

4.0 PASSIVE ACOUSTIC MONITORING METHODOLOGY

4.1 ACOUSTICS ARRAY CONFIGURATION

A cross configuration was selected for the placement of five marine autonomous recording units (i.e., “pop-ups”) from the BRP with roughly 72 km (39 NM) between the southern and northern stations and about 24 km (13 NM) between the eastern and western deployment coordinates (**Figure 4-1**). The first deployment of these five pop-ups was conducted in March 2008. In June 2008, one pop-up was not recovered from the March deployment; therefore, the four remaining pop-ups were deployed in a diamond pattern (i.e., station [S] 3 was not deployed). The third deployment occurred in September 2008 and consisted of five units deployed in the cross configuration pattern. Four of these units were recovered and refurbished from the previous deployment, and the fifth was a pop-up that was delivered to replace the one lost in March. The recovery of units deployed in September 2008 spanned the first two weeks of December. Weather and equipment issues extended the time frame for recovery, refurbishment, and redeployment. Two pop-ups (PU063 at S1 and PU081 at S2) were not found and did not return to the surface when called. It is likely they were somehow removed from the area. Two replacement units from BRP were provided, and redeployment included five units for the fourth deployment in December 2008. Because of the loss of two pop-ups from S1, new coordinates for this deployment were identified that were slightly to the northwest of the original location (S1a on **Figure 4-1**). The new GPS coordinates placed S1 in an area marked “obstruction” on the chart; the crew and chief scientist agreed that this area would be relatively free from potential trawler activity because trawlers tend to avoid obstructions on the sea floor. The other four pop-ups were deployed in the pre-identified cross-configuration pattern.

The fifth deployment occurred in March 2009. Three pop-ups were deployed at S1a, S2, and S4. In the attempted recovery of one unit from the June 2008 (PU134) and two units from the December 2008 (PU202 and PU134) deployments, the audio burn unit did not work as intended. Unit PU134 from the June 2008 deployment did not respond to the audio burn cue and was thus recovered by a diver. Both PU202 and PU134 responded to audio burn cues but did not rise to the surface for recovery within the allotted time frame. (Typically, one hour maximum is allotted for each PU recovery attempt and usually each recovery requires less than 10 min. from audio signal being sent to the PU arriving at the surface.) Because of the inconsistency with the audio burn units, the pop-ups deployed in March 2009 to the two most-shallow depths (S1a and S2) were shackled directly to their anchor moorings, thus requiring diver-assisted recovery. The burn unit was engaged on the unit deployed to S4. Recovery of the units was scheduled for 11 June 2009. Both low frequency units recorded during the deployment and yielded the full deployment tenure of data. The high frequency unit (PU171, S2) encountered a preventable gain error and did not record data that could be examined for marine mammal calls. Thus, BRP offered an additional pop-up for use at no cost during our sixth deployment.

The sixth and final deployment of pop-ups was conducted in August 2009 with six pop-up units deployed. The original cross-configuration array pattern was used with three minor exceptions: 1) S3 was shifted 4.8 to 6.4 km (2.6 to 3.5 NM) to the south-southeast from its original GPS coordinates (S3a); 2) S1b was used for the southern-most drop spot; and 3) two pop-ups were deployed at S2. The units deployed at S4 and S5 were placed in locations consistent with the original plan (**Figure 4-1**). Previously (during the March 2009 recovery), PU134 encountered a burn unit malfunction that could not be diagnosed, nor repeated, in the controlled setting of the engineering lab. That is, the grounding rod of PU134 was coated with a magnesium hydroxide, which is non-conductive to electrical charges. This material prevented the burn unit from functioning properly and, thus, caused the significant delay in recovery of PU134 in March 2009. Therefore, PU134 was re-deployed within 23 m (75 ft) of PU182 in an effort to repeat the error situation while facilitating swift deployment and recovery operations.

Other methodological adjustments were followed in an attempt to facilitate recovery of all units deployed during August 2009. The units deployed to S1b, S2 (both units), and S3a were shackled directly to their mooring anchor. S1b was shifted slightly in an attempt to maximize the possibility of recovery. The burn units were bypassed but included to examine the effect of the sea on these units. Pop-ups deployed at S4 and S5 included a new Argos GPS tracking device so that if the pop-ups released from their burn unit or mooring earlier than planned, the GPS device would send a signal to BRP allowing these units to be tracked.

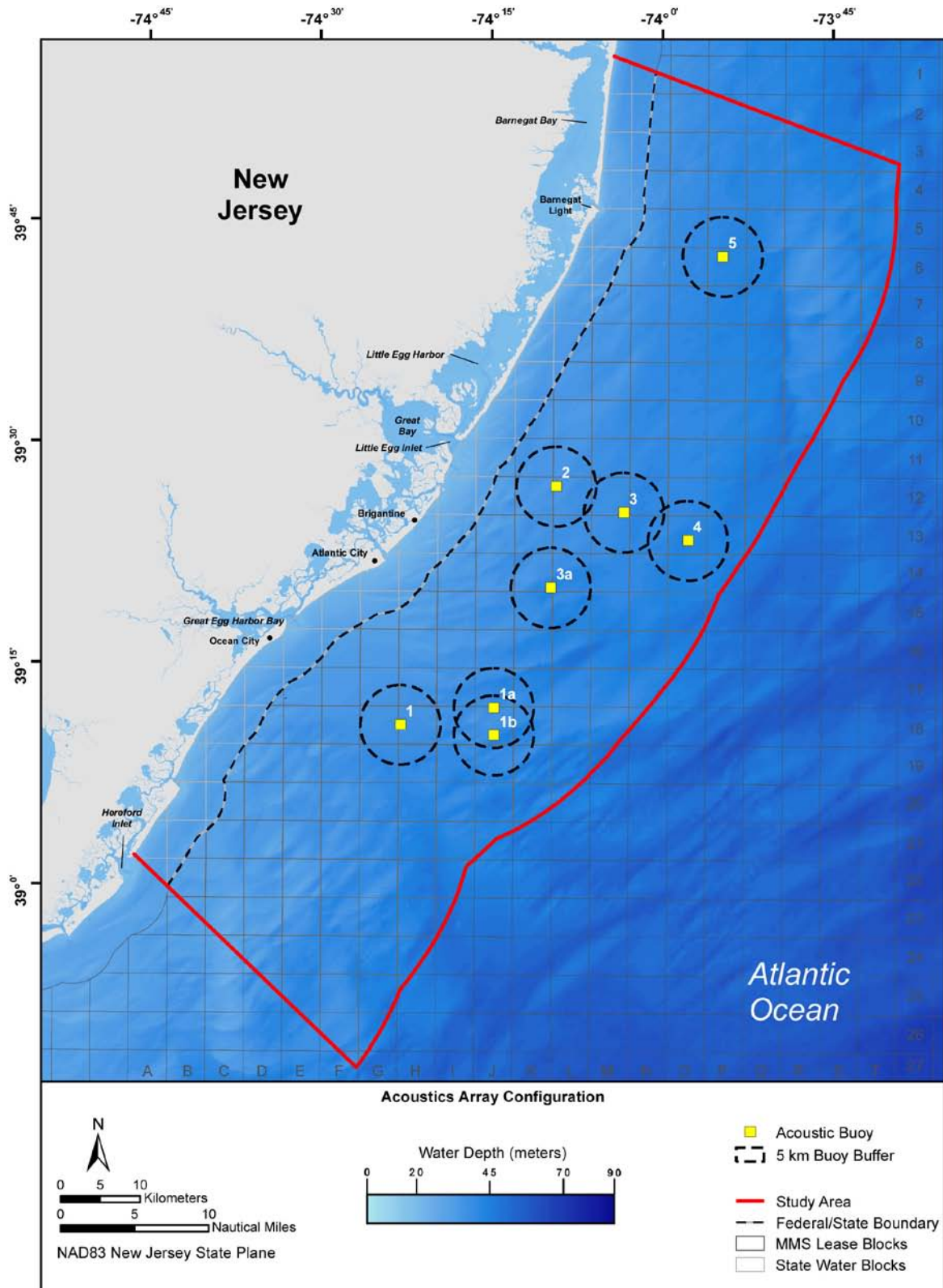


Figure 4-1. Locations of acoustic pop-up buoys in the Study Area from March 2008 to August 2009. The pop-ups were deployed in a cross-configuration in an attempt to record whale and dolphin sounds over as much of the Study Area as possible. Please refer to Table 4-1 for details on sample rate per buoy location per deployment.

Pop-ups were consistently placed within 6 m (20 ft) of the GPS coordinates identified for deployment. Depths for deployed pop-ups ranged from 17.7 to 27.4 m (58 to 90 ft) with the shallowest units at S1 and S2 (new and original coordinates not withstanding).

4.2 ACOUSTIC SAMPLING RATES AND DUTY CYCLES

The March 2008 deployment had five pop-ups each with a 2-kilohertz (kHz) sample rate and continuous duty cycle for recording. This protocol yields roughly 2,000 hours (hrs) of data per pop-up unit recovered; four pop-ups recovered translates to 8,000 hrs of data for processing. A 2-kHz sample rate is biased towards capturing baleen whale calls only. For this reason, two pop-ups were equipped with a modified sample rate and duty cycle for each deployment from June 2008 forward (**Table 4-1**). The pop-ups at S1, S1a, S1b, S3, S3a, and S5 retained the 2 kHz sample rate and continuous duty cycle for deployment. Pop-ups at S2 and S4 were given a 32-kHz sample rate with a 5-min on/25-min off duty cycle. The increased sample rate provided a significantly larger amount of data for each frequency/time period and enabled examination of the data for toothed whale calls (e.g., dolphin whistles). Roughly 240 min (5 min per half hour over 24 hrs) of data were collected per 24-hr period on the units with a high frequency sample rate (the sample rate is twice the frequency of interest).

Table 4-1. Summary of pop-up logistic information per deployment during the study period. Array configuration station, GPS coordinates, pop-up ID number, sample rate, duty cycle and status per deployment for each unit are included. Status relates to whether the unit was recovered, lost, or malfunctioned.

Deployment	Station #	GPS Coordinates	Pop-Up ID	Sample Rate	Target Species Calls	Duty Cycle	Status
March 2008	1	N39° 10.789 W74° 23.298	PU039	2 kHz	Baleen whales	Continuous	Lost
	2	N39° 26.932 W74° 09.511	PU086	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	3	N39° 25.032 W74° 03.651	PU063	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	4	N39° 23.210 W73° 58.264	PU081	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	5	N39° 42.500 W73° 55.022	PU134	2 kHz	Baleen whales	Continuous	Recovered, analyzed
June 2008	1	N39° 10.754 W74° 23.148	PU063	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	2	N39° 26.900 W74° 09.474	PU081	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	4	N39° 23.159 W73° 58.124	PU086	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	5	N39° 42.403 W73° 54.991	PU134	2 kHz	Baleen whales	Continuous	Recovered, analyzed
September 2008	1	N39° 10.727 W74° 23.176	PU063	2 kHz	Baleen whales	Continuous	Lost
	2	N39° 26.915 W74° 09.473	PU081	32 kHz	Delphinids	5 min on/25 min off	Lost
	3	N39° 25.067 W74° 03.633	PU202	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	4	N39° 23.188 W73° 58.091	PU086	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	5	N39° 42.459 W73° 54.942	PU203	2 kHz	Baleen whales	Continuous	Recovered, analyzed

Table 4-1 (continued). Summary of pop-up logistic information per deployment during the study period. Array configuration station, GPS coordinates, pop-up ID number, sample rate, duty cycle and status per deployment for each unit are included. Status relates to whether the unit was recovered, lost, or malfunctioned.

Deployment	Station #	GPS Coordinates	Pop-Up ID	Sample Rate	Target Species Calls	Duty Cycle	Status
December 2008	1a	N39° 14.492 W74° 21.553	PU179	2 kHz	Baleen whales	Continuous	Lost
	2	N39° 26.875 W74° 09.483	PU134	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	3	N39° 25.009 W74° 03.651	PU202	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	4	N39° 23.175 W73° 58.149	PU086	32 kHz	Delphinids	5 min on/25 min off	Lost
	5	N39° 41.330 W73° 55.086	PU203	2 kHz	Baleen whales	Continuous	Lost
March 2009	1a	N39° 11.882 W74° 15.034	PU002	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	2	N39° 26.872 W74° 09.677	PU171	32 kHz	Delphinids	5 min on/25 min off	Malfunctioned
	4	N39° 23.109 W73° 58.204	PU182	2 kHz	Baleen whales	Continuous	Recovered, analyzed
August 2009	1b	N39° 10.011 W74° 14.030	PU145	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	2	N39° 26.866 W74° 09.506	PU134	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	2	N39° 26.866 W74° 09.506	PU182	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	3a	N39° 20.002 W74° 10.020	PU160	2 kHz	Baleen whales	Continuous	Recovered, analyzed
	4	N39° 23.134 W73° 58.074	PU153	32 kHz	Delphinids	5 min on/25 min off	Recovered, analyzed
	5	N39° 42.333 W73° 54.864	PU162	2 kHz	Baleen whales	Continuous	Recovered, analyzed