VESSEL-BASED ACOUSTIC BAT MONITORING

Block Island Wind Farm
Rhode Island

Prepared for:
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1.0 INTRODUCTION

Stantec Consulting Services Inc. (Stantec) conducted vessel-based acoustic bat monitoring for Deepwater Wind Block Island, LLC (Deepwater) at the Block Island Wind Farm (BIWF) during erection of the wind turbine generators (WTGs). The BIWF, which is America's first offshore wind farm, is located approximately 3 miles off the coast of Block Island, Rhode Island (Figure 1), BIWF includes five, 6 MW WTGs, along with submarine Inter-Array and Export cables which connect the BIWF to a substation on Block Island. The foundations were installed in 2015. WTG erection occurred from 2 – 18 August 2016 (Figure 2).

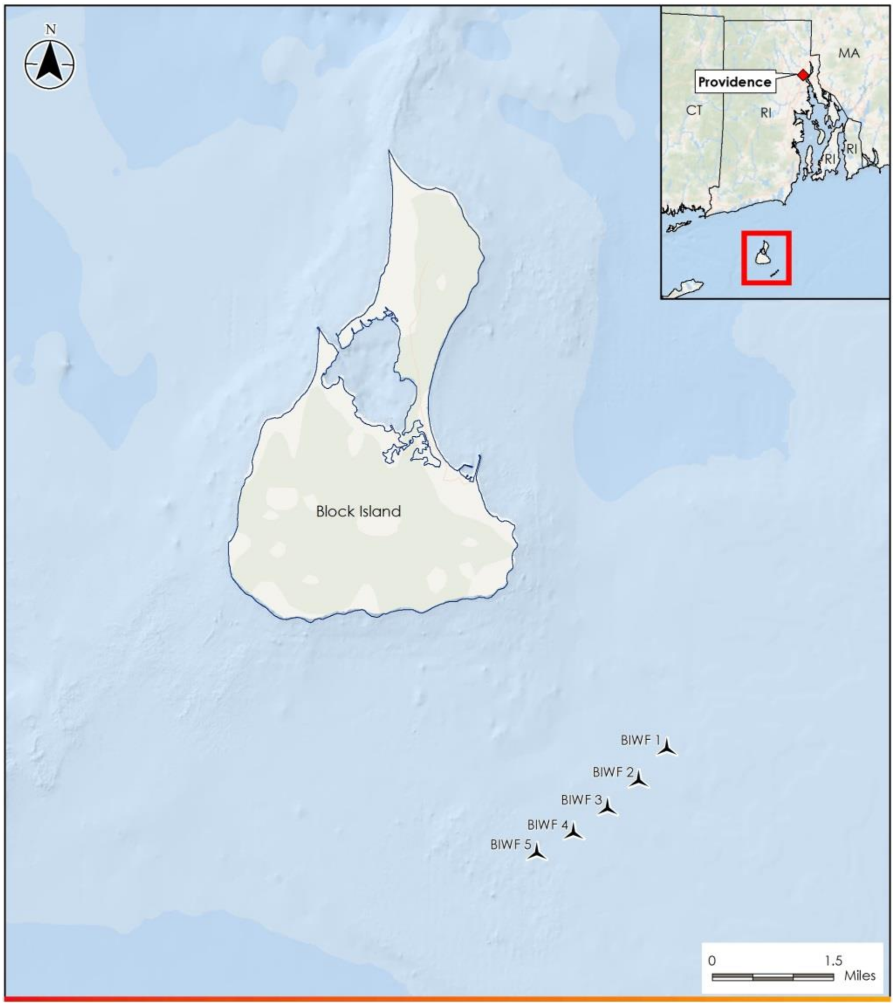

Figure 1. Block Island Wind Farm, Rhode Island.

Figure 2. (L) Photo of a foundation base prior to WTG erection. (R) Photo of L/B Paul with tower section and blades.

The vessel-based surveys were conducted in accordance with the agency approved Construction and Post-Construction Avian and Bat Monitoring Plan (Revised April 2015; Tetra Tech 2015) and followed methods outlined in a Stantec memo dated [redacted] [redacted] as described below. Acoustic surveys were designed to simultaneously monitor bat activity on 2 of the two large barges used for the erection of the WTGs. Bat activity was monitored aboard the Brave Tern (Figure 3), a 433-foot jack-up vessel that remained offshore at BIWF throughout the WTG erection period, and the Lift Boat (L/B) Caitlin (Caitlin; Figure 4), a 137-foot jack-up vessel that provided support for the Brave Tern and traveled back and forth between BIWF and Port of Providence, Rhode Island.

An additional goal of the surveys was to document the potential effect of vessel lighting on bat activity during WTG erection. This report summarizes methods and results of the acoustic bat survey, comparing results to pre-construction data and regional acoustic monitoring where appropriate.

Figure 3. Acoustic detector locations (highlighted in magenta circles) on the Brave Tern.

Figure 4. Acoustic detector locations (highlighted in red circles) on the L/B Caitlin.

2.0 METHODS

2.1 FIELD SURVEY

Stantec deployed 2 ultrasonic acoustic bat detectors on each vessel on 2 August 2016 (prior to the start of WTG erection), mounting detectors such that microphones were oriented horizontally, facing into the open airspace adjacent each vessel (Figure 5). Stantec used full spectrum acoustic bat detectors (Wildlife Acoustics™ SM4BAT), each equipped with a SMM-U1 ultrasonic omnidirectional microphone and programmed each detector to operate from 30 minutes before sunset until 30 minutes after sunrise in "triggered .wav" mode using default trigger threshold settings as recommended by the manufacturer. Deepwater personnel removed the detectors after the night of 17 August, following erection of all 5 WTGs.

Figure 5. Acoustic bat detector deployed on the railing of the crane pad on the Brave Tern.

Stantec obtained weather data from an automated weather station on Block Island (KRIBLOCK2), downloading data archived by Weather Underground online. Data were collected at hourly intervals, and summarized nightly (sunset – sunrise). Weather metrics included mean temperature, wind speed, relative humidity, and barometric pressure for each night within the monitoring period.

2.2 DATA ANALYSIS

Stantec downloaded data files from each detector at the conclusion of the monitoring period and inspected detector components (microphone and battery levels) and system status log files to determine whether the detectors were operating properly for the duration of deployment. Stantec converted all recorded call files into zero-crossing format using Kaleidoscope Pro software (version 3.1.7), simultaneously processing all files through an automated identification process within the software (classifier 3.1.0, set to the "-1 More Sensitive" setting and configured for the set of bat species potentially occurring in Rhode Island).

A Stantec biologist experienced in the analysis of acoustic bat signatures visually inspected all recorded call files using Analook 3.7w software (Corben 2009) to determine whether a bat pass had been detected and to determine whether the file was of sufficient quality for identification. The same individual categorized all bat passes with fewer than 5 pulses as either high frequency unknown (HFUN) if the minimum frequency of bat pulses was greater than 30 kilohertz (kHz) or low frequency unknown (LFUN) if the minimum frequency of pulses was less than 30 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. (2011). Guild and species categories used in this report are summarized in Table 1, with guilds accounting for overlap in characteristics of acoustic calls among certain species. A second experienced Stantec biologist performed a visual QAQC of each identified bat pass to confirm the accuracy of the initial categorization. As part of this QAQC process, the second biologist also reviewed all files identified as bats by Kaleidoscope Pro software that were not labeled as bats during visual analysis to determine whether any bat passes had been overlooked during initial analysis.

Table 1. Guilds used in categorizing bat passes recorded at BIWF. Species-specific codes in parentheses were used in cases where calls could be identified to species.

Guild	Potential Species
BBSH	Big brown bat (*Eptesicus fuscus*; EPFU), silver-haired bat (*Lasionycteris noctivagans*; LANO)
LACI	Hoary bat (*Lasiurus cinereus*; LACI)
MYSP	*Myotis* species [little brown bat (*Myotis lucifugus*), northern long-eared bat (*Myotis septentrionalis*), eastern small-footed bat (*Myotis leibii*), Indiana bat (*Myotis sodalis*)]
RBTB	Eastern red bat (*Lasiurus borealis*; LABO), tri-colored bat (*Perimyotis subflavus*; PESU)
UNKN	High-frequency unknown (HFUN), low-frequency unknown (LFUN)

Stantec determined the location of vessels during times when bat activity occurred based on a log of ship movements provided by Deepwater. Although all bat passes were inspected and identified to guild or species, passes detected when vessels were not at BIWF (>15 minutes before a vessel arrived at BIWF or > 15 minutes past a vessels' departure from BIWF) were categorized as outside the project area and not included in bat activity summaries. All recorded bat passes and original data files have been archived electronically and can be made available upon request.

2.3 DATA SUMMARY

Stantec generated nightly summaries of activity by species/guild for each bat detector and analyzed overall species composition, nightly activity by species/guild, nightly timing, and relationship between nightly bat activity and nightly mean weather variables measured at Block Island. We calculated the number of bat passes per detector-night and the percent of nights/hours with activity as overall metrics of the intensity of bat activity comparable to those used in pre-construction acoustic surveys at BIWF and in regional surveys of bat activity offshore (Stantec 2016). Analyses of bat activity were based on results of the visual identification process as opposed to automated analysis using Kaleidoscope Pro software, as we consider visual identification most accurate in terms of discerning bat activity from non-bat static/noise.

3.0 RESULTS

The 4 bat detectors deployed on vessels within the BIWF project area operated for a total of 54 detector-nights from 2 – 17 August, during which time 1,546 bat passes were detected. Detectors worked properly for the duration of the survey period, although the Caitlin was away from BIWF during 5 survey nights. Overall bat detection rates during the survey period (passes/detector night) ranged from 2.4 at the Caitlin Starboard detector to 46.7 at the Brave Tern Cranepad detector, with up to 596 passes recorded during a single night (Table 2). Bats were detected on 7 nights (44%) at the Brave Tern Cranepad detector, 11 nights (69%) at the Brave Tern Helipad detector, 6 nights (55%) at the Caitlin Port detector, and 5 nights (45%) at the Caitlin Starboard detector. Notably, most bat activity at the Brave Tern detectors occurred during the final night of surveys (17 August) (Figure 6). Detectors on the Caitlin also recorded a substantial amount of activity during the night of 17 August (72 passes total) while the vessel was in transit to Providence beyond the BIWF. The Caitlin detectors recorded a total of 2,310 bat passes while outside the BIWF project area, most which presumably occurred while the vessel was in port in Providence. Most of these bat passes (n = 2,143) occurred during the night of 5 August.

Bat detectors operated for a total of 293 hours between sunset and sunrise during the survey period, with bat activity occurring during 98 (33%) of surveyed hours. Although most monitoring occurred between sunset and sunrise, detectors monitored 30 minutes before sunset until 30 minutes past sunrise each night, totaling 54 hours of monitoring in evening or dawn. No bats were detected prior to sunset (the earliest bat passes occurred was ~16 minutes past sunset), although 12 passes were detected up to 24 minutes past sunrise. Timing of bat activity varied among nights, occurring primarily from 2 – 5 hours past sunset at the Caitlin detectors. Overall timing of activity at the Brave Tern detectors was dominated by the final night of monitoring, when most activity occurred 8 – 9 hours past sunset (Figure 7).

Table 2. Summary of survey effort and overall activity levels per detector during vessel-based acoustic bat surveys at Block Island Wind Farm, August 2016.

Detector	Dates Deployed	Calendar Nights	Detector-Nights**	Recorded Sequences	Detection Rate ***	Maximum Sequences recorded ****
Brave Tern Cranepad	2–17 August	16	16	747	46.7	596
Brave Tern Helipad	2–17 August	16	16	732	45.8	411
Caitlin Port*	2–17 August	16	11	41	3.7	21
Caitlin Starboard*	2–17 August	16	11	26	2.4	16
Overall Results		***64***	***54***	***1,546***	***28.6***	--

* The Caitlin was away from BIWF for 5 nights during the survey period. Data recorded offsite were not included in summary.

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

*** Number of bat passes recorded per detector-night.

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

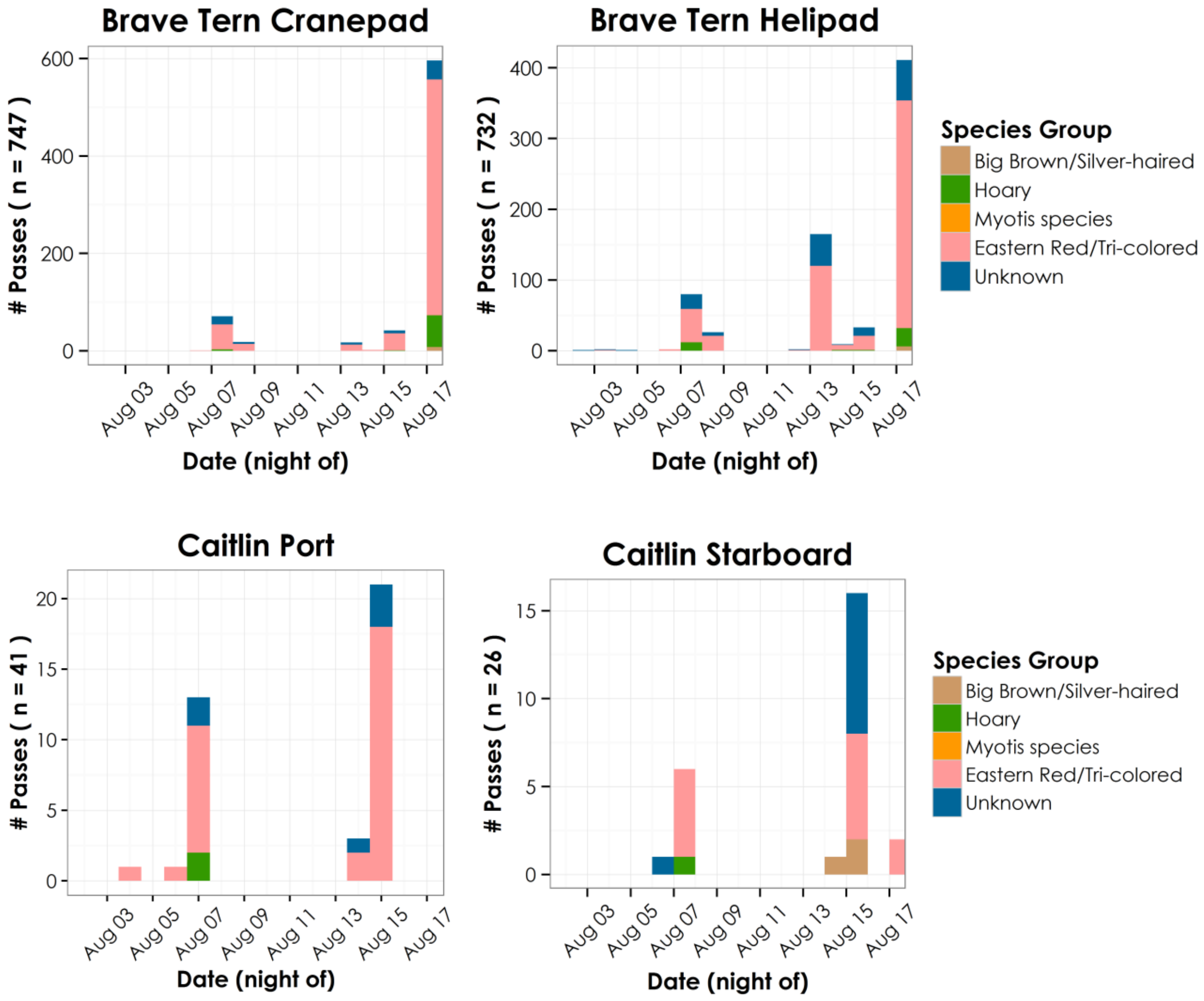

Figure 6. Nightly bat activity by species group detected during vessel-based acoustic bat surveys at the Block Island Wind Farm, August 2016.

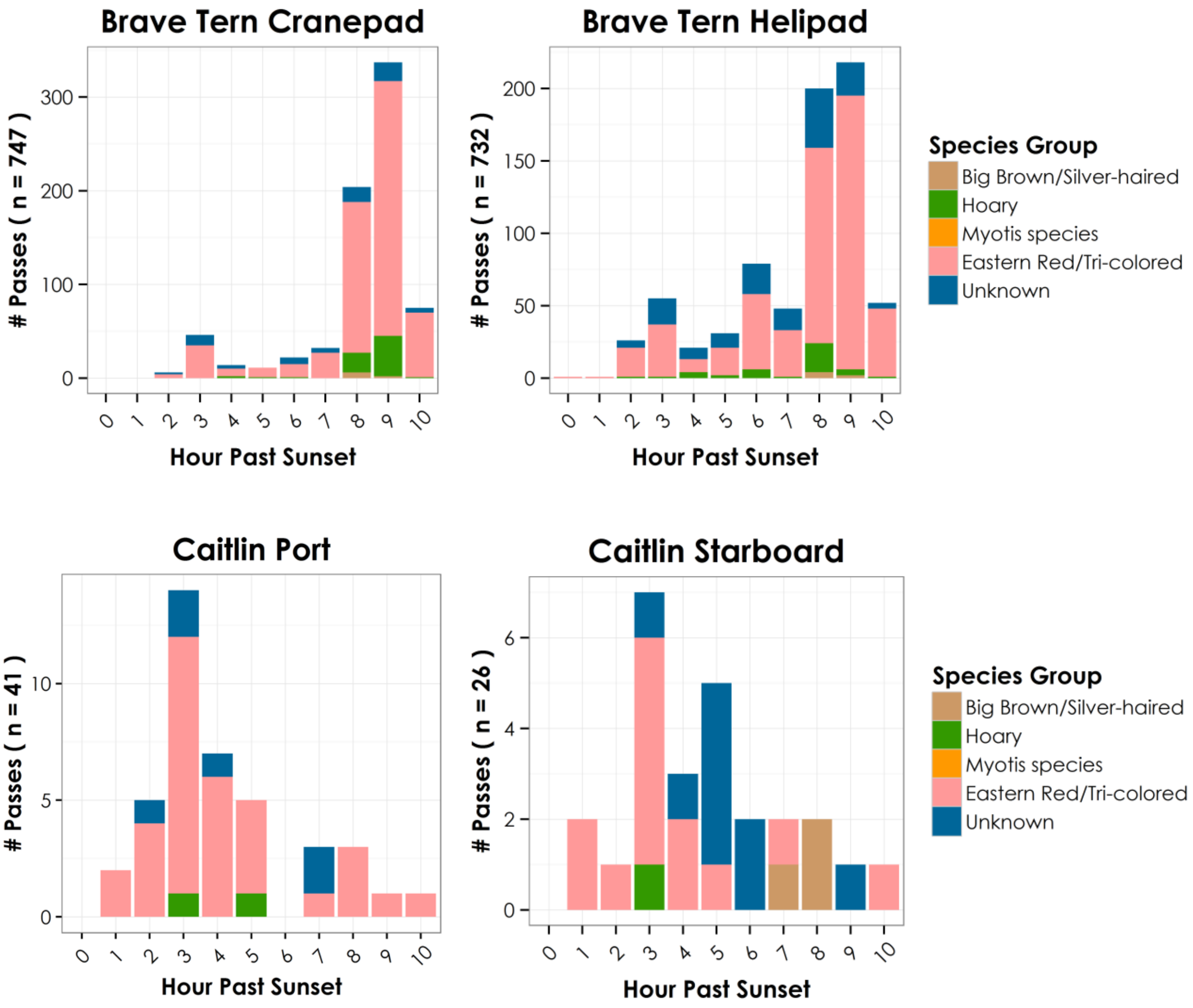

Figure 7. Overall timing of bat activity recorded during vessel-based acoustic bat surveys at the Block Island Wind Farm, August 2016.

Of the 1,546 recorded bat passes, 1,307 (85%) were assigned to a species, 9 (<1%) were assigned to a species group, and 230 (15%) were categorized as high frequency or low frequency unknown based on visual identification (Table 3). Of the 1,307 passes identified to species, eastern red bats accounted for 90% (n = 1,180), hoary bats accounted for 9% (n = 112), and silver-haired accounted for 1% (n = 14). One pass was labeled as a big brown bat and no passes were identified as *Myotis* species [redacted]. Species composition was similar among detectors (Figure 8).

Table 3. Bat activity by species group during vessel-based acoustic bat surveys at Block Island Wind Farm, August 2016.

Detector	Guild					Total
	BBSH	HB	MYSP	RBTB	UNKN	
Brave Tern Cranepad	8	69	0	600	70	747
Brave Tern Helipad	6	40	0	541	145	732
Caitlin Port	0	2	0	33	6	41
Caitlin Starboard	3	1	0	13	9	26
Total	**17**	**112**	**0**	**1,187**	**230**	**1,546**
Guild Composition %	**1.1%**	**7.2%**	**0.0%**	**76.8%**	**14.9%**	

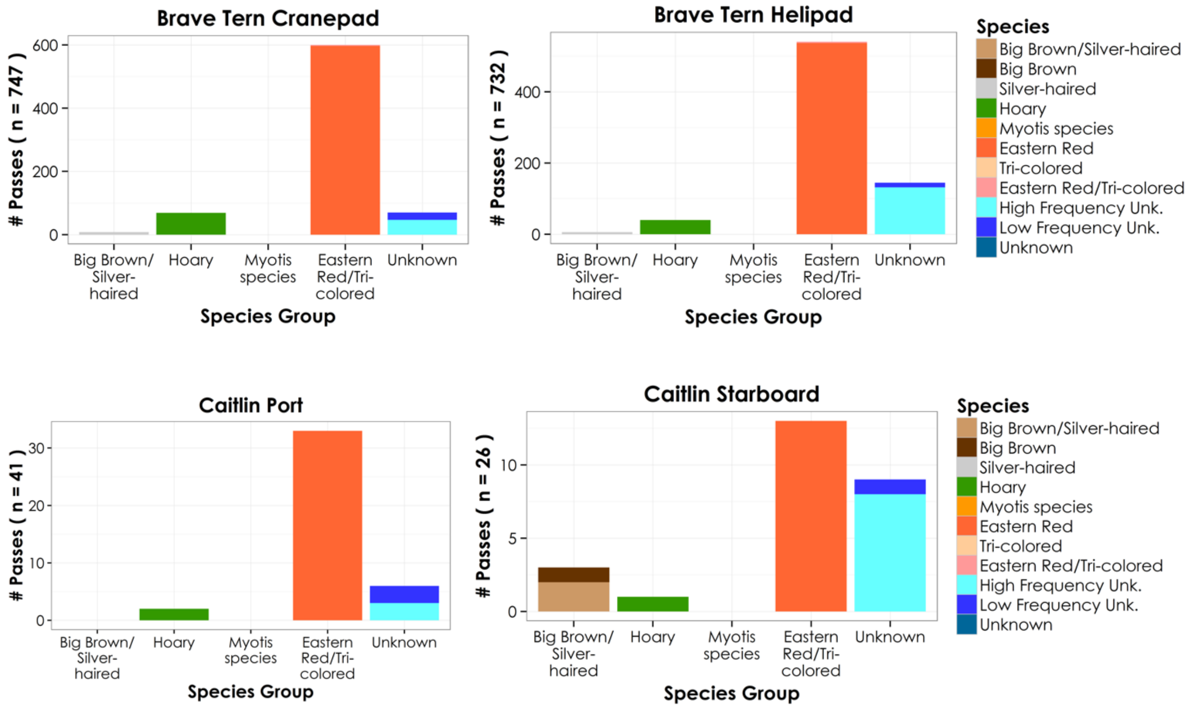

Figure 8. Species composition of bat activity during vessel-based acoustic bat surveys at Block Island Wind Farm, August 2016.

Bat activity levels were highest on nights with relatively warm temperatures and low wind speeds. Only 2 bat passes were recorded on nights with mean wind speed greater than 4.5 m/s and only 4 bat passes were recorded on nights with mean temperatures less than 18° C (Figure 9 and Figure 10).

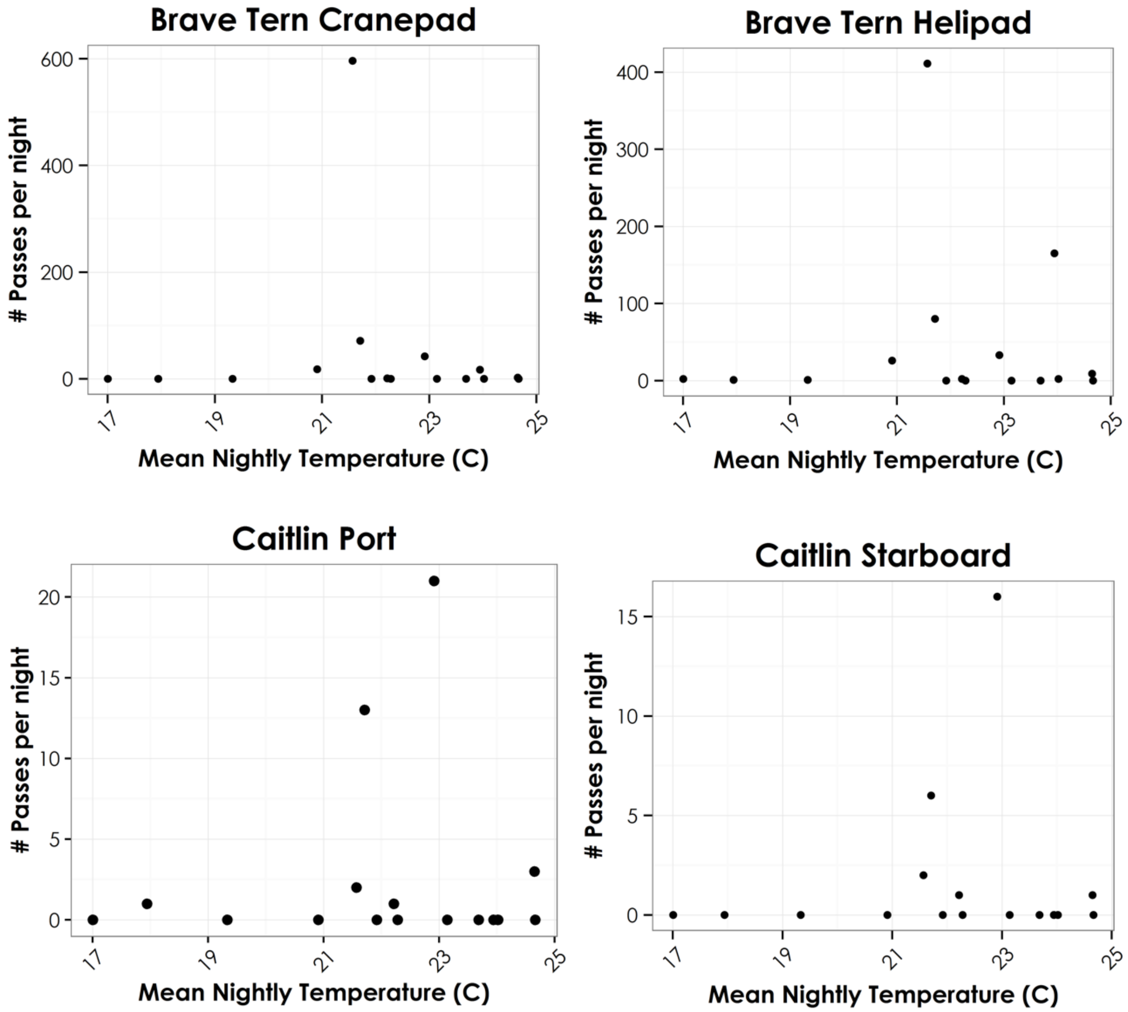

Figure 9. Nightly bat activity versus nightly mean temperature during vessel-based acoustic bat surveys at Block Island Wind Farm, August 2016.

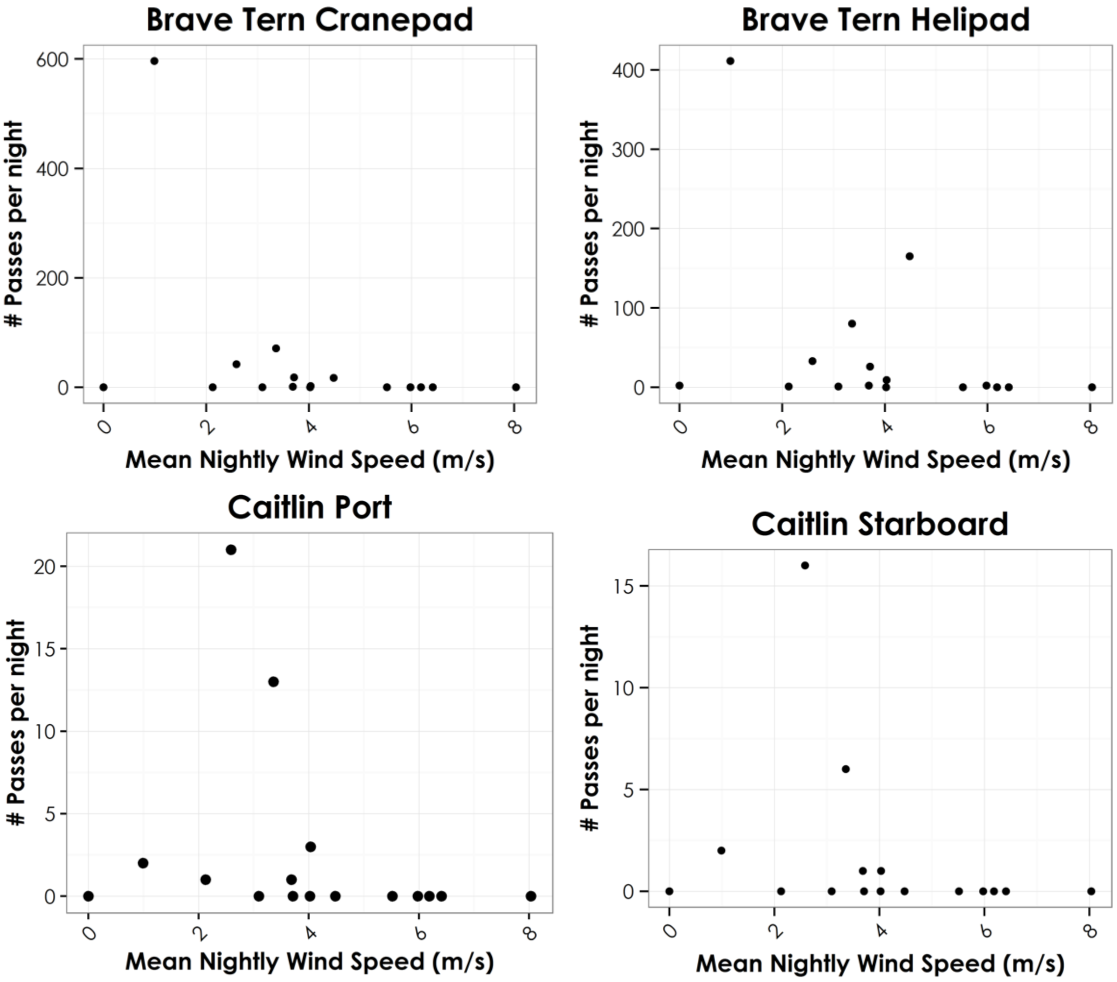

Figure 10. Nightly bat activity versus nightly wind speed during vessel-based acoustic bat surveys at Block Island Wind Farm, August 2016.

Of the 1,546 bat passes identified visually, Kaleidoscope Pro labeled 1,398 as bats, identifying 1,291 of these as eastern red bats (Table 4). The 148 bats identified visually that were missed by Kaleidoscope were primarily from files containing bat passes from more than 1 bat species (Kaleidoscope assigns only 1 species per file). Stantec confirmed that the 11 files labeled as bats by Kaleidscope but not identified visually were in fact non-bat noise. Similarly, Stantec double-checked the visual identification of the 13 passes identified as little brown bats (MYLU) by Kaleidoscope and confirmed that they were passes produced by other bat species. Although we classified 6 of these as high frequency unknown, they were of low quality, did not have characteristics diagnostic of little brown bats, and were more likely low-quality fragments of eastern red bats.

Table 4. Comparison of identifications based on visual analysis (rows) and Kaleidoscope Pro software (columns) for bat passes recorded during vessel-based surveys at the Block Island Wind Farm, August 2016.

Species/ Species Group		**Kaleidoscope Pro Identification**							
		EPFU	**LABO**	**LACI**	**LANO**	**MYLU**	**PESU**	**No ID**	**Total**
Visual Identification	**BBSH**	1						1	**2**
	EPFU				1				**1**
	HFUN	5	153		4	6	2	20	**190**
	LABO	5	1,046		2	6	2	119	**1,180**
	LACI		61	41	2	1		7	**112**
	LANO		9	1	4				**14**
	LFUN	2	19	18				1	**40**
	MYSP								**0**
	PESU								**0**
	RBTB		3				4		**7**
	No ID			10	1				**11**
	Total	**13**	**1,291**	**70**	**14**	**13**	**8**	**148**	**1,557**

4.0 DISCUSSION

Vessel-based acoustic bat monitoring documented bat activity during 29 of the 54 (54%) detector-nights surveyed during erection of the BIWF WTGs. The amount of activity varied considerably among nights at BIWF, with 65% of bat activity recorded during a single night. Long-distance migratory bats accounted for almost all recorded bat activity, with eastern red bats detected most frequently. Visual analysis was more reliable than automated analysis for discerning bat activity from non-bat noise. In particular, the presence of a substantial number of files with multiple bats resulted in considerable differences between identification methods, as the software is able to assign only one species per file.

The timing of vessel-based acoustic bat surveys at BIWF coincided with a time of year when long-distance migratory bat species are often present in coastal and offshore sites in the northeast based on regional acoustic monitoring (Stantec 2016). A long-term regional acoustic survey conducted by Stantec between 2009 and 2014 documented more consistent presence of eastern red, silver-haired, and hoary bats during August and September than during any other time of year. Although these regional surveys did not survey locations near BIWF, similar seasonal patterns occurred in the Gulf of Maine, mid-Atlantic coast, and Great Lakes (Stantec 2016).

Bat activity levels documented during WTG erection at BIWF were substantially higher than those documented during pre-construction acoustic surveys on nearby Block Island or on weather buoys in the vicinity of BIWF. Summer/fall 2009 and spring 2010 surveys documented only 157 bat passes during 920 detector-nights of monitoring (0.17 passes per detector-night) on Block Island and only 16 bat passes (0.07 passes per detector-night) on a weather buoy 3 nautical miles south of Block Island during fall 2009 and spring through fall 2010 surveys (Tetra Tech 2012). Most of the bat activity documented during pre-construction surveys occurred during late May and between late July and late August, although no more than 15 passes were recorded during a single night (Tetra Tech 2012).

The vessels used to install turbines at BIWF are large, complex vessels with numerous structures and extensive artificial lighting. Presence of extensive lighting and novel structures associated with the vessels could have attracted bats, which may have been foraging around the vessels and/or temporarily roosting on the vessels by day or night. The magnitude of acoustic activity documented at both ships does suggest potential attraction to the vessel and/or temporary roosting on the vessel during certain nights, as corroborated by multiple reports by crew members of bats roosting on the ship during the day (Figure 11).

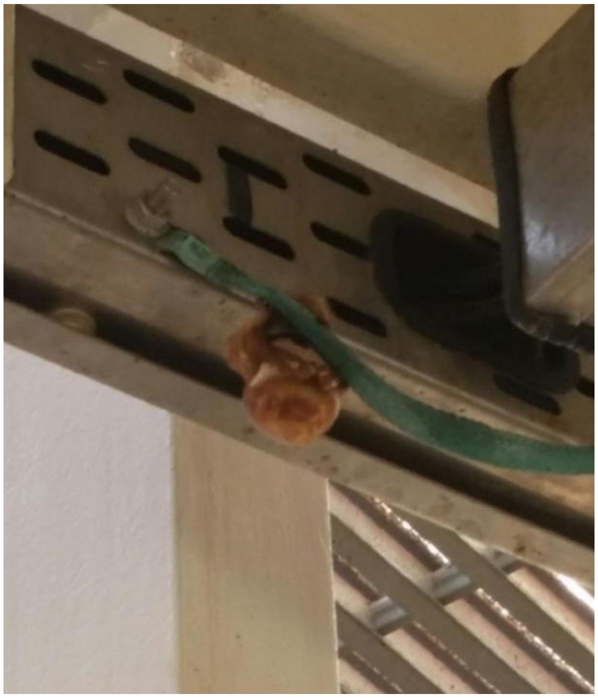

Figure 11. Eastern red bat roosting below an elevated deck on the Brave Tern (photo sent to Stantec by crewmember, August 2016).

Importantly, the number of recorded bat passes does not necessarily indicate the number of bats in an area, as individual bats can be detected multiple times. However, presence of multiple bats in a substantial number of recordings indicates presence of multiple individuals of multiple species. The extent to which ship-based lighting or structures on the ships may have attracted bat activity cannot be assessed based on available data, as bat activity was not surveyed at control sites (i.e., sites away from lit ships). Previous regional data from constantly illuminated lighthouses suggests that bats may concentrate activity near such structures, possibly through direct attraction or foraging on concentrations of insect prey near the lights (Stantec 2016).

While magnitude of activity may not indicate bat abundance, the conditions during which activity occurs can help identify conditions/periods with higher risk (Weller and Baldwin 2012). Vessel-based surveys at BIWF in August 2016 indicated that activity occurred almost exclusively during nights with low wind speed (mean < 4.5 m/s) and warm temperatures (mean > 18° C). Stantec was unable to obtain temperature and wind speed data directly from the ship to perform detailed analyses of conditions during which individual passes were detected, although such analyses could improve a characterization of weather conditions during which activity levels were highest.

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Construction and Post-Construction Avian and Bat Monitoring Plan

Block Island Wind Farm

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March 2012
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Revised April 2015

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1.0 INTRODUCTION

Deepwater Wind Block Island, LLC (Deepwater Wind) proposes to develop the Block Island Wind Farm (BIWF or Project), a 30 megawatt offshore wind farm located in state waters approximately 3 miles (mi) (4.8 kilometers [km]) southeast of Block Island, Rhode Island. The BIWF will consist of five 6 megawatt wind turbine generators (WTGs), a submarine cable interconnecting the WTGs (Inter-Array Cable), and a 34.5-kilovolt transmission cable from the northernmost WTG to an interconnection point on Block Island (Export Cable). Federal and State permit applications were submitted in 2012.

1.1 Purpose and Need

Deepwater Wind is committed to environmental due diligence and recognizes the need to assess potential impacts of the BIWF on birds and bats. This proposed monitoring plan is in response to U.S. Fish and Wildlife Service (USFWS) and Rhode Island Coastal Resource Management Council (CRMC) recommendations.

Potential impacts to bird and bat species were evaluated based on the pre-construction data collected during the BIWF Pre-Construction Avian and Bat Assessment, 2009–2011. The potential impacts of the BIWF may include:

1. **Construction**
    a. Direct habitat loss and change
    b. Disturbance during construction
2. **Operational**
    a. Collision during operation
    b. Displacement of foraging birds during operation
    c. Barrier effects on birds transiting or migrating through the area during operation

The purpose of this document is to describe the proposed construction and post-construction monitoring (PCM) surveys for the BIWF, as well as to outline a process for data collection and analyses. The proposed survey methods in this document are consistent with similar monitoring survey protocols for offshore wind energy facilities in Europe (Maclean et al. 2009).

Monitoring will include:

- Construction Phase:
    - pre-construction beached bird surveys on Block Island;
    - bat acoustic monitoring during construction of the BIWF;
- Post Construction Phase:
    - post-construction beached bird surveys on Block Island;
    - visual observation surveys in and around the BIWF during operation;

- thermal imaging camera monitoring during operation of the BIWF; and
- avian radar monitoring during operation of the BIWF.

Deepwater Wind will complete one year of pre-construction beached bird monitoring as well as bat acoustic monitoring during construction. Post-construction, Deepwater Wind will complete three nonconsecutive years of PCM surveys within the first five years of Project operations. The initial year of PCM surveys would coincide with the first year the Project is operational. The second and third years of monitoring would be performed during the third and fifth year of operations.

2.0 CONSTRUCTION AND POST-CONSTRUCTION AVIAN AND BAT MONITORING

2.1 Objectives of Construction Monitoring

The objectives of the beached bird survey is to assess the relative abundance of bird carcasses washing up on the south and east coast of Block Island prior to construction of the BIWF and after construction of the BIWF. The objective of the bat acoustic survey is to determine if bats are attracted to lit construction vessels during nighttime construction activity at the BIWF WTGs.

2.2 Objectives of Post-Construction Monitoring

The objectives of the PCM surveys are to assess changes in temporal and spatial patterns of avian and bat occurrence in the BIWF Project area, as well as to sample potential avian collision rates at select WTGs. The ability to accurately assess the collision rate of birds and bats at the BIWF is limited because traditional mortality ground searches are not possible in the marine environment. Potential impacts of the BIWF are not limited to mortality and may also include displacement of foraging and migrating birds. The PCM surveys are designed to assess these impacts.

The goals of the PCM are to:

1. Evaluate the potential displacement of foraging and migrating birds from the installation of the WTGs within the Project area and vicinity.
2. Evaluate potential collision rates of migratory birds with the WTG array.

2.2 Level of Effort and Timing

Table 1 provides a summary of the level of effort and timing for each survey.

Table 1. Construction and Post-Construction Monitoring Survey Summary

Effort		Total Duration	Timing	Focus
Construction Monitoring				
Beached Bird Surveys	Twice per month at each of three Block Island beaches (as detailed in Figure 1)	1 year	One full year pre-construction, and during years 1 and 3 of operation	Baseline and post-construction beached bird carcass wash up rates on southern Block Island
Bat Acoustic Vessel Monitoring	Nightly on a maximum of two construction vessels operating with deck lights on, with a minimum of two bat acoustic detectors on each vessel	1 season	Nightly during the warm period (March 15 – October 15) during construction only	Bat activity during construction
Post-construction Monitoring				
Beached Bird Surveys	Twice per month, year round at each of three Block Island beaches (as detailed in Figure 1)	2 years	During the first and third year that the BIWF wind farm is operational	Baseline and post-construction beached bird carcass wash up rates on southern Block Island
Ship-based Bird Monitoring	Once per month	2 years	Year round, during years 1 and 3 of operation	Displacement of migrating and foraging birds
Nocturnal Bird Flight and Collision Monitoring (Thermal Imaging)	24 hours per day, year round.	3 years	Year round, during years 1, 3, and 5 of operation.	Nocturnal migrant activity and collision rates at two WTGs
Avian Radar Monitoring	24 hours per day, year round.	3 years	Year round, during years 1, 3, and 5 of operation.	Migration activity, flight behavior, passage rates, and avoidance behavior in BIWF

3.0 CONSTRUCTION AND POST-CONSTRUCTION MONITORING SURVEY METHODS

3.1 Beached Bird Surveys

Rationale

Beached bird carcass surveys are considered to be an effective method for evaluating long-term trends in seabird populations. The abundance of beached birds is thought to be a result of habitat change and disruption caused by natural phenomena (i.e., hurricanes and Nor'Easters), as well as human impacts such as development and oil spills. Beach surveys have also been used to identify and quantify other threats to seabirds such as fishing gear entanglement, marine pollution, disease, marine debris ingestion, and trauma (Harris et al. 2006).

Traditional onshore wind energy post-construction monitoring techniques for assessing avian mortality are logistically impossible at offshore wind farms. The beached bird surveys will not provide a estimate of bird mortality associated with the wind farm. They will provide the relative abundance of beached birds washing up on the southern and eastern coasts of Block Island before construction and during operation of the wind farm.

Methods

Several acceptable survey methodologies have been developed for conducting beached bird surveys. For the purposes of this study the methods outlined in *Seabird Ecological Assessment Network's (SEANET) Protocol, A Guide for SEANET Volunteers, Version 3.1, 2010* (SEANET 2010) will be used.

Beached bird surveys will be performed by trained field technicians on three beaches along the southern, southeastern, and eastern portions of Block Island (Figure 1). Surveys are scheduled to be performed twice per month at each location year round starting approximately 12 months prior to construction of the BIWF. Once the BIWF is constructed beached bird surveys will continue at a rate of twice per month for the first and third years of operation. Data will be recorded on standardized data sheets (Appendix A). Data sheets will be transferred to Project biologists once per month by the field technicians on Block Island.

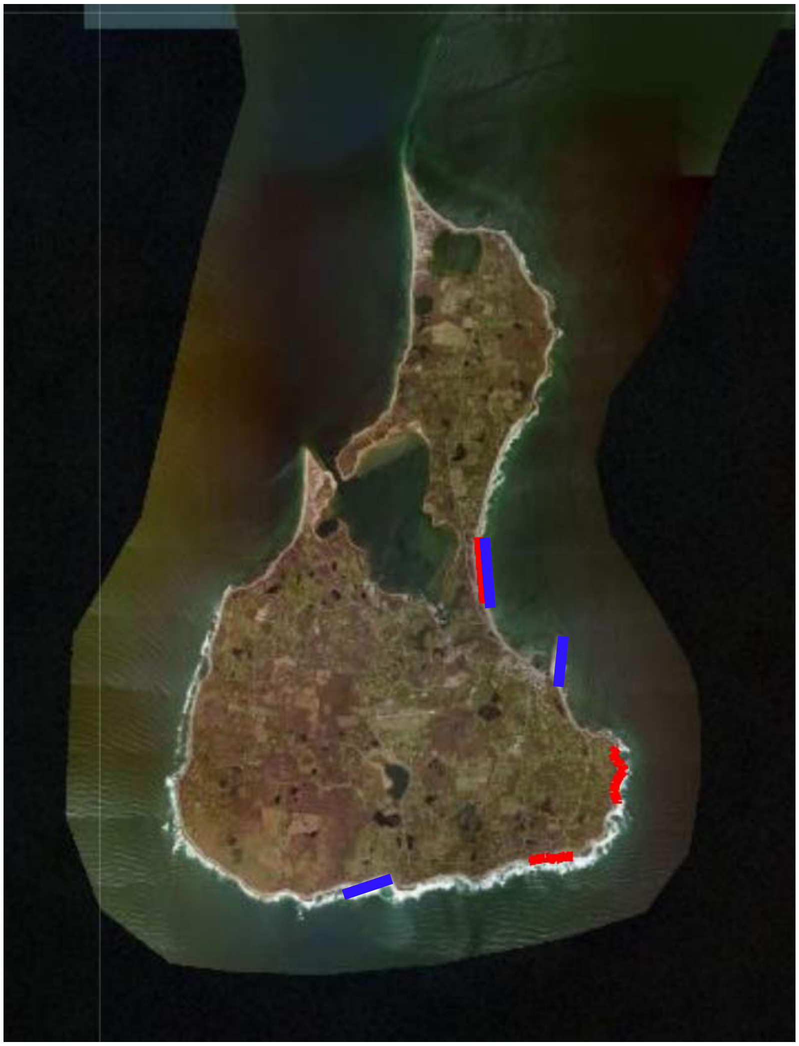


Figure 1. Beached bird survey transect locations, originally proposed survey beaches shown in red, revised 2015 locations shown in blue.

3.2 Bat Acoustic Vessel Monitoring

Rationale

In order to address USFWS's concern that bats may be attracted to bright lights on construction vessels during installation of the BIWF WTGs, Deepwater Wind will conduct acoustic monitoring of lit vessels

Acoustic monitoring is one of the most effective and efficient means of assessing bat species diversity and activity levels (Britzke et al. 2010). Active sampling can be useful in determining species presence and activity levels, with the added benefit of producing precise spatial distribution information correlated with a global positioning system (GPS).

Methods

Bat acoustic monitoring during construction will be performed on vessels operating at night with deck lights, or other work lights that are continuously illuminated, during at least 4 hours of the night. Surveys will be performed on a maximum of two construction vessels, with a minimum of two ultrasonic bat acoustic monitoring systems. Vessel monitoring will occur whenever the selected construction vessels are active at night between March 15 and October 15.

The detectors will be placed as high as possible above the decks of the ships and as far away from noisy equipment as possible. Prior to vessel deployment, and once per week after construction has begun, the bat acoustic monitoring systems will be manually checked by Tetra Tech staff or the Deepwater Wind Construction Environmental Compliance Monitor, and the data from each unit will be downloaded and stored on redundant hard drives.

The methods for analyzing and summarizing the bat acoustic vessel monitoring data will be similar to the methods used to analyze the bat acoustic data collected during pre-construction surveys for the BIWF. Qualitative, visual comparisons of recorded call sequences of sufficient length (three or more pulses) will be made to established reference libraries of bat calls. This technique of comparing recorded call sequences to known parameters for typical species specific call sequences allows for relatively accurate identification of bat species (O' Farrell et al. 1999, O' Farrell and Gannon 1999).

3.3 Ship-Based Avian Surveys

Rationale

One potential impact of the BIWF is displacement of foraging or migrating birds from the area where the WTGs are installed. In order to determine the magnitude of this potential impact Deepwater Wind proposes to conduct year-round ship-based avian surveys using similar methods to the pre-construction ship-based surveys. Ship-based surveys will be conducted in the first and third year the BIWF is operational.

The purpose of the surveys will be to record information on birds that may be foraging, transiting, or migrating through the BIWF area and adjacent areas. The goal of the ship-based surveys is to assess potential displacement effects of the BIWF on birds.

Ship-based strip transect surveys, at a sampling rate of once per month, are proposed for the following reasons:

1. Strip transects are preferable to point counts because vessel time is maximized by collecting data for the entire duration the field team is on the water. Data collection time would be lost traveling between point count locations. Additionally, because of the general homogeneity of habitat in the Project area it will be more effectively sampled by continuous observation strip transects. If there were significant differences in habitat type across the Lease Area then a point count sampling approach would be more effective (Buckland et al. 1993).
2. By sampling a large area (across the entire BIWF Project area) it may be possible to reduce potential misinterpretations of shifts in the distribution of pelagic birds as changes in temporal occurrence patterns (Buckland et al. 1993).
3. Based on our survey goals we feel that 12 replications per year is sufficient to sample adequate variance in the target populations and will allow a "reasonable" degree of freedom for analyses of clustered and unique data points (i.e., seaducks and pelagics) (Buckland et al. 1993, Gray and Burlew 2007).

4. The evaluation of the effects of offshore wind energy facilities on avian distribution patterns in Europe have used similar survey techniques at similar levels of effort (Kahlert et al. 2000, Innogy 2003, Camphuysen et al. 2004, CEFAS 2004, BOWind 2005, Chamberlain et al. 2005, Fox et al. 2006, Hüppop et al. 2006, Petersen et al. 2006, Winiarski et al. 2009, NJDEP 2010, Winiarski et al. 2011).

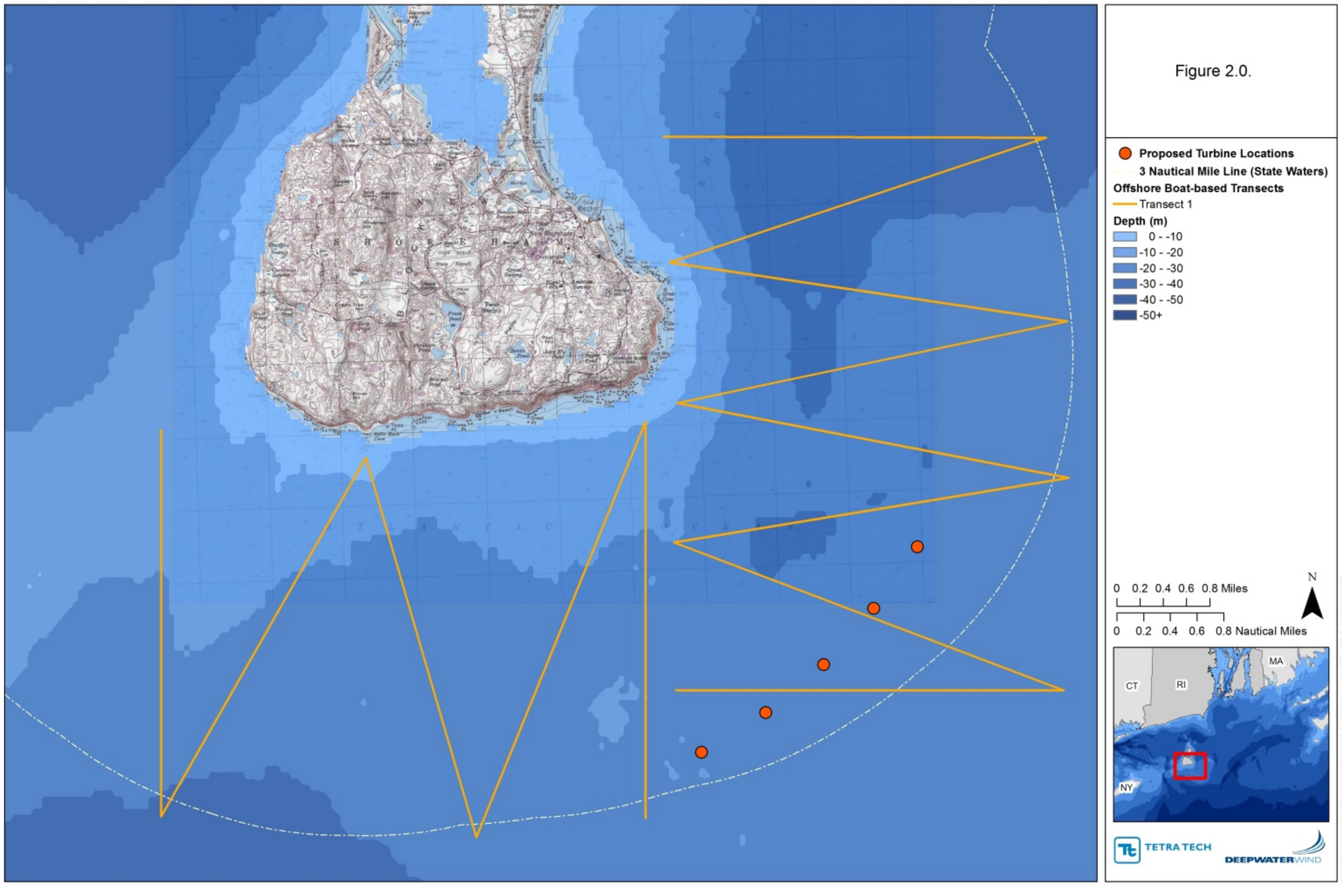
Methods

Monthly systematic ship-based visual observation surveys will begin the first year the BIWF is operational, and again during the third year of operation. Ship-based surveys will occur once per month and will follow a double saw tooth pattern throughout the BIWF Project area. The survey transect will cover a sufficiently large spatial area to assure that nearshore and offshore areas are sampled around the BIWF.

Separation between transects will be 300 m, at a minimum, to avoid double counting. Data will be collected using standard distance sampling techniques including distance and direction of the observed bird to observer, and the behavior of the bird (Thomas et al. 2006). Surveys will be conducted on days when seas are appropriate for a safe and productive ship-based survey (World Meteorological Organization Sea states of 1−4). Detailed weather observations will be recorded using handheld anemometers every 30 minutes during the survey. Observers will record wind speed, wind direction, air temperature, relative humidity, and sea state on standardized data sheets. Surveys will be a minimum of three days apart. Surveys will be conducted on days when sea conditions are appropriate for a safe and productive ship-based survey (World Meteorological Organization Sea States of 1–4).

The survey vessel will travel at a constant speed of 10 knots (18.5 km/hour). Surveys will begin at or after sunrise and continue until the full transect is complete. Two qualified biologists will conduct the surveys; one primary observer will record all birds that fall within a moving “box” that measures 400 m ahead and 400 m perpendicular to the ship. The primary observer will be assisted by a data recorder-observer so that the primary observer can focus on identifying birds. Data will be recorded on a handheld personal digital assistant (Trimble Yuma) equipped with a global positioning system (GPS). All individual birds detected during the surveys will be identified to species level, when possible. Behavioral information on all birds encountered will be recorded including feeding, sitting on water, direct flight, and diving. For birds sitting on the water (and for birds in flight, when possible) the observer will estimate a perpendicular distance from ship to the bird using the following categories and record the distance to the nearest 10 meters. Observers will be equipped with range finders to calibrate their estimates of bird distances. Prior to each survey, observers will use a fixed point, such as a buoy at a variety of distances, to visually calibrate their distance estimate. For birds observed in flight, the vertical flight elevation above the water will be recorded in the following height bins: <10 m, 10–25 m, 26–125 m, 126–200 m, and >200m. Observers will perform a series of flight height tests using laser range finders to accurately gauge flight heights from a subset of birds flying directly overhead. Gulls often kite over moving vessels offshore and therefore serve as large targets that can be used to calibrate flight height estimates as they follow the vessel during transit to the survey transects (i.e., prior to the start of surveys). Definitive flight direction will also be recorded as follows: north (N), northeast (NE), northwest (NW), south (S), southeast (SE), southwest (SW), east (E), west (W), and variable. Data will be analyzed using standard distance sampling methods (Thomas et al. 2006). Estimated density, encounter rate, and relative abundance of birds within subsections of the proposed lease area will be calculated. Data will be plotted spatially via geographic information systems (GIS) and presented on map figures. Data will be archived and backed up by field biologists during transit, and at Tetra Tech’s Portland, Maine office.

Figure 2. Ship-based survey transect.



3.4 Nocturnal Bird Flight and Collision Monitoring (Thermal Imaging)

Rationale

Birds, especially nocturnal migrants, and bats have potential to collide with the BIWF WTG blades, towers, and jacket foundations. Monitoring nocturnal migration at offshore wind farms is exceedingly challenging. Thermal imaging cameras mounted on two WTG structures will provide insight into the interactions between wildlife and WTG blades during the day, at night, and during periods of poor visibility. The goal of the Thermal Imaging Monitoring is to sample avian collision rates at two WTGs with thermal imaging videography.

Desholm (2003 and 2005) pioneered the use of thermal imaging videography to monitor offshore WTGs with the Thermal Animal Detection System (TADS). Thermal imaging technology is progressing rapidly and therefore prior to the start of construction Deepwater Wind will identify the best available technology for use on the Project rather than committing to a technology at this time.

Methods

Thermal image monitoring will be initiated during the first year the Project is operational and will occur year-round for a total of three years during the first, third, and fifth years of operation.

Vertically orientated thermal imaging cameras will monitor two of the WTGs. Cameras will have a resolution of at least 320 x 240 pixels. Images of the entire rotor swept area (RSA) will be recorded. Data will be recorded locally at the WTGs and transmitted via a remote data connection from the camera systems to Project biologist.

Cameras will be ground-truthed and settings adjusted during the initial setup period, and then revisited periodically for maintenance and quality assurance. Quality assurance visits will take place once per quarter during the survey window (ground-truthing days will be conducted in spring, summer, fall, and winter) at each of the two WTGs monitored. The thermal imaging camera settings will be adjusted quarterly in order to provide optimal recording of target species groups. The target species groups will change by season and will include:

- Songbird during spring and fall
- Seaducks and gulls during the winter
- Terns and pelagic birds during the summer

Quality assurance visits will be completed by two biologists who will refine the settings of the video system to maintain optimal surveillance of the RSA air space and of target species groups. During quality assurance visits one biologist will monitor the video output of the thermal camera(s) and one biologist will visually monitor (with binoculars and/or spotting scope) the RSA of the WTG. The biologists will quantify the efficacy of the thermal camera and software at detecting birds. Any modifications to the settings of the system will be cataloged to facilitate future refinements of the technique. The quality of the videos recorded, as well as the sensitivity of the image recognition software, will be evaluated quarterly.

The results of the video survey effort will include a list of all targets recorded, approximate height above sea level that targets flew, type of target (i.e., taxa and, if possible, bird or bat species or at least a general description of size), weather conditions during which the target was observed, and whether the target collided with any portion of the WTGs. Statistical methods for estimating collision rates from the thermal imaging data are under development and will be incorporated into the video survey results as appropriate.

3.5 Avian Radar

Rationale

During pre-construction surveys Deepwater Wind's MERLIN avian radar system provided near continuous, 24-hours per day surveillance of biological target (birds and bats) movements in the Study Area. The system's dual radars, vertical and horizontal, allowed for multiple "zones" of the Study Area to be subsampled and compared. Target passage rates (TPR), flight heights, and flight directions were recorded. A similar survey effort will be implemented during post-construction monitoring of the Project.

Determining the impact of the proposed BIWF on birds, especially nocturnal migrants, is an important component of the BIWF post-construction monitoring program. Ship-based surveys will provide data for birds active during the day, and thermal imaging is expected to gather data on nocturnal activity within the RSA of two of the WTGs. The use of avian radar, either mounted directly to a turbine platform or on the Block Island shore, will gather information on diurnal and nocturnal migrants in the wind farm and adjacent areas. Flight heights, flight direction, and the magnitude of activity (target passage rates) will be recorded. The post-construction radar data would then be comparable to the pre-construction survey data.

Methods

Avian Radar surveys of the WTG array will be conducted year-round during the first, third, and fifth years the BIWF is operational. The radar system will have dual marine radar sensors. A remote data uplink will allow remote system monitoring through the Internet, access to recorded data, and system administration. Project biologists will conduct the initial setup and periodic maintenance visits. The system will otherwise be remotely monitored via the data uplink/Internet connections.

Vertical Scanning Radar (VSR) Operation

The VSR X-band radar will operate in the vertical (y-z) plane transmitting a wedge-shaped beam from horizon to horizon using the vertical scanning technique. In this configuration the radar is turned on its side so it scans a vertical slice through the atmosphere. The radar software detects and tracks targets that pass through or along the vertical beam, recording target size, speed, and altitude attributes, as well as other characteristics. This radar transmits a 22°, fan-shaped beam at a scan rate of approximately 2.5 seconds/scan, and can reliably detect small, bird- and bat-sized targets on either side of and above the radar. The VSR in this configuration outputs the lowest power density, but it provides high spatial resolution data with low side lobe returns to provide optimal detection of bird/bat targets as they pass through the study site. As the X-band is a short wavelength radar (3 cm), it is susceptible to interference from precipitation; radar data collected during moderate to heavy rain events will be quantified and removed during post-processing. The VSR data will be used to determine target altitudes and are also the primary dataset used to determine target counts and target passage rates.

Horizontal Scanning Radar (HSR) Operation

The HSR S-band radar will operate in the horizontal (x-y) plane transmitting a 24°, wedge-shaped beam relatively perpendicular to the VSR. The HSR for this survey will be configured to operate with a short pulse but transmits at a longer wavelength (10 cm) of energy than the VSR. The S-band has the advantage of greater detection range and less signal attenuation (interference) from surrounding vegetation and waves (typically referred to as ground and wave clutter, respectively), as well as rain. It is also less sensitive to insect contamination. Clutter interference is additionally reduced by applying the radar software clutter suppression algorithms that improve detection of small (bird- and bat-sized) targets in high clutter environments. The HSR scans 360° in the horizontal plane at a scan rate of approximately 2.5 seconds/scan and a range setting of 3.7 km (2.0 nm) radius (for this survey), detecting and tracking targets moving around the survey site. The HSR data will be used to determine directional movement of targets over or through the Project Area.

The results of the radar survey effort will include a summary of target flight heights, passage rates, and flight directions. Summaries will be presented for different biological periods (spring, summer, fall, and winter) as well as day, night, dawn, and dusk. Discrete spatial summaries will be provided for different portions of the BIWF and adjacent areas. Data will then be compared to the pre-construction avian radar results.

4.0 AGENCY COORDINATION

4.1 Quarterly Updates

Deepwater Wind will provide quarterly field report to the USACE, the USFWS and the CRMC during the execution of the PCM surveys. The quarterly field reports will summarize the activities conducted during the quarter, the level of effort, and plans for the next quarter's activities.

4.2 Annual Reporting

Deepwater Wind will prepare a comprehensive annual report following the completion of each year of PCM surveys. Deepwater Wind will provide statistical interpretation of the post-construction data and conclusions. Deepwater Wind shall also hold a meeting with USACE, USFWS and CRMC following each year of PCM surveys at the BIWF.

4.3 Continued Coordination

Deepwater Wind commits to continued coordination with USACE, USFWS and CRMC regarding impacts to protected avian and bat species throughout the PCM period and the duration of the BIWF. Yearly during the PCM period, Deepwater Wind will review the results of the surveys with said agencies and modify the PCM if deemed appropriate.

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APPENDIX A

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DEEPWATERWIND

Beached Bird Survey Data Sheet

PROGRAM DATA

Name(s)_________________________________
____
Email address or Phone#_________________
____
Beach Name:_____________________________
Beach ID:________________________________
(example: MA_25)

Date:__________________
(mm/dd/yyyy)

Start Time:__________AM/PM

Survey Duration:___________
(hours and minutes)
Number in party:____________

CONDITIONS DATA

Temperature:_______ **Fog**: ☐No ☐Yes **Sky**: ☐ Clear ☐ Partly Cloudy ☐ Overcast

Wind Direction: (*direction wind is coming from*)
N NE E SE S SW W NW Calm

Wind Speed
☐ No wind ☐ Light wind ☐ Strong wind

Precipitation? ☐ None ☐ Rain ☐ Snow
Storm in last 48 hrs? ☐ No ☐Yes
Ice/Snow on beach? ☐ None ☐ Partial ☐ Full coverage
Wrack Line: ☐None ☐Patchy ☐Continuous
If Continuous: ☐ Narrow (<1m wide) ☐ Wide (>1m)
Human-generated wrack: ☐ plastic bottles ☐ balloons ☐ fishing line ☐ plastic bags
☐ crab/lobster traps Other____

Tide (*circle one*): **outgoing / incoming**
Tide State: ☐ Low ☐ Mid ☐ High

Beach raked? ☐ No ☐ Yes **Recent beach stabilization?** ☐ No ☐ Yes
Oil on beach: ☐YES ☐NO **Did you have a dog with you on your walk?** ☐YES ☐NO
Other observations? (e.g. fish kill, shellfish kills, marine mammal or sea turtle strandings)
____
____

LIVE BIRD COUNTS

Is this a complete list of all live birds seen? ☐YES ☐NO

Confidence in ID codes: V = very S= somewhat NV= not very

Species:	**Confidence in ID**	**Total #**	**Use this space for running tallies**
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________
______________________	_____	________	_______________________________

Counts continued on page ___

Beach ID______ Observer Last name__________________________ Date________ Page __ of __

LIVE BIRD COUNTS CONTINUED

Confidence in ID codes: V = very S= somewhat NV= not very

Species:	Confidence in ID	Total #	Use this space for running tallies

Beach ID_____ Observer Last name________________________ Date_______ Page __ of __

BEACHED BIRD RECORD SHEET

Common Name____

Example (Great Black- backed Gull)

BEACHED BIRD CONDITION:

Status (*check one*):
☐Fresh Dead
☐Moderate Decomposition
☐Advanced Decomposition
☐Mummified Skeletal
☐Alive

Body Parts Found:
☐ Whole carcass
☐ Head
☐ Breastbone (sternum)
☐ Wings (L R Both)
☐ Feet (L R Both)

Entangled:
☐ No
☐ Net
☐ Line
☐ Hook
☐ Plastic

Oil (*check one*):
☐ None
☐ Slightly
☐ Moderate
☐ Heavily

Evidence of Scavenging:
☐ Yes ☐No

Sex
☐ Male
☐ Female
☐ Unknown

Age Class
☐ Adult
☐ Subadult
☐ Chick
☐ Unknown

Banded? ☐ No If YES, type of band? leg / wing Band #____________ Band color(s)?_________
Was band # reported to Bird Banding Lab? ☐ Yes ☐No

Measurements:
Wing Chord: ________________**cm** Culmen: ____________________**mm** Tarsus: _____________________**mm**

Bird Disposition: ☐ Left at Site ☐Transferred for necropsy (Facility ______________________________________)
☐ Discarded ☐Transferred for rehabilitation (Facility____________________________________)

If Left at Site, which body parts were marked?____
If numbered cable tie placed on bird, number?______________________

Additional Notes:____

[redacted]

[redacted]

[redacted]

[redacted]

[redacted]