Floating LiDAR Metocean Data Collection Services

E05 and E06 Bat and Bird Acoustic Analysis and Results Summary

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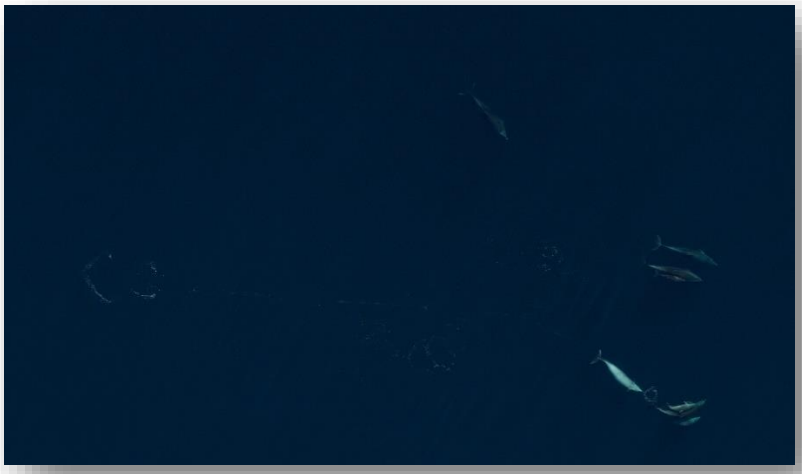

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Bat and Bird Acoustic Data Analysis and Results Summary for Data Collection Periods 1–8

This report summarizes bat and bird acoustic data associated with the E05 Hudson North (E05) and E06 Hudson South (E06) NYSERDA buoys collected from August 2019 through October 2021, plus an additional collection period for E06 through campaign end in April 2022. Analyses and results are presented as cumulative and thus show all identified species to date.

Bat and bird acoustic sensors were deployed at E05 on 10 Aug 2019 and E06 on 03 Sep 2019. To date, bat and bird data collected at E05 have been analyzed and are reported here through campaign end (collected 15 Oct 2021) and at E06 through campaign end (collected 04 Apr 2022) (Table 1).

To date we have recorded 32 bat and 702 bird vocalizations representing 2 bat species and 27 bird species from E05 and E06 (Table 1). There were 2 bat species recorded at E05 (silver-haired bat and Eastern red bat) and 1 bat species at E06 (silver-haired bat) (Table 1). There were 23 bird species at E05 and 10 species at E06. Herring gull accounted for most of the bird activity at E05 (n=358, 71%) and E06 (n=162, 83%) (Table 1).

We matched bird observation times to LiDAR-derived wind speed at 98 m, which was collected simultaneously from the buoys. When available, Meteo wind data substituted any periods when LiDAR was non-operational; however, this did not fill all gaps. The small number of bat detections precluded us from making any conclusions about the effects of wind speed on bat activity. Of the 702 bird detections, 598 had available wind speed data between LiDAR and Meteo. We summarized wind speed to the nearest whole value and generated a distribution to determine the proportion of observations at the recorded wind speed values.

Acoustic Analysis

Bat Acoustic Analysis

Upon receipt, data were backed up for storage and processing. We ran each dataset through bat acoustic identification software (SonoBat; Arcata, USA). Generally running files through a scrubber can eliminate WAV files that are algorithmically determined to be noise files and not bats based on features of the sonogram. For example, WAV files with a bandwidth ranging from 20 kHz and below 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. In the case of 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 LiDAR) make pulsing ultrasonic noise that scrubber algorithms will not eliminate. We used the SonoBat automated identification classifier on all recorded WAV files.

Table 1. Bat and Bird Species/Species Groups Identified Between August 2019 and October 2021 at E05 and Between September 2019 and April 2022 at E06

Buoy	Type	Species / Species Group	Vocalization Sequences
E05	Birds	Spotted sandpiper	5
		Solitary sandpiper	3
		Laughing gull	15
		Herring gull	358
		Great black-backed gull	2
		Royal tern	73
		Wilson's storm-petrel	3
		Brown pelican	12
		Least bittern	2
		Osprey	2
		Veery	1
		Swainson's thrush	1
		White-throated sparrow	3
		Savannah sparrow	1
		Song sparrow	14
		Common yellowthroat	1
		American redstart	1
		Magnolia warbler	2
		Yellow warbler	3
		Palm warbler	1
		Rose-breasted grosbeak	1
		Blue grosbeak	1
		Indigo bunting	1
	E05 Birds Total		**506**
	Bats	Silver-haired bat	27
		Eastern red bat	2
		Silver-haired bat or hoary bat	1
	E05 Bats Total		**30**
E05 TOTAL			**536**
E06	Birds	Laughing gull	7
		Ring-billed gull	1
		Herring gull	162
		Brown pelican	11
		Green heron	1
		Osprey	3
		Gray-cheeked thrush	2
		Wood thrush	2
		Song sparrow	5
		American redstart	2
	E06 Birds Total		**196**
	Bats	Silver-haired bat	2
	E06 Bats Total		**2**
E06 TOTAL			**198**
TOTAL			**734**

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 every ≈10 ms with a mean characteristic frequency (f_c) of ≈39.75 kHz and a bandwidth of ≈4 kHz. The characteristics of these sounds are not like any bat species, and we eliminated files containing only those parameters (≈90% reduction) before manual vetting (i.e., human analyst review of files with a non-negligible probability of having ultrasonic bat vocalization signatures).

Between 10 Aug 2019 and 15 Oct 2021, bat acoustic sensors at E05 were operational for 434 days (Figure 1), and between 03 Sep 2019 and 04 Apr 2022 bat acoustic sensors at E06 were operational for 579 days (Figure 2). Interruptions in operation were likely due to storage capacity as power supply was much more consistent during data collection periods 5 and 6 compared to collection periods 1 through 4; a conclusion further supported in that there were no operational interruptions during data periods 7 and 8.

Through eight data collection periods, SM4BAT acoustic detectors collected 462,554 WAV files at E05 and 210,749 at E06 (

Table 2). The number of files does not correlate with the total number of observed bat vocalizations but rather with the number of times the microphone was triggered by an ultrasonic sound that resulted in a recording. Unlike SM4 bird-acoustic detectors that record continuously, the SM4BAT units only create recordings when the microphone detects an ultrasonic signal in the environment. Slight differences in the placement of the microphone in relation to peripheral buoy instruments that may give off consistent intermittent ultrasonic pulses can result in differences in the number of recordings created with an SM4BAT unit. That the unit is making thousands of recordings when operational is a good indicator that the units are functioning properly despite an overall paucity of bat acoustic activity around the buoy.

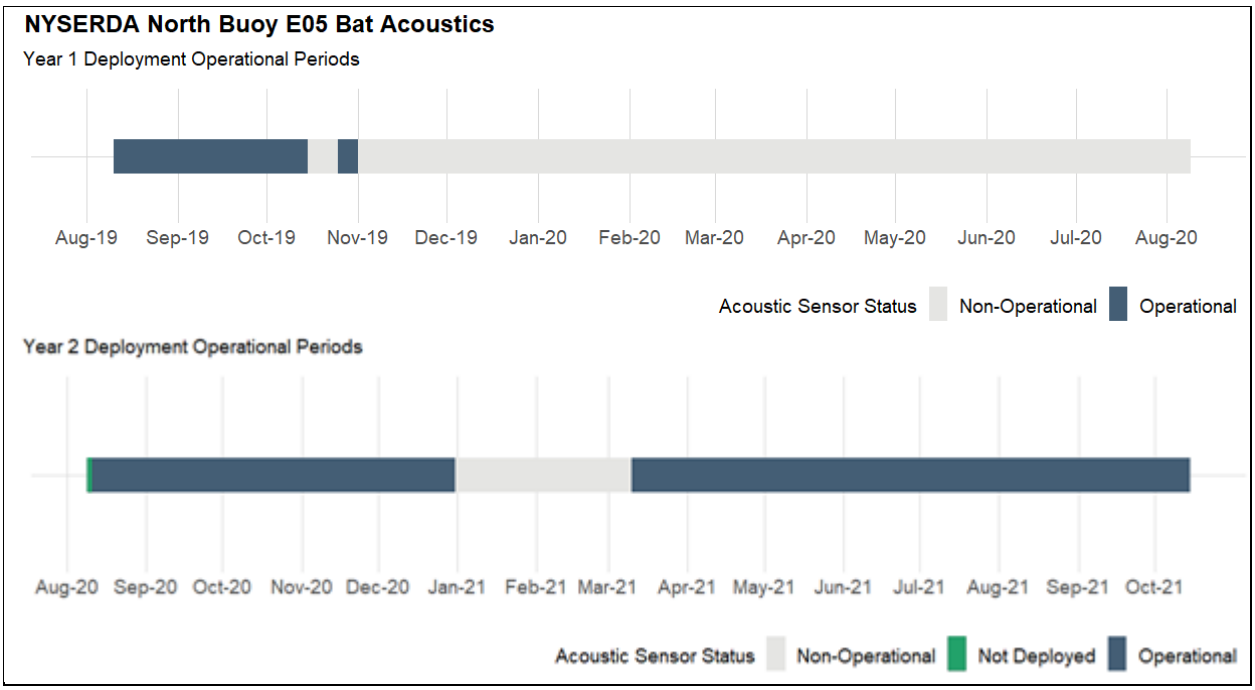

Figure 1. E05 Hudson North bat acoustics operational status in years 1 and 2.

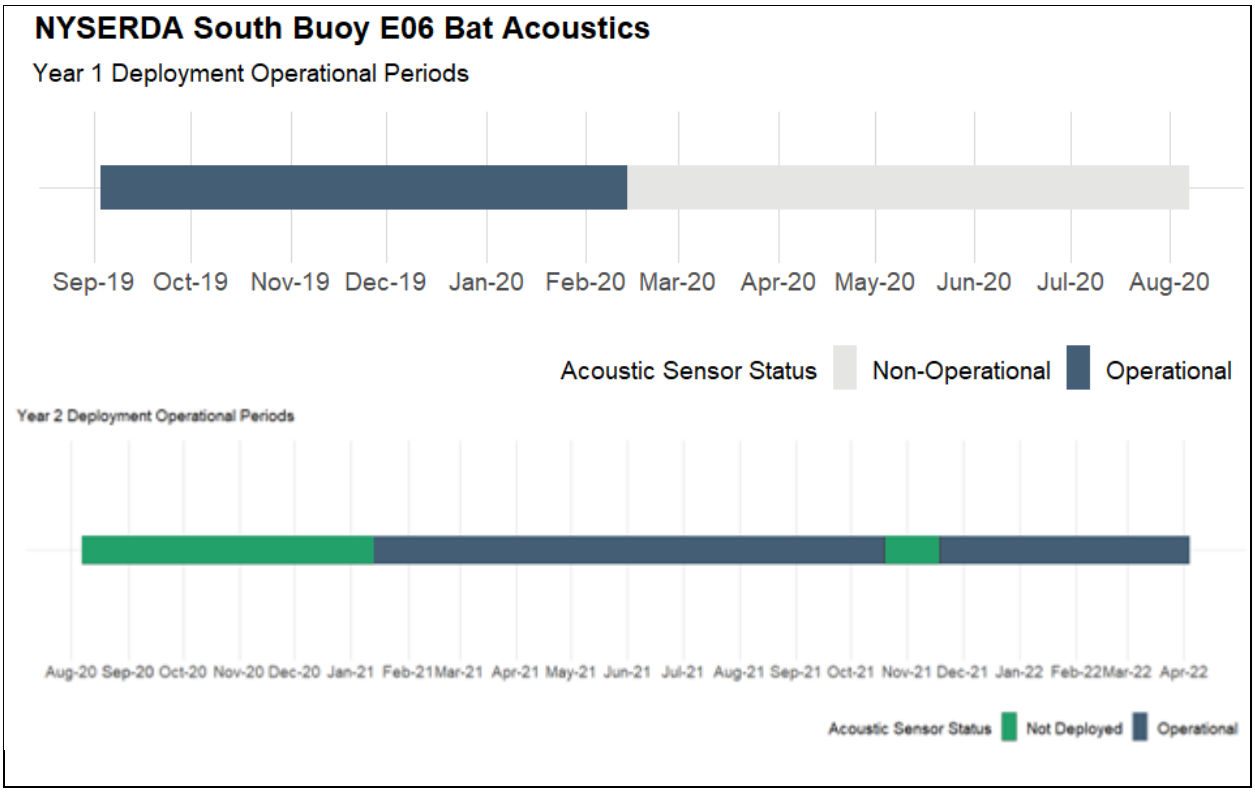

Figure 2. E06 buoy bat acoustics operational status in years 1 and 2.

Table 2. Deployment and Operation Information Associated with SM4BAT Acoustic Data Collected at E05 and E06 Buoys

Buoy	Collection Period	Deployment Period	Detector Operational Periods	Number of WAV Files	Data Status
E05	1	10 Aug–25 Oct 19	10 Aug–15 Oct 19	NA	Analyzed/reported herein
	2–4	25 Oct–9 Aug 20	25 Oct–1 Nov 19	28,846	Analyzed/reported herein
	5–6	11 Aug 20–10 Mar 21	11 Aug–31 Dec 20	169,569	Analyzed/reported herein
	7	10 Mar–14 May 21	10 Mar–14 May 21	106,137	Analyzed/reported herein
	8	14 May–15 Oct 21	14 May–15 Oct 21	158,002	Analyzed/reported herein
E05 TOTAL				**462,554**	
E06	1–4	3 Sep 19–7 Aug 20	3 Sep 19–14 Feb 20	15,803	Analyzed/reported herein
	5–6	13 Jan–26 Feb 21	13 Jan–26 Feb 21	49,822	Analyzed/reported herein
	7	26 Feb–15 Jul 21	26 Feb–15 Jul 21	32,187	Analyzed/reported herein
	8	15 Jul–19 Oct 21	15 Jul–19 Oct 21	1,871	Analyzed/reported herein
	8.1	19 Nov 21–4 Apr 22	19 Nov 21–4 Apr 22	111,066	Analyzed/reported herein
E06 TOTAL				**210,749**	

Bird Acoustic Analysis

Data reviewed from the first retrieval in late 2019 (data collection periods 1–4) was found to be excessively clipped due to high amplitude wind, water, and buoy noise. The data collected

during periods 1–4 were used to create an automated WAV-file-clipping check algorithm in MATLAB (Mathworks, Natick, MA), which was designed to inform all subsequent files as to which files contained the least amount of clipping and thus could be processed further with the Kaleidoscope software (Wildlife Acoustics, Maynard, MA).

Between 10 Aug 2019 and 15 Oct 2021, bird acoustic sensors at E05 were operational for 437 days (Figure 3) and between 03 Sep 2019 and 04 Apr 2022 at E06 for 445 days (Figure 4).

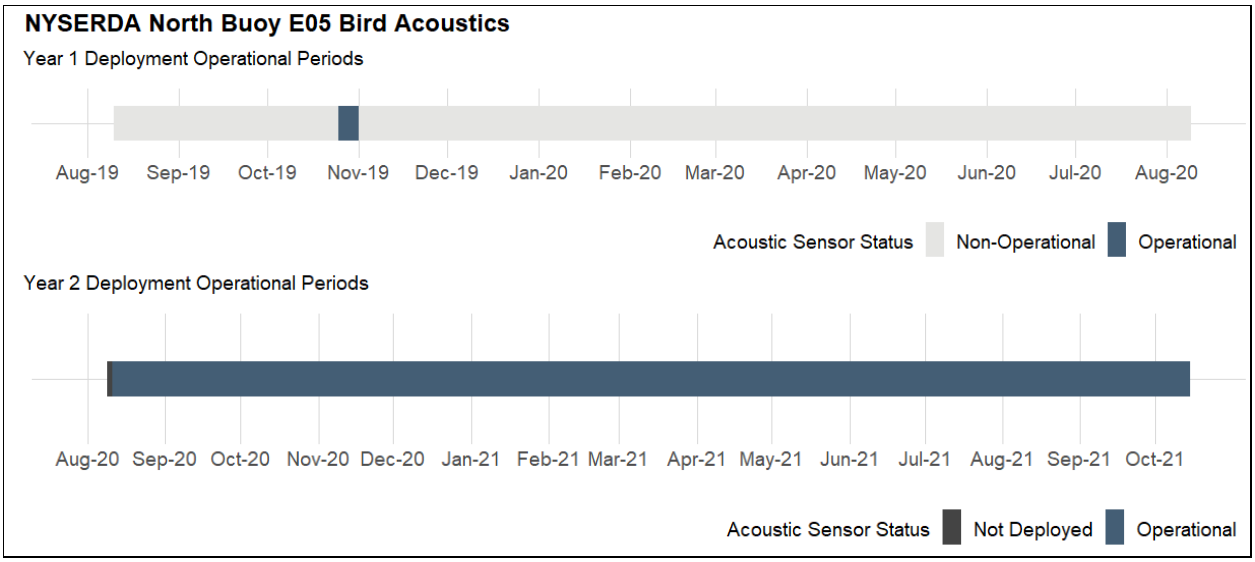

Figure 3. E05 bird acoustics operational status in years 1 and 2.

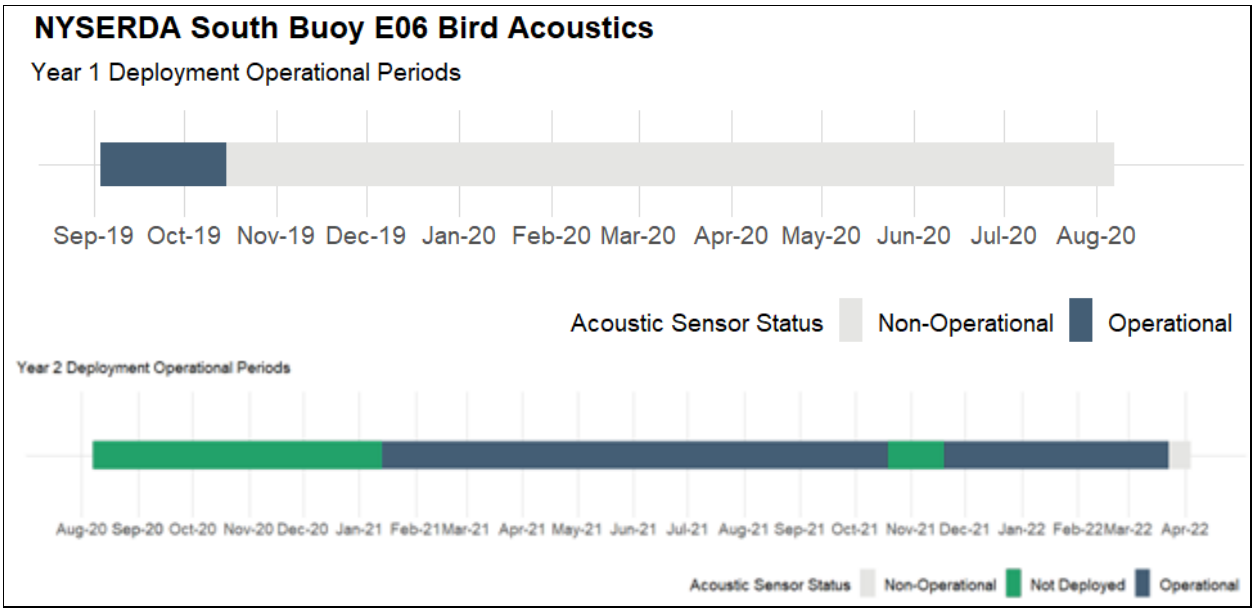

Figure 4. E06 bird acoustics operational status in years 1 and 2.

Through eight data collection periods, SM4 bird-acoustic detectors recorded 18,421 hour-long WAV files consisting of 15,459 useable hours of data processed and analyzed (Table 3). After

setting adjustments, data recorded during periods 5–8 had less clipping and improved overall quality than data collected during collection periods 1–4.

The usable data from each buoy was processed with Kaleidoscope software using automated detection parameters for the flight calls of species listed in Table 4 (Cornell Lab of Ornithology Macaulay Library archives; https://search.macaulaylibrary.org/catalog). Additional bird species were confirmed from detections that are not those listed in Table 4, focusing on but not limited to gulls and terns such as herring gull, Bonaparte's gull, Franklin's gull, laughing gull, ring-billed gull, and roseate tern. The parameters were chosen to be lenient and allow more false alarms to avoid discarding true positives as much as possible.

Table 3. Deployment and Operation Information Associated with SM4 Bird-Acoustic Detector Data Collected at E05 Hudson North and E06 Hudson South NYSERDA Buoys

Buoy	Collection Period	Deployment Period	Detector Operational Periods	Number of 1-hr WAV Files	Hours of Usable Data	Data Status	Comment
E05	1–4	10 Aug 19– 9 Aug 20	25 Oct 19– 1 Nov 19	180	5 (3%)	Analyzed/reported herein	Data 'clipped' from high amplitude noise
	5–6	11 Aug 20– 10 Mar 21	11 Aug 20– 10 Mar 21	2,303	2,210 (96%)	Analyzed/reported herein	
	7	10 Mar 21– 14 May 21	10 Mar 21– 14 May 21	1,561	1,537 (98%)	Analyzed/reported herein	
	8	14 May– 15 Oct 21	14 May– 15 Oct 21	3,791	3,721 (98%)	Analyzed/reported herein	
E05 TOTAL				**7,835**	**7,473**		
E06	1–4	3 Sep 19– 7 Aug 20	3 Sep 19– 15 Oct 19	1,510	127 (8.5%)	Analyzed/reported herein	Data 'clipped' from high amplitude noise
	5–6	13 Jan 21– 26 Feb 21	13 Jan 21– 26 Feb 21	474	415 (88%)	Analyzed/reported herein	
	7	26 Feb 21– 15 Jul 21	26 Feb 21– 15 Jul 21	3,334	3,281 (98%)	Analyzed/reported herein	
	8	15 Jul 21– 19 Oct 21	15 Jul 21– 19 Oct 21	2,306	2,286 (99%)	Analyzed/reported herein	
	8.1	19 Nov 21– 4 Apr 22	19 Nov 21– 4 Apr 22	2,962	1,877 (63%)	Analyzed/reported herein	
E06 TOTAL				**10,586**	**7,986**		
TOTAL				**18,421**	**15,459**		

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

Cape may warbler	Northern parula	Bobolink
Ovenbird	American redstart	Palm warbler
Gray-cheeked thrush	Black-throated blue warbler	Black-and-white warbler
Blackpoll warbler	Common yellowthroat	Bay-breasted warbler
Least bittern	Green heron	Veery
Swainson's thrush	Wood thrush	Northern waterthrush
Magnolia warbler	Blackburnian warbler	Yellow warbler

Chestnut-sided warbler	Yellow-rumped warbler	Savannah sparrow
White-throated sparrow	Blue grosbeak	Indigo bunting

Results

Bat Acoustic Results

Through eight data collection periods, SM4BAT acoustic detectors recorded 32 bat calls at E05 and E06 buoys with all occurrences during the autumn migratory/mating period (Table 5). Although only 28 occurrence records of bats are associated with a wind speed, wind speeds ranged between 2.5 and 17.5 ms with a median wind speed of 8.1 ms. Overall, bat calls were recorded in much higher wind speeds than those associated with bird acoustics (see bird results below). This difference highlights that while birds can sit on water when flight conditions become unfavorable, bats have fewer opportunities for refuge when offshore and must continue to fly as flight conditions worsen.

A typical silver-haired bat call is shown in Figure 5.

Table 5. Bat Species Recorded at E05 and E06 Buoys

Buoy	Year-Month	Species	Count
E05	2019-09	Unidentified low-frequency bat spp.	1
		Silver-haired bat	3
	2020-08	Silver-haired bat	1
	2020-10	Silver-haired bat	2
	2021-08	Silver-haired bat	4
	2021-09	Eastern red bat	2
		Silver-haired bat	17
E06	2019-09	Silver-haired bat	1
	2019-10	Silver-haired bat	1

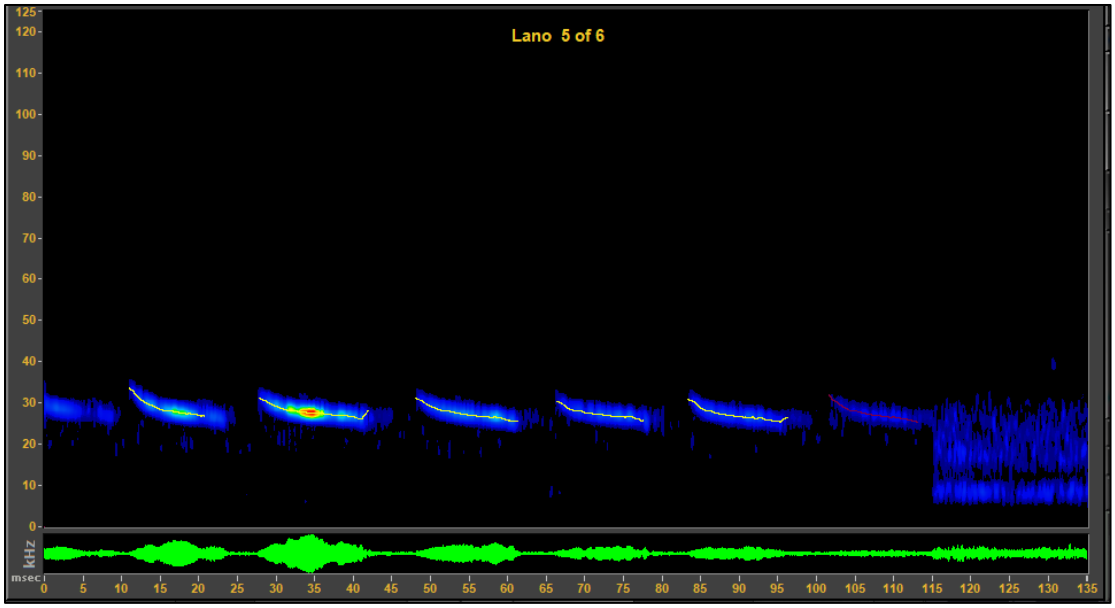

Figure 5. Typical Silver-haired bat (*Lasionycteris noctivagans*) call sequence recorded at E05 and E06 buoys.

Screen shot from SonoBat acoustic analysis software (Arcata CA, USA).

Bird Acoustic Results

Between 10 Aug 2019 and 15 October 2021, 23 bird species and 506 unique bird vocalizations were detected at E05 (Appendix A), and between 03 Sep 2019 and 04 Apr 2022, 10 bird species and 196 bird vocalizations were detected at E06 (Appendix A).

Non-gull species were most prevalent during the autumn migratory period during 2019 and 2020. Of the non-gull species groups, passerines were the most well represented with 15 species across E05 and E06. Other species groups occurring in the fall migratory period include gulls (4 species), shorebirds (2 species), wading birds (2 species), terns (1 species), raptors (1 species), pelicans (1 species), and storm-petrels (1 species) (Table 6). Herring gull (n=520) comprised the vast majority of detections (71% at E05, 83% at E06) and were particularly prevalent during the spring (Figure 6, Figure 7). After herring gull, the most abundant species across E05 and E06 included royal tern (n=73), brown pelican (n=23), and laughing gull (n=22) (Appendix A).

Table 6. Number of Species and Associated Vocalizations Detected at E05 and E06

Species Group	Species Detected	Vocalizations
Gull	4	545
Passerine	15	42
Pelican	1	23
Raptor	1	5
Shorebird	2	8
Storm-petrel	1	3
Tern	1	73

Species Group	Species Detected	Vocalizations
Wading Bird	2	3
Total	**27**	**702**

Birds were recorded at wind speeds ranging between 0.6 ms up to 16 ms with the median number of detections occurring at 3.4 ms (Figure 8). Most bird acoustic observations occurred when wind speeds were less than 5.0 ms (Figure 8). These results suggest that much of the bird activity could be occurring when wind speeds are below the cut-in speed of future, larger turbines. This suggests the risks to birds will be much less than if activity were more frequent at higher wind speeds.

Representative bird sonograms are shown in (Figure 9–Figure 14).

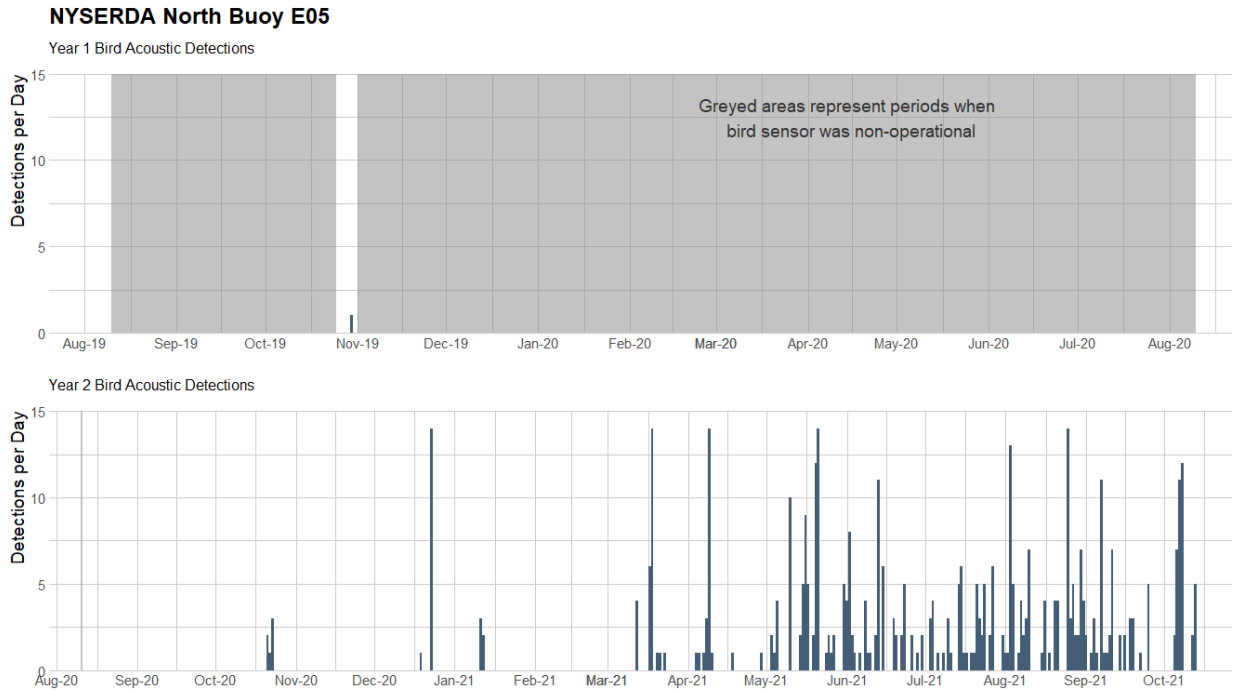

Figure 6. Bird acoustic detections recorded per day at E05.

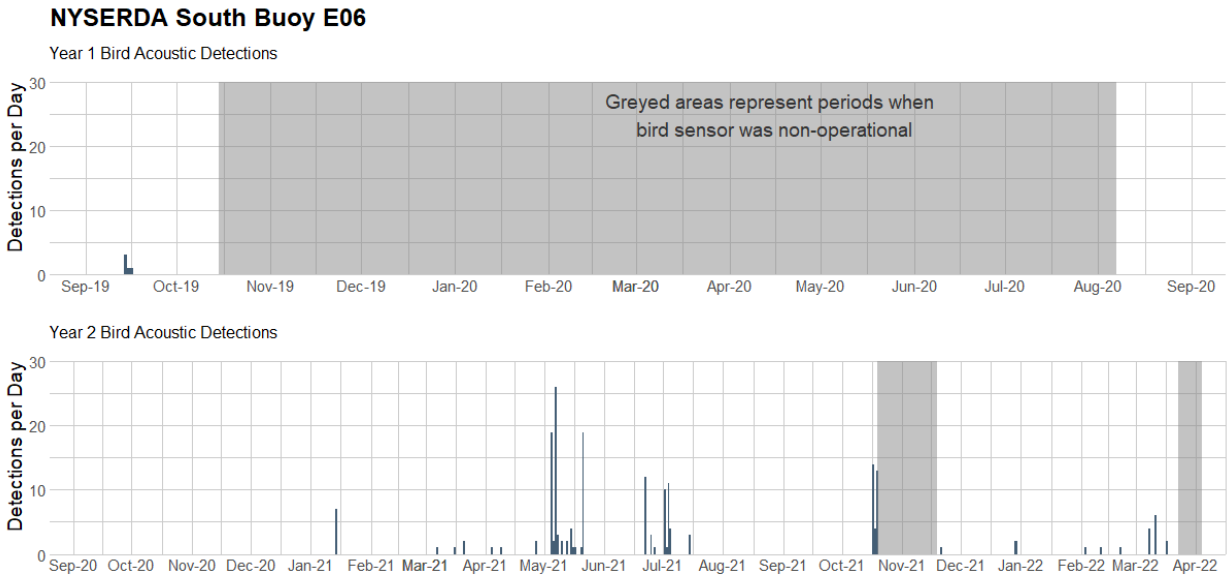

Figure 7. Bird acoustic detections recorded per day at E06.

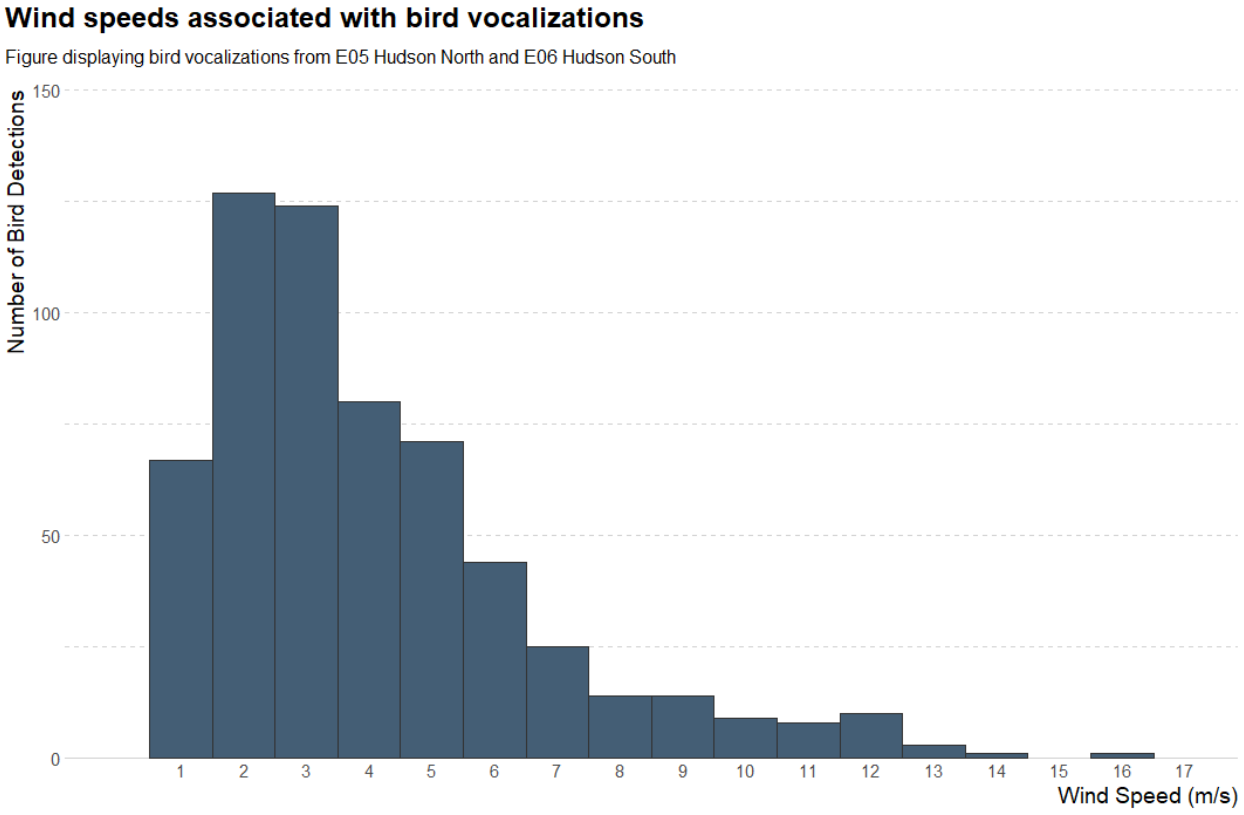

Figure 8. Bird acoustic detections recorded per wind speed (ms) observed at E05 and E06.

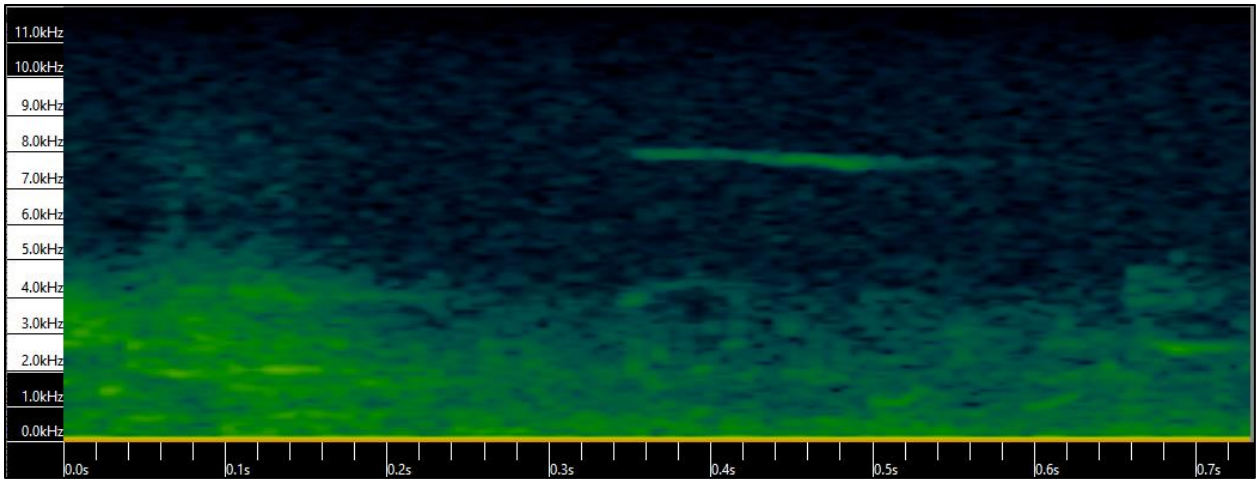

Figure 9. White-throated sparrow detection on 19 Dec 2020 at 08:57:18.

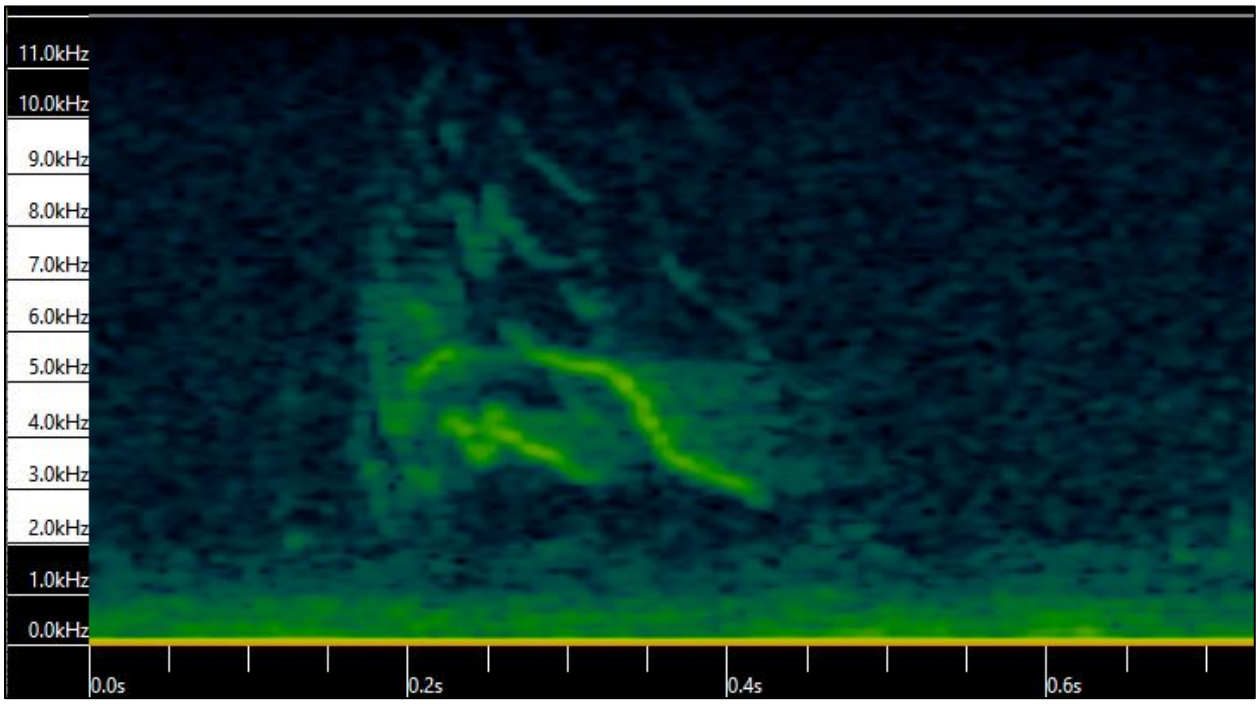

Figure 10. Yellow warbler detection on 23 Oct 2020 at 12:17:37.

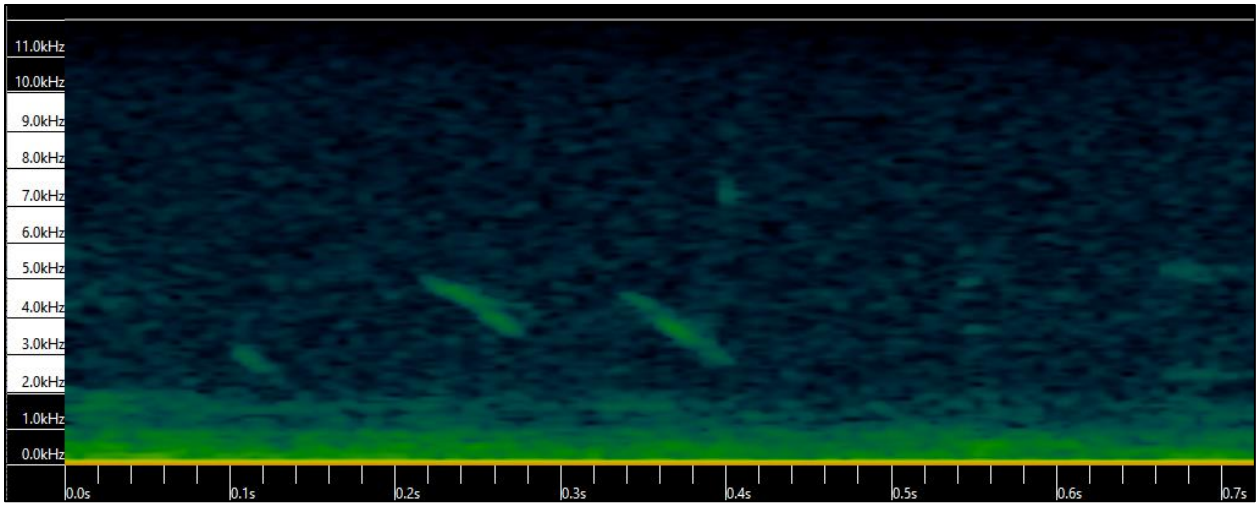

Figure 11. Palm warbler detection on 22 Oct 2020 at 11:20:57.

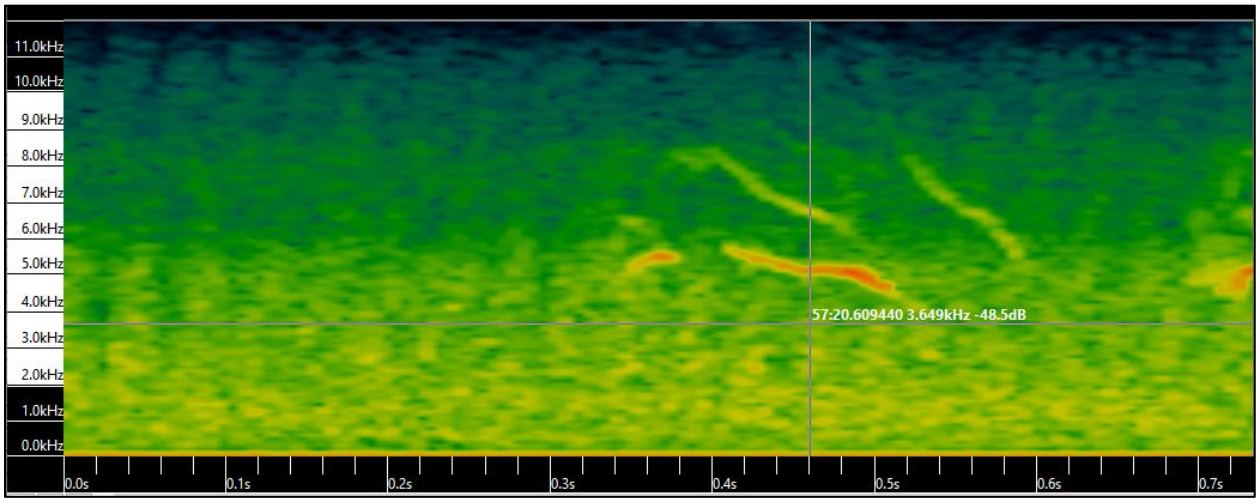

Figure 12. White-throated sparrow detection on 23 Oct 2020 at 16:07:22.

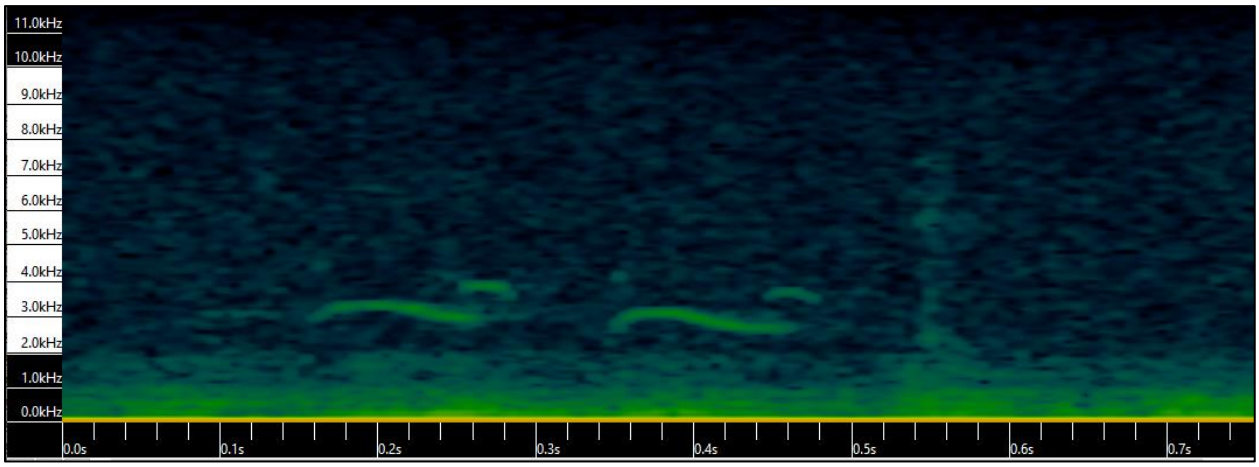

Figure 13. Least bittern detection on 21 Oct 2020 at 08:33:47.

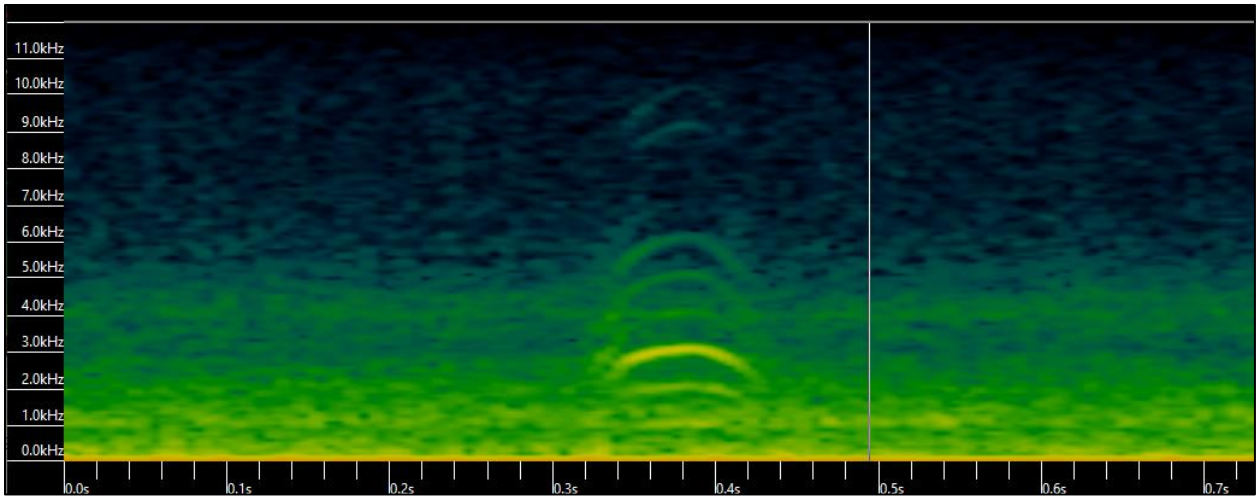

Figure 14. Gray-cheeked thrush detection on 14 Jan 2021 at 08:35:50.

Motus Detections

Two tagged birds and two tagged bats were theoretically detected by the Motus receiver at E05, and these are summarized in Table 7. There were no detections at E06. The bird species detected were Eastern whip-poor-will (*Antrostomus vociferus*) and chimney swift (*Chaetura pelagica*), and the bats were both little brown bat (*Myotis lucifugus*). On motus.org, the map views of all these detections make no sense, and biologically the detections are unlikely considering the duration of the whip-poor-will detection (several weeks) and the presence of the little brown bat, which was not detected in any of the acoustic data and has not been positively detected and reported at other offshore sensors. It should be noted that there are other Motus/CTT receivers deployed on other structures with similar apparently false-positive detections. We provide these results for reference and are working with motus.org to understand the issues and reduce future potential false-positive detections.

Table 7. Motus (Likely False) Detections from Receivers at E05

Tag	Species	Date
GrahameNightjars#70:4.9 M.45364	Eastern whip-poor-will	15 Aug 2020
GrahameNightjars#70:4.9 M.45364	Eastern whip-poor-will	17 Aug 2020
GrahameNightjars#70:4.9 M.45364	Eastern whip-poor-will	22 Aug 2020
GrahameNightjars#70:4.9 M.45364	Eastern whip-poor-will	02 Sep 2020
Habitat-ChimneySwift#70:3.1 M.46555	Chimney swift	31 Aug 2021
ON_bats#70:8.3 M.56931	Little brown bat	30 Sep 2021
UPDE Bats#70:4.3 M.57013	Little brown bat	30 Sep 2021

Appendix A. Bird Detections at E05 and E06 during the First 2 Study Years

Buoy	Year	Month	Species	Count
E05	2019	10	American redstart	1
	2020	10	Least bittern	2
			White-throated sparrow	1
			Yellow warbler	2
			Palm warbler	1
		12	Herring gull	14
			White-throated sparrow	1
	2021	1	Herring gull	5
		3	Herring gull	27
		4	Herring gull	23
		5	Laughing gull	2
			Herring gull	61
			Great black-backed gull	1
			Royal tern	7
			Brown pelican	3
			Song sparrow	2
			Blue grosbeak	1
		6	Spotted sandpiper	2
			Laughing gull	4
			Herring gull	56
			Royal tern	12
			Wilson's storm-petrel	1
			Brown pelican	3
			Song sparrow	3
			Magnolia warbler	1
		7	Spotted sandpiper	2
			Solitary sandpiper	2
			Laughing gull	4
			Herring gull	61
			Royal tern	17
			Wilson's storm-petrel	1
			White-throated sparrow	1
			Song sparrow	3

(continued)

Appendix A (continued)

Buoy	Year	Month	Species	Count
E05 (cont)	2021 (cont)	8	Herring gull	62
			Great black-backed gull	1
			Royal tern	15
			Brown pelican	3
			Savannah sparrow	1
			Song sparrow	3
			Common yellowthroat	1
			Yellow warbler	1
			Indigo bunting	1
		9	Laughing gull	2
			Herring gull	27
			Royal tern	10
			Wilson's storm-petrel	1
			Veery	1
			Swainson's thrush	1
			Song sparrow	2
			Magnolia warbler	1
		10	Spotted sandpiper	1
			Solitary sandpiper	1
			Laughing gull	3
			Herring gull	22
			Royal tern	12
			Brown pelican	3
			Osprey	2
			Song sparrow	1
			Rose-breasted grosbeak	1
E06	2019	9	Green heron	1
			Wood thrush	2
			American redstart	2
	2021	1	Herring gull	5
			Gray-cheeked thrush	2
		3	Herring gull	4
		4	Ring-billed gull	1
			Herring gull	3
		5	Herring gull	80
		6	Herring gull	16
		7	Herring gull	29

(continued)

Appendix A (continued)

Buoy	Year	Month	Species	Count
E06 (cont)	2021 (cont)	10	Laughing gull	2
			Herring gull	12
			Brown pelican	9
			Osprey	3
			Song sparrow	5
		11	Herring gull	1
		12	Herring gull	4
	2022	2	Herring gull	3
		3	Laughing gull	5
			Herring gull	5
			Brown pelican	2