Bat and Bird Data Analysis and Results Summary

May 2021 to May 2023

Final Report

US Wind Metocean Buoy Campaign

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Revisions

Version	Date	Author	Comment
1.0	Monday, 13 May 2024	Normandeau Associates	Correction to executive summary

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Executive Summary

This report summarizes bat and bird acoustic data collected for two years between 19 May 2021 and 18 May 2023 at the E14 US Wind buoy. For analyses in this report, Year 1 refers to the 365-day period from 19 May 2021 to 18 May 2022 and Year 2 refers to the 365-day period from 19 May 2022 to 18 May 2023. There were some data recording interruptions throughout the two years. The bat and bird acoustic sensors deployed on the buoy recorded 67 bat and 216 bird detections, representing 26 unique species identified by their vocalization characteristics. Bat acoustic detections were produced by three species: eastern red bat (*Lasiurus borealis*), hoary bat (*Lasiurus cinereus*), and silver-haired bat (*Lasionycteris noctivagans*). Eastern red bats and silver-haired bats accounted for most bat vocalization sequences at 49.3% (n=33) and 41.8% (n=28) respectively. Bird acoustic detections were produced by 22 species. Gull and tern species accounted for 61.1% of all avian vocalization sequences, with most calls produced by herring gulls (n=103).

Detections for both species groups dropped significantly in windspeeds above 8 m/s, with bats showing a tendency to be generally more active in slightly higher windspeeds than birds (median 5.4 m/s for bats and 4.3 m/s for birds).

No endangered species were detected by any sensors deployed throughout the two-year campaign.

Introduction and Justification

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 US, most species found offshore are long-distance migratory species, which include eastern red bats, hoary bats, and silver-haired bats (Sjollema et al. 2014). Short-distance migratory species from the genera *Myotis* and *Perimyotis* have also been detected. Offshore bat activity peaks significantly throughout the autumn migration period of August–early November (Peterson et al. 2014; Lagerveld et al. 2015, 2017, 2020). Bats have experienced significant population declines via turbine collisions at terrestrial wind energy developments; whether a similar collision risk will be experienced at offshore facilities is an open question.

Off the coast of Maryland (USA) the offshore environment provides habitat for waterbird species, including sea ducks, loons, gulls, scoters, terns, alcids, gannets, shearwaters, petrels, and shorebirds. Some passerine species may also use the offshore environment during long-distance seasonal migrations (DeLuca et al. 2015). Understanding the prevalence of certain bird species within the US Wind project area is paramount to evaluating relative exposure and potential risks to species when considering adverse effects such as collision and displacement (Garthe and Hüppop 2004; Furness et al. 2013; Robinson Willmott et al. 2013).

Understanding the prevalence of bats and birds in the offshore environment and under what ambient conditions they occur prior to, during, and after wind farm construction will provide US Wind the ability to detect changes to species prevalence and support an informed response to any potential species impacts and identification of any mitigation strategies.

Operations and Analysis Summary

Deployment and recovery timelines provided by the field team are summarized in Table 1 for both bat and bird detectors. The SM4 Bat acoustic detector was operational for 274 days in the first year of monitoring and 184 days in the second year of monitoring (Figure 1**,** Table 2). The SM4 Bat acoustic detector was set to record from an hour before sunset to an hour after sunrise. A timestamp error occurred for 78 days from 17 Jan 2022 until the unit was replaced on 05 Apr 2022. During this time the device still recorded audio files, but correct timestamps were not recorded. This period was considered non-operational because it was not possible to determine if the detector was recording these files during the sunset-sunrise setting. Even though we could not be certain of when the SM4 Bat acoustic sensor was correctly operational during this period, we still examined the audio files for calls, and none were found. The SM4 Bat detector experienced non-operational periods due to power supply issues and damage to the battery.

The SM4 Bird acoustic detector was operational for 264 days, plus partially operational for 77 days, in the first year of monitoring and 182 days in the second year of monitoring (Figure 2, Table 2). The SM4 Bird acoustic detector was set to record continuously 24/7. A timestamp error occurred for 77 days from 17–18 Jan 2022 until the unit was replaced on 05 Apr 2022. During this time the device still recorded audio files, but correct timestamps were not recorded. This period is referred to as partially operational since the detector was set to record 24/7 and bird

calls were found when data were analyzed. These observations without timestamps are reported with species totals but are removed from figures that show detection dates as it cannot be determined when in Jan–Apr these calls occurred. There were 43 vocalizations during this time (3 great black-backed gull, 38 herring gull, 1 laughing gull, and 1 magnolia warbler). The SM4 Bird detector experienced non-operational periods due to power supply issues and damage to the battery.

Table 1. Deployment and Recovery Dates for the SM4 Bat and SM4 Bird Acoustic Detectors at the E14 US Wind Buoy

Taxonomic Group	Deployment Date (mm/dd/yyyy)	Recovery Date (mm/dd/yyyy)	Comments
Bat	05/19/2021	08/30/2021	
	08/31/2021	01/13/2022	
	01/13/2022	04/05/2022	Acoustic recordings were collected but instrument clock failed. Data were analyzed; no bat calls were found during this period.
	04/05/2022	06/30/2022	
	06/30/2022	08/18/2022	
	08/18/2022	01/10/2023	
	01/10/2023	06/06/2023	Campaign end 18 May 2023
Bird	05/19/2021	08/30/2021	
	08/31/2021	01/13/2022	
	01/13/2022	04/05/2022	Acoustic recordings were collected but instrument clock failed. Data were analyzed and presented where timestamps were not required.
	04/05/2022	06/30/2022	
	06/30/2022	08/18/2022	
	08/18/2022	01/10/2023	
	01/10/2023	06/06/2023	Campaign end 18 May 2023

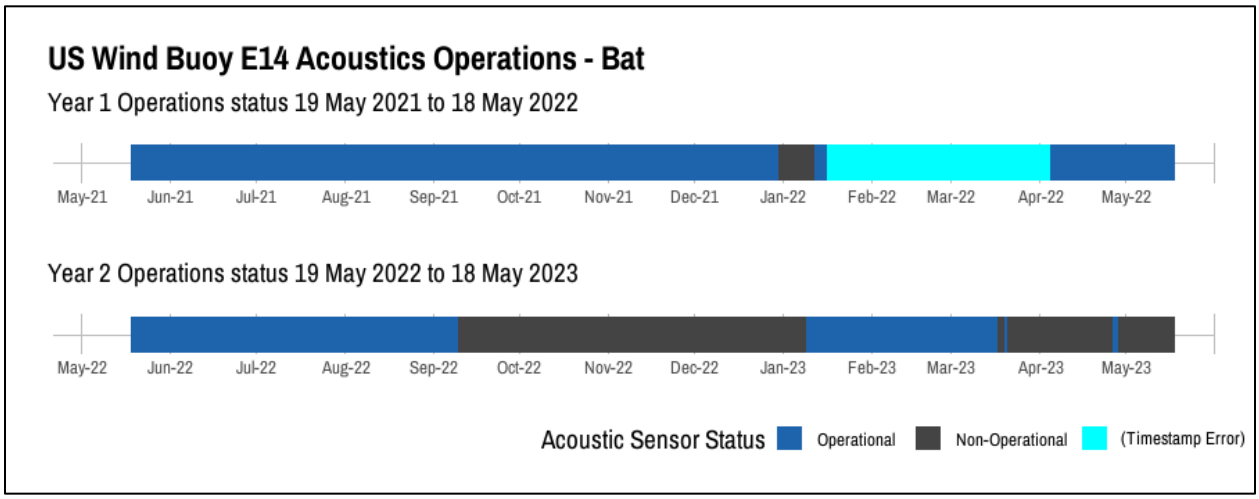

Figure 1. Bat acoustic sensor operations on the E14 US Wind buoy during the two-year monitoring period.

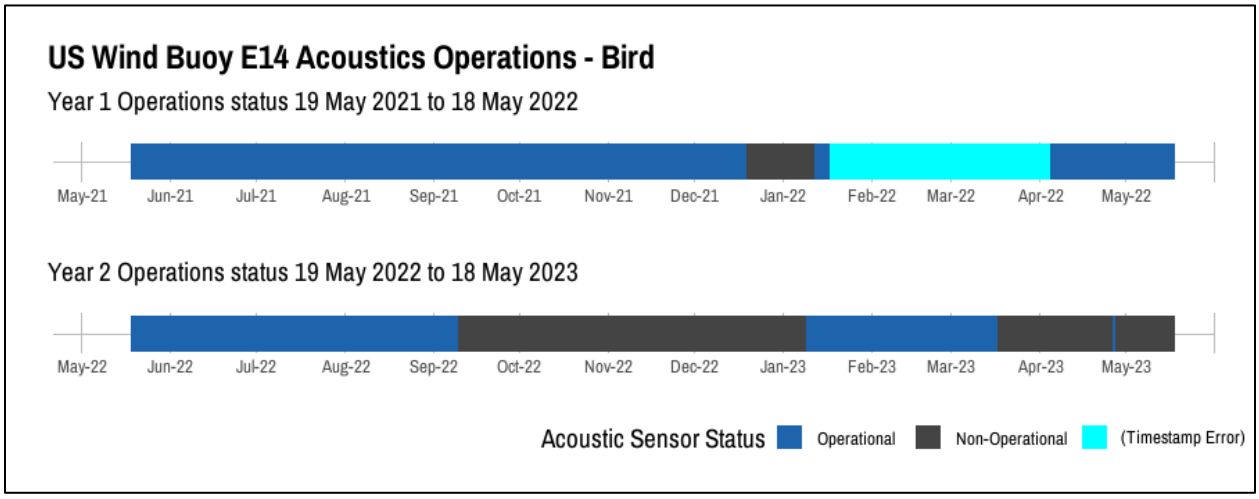

Figure 2. Bird acoustic sensor operations on the E14 US Wind buoy during the two-year monitoring period.

Table 2. Operational Uptime for the SM4 Bat and SM4 Bird Acoustic Detectors at the E14 US Wind Buoy

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	Total
BAT													
Year 1 (May 2021–May 2022)													
# Operational Days	31	30	31	31	30	31	30	30	4			26	**274**
# Non-Operational Days								1	12				**13**
# Days with Timestamp Error									15	28	31	4	**78**
Year 2 (May 2022–May 2023)													
# Operational Days	13	30	31	31	9				22	28	18	2	**184**
# Non-Operational Days	18				21	31	30	31	9		13	28	**181**
BIRD													
Year 1 (May 2021–May 2022)													
# Operational Days	31	30	31	31	30	31	30	19	5			26	**264**
# Non-Operational Days								12	12				**24**
# Days with Timestamp Error									14	28	31	4	**77**
Year 2 (May 2022–May 2023)													
# Operational Days	13	30	31	31	9				22	28	17	1	**182**
# Non-Operational Days	18				21	31	30	31	9		14	29	**183**

Note: Non-operational days are days with zero uptime logged by the acoustic device

Bat Acoustic Analysis Summary

Upon data receipt we uploaded the contents of each card to local hard drives for storage and processing and results were uploaded to the Normandeau ReMOTe server database. We ran each data set through bat acoustic identification software SonoBat (Arcata, USA) and Kaleidoscope. Generally, running files through a scrubber can eliminate WAV files that are algorithmically determined to be noise files rather than bats based on features of the sonogram. For example, WAV files with bandwidth below 20 kHz can be identified and eliminated as produced by audible insect noises, and files that have pulses of sound above 20 kHz can be kept for further analysis. With the buoy data, it is difficult to pre-filter noise because, unlike insect chatter, noise associated with the other equipment on the buoy, such as the LiDAR, make detectable pulsing ultrasonic noise that scrubber algorithms will not eliminate. We therefore used the SonoBat automated identification classifier on all recorded WAV files.

We determined the most typical SonoBat output for non-bat high-frequency recordings (i.e., noises generated by peripheral buoy sensors) was a constant pulse approximately every 10 m/s with a mean characteristic frequency of ≈39.75 kHz and a bandwidth of ≈4 kHz. The characteristics of these sounds are not like any bat species, and we determined which calls were more likely bats based on these parameters, effectively scrubbing all the files to a reduced batch for manual vetting (≈90% reduction).

Bat Acoustic Results Summary

Over the two-year period we recorded 67 discrete bat call sequences at the E14 buoy (Figure 3, Table 3). No bat recordings were captured between 17 Jan 2022 and 04 Apr 2022 when timestamps were incorrectly recorded. Bat activity was highest on 01 Sep 2022 with 15 vocalizations. One vocalization from an eastern red bat was recorded during the spring 2021 migratory period (Figure 3). Most vocalization sequences were recorded during the fall migratory period (Aug–Oct) (Figure 3). Overall, bat activity was very low throughout the summer months and increased during fall migration, which is consistent with the literature and other survey data. Bats were recorded at wind speeds ranging between 1.5 m/s to 14.1 m/s with the median number of detections occurring at 5.4 m/s (Figure 4). Bat activity declined sharply when wind speeds were above 8 m/s (Figure 4). Figure 5 shows the mean daily wind speed and number of bat vocalizations detected per date for the two-year monitoring period.

Spectrograms collected at the E14 US Wind Buoy for eastern red bat, hoary bat, and silver-haired bat are shown in Figure 6, Figure 7, and Figure 8.

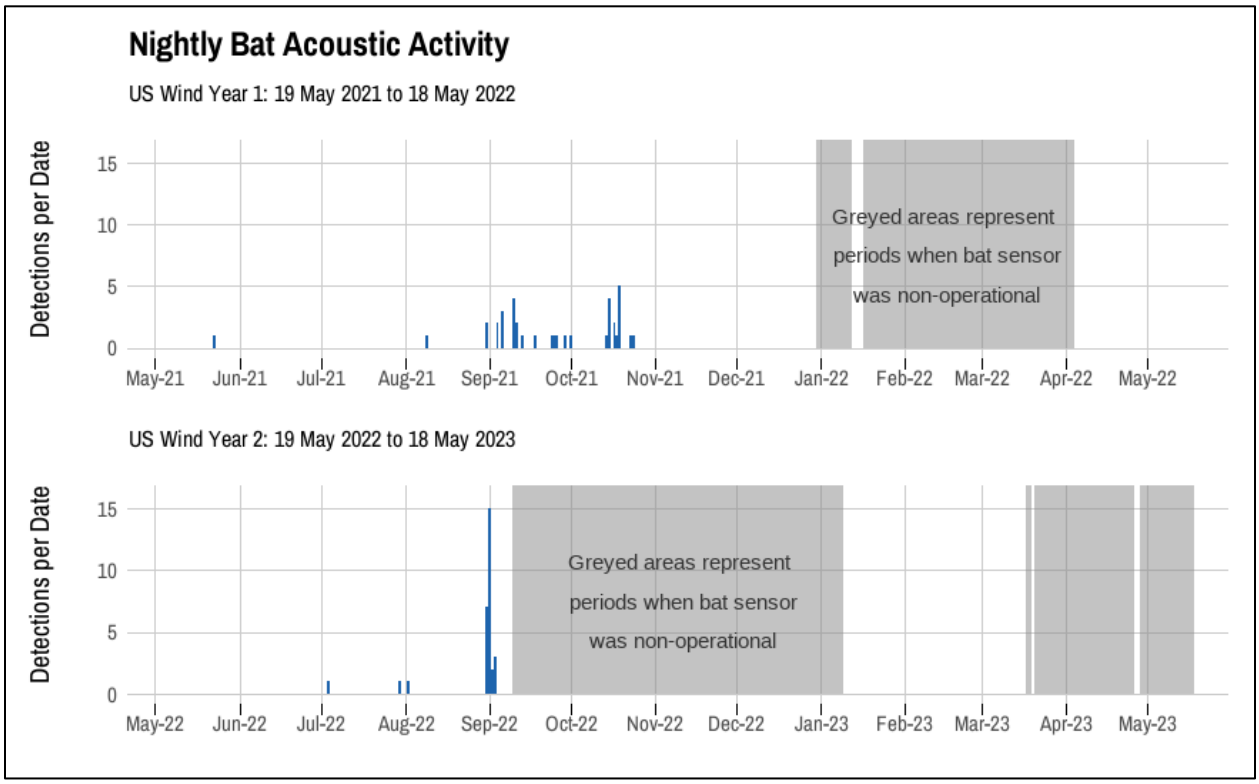

Figure 3. Bat occurrences at the E14 US Wind buoy during the two-year monitoring period.

Table 3. Bat Occurrences by Month
Vocalization sequences are counted per date by recording timestamp in UTC-5.

Month Year	Species	Vocalization Sequences
May 2021	Eastern red bat	1
Aug 2021	Eastern red bat	3
Sep 2021	Silver-haired bat	12
	Eastern red bat	5
Oct 2021	Hoary bat	3
	Silver-haired bat	13
Jul 2022	Eastern red bat	1
	Hoary bat	1
Aug 2022	Eastern red bat	6
	Hoary bat	2
Sep 2022	Eastern red bat	17
	Silver-haired bat	3
May 2021–May 2023	Eastern Red Bat	33
	Hoary Bat	6
	Silver-haired Bat	28

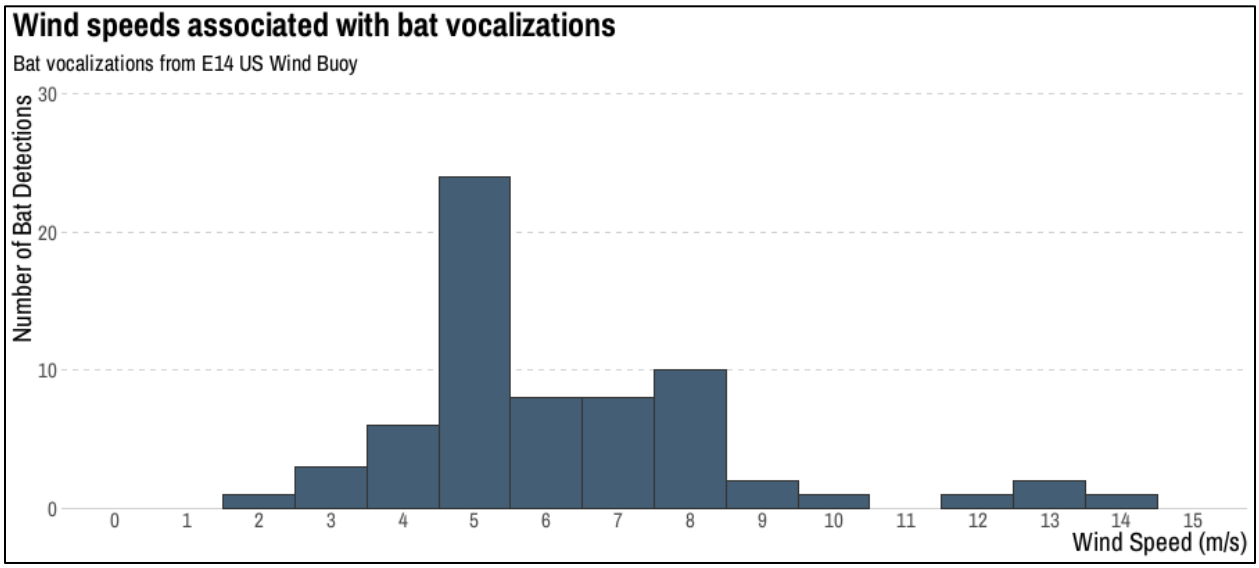

Figure 4. Bat acoustic detections recorded per wind speed (m/s) observed at the US Wind Buoy E14.

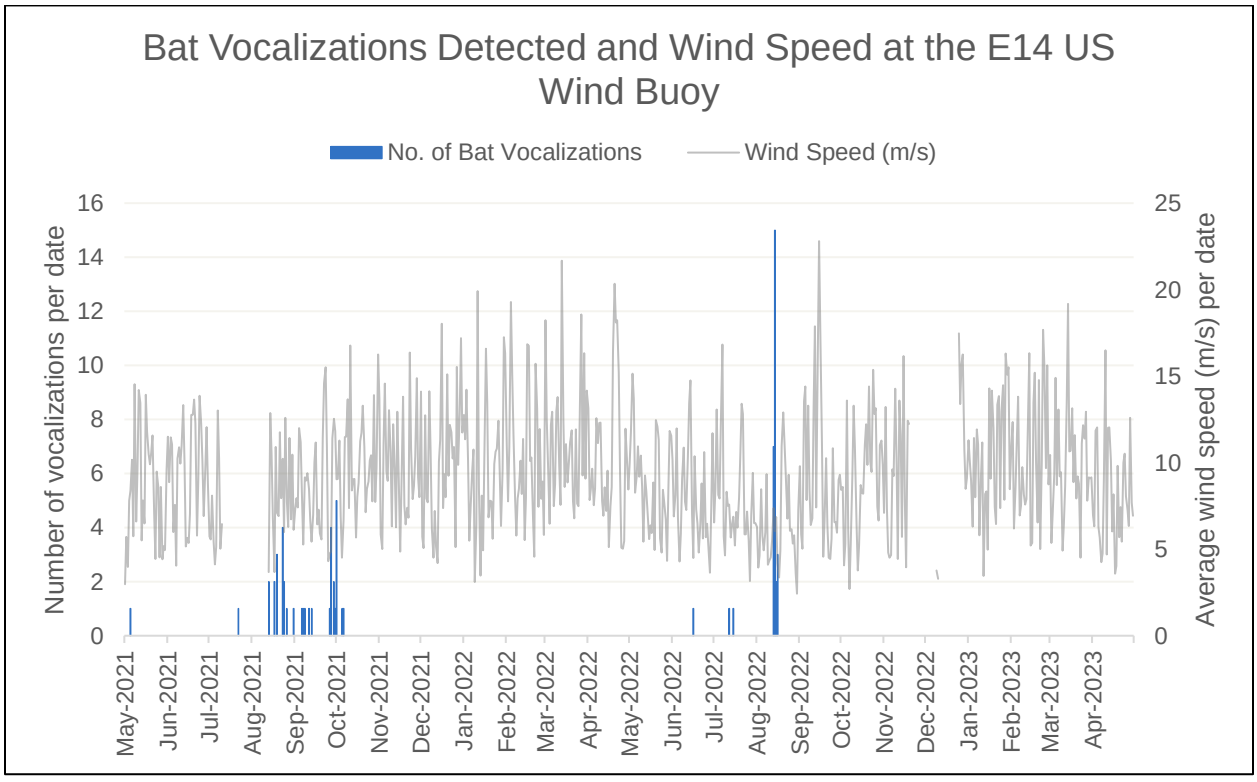

Figure 5. Number of bat vocalizations detected per date and mean daily wind speed (m/s) from the LiDAR 98m sensor at the US Wind Buoy E14.
Missing wind speed data were substituted with data from the LiDAR 10m sensor when available or left blank and not included in mean calculations.

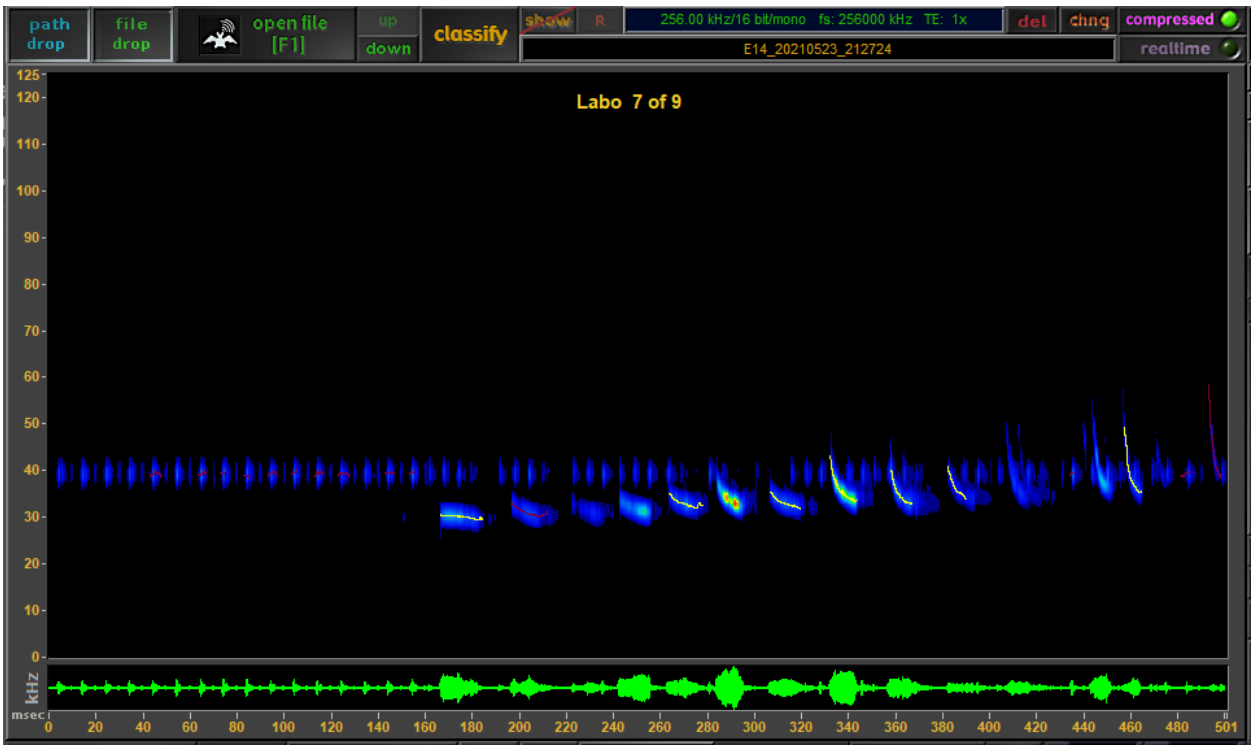

Figure 6. Spectrogram of eastern red bat collected at the E14 US Wind buoy.

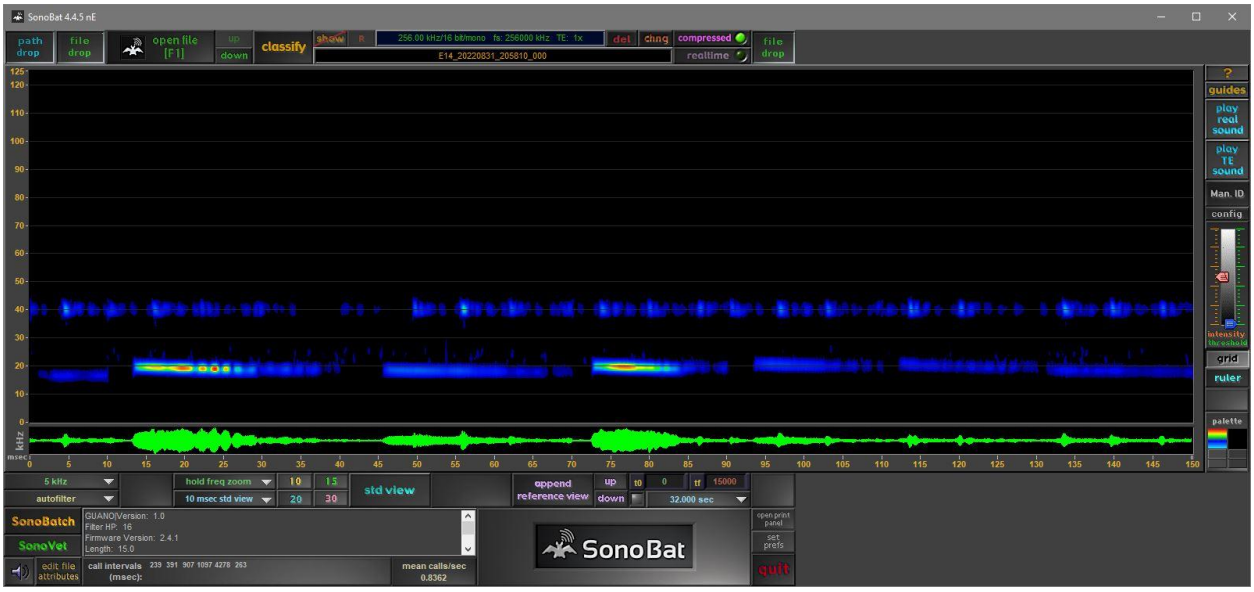

Figure 7. Spectrogram of hoary bat collected at the E14 US Wind buoy.

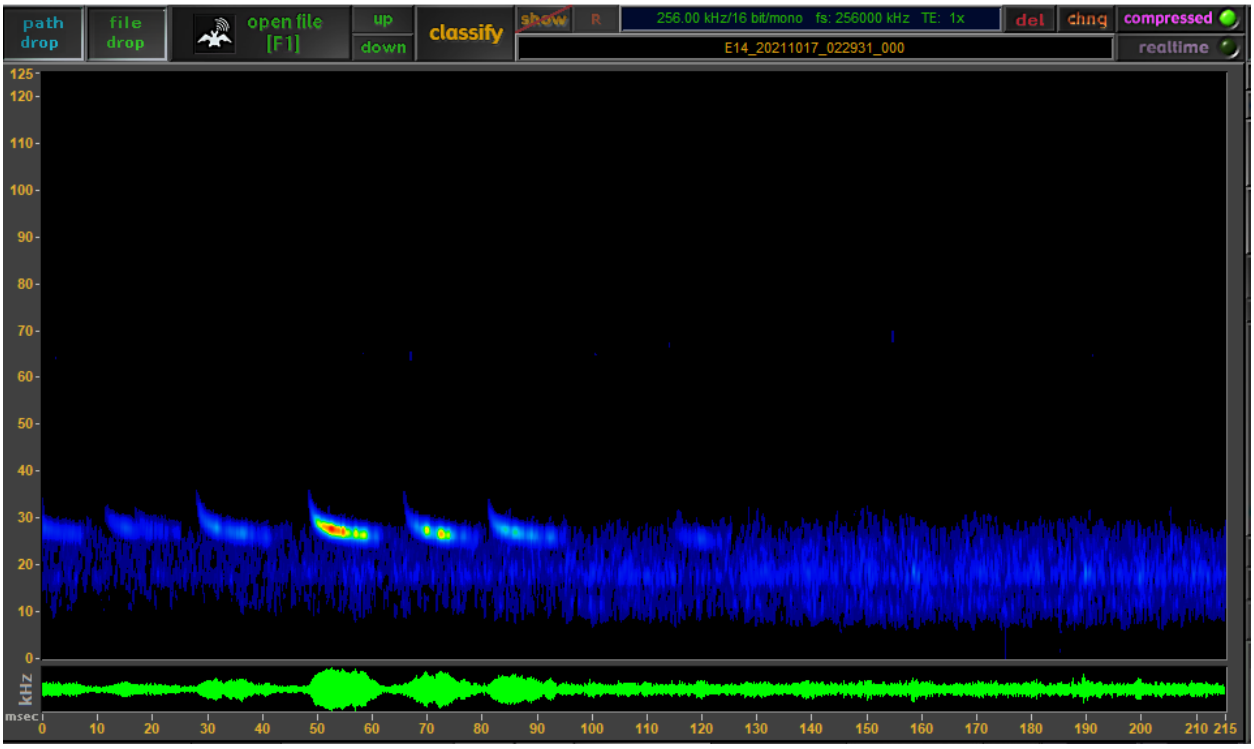

Figure 8. Spectrogram of silver-haired bat collected at the E14 US Wind buoy.

Bird Acoustic Analysis Summary

Bird acoustic data were processed with Wildlife Acoustics Kaleidoscope Pro software using automated detection parameters determined for the flight calls of species in Table 4 using flight call audio data in the Cornell Lab of Ornithology Macaulay Library archives (https://search.macaulaylibrary.org/catalog). These 30 species were chosen based on sightings noted in ebird.org for the Eastern US region and cross-referenced with the Migratory Bird Treaty Act. Note that detection parameters for the species listed do not necessarily exclude other species or non-bird sounds so manual auditory (headphones) and visual (spectrogram) review of the detections is necessary to confirm any bird call within or outside the list and to exclude false positives. Additional bird species were confirmed from detections that did not fall within those listed in Table 4, focusing on but not limited to gulls, terns, and sandpipers. This species list is not to be taken as exhaustive as the Kaleidoscope settings can also detect species outside this list.

Manual auditory and visual review was conducted on every detection in the first 200 detections within each cluster generated by the Kaleidoscope Pro software auto-detection cluster analysis. Any clusters with fewer than 200 detections had every detection reviewed. Any detections that were not birds were confirmed to be water, wind, buoy noise, or some combination of those, and are not listed. For this analysis, one call corresponds to at least one confirmed detection within any one-minute span. Two calls from the same species within the same one-minute period are counted as one occurrence.

Table 4. Bird Species whose Flight Calls were Used for Automatic Detection Parameter Selection

Herring gull	Bonaparte's gull	Great black-backed gull
Cape May warbler	Northern parula	Palm warbler
Ovenbird	American redstart	Yellow-rumped warbler
Gray-cheeked thrush	Black-throated blue warbler	Black-and-white warbler
Blackpoll warbler	Common yellowthroat	Bay-breasted warbler
Least bittern	Green heron	Veery
Magnolia warbler	Chestnut-sided warbler	White-throated sparrow
Blackburnian warbler	Bobolink	Blue grosbeak
Yellow warbler	Savannah sparrow	Indigo bunting
Swainson's thrush	Wood thrush	Northern waterthrush

Bird Acoustic Results Summary

Over the two-year period we detected 22 species across 216 vocalization sequences (173 with timestamps, 43 without timestamps) at the E14 buoy with most calls occurring during the late spring/early summer and late summer/early fall (Figure 9). Gull and tern species accounted for 132 (61%) of the 216 bird vocalization sequences (Table 5). The most commonly occurring species was herring gull (n=103) (Table 6). We observed 34 vocalization sequences attributed to 9 warbler species: northern waterthrush, black-and-white warbler, American redstart, Cape May warbler, magnolia warbler, bay-breasted warbler, yellow warbler, chestnut-sided warbler, and blackpoll warbler (Table 5, Table 6). Birds were recorded in wind speeds ranging between 0.5 m/s up to 19.3 m/s with the median number of detections occurring at 4.3 m/s (Figure 10). Bird activity declined sharply when wind speeds were above 8.0 m/s (Figure 10). Figure 11 shows the mean daily wind speed and number of bird vocalizations detected per date for the two-year monitoring period.

Representative acoustic bird calls from each species detected at the buoy are pictured in Figure 12 through Figure 22.

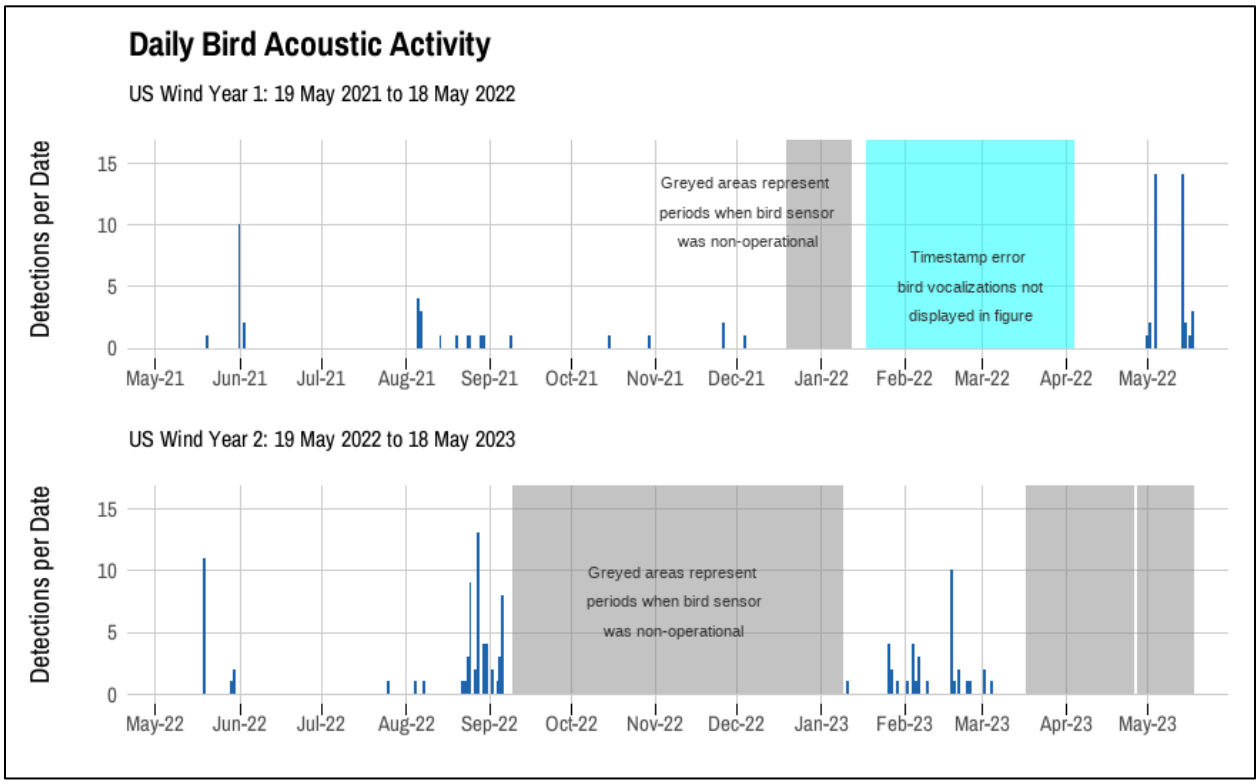

Figure 9. Daily bird occurrences at the E14 US Wind buoy during the two-year collection period. This figure does not include the 43 birds recorded during the period when accurate timestamps were missing.

Table 5. Bird Occurrences by Month (or Data Period for Individuals Recorded when Instrument had the Timestamp Error)

Month Year	Species	Vocalization Sequences
May 2021	Chestnut-sided Warbler	1
Jun 2021	Herring Gull	12
Aug 2021	Semipalmated Plover	1
	Spotted Sandpiper	1
	Solitary Sandpiper	2
	Herring Gull	8
	Wood Thrush	1
Sep 2021	White-throated Sparrow	1
Oct 2021	Laughing Gull	1
	Northern Waterthrush	1
Nov 2021	Herring Gull	1
	Blackpoll Warbler	1
Dec 2021	Common Loon	1
18 Jan 2022 to 04 Apr 2022	Laughing Gull	1
	Herring Gull	38
	Great Black-backed Gull	3
	Magnolia warbler	1
May 2022	Laughing Gull	3
	Herring Gull	38
	Brown Pelican	10
Jul 2022	Solitary Sandpiper	1
Aug 2022	Spotted Sandpiper	9
	Solitary Sandpiper	2
	Herring Gull	1
	Royal Tern	3
	Northern Waterthrush	1
	Black-and-white Warbler	3
	American Redstart	6
	Cape May Warbler	4
	Magnolia Warbler	4
	Bay-breasted Warbler	2
	Yellow Warbler	3
	Chestnut-sided Warbler	1

Month Year	Species	Vocalization Sequences
Sep 2022	Herring Gull	3
	Royal Tern	8
	Northern Waterthrush	1
	Black-and-white Warbler	1
	Yellow Warbler	1
Jan 2023	Killdeer	1
	Herring Gull	1
	Royal Tern	3
	White-throated Sparrow	2
	Yellow Warbler	1
Feb 2023	Killdeer	3
	Laughing Gull	1
	Herring Gull	1
	Royal Tern	5
	Osprey	2
	White-throated Sparrow	3
	Savannah Sparrow	8
	Yellow Warbler	1
	Chestnut-sided Warbler	1
Mar 2023	Killdeer	2
	Royal Tern	1

Table 6. Bird Species Identified from May 2021 to May 2023

Species	Vocalization Sequences with Timestamp
Killdeer	6
Semipalmated Plover	1
Spotted Sandpiper	10
Solitary Sandpiper	5
Laughing Gull	6*
Herring Gull	103*
Great Black-backed Gull	3*
Royal Tern	20
Common Loon	1
Brown Pelican	10
Osprey	2
Wood Thrush	1

Species	Vocalization Sequences with Timestamp
White-throated Sparrow	6
Savannah Sparrow	8
Northern Waterthrush	3
Black-and-white Warbler	4
American Redstart	6
Cape May Warbler	4
Magnolia Warbler	5*
Bay-breasted Warbler	2
Yellow Warbler	6
Chestnut-sided Warbler	3
Blackpoll Warbler	1
TOTAL	**216**

* Includes data with timestamp error that occurred between 18 Jan 2022 and 04 Apr 2022

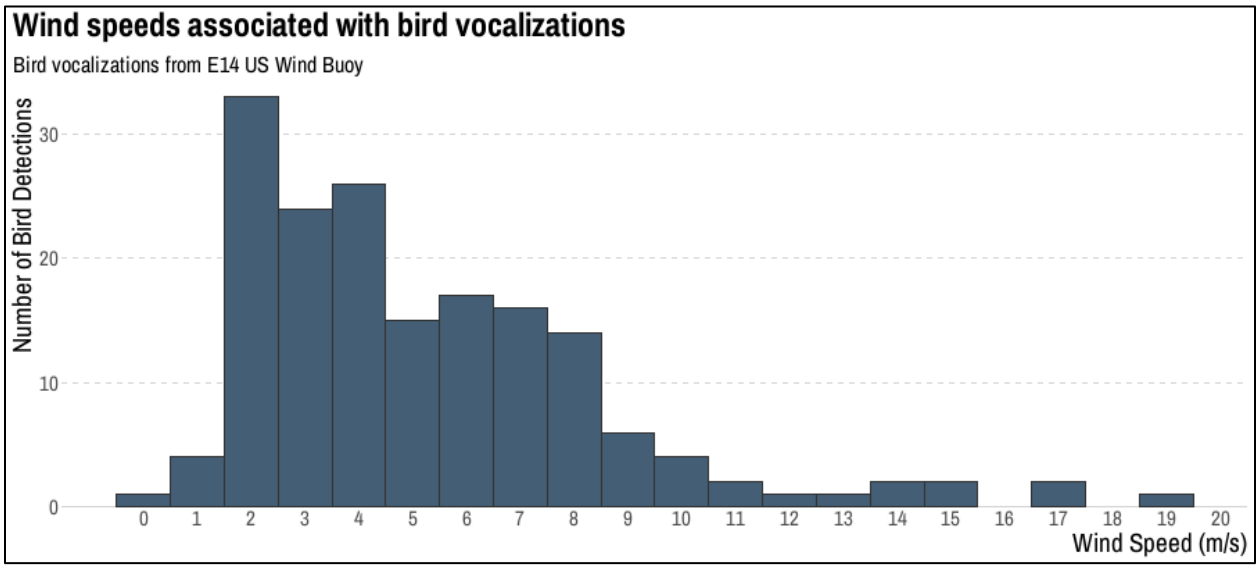

Figure 10. Bird acoustic detections recorded per wind speed (m/s) at the US Wind Buoy E14.
This figure does not include the 43 birds recorded during the period when accurate timestamps were missing.

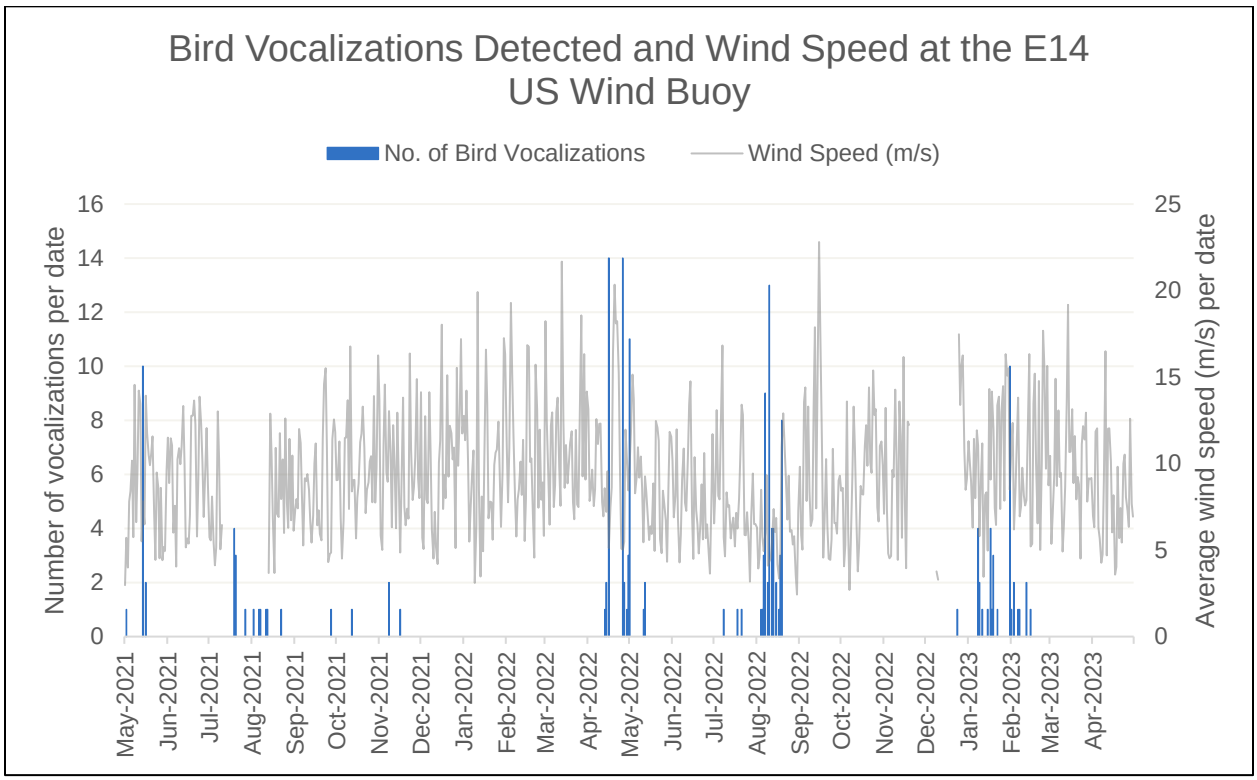

Figure 11. Number of bird vocalizations detected per date and mean daily wind speed (m/s) from the LiDAR 98m sensor at the US Wind Buoy E14.
Missing wind speed data were substituted with data from the LiDAR 10m sensor when available or left blank and not included in mean calculations. This figure does not include the 43 birds recorded during the period when accurate timestamps were missing.

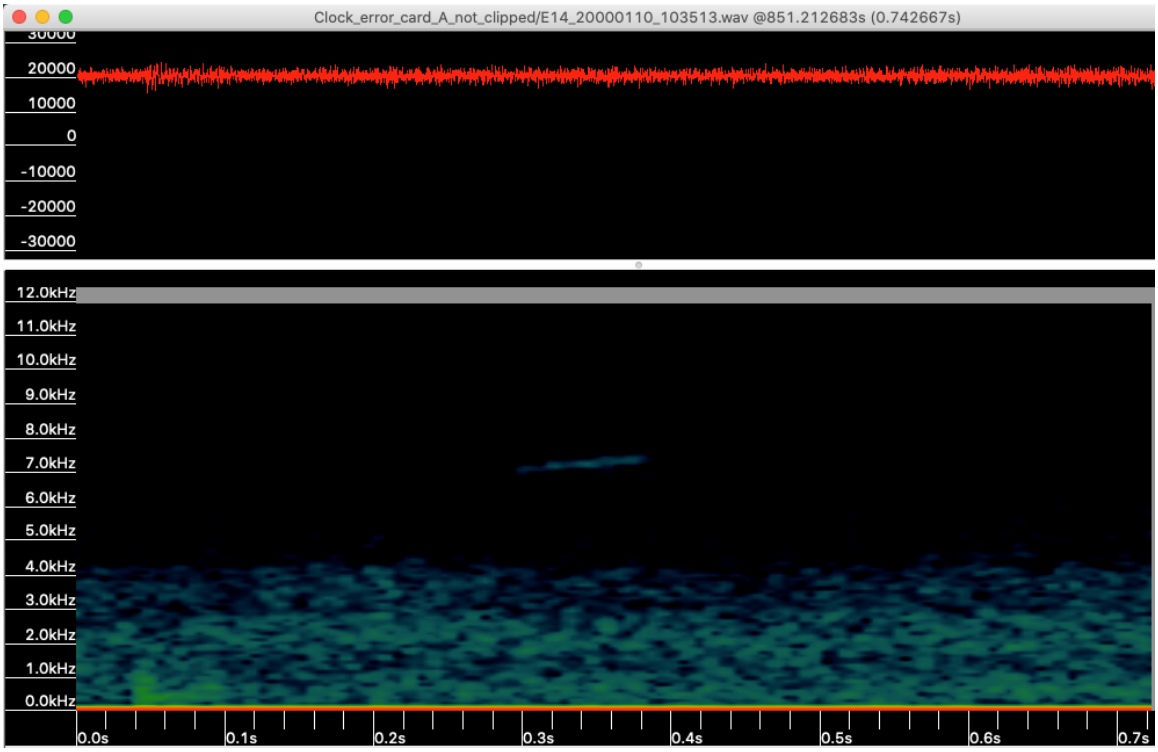

Figure 12. Spectrogram of magnolia warbler call collected at the E14 US Wind Buoy.

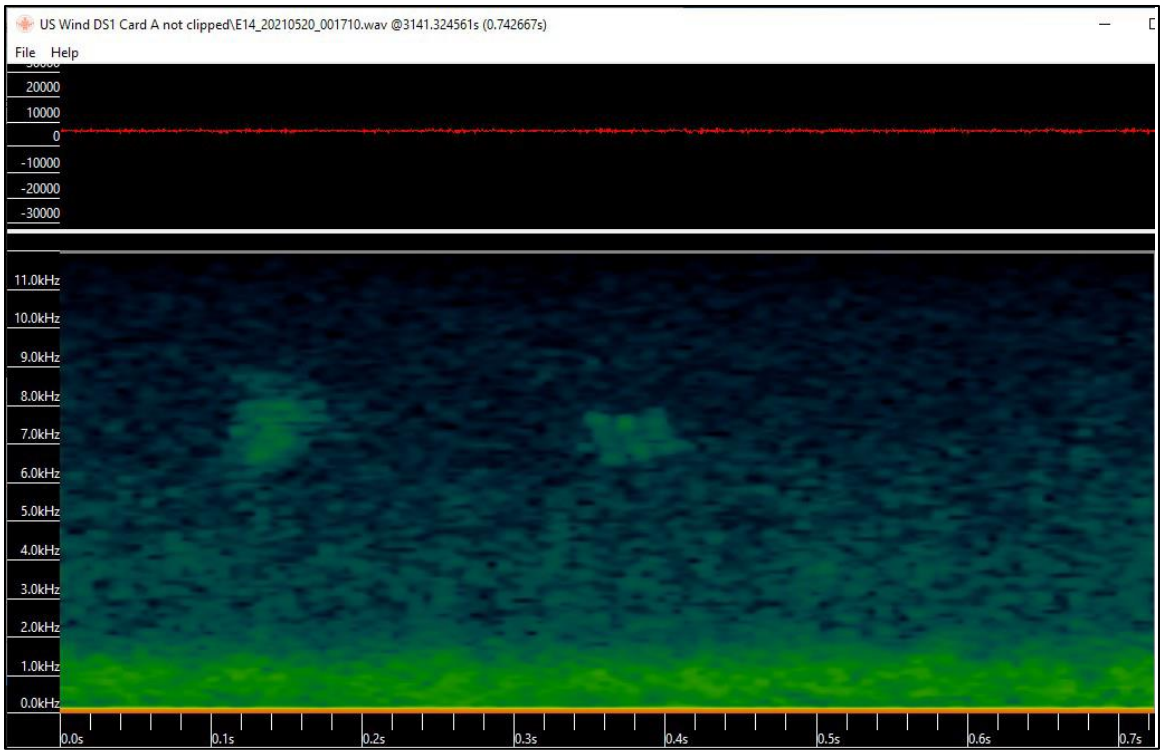

Figure 13. Spectrogram of chestnut-sided warbler call collected at the E14 US Wind Buoy.

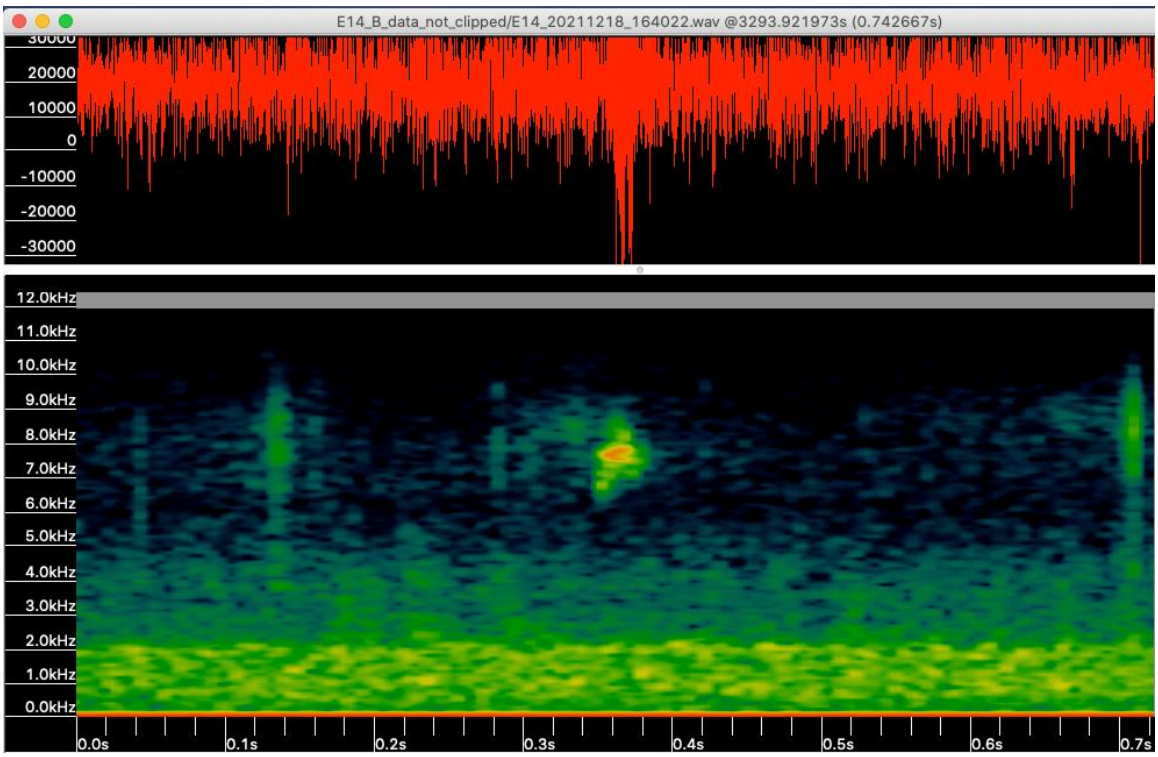

Figure 14. Spectrogram of blackpoll warbler call collected at the E14 US Wind Buoy.

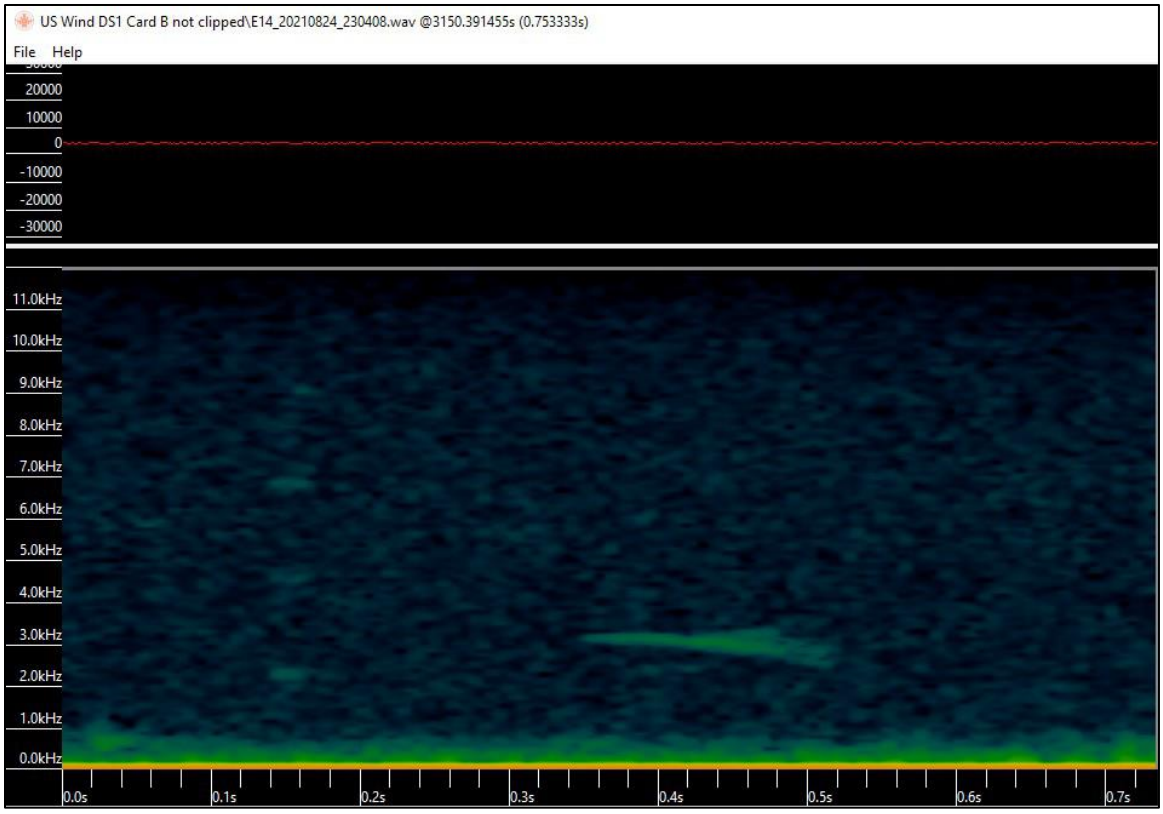

Figure 15. Spectrogram of wood thrush call collected at the E14 US Wind Buoy.

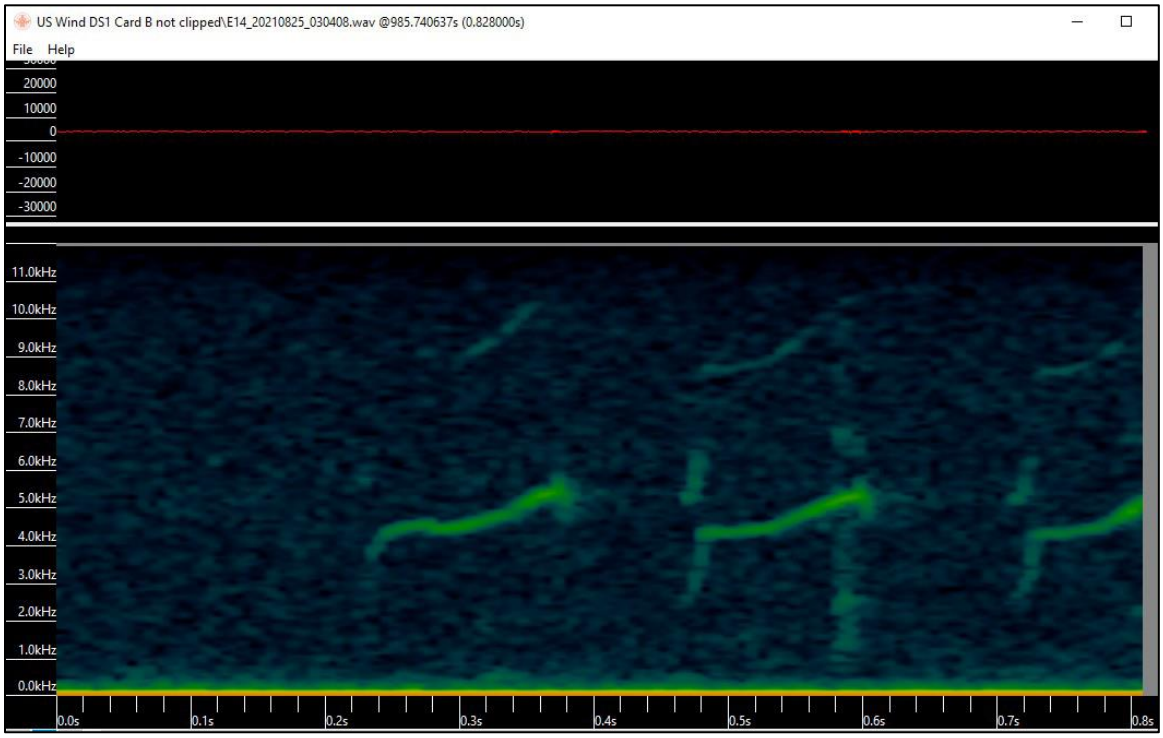

Figure 16. Spectrogram of solitary sandpiper call collected at the E14 US Wind Buoy.

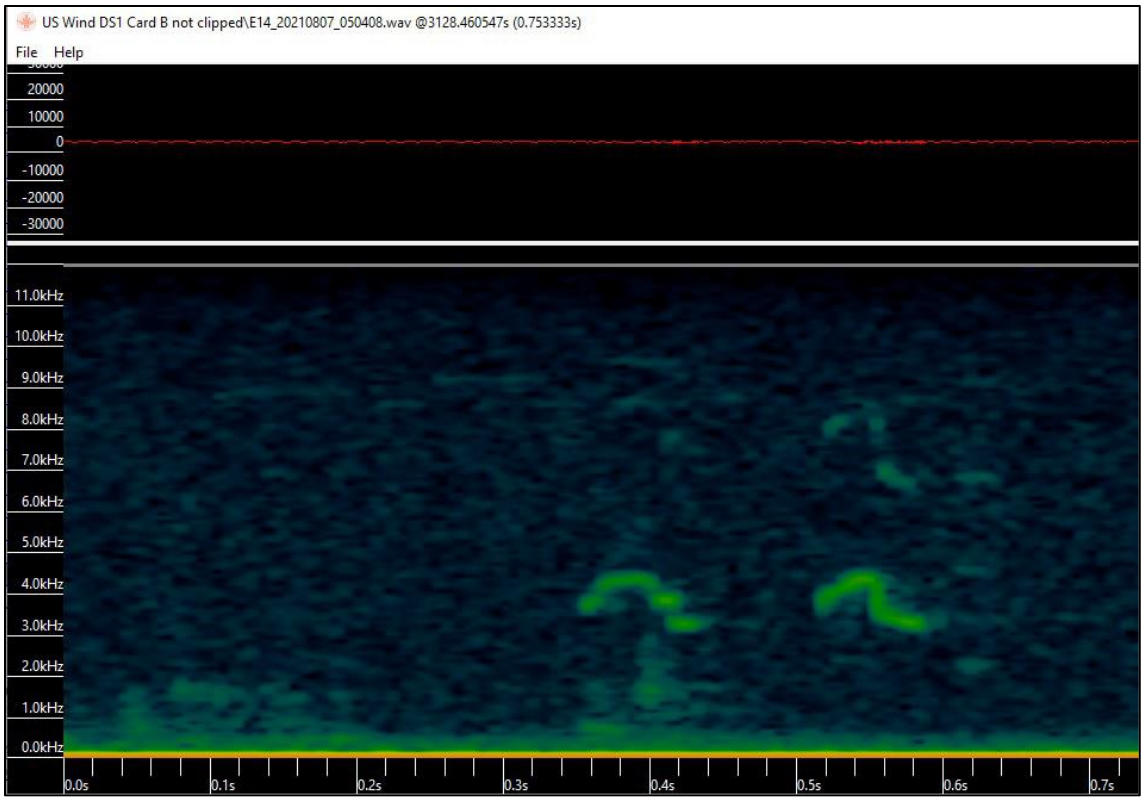

Figure 17. Spectrogram of spotted sandpiper call collected at the E14 US Wind Buoy.

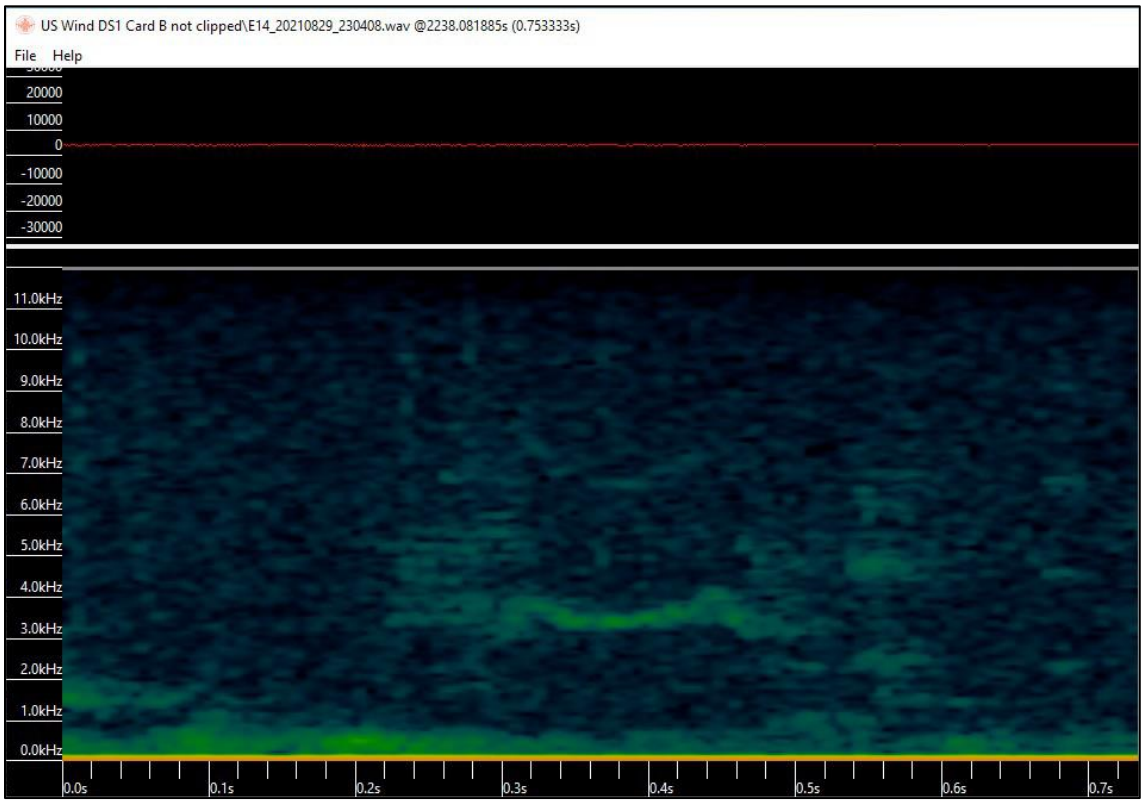

Figure 18. Spectrogram of semipalmated plover call collected at the E14 US Wind Buoy.

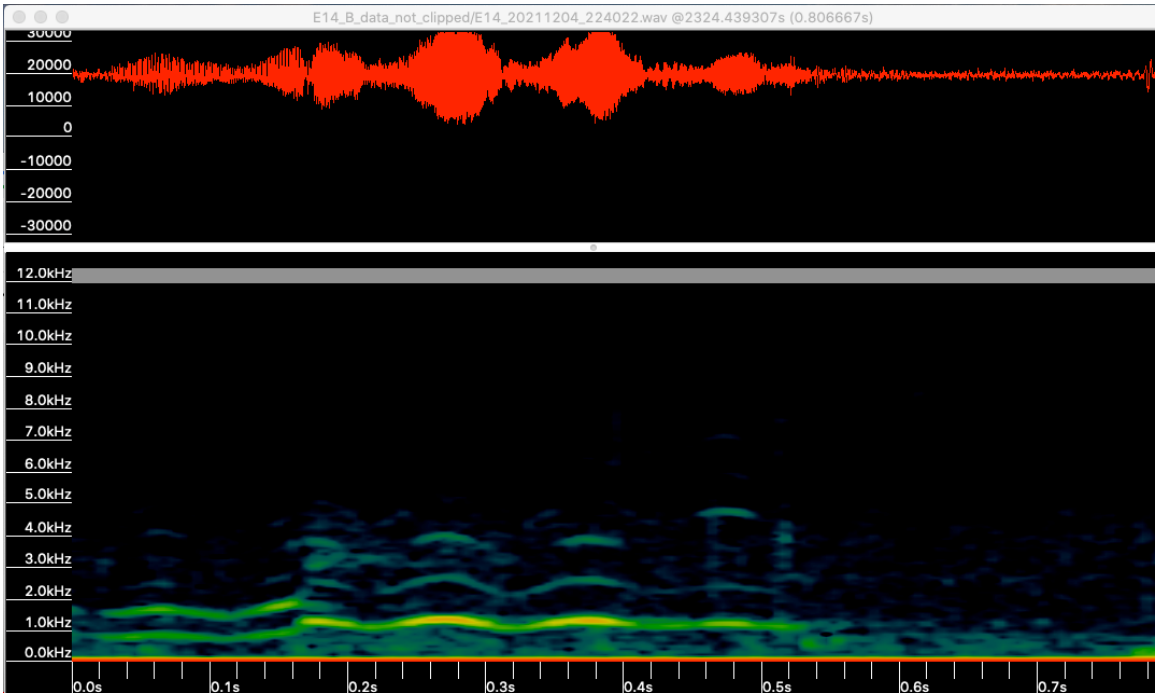

Figure 19. Spectrogram of common loon call collected at the E14 US Wind Buoy.

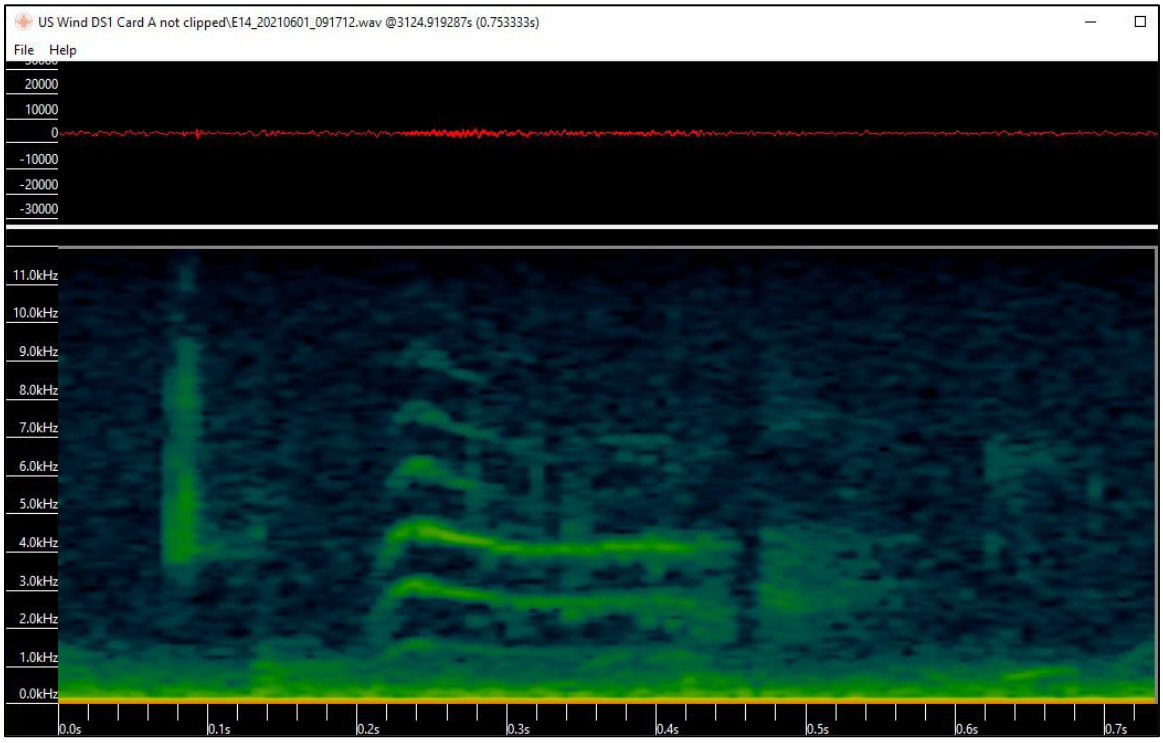

Figure 20. Spectrogram of herring gull call collected at the E14 US Wind Buoy.

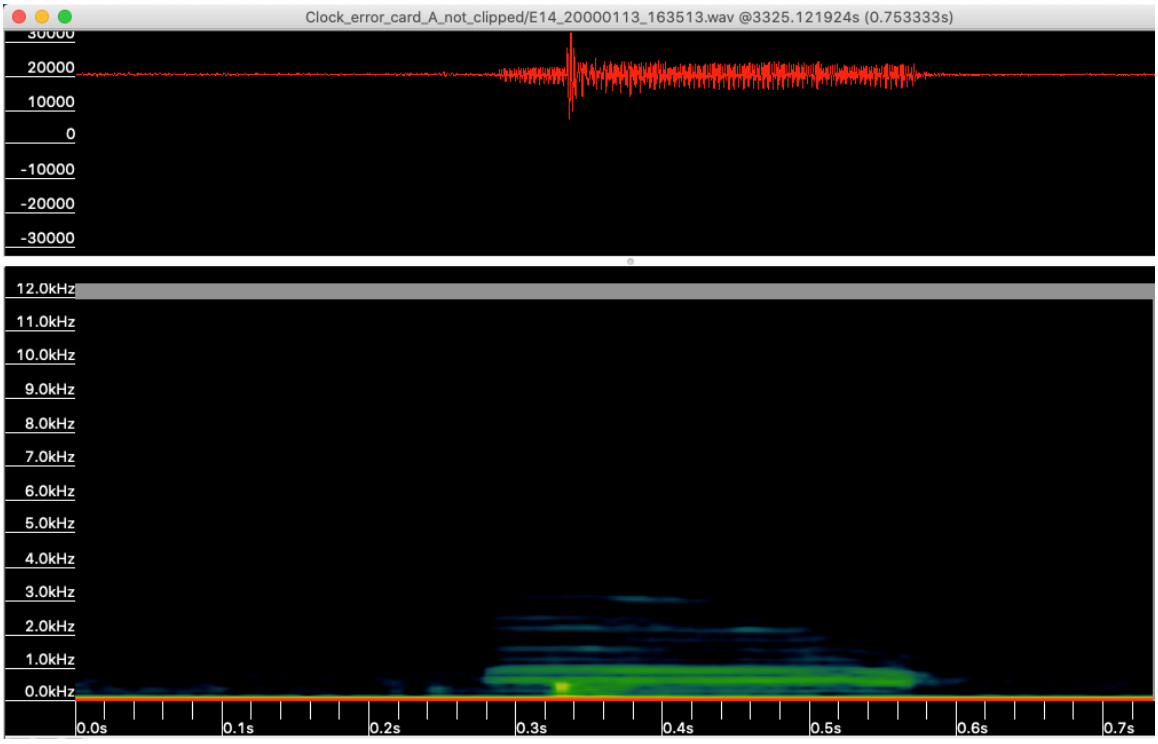

Figure 21. Spectrogram of laughing gull call collected at the E14 US Wind Buoy.

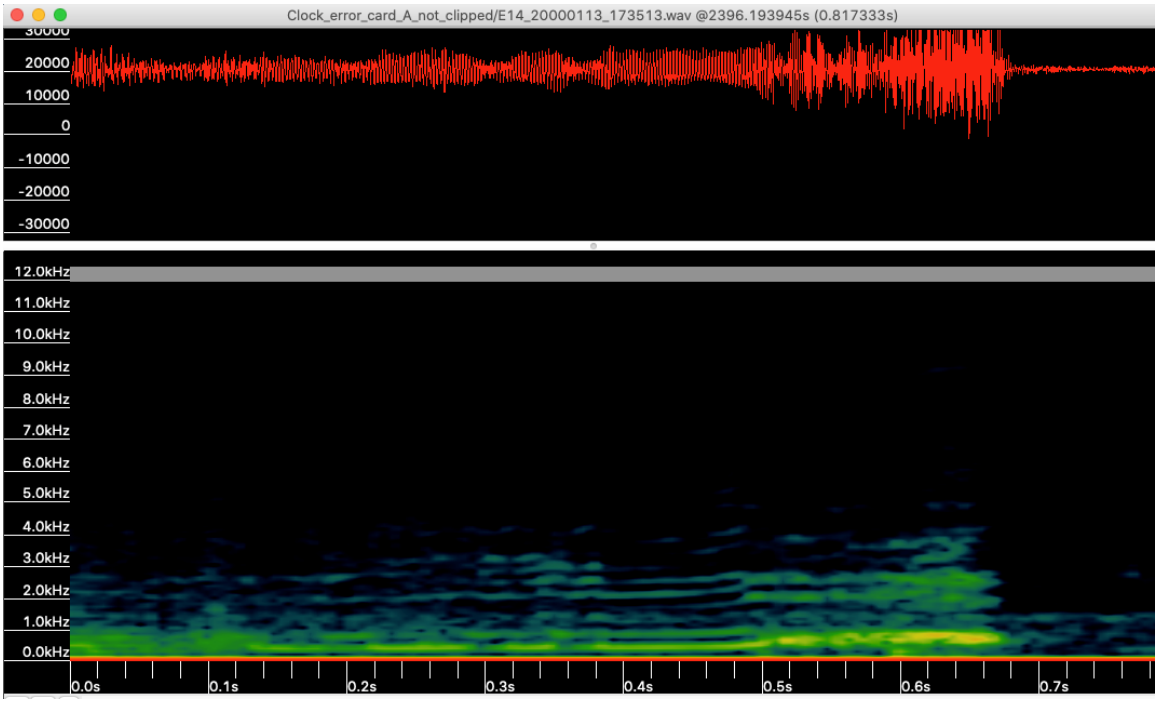

Figure 22. Spectrogram of great black-backed gull call collected at the E14 US Wind Buoy.

Motus Detections

Table 7 lists the tags detected by the Motus receiver at E14 (E-14 CTT SensorStation deployment ID# 8389 and 9304). Only test tags have been detected and no species tags. Motus.org removed an erroneous tag detection that was listed in previous reports. As no calibration or test tag information has been made available, we are not certain whether there were no detections or if the station itself was not fully functional.

Table 7. Motus Detections from the Receiver at the US Wind Buoy E14

Tag	Species	Date (UTC)
No species detected		

Discussion

Relationships between birds and bats with wind speed differed between the two taxa. Bat activity was more uniform across the wind speed range, ranging from 1.5 m/s to 14.1 m/s. There was some activity drop off above 8 m/s and a median activity and windspeed association of 5.4 m/s (Figure 4). Although bird activity similarly declined above 8 m/s (Figure 10), activity ranged between 0.5 m/s and 19.3 m/s. The median windspeed associated with activity remained lower than that of bats at 4.3 m/s. This difference in wind speed preferences may be due to migration tendencies of birds and bats with birds often preferring low wind speeds (Richardson 1990; Ramenofsky et al. 2012) and bats preferring higher wind speeds. Indeed, many of the birds active in higher windspeeds were gull species heard during April and May. Migratory bird species in

spring and fall were mostly active during lower windspeeds. For bats, this tendency to prefer higher windspeeds is particularly important in adverse weather as bats try to minimize energy expenditure (Dechmann et al. 2017). Pettit and O'Keefe (2017) also found bats to prefer higher wind speeds in the fall, which is when nearly all detections in this study were found.

The median windspeed relating to activity for birds at 4.3 m/s is likely below the cut-in speed of most offshore turbines.

No endangered species were detected by any sensors deployed throughout the two-year campaign.

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