Floating LiDAR Metocean Data Collection Services

E05 and E06 Hydrophone Analysis and Results

Final Report

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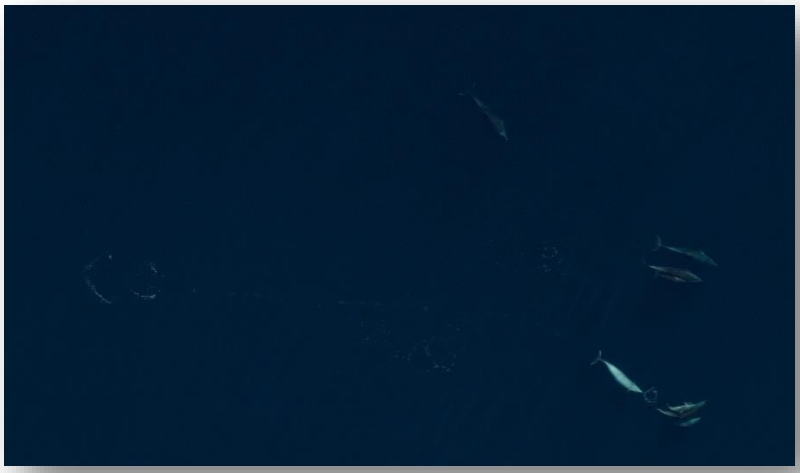

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Marine Mammal Acoustic Analysis Process and Results Summary

This report summarizes the marine mammal hydrophone acoustic data associated with the E05 Hudson North and E06 Hudson South buoy locations in the New York Bight from September 2019 to April 2022. Due to recording interruptions of the hydrophones at both locations, data are available intermittently from October 2019 to March 2021 at E05 Hudson North, and intermittently from September 2019 to October 2021 at E06 Hudson South. The hydrophone at E05 Hudson North was unrecoverable after its last deployment on 10 Mar 2021, and the hydrophone at E06 Hudson South malfunctioned during its last deployment in November 2021.

Data Collection

Hydrophones were deployed via a trawl-resistant bottom mount (TRBM) at the E05 Hudson North buoy location on 25 October 2019 and E06 Hudson South buoy location on 03 September 2019. This report includes all data collected at these two locations for the 2019-2022 monitoring period (Table 1). For analyses in this report, yearly periods are considered to be September 2019 through August 2020, September 2020 through August 2021, and September 2021 through August 2022. Throughout the entire period, the hydrophone at E05 Hudson North was operational and data recoverable for a total of 192 days (Figure 1) and the hydrophone at E06 Hudson South was operational and data recoverable for a total of 365 days (Figure 1).

Table 1. Deployment and Operation Information Associated with Hydrophones at Buoy Locations E05 Hudson North and E06 Hudson South

Station	Deployment Date	Recovery Date	Operational Dates	Comments
E05 Hudson North	10/25/2019	08/09/2020	10/25/2019 – 12/25/2019	
	08/09/2020	03/10/2021	08/09/2020 – 03/09/2021	
	03/10/2021	–	Unrecoverable	Recovery failed due to retrieval buoy malfunction. Considered "lost at sea"
E06 Hudson South	09/03/2019	01/15/2021	09/03/2019 – 11/03/2019	First recovery attempt in August 2020 failed.
	08/08/2020	01/15/2021	08/08/2020 – 01/14/2021	
	01/14/2021	07/15/2021	01/15/2021 – 03/01/2021	Stopped recording in March 2021
	07/15/2021	10/19/2021	07/15/2021 – 10/19/2021	
	11/21/2021	08/19/2022	No usable data recorded	Sensor malfunction after deployment. Campaign ended 04/03/2022

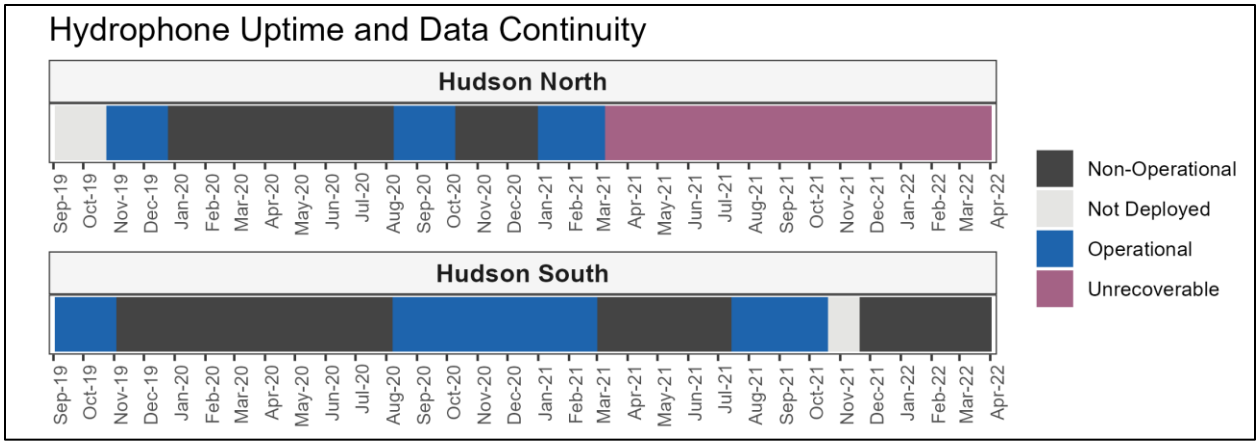

Figure 1. Hydrophone uptime and data continuity at buoy locations E05 Hudson North and E06 Hudson South.

Data were retrieved by Ocean Tech Services (Ocean Tech) and analyzed by the University of Rhode Island, Department of Oceanography (URI) and Normandeau Associates Inc. (Normandeau).

For data collected in 2019, the 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, equals to a 50% duty cycle) with each data file representing a 1-minute 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 minutes on/10 minutes off (33% duty cycle) for data collected in 2020-2022.

Data Analysis Methods

All acoustic data were processed with the acoustic analysis software 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 different frequency ranges and facilitate species identification via visual inspection (Figure 2). Panels C and D of Figure 2 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.

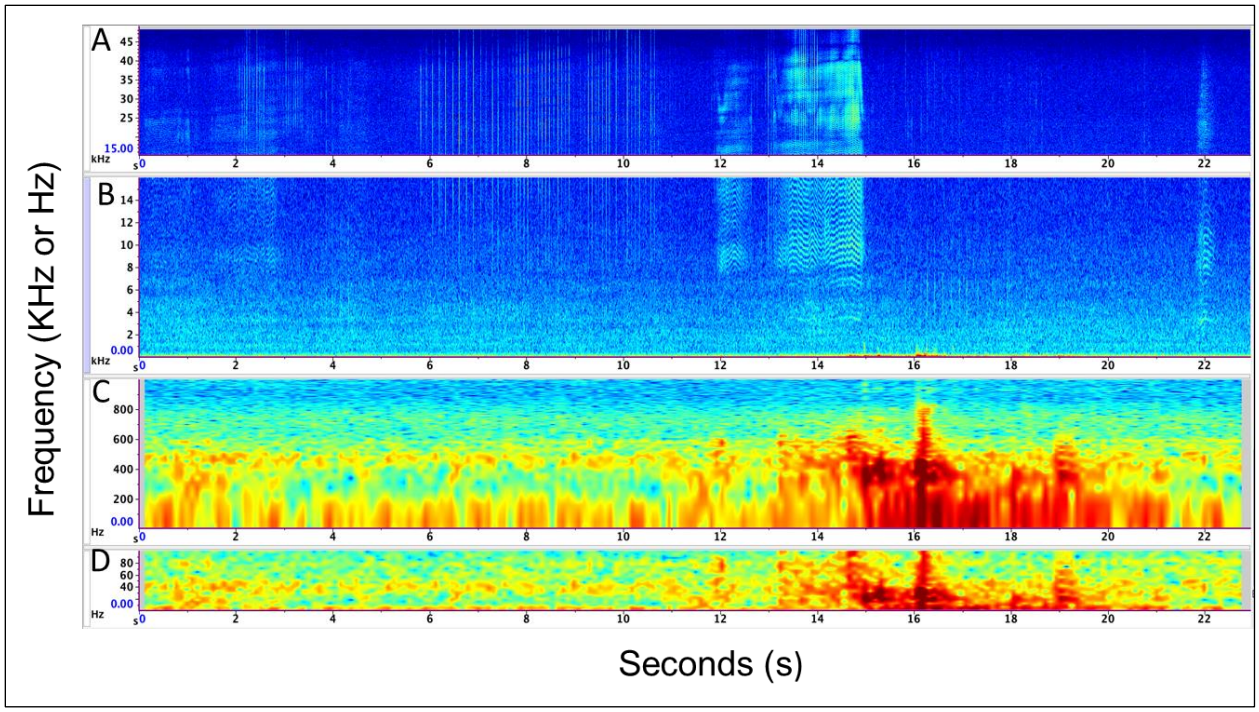

Figure 2. Four-panel spectrogram used by analysts when viewing hydrophone data collected at E05 Hudson North and E06 Hudson South buoy.

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.

Manually reviewing all recordings significantly increased analysis time, making it impossible to analyze the entire dataset in a reasonable period. As a result, a subsampling approach was used, in which 5-minute periods were analyzed in 2-hour intervals. This subsampling rate was tested by comparing the species identification results for all 10-minute interval files across 35 days for E06 Hudson South hydrophone data and 40 days of E05 Hudson North hydrophone data. The species identification results were compared with the same set of days but for a subsampled structure of 5-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.

To further test the validity of this approach, each dataset was analyzed by multiple analysts and their results were compared.

The resulting species composition for each day was compared at each sampling interval, and an optimal subsampling strategy was determined for each dataset. Overall, 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 3; 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. Therefore, the 2-hour sampling interval ensures the best balance between accuracy of detections and efficiency of data processing.

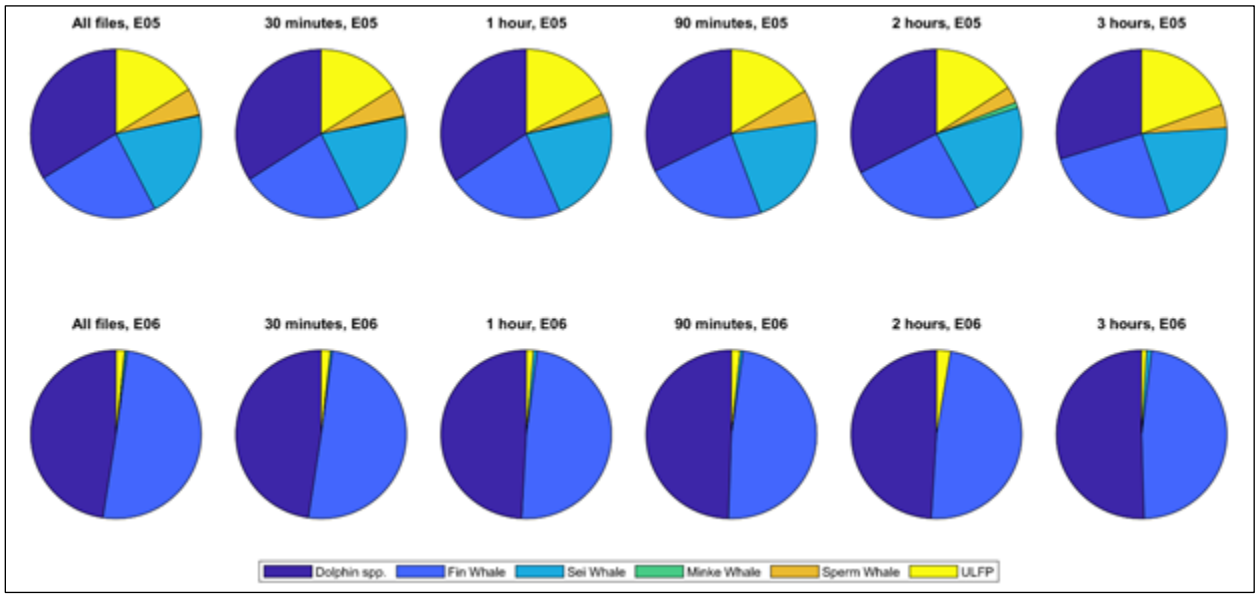

Figure 3. Subsample test results showing little drop in species detections and daily species composition with increasing subsample intervals.

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

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

Results

Implementing the subsampling analysis procedure, analysists reviewed five minutes of recording time every two hours and identified species' vocalization sequences. These vocalizations are counted as detections which indicate general activity and species composition rather than number of individuals. Over 557 days of hydrophone operation, 2,153 acoustic vocalization sequences were identified at E05 Hudson North representing 9 total species/species groups, and 2,239 vocalization sequences were identified at E06 Hudson South representing 10 total species/species groups (Table 4).

Of the months with operational hydrophone data, E05 Hudson North recorded its greatest number of species and vocalizations from August to October, and E06 Hudson South from September to October and December to February (Table 5, Figure 4, Figure 5). It is important to note that hydrophone malfunctions and failed recovery attempts led to an uneven sampling effort between months, and while some months were sampled repeatedly across years and location (e.g., August and September), some months were sampled only partially (not full month, only

one location, e.g., March and July), and some months were not sampled at all (April, May, June). See Figure 1, Figure 8 and Figure 9 for sampling effort visualization.

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

Buoy	Species/Species Group	Vocalization Sequences
E05	Common Minke Whale	66
	Dolphin spp.	673
	Fin Whale	1,072
	Humpback Whale	22
	North Atlantic Right Whale	2
	Pilot Whale (unid.)	1
	Sei Whale	152
	Sperm Whale	55
	Low frequency whale spp.	110
E06	Blue Whale	1
	Common Minke Whale	16
	Dolphin spp.	570
	Fin Whale	1,400
	Humpback Whale	38
	North Atlantic Right Whale	9
	Pilot Whale (unid.)	10
	Sei Whale	66
	Sperm Whale	17
	Low frequency whale spp.	112

Table 5. Number of Species Identified per Month During Entire Monitoring Period

Month	E05 Number of Species	E05 Number of Operational Days	E06 Number of Species	E06 Number of Operational Days
Jan	5	31	8	31
Feb	5	28	7	28
Mar	3	9	3	1
Apr	-	0	-	0
May	-	0	-	0
Jun	-	0	-	0
Jul	-	0	4	17
Aug	7	23	5	55
Sep	7	30	6	88
Oct	8	16	8	81
Nov	6	30	5	33
Dec	6	25	8	31
Highlighted cells are months with no sampling effort or less than 10 days throughout the entire monitoring period				

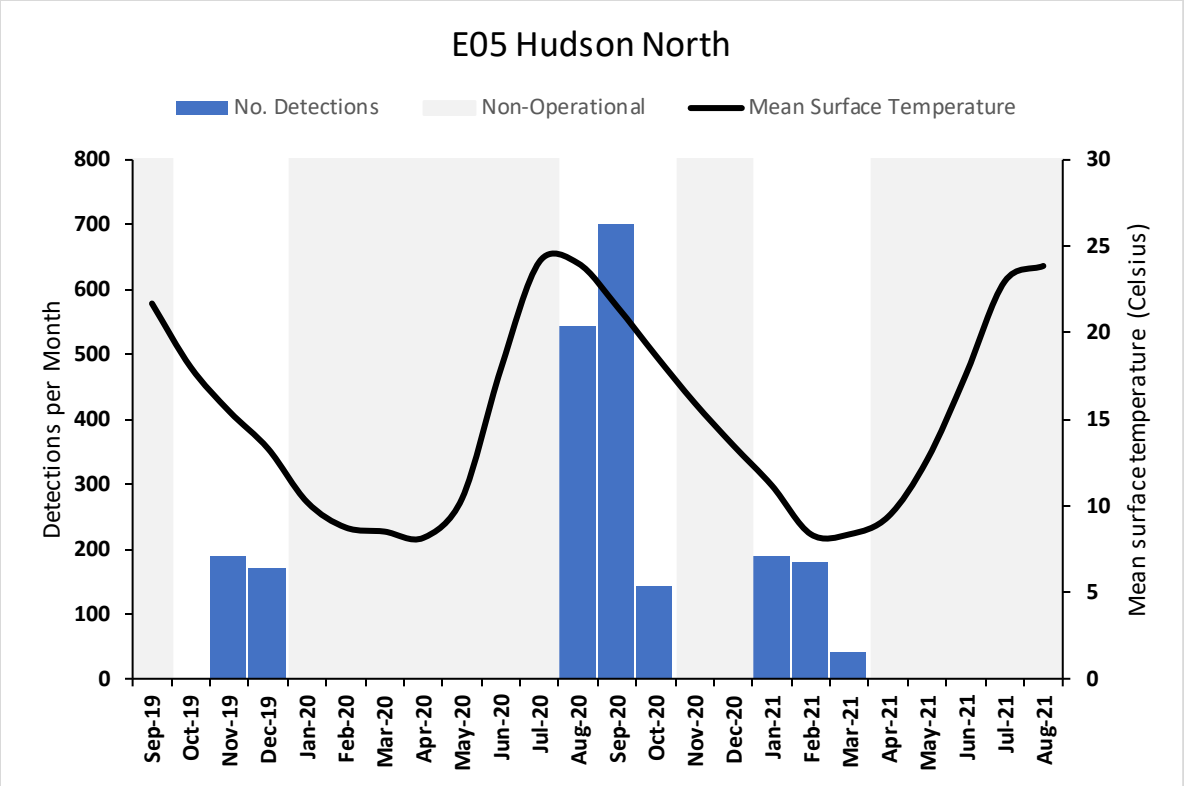

Figure 4. Number of mammal detections recorded per month at E05 Hudson North.

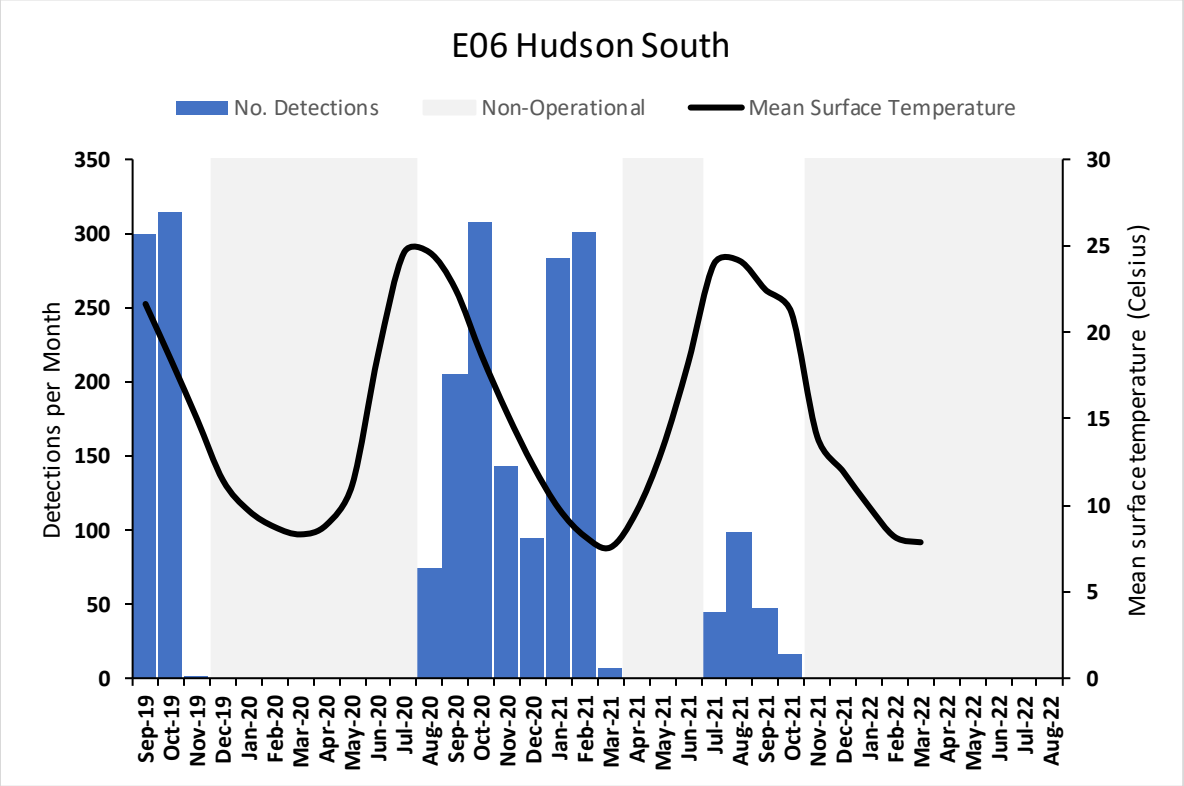

Figure 5. Number of mammal detections recorded per month at E06 Hudson South.

Fin whale were the most prevalent species group representing 50% and 62% of total detections associated with the E05 Hudson North buoy and E06 Hudson South buoy, respectively (Figure 6, Figure 7). Dolphins were difficult to identify to species but 31% of E05 Hudson North and 25% of E06 Hudson South vocalization sequences were categorized as dolphin spp. (Figure 6, Figure 7). 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 Hudson North or 5% at E06 Hudson South (Figure 6, Figure 7).

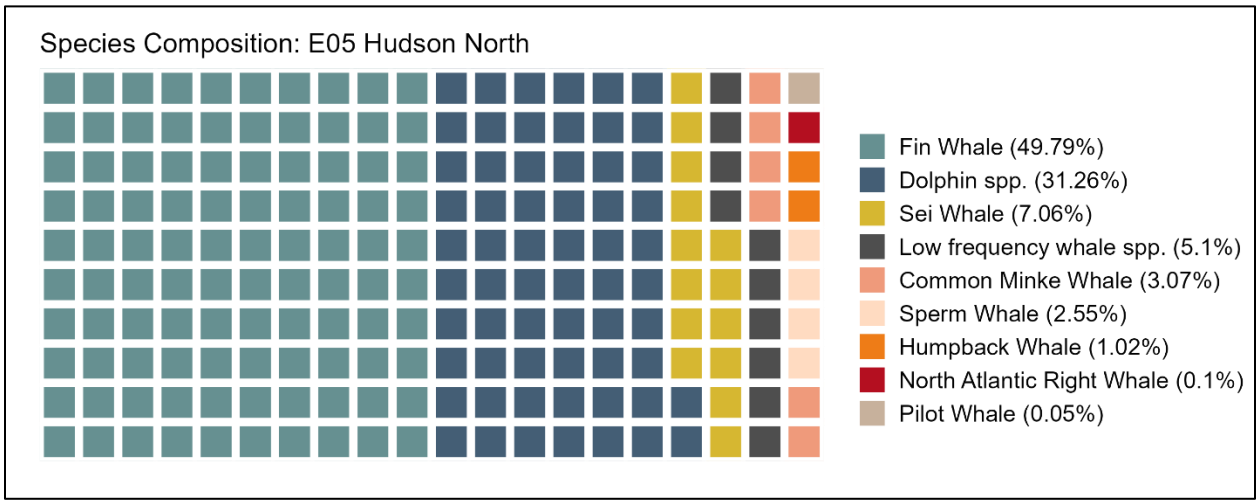

Figure 6. Species and species group composition for E05 NYSERDA buoy.
Each block represents 0.5% and all blocks add up to account for 100% of the identifications. Percentages are adjusted to conform to 0.5% increments (actual percentages are in parentheses).

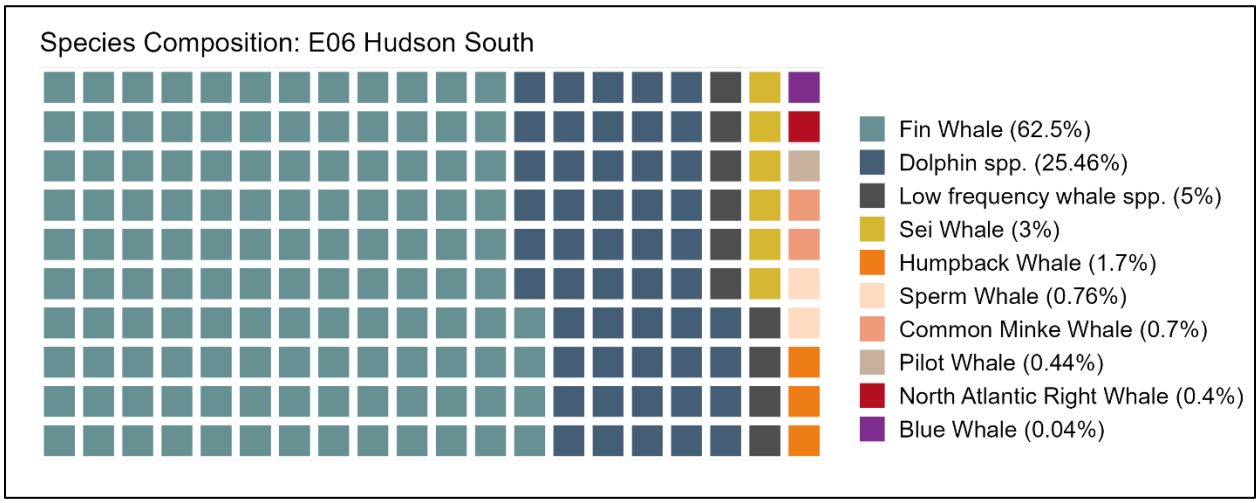

Figure 7. Species and species group composition for E06 NYSERDA buoy.
Each block represents 0.5% and all blocks add up to account for 100% of identifications. Percentages are adjusted to conform to 0.5% increments (actual percentages are in parentheses).

Overall, activity measured in detections per day was greatest in the late summer/early fall months August to October and late winter January to February (Figure 8, Figure 9), though this is likely biased by the fact that spring was not sampled at all and early summer was under-sampled compared to late summer, fall, and winter. Over the entire monitoring period, the

hydrophone at E05 Hudson North recorded greater than 30 detections per day for multiple days while the hydrophone at E06 Hudson South rarely exceeded 20 detections per day (Figure 8, Figure 9).

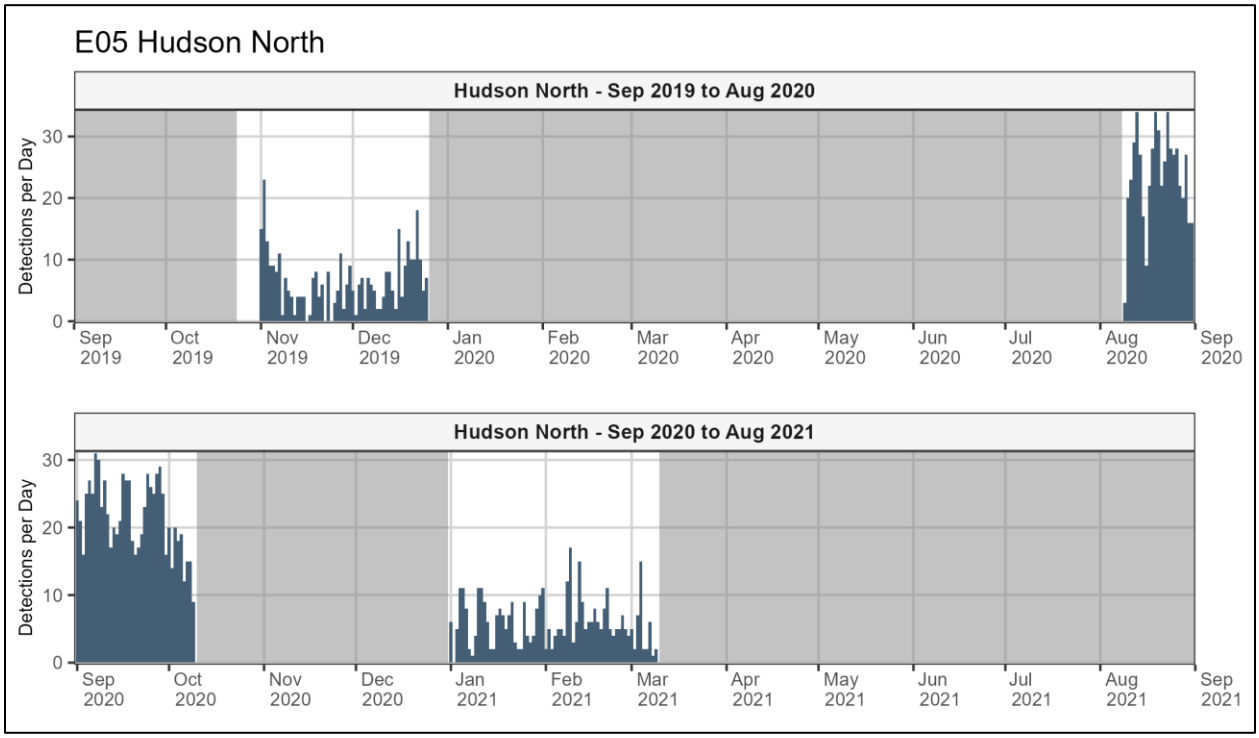

Figure 8. Marine mammal acoustic detections recorded per day at E05 Hudson North. Greyed areas represent periods when hydrophones were non-operational.

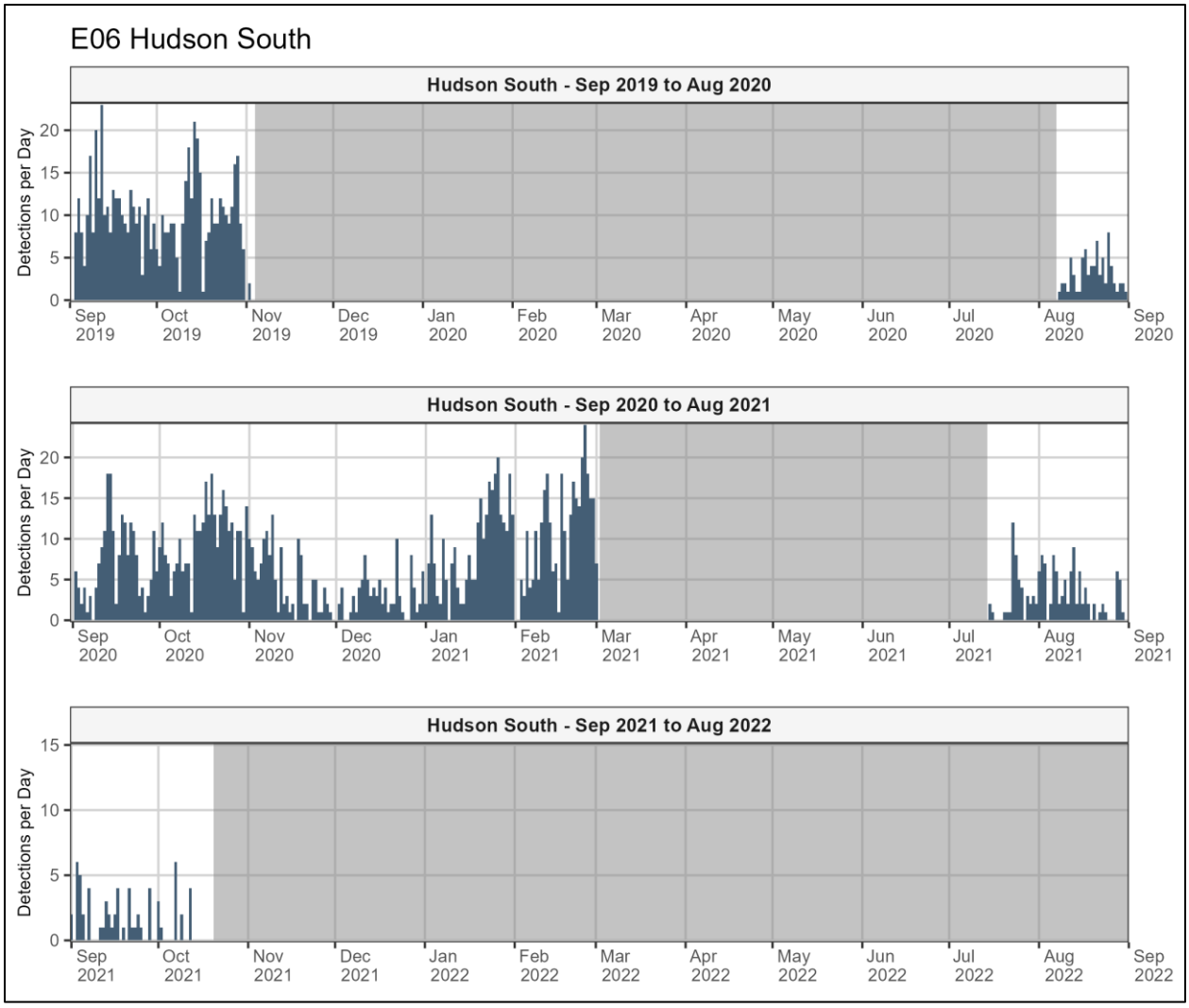

Figure 9. Marine mammal acoustic detections recorded per day at E06 Hudson South. Greyed areas represent periods when hydrophones were non-operational.

North Atlantic right whales were detected at both locations during December and January totaling 11 detections (Table 6). It is important to note that this temporal distribution is biased due to lack of consistent sampling effort among all months.

Table 6. North Atlantic right whale observation dates and Number of 5-min Recording Periods Containing a Vocalization Sequence

E05 Hudson North	
Date	**Vocalization Sequences**
01/25/2021	1
01/30/2021	1

E06 Hudson South	
Date	**Vocalization Sequences**
12/23/2020	2
12/28/2020	1
01/02/2021	2
01/16/2021	1
01/17/2021	1
01/24/2021	2