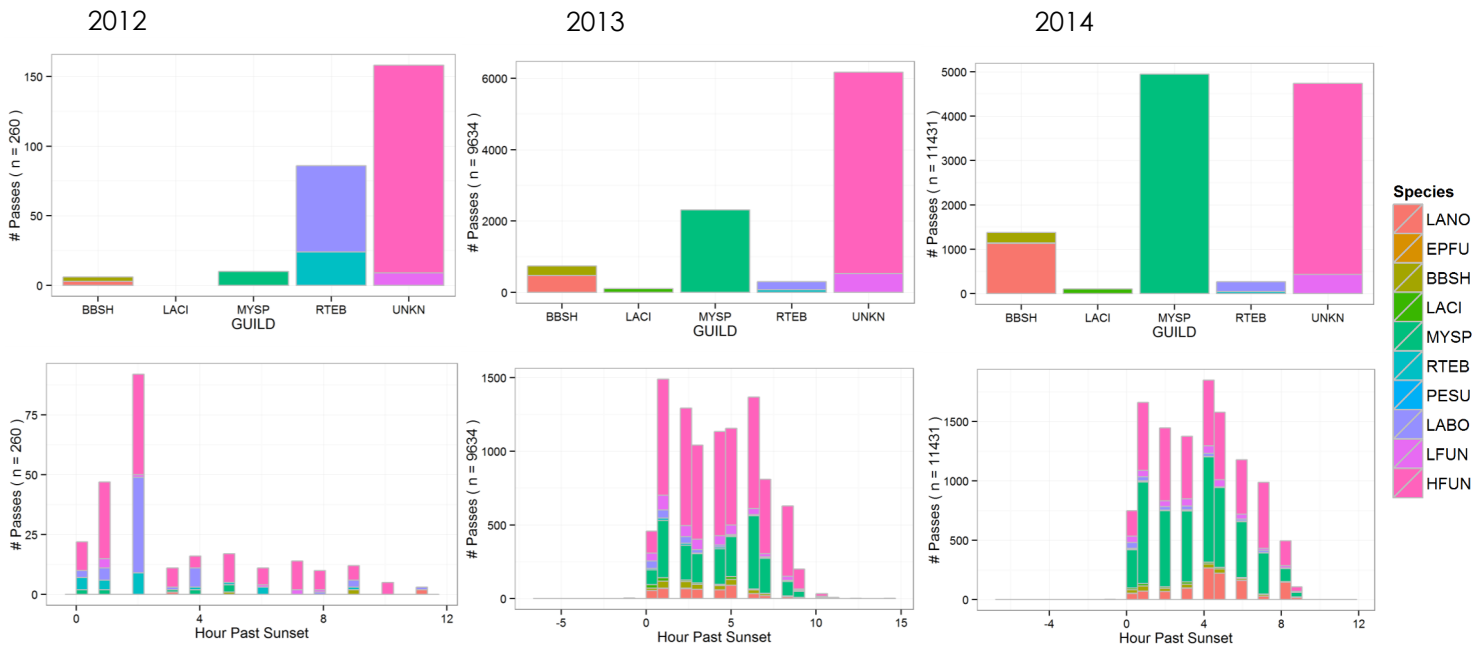


Bat detection rate peaked during August, but detection frequency also had a spring peak in June in 2013. Activity levels dropped during mid summer in 2013, with no bats were detected between 3 July and 29 July 2013 despite relatively high detection rates immediately before and following these dates. The same summer dip in activity did not occur in 2014, when *Myotis* activity occurred throughout much of the summer, likely indicating a resident colony of bats in or near the lighthouse.

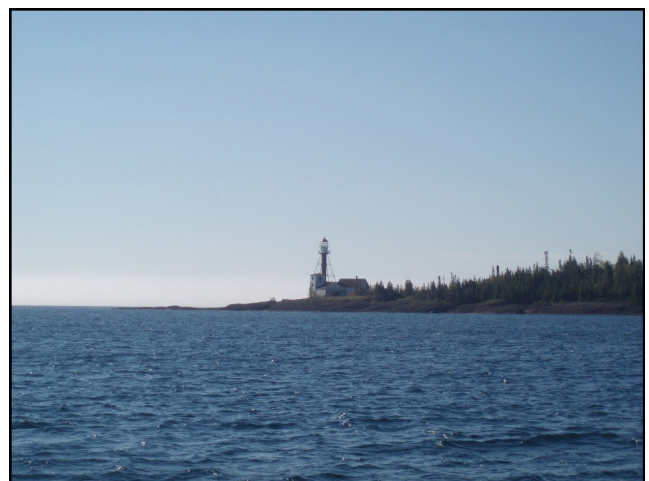
Manitou Island, Michigan

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most commonly identified species category identified at this site overall ($n = 7,269$), with the amount of *Myotis* activity increasing steadily between 2012 and 2014. Silver-haired bats were next most frequently detected ($n = 1,605$), with a pronounced peak in activity occurring in May and June and another peak in late August/early September. Eastern red bats ($n = 506$) were detected regularly during late August and early September, but were not detected in the spring. We also detected small number of big brown bat ($n = 14$) and tricolored bat ($n=5$) passes. Most activity occurred between sunset and sunrise, although a few passes occurred as many as 6 hours before sunset ($n = 8$) and up to 4 hours past sunrise ($n = 39$). Most daytime activity occurred between mid August and mid September.



View from detector looking south (left) and of the lighthouse tower looking east (right). This low-lying, 423-hectare island in Lake Superior is 4.7 km from the tip of the Keweenaw Peninsula. The lighthouse and related buildings from a former life-saving station are on the east end of the island, which is dominated by spruce-fir forest.

Matinicus Rock, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

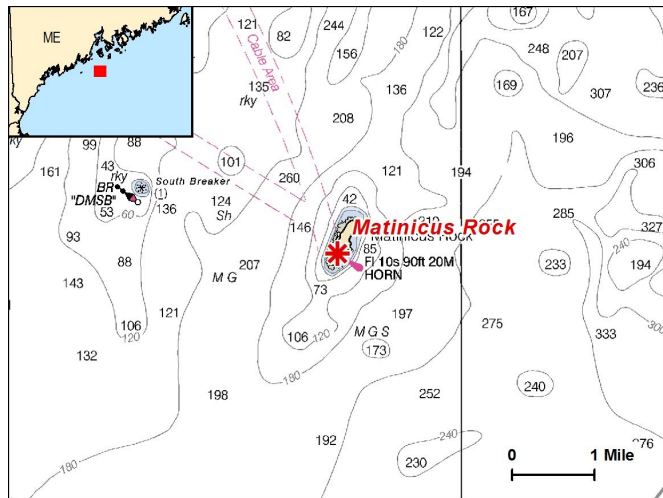


Table 1. Site Information

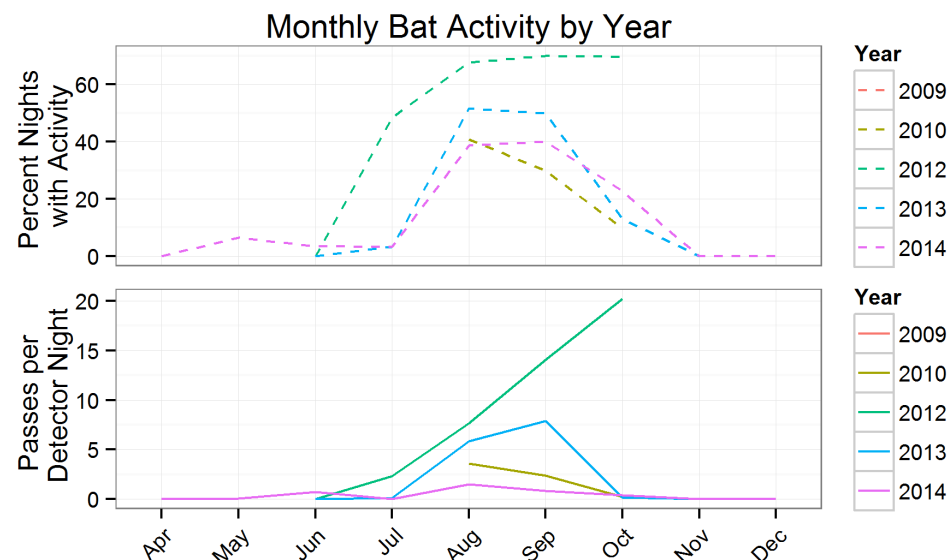
Region	Gulf of Maine
Category	Small Island
Lat/Long	43.783831, -68.855002
Area (hectares)	10.3
Distance from Mainland (km)	32.9
% Land in 3 nm buffer	0.7
% Forest in 150 m buffer	0.0
Detector Location	Lighthouse
Detector Height (m)	14
Distance from Shore (m)	70

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	2 Sep – 14 Sep	13	102	44	0.54	7.46	-
2010	5 Aug – 31 Oct	88	178	24	0.32	2.44	0.84
2012	22 Jun – 23 Oct	124	1,495	326	0.68	12.66	0.88
2013	25 Jun – 4 Nov	133	441	161	0.34	4.51	0.92
2014	4 Apr – 31 Dec	272	111	21	0.31	0.86	0.84

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Matinicus Rock was one of the more remote sites surveyed between 2009 and 2014, although bats were present frequently between August and October. The highest detection rates occurred in October 2012, when a large amount of eastern red bat activity occurred. No bat activity occurred for 38 consecutive nights between 3 July and 9 August 2013 or for 61 consecutive nights between 4 June and 3 August, 2014.

Matinicus Rock, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats were the most frequently identified species (n = 757), although silver-haired bats (n = 103) occurred regularly between late August and early October and hoary bats (n = 77) were often present in mid August. We detected *Myotis* species (n = 20) occasionally at the site, most often in mid September. Considerable activity occurred at this site after sunrise (n = 322) with bats detected up to 4 hours past sunrise. Only 2 passes were recorded before sunset.

Matinicus Rock, Maine



View of detector looking southeast (left) and as mounted in the lighthouse tower (right). This 10.3 hectare wave swept island is 32.9 km from the mainland and lacks woody vegetation or any structures other than the lighthouse. The acoustic detector was deployed in the lighthouse tower and oriented southward.

Metinic Tower, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

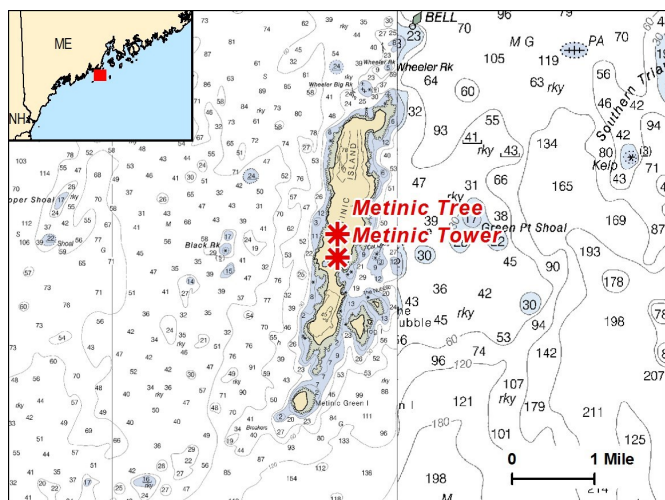


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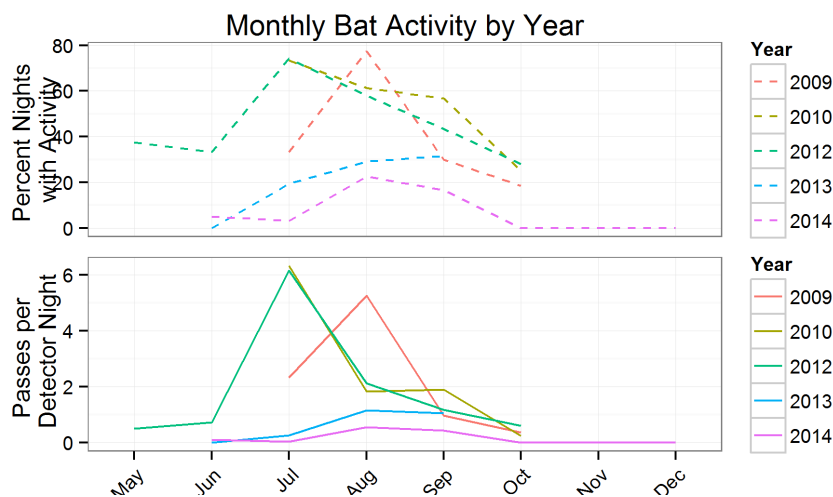
Region	Gulf of Maine
Category	Medium Island
Lat/Long	43.879591, -69.12707
Area (hectares)	139.8
Distance from Mainland (km)	8.7
% Land in 3 nm buffer	1.6
% Forest in 150 m buffer	0.0
Detector Location	Temporary tower
Detector Height (m)	6
Distance from Shore (m)	120

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	29 Jul – 27 Oct	91	209	29	0.46	2.56	0.77
2010	16 Jul – 16 Oct	92	213	21	0.56	2.33	0.71
2012	24 May – 25 Oct	155	333	51	0.48	2.73	0.80
2013	19 Jun – 19 Sep	93	64	16	0.30	0.94	0.85
2014	11 Jun – 4 Dec	177	33	5	0.14	0.33	0.91

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

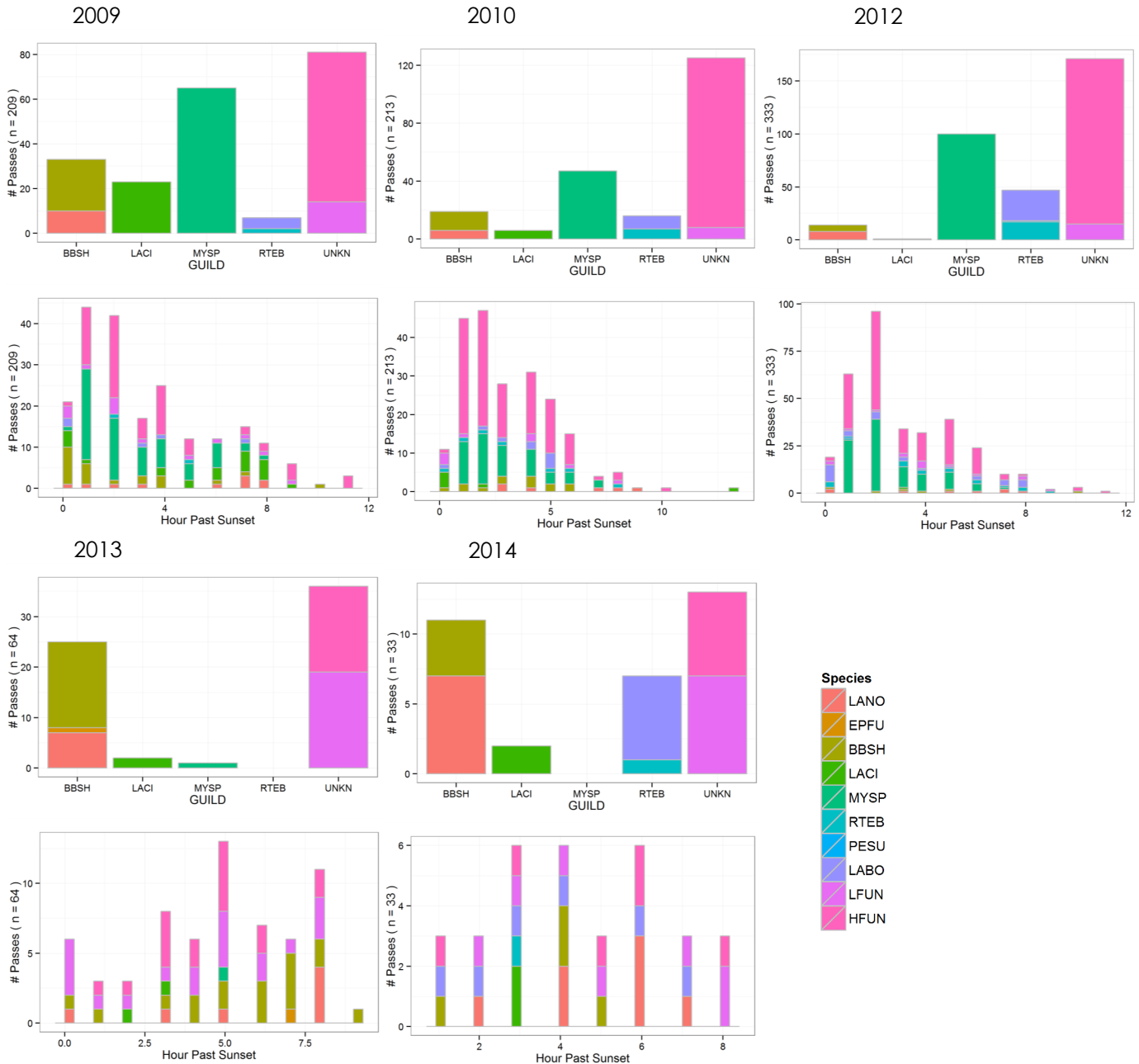


Detection rates and frequency of activity were relatively consistent between 2009 and 2012, then declined substantially in 2013 and 2014, with the Gini coefficient increasing over the same period. Peak detection rates occurred between July and September among years, with no bat activity documented after 24 October. Detection rates were 3.2 to 8.8 times lower at this site than the Metinic Tree site, located 0.4 km to the south.

Metinic Tower, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Although *Myotis* species were the most commonly identified species group (n=213), *Myotis* activity levels dropped sharply after 2012 and no *Myotis* were detected in 2014. Other species remained a similar levels among years, with eastern red bats (n = 49), silver-haired bats (n = 38) and hoary bats (n = 34) also present most years. We detected 1 big brown and 1 tri-colored bat. No activity occurred before sunset although we recorded 4 passes up to 2 hours after sunrise.

Metinic Tower, Maine



View of detector mounted in a temporary tower. The acoustic detector was deployed in a temporary tower in an open field area of this 140 hectare island located 8.7 km from the mainland. Roughly half the narrow island is a treeless grassy field and the remainder is forest dominated by red spruce, balsam fir, and mixed hardwoods, principally red maple. This detector was positioned 0.4 km north of the Metinic Tree site.



Metinic Island is managed by the U.S. Fish and Wildlife Service as an important colony for nesting seabirds and stopover site for songbirds during fall migration.

Metinic Tree, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

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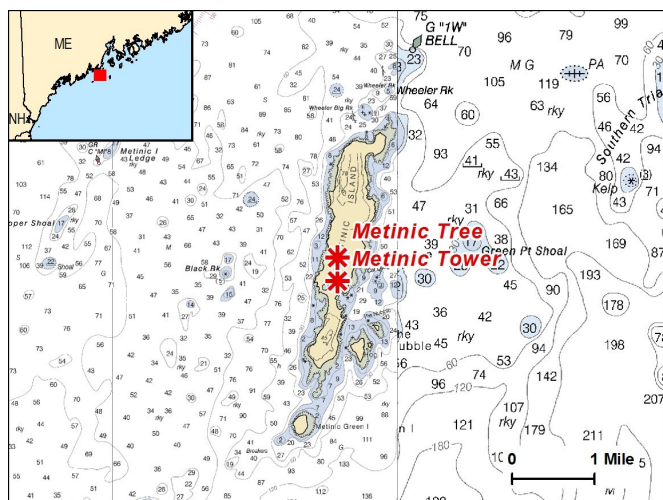


Table 1. Site Information

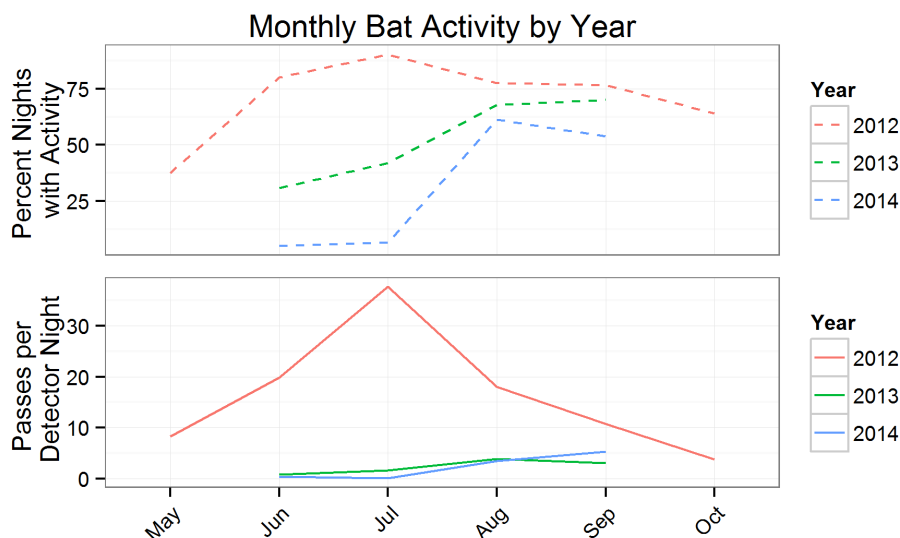
Region	Gulf of Maine
Category	Medium Island
Lat/Long	43.882539, -69.127094
Area (hectares)	139.8
Distance from Mainland (km)	8.7
% Land in 3 nm buffer	1.6
% Forest in 150 m buffer	23.6
Detector Location	Tree
Detector Height (m)	2
Distance from Shore (m)	125

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	24 May – 25 Oct	155	2,802	122	0.74	15.31	0.70
2013	18 Jun – 30 Sep	105	272	33	0.64	3.04	0.66
2014	11 Jun – 13 Sep	95	184	28	0.44	2.89	0.78

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



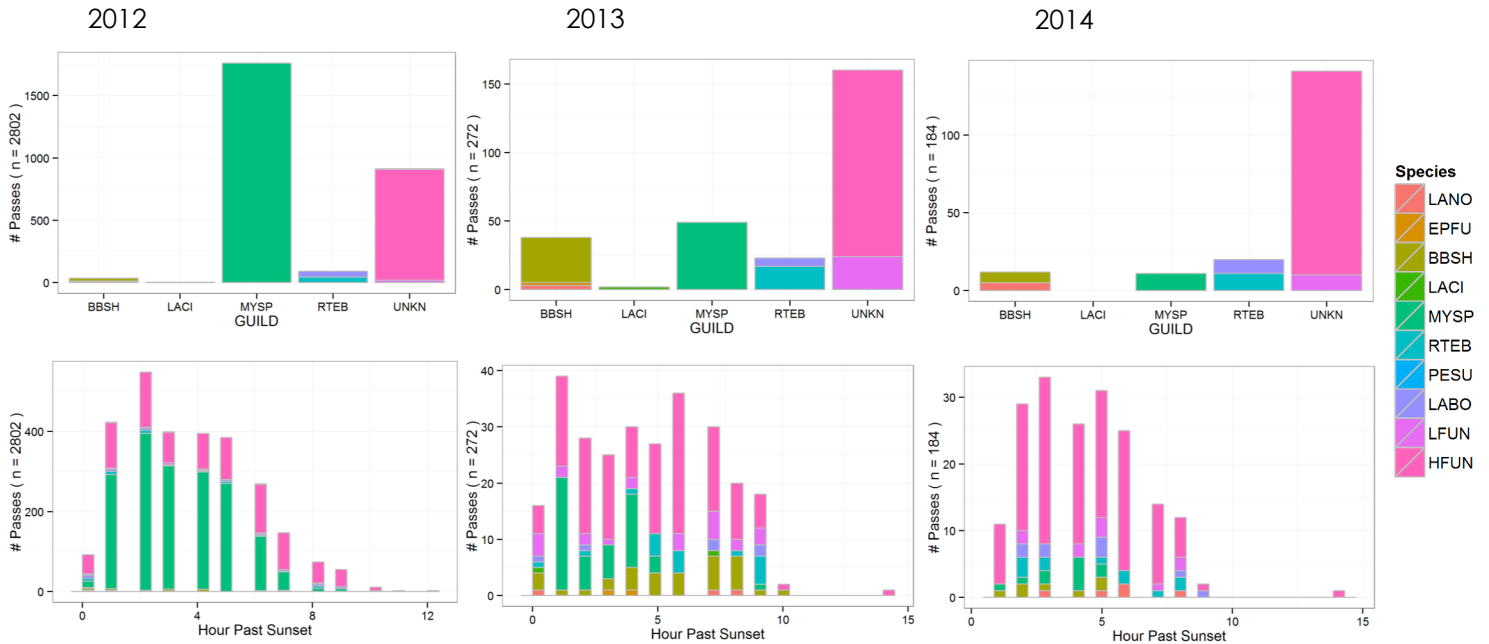
Detection rates declined dramatically at this site between 2012 and 2013, largely driven by a decrease in *Myotis* species activity. Monthly detection rates were highest in July 2009 although detection rates and frequencies in 2013 and 2014 were higher during August and September.

Annual detection rates were between 3.2 and 8.8 times higher at this site than the Metinic Tower site, located 0.4 km to the north.

Metinic Tree, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Although *Myotis* species were the most commonly species group overall (n = 1,820), *Myotis* activity dropped dramatically after 2012, as did overall bat detection rates. We also detected passes of eastern red bats (n = 61), silver-haired bats (n = 17), hoary bats (n = 5), and big brown bats (n = 4) at this site. No bat activity occurred before sunset, although 2 passes were recorded up to 6 hours past sunrise.



View of detector mounted in a tree at the field edge. The acoustic detector was deployed in a tree along the edge of the forested portion of this 140 hectare island located 8.7 km from the mainland. Roughly half the narrow island is a treeless grassy field and the remainder is forest dominated by red spruce, balsam fir, and mixed hardwoods, principally red maple.

Monhegan Island, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

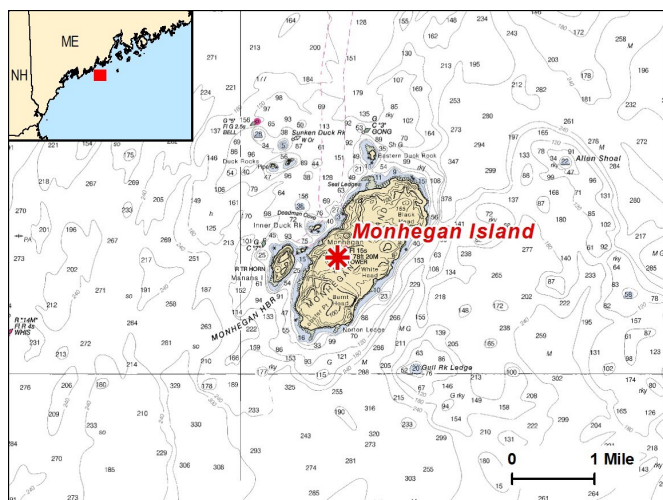


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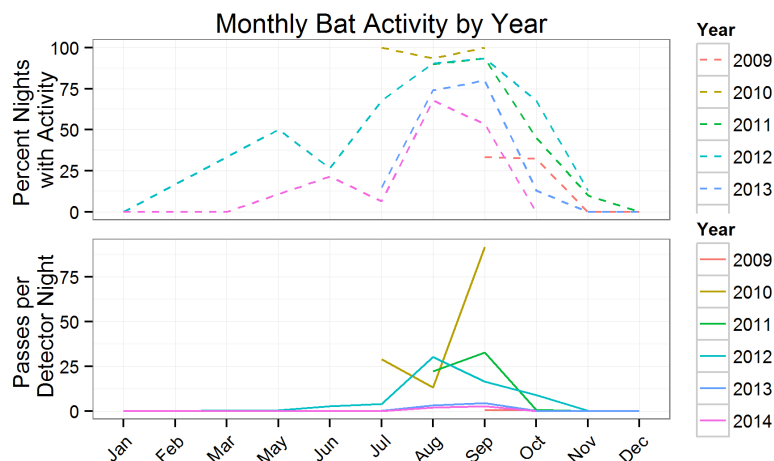
Region	Gulf of Maine
Category	Large
Lat/Long	43.764766, -69.316277
Area (hectares)	207.6
Distance from Mainland (km)	17.1
% Land in 3 nm buffer	2.3
% Forest in 150 m buffer	9.8
Detector Location	Lighthouse
Detector Height (m)	14
Distance from Shore (m)	295

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	16 Sep – 27 Dec	103	27	5	0.43	0.83	0.70
2010	19 Jul – 4 Sep	48	1,157	197	0.96	24.08	0.61
2011	12 Aug – 31 Dec	142	1,452	235	0.82	22.14	0.73
2012	1 Jan – 23 Nov	200	1,926	151	0.85	18.32	0.66
2013	12 Jul – 31 Dec	173	247	33	0.57	2.65	0.71
2014	1 Jan – 9 Oct	204	154	36	0.45	1.69	0.80

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Monthly detection rates and detection frequencies followed consistent seasonal patterns among years, with bats detected most often in August and September. The spike in detection rate in September 2010 was the result of sampling occurring during only 4 nights in that month.

Monhegan Island, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats were the most commonly identified species at this site (n = 809). Myotis activity levels (n = 648) were also high through 2011, but dropped substantially in 2012 after which point no Myotis were detected. Hoary bats (n = 70) occurred at this site primarily during mid to late August and silver-haired bats (n = 65) occurred most often in early September across years. We also detected 5 big brown bats. We detected 19 passes up to 2 hours before sunset and 4 passes up to 2 hours past sunrise.

Monhegan Island, Maine



View of detectors mounted in tower (upper left) view from tower looking north (upper right) and south (lower left) and of the lighthouse tower surroundings (lower right). This 208 hectare island is 17 km from the mainland and is primarily forested, with an active seasonal and year-round community. The acoustic detector was deployed in the lighthouse tower and oriented southwest.

Mount Desert Rock, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

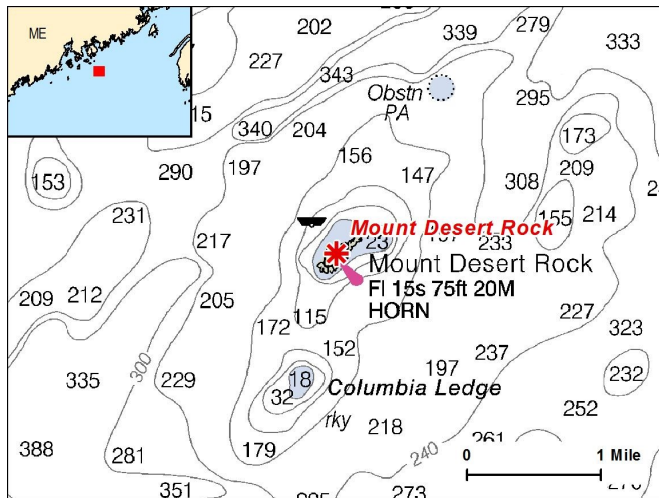


Table 1. Site Information

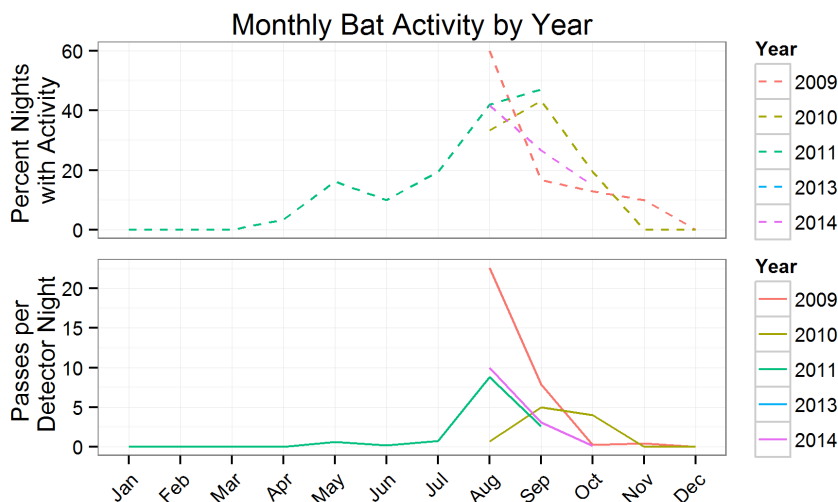
Region	Gulf of Maine
Category	Small Island
Lat/Long	43.964338, -68.1411
Area (hectares)	0.8
Distance from Mainland (km)	41.6
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Lighthouse
Detector Height (m)	17
Distance from Shore (m)	20

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	17 Aug – 31 Dec	137	597	168	0.30	9.63	0.90
2010	26 Aug – 31 Dec	128	277	92	0.41	5.04	0.90
2011	1 Jan – 17 Sep	260	366	133	0.42	3.28	0.90
2013	9 Jul – 23 Jul	15	7	7	0.00	0.00	-
2014	8 Aug – 27 Oct	81	336	77	0.28	4.61	0.92

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Mount Desert Rock was the most isolated island site surveyed in the Gulf of Maine, although bats were detected at the site during each of 5 season of monitoring. Detection rates and frequencies followed an overall seasonal pattern and were highest in August or September each year. Our results align with observations made by lighthouse keepers at this site in the 1800's, as reported in Merriam 1887.

Mount Desert Rock, Maine

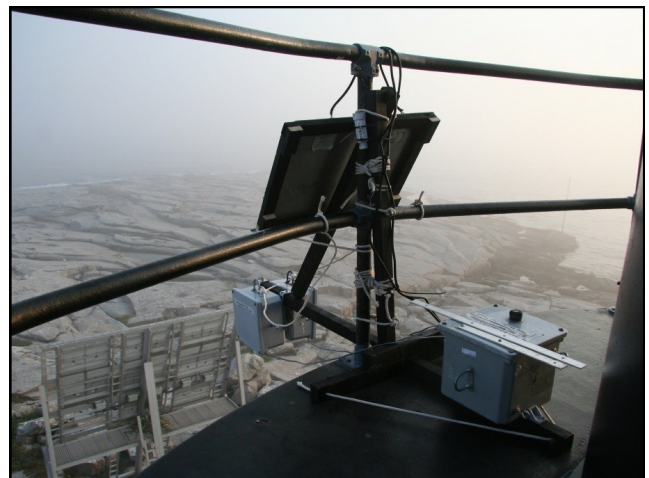
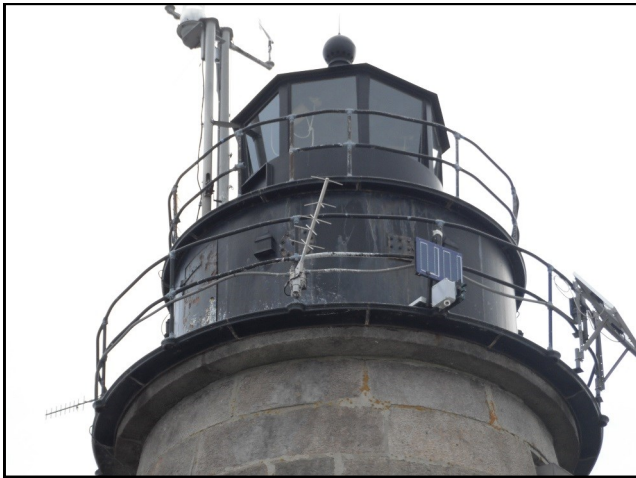
Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Species composition varied substantially among years, although silver-haired bats (n = 268) were most commonly identified overall and detected most often in late August and early September. *Myotis* species activity (n = 202) occurred sporadically during every year except 2014, although 143 of these passes (71%) occurred during the night of 15 September 2009. No *Myotis* were detected during the 22 previous nights or at any point later that season. We detected 139 passes up to 1 hour before sunset (many of which occurred on 2, 3 August 2011) and 35 passes up to 3 hours past sunrise.

Mount Desert Rock, Maine



This 0.8 hectare wave-swept rock is 41.6 km from the nearest mainland location and lacks any potential roosting habitat other than the lighthouse tower and associated house. Waves routinely wash over the rock during fall and winter storms. The damage to the house structure visible in the lower left photo was caused by tropical storm Bill in late August 2009. The bat detector was in the tower at the time of the storm and continued to operate afterwards, recording bats on the days immediately preceding and following the storm.

Mount Ojibway, Michigan (Isle Royale)

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

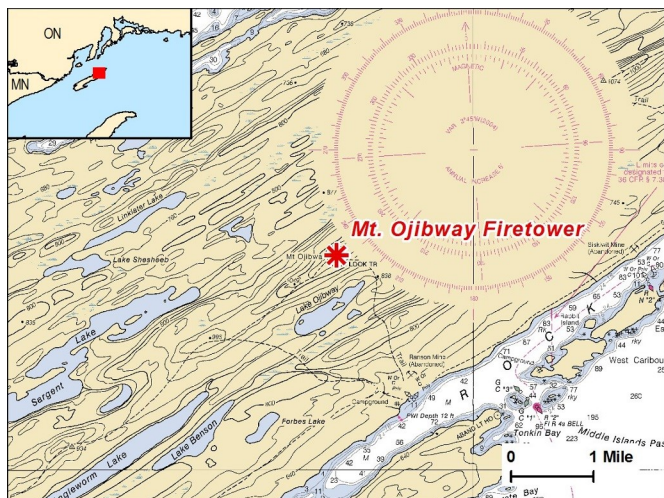


Table 1. Site Information

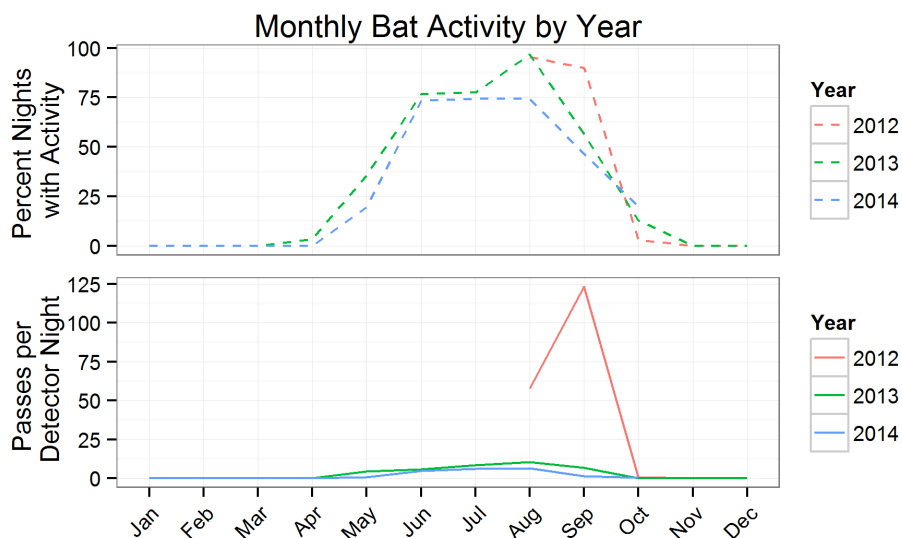
Region	Great Lakes
Category	Large Island
Lat/Long	48.10843, -88.607239
Area (hectares)	54,400
Distance from Mainland (km)	26
% Land in 3 nm buffer	66.5
% Forest in 150 m buffer	78.8
Detector Location	Fire tower
Detector Height (m)	20
Distance from Shore (m)	1,990

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	10 Aug – 31 Dec	144	4,985	773	0.73	74.40	0.78
2013	1 Jan – 31 Dec	365	1,109	101	0.70	7.00	0.69
2014	1 Jan – 5 Oct	278	599	63	0.61	4.81	0.80

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

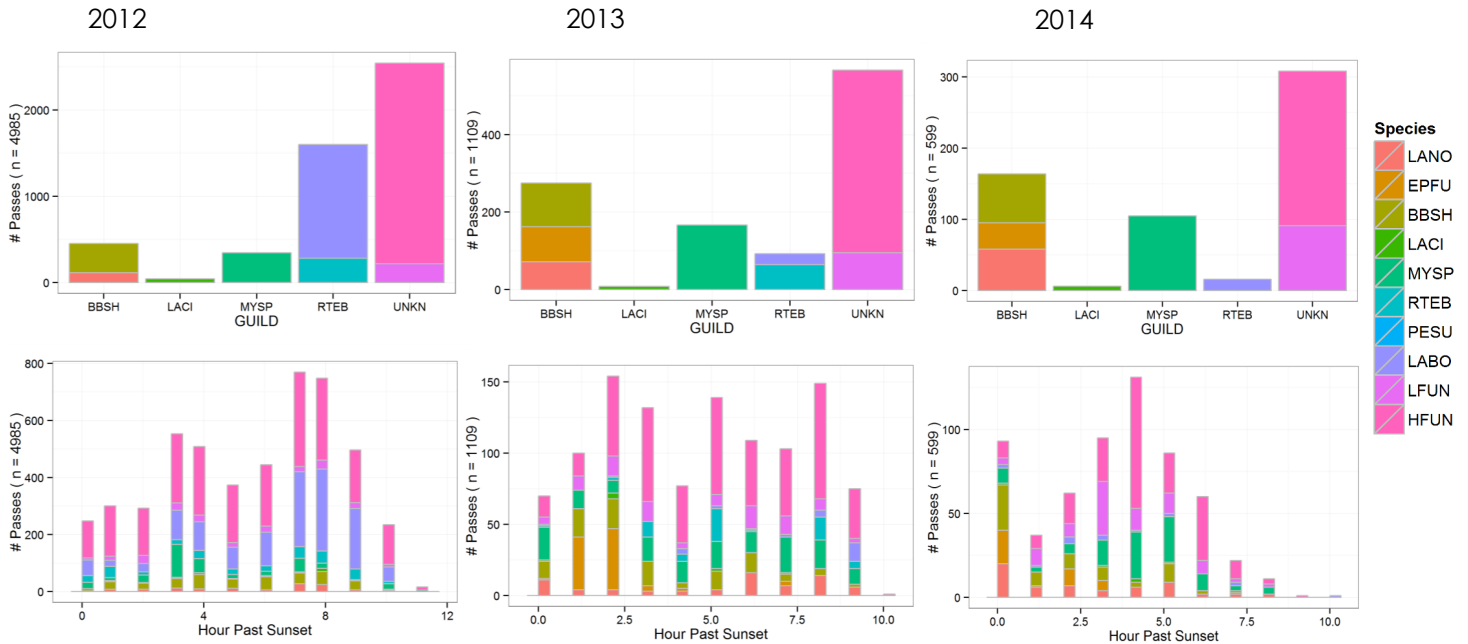


We detected bats at this site between late April and early October, with consistent patterns in frequency of detection. Detection rates spiked in September 2012, driven largely by high levels of *Myotis* and eastern red bat activity. Activity levels were lower in 2013 and 2014, although followed similar seasonal patterns. Bats are not known to overwinter on Isle Royale.

Mount Ojibway, Michigan (Isle Royale)

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats ($n = 1,362$) were the most frequently detected species overall, although were detected primarily during 2012. *Myotis* species ($n = 618$) were detected regularly during each year between May and late September, and were the most commonly identified group in 2013 and 2014. Silver-haired bats ($n = 243$) occurred each season, primarily between late August and early September. Big brown bats ($n = 128$) and hoary bats ($n = 58$) also occurred periodically throughout the survey period.



View of detector looking northwest (left). The Ontario shoreline is visible in the distance. Mt. Ojibway firetower (right) is on a high, rocky ridgeline running the length of Isle Royale, a 544 km² wilderness island in Lake Superior 26 km from mainland Ontario. The tower is surrounded by coniferous forest dominated by balsam fir. This detector was the furthest from shore of any detector in the study, and consequently had the highest % land within 3 nm.

NERACOOS Buoy A, Massachusetts

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

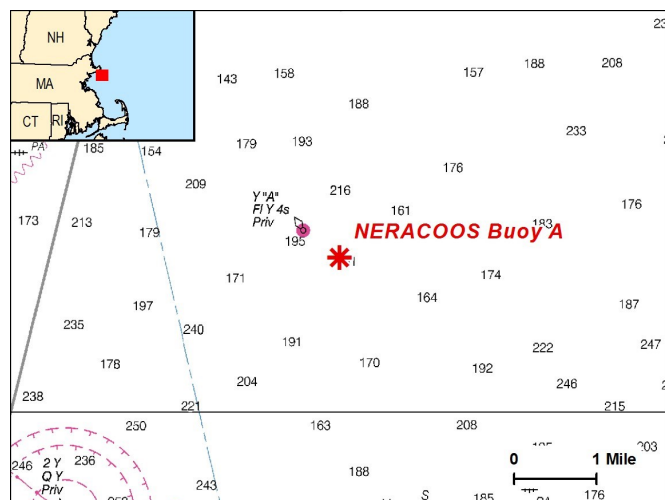


Table 1. Site Information

Region	Gulf of Maine
Category	Structure
Lat/Long	42.52, -70.56
Area (hectares)	n/a
Distance from Mainland (km)	10.5
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Buoy
Detector Height (m)	2
Distance from Shore (m)	n/a

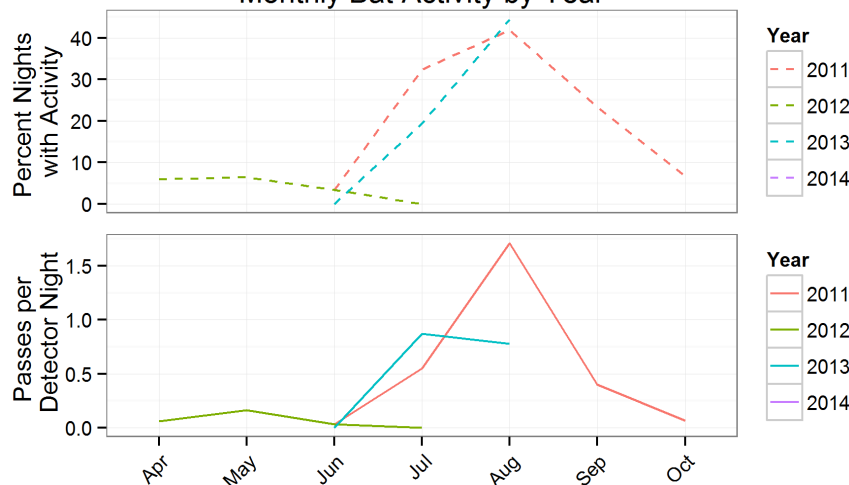
Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2011	1 Jun – 15 Oct	137	84	9	0.31	0.86	0.82
2012	14 Apr – 2 Jul	80	7	3	-	-	-
2013	18 Jun – 18 Aug	62	41	20	0.40	1.06	0.86
2014	1 Apr – 17 Apr	17	0	0	-	-	-

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

Monthly Bat Activity by Year

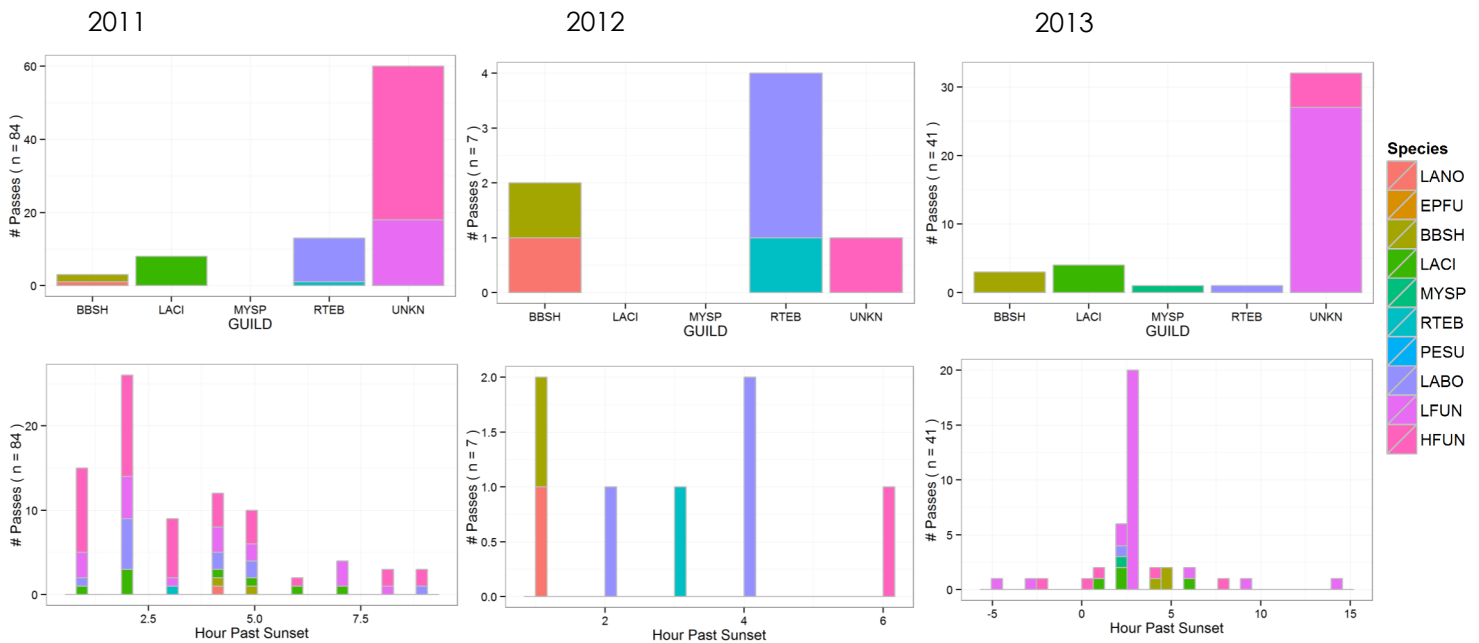


Bat activity occurred at this buoy during 40% or more of nights during August 2011 and 2013, with up to 20 bats detected per night. Bats were also detected during up to 5 hours within a night. Most activity occurred during late summer, with low numbers of bat passes recorded during spring and early summer monitoring.

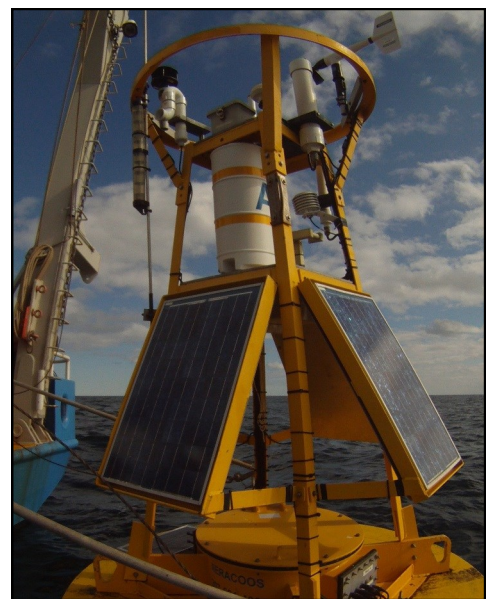
NERACOOS Buoy A, Massachusetts

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats (n = 16) and hoary bats (n = 12) were the most frequently identified species at this buoy, although we also detected 2 silver-haired bats and 1 Myotis. Timing of activity was somewhat erratic, with passes (n = 3) recorded up to 5 hours before sunset and 1 pass recorded 5 hours past sunrise.



View of detector (in red circle) mounted on buoy. The acoustic detector was deployed on the upper structure of a weather buoy deployed approximately 8.9 km off the coast of Gloucester, Massachusetts, with a slightly different microphone enclosure (right)

NERACOOS Buoy B, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

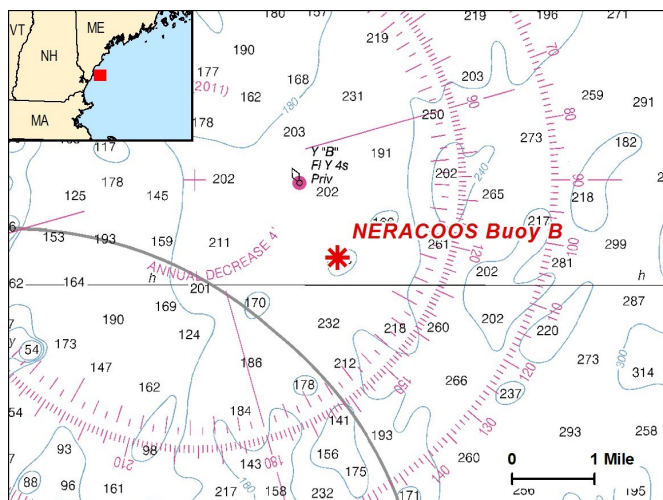


Table 1. Site Information

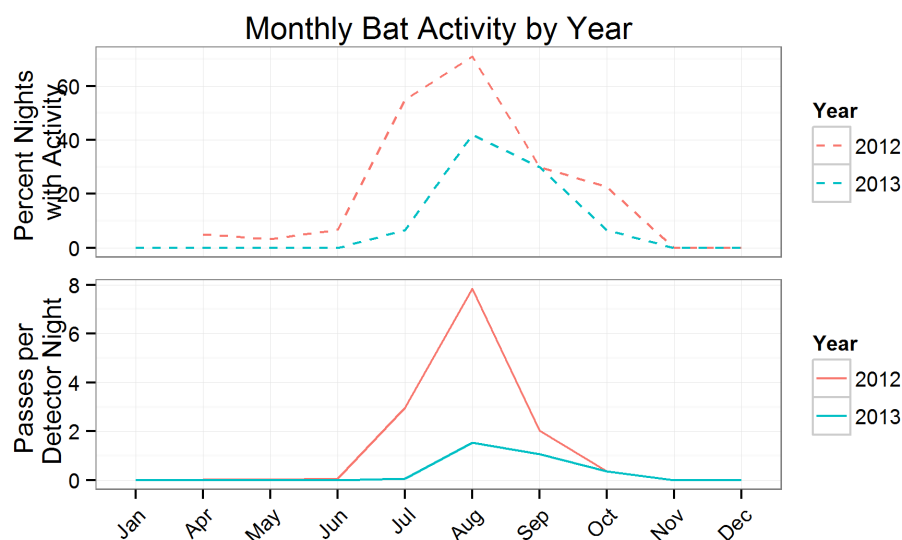
Region	Gulf of Maine
Category	Structure
Lat/Long	43.17, -70.42
Area (hectares)	n/a
Distance from Mainland (km)	14.1
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Buoy
Detector Height (m)	2
Distance from Shore (m)	n/a

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	11 Apr – 31 Dec	265	411	32	0.46	3.83	0.77
2013	1 Jan – 17 Dec	203	93	11	0.28	0.99	0.83

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

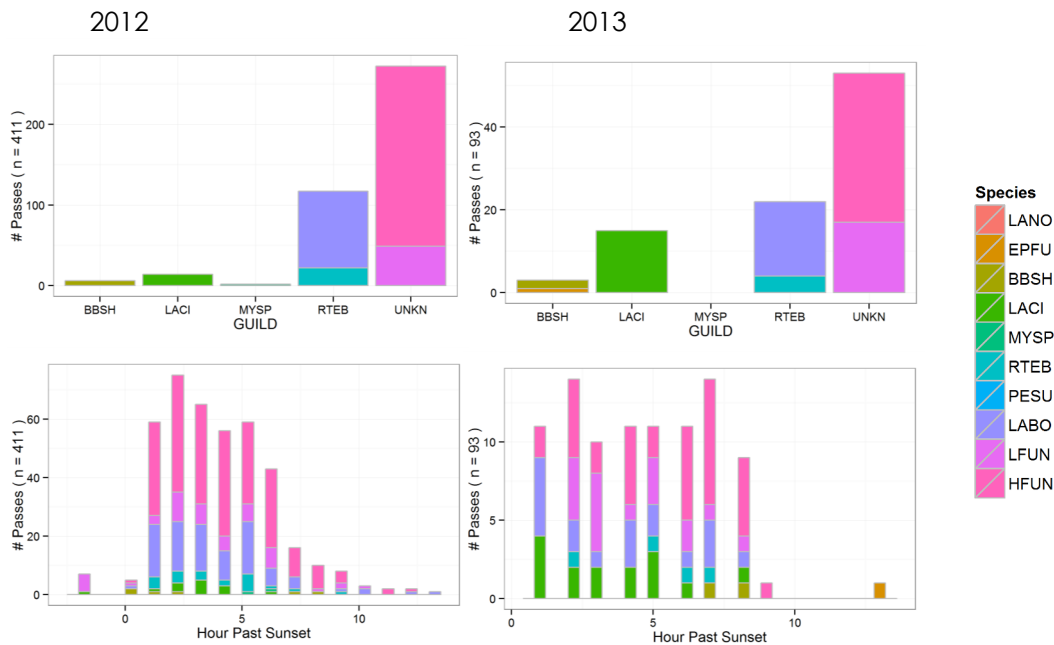


Bats were present at this buoy for over 60% of nights in August 2012 and ~40% of nights in August 2013. Bats were detected during up to 8 hours in a single night. No bat activity occurred at this buoy between 23 October 2012 and 14 August 2013. The detector functioned properly for 468 continuous nights from 11 April 2012 through 17 December 2013, when the battery charging system malfunctioned.

NERACOOS Buoy B, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats (n = 113) and hoary bats (n = 29) were the most commonly detected species at this buoy, although we also detected 2 *Myotis* species and 1 big brown bat. No silver-haired bats were identified detected at this buoy, although several call sequences could not be distinguished between silver-haired or big brown bats. Most activity occurred between sunset and sunrise, although we detected 7 passes 2 hours before sunset and 6 passes up to 4 hours past sunrise.



View of detector (in red circle) mounted on buoy (left) and a series of buoys with detectors installed, ready for deployment (right). The acoustic detector was deployed on the upper structure of a weather buoy deployed approximately 14.1 km off the coast of York, Maine.

NERACOOS Buoy E, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

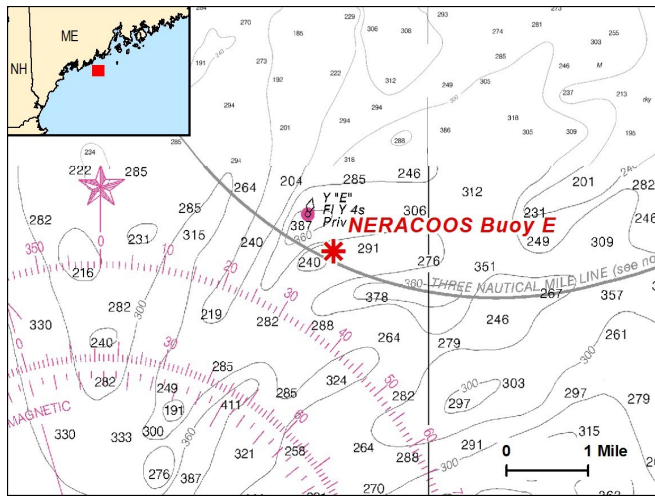


Table 1. Site Information

Region	Gulf of Maine
Category	Structure
Lat/Long	43.71, -69.35
Area (hectares)	n/a
Distance from Mainland (km)	18.8
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Buoy
Detector Height (m)	2
Distance from Shore (m)	n/a

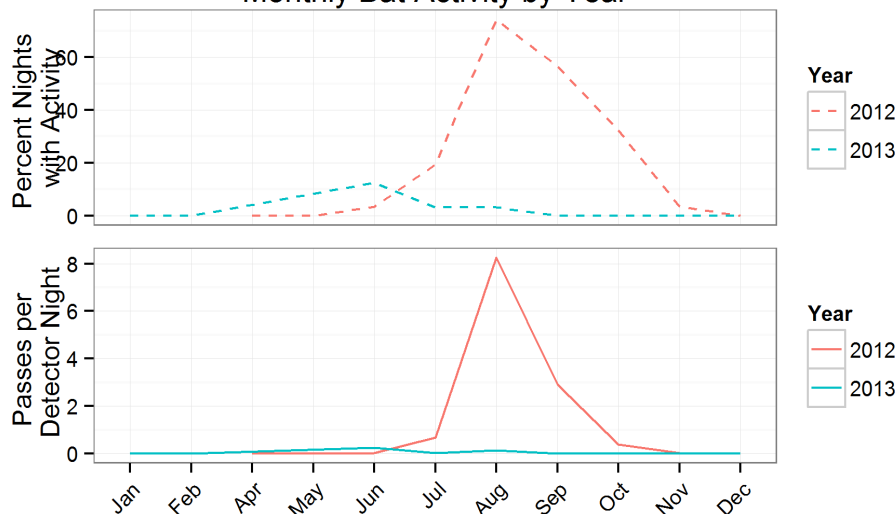
Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	11 Apr – 31 Dec	265	378	44	0.55	3.96	0.77
2013	1 Jan – 10 Dec	218	7	4	0.01	0.04	0.99

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

Monthly Bat Activity by Year

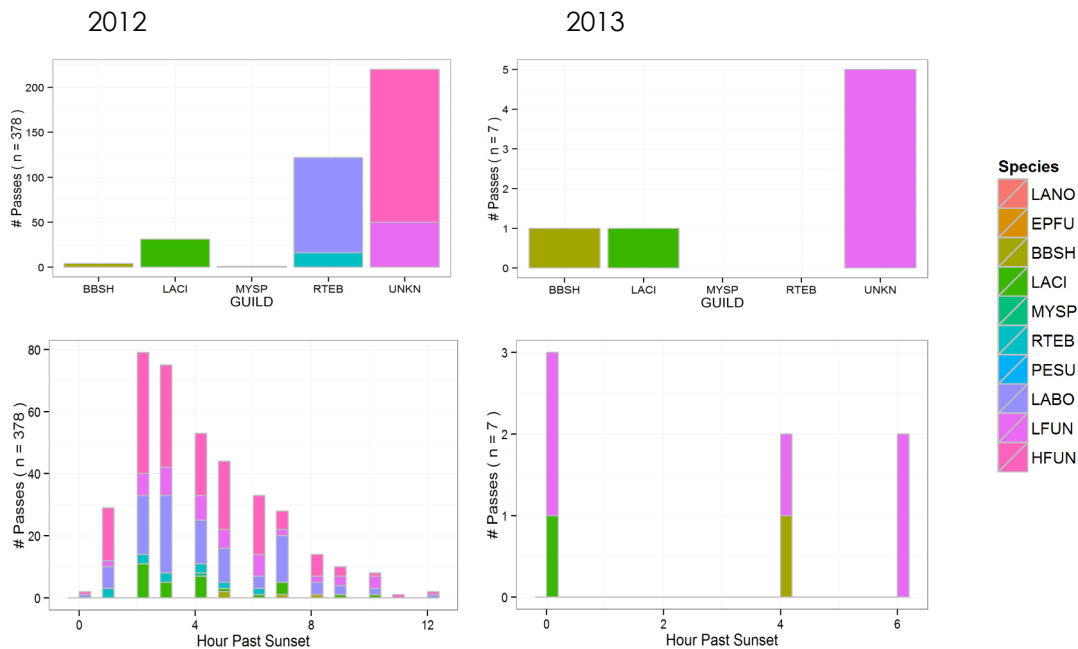


Bats occurred at this buoy during over 70% of nights in August 2012, when ~8 bats per night were detected on average. Bats occurred for up to 9 hours during a single night, and every night for 9 consecutive nights in August 2012. No bat activity occurred between 3 November 2012 and 22 June 2013. Although the detector continued to function through 17 December 2013, the microphone may have been damaged during winter, as the detector recorded only 3 passes in 2013.

NERACOOS Buoy E, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats (n = 106) and hoary bats (n = 32) were detected somewhat frequently, and we also detected 1 *Myotis* at this buoy. With the exception of 3 passes recorded 1 hours past sunrise, all activity occurred at night, with peak activity occurring 3 hours past sunset.



View of buoy E as deployed (photo credit www.neracoos.org) mounted on buoy (left) and a series of buoys with detectors installed, ready for deployment (right). The acoustic detector was deployed on the upper structure of a weather buoy deployed approximately 18 km off the coast of Pemaquid, Maine, and 5.6 km southwest of Monhegan Island.

NERACOOS Buoy F, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

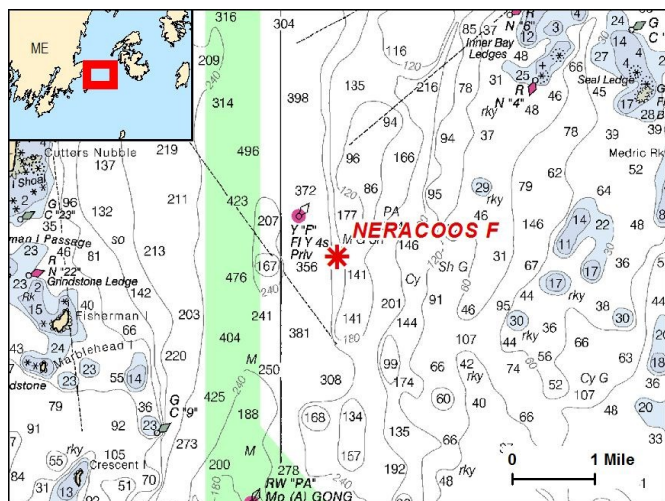


Table 1. Site Information

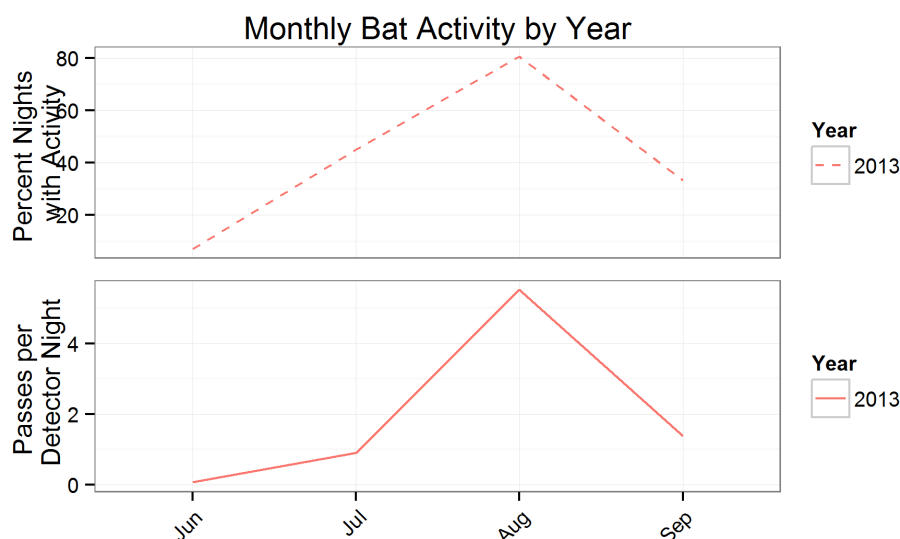
Region	Gulf of Maine
Category	Structure
Lat/Long	44.05, -68.99
Area (hectares)	n/a
Distance from Mainland (km)	5.9
% Land in 3 nm buffer	1.2
% Forest in 150 m buffer	0.0
Detector Location	Buoy
Detector Height (m)	2
Distance from Shore (m)	n/a

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	17 Jun – 24 Sep	100	233	22	0.57	3.03	0.71

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



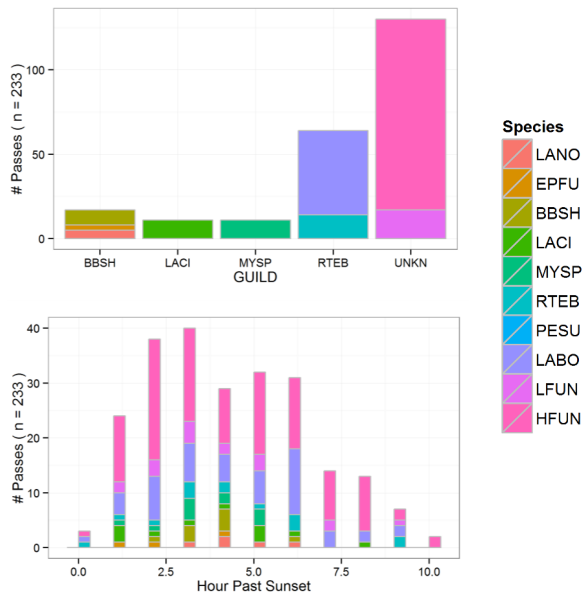
Bats were present at this buoy for 80% of nights in August 2013, and over half of nights between 15 July and 15 October. We recorded bats during 15 consecutive nights at this buoy in August 2013. Of the 5 buoys we monitored, this was the closest to the mainland and the only buoy with any land within a 3 nm radius. The detection rate and frequency of detection were higher at this buoy than any other, and Gini coefficient was lower (indicating consistent activity).

NERACOOS Buoy F, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown

2013



We detected 5 species of bats at this buoy including eastern red bats (n = 50), *Myotis* species (n = 11), hoary bats (n = 11), silver-haired bats (n = 5) and big brown bats (n = 3). *Myotis*, eastern red bats, and hoary bats were detected frequently during August 2013 while all silver-haired passes occurred within 1 night (23 August 2013). We detected bats for up to 9 hours during a single night, and all but 1 pass occurred between sunset and sunrise.



View of detector (in red circle) mounted on buoy (left) and a series of buoys with detectors installed, ready for deployment (right). The acoustic detector was deployed on the upper structure of a weather buoy deployed approximately 5.9 km southeast of Owl's Head, Maine.

NERACOOS Buoy I, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

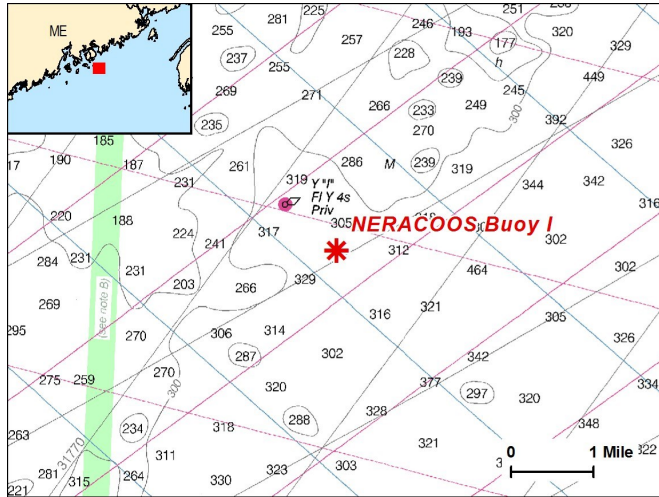


Table 1. Site Information

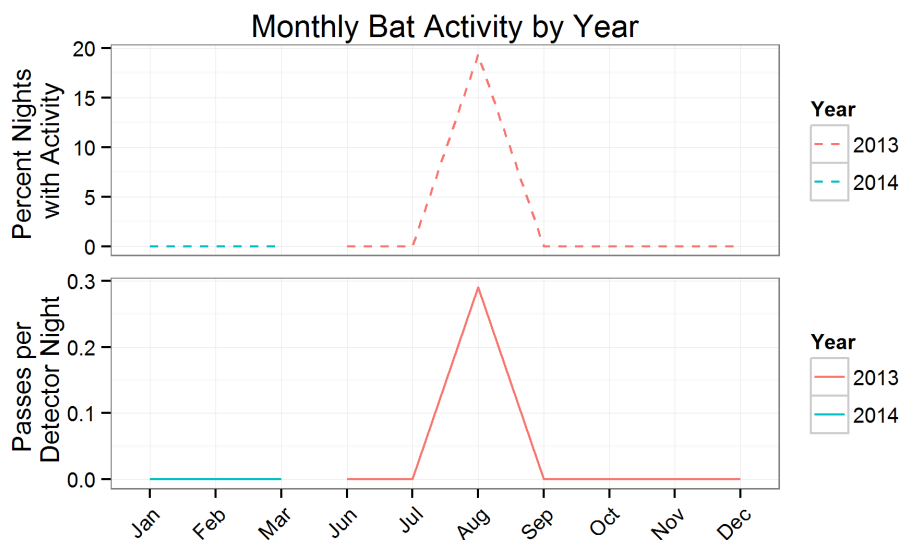
Region	Gulf of Maine
Category	Structure
Lat/Long	44.1, -68.1
Area (hectares)	n/a
Distance from Mainland (km)	26.2
% Land in 3 nm buffer	0.0
% Forest in 150 m buffer	0.0
Detector Location	Buoy
Detector Height (m)	2
Distance from Shore (m)	n/a

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	24 Jun – 31 Dec	191	9	3	0.06	0.05	0.96
2014	1 Jan – 3 Mar	62	0	0	-	-	-

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



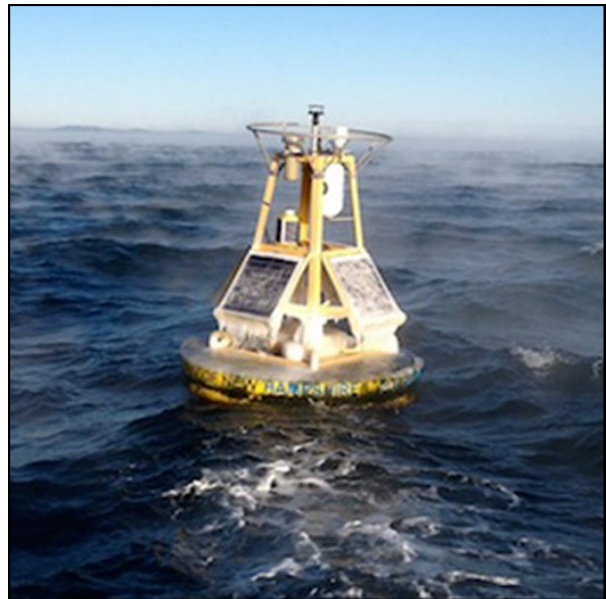
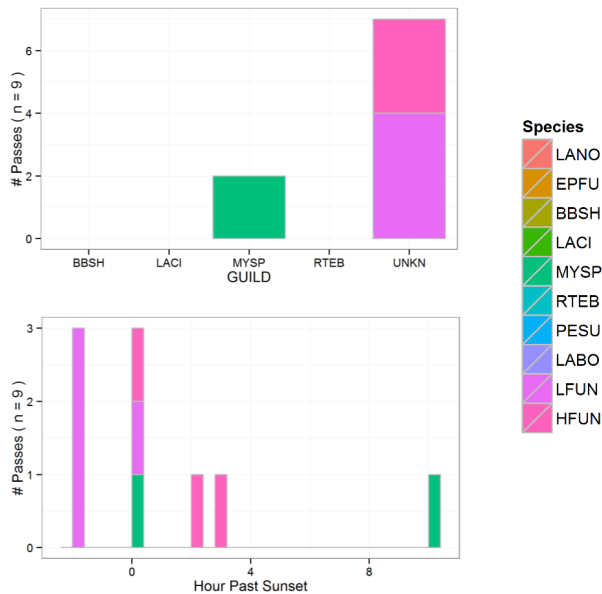
Located 12 km southeast of Great Duck Island and 14 km northeast of Mount Desert Rock, this was the most isolated buoy we monitored. We recorded 9 passes at this buoy, all of which occurred during 6 nights between 9 August and 19 August 2013.

NERACOOS Buoy I, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown

2013



NERACOOS buoy showing harsh winter conditions offshore. Photo credit www.neracoos.org

Despite the isolation of this site, the only species identified was *Myotis* (n = 2). The remaining 7 calls were of insufficient quality for identification, but were distinguishable as bats.



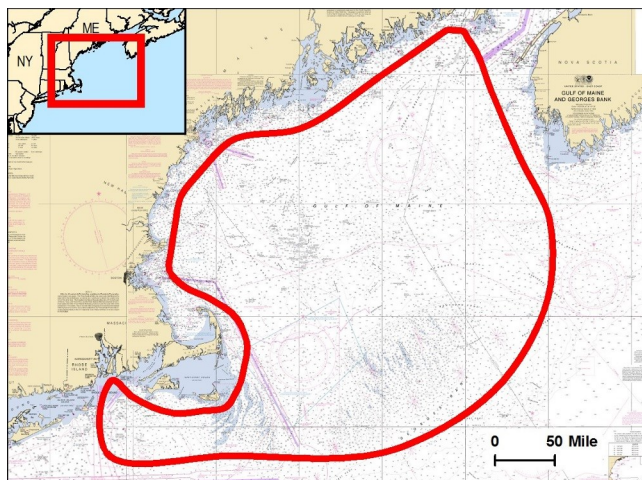
View of detector (in red circle) mounted on buoy (left) and a series of buoys with detectors installed, ready for deployment (right). The acoustic detector was deployed on the upper structure of a weather buoy deployed approximately 12 km southeast of Great Duck Island.

NOAA Vessels Gunter, Pisces, and Bigelow

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

2012



2013 & 2014

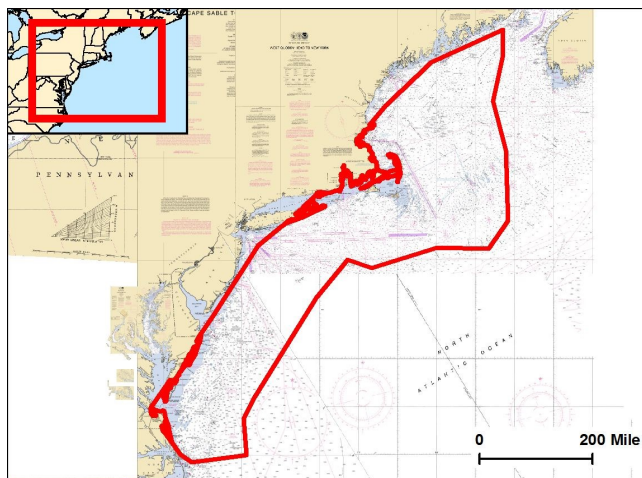
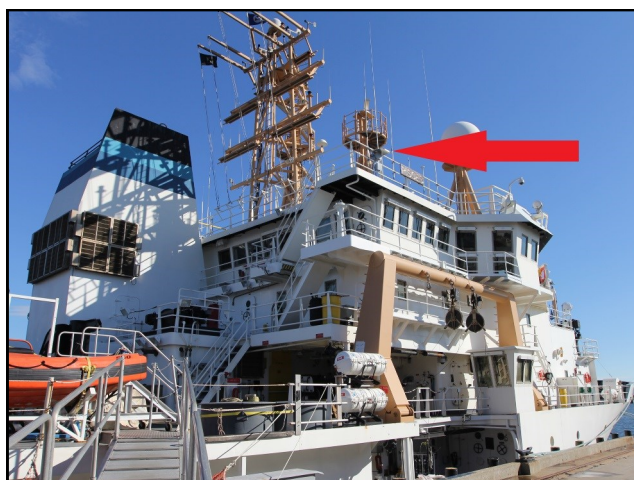


Table 1. Acoustic bat survey effort and results

Ship	Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Calls/ Night	% Nights with Activity*	Detection Rate*
Gunter	2013	12 May – 22 Jul	72	19	4	0.00	0.00
Pisces	2012	10 Sep – 24 Sep	15	0	0	0.00	0.00
	2013	12 May – 15 Jul	65	6	2	0.00	0.00
Bigelow	2013	8 Apr – 21 Apr	14	0	0	0.00	0.00
	2014	17 Jun – 30 Sep	106	127	26	0.38	1.62

* Calculated for dates between 15 July and 15 October to allow comparisons of similar time periods among sites

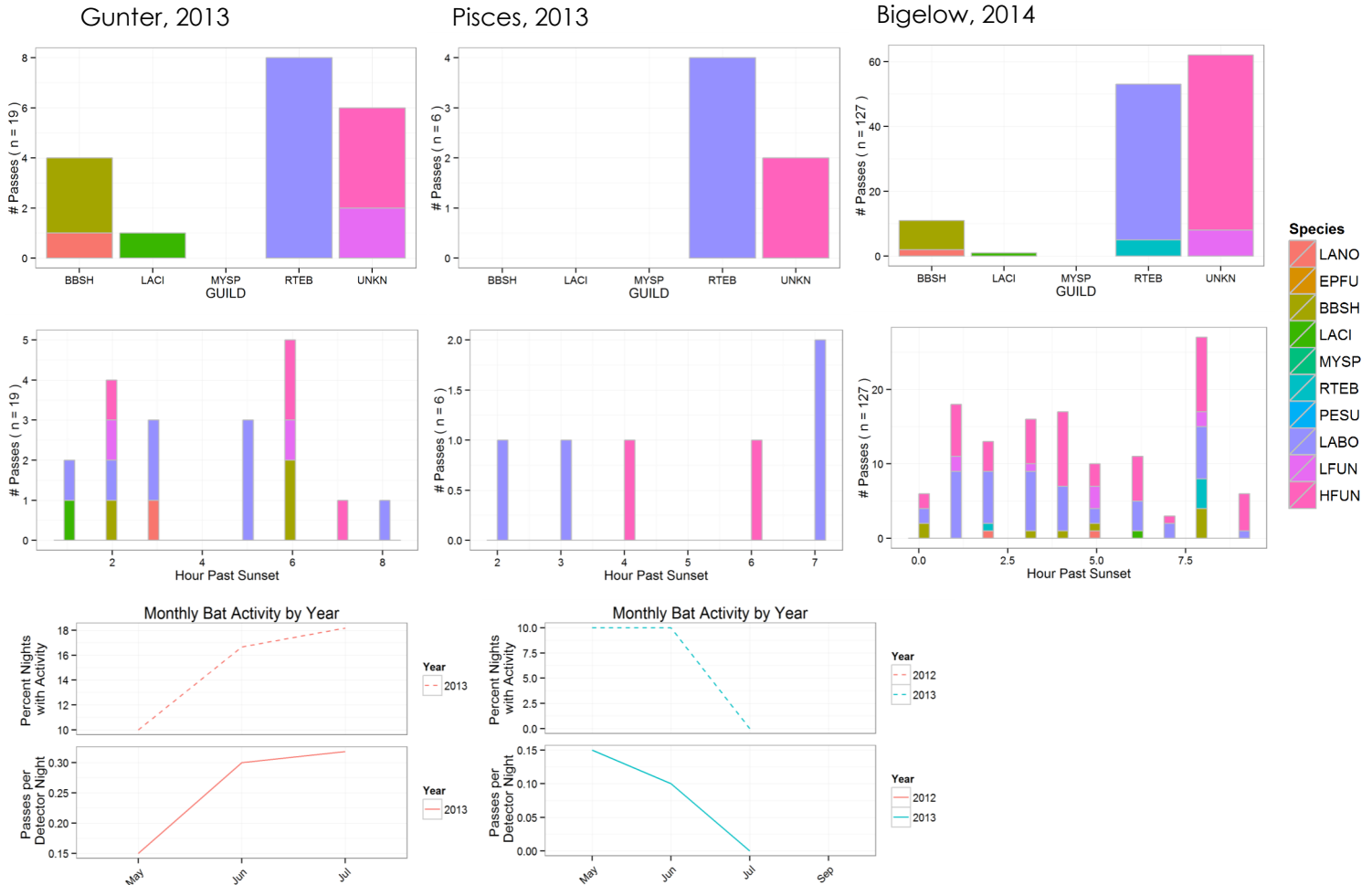


We deployed bat detectors on the railings above the ships' bridges, approximately 15 m above water level. Ship-based detectors malfunctioned prematurely in several cases, possibly related to vibration of components when the ships were under way.

NOAA Vessels Gunter, Pisces, and Bigelow

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



We detected bat activity with ship-based detectors only during occasions when vessels were in port in 2012 and 2013. However, in 2014, we detected 35 passes while the Bigelow was underway, with bats detected between 5.26 to 129.63 km from shore. These detections occurred during 7 nights between 15 August and 29 September when the vessel was on several separate missions in the waters off the mid-Atlantic OCS, with bats detected between the waters east of Long Island, New York, and east of the outlet of Albermarle Sound, North Carolina.

Ocracoke Light, North Carolina

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

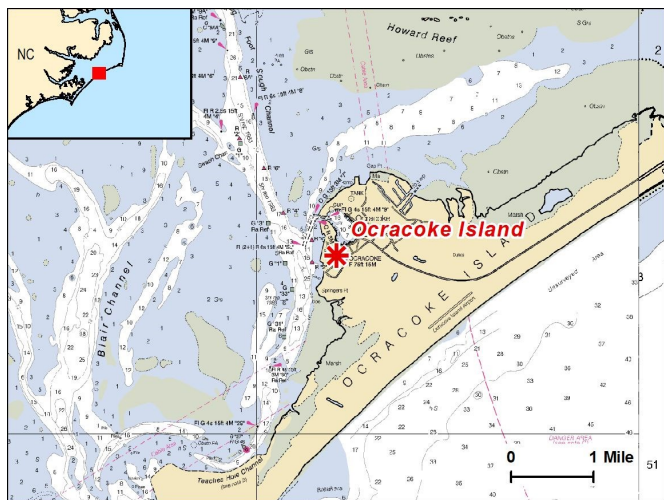


Table 1. Site Information

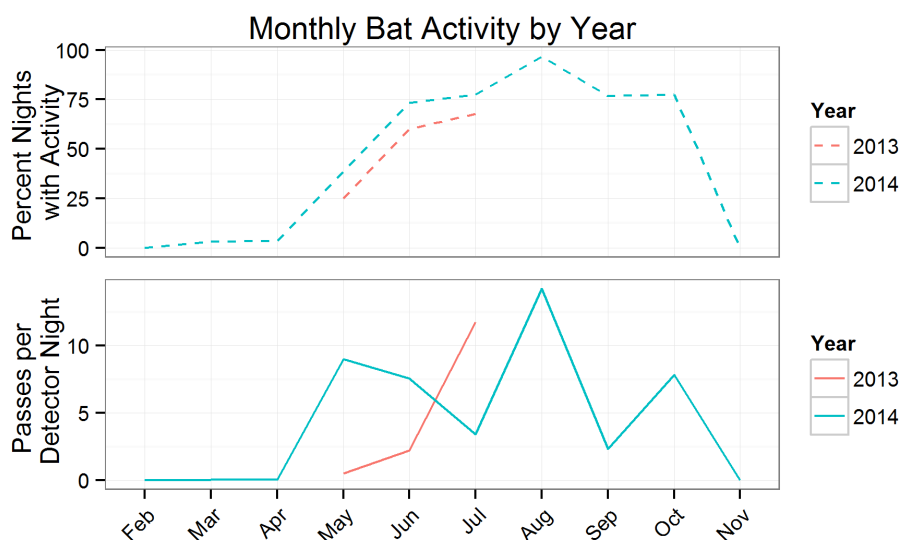
Region	mid-Atlantic
Category	Large Island
Lat/Long	35.108942, -75.985901
Area (hectares)	1190
Distance from Mainland (km)	28.5
% Land in 3 nm buffer	12.3
% Forest in 150 m buffer	33.5
Detector Location	Lighthouse
Detector Height (m)	20
Distance from Shore (m)	215

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	28 May – 28 Jul	62	397	197	0.79	21.50	-
2014	28 Feb – 1 Nov	247	1,368	159	0.85	7.63	0.61

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

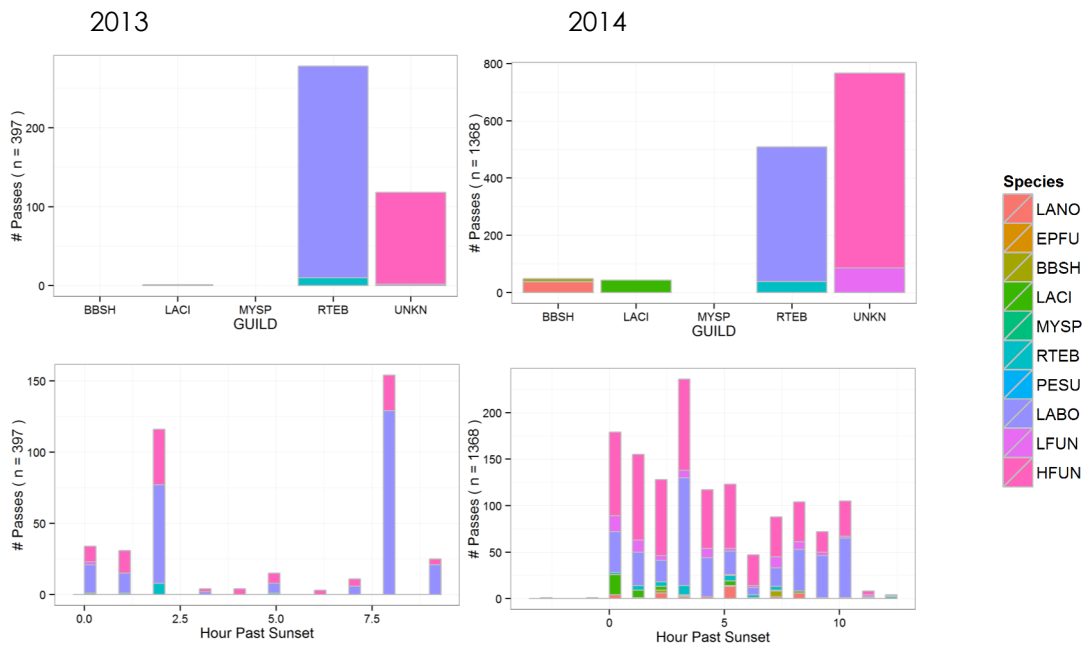


Detection rates varied substantially among months in 2014, with peaks in August, May, and October. Seasonal activity patterns were driven largely by eastern red bats. We detected bat activity as early as March 20 at this site. Monitoring did not extend past 1 November during 2013 or 2014, although bats were detected regularly through 31 October 2014.

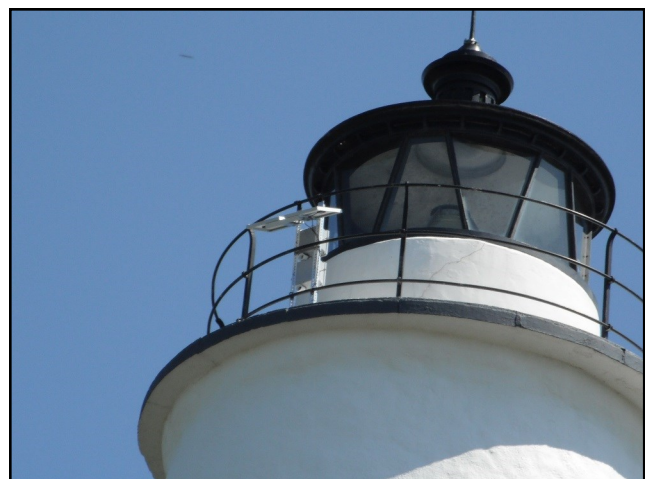
Ocracoke Light, North Carolina

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats ($n = 738$) were the most commonly detected species at this site and occurred throughout both 2013 and 2014 monitoring periods. Hoary bats ($n = 45$) occurred only during 11 nights total, with 41 of these passes detected during 7 consecutive nights between 30 July and 5 August 2014. Silver-haired bats ($n = 37$) were detected during only 14 nights, with most consistent activity occurring between 19 October and 29 October 2014. We also detected 1 tri-colored bat and 1 big brown bat. Most activity occurred at night, although 2 passes occurred up to 2 hours before sunset and 4 passes occurred up to 3 hours past sunrise.



View of detector looking west (left) and as mounted in the lighthouse tower (right). The acoustic detector was deployed in the top of the lighthouse tower, oriented to the southwest. The lighthouse is surrounded by residential development and adjacent to a small marsh on the western shore of this 1,190 hectare island.

Owl's Head, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

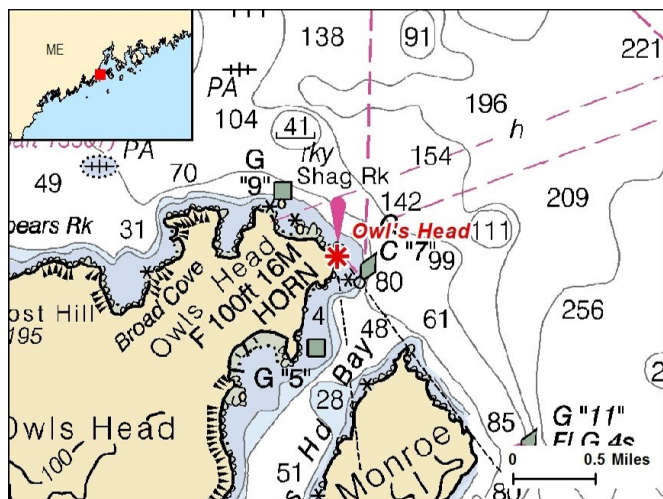


Table 1. Site Information

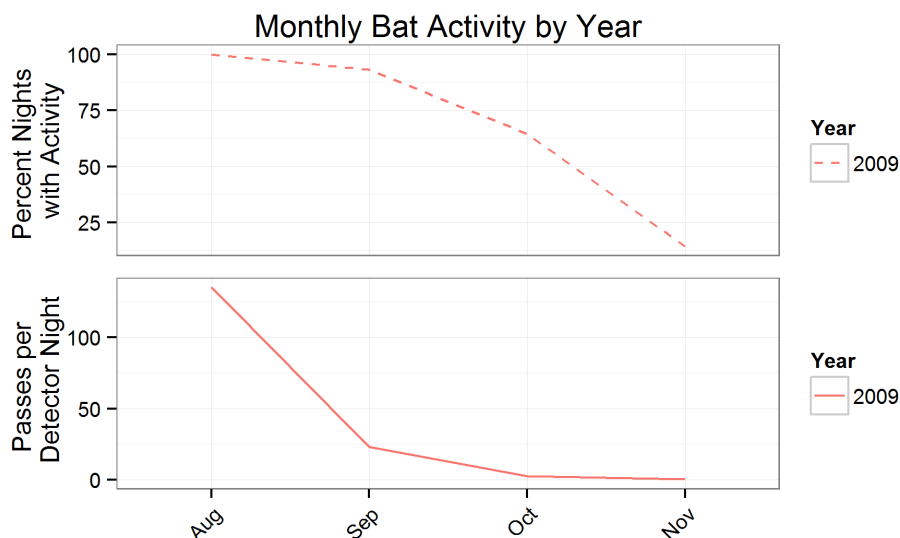
Region	Gulf of Maine
Category	Coastal
Lat/Long	44.091903, -69.044031
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	19.1
% Forest in 150 m buffer	18.7
Detector Location	Temporary tower
Detector Height (m)	2
Distance from Shore (m)	n/a

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	11 Aug – 14 Nov	93	3,208	397	0.90	50.48	0.71

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

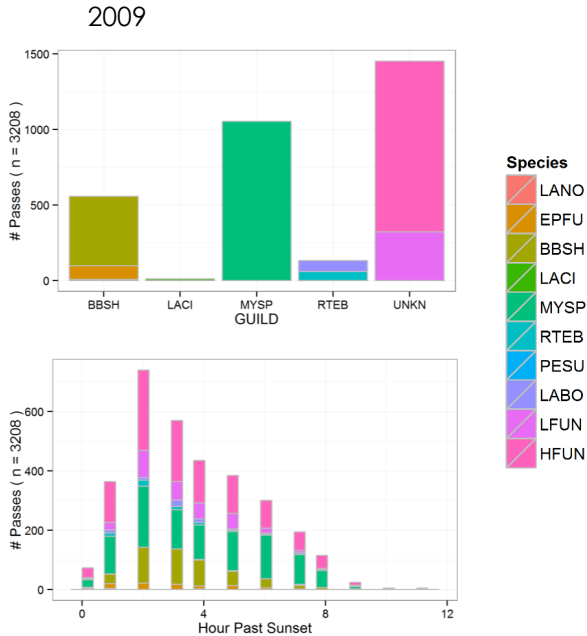


Bats occurred at this site most nights during the 2009 survey period, with the last bat activity documented on 8 November 2009. Bats were consistently active for 10 hours per night during August and September, with activity becoming more sporadic by early October.

Owl's Head, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species were the most active bats at this site (n = 1,054), and were detected during most nights surveyed. We also detected big brown bats (n = 90), eastern red bats (n = 73), hoary bats (n = 11) and silver-haired bats (n = 7). Bat activity peaked 2 hours past sunset overall, with no calls detected before sunset or after sunrise.



Owl's Head visible through light fog.



The detector was mounted in a temporary tower near the former oil shed for the lighthouse (left) on a high bluff overlooking the west entrance to Penobscot Bay (right).

Passage Island, Michigan (Isle Royale)

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

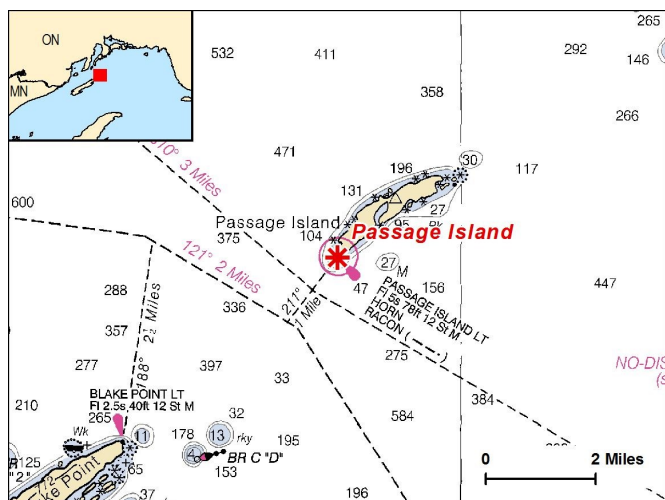


Table 1. Site Information

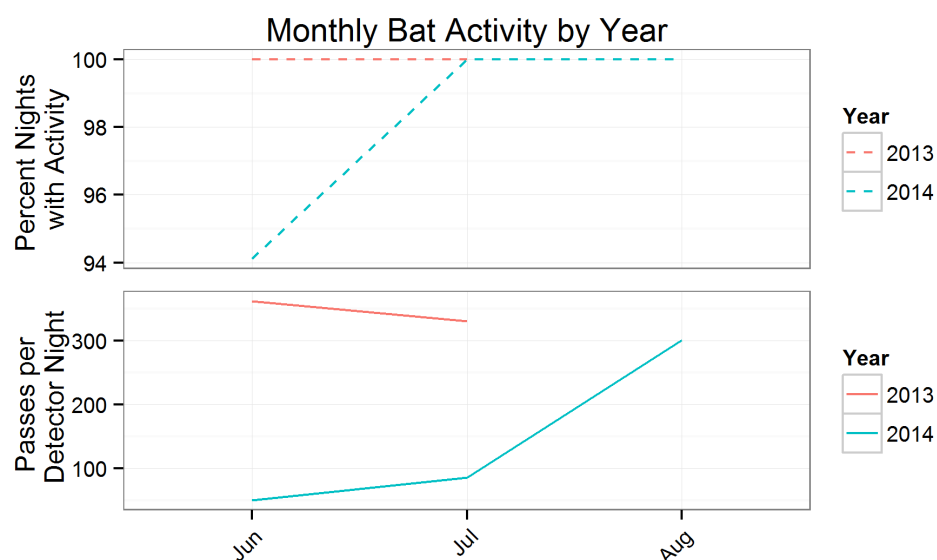
Region	Great Lakes
Category	Medium Island
Lat/Long	48.223536, -88.365877
Area (hectares)	88.2
Distance from Mainland (km)	25.3
% Land in 3 nm buffer	0.9
% Land in 150 m buffer	9.4
Detector Location	Lighthouse
Detector Height (m)	10
Distance from Shore (m)	50

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	26 Jun – 4 Jul	9	3,133	820	-	-	-
2014	13 Jun – 26 Aug	74	11,338	1,661	1.00	205.88	0.55

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

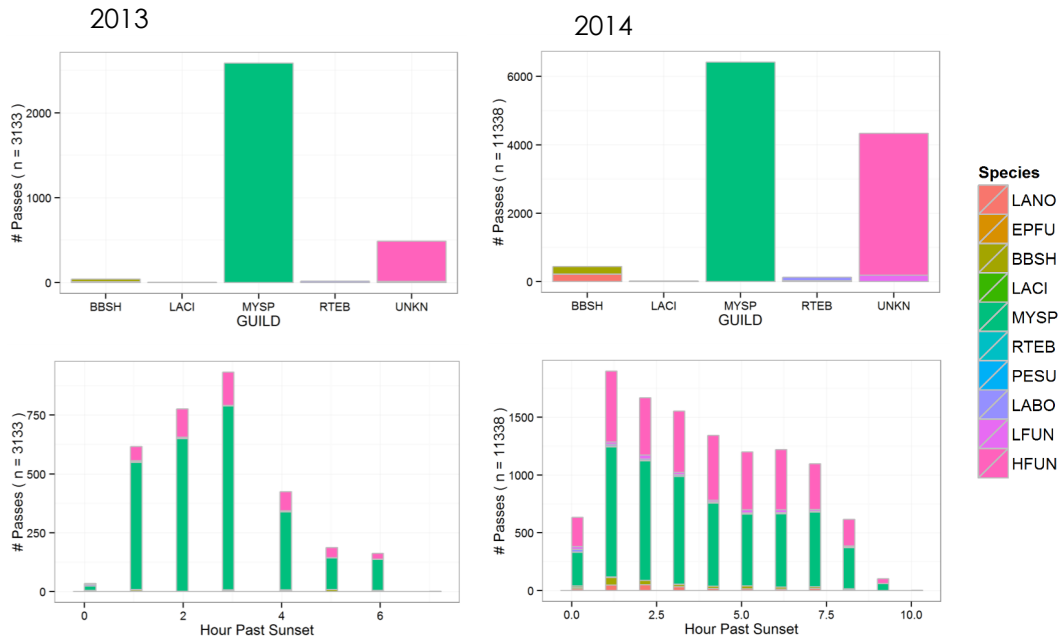


Myotis species occurred at high activity levels at this site during late summer 2014 and the brief 2013 survey period. The particularly high rates of activity at this site suggest an active resident population of *Myotis* (likely little brown bats) present in close proximity to the detector. The detector's memory filled to capacity prematurely, preventing data from being collected through fall.

Passage Island, Michigan (Isle Royale)

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



High levels of *Myotis* species activity (n = 8,999) occurred at this site during the relatively brief 2013 and 2014 survey periods. We also detected silver-haired bat (n = 225), eastern red bat (n = 109), hoary bat (n = 24), and big brown bat activity (n = 2) during this period. Activity levels, based on the longer 2014 monitoring period were highest in the first hour past sunset, declining steadily thereafter.



View northeast of the detector (left) and looking towards Isle Royale, 5.5 km to the southwest (right).

Petit Manan Island, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

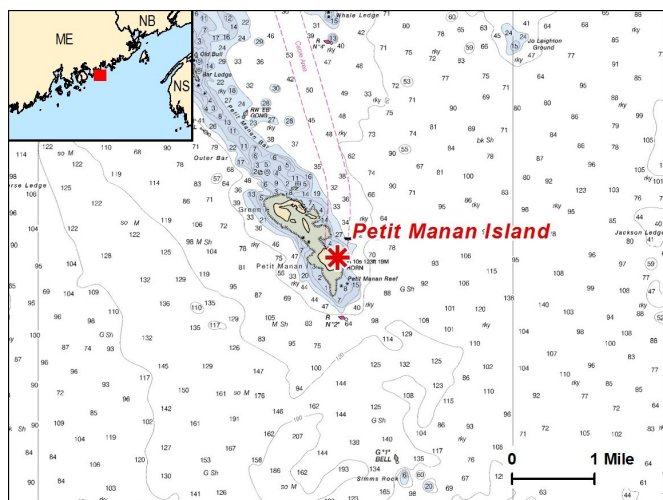


Table 1. Site Information

Region	Gulf of Maine
Category	Small Island
Lat/Long	44.367569, -67.864117
Area (hectares)	6.3
Distance from Mainland (km)	4
% Land in 3 nm buffer	1.5
% Forest in 150 m buffer	4.8
Detector Location	Lighthouse
Detector Height (m)	30
Distance from Shore (m)	30

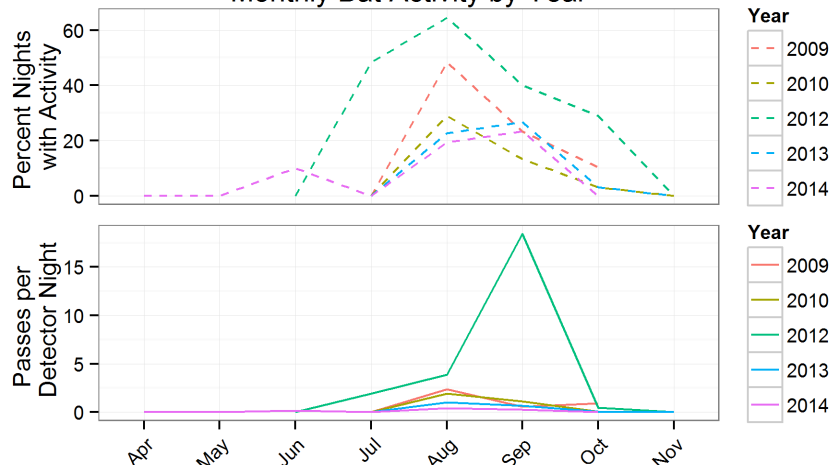
Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	28 Jul – 29 Oct	94	117	36	0.31	1.46	0.88
2010	30 Jul – 11 Nov	105	94	27	0.17	1.18	0.93
2012	30 Jun – 17 Nov	141	746	494	0.52	7.71	0.91
2013	11 Jul – 5 Nov	118	52	13	0.17	0.56	0.91
2014	1 Apr – 29 Oct	212	25	5	0.14	0.20	0.91

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

Monthly Bat Activity by Year



We recorded consistently low levels of bats activity at this site, with a notable exception of the night of 1 September 2012, when we detected 390 *Myotis* species. Detection frequencies were highest in August during 3 of the 5 years we surveyed this site, and higher in September during 2 years.

Petit Manan Island, Maine

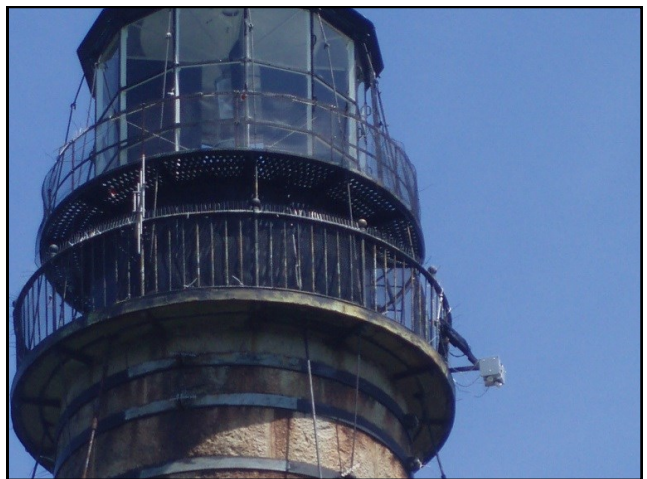
Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species passes (n = 462) were detected here in higher numbers than any other species, although 84% of these passes occurred during three hours in a single night in 2012. No Myotis were detected in 2013 and 2014. Eastern red bats (n = 68), hoary bats (n = 66) and silver-haired bats (n = 46) occurred regularly at the site and we also detected 4 big brown bat passes. Timing was irregular at this site, and although most activity occurred at night, we detected 1 pass in the hour before sunset and 11 passes up to 3 hours past sunrise.

Petit Manan Island, Maine



The Petit Manan Island lighthouse is one of the tallest along the Maine coast (upper left), providing a panoramic view of the small, treeless island and the distant coast (upper right). The acoustic detector was deployed in the lighthouse tower and oriented southward (lower left and right). This 6.3 hectare island is 4 km from the mainland, lacks trees, and supports nesting seabirds. Vegetation is limited to grass and small shrubs.

Petit Manan Point Field, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

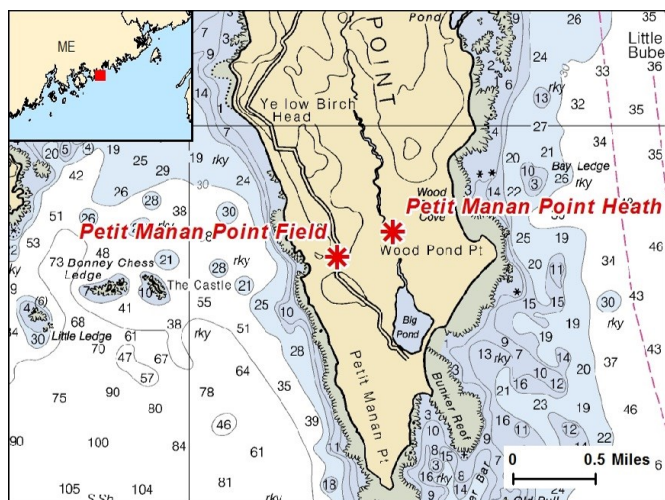


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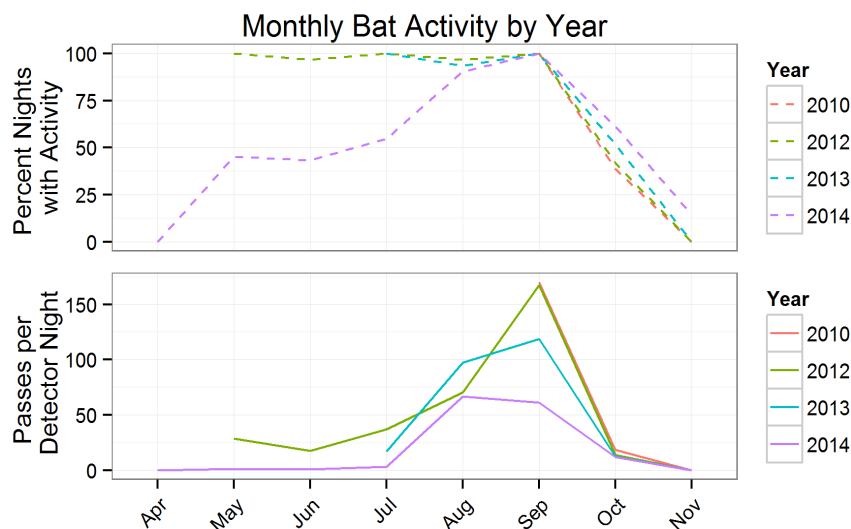
Region	Gulf of Maine
Category	Coastal
Lat/Long	44.408454 -67.9036
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	23.4
% Forest in 150 m buffer	72.2
Detector Location	Tree
Detector Height (m)	2
Distance from Shore (m)	250

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2010	7 Sep – 4 Nov	59	4,659	978	0.87	119.38	0.72
2012	25 May – 7 Nov	167	9,530	1,143	0.90	89.42	0.66
2013	11 Jul – 6 Nov	119	7,343	573	0.97	77.47	0.63
2014	1 Apr – 7 Nov	221	4,467	342	0.89	46.84	0.58

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Myotis species contributed to high passage rates at this site during each year of monitoring, consistently occurring for much of the summer. Peak detection rates occurred in September in most years and dropped quickly in October. We detected bats between 1 May and 5 November, although monitoring did not extend past 7 November during any year.

Petit Manan Point Field, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



We recorded consistently high levels of *Myotis* activity ($n = 12,428$) during each year of monitoring at this coastal site. Other species included eastern red bats ($n = 369$), silver-haired bats ($n = 101$), hoary bats ($n = 25$), and tri-colored bats ($n = 7$). We detected no big brown bats during any of the 4 monitoring periods. Silver-haired bats were detected primarily between late August and mid-September and hoary bats occurred primarily in mid-August. Eastern red bat activity was distributed throughout the monitoring periods with most passes detected between mid-August and late September. All but 2 passes were recorded between sunset and sunrise.

Petit Manan Point Field, Maine



The acoustic detector was deployed in a tree (see arrow) at the western edge of a small (0.6 ha) clearing and oriented towards the center of the clearing (upper left). The surrounding forest is mixed coniferous and deciduous with a canopy height of approximately 15-20 m.

Stantec conducted a pilot study tracking bats offshore using nanotags in 2013 and 2014, setting our mist nets (upper right) up near the Petit Manan Point Field detector. Although focused on migratory species, we tracked multiple *Myotis* species, including a little brown bat (*Myotis lucifugus*) that was day-roosting in cracks in the granite shoreline, only a few meters above the high tide mark (lower left and right).

Petit Manan Point Heath, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

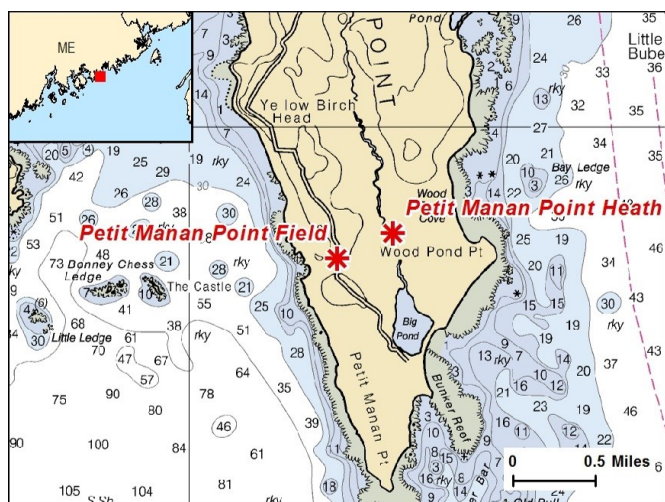


Table 1. Site Information

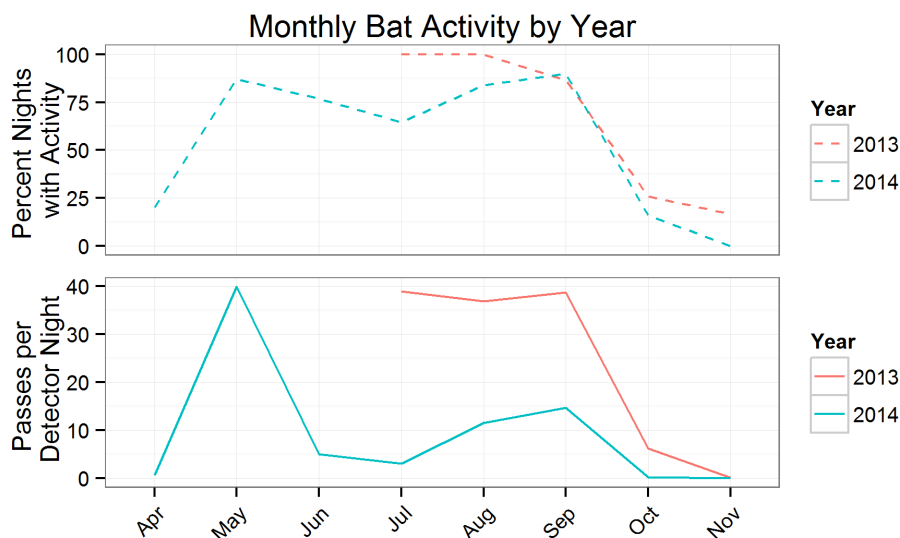
Region	Gulf of Maine
Category	Coastal
Lat/Long	44.410024, -67.898776
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	23.3
% Forest in 150 m buffer	24.2
Detector Location	Tree
Detector Height (m)	2
Distance from Shore (m)	470

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	11 Jul – 6 Nov	119	3,313	320	0.88	34.10	0.62
2014	1 Apr – 7 Nov	221	2,302	349	0.71	9.40	0.77

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

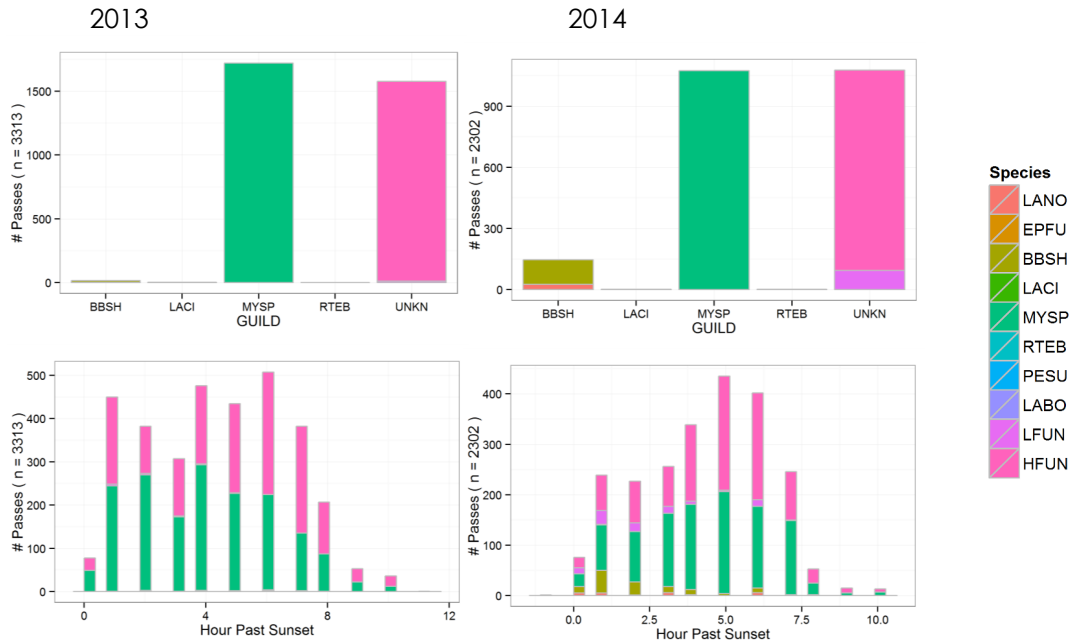


Bats were active during most nights monitored between May and September at this site in 2013 and 2014. Detection rates peaked in May 2014, but were similarly high between July and September 2013, driven largely by *Myotis* species activity. Detection rates were substantially lower at this detector than the nearby Petit Manan Point Field detector.

Petit Manan Point Heath, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species accounted for the majority of recorded acoustic activity at this site (n = 2,794) with similar numbers detected in 2013 and 2014. Other species included silver-haired bats (n = 27), detected primarily in late August 2014, eastern red bats (n = 3), and hoary bats (n = 3). Bat activity was highest 5 hours past sunset during both years.



The acoustic detector was deployed at the edge of a cluster of trees (left), oriented southward towards a large scrub-shrub marsh centrally located on Petit Manan Point (right).

Presque Isle, Pennsylvania

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

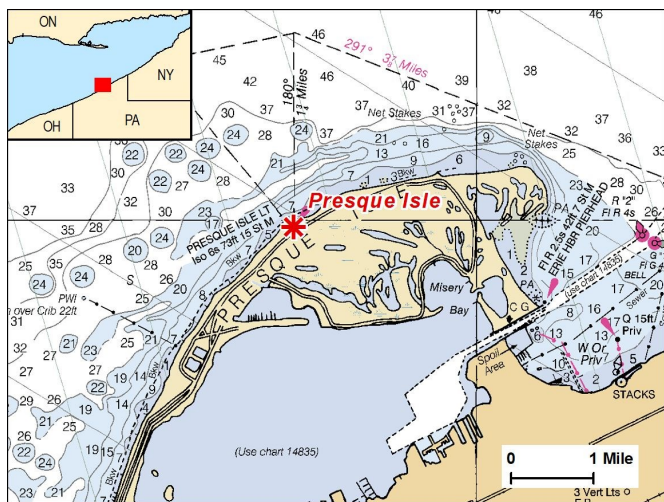


Table 1. Site Information

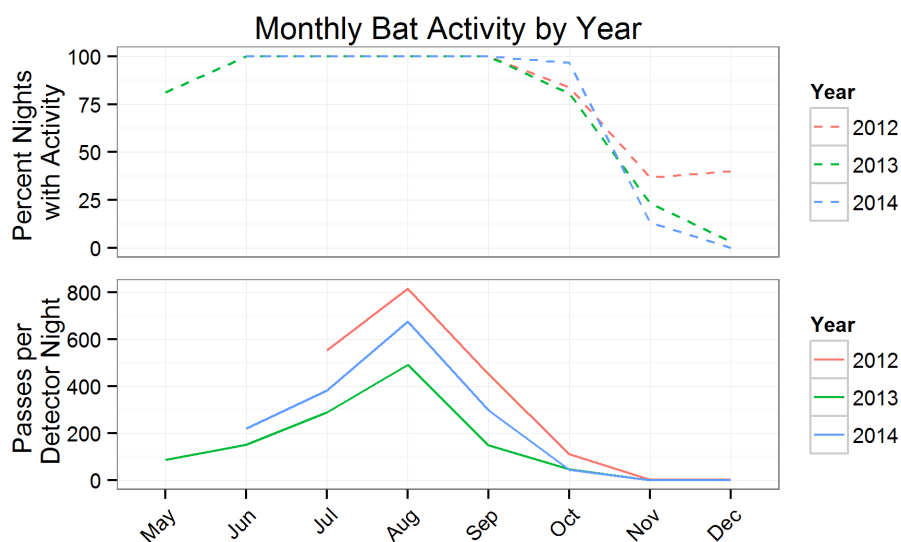
Region	Great Lakes
Category	Coastal
Lat/Long	42.16576, -80.11540
Area	n/a
Distance from Mainland	n/a
% Land in 3 nm buffer	19.4
% Forest in 150 m buffer	27.3
Detector Location	Lighthouse Tower
Detector Height (m)	11
Distance from Shore (m)	70

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	30 Jul – 5 Dec	129	43,462	1,575	1.0	542.60	0.43
2013	16 May – 31 Dec	230	36,140	1,097	1.0	292.32	0.43
2014	4 Jun – 31 Dec	211	49,009	1,468	1.0	428.73	0.41

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated

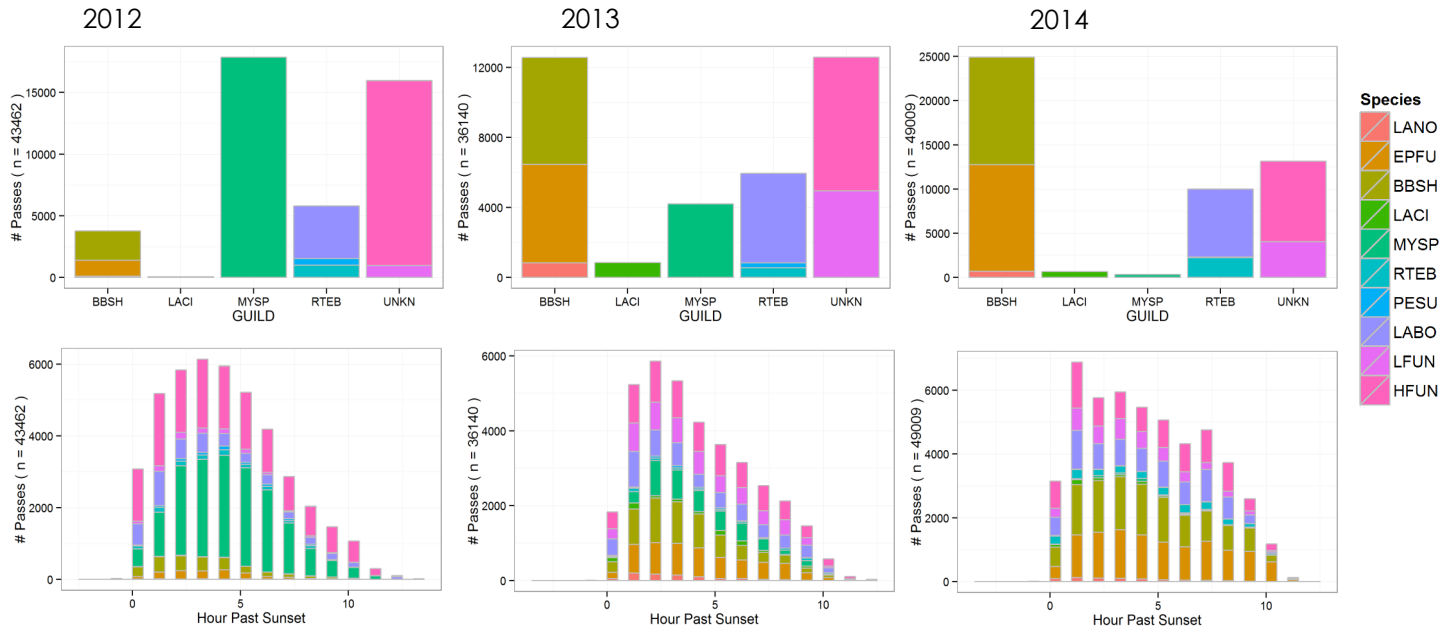


Seasonal trends in bat activity were similar among years, with detection rates and frequency of presence increasing steadily between May and August, then declining steadily through late October. Presque Isle had the highest detection rate of any site monitored in the study, with bats present during every night surveyed between 15 July and 15 October each year. Although species composition shifted dramatically during the study (see reverse), overall activity levels remained consistently high.

Presque Isle, Pennsylvania

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



The proportion of bat passes identified as *Myotis* species declined from 41% in 2012 to <1% in 2014, likely as a result of white-nose syndrome, which has decimated populations of cave-hibernating species in the northeast. The proportion of big brown bats showed an opposite trend, increasing from 3% in 2012 to 25% in 2014. Numbers of passes identified as long-distance migratory eastern red, hoary, and silver-haired bats fluctuated among years but did not show consistent trends.

Timing of bat activity varied among nights but followed consistent overall patterns among years. Activity began during the first hour past sunset, peaked 2-4 hours past sunset, then declined steadily for the remainder of the night.



The detector was deployed near the canopy height of the surrounding deciduous forest and oriented westward towards a gap in the trees and the sand beach along the Lake Erie Shoreline.

Rock of Ages, Michigan (Isle Royale)

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

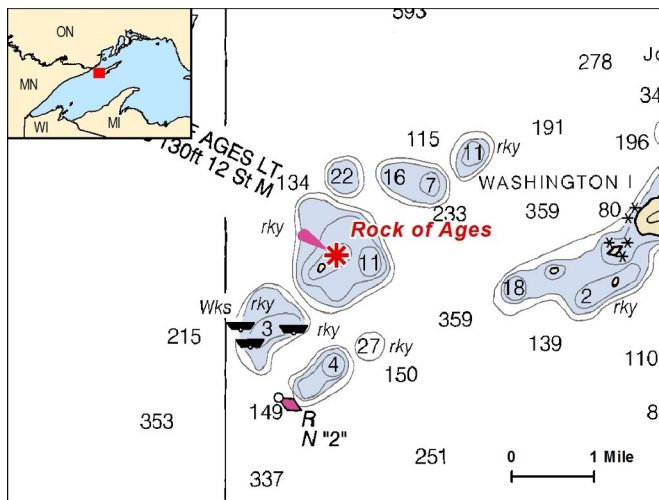


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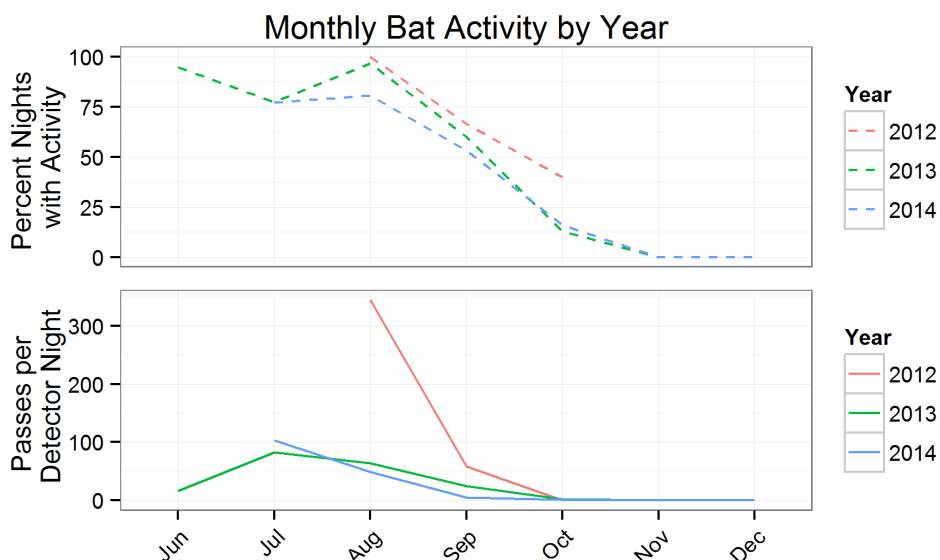
Region	Great Lakes
Category	Small Island
Lat/Long	47.855081, -89.326645
Area (hectares)	0.1
Distance from Mainland (km)	21
% Land in 3 nm buffer	0.2
% Forest in 150 m buffer	0.0
Detector Location	Lighthouse
Detector Height (m)	45
Distance from Shore (m)	0

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2012	28 Aug – 10 Oct	44	3,132	1,113	0.64	71.05	0.87
2013	12 Jun – 6 Dec	178	5,671	922	0.70	37.84	0.73
2014	10 Jul – 31 Dec	175	3,979	604	0.66	42.71	0.82

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

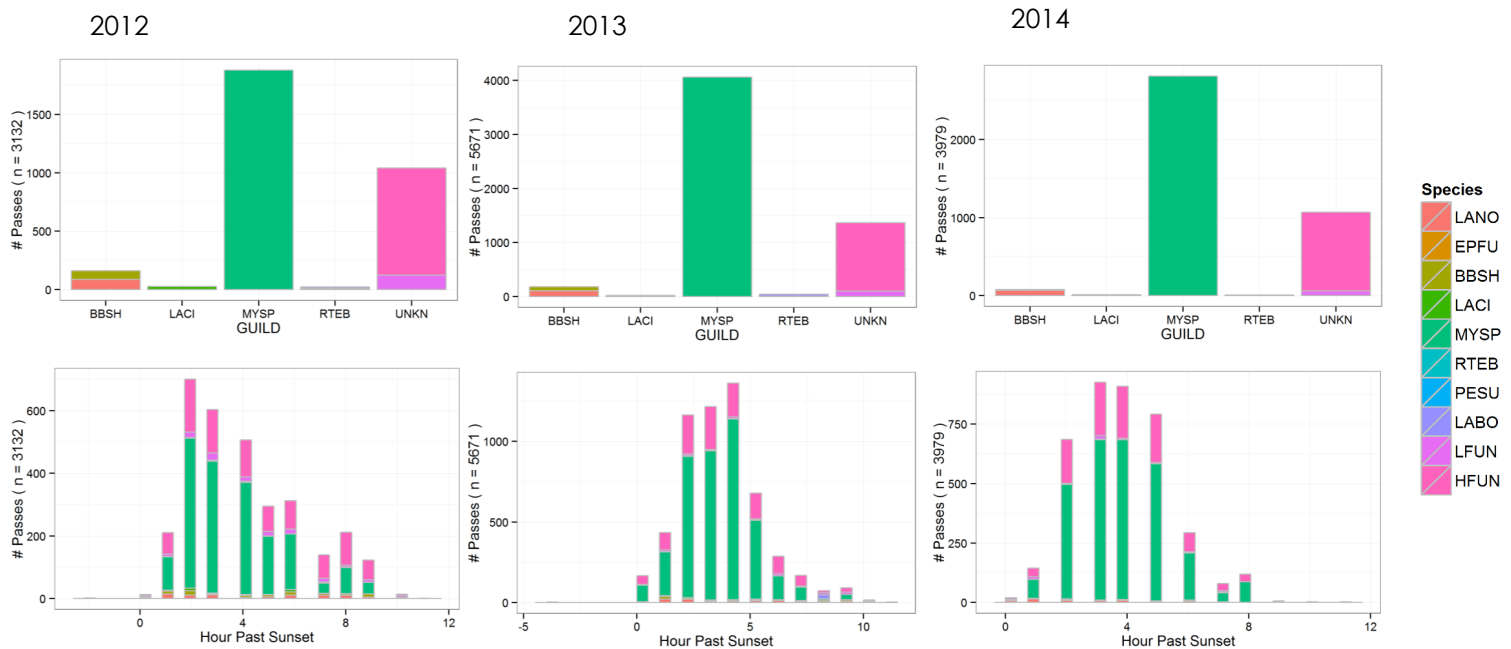


This site was the most isolated we surveyed in the Great Lakes region, although bat activity levels were consistently high in 2012, 2013, and 2014. Bats were active for up to 11 hours during a single night, with passes recorded during nearly 100% of nights surveyed in August during each year. The last bat detection at this site occurred on October 12 in 2012, October 5 in 2013, and October 16 in 2014.

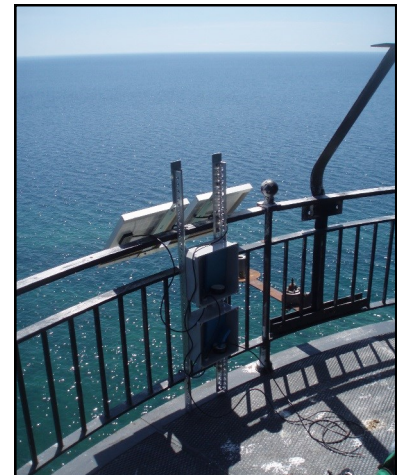
Rock of Ages, Michigan (Isle Royale)

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



We recorded consistently high levels of *Myotis* species activity at this site each year ($n = 8,748$), with overall activity peaking 2 to 4 hours past sunset among years. Silver-haired bats ($n = 261$) were also detected frequently, primarily between late August and early September each year. We also detected eastern red bats ($n = 58$), hoary bats ($n = 59$), 2 passes identified as big brown bats and 1 pass identified as a tri-colored bat.



Rock of Ages lighthouse sits atop a small, exposed rock ~ 6 km off the western tip of Isle Royale in Lake Superior (left), shown surrounded by ice in winter 2015 (center, photo credit Rolf Peterson). We deployed the detector on the lighthouse railing oriented southward (right).

Schoodic Peninsula FD, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

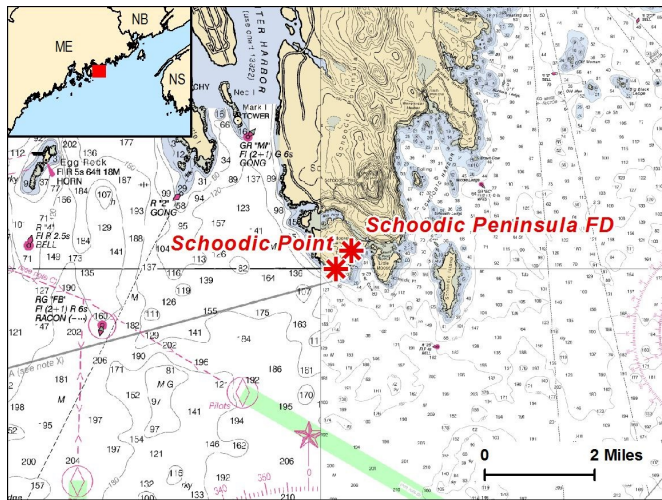


Table 1. Site Information

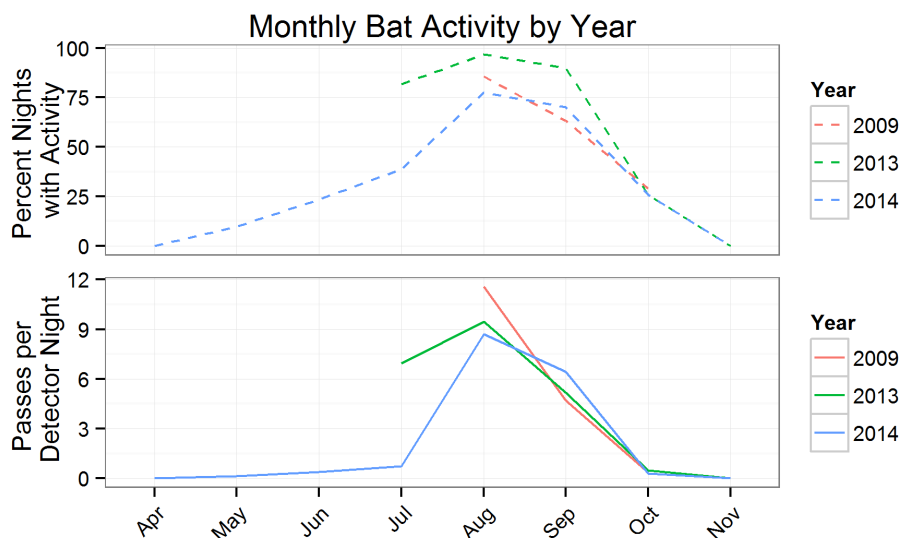
Region	Gulf of Maine
Category	Coastal
Lat/Long	44.336759, -68.057987
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	18.6
% Forest in 150 m buffer	25.3
Detector Location	Building
Detector Height (m)	6
Distance from Shore (m)	112

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	18 Aug – 31 Oct	75	314	49	0.64	5.29	0.75
2013	10 Jul – 6 Nov	120	616	54	0.82	5.76	0.57
2014	1 Apr – 7 Nov	221	510	116	0.62	5.24	0.79

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

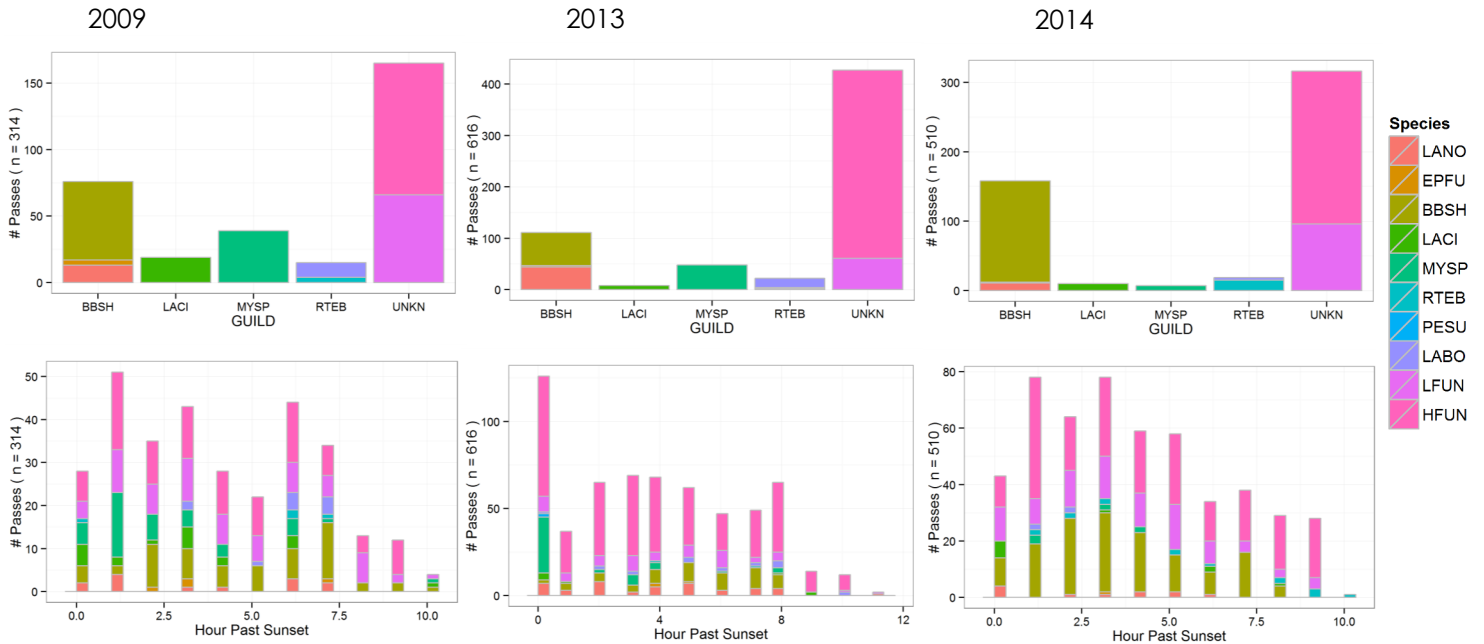


Bat detection rates followed consistent seasonal patterns at this site, peaking in August during each monitoring season. Detection rates were also stable among years, although activity was more consistent during 2013 than other years (indicated by a lower Gini coefficient). We detected bats between early May and the end of October at this site.

Schoodic Peninsula FD, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species (n = 94) were identified more often than other species at this site, although we also detected silver-haired bats (n = 68), hoary bats (n = 37), eastern red bats (n = 33), big brown bats (n = 8) and tri-colored bats (n = 2). Timing was relatively consistent among years, with peak activity occurring in the 1st or 2nd hour past sunset. No passes were recorded before sunset and 3 passes were recorded up to 3 hours past sunrise.



The acoustic detector was deployed in a mast on top of an old fire department, oriented southeastward. The building has a gravel rooftop and is surrounded by coniferous, spruce-dominated forest and adjacent a mowed lawn.

Schoodic Point, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

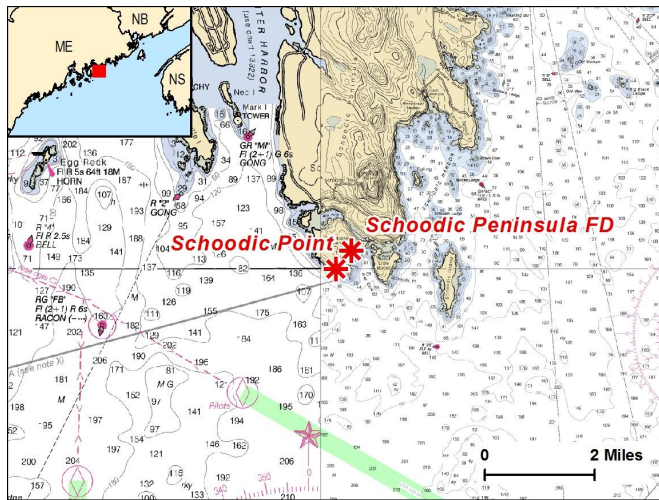


Table 1. Site Information

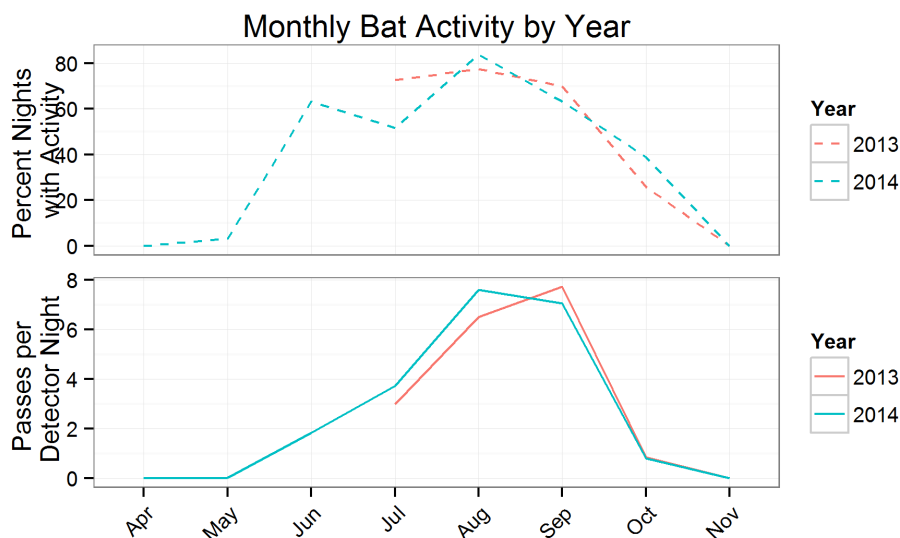
Region	Gulf of Maine
Category	Coastal
Lat/Long	44.333296, -68.062063
Area (hectares)	n/a
Distance from Mainland (km)	n/a
% Land in 3 nm buffer	16.7
% Forest in 150 m buffer	36.0
Detector Location	Tree
Detector Height (m)	4
Distance from Shore (m)	55

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	10 Jul – 6 Nov	120	526	52	0.70	5.46	0.67
2014	1 Apr – 7 Nov	221	645	75	0.67	6.15	0.72

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.

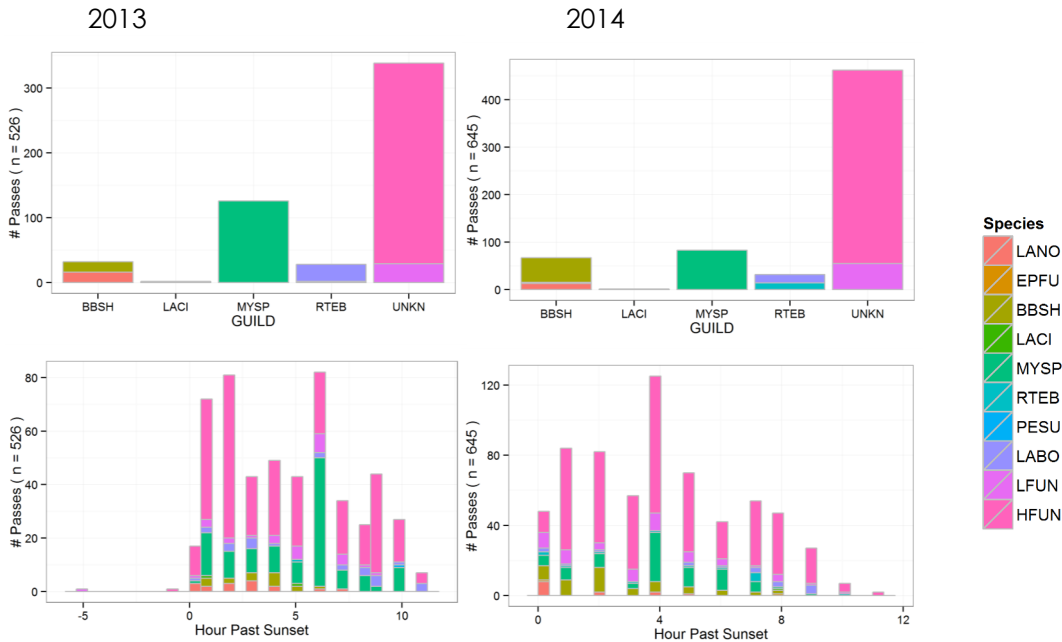


Bats were active at this site during 70 to 80% of nights surveyed in August and September 2013 and 2014, with similar seasonal patterns documented between years. We did not detect any bats at this site after 31 October or before 31 May.

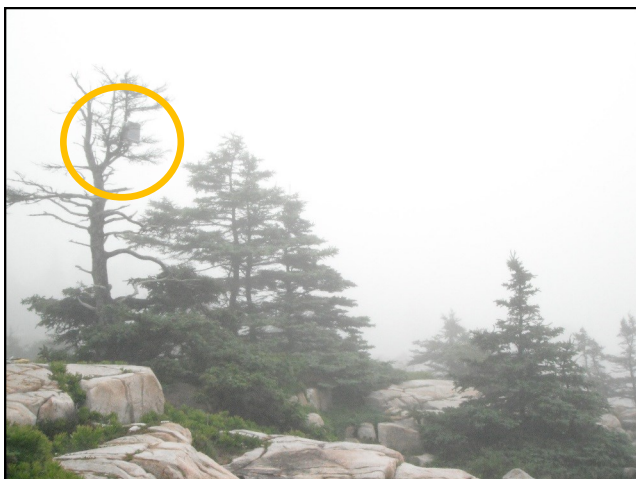
Schoodic Point, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Myotis species (n = 209) were identified at this site more than other species, although we also detected eastern red bats (n = 44), silver-haired bats (n = 29), hoary bats (n = 3), big brown bats (n = 2), and 1 tri-colored bat. A large proportion of passes could not be identified due to poor call quality, although many appeared to be fragments of either Myotis species or eastern red bat pulses. Bat activity varied among nights, with overall peaks occurring 2, 4, and 6 hours past sunset. Most bat activity occurred at night, although we detected 2 passes up to 5 hours before sunset.



View of detector (circled) looking east. The acoustic detector was deployed in a spruce tree near the tip of Schoodic Point, oriented southward. The detector was positioned on the edge of the treeline just above the rocky shoreline.

Seguin Island, Maine

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

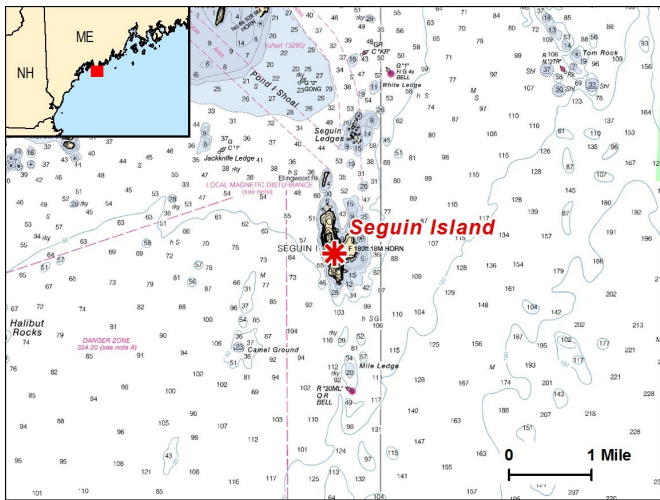


Table 1. Site Information

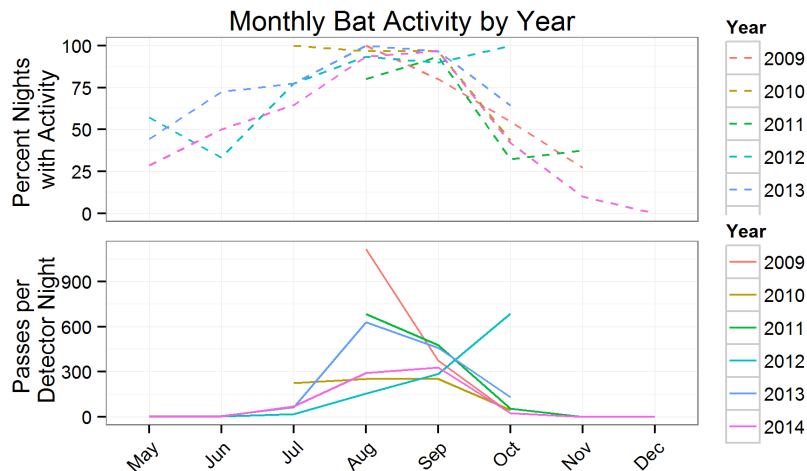
Region	Gulf of Maine
Category	Medium Island
Lat/Long	43.707498, -69.758073
Area (hectares)	25.6
Distance from Mainland (km)	4.1
% Land in 3 nm buffer	4.2
% Forest in 150 m buffer	31.5
Detector Location	Lighthouse
Detector Height (m)	16
Distance from Shore (m)	130

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2009	25 Aug – 11 Nov	79	19,820	2,492	0.81	380.60	0.70
2010	15 Jul – 23 Oct	101	20,203	1,989	0.90	217.15	0.67
2011	27 Aug – 8 Nov	74	19,447	1,775	0.82	388.78	0.60
2012	18 May – 17 Oct	153	25,774	2,301	0.94	254.18	0.80
2013	10 May – 14 Oct	153	37,389	1,877	0.91	400.18	0.57
2014	25 May – 31 Dec	221	21,988	1,443	0.87	234.97	0.68

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Seguin Island was consistently one of the busiest sites we monitored between 2009 and 2014. Despite a pronounced reduction in *Myotis* species detection rates (none were detected in 2014), overall activity remained stable across years. High activity levels appear to be the function of a local population (assumed to be relatively small) of resident bats attracted to the insects that are attracted to the constantly illuminated lighthouse beacon on this island.

Seguin Island, Maine

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats (n = 43,216) the predominant species detected species at this site overall, although *Myotis* species (n = 6,621) were identified more often in 2011. Numbers of *Myotis* passes declined dramatically between 2011 and 2013, and no *Myotis* were detected at the site in 2014. Big brown bats (n = 3,172) were detected at low levels prior to 2012, but increased by an order of magnitude between 2013 and 2014. Hoary bats (n = 1,340) have been detected at this site regularly each season, with periodic peaks in activity in August, September, and October. We also detected silver-haired bats (n = 251) each year and tri-colored bats (n = 21) in 2011 and 2013. Nightly timing varied somewhat among years, although very few passes occurred before sunset (n = 9) or after sunrise (n = 17).

Seguin Island, Maine



Seguin Island is located off the coast of Phippsburg, Maine, near the mouth of the Kennebec River. We deployed the detector on the lighthouse railing tower (upper left and right). Seguin Lighthouse is the only lighthouse we monitored where the light is constantly illuminated, magnified by a large, 1st order Fresnel lens (lower left). Resident caretakers reported concentrations of insects and bats foraging around the lighthouse.

Town of Duck, North Carolina

Site-specific summary of acoustic bat survey results from a regional study of offshore bat activity conducted to establish baseline offshore bat activity levels in the Great Lakes, mid-Atlantic coast, and Gulf of Maine.

Acknowledgement: This material is based upon work supported by the Department of Energy under Award Number DE-EE005378.

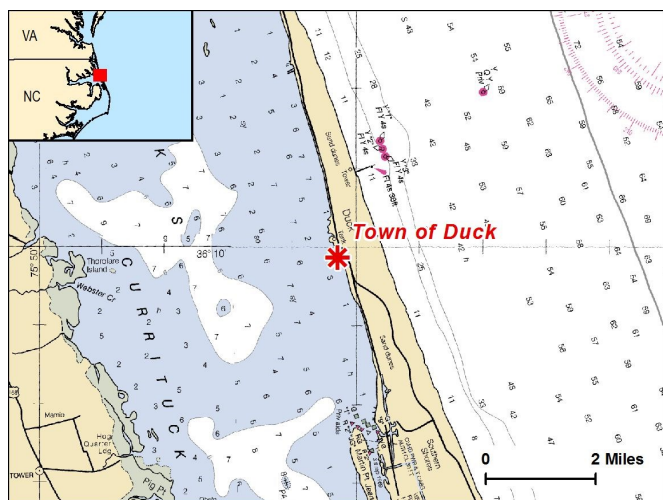


Table 1. Site Information

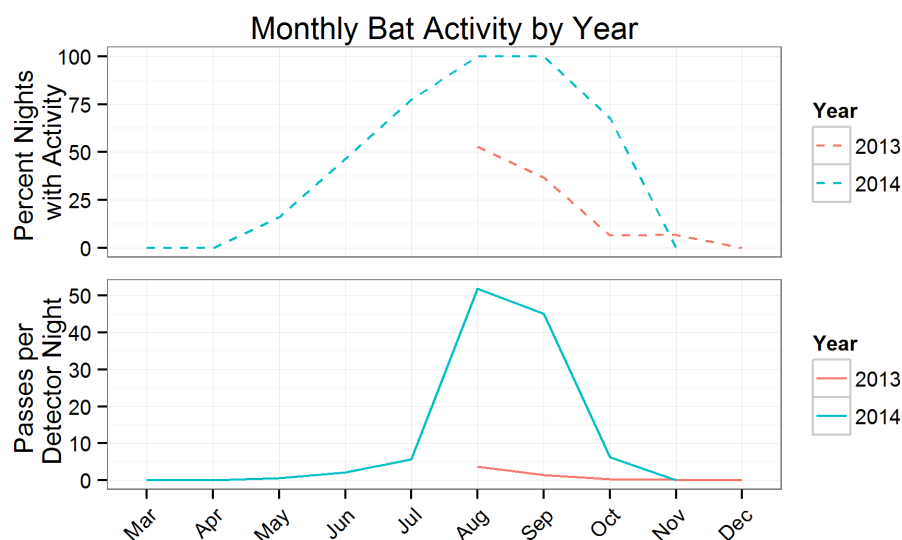
Region	Mid-Atlantic
Category	Large
Lat/Long	36.164414, -75.754924
Area (hectares)	4,985
Distance from Mainland (km)	6
% Land in 3 nm buffer	11.9
% Forest in 150 m buffer	0.0
Detector Location	Boardwalk
Detector Height (m)	3
Distance from Shore (m)	0

Table 2. Acoustic bat survey effort and results

Year	Dates Surveyed	Nights Surveyed	Total Passes	Max. Passes/ Night	% Nights with Activity*	Detection Rate*	Gini Coefficient**
2013	15 Aug – 14 Dec	122	118	42	0.34	1.81	0.86
2014	1 Mar – 16 Nov	261	3,409	643	0.97	34.56	0.65

* Calculated for nights only between 15 July and 15 October to allow comparisons of similar time periods among sites

**The Gini Coefficient is an index of consistency of bat activity, ranging from 0 (even distribution) to 1 (uneven distribution) and was calculated for datasets with > 30 nights between 15 July and 15 October.



Detection rates peaked in August during both years, but were substantially higher in 2014 than 2013. Bats were detected during 100% of nights in August and September 2014. We detected no bats after 18 November (although few passes were detected past mid-October) or before 22 May.

Town of Duck, North Carolina

Species/Guild Composition (upper) and Nightly Timing (lower) of Bat Activity by Year.

BBSH=big-brown (EPFU)/silver-haired (LANO), LACI=hoary, MYSP=Myotis, RTEB=eastern red (LABO)/tri-colored (PESU), UNKN=low (LFUN) or high (HFUN) unknown



Eastern red bats ($n = 1,629$) accounted for most activity recorded at the site, occurring regularly throughout the survey period. We detected silver-haired bat activity ($n = 165$) primarily between late August and mid September, and also identified tri-colored bats ($n = 27$), hoary bats ($n = 14$), and big brown bats ($n = 5$). No *Myotis* species occurred at this site. Peak activity occurred 1 hour past sunset and no passes were recorded before sunset or after sunrise.



The acoustic detector was deployed along a boardwalk facing Currituck Sound on the west shore of this 4,985 hectare outer banks island.

**LONG-TERM BAT MONITORING ON ISLANDS, OFFSHORE STRUCTURES, AND COASTAL SITES IN THE
GULF OF MAINE, MID-ATLANTIC, AND GREAT LAKES—FINAL REPORT**

January 15, 2016

Appendix B PUBLICLY AVAILABLE TERRESTRIAL STUDIES

LONG-TERM BAT MONITORING ON ISLANDS, OFFSHORE STRUCTURES, AND COASTAL SITES IN THE GULF OF MAINE, MID-ATLANTIC, AND GREAT LAKES—FINAL REPORT

January 15, 2016

Project Site	Season	Dates	Year	Calendar Nights	Detector-Nights*	Recorded Sequences	Detection Rate **	Citation
Antrim, Hillsborough Cty, NH	spring	4/7 – 6/1	2011	323	304	1,483	4.9	Stantec Consulting Services Inc. 2011. Spring 2011 Radar and Acoustic Bat Survey Report for the Antrim Wind Energy Project in Antrim, New Hampshire. Prepared for Eolian Renewable Energy.
Antrim, Hillsborough Cty, NH	summer/fall	6/1 – 10/23	2011	849	802	4,335	5.4	Stantec Consulting Services Inc. 2011. Summer and Fall 2011 Radar and Acoustic Bat Survey Report for the Antrim Wind Energy Project in Antrim, New Hampshire. Prepared for Antrim Wind Energy, LLC.
Bingham, Somerset Cty, ME	spring	4/13 – 6/8	2010	149	425	110	0.3	Stantec Consulting Services Inc. 2010. Spring 2010 Avian and Bat Survey Report for the Bingham Wind Project. Prepared for Blue Sky East Wind LLC.
Bingham, Somerset Cty, ME	fall	6/3 – 10/31	2010	1,184	1,084	2,755	2.5	Stantec Consulting Services Inc. 2012. Fall 2010 Avian and Bat Survey Report for the Bingham Wind Project. Prepared for Blue Sky East Wind, LLC.
Bowers, Washington Cty, ME	fall	9/4 – 11/4	2009	354	342	2,374	6.9	Stantec Consulting Services Inc. 2010. Fall 2009 Avian and Bat Surveys for the Bowers Wind Project. Prepared for Champlain Wind Energy, LLC.
Bowers, Washington Cty, ME	spring/summer	4/15 – 9/4	2010	858	784	9,825	12.5	Stantec Consulting Services Inc. 2010. 2010 Spring Avian and Spring/Summer Bat Surveys for the Bowers Wind Project. Prepared for Champlain Wind Energy LLC.
Bull Hill, Hancock Cty, ME	fall	7/14 – 11/4	2009	436	426	4,612	10.8	Stantec Consulting Services Inc. 2010. Summer and Fall 2009 Avian and Bat Survey Report for the Bull Hill Project. Prepared for Blue Sky East Wind, LLC.
Bull Hill, Hancock Cty, ME	spring	4/15 – 7/14	2010	546	467	2,703	5.8	Stantec Consulting Services Inc. 2010. Spring 2010 Avian and Bat Survey Report for the Bull Hill Wind Project. Prepared for Blue Sky East Wind, LLC.
Bull Hill, Hancock Cty, ME	fall	7/12 – 10/20	2013	507	412	2,036	4.9	Stantec Consulting Services Inc. 2015. Bull Hill Wind Project Year 2 Post-Construction Wildlife Monitoring Report, 2014. Prepared for Blue Sky East Wind, LLC.
Bull Hill, Hancock Cty, ME	summer/fall	6/24 – 10/22	2014	770	717	631	0.9	Stantec Consulting Services Inc. 2015. Bull Hill Wind Project Year 2 Post-Construction Wildlife Monitoring Report, 2014. Prepared for Blue Sky East Wind, LLC.
Cassadaga, Chautauqua Cty, NY	year	8/14/13 – 10/21/13; 4/16/14 – 10/15/14	2013/2014	324	306	3,170	10.4	Stantec Consulting Services Inc. 2015. Cassadaga Wind Project Bird and Bat Survey Report, 2013-2014. Prepared for EverPower Wind Holdings, Inc.
Cohocton, Steuben Cty, NY	year	4/15 – 10/31	2009	600	525	4,418	8.4	Stantec Consulting Services Inc. 2010. Cohocton and Dutch Hill Wind Farms Year 1 Post-Construction Monitoring Report, 2009. Prepared for Canandaigua Power Partners, LLC and Canandaigua Power Partners II, LLC.
Cohocton, Steuben Cty, NY	year	4/21 – 10/23	2010	555	434	46,293	106.7	Stantec Consulting Services Inc. 2011. Cohocton and Dutch Hill Wind Farms Year 2 Post-Construction Monitoring Report, 2010. Prepared for Canandaigua Power Partners, LLC and Canandaigua Power Partners II, LLC.
Cohocton, Steuben Cty, NY	fall	7/8 – 10/15	2013	300	275	7,356	26.7	Stantec Consulting Services Inc. 2014. Cohocton and Dutch Hill Wind Farms 2013 Post-Construction Wildlife Monitoring Report. Prepared for First Wind.
Deerfield, Bennington Cty, VT	year	4/15 – 10/15	2011	1,472	1,385	2,263	1.6	Stantec Consulting Services Inc. 2011. 2011 Acoustic Bat Survey Report for the Deerfield Wind Project In Searsburg and Readsboro, Vermont. Prepared for Iberdrola Renewables, Inc.
Groton Wind, Grafton Cty, NH	fall	8/13 – 10/22	2009	537	466	2,104	4.5	Stantec Consulting Services Inc. 2009. 2009 Spring, Summer, and Fall Avian and Bat Surveys for the Groton Wind Project. Prepared for Groton Wind, LLC.
Groton Wind, Grafton Cty, NH	year	4/9 – 8/18	2010	1,056	986	6,356	6.4	Stantec Consulting Services Inc. 2010. Spring and Summer 2010 Acoustic Bat Survey Report for the Groton Wind Project. Prepared for Groton Wind, LLC.
Highland, Somerset Cty, ME	spring/summer	4/23 – 8/17	2009	692	553	166	0.3	Stantec Consulting Services Inc. 2009. Spring 2009 Ecological Surveys. Prepared for Highland Wind LLC.
Kingdom Community, Orleans Cty, VT	year	4/16 – 10/18	2009	928	856	10,130	11.8	Stantec Consulting Services Inc. 2009. 2009 Acoustic Bat Survey for the Kingdom Community Wind Project. Prepared for Vermont Environmental Research Associates.
Laurel Mountain, Randolph and Barbour Ctys, WV	year	8/20/11 – 11/1/11; 4/1/12 – 7/31/12	2011/2012	1,584	1,507	29,510	19.6	Stantec Consulting Services Inc. 2013. Fall 2011 and Spring/Summer 2012 Post-construction Monitoring, Mortality Estimate, Acoustic \ Analysis and Curtailment Study for the Laurel Mountain Wind Energy Project. Prepared for AES Laurel Mountain Wind, LLC.

LONG-TERM BAT MONITORING ON ISLANDS, OFFSHORE STRUCTURES, AND COASTAL SITES IN THE GULF OF MAINE, MID-ATLANTIC, AND GREAT LAKES—FINAL REPORT

January 15, 2016

Project Site	Season	Dates	Year	Calendar Nights	Detector-Nights*	Recorded Sequences	Detection Rate **	Citation
Laurel Mountain, Randolph and Barbour Ctys, WV	year	4/1 – 11/13	2013	no data	1,734	18,770	10.8	Stantec Consulting Services Inc. 2014. Laurel Mountain Wind Energy Project 2013 Acoustic Monitoring Report. Prepared for AES Laurel Mountain Wind, LLC.
Laurel Mountain, Randolph and Barbour Ctys, WV	year	4/9 – 11/15	2014	no data	1,815	10,012	5.5	Stantec Consulting Services Inc. 2015. Laurel Mountain Wind Energy Project 2014 Acoustic Monitoring Report. Prepared for AES Laurel Mountain Wind, LLC.
Passadumkeag, Grand Falls Twp, ME	spring	4/22 – 5/31	2011	710	157	1,133	7.2	Stantec Consulting Services Inc. 2011. Spring and Summer 2011 Avian and Bat Survey Report for the Passadumkeag Wind Project in Grand Falls Township, Maine. Prepared for Noble Passadumkeag Windpark LLC.
Passadumkeag, Grand Falls Twp, ME	fall	6/1 – 10/16	2011	552	534	17,492	32.8	Stantec Consulting Services Inc. 2011. Summer and Fall 2011 Avian and Bat Survey Report for the Passadumkeag Wind Project in Grand Falls Township, Maine. Prepared for Passadumkeag Windpark LLC.
Record Hill, Oxford City, ME	year	4/16 – 10/23	2012	759	639	15,724	24.6	Stantec Consulting Services Inc. 2014. Record Hill Wind Project Post-Construction Monitoring Report, 2012. Prepared for Record Hill Wind LLC.
Sisk, Kibby and Chain of Ponds Twps, ME	fall	8/11 – 10/15	2009	208	204	94	0.5	Stantec Consulting Services Inc. 2009. Fall 2009 Nocturnal Migration Survey Report for the Kibby Expansion Wind Project. Prepared for TRC Engineers LLC.
South Mountain, Delaware City, NY	fall	8/17 – 10/18	2011	126	126	6,074	48.2	Stantec Consulting Services Inc. 2012. Fall 2011 Avian and Bat Survey Report for the South Mountain Wind Project in Delaware County, New York. Prepared for Ridgeline Energy LLC.
South Mountain, Delaware City, NY	spring/summer	4/15 – 8/15	2012	246	206	6,241	30.3	Stantec Consulting Services Inc. 2013. Spring 2012 Avian and Bat Survey Report for the South Mountain Wind Project in Delaware County, New York. Prepared for South Mountain Wind LLC.
Steel Winds, Erie Cty, NY	year	3/20 – 11/5	2012	590	386	28,678	74.3	Stantec Consulting Services Inc. 2013. Steel Winds I and II Post-Construction Monitoring Report, 2012. Prepared for First Wind Management, LLC.
Steel Winds, Erie Cty, NY	year	3/21 – 11/4	2013	686	591	5,379	9.1	Stantec Consulting Services Inc. 2014. Steel Winds I and II Year 2 Post-Construction Wildlife Monitoring Report, 2013. Prepared for First Wind.
Stetson I, Penobscot and Washington Cty, ME	summer/fall	7/10 – 10/14	2009	97	509	9,997	19.6	Stantec Consulting Services Inc. 2010. Stetson I Mountain Wind Project Year 1 Post-Construction Monitoring Report, 2009 for the Stetson Mountain Wind Project. Prepared for First Wind Management, LLC.
Weaver, Hancock Cty, ME	year	4/22 – 10/15	2014	708	666	334	0.5	Stantec Consulting Services Inc. 2014. 2014 Pre-Construction Avian and Bat Surveys – Weaver Wind Project. Prepared for First Wind, LLC.
Wild Meadows, Grafton and Merrimack Ctys, NH	fall	8/19 – 10/22	2009	193	178	191	1.1	Stantec Consulting Services Inc. 2013. Fall 2009 Radar and Acoustic Surveys, Wild Meadows Wind Project in Grafton and Merrimack Counties, New Hampshire. Prepared for Atlantic Wind LLC.
Wild Meadows, Grafton and Merrimack Ctys, NH	spring/summer	4/8 – 8/19	2010	1,138	1,097	1,980	1.8	Stantec Consulting Services Inc. 2013. Spring 2010 Avian and Bat Survey Report for the Wild Meadows Wind Project in Grafton and Merrimack Counties, New Hampshire. Prepared for Atlantic Wind LLC.
* One detector-night is equal to a one detector successfully operating throughout the night.								
** Number of bat passes recorded per detector-night.								