Offshore Bat Monitoring and Detections

Maryland Offshore Wind Project
Lease OCS-A 0490

August 2022

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TABLE OF CONTENTS

Section **Page**

EXECUTIVE SUMMARY III

1.0 INTRODUCTION 1

2.0 MATERIALS AND METHODS 1

2.1 Background Research 1
2.2 Study Area 2
2.3 Monitoring Period 1
2.4 Equipment 2

3.0 DATA ANALYSIS 3

3.1 Measures of Bat Activity 3
3.2 Bat Species Composition 3
3.3 Bat Activity and Seasonality 5
3.4 Bat Activity and Proximity 5

4.0 RESULTS 7

4.1 Equipment Performance 7
4.2 Measures of Bat Activity 7
4.3 Bat Activity and Species Composition 12
4.3.1 *Brooks* 12
4.3.2 *Emma* 12
4.3.3 *Regulus* 13
4.4 Bat Activity and Seasonality 14
4.5 Proximity Analysis by Species 16

5.0 SUMMARY 19

6.0 LITERATURE CITED 19

TABLES

Table 1. Acoustic Bat Monitoring Periods by Vessel 1
Table 2. Species and Acoustic Call Grouping Acronyms and Names Observed Throughout Survey 4
Table 3. *Brooks* Species Composition 12
Table 4. *Emma* Species Composition 12
Table 5. *Regulus* Species Composition 14
Table 7. Combined Proximity Analysis by Species 18

FIGURES

Figure 1. Study Area depicting Lease Area, Port Area, and Offshore Area........ 3
Figure 2. Photograph of Microphone and Reflector Plate Depicting the Correct Orientation of the Device 2
Figure 3. Microphones installed on the *Brooks* and *Emma*........ 3
Figure 4. Bat Detections by Vessel........ 6
Figure 5. *Brooks* Time of Night Plot of Activity. 9
Figure 6. *Emma* Time of Night Plot of Activity. 10
Figure 7. *Regulus* Time of Night Plot of Activity. 11
Figure 8. Frequency (k band) versus time (seconds) graph of a Mexican Free-tailed Bat..13
Figure 9. Bat Detections by Species per Month of Survey 15
Figure 10. Bat Detections by Species........ 17
Figure 11. Bat Detections and Distance (mi) by Species........ 19

EXECUTIVE SUMMARY

US Wind, Inc. (US Wind) is developing the Maryland Offshore Wind Project (the Project), an offshore wind energy project of up to approximately two gigawatts (GW) of nameplate capacity within OCS-A 0490 (the Lease), a Lease area of approximately 80,000 acres located off the coast of Maryland on the Outer Continental Shelf.

Offshore bat monitoring was opportunistically undertaken using vessels conducting other surveys for the Project to determine if bats and bat patterns occur in the Lease area. The Lease area is located on the OCS within the Atlantic Ocean, approximately 10.5 miles offshore Ocean City, Maryland. For the purposes of this document, all distances are referred to as statute miles, unless stated otherwise.

Bat activity off the shores of the Delmarva Peninsula in the Atlantic Ocean was documented using ultrasonic detectors mounted on three offshore geophysical survey vessels between March and October 2021, April and November 2021, and December 2021 and April 2022. Individual bat echolocation detections totaled 148. Individual bats cannot be distinguished acoustically; therefore, the aggregate number of recorded bat detections do not necessarily indicate the true number of bats present. Although recorded bat detections do not indicate the number of bats present within a given period of time, the metric provides a useful measure of bat activity.

The association between bat activity, observation of species, time of year, and proximity from shore was investigated. Maximum detection distance from shore was 26.26 miles (mi), and mean distance was 3.4 mi. The most frequently detected bat was identified as Eastern Red Bat (*Lasiurus borealis*; LABO), representing 51% of bats identified to species or species group. Calls categorized as no identification (NOID) are defined as distinct bat detections, although the recording was not clear enough to be identified to the species level. These NOID detections represented 34% of detections. The remaining 15% of detections comprise of 9% Mexican Free-tailed Bat (*Tadarida brasiliensis*; TABR), 4% Silver-haired Bat (*Lasionycteris noctivagans*; LANO), and 2% Big Brown Bat (*Eptesicus fuscus*; EPFU). The results of this survey show that as distance from shore increases, number of bat species and bat detections decrease. Bat detections in the Lease area represented approximately 9% of all bat detections. The highest density of bat detections occurred in late summer, which coincides with seasonal migratory bat patterns.

1.0 Introduction

ESS Group, LLC (ESS), a TRC Company, conducted acoustic bat monitoring for the Maryland Offshore Wind Project. This survey included the recording of bat call and Global Positioning System (GPS) data to monitor bat activity and position during the deployment of three marine survey research vessels *R/V Brooks McCall (Brooks), R/V Emma McCall (Emma),* and *M/V Regulus (Regulus).*

2.0 Materials and Methods

2.1 Background Research

Bat mortality caused by terrestrial wind-power structures has been studied to a greater extent compared to those caused by offshore developments. The New Jersey Ecological Baseline Study is the main source of offshore bat activity research in the mid-Atlantic. The survey includes results for bats over the New Jersey Lease area offshore New Jersey out to 23 mi (NJDEP 2010). Anabat II detectors were deployed on vessels in March-June and August-October of 2009. During the March, April and June surveys, no bats were detected. In May, one bat, likely a Big Brown or Silver-haired Bat was detected. As the survey progressed into the late summer and early fall, bat detections increased. Eastern Red Bats were the most detected bat species. The mean detection distance from shore was 6.59 mi and the farthest distance was 11.93 mi (NJDEP 2010).

Between 2012 and 2014, an acoustic survey of bat activity on islands, offshore structures, and coastal sites in the Gulf of Maine, mid-Atlantic, and Great Lakes regions was conducted (Stantec 2016). The purpose of the research was to understand where and when bats occur offshore. The survey recorded bat detections more than 180 miles off the shore of New Jersey; however, a statistically significant decline in bat activity was documented as distance from shore increased. Additionally, the study suggests that bats only occur offshore during migration and foraging due to the absence of suitable offshore roosting habitat. Therefore, it is suggested that bat activity offshore is less frequent compared to terrestrial sites.

Throughout the Mid-Atlantic Baseline Studies (MABS), twelve visual observations of presumed Eastern Red Bats were recorded off the coast of New Jersey, Delaware, and Virginia in the month of September. All observations were documented between approximately 10 and 44 mi from shore, with an average of 19 mi.

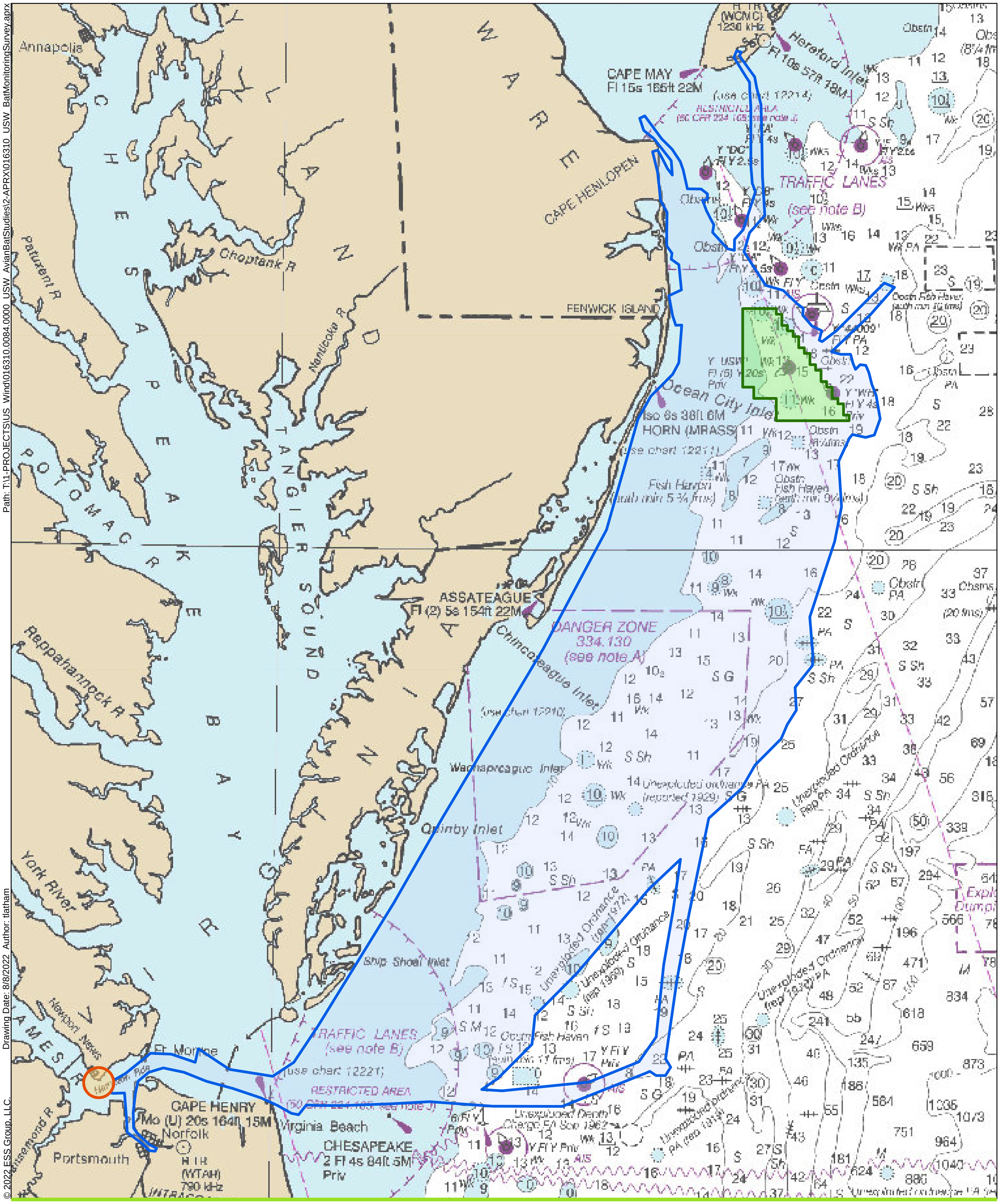
Research conducted on bat migration and seasonality was reviewed. Eastern Red Bats typically are found migrating south in areas north of New York City around June (Cryan 2003). This seasonal pattern would result in this species migrating south along the shorelines of Maryland in late summer and early autumn. Big Brown Bats are most active on the Atlantic Coastal Plain in the summer months (Sjollema et al. 2014). Silver-haired female bats are known to move south into areas occupied by males during the late summer and early autumn (Cryan 2003). Mexican

Free-tailed Bats could occur in portions of the mid-Atlantic region (Stantec 2016). The majority of migratory Mexican Free-tailed (TABR) are pregnant females, while the male bats largely reside in Mexico. After the young are born in late-May to mid-June, adult females leave the maternity caves and migrate farther north before the southward migration begins in August and September (Zubaid, McCraken, and Kunz 2006).

Little work has been done to study the effects of offshore lighting on migratory bat species. In a synthesis of studies of bat fatalities at onshore wind energy facilities, it was found that lighting, or lack thereof, did not influence bat mortality (Arnett et al. 2011).

2.2 Study Area

Although the survey primarily focused on activities in the Lease area and export cable corridors, the bat detectors were operational and recording when the vessels had power; therefore, detections were observed in port, in the offshore environment, and in the Lease area. Three areas were developed to categorize proximity and bat activity: in port, offshore, and in Lease area (**Figure 1**). Port detections are defined as detections recorded within three miles from the Fairleads Shipyard in Newport News, VA. Offshore detections are defined as all detections recorded in the marine environment excluding detections in the port and Lease area. Lease area detections are defined as detections recorded within the boundaries of the Lease area. The Lease area is about 10.5 miles offshore of Maryland and encompasses approximately 124 square miles (79,616 acres) (**Figure 1**).



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0 5 10 15 Miles

Maryland Offshore Wind Project
Offshore Maryland and Delaware

Lease Area
Port Area
Offshore Area

Source: 1) ESS, GPS Locations, 2021
2) NOAA, Chart 13003, 07/11/2022

Study Area

Figure 1

2.3 Monitoring Period

The monitoring period coincided with the high resolution geophysical (HRG) and geotechnical surveys of the Lease area. An Anabat Swift bat detector was deployed on the *Brooks* between March 31, 2021 and October 21, 2021. The *Emma* Anabat Swift was deployed between April 25, 2021 and November 5, 2021. Finally, an Anabat Swift was deployed on the *Regulus* between December 14, 2021 and April 23, 2022 (**Table 1**).

Table 1. Acoustic Bat Monitoring Periods by Vessel			**2021**										**2022**			
Vessel	**Start Date**	**End Date**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Jan**	**Feb**	**Mar**	**Apr**
R/V Brooks McCall	03/31/2021	10/21/2021														
R/V Emma McCall	04/25/2021	11/05/2021														
M/V Regulus	12/14/2021	04/23/2022														

2.4 Equipment

One Anabat Swift Bat Detector with zero-crossings analysis interface modules for acoustic monitoring was deployed on each vessel. These units are broadband, frequency-division detectors sensitive to sound up to 250 kilohertz (kHz). Each detector was equipped with a Swift Stainless Directional Microphone and two 32 gigabyte (GB) Memory Secure Digital High Capacity (SDHC) Cards. The SDHC cards were checked at each data download and replaced when it was close to capacity. Each Anabat Swift Bat Detector was housed inside a waterproof pelican case which was attached to the second aft deck of each survey vessel. A ten-meter (m) microphone extension cable connected the detector to the directional ultrasonic microphone, which was mounted with a sonic reflector plate and faced the stern of each vessel (**Figure 2**). The device was powered by a lithium 12-volt three-amp battery. The microphone height above sea surface for each Anabat Swift was recorded to be 23 ft, 26 ft, and 46 ft for the *Brooks*, *Emma*, and *Regulus*, respectively. The bat detectors on the *Brooks* and *Emma* were initially programed to start recording half-an-hour before sunset and stop half-an-hour after sunrise. However, in April 2021, both bat detectors were reprogrammed to run 24 hours per day to capture potential daytime bat activity. The bat detector on the *Regulus* was programed to record 24 hours per day throughout the duration of survey. Each unit was calibrated by Titley Scientific (United States), prior to deployment.

Figure 2. Photograph of Microphone and Reflector Plate Depicting the Correct Orientation of the Device

Figure 3. Microphones installed on the *Brooks* and *Emma*

3.0 Data Analysis

3.1 Measures of Bat Activity

Data recorded from the bat detectors was downloaded periodically and files were inspected to determine sufficient quality for species identification. Each potential detection file consisted of a brief (generally less than 15 seconds) time-stamped time/frequency plot. Time-of-night plots were generated for each vessel to portray time and bat activity (Section 4.2). The aggregate number of recorded bat detections do not necessarily indicate the number of bats recorded by the bat detector, as individual bats can be detected repeatedly. Due to this possible bias, all echolocations recorded within one minute were also identified as the same individual, and as a single detection. Echolocations recorded greater than one minute apart were identified as separate individuals. Other measures of bat activity include percent of detection dates per dates deployed and number of detections per month.

3.2 Bat Species Composition

Titley Scientific performed the bat call identification by analyzing the detail of the shape of pulses and temporal patterns for each detection. The recordings are examined in Analook version 4.6i, using a time magnification of five milliseconds per eight screen pixels and a logarithmic vertical (frequency) axis covering eight to 120 kHz. The initial view of each recording is compressed in a manner such that the time between echolocation pulses is not displayed. A truetime display shows the actual time between pulses; therefore, truetime views are used to assess the temporal patterns of bat calls if a bat call sequence is found. A bat detection can be identified to species level if two “pulses” in the ultrasonic range suitable for bats in the region are observed. Identification to species, where possible, is achieved by using a combination of the temporal patterns, call frequencies and call shapes, where the shape is how the frequency changes with time within a pulse. Periodically, recordings contained definite bat noises, but did not contain enough detail to identify to species level.

Using the echolocation data recordings, acoustic calls of four species were identified: Big Brown Bat (*Eptesicus fuscus*; EPFU), Eastern Red Bat (*Lasiurus borealis*; LABO), Silver-haired Bat (*Lasionycteris noctivagans*; LANO), Mexican Free-tailed Bat (*Tadarida brasiliensis*; TABR) (**Table 2**). Additionally, six groupings were created to categorize acoustic calls by frequency and are represented as no identification (NOID) hereafter. The six groupings are defined as follows: bat (definite bat detection because of the temporal pattern), q25 (either LABO, LANO, TABR or Hoary Bat (*Lasiurus cinereus*), call frequency about 25 kHz), q30 (likely LABO or one of the q25 species, call frequency about 30 kHz), q35 (most probably LABO, call frequency about 35 kHz), q40 (most probably LABO, call frequency about or above 40 kHz), qMY (potentially Myotis, but does not fit any of the local, likely species, except perhaps the *Myotis leibii* (eastern small-footed bat)) (**Table 2**).

Table 2. Species and Acoustic Call Grouping Acronyms and Names Observed Throughout Survey

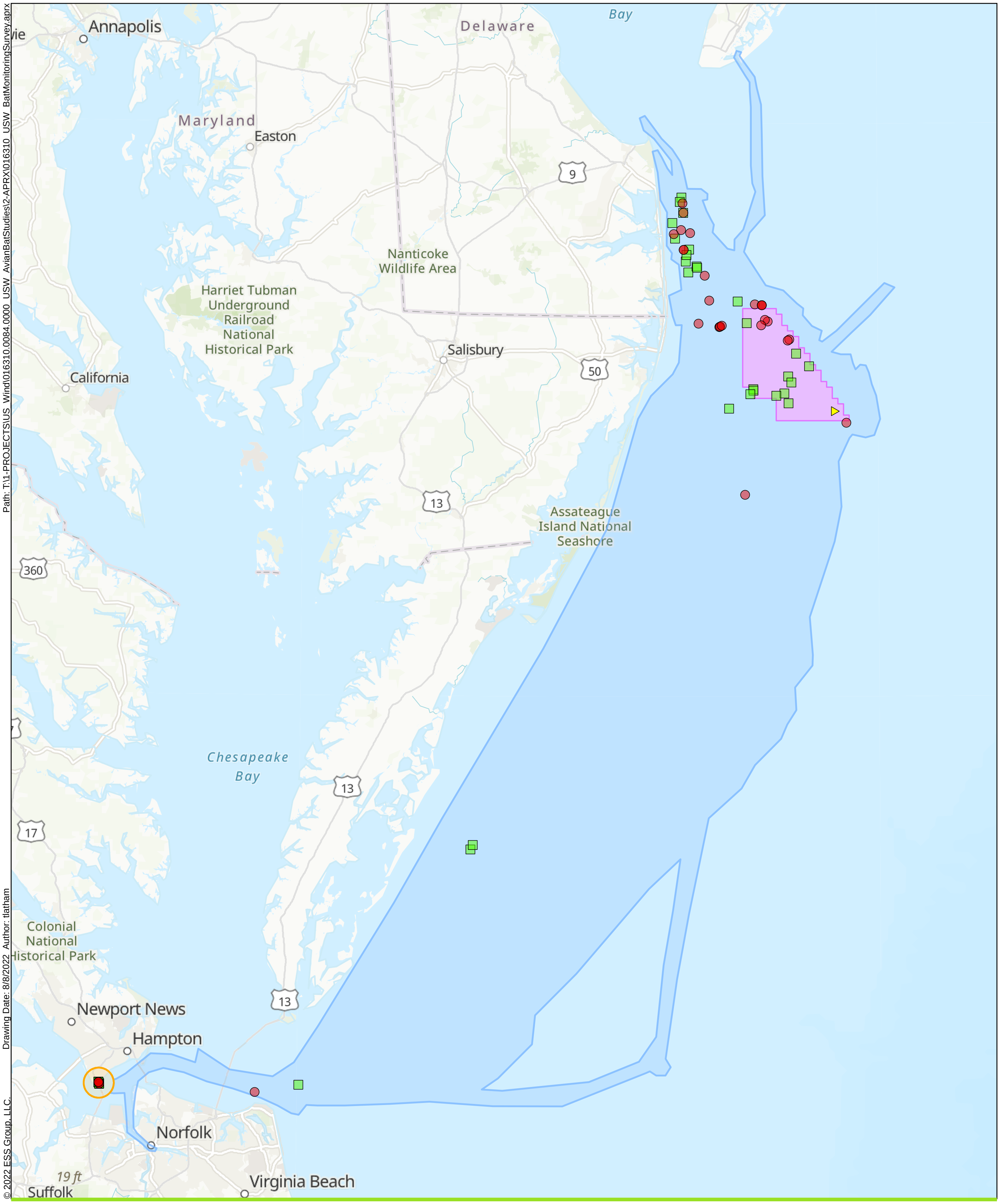
Acronym	Species Name
EPFU	Big Brown Bat
LABO	Eastern Red Bat
LANO	Silver-haired Bat
TABR	Mexican Free-tailed Bat
NOID	Bat, q25, q30, q35, q40, qMY

3.3 Bat Activity and Seasonality

Each echolocation data point is associated with a bat species and a date and time stamp. Frequency of bat activity in relation to months was determined throughout the duration of the survey. The bat detections were further broken down to species.

3.4 Bat Activity and Proximity

A proximity analysis of bat species to the shoreline was conducted to observe spatial pattern in bat species activity. A GIS analytical method used the time and date associated with each detection and GPS coordinates from the vessel track-logs to measure each detection's distance from shore. Shoreline for the proximity analysis was developed by manually digitizing a polyline superimposed on recent aerial photography at a scale of approximately 1 (inch):1,250 (feet). This scale provided sufficient resolution for an accurate placement of the polyline with a high level of detail valuable for the analysis. Due to the requirements of the analysis, the shoreline polyline was then converted into a sequential series of points at 100-foot and one-foot intervals and used in the analysis along with the vessel position data. Three areas were developed to further categorize proximity and bat activity: in port, offshore, and in Lease area (**Figure 4).**



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Drawing Date: 8/8/2022 Author: tlatham

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0 5 10 15 Miles

Maryland Offshore Wind Project
Offshore Maryland and Delaware

Source: 1) ESS, GPS Locations, 2021
2) ESRI, World Topographic Map

Bat Detection by Vessel
- Detected by M/V Regulus
- Detected by R/V Brooks McCall
- Detected by R/V Miss Emma McCall

- Lease Area
- Port Area
- Offshore Area

Bat Detections by Vessel

Figure 4

4.0 Results

This section documents the results of the survey in terms of equipment performance, bat activity and species composition, seasonality, and proximity from shore.

4.1 Equipment Performance

The Anabat Swift Bat Detectors were effective in recording bat calls during the bat monitoring period (**Table 1**). The devices remained well calibrated throughout the duration of the monitoring period; however, the most common problems that arose surrounded the internal GPS systems and the microphone originally installed on the *Emma*.

The Anabat Swift is designed to collect accurate GPS coordinates every time a detection is recorded; however, the device experienced inconsistencies with recording the GPS data. Therefore, the Anabat Swift's GPS was unreliable; and required the date and time of detections to be cross-referenced with the coordinates from vessel tracking logs.

The Swift Microphone set up on the *Emma* experienced internal microphone noise that was resolved by replacing the microphone while at sea. The *Emma* experienced the microphone noise for about two weeks in early July 2021. During this event, a filter was applied to the acoustic data to extract the bat calls within the microphone noise.

During the *Regulus* deployment, a problem in the firmware created a file naming issue. This was resolved by automating an algorithm that corrected the names, dates, and contents of the files.

4.2 Measures of Bat Activity

Time-of-night plots were generated for each vessel to graphically portray time and bat activity (**Figures 5, 6, 7**). These plots demonstrate the temporal boundaries of bat detections.

The vertical axis is the time of night, starting at the bottom at midday and ending at the top at midday. The vertical axis shows a resolution of 5 minutes. The horizontal axis is the date which contains sunset. Times of sunset and sunrise are indicated by orange lines.

The dark grey background indicates when the detector was actively recording, which demonstrates data coverage. Areas that are black indicate that the device was not running. This occurs when the vessel is in port with no power.

Green squares indicate when GPS data was collected by the detector in a GPX file. The size of the symbol is logarithmically related to the number of GPS fixes in that cell. If a cell received a full count of 300 fixes (1 per second) it will contact adjacent blocks to form a solid area.

The blue circles indicate when files were saved by the detector. The size of the symbol is logarithmically related to the number of files recorded in the half-hour cell. Altogether, 27,486 files were recorded on the Brooks, 9,907 on the Emma, and 6,413 on the Regulus. Most of these files contained noise and no bat calls.

The presence of identifiable bats is shown by yellow crosses for Eastern Red Bats (LABO), white circles for Silver-haired Bats (LANO), red triangle pointing left for Big Brown Bat (EPFU), and pink triangle pointing to the right for bats showing features of Mexican Free-tailed Bat (TABR).

Red marks indicate microphone warnings (**Figure 7**). These are unreliable as a guide to microphone malfunction, although the first two days on the *Regulus* show continuous warnings which would usually indicate a problem. However, these warnings were resolved and after the third day and were only found occasionally and generally after a restart of the detector (e.g., after downloading). This pattern was not a cause for concern.

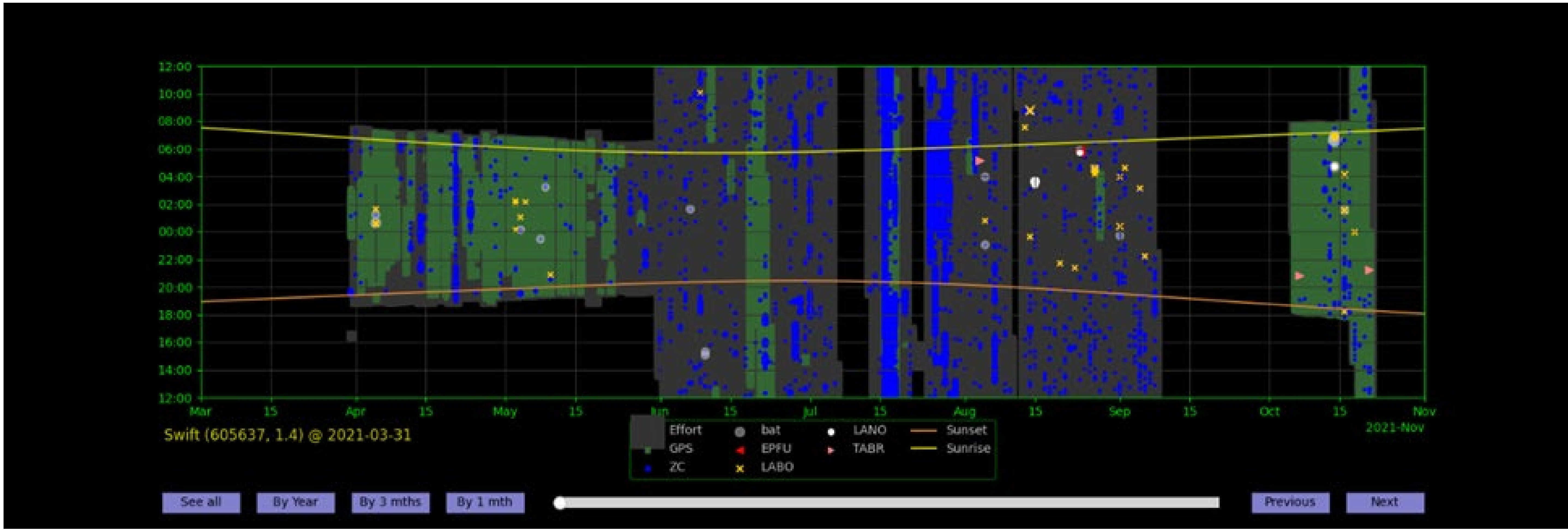


Figure 5. ***Brooks*** **Time of Night Plot of Activity.**

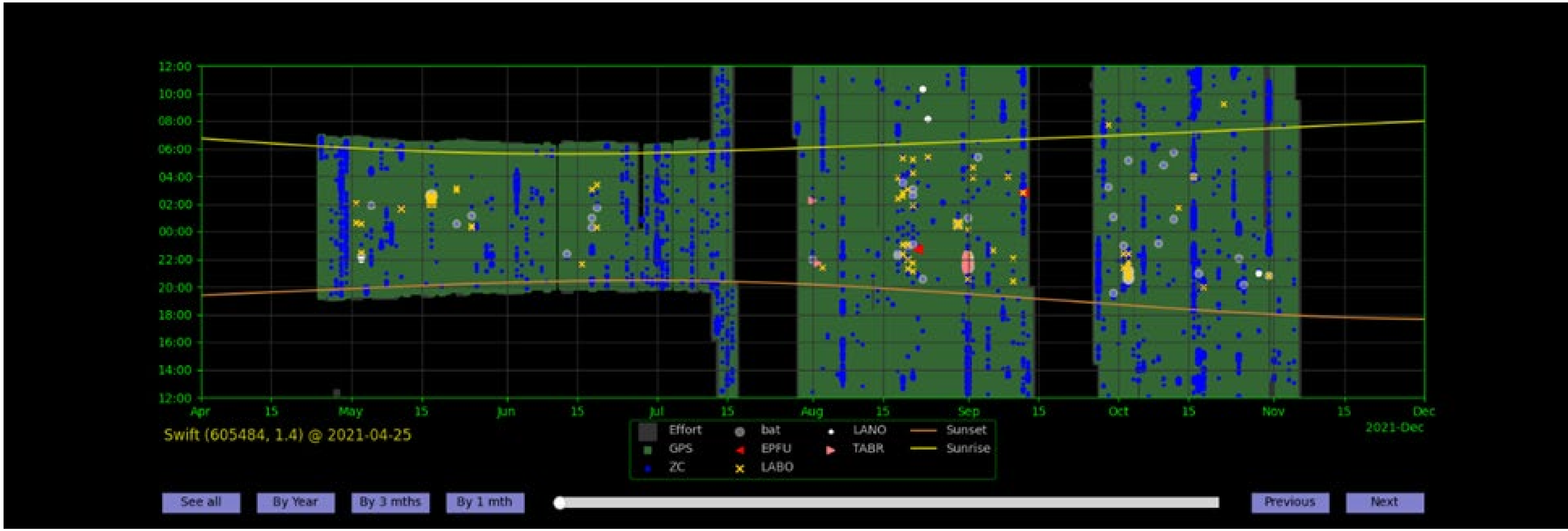


Figure 6. ***Emma*** **Time of Night Plot of Activity.**

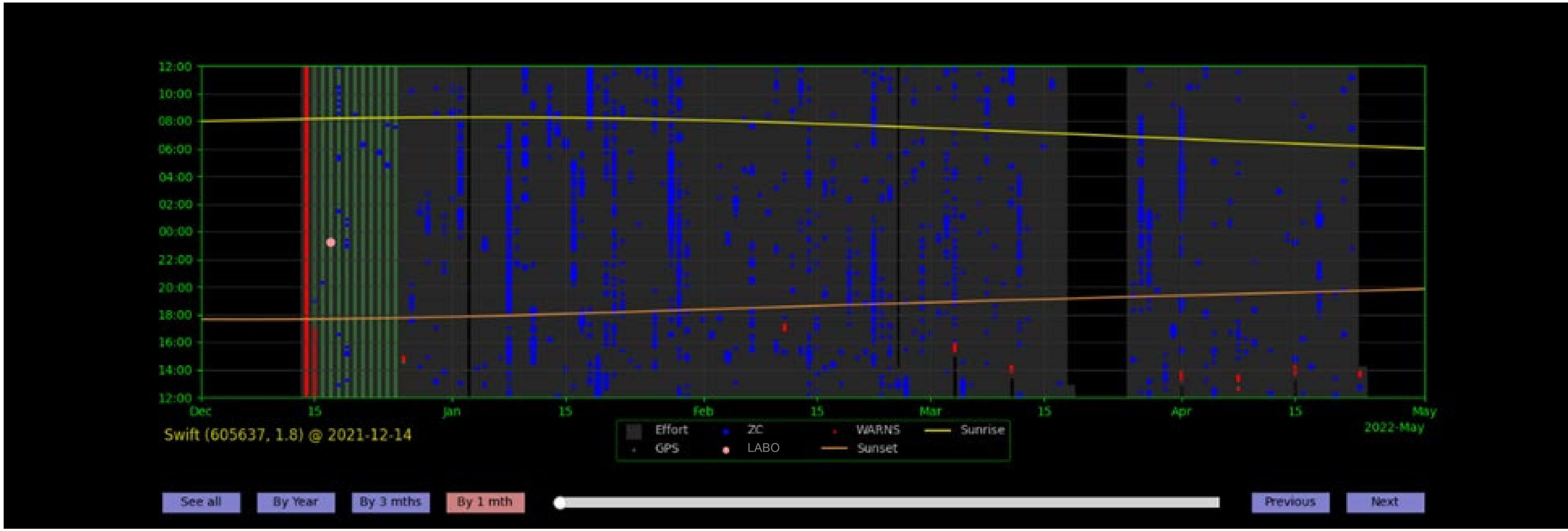


Figure 7. ***Regulus*** **Time of Night Plot of Activity.**

4.3 Bat Activity and Species Composition

The survey recorded 148 bat detections, 65% of which were identified to species. The remaining detections were categorized as NOID.

4.3.1 *Brooks*

The *Brooks* was deployed for 163 dates and recorded 27 detection dates, resulting in 17% detection dates per dates deployed. The *Brooks* detected four species of bats throughout the survey: Big Brown Bat, Eastern Red Bat, Silver-haired Bat, and Mexican Free-tailed Bat. The most common species observed was the Eastern Red Bat, which had 25 total detections (**Table 3**).

Table 3. *Brooks* Species Composition

Species Name	Number of Detections	Percent of Total Detections
Big Brown Bat	1	2
Eastern Red Bat	25	54
Silver-haired Bat	2	4
Mexican Freetail Bat	3	7
NOID	15	33
Total Detections	46	100

4.3.2 Emma

The *Emma* was deployed for 171 dates and recorded 56 detection dates, resulting in 33% detection dates per dates deployed. The *Emma* identified four species of bats throughout the survey: Big Brown Bat, Eastern Red Bat, Silver-haired Bat, and Mexican Free-tailed Bat. The most common species observed was the Eastern Red Bat, which had 50 total detections (**Table 4**).

Table 4. *Emma* Species Composition

Species Name	Number of Detections	Percent of Total Detections
Big Brown Bat	2	2
Eastern Red Bat	50	49
Silver-haired Bat	3	3
Mexican Free-tailed Bat	10	10

Table 4. *Emma* Species Composition		
Species Name	**Number of Detections**	**Percent of Total Detections**
NOID	36	36
Total Detections	101	100

Mexican Free-tailed Bats were observed on both the *Brooks* and *Emma.* Geographically, this species is normally found farther south; however, these bats have expanded their range into western North Carolina, eastern Tennessee, and Virginia as they shift to higher latitudes in response to changing climate (McCracken et al. 2018). Mexican Free-tailed Bats produce a very wide range of call types; however, the sequence represented is more distinctive than most, and unlikely to have been made by any other species (**Figure 8**). A compressed view of the recorded file (left) shows in detail the shapes of the pulses; and an uncompressed view on the right shows the correct temporal patterns. Chris Corben, a bat biologist, with Titley Scientific, who has decades of experience with bat detectors, bat bioacoustics, and bat call identification, has reviewed all collected files and identified bats detected in this study.

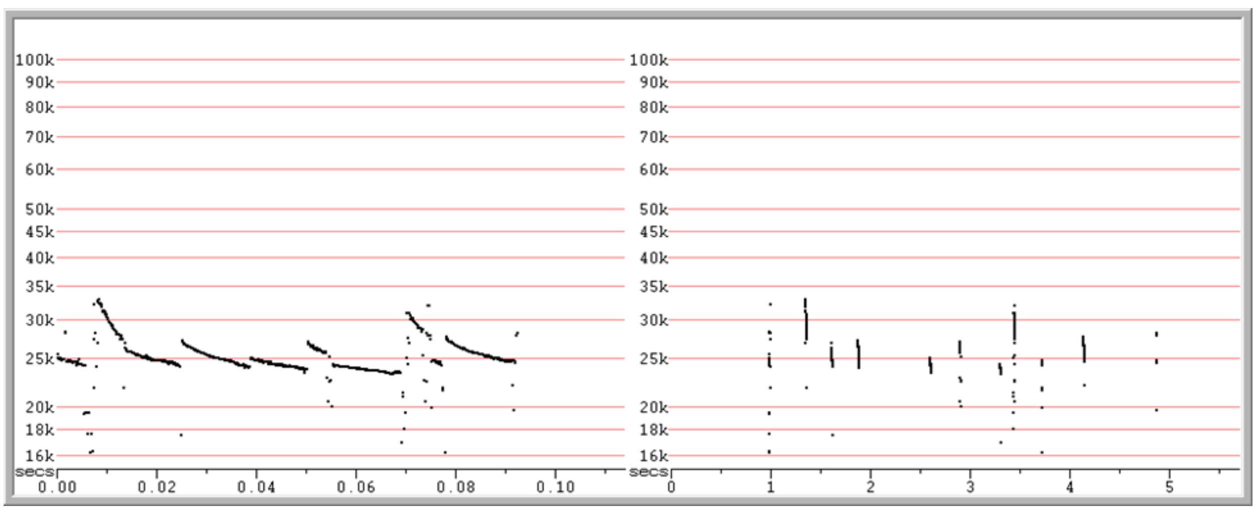


Figure 8. Frequency (k band) versus time (seconds) graph of a Mexican Free-tailed Bat recorded at 02:12 on August 2, 2021, on the *Emma*

4.3.3 Regulus

The Regulus was deployed for 131 dates and recorded 1 detection date, resulting in 0.7% detection dates per dates deployed. The *Regulus* identified a single species of bat through the survey: Eastern Red Bat (**Table 5**).

Table 5. *Regulus* Species Composition	
Species Name	**Number of Detections**
Eastern Red Bat	1

4.4 Bat Activity and Seasonality

Bat detections were compared to time to analyze the seasonality of bat activity. Seasonal patterns and bat activity were observed coinciding with late summer migration.

The months of highest bat detections were August and September (**Figure 9**). Eastern Red Bats detection density was highest in both August and September, while Big Brown Bat and Silver-haired Bats peaked in August, and Mexican Free-tailed Bats peaked in September. Seventy eight percent of all bat detection occurred between August and October 2021. One detection was observed in December 2021. No subsequent detections were identified for the remainder of the survey, which concluded in April 2022. The months of July and November have missing data sets because the vessels were in port with no power for 20 days in July and data collection stopped on October 21, 2021, on the *Brooks* and on November 5, 2021, on the *Emma*. Therefore, a decrease in activity shown in the data during July and November may not be representative.

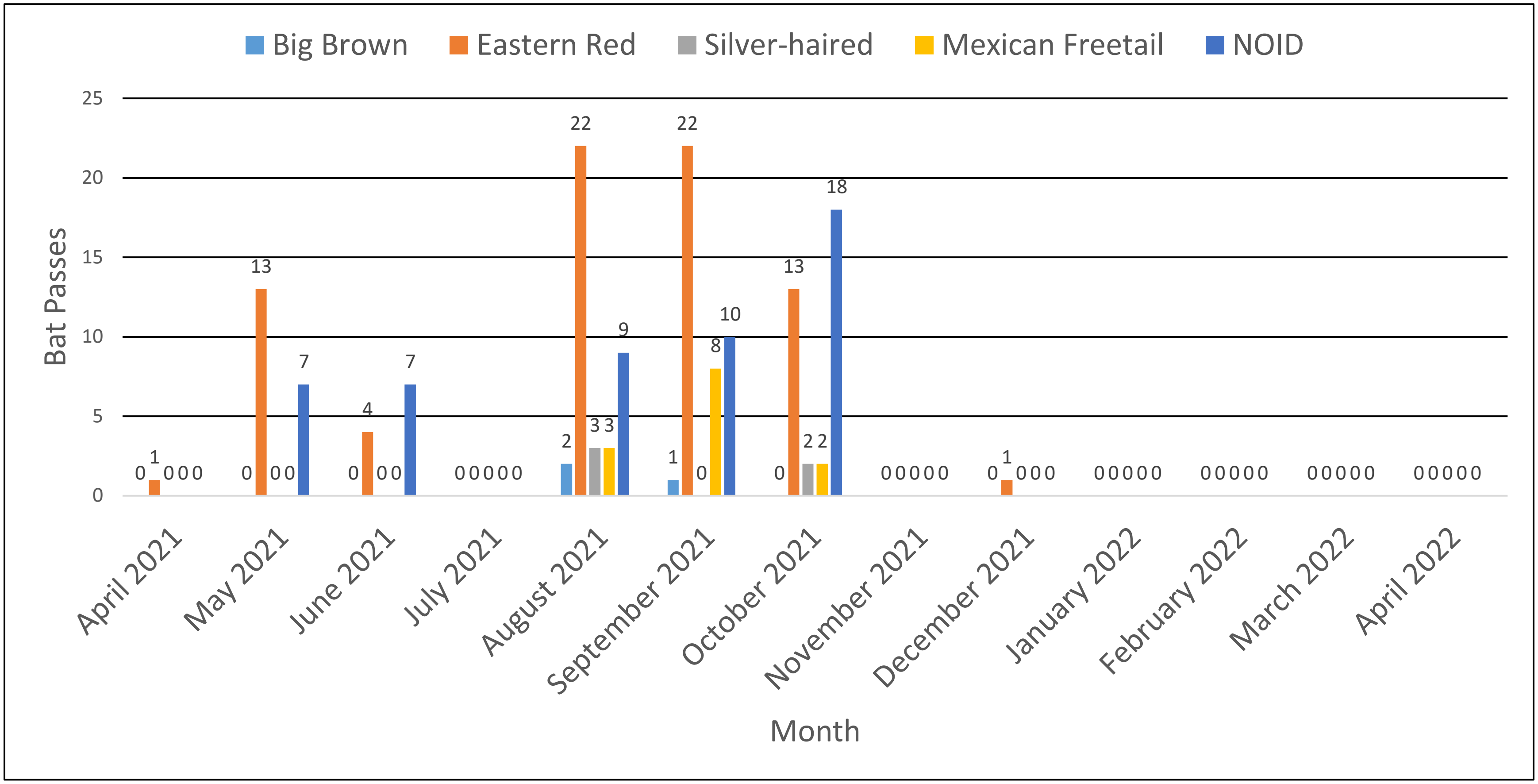
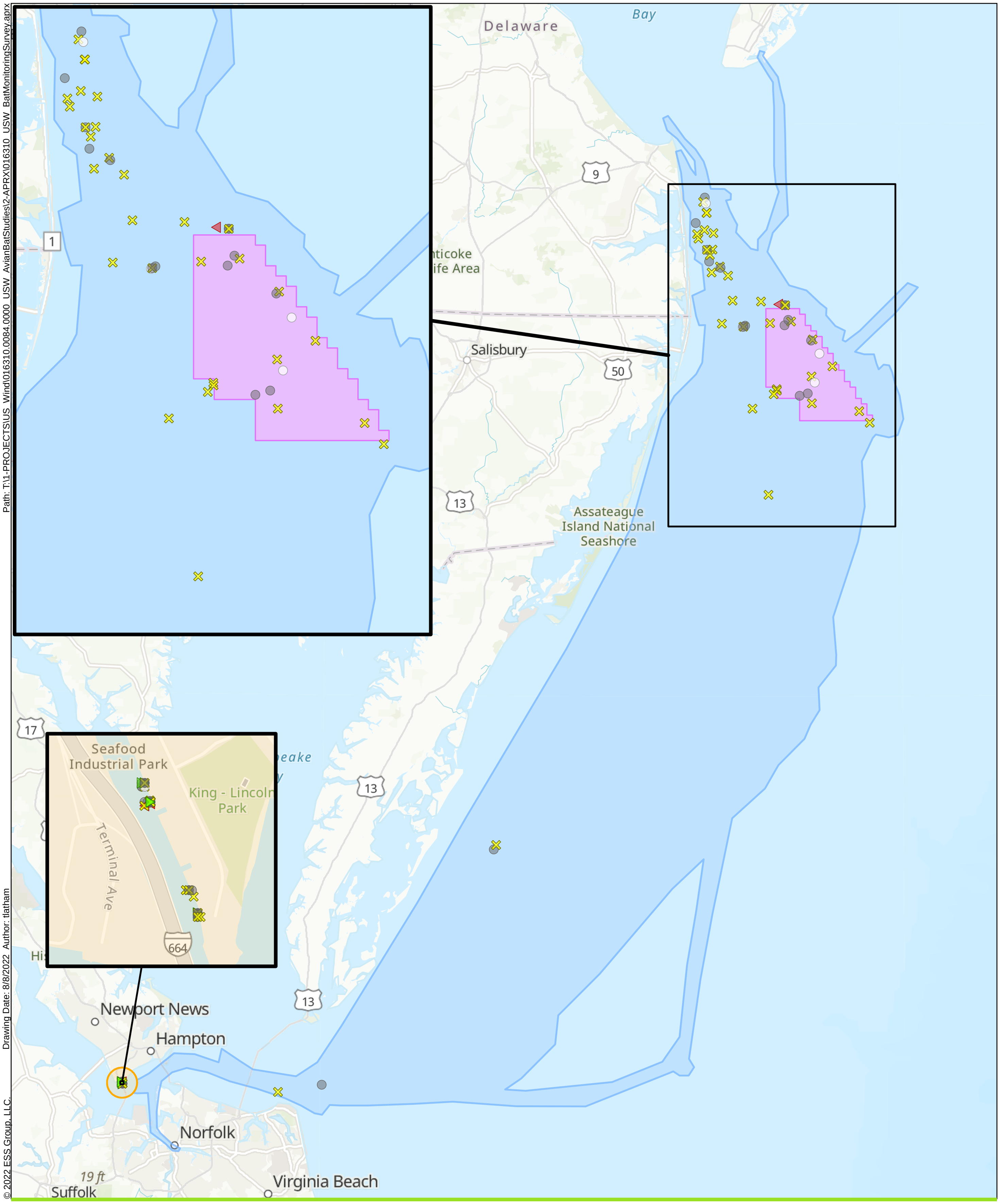


Figure 9. Bat Detections by Species per Month of Survey

4.5 Proximity Analysis by Species

A proximity analysis was performed to measure each detection's distance from shore. Each detection is associated with a coordinate. Using the coordinates, it was determined if a bat was detected in port, offshore, or in the Lease area (**Figure 10, Table 6**). Of those bats identified to species Big Brown, Eastern Red, and Mexican Free-tailed Bats were primarily detected in port. Detections of these three species declined offshore by more than 50%. The Eastern Red Bat observed the most frequently in the Lease area. The Silver-haired Bats were detected equally offshore and in the Lease area. NOID was most commonly detected in port.



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0 5 10 15 Miles

Maryland Offshore Wind Project

Offshore Maryland and Delaware

Source: 1) ESS, GPS Locations, 2021
2) ESRI, World Topographic Map

Bat Detection by Species

- Big Brown Bat
- Silver-Haired Bat
- Mexican Free-Tailed Bat
- Eastern Red Bat
- No ID

- Lease Area
- Port Area
- Offshore Area

Bat Detections by Species

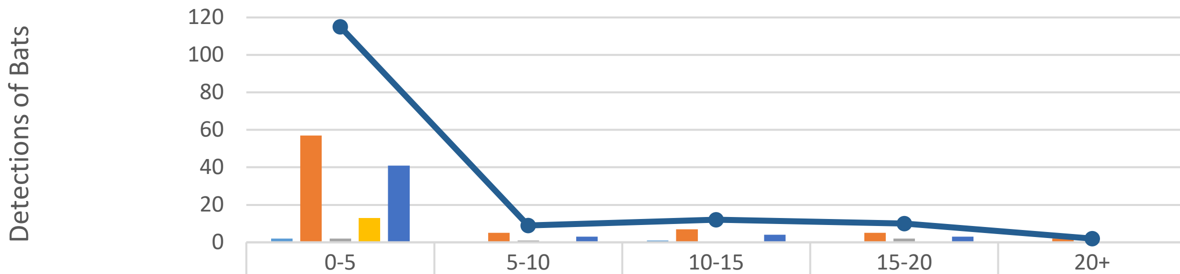
Figure 10

Table 6. Combined Species Composition				
Species Name	**In Port**	**Offshore**	**Lease Area**	**Total**
Big Brown Bat	2	1	0	3
Eastern Red Bat	43	26	7	75
Silver-haired Bat	1	2	2	5
Mexican Free-tailed Bat	13	0	0	13
NOID	35	11	5	51

Distance traveled by species was expressed by calculating the minimum, maximum, mean, and median distances for each detection from shore (**Table 7**). The Mexican Free-tailed Bat was detected a maximum distance from shore of less than 0.01 mi. The Silver-haired Bat had the highest mean and median at 9.14 mi and 7.09 mi, respectively. This species was more likely to travel further into the offshore and Lease areas; however, the Silver-haired Bat was only detected five times during the survey period. The Big Brown Bat traveled a maximum distance of 11.74 mi offshore; however, the median (<0.01 mi) indicated that many individuals were detected close to shore. The Eastern Red Bat traveled 26.26 miles offshore, which was the farthest distance from shore of any bat species in this survey. Like the Big Brown Bat, the Eastern Red Bat's median (<0.01 mi) indicated that many individuals were detected close to shore. NOID traveled a maximum distance of 17.28 mi; however, its median distance from shore was <0.01mi.

Table 7. Combined Proximity Analysis by Species				
	Distances from Shore (mi)			
Species Name	**Minimum**	**Maximum**	**Mean**	**Median**
Big Brown Bat	<0.01	11.74	3.92	0.01
Eastern Red Bat	<0.01	26.30	3.99	<0.01
Silver-haired Bat	<0.01	17.84	9.14	7.09
Mexican Free-tailed Bat	<0.01	<0.01	2.80	<0.01
NOID	<0.01	17.28	<0.01	<0.01

Detection of bats and distance can be compared to determine the regularity from shore. The highest frequency distance where bats were detected was between 0-5 miles (**Figure 11**). The Lease area spans 10-26 miles offshore from east to west. Of all detections throughout the duration of the survey, 16% were recorded 10 or more miles offshore; however, only 9% of detections were recorded in the Lease area.



	0-5	5-10	10-15	15-20	20+
Big Brown	2	0	1	0	0
Eastern Red	57	5	7	5	2
Silver-haired	2	1	0	2	0
Mexican Freetail	13	0	0	0	0
NOID	41	3	4	3	0
Total	115	9	12	10	2

Distance Category (mi)

Figure 11. Bat Detections and Distance (mi) by Species.

5.0 Summary

Through determining species composition, proximity, and time of year patterns, a relationship has been observed between distance, species, bat activity, and time of year.

The most common bat detected at any distance from shore was the Eastern Red Bat. Additionally, as distance from shore increased, observed bat diversity decreased. The highest bat diversity and detections was detected in port. The Eastern Red Bat was the only species recorded at distances greater than 18 mi offshore. As distance increased, bat detections decreased. The number of detections remained relatively consistent between five to 20 miles from the shore. However, detections were not common beyond 20 miles from shore. Of all detections, 9% occurred within the Lease area. Peak bat activity occurred in August, as bat migration increased on the Atlantic coastline.

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