Acoustic Bat Surveys on Monhegan Island in 2009, 2010, and 2011

Prepared for

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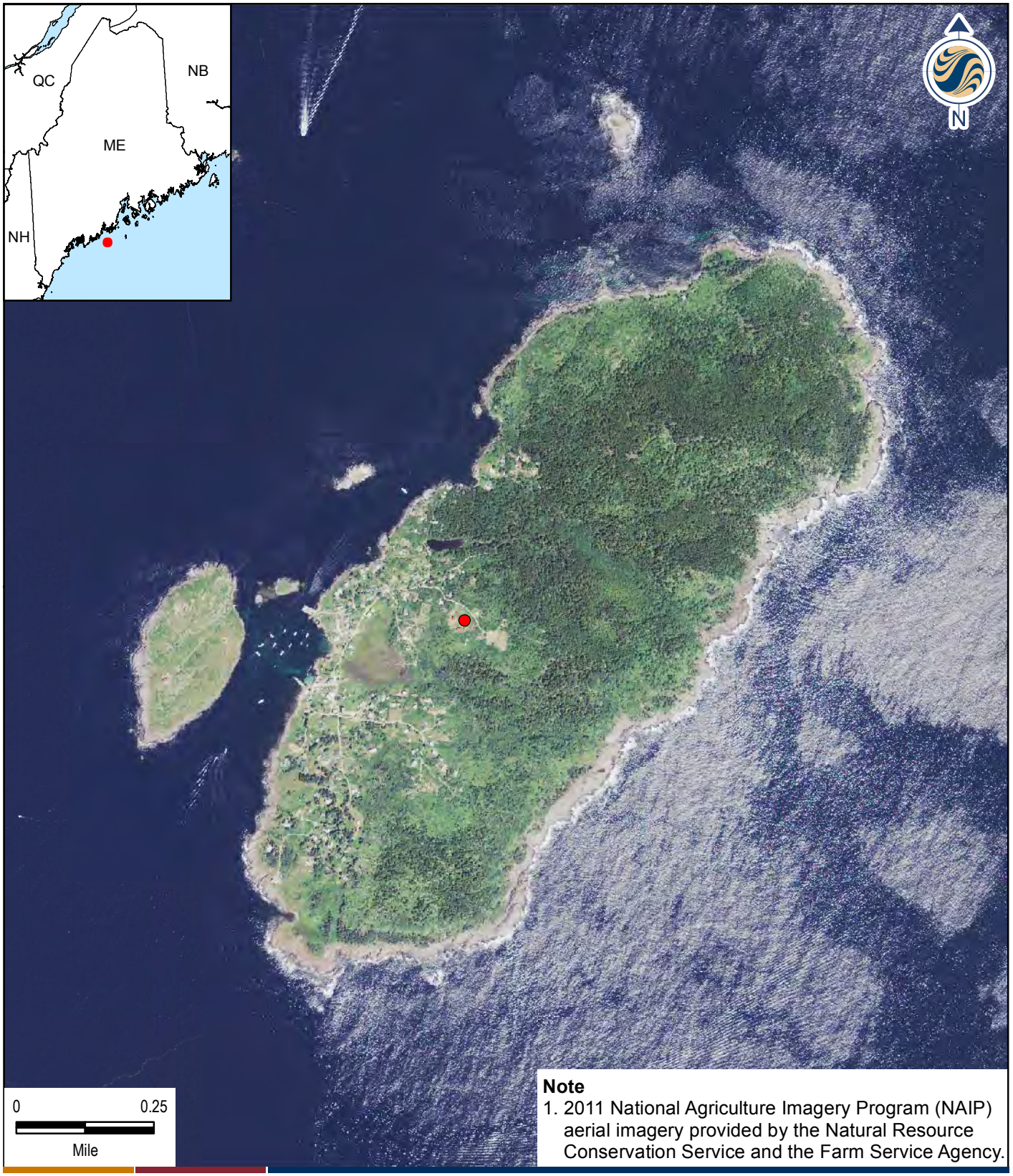
1.0 Introduction

Stantec Consulting Services Inc. (Stantec) initiated an effort to monitor bat activity offshore and along the coast of Maine using ultrasonic acoustic bat detectors beginning in 2009. Surveys were continued in 2010 and 2011, sampling a total of 16 distinct sites ranging from Kent Island, New Brunswick, to a Northeast Regional Association of Coastal Ocean Observing Systems (NERACOOS) buoy off the coast of Gloucester, MA. Survey locations have included primarily lighthouse towers, although detectors have also been deployed on portable towers, trees, and floating buoys. The effort is not associated with any single project, but is instead designed to build a baseline dataset on activity patterns and species composition of bats in the offshore and nearshore environment in the Gulf of Maine. Prior to this effort, no systematic surveys of bat activity have been attempted offshore in the United States. Stantec hopes that the data collected through this effort will help characterize bats' habitat use and behavior offshore, which will be useful in assessing, avoiding, and mitigating potential impacts of offshore wind energy on bats.

This report has been prepared for the Maine State Planning Office to summarize the acoustic bat surveys conducted specifically on Monhegan Island between August and December, 2011. Additionally, the report makes comparisons, where appropriate, to acoustic data collected on Monhegan Island in summer 2009 and 2010 as part of Stantec's offshore acoustic bat survey effort, and to overall patterns in bat activity documented through the larger offshore monitoring effort.

Although no reliable background data on bat species presence exists for Monhegan Island, species occurring in Maine that could theoretically be present on the island include the little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), eastern small-footed bat (*Myotis leibii*), tri-colored bat (*Perimyotis subflavus*), eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*).

Monhegan Island is located off the mid-coast of Maine between Pemaquid Point and Port Clyde, approximately 11 miles (18 kilometers [km]) from the mainland (Figure 1-1). The island is approximately 1 square mile (2.6 square km) in area, with a maximum elevation of approximately 160 feet (49 meters [m]) above sea level (Ellsworth 1912). The year-round population, according to the 2010 census, was 69, although the summer population is considerably larger. Forests on Monhegan Island consist primarily of spruce-fir forests typical of the peninsulas and islands along the coast of Maine, with the climate moderated by the influence of the ocean (Davis 1966). The light itself, originally constructed in 1824 and rebuilt in 1850 following storm damage, is 48 feet (15 m) tall, and is the second highest lighthouse in Maine relative to sea level (USCG 2012). The light is presently located in a mowed clearing surrounded by several houses and other buildings and is frequented by numerous tourists during the summer.



Note

1. 2011 National Agriculture Imagery Program (NAIP) aerial imagery provided by the Natural Resource Conservation Service and the Farm Service Agency.

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Legend

- Acoustic Bat Survey Location

Client/Project

Maine State Planning Office
Acoustic Bat Survey
Monhegan Island, Maine

Figure No.

1-1

Title

Acoustic Bat Survey Location Map

January 31, 2012

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2.0 Methods

Stantec deployed an Anabat ultrasonic acoustic bat detector (Titley Scientific, Queensland, Australia) on a purpose-built wooden bracket mounted on the tower platform of the Monhegan Island lighthouse (Figure 2-1). A second detector was deployed as a backup to minimize the possibility of data loss due to equipment malfunction. The system was powered by two sealed 12-volt gel batteries (7 amp-hour) charged by two 10-watt solar panels and regulated by a low capacity charge controller. Detectors were deployed in modified rigid PVC utility boxes, with the microphone positioned on the bottom of the box within a 2.5 inch, 90 degree PVC elbow to weatherproof the microphone and enable sampling of the airspace horizontally in front of the unit (Figure 2-1). The microphone was oriented southward, roughly perpendicular to the lighthouse tower. Identical acoustic detection systems were deployed at Monhegan Island in 2009, 2010, and 2011, although the timing of surveys differed between years.

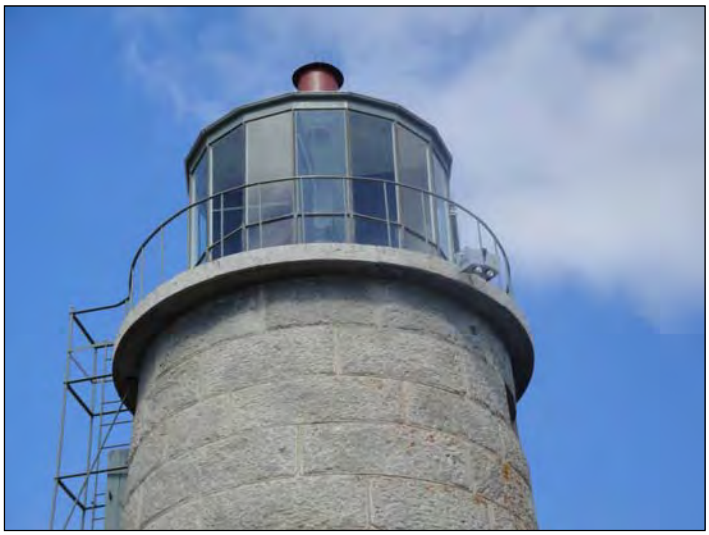

Figure 2-1. Photograph of the acoustic bat detection system installed on Monhegan Island light

Acoustic detectors were programmed to operate and record data on a nightly basis from 1800 to 0800 to enable sampling of the full period between sunset and sunrise plus a buffer on either side. Detector sensitivity was set to a value of approximately 7.0 to maximize potential to detect bats while limiting unwanted static. Detectors stored data on removable 1 gigabyte Compact Flash memory cards.

At the end of the monitoring period, acoustic data were downloaded from the detectors using CFCread software (version 4.3n, default settings; Corben 2009), which creates nightly folders into which potential bat call files are parsed. Data files and detector status files were initially inspected to determine whether detectors were functioning properly, based on whether files were recorded and whether the detector remained on for the duration of the sampling period. Stantec visually inspected all recorded call files to determine whether a bat pass had been recorded, and to determine whether the file was of sufficient quality for identification. Each potential call file consists of a brief (15 seconds or less) time-stamped recording that can be analyzed visually in Analook software (version 3.7w; Corben 2009). To be considered a bat pass, a call file was required to contain at least two 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.

Stantec categorized all call sequences with fewer than five pulses as either high frequency unknown (HFUN) if the minimum frequency of pulses was greater than 33 kHz or low frequency unknown (LFUN) if the minimum frequency of pulses was less than 33 kHz. Call files with greater than five pulses were identified to species or "guild" when possible based on qualitative inspection of call parameters and comparison to reference libraries of known calls (as in Johnson *et al* 2011). We summarized species composition, nightly range in activity levels, and seasonal patterns in activity, calculated the number of hours and minutes past sunset that each call file was recorded and summarized call timing on a nightly and seasonal basis, and calculated detection rates by dividing the number of call sequences by the number of nights during particular seasons and time periods.

Stantec obtained wind speed, air temperature, and barometric pressure data recorded at 10-minute intervals by NERACOOS buoys E01 and E02, each located approximately 3 miles (5 km) southwest of Monhegan Island (NERACOOS 2011). Weather data were summarized by night and visually compared to acoustic activity patterns recorded at Monhegan Island. For the purposes of this analysis, "night" was defined as the period between 18:00 and 06:00, and data were summarized by "night of" date rather than the traditional date.

3.0 Results

Data obtained from NERACOOS buoys E01 and E02 for the 2011 survey period indicated that weather variables were similar between the two buoys while both buoys were operational. However, because buoy E02 stopped reporting data in early October, only data from buoy E01 were included in analyses. Weather data also were obtained from buoy E01 for the 2009 and 2010 acoustic survey periods. Mean nightly wind speed between August 12 and November 30, 2011 ranged from 1.5 meters per second (m/s) on September 24, to 13.7 m/s on August 28, with mean nightly temperature during the same period ranging from 1.6 degrees Celsius (° C) on November 23 to 19.2° C on August 27 (Figure 3-1). Tropical storm Irene passed over Monhegan Island on August 28, 2011, contributing to a spike in nightly wind speed observed on that date. Maximum 24-hr precipitation during the 2011 survey period, as measured at Pemaquid Point Lighthouse, was 3 inches (7.7 centimeters), occurring on October 2. Monthly mean temperature declined steadily and monthly mean wind speed increased steadily between July and November, 2011, with similar trends observed in 2009 and 2010 (Figure 3-2).

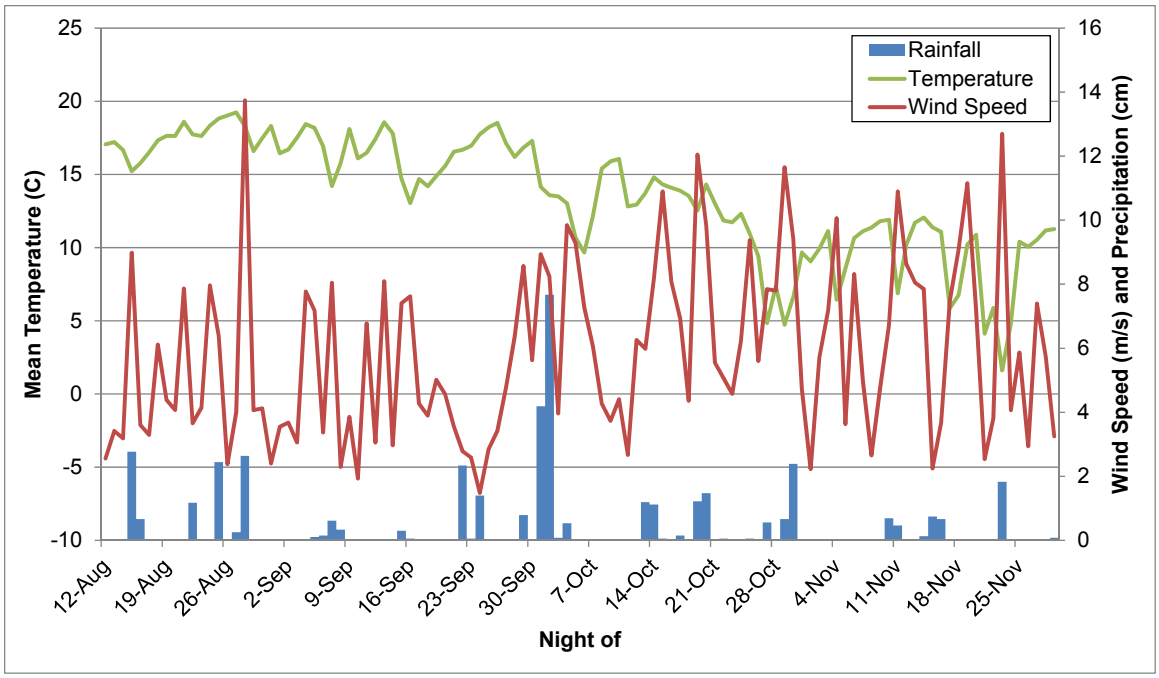

Figure 3-1. Mean nightly temperature and wind speed measured at buoy E01 and total 24-hr precipitation measured at Pemaquid Point lighthouse between August 12 and November 30, 2011.

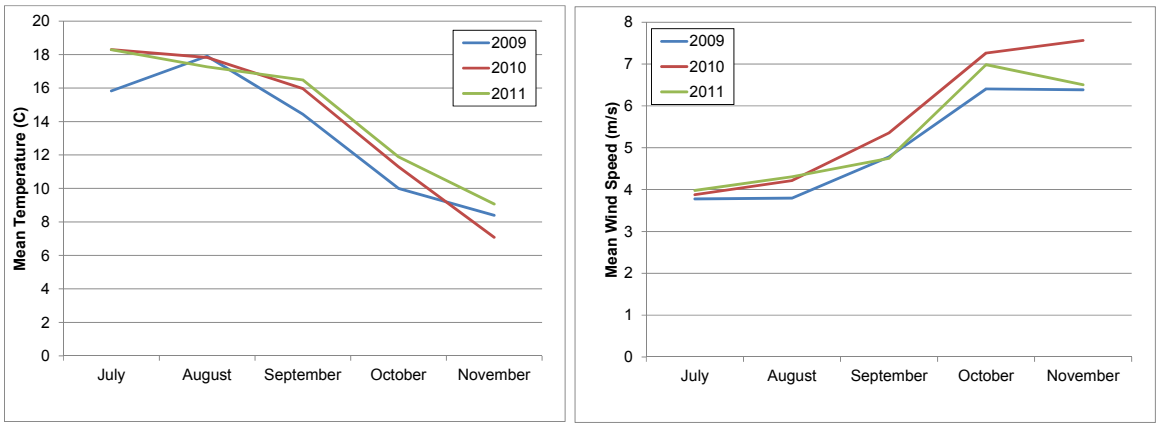

Figure 3-2. Mean monthly temperature (left) and wind speed (right) recorded at buoy E01 near Monhegan Island in 2009, 2010, and 2011

The acoustic bat detection system was deployed at the Monhegan Island lighthouse on August 12, 2011, and recovered in early January, 2012, effectively sampling bat activity throughout the survey period. During this period, one detector operated without any issues, whereas the backup detector malfunctioned periodically, so data from only the primary detector were used in analysis. This detector recorded a total of 9,033 files during the 164 nights it was deployed, 1,451 of which were determined to be bat call sequences. In 2010, the primary detector was deployed between July 19 and the end of November, although both the primary and backup units malfunctioned after September 4, 2010, recording a total of 4,763 files during 48 nights, 1,157 of which were determined to be bat call sequences. Year 2009 sampling occurred between September 16 and December 27, during which 3,999 files were recorded during 103 nights, although only

27 files were determined to be bat call sequences. Appendix A contains tables summarizing nightly acoustic survey results from 2011, 2010, and 2009.

Fewer than 50 bat call sequences were recorded on a nightly basis for all but 6 nights during the 2011 survey period, with greater than 200 sequences recorded on 2 nights (September 17 and 24, 2011). Bats were detected during every night between August 12 and September 26 with the exception of August 28, when the tropical storm associated with Hurricane Irene moved through the region (Figures 3-3 and 3-4). Overall activity levels dropped substantially after September 24, 2011, after which point a total of only 42 call sequences were recorded through the end of November, 2011 (Figure 3-3 and 3-4). The greatest number of call sequences recorded after September 26 was 7 on October 3, 2011. No bats were detected after the night of November 26, when one call sequence was recorded.

During 2010 surveys, bats were detected on all but two nights surveyed between July 19 and September 4, with the highest nightly activity levels detected on September 1 (197 call sequences) and September 2 (158 call sequences) (Figures 3-5 and 3-6). The 2010 survey period ended after the night of September 4 due to equipment malfunction. Bats were detected on 15 of the 76 nights surveyed in 2009, with the highest activity level (5 call sequences) occurring on October 5, 2009 (Figure 3-7).

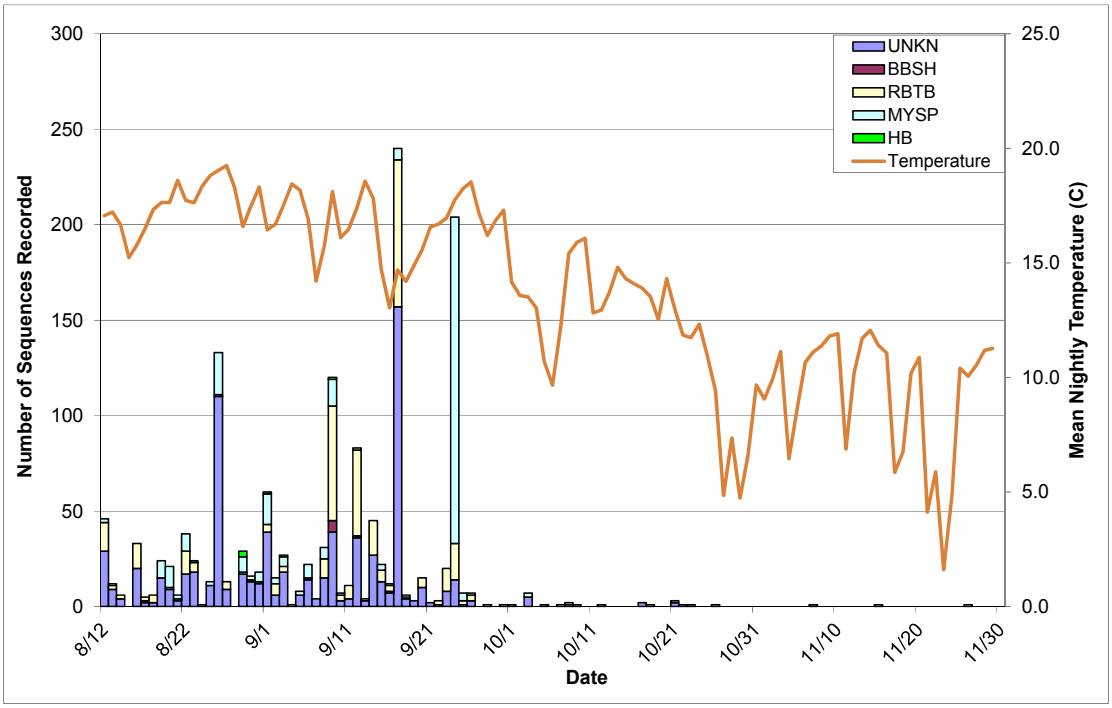

Figure 3-3. 2011 Nightly acoustic bat activity by guild and temperature at Monhegan Island. UNKN = unknown species, BBSH = big brown/silver-haired bat, RBTB = eastern red bat/tri-colored bat, MYSP = *Myotis* species, and HB = hoary bat.

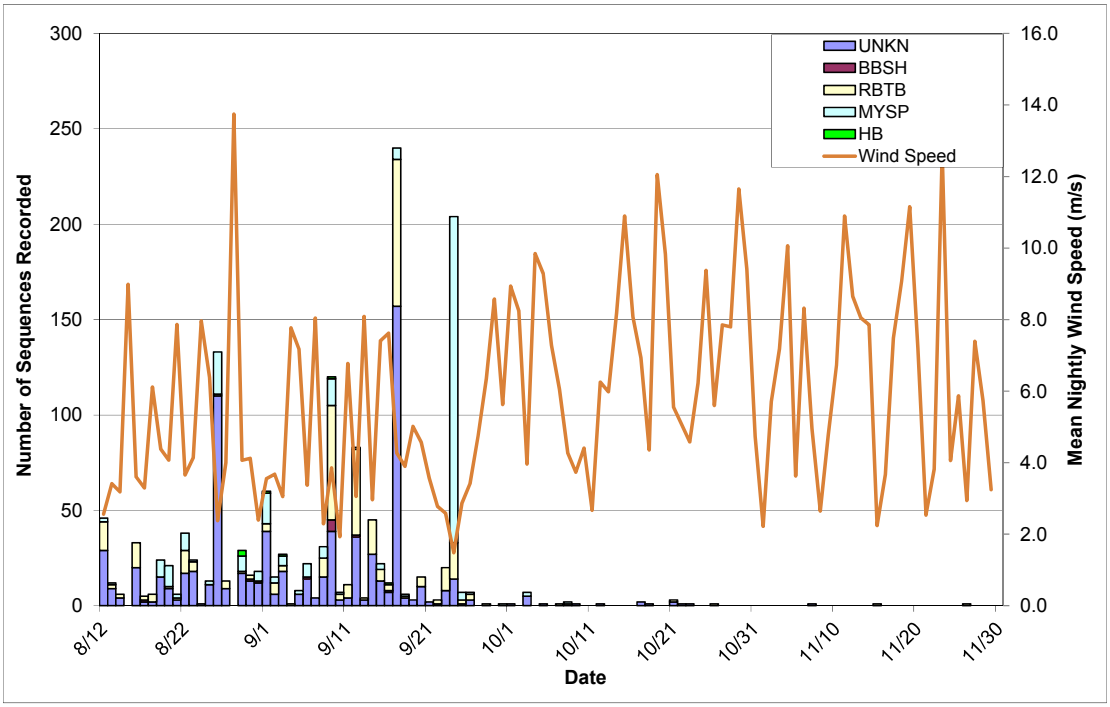

Figure 3-4. 2011 Nightly acoustic bat activity by guild and wind speed at Monhegan Island. UNKN = unknown species, BBSH = big brown/silver-haired bat, RBTB = eastern red bat/tri-colored bat, MYSP = *Myotis* species, and HB = hoary bat.

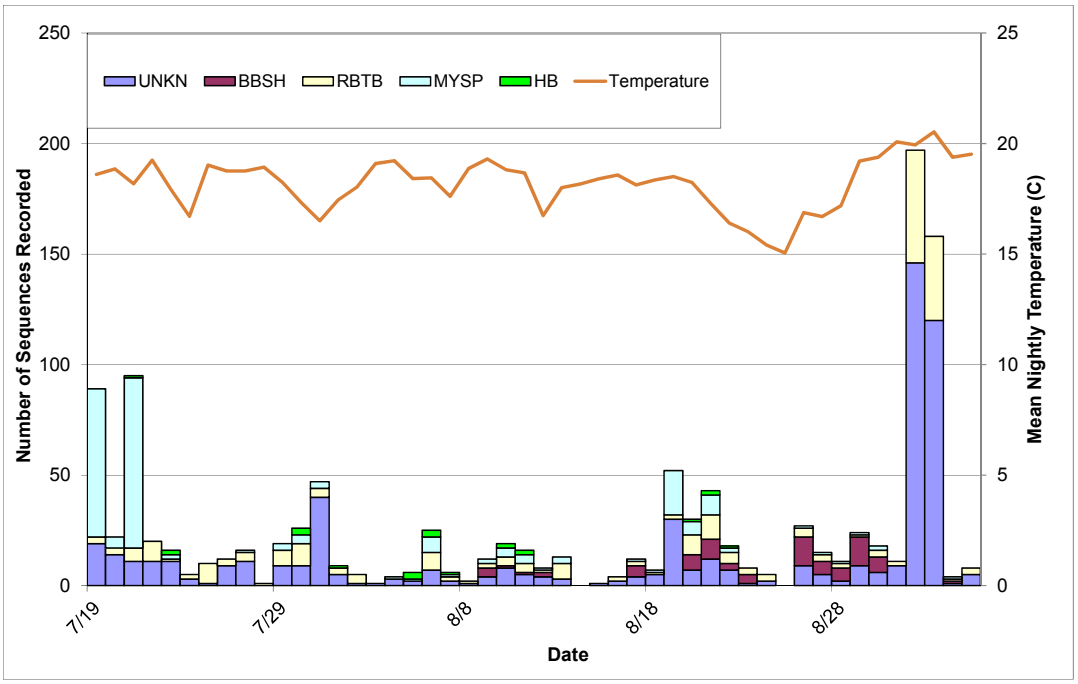

Figure 3-5. Nightly acoustic bat activity by guild and temperature at Monhegan Island. UNKN = unknown species, BBSH = big brown/silver-haired bat, RBTB = eastern red bat/tri-colored bat, MYSP = *Myotis* species, and HB = hoary bat.

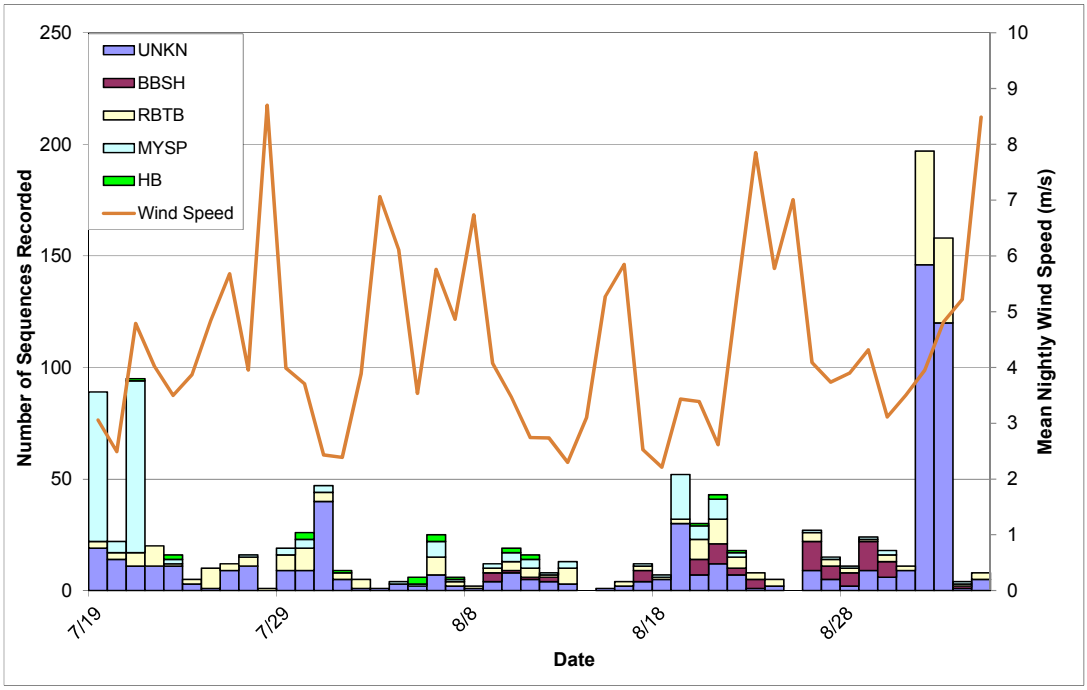

Figure 3-6. 2010 Nightly acoustic bat activity by guild and wind speed at Monhegan Island. UNKN = unknown species, BBSH = big brown/silver-haired bat, RBTB = eastern red bat/tri-colored bat, MYSP = *Myotis* species, and HB = hoary bat.

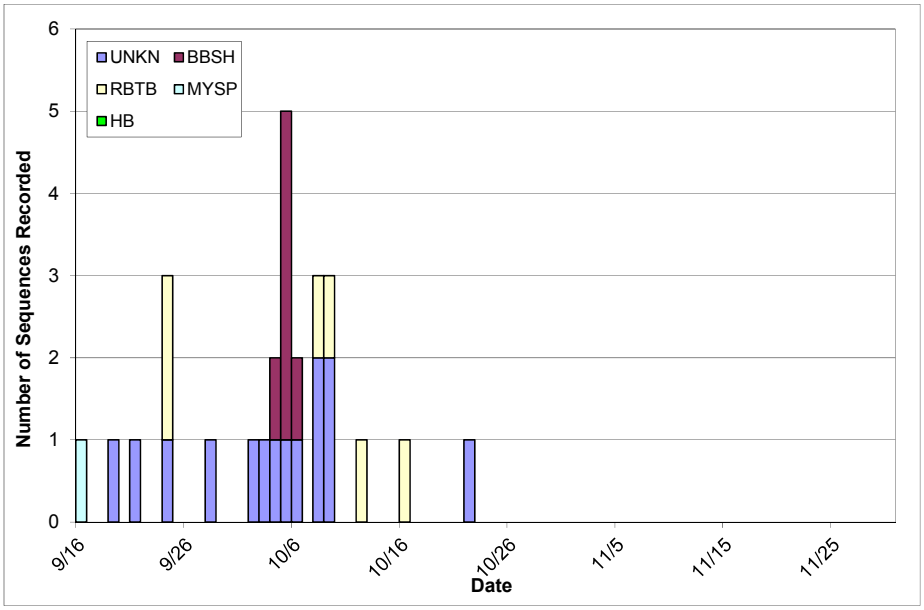

Figure 3-7. 2009 Nightly acoustic bat activity by guild and wind speed at Monhegan Island. UNKN = unknown species, BBSH = big brown/silver-haired bat, RBTB = eastern red bat/tri-colored bat, MYSP = *Myotis* species, and HB = hoary bat.

On a monthly basis, activity levels were highest in September during 2010 and 2011 sampling, although surveys occurred for only 4 nights in September, 2010 (Table 3-1). Among the three survey years, overall activity levels were highest in 2010, although the survey period spanned different dates among the three years, complicating overall comparison of results. Considering 2009-2011 results together, a monthly comparison of results suggests somewhat consistently high activity levels in July and August, a slight increase during September, and a sharp decline in activity after September, with only intermittent activity occurring in October and November. This general pattern of bat activity is similar to other offshore observations within the Gulf of Maine to date (Pelletier *et al.* 2011).

Table 3-1. Monthly activity levels during 2009, 2010, and 2011 acoustic bat surveys at the Monhegan Island Lighthouse

Year	Month	Dates	Detector-Nights*	Recorded Sequences	Detection Rate **	Maximum Sequences recorded ***
2009	September	September 16-30	15	7	0.5	3
	October	October 1-31	31	20	0.6	5
	November	November 1-30	30	0	0.0	0
	Total		***76***	***27***	***0.4***	**--**
2010	July	July 19-31	13	378	29.1	95
	August	August 1-31	31	412	13.3	52
	September	September 1-4	4	367	91.8	197
	Total		***48***	***1157***	***24.1***	**--**
2011	August	August 12-31	20	444	22.2	133
	September	September 1-30	30	981	32.7	240
	October	October 1-31	31	23	0.7	7
	November	November 1-30	30	3	0.1	1
	Total		***111***	***1451***	***13.1***	--

* One detector-night is equal to a one detector successfully operating throughout the night.

** Number of bat echolocation sequences recorded per detector-night.

*** Maximum number of bat passes recorded from any single detector for a detector-night.

Acoustic activity measured at the Monhegan Island lighthouse in 2011 and 2010 was related to wind speed and temperature patterns documented at buoy E01 on a coarse scale. Nightly activity levels showed a weak positive correlation with nightly mean temperature and a weak negative correlation with mean nightly wind speed as measured at buoy E01 (Figures 3-8 and 3-9). Qualitative comparison of nightly wind speed and bat activity demonstrate a relationship between extreme weather events such as the high winds associated with tropical storm Irene on August 28, 2011 and bat activity. By contrast, a spike in bat activity occurred on the night of September 24, 2011, when mean nightly wind speeds were considerably lesser than surrounding nights (Figure 3-4).

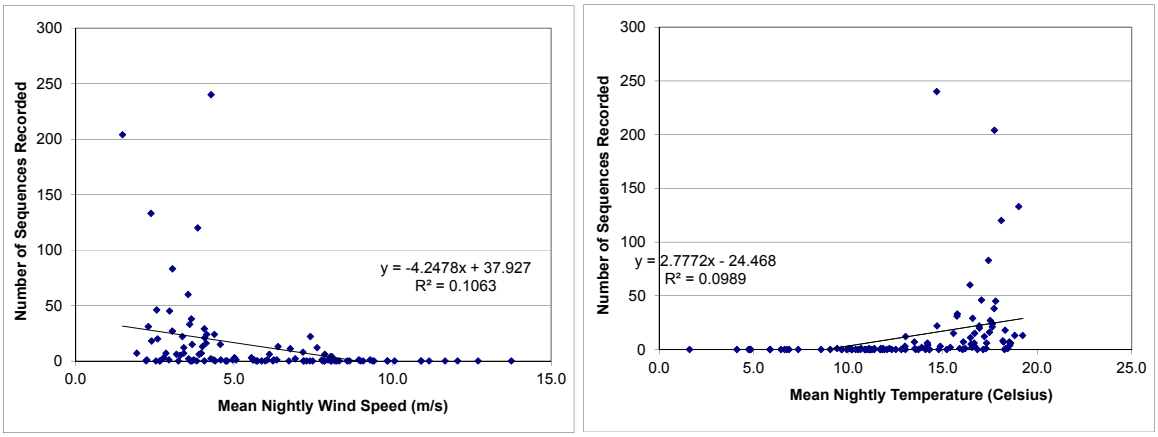

Figure 3-8. Nightly acoustic bat activity at Monhegan Island in 2011 versus nightly mean wind speed (left) and temperature (right) measured at buoy E01

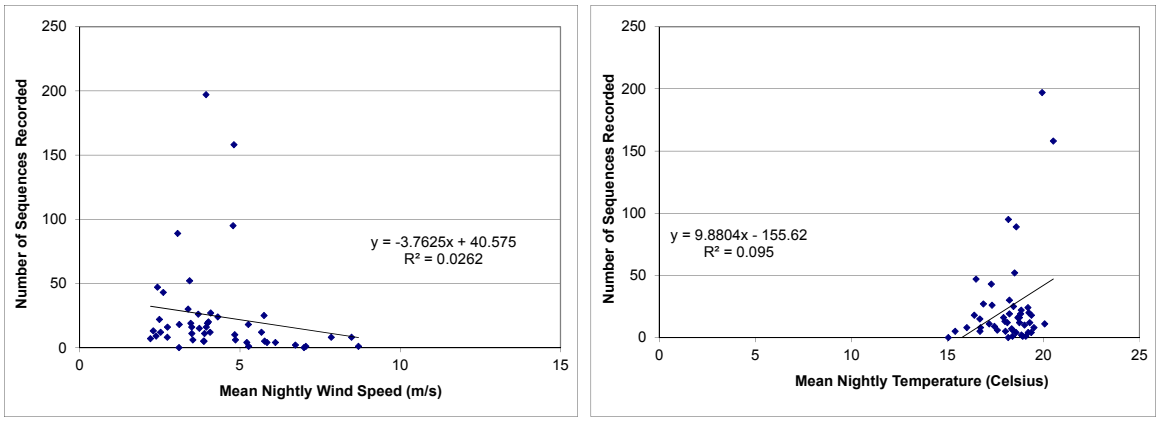

Figure 3-9. Nightly acoustic bat activity at Monhegan Island in 2010 versus nightly mean wind speed (left) and temperature (right) measured at buoy E01

Of the 1,451 bat call sequences recorded during 2011 acoustic surveys at Monhegan Island, 696 (48%) were identified to species/guild. The most commonly identified guild was the eastern red bat/tri-colored bat (RBTB), comprising 360 call sequences, or 52 percent of identified sequences (Figure 3-10). Of these, 142 were identified as eastern red bats and 218 could not reliably be distinguished between the two species. No call sequences were identified as tri-colored bats. The *Myotis* (MYSP) guild was the next most commonly identified, comprising 317 (46%) of the identified sequences. The big brown/silver-haired (BBSH) guild comprised 2 percent of identified sequences, with 8 sequences identified as silver-haired bats, 0 identified as big brown bats, and 4 indistinguishable between the two species. Lastly, 7 call sequences (1% of identified sequences) were identified as hoary bats. Of the 755 sequences (52%) which could not be identified due to poor quality or having fewer than 5 pulses, 724 sequences (96%) were categorized as high frequency (HFUN) unknown and 31 sequences (4%) were categorized as low frequency (LFUN) unknown (Figure 3-10).

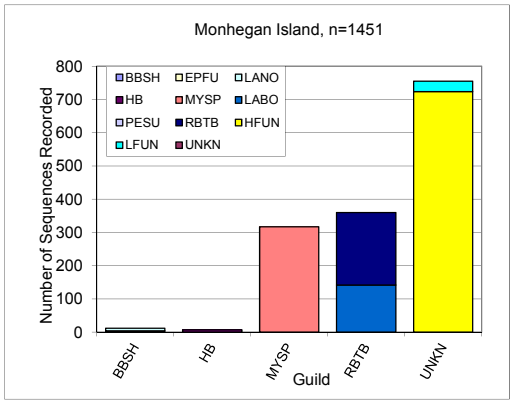

Figure 3-10. Species/guild composition of bats during 2011 surveys at Monhegan Island. BBSH = big brown/silver-haired bat, EPFU = big brown bat, LANO = silver-haired bat, HB = hoary bat, MYSP = *Myotis* species, LABO = eastern red bat, PESU = tri-colored bat, RBTB = eastern red bat/tri-colored bat, HFUN = high-frequency unknown, LFUN = low-frequency unknown, and UNKN = unknown

Species composition of bats recorded in 2010 surveys at Monhegan Island was similar to 2011, with the RBTB guild being the most commonly identified, but only slightly higher than the MYSP guild (Figure 3-11). In 2010, 580 call sequences out of the 1,157 recorded (50%) were identifiable to species/guild and the remaining call sequences were classified as either HFUN or LFUN due to lack of a sufficient number of pulses or sufficient quality for identification. Of these calls, 546 (95%) were classified as HFUN and 31 (5%) were classified as LFUN. Of the 27 call sequences recorded in 2009, 13 (48%) were identified to guild/species, with 6 sequences identified to each of the BBSH and RBTB guilds, and one call sequence identified to the MYSP guild. Of the remaining "unknown" call sequences, twelve (86%) were classified as HFUN and 2 (14%) were classified as LFUN.

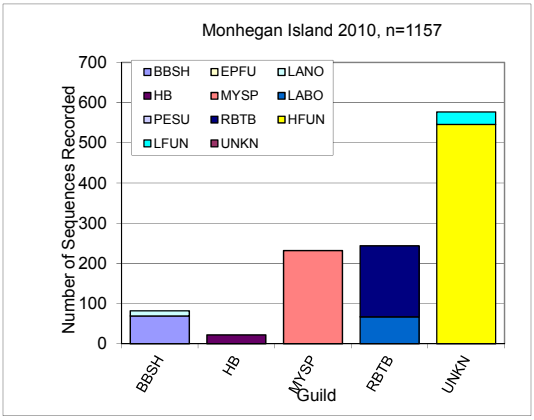

Figure 3-11. Species/guild composition of bats during 2010 surveys at Monhegan Island. BBSH = big brown/silver-haired bat, EPFU = big brown bat, LANO = silver-haired bat, HB = hoary bat, MYSP = *Myotis* species, LABO = eastern red bat, PESU = tri-colored bat, RBTB = eastern red bat/tri-colored bat, HFUN = high-frequency unknown, LFUN = low-frequency unknown, and UNKN = unknown

Bat activity was detected during every hour between sunset and 10 hours past sunset in 2010 and between sunset and 11 hours past sunset in 2011, with the difference between years likely the result of the longer nights surveyed in October, 2011 (Figure 3-12). Year 2010 data showed a peak in overall activity 4 hours past sunset, whereas timing was variable between 1 and 9 hours past sunset in 2011. Call timing fluctuated considerably among survey nights during both 2010 and 2011 surveys. Call timing was not summarized in 2009 due to the small number of recorded call sequences.

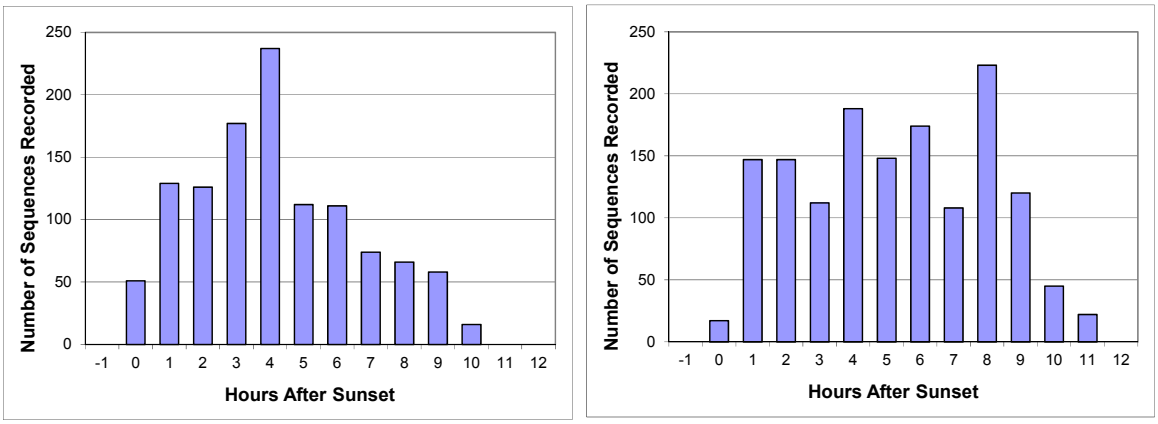

Figure 3-12. Overall timing of bat activity by hour past sunset in 2010 (left), and 2011 (right).

4.0 Discussion

Acoustic surveys conducted at the Monhegan Island lighthouse in 2011, 2010, and 2009 provide the first systematic survey of bat activity patterns on the island and help characterize overall trends in bat activity on the island during the late summer and fall. Although the three seasons of surveys spanned differing lengths of fall time periods, the 2011 monitoring results suggest that bats are most active near the Monhegan lighthouse in September. Activity levels were highly variable among survey nights, although bats were detected consistently on most surveyed nights in July, August, and September. After the end of September, activity levels dropped dramatically, with bats detected only sporadically during October and November. This may suggest that few if any bats overwinter on Monhegan Island, although the surveys represent only one location on the island and a larger-scale roving survey would be required to assess whether any bats remain active on the island in late fall.

The two most commonly identified species groups in 2011 and 2010 were the RBTB and MYSP guilds. Although calls can be difficult to distinguish between eastern red bats and tri-colored bats, the two species comprising the RBTB guild, the lack of any calls identified as tri-colored bats in 2010 or 2011 suggests that eastern red bats comprised most if not all of the activity within the guild. Within the MYSP guild, there is considerable overlap in call characteristics among species. However, qualitative analysis suggests that the majority of call sequences within the guild were more similar to little brown bats than the other two *Myotis* species potentially present on the island (northern long-eared bat and eastern small-footed bat). If present, northern long-eared bats would likely be more active in forested habitats on Monhegan Island than the lighthouse, as the species is considered a sub-canopy forager (LaVal *et al.* 1977).

Based on acoustic survey results, eastern red bats and *Myotis* species (likely little-brown bats) appeared to be residents on Monhegan Island, as they were detected on most surveyed nights in July through September. Whereas *Myotis* species are not considered long-distance migrants and are known to hibernate in various locations in the state, eastern red-bats migrate long distances to the south during the winter. Similarly, silver-haired bats and hoary bats, which were detected in low numbers on Monhegan Island,

are long-distance migrants, although these species were detected sporadically and are more likely to have been stopping over at Monhegan Island during migration rather than residents, according to acoustic survey results.

Interestingly, no big brown bats were identified during acoustic surveys on Monhegan Island in 2009, 2010, or 2011. Although many call sequences were categorized as BBSH (either big brown or silver-haired) due to similarity of calls between these species, no call sequences were determined to be big brown bats, whereas a number of calls were classified as silver-haired bats, suggesting that most if not all calls were likely silver-haired bats. Big brown bats are common in Maine, and particularly in developed areas, where they can often be found roosting and overwintering in old buildings. If present on Monhegan Island, the species would likely have been detected at some level during acoustic surveys.

Although acoustic bat surveys are commonly used to assess species composition, not all species are equally detectable acoustically, and quiet species that typically forage in closed canopies may be underrepresented in the survey results (Hayes 2000; Gannon *et al.* 2003). Also, the number of bat calls does not necessarily indicate the number of bats in the area and should not be considered proportional to bat population size (Hayes 2000). Because acoustic surveys took place at a fixed location during each survey season, results should not be considered representative of bat species composition, distribution, and activity patterns for the entire island. Bat species are adapted to fly and forage in different types of habitat and are therefore not equally likely to be present at the lighthouse, which is located in relatively exposed, developed habitat on a high point of the island.

In addition to surveys on Monhegan Island, Stantec has conducted acoustic bat surveys at a total of 16 offshore locations in the Gulf of Maine during the 2009 through 2011 period. Sites have ranged from large, forested islands such as Monhegan, to small, rocky outcrops lacking any permanent vegetation, such as Mount Desert Rock, Matinicus Rock, and Halfway Rock. This survey effort has provided an unprecedented opportunity to assess larger-scale patterns in bat activity offshore and to contextualize the results of each surveyed site. Although variable throughout the seasons surveyed, bat activity patterns on Monhegan Island were relatively consistent among nights as compared to patterns documented on smaller, more remote islands. Given the size of Monhegan Island and the extent of suitable foraging and roosting habitat, as well as acoustic survey results, the Island appears to support a seasonal population of several bat species. By contrast, offshore sites lacking suitable habitat appear to serve as stopover roosting/foraging sites during migration, as evidenced by more sporadic acoustic activity (Stantec, unpublished data).

Species composition has varied considerably among offshore sites surveyed in 2009 through 2011, although the absence or very low activity levels of big brown bats and tri-colored bats has been noted at most offshore sites Stantec has surveyed, despite the presence of suitable foraging and roosting habitat. Also, an abundance of eastern red bat activity has been noted at many of the offshore sites included in the regional survey. Activity patterns of silver-haired and hoary bats have been sporadic among surveyed sites, although have consistently been most frequently recorded in early September across all surveyed sites, suggesting a large-scale movement of the species through the region during this period.

Overall, acoustic surveys on Monhegan Island suggest that eastern red bats and *Myotis* species, likely dominated by the little brown bat, are the most active species in the vicinity of the lighthouse and are likely residents of the island throughout the summer. The fact that activity levels appear highest in September may also suggest the seasonal influx of migratory species including eastern red bats, hoary bats, and silver-haired bats moving through the region and using islands as stopover sites for roosting and foraging. The sharp decline in activity after September on Monhegan Island suggests that few bats remain on the island throughout the winter, or that bats may move to less exposed habitats on the island as weather becomes more severe.

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Appendix A
Bat Data Tables – 2011, 2010, and 2009

Appendix A Table 1. Summary of acoustic bat data and weather during each survey night at the Monhegan Island lighthouse – Fall, 2011

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
08/12/11	1					2	10		5	29			**46**	2.6	17.1
08/13/11	1					1	1		1	8	1		**12**	3.4	17.2
08/14/11	1						2			4			**6**	3.2	16.7
08/15/11	1												**0**	9.0	15.2
08/16/11	1						11		2	19	1		**33**	3.6	15.8
08/17/11	1			1			2			2			**5**	3.3	16.5
08/18/11	1						3		1	2			**6**	6.1	17.3
08/19/11	1					9				15			**24**	4.4	17.6
08/20/11	1					11	1			9			**21**	4.1	17.6
08/21/11	1					2	1			3			**6**	7.9	18.6
08/22/11	1					9	9		3	17			**38**	3.7	17.7
08/23/11	1					1	4		1	18			**24**	4.1	17.6
08/24/11	1									1			**1**	8.0	18.3
08/25/11	1					2				11			**13**	6.4	18.8
08/26/11	1					22	1			108	2		**133**	2.4	19.0
08/27/11	1						3		1	9			**13**	4.0	19.2
08/28/11	1												**0**	13.7	18.3
08/29/11	1				3	8	1			13	4		**29**	4.1	16.6
08/30/11	1			1			2			11	2		**16**	4.1	17.5
08/31/11	1			1		5				10	2		**18**	2.4	18.3
09/01/11	1				1	16	2		2	39			**60**	3.5	16.4
09/02/11	1					3	5		1	5	1		**15**	3.7	16.7
09/03/11	1				1	5			3	18			**27**	3.1	17.5
09/04/11	1								1				**1**	7.8	18.5
09/05/11	1					2				6			**8**	7.2	18.2
09/06/11	1			1		7				14			**22**	3.4	16.9
09/07/11	1									4			**4**	8.0	14.2
09/08/11	1					6	5		5	15			**31**	2.3	15.8
09/09/11	1	4		2	1	14	14		46	35	4		**120**	3.9	18.1
09/10/11	1					1			3	2	1		**7**	1.9	16.1
09/11/11	1						1		6	4			**11**	6.8	16.5
09/12/11	1			1		1	10		35	35	1		**83**	3.1	17.4
09/13/11	1								1	3			**4**	8.1	18.6
09/14/11	1						7		11	27			**45**	3.0	17.8
09/15/11	1					3	2		4	9	4		**22**	7.4	14.7
09/16/11	1			1	1		1		2	7			**12**	7.6	13.0
09/17/11	1					6	16		61	155	2		**240**	4.3	14.7
09/18/11	1					1	1			4			**6**	3.9	14.2
09/19/11	1									3			**3**	5.0	14.9
09/20/11	1						1		4	10			**15**	4.6	15.6
09/21/11	1									2			**2**	3.6	16.6
09/22/11	1						2			1			**3**	2.8	16.7
09/23/11	1						8		4	8			**20**	2.6	17.0
09/24/11	1					171	13		6	14			**204**	1.5	17.7
09/25/11	1					4	1		1	1			**7**	2.9	18.2
09/26/11	1					1			3	3			**7**	3.4	18.5
09/27/11	1												**0**	4.8	17.1
09/28/11	1						1						**1**	6.3	16.2
09/29/11	1												**0**	8.6	16.8
09/30/11	1					1							**1**	5.6	17.3
10/01/11	1									1			**1**	8.9	14.1
10/02/11	1												**0**	8.2	13.6
10/03/11	1					2				2	3		**7**	4.0	13.5
10/04/11	1												**0**	9.8	13.0
10/05/11	1										1		**1**	9.3	10.7
10/06/11	1												**0**	7.3	9.7
10/07/11	1								1				**1**	6	12
10/08/11	1					1			1				**2**	4	15
10/09/11	1									1			**1**	4	16
10/10/11	1												**0**	4	16
10/11/11	1												**0**	3	13
10/12/11	1									1			**1**	6	13
10/13/11	1												**0**	6	14
10/14/11	1												**0**	8	15
10/15/11	1												**0**	11	14
10/16/11	1												**0**	8	14
10/17/11	1									1	1		**2**	7	14
10/18/11	1										1		**1**	4	14
10/19/11	1												**0**	12	13
10/20/11	1												**0**	10	14
10/21/11	1								1	2			**3**	6	13
10/22/11	1									1			**1**	5	12
10/23/11	1									1			**1**	5	12
10/24/11	1												**0**	6	12
10/25/11	1												**0**	9	11
10/26/11	1								1				**1**	6	9
10/27/11	1												**0**	8	5
10/28/11	1												**0**	8	7
10/29/11	1												**0**	12	5
10/30/11	1												**0**	9	7
10/31/11	1												**0**	5	10
11/01/11	1												**0**	2	9
11/02/11	1												**0**	6	10
11/03/11	1												**0**	7	11
11/04/11	1												**0**	10	6
11/05/11	1												**0**	4	9
11/06/11	1												**0**	8	11
11/07/11	1									1			**1**	5	11
11/08/11	1												**0**	3	11
11/09/11	1												**0**	5	12
11/10/11	1												**0**	7	12
11/11/11	1												**0**	11	7
11/12/11	1												**0**	9	10
11/13/11	1												**0**	8	12
11/14/11	1												**0**	8	12
11/15/11	1								1				**1**	2	11
11/16/11	1												**0**	4	11
11/17/11	1												**0**	7	6
11/18/11	1												**0**	9	7
11/19/11	1												**0**	11	10
11/20/11	1												**0**	7	11
11/21/11	1												**0**	3	4
11/22/11	1												**0**	4	6
11/23/11	1												**0**	13	2
11/24/11	1												**0**	4	5
11/25/11	1												**0**	6	10
11/26/11	1						1						**1**	3	10
11/27/11	1												**0**	7	11
11/28/11	1												**0**	6	11
11/29/11	1												**0**	3	11
11/30/11	1												**0**		
By Species		**4**	**0**	**8**	**7**	**317**	**142**	**0**	**218**	**724**	**31**	**0**	**1451**		
By Guild		**12**			**7**	**317**	**360**			**755**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix A Table 2. Summary of acoustic bat data and weather during each survey night at the Monhegan Island lighthouse – Fall, 2010

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
07/19/10	1					67	1		2	19			**89**	3.1	18.6
07/20/10	1					5			3	14			**22**	2.5	18.9
07/21/10	1				1	77	2		4	11			**95**	4.8	18.2
07/22/10	1						1		8	10	1		**20**	4.0	19.2
07/23/10	1				2	2			1	11			**16**	3.5	17.9
07/24/10	1						1		1	3			**5**	3.9	16.7
07/25/10	1								9	1			**10**	4.8	19.0
07/26/10	1						1		2	9			**12**	5.7	18.8
07/27/10	1					1			4	11			**16**	4.0	18.8
07/28/10	1								1				**1**	8.7	18.9
07/29/10	1					3	3		4	8	1		**19**	4.0	18.2
07/30/10	1				3	4	6		4	9			**26**	3.7	17.3
07/31/10	1					3	1		3	38	2		**47**	2.4	16.5
08/01/10	1				1		2		1	4	1		**9**	2.4	17.5
08/02/10	1						1		3	1			**5**	3.9	18.0
08/03/10	1									1			**1**	7.1	19.1
08/04/10	1					1				3			**4**	6.1	19.2
08/05/10	1				3	1				2			**6**	3.5	18.4
08/06/10	1				3	7	5		3	6	1		**25**	5.8	18.4
08/07/10	1				1	1			2	2			**6**	4.9	17.6
08/08/10	1								1	1			**2**	6.7	18.9
08/09/10	1	4				2	1		1	4			**12**	4.1	19.3
08/10/10	1	1			2	4	1		3	7	1		**19**	3.5	18.8
08/11/10	1			1	2	4			4	3	2		**16**	2.7	18.7
08/12/10	1	1		1		1	1			3	1		**8**	2.7	16.7
08/13/10	1					3			7	3			**13**	2.3	18.0
08/14/10	1												**0**	3.1	18.2
08/15/10	1									1			**1**	5.3	18.4
08/16/10	1								2	2			**4**	5.8	18.6
08/17/10	1	5				1	1		1	4			**12**	2.5	18.1
08/18/10	1					1	1			5			**7**	2.2	18.4
08/19/10	1					20	1		1	30			**52**	3.4	18.5
08/20/10	1	7			1	6	1		8	6	1		**30**	3.4	18.2
08/21/10	1	5		4	2	9	8		3	8	4		**43**	2.6	17.3
08/22/10	1			3	1	2	5			4	3		**18**	5.3	16.4
08/23/10	1	4					2		1	1			**8**	7.9	16.0
08/24/10	1						2		1	2			**5**	5.8	15.4
08/25/10	1												**0**	7.0	15.1
08/26/10	1	11		2		1			4	7	2		**27**	4.1	16.9
08/27/10	1	5		1		1	1		2	2	3		**15**	3.7	16.7
08/28/10	1	6				1			2	2			**11**	3.9	17.2
08/29/10	1	13				1			1	5	4		**24**	4.3	19.2
08/30/10	1	7				2			3	5	1		**18**	3.1	19.4
08/31/10	1								2	8	1		**11**	3.5	20.1
09/01/10	1						10		41	145	1		**197**	3.9	19.9
09/02/10	1						6		32	120			**158**	4.8	20.5
09/03/10	1			1		1			1	1			**4**	5.2	19.4
09/04/10	1						2		1	4	1		**8**	8.5	19.5
By Species		**69**	**0**	**13**	**22**	**232**	**67**	**0**	**177**	**546**	**31**	**0**	**1157**		
By Guild		**82**			**22**	**232**	**244**			**577**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night

Appendix A Table 3. Summary of acoustic bat data and weather during each survey night at the Monhegan Island lighthouse – Fall, 2009

		BBSH			HB	MYSP	RBTB			UNKN					
Night of	Operational?	BBSH	Big brown	Silver-haired	Hoary	MYSP	Eastern red	Tri-colored	RBTB	HFUN	LFUN	UNKN	Total	Wind Speed (m/s)	Temperature (celsius)
09/16/09	1					1							**1**	12.5	5.8
09/17/09	1												**0**	13.2	4.5
09/18/09	1												**0**	14.3	8.3
09/19/09	1									1			**1**	13.8	5.2
09/20/09	1												**0**	14.2	3.4
09/21/09	1									1			**1**	14.3	1.9
09/22/09	1												**0**	15.6	6.3
09/23/09	1												**0**	16.7	7.7
09/24/09	1						1		1	1			**3**	15.7	2.9
09/25/09	1												**0**	11.6	7.2
09/26/09	1												**0**	12.6	7.3
09/27/09	1												**0**	14.8	8.4
09/28/09	1									1			**1**	15.1	5.8
09/29/09	1												**0**	15.1	7.4
09/30/09	1												**0**	11.4	6.3
10/01/09	1												**0**	10.8	3.7
10/02/09	1									1			**1**	12.0	4.5
10/03/09	1									1			**1**	13.7	6.5
10/04/09	1			1						1			**2**	13.8	2.6
10/05/09	1	2		2							1		**5**	13.5	5.8
10/06/09	1			1						1			**2**	13.8	3.9
10/07/09	1												**0**	13.0	9.2
10/08/09	1						1			1	1		**3**	12.6	5.1
10/09/09	1								1	2			**3**	12.9	5.6
10/10/09	1												**0**	11.3	7.1
10/11/09	1												**0**	10.6	9.0
10/12/09	1								1				**1**	10.6	7.1
10/13/09	1												**0**	6.4	9.3
10/14/09	1												**0**	6.0	7.5
10/15/09	1												**0**	5.9	6.8
10/16/09	1						1						**1**	7.4	8.4
10/17/09	1												**0**	8.5	7.1
10/18/09	1												**0**	5.3	11.7
10/19/09	1												**0**	10.0	2.6
10/20/09	1												**0**	10.8	3.4
10/21/09	1												**0**	10.5	4.3
10/22/09	1									1			**1**	7.3	8.0
10/23/09	1												**0**	6.9	5.6
10/24/09	1												**0**	13.1	9.4
10/25/09	1												**0**	10.8	5.8
10/26/09	1												**0**	9.6	5.1
10/27/09	1												**0**	9.6	5.9
10/28/09	1												**0**	8.0	9.9
10/29/09	1												**0**	8.5	2.6
10/30/09	1												**0**	10.1	7.7
10/31/09	1												**0**	12.7	8.3
11/01/09	1												**0**	10.2	6.2
11/02/09	1												**0**	8.4	6.5
11/03/09	1												**0**	8.7	7.4
11/04/09	1												**0**	7.0	5.5
11/05/09	1												**0**	5.5	6.1
11/06/09	1												**0**	5.0	8.0
11/07/09	1												**0**	8.1	8.1
11/08/09	1												**0**	10.8	3.4
11/09/09	1												**0**	12.0	8.2
11/10/09	1												**0**	10.4	3.8
11/11/09	1												**0**	8.9	3.8
11/12/09	1												**0**	8.3	5.5
11/13/09	1												**0**	9.7	8.3
11/14/09	1												**0**	11.8	8.9
11/15/09	1												**0**	10.4	2.3
11/16/09	1												**0**	8.1	7.7
11/17/09	1												**0**	7.5	3.3
11/18/09	1												**0**	8.8	7.0
11/19/09	1												**0**	10.2	3.8
11/20/09	1												**0**	10.8	9.6
11/21/09	1												**0**	9.4	4.8
11/22/09	1												**0**	6.8	5.7
11/23/09	1												**0**	8.1	7.3
11/24/09	1												**0**	8.2	7.4
11/25/09	1												**0**	7.9	3.3
11/26/09	1												**0**	8.2	4.2
11/27/09	1												**0**	6.3	10.5
11/28/09	1												**0**	7.0	10.7
11/29/09	1												**0**	9.2	4.7
11/30/09	1												**0**	5.4	8.1
By Species		**2**	**0**	**4**	**0**	**1**	**3**	**0**	**3**	**12**	**2**	**0**	**27**		
By Guild		**6**			**0**	**1**	**6**			**14**					
		BBSH			**HB**	**MYSP**	**RBTB**			**UNKN**			**Total**		

* 1 = Detector functioned for then entire night; 0 = Non-operational for all or part of the night