Occurrence, Distribution, and Density of Protected Marine Species in the Chesapeake Bay Near Naval Air Station Patuxent: 2016 Annual Progress Report

NAVFAC
Naval Facilities Engineering Command

Prepared by

Michael Richlen[1], Tiffany Keenan-Bateman[2], Erin Cummings[2], Ryan McAlarney[2], William McLellan[2], D. Ann Pabst[2], Jessica Aschettino[1], Amy Engelhaupt[3], and Dan Engelhaupt[1]

[1]HDR
Virginia Beach, Virginia

[2]Department of Biology and Marine Biology
University of North Carolina Wilmington
Wilmington, North Carolina

[3]Amy Engelhaupt Consulting
Virginia Beach, Virginia

Submitted by:

HDR

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Bottlenose dolphins (*Tursiops truncatus*) observed in the Chesapeake Bay. Photograph taken by Jessica Aschettino under National Marine Fisheries Service permit no. 16239.

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Acronyms and Abbreviations

BSS	Beaufort Sea State
CREEM	Centre for Research into Ecological and Environmental Modelling
DPM	detection-positive minutes
DPD	detection-positive days
NAS	Naval Air Station
PAX	Patuxent
photo-ID	photo identification
UNCW	University of North Carolina Wilmington
U.S.	United States

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1. Summary

Due to the potential impact to marine species resulting from United States (U.S.) Navy training exercises taking place in the Chesapeake Bay, the HDR Monitoring Team has been conducting surveys to provide quantitative data and information on the seasonal occurrence, distribution, and density of marine mammals and sea turtles in the waters near Naval Air Station (NAS) Patuxent (PAX) River, roughly from Drum Point, south to Smith Point along the western shore and over to the coastal waters of the eastern shore. An area of interest was determined during discussions with U.S. Naval Air Systems Command personnel, for which protected marine species occurrence and density data is desired for use in environmental planning and regulatory compliance efforts. Aerial surveys were initiated in April 2015 and the first deployment of C-PODs (passive acoustic data loggers; chelonia.co.uk) was in July 2015. The University of North Carolina Wilmington (UNCW) is conducting monthly fixed-wing aerial line-transect surveys to document the occurrence and distribution of marine mammals and sea turtles in the study area. HDR has been deploying and refurbishing C-PODs on a four-month cycle to document the occurrence and seasonality of echolocating cetaceans in the study area. Additionally, HDR has opportunistically collected photographs of bottlenose dolphins (*Tursiops truncatus*) during C-POD servicing trips for photo-identification (photo-ID) analysis. The Centre for Research into Ecological and Environmental Modelling (CREEM) at the University of St. Andrews has operated in an advisory capacity on survey design for both the visual and passive-acoustic data, and will analyze data from the line-transect surveys using standard analysis methods.

This progress report is a summary of work completed during 2016. To date, both aerial survey and acoustic monitoring have confirmed that dolphins and sea turtles occur in the area seasonally. Summertime distribution of bottlenose dolphins peaks in June and July, and no detections have been made in the wintertime between November and March. C-POD deployments and visual surveys will continue through September 2017.

2. Methods

2.1 Study Area

NAS PAX is located at the mouth of the Patuxent River, MD (**Figure 1**). The area of interest was determined during discussions with U.S. Naval Air Systems Command personnel, who require protected marine species occurrence and density data for use in environmental planning and regulatory compliance efforts.
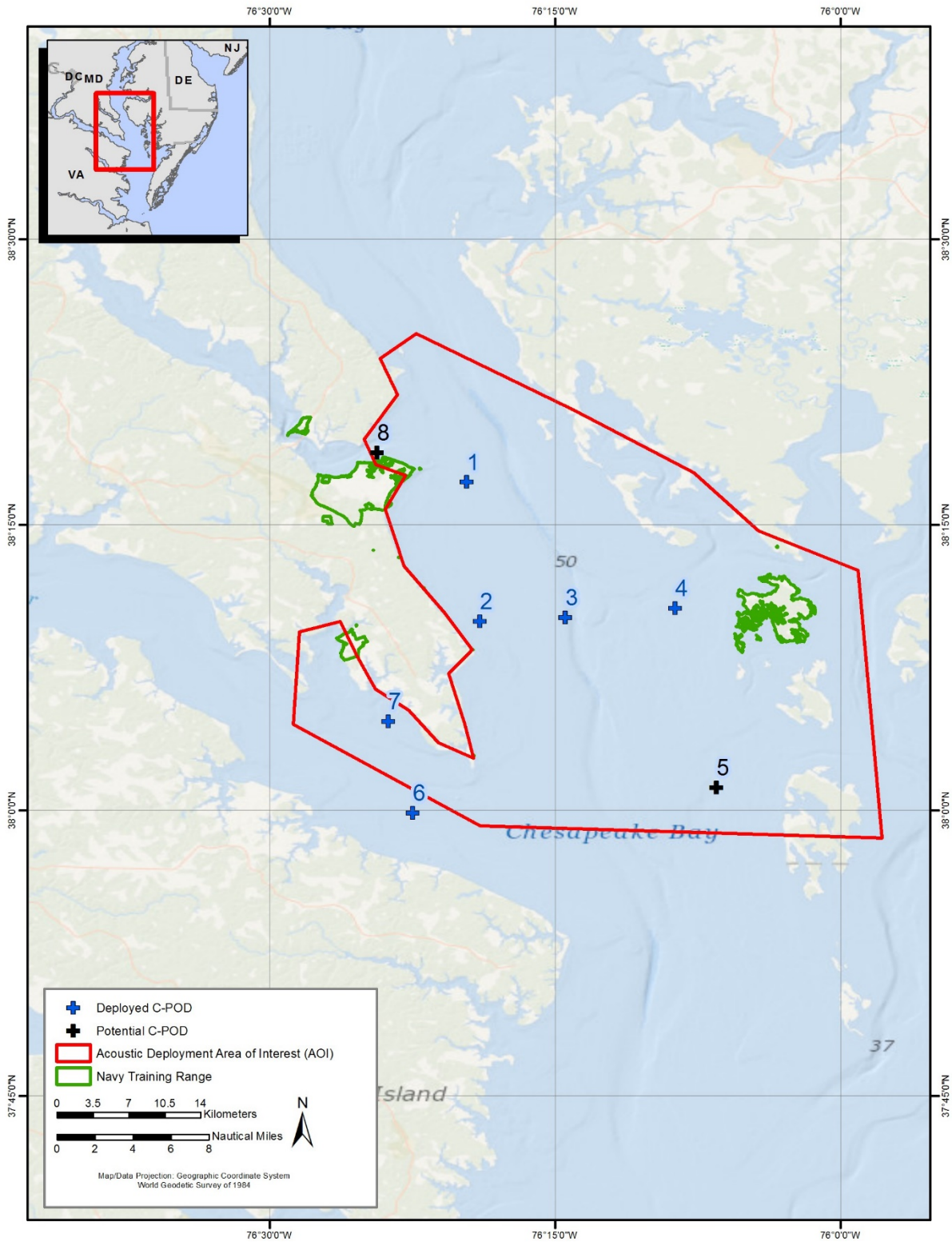
Figure 1. Locations of C-POD deployments around NAS PAX in 2016 (blue +) and alternative deployment sites (black +).

2.2   Passive Acoustic Methods

HDR deployed five underwater acoustic monitoring devices (C-PODs, Chelonia Limited, Mousehole, UK; www.chelonia.co.uk) to document the presence of bottlenose dolphins in the study area. The C-PODs can detect the presence of echolocating bottlenose dolphins and other odontocetes in addition to collecting a record of ambient water temperatures. Multiple deployment sites were included in the initial planning to allow for flexibility in case interest shifted to other areas over the course of the study. The C-PODs were bottom-mounted and an acoustic release (Sport MFE Push Off Release Transponder, Edgetech, West Wareham, MA) was used for retrieval. To ensure that the device will float to the surface upon release, a syntactic foam float was attached to the unit. The devices were first deployed on 11 July 2015 and recovered/redeployed at 4-month intervals, the most recent of which was December 2016. In July 2016, deployment Site 6 was shifted to the alternate Site 7 (**Figure 1**). C-POD data will be collected through July 2017.

The raw click data were imported into custom analysis software and processed using the KERNO classifier (a custom function built into proprietary Chelonia Limited software) to detect click trains and classify their likely sources. A secondary encounter classifier called GENENC (custom function built into proprietary Chelonia Limited software) which uses a longer classification time window to improve detection performance was also used on these data. Additionally, an experienced C-POD analyst conducted quality control and detection validation.

Bottlenose dolphin occurrence is measured by the presence of clicks within 1-minute blocks of data (detection-positive minutes [DPM]). An additional measure of detection-positive days (DPD) were also used to describe occurrence more generally as the number of DPM may be misleading since the group sizes and durations of each encounter within the detectable range of each C-POD are unknown. DPD are days were one or more DPM have been recorded that day.

2.3   Dolphin Photo-Identification and Visual Surveys

During each of the five C-POD deployment/recovery trips, HDR researchers maintained a visual lookout for dolphins while underway. These surveys were non-systematic and opportunistically conducted to maximize data collection while on the water. Time and weather permitting, efforts were made to obtain photographs to be used for photo-ID analysis. A collaboration was established with researchers from Georgetown University (Potomac-Chesapeake Dolphin Project), who also are conducting bottlenose dolphin surveys in the Potomac River. Photo-IDs will be made available for comparisons with HDR's bottlenose dolphin photo-ID catalog from Norfolk and Virginia Beach, Virginia (Engelhaupt et al. 2016). The photographs from the HDR catalog are also included as part of the Mid-Atlantic Bottlenose Dolphin Catalog, curated by Duke University.

2.4   Aerial Survey Methods

Aerial line-transect surveys were conducted in the waters of the Chesapeake Bay, and the mouth of the Potomac River, surrounding NAS PAX (**Table 1, Figure 2**). Surveys were flown in an over-wing, twin-engine Cessna 337 Skymaster, at an altitude of 305 meters and groundspeed of 185 kilometers/hour. Two observers, one positioned on each side of the aircraft, carried out surveys. The goal of each monthly survey was to cover the full set of tracklines in a single day (**Table 1**).

Following the protocols for conducting line-transect surveys, only species that were observed within the survey area were classified as "on-effort" sightings. Animals observed opportunistically between transect lines, or outside of the survey area, were classified as "off-effort" sightings.

Table 1. Trackline endpoint coordinates for the Patuxent River study site. Note that the seven Z line points denote endpoints for six tracklines.

| Transect	Latitude (°N)	Longitude (°W)	Transect	Latitude (°N)	Longitude (°W)	Transect	Latitude (°N)	Longitude (°W)
1W	37.92217	76.29089	1E	37.92583	75.89691	Z1	38.14046	76.50664
2W	37.95300	76.35423	2E	37.95738	75.89579	Z2	38.02788	76.51701
3W	37.98468	76.24193	3E	37.98893	75.89582	Z3	38.13213	76.43518
4W	38.01637	76.32963	4E	38.02047	75.89584	Z4	37.99095	76.44934
5W	38.04801	76.32098	5E	38.05202	75.89587	Z5	38.07689	76.37031
6W	38.07945	76.33015	6E	38.08356	75.89590	Z6	37.95600	76.37821
7W	38.11091	76.33740	7E	38.11510	75.89593	Z7	38.01216	76.33126
8W	38.14261	76.32279	8E	38.14618	75.95522			
9W	38.17386	76.34884	9E	38.17775	75.95189			
10W	38.20512	76.37349	10E	38.20963	75.90946			
11W	38.23644	76.39159	11E	38.24073	75.96450			
12W	38.26790	76.39853	12E	38.27197	76.00080			
13W	38.29972	76.37556	13E	38.30154	76.21005			
14W	38.33082	76.41266	14E	38.33258	76.25759			
15W	38.36267	76.38674	15E	38.36422	76.24889			
16W	38.39403	76.40185	16E	38.39542	76.28056			
17W	38.42525	76.42832	17E	38.42681	76.29400			
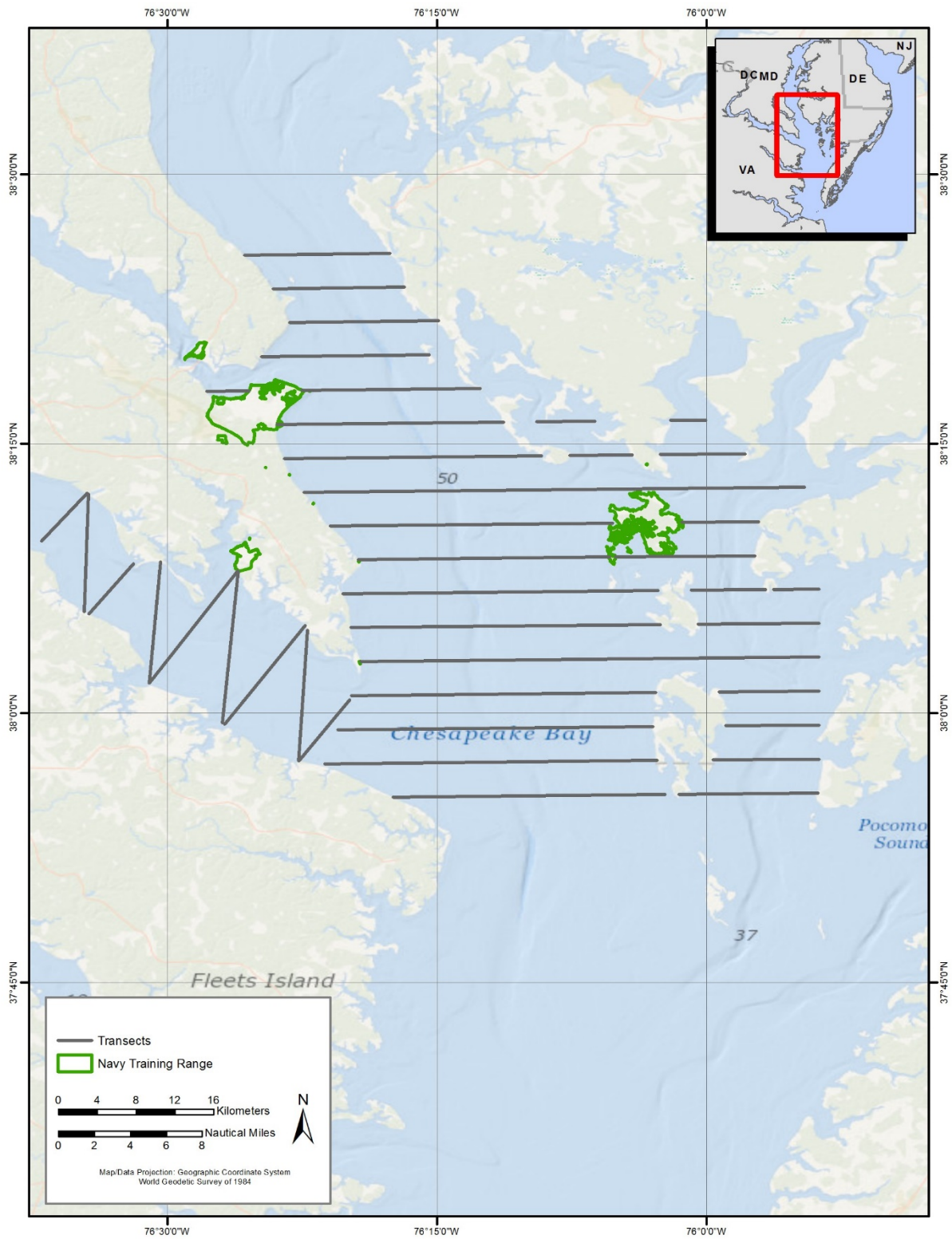
Figure 2. Aerial survey tracklines for the PAX River study area.

3. Results

3.1 Passive Acoustic Monitoring (Cumulative Results)

Five sets of deployments have been made to date (**Table 2**). C-PODs at all five locations recorded good quality data during each deployment and were still logging data when recovered for refurbishment. For these data, the KERNO classifier was found to work better than the GENENC classifier, and the results were filtered for moderate- and high-quality click trains with specific sound pressure levels. This step was to remove weak vessel sonar that could otherwise be misclassified as dolphins. Bottlenose dolphins were the only cetacean species detected and occurred at all deployment locations.

Table 2. Results from the first four sets of C-POD deployments.

C-POD Site	Start Date	End Date	Minutes Recorded	Dolphin DPM[1]	Dolphin % DPM[2]	Dolphin DPD[3]	Boat Sonar DPM[1]
1	07/11/2015	11/23/2015	194,754	5	0.00%	11	40
1	11/24/2015	04/19/2016	211,774	11	0.0052%	5	339
1	04/19/2016	07/19/2016	131,164	499	0.3804%	52	492
1	07/19/2016	12/04/2016	198,680	167	0.0841%	9	1005
2	07/11/2015	11/23/2015	194,747	56	0.0300%	6	15
2	11/24/2015	04/18/2016	210,296	5	0.0024%	4	135
2	04/18/2016	07/19/2016	132,553	812	0.6126%	59	334
2	07/19/2016	12/04/2016	198,716	111	0.0559%	20	1040
3	07/11/2015	11/23/2015	194,726	50	0.0300%	5	36
3	11/24/2015	04/18/2016	210,405	10	0.0048%	7	1589
3	04/18/2016	07/19/2016	132,415	601	0.4539%	58	1281
3	07/19/2016	12/04/2016	198,715	103	0.0518%	20	1043
4	07/11/2015	11/23/2015	194,703	35	0.0200%	6	0
4	11/23/2015	04/18/2016	211,567	6	0.0028%	3	66
4	04/18/2016	07/19/2016	132,221	501	0.3789%	32	18
4	07/19/2016	12/04/2016	198,708	22	0.0111%	4	136
6	07/11/2015	11/24/2015	195,619	45	0.0200%	5	47
6	11/24/2015	04/18/2016	210,205	3	0.0014%	2	238
6	04/18/2016	07/19/2016	132,404	465	0.3512%	35	175
7	07/19/2016	12/04/2016	198,730	51	0.0257%	7	583

[1] Detection Positive Minutes (DPM) are minutes where one or more trains have been classified in that minute.

[2] Percent DPM indicate that after filtering, the percentage of all minutes recorded that contained dolphin detections.

[3] Detection Positive Days (DPD) are days where one or more DPM have been recorded in that day.

Bottlenose dolphins were detected in all of the C-POD files with 0.12% DPM out of the total time recorded to date. Visual validation of the DPMs showed only a 4.1% false positive rate meaning that 95.9% of the automated detections were true positive minutes. Inspection of the data showed that weak boat sonar trains, sediment transport noise, and low quality bottlenose dolphin trains were the source of false positives in the acoustic data. The error rates found for

bottlenose dolphins were low enough to have no significant effect on the number of DPD. False negatives were not evaluated because they are considered a result of the sensitivity of the instruments.

Bottlenose dolphin occurrence, as expected from the preliminary 2015 results from this study (Richlen et al. 2016), was higher during the warmer summer months (**Figure 3**). **Figure 4** shows 1 year of mean water temperatures, recorded at each location, from November 2015 through November 2016. The DPM decreased precipitously in the fall, and no detections were made after November. There was a diel pattern evident in the data, with more DPM during nighttime periods (**Figure 5**).

Figure 3. Monthly bottlenose dolphin DPM, summed across all PAX sites for the duration of the project to date, 11 July 2015 through 04 December 2016 (total *n*=3,555).

Figure 4. Daily mean temperatures recorded by the C-PODs at each deployment location from November 2015 through November 2016.
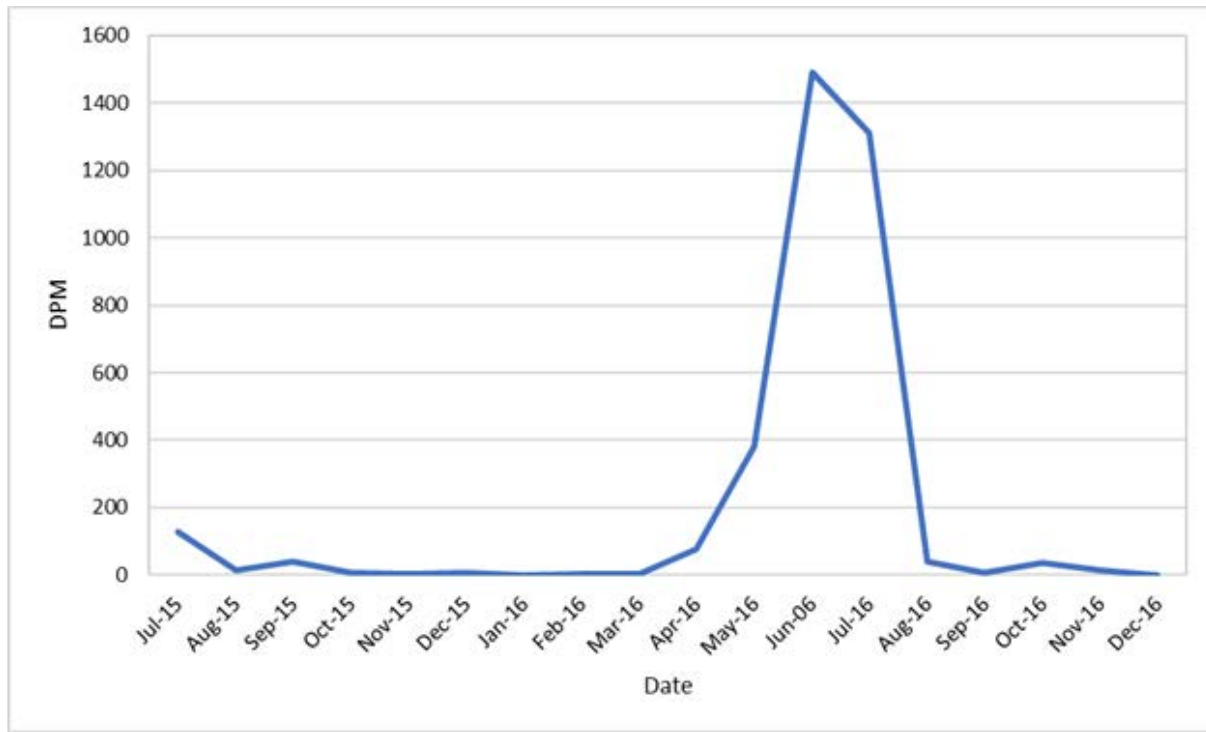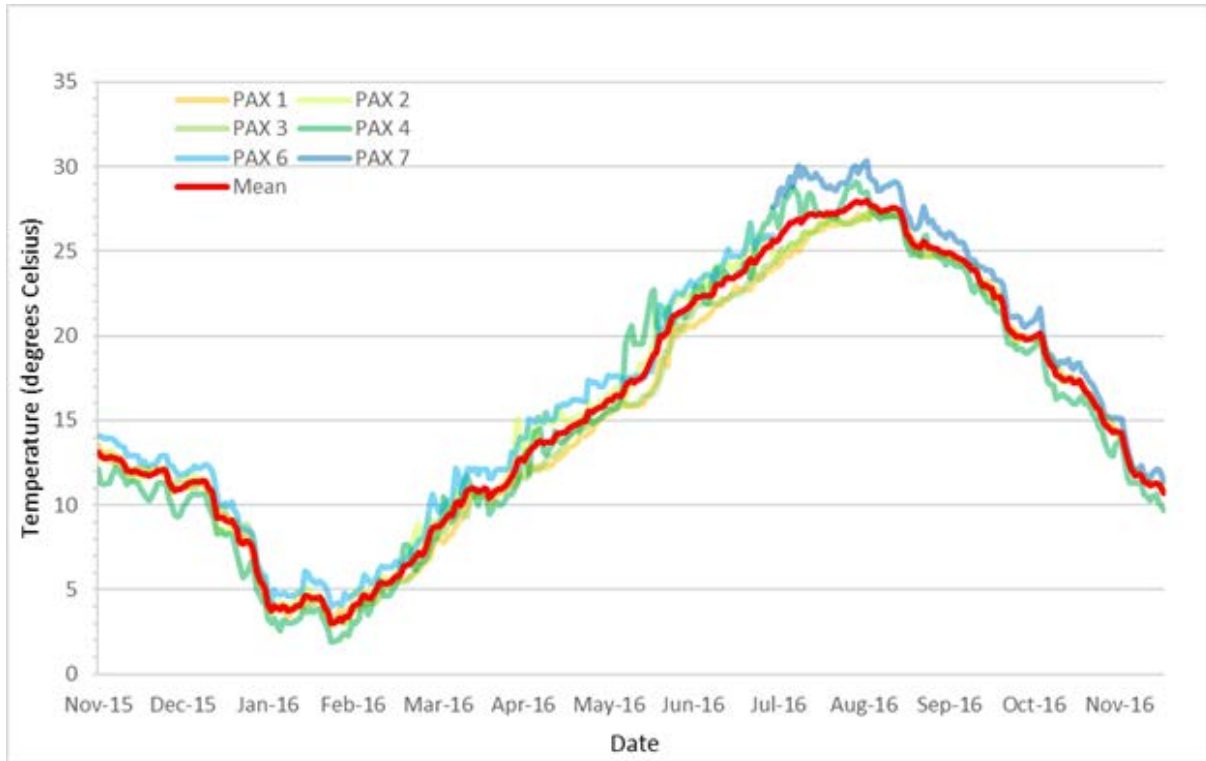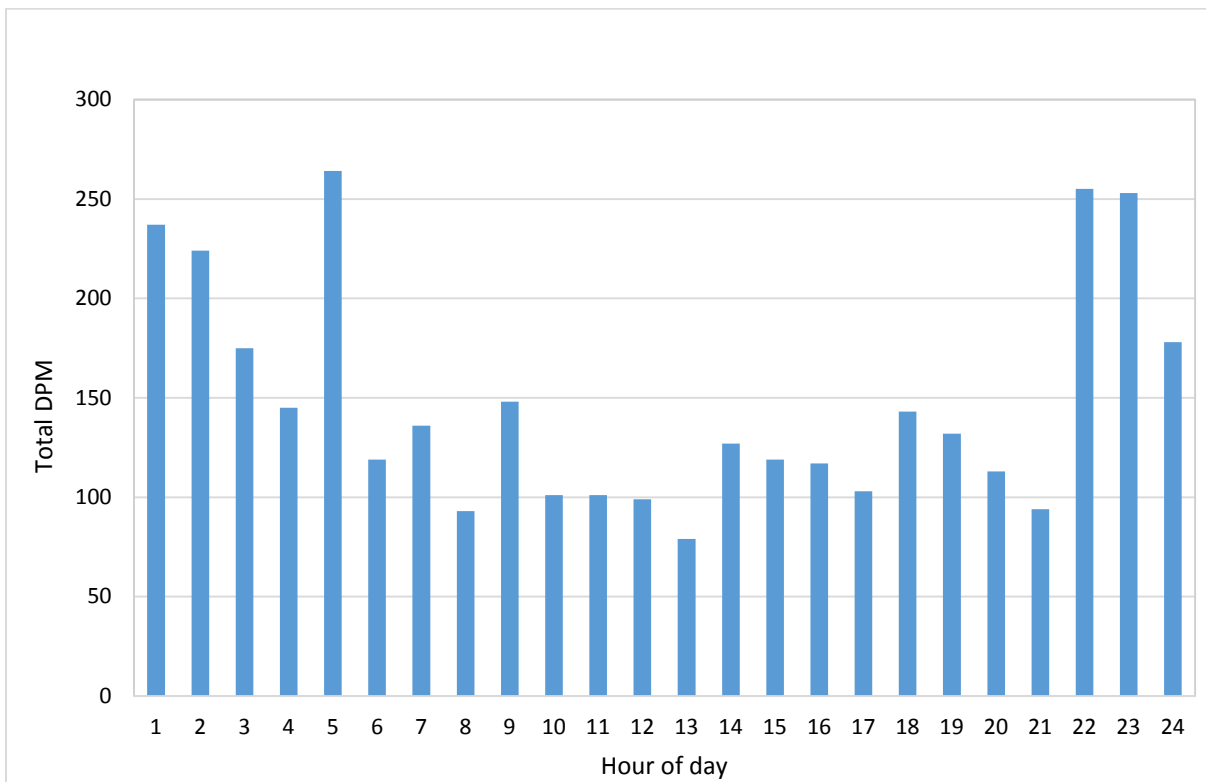

Figure 5. Hourly bottlenose dolphin DPM summed across all five locations for the duration of the project to date, 11 July 2015 through 04 December 2016 (total *n*=3,555). Chart starts and ends at midnight.

3.2 Photo-Identification

Four bottlenose dolphin sightings have been made through 2016 during C-POD refurbishment trips and extended survey effort north of the study site and into the Patuxent River (**Table 3**, **Figure 6**). Identification photos were collected during three of the four sightings. Group size ranged from five to 70 individuals (mean=30). Approximately half of the photographs have been sorted and prepared for cataloging. These data will be archived and available for future analysis and/or collaboration with researchers from Georgetown University and the Mid-Atlantic Bottlenose Dolphin Catalog.

Table 3. Summary of opportunistic sightings during C-POD refurbishment trips.

Date	Time (EDT)	Latitude (°N)	Longitude (°W)	Group Size	# of Photos Taken
07/12/2015	8:52:08	38.327083	76.310200	35	1487
07/19/2016	11:01:13	38.037200	76.200100	10	274
07/19/2016	14:48:39	38.163916	76.316650	5	0
07/26/2016	12:43:57	37.802833	76.286400	70	752

Figure 6. Bottlenose dolphin sightings made opportunistically during the C-POD refurbishment trips.

3.3   Aerial Surveys

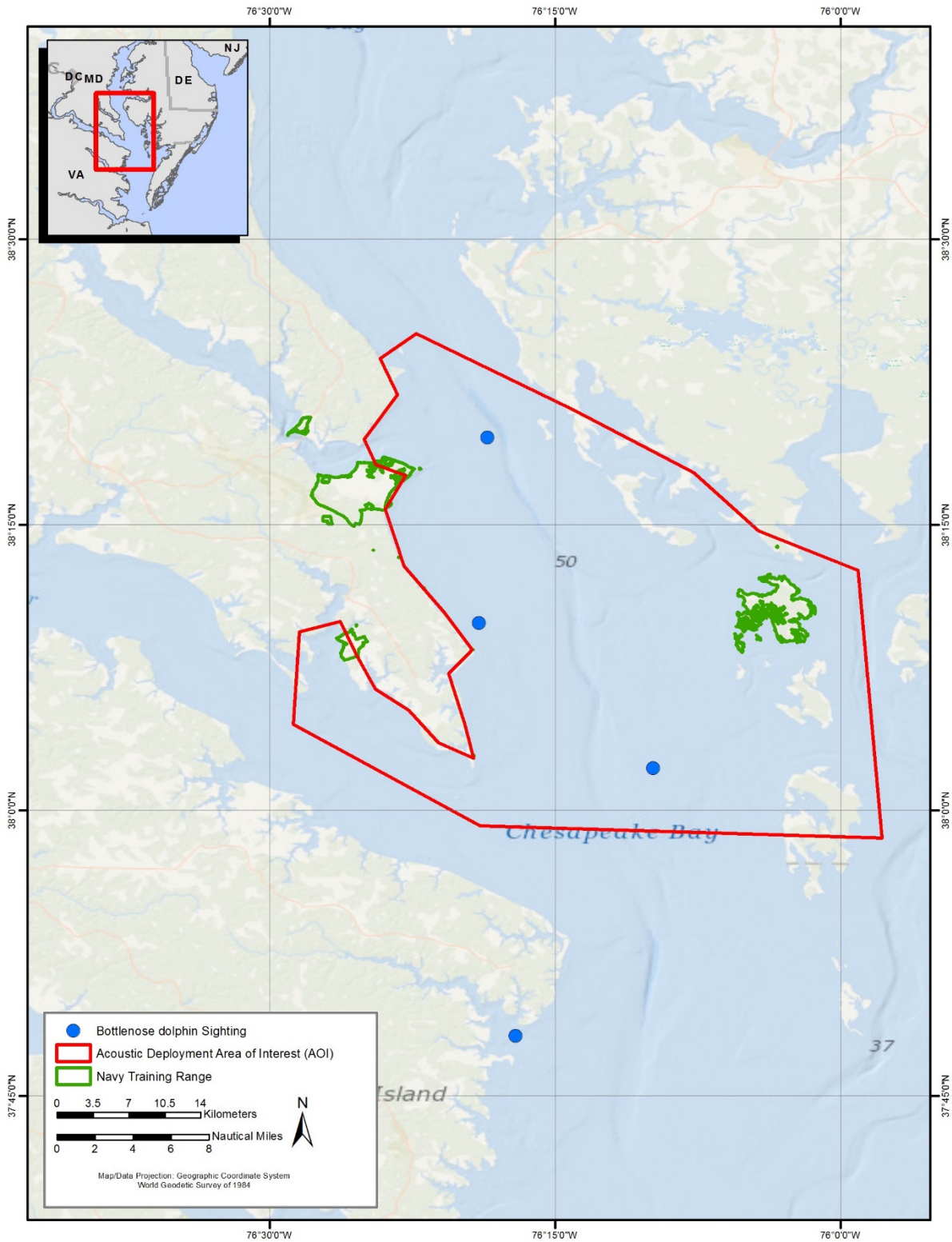A total of ten days of aerial survey effort was conducted during 2016 (**Table 4**). A concerted effort was made to schedule survey effort during optimal weather conditions to maximize visibility, with Beaufort Sea States (BSS) of three or less for the majority of the time (**Figure 7**). Monthly effort was consistent and all survey tracklines were completed each for each survey day. There were 11 sightings of bottlenose dolphins, 10 on-effort (*n*=301 individuals) and one off-effort (*n=2* individuals) during 2016, with an estimated group size ranging from 2—80 individuals (mean=27.5) (**Tables 5 and 6, Figures 8 through 10**). All on-effort sightings occurred between May and August and were concentrated primarily in the southern portion of the survey area, near the confluence of the Potomac River with the Chesapeake Bay, with the exception of one sighting that occurred in the northeastern portion of the study site (Figure 8). One off-effort sighting of a pair of bottlenose dolphins occurred in April. These animals were observed in the center of the bay during the return transit to Norfolk.

Table 4. Summary of aerial survey effort conducted at the PAX study site during 2016.

| Date	Tracklines Flown AM	Tracklines Flown PM	Total km Flown	Hobbs Hours
31-Jan-2016	Z, 9 to 17	8 to 1	586.50	5.5
21-Feb-2016	Z, 9 to 17	8 to 1	582.10	5.6
26-Mar-2016	1 to 9	17 to 10, Z	584.05	5.2
17-Apr-2016	1 to 8	17 to 9, Z	583.10	5.2
08-May-2016	Z, 9 to 17	8 to 1	574.90	6.3
12-Jun-2016	Z, 9 to 17	8 to 1	589.70	5.2
23-Jul-2016	1 to 9	17 to 10, Z	580.35	6.2
07-Aug-2016	Z, 9 to 17	8 to 1	584.70	5.8
02-Oct-2016	Z, 9 to 17	8 to 1	588.78	5.6
06-Nov-2016	1 to 9	17 to 10, Z	580.00	5.3
Totals			**5834.18**	**55.9**
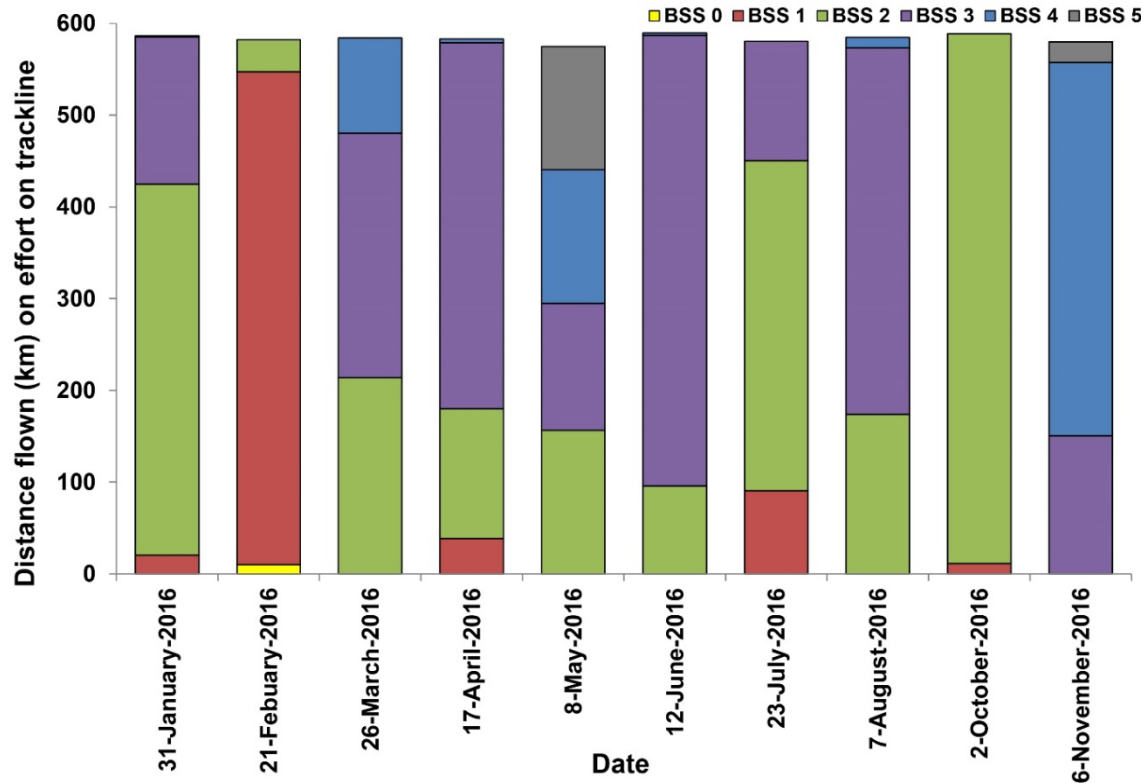
Figure 7. Summary of effort by Beaufort Sea State (BSS) for each survey day at the PAX study site during 2016.

Table 5. Summary of sightings from aerial surveys at the PAX study site during 2016.

Common Name	Scientific Name	# of Sightings	# of Individuals
Bottlenose dolphin	*Tursiops truncatus*	10	301
Bottlenose dolphin (off-effort)	*Tursiops truncatus*	1	2
Loggerhead sea turtle	*Caretta caretta*	11	11
Unidentified sea turtle	N/A	1	1

Table 6. Bottlenose dolphin sightings from aerial surveys at the PAX study site during 2016.

Date	Time (EDT)	On-/Off-Effort	Latitude (°N)	Longitude (°W)	Trackline	Group Size
17-Apr-2016	15:03:43	Off	37.296368	76.160510	N/A	2
08-May-2016	10:40:39	On	38.238632	76.118558	11	28
12-Jun-2016	9:13:57	On	37.937140	76.322106	Z	70
23-Jul-2016	9:34:21	On	37.920542	76.206547	1	23
23-Jul-2016	9:41:39	On	37.912137	76.122343	1	5
23-Jul-2016	9:55:40	On	37.967303	76.063693	2	32
23-Jul-2016	10:20:28	On	37.984998	76.172077	3	2
23-Jul-2016	10:45:19	On	38.047783	76.289443	5	3
23-Jul-2016	11:14:19	On	38.081213	76.267852	6	13
23-Jul-2016	15:19:40	On	37.963757	76.378748	Z	80
07-Aug-2016	9:46:40	On	38.074078	76.475926	Z	45
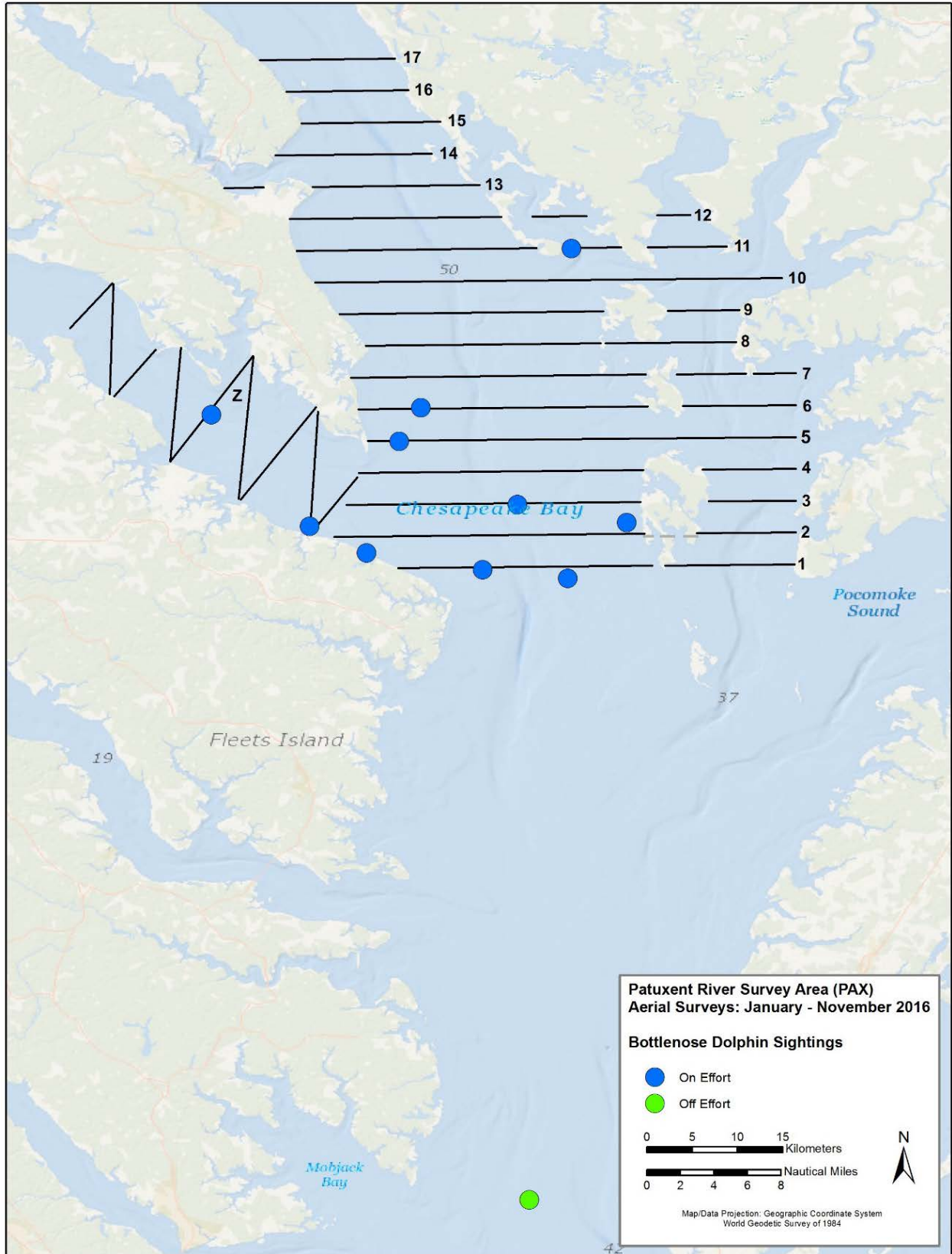
Figure 8. All bottlenose dolphin sightings from aerial surveys at the PAX study site during 2016.
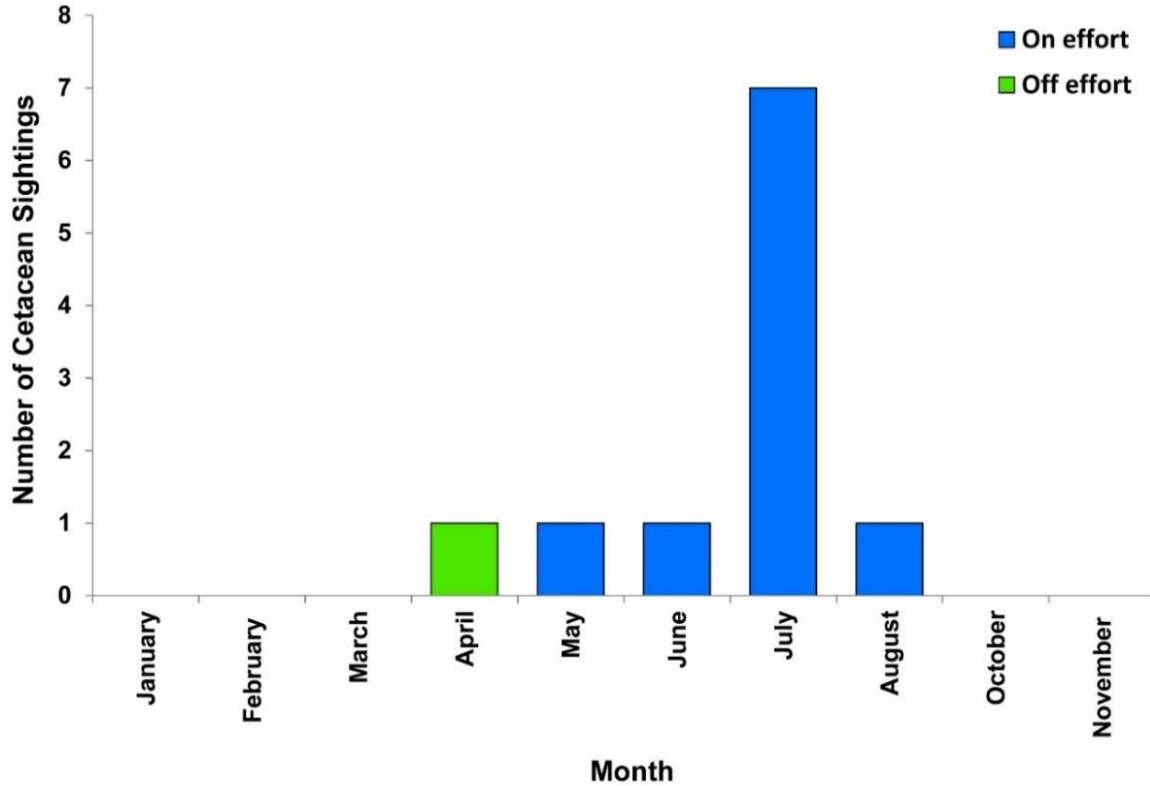
Figure 9. Bottlenose dolphin sightings per month from aerial surveys at the PAX study site during 2016.

Figure 10. Number of individual bottlenose dolphins observed per month from aerial surveys at the PAX study site during 2016.

There were also 12 sea turtle sightings at the PAX study site in 2016, all during the months of July and October (**Figures 11 and 12**, **Table 7**). Eleven sightings were positively identified as loggerhead sea turtles (*Caretta caretta*), and one individual was classified as an unidentified sea turtle.

Figure 11. Sea turtle sightings from aerial surveys at the PAX study site in 2016.

Figure 12. Sea turtle sightings per month from aerial surveys at the PAX study site in 2016.

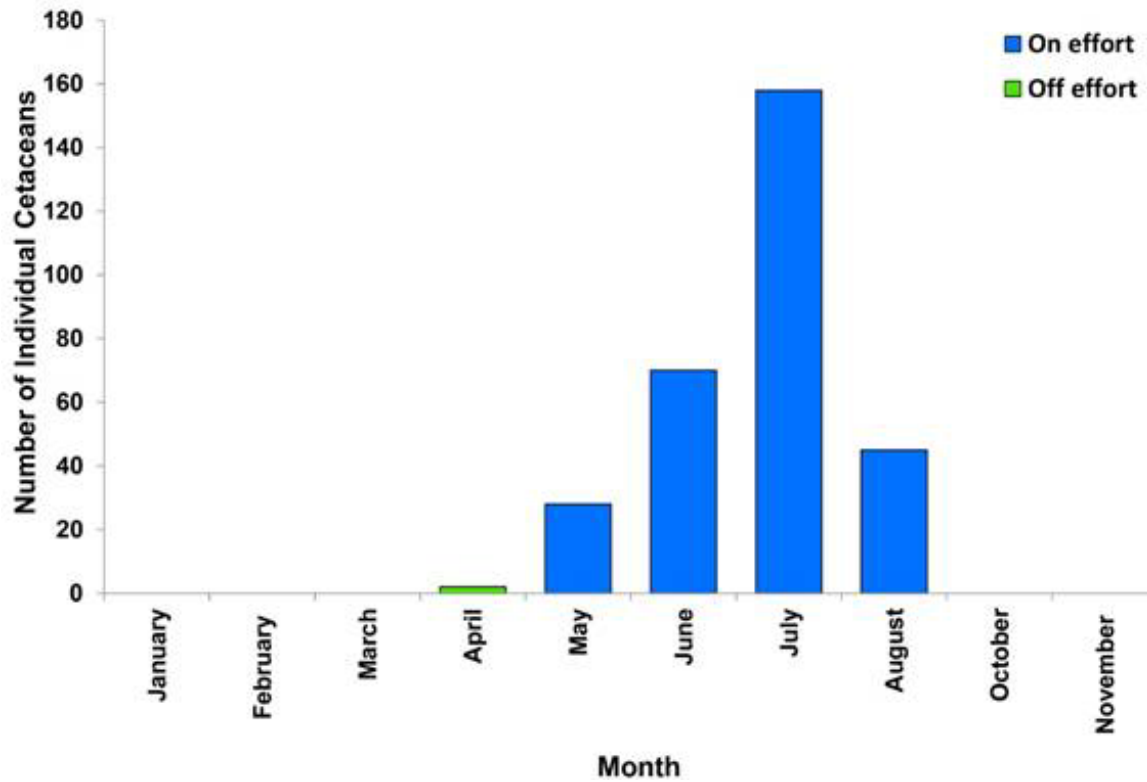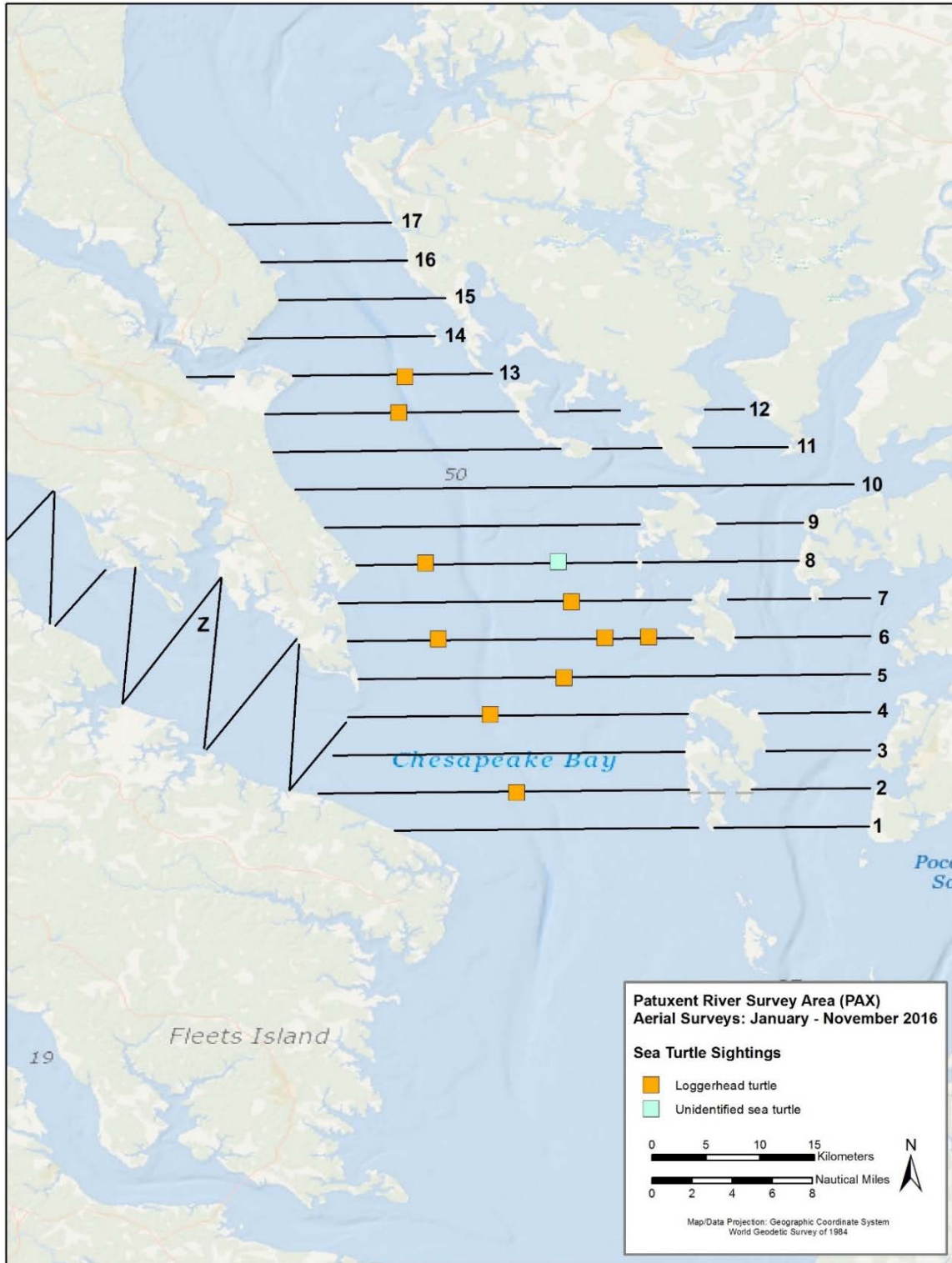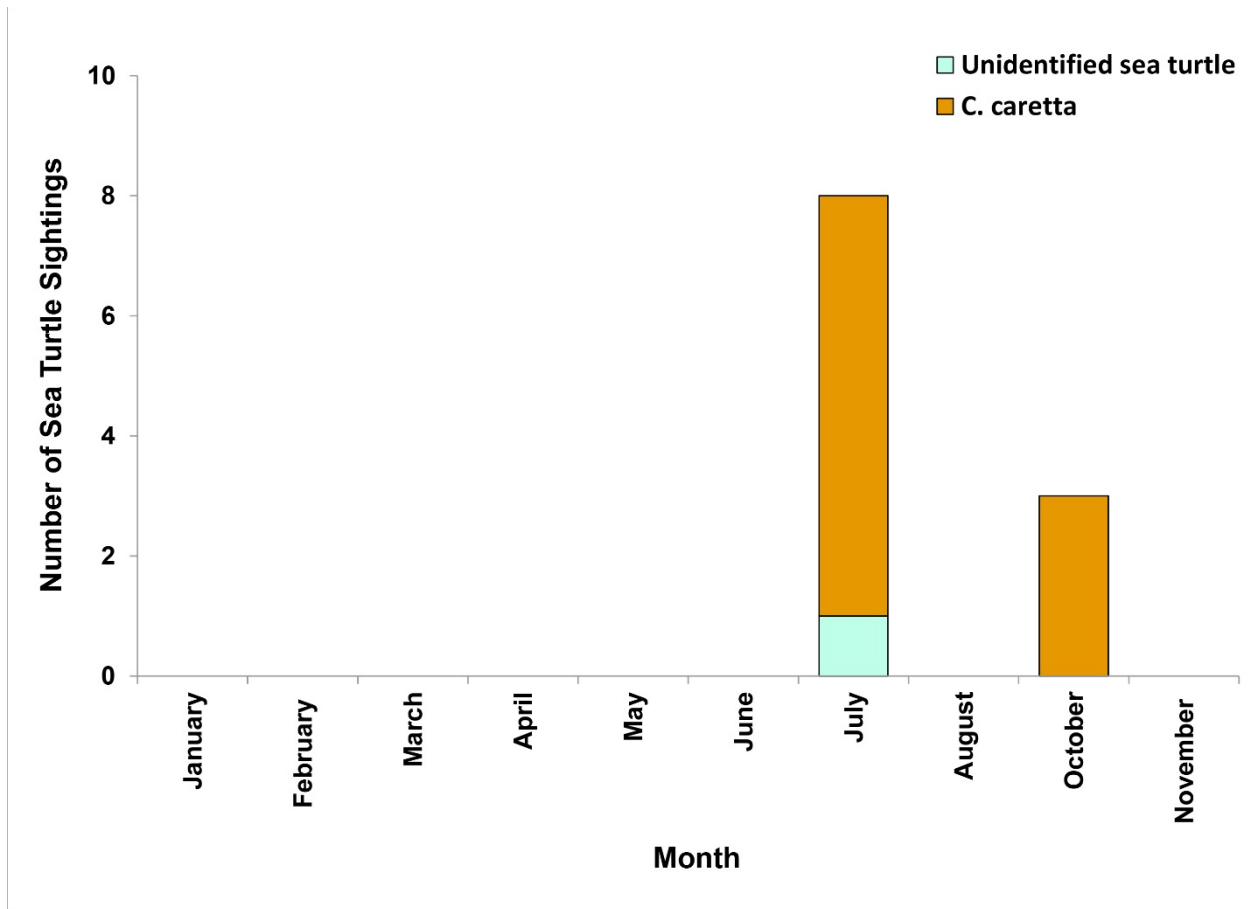**Table 7. Sea turtle sightings from aerial surveys at the PAX study site in 2016.**

Date	Time (EDT)	On-/Off-Effort	Latitude (°N)	Longitude (°W)	Trackline	Species	Group Size
23-Jul-2016	10:03:23	On	37.953703	76.189552	2	Loggerhead Sea Turtle	1
23-Jul-2016	10:38:12	On	38.018575	76.211452	4	Loggerhead Sea Turtle	1
23-Jul-2016	11:08:35	On	38.082920	76.079766	6	Loggerhead Sea Turtle	1
23-Jul-2016	11:09:28	On	38.082388	76.116128	6	Loggerhead Sea Turtle	1
23-Jul-2016	11:12:55	On	38.081201	76.254733	6	Loggerhead Sea Turtle	1
23-Jul-2016	11:39:41	On	38.145253	76.154868	8	Unidentified Sea Turtle	1
23-Jul-2016	11:42:35	On	38.144247	76.265086	8	Loggerhead Sea Turtle	1
23-Jul-2016	14:00:23	On	38.298955	76.282322	13	Loggerhead Sea Turtle	1
02-Oct-2016	11:07:07	On	38.268872	76.287573	12	Loggerhead Sea Turtle	1
02-Oct-2016	13:39:31	On	38.112069	76.143958	7	Loggerhead Sea Turtle	1
02-Oct-2016	14:06:44	On	38.049042	76.150014	5	Loggerhead Sea Turtle	2

Cownose rays (*Rhinoptera bonasus*) were also sighted across the range of the study area from April through October (**Figure 13, Table 8**).
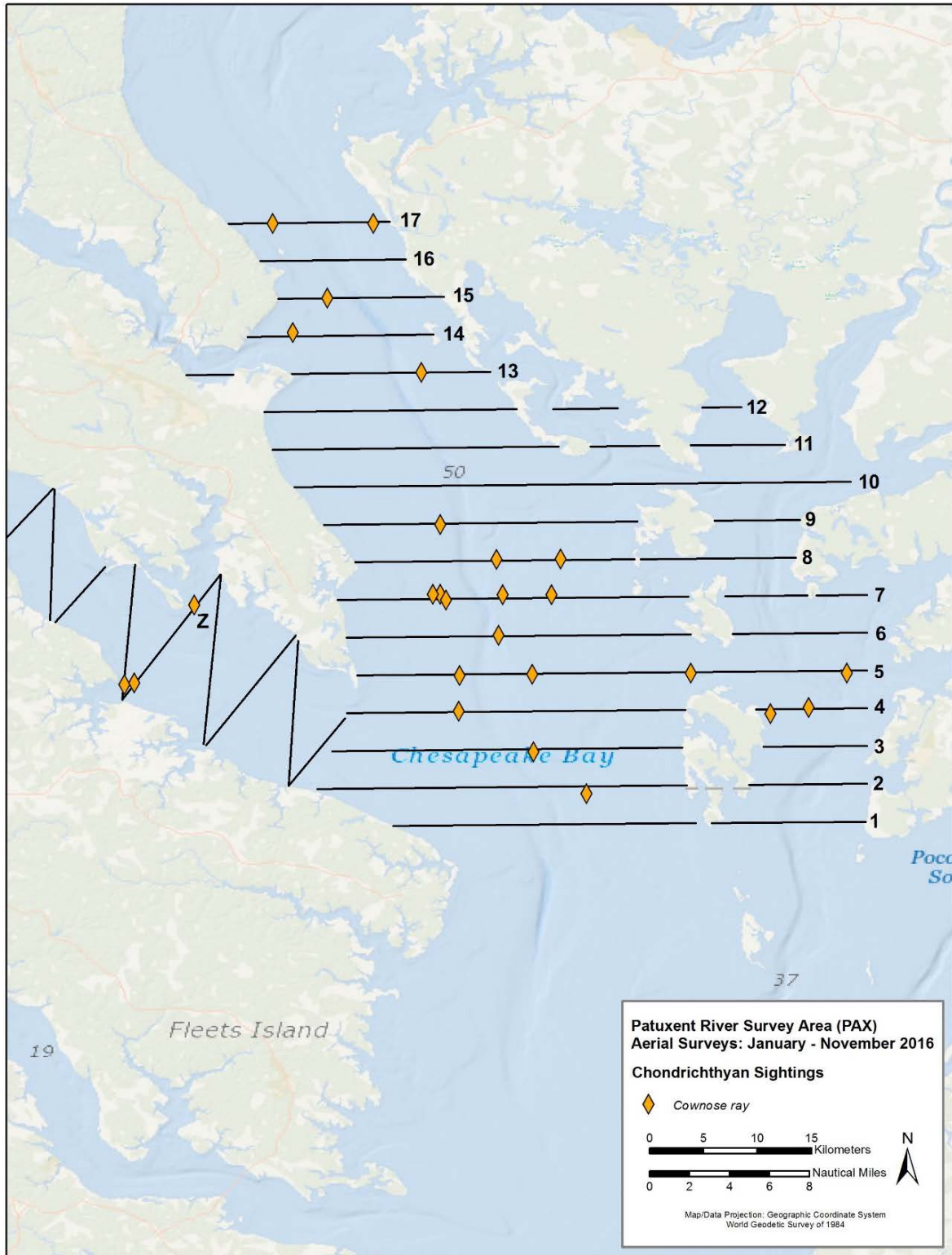

Figure 13. Cownose ray sightings from aerial surveys at the PAX study site during 2016.

Table 8. Cownose ray sightings from aerial surveys at the PAX study site in 2016.

Date	Time	On-/ Off-Effort	Latitude (°N)	Longitude (°W)	Trackline	Group Size
17-Apr-2016	10:16:10	On	38.050208	75.912298	5	25
23-Jul-2016	10:52:57	On	38.048000	76.235460	5	27
23-Jul-2016	10:54:27	On	38.049153	76.174843	5	25
23-Jul-2016	11:22:26	On	38.115698	76.251413	7	55
23-Jul-2016	11:24:41	On	38.115400	76.158585	7	22
23-Jul-2016	11:48:34	On	38.174122	76.251628	9	40
23-Jul-2016	13:37:30	On	38.425638	76.391342	17	8
23-Jul-2016	13:47:41	On	38.363253	76.345658	15	11
23-Jul-2016	10:31:24	On	38.021121	75.944208	4	11
23-Jul-2016	11:11:38	On	38.081695	76.202809	6	85
23-Jul-2016	11:22:17	On	38.115690	76.257556	7	40
23-Jul-2016	11:23:41	On	38.115359	76.199365	7	65
23-Jul-2016	11:41:00	On	38.144868	76.204594	8	85
23-Jul-2016	13:39:38	On	38.425637	76.307563	17	25
23-Jul-2016	13:54:45	On	38.334350	76.374389	14	35
23-Jul-2016	14:58:24	On	38.106782	76.456762	Z	25
07-Aug-2016	14:38:38	On	37.949486	76.129626	2	30
07-Aug-2016	14:14:22	On	38.016066	75.976087	4	5
07-Aug-2016	14:26:29	On	37.984198	76.173693	3	85
02-Oct-2016	09:38:08	On	38.040524	76.514971	Z	30
02-Oct-2016	09:40:43	On	38.041875	76.506666	Z	90
02-Oct-2016	11:15:21	On	38.301311	76.267336	13	40
02-Oct-2016	13:25:07	On	38.145203	76.151131	8	15
02-Oct-2016	13:42:08	On	38.110900	76.246730	7	11
02-Oct-2016	14:03:56	On	38.050009	76.042454	5	8
02-Oct-2016	14:15:49	On	38.018138	76.236060	4	11

4. Discussion

Similar to the preliminary results from the 2015 efforts, the occurrence of bottlenose dolphins and sea turtles at the PAX study site within the Chesapeake Bay is seasonally dependent. The C-POD results demonstrate that bottlenose dolphins arrive in the study area in March, leave by November, and peak in July. Between July 2015 and December 2016, only 16.7% of the days contained bottlenose dolphins (*n*=317 total DPD among all C-PODs [four deployments at five locations]). Detections were made at each deployment location including the relocated unit that was shifted from site 6 to site 7 in July 2016. There was also a diel pattern observed with the majority of echolocation clicks produced during the nighttime peaking at 2200 and 0500 EDT. This may be indicative of peak foraging times for the bottlenose dolphins since the absence, or reduction of the number of clicks, cannot be construed as the bottlenose dolphins leaving the

area. The increase in echolocation could also be a factor of nighttime darkness, although the peaks at specific times likely denotes foraging activity.

Photographs were taken of bottlenose dolphins opportunistically seen during transits between C-POD deployment sites on three different occasions. All sightings were made in the month of July and the group sizes ranged from and estimated five to 75 individuals. The photo-ID analyses have not been completed but the images have been cataloged and archived to be shared with collaborating researchers also conducting efforts in the same region. Sightings of bottlenose dolphins during aerial surveys occurred April—August 2016. Mean group size for sightings of bottlenose dolphins from aerial surveys (27.5, *n*=11) was similar to those seen opportunistically during C-POD deployments (30, *n*=4).

While the C-PODs had detections distributed throughout the study area, visual sightings of bottlenose dolphins made during aerial surveys were predominantly in the southern end of the study area, with the highest number of sightings in and around the Potomac River. Only 11 sightings were made between January and November 2016, one of which was made off-effort while the aircraft was transiting back to Norfolk, Virginia. Loggerhead sea turtles and cownose rays were also observed during the summer months and distributed throughout the study area (with the exception of sea turtles occurring in the Potomac River). To date, no abundance or density estimation has been attempted due to low sample sizes although ultimately this is a goal of the project.

5. Literature Cited

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