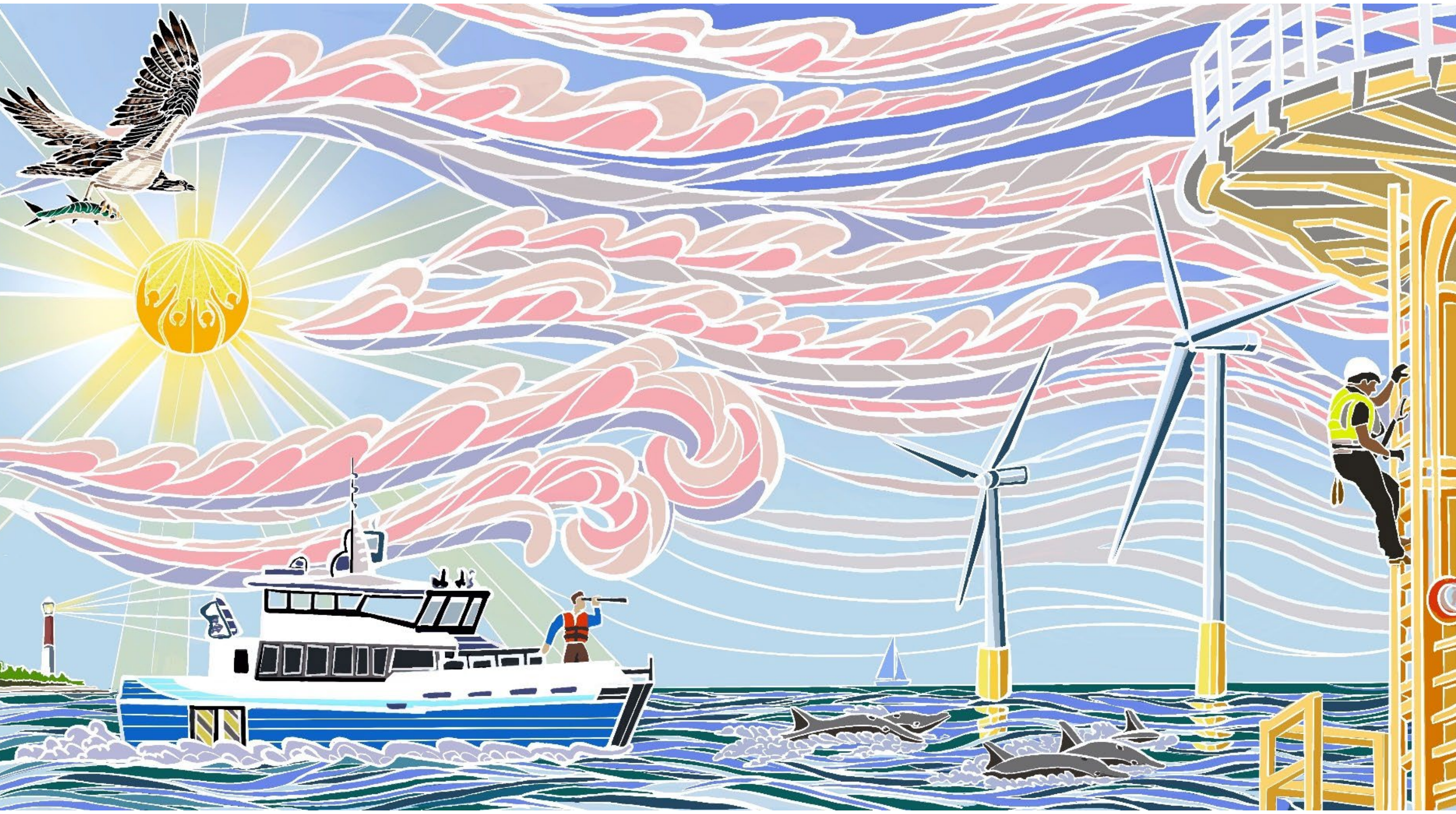


Appendix II-F1

Avian and Bat Survey Plan

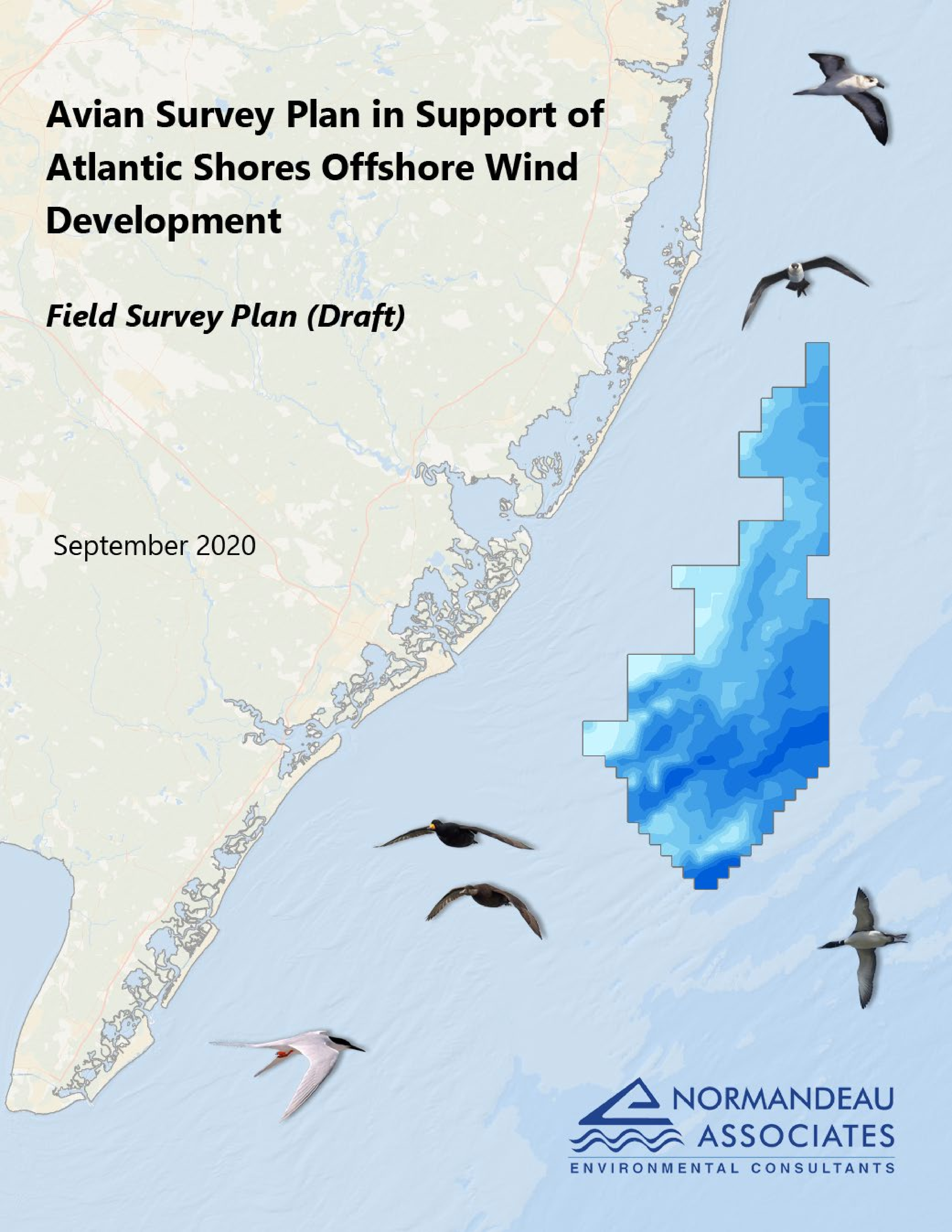
CONFIDENTIAL - NOT FOR PUBLIC DISTRIBUTION

March 2024

Avian Survey Plan in Support of Atlantic Shores Offshore Wind Development

Field Survey Plan (Draft)

September 2020



NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

Avian and Bat Survey Plan in Support of Atlantic Shores Offshore Wind Development

Field Survey Plan

September 2020

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NORMANDEAU ASSOCIATES
ENVIRONMENTAL CONSULTANTS

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List of Abbreviations and Acronyms

APEM	APEM, Inc.
ASL	Above Sea Level
Atlantic Shores Offshore Wind, LLC	Atlantic Shores LLC, EDR, and Normandeau subject matter managers
BACI	Before-After-Control-Impact designs
BOEM	Bureau of Ocean Energy Management
EDR	Environmental Design & Research, Landscape Architecture, Engineering & Environmental Services, D.P.C.
ESA	Endangered Species Act
ft	Feet; foot
GSD	Ground sampling distance
km	Kilometer
m	meter
nmi	Nautical Mile
NJDFW	New Jersey Division of Fish and Wildlife
NLEB	Northern long-eared bat
Normandeau	Normandeau Associates, Inc.
NYSDEC	New York State Department of Environmental Conservation
NYSERDA	New York State Energy Research Development Authority
OBIS-SEAMAP	Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations
Lease Area	Atlantic Shores Lease Area OCS-A 0499
Team	Normandeau Associates, Inc., and APEM, Inc.
USFWS	U.S. Fish and Wildlife Service
USGS	United States Geological Survey
WEA	Wind Energy Area

1 Introduction

Normandeau Associates, Inc. (Normandeau), was contracted by Environmental Design & Research, Landscape Architecture, Engineering & Environmental Services, D.P.C. (EDR) to conduct a gap analysis for bird and bat data relating to the Atlantic Shores Offshore Wind, LLC (Atlantic Shores) Lease Area OCS-A 0499 (Lease Area) (Figure 1–1) and associated onshore facilities. When the gap analysis was completed, the Atlantic Shores project team discussed suitable pre- and post-construction monitoring designs and determined that an Avian Survey Plan (Survey Plan) be developed to meet the Bureau of Ocean Energy Management (BOEM) standards under avian information requirements in 30 CFR Part 585 Subpart F.

The purpose of this Survey Plan is to:

- Provide a baseline survey strategy that when implemented as part of both pre- and post-construction monitoring has the appropriate statistical power to detect changes in distribution and densities of birds;
- Collect data that will assist in reducing uncertainty surrounding the potential risks of impacts to some migrating species; and
- Provide additional information to BOEM and other regulatory agencies including the U.S. Fish and Wildlife Service (USFWS) on the avoidance by birds of an offshore wind facility, providing sufficient data to assess species-specific general displacement sensitivity at this facility.

The Survey Plan addresses data gaps in the natural history of birds and bats (i.e., temporal and spatial distributions) as well as scientific data gaps in the offshore environment. Atlantic Shores selected strategies based on the suite of remote sensing capabilities available to help address the identified data gaps. Normandeau is teamed with APEM Inc. (APEM) (Team) and has been providing grid surveys of wind energy areas (WEAs) for BOEM, New York State Energy Research Development Authority (NYSERDA), and developers. Normandeau has also provided satellite and/or telemetry tracking surveys using satellite tags or fixed receivers for birds and bats on behalf of BOEM, NYSERDA, and developers. This Survey Plan proposes the use of satellite tracking.

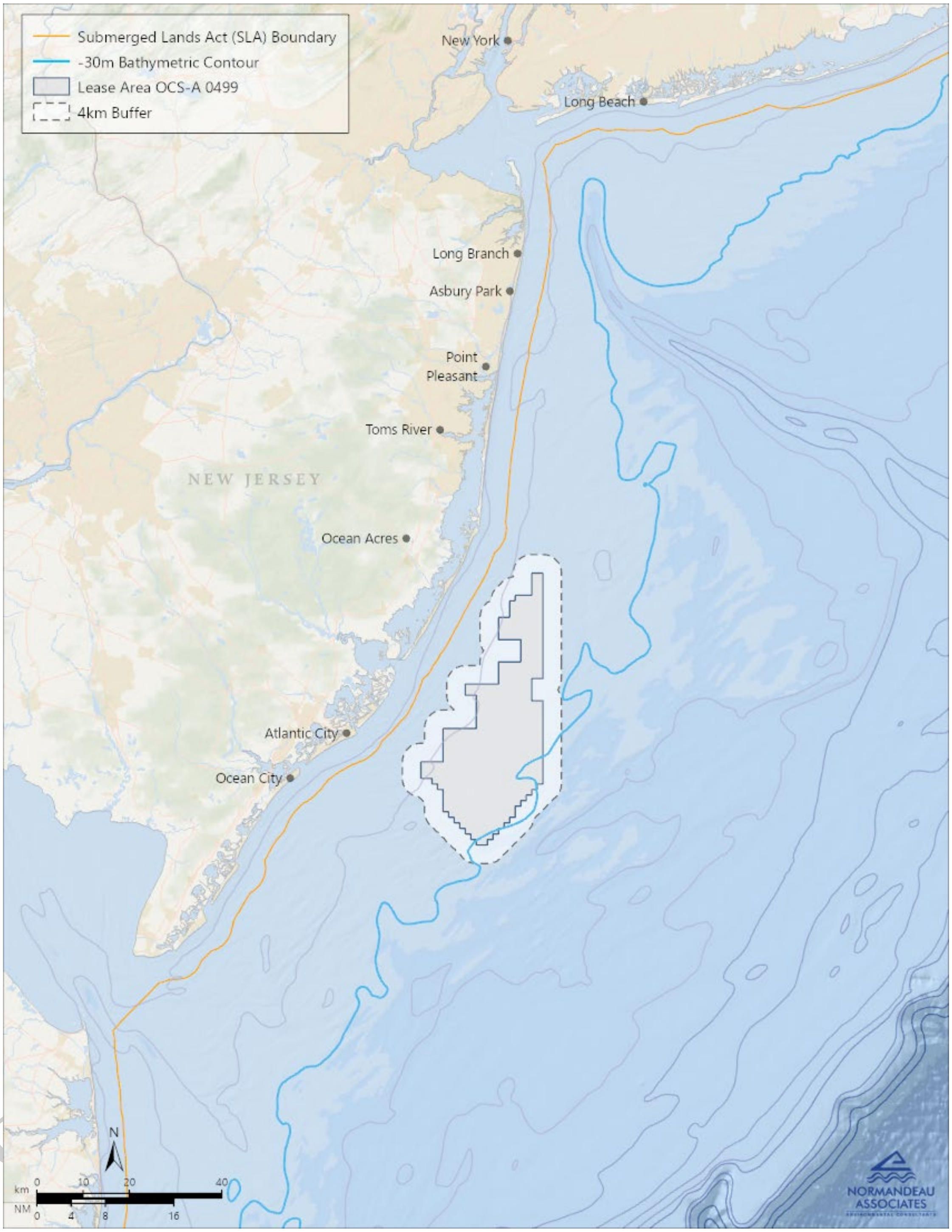

Figure 1–1. Lease Area (OCS-A 0499)

1.1 Existing Data for Offshore Wind in General and the Lease Area Specifically

The potential impacts to birds from offshore wind fall into two categories—collision with the turbines and other above-water structures, and displacement from the area caused by avoidance of the turbines and construction and maintenance traffic.

1.1.1 Collisions

Bird collisions with offshore wind turbines are rare (Pettersson 2005; Desholm 2006; Skov et al. 2018). Despite challenges in monitoring collisions, studies using available technology recorded less than 15 collisions in four studies over an 11.5-year combined period (Table 1–1). Most European projects have used models to predict collision mortality for each offshore wind project. These models have not been validated, so it is unclear if they accurately predict empirical collision mortality data. Both proposed survey methodologies in this Survey Plan will provide species-specific data that could be used to compliment a collision risk model, if considered beneficial by agencies and stakeholders.

Table 1–1. Published Studies and Results of Bird Collisions with Offshore Wind Turbines

Study	Results
Pettersson (2005)	4 eiders offshore, Sweden (6-year study)
Desholm (2006)	1 unidentified small bird or bat, Denmark (2.5-year study)
Skov et al. (2018)	6+ gulls/kittiwake, UK (3 years monitoring, 12 mi offshore)

1.1.2 Displacement

Published studies showing some species-specific displacement from offshore wind exist, and displacement distance varies depending on the species involved (Pettersson 2005; Masden et al. 2009; Welker and Nehls 2016; Mendel et al. 2019). Before-After-Control-Impact (BACI) designs are good for detecting large changes after impact, detecting permanent changes, and for monitoring changes in mean densities (Bailey et al. 2014). The proposed survey methodology in this Survey Plan will provide species-specific data that could potentially be used in a BACI design.

1.1.3 Piping Plovers, Roseate Terns, and Red Knots

Some data are available regarding offshore movements of piping plovers (*Charadrius melodus*) and roseate terns (*Sterna dougallii*) (two important bird species protected under the federal Endangered Species Act (ESA)) using radio tracking (Loring et al. 2019). While these data are insufficient to address much of the information gaps on piping plover exposure to lease areas, this study did develop risk models to estimate exposure and quantify the effects of weather and time of day on plover movement. Roseate terns are known to occur more than 100 km from shore and risk was considered higher during morning hours and in high barometric conditions (i.e., fair weather), while peak piping plover exposure occurred on evenings in early August during periods of southwest wind conditions. Flight height estimates with high uncertainty surrounding accuracy placed most terns below 25 m; although 6.4% of the roseate tern flights did occur between 25 m and 200 m, as did just over 21% of piping plover flight heights. Over two breeding seasons and out of 102 individuals, two piping plover tracks were calculated to occur at the Lease Area mostly near the outer perimeter; although, to caveat these data, no piping plovers were tagged south of Rhode Island and there are spatial accuracy limitations with the data (Figure 1–2). The study modeled moderate density for piping plover in the northeastern corner of the Lease Area and low density over the rest of the Lease Area. No roseate terns were recorded in the Lease Area. These data provide some information on likely exposure to the WTA of piping plover and roseate terns.

Although suitable for larger birds such as roseate terns, the weight constraints on available tags suitable for tracking of piping plover means that there is currently no way to get better resolution on flight patterns and flight heights than by the methods used in Loring et al. 2019 (i.e., using nanotag receivers that have detection ranges of less than 11 nautical miles [NM; 20 km] and with an associated high margin of error) or by the aerial digital surveys proposed here.

However, red knot is a species that can take the heavier satellite tag, an available technology that provides more accurate three-dimensional information, although such data are sparse. This satellite tagging method will provide new important data on red knot activity and flight altitudes and help reduce some of the uncertainty surrounding red knot exposure to offshore wind energy development.

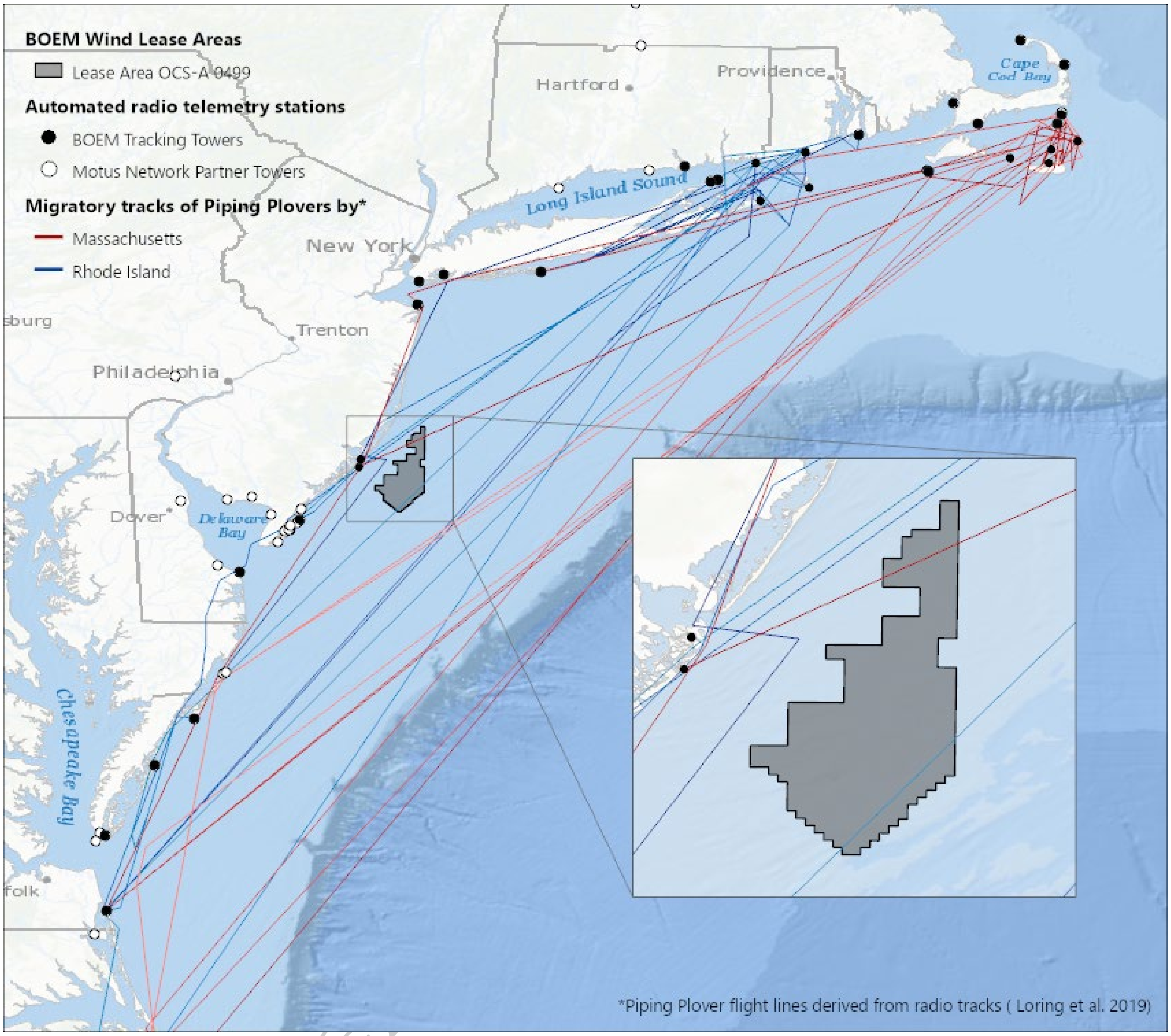

Figure 1–2. Flight lines of piping plover derived from a radio-tracking study (Loring et al. 2019)

Thirty-one boat-based surveys were conducted in the Lease Area during 2008 and 2009 (Table 1–2). These allow some baseline species-specific density and distribution assumptions to be made and validated with the proposed methodology in this Survey Plan. Atlantic Shores decided to augment these boat-based data with digital aerial surveys that could provide a suitable baseline for a potential BACI (i.e., for detecting change pre- and post-construction).

Ten bird species and two bat species that are protected by either Federal or State endangered species laws have been found in the offshore and onshore Project Area (Table 1–3).

Table 1–2. Datasets that Include Surveys through the Lease Area, Identifying Year, Month, and Percent Coverage within the Lease Area per Survey

Survey Type	Month	Year	Coverage of Project Area (%)	Year	Coverage of Project Area (%)
Shipboard WEA Dedicated	Jan	2008	6.32	2009	8.69
Shipboard WEA Dedicated	Feb	2008	1.43	2009	12.39
Shipboard WEA Dedicated	Mar	2008	10.16	2009	11.35
Shipboard WEA Dedicated	Apr	2008	11.82	2009	7.26
Shipboard WEA Dedicated	May	2008	6.25	2009	10.22
Shipboard WEA Dedicated	Jun	2008	11.77	2009	6.30
Shipboard WEA Dedicated	Jul	2008	10.30	2009	
Shipboard WEA Dedicated	Aug	2008	11.12	2009	13.79
Shipboard WEA Dedicated	Sep	2008	11.76	2009	12.10
Shipboard WEA Dedicated	Oct	2008	11.52	2009	4.95
Shipboard WEA Dedicated	Nov	2008	5.20	2009	6.94
Shipboard WEA Dedicated	Dec	2008	4.66	-	-
Boat-based opportunistic	Aug	-	-	2009	6.44
Boat-based opportunistic	Sep	-	-	2009	7.37
Boat-based opportunistic	Oct	-	-	2009	0.51
Boat-based opportunistic	Nov	-	-	2009	0.00
Boat-based opportunistic	Dec	-	-	2009	1.59
SeaWatch opportunistic	Oct	-	-	2009	0.22
SeaWatch opportunistic	Nov	-	-	2009	0.09
SeaWatch opportunistic	Dec	-	-	2009	0.00

Table 1–3. Threatened and Endangered Bird and Bat Species Listed or Proposed for Listing by Federal and State Agencies

Species of Interest	Listing
FEDERAL	
Roseate Tern (*Sterna dougallii*)	E
Piping Plover (*Charadrius melodus*)	E
Red Knot (*rufa*)	T
Black-capped Petrel (*Pterodroma hasitata*)	proposed listing T
Indiana Bat (*Myotis sodalis*)	E
Northern Long-eared Bat (*Myotis septentrionalis*)	T

Species of Interest	Listing
STATE	
Bald Eagle (*Haliaeetus leucocephalus*)	NJ-E
Black Tern (*Chlidonias niger*)	NJ-E
Common tern (*Sterna hirundo*)	NY-T
Osprey (*Pandion haliaetus*)	NJ-T
Pied-billed Grebe (*Podilymbus podiceps*)	NJ-E
Black-crowned Night Heron (*Nycticorax nycticorax*	NJ-T
Yellow-crowned Night Heron (*Nyctanassa violacea*)	NJ-T

1.2 Offshore Bats

Bats have been observed offshore for over 100 years (Merriam 1887; Thomas 1921) yet the extent of their presence in the pelagic environment is only recently beginning to be understood. In the Eastern U.S., the majority of species found offshore are 'long–distance migratory tree bat species,' which include eastern red bats (*Lasiurus borealis*), hoary bats (*Lasiurus cinereus*), and silver-haired bats (*Lasionycteris noctivagans*) (Peterson 2016).

Bats can be detected offshore from the months of April through November; however, across all records, offshore bat activity peaks significantly throughout the autumn migration period of August to early November outside of which significantly fewer detections are made. Offshore bat activity is consistently negatively correlated with wind speed (Ahlén et al. 2009; Cryan and Brown 2007; Sjollema et al. 2014; Peterson et al. 2014; Peterson 2016). Peterson (2016) found that mean nightly wind speed had a negative effect on activity up to ~10 m/s. Sjollema et al. (2014) found bats active up to 6.9 m/s. In Europe, Ahlén et al. (2009) found that the majority of bat flights across the Baltic Sea took place at wind speeds less than 5 m/s (though flights in winds of 10 m/s were observed). In at least one study, ambient temperature was correlated with bat activity finding that bat detection was greatest between a nightly range of 7 and 20°C (Peterson 2016).

1.3 Terrestrial Bats

The Indiana bat (*Myotis sodalis*) range does not overlap with Atlantic Shores Onshore Project Area (Onshore Project Area). However, Indiana bats are known to migrate regionally and the USFWS, New York State Department of Environmental Conservation (NYSDEC), or New Jersey Division of Fish and Wildlife (NJDFW) may request presence/probable absence surveys during project review or informal ESA consultation to ensure that Indiana bats are not located in the Onshore Project Area.

The northern long-eared bat (*Myotis septentrionalis; NLEB*) range overlaps with the Onshore Project Area. However, the NLEB was listed under the 4(d) provision of the ESA, and a programmatic Biological Opinion exists to assist with Section 7 consultation. Under this opinion, the USFWS has determined that activities away from known roost trees and hibernacula are not likely to impact the species. Therefore, if the project can avoid removing trees 0.25 miles (mi [0.40 kilometers {km}]) from known hibernacula, or 150 feet (ft [0.05 meters {m}]) around a known roost tree from 1 June to 31 July, formal Section 7 consultation can be avoided.

In New Jersey, known NLEB roosts, maternity colonies, and hibernacula exist in Monmouth and Atlantic counties yet the proximity to the Onshore Project Area, specifically the Cardiff and Larrabee point of interconnections, remains unknown. A project review through the USFWS and NJDFW is necessary to determine the precise locations of these known occurrences. Removal of trees 0.25 mi (0.40 km) from known hibernacula is restricted year-round and a buffer of 150 ft (0.05 m) is required around a known roost tree from 1 June to 31 July. However, most bat related issues can be mitigated if the project can commit to conducting forestry-related activities during the winter months when bats are in hibernation.

The 4(d) status of the NLEB may change based on a recent court case that determined the USFWS must re-evaluate the listing of the species as threatened with a 4(d) provision (U.S. District Court for the District of Columbia, Civil Action No. 16-910). If the NLEB is listed as endangered in the future, the 4(d) regulations will no longer be valid and additional surveys, such as presence/absence following the Range-wide Indiana Bat Survey Guidelines (USFWS 2020), may be required.

2 Survey Methods

2.1 Aerial Digital Survey by Grid

Aerial digital surveys collect data faster than other survey methodologies, provide a snapshot in time, and minimize double counting. These surveys are conducted at an altitude high enough above sea level (ASL) to allow the same survey design to be used both pre- and post-construction. This high altitude also minimizes observer platform attraction and repulsion effects that affect animal behavior and removes field observer biases in identification abilities, distance judgments, or swamping by large aggregations of animals. Counts are accurate, identifications can be validated, and detection of all species within the footprint of the image is the same. No distance sampling is required to model data, allowing for more accurate densities to be estimated. The data can be revisited and additional data can be analyzed should additional information be required or questions surrounding survey results arise.

The aerial digital surveys will be collected via a grid pattern. The same proportion of area coverage by a grid pattern provides greater accuracy when surveying aggregated species in comparison with the same degree of coverage achieved by transect surveys (Elliott 1971; McGovern and Rehfisch 2015; Coppack et al. 2017).

2.1.1 Aerial Digital Resolution

The aerial digital surveys will be flown at 1,360 ft (415 m) ASL, collecting imagery at 1.5-cm (0.6-inch [in.]) ground sampling distance (GSD) resolution. Although higher resolution is possible, there are no species for which identification accuracy is likely to be improved that are likely to be recorded in the Lease Area, and higher resolution comes with a loss of spatial coverage. Species that are currently difficult to identify to species such as phalaropes, storm-petrels, and some duck species are problematic because of very similar morphological features rather than because there is insufficient resolution in the imagery. Red knot will most likely be migrating at night and data collection on this species at any resolution is unlikely. At the recommended resolution, surveys will capture other biota visible from the sea surface such as marine mammals, turtles, sharks, large bony fish, and fish shoals.

2.1.2 Aerial Digital Area Coverage

Using APEM's Shearwater III camera system, each image footprint will be approximately 0.027 mi^2 (0.043 km^2). A minimum of 40% of the Lease Area plus a 2.5-nmi (4-km) buffer will be surveyed; however, only a quarter of the images (representing 10% of the Lease Area) will be analyzed (Figure 2–1). The remaining unanalyzed data will be used should additional questions arise or more statistical power is needed for post-construction effects detection.

2.1.3 Aerial Digital Survey Aircraft

The survey aircraft will be provided by APEM's aircraft and pilot provider. This will be a twin-engine aircraft with a floor-based survey hatch for recording imagery that is capable of safe, slow flight speeds of 120 knots (138 miles per hour [mph]) to provide image clarity and minimize motion blur. The aircraft will have long endurance with the given payload to provide survey efficiency and will be well maintained and reliable. The aircraft and pilots will adhere to all applicable FAA and internal guidance, and the aircraft will be equipped with all necessary safety equipment, including, but not limited to, life raft, personal location beacons, life jackets, and aviation offshore immersion suits. Aircraft will transit and be based out of local airfields near the survey area.

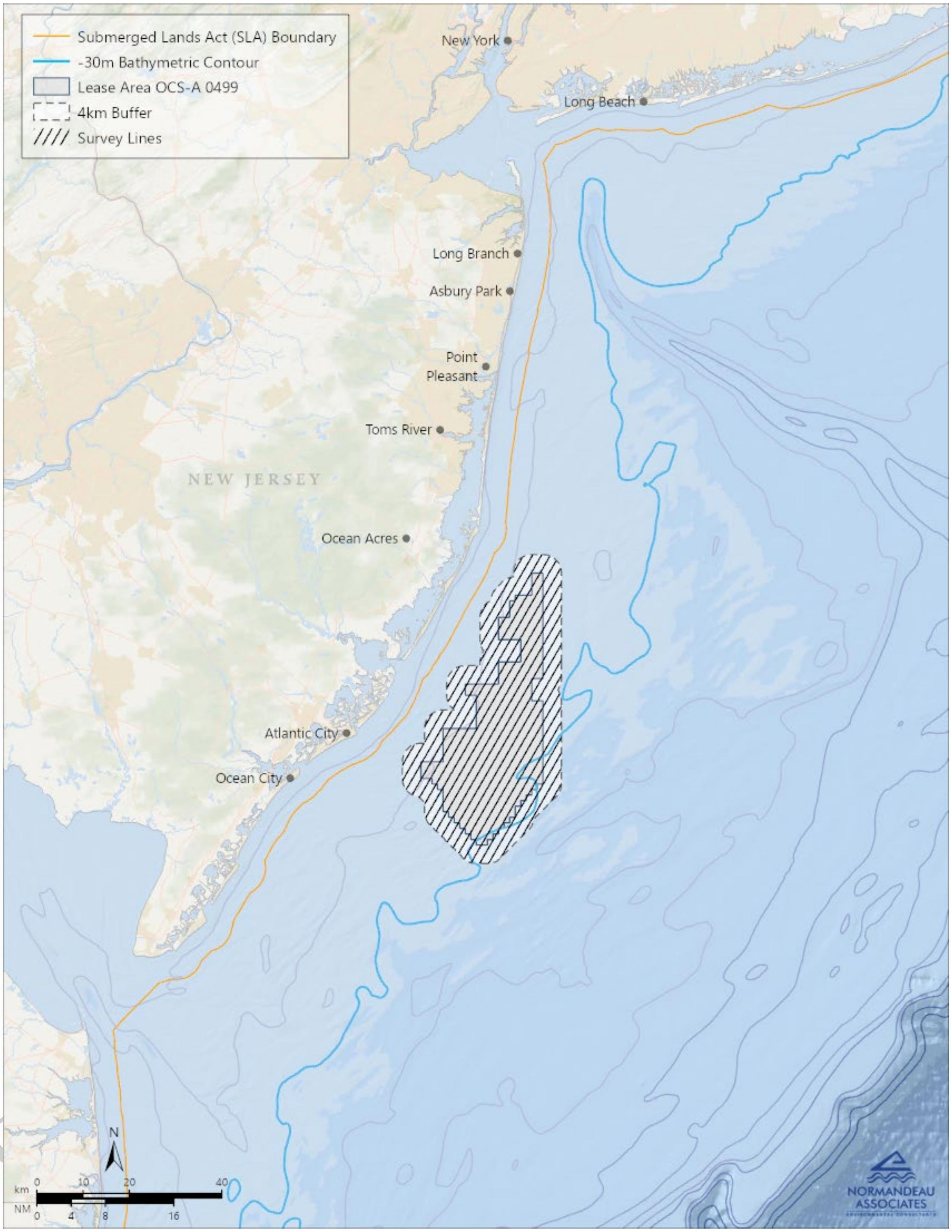

Figure 2–1. Lease Area survey protocol to achieve 40% transect coverage

2.1.4 Aerial Digital Survey Conditions and Image Quality

Surveys will be conducted in weather conditions that do not limit the ability to identify marine fauna at or near the water surface following protocols identified in Camphuysen et al. (2004). These target conditions are cloud base >1,400 ft (427 m), visibility >5 km (3 mi), wind speed <30 knots (35 mph), and sea state Beaufort 3 (small waves with few whitecaps) or less, aiming for 2 (small waves with no whitecaps) or less to maximize recording of images of turtles that can be accurately identified.

In addition, on days with little cloud cover, surveys will avoid the middle of the day to minimize collecting images with glint (strong reflected light off the sea) that makes finding and subsequently identifying the marine fauna recorded in the images more difficult. The onboard camera technician will continuously monitor the images collected and, if they cease to be of sufficient quality, image acquisition will cease until suitable conditions return. In addition, extra imagery will be recorded to replace potentially glint-affected images.

2.1.5 Aerial Digital Survey Schedule

A review of existing data sets was performed, including the Ocean Biogeographic Information System Spatial Ecological Analysis of Megavertebrate Populations (OBIS-SEAMAP) and the U.S. Geological Survey (USGS) Atlantic Offshore Seabird Dataset Catalog (USGS Seabird Compendium), which includes the New Jersey Baseline Surveys of 2008 and 2009 and data from a broader geographic area such as the NYSERDA baseline surveys and the BOEM surveys of North Carolina and South Carolina. Based on this review, some target annual periods and expected taxa of interest were identified. Surveys will include evaluation of diurnally migrating, foraging, and resting state and federal listed species for which this is an appropriate surveying technique (Figure 2–2 and Figure 2–3) and will be timed to correspond with peak abundances for these species. The survey schedule has also been selected to target species about which the broader scientific community has expressed concerns regarding collision (Figure 2–4 and Figure 2–5) or displacement (Figure 2–6) risk.

Peak abundance data will enable validation of the 2008–2009 baseline surveys for species that are sufficiently abundant within the survey area. Conversely, for rare species with low population density that are represented by few or no observations, neither the

2008–2009 baseline surveys nor our surveys are likely to provide an adequate characterization of presence, abundance, movement, or seasonality.

Aerial digital survey effort will be focused on the eight months that have main overlap with the species of interest (Table 2–1; Figure 2–2 through Figure 2–6).

Table 2–1. Months, Frequency and Target Species for Aerial Digital Surveys of the Lease Area

Month/Year	Frequency	Target Animals
Oct 2020	1	Gannets, Black-legged kittiwake, Scoters, Common Tern, loons, auks and scoters
Nov 2020	1	Black-capped Petrel, Common Tern, gulls, gannets, Black-legged kittiwake, loons, auks and scoters
Dec 2020	1	Gulls, gannets, Black-legged kittiwake, loons, auks and scoters
Jan 2021	1	Gulls, gannets, Black-legged Kittiwake, loons, auks and scoters
Feb 2021	1	Gulls, gannets, Black-legged kittiwake, loons, auks and scoters
Mar 2021	1	Gulls, gannets, Black-legged kittiwake, loons, auks and scoters
Apr 2021	1	Black-capped Petrel, Roseate Tern, Common Tern, gulls, gannets, Black-legged kittiwake, loons, auks and scoters
May 2021	1	Roseate Tern, Black-capped Petrel, Common Tern, gannets, Black-legged kittiwake, loons and scoters
TOTAL	**8**	

An additional advantage of using aerial digital surveys is that information on other marine fauna is simultaneously collected, and survey timing coincides with peak months for the following marine mammal species (see Table 2–2):

1. North Atlantic right whale (*Eubalaena glacialis*)
2. Minke whale (*Balaenoptera acutorostrata*)
3. Fin whale (*Balaenoptera physalus*)
4. Humpback whale (*Megaptera novaeangliae*)
5. Short-beaked common dolphin (*Delphinus delphis*)
6. Harbor seal (*Phoca vitulina*)
7. Harbor porpoise (*Phocoena phocoena*)

The proposed pre-construction aerial digital surveys will also help inform boat-traffic best management practices for the operations and maintenance phase of the development to mitigate and minimize disturbance to displacement-sensitive birds.

Pending further discussion, the aerial digital survey strategy may be repeated two years prior to turbine installation and two years after installation is complete. If changes in distribution and density are evident for any taxa of interest two years after project build, then an additional survey at five years post-construction could be completed.

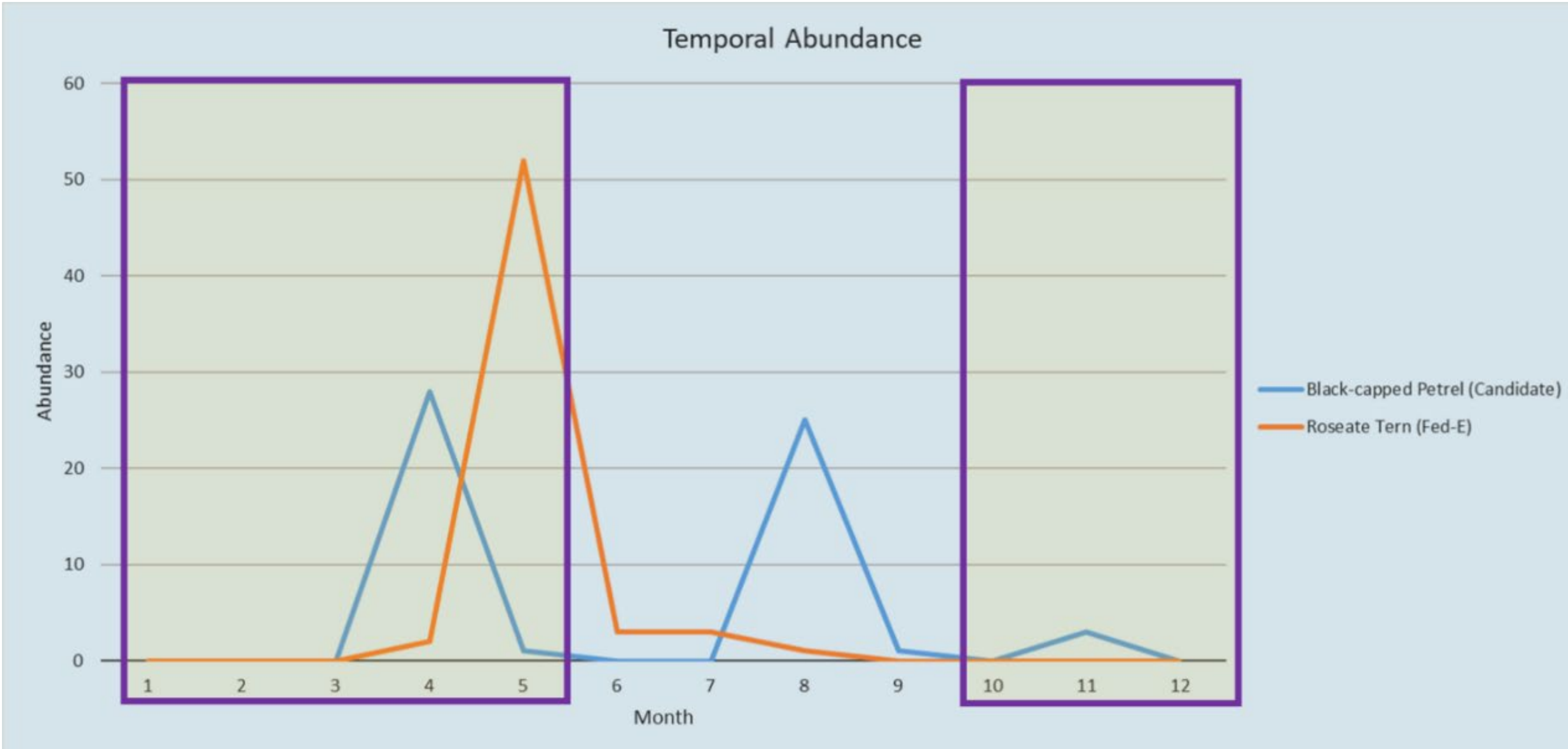

Figure 2–2. Times of peak abundance for listed Federal and candidate bird species
Data derived from Williams et al. (2015); O'Connell et al. (2011); NJDEP (2010); Normandeau and APEM (2019); APEM and Normandeau (2020).

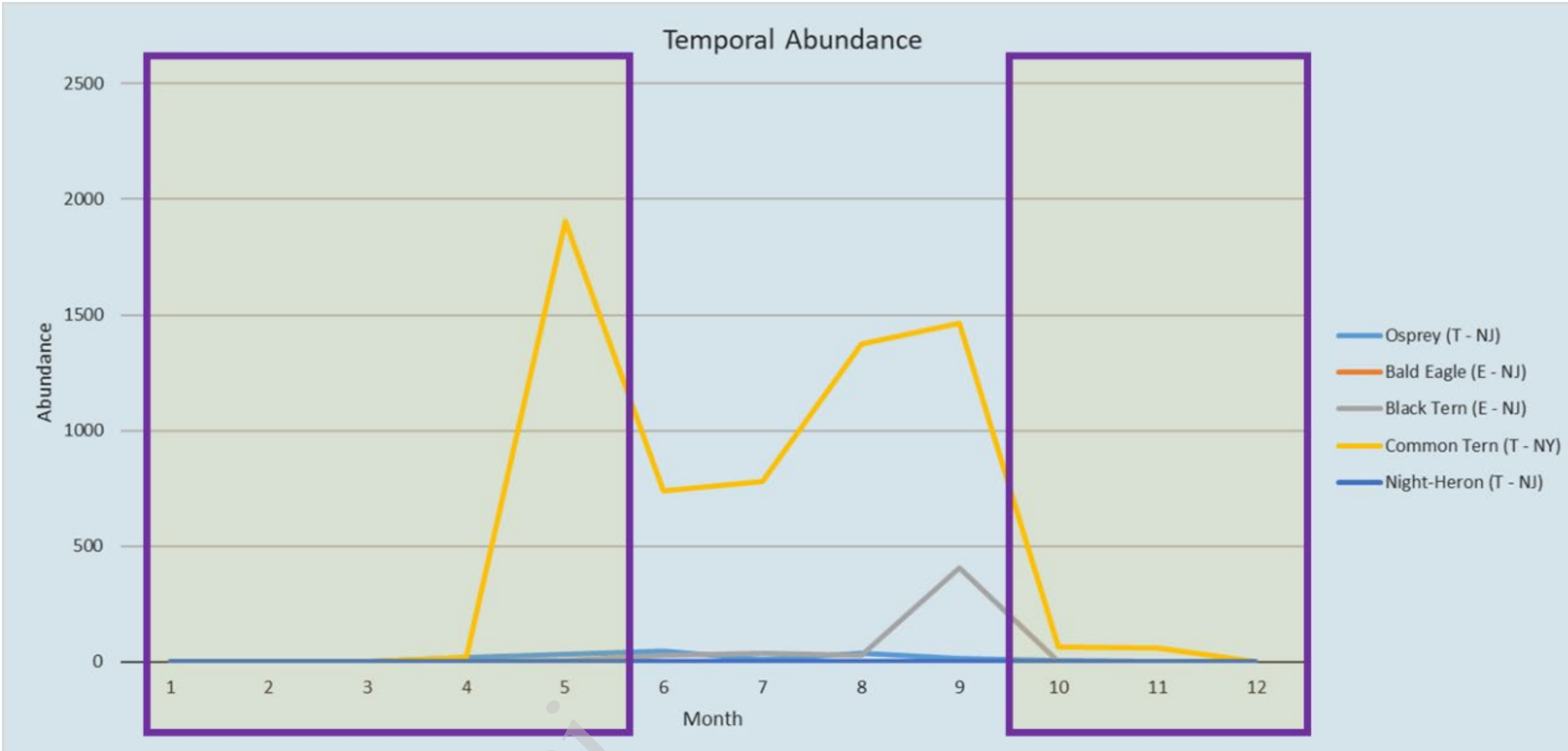

Figure 2–3. Times of peak abundance for NY and NJ State listed bird species

Data derived from Williams et al. (2015); O'Connell et al. (2011); NJDEP (2010); Normandeau and APEM (2019); APEM and Normandeau (2020).

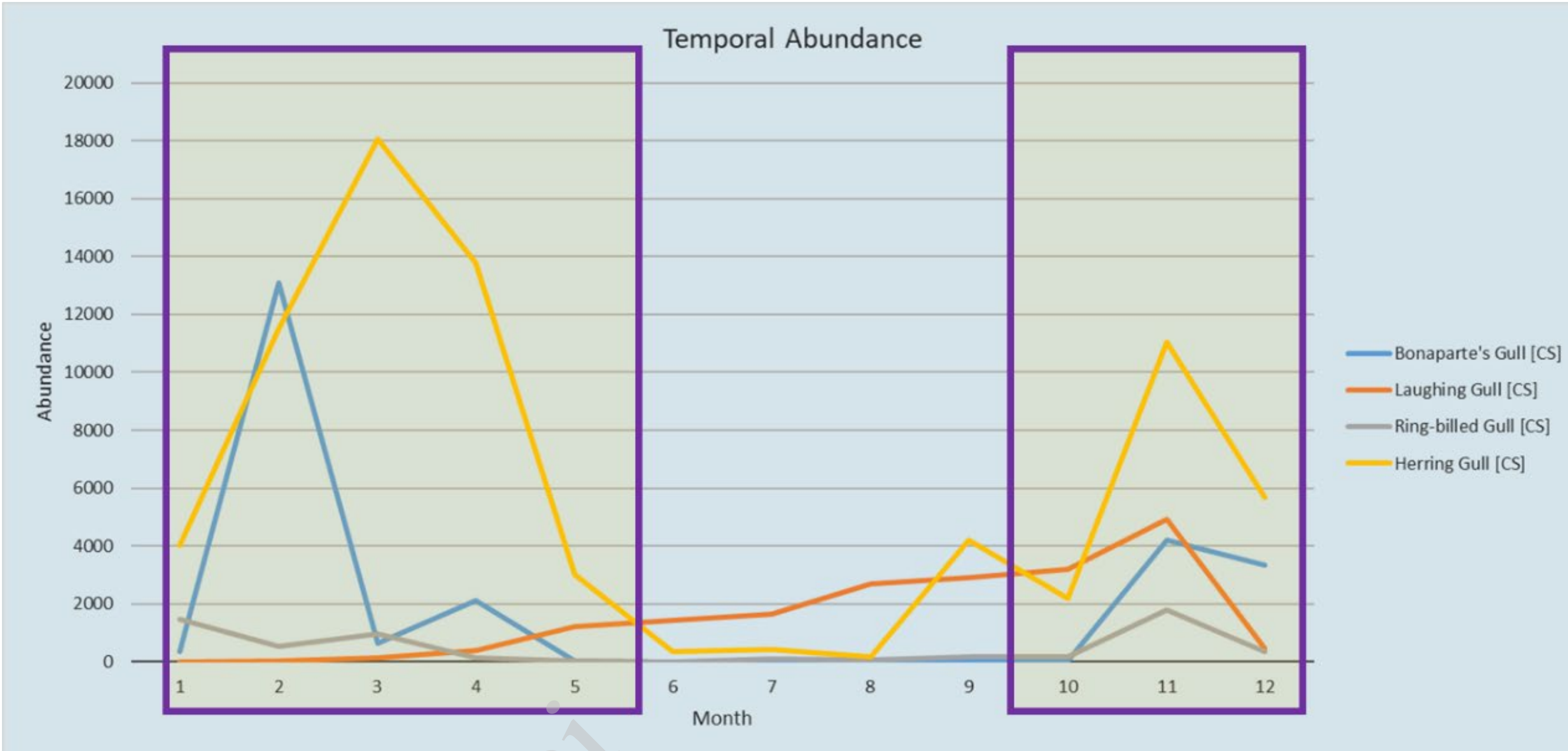

Figure 2–4. Times of peak abundance for collision-sensitive (CS) gull species

Data derived from Williams et al. (2015); O'Connell et al. (2011); NJDEP (2010); Normandeau and APEM (2019); APEM and Normandeau (2020).

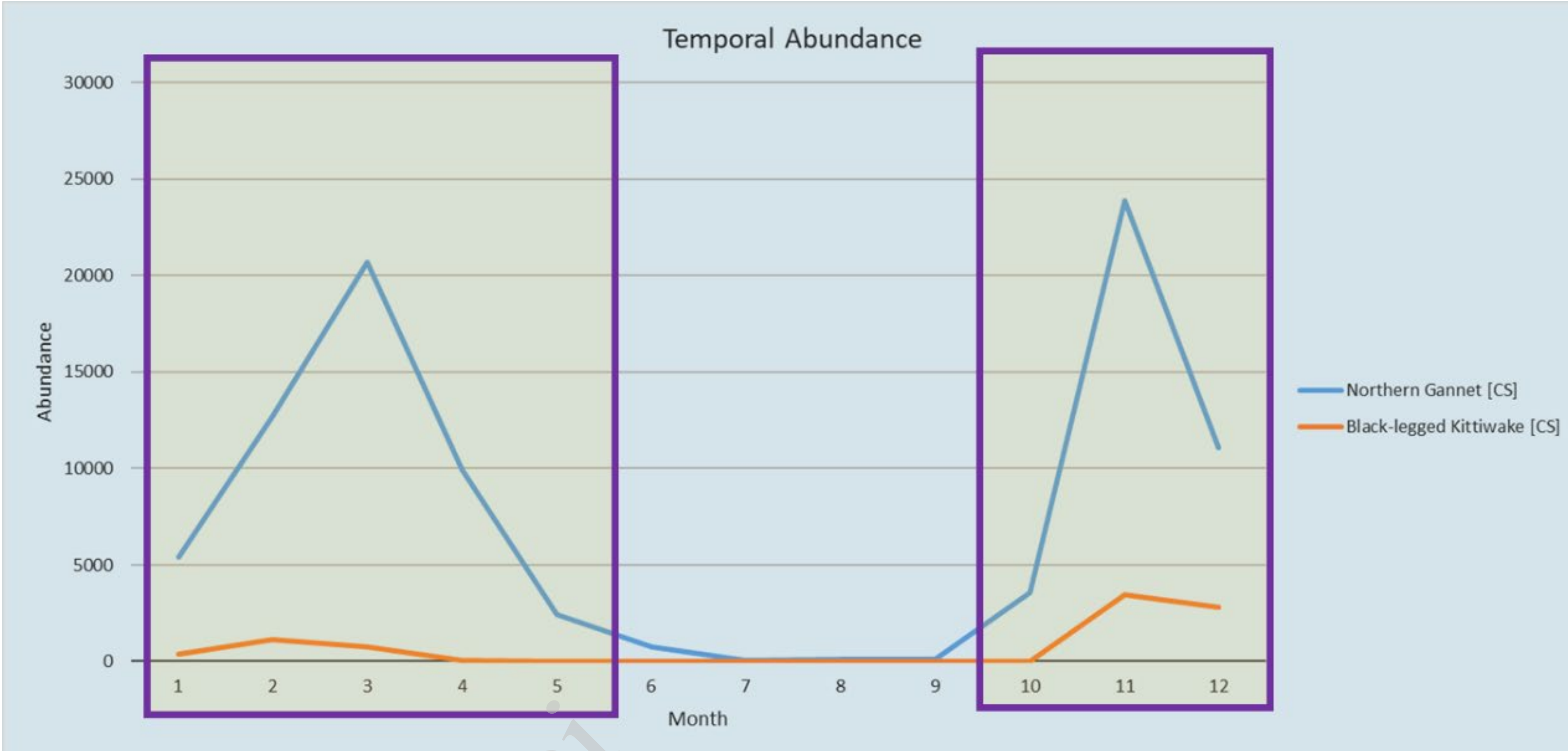

Figure 2–5. Times of peak abundance for collision-sensitive (CS) bird species

Data derived from Williams et al. (2015); O'Connell et al. (2011); NJDEP (2010); Normandeau and APEM (2019); APEM and Normandeau (2020).

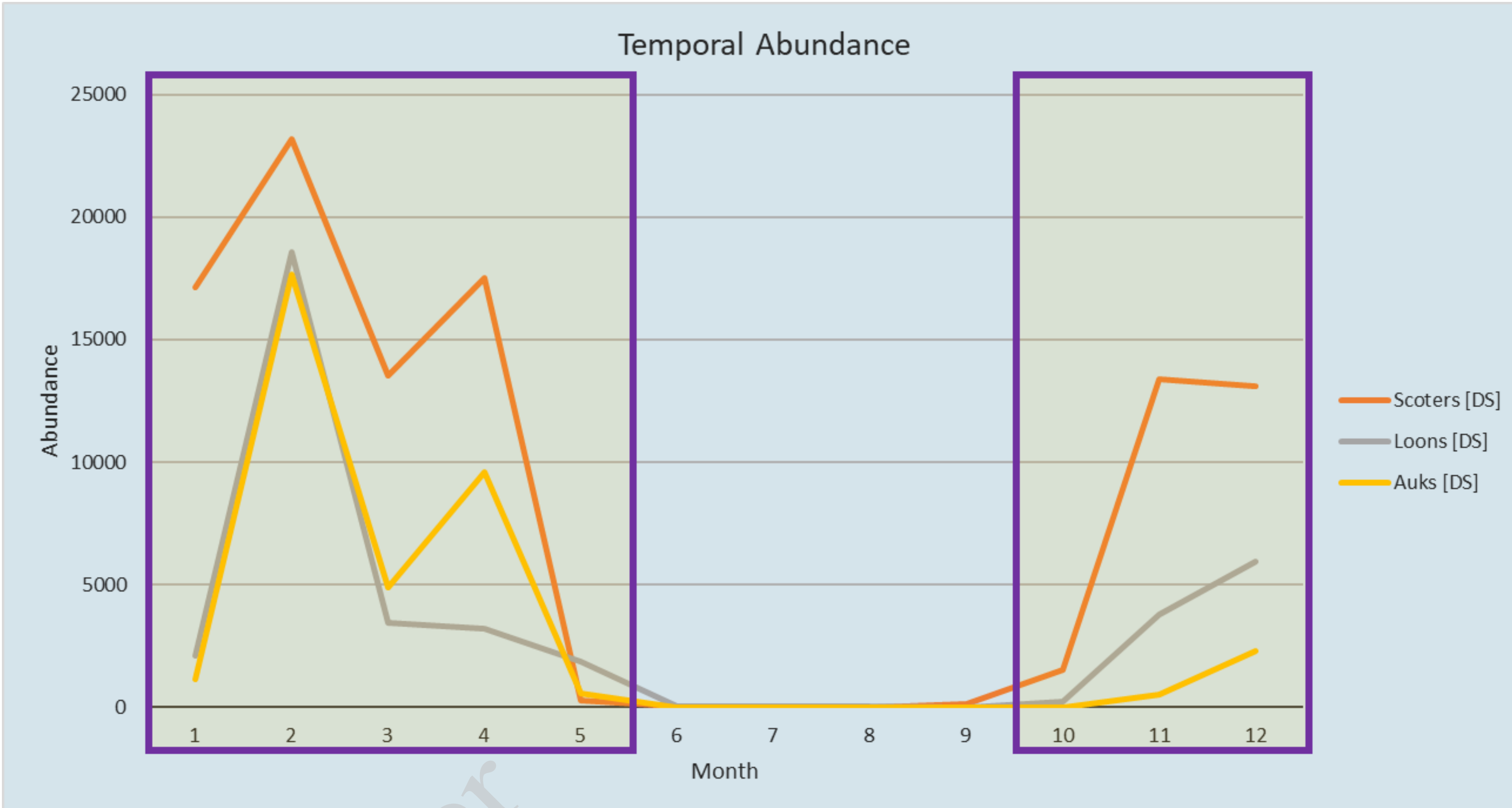

Figure 2–6. Times of peak abundance for displacement-sensitive (DS) bird species

Data derived from Williams et al. (2015); O'Connell et al. (2011); NJDEP (2010); Normandeau and APEM (2019); APEM and Normandeau (2020).

Table 2–2. Months of Peak Occurrences for Mammal Species Presence Offshore New Jersey

Green shading represents proposed survey months

Month	Species							
	North Atlantic Right Whale	Humpback Whale	Minke Whale	Fin Whale	Bottlenose Dolphin	Short-beaked Common Dolphin	Harbor Porpoise	Harbor Seal
January		**X**	**X**	**X**		**X**	**X**	**X**
February	**X**	**X**	**X**	**X**		**X**	**X**	**X**
March	**X**	**X**	**X**	**X**	**X**	**X**	**X**	**X**
April	**X**	**X**	**X**	**X**	**X**			**X**
May	**X**	**X**		**X**	**X**			
June		X		X	X			
July		X		X	X			
August		X		X	X			
September		X		X	X			
October	**X**	**X**		**X**	**X**			
November	**X**	**X**		**X**		**X**		
December	**X**	**X**	**X**	**X**		**X**		**X**

Data Source: Baumgartner et al. (2020); Davis et al. (2017); NJDEP (2010); Whitt et al. (2013)

2.2 Tracking *rufa* Red Knot Movements in the U.S. Atlantic Using Satellite Telemetry

Red knots are a nocturnally migrating species that occur along the East Coast of the U.S., which makes aerial digital surveys an unsuitable surveying platform. There are three different subpopulations of red knots present in and around the Delaware Bay, and each subpopulation has a slightly different migratory strategy (Piersma et al. 2005; Buehler and Piersma 2007; Loring et al. 2018; Baker et al. 2020). All subpopulations breed in the Arctic and make long, mid-, and short-distance migrations, wintering in the Southern Coastal Regions of South America as far south as Tierra del Fuego (Piersma et al. 2005). High proportions of the populations use overlapping migration staging locations during their journey (Buehler and Piersma 2007; Loring et al. 2018;

Baker et al. 2020). During the southbound migration in the fall, stopover sites within the U.S. Atlantic Coast include Cape Cod and sites in New York and New Jersey. During northbound migration in the spring, birds arrive along the Atlantic Coast with the highest concentration of red knots occurring in the Delaware Bay due to the abundance of horseshoe crab eggs, a critical food supply (Buehler and Piersma 2007; Loring et al. 2018; Baker et al. 2020).

While broad patterns in migration routes and behavior of red knots have been documented by tracking and banding studies (Burger et al. 2012; Loring et al. 2018; Niles et al. 2010), fine-scale information is still lacking on the routes, altitudes, timing, and environmental conditions associated with flights over the Atlantic OCS. Tracking data from geolocator studies indicate that offshore wind facilities on the Atlantic OCS may pose some risk to red knots during migration, and similar conclusions were drawn during development of conceptual risk models (Burger et al. 2011; Burger et al. 2012; Gordon and Nations 2016).

Recent advances in light-weight satellite tracking technology now make it possible to collect high-resolution, three-dimensional movement data of small-bodied shorebirds in offshore environments. Such fine-scale information is needed to refine assessments of exposure to the Lease Area and to improve estimates of collision risk. We are using satellite telemetry to track movements of *rufa* red knots to address the following objectives:

1. Estimate flight paths and altitudes of *rufa* red knots departing from migratory staging areas along the U.S. Atlantic Coast during fall migration.
2. Assess movements of *rufa* red knots in the Lease Area relative to meteorological conditions (i.e., wind speed, wind direction, visibility, precipitation) and temporal effects (e.g., time of day, date).
3. Summarize exposure of *rufa* red knots to the Lease Area.

2.2.1 Transmitter Specifications

We have completed field efforts to enable us to track the movements of approximately 30 red knots during fall migration using PinPoint Argos-75 GPS Transmitters (Lotek Wireless, Ontario, Canada). Transmitters weigh 4.1 g and measure 25 × 14 × 7 mm, with a 5-cm GPS antenna and 23-cm Argos antenna. Each transmitter weighed <3% of the average body mass of tagged red knots (approximately 130 g). Thus far, each successfully deployed transmitter has collected between 40 and 80 GPS locations on a user-customized schedule. Estimated accuracy of positions is within 10 m for 2-D location estimates and within 20 m for altitude estimates (M. van den Tillart, Lotek, pers. comm., September 2020). Transmitters were programmed to optimize data collection during periods when migratory departure was most likely to occur (e.g. within four hours of local sunset) to increase the likelihood of collecting location data while birds were off shore. Location data are being relayed online via the Argos satellite system (https://www.argos-system.org/).

2.2.2 Capture, Banding, and Transmitter Attachment

Capture took place in coastal New Jersey at Brigantine Natural Area in Atlantic County (39°26'35"N, 74°19'45"W) and Stone Harbor Point in Cape May County (39°01'47"N, 74°46'31"W). Target timing for captures was 15 July to 15 September 2020 to maximize the number of transmitters deployed on long-distance red knots that were likely to depart from the Atlantic Coast by mid-September (L. Niles, pers. comm.).

Red knots were captured using cannon nets, removed immediately from the net, and placed in dark, secure boxes until processing. Each red knot was banded with one standard metal band and a colored leg flag engraved with a unique alpha-numeric combination. Red knots captured in the U.S. are marked with a light green flag with black characters.

Morphometric data was collected from all individuals using standard protocols including measurements of bill (±0.1 mm), head and bill (±0.1 mm), flattened wing chord (±1 mm), and mass (±1 g); fat condition score; and examination of feather molt. Age class was determined by plumage characteristics and molt with birds classified as either Hatch Year, Second Year, After Hatch Year, or After Second Year.

Transmitters were attached to red knots (n=30) by clipping a small area of feathers from the synsacral region and gluing the tags to the feather stubble and skin with a cyanoacrylate gel adhesive. This glue method has been used on red knots to secure radio tags in the past with no evidence of adverse effects on behavior (Loring et al. 2018). All capture, marking and transmitter-attachment activities were conducted under the direction of L. Niles (Bird Banding Laboratory Permit #22803). Transmitters are anticipated to fall off the birds within three months of attachment (Loring 2016).

Analyses of data should allow:

1. Mapping of movement patterns and flight altitudes of red knots in the U.S. Atlantic Region.
2. Summarizing meteorological conditions and timing of offshore flights in the Atlantic OCS.
3. Estimating exposure of red knots to the Lease Area.

2.2.3 Survey Timing

Netting, banding, and tag deployment were timed to capture southbound migrants just prior to their anticipated departure. Departure timing and likely migration route can be inferred by weight and molt (Harrington et al. 2010; L. Niles, pers. comm.), and long-distance migrants were targeted as these are most likely to travel over the WTA. However, it is likely that individuals do not exactly fit this profile and that some of the medium and shorter distance migrants were captured. All subpopulations are in the New Jersey area between mid-July and late September, depending on breeding success and staging timing. All tagging occurred in August.

2.3 Offshore Bats and Boat-based Bat Acoustic Surveys

To determine species composition and relative abundance and further understand the patterns of distribution as they relate to weather conditions, we are collecting broad-spectrum bat acoustic data using an ultrasonic detector installed on vessels active throughout the Lease Area between July and October 2020. All bat acoustic data will be georeferenced with associated date and time information and correlated with the research vessel's real-time weather data.

3 Data Management

3.1 Aerial Digital Surveys

For aerial digital imagery data, each aerial survey will be managed by the camera technician. The camera technician will upload flight plans to the camera system, select which line to capture, adjust the camera exposure settings accordingly and be responsible for inflight Quality Assurance of the captured imagery.

Upon completion of each flight, all images will be securely saved and backed up on a local data processing computer. At this point, multiple copies of the data will be created and cross-checked.

Management of the data will be overseen in the U.S. with a secondary data manager in the UK. The Team has appropriate workflows in place to ensure the rapid transportation and processing of data. Once those data have been processed and screened for potential targets, data will be accessible to the Team's taxonomic experts for completion of species identification and associated QA/QC of the data and processing.

By the end of the project, the entire library of georectified target images and associated data and analyses (including all approved reports) will be accessible to Atlantic Shores collaborators for view and download through Normandeau's dedicated web portal at ReMOTe.normandeau.com.

3.2 Tracking *rufa* Red Knot Movements using Satellite Tracking

The Argos satellite tracking system streams the satellite data, which can be downloaded in Excel format. These data will be manipulated using R version 4.0.0 and delivered using an interactive R Shiny data visualization dashboard providing individual X, Y, and Z coordinates. These manipulated data will be stored and managed and accessible to Atlantic Shores collaborators through Normandeau's dedicated web portal at ReMOTe.normandeau.com.

3.3 Boat-based Bat Acoustic Surveys

Hard drives from the bat sensors are backed up and shipped to Normandeau for analysis. Data are stored on a secure server and are accessible to analysts and the project team via Normandeau's dedicated web portal at ReMOTe.normandeau.com. Visualizations of location, species, and associated weather will be accessible to Atlantic Shores collaborators through ReMOTe.normandeau.com.

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