Floating LiDAR Metocean Data Collection Services

E05 and E06 Hydrophone Analysis and Results Summary

Prepared for
Ocean Tech Services, LLC
985 Ocean Drive
Cape May, NJ 08204

Prepared by
Normandeau Associates, Inc.
Ocean Tech Services, LLC
University of Rhode Island

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Marine Mammal Hydrophone Acoustic Analysis and Results Summary

This report summarizes the marine mammal hydrophone acoustic data associated with the E05 Hudson North and E06 Hudson South NYSERDA buoys collected from August 2019 through July 2021. Analyses and results are presented for all results to date.

Data Analysis Methods

Hydrophones were deployed at the EO5 Hudson North buoy on 25 Oct 2019 and E06 Hudson South buoy on 03 Aug 2019 where they remain deployed on a continuous data collection schedule. To date, data have been analyzed for both service trips for the E05 buoy hydrophone and for the E06 buoy hydrophone (Table 1). Data collection periods 1 and 2 for E05 Hudson North buoy and data collection periods 1, 2, and the second half of data collection period 3 for E06 Hudson South buoy had operational periods shorter in duration than associated deployment periods (Table 1). Overall, the E05 Hudson North buoy hydrophone has been operational for 274 days (Figure 1) and the E06 Hudson South buoy hydrophone has been operational for 266 days (Figure 2).

Table 1. Deployment and Operation Information Associated with Hydrophone at E05 Hudson North NYSERDA Buoy and the E06 Hudson South NYSERDA Buoy

Buoy	Collection Period	Deployment Period	Detector Operational Periods	Data Status
E05	1–2	25 Oct 2019–7 Aug 2020	25 Oct 2019–25 Dec 2019	Analyzed and reported in this summary
	3	9 Aug 2020–10 Mar 2021	9 Aug 2020–10 Mar 2021	Analyzed and reported in this summary
	4	10 Mar 2021	NA	Data collection currently ongoing
E06	1–2	3 Sep 2019–8 Aug 2020	3 Sep 2019–3 Nov 2019	Analyzed and reported in this summary
	3	8 Aug 2020–15 Jul 2021	8 Aug 2020–1 Mar 2021	Analyzed and reported in this summary
	4	15 Jul 2021	NA	Data collection currently ongoing

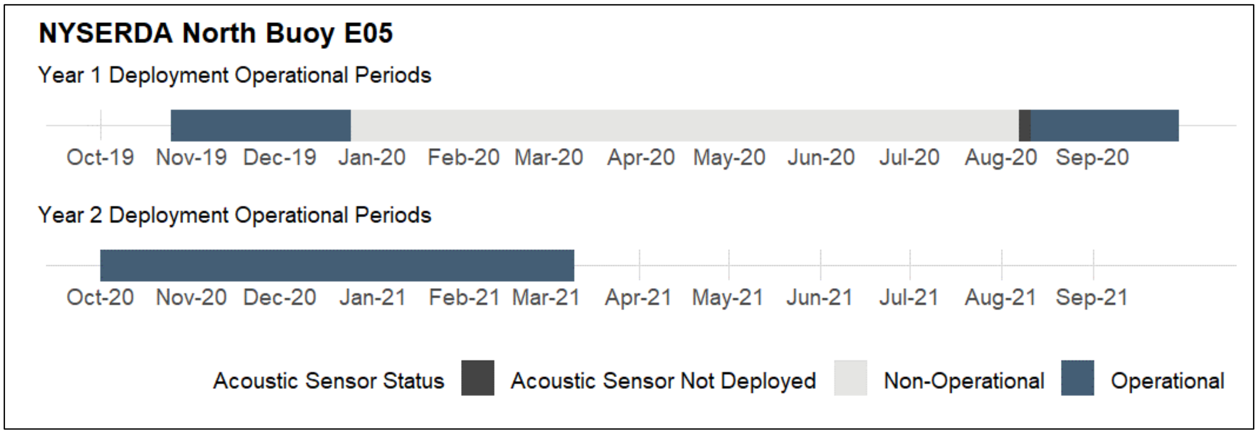

Figure 1. **E05 Hudson North hydrophone operational status in years 1 and 2.**

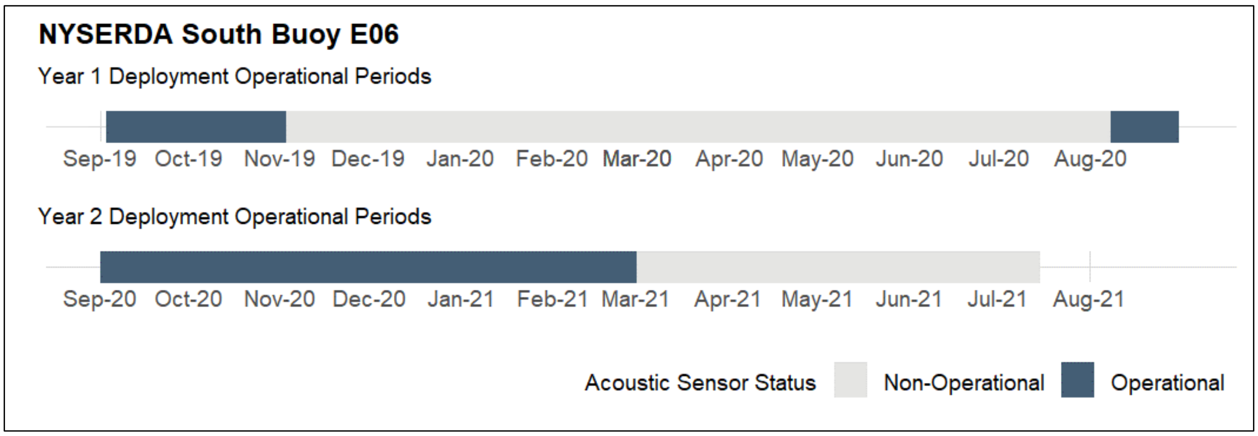

Figure 2. **E06 Hudson South hydrophone operational status in years 1 and 2.**

Data cards were shipped to Normandeau Associates Inc. (Normandeau) and backed-up on the Normandeau ReMOTe server. Data were then packaged and shipped for processing to the University of Rhode Island, Department of Oceanography (URI).

During data collection periods 1 and 2, both buoy hydrophones were set to collect data in 60-second increments (i.e., repeated cycle of 60 seconds of recorder on followed by 60 seconds recorder off) with each data file representing a 1-min recording interval. After finding operational periods under this setting structure were much shorter than anticipated, hydrophone settings were adjusted to a repeated cycle of 5 min on/10 min off for data collection periods 3 and 4.

All acoustic data were processed with the software program Raven Pro (Cornell Lab of Ornithology, Center for Conservation Acoustics, Ithaca NY, USA). For every recording file, a 4-panel spectrogram was generated to display sonograms and facilitate species identification via visual inspection (Figure 3). Panels C and D of Figure 3 made it possible to view species such as sei and fin whales that would have otherwise not been detected with a standard single panel view.

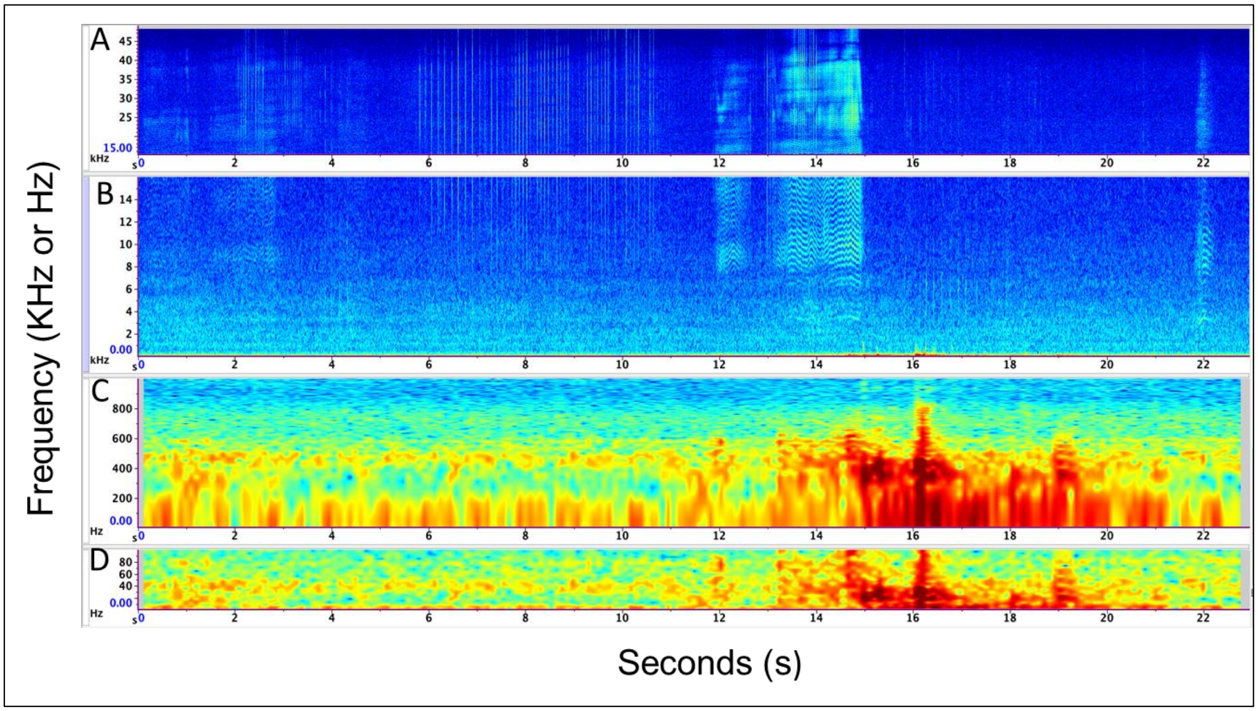

Figure 3. Four-panel spectrogram used by analysts when viewing hydrophone data collected at E05 Hudson North and E06 Hudson South buoy.

Panel C displays a spectrogram on a logarithmic y-scale from 0 to 1 kHz. This scale visually "enlarges" lower frequency calls, such as fin or sei whales so that they are easier to detect. Numeric tick mark values are inaccurate for this scale in the current version of Raven Pro. Panel D displays the same frequency ranges as Panel C on a non-logarithmic scale.

Data analysis had originally been conceived as a multimodal process joining Raven Pro auto classification algorithms with manual analyst identification. Analysts tested Raven Pro auto classification to parse out possible marine mammal signals and eliminate noise files so analysts could focus their manual identification efforts and reduce overall analysis time. Raven Pro auto classification had success with some higher frequency species but other low frequency species, such as sperm whale, where consistently classified as noise because their vocalizations occupy a frequency range shared by mooring and ship noise. Low confidence in Raven Pro auto classification led analysts to manually review all data.

Manual review slowed analysis to such an extent that an anticipated analysis completion data of spring 2022 was identified, and identification of a robust subsampling strategy was instigated. A subsampling rate test was conducted by comparing the species identification results for all 10-min interval files across 35 days for E06 hydrophone data and 40 days of E05 hydrophone data. The species identification results were compared with the same set of days but for a subsampled structure of 10-min interval files every 30-min, 60-min, 90-min, 120-min, and 180-min intervals. To ensure the results of this initial test were robust through time, all data were analyzed for at least one day per subsequent month and compared to results generated using a subsampling strategy.

Multiple analysts worked on the dataset, and it was therefore appropriate to compare analyst performance to ensure consistency. To compare results, each analyst reviewed the same dataset and compared the results.

Results

Subsampling Strategy Results

The resulting species composition for the day was compared at each sampling interval, and a subsampling strategy was determined for each dataset. It was determined that a sampling rate at 2-hour intervals represented a substantial increase in analyst efficiency without any noteworthy drop-off in species detection Figure 4; Table 2). This is likely because marine mammal vocalizations can be detected 10–50 km away and short sampling intervals result in the same individuals being present on consecutive recordings.

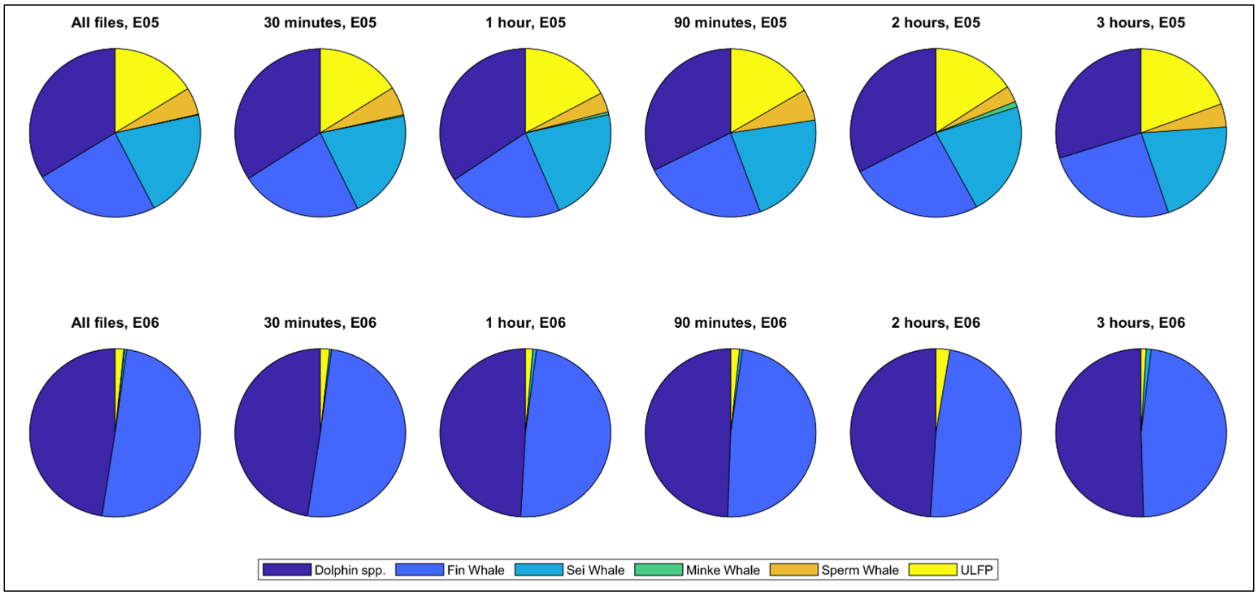

Figure 4. Subsample test results showing little drop in species detections and daily species composition with increasing subsample intervals.

ULFP are unidentified low frequency pulse.

Table 2. Subsample Test Results Showing Little Drop in Species Detections and Daily Species Composition with Increasing Subsample Intervals

ULFP are unidentified low frequency pulse.

Buoy	Increment	Dolphin	Fin	Sei	Minke	Sperm	ULFP	Total
E05	All	265 (33.8%)	186 (23.7%)	164 (20.9%)	1 (0.1%)	41 (5.2%)	127 (16.2%)	784
	30-min	130 (34.1%)	88 (23.1%)	80 (21.0%)	1 (0.3%)	21 (5.5%)	61 (16.0%)	381
	1-hour	64 (34.4%)	41 (22.0%)	41 (22.0%)	1 (0.5%)	7 (3.8%)	32 (17.2%)	186
	90-min	43 (32.3%)	31 (23.3%)	29 (21.8%)	—	8 (6.0%)	22 (16.5%)	133
	2-hour	31 (32.6%)	24 (25.3%)	21 (22.1%)	1 (1.1%)	3 (3.2%)	15 (15.8%)	95
	3-hour	20 (29.9%)	17 (25.4%)	14 (20.9%)	—	3 (4.5%)	13 (19.4%)	67
E06	All	541 (48.6%)	572 (51.4%)	5 (0.4%)	—	1 (<0.1%)	19 (1.7%)	1,113
	30-min	269 (47.6%)	284 (50.2%)	2 (0.4%)	—	—	10 (1.8%)	565
	1-hour	141 (49.1%)	140 (48.7%)	2 (0.7%)	—	—	4 (1.4%)	287
	90-min	89 (49.4%)	87 (48.3%)	1 (0.5%)	—	—	3 (1.7%)	180
	2-hour	74 (49.0%)	73 (48.3%)	—	—	—	4 (2.6%)	151
	3-hour	53 (50.5%)	50 (47.6%)	1 (1.0%)	—	—	1 (1.0%)	105

Species Identification QC Results

Although the total number of calls varied slightly between the two analysts, overall species compositions were consistent (Table 3).

Table 3. Data and Species Identification Results when Compared Between Analysts to Assess Consistency

ULFP are unidentified low frequency pulse.

Buoy	Analyst	Dolphin	Fin	Sei	Minke	Sperm	ULFP	Total
E05	1	35 (28%)	34 (27%)	26 (21%)	2 (1.6%)	8 (6.3%)	21 (17%)	126
	2	36 (25%)	44 (30%)	40 (27%)	6 (4.1%)	4 (2.7%)	16 (11%)	146
E06	1	8 (47.1%)	2 (11.8%)	—	—	7 (41.2%)	—	17
	2	6 (30%)	5 (25%)	—	—	8 (40%)	1 (5%)	20

Species Composition and Call Frequency Results

Over 540 days of hydrophone operation, 2,153 acoustic vocalization sequences were identified at E05 Hudson North representing 9 total species/species groups, and 2,052 vocalization sequences were identified at E06 Hudson South representing 12 total species/species groups (Table 4). Fin whale were the most prevalent species group representing 50% and 66% of total call sequences associated with the E05 buoy and E06 buoy, respectively (Figure 5, Figure 6). Dolphins were difficult to identify to species but 31% of E05 buoy and 22% of E06 buoy vocalization sequences were categorized as dolphin spp. (Figure 5, Figure 6). Vocalization sequences from all other species/species groups, comprised less than 20% of all calls at each buoy. No other species/species group besides fin whale and dolphin spp. comprised greater than 7% at E05 or 4% at E06 (Figure 5, Figure 6).

Table 4. Species and Species/Groups Identified and Number of 5-min Recording Periods Containing a Vocalization Sequence

Buoy	Species / Species Group	Vocalization Sequences
E05	Dolphin spp.	673
	Fin Whale	1,073
	Humpback Whale	22
	Whale spp.	109
	Minke Whale	66
	North Atlantic Right Whale	2
	Pilot Whale	1
	Sei Whale	152
	Sperm Whale	55
E06	Blue Whale	1
	Dolphin spp.	435
	Fin Whale	1,361
	Humpback Whale	28
	Whale spp.	116
	Minke Whale	16
	North Atlantic Right Whale	9
	Pilot Whale	4
	Sei Whale	65
	Sperm Whale	15

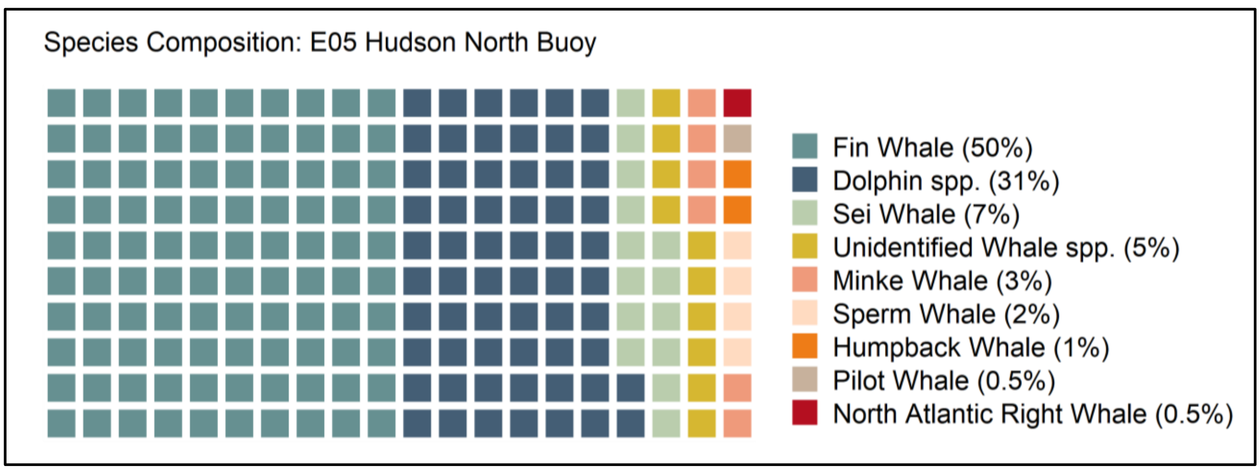

Figure 5. Species and species group composition for E05 NYSERDA buoy.
Each block represents 0.5% and all blocks add up to account for 100% of the identifications.

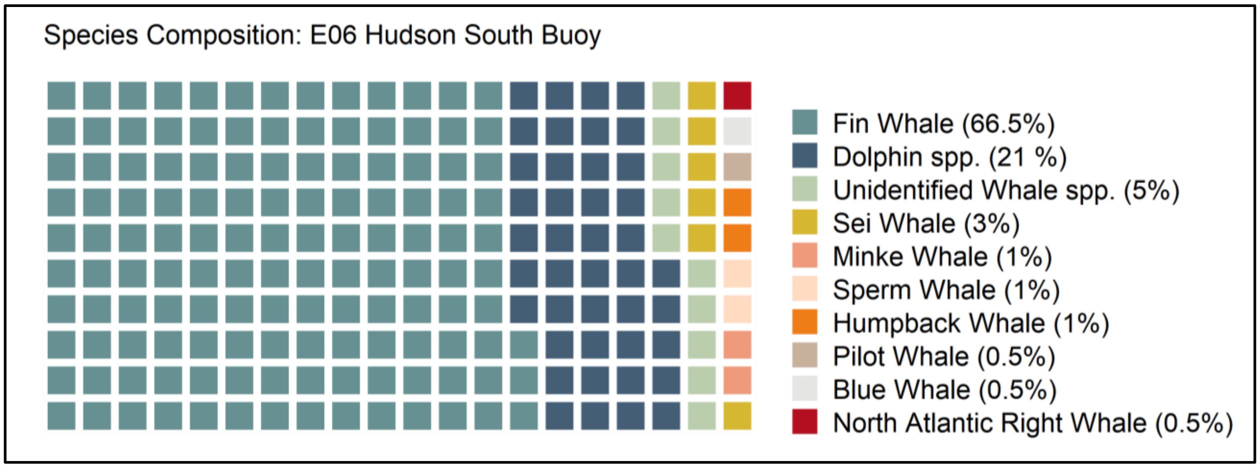

Figure 6. Species and species group composition for E06 NYSERDA buoy.
Each block represents 0.5% and all blocks add up to account for 100% of identifications.

Overall, activity measured in detections per day was greatest between August and mid-November (Figure 7, Figure 8). At both buoys, detections per day were on average nearly double that of the detections per day observed between November and March (Figure 7, Figure 8). During the late summer and fall periods when detections were greatest, the E05 buoy hydrophone regularly recorded greater than 30 detections per day while the E06 buoy hydrophone rarely exceed 20 detections per day, suggesting that the area surrounding the E05 buoy may be associated with greater activity rates (Figure 7, Figure 8).

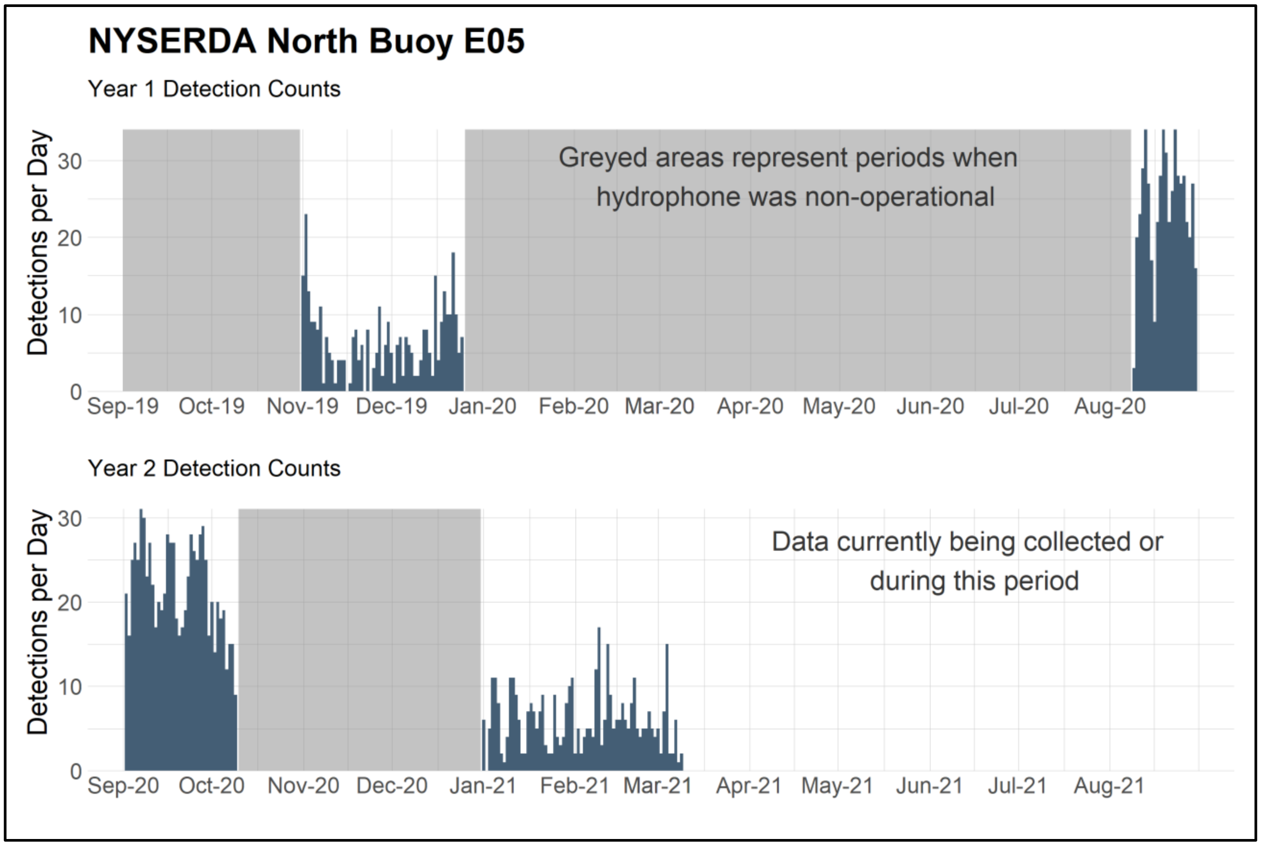

Figure 7. Marine mammal acoustic detections recorded per day at NYSERDA Buoy E05 Hudson North.

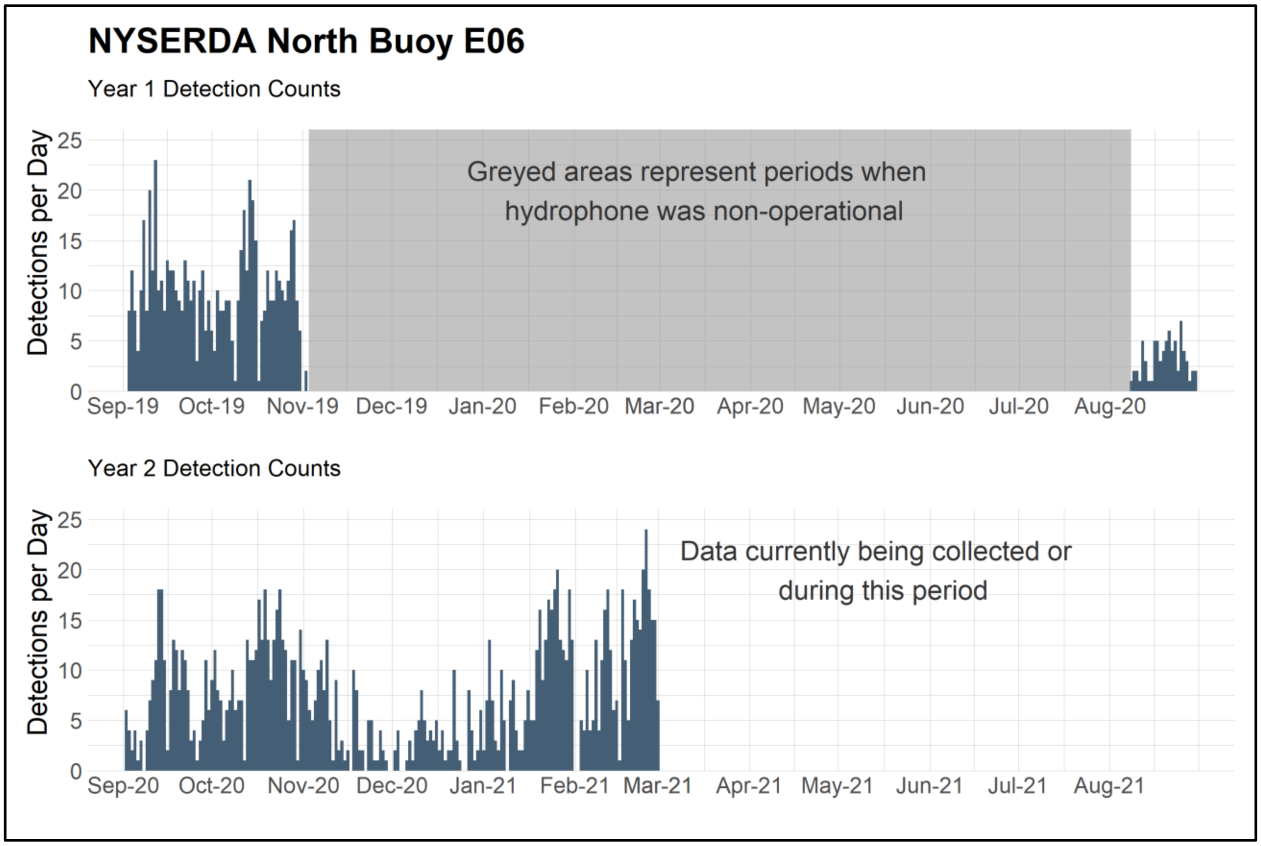

Figure 8. Marine mammal acoustic detections recorded per day at NYSERDA Buoy E06 Hudson South.

Fin whale and dolphin spp. comprised most detections for most weeks (Figure 9, Figure 10). Dolphin spp. detections at E06 were less prevalent during September and October 2019 (Figure 10). During the last week of November and first week of December 2020, humpback whale comprised a large proportion of the weekly detections at E06 (Figure 10). Between both buoys North Atlantic right whales were detected 11 times; all during year 2 (Table 5). At E05, North Atlantic right whale vocalization sequences were detected during the week of 24 January 2021 at E05 (Figure 9). At E06, North Atlantic right whale calls were detected, twice during the week of 20 December 2020, three times during the week of 27 December 2020, and four times spanning third the weeks of 10 January and 24 January 2020 (Figure 10).

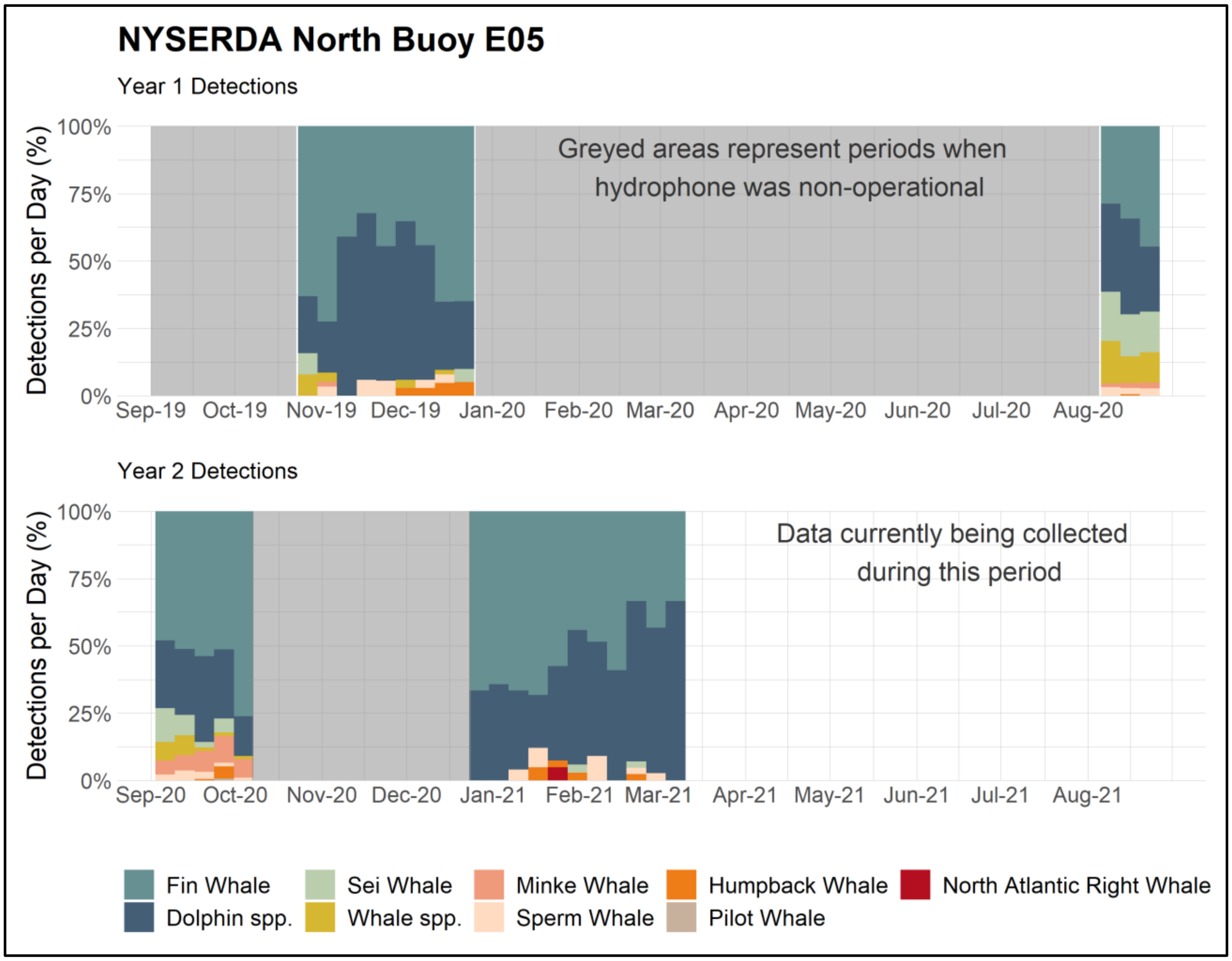

Figure 9. Percent marine mammal acoustic detections recorded per week at NYSERDA Buoy E05 Hudson North.

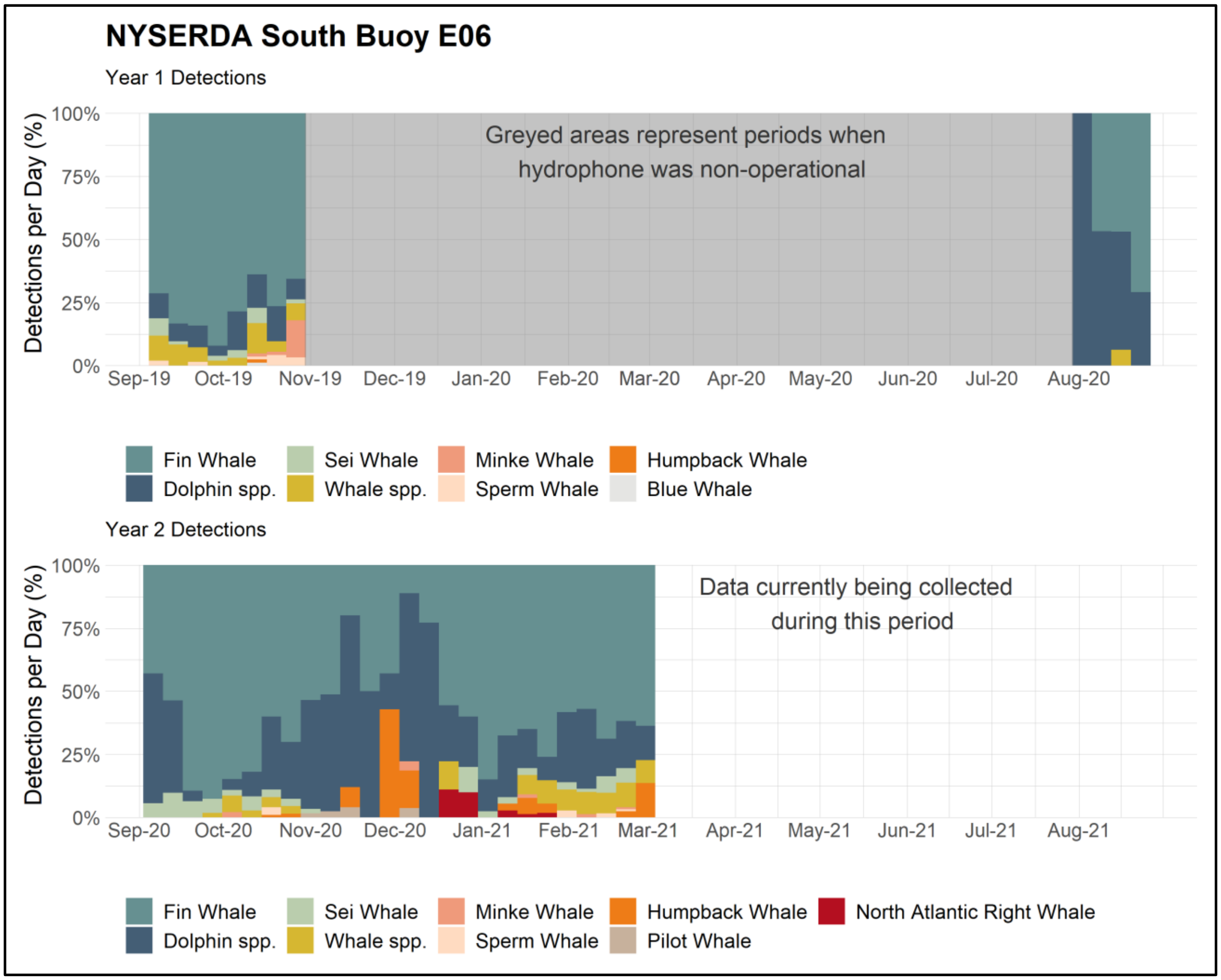

Figure 10. Percent marine mammal acoustic detections recorded per week at NYSERDA Buoy E06 Hudson South.

Table 5 North Atlantic right whale observation dates and Number of 5-min Recording Periods Containing a Vocalization Sequence

Buoy	Date	Vocalization Sequences
E05	2021-01-25	1
	2021-01-30	1
E06	2020-12-23	2
	2020-12-28	1
	2021-01-02	2
	2021-01-16	1
	2021-01-17	1
	2021-01-24	2

Recommendations

Methodological improvements to extend the hydrophone battery life and reduce background noise have already been implemented. To extend battery life, the hydrophone recording schedule has been adjusted to cycles of 5 min on/10 min off. After conducting the analysis of sampling rate and finding no difference in species detectability at a 2-hour sampling rate, we suggest that changing the sampling structure to record for 5–10 minutes every 120 minutes will result in a sampling structure with little to no drop off in species detection probability while simultaneously extending the battery life and storage capacity of the hydrophones, resulting in greater overlap in the deployment period and the operational period.