Protected Species Monitoring in the Proposed Undersea Warfare Training Range (USWTR) Onslow Bay, NC

Final Report, Year 2 (July 2008 – June 2009)

November 16, 2009




Executive Summary

This document comprises the second annual progress report to the Department of the Navy for the reporting period of July 2008 through June 2009 (Year Two). It includes data from the monitoring program for protected marine species at the proposed site of an Undersea Warfare Training Range (USWTR) in Onslow Bay, North Carolina. Aerial surveys, vessel-based surveys, and passive acoustics were techniques used to monitor the proposed USWTR site. Density estimates for marine mammals and sea turtles were determined from data collected during the aerial and vessel-based surveys. Two years of continuous monitoring have provided important baseline data on the density, abundance and distribution of marine mammals, sea turtles and seabirds, as well as information on movements and habitat use of these species in the proposed USWTR site.

Study Area

The proposed USWTR in Onslow Bay is 25 nm (46 km) long and 20 nm (37 km) wide. The survey area consists of a box that extends 20 nm in each direction past the proposed USWTR. Ten transect lines 40 nm (74 km) in length and spaced approximately 5 nm (9.3 km) apart crossed the survey area. Transect lines were oriented parallel to the short axis of the USWTR boundaries and perpendicular to the primary bathymetric and prevailing oceanographic features influencing the region. This design yielded a total of 400 nm (~740 km) of track line surveyed by both aerial and shipboard platforms.

Aerial Surveys

Personnel from the University of North Carolina at Wilmington conducted aerial surveys in the proposed USWTR site in Onslow Bay. Monthly aerial surveys of track lines were flown between June 2008 and June 2009. The goal was to survey the entire USWTR site (10 track-lines) twice per month. This goal was accomplished for seven of the twelve months. For the remaining months a single set of lines were flown except November, in which 16 lines were flown, and September, in which no lines were flown. A total of 64 cetacean sightings of 1,422 individuals, and 237 sea turtle sightings, representing 266 individuals, were observed while on effort in the study area. No right whales (*Eubalaena*

glacialis) were observed within the site. Three cetacean species were observed in the survey site while on effort including bottlenose dolphins (*Tursiops truncatus*; 36 sightings of 634 individuals), spotted dolphins (*Stenella frontalis*; 22 sightings of 717 individuals), and short-finned pilot whales (*Globicephala macrorhynchus*; 2 sightings of 30 individuals). In addition, there were four sightings of 41 individual dolphins where species identity could not be established with 100% certainty (*i.e*. "unidentified delphinids"). There was also a single "off effort" sighting of 20 Risso's dolphins (*Grampus griseus*) that was made during the transit between the offshore ends of track-lines 3 and 4. This sighting demonstrates the presence of this species near the proposed USWTR range but is not included in any of the analyses presented here.

As a comparison, during last year's aerial surveys 66 cetacean sightings, representing 853 individuals, were made (Table 1)(Pabst *et al*. 2008). The sightings by species were: bottlenose dolphins (33 sightings of 461 individuals), spotted dolphins (11 sightings of 177 individuals), short-finned pilot whales (3 sightings of 53 individuals), rough-toothed dolphins (*Steno bredanensis*; 3 sightings of 40 individuals), and Risso's dolphins (3 sightings of 20 individuals). In addition, a total of two sightings of five individuals were categorized as *T. truncatus / S. frontalis* and 11 sightings of 97 individuals were recorded as unidentified delphinids.

Vessel-Based Surveys

Researchers from Duke University conducted vessel-based surveys and passive acoustic monitoring in the proposed USWTR site in Onslow Bay. Twenty-two track lines were surveyed in approximately 102 hours and 1,609 km of survey effort. Most effort (73%) occurred in Beaufort Sea States 2 and 3. A total of 33 groups of cetaceans were sighted during vessel surveys (29 while on effort, four while off effort) and two species were observed: bottlenose dolphins (14 sightings), Atlantic spotted dolphins (17 sightings). Two sightings of unidentified delphinids were also recorded. Similar to Year One, in Year Two bottlenose dolphins were observed in both shallow and deep waters across the continental shelf break, whereas spotted dolphins were observed only in shallow waters on the continental shelf. No mixed-species groups were observed in Year Two. Forty-

nine loggerhead sea turtles (*Caretta caretta*) were also observed during Year Two surveys. Approximately 1000 digital images were taken for species identification and individual recognition during Year Two. No individuals of any species have been resighted in the USWTR.

Passive Acoustic Monitoring

During 17 surveys, a four-element hydrophone array was towed behind the vessel. Twenty groups of cetaceans (bottlenose dolphins and spotted dolphins) were detected with the hydrophone array and also were identified by visual observers. Recordings from the hydrophone array will be used to help identify species vocalizations recorded on a bottom-mounted acoustic recording device (High Frequency Acoustic Recording Package; HARP).

The HARP was deployed on three separate occasions since the start of Year One. The instrument was deployed, recovered and redeployed near the center of the USWTR site, close to the 200 m shelf break. In all three deployments, the instrument was programmed to record at a sample rate of 200 kHz for five-minute periods, separated by an inactive interval of five minutes. A total of 1,555 marine mammal vocal events have been identified since June 2007. Since commencing the HARP monitoring, sperm whales (*Physeter macrocephalus*) and a probable beaked whale have been detected using the HARP, but were not detected by aerial or vessel-based observers. Analysis of these recordings is ongoing.

Seabirds

Nearly 800 seabirds were observed in approximately 70 hours of survey effort between May 2008 and June 2009, yielding a sighting per unit effort (the number of seabirds recorded per hour of effort) between 0.72 and 61.64 per hour. Twenty-three species of seabird were recorded, with the greatest diversity observed during July and August 2008. Cory's (*Calonectris diomedea*) Shearwaters were the species sighted most frequently in both Year One and Year Two.

Density Estimation

Scientists from the University of St. Andrews conducted analysis of the data from the combined aerial and shipboard surveys of the USWTR from June 2007 through August 2009, combined with that of the earlier aerial surveys of the UNCW for Onslow Bay 1998/1999, allowed estimation of density surfaces for bottlenose dolphins *Tursiops truncatus*, spotted dolphins, *Stenella frontalis*, pilot and beaked whales combined, and loggerhead turtles *(Caretta caretta)* as well as providing some evidence of the environmental correlates of the animals distributions.

Detection functions were estimated from the multi-platform, multi-year USWTR survey data with additional data from UNCW right whale surveys, the 1998/1999 UNCW aerial surveys of Wallop Island, and shipboard surveys off Cape Hatteras. Abundance for the USWTR region and an outer margin of 20 nm around it was estimated using the estimated detection probabilities and separately estimating (a) animal presence/absence using a logistic general additive model and (b) estimating density given presence. Detection functions were not fitted to all of the detected species owing to a paucity of data (shipboard whale sightings).

Depending on the best fitted spatial models used, estimates were obtained as an average over the entire time period, for each year or for each month. At the highest resolution, estimates were obtained for the USWTR core region and the outer region for September 1998 through to July 1999 and June 2007 through to August 2009. Estimated bottlenose dolphin numbers varied between 20 (95% CI: 10 – 90, August 2008) and c. 100 (30 – 180, Jan 2008) for the inner region and from 60 (30 – 240, August 2008) to 290 (80 – 540, May 1999) for the outer region. Estimated spotted dolphin numbers varied from 0 (0 – 0) in 1998/1999 to 400 (110 – 1200) in January 2009 in the inner region and from 0 (0 – 0) in 1998/1999 to c. 920 (260 – 2700, in January 2009) in the outer region. Spotted dolphins only appeared in the shallower parts of the region of interest from 2007.

Pilot and beaked whale numbers were very low (< 10, 2 – 14) throughout the survey period. Estimated loggerhead turtle numbers varied from 2 (2 – 6) in July 1999 to 270

(50 – 800) in March 2009 in the inner region and from 5 (1 – 13) in July 1999 to 530 (90 – 1600) in March 2009 in the outer region. All the above estimates assumed perfect detection on the trackline. Small sample sizes result in very little power to detect trend in abundance but there was no evidence of a systematic decline in any species in the last ten years and substantial evidence for an increase in spotted dolphin numbers.

There was evidence that the abundance of bottlenose dolphins fluctuated with season (perhaps in response to temperature), as did the presence of loggerhead turtles who were likely to be associated with water between 18 – 20˚C. Spotted dolphins and loggerhead sea turtles were associated with shallower water less than 100 m deep.

AERIAL SURVEYS OF THE PROPOSED UNDER SEA WARFARE TRAINING RANGE (USWTR) IN ONSLOW BAY, NORTH CAROLINA, JULY 2008 TO JUNE 2009

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Executive Summary – Aerial Surveys

This document is an annual progress report to the U.S. Department of the Navy on aerial surveys conducted at the proposed Under Sea Warfare Training Range (USWTR) in Onslow Bay, North Carolina between July 2008 and June 2009. The aerial surveys were carried out by the University of North Carolina Wilmington. The goal was to survey the entire USWTR site (10 track-lines) twice per month. This goal was accomplished for seven of the twelve months. For the remaining months a single set of lines were flown except November, in which 16 lines were flown, and September, in which no lines were flown. A total of 64 cetacean sightings, of 1,422 individuals, and 237 sea turtle sightings, representing 266 individuals, were observed while on effort in the study area (Table 1, Figure 1). No right whales (*Eubalaena glacialis*) were observed within the site. Three cetacean species were observed in the survey site while on effort including bottlenose dolphins (*Tursiops truncatus*; 36 sightings of 634 individuals), spotted dolphins (*Stenella frontalis*; 22 sightings of 717 individuals), and short-finned pilot whales (*Globicephala macrorhynchus*; 2 sightings of 30 individuals). In addition, there were four sightings of 41 individual dolphins where species identity could not be established with 100% certainty (*i.e*. "unidentified delphinids"). There was also a single "off effort" sighting of 20 Risso's dolphins (*Grampus griseus*) that was made during the transit between the offshore ends of track-lines 3 and 4. This sighting demonstrates the presence of this species near the proposed USWTR range but is not included in any of the calculations presented here.

As a comparison, during last year's aerial surveys 66 cetacean sightings, representing 853 individuals, were made (Table 1)(Pabst *et al*. 2008). The sightings by species were: bottlenose dolphins (33 sightings of 461 individuals), spotted dolphins (11 sightings of 177 individuals), short-finned pilot whales (3 sightings of 53 individuals), rough-toothed dolphins (*Steno bredanensis*; 3 sightings of 40 individuals), and Risso's dolphins (3 sightings of 20 individuals). In addition, a total of two sightings of five individuals were categorized as *T. truncatus / S. frontalis* and 11 sightings of 97 individuals were labeled unidentified delphinids.

During the 2008-2009 season, the number of cetacean sightings varied by month, with the highest number of sightings occurring in March, April, May and June (Table 1).

Monthly sighting data from the 2007-2008 season showed a similar increase in sightings during the spring months.

A total of 266 sea turtles were observed during the study period. Of these, 226 were identified as loggerhead sea turtles (*Caretta caretta*), 39 were recorded as "unidentified sea turtles", and one was identified as a leatherback sea turtle (*Dermochelys coriacea*). Leatherback sea turtles had not been seen in the range during the 2007-2008 survey, but had been observed in December and July during aerial surveys conducted in 1997-1998.

As previously demonstrated in other aerial survey studies, sightings drop off dramatically as the Beaufort Sea State (BSS) increases. In the present study, as the BSS increased from one to three, cetacean sightings decreased from 14.10 to 1.93 per 1000 km surveyed, whereas sea turtle sightings decreased from 46.64 to 7.73 per 1000 km surveyed respectively.

In addition to cetaceans and sea turtles, other pelagic marine vertebrates, including manta rays, ocean sunfish and sharks, were sighted. The majority of vessels encountered in the proposed USWTR range were recreational fishing vessels, which were predominately observed shoreward of the 100 fathom depth contour.

Table 1. Total number of sightings and individuals for each species by month from June 2007 - June 2009 for the Onslow Bay, NC USWTR survey site. *No surveys were flown in January and September of 2008.

		2008						2009						
		July	August	September	October	November	December	January	February	March	April	May	June	Total
Tursiops truncatus	Sightings	2	1		4	3			2	3	6	9	6	**36**
	# of individuals	42	9		48	79			80	11	78	186	101	**634**
Stenella frontalis	Sightings		1			1			3	8	5	1	3	**22**
	# of individuals		22			30			160	257	198	25	25	**717**
Globicephala macrorhynchus	Sightings	2												**2**
	# of individuals	30												**30**
Unidentified delphinid	Sightings									1		2	1	**4**
	# of individuals									3		27	11	**41**
	Total sightings	**4**	**2**	**0**	**4**	**4**	**0**	**0**	**5**	**12**	**11**	**12**	**10**	**64**
	Total individuals	**72**	**31**	**0**	**48**	**109**	**0**	**0**	**240**	**271**	**276**	**238**	**137**	**1422**

		2007							2008						
		June	July	August	September	October	November	December	January	February	March	April	May	June	Total
Tursiops truncatus	Sightings	1				1	9	1			3	5	5	8	**33**
	# of individuals	80				40	113	1			33	43	67	84	**461**
Stenella frontalis	Sightings				1					4	1		1	4	**11**
	# of individuals				4					68	36		11	58	**177**
Globicephala macrorhynchus	Sightings	1											2		**3**
	# of individuals	32											21		**53**
Steno bredanensis	Sightings											1		2	**3**
	# of individuals											26		14	**40**
Grampus griseus	Sightings												1	2	**3**
	# of individuals												5	15	**20**
Tursiops/ Stenella frontalis	Sightings										1			1	**2**
	# of individuals										3			2	**5**
Unidentified delphinid	Sightings		1	1	1		4			2	1			1	**11**
	# of individuals		6	3	6		56			20	5			1	**97**
	Total sightings	**2**	**1**	**1**	**2**	**1**	**13**	**1**	**0**	**6**	**6**	**6**	**9**	**18**	**66**
	Total individuals	**112**	**6**	**3**	**10**	**40**	**169**	**1**	**0**	**88**	**77**	**69**	**104**	**174**	**853**

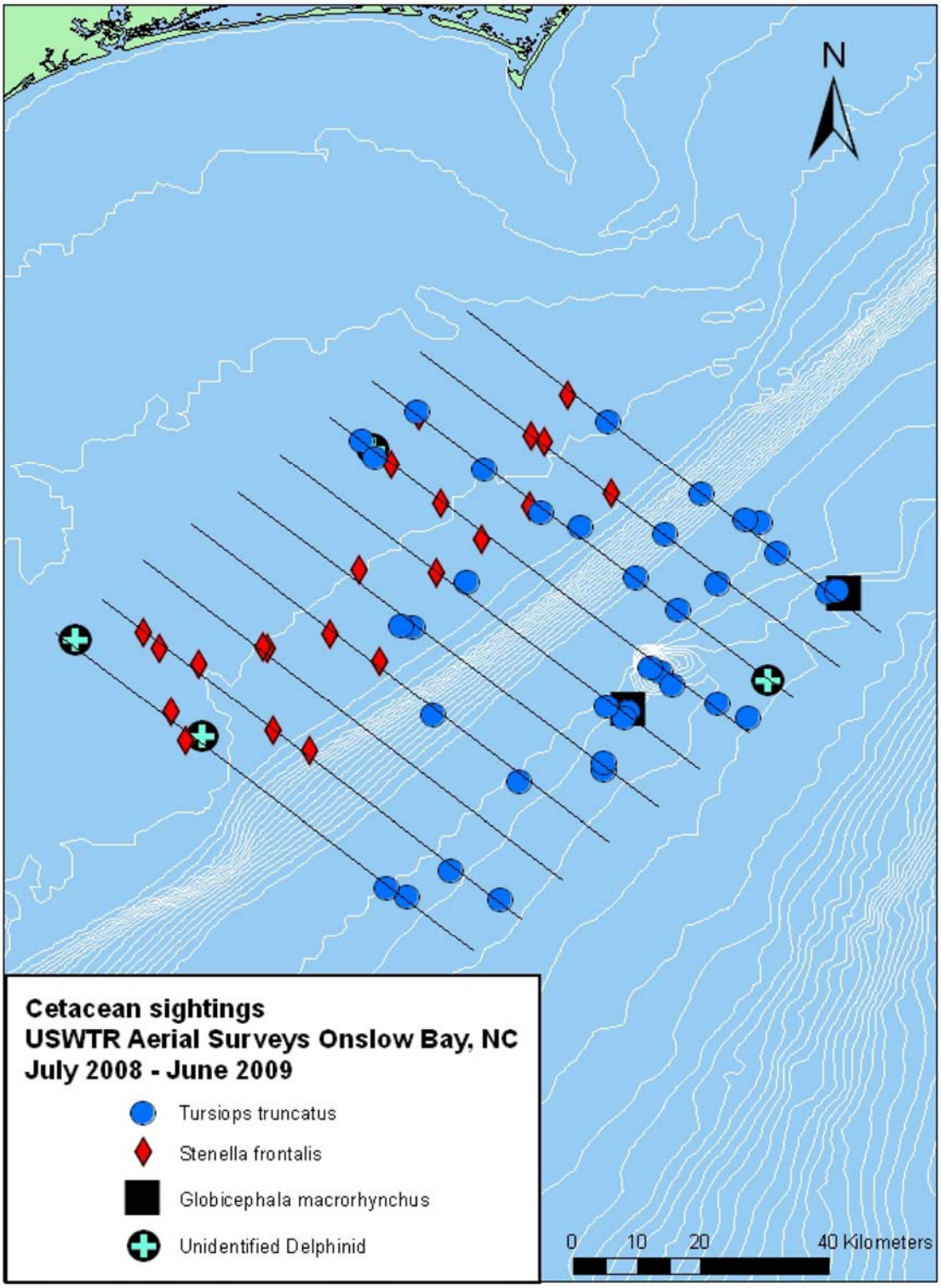

Figure 1. All cetacean sightings made during the 2008 – 2009 UNCW aerial surveys of the proposed USWTR site in Onslow Bay, NC.

Methodology

Survey design and logistics

The University of North Carolina Wilmington (UNCW) provided experienced aerial observers and contracted Orion Aviation, Siler City, NC, to provide planes and certified pilots. Surveys were conducted using NOAA – SER Minimum Aircraft and Crew Provisions Guidelines, which require that aircraft are CFR Part 135 certified and that pilots have demonstrated experience working below 1000 ft in support of biological observational studies. Surveys were flown in a Cessna 337 Skymaster, at 305 m altitude and 185 km/hr speed, with a pilot, co-pilot and two observers. Each observer wore a Nomex ® fire retardant suit, a Switlik ® inflatable life jacket, a personal Emergency Positioning Beacon (EPIRB), as well as additional safety equipment. An inflatable life-raft, plane EPIRB, and satellite phone were also onboard at all times.

The survey consisted of ten 74 km long track-lines spaced 6.5 km apart, which covered the proposed USWTR site and an 18 km boundary around the site in Onslow Bay (Fig. 2 and Table 2). The corners of the core USWTR site are: N34. 07°/W-76.56° (NW), N33.83°/ W-76.27° (NE), N33.54°/W-76.63° (SW), and N33.77°/W-76.95° (SE). Survey dates were chosen based upon weather and sea conditions, and access to restricted military areas within the site. Because the primary objective of the surveys was to locate and identify to species cetaceans and sea turtles, the sea state and consequent sighting conditions during surveys were key factors that dictated when to initiate and, if necessary, to abort, surveys. Low sea states (*i.e.* winds preferably 5 – 10 knots, but no more than 15 knots and seas maximum 4 feet) were selected to optimize sighting conditions. Sighting rates of small cetaceans drop off to near zero in a Beaufort Sea State (BSS) of four or higher, as demonstrated by several previous aerial survey studies (Gómez de Segura *et al*. 2006, DeMaster *et al.* 2001). Once an appropriate weather window was identified, observers from UNCW and Orion Aviation pilots would coordinate to meet at an FBO at the Wilmington, NC airport, from which all the surveys originated.

Table 2. Coordinates for track-line end points of the Onslow Bay, NC survey site

	Western Way Point		Eastern Way Point	
Transect Line	**Latitude**	**Longitude**	**Latitude**	**Longitude**
1	33.8119	-77.1926	33.3596	-76.6017
2	33.8620	-77.1249	33.4074	-76.5370
3	33.9146	-77.0666	33.4575	-76.4724
4	33.9671	-77.0020	33.5149	-76.4047
5	34.0148	-76.9342	33.5626	-76.3399
6	34.0673	-76.8726	33.6152	-76.2783
7	34.1198	-76.8017	33.6653	-76.2104
8	34.1723	-76.7431	33.7154	-76.1456
9	34.2119	-76.6721	33.7679	-76.0870
10	34.2724	-76.6104	33.8157	-76.0252

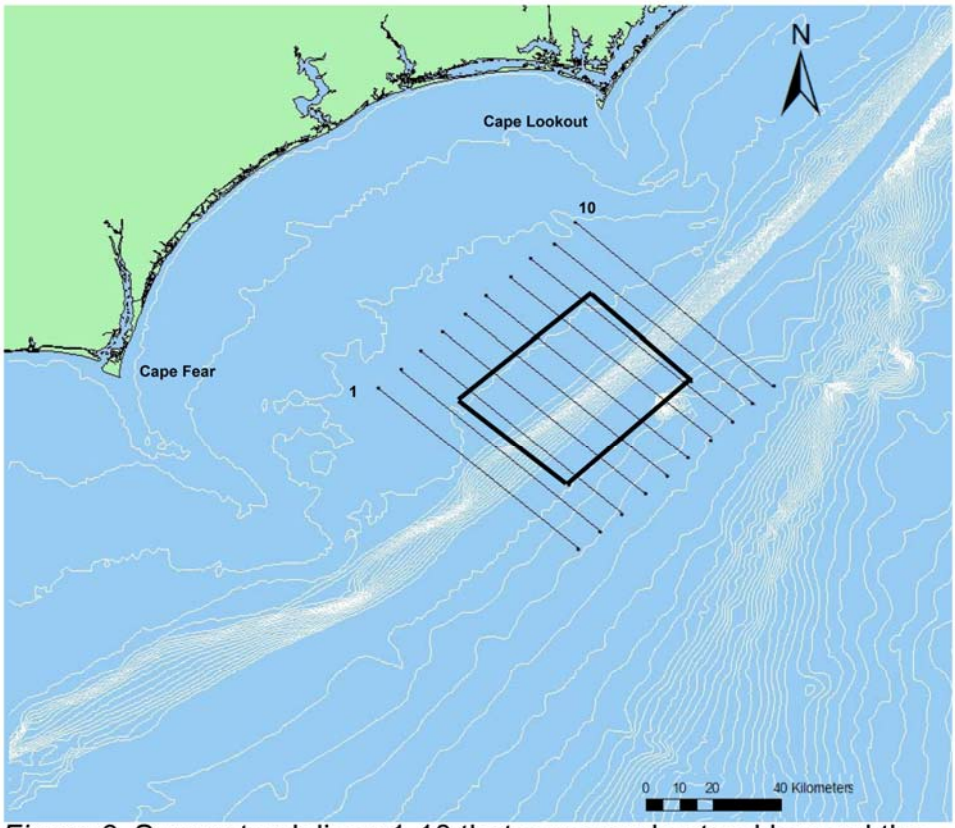

Figure 2. Survey track lines 1-10 that cover and extend beyond the boundaries of the proposed USWTR site in Onslow Bay, NC

Data collection

Each side of the plane was monitored by one observer with his or her own GPS unit, data sheet (see Appendix A), and binoculars, and each side was considered an independent strip transect. The start and end of transect lines, changes in environmental variables (*i.e*. cloud cover, BSS, visibility, and glare), and sightings of marine mammals, sea turtles and vessels in the survey area were recorded by each observer throughout the survey (see Appendix B for sighting codes). When a sighting cue was observed, horizontal and vertical angles between the plane and the sighting cue were recorded. Observers would then record a break track point and go off effort from the survey line to investigate the sighting. The plane would close on the sighting location and circle above the animal(s) to obtain photographic evidence of species. Initial and final locations of the sighting were recorded so that the distance of the initial sighting from the track line, and any general movements of animal(s), could be calculated. During a marine mammal encounter, the observer on the left side of the plane was the designated data recorder and the right observer took digital photographs to confirm species identification. The camera used was a Canon 40D with a 100-400 mm image stabilizer lens. The minimum and maximum numbers of animals in each sighting were estimated by both observers in the field and recorded. After photographic and sighting data were collected, the plane returned to the initial sighting location on the track line taking another waypoint marking the return to on effort surveys. All data collected during a sighting were recorded on the Sighting Data Sheet (Appendix C).

The plane did not break track for sightings of sea turtles, other marine vertebrates (*e.g*. sharks and rays) or vessels, however, these types of sightings were all recorded and logged.

Data analysis

Upon completion of a daily survey, GPS way points were downloaded to a desktop computer utilizing the GPS Utility software program (GPS Utility Limited, UK) and subsequently transferred into Microsoft ® Excel spread sheets. Observational data (*e.g*. start and stop track line, sightings, and weather conditions) were entered manually into the spread sheet for each GPS way point. All digital images collected during a

survey were also downloaded and separated into individual folders for each sighting that day. The use of digital photography allowed for enlargement of images once in the lab, which enhanced the ability to identify animals to species. For each sighting, a group of best images was selected based on visible diagnostic features. These images were used in conjunction with the preliminary species identification (ID) made in the field, based upon appearance, group size and behavior, to determine species identity. During the first year of surveys observers from Duke and UNCW met on two occasions to review sighting images and establish a clear set of diagnostic features to positively identify each cetacean species. These features were used by both teams during their photo analysis for the second year. Unless the dolphin species identity could be unequivocally established, the designation "unidentified delphinids" was used. Unidentifiable species were often the result of high BSS conditions where a clear set of images could not be obtained. Images obtained during a sighting were similarly employed to calculate group numbers, and a best estimate of group size was established based on field observations and images.

Geographical Information System (GIS) maps of sightings of cetaceans, sea turtles, other marine vertebrates, and vessels within the survey area were created. Positional data were imported from Excel spread sheets into Arc GIS version 9.2 (ESRI®, Redlands, CA), and used to plot sightings.

The distances between the break track waypoint (2.0) and the initial position of each sighting (2.4) was calculated using the online software Scripts Movable Type (http://www.movable-type.co.uk/scripts/latlong.html), which uses the Haversine formula to calculate distances between two geographical reference points. Since there is a bias in estimating the location of a group of mobile marine mammals from a fast moving airplane, the distances calculated between break track and sighting were recorded to 0.1 km. All data obtained during a marine mammal sighting (*e.g.* observational notes, group size, GPS coordinates and image numbers) were summarized in the Sighting Summary Sheet (See Appendices D and E for example and explanation). When all surveys for a month were completed, tables with sightings and effort (see Tables 3 and 4 for examples) were sent to Duke University Marine Lab (DUML) for inclusion in the monthly progress report compiled and sent by DUML to Geo-Marine Inc. (Plano, TX) and Parsons (Norfolk, VA).

Off effort sightings (*i.e.* "10.0" and sightings made on effort transits to and from the range) were not included in spread sheets used for data analysis.

Table 3. Sighting summary table of USWTR aerial surveys in Onslow Bay for June 2009.

Date	Time	On/Off Effort	Latitude	Longitude	Track Number	Species	Group Size
1-Jun-09	10:05	On	33.821909	-76.687991	5	Tursiops truncatus	3
1-Jun-09	10:36	On	33.773081	-76.476520	6	Caretta caretta	1
1-Jun-09	10:55	Off	34.052427	-76.730425	7	Mola mola	1
1-Jun-09	10:57	Off	34.064991	-76.736280	7	Stenella frontalis	3
1-Jun-09	11:05	On	34.053559	-76.718352	7	Stenella frontalis	6
1-Jun-09	11:42	On	33.964068	-76.450177	8	Tursiops truncatus	2
1-Jun-09	11:52	On	34.086870	-76.629366	8	Caretta caretta	1
1-Jun-09	11:55	On	34.155358	-76.718417	8	Unidentified Sea Turtle	1
1-Jun-09	12:05	On	34.056448	-76.466167	9	Unidentified Sea Turtle	1
1-Jun-09	12:27	On	33.927627	-76.170854	8	Tursiops truncatus	28
1-Jun-09	12:42	On	34.118759	-76.411411	10	Caretta caretta	1
1-Jun-09	12:44	On	34.171457	-76.471264	10	Caretta caretta	1
1-Jun-09	12:48	On	34.228561	-76.544918	10	Dermochelys coriacea	1
1-Jun-09	14:56	On	33.882602	-76.887040	4	Manta birostris	1
1-Jun-09	15:33	On	33.817667	-76.942687	3	Osteichthyes	1
1-Jun-09	15:47	On	33.767246	-76.990013	2	Stenella frontalis	13
1-Jun-09	16:42	On	33.437666	-76.695101	1	Tursiops truncatus	35
1-Jun-09	17:15	On	33.665030	-76.986169	1	Unidentified Delphinid	11
2-Jun-09	9:43	On	33.824363	-76.702676	5	Tursiops truncatus	8
2-Jun-09	10:26	On	33.685348	-76.629302	4	Chondrichthyes	1
2-Jun-09	10:55	On	33.902160	-77.050108	3	Caretta caretta	1
2-Jun-09	11:03	On	33.790918	-77.046095	2	Stenella frontalis	5
2-Jun-09	11:36	On	33.473489	-76.633977	2	Tursiops truncatus	25
2-Jun-09	14:24	On	33.844391	-76.188814	9	Unidentified Sea Turtle	1
2-Jun-09	14:32	On	34.030103	-76.429515	9	Unidentified Sea Turtle	1
2-Jun-09	14:55	On	33.920512	-76.407837	8	Manta birostris	1

Table 4. Example of June effort data submitted to Duke University Marine Lab

Date	Line	Sea State	Kilometers flown
1-Jun-09	5	1 to 2	74.4
1-Jun-09	6	1 to 2	73.1
1-Jun-09	7	1 to 2	73.8
1-Jun-09	8	1 to 2	72.5
1-Jun-09	9	1 to 2	72.5
1-Jun-09	10	2	70.3
1-Jun-09	4	1 to 2	74.7
1-Jun-09	3	1 to 2	75.0
1-Jun-09	2	1 to 2	72.0
1-Jun-09	1	1 to 2	68.8
2-Jun-09	6	1 to 2	74.6
2-Jun-09	5	1 to 2	70.8
2-Jun-09	4	1	74.7
2-Jun-09	3	1	74.7
2-Jun-09	2	1	70.1
2-Jun-09	1	1	74.1
2-Jun-09	10	1 to 3	75.1
2-Jun-09	9	1 to 3	73.2
2-Jun-09	8	1 to 3	76.3
2-Jun-09	7	1 to 3	78.3

Data storage

All data obtained during a flight (GPS coordinates and digital pictures) and transcribed notes (*e.g.* observations and sightings) are stored electronically in three separate places: on a networked computer hard drive (which is backed up twice a week), an external hard drive, and on separate CDRs or DVDs. Additionally, the original data sheets used in the plane [*i.e.* daily plane log (Appendix F), observer notes and sightings sheets] are stored in binders, as are electronically entered versions of the same and printed forms of all electronic files. All data are stored at UNCW. In addition, all survey data, once edited, are regularly posted online to OBIS SEAMAP (http://seamap.env.duke.edu/).

Results

Two full sets of survey track lines were flown for all months from July 2008 to June 2009 except for December 2008, February 2009 and April 2009 (10 track-lines or one full set each month), November 2008 (16 track-lines), and September 2009 (no surveys flown) for a total of 14,035.6 km (Table 5). Survey conditions ranged from a Beaufort Sea State (BSS) 1 to 4, with the majority of the surveys flown in a BSS 2 or 3 [BSS 1: 1,843.8 km (13.1%), BSS 2: 4,026.4 km (28.7%), BSS 3: 6,211.4 km (44.3 %), BSS 4: 1,953.9 km (13.9%)(Fig. 3a and 3b)]. For each survey month an average BSS value was calculated as a way of comparing conditions across months. This was done by taking the distance flown at each sea state multiplied by the BSS number (i.e. BSS 1 distances would be multiplied by 1) these values were then summed and divided by the total distance flown that month (Figure 3c). Survey effort was terminated at BSS greater than 4. Cetacean sighting rates dropped off dramatically as BSS increased beyond a BSS 2, with 26 sightings made in a BSS 1 (14.10 sightings/1000 km flown), 25 in a BSS 2 (6.21 sightings/1000 km flown), 12 in a BSS 3 (1.93 sightings/1000 km flown) and one sighting in a BSS 4 (0.51 sightings/ 1000 km flown) (Fig. 4a - c).

Table 5. Track lines and km flown during aerial surveys of the proposed USWTR site in Onslow Bay, NC, between July 2008 and June 2009. Track line numbers are listed in the order in which they were flown. *Only the inshore half of lines 1 thru 6 were flown due to range closure. A total of 196 tracklines were flown.

Date	Track lines flown AM	Track lines flown PM	Total km flwon per day
16-Jul-2008	10 to 5	1 to 4	703.6
17-Jul-2008	10 to 5	1, 4, 3, 2	664.0
1-Aug-2008	none	10 to 7	297.1
2-Aug-2008	6 to 1	none	436.8
3-Aug-2008	4 to 3	none	149.2
4-Aug-2008	1 to 2, 5 to 10	none	595.0
15-Oct-2008	6 to 1	7 to 10	736.0
16-Oct-2008	10 to 5	4 to 1	742.9
23-Nov-2008	10 to 7	1 to 6*	495.3
24-Nov-2008	1 to 6	none	440.6
30-Dec-2008	10 to 7	6 to 1	679.0
22-Jan-2009	1 to 6	7 to 10	744.9
7-Feb-2009	5 to 10	4 to 1	729.4
17-Feb-2009	5 to 8	4 to 1, 9-10	741.0
4-Mar-2009	5 to 10	4 to 1	735.0
5-Mar-2009	10 to 5	4 to 1	737.5
24-Apr-2009	10 to 5	none	442.8
25-Apr-2009	none	4 to 1	299.8
12-May-2009	6 to 1	none	443.9
28-May-2009	1 to 4	5 to 8	575.8
30-May-2009	none	10 to 5	442.8
31-May-2009	10 to 7 and 4 & 3	1 to 2 and 9 to 10	733.9
1-Jun-2009	5 to 10	4 to 1	727.1
2-Jun-2009	6 to 1	7 to 10	741.8
			14035.6

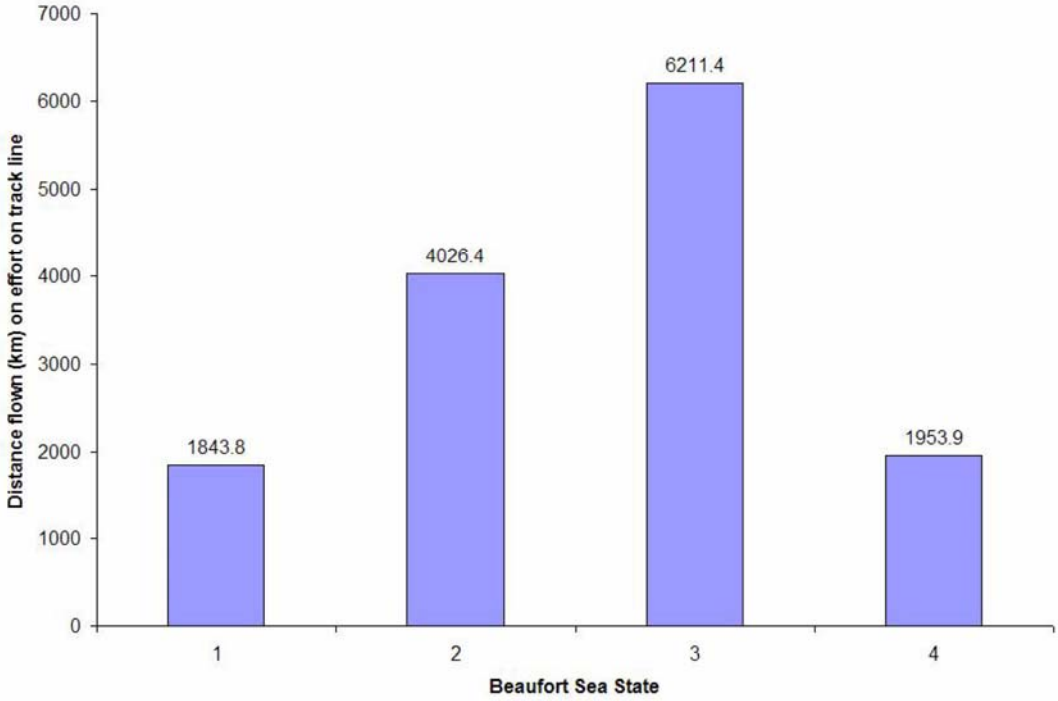

Figure 3a. **Total distance surveyed per Beaufort Sea State during the July 2008 – June 2009 UNCW USWTR aerial surveys in Onslow Bay, North Carolina.**

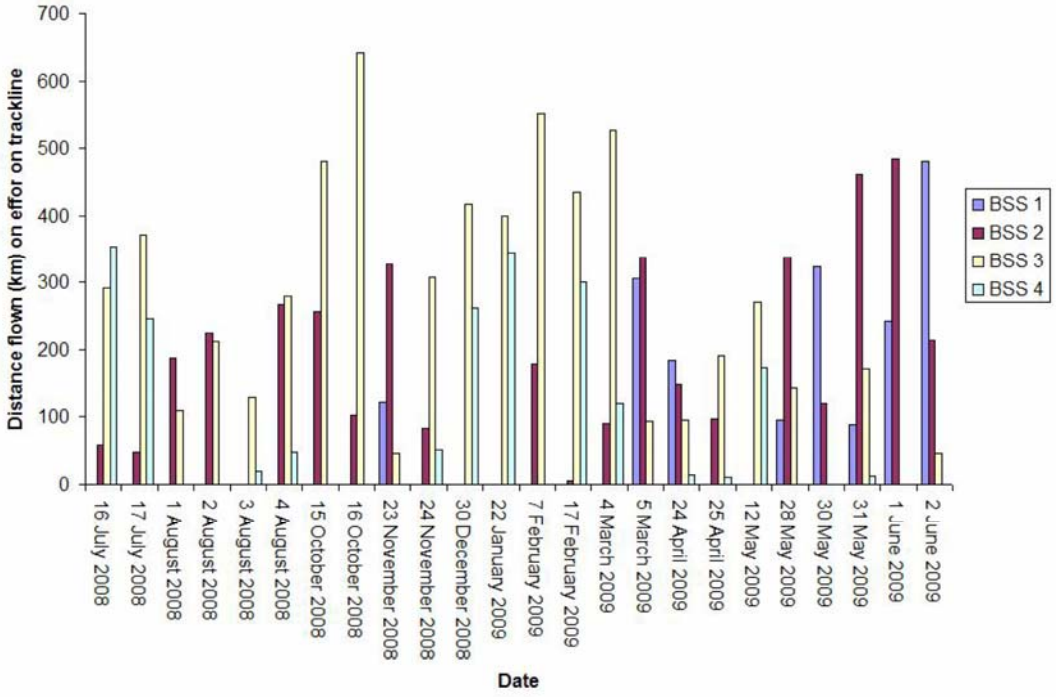

Figure 3b. **Effort by Beaufort Sea State for each survey day during the July 2008 – June 2009 UNCW USWTR aerial surveys in Onslow Bay, North Carolina.**

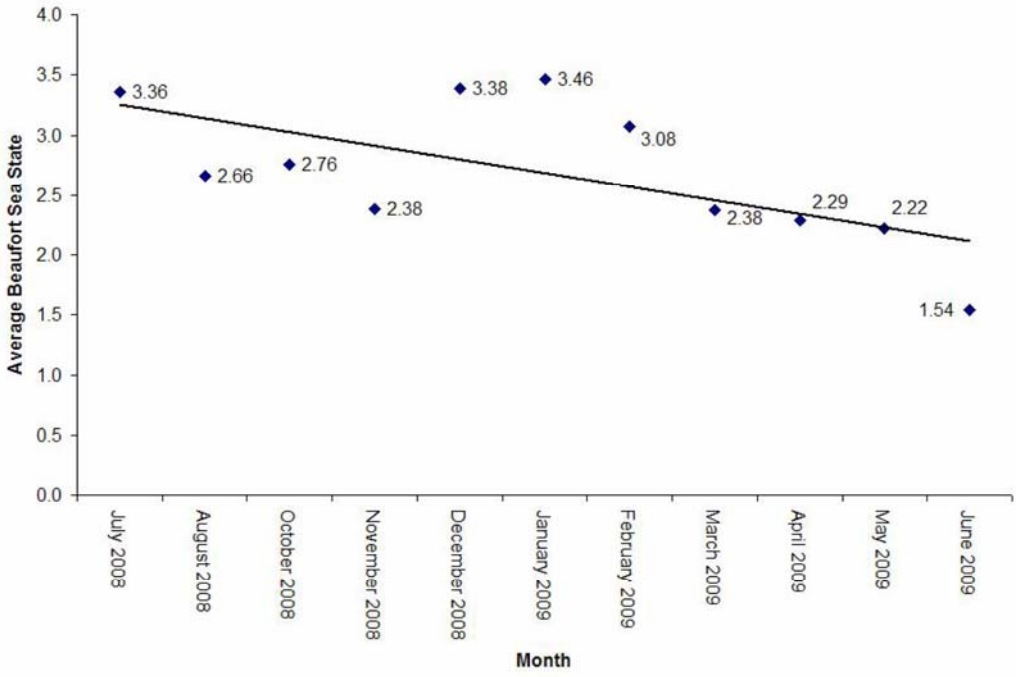

Figure 3c. **Average Beaufort Sea State for each month during the July 2008 – June 2009 UNCW USWTR aerial surveys in Onslow Bay, North Carolina. Values were calculated using the formula AvgBSS = [(Distance @ BSS 1 * 1)+(Distance @ BSS 2 * 2)+…/Total distance flown that day]**

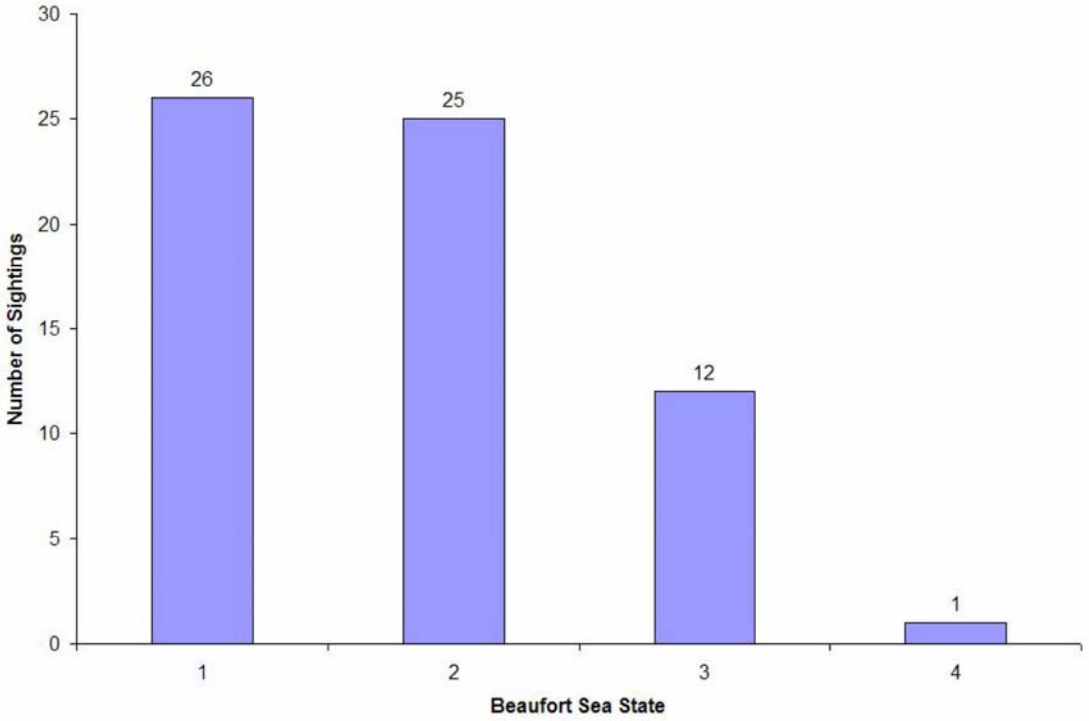

Figure 4a. **Total number of cetacean sightings per Beaufort Sea State during the July 2008 – June 209 aerial surveys in Onslow Bay, North Carolina.**

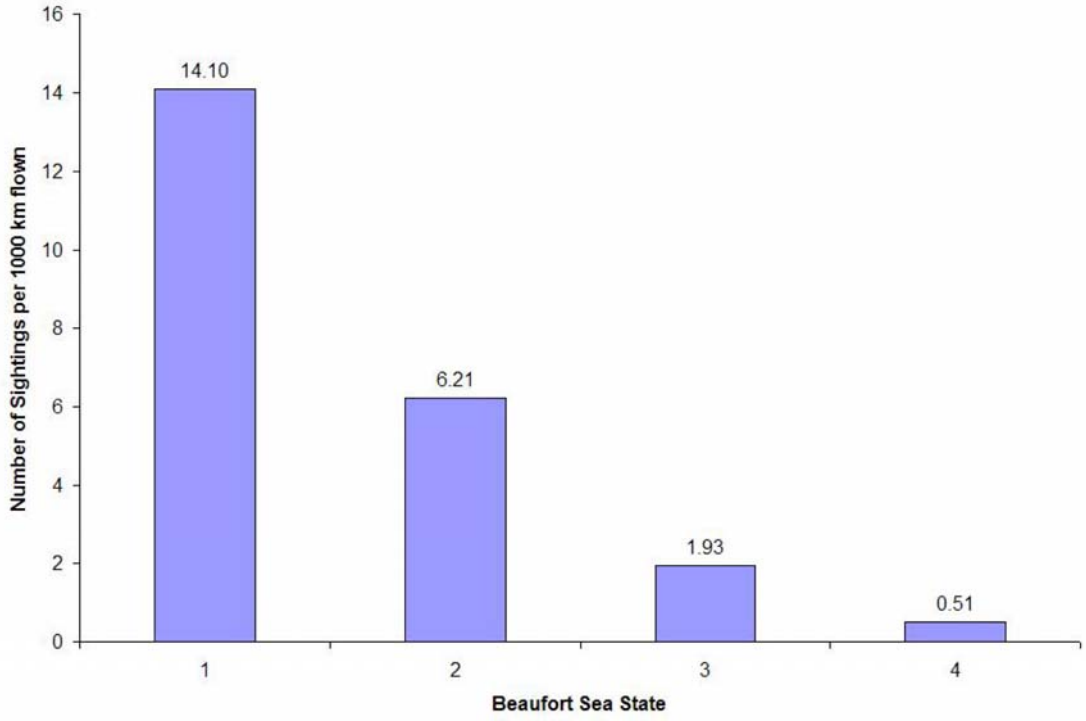

Figure 4b. **Cetacean sightings per 1000 km flown by Beaufort Sea State from July 2008 – June 2009 in the proposed USWTR site in Onslow Bay, North Carolina.**

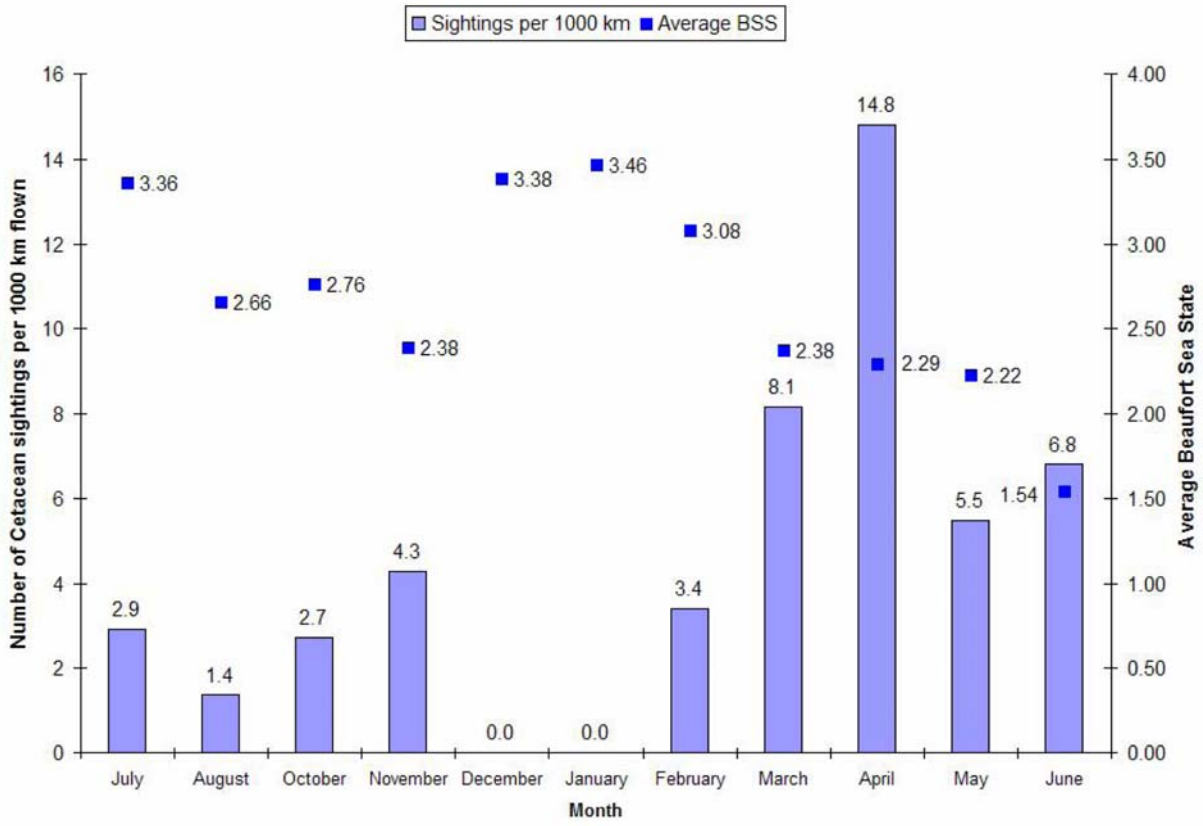

Figure 4c. **Cetacean sightings per 1000 km surveyed and the average Beaufort Sea State per month from July 2008 – June 2009 in the proposed USWTR site in Onslow Bay, North Carolina.**

The mean sighting distance for all cetacean sightings was 0.8 km (SD=0.4) and most sightings were made within 1.2 km of the plane (Fig.5a). The mean sighting distance tended to decrease as BSS increased (Fig. 5b). Average sighting distances were calculated after removing outliers. An outlier was defined as a value in excess of three standard deviations from the mean. Two sighting distances were removed from these calculations as outliers (*i.e.* sighting distances calculated at 2.11, and 2.3 km from the trackline). A single delphinid sighting was removed from our calculations as an actual location of the animal was not taken preventing a sighting distance from being calculated.

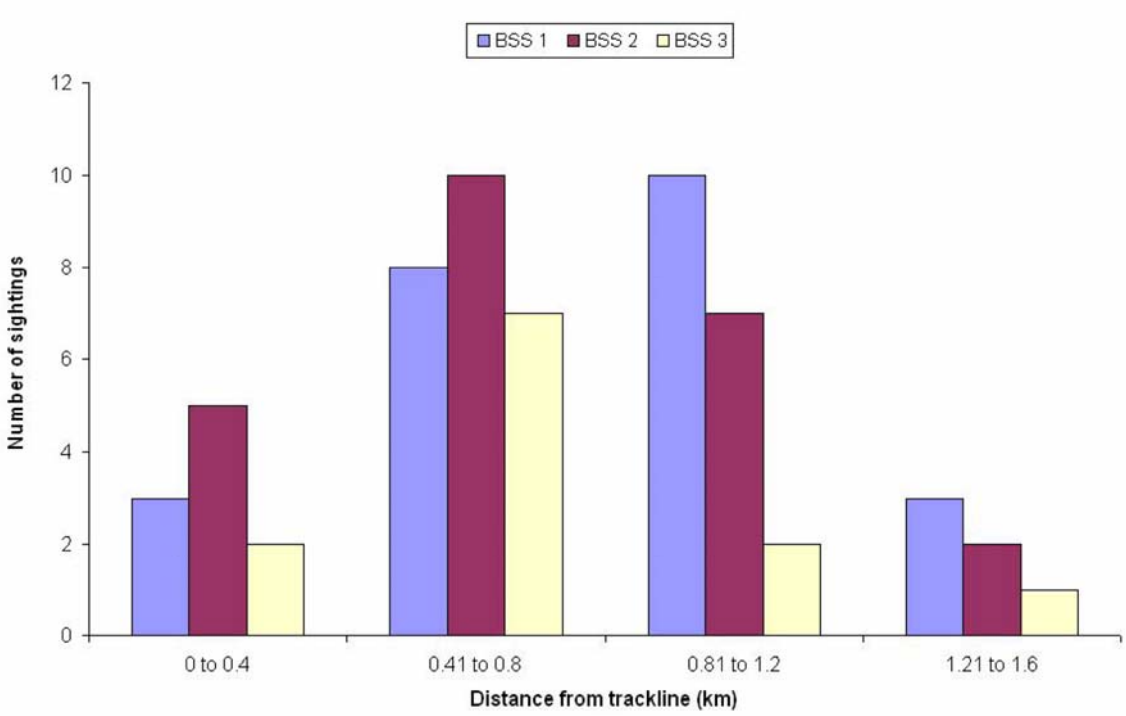

Figure 5a. **Sighting distances by Beaufort Sea State for cetacean sighting from July 2008 – June 2009 in the proposed USWTR site in Onslow Bay, North Carolina. A total of 60 sightings are graphed (2 outliers were removed and 1 delphinid sighting was omitted because an actual position was not taken).**

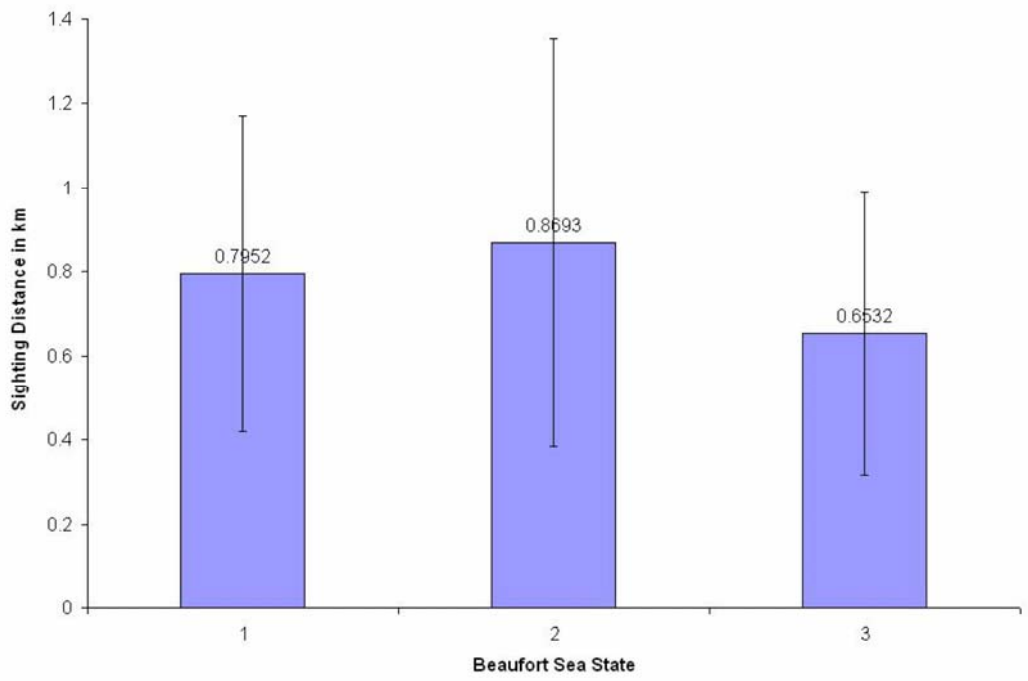

Figure 5b. **Mean sighting distance by Beaufort Sea State for all cetacean sightings from July 2008 – June 2009 in the proposed USWTR site in Onslow Bay, North Carolina. Error bars denote standard deviation for each category.**

Marine Mammal Sightings

No pinnipeds, baleen whales, or any odontocete species listed as endangered under the Endangered Species Act were observed in the Onslow Bay survey site during the surveys. On December 30, 2008 a north Atlantic right whale (*Eubalaena glacialis*) mother calf pair was encountered while returning from the USWTR range approximately 10 nm off the north end of Wrightsville Beach, NC. Photo-documentation was collected and provided to the New England Aquarium. A positive identification was returned for the mother as "Calvin" (Eg #2223) and her new calf. This off effort sighting was the only sighting of "Calvin" in the mid- and southeast Atlantic in the 2008-2009 season.

Species are listed below in order of decreasing number of sightings (*i.e.* most commonly sighted species first). Total number of individuals is based upon the best estimate of group size. Sighting data for the 2007-2008 surveys are also included for comparison purposes (Pabst *et al*. 2008). Summaries for each individual sighting are in Appendix D. All sightings for each month are summarized in Appendix G.

Bottlenose dolphins (*Tursiops truncatus*) (Table 6, Fig. 6)

The bottlenose dolphin was the most commonly observed cetacean species during the present study, based upon number of sightings. This species was observed 36 times for a total of 634 individuals. Group size ranged between 1-60 individuals (mean=17.6). Bottlenose dolphins were seen in July, August, (no survey in September), October, November, February, March, April, May, and June. Calves were seen in November, May and June. Based on the distance from shore (*e.g.* greater than 69 km), these bottlenose dolphins were most likely the offshore ecotype (Torres *et al*. 2003). Overall, smaller groups were encountered inshore, and larger groups were seen at and beyond the continental shelf break. This group size pattern was also observed during last year's surveys. During the 2007/2008 aerial survey of the same area, bottlenose dolphins were encountered 33 times for a total of 461 individuals. During the 1998/1999 aerial survey of the same area, bottlenose dolphins were encountered 17 times for a total of 151 individuals (McLellan *et al*. 1999). The current best estimate of offshore bottlenose dolphins in the Western Atlantic Ocean, between central Florida and Canada, is 81,588 (CV = 0.17) (NOAA Stock Assessment Report; Waring *et al*. 2007).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
17-Jul-08	11:02	27	33.764159	-76.349701	NW	7	1	90°	30
17-Jul-08	11:45	41	33.698622	-76.380418	SE	6	3	120°	12
4-Aug-08	12:38	45	34.01133	-76.27702	NW	10	3	90°	9
15-Oct-08	9:41	7	33.616653	-76.415914	NW	5	3	60°	25
15-Oct-08	14:02	40	34.088073	-76.760254	SE	7	2	90°	3
15-Oct-08	14:46	51	33.892292	-76.370334	NW	8	3	70°	19
16-Oct-08	15:11	41	33.432662	-76.562262	SE	2	3	90°	1
23-Nov-08	10:31	24	33.8732	-76.085829	SE	10	2	90°	45
23-Nov-08	10:53	31	33.953335	-76.328943	NW	9	1	90°	13
23-Nov-08	11:32	43	33.846505	-76.310977	SE	8	1	90°	21
7-Feb-09	9:49	13	33.708546	-76.412508	NW	6	2	90°	50
7-Feb-09	11:30	40	33.974045	-76.215818	NW	10	2	90°	30
5-Mar-09	9:22	6	34.113989	-76.410242	SE	10	3	90°	4
5-Mar-09	10:37	33	34.046132	-76.585129	SE	8	3	120°	2
5-Mar-09	11:23	47	33.691181	-76.211484	NW	7	1	90°	5
24-Apr-09	10:11	19	33.969252	-76.195643	SE	10	3	120°	10
24-Apr-09	10:23	27	33.871845	-76.097792	SE	10	1	90°	10
24-Apr-09	10:45	34	33.883920	-76.255597	NW	9	2	90°	15
24-Apr-09	11:23	57	34.129500	-76.679869	SE	8	1	45°	2
24-Apr-09	12:02	75	33.739365	-76.318960	NW	7	2	90°	32
24-Apr-09	12:39	92	34.063458	-76.741129	NW	7	2	90°	9
28-May-09	9:38	10	33.448227	-76.724387	SE	1	3	110°	60
28-May-09	13:40	42	33.627112	-76.416079	SE	5	2	45°	40
28-May-09	14:00	48	33.690512	-76.386340	NW	6	2	45°	35
28-May-09	14:43	58	33.756924	-76.335357	SE	7	3	90°	10
30-May-09	14:29	39	33.711527	-76.255299	NW	7	2	90°	4
30-May-09	15:36	54	33.885123	-76.611188	SE	6	1	50°	3
31-May-09	9:47	23	33.984991	-76.505104	SE	8	3	100°	10
31-May-09	11:08	42	33.694609	-76.657794	SE	4	3	100°	9
31-May-09	11:51	46	33.601105	-76.536491	SE	4	3	100°	15
1-Jun-09	10:05	7	33.821909	-76.687991	SE	5	1	90°	3
1-Jun-09	11:42	35	33.964068	-76.450177	NW	8	3	90°	2
1-Jun-09	12:27	49	33.927627	-76.170854	NW	8	3	90°	28
1-Jun-09	16:42	84	33.437666	-76.695101	NW	1	2	90°	35
2-Jun-09	9:43	9	33.824363	-76.702676	NW	5	3	60°	8
2-Jun-09	11:36	31	33.473489	-76.633977	SE	2	1	90°	25

Table 6. All *Tursiops truncatus* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

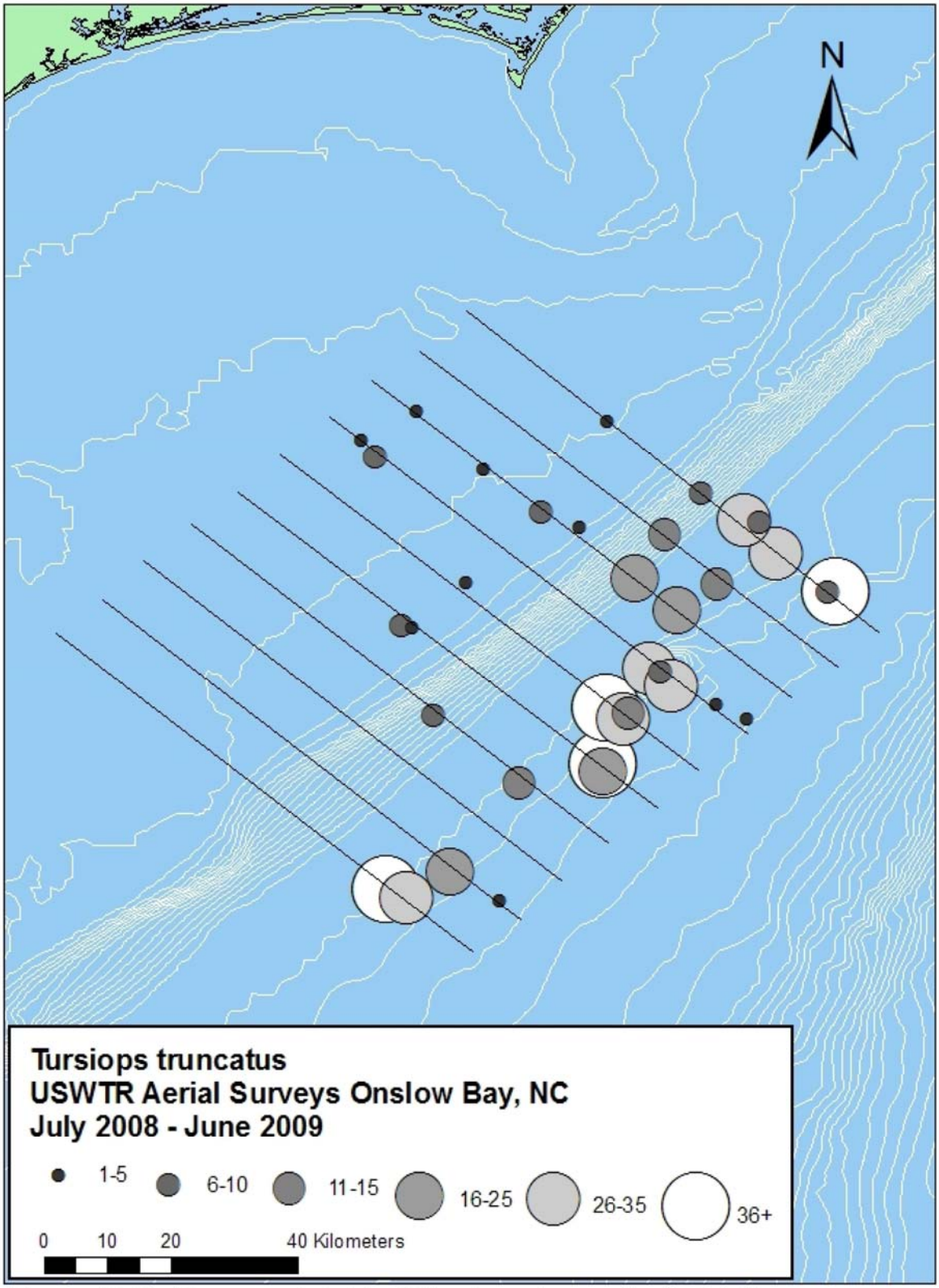

Figure 6. Bottlenose dolphin (*Tursiops truncatus*) sightings indicating group size.

Atlantic spotted dolphins (*Stenella frontalis*) (Table 7, Fig. 7)

The spotted dolphin was the second most commonly encountered species in the survey area, and represented the species for which the most individuals were observed. Groups of spotted dolphins were sighted 22 times for a total of 717 individuals. This species was encountered in August, (no survey was completed in September), November, February, March, April, May, and June. Group size ranged between five and 100 (mean group size = 32.4). Spotted dolphins were exclusively encountered on the shallower, inshore side of the continental shelf break. There are two distinct forms or ecotypes of the Atlantic spotted dolphin in the western north Atlantic: a heavily spotted, larger form that typically occurs on the continental shelf and is most often encountered around the 200 m isobar or in shallower water, and a less spotted and smaller form which occurs further offshore and around islands (Perrin *et al*. 1987, 1994). It is likely, based upon the sighting pattern observed, that the spotted dolphins observed during the present study belong to the continental shelf variety. During the 2007/2008 aerial survey of the same area, spotted dolphins were encountered 11 times for a total of 177 individuals. Spotted dolphins were not recorded during the 1998/1999 aerial surveys of the same area (McLellan *et al*. 1999). The abundance estimate for *S. frontalis* (both inshore and offshore ecotypes) in the western north Atlantic is 50,978 (CV=0.42); the status of the stock(s) is/are unknown (Waring *et al*. 2007).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
2-Aug-08	10:56	26	33.789778	-76.893012	NW	3	2	90°	22
23-Nov-08	15:52	90	33.657244	-77.008915	NW	1	3	120°	30
7-Feb-09	14:20	55	33.791982	-76.899026	NW	3	2	90°	40
7-Feb-09	14:49	63	33.642891	-76.833414	SE	2	1	90°	90
17-Feb-09	14:42	38	34.086324	-76.500645	SE	9	2	90°	30
4-Mar-09	14:16	37	33.770836	-76.734183	SE	4	3	110°	15
4-Mar-09	15:10	53	33.672379	-76.886136	SE	2	1	90°	100
5-Mar-09	10:09	20	34.093806	-76.519452	NW	9	3	90°	20
5-Mar-09	10:26	29	34.12227	-76.678416	SE	8	3	90°	25
5-Mar-09	10:44	38	33.992231	-76.520647	SE	8	3	90°	8
5-Mar-09	11:59	67	33.897213	-76.653975	SE	6	1	120°	24
5-Mar-09	12:38	80	33.901567	-76.764022	NW	5	1	120°	35
5-Mar-09	16:29	117	33.699009	-77.030164	NW	1	3	90°	30
24-Apr-09	9:48	10	34.151427	-76.468262	SE	10	3	90°	55
24-Apr-09	10:58	40	34.012365	-76.406003	NW	9	2	45°	80
24-Apr-09	12:32	87	33.996132	-76.648635	NW	7	2	90°	37
24-Apr-09	12:22	83	33.944397	-76.589046	NW	7	2	120°	10
25-Apr-09	10:12	19	33.813468	-77.070257	NW	2	3	90°	16
28-May-09	11:00	30	33.811291	-76.804148	NW	4	2	110°	25
1-Jun-09	11:05	22	34.053559	-76.718352	SE	7	2	110°	7
1-Jun-09	15:47	77	33.767246	-76.990013	SE	2	3	60°	13
2-Jun-09	11:03	27	33.790918	-77.046095	SE	2	3	110°	5

Table 7. All *Stenella frontalis* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

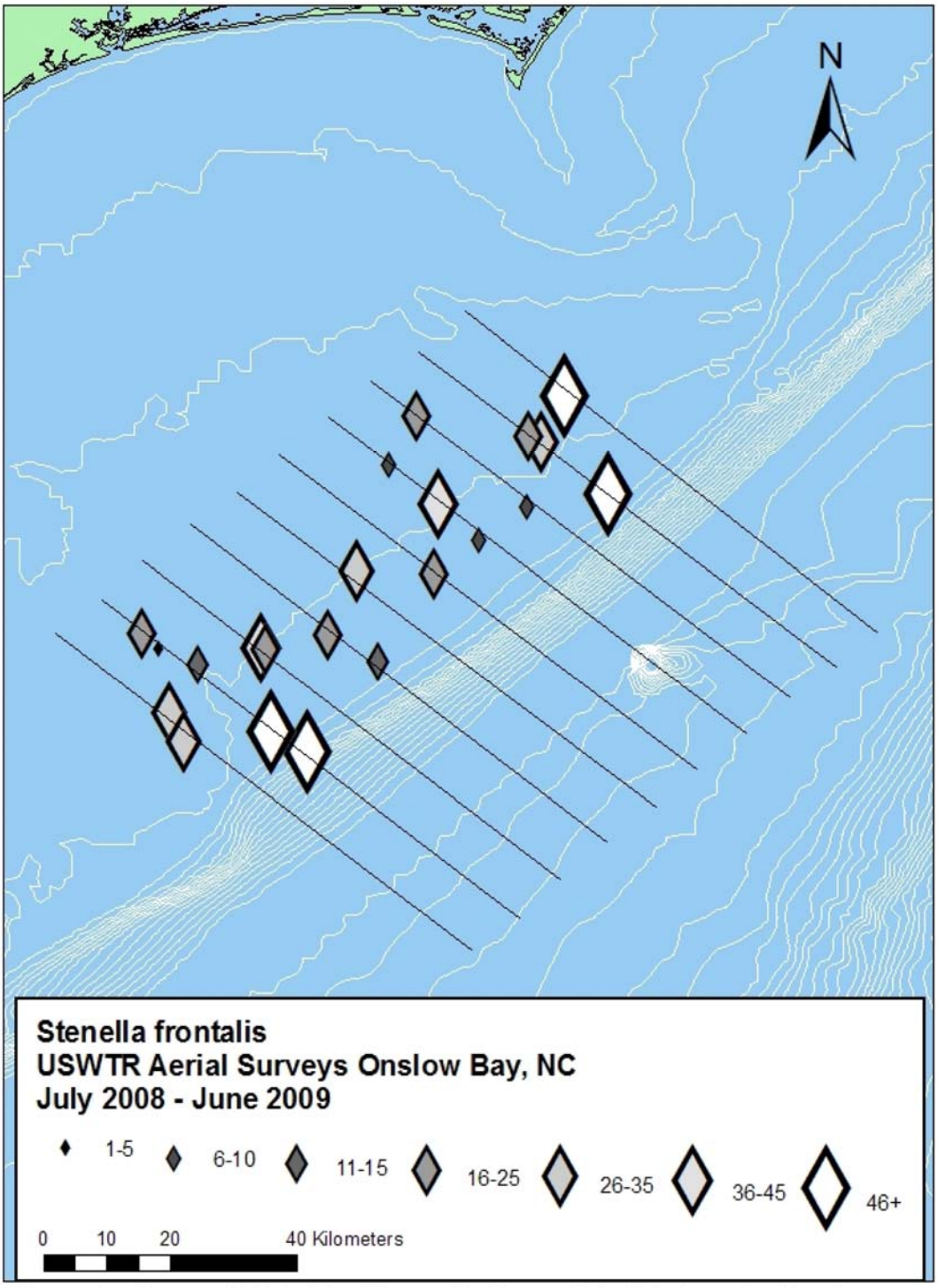

Figure 7. Spotted dolphin (*Stenella frontalis*) sightings indicating group size.

Short-finned pilot whales (*Globicephala macrorhynchus)* (Table 8, Fig. 8)

Short-finned pilot whales were encountered twice, both times in July 2008, for a total of 30 individuals. Both sightings of this species were offshore of the continental shelf break. During the 2007/2008 aerial survey of the same area, short-finned pilot whales were encountered three times for a total of 53 individuals Pilot whales of unidentified species were encountered once during the 1998/1999 aerial surveys, in May 1999 (McLellan *et al*. 1999).

Owing to the difficulty of differentiating short-finned and long-finned pilot whales (*Globicephala melas*) at sea, NMFS reports stock numbers and status as *Globicephala* spp. (Waring *et al*. 2007). The abundance estimate of *Globicephala* spp. (14,411, CV 0.43) is based upon shipboard surveys along the outer continental shelf of the US Atlantic between Florida and Maryland (Waring *et al*. 2007). The status of short-finned pilot whales in the U.S. Atlantic is currently unknown (Waring *et al*. 2007).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
17-Jul-08	9:47	10	33.868501	-76.075161	SE	10	3	60°	18
17-Jul-08	11:54	43	33.703817	-76.380409	SE	6	3	90°	12

Table 8. All *Globicephala macrorhynchus* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

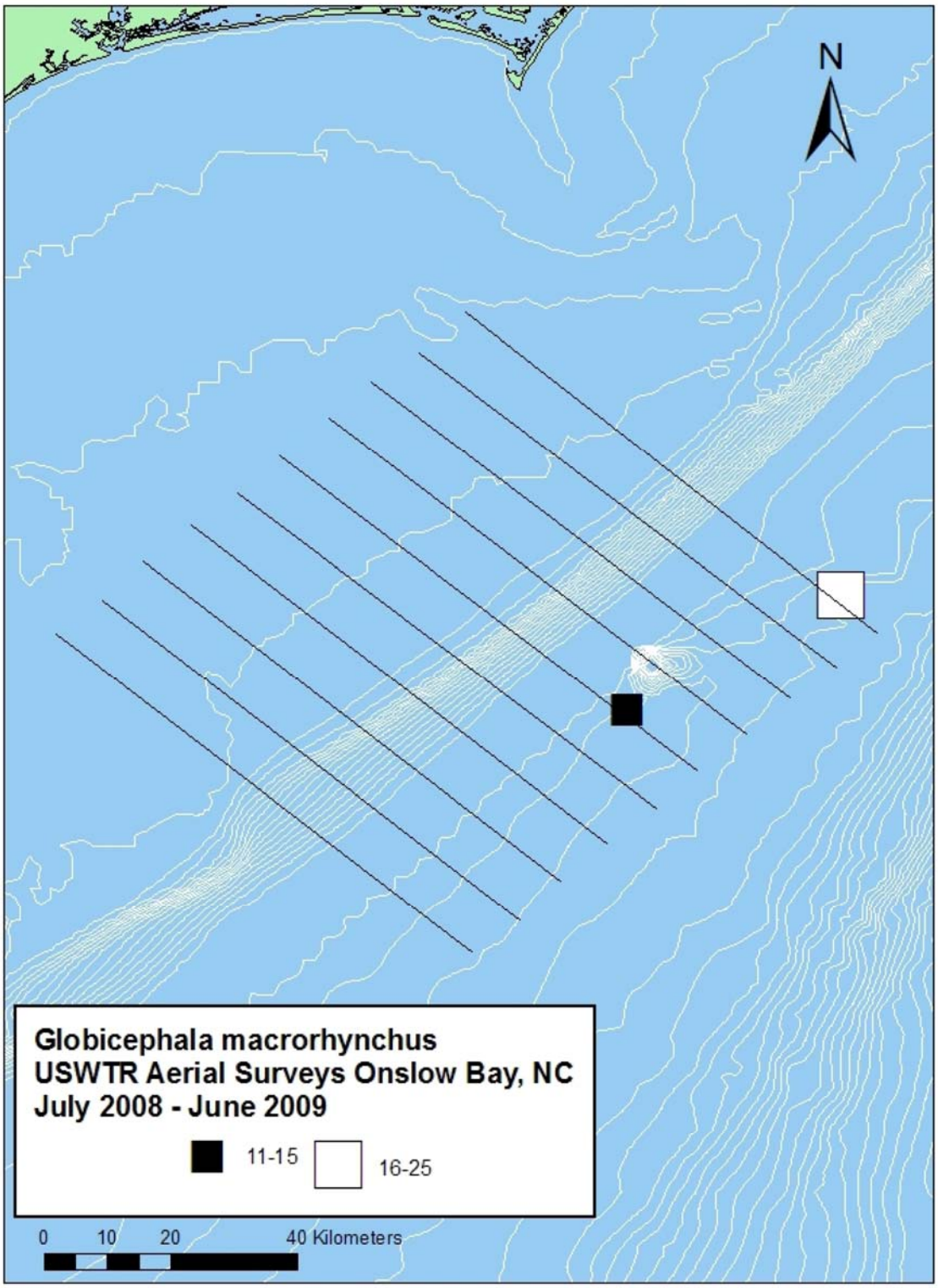

Figure 8. Short-finned pilot whales (*Globicephala macrorhynchus)* sightings indicating group size.

Risso's dolphins *(Grampus griseus)* (Table 9, Fig. 9 adjust)

While there were no "on effort" sightings of this species inside the USWTR, a single sighting was made during the "off effort" transit between the offshore ends of lines 3 and 4 on the 16 July 2008. A total of 20 individuals were observed including two adult animals with calves. This species was encountered three times during the 2007 – 2008 surveys; once in May 2008 and twice in June 2008, for a total of 20 individuals. A single calf (less than half the length of the associated larger animal) was observed during one of the encounters in June 2008. Risso's dolphins were also seen during the 1998 - 1999 aerial surveys in May and July (McLellan *et al*. 1999). All encounters occurred in offshore waters where Risso's dolphins have been found to reside along the mid-Atlantic continental shelf edge year round, with some movement north during spring, summer and fall, and into the mid-Atlantic Bight during winter (Waring *et al*. 2007). The best available estimate for Risso's dolphins based upon results from two US Atlantic surveys conducted in 2004 is 20,479 (CV=0.59) (Waring *et al*. 2007). The status of this species in the western Atlantic is unknown (Waring *et al*. 2007).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
16-Jul-08	15:36	60	33.450539	-76.458058					20	Off effort sighting

Table 9. Risso's dolphin (*Grampus griseus*) sighting in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

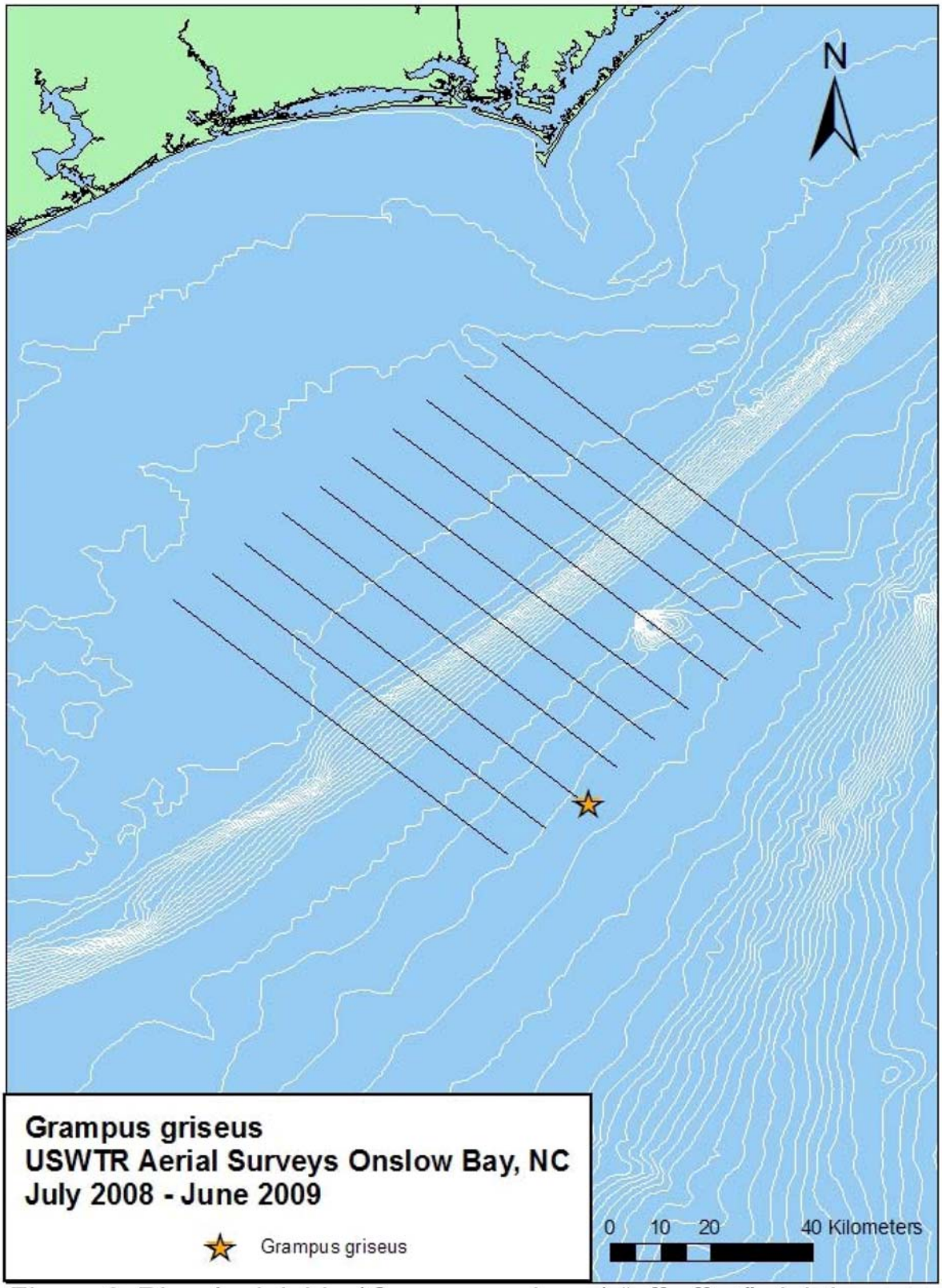

Figure 9. Risso's dolphin (*Grampus griseus*) "off effort" sighting.

Unidentified delphinids (Table 10, Fig. 10)

When no images were obtained or when images obtained during encounters were not of sufficient quality to make an unequivocal species identification, the designation "unidentified delphinids" was used. A total of 41 unidentified delphinids in four sightings were recorded. Group size of unidentified delphinids ranged between one and 26 (mean=10.3). During the 2007/2008 aerial survey 11 sightings for a total of 97 individuals were labeled as unidentified delphinids.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
4-Mar-09	10:45	24	33.744182	-76.185632	NW	8	3	90°	3
12-May-09	11:40	35	33.803048	-77.166464	NW	1	3	90°	26
30-May-09	15:10	47	34.075319	-76.745905	NW	7	2	60°	1
1-Jun-09	17:15	88	33.66503	-76.986169	NW	1	1	90°	11

Table 10. All unidentified delphinids sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

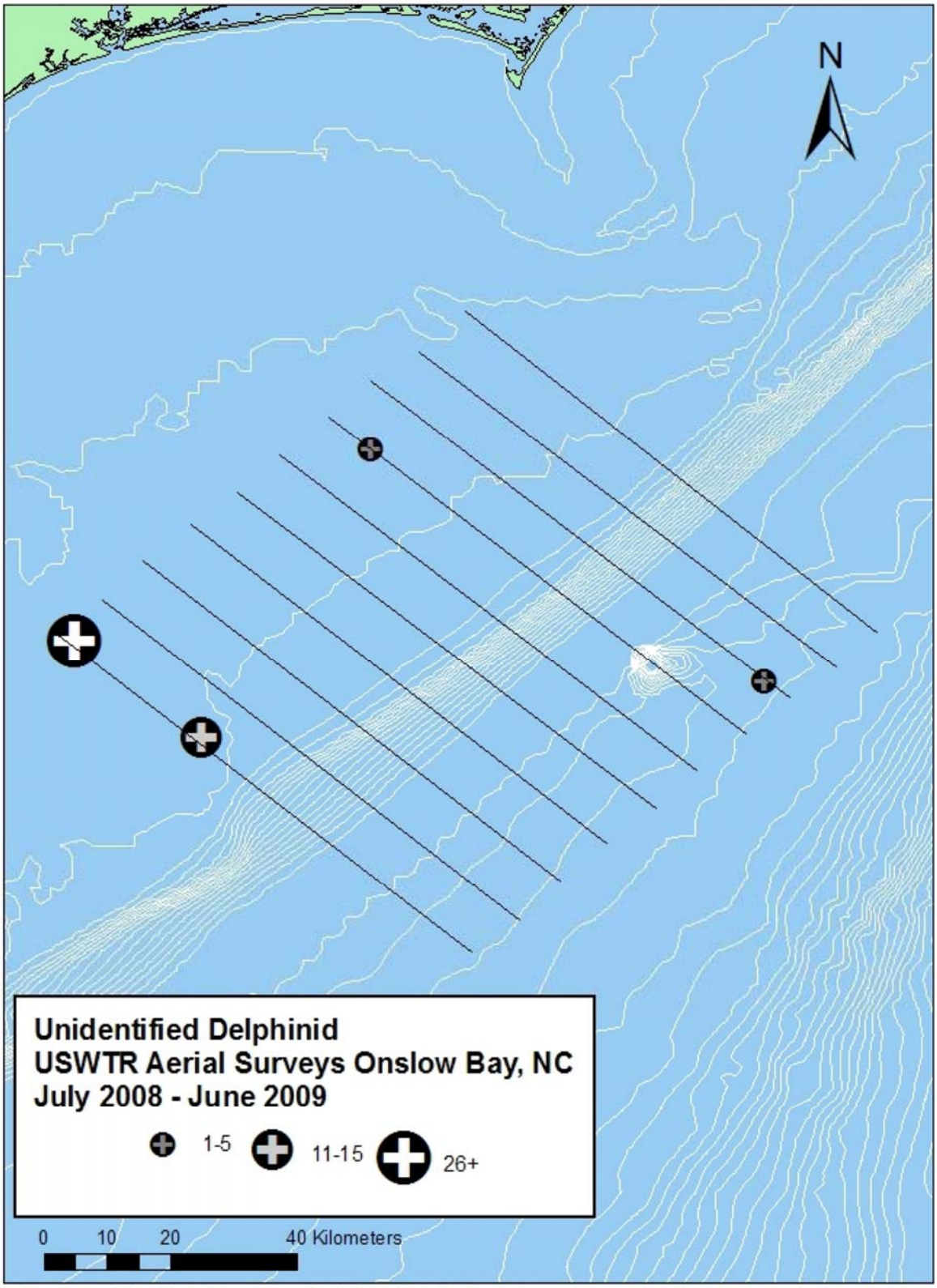

Figure 10. Unidentified delphinid sightings indicating group size.

Sea Turtles (Tables 11 to 13, Figs. 11 and 12a-c)

The most common sea turtle off the North Carolina coast is the loggerhead sea turtle (*Caretta caretta),* a species that nests along the NC coast and is listed as threatened under the US Endangered Species Act (National Marine Fisheries Service and U.S. Fish and Wildlife Service 2008). Other sea turtle species present in the mid-Atlantic are the green (*Chelonia mydas*), leatherback (*Dermochelys coriacea),* hawksbill *(Eretmochelys imbricata),* and Kemps Ridley (*Lepidochelys kempii)* (National Marine Fisheries Service and U.S. Fish and Wildlife Service 1991, 1992a, 1992b, 1993). A total of 266 sea turtles were seen in the survey area between July 2008 and June 2009. Of these, 226 were identified as loggerhead sea turtles and the 39 were recorded as "unidentified sea turtles". There was also a single leatherback sea turtle sighting in June, a species that had not been seen during the 2007/2008 season but had been seen in the 1998/1999 surveys (McLellan *et al*. 1999). Sea turtles were seen during all months surveyed except in July 2008, although abundance fluctuated throughout the year. The lowest densities were observed between July and January (0.0 to 2.7 sea turtles /1000 km) and the highest densities occurred between March and April (72.0 to 82.1 sea turtles /1000 km). The majority of sea turtles were observed shoreward of the continental shelf break. As expected, sea turtle sightings were strongly correlated with Beaufort Sea State.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
1-Aug-08	16:04	24	34.038958	-76.695657	NW	7	3	90°	1
2-Aug-08	10:22	21	33.742594	-76.707212	SE	4	3	90°	1
2-Aug-08	11:11	29	33.912247	-77.066962	NW	3	2	90°	1
2-Aug-08	11:57	40	33.644080	-76.964473	NW	1	90	2°	1
15-Oct-08	9:13	4	33.989294	-76.767933	SE	6	2	90°	1
15-Oct-08	14:13	35	34.085084	-76.751627	SE	7	2	90°	1
15-Oct-08	14:18	43	33.984714	-76.621745	SE	7	2	130°	2
15-Oct-08	15:11	45	34.160593	-76.602592	SE	9	2	90°	1
16-Oct-08	10:11	11	34.162878	-76.731009	SE	8	2	90°	1
16-Oct-08	11:00	18	34.121808	-76.804246	NW	7	1	90°	1
16-Oct-08	11:05	19	34.025437	-76.812227	SE	6	2	90°	1
23-Nov-08	10:18	21	34.109247	-76.399888	SE	10	1	90°	1
23-Nov-08	10:20	22	34.083306	-76.367013	SE	10	2	90°	1
23-Nov-08	11:07	25	34.124958	-76.557463	NW	9	1	45°	1
23-Nov-08	12:07	41	34.077442	-76.745548	NW	7	2	90°	1
23-Nov-08	14:26	67	33.874893	-76.618261	SE	6	3	90°	1
23-Nov-08	15:00	74	33.960331	-77.003912	SE	4	1	90°	1
23-Nov-08	15:11	78	33.762723	-76.730951	SE	4	1	90°	2
23-Nov-08	15:29	71	33.894655	-77.040208	NW	3	1	90°	1
24-Nov-08	12:55	6	33.736975	-77.094039	SE	1	1	90°	1
24-Nov-08	14:44	10	33.892272	-77.037385	SE	3	2	3°	1
30-Dec-08	13:48	24	33.646497	-76.975000	SE	1	3	90°	1
30-Dec-08	13:50	25	33.605492	-76.919933	SE	1	3	90°	1
30-Dec-08	13:52	26	33.578012	-76.884516	SE	1	3	60°	1
30-Dec-08	14:17	21	33.665407	-76.870780	NW	2	1	90°	1
30-Dec-08	14:20	22	33.741291	-76.968918	NW	2	1	90°	1
30-Dec-08	15:02	28	33.764728	-76.735140	NW	4	1	90°	1
22-Jan-09	10:26	12	33.663271	-76.868349	NW	2	3	90°	2
7-Feb-09	9:26	6	33.834228	-76.699331	SE	5	3	90°	1
7-Feb-09	10:00	11	33.875123	-76.613947	NW	6	3	90°	1
7-Feb-09	10:03	12	33.942368	-76.705816	NW	6	4	90°	1
7-Feb-09	10:56	25	34.136500	-76.699785	NW	8	2	45°	1
7-Feb-09	11:18	34	33.794991	-76.122221	SE	9	2	45°	2
7-Feb-09	14:11	48	33.703733	-76.783065	NW	3	1	90°	1
7-Feb-09	14:12	49	33.716371	-76.798749	NW	3	3	90°	3
7-Feb-09	14:46	60	33.658782	-76.864830	SE	2	2	90°	1
7-Feb-09	15:23	60	33.608542	-76.923389	NW	1	3	90°	1
17-Feb-09	10:11	6	33.957656	-76.728973	NW	6	2	90°	1
17-Feb-09	12:51	20	33.900806	-76.911384	SE	4	2	90°	1
17-Feb-09	12:52	21	33.872492	-76.873191	SE	4	3	90°	1
17-Feb-09	13:42	27	33.690862	-76.897643	SE	2	2	90°	1
17-Feb-09	13:42	28	33.678229	-76.881284	SE	2	1	90°	1
17-Feb-09	14:09	25	33.641704	-76.970975	NW	1	2	90°	1
17-Feb-09	14:13	28	33.716001	-77.067279	NW	1	1	90°	1

Table 11. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
17-Feb-09	14:16	29	33.781273	-77.153022	NW	1	2	90°	1
17-Feb-09	14:17	33	33.786206	-77.159444	NW	1	2	90°	1
17-Feb-09	14:17	30	33.790234	-77.164722	NW	1	1	90°	1
17-Feb-09	15:22	37	34.186796	-76.501455	NW	10	2	90°	1
17-Feb-09	15:25	39	34.251821	-76.585047	NW	10	1	90°	1
4-Mar-09	10:09	11	33.924501	-76.682734	NW	6	2	90°	1
4-Mar-09	10:10	13	33.944289	-76.716012	NW	6	2	90°	1
4-Mar-09	10:10	14	33.952782	-76.733972	NW	6	2	90°	1
4-Mar-09	10:12	15	33.991931	-76.777413	NW	6	3	90°	1
4-Mar-09	10:26	19	33.974316	-76.606282	SE	7	3	90°	1
4-Mar-09	11:10	26	34.063691	-76.583742	NW	8	1	90°	1
4-Mar-09	11:15	27	34.165980	-76.733542	NW	8	2	90°	1
4-Mar-09	11:59	32	34.168174	-76.478305	NW	10	2	90°	1
4-Mar-09	11:59	33	34.180342	-76.493296	NW	10	3	90°	1
4-Mar-09	12:01	34	34.214459	-76.533296	NW	10	2	90°	1
4-Mar-09	14:48	48	33.716516	-76.800780	NW	3	3	90°	1
4-Mar-09	14:51	49	33.764887	-76.868203	NW	3	2	90°	1
4-Mar-09	14:54	51	33.841811	-76.965607	NW	3	3	90°	1
4-Mar-09	14:57	52	33.905291	-77.047214	NW	3	2	90°	1
4-Mar-09	15:04	47	33.786456	-77.041215	SE	2	2	90°	1
4-Mar-09	15:04	48	33.776813	-77.029883	SE	2	1	90°	1
4-Mar-09	15:05	49	33.764465	-77.012921	SE	2	2	90°	1
4-Mar-09	15:05	50	33.754695	-77.000041	SE	2	1	90°	1
4-Mar-09	15:09	51	33.690695	-76.906642	SE	2	2	90°	1
4-Mar-09	15:09	56	33.676729	-76.892476	SE	2	3	90°	1
4-Mar-09	15:45	64	33.481767	-76.759075	NW	1	3	90°	1
4-Mar-09	15:52	66	33.631594	-76.948973	NW	1	2	90°	2
4-Mar-09	15:53	67	33.648365	-76.974684	NW	1	3	90°	2
4-Mar-09	15:58	68	33.750784	-77.112554	NW	1	2	90°	2
4-Mar-09	15:59	69	33.785348	-77.159437	NW	1	1	90°	1
5-Mar-09	9:12	3	34.259277	-76.592480	SE	10	2	90°	1
5-Mar-09	9:13	5	34.231549	-76.555056	SE	10	2	90°	1
5-Mar-09	9:14	3	34.221049	-76.546716	SE	10	2	90°	1
5-Mar-09	9:15	4	34.194414	-76.522752	SE	10	2	90°	1
5-Mar-09	9:16	6	34.173124	-76.496880	SE	10	3	90°	1
5-Mar-09	9:17	7	34.152501	-76.467137	SE	10	1	90°	1
5-Mar-09	9:17	8	34.145857	-76.456643	SE	10	3	90°	1
5-Mar-09	9:19	9	34.114517	-76.411413	SE	10	3	90°	1
5-Mar-09	9:37	10	34.034687	-76.305650	SE	10	2	90°	1
5-Mar-09	9:39	12	33.991634	-76.248305	SE	10	3	90°	1
5-Mar-09	9:40	11	33.970383	-76.220800	SE	10	2	90°	1
5-Mar-09	10:15	24	34.115475	-76.541033	NW	9	1	90°	1
5-Mar-09	10:17	27	34.171097	-76.614878	NW	9	2	90°	1
5-Mar-09	10:19	23	34.207816	-76.664001	NW	9	2	90°	1
5-Mar-09	10:19	28	34.203019	-76.656623	NW	9	2	90°	1

Table 11 (Continued) All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
5-Mar-09	10:23	31	34.150762	-76.719255	SE	8	3	90°	1
5-Mar-09	10:24	27	34.136761	-76.701541	SE	8	3	90°	2
5-Mar-09	10:42	36	34.004863	-76.527474	SE	8	2	90°	1
5-Mar-09	11:28	49	33.767885	-76.338348	NW	7	2	90°	1
5-Mar-09	11:33	52	33.888321	-76.490732	NW	7	2	90°	1
5-Mar-09	11:33	51	33.877784	-76.476576	NW	7	2	90°	1
5-Mar-09	11:33	52	33.892178	-76.495989	NW	7	1	90°	1
5-Mar-09	11:34	53	33.908190	-76.518077	NW	7	1	90°	1
5-Mar-09	11:35	53	33.923970	-76.541529	NW	7	2	60°	1
5-Mar-09	11:38	56	34.003011	-76.647040	NW	7	3	90°	1
5-Mar-09	11:39	54	34.017019	-76.666985	NW	7	3	90°	4
5-Mar-09	11:40	55	34.055768	-76.719444	NW	7	3	90°	1
5-Mar-09	11:47	59	34.052994	-76.858910	SE	6	3	90°	1
5-Mar-09	11:48	60	34.025048	-76.825502	SE	6	2	60°	1
5-Mar-09	11:49	61	34.001331	-76.787330	SE	6	3	90°	1
5-Mar-09	11:56	62	33.948273	-76.717760	SE	6	3	90°	1
5-Mar-09	11:58	65	33.905880	-76.658259	SE	6	2	90°	1
5-Mar-09	12:07	70	33.873560	-76.613959	SE	6	3	90°	1
5-Mar-09	12:34	78	33.805124	-76.658793	NW	5	3	90°	1
5-Mar-09	12:34	68	33.805564	-76.659556	NW	5	2	90°	1
5-Mar-09	12:36	69	33.854204	-76.717060	NW	5	1	90°	1
5-Mar-09	12:57	72	33.946938	-76.844484	NW	5	1	90°	1
5-Mar-09	12:58	73	33.972982	-76.875953	NW	5	2	90°	3
5-Mar-09	15:11	89	33.947366	-76.977663	SE	4	3	90°	1
5-Mar-09	15:12	90	33.914648	-76.932768	SE	4	1	90°	1
5-Mar-09	15:13	91	33.896828	-76.908673	SE	4	2	90°	1
5-Mar-09	15:15	92	33.849773	-76.855795	SE	4	1	90°	1
5-Mar-09	15:17	79	33.806393	-76.782012	SE	4	1	90°	1
5-Mar-09	15:18	93	33.789312	-76.757007	SE	4	3	90°	1
5-Mar-09	15:18	80	33.767430	-76.727868	SE	4	1	90°	1
5-Mar-09	15:42	85	33.713291	-76.802299	NW	3	1	90°	1
5-Mar-09	15:42	86	33.726540	-76.819227	NW	3	2	90°	1
5-Mar-09	15:43	87	33.738502	-76.834584	NW	3	1	90°	1
5-Mar-09	15:43	88	33.744750	-76.842955	NW	3	2	90°	1
5-Mar-09	15:44	89	33.778469	-76.898590	NW	3	1	90°	1
5-Mar-09	15:49	90	33.898740	-77.040711	NW	3	3	90°	1
5-Mar-09	15:54	104	33.829787	-77.082470	SE	2	2	90°	1
5-Mar-09	15:55	105	33.805706	-77.050264	SE	2	1	90°	1
5-Mar-09	15:57	106	33.761994	-76.993303	SE	2	2	90°	1
5-Mar-09	15:59	93	33.723830	-76.946609	SE	2	1	90°	1
5-Mar-09	16:00	108	33.678277	-76.886988	SE	2	3	90°	3
5-Mar-09	16:01	109	33.665950	-76.869617	SE	2	2	90°	1
5-Mar-09	16:01	94	33.668537	-76.873243	SE	2	1	90°	2
5-Mar-09	16:02	95	33.651745	-76.851343	SE	2	2	90°	1
5-Mar-09	16:26	102	33.641484	-76.967851	NW	1	2	90°	1

Table 11 (Continued). All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
5-Mar-09	16:26	103	33.654194	-76.984757	NW	1	3	90°	1
5-Mar-09	16:33	106	33.748297	-77.106274	NW	1	1	90°	1
24-Apr-09	9:33	3	34.267071	-76.602777	SE	10	2	90°	1
24-Apr-09	9:35	5	34.221797	-76.532724	SE	10	3	90°	1
24-Apr-09	10:02	14	34.118761	-76.402646	SE	10	1	90°	2
24-Apr-09	10:04	15	34.094298	-76.375619	SE	10	1	90°	1
24-Apr-09	10:05	16	34.070895	-76.341670	SE	10	1	90°	1
24-Apr-09	10:31	30	33.854811	-76.077586	SE	10	1	40°	1
24-Apr-09	10:57	38	34.012194	-76.407013	NW	9	2	90°	1
24-Apr-09	11:08	43	34.058745	-76.470241	NW	9	3	90°	1
24-Apr-09	11:08	28	34.049851	-76.457049	NW	9	2	45°	1
24-Apr-09	11:08	29	34.062886	-76.476010	NW	9	1	60°	1
24-Apr-09	11:08	44	34.067309	-76.481896	NW	9	2	90°	2
24-Apr-09	11:11	30	34.117200	-76.540516	NW	9	2	90°	1
24-Apr-09	11:11	45	34.124932	-76.550406	NW	9	2	90°	2
24-Apr-09	11:11	46	34.128446	-76.555005	NW	9	3	90°	2
24-Apr-09	11:12	47	34.141468	-76.572734	NW	9	3	90°	1
24-Apr-09	11:13	48	34.170821	-76.617597	NW	9	2	90°	1
24-Apr-09	11:13	32	34.157560	-76.596036	NW	9	3	90°	1
24-Apr-09	11:13	33	34.171268	-76.618321	NW	9	3	90°	1
24-Apr-09	11:14	34	34.187332	-76.643437	NW	9	3	60°	1
24-Apr-09	11:19	53	34.164618	-76.733617	SE	8	1	90°	1
24-Apr-09	11:19	54	34.159609	-76.725310	SE	8	2	90°	1
24-Apr-09	11:19	37	34.162582	-76.730074	SE	8	3	60°	2
24-Apr-09	11:20	55	34.141372	-76.700966	SE	8	1	90°	1
24-Apr-09	11:37	63	34.030129	-76.556001	SE	8	2	90°	1
24-Apr-09	11:37	64	34.029088	-76.554367	SE	8	1	90°	1
24-Apr-09	11:37	40	34.021506	-76.542386	SE	8	3	90°	1
24-Apr-09	11:38	41	33.999129	-76.512543	SE	8	2	60°	1
24-Apr-09	12:20	80	33.925264	-76.550127	NW	7	3	90°	1
24-Apr-09	12:46	61	34.103790	-76.783318	SE	7	2	60°	1
24-Apr-09	14:52	100	34.057227	-76.860930	SE	6	3	90°	1
24-Apr-09	14:52	101	34.039952	-76.838541	SE	6	1	90°	1
24-Apr-09	14:52	66	34.040780	-76.839376	SE	6	2	30°	1
24-Apr-09	14:53	102	34.018162	-76.809557	SE	6	2	45°	1
24-Apr-09	14:55	67	33.988536	-76.768749	SE	6	2	60°	1
24-Apr-09	14:56	103	33.975468	-76.751264	SE	6	2	90°	1
24-Apr-09	14:56	68	33.973914	-76.748907	SE	6	1	60°	1
24-Apr-09	14:57	104	33.940844	-76.704275	SE	6	3	120°	1
24-Apr-09	14:58	105	33.918651	-76.675768	SE	6	3	90°	1
24-Apr-09	14:58	70	33.914387	-76.670629	SE	6	3	60°	2
24-Apr-09	14:59	106	33.910982	-76.666686	SE	6	3	90°	1
24-Apr-09	14:59	107	33.901816	-76.655485	SE	6	3	90°	1
24-Apr-09	15:33	78	33.955538	-76.848630	NW	5	3	90°	2
24-Apr-09	15:35	117	34.003770	-76.913145	NW	5	3	90°	1

Table 11 (Continued). All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
25-Apr-09	10:30	27	33.758465	-77.116488	NW	1	2	90°	1
12-May-09	9:52	13	33.940350	-76.966487	SE	4	2	90°	1
30-May-09	13:32	9	33.824461	-76.152444	NW	9	2	90°	1
30-May-09	13:45	13	34.082491	-76.493980	NW	9	3	90°	1
30-May-09	13:49	17	34.170325	-76.608701	NW	9	3	45°	1
30-May-09	14:00	23	34.020507	-76.537506	SE	8	1	45°	1
30-May-09	14:56	33	33.961199	-76.585128	NW	7	2	60°	1
30-May-09	15:01	35	34.069648	-76.735551	NW	7	2	60°	1
30-May-09	15:27	52	33.983569	-76.758342	SE	6	2	60°	1
30-May-09	15:47	58	33.766050	-76.476238	SE	6	2	60°	1
30-May-09	16:04	62	33.707423	-76.532603	NW	5	2	45°	1
30-May-09	16:08	47	33.796473	-76.643934	NW	5	3	60°	1
30-May-09	16:11	63	33.867255	-76.736276	NW	5	2	90°	1
31-May-09	9:30	16	34.101090	-76.524424	NW	9	2	45°	1
31-May-09	9:32	17	34.147939	-76.593653	NW	9	1	60°	1
31-May-09	12:10	53	33.776648	-76.880422	NW	3	3	90°	1
1-Jun-09	10:36	13	33.773081	-76.476520	NW	6	1	90°	1
1-Jun-09	11:52	39	34.086870	-76.629366	NW	8	2	140°	1
1-Jun-09	12:42	46	34.118759	-76.411411	NW	10	2	60°	1
1-Jun-09	12:44	47	34.171457	-76.471264	NW	10	2	135°	1
2-Jun-09	10:55	22	33.902160	-77.050108	NW	3	1	90°	1

Table 11 (Continued). All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
1-Jun-09	12:48	49	34.228561	-76.544918	NW	10	3	120°	1

Table 12. All *Dermochelys coriacea* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
1-Aug-08	15:15	15	34.213689	-76.672559	NW	9	3	60°	1
2-Aug-08	9:57	11	33.803131	-76.658313	NW	5	2	110°	1
4-Aug-08	12:04	36	34.173503	-76.620823	SE	9	3	90°	1
4-Aug-08	13:01	49	34.227853	-76.552963	NW	10	2	90°	1
23-Nov-08	10:11	19	34.249053	-76.580497	SE	10	2	90°	1
23-Nov-08	10:17	20	34.141235	-76.441115	SE	10	1	90°	1
23-Nov-08	11:07	35	34.122138	-76.553819	NW	9	2	90°	1
23-Nov-08	14:18	65	34.027954	-76.820858	SE	6	2	90°	1
23-Nov-08	14:26	68	33.864839	-76.605419	SE	6	2	90°	1
23-Nov-08	15:07	75	33.847092	-76.842064	SE	4	2	90°	1
23-Nov-08	15:42	86	33.682273	-76.891332	SE	2	1	90°	1
23-Nov-08	15:43	87	33.665602	-76.869826	SE	2	2	90°	1
7-Feb-09	10:04	13	33.959397	-76.729074	NW	6	1	90°	1
7-Feb-09	10:17	16	34.022661	-76.674604	SE	7	4	90°	1
7-Feb-09	10:44	25	33.890859	-76.371861	NW	8	3	90°	1
7-Feb-09	11:25	37	33.885607	-76.106496	NW	10	2	45°	1
7-Feb-09	13:37	50	33.936493	-76.956787	SE	4	3	45°	1
5-Mar-09	10:23	26	34.147207	-76.71607	SE	8	2	90°	1
5-Mar-09	11:41	56	34.063284	-76.732753	NW	7	2	90°	2
5-Mar-09	11:55	64	33.958232	-76.732161	SE	6	2	60°	1
5-Mar-09	12:07	65	33.877663	-76.618751	SE	6	3	90°	1
5-Mar-09	16:00	107	33.697654	-76.913258	SE	2	1	90°	1
5-Mar-09	16:34	107	33.78494	-77.155645	NW	1	3	120°	1
24-Apr-09	10:03	14	34.111250	-76.398725	SE	10	3	90°	2
24-Apr-09	11:14	49	34.194347	-76.654788	NW	9	1	90°	1
24-Apr-09	11:39	65	33.991338	-76.503323	SE	8	2	90°	1
24-Apr-09	12:21	81	33.946672	-76.575784	NW	7	2	90°	2
24-Apr-09	12:38	90	34.052584	-76.715796	NW	7	3	90°	1
25-Apr-09	9:20	10	33.954420	-76.983899	NW	4	1	90°	1
25-Apr-09	9:21	11	33.967967	-77.003633	NW	4	2	90°	1
25-Apr-09	10:32	28	33.711090	-77.052273	NW	1	2	90°	1
30-May-09	15:24	40	34.043226	-76.842363	SE	6	3	60°	1
30-May-09	15:31	41	33.887193	-76.63428	SE	6	3	60°	1
1-Jun-09	11:55	33	34.155358	-76.718417	NW	8	2	90°	1
1-Jun-09	12:05	37	34.056448	-76.466167	SE	9	3	120°	1
2-Jun-09	14:24	52	33.844391	-76.188814	NW	9	2	90°	1
2-Jun-09	14:32	55	34.030103	-76.429515	NW	9	1	90°	1

Table 13. All unidentified sea turtle sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

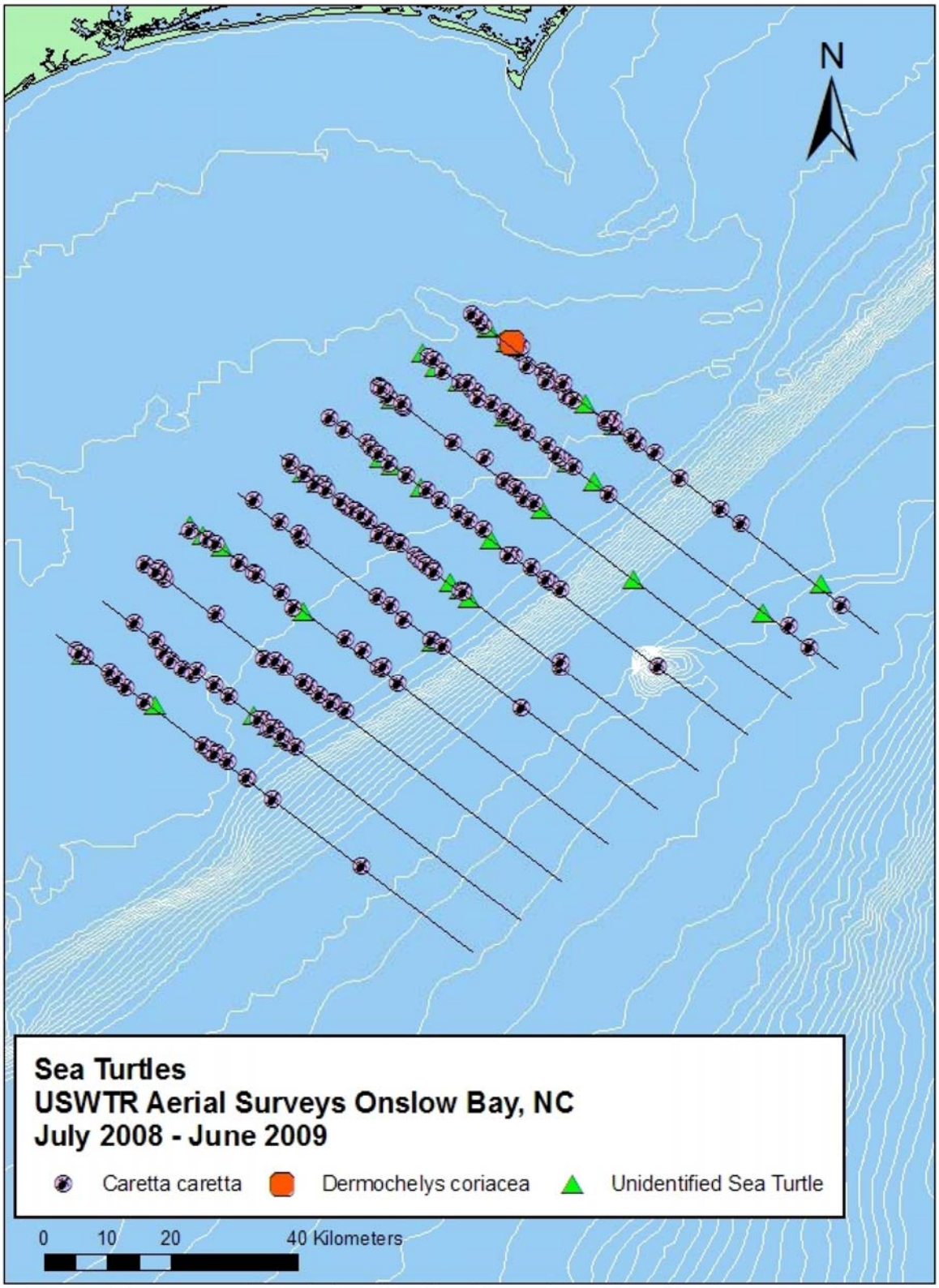

Figure 11. Loggerhead, leatherback and unidentified sea turtle sightings.

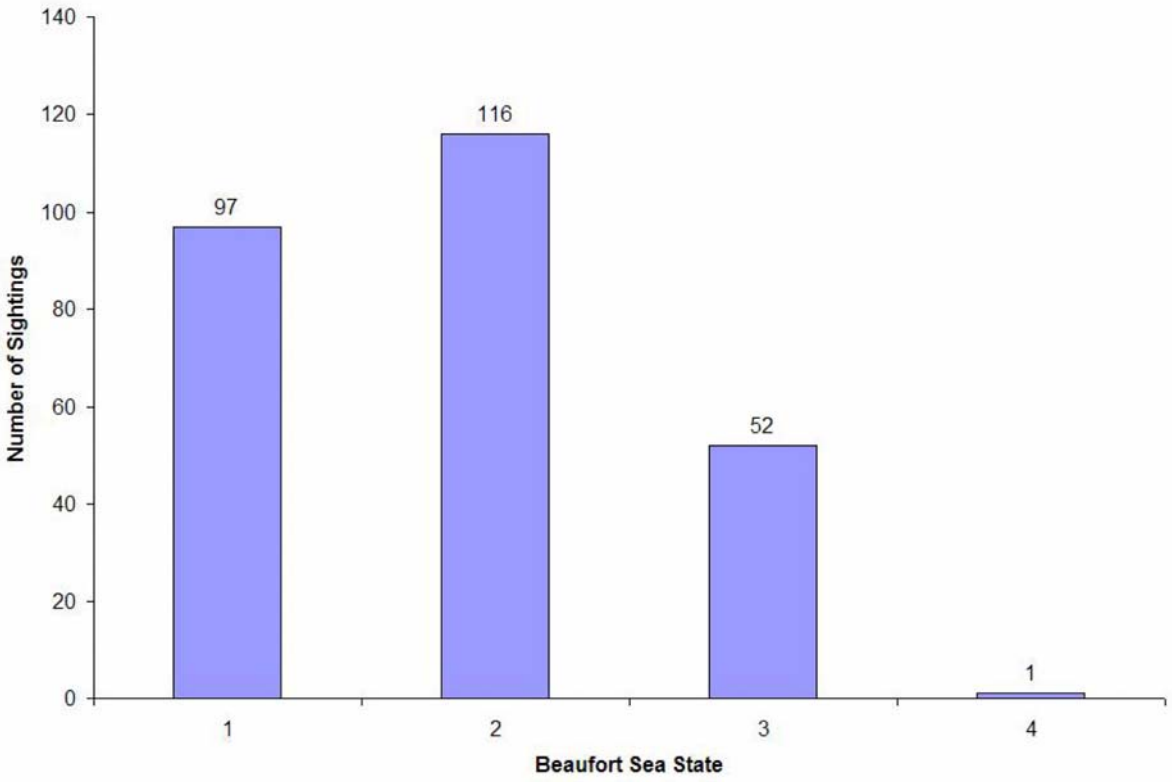

Figure 12a. **Total number of sea turtle sightings by Beaufort Sea State in the proposed USWTR site in Onslow Bay, North Carolina during the July 2008 – June 2009 surveys.**

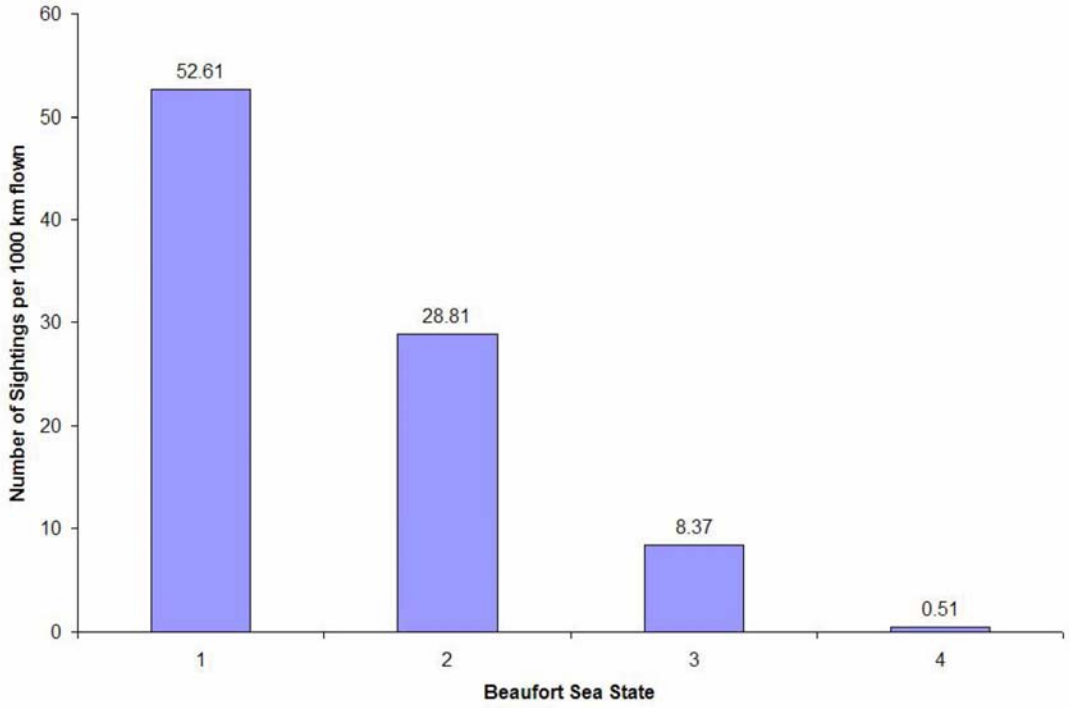

Figure 12b. **Turtle sightings per 1000 km flown by Beaufort Sea State during the July 2008 – June 2009 surveys** in **the proposed USWTR site in Onslow Bay, North Carolina.**

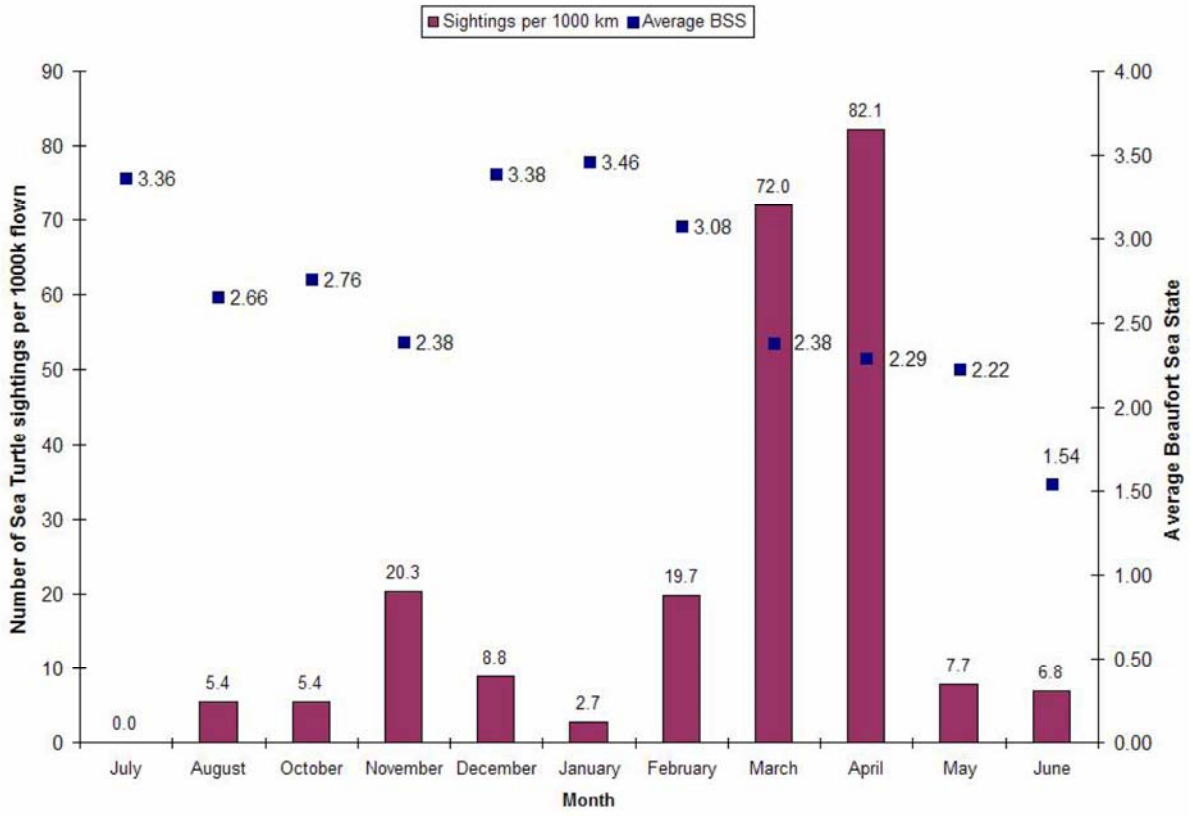

Figure 12c. **Number of Sea Turtles seen per 1000 km flown during the July 2008 – June 2009 surveys in the proposed USWTR site in Onslow Bay, North Carolina.**

Other Marine Vertebrate Sightings (Tables 14-17, Fig. 13)

Chondrichthyan fishes

A total of 14 sharks were observed throughout the survey period; hammerhead sharks (*Sphyrna* spp.) accounted for 78 percent of these sightings (n=11) (Table 14).

Twenty-seven manta rays (*Manta birostris*) were observed during the survey period. The majority of sightings (n=12) occurred during the February surveys (Table 15). There were also seven stingray sightings that could not be positively identified to species that were labeled as unidentified rays (Table 16).

Other fishes

Ocean sunfish (*Mola mola*) were encountered six times with no discernable spatial or temporal trends (Table 17).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
15-Oct-08	15:23	60	33.919915	-76.285600	SE	9	2	11°	1	
23-Nov-08	15:22	70	33.767792	-76.874564	NW	3	2	90°	1	
7-Feb-09	10:46	26	33.939765	-76.433652	NW	8	2	45°	1	Hammerhead
7-Feb-09	10:47	23	33.941986	-76.436083	NW	8	3	90°	1	Hammerhead
5-Mar-09	12:16	72	33.665661	-76.342424	SE	6	3	90°	1	Hammerhead
5-Mar-09	16:02	110	33.639857	-76.836927	SE	2	2	90°	4	Hammerhead
24-Apr-09	12:19	53	33.898299	-76.510713	SE	7	3	60°	1	Hammerhead
30-May-09	13:43	12	34.049953	-76.451432	NW	9	3	90°	1	Hammerhead
31-May-09	10:34	32	33.800216	-76.383575	NW	7	3	90°	1	Hammerhead
31-May-09	10:48	37	34.10463	-76.784743	NW	7	3	90°	1	Hammerhead
2-Jun-09	10:26	16	33.685348	-76.629302	SE	4	4	90°	1	

Table 14. All shark sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
23-Nov-08	10:24	16	33.989662	-76.246636	SE	10	3	90°	1	Large manta
23-Nov-08	14:38	62	33.960273	-76.862225	NW	5	2	90°	2	
22-Jan-09	10:57	17	33.548651	-76.584937	SE	3	3	45°	2	
7-Feb-09	11:35	35	34.019209	-76.282585	NW	10	2	60°	2	Below Surface
7-Feb-09	11:37	37	34.059904	-76.328800	NW	10	3	90°	1	
7-Feb-09	14:12	50	33.728410	-76.813923	NW	3	2	90°	1	
17-Feb-09	10:38	10	33.731035	-76.293904	SE	7	3	90°	2	
17-Feb-09	10:40	11	33.669269	-76.211215	SE	7	3	90°	1	
17-Feb-09	10:47	14	33.79302	-76.247628	NW	8	3	90°	1	
17-Feb-09	14:11	27	33.662654	-76.993829	NW	1	2	90°	2	Two manta rays
17-Feb-09	14:56	41	33.923845	-76.288003	SE	9	2	90°	2	
4-Mar-09	9:48	7	33.621785	-76.423133	SE	5	2	90°	1	
4-Mar-09	9:56	10	33.648188	-76.323446	NW	6	2	90°	1	
4-Mar-09	10:25	18	33.999432	-76.644062	SE	7	3	90°	1	
4-Mar-09	14:48	47	33.697078	-76.774192	NW	3	2	90°	1	
5-Mar-09	9:49	14	33.835216	-76.049972	SE	10	4	90°	1	
28-May-09	10:04	16	33.631837	-76.822565	NW	2	1	90°	1	Dark grey manta
28-May-09	11:12	32	33.962867	-76.995137	NW	4	1	90°	1	Light grey manta
31-May-09	9:42	22	34.072924	-76.609366	SE	8	1	60°	1	Brown-colored manta
1-Jun-09	14:56	58	33.882602	-76.887040	SE	4	1	60°	1	Brown-colored manta
2-Jun-09	14:55	60	33.920512	-76.407837	SE	8	3	110°	1	Circle for manta ray

Table 15. All *Manta birostris* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
4-Mar-09	9:55	8	33.633595	-76.305435	NW	6	1	90°	1	Yellow-brown large ray
4-Mar-09	10:39	18	33.704174	-76.259061	SE	7	2	90°	1	Large yellow stingray
4-Mar-09	10:39	18	33.704174	-76.259061	SE	7	2	90°	1	Large yellow stingray
5-Mar-09	9:42	13	33.964032	-76.208425	SE	10	1	90°	2	Two large yellow/brown rays
5-Mar-09	11:04	44	33.774620	-76.222852	SE	8	2	100°	1	Large yellow/brown ray
5-Mar-09	15:36	84	33.592176	-76.642626	NW	3	2	90°	1	Large brown ray

Table 16. All unidentified ray sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #
7-Feb-09	10:22	19	33.921963	-76.542083	SE	7	2	90°	1
5-Mar-09	10:51	39	33.952648	-76.46143	SE	8	3	100°	1
5-Mar-09	15:43	101	33.75787	-76.862445	NW	3	3	90°	1
24-Apr-09	11:43	67	33.919818	-76.385878	SE	8	1	90°	1
24-Apr-09	15:35	79	34.004660	-76.914460	NW	5	1	90°	1
25-Apr-09	9:21	7	33.961913	-76.994609	NW	4	1	90°	1

Table 17. All *Mola mola* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

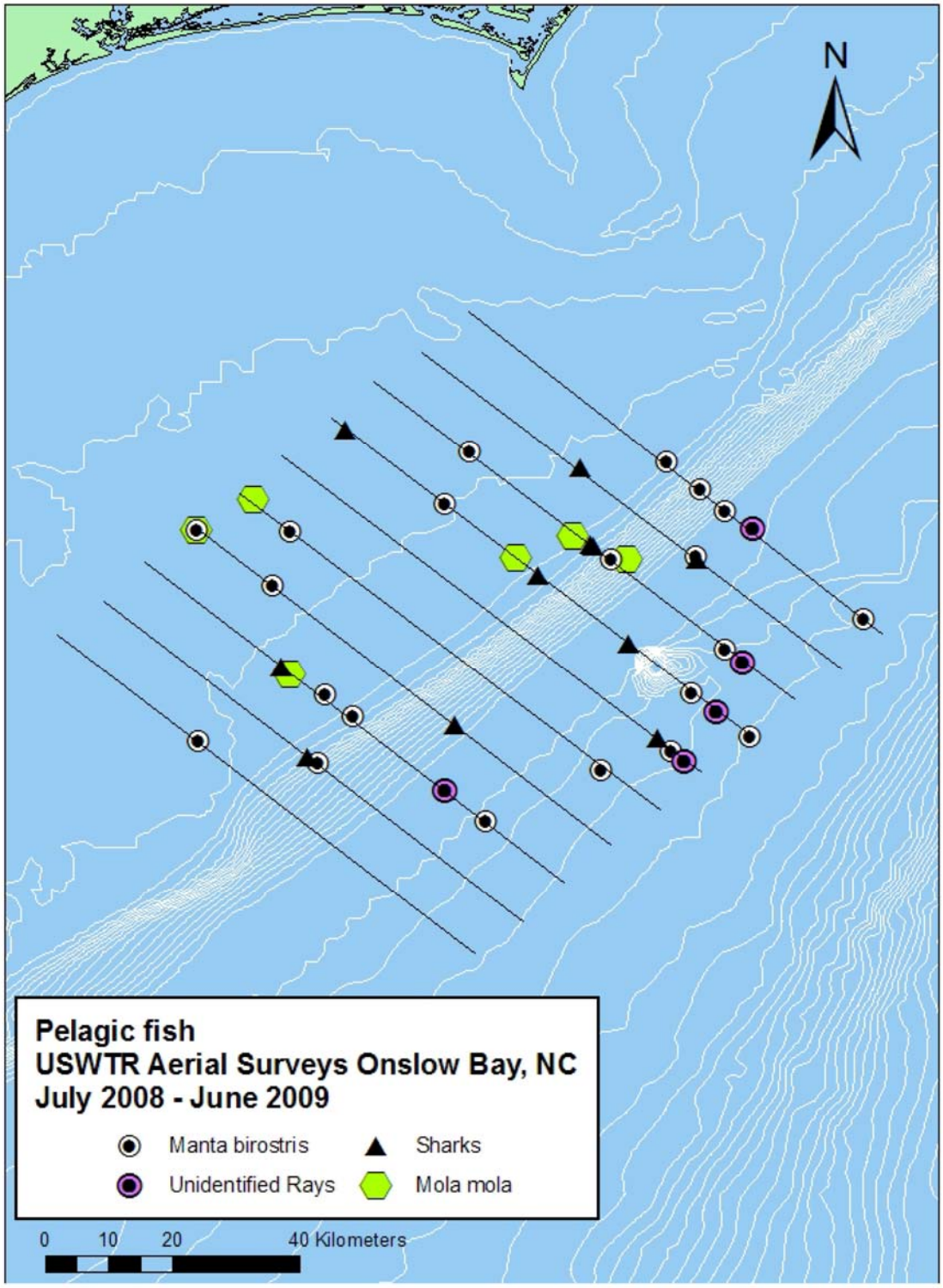

Figure 13. Ocean sunfish, Manta ray and shark sightings.

Vessel Sightings

Commercial (Table 18, Fig. 14)

A total of 57 commercial vessels were seen during the study. This category includes tankers, container/cargo vessels, and car carriers.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
16-Jul-08	9:20	5	34.187347	-76.50110	SE	10	2	45°	1	Tanker bardge
16-Jul-08	9:21	5	34.182093	-76.494756	SE	10	4	110°	1	Tanker
16-Jul-08	9:21	6	34.171135	-76.48098	SE	10	5	30°	1	Large container
16-Jul-08	9:28	8	34.036359	-76.30324	SE	10	5	30°	1	Container Vessel
16-Jul-08	10:19	18	33.946815	-76.448735	SE	8	4	90°	1	Car carrier
16-Jul-08	14:28	45	33.606441	-76.933005	SE	1	1	90°	1	Tanker
17-Jul-08	9:28	4	34.176095	-76.484963	SE	10	4	90°	1	Large tanker
17-Jul-08	11:36	39	33.840782	-76.56245	SE	6	5	30°	1	Roll on roll off
17-Jul-08	12:15	29	33.617311	-76.283784	SE	6	3	70°	1	Cargo vessel
17-Jul-08	15:16	57	33.752289	-77.109885	SE	1	4	90°	1	Large cargo vessel
17-Jul-08	16:42	72	33.518244	-76.67309	NW	2	3	45°	1	Large cargo vessel
17-Jul-08	16:55	74	33.772607	-77.010308	NW	2	5	60°	2	Tug and Barge
1-Aug-08	14:33	4	34.148778	-76.452684	SE	10	4	120°	1	Large container vessel
1-Aug-08	16:04	22	34.035424	-76.691059	NW	7	4	45°	1	Large cargo vessel
2-Aug-08	9:48	14	33.630587	-76.434071	NW	5	2	30°	1	Large tanker
3-Aug-08	10:01	4	33.520698	-76.410762	SE	4	2	45°	1	Cargo vessel
3-Aug-08	10:15	8	33.627367	-76.693579	NW	3	4	45°	1	Resight of cargo vessel
4-Aug-08	9:46	7	33.606994	-76.796372	NW	2	3	90°	1	Large container vessel
4-Aug-08	9:55	9	33.780773	-77.017829	NW	2	2	110°	1	Large container vessel
4-Aug-08	11:32	29	33.865298	-76.341077	NW	8	4	90°	1	Large container vessel
4-Aug-08	12:06	37	34.13951	-76.574947	SE	9	4	90°	1	Barge
15-Oct-08	10:46	20	33.550513	-76.593242	NW	3	4	90°	1	Car carrier, 4-5 NM off, heading North
15-Oct-08	14:29	46	33.759297	-76.329095	SE	7	1	60°	1	Container vessel
15-Oct-08	14:41	40	33.799919	-76.254886	NW	8	1	45°	1	Large container vessel heading North
15-Oct-08	14:54	54	33.944438	-76.444453	NW	8	4	90°	1	Container vessel
15-Oct-08	15:46	64	33.984757	-76.241075	NW	10	3	30°	1	Container vessel, heading South
16-Oct-08	9:53	7	33.919965	-76.284417	NW	9	4	90°	1	Container vessel
16-Oct-08	14:05	34	33.762071	-76.729207	SE	4	4	45°	1	Large RORO
23-Nov-08	10:32	25	33.868158	-76.085522	SE	10	2	90°	1	Container vessel
23-Nov-08	11:00	23	33.976879	-76.361979	NW	9	3	60°	1	Large container vessel
23-Nov-08	11:39	33	33.788882	-76.241009	SE	8	4	60°	1	Large container vessel
23-Nov-08	11:40	46	33.809562	-76.267634	SE	8	2	45°	1	Tanker
23-Nov-08	11:54	37	33.811709	-76.399341	NW	7	1	60°	1	Large container
23-Nov-08	15:02	65	33.935387	-76.95964	SE	4	4	60°	1	Container
30-Dec-08	14:59	33	33.719661	-76.674984	NW	4	4	20°	1	Large container
30-Dec-08	15:04	34	33.812933	-76.798064	NW	4	3	90°	1	Large container RORO
30-Dec-08	15:04	29	33.823562	-76.812431	NW	4	4	40°	1	Large tanker
22-Jan-09	9:53	4	33.754067	-77.113782	SE	1	3	45°	1	Container vessel
22-Jan-09	9:59	7	33.617869	-76.935600	SE	1	1	20°	1	Large container vessel
7-Feb-09	14:01	46	33.472942	-76.491156	NW	3	4	30°	1	Tug boat
7-Feb-09	14:10	47	33.673640	-76.744927	NW	3	3	30°	1	Large container vessel
4-Mar-09	10:27	20	33.956903	-76.581816	SE	7	4	60°	1	Large container heading North
4-Mar-09	14:06	39	33.895674	-76.912028	SE	4	3	30°	1	Large container heading South
5-Mar-09	10:05	20	34.033383	-76.429585	NW	9	4	45°	1	Large tanker
5-Mar-09	10:59	42	33.887004	-76.369626	SE	8	3	30°	1	Tanker
5-Mar-09	12:18	73	33.635457	-76.307029	SE	6	3	90°	1	Large cargo vessel
5-Mar-09	15:34	98	33.523391	-76.558751	NW	3	3	60°	1	Cargo vessel
5-Mar-09	16:06	96	33.529684	-76.696443	SE	2	4	45°	1	Cargo vessel
5-Mar-09	16:27	115	33.664293	-76.99914	NW	1	4	30°	1	Large cargo vessel
25-Apr-09	9:10	4	33.717729	-76.678451	NW	4	1	60°	1	Large container
25-Apr-09	9:14	7	33.814184	-76.795686	NW	4	4	90°	1	Large container vessel

Table 18. All commercial vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
12-May-09	9:53	12	33.902390	-76.916227	SE	4	4	45°	1	Tanker
12-May-09	10:25	19	33.668301	-76.746463	NW	3	4	65°	1	Container vessel
12-May-09	10:26	20	33.693205	-76.777495	NW	3	4	60°	1	Tanker heading North
12-May-09	10:26	20	33.698030	-76.783474	NW	3	4	50°	1	Container vessel
12-May-09	10:48	26	33.665392	-76.871039	SE	2	4	60°	1	Large container heading South
12-May-09	11:08	31	33.485518	-76.759674	NW	1	4	60°	1	Roll on roll off
28-May-09	13:23	39	33.977910	-76.882768	SE	5	4	30°	1	Container ship
28-May-09	14:32	55	33.957779	-76.592999	SE	7	3	15°	1	Container vessel
30-May-09	14:12	27	33.760874	-76.200149	SE	8	3	30°	1	Cargo vessel
30-May-09	13:16	13	34.052162	-76.320504	SE	10	4	90°	1	Container ship
30-May-09	14:47	42	33.750939	-76.324048	NW	7	1	90°	1	Container ship
31-May-09	10:25	28	33.734337	-76.169646	SE	8	4	15°	1	Car carrier
31-May-09	14:22	66	33.609065	-76.92841	SE	1	2	90°	1	Container ship
1-Jun-09	10:46	12	33.998976	-76.781951	NW	6	4	90°	1	Tug and Barge
1-Jun-09	15:16	69	33.460745	-76.478690	NW	3	2	90°	1	Cargo vessel
1-Jun-09	16:29	71	33.528321	-76.692316	SE	2	4	60°	1	Tanker
1-Jun-09	17:08	76	33.545348	-76.837142	NW	1	1	60°	1	Large tug boat
2-Jun-09	11:33	27	33.526005	-76.682515	SE	2	4	110°	1	Cargo vessel
2-Jun-09	14:09	49	34.004389	-76.266916	SE	10	4	45°	1	Car carrier
2-Jun-09	14:58	62	33.888906	-76.369827	SE	8	1	90°	1	Tug and Barge

Table 18 (Continued). All commercial vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

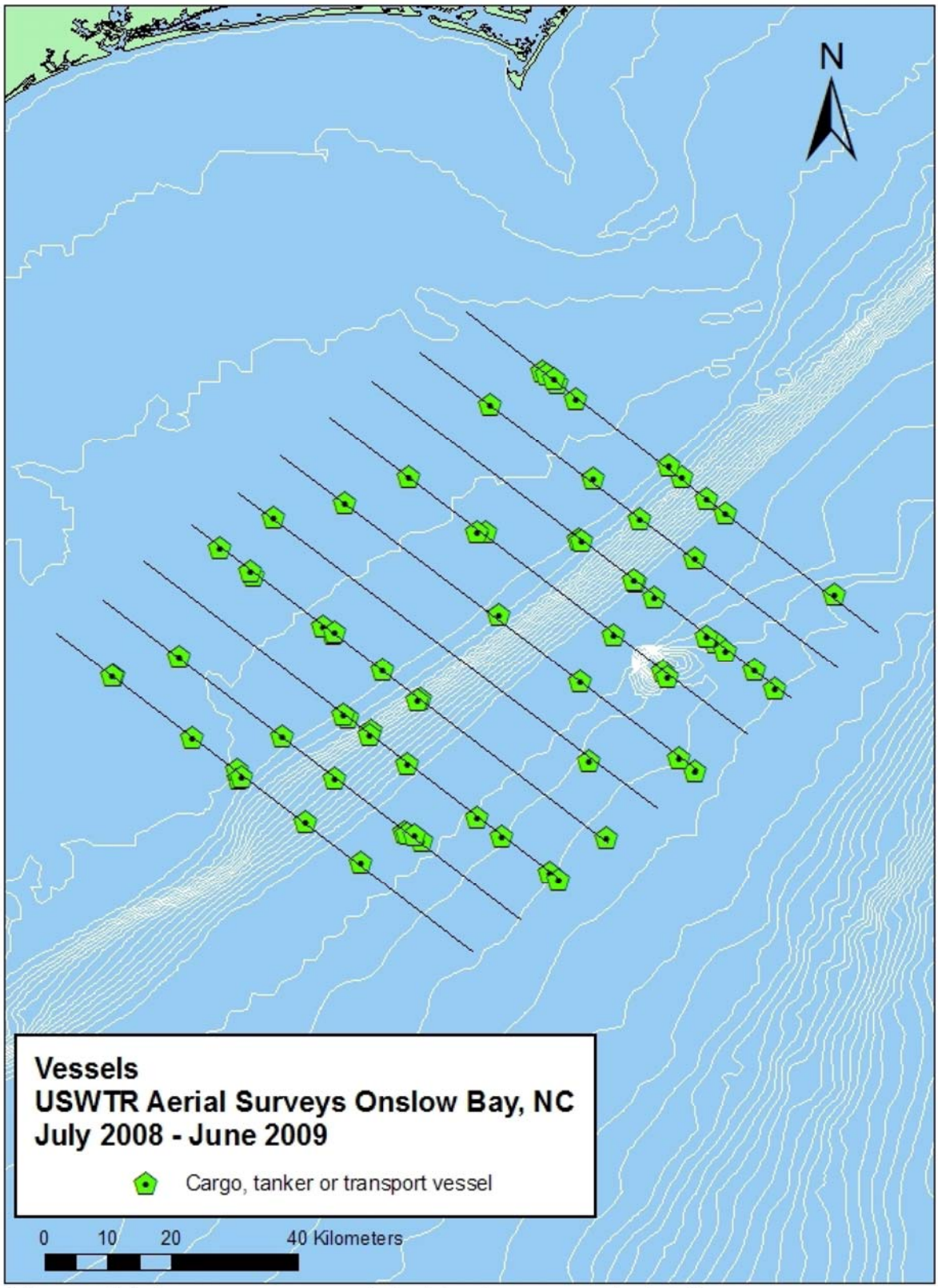

Figure 14. Large commercial shipping vessel sightings.

Military (Table 19, Fig. 15)

A total of 25 U.S. Military vessels were observed in the study site.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
16-Jul-08	11:18	31	33.685111	-76.365502	SE	6	4	90°	1	Navy warship
16-Jul-08	16:29	45	33.851675	-76.83873	NW	4	2	60°	1	Navy vessel
17-Jul-08	12:11	46	33.678059	-76.363175	SE	6	3	90°	1	Military
17-Jul-08	12:25	51	33.726008	-76.542013	NW	5	3	45°	7	Line of military vessels
17-Jul-08	15:47	43	33.541936	-76.444718	NW	4	4	45°	1	Navy war ship
17-Jul-08	15:51	63	33.634754	-76.560937	NW	4	4	90°	1	Military vessel
17-Jul-08	15:51	45	33.624271	-76.547502	NW	4	3	90°	1	Navy war ship
17-Jul-08	15:53	46	33.674114	-76.614212	NW	4	3	60°	1	Navy war ship
7-Feb-09	10:49	29	33.982600	-76.494905	NW	8	6	90°	1	Military vessels
4-Mar-09	11:33	26	33.883448	-76.231747	SE	9	1	90°	1	USCG Cutter
24-Apr-09	11:50	69	33.807221	-76.271981	SE	8	3	90°	1	Navy aircraft carrier
24-Apr-09	15:06	110	33.745687	-76.446712	SE	6	4	45°	1	
25-Apr-09	9:10	6	33.735821	-76.702668	NW	4	4	60°	1	Navy vessel
25-Apr-09	9:50	16	33.409873	-76.541904	NW	2	4	60°	2	Navy frigate and submarine
31-May-09	11:53	47	33.550494	-76.447359	SE	4	2	45°	1	Frigate
31-May-09	15:33	75	33.835725	-76.048668	NW	10	3	45°	1	Frigate
2-Jun-09	14:14	49	33.90456	-76.137616	SE	10	4	10°	1	Large Navy vessel
2-Jun-09	14:24	53	33.835210	-76.175465	NW	9	4	90°	1	Navy vessel

Table 19. All military vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

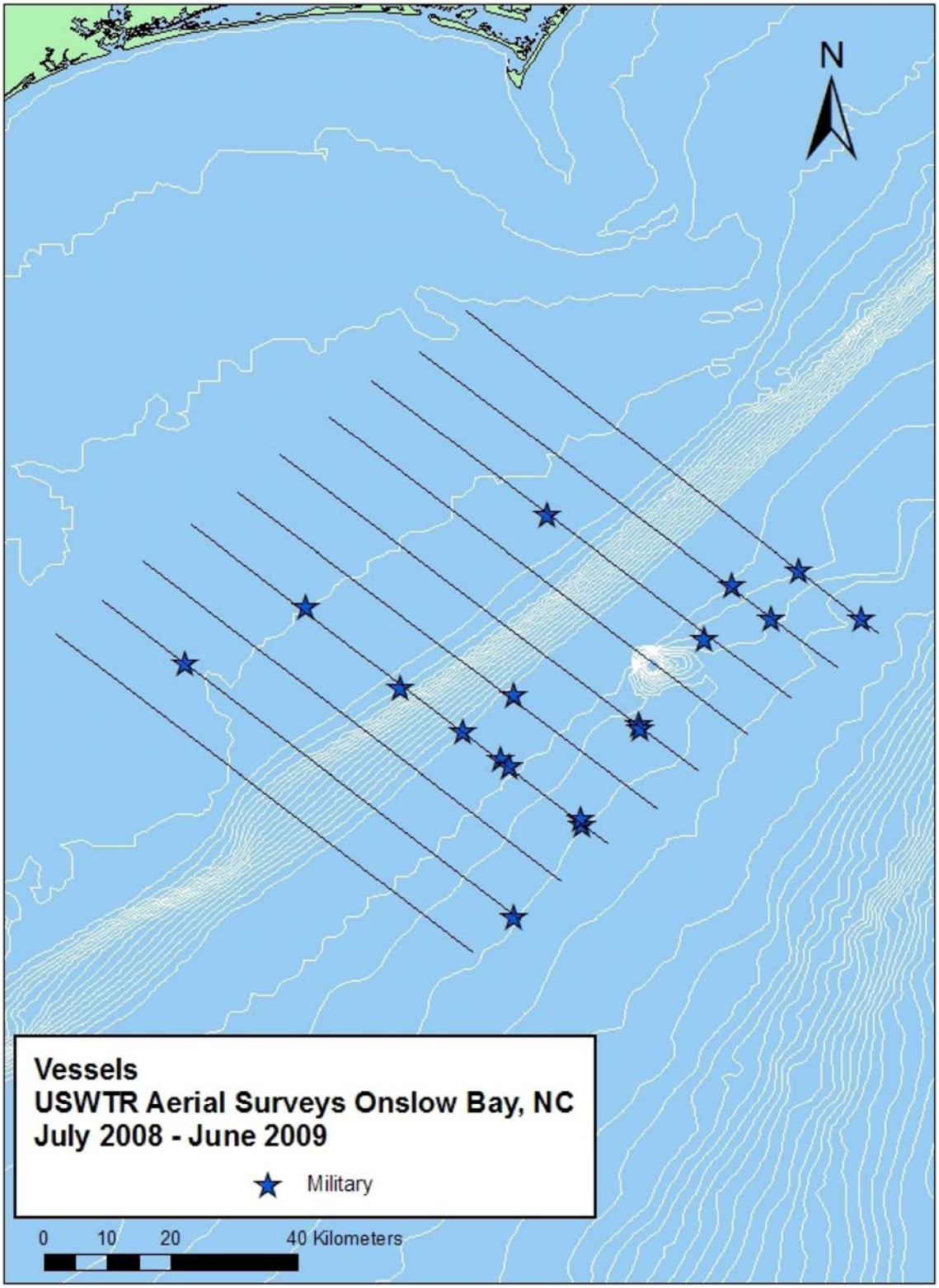

Figure 15. Military vessel sightings.

Recreational (Table 20, Fig. 16)

The most commonly sighted type of vessel in the survey area were recreational fishing vessels (n=334), with the majority of sightings occurring at or shoreward of the continental shelf break.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
16-Jul-08	9:17	3	34.25831	-76.58709	SE	10	2	100°	1	Recreational fishing vessel
16-Jul-08	9:18	3	34.24197	-76.56703	SE	10	3	90°	1	Recreational fishing vessel
16-Jul-08	9:19	4	34.21183	-76.53096	SE	10	4	90°	1	Recreational fishing vessel
16-Jul-08	9:19	4	34.22262	-76.54397	SE	10	4	45°	1	Recreational fishing vessel
16-Jul-08	10:02	15	34.15987	-76.59747	NW	9	4	90°	1	Unid vessel
16-Jul-08	10:19	19	33.93397	-76.43258	SE	8	1	80°	1	Recreational fishing vessel
16-Jul-08	10:52	21	34.01300	-76.65912	NW	7	3	90°	1	Recreational fishing vessel
16-Jul-08	11:05	24	33.94263	-76.70162	SE	6	4	45°	1	Recreational fishing vessel
16-Jul-08	14:20	42	33.78776	-77.14290	SE	1	3	90°	1	Recreational fishing vessel
16-Jul-08	14:27	44	33.62612	-76.95817	SE	1	4	90°	1	Recreational fishing vessel
16-Jul-08	15:15	57	33.85070	-76.97993	SE	3	2	100°	1	Recreational fishing vessel
16-Jul-08	15:15	56	33.86403	-76.99879	SE	3	3	90°	1	Unid vessel
16-Jul-08	16:29	64	33.84285	-76.82495	NW	4	3	90°	1	Recreational fishing vessel
17-Jul-08	9:25	3	34.23195	-76.55654	SE	10	2	90°	1	Dive boat on anchor
17-Jul-08	9:30	3	34.14722	-76.44651	SE	10	2	60°	1	Recreational fishing vessel
17-Jul-08	9:30	5	34.14129	-76.43819	SE	10	2	90°	1	Recreational fishing vessel
17-Jul-08	9:36	6	34.01862	-76.28129	SE	10	4	60°	1	Recreational fishing vessel
17-Jul-08	10:36	20	34.01032	-76.52666	SE	8	1	90°	1	Recreational fishing vessel
17-Jul-08	10:41	22	33.91490	-76.40026	SE	8	4	90°	1	
17-Jul-08	16:01	65	33.85343	-76.84717	NW	4	3	45°	1	
17-Jul-08	16:12	68	33.87526	-77.00939	SE	3	4	30°	1	Recreational fishing vessel
17-Jul-08	16:52	53	33.71678	-76.93775	NW	2	3	90°	1	Recreational fishing vessel
1-Aug-08	14:27	3	34.25683	-76.58835	SE	10	3	45°	1	Head boat
1-Aug-08	14:29	3	34.23147	-76.55710	SE	10	2	90°	1	Recreational fishing vessel
1-Aug-08	14:39	6	34.02908	-76.29715	SE	10	3	90°	1	Recreational fishing vessel
1-Aug-08	14:39	5	34.02440	-76.29111	SE	10	2	30°	2	Recreational fishing vessel
1-Aug-08	14:40	6	33.99415	-76.25094	SE	10	3	45°	2	Recreational fishing vessel
1-Aug-08	15:01	11	33.92027	-76.29881	NW	9	4	45°	1	Recreational fishing vessel
1-Aug-08	15:01	12	33.91912	-76.29656	NW	9	2	90°	1	Recreational fishing vessel
1-Aug-08	15:02	12	33.94245	-76.32492	NW	9	2	30°	1	Recreational fishing vessel
1-Aug-08	15:03	13	33.98010	-76.36903	NW	9	2	90°	1	Recreational fishing vessel
2-Aug-08	9:08	4	34.01580	-76.80350	SE	6	3	45°	1	Recreational fishing vessel
2-Aug-08	9:31	9	33.78030	-76.49717	SE	6	4	45°	1	Recreational fishing vessel
2-Aug-08	10:48	23	33.67803	-76.75468	NW	3	1	90°	1	Dive boat
2-Aug-08	11:19	32	33.77017	-77.00784	SE	2	4	90°	1	Recreational fishing vessel
2-Aug-08	11:24	32	33.65206	-76.85683	SE	2	3	45°	1	Head boat
2-Aug-08	11:55	39	33.60180	-76.91422	NW	1	3	30°	1	Recreational fishing vessel
3-Aug-08	9:50	4	33.74489	-76.70366	SE	4	4	80°	1	Car carrier
3-Aug-08	10:17	8	33.66654	-76.74480	NW	3	3	60°	1	Luxury yacht
4-Aug-08	10:55	18	34.03884	-76.83400	NW	6	2	90°	1	Recreational fishing vessel
4-Aug-08	11:04	22	34.02005	-76.67004	SE	7	3	90°	1	Recreational fishing vessel
4-Aug-08	11:12	24	33.87294	-76.47831	SE	7	3	90°	1	Recreational fishing vessel
4-Aug-08	11:35	30	33.92073	-76.41145	NW	8	3	90°	1	Recreational fishing vessel
4-Aug-08	12:12	25	34.01291	-76.40914	SE	9	2	60°	1	Recreational fishing vessel
4-Aug-08	12:52	48	34.04393	-76.31196	NW	10	3	90°	1	Recreational fishing vessel
15-Oct-08	10:00	11	33.77686	-76.61302	NW	5	2	90°	1	Recreational fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
15-Oct-08	10:00	12	33.78903	-76.62955	NW	5	3	100°	1	Recreational fishing vessel
15-Oct-08	10:24	16	33.80372	-76.77895	SE	4	2	45°	1	Recreational fishing vessel
15-Oct-08	10:55	22	33.72529	-76.82178	NW	3	3	30°	1	Recreational fishing vessel
15-Oct-08	15:01	56	34.07482	-76.61281	NW	8	3	30°	1	Recreational fishing vessel
15-Oct-08	15:57	65	34.19311	-76.51035	NW	10	4	45°	1	Recreational fishing vessel
16-Oct-08	9:31	4	34.04411	-76.31845	SE	10	3	45°	1	Recreational fishing vessel
16-Oct-08	9:56	8	33.98112	-76.36570	NW	9	2	90°	2	Recreational fishing vessel
16-Oct-08	10:03	9	34.11470	-76.54295	NW	9	1	90°	1	Recreational fishing vessel
16-Oct-08	10:19	12	34.00675	-76.52457	SE	8	3	90°	1	Recreational fishing vessel
16-Oct-08	10:47	15	33.87929	-76.48577	NW	7	2	90°	2	Recreational fishing vessel
16-Oct-08	10:49	16	33.90935	-76.52422	NW	7	3	90°	2	Recreational fishing vessel
16-Oct-08	11:08	22	33.96461	-76.73621	SE	6	1	90°	1	Recreational fishing vessel
16-Oct-08	11:15	23	33.82617	-76.55474	SE	6	3	45°	1	Recreational fishing vessel
16-Oct-08	11:39	28	33.79053	-76.63741	NW	5	3	90°	1	Recreational fishing vessel
16-Oct-08	11:42	29	33.85148	-76.72171	NW	5	3	90°	1	Yacht
16-Oct-08	14:32	39	33.66759	-76.74480	NW	3	3	45°	1	Recreational fishing vessel
16-Oct-08	14:38	40	33.79328	-76.90756	NW	3	3	90°	1	Recreational fishing vessel
16-Oct-08	14:40	41	33.84417	-76.97370	NW	3	3	90°	1	Recreational fishing vessel
16-Oct-08	14:54	44	33.72406	-76.94352	SE	2	4	90°	1	Recreational fishing vessel
16-Oct-08	14:56	45	33.69122	-76.90225	SE	2	3	90°	1	Recreational fishing vessel
23-Nov-08	10:11	12	34.25150	-76.58355	SE	10	3	60°	1	
23-Nov-08	10:12	13	34.23821	-76.56644	SE	10	3	60°	1	Sail boat
23-Nov-08	10:12	14	34.23695	-76.56484	SE	10	3	90°	1	
23-Nov-08	10:21	15	34.05413	-76.32896	SE	10	4	60°	1	
23-Nov-08	11:00	34	33.97540	-76.36014	NW	9	1	90°	1	Recreational fishing vessel
23-Nov-08	11:06	24	34.10643	-76.53196	NW	9	2	90°	1	Recreational fishing vessel
23-Nov-08	11:07	26	34.13616	-76.57156	NW	9	3	90°	1	
23-Nov-08	11:11	36	34.19784	-76.65372	NW	9	3	90°	1	Recreational fishing vessel
23-Nov-08	11:15	39	34.15803	-76.72565	SE	8	1	90°	1	Sail boat
23-Nov-08	11:15	29	34.15159	-76.71569	SE	8	3	60°	1	
23-Nov-08	11:25	40	33.95351	-76.45551	SE	8	2	90°	1	Recreational fishing vessel
23-Nov-08	11:27	41	33.92853	-76.42324	SE	8	3	90°	1	Recreational fishing vessel
23-Nov-08	14:22	66	33.94207	-76.70718	SE	6	2	30°	1	Head boat
23-Nov-08	14:34	61	33.87248	-76.74558	NW	5	2	45°	1	
23-Nov-08	15:07	76	33.83848	-76.83077	SE	4	1	90°	2	Recreational fishing vessel
23-Nov-08	15:08	77	33.82964	-76.81937	SE	4	3	90°	1	Recreational fishing vessel
23-Nov-08	15:12	79	33.75364	-76.71871	SE	4	1	90°	1	Recreational fishing vessel
24-Nov-08	13:29	10	33.64140	-76.83774	NW	2	4	90°	1	Recreational fishing vessel
24-Nov-08	14:08	20	33.52642	-76.40786	SE	3	4	90°	1	Shrimper
24-Nov-08	14:33	27	33.99998	-76.91386	SE	5	4	90°	1	Recreational fishing vessel
24-Nov-08	14:34	28	33.99211	-76.90323	SE	5	1	90°	1	Recreational fishing vessel
24-Nov-08	15:08	33	33.81875	-76.54537	NW	6	2	90°	1	Recreational fishing vessel
24-Nov-08	15:09	34	33.83612	-76.56703	NW	6	4	90°	1	Recreational fishing vessel
30-Dec-08	14:25	23	33.86552	-77.12993	NW	2	3	30°	1	Recreational fishing vessel
30-Dec-08	14:36	25	33.71791	-76.80868	SE	3	2	90°	1	
22-Jan-09	9:55	5	33.70947	-77.06107	SE	1	2	60°	1	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
22-Jan-09	9:57	6	33.65516	-76.98721	SE	1	4	60°	1	Recreational fishing vessel
22-Jan-09	10:01	4	33.58085	-76.88832	SE	1	4	90°	1	Recreational fishing vessel
22-Jan-09	10:44	11	33.79235	-76.90641	SE	3	1	90°	1	Recreational fishing vessel
22-Jan-09	11:19	18	33.80870	-76.79618	NW	4	4	90°	1	Recreational fishing vessel
22-Jan-09	11:24	19	33.91591	-76.93338	NW	4	3	90°	4	Recreational fishing vessel
22-Jan-09	11:24	22	33.92196	-76.94112	NW	4	3	60°	1	Recreational fishing vessel
22-Jan-09	11:37	25	33.83196	-76.69545	SE	5	4	90°	1	Recreational fishing vessel
22-Jan-09	12:02	29	33.81868	-76.53904	NW	6	3	90°	2	Recreational fishing vessel
22-Jan-09	12:04	25	33.84403	-76.57138	NW	6	1	90°	1	Recreational fishing vessel
22-Jan-09	14:41	37	33.91565	-76.40460	NW	8	4	45°	1	Recreational fishing vessel
22-Jan-09	14:58	40	34.18541	-76.63188	SE	9	3	90°	1	Recreational fishing vessel
22-Jan-09	15:33	41	34.04702	-76.31849	NW	10	1	90°	1	Recreational fishing vessel
7-Feb-09	9:28	7	33.78175	-76.62823	SE	5	3	90°	1	Recreational fishing vessel
7-Feb-09	10:08	16	34.04624	-76.83728	NW	6	4	45°	1	Recreational fishing vessel
7-Feb-09	10:23	18	33.88237	-76.49061	SE	7	1	90°	1	Recreational fishing vessel
7-Feb-09	10:24	19	33.87246	-76.45543	SE	7	2	45°	1	Recreational fishing vessel
7-Feb-09	10:24	21	33.87539	-76.46982	SE	7	4	90°	2	Recreational fishing vessel
7-Feb-09	10:47	27	33.95599	-76.45772	NW	8	3	45°	1	Recreational fishing vessel
7-Feb-09	11:12	33	33.94045	-76.31319	SE	9	4	45°	1	Recreational fishing vessel
7-Feb-09	11:36	36	34.03632	-76.30337	NW	10	2	90°	1	Recreational fishing vessel
7-Feb-09	11:46	43	34.24440	-76.57245	NW	10	2	45°	2	Recreational fishing vessel
7-Feb-09	11:46	38	34.25102	-76.58132	NW	10	4	60°	2	Recreational fishing vessel
7-Feb-09	14:10	53	33.68284	-76.75639	NW	3	4	90°	1	Recreational fishing vessel
7-Feb-09	14:28	53	33.80525	-76.93033	NW	3	4	90°	1	Recreational fishing vessel
7-Feb-09	15:30	61	33.76277	-77.12805	NW	1	4	90°	1	Recreational fishing vessel
4-Mar-09	10:03	11	33.80614	-76.51730	NW	6	4	90°	1	Recreational fishing vessel
4-Mar-09	10:31	15	33.87248	-76.47154	SE	7	1	90°	1	Recreational fishing vessel
4-Mar-09	10:32	16	33.85769	-76.45365	SE	7	2	90°	1	Recreational fishing vessel
4-Mar-09	11:29	25	33.97966	-76.37794	SE	9	4	30°	1	Recreational fishing vessel
4-Mar-09	12:02	30	34.24950	-76.58205	NW	10	3	90°	1	Recreational fishing vessel
5-Mar-09	9:13	4	34.24979	-76.58227	SE	10	3	45°	1	Recreational fishing vessel
5-Mar-09	10:02	19	33.94959	-76.32534	NW	9	3	60°	1	Recreational fishing vessel
5-Mar-09	10:07	21	34.06674	-76.47861	NW	9	3	60°	1	Recreational fishing vessel
5-Mar-09	10:16	25	34.14038	-76.57116	NW	9	1	90°	1	Recreational fishing vessel
5-Mar-09	10:16	26	34.14930	-76.58290	NW	9	3	90°	2	Recreational fishing vessel
5-Mar-09	10:57	41	33.94551	-76.44407	SE	8	2	60°	1	Recreational fishing vessel
5-Mar-09	11:00	43	33.86589	-76.34561	SE	8	3	60°	2	Recreational fishing vessel
5-Mar-09	11:32	51	33.85665	-76.45219	NW	7	3	60°	8	Recreational fishing vessel
5-Mar-09	11:36	54	33.95099	-76.57939	NW	7	2	60°	1	Recreational fishing vessel
5-Mar-09	11:41	57	34.07086	-76.74619	NW	7	4	90°	1	Recreational fishing vessel
5-Mar-09	12:09	71	33.82682	-76.55497	SE	6	4	60°	1	Recreational fishing vessel
5-Mar-09	12:32	77	33.75993	-76.59868	NW	5	3	90°	2	Recreational fishing vessel
5-Mar-09	15:14	78	33.87911	-76.89033	SE	4	3	30°	1	Recreational fishing vessel
5-Mar-09	15:20	94	33.73502	-76.68175	SE	4	2	90°	1	Recreational fishing vessel
5-Mar-09	15:41	100	33.69630	-76.77063	NW	3	4	60°	1	Recreational fishing vessel
24-Apr-09	9:34	4	34.25787	-76.58755	SE	10	1	90°	1	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
24-Apr-09	9:35	4	34.23889	-76.55450	SE	10	3	90°	1	Recreational fishing vessel
24-Apr-09	10:07	17	34.01084	-76.27374	SE	10	4	120°	1	Recreational fishing vessel
24-Apr-09	10:19	18	33.92333	-76.16016	SE	10	4	60°	1	Recreational fishing vessel
24-Apr-09	10:53	37	33.92734	-76.29519	NW	9	3	60°	1	Recreational fishing vessel
24-Apr-09	10:54	25	33.93189	-76.29996	NW	9	4	45°	1	Recreational fishing vessel
24-Apr-09	11:11	31	34.13205	-76.55977	NW	9	2	60°	1	Head boat
24-Apr-09	11:15	50	34.19865	-76.66185	NW	9	2	90°	1	Head boat
24-Apr-09	11:41	66	33.93859	-76.44017	SE	8	3	45°	1	Recreational fishing vessel
24-Apr-09	11:41	42	33.93377	-76.43392	SE	8	2	45°	1	Recreational fishing vessel
24-Apr-09	11:46	45	33.89461	-76.37386	SE	8	1	90°	1	Duke survey vessel - Cetus
24-Apr-09	11:59	73	33.70155	-76.26230	NW	7	2	90°	1	
24-Apr-09	12:16	52	33.84876	-76.44962	SE	7	3	30°	1	Recreational fishing vessel
24-Apr-09	12:17	78	33.86902	-76.47315	NW	7	3	90°	5	Recreational fishing vessel
24-Apr-09	12:30	56	33.98614	-76.62510	SE	7	3	60°	1	Recreational fishing vessel
24-Apr-09	14:57	69	33.93811	-76.70032	SE	6	1	60°	1	Recreational fishing vessel
24-Apr-09	15:03	72	33.81424	-76.53968	SE	6	4	60°	1	Recreational fishing vessel
24-Apr-09	15:25	75	33.76954	-76.62249	NW	5	3	60°	2	Recreational fishing vessel
24-Apr-09	15:28	76	33.83356	-76.69360	NW	5	2	30°	2	Recreational fishing vessel
24-Apr-09	15:28	115	33.84425	-76.71403	NW	5	3	90°	1	Recreational fishing vessel
25-Apr-09	9:09	5	33.70409	-76.65534	NW	4	4	90°	1	Recreational fishing vessel
25-Apr-09	9:14	5	33.82508	-76.81226	NW	4	2	60°	1	Recreational fishing vessel
25-Apr-09	9:28	10	33.84485	-76.97598	SE	3	3	60°	1	Recreational fishing vessel
25-Apr-09	9:33	15	33.72844	-76.81537	SE	3	3	45°	1	Recreational fishing vessel
25-Apr-09	9:34	16	33.72071	-76.80498	SE	3	2	90°	1	Recreational fishing vessel
25-Apr-09	9:35	12	33.69104	-76.76538	SE	3	2	60°	1	Recreational fishing vessel
25-Apr-09	9:36	13	33.67884	-76.74888	SE	3	3	90°	2	Recreational fishing vessel
25-Apr-09	10:02	19	33.68100	-76.90121	NW	2	3	90°	1	Recreational fishing vessel
25-Apr-09	10:04	21	33.71916	-76.94040	NW	2	3	90°	1	Recreational fishing vessel
25-Apr-09	10:06	22	33.76508	-76.99699	NW	2	3	90°	1	Recreational fishing vessel
25-Apr-09	10:32	29	33.70528	-77.04536	NW	1	1	90°	1	Recreational fishing vessel
25-Apr-09	10:34	30	33.66290	-76.99482	NW	1	2	90°	1	Recreational fishing vessel
25-Apr-09	10:37	25	33.60027	-76.92029	SE	1	4	60°	1	Recreational fishing vessel
25-Apr-09	10:38	26	33.58261	-76.89969	SE	1	2	60°	1	Recreational fishing vessel
12-May-09	9:13	5	33.86620	-76.60644	SE	6	4	90°	1	Recreational fishing vessel
12-May-09	9:40	8	33.84056	-76.70271	NW	5	3	60°	2	Recreational fishing vessel
12-May-09	9:42	9	33.88235	-76.76245	NW	5	3	30°	1	Recreational fishing vessel
12-May-09	10:29	21	33.75533	-76.85891	NW	3	3	45°	1	Recreational fishing vessel
12-May-09	11:16	28	33.66604	-77.00164	NW	1	3	90°	1	Recreational fishing vessel
28-May-09	9:21	5	33.76047	-77.11794	SE	1	4	60°	1	Luxury yacht
28-May-09	9:21	6	33.74973	-77.10380	SE	1	4	90°	1	Sailing yacht
28-May-09	9:22	6	33.74455	-77.09749	SE	1	4	60°	1	Small fishing vessel
28-May-09	10:11	18	33.78187	-77.02126	NW	2	4	60°	1	Recreational fishing vessel
28-May-09	10:20	20	33.85475	-76.98559	SE	3	3	90°	1	Luxury yacht
28-May-09	10:22	23	33.80922	-76.92673	SE	3	4	30°	1	Recreational fishing vessel
28-May-09	13:31	35	33.79811	-76.64515	SE	5	4	30°	1	Recreational fishing vessel
28-May-09	14:18	46	33.96446	-76.74024	NW	6	1	90°	1	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
28-May-09	14:18	52	33.96596	-76.74242	NW	6	4	30°	1	Recreational fishing vessel
30-May-09	13:07	4	34.26120	-76.59586	SE	10	3	30°	1	Recreational fishing vessel
30-May-09	13:08	7	34.23961	-76.56224	SE	10	2	90°	1	Recreational fishing vessel
30-May-09	13:11	8	34.16401	-76.46601	SE	10	2	90°	1	Sail boat
30-May-09	13:14	10	34.10693	-76.39367	SE	10	2	90°	1	Recreational fishing vessel
30-May-09	13:14	11	34.09540	-76.37850	SE	10	1	90°	1	Recreational fishing vessel
30-May-09	13:15	12	34.08855	-76.37004	SE	10	3	90°	1	Sail boat
30-May-09	13:17	5	34.04959	-76.31716	SE	10	4	45°	1	Recreational fishing vessel
30-May-09	13:18	14	34.00965	-76.26988	SE	10	1	90°	1	Recreational fishing vessel
30-May-09	13:39	19	33.97088	-76.34846	NW	9	1	90°	1	Recreational fishing vessel
30-May-09	13:40	20	33.98660	-76.36805	NW	9	2	90°	1	Recreational fishing vessel
30-May-09	13:41	21	34.00679	-76.39472	NW	9	2	90°	1	Recreational fishing vessel
30-May-09	13:45	22	34.09811	-76.51477	NW	9	3	90°	1	Recreational fishing vessel
30-May-09	13:45	14	34.09753	-76.51394	NW	9	4	60°	1	Recreational fishing vessel
30-May-09	13:46	15	34.11269	-76.53420	NW	9	2	60°	2	Recreational fishing vessel
30-May-09	13:47	16	34.13339	-76.56312	NW	9	2	30°	1	Recreational fishing vessel
30-May-09	13:49	23	34.18082	-76.62494	NW	9	3	90°	1	Recreational fishing vessel
30-May-09	13:49	18	34.18031	-76.62402	NW	9	3	45°	1	Recreational fishing vessel
30-May-09	13:53	21	34.16109	-76.73597	SE	8	1	90°	1	Head boat
30-May-09	13:55	26	34.12497	-76.68361	SE	8	2	90°	1	Recreational fishing vessel
30-May-09	13:58	27	34.07058	-76.60551	SE	8	2	90°	5	Recreational fishing vessel
30-May-09	13:58	22	34.06281	-76.59415	SE	8	1	30°	1	Recreational fishing vessel
30-May-09	14:02	28	33.97754	-76.48011	SE	8	1	90°	1	Recreational fishing vessel
30-May-09	14:02	24	33.98257	-76.49087	SE	8	3	60°	1	Recreational fishing vessel
30-May-09	14:04	31	33.92843	-76.42328	SE	8	1	90°	1	Recreational fishing vessel
30-May-09	14:04	26	33.93712	-76.43350	SE	8	3	60°	1	Recreational fishing vessel
30-May-09	14:12	33	33.76656	-76.20942	SE	8	1	90°	1	Sail boat
30-May-09	14:54	32	33.90667	-76.51668	NW	7	2	45°	1	Recreational fishing vessel
30-May-09	14:56	43	33.95793	-76.57996	NW	7	1	90°	1	Recreational fishing vessel
30-May-09	14:57	44	33.97673	-76.60873	NW	7	2	90°	1	Recreational fishing vessel
30-May-09	14:58	45	33.98664	-76.62648	NW	7	2	90°	1	Recreational fishing vessel
30-May-09	15:01	34	34.05986	-76.72231	NW	7	4	45°	1	Recreational fishing vessel
30-May-09	16:10	49	33.84036	-76.70095	NW	5	4	90°	1	Recreational fishing vessel
30-May-09	16:16	50	33.98029	-76.87869	NW	5	1	60°	1	Recreational fishing vessel
31-May-09	8:52	4	34.25942	-76.59386	SE	10	1	45°	1	Recreational fishing vessel
31-May-09	8:52	4	34.26206	-76.59711	SE	10	2	60°	2	Recreational fishing vessel
31-May-09	8:53	5	34.24233	-76.56713	SE	10	2	45°	3	Recreational fishing vessel
31-May-09	8:54	6	34.23088	-76.55189	SE	10	3	90°	2	Recreational fishing vessel
31-May-09	8:55	5	34.20572	-76.52042	SE	10	2	60°	1	Recreational fishing vessel
31-May-09	8:56	7	34.16967	-76.47715	SE	10	2	30°	2	Recreational fishing vessel
31-May-09	8:58	6	34.13577	-76.43509	SE	10	3	60°	1	Recreational fishing vessel
31-May-09	8:58	8	34.13732	-76.43713	SE	10	1	45°	1	Recreational fishing vessel
31-May-09	8:59	7	34.10070	-76.38877	SE	10	3	90°	1	Recreational fishing vessel
31-May-09	8:59	9	34.09800	-76.38516	SE	10	1	60°	1	Recreational fishing vessel
31-May-09	9:00	8	34.09008	-76.37409	SE	10	3	45°	1	Recreational fishing vessel
31-May-09	9:00	10	34.08880	-76.37240	SE	10	1	45°	1	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
31-May-09	9:01	9	34.06507	-76.34458	SE	10	4	45°	1	Recreational fishing vessel
31-May-09	9:02	10	34.04810	-76.32259	SE	10	4	60°	1	Recreational fishing vessel
31-May-09	9:02	11	34.04663	-76.32050	SE	10	2	60°	2	Recreational fishing vessel
31-May-09	9:23	14	33.95637	-76.33518	NW	9	3	30°	1	Recreational fishing vessel
31-May-09	9:24	15	33.98384	-76.36823	NW	9	2	90°	10	Boats widely spaced
31-May-09	9:24	15	33.98382	-76.36815	NW	9	3	45°	6	Recreational fishing vessel
31-May-09	9:27	16	34.04088	-76.44250	NW	9	3	30°	1	Recreational fishing vessel
31-May-09	9:32	17	34.14606	-76.59124	NW	9	4	45°	4	Recreational fishing vessel
31-May-09	9:33	18	34.15934	-76.60824	NW	9	3	60°	2	Recreational fishing vessel
31-May-09	9:38	20	34.15775	-76.72953	SE	8	4	60°	3	Recreational fishing vessel
31-May-09	9:41	21	34.09920	-76.64330	SE	8	3	45°	1	Recreational fishing vessel
31-May-09	9:42	21	34.07478	-76.61164	SE	8	4	90°	1	Recreational fishing vessel
31-May-09	9:44	23	34.04017	-76.56854	SE	8	4	60°	3	Recreational fishing vessel
31-May-09	10:16	26	33.94858	-76.45572	SE	8	2	45°	1	Recreational fishing vessel
31-May-09	10:16	26	33.94737	-76.45452	SE	8	3	90°	6	Recreational fishing vessel
31-May-09	10:17	27	33.92528	-76.42428	SE	8	2	60°	2	Recreational fishing vessel
31-May-09	10:18	28	33.89515	-76.38219	SE	8	3	45°	2	Recreational fishing vessel
31-May-09	10:37	33	33.86441	-76.46453	NW	7	2	60°	1	Recreational fishing vessel
31-May-09	10:38	31	33.89131	-76.49949	NW	7	3	90°	6	Recreational fishing vessel
31-May-09	10:39	32	33.91520	-76.52966	NW	7	1	30°		Fishing vessel
31-May-09	10:39	35	33.91131	-76.52454	NW	7	2	60°	1	Recreational fishing vessel
31-May-09	10:41	33	33.94877	-76.57501	NW	7	3	60°	3	Recreational fishing vessel
31-May-09	10:42	36	33.98812	-76.62606	NW	7	3	30°	1	Recreational fishing vessel
31-May-09	10:43	34	34.00887	-76.65464	NW	7	3	60°	1	Recreational fishing vessel
31-May-09	10:48	35	34.10612	-76.78629	NW	7	1	30°	1	Recreational fishing vessel
31-May-09	10:56	38	33.94837	-76.98004	SE	4	3	90°	2	Recreational fishing vessel
31-May-09	10:57	39	33.92244	-76.94325	SE	4	2	45°	1	Recreational fishing vessel
31-May-09	10:58	40	33.91806	-76.93670	SE	4	3	45°	1	Recreational fishing vessel
31-May-09	11:01	40	33.83520	-76.82976	SE	4	1	110°	1	Recreational fishing vessel
31-May-09	11:03	41	33.78269	-76.75828	SE	4	3	45°	1	Recreational fishing vessel
31-May-09	11:05	42	33.74497	-76.70363	SE	4	4	30°	3	Recreational fishing vessel
31-May-09	12:02	50	33.58334	-76.62928	NW	3	3	45°	1	Recreational fishing vessel
31-May-09	12:06	52	33.67653	-76.74901	NW	3	4	45°	1	Recreational fishing vessel
31-May-09	12:12	50	33.83456	-76.95897	NW	3	3	45°	1	Yacht
31-May-09	12:12	54	33.83636	-76.96177	NW	3	2	45°	1	
31-May-09	12:15	55	33.90365	-77.05245	NW	3	3	45°	2	Recreational fishing vessel
31-May-09	14:14	62	33.77389	-77.14220	SE	1	2	90°	1	Recreational fishing vessel
31-May-09	14:15	63	33.75676	-77.11565	SE	1	2	90°	1	Recreational fishing vessel
31-May-09	14:18	64	33.70316	-77.04471	SE	1	3	90°	1	Recreational fishing vessel
31-May-09	14:19	58	33.68075	-77.01638	SE	1	2	30°	2	Recreational fishing vessel
31-May-09	14:20	65	33.66205	-76.99472	SE	1	3	90°	1	Recreational fishing vessel
31-May-09	14:22	67	33.59991	-76.91432	SE	1	1	90°	1	Recreational fishing vessel
31-May-09	14:22	59	33.61275	-76.93335	SE	1	2	45°	1	Recreational fishing vessel
31-May-09	14:23	68	33.58688	-76.89506	SE	1	3	90°	1	Recreational fishing vessel
31-May-09	14:47	73	33.65462	-76.84911	NW	2	2	90°	1	Recreational fishing vessel
31-May-09	14:47	64	33.64917	-76.84266	NW	2	2	45°	2	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
31-May-09	14:49	65	33.70634	-76.91962	NW	2	4	90°	1	Recreational fishing vessel
31-May-09	14:50	75	33.71577	-76.93412	NW	2	3	120°	1	Recreational fishing vessel
31-May-09	14:51	76	33.74727	-76.96624	NW	2	3	90°	1	Recreational fishing vessel
31-May-09	14:52	77	33.76349	-76.98893	NW	2	3	90°	1	Recreational fishing vessel
31-May-09	14:56	66	33.84626	-77.09346	NW	2	1	30°	1	Recreational fishing vessel
31-May-09	15:13	81	34.15806	-76.60535	SE	9	2	90°	1	Recreational fishing vessel
31-May-09	15:13	82	34.14383	-76.58215	SE	9	1	90°	1	Recreational fishing vessel
31-May-09	15:14	83	34.13395	-76.56970	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:16	84	34.08632	-76.50391	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:16	85	34.07979	-76.49547	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:17	87	34.05309	-76.45953	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:17	69	34.07320	-76.48823	SE	9	3	30°	1	Recreational fishing vessel
31-May-09	15:18	88	34.04252	-76.44669	SE	9	2	90°	1	Recreational fishing vessel
31-May-09	15:18	89	34.03619	-76.43861	SE	9	2	90°	1	Recreational fishing vessel
31-May-09	15:19	90	34.02249	-76.41783	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:19	91	34.02005	-76.41408	SE	9	1	90°	1	Recreational fishing vessel
31-May-09	15:19	70	34.00829	-76.39947	SE	9	3	30°	2	Recreational fishing vessel
31-May-09	15:20	92	33.99570	-76.38602	SE	9	3	90°	3	Recreational fishing vessel
31-May-09	15:20	71	33.98600	-76.37053	SE	9	2	60°	1	Recreational fishing vessel
31-May-09	15:22	93	33.96181	-76.33654	SE	9	3	90°	1	Recreational fishing vessel
31-May-09	15:31	96	33.79053	-76.03628	SE	9	1	90°	1	Sailboat
31-May-09	15:41	99	34.01949	-76.28083	NW	10	3	100°	1	Recreational fishing vessel
31-May-09	15:43	100	34.05291	-76.33617	NW	10	3	90°	1	Recreational fishing vessel
31-May-09	15:53	103	34.17704	-76.50996	NW	10	1	90°	1	Recreational fishing vessel
31-May-09	15:57	79	34.26891	-76.60911	NW	10	2	30°	1	Recreational fishing vessel
1-Jun-09	9:59	5	33.87818	-76.75325	SE	5	1	90°	1	Recreational fishing vessel
1-Jun-09	10:01	7	33.83674	-76.69891	SE	5	3	60°	1	Recreational fishing vessel
1-Jun-09	10:39	11	33.84880	-76.57665	NW	6	3	90°	1	Recreational fishing vessel
1-Jun-09	10:48	14	34.04424	-76.84339	NW	6	3	90°	1	Recreational fishing vessel
1-Jun-09	11:08	25	34.02908	-76.68681	SE	7	1	90°	1	Recreational fishing vessel
1-Jun-09	11:10	22	33.97174	-76.60860	SE	7	3	90°	1	Recreational fishing vessel
1-Jun-09	11:13	26	33.91286	-76.52969	SE	7	1	90°	1	Sail boat
1-Jun-09	11:18	29	33.86982	-76.47661	SE	7	2	90°	1	Recreational fishing vessel
1-Jun-09	11:19	30	33.85142	-76.44963	SE	7	3	90°	1	Recreational fishing vessel
1-Jun-09	11:38	33	33.93902	-76.43165	NW	8	2	90°	1	Recreational fishing vessel
1-Jun-09	11:51	38	34.07193	-76.60959	NW	8	3	90°	1	Recreational fishing vessel
1-Jun-09	11:53	31	34.11927	-76.66502	NW	8	4	90°	1	Recreational fishing vessel
1-Jun-09	12:00	36	34.16405	-76.61550	SE	9	4	90°	1	Head boat
1-Jun-09	12:03	42	34.11266	-76.54450	SE	9	1	90°	1	Recreational fishing vessel
1-Jun-09	12:07	38	33.99957	-76.38849	SE	9	3	135°	1	Recreational fishing vessel
1-Jun-09	12:08	39	33.98047	-76.36898	SE	9	4	90°	2	Recreational fishing vessel
1-Jun-09	12:08	43	33.99341	-76.38208	SE	9	2	90°	10	Recreational fishing vessel
1-Jun-09	12:08	44	33.97476	-76.36158	SE	9	3	90°	2	Recreational fishing vessel
1-Jun-09	12:38	45	34.02313	-76.28281	NW	10	2	90°	4	Recreational fishing vessel
1-Jun-09	12:39	52	34.04852	-76.31739	NW	8	3	90°	1	Recreational fishing vessel
1-Jun-09	12:53	55	34.25146	-76.58285	NW	8	1	90°	3	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
1-Jun-09	14:52	57	33.96097	-76.98842	SE	4	3	45°	1	Recreational fishing vessel
1-Jun-09	15:05	60	33.67508	-76.61151	SE	4	4	45°	1	Recreational fishing vessel
1-Jun-09	15:26	71	33.67311	-76.75174	NW	3	4	90°	1	Recreational fishing vessel
1-Jun-09	15:31	63	33.78344	-76.89090	NW	3	4	60°	1	Recreational fishing vessel
1-Jun-09	15:41	74	33.83252	-77.08241	SE	2	3	45°	1	Recreational fishing vessel
1-Jun-09	15:42	67	33.80933	-77.05423	SE	2	1	60°	1	Recreational fishing vessel
1-Jun-09	15:43	75	33.79002	-77.03035	SE	2	3	60°	1	Recreational fishing vessel
1-Jun-09	16:22	80	33.67618	-76.88225	SE	2	4	60°	1	Recreational fishing vessel
1-Jun-09	17:31	91	33.71689	-77.06661	NW	1	2	90°	1	
1-Jun-09	17:33	78	33.77404	-77.14093	NW	1	1	45°	1	Recreational fishing vessel
2-Jun-09	9:09	4	34.03761	-76.82988	SE	6	4	90°	1	Sail boat
2-Jun-09	10:09	12	33.94466	-76.83870	NW	5	3	45°	1	Recreational fishing vessel
2-Jun-09	10:15	11	33.94455	-76.96786	SE	4	4	90°	1	Recreational fishing vessel
2-Jun-09	10:16	12	33.92505	-76.94171	SE	4	3	90°	1	Head boat
2-Jun-09	10:19	15	33.86039	-76.85367	SE	4	3	60°	1	Recreational fishing vessel
2-Jun-09	10:20	13	33.82827	-76.81977	SE	4	3	90°	1	Recreational fishing vessel
2-Jun-09	10:21	14	33.81357	-76.79928	SE	4	4	90°	1	Recreational fishing vessel
2-Jun-09	10:46	20	33.70233	-76.78595	NW	3	4	45°	1	Recreational fishing vessel
2-Jun-09	10:49	19	33.75417	-76.85349	NW	3	1	90°	1	Recreational fishing vessel
2-Jun-09	10:53	20	33.86521	-76.99550	NW	3	3	90°	1	Head boat
2-Jun-09	10:53	21	33.84942	-76.97655	NW	3	1	90°	1	Recreational fishing vessel
2-Jun-09	10:59	25	33.83867	-77.09091	SE	2	2	45°	1	Recreational fishing vessel
2-Jun-09	11:23	25	33.74897	-76.97846	SE	2	3	90°	1	Recreational fishing vessel
2-Jun-09	11:27	26	33.67421	-76.87487	SE	2	3	90°	1	Head boat
2-Jun-09	12:01	36	33.61999	-76.93812	NW	1	4	30°	1	Head boat
2-Jun-09	12:01	31	33.62971	-76.95068	NW	1	4	90°	1	Recreational fishing vessel
2-Jun-09	12:04	32	33.67923	-77.02017	NW	1	3	90°	2	Recreational fishing vessel
2-Jun-09	12:06	37	33.72723	-77.07590	NW	1	4	45°	1	Recreational fishing vessel
2-Jun-09	12:07	38	33.76306	-77.12878	NW	1	3	60°	1	Recreational fishing vessel
2-Jun-09	14:00	40	34.22877	-76.55226	SE	10	2	90°	2	Two small boats with lots of buoys
2-Jun-09	14:00	41	34.20859	-76.52912	SE	10	4	30°	1	Recreational fishing vessel
2-Jun-09	14:04	43	34.11846	-76.41178	SE	10	1	90°	1	Recreational fishing vessel
2-Jun-09	14:05	44	34.10624	-76.39640	SE	10	1	90°	1	Recreational fishing vessel
2-Jun-09	14:06	47	34.08216	-76.36564	SE	10	2	45°	1	Recreational fishing vessel
2-Jun-09	14:06	45	34.09209	-76.37830	SE	10	1	90°	1	Recreational fishing vessel
2-Jun-09	14:07	46	34.06405	-76.34315	SE	10	4	90°	1	Recreational fishing vessel
2-Jun-09	14:08	48	34.03339	-76.30400	SE	10	2	45°	1	Recreational fishing vessel
2-Jun-09	14:08	48	34.03483	-76.30566	SE	10	2	90°	1	Recreational fishing vessel
2-Jun-09	14:31	54	33.99183	-76.38030	NW	9	3	90°	1	Recreational fishing vessel
2-Jun-09	14:31	54	33.99139	-76.37966	NW	9	4	90°	1	Recreational fishing vessel
2-Jun-09	14:46	57	34.12808	-76.68080	SE	8	4	90°	2	Recreational fishing vessel
2-Jun-09	14:49	59	34.06381	-76.59602	SE	8	4	90°	1	Recreational fishing vessel
2-Jun-09	14:50	58	34.02253	-76.54579	SE	8	3	45°	1	Recreational fishing vessel
2-Jun-09	14:53	61	33.95435	-76.45751	SE	8	4	30°	2	Recreational fishing vessel
2-Jun-09	15:18	65	33.87454	-76.47600	NW	7	2	90°	2	Recreational fishing vessel
2-Jun-09	15:20	66	33.90724	-76.52172	NW	7	2	90°	1	Recreational fishing vessel

Table 20 (Continued). All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from July 2008 to June 2009.

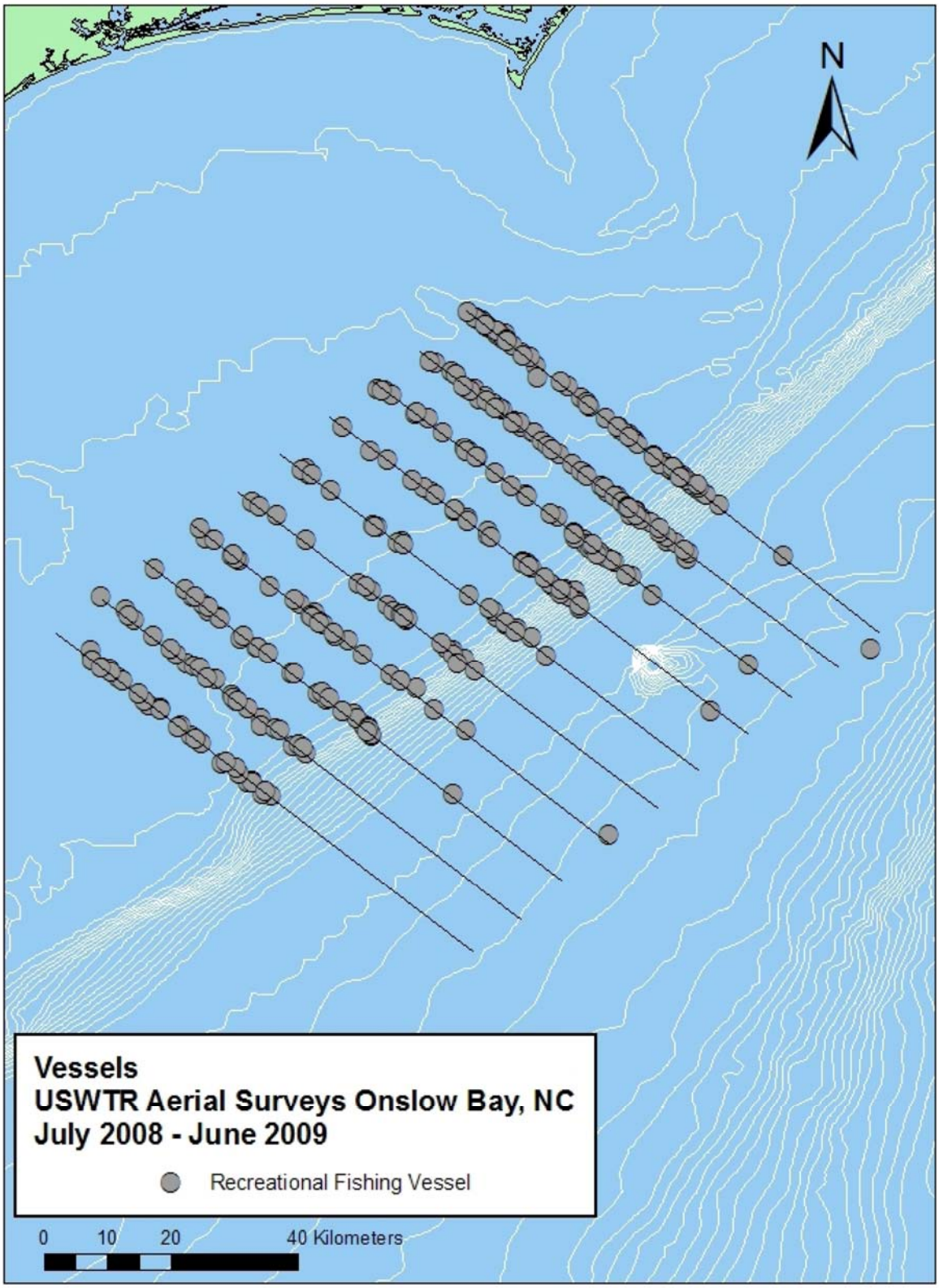

Figure 16. Recreational fishing vessel sightings.

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Date:_____ **Pilot:**_____ **Co-Pilot:**_____ **Page**_____

Left Observer :_____ **Right Observer:**_____ **Hobbs:**_____

Time	Waypoint #	Event	Heading	Track #	Obsrv #	Visibility	BSS	Cloud	Glare L	Glare R	Horizontal degree	Vertical Angle	Sighting Cue	Species	Reliability	Min #	Max #	Best Est	Comme

Appendix B

Codes for Variables on USWTR Aerial Survey Data Sheet

Date: YYYYMMDD **Track#:** opportunistic track line=99

Event:

1.1 = On effort/on track
1.2 = Off effort

3.1 = Change in environmental conditions

10.0 = Opportunistic sighting(s)
PF = Preflight
XB = Cross Beach
WU = Wheels Up
WD = Wheels Down
TE = Transit Leg on Effort

2.0 = Sighting-breaking track/off effort (real time)
2.2 = Sighting of commercial fishing vessel
2.3 = Vessel sighting
2.4 = Sighting of marine mammal (real location)
2.41 = Location of Sighting Cue, No Animals sighted
2.42 = Break from sighting
2.7 = Sighting of sea turtle (real location)
2.8 = Sighting of large vessel (Military, commercial, etc.)
2.9 = Unidentified sighting, requires comments

Sighted by: 1= pilot 2= co-pilot 3= observer left side 4= observer right side

Confidence of cue
1 = definite
2 = probable
3 = possible/unsure

Visibility:
1 = clear to horizon
2 = half the distance to the horizon
3 = less than half the distance to the horizon

Sea State:
0 = slick, calm, mirror-like
1 = small waves
2 = whitecaps 0-33%, waves 1-2 feet
3 = whitecaps 33-50%, waves 2-3 feet
4 = whitecaps 50-65%, waves 3-5 feet
5 = whitecaps >65%, waves >5 feet
6 = too rough too survey

Sighting Cues:
1 = Blow
2 = Splash
3 = Body Part
4 = Breach
5 = Other (needs comments)

Cloud Cover:
01 = clear
02 = partly cloudy
03 = continuous layer of clouds
04 = rain
05 = haze
99 = other, requires comments

Vertical Angle is given in rough increments of 20 degrees with 1 being directly on the trackline and 5 being anything outside of survey wide to horizon

Horizontal Angle is given assuming the nose of the plane is 0 degrees and directly off the wing is 90 degrees – measurements are taken from 1-180 on each side of the plane.

Glare
0 = No glare 1 = 0-25 %
2 = 25 -50 % 3 = >50%

Appendix B

Species List for Aerial Surveys		
Common Name	**Scientific Name**	**Species Code**
Cetaceans		
North Atlantic right whale	*Eubalaena glacialis*	Egl
minke whale	*Balaenoptera acutorostrata*	Bac
sei whale	*Balaenoptera borealis*	Bbo
fin whale	*Balaenoptera physalis*	Bph
Brydes whale	*Balaenoptera edeni*	Bed
humpback whale	*Megaptera novaeangliae*	Mno
unidentified balaenopterid	Family *Balaenopteridae*	BALA
sperm whale	*Physeter catadon*	Pca
pygmy sperm whale	*Kogia breviceps*	Kbr
dwarf sperm whale	*Kogia simus*	Ksi
unidentified Kogia	*Kogia* spp.	KOGI
bottlenose whale	*Hyperodon ampullatus*	Ham
Cuvier's beaked whale	*Ziphius cavirostris*	Zca
Mesoplodon beaked whale	Genus *Mesoplodon*	MESO
unidentified beaked whale	Family *Ziphiidae*	ZIPH
harbor porpoise	*Phocoena phocoena*	Pph
killer whale	*Orcinus orca*	Oor
melon-headed whale	*Peponocephala electra*	Pel
pygmy killer whale	*Feresa attenuata*	Fat
false killer whale	*Pseudorca crassidens*	Pcr
Risso's dolphin	*Grampus griseus*	Ggr
long-finned pilot whale	*Globicephala melaena*	Gme
short-finned pilot whale	*Globicephala macrorhynchus*	Gma
unidentified pilot whale	Genus *Globicephala*	GLOB
rough-toothed dolphin	*Steno bredanensis*	Sbr
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	Lac
Fraser's dolphin	*Lagenodelphis hosei*	Lho
common dolphin	*Delphinus delphis*	Dde
bottlenose dolphin	*Tursiops truncatus*	Ttr
spotted dolphin	*Stenella frontalis*	Sfr
striped dolphin	*Stenella coeruleoalba*	Sco
spinner dolphin	*Stenella clymene*	Scl
unidentified *Stenella*	Genus *Stenella*	STEN
unidentified delphinid	Family *Delphinidae*	DELP
unidentified cetacean		CETA
Pinnipeds		
gray seal	*Halichoerus grypus*	Hgr
harbor seal	*Phoca vitulina*	Pvi
harp seal	*Phoca groenlandica*	Pgr
hooded seal	*Cystophora cristata*	Ccr
unidentified phocid	Family *Phocidae*	PHOC
Sea Turtles		
loggerhead	*Caretta caretta*	Cca
leatherback	*Dermochelys coriacea*	Dco
green	*Chelonia mydas*	Cmy
Kemp's ridley	*Lepidochelys kempii*	Lke
hawksbill	*Eretmochelys imbricata*	Eim
unidentified sea turtle		TURT
Other interesting sightings		
basking shark	*Cetorhinus maximus*	Cma
manta ray	*Manta birostris*	Mbi
ocean sunfish	*Mola mola*	Mmo
spotted eagle-ray	*Aetobatus narinari*	Ana
Unidentified elasmobranch Unidentified marine vertebrate		CHON VERT

Date:_____ - UNCW USWTR Aerial Survey - Sighting #_____

Sighting Data Sheet

Initial Sighting on Track

Time:_____ WP:_____ Sighting Cue:_____

Confidence: 1 2 3 4 Vertical Angle: 1 2 3 4 Horizontal Bearing in Degrees:_____

Observer:_____ Observer Side: L R

Beaufort Sea State: _____ Track Line: _____

Actual Time and Position of Sighting

Time: _____ WP #:_____

Species: _____ Numbers: (Low/ High/ Best):____/____/____

Photographer:_____ Frame Numbers: _____ to _____ Spacer:_____

Final Time and Position of Sighting

Time: _____ WP#: _____

Behavior and Additional Comments:

Complete Sighting Summaries.

Compiled here are all sighting summaries for animals seen during the July 2008-June 2009 USWTR Onslow Bay survey season. Each of the 64 on effort cetacean sightings is represented along with four additional sightings. Sighting 1 on July 16, 2008 and sighting 2 on October 16, 2008 were off effort sightings that occurred during transit between two USWTR track-lines. Sighting 2 on June 1, 2009 occurred within the USWTR range but was seen by the flights co-pilot and is thus recorded as an off effort sighting. Finally a summary was included for the right whale sighting made on December 30, 2008. This sighting was made a few miles off the coast of the north end of Wrightsville Beach and is included because of it importance in the conservation of the species.

Wednesday, July 16, 2008 Sighting # 1

Initial sighting on Track

Time: NA WP#: NA Lat: NA Long: NA
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: Off Trackline: between 2 - 3 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 15:26 WP#: 60 Lat: 33.450539 Long: -76.458058
Species: *Grampus griseus* Numbers (Low/High/Best): 15 / 25 / 20
Features used in Species ID: Blunt or square head, body color dark with light "suspenders" on flanks, tall falcate dorsal fin.
Representative images used for Species ID: 666, 672, 673, 678
Photographer: RJM Frame numbers: 639 to 690 Spacer: None
Calculated distance from Trackline: NA

Final Time and Position of Sighting

Time: NA WP#: NA Lat: NA Long: NA
Calculated Distance Traveled: NA

Behavior and Additional Comments

When first sighted 3 to 5 animals "surfing" front side of waves, later group increased its rate of travel and began preforming low leaps and breaches. Heavy rains during the sighting. Animals leaping and fast "erratic movements, and non directional travel. Group spread out over hundreds of meters, split into smaller sub-groups of pairs, trios or groups of 4-5. Calves were observed

Thursday, July 17, 2008 Sighting # 1

Initial sighting on Track

Time: 9:45 WP#: 8 Lat: 33.860647 Long: -76.078314
Vertical Angle: 3 Horizontal Bearing in Degrees: 60 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 3
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 9:44 WP#: 9 Lat: 33.86417 Long: -76.080665
Species: *Globicephala macrorhynchus* Numbers (Low/High/Best): 12 / 20 / 18
Features used in Species ID: Dark body, square melon, robust dorsal fin situated ~ 1/3 of the way back the animals body.
Representative images used for Species ID: 698, 703, 711, 712, 722, 724, 725, 731, 739, 752, 754
Photographer: PBN Frame numbers: 692 to 793 Spacer: 794
Calculated distance from Trackline: 0.5 km

Final Time and Position of Sighting

Time: 9:54 WP#: 11 Lat: 33.860877 Long: -76.077699
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Animals moving slowly and spending much of the time below the surface. Initial sighting was of a group of 4 to 6 animals near the original group exhibiting the same behavior. After circling the animals for a short period, individuals began moving closer to one another but did not change any other behavior. Calves were observed

Thursday, July 17, 2008 Sighting # 2

Initial sighting on Track

Time: 11:00 WP#: 26 Lat: 33.767799 Long: -76.341207
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Splash
On/Off Effort: On Trackline: 7 Beaufort Sea State: 3
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 11:02 WP#: 27 Lat: 33.764159 Long: -76.349701
Species: *Tursiops truncatus* Numbers (Low/High/Best): 25 / 30 / 30
Features used in Species ID: Short rostrum, uniform gray lateral coloration, robust body, and a broad based dorsal fin.
Representative images used for Species ID: 804, 807, 831, 833, 834, 836
Photographer: PBN Frame numbers: 795 to 840 Spacer: 841
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 11:06 WP#: 31 Lat: 33.768778 Long: -76.365262
Calculated Distance Traveled: 1.5 km

Behavior and Additional Comments

Animals in three closely paced groups following one another and traveling fast. Animals broke the surface briefly while surfacing to breathe and created large splashes and bubble trails.

No calves were observed

Thursday, July 17, 2008 Sighting # 3

Initial sighting on Track

Time: 11:44 WP#: 40 Lat: 33.692073 Long: -76.378848
Vertical Angle: 3 Horizontal Bearing in Degrees: 120 Sighting Cue: Splash
On/Off Effort: On Trackline: 6 Beaufort Sea State: 2
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 11:45 WP#: 41 Lat: 33.698622 Long: -76.380418
Species: *Tursiops truncatus* Numbers (Low/High/Best): 8 / 12 / 12
Features used in Species ID: Robust body appearance, uniform gray color with light shoulder blaze ending behind the dorsal fin. Short rostrum with crease at the intersection with the melon.
Representative images used for Species ID: 857, 860, 862, 864, 865, 868, 871, 873
Photographer: PBN Frame numbers: 852 to 877 Spacer: 878
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 11:51 WP#: 42 Lat: 33.700454 Long: -76.37529
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Animals were moving in a closely packed group swimming very fast and causing a large splash when surfacing. Individuals overlapping and changing position within the group as they continued in one direction.

No calves were observed

Friday, July 17, 2009 Sighting # 4

Initial sighting on Track

Time: 11:44 WP#: 40 Lat: 33.692073 Long: -76.37885
Vertical Angle: 3 Horizontal Bearing in Degrees: 120 Sighting Cue: Body
On/Off Effort: On Trackline: 6 Beaufort Sea State: 2
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 11:54 WP#: 43 Lat: 33.703817 Long: -76.380409
Species: *Globicephala macrorhynchus* Numbers (Low/High/Best): 10/12/12
Features used in Species ID: Dark body, bulbous/square melon, backwards sloping dorsal fin positioned far anterior on animal
Representative images used for Species ID: 847, 850, 893, 897, 900, 904, 912, 913, 916, 929, 933
Photographer: PBN Frame numbers: 842 - 972 Spacer: 973
Calculated distance from Trackline: 1.3 km

Final Time and Position of Sighting

Time: 12:09 WP#: 44 Lat: 33.709303 Long: -76.37812
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments

Group made up of singles or pairs of animals in a well spaced line. During almost the entire observation period individuals were hanging at the surface holding very still taking occasional breaths. At first there were around 7 animals "resting" at the surface but by the end of the encounter all animals were hanging at the surface. There were calves observed.

2 August 2008 Sighting # 1

Initial sighting on Track

Time: 10:54 WP#: 25 Lat: 33.791186 Long: -76.791186
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 3 Beaufort Sea State: 2
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 10:56 WP#: 26 Lat: 33.789778 Long: -76.893012
Species: *Stenella frontalis* Numbers (Low/High/Best): 21/23/22
Features used in Species ID: White rostrum tip, coloration patterns (spots, blaze on flanks, alternating dark and light "bands" when viewed from above)
Representative images used for Species ID: 1123, 1124, 1128, 1129, 1130, 1134, 1136, 1141
Photographer: RJM Frame numbers: 1102 - 1143 Spacer: 1144
Calculated distance from Trackline: 0.6 km

Final Time and Position of Sighting

Time: 11.01 WP#: 22 Lat: 33.789455 Long: -76.890461
Calculated Distance Traveled: 0.2 km

Behavior and Additional Comments

Animals traveling "in a long line". Four mother/calf pairs, at least two of the calves seemed very small.

Tuesday, August 4, 2009 Sighting # 1

Initial sighting on Track

Time: 12:37 WP#: 44 Lat: 34.01310 Long: -76.26651
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 12:38 WP#: 45 Lat: 34.01133 Long: -76.27702
Species: *Tursiops truncatus* Numbers (Low/High/Best): 9/11/9
Features used in Species ID: Short rostrums, gray, sturdy/stocky, darker dorsal cape evident on some animals
Representative images used for Species ID: 1159, 1162, 1164, 1168, 1175, 1177
Photographer: RJM Frame numbers: 1145 - 1183 Spacer: 1184
Calculated distance from Trackline: 1.0 km

Final Time and Position of Sighting

Time: 12:51 WP#: 46 Lat: 34.01169 Long: -76.28705
Calculated Distance Traveled: 0.9 km

Behavior and Additional Comments

Fast travel, lots of splashes. Long dive times, lost dolphins several times (in BSS 2 with good sighting conditions) - evasive behavior of feeding? One mother/calf pair (calf seemed very small, less then half of the length of the mother).

15 October 2008 Sighting # 1

Initial sighting on Track

Time: 9:40 WP#: 6 Lat: 33.621686 Long: -76.421251
Vertical Angle: 3 Horizontal Bearing in Degrees: 60 Sighting Cue: Body
On/Off Effort: On Trackline: 5 Beaufort Sea State: 3
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 9:41 WP#: 7 Lat: 33.616653 Long: -76.415914
Species: *Tursiops truncatus* Numbers (Low/High/Best): 20/30/25
Features used in Species ID: Sturdy animals with short rostrums, distinct high cape
Representative images used for Species ID: 1286, 1302, 1306 - 1308
Photographer: RJM Frame numbers: 1271 - 1312 Spacer: None
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 9:51 WP#: 8 Lat: 33.618865 Long: -76.421931
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments

Spaced out group - loose aggregation. Overall shape, size and color of animals seem to indicate T. truncatus. Subgroups of 2-4 animals in each spread out over a few hundred meters. Fairly quick travel.

No calves were observed.

Thursday, October 15, 2009 Sighting # 2

Initial sighting on Track

Time: 13:59 WP#: 39 Lat: 34.082779 Long: -76.756875
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 14:02 WP#: 40 Lat: 34.088073 Long: -76.760254
Species: *Tursiops truncatus* Numbers (Low/High/Best): 3/3/3
Features used in Species ID: Fairly large, falcate dorsal fin, over all sturdy impression, short rostrums, dark high cape
Representative images used for Species ID: 1313, 1317, 1318, 1323, 1326
Photographer: RJM Frame numbers: 1313 - 1357 Spacer: None
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 14:12 WP#: 41 Lat: 34.098269 Long: -76.764306
Calculated Distance Traveled: 1.2 km

Behavior and Additional Comments

Slow traveling, mainly subsurface. Close together.

No calves were observed.

15 October 2008 Sighting # 3

Initial sighting on Track

Time: 14:45 WP#: 50 Lat: 33.891100 Long: -76.373233
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 3
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 14:46 WP#: 51 Lat: 33.892292 Long: -76.370334
Species: *Tursiops truncatus* Numbers (Low/High/Best): 16 / 22 / 19
Features used in Species ID: High, distinct dark gray cape, falcate dorsal fin, short rostrum
Representative images used for Species ID: 1361 - 1363, 1374, 1375, 1381 - 1383, 1390, 1391
Photographer: RJM Frame numbers: 1358 - 1404 Spacer: None
Calculated distance from Trackline: 0.3 km

Final Time and Position of Sighting

Time: 14:51 WP#: 52 Lat: 33.888667 Long: -76.366554
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Traveling in a "bent" line, in sub-groups of 2 to 4, separated by tens of meters, looks like Tursiops.

No calves were observed.

16 October 2008 Sighting # 1

Initial sighting on Track

Time: 15:11 WP#: 40 Lat: 33.42462 Long: -76.556023
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 2 Beaufort Sea State: 2
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 15:11 WP#: 41 Lat: 33.432662 Long: -76.562262
Species: *Tursiops truncatus* Numbers (Low/High/Best): 1/1/1
Features used in Species ID: Short rostrum length, robust body, lateral blaze ending behind dorsal fine, white coloration on dorsal side of peduncle
Representative images used for Species ID: 1416, 1418, 1419, 1421, 1423, 1430,1432, 1438-1442
Photographer: PBN Frame numbers: 1407 - 1446 Spacer: 1447
Calculated distance from Trackline: 1.065 km

Final Time and Position of Sighting

Time: 15:14 WP#: 42 Lat: 33.437478 Long: -76.563115
Calculated Distance Traveled: 0.54113 km

Behavior and Additional Comments

Single animal moving mainly subsurface with fairly good disturbance at surface when surfacing.

No calves were observed.

16 October 2008 Sighting # 2

Initial sighting on Track

Time: N/A WP#: N/A Lat: N/A Long: N/A
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: Off Trackline: 1 and 2 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 15:19 WP#: 45 Lat: 33.370941 Long: -76.551326
Species: *Tursiops truncatus* Numbers (Low/High/Best): 2/2/2
Features used in Species ID: Short rostrum, robust body, blaze ending behind dorsal fin, rounded dorsal fin
Representative images used for Species ID: 1454, 1461 - 1465, 1472, 1474, 1477 - 1480
Photographer: PBN Frame numbers: 1448 - 1485 Spacer: 1486
Calculated distance from Trackline: N/A

Final Time and Position of Sighting

Time: N/A WP#: N/A Lat: N/A Long: N/A
Calculated Distance Traveled: N/A

Behavior and Additional Comments

No calves were observed.

23 November 2008 Sighting # 1

Initial sighting on Track

Time: 09:35 WP#: 6 Lat: 34.255539 Long: -77.351924
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 9:35 WP#: 7 Lat: 34.241088 Long: -77.355752
Species: *Stenella frontalis* Numbers (Low/High/Best): 25/40/30
Features used in Species ID: Coloration pattern, blaze on flanks, white rostrum tip

Representative images used for Species ID: 1593, 1594, 1603, 1606, 1607, 1615, 1616
Photographer: RJM Frame numbers: 1591-1617 Spacer: 1618
Calculated distance from Trackline: 1.6 km

Final Time and Position of Sighting

Time: 09.43 WP#: 8 Lat: 34.245668 Long: -77.356000
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Three groups - active. Lots of surface activity. Track Line was an on effort
transit from shore to track line 10. On effort but not in range.

No calves were observed.

23 November 2008 Sighting # 2

Initial sighting on Track

Time: 10:30 WP#: 23 Lat: 33.865154 Long: -76.083604
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 10:31 WP#: 24 Lat: 33.8732 Long: -76.085829
Species: *Tursiops truncatus* Numbers (Low/High/Best): 40/50/45
Features used in Species ID: Light caudal peduncle, distinctive dark gray dorsal cape, short rostrum

Representative images used for Species ID: 1648, 1650, 1651, 1654, 1656, 1657, 1658
Photographer: RJM Frame numbers: 1638-1658 Spacer: 1659
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 10:37 WP#: 26 Lat: 33.868425 Long: -76.094426
Calculated Distance Traveled: 0.95 km

Behavior and Additional Comments

In two groups, not bunched up. "Leisurely" travel.

Calves were observed.

Sunday, November 23, 2008 Sighting # 3

Initial sighting on Track

Time: 10:52 WP#: 30 Lat: 33.951376 Long: -76.327504
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 9 Beaufort Sea State: 2
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 10:53 WP#: 31 Lat: 33.953335 Long: -76.328943
Species: *Tursiops truncatus* Numbers (Low/High/Best): 12/15/13
Features used in Species ID: Dark gray dorsal cape, light dorsal caudal peduncle

Representative images used for Species ID: 1664, 1665, 1671, 1672, 1676, 1677
Photographer: RJM Frame numbers: 1660 - 1686 Spacer: 1687
Calculated distance from Trackline: 0.25 km

Final Time and Position of Sighting

Time: 10:58 WP#: 32 Lat: 33.951673 Long: -76.330678
Calculated Distance Traveled: 0.24 km

Behavior and Additional Comments

Lots of activity, looks like social interaction (chasing). A shark observed in the group of dolphins - the latter seemed to ignore the former. Tight group - lots of white water.

No calves were observed.

23 November 2008 Sighting # 4

Initial sighting on Track

Time: 11:31 WP#: 42 Lat: 33.844468 Long: -76.312427
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 11:32 WP#: 43 Lat: 33.846505 Long: -76.310977
Species: *Tursiops truncatus* Numbers (Low/High/Best): 19/23/21
Features used in Species ID: Short rostrum, gray, with darker gray cape, light peduncle

Representative images used for Species ID: 1692 - 1695, 1704, 1706
Photographer: RJM Frame numbers: 1688 - 1709 Spacer: 1710
Calculated distance from Trackline: 0.26 km

Final Time and Position of Sighting

Time: N/A WP#: N/A Lat: N/A Long: N/A
Calculated Distance Traveled: N/A

Behavior and Additional Comments

Lots of activity - "chasing" - feeding or socializing?

No calves were observed.

23 November 2008 Sighting # 5

Initial sighting on Track

Time: 15:50 WP#: 76 Lat: 33.67022 Long: -77.00662
Vertical Angle: 3 Horizontal Bearing in Degrees: 120 Sighting Cue: Splash
On/Off Effort: On Trackline: 1 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 15:52 WP#: 90 Lat: 33.657244 Long: -77.008915
Species: *Stenella frontalis* Numbers (Low/High/Best): 20/40/30
Features used in Species ID: Alternating dark and light color patterns, white rostrum tip, blaze on flanks
Representative images used for Species ID: 1756, 1796, 1797, 1804, 1805
Photographer: RJM Frame numbers: 1726 - 1617 Spacer: 1618
Calculated distance from Trackline: 1.5 km

Final Time and Position of Sighting

Time: 16:08 WP#: 91 Lat: 33.651022 Long: -77.017208
Calculated Distance Traveled: 1.0 km

Behavior and Additional Comments

Fast moving, not showing a lot. In singles and small groups of up to five animals. Group spread out over several hundred meters.

No calves were observed.

30 December 2008 Sighting # 1

Initial sighting on Track

Time: 10:56 WP#: 11 Lat: 34.22702 Long: -77.68047
Vertical Angle: NA Horizontal Bearing in Degrees: N/A Sighting Cue: Body
On/Off Effort: Off Trackline: N/A Beaufort Sea State: 2
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 10:56 WP#: 12 Lat: 34.224482 Long: -77.684875
Species: *Eubalaena glacialis* Numbers (Low/High/Best): 2/2/2
Features used in Species ID: Unmistakable; large, black, rotund whale, lacking a dorsal fin and with multiple white callosities on head
Representative images used for Species ID: 2511 - 2513, 2535, 2545, 2721, 2726, 2738
Photographer: PBN Frame numbers: 2499 - 2745 Spacer: N/A
Calculated distance from Trackline: 0.49 km

Final Time and Position of Sighting

Time: 11:18 WP#: 19 Lat: 34.229141 Long: -77.688053
Calculated Distance Traveled: 0.59

Behavior and Additional Comments

Right whale cow/calf pair, female later identified by UNCW and NEAq as Eg # 2223 - "Calvin". The calf seemed small, spent a lot of time around the head of female. The general direction of travel was south. Midway into sighting small recreational vessel (a "Carolina Skiff") approached whales with 100-150m. Three attempts made from plane to contact vessel via VHF 16, no contact was made. Reported to USCG.

Saturday, February 7, 2009 Sighting # 1

Initial sighting on Track

Time: 9:46 WP#: 11 Lat: 33.719172 Long: -76.410534
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 6 Beaufort Sea State: 3
Observer: ECW Observer side: Left

Actual Time and Position of Sighting

Time: 9:49 WP#: 13 Lat: 33.708546 Long: -76.412508
Species: *Tursiops truncatus* Numbers (Low/High/Best): 40 / 60 / 50
Features used in Species ID: Robust body type, compact rostrum with clear crease at melon, uniform gray body coloration withlight blaze terminating behind dorsal fin.
Representative images used for Species ID: 9, 34, 36, 38, 39
Photographer: RJM Frame numbers: 1 to 40 Spacer: 41
Calculated distance from Trackline: 1.196 km

Final Time and Position of Sighting

Time: 9:53 WP#: 14 Lat: 33.709904 Long: -76.418734
Calculated Distance Traveled: 0.5954 km

Behavior and Additional Comments

Animals were widely spaced traveling singly or in pairs in a southeast direction. Animals spent most of their time just below the surface with some diving deeper and occasionally swimming belly to belly.

No calves were observed

Saturday, February 7, 2009 Sighting # 2

Initial sighting on Track

Time: 11:29 WP#: 39 Lat: 33.973833 Long: -76.23032
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 3
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 11:30 WP#: 40 Lat: 33.974045 Long: -76.215818
Species: *Tursiops truncatus* Numbers (Low/High/Best): 20 / 40 / 30
Features used in Species ID: Light caudal peduncle, distinctive dark gray dorsal cape, short rostrum, shoulder blaze to behind dorsal fin.
Representative images used for Species ID: 54, 61, 64, 79
Photographer: RJM Frame numbers: 49 to 80 Spacer: 81
Calculated distance from Trackline: 1.337 km

Final Time and Position of Sighting

Time: 11:32 WP#: 41 Lat: 33.976973 Long: -76.222186
Calculated Distance Traveled: 0.6714 km

Behavior and Additional Comments

Animals were traveling southwest just below the surface in a dispersed group with some animals preforming shallow dives.

No calves were observed

Saturday, February 7, 2009 Sighting # 3

Initial sighting on Track

Time: 14:15 WP#: 54 Lat: 33.791670 Long: -76.900267
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 3 Beaufort Sea State: 3
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 14:20 WP#: 55 Lat: 33.791982 Long: -76.899026
Species: *Stenella frontalis* Numbers (Low/High/Best): 30 / 50 / 40
Features used in Species ID: Shoulder blaze, white tip to beak and spotting pattern on flanks of body.
Representative images used for Species ID: 211, 215 and 217
Photographer: RJM Frame numbers: 194 to 244 Spacer: 245
Calculated distance from Trackline: 0.1198 km

Final Time and Position of Sighting

Time: 14:27 WP#: 56 Lat: 33.790089 Long: -76.909362
Calculated Distance Traveled: 0.9781 km

Behavior and Additional Comments

Animals were traveling quickly just below the surface occasionally jumping out of the water while surfacing. Group would disperse and then reform with animals traveling in many directions while within the group.

Saturday, February 7, 2009 Sighting # 4

Initial sighting on Track

Time: 14:46 WP#: 61 Lat: 33.638620 Long: -76.839465
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 2 Beaufort Sea State: 3
Observer: ECW Observer side: Left

Actual Time and Position of Sighting

Time: 14:49 WP#: 63 Lat: 33.642891 Long: -76.833414
Species: *Stenella frontalis* Numbers (Low/High/Best): 70 / 100 / 90
Features used in Species ID: Shoulder blaze, white tipped beak and spotting pattern on flanks of body.
Representative images used for Species ID: 253, 254, 258, 277, 278, 281, 285, 290, 292, 297
Photographer: RJM Frame numbers: 246 to 305 Spacer: 306
Calculated distance from Trackline: 0.7344 km

Final Time and Position of Sighting

Time: 14:57 WP#: 64 Lat: 33.654001 Long: -76.823448
Calculated Distance Traveled: 1.542 km

Behavior and Additional Comments

A large number of animals but well dispersed with majority in small groups of 2-3. Animals appear to be milling, traveling in all different directions, swimming just below the surface with conspicuous surfacing. One group branched off and formed a bigger group but then dispersed again.

Tuesday, February 17, 2009 Sighting # 1

Initial sighting on Track

Time: 14:39 WP#: 36 Lat: 34.08356 Long: -76.496163
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 9 Beaufort Sea State: 3
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 14:42 WP#: 38 Lat: 34.08632 Long: -76.500645
Species: *Stenella frontalis* Numbers (Low/High/Best): 28 / 35 / 30
Features used in Species ID: Alternating light and dark dorsal areas, white rostrum tip, and spotted appearance on sides.
Representative images used for Species ID: 4219, 4220, 4223, 4226, 4234, 4250
Photographer: PBN Frame numbers: 4208 to 4255 Spacer: 4256
Calculated distance from Trackline: 0.5 km

Final Time and Position of Sighting

Time: 14:48 WP#: 39 Lat: 34.09173 Long: -76.496073
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments

Animals traveling away from track line in a tight bunch close to the surface. A slow rate of travel in a variety of directions was observed (milling)

No calves were observed

Wednesday, March 4, 2009 Sighting # 1

Initial sighting on Track

Time: 10:45 WP#: 21 Lat: 33.763459 Long: -76.184182
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 4
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: NA WP#: NA Lat: NA Long: NA
Species: *Unidentified Delphinid* Numbers (Low/High/Best): 3 / 3 / 3
Features used in Species ID:
Representative images used for Species ID: NA
Photographer: NA Frame numbers: NA Spacer: NA
Calculated distance from Trackline: NA

Final Time and Position of Sighting

Time: NA WP#: NA Lat: NA Long: NA
Calculated Distance Traveled: NA

Behavior and Additional Comments

A group of three dolphins with no seen after the initial sighting cue.

No calves were observed

Wednesday, March 4, 2009 Sighting # 2

Initial sighting on Track

Time: 14:12 WP#: 36 Lat: 33.768266 Long: -76.737506
Vertical Angle: 3 Horizontal Bearing in Degrees: 110 Sighting Cue: Body
On/Off Effort: On Trackline: 4 Beaufort Sea State: 3
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 14:16 WP#: 37 Lat: 33.770836 Long: -76.734183
Species: *Stenella frontalis* Numbers (Low/High/Best): 15 / 16 / 15
Features used in Species ID: Overall color pattern of alternating light and dark areas with a white tip to rostrum and a light shoulder blaze
Representative images used for Species ID: 4887, 4891, 4904, 4905, 4915, 4919
Photographer: RJM Frame numbers: 4883 to 4935 Spacer: 4936
Calculated distance from Trackline: 0.4195 km

Final Time and Position of Sighting

Time: 14:22 WP#: 38 Lat: 33.761217 Long: -76.722312
Calculated Distance Traveled: 1.532 km

Behavior and Additional Comments

Animals look small during initial sighting sequence. Animals formed a "disorganized" group with multiple changes in direction and where loosely associated. Overall coloration pattern suggested Stenella frontalis

No calves were observed

Wednesday, March 4, 2009 Sighting # 3

Initial sighting on Track

Time: 15:09 WP#: 52 Lat: 33.669594 Long: -76.885527
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 2 Beaufort Sea State: 2
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 15:10 WP#: 53 Lat: 33.672379 Long: -76.886136
Species: *Stenella frontalis* Numbers (Low/High/Best): 90 / 110 / 100
Features used in Species ID: Light blaze on flank, alternating light and dark areas starting with white tip of rostrum
Representative images used for Species ID: 4961, 4965, 4973-4974, 4980, 5012
Photographer: RJM Frame numbers: 4937 to 5018 Spacer: 5019
Calculated distance from Trackline: 0.3148 km

Final Time and Position of Sighting

Time: NA WP#: NA Lat: None taken Long: None taken
Calculated Distance Traveled: NA

Behavior and Additional Comments

Large group, split into two groups. Apparent social interactions. Loose, "disorganized" group. Fast movements, low leaping surfacings, belly to belly swimming. Group created lots of splashes and white water.

No calves were observed

Thursday, March 5, 2009 Sighting # 1

Initial sighting on Track

Time: 9:19 WP#: 5 Lat: 34.11273 Long: -76.410002
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Splash
On/Off Effort: On Trackline: 10 Beaufort Sea State: 1
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 9:22 WP#: 6 Lat: 34.11399 Long: -76.41024
Species: *Tursiops truncatus* Numbers (Low/High/Best): 4 / 4 / 4
Features used in Species ID: Uniform gray coloration, blunt rostrum and robust dorsal fin.

Representative images used for Species ID: 5027, 5043, 5055
Photographer: PBN Frame numbers: 5019 to 5061 Spacer: 5062
Calculated distance from Trackline: 0.1418 km

Final Time and Position of Sighting

Time: 9:34 WP#: 7 Lat: 34.11437 Long: -76.39691
Calculated Distance Traveled: 1.228 km

Behavior and Additional Comments

Original sighting of 3 animals were seen splashing at the surface and traveling at a slow rate of speed. During sighting a fourth dolphin was seen at which time animals were in two groups of two and widely spaced from one another. Animals performed faster surfacing and increased rate of speed. Group form 4 and traveled deep to the surface. Calves observed: Yes img 5035

Thursday, March 5, 2009 Sighting # 2

Initial sighting on Track

Time: 10:09 WP#: 19 Lat: 34.09635 Long: -76.515234
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 9 Beaufort Sea State: 1
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 10:09 WP#: 20 Lat: 34.09381 Long: -76.519452
Species: *Stenella frontalis* Numbers (Low/High/Best): 10 / 20 / 20
Features used in Species ID: Distinguishing light tip to rostrum followed by dark, light alternating pattern along dorsal body. Small flukes and thin peduncles. Shoulder blaze terminates at level of d fin.
Representative images used for Species ID: 5084, 5085, 5092, 5094, 5111
Photographer: PBN Frame numbers: 5063 to 5136 Spacer: 5137
Calculated distance from Trackline: 0.4802 km

Final Time and Position of Sighting

Time: 10:14 WP#: 21 Lat: 34.09541 Long: -76.525093
Calculated Distance Traveled: 0.5491 km

Behavior and Additional Comments

First group of ten that was originally sighted was spread out in a long line traveling in a follow the leader fashion. A second group o f7 was seen about 200m from the first group. All animals were seen milling close to the surface with frequent surfacing. Animals were seen to be interaction with one another with some animals traveling in close pairs and some belly to belly swimming. No calves seen.

Thursday, March 5, 2009 Sighting # 3

Initial sighting on Track

Time: 10:24 WP#: 28 Lat: 34.12206 Long: -76.680634
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 1
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 10:26 WP#: 29 Lat: 34.12227 Long: -76.67842
Species: *Stenella frontalis* Numbers (Low/High/Best): 20 / 25 / 25
Features used in Species ID: Alternating light, dark coloration along dorsal surface with white at tip of rostrum. Thin caudal peduncle before a narrow smaller fluke.
Representative images used for Species ID: 5149, 5151, 5165, 5176
Photographer: PBN Frame numbers: 5138 to 52203 Spacer: 5204
Calculated distance from Trackline: 0.2051 km

Final Time and Position of Sighting

Time: 10:29 WP#: 30 Lat: 34.12716 Long: -76.684693
Calculated Distance Traveled: 0.7931 km

Behavior and Additional Comments

A line of about 20 animals was sighted heading south across our trackline. Group was evenly spaced and traveling slow and close to the surface where they would surface frequently. Animals showed little change in behavior during the sighting.

No calves sighted

Thursday, March 5, 2009 Sighting # 4

Initial sighting on Track

Time: 10:33 WP#: 32 Lat: 34.04629 Long: -76.573132
Vertical Angle: 3 Horizontal Bearing in Degrees: 120 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 1
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 10:37 WP#: 33 Lat: 34.04613 Long: -76.58513
Species: *Tursiops truncatus* Numbers (Low/High/Best): 2 / 2 / 2
Features used in Species ID: Animals with bigger fluke and peduncles than Stenella sp. Dorsal fin was more forward on the body as well.
Representative images used for Species ID: 5208, 5211, 5234, 5235
Photographer: PBN Frame numbers: 5205 to 5236 Spacer: 5237
Calculated distance from Trackline: 1.106 km

Final Time and Position of Sighting

Time: 10:40 WP#: 34 Lat: 34.04273 Long: -76.583253
Calculated Distance Traveled: 0.4157 km

Behavior and Additional Comments

Two animals were seen at the surface and showed little signs of avoidance.

No calves were observed

Thursday, March 5, 2009 Sighting # 5

Initial sighting on Track

Time: 10:43 WP#: 37 Lat: 33.99067 Long: -76.5114
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 1
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 10:44 WP#: 38 Lat: 33.99223 Long: -76.52065
Species: *Stenella frontalis* Numbers (Low/High/Best): 8 / 8 / 8
Features used in Species ID: Alternating light and dark pattern along dorsal surface of animals body. White tip to rostrum, shoulder blaze terminates behind d fin. Clear presence of spotting pattern.
Representative images used for Species ID: 5247, 5276-5279, 5281, 5283, 5302, 5304
Photographer: PBN Frame numbers: 5238 to 5305 Spacer: 5306
Calculated distance from Trackline: 0.8703 km

Final Time and Position of Sighting

Time: 10:50 WP#: 39 Lat: 33.99098 Long: -76.51701
Calculated Distance Traveled: 0.3632 km

Behavior and Additional Comments

A total of 8 animals seen separated into two groups each traveling fast and causing large splashes when surfacing. Second group was more widely spaced than first. As the sighting continued each group began a more leisurely rate of travel with increased time near the surface.
No calves observed

Thursday, March 5, 2009 Sighting # 6

Initial sighting on Track

Time: 11:14 WP#: 46 Lat: 33.67231 Long: -76.214173
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 2
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 11:23 WP#: 47 Lat: 33.69118 Long: -76.21148
Species: *Tursiops truncatus* Numbers (Low/High/Best): 5 / 5 / 5
Features used in Species ID: Animals had robust thoracic region and a a shorter rostrum and crease at junction with melon. High dark dorsal cape. Large set of flukes.
Representative images used for Species ID: 5382, 5401, 5428, 5430, 5431, 5432, 5445
Photographer: PBN Frame numbers: 5307 to 5472 Spacer: 5473
Calculated distance from Trackline: 2.113 km

Final Time and Position of Sighting

Time: 11:24 WP#: 48 Lat: 33.6744 Long: -76.22378
Calculated Distance Traveled: 2.1 km

Behavior and Additional Comments

Initial sighting of 2 animals traveling at moderate speed just below the surface with quick surfacings. An additional 3 animals joined the original group after which the animals spent an increase amount of time deep to the surface while traveling.
No calves were observed

Thursday, March 5, 2009 Sighting # 7

Initial sighting on Track

Time: 11:58 WP#: 66 Lat: 33.89674 Long: -76.646494
Vertical Angle: 1 Horizontal Bearing in Degrees: 120 Sighting Cue: Body
On/Off Effort: On Trackline: 6 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 11:59 WP#: 67 Lat: 33.89721 Long: -76.65398
Species: *Stenella frontalis* Numbers (Low/High/Best): 20 / 24 / 24
Features used in Species ID: Animal with alternating light and dark color patterning along dorsal surface. White tips to the rostrum, narrow peduncle and medium sized flukes.
Representative images used for Species ID: 5479, 5488, 5546
Photographer: PBN Frame numbers: 5474 to 5568 Spacer: 5569
Calculated distance from Trackline: 0.6929 km

Final Time and Position of Sighting

Time: 12:06 WP#: 68 Lat: 33.89888 Long: -76.64758
Calculated Distance Traveled: 0.6192 km

Behavior and Additional Comments

About 20 animals seen traveling slowly at the surface. Group condensed after circling began and then split into 3 groups (6, 12, 4) which all continued to travel just below the surface. Largest group spent increased time deep below the surface making them difficult to relocate - this may have been an avoidance behavior. No calves were observed

Thursday, March 5, 2009 Sighting # 8

Initial sighting on Track

Time: 12:37 WP#: 79 Lat: 33.89318 Long: -76.763212
Vertical Angle: 1 Horizontal Bearing in Degrees: 120 Sighting Cue: Body
On/Off Effort: On Trackline: 6 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 12:38 WP#: 80 Lat: 33.90157 Long: -76.764022
Species: *Stenella frontalis* Numbers (Low/High/Best): 35 / 35 / 35
Features used in Species ID: Animals with white tips to rostrum, alternating light and dark pattern along body, and should blaze that terminates behind the dorsal fin.
Representative images used for Species ID: 5590, 5592, 5599, 5600
Photographer: PBN Frame numbers: 5576 to 5647 Spacer: 5648
Calculated distance from Trackline: 0.9359 km

Final Time and Position of Sighting

Time: 12:54 WP#: 81 Lat: 33.87423 Long: -76.75903
Calculated Distance Traveled: 3.0 km

Behavior and Additional Comments

Large group of dolphins ~35 fanned out over a large area. Animals showed lots of milling activity seen at the surface. Sighting was cut short because of Mayday call on marine 16 that we responded to.

No calves were observed

Thursday, March 5, 2009 Sighting # 9

Initial sighting on Track

Time: 16:28 WP#: 116 Lat: 33.69154 Long: -77.03411
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 1
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 16:29 WP#: 117 Lat: 33.69901 Long: -77.030164
Species: *Stenella frontalis* Numbers (Low/High/Best): 30 / 30 / 30
Features used in Species ID: Animals had shoulder blaze that terminated behind the dorsal fin and had spotting on both sides. Lots of tactile interactions within group: rolling over, belly showing,ect.
Representative images used for Species ID: 5655, 5657, 5693, 5722
Photographer: PBN Frame numbers: 5649 to 5737 Spacer: 5738
Calculated distance from Trackline: 0.9073 km

Final Time and Position of Sighting

Time: 16:31 WP#: 118 Lat: 33.69822 Long: -77.033015
Calculated Distance Traveled: 0.2 km

Behavior and Additional Comments

Multiple small groups of dolphins were seen scattered over 100-200m area. All animals milling at the surface with lots of belly to belly swimming observed. A single shark was seen nearby the group of dolphins but no apparent interactions were observed.

No calves were observed

Friday, April 24, 2009 Sighting # 1

Initial sighting on Track

Time: 9:48 WP#: 9 Lat: 34.158381 Long: -76.462273
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Splash
On/Off Effort: On Trackline: 10 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 9:48 WP#: 10 Lat: 34.151427 Long: -76.468262
Species: *Stenella frontalis* Numbers (Low/High/Best): 50 / 60 / 55
Features used in Species ID: White rostrum tip, light flank blaze and obvious spotting pattern.
Representative images used for Species ID: 5798, 5801, 5817, 5834-36
Photographer: RJM Frame numbers: 5780 to 5853 Spacer: 5854
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 9:56 WP#: 11 Lat: 34.151094 Long: -76.462907
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Two (22 and 28 minimum) subgroups separated by 100m or so, animals swimming between groups. Fairly fast moving, erratic swimming. Very close group, tight cohesion. Circled animals between 750 and 1000 ft. No avoidance behavior was noted.

No calves were observed

Friday, April 24, 2009 Sighting # 2

Initial sighting on Track

Time: 10:10 WP#: 18 Lat: 33.956824 Long: -76.198993
Vertical Angle: 3 Horizontal Bearing in Degrees: 120 Sighting Cue: Splash
On/Off Effort: On Trackline: 10 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 10:11 WP#: 19 Lat: 33.969252 Long: -76.195643
Species: *Tursiops truncatus* Numbers (Low/High/Best): 10 / 11 / 10
Features used in Species ID: Overall elongate body and head shape. Gray body coloration with a light dorsal peduncle region.
Representative images used for Species ID: 5858, 5859
Photographer: RJM Frame numbers: 5855-5873 Spacer: 5874
Calculated distance from Trackline: 1.4 km

Final Time and Position of Sighting

Time: 10:13 WP#: 20 Lat: 33.967295 Long: -76.195643
Calculated Distance Traveled: 0.2 km

Behavior and Additional Comments

Group dove after initial fly over. Small subgrous (e.g. singles, 3's or 4's), separated by 10's to 100's of meters. Lots of subsurface swimming. Circled animals at between 750 and 1000ft with no avoidance behavior observed.

No calves were observed

Friday, April 24, 2009 Sighting # 3

Initial sighting on Track

Time: 10:21 WP#: 26 Lat: 33.871395 Long: -76.098462
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 10:23 WP#: 27 Lat: 33.871845 Long: -76.097792
Species: *Tursiops truncatus* Numbers (Low/High/Best): 9 / 9 / 10
Features used in Species ID: Dark dorsal cape and light dorsal peduncle region.
Representative images used for Species ID: 5886, 5887, 5892, 5897, 5914, 5915, 5916
Photographer: RJM Frame numbers: 5875 to 5920 Spacer: 5921
Calculated distance from Trackline: 0.08 km

Final Time and Position of Sighting

Time: 10:29 WP#: 28 Lat: 33.869757 Long: -76.102108
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

White dorsal peduncle area. Subgroups of 1 to 5, separated by 100's f meters. Slow travel. Animals showed no signs of avoidance behavior.

No calves were observed

Friday, April 24, 2009 Sighting # 4

Initial sighting on Track

Time: 10:40 WP#: 33 Lat: 33.883920 Long: -76.238329
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 9 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 10:45 WP#: 34 Lat: 33.883920 Long: -76.255597
Species: *Tursiops truncatus* Numbers (Low/High/Best): 14 / 16 / 15
Features used in Species ID: Short rostrum, overall gray body coloration and a dark dorsal cape.

Representative images used for Species ID: 5922, 5925, 5935, 5937, 5952
Photographer: RJM Frame numbers: 5922 to 5959 Spacer: 5960
Calculated distance from Trackline: 1.594 km

Final Time and Position of Sighting

Time: 10:52 WP#: 35 Lat: 33.888304 Long: 76.250269
Calculated Distance Traveled: 0.4612 km

Behavior and Additional Comments

Slow travel with not much time spent near the surface. Looks like bottlenose dolphins because of animals long bodies and short beaks. Circled the animals between 750 and 1000 ft and they showed no signs of avoidance.

Friday, April 24, 2009 Sighting # 5

Initial sighting on Track

Time: 10:57 WP#: 39 Lat: 34.013492 Long: -76.408418
Vertical Angle: 2 Horizontal Bearing in Degrees: 45 Sighting Cue: Body
On/Off Effort: On Trackline: 9 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 10:58 WP#: 40 Lat: 34.012365 Long: -76.406003
Species: *Stenella frontalis* Numbers (Low/High/Best): 70 / 90 / 80
Features used in Species ID: Light flank blaze, alternating light and dark dorsal coloration pattern. Animals had obvious white tip to their rostrums
Representative images used for Species ID: 5961, 5981, 5983, 5998, 6003
Photographer: RJM Frame numbers: 5961 to 6054 Spacer: 6055
Calculated distance from Trackline: 0.3 km

Final Time and Position of Sighting

Time: 11:06 WP#: 41 Lat: 34.017488 Long: -76.408068
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments

Group made up of three sub-groups. Close association initially, became looser during the encounter, eventually group spread out over hundreds of meters. Circled animals at between 750 and 1000 ft. Animals showed no signs of avoidance.

Friday, April 24, 2009 Sighting # 6

Initial sighting on Track

Time: 11:21 WP#: 56 Lat: 34.123323 Long: -76.674774
Vertical Angle: 1 Horizontal Bearing in Degrees: 45 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 11:23 WP#: 57 Lat: 34.129500 Long: -76.679869
Species: *Tursiops truncatus* Numbers (Low/High/Best): 2 / 2 / 2
Features used in Species ID: uniform gray body coloration with light gray on dorsal caudal peduncle, broad flukes and a short rostrum.
Representative images used for Species ID: 6093, 6096, 6099, 6104, 6105
Photographer: RJM Frame numbers: 6056 to 6114 Spacer: 6115
Calculated distance from Trackline: 0.8317 km

Final Time and Position of Sighting

Time: 11:31 WP#: 61 Lat: 34.131094 Long: -76.681215
Calculated Distance Traveled: 0.2163 km

Behavior and Additional Comments

Fairly long dive times. Animals showed no signs of avoidance.

No calves were observed

Friday, April 24, 2009 Sighting # 7

Initial sighting on Track

Time: 12:01 WP#: 74 Lat: 33.741955 Long: -76.314136
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 10 Beaufort Sea State: 3
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 12:02 WP#: 75 Lat: 33.739365 Long: -76.318960
Species: *Tursiops truncatus* Numbers (Low/High/Best): 30 / 38 / 32
Features used in Species ID: Robust body shape, light gray peduncle, broad flukes, uniform light gray body with a lighter gray blaze terminating behind the dorsal fin.
Representative images used for Species ID: 6125, 6142, 6149, 6168
Photographer: RJM Frame numbers: 6115 to 6189 Spacer: 6190
Calculated distance from Trackline: 0.5309 km

Final Time and Position of Sighting

Time: 12:11 WP#: 76 Lat: 33.736547 Long: -76.323966
Calculated Distance Traveled: 0.559 km

Behavior and Additional Comments

Slow surface travel. Fairly cohesive group. Animals showed no signs of avoidance behavior.

No calves were observed

Friday, April 24, 2009 Sighting # 8

Initial sighting on Track

Time: 12:21 WP#: 82 Lat: 33.957016 Long: -76.588721
Vertical Angle: 2 Horizontal Bearing in Degrees: 120 Sighting Cue: Splash
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 12:22 WP#: 83 Lat: 33.944397 Long: -76.589046
Species: *Stenella frontalis* Numbers (Low/High/Best): 10 / 10 / 10
Features used in Species ID: White rostrum tip with an alternating light and dark coloration along the body
Representative images used for Species ID: 6199, 6200, 6216, 6223, 6225
Photographer: RJM Frame numbers: 6191 to 6264 Spacer: 6265
Calculated distance from Trackline: 1.4 km

Final Time and Position of Sighting

Time: 12:29 WP#: 84 Lat: 33.954122 Long: -76.584471
Calculated Distance Traveled: 1.1 km

Behavior and Additional Comments

Two subgroups of five animals each traveling leisurely at the surface. Spotting dolphin coloration , but overall body shape similar to Tursiops - determine ID from photographs. No avoidance behavior observed.

No calves were observed

Friday, July 24, 2009 Sighting # 9

Initial sighting on Track

Time: 12:31 WP#: 86 Lat: 33.999281 Long: -76.644279
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 12:32 WP#: 87 Lat: 33.996132 Long: -76.48635
Species: *Stenella frontalis* Numbers (Low/High/Best): 30 / 45 / 37
Features used in Species ID: Alternating dark and light dorsal color pattern, obvious white rostrum tip, visible spots on lateral surface of animals body.
Representative images used for Species ID: 6279, 6292, 6328
Photographer: RJM Frame numbers: 6267 to 6341 Spacer: 6342
Calculated distance from Trackline: 0.5349 km

Final Time and Position of Sighting

Time: 12:36 WP#: 88 Lat: 33.993872 Long: -76.649991
Calculated Distance Traveled: 0.2807 km

Behavior and Additional Comments

Fast moving animals with quick changes in direction. Very cohesive, tight groups - part of group "in a pile". Circled animal at between 750 and 1000 ft. No avoidance reaction noted.

No calves were observed

Friday, April 24, 2009 Sighting # 10

Initial sighting on Track

Time: 12:39 WP#: 91 Lat: 34.067127 Long: -76.734985
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: PBN Observer side: Left

Actual Time and Position of Sighting

Time: 12:39 WP#: 92 Lat: 34.063458 Long: -76.741129
Species: *Tursiops truncatus* Numbers (Low/High/Best): 9 / 9 / 9
Features used in Species ID: Long, "stocky" but elongated dolphins, gray with darker gray cape short rostrum.
Representative images used for Species ID: 6360, 6361, 6365, 6366, 6376
Photographer: RJM Frame numbers: 6343 to 6393 Spacer: 6394
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 12:45 WP#: 93 Lat: 34.063285 Long: -76.734693
Calculated Distance Traveled: 0.03 km

Behavior and Additional Comments

Socializing, milling and non-directional movement to group. Two sharks (estimate size: <2m) following dolphin group at a distance of approximately 15-20 m. Circled animals between 750 and 1000 ft. No avoidance reaction noted.
No calves were observed

Saturday, April 25, 2009 Sighting # 1

Initial sighting on Track

Time: 10:11 WP#: 18 Lat: 33.820696 Long: -77.071278
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 2 Beaufort Sea State: 2
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 10:12 WP#: 19 Lat: 33.813468 Long: -77.070257
Species: *Stenella frontalis* Numbers (Low/High/Best): 16 / 17 / 16
Features used in Species ID: White tip to rostrum with alternating light and dark body coloration. Shoulder blaze ending before or at level of dorsal fin. Spotting pattern over some of the animals bodies.
Representative images used for Species ID: 6140, 6411, 6415, 6418, 6436, 6438, 6454-6460
Photographer: PBN Frame numbers: 6404 to 6465 Spacer: 6466
Calculated distance from Trackline: 0.8 km

Final Time and Position of Sighting

Time: 10:21 WP#: 20 Lat: 33.806721 Long: -77.069029
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments

Animals were in a dense group traveling slowly at the surface either in a line or bunched closely together. Animals engaged ina lot of subsurface activity and interactions among animals. Body appearance of dolphins somewhat elongated. Circled animals between 750 and 1000ft. No avoidance behavior noted. No calves were observed

Tuesday, May 12, 2009 Sighting # 1

Initial sighting on Track

Time: 11:23 WP#: 33 Lat: 33.80007 Long: -77.17177
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 3
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 11:40 WP#: 35 Lat: 33.80305 Long: -77.16646
Species: *Unidentified Delphinid* Numbers (Low/High/Best): 23 / 27 / 26
Features used in Species ID: Streamlined gray body ~6-7ft long with central positioned dorsal fin. Clear rostrum present, vertical movement of caudal fin, and animals surfacing frequently.
Representative images used for Species ID: No images taken
Photographer: PBN Frame numbers: No images taken Spacer: None
Calculated distance from Trackline: 0.6 km

Final Time and Position of Sighting

Time: 11:48 WP#: 36 Lat: 33.81485 Long: -77.17013
Calculated Distance Traveled: 1.4 km

Behavior and Additional Comments

Animals difficult to relocate because of sea state conditions. Upon initial sighting animals were seen traveling side by side in a loosely packed straight line. Later sightings had animals moving into a denser group with many tactile interactions among individuals. Animals were fairly active while surfacing and spent most of their time just under the surface. Group showed no signs of avoidance. No calves seen

Thursday, May 28, 2009 Sighting # 1

Initial sighting on Track

Time: 9:35 WP#: 9 Lat: 33.452093 Long: -76.718627
Vertical Angle: 3 Horizontal Bearing in Degrees: 110 Sighting Cue: Splash
On/Off Effort: On Trackline: 1 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 9:38 WP#: 10 Lat: 33.448227 Long: -76.724387
Species: *Tursiops truncatus* Numbers (Low/High/Best): 50 / 70 / 60
Features used in Species ID: Short rostrum, well-defined crease at beak, slate gray with darker cape, broad-based dorsal fin, light-colored peduncle area, robust thoracic region.
Representative images used for Species ID: 7289, 7298, 7322, 7338, 7366, 7367
Photographer: PBN Frame numbers: 7288 to 7376 Spacer: 7377 to 7379
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 9:45 WP#: 11 Lat: 33.446113 Long: -76.730376
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments

Multiple sub groups porpoising quickly, light dorsal peduncle region.

No calves were observed

Thursday, May 28, 2009 Sighting # 2

Initial sighting on Track

Time: 10:58 WP#: 29 Lat: 33.818045 Long: -76.811912
Vertical Angle: 2 Horizontal Bearing in Degrees: 110 Sighting Cue: Body
On/Off Effort: On Trackline: 4 Beaufort Sea State: 1
Observer: REH Observer side: Left

Actual Time and Position of Sighting

Time: 11:00 WP#: 30 Lat: 33.811291 Long: -76.804148
Species: *Stenella frontalis* Numbers (Low/High/Best): 20 / 30 / 25
Features used in Species ID: Pointed, falcate dorsal fin, white-tipped rostrum, alternating light and dark patterning, light-colored blaze below dorsal fin, obvious spotted pattern.
Representative images used for Species ID: 7384, 7388, 7395, 7399, 7414
Photographer: PBN Frame numbers: 7380 to 7419 Spacer: 7420
Calculated distance from Trackline: 1.0 km

Final Time and Position of Sighting

Time: 11:05 WP#: 31 Lat: 33.812074 Long: -76.800995
Calculated Distance Traveled: 0.3 km

Behavior and Additional Comments

One tight group, moving slowly, staying close to the surface, little splashing or white water.

No calves were observed

Thursday, May 28, 2009 Sighting # 3

Initial sighting on Track

Time: 13:39 WP#: 41 Lat: 33.625263 Long: -76.419579
Vertical Angle: 2 Horizontal Bearing in Degrees: 45 Sighting Cue: Splash
On/Off Effort: On Trackline: 5 Beaufort Sea State: 2
Observer: REH Observer side: Left

Actual Time and Position of Sighting

Time: 13:40 WP#: 42 Lat: 33.627112 Long: -76.416079
Species: *Tursiops truncatus* Numbers (Low/High/Best): 30 / 50 / 40
Features used in Species ID: Broad-based dorsal fin, obvious crease between melon and rostrum, short blunt rostrum, robust thoracic region, slate gray, wide flukes, light-colored peduncle area.
Representative images used for Species ID: 7449, 7464, 7465, 7468, 7479, 7480
Photographer: PBN Frame numbers: 7421 to 7484 Spacer: 7485
Calculated distance from Trackline: 0.4 km

Final Time and Position of Sighting

Time: 13:48 WP#: 43 Lat: 33.627083 Long: -76.420899
Calculated Distance Traveled: 0.4 km

Behavior and Additional Comments

Eight to nine sub-groups, porpoising with some splashing and white ater, traveling quickly, widely spread over a larger area.

No calves were observed

Thursday, May 28, 2009 Sighting # 4

Initial sighting on Track

Time: 13:58 WP#: 47 Lat: 33.694522 Long: -76.388631
Vertical Angle: 2 Horizontal Bearing in Degrees: 45 Sighting Cue: Splash
On/Off Effort: On Trackline: 6 Beaufort Sea State: 1
Observer: REH Observer side: Left

Actual Time and Position of Sighting

Time: 14:00 WP#: 48 Lat: 33.690512 Long: -76.386340
Species: *Tursiops truncatus* Numbers (Low/High/Best): 25 / 45 / 35
Features used in Species ID: Short rostrum, borad-based dorsal fin, light-colored caudal peduncle, slate gray individuals with blaze terminating behind dorsal fin.
Representative images used for Species ID: 722, 7423, 7524, 7554
Photographer: PBN Frame numbers: 25 / 45 / 35 Spacer: 7558
Calculated distance from Trackline: 0.8 km

Final Time and Position of Sighting

Time: 14:06 WP#: 49 Lat: 33.690322 Long: -76.385158
Calculated Distance Traveled: 0.1 km

Behavior and Additional Comments

Multiple sub-groups of about 4-6 animals, porpoising quickly.

No calves were observed

Thursday, May 28, 2009 Sighting # 5

Initial sighting on Track

Time: 14:41 WP#: 57 Lat: 33.757755 Long: -76.330783
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Splash
On/Off Effort: On Trackline: 7 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 14:43 WP#: 58 Lat: 33.756924 Long: -76.335357
Species: *Tursiops truncatus* Numbers (Low/High/Best): 8 / 12 / 10
Features used in Species ID: Light colored peduncle, robust thoracic region, blunt rostrum, broad based dorsal fin, well defined crease between melon and rostrum.
Representative images used for Species ID: 7570, 7575, 7581, 7582, 7583
Photographer: PBN Frame numbers: 7559 to 7584 Spacer: 7585
Calculated distance from Trackline: 0.4 km

Final Time and Position of Sighting

Time: 14:53 WP#: 59 Lat: 33.751734 Long: -76.341588
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments

Two sub-groups,one with two animals and one with 8-10, both groups swimming quickly. One animal had a large circular scar on the right side of its dorsal fin.

No calves were observed

30 May 2009 Sighting # 1

Initial sighting on Track

Time: 14:19 WP#: 37 Lat: 33.703545 Long: -76.255636
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 14:29 WP#: 39 Lat: 33.711527 Long: -76.255299
Species: *Tursiops truncatus* Numbers (Low/High/Best): 3/4/4
Features used in Species ID: Animals displayed robust body, dark dorsal cape, blaze trailing behind dorsal fin, compact rostrum, white coloration on caudal peduncle
Representative images used for Species ID: 7609, 7602-7624, 7652, 7654, 7655, 7657
Photographer: RJM Frame numbers: 7606-7657 Spacer: 7658
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 14:44 WP#: 40 Lat: 33.722278 Long: -76.257567
Calculated Distance Traveled: 1.2 km

Behavior and Additional Comments

Individuals were spaced widely apart and traveling at 'normal' speeds.

No calves were observed.

30 May 2009 Sighting # 2

Initial sighting on Track

Time: 15:02 WP#: 46 Lat: 34.080650 Long: -76.750043
Vertical Angle: 2 Horizontal Bearing in Degrees: 60 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: RJM Observer side: Right

Actual Time and Position of Sighting

Time: 15:10 WP#: 47 Lat: 34.075319 Long: -76.745905
Species: *Unidentified Delphinid* Numbers (Low/High/Best): 1/1/1
Features used in Species ID: Due to evasive behavior of animals and short time of encounter, species-identifying images were not obtained
Representative images used for Species ID: 7677
Photographer: RJM Frame numbers: 7659-7678 Spacer: 7679
Calculated distance from Trackline: 0.8 km

Final Time and Position of Sighting

Time: 15:18 WP#: 48 Lat: 34.063018 Long: -76.747865
Calculated Distance Traveled: 1.4 km

Behavior and Additional Comments

One evasive individual observed. Final position is an estimate as animal was not resighted at end of sighting. Individual spent majority of time well under the surface, making clear photographs difficult.

No calves were observed.

Saturday, May 30, 2009 Sighting # 3

Initial sighting on Track

Time: 15:31 WP#: 53 Lat: 33.878143 Long: -76.615686
Vertical Angle: 1 Horizontal Bearing in Degrees: 50 Sighting Cue: Body
On/Off Effort: On Trackline: 6 Beaufort Sea State: 1
Observer: HJF Observer side: Left

Actual Time and Position of Sighting

Time: 15:36 WP#: 54 Lat: 33.885123 Long: -76.611188
Species: *Tursiops truncatus* Numbers (Low/High/Best): 3/3/3
Features used in Species ID: Animals displayed a blunt rostrum, robust dorsal fin, and a shoulder blaze trailing behind dorsal fin
Representative images used for Species ID: 7688, 7689, 7691, 7693, 7694
Photographer: RJM Frame numbers: 7680 - 7702 Spacer: 7703
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 15:42 WP#: 55 Lat: 33.893453 Long: -76.614049
Calculated Distance Traveled: 1.0 km

Behavior and Additional Comments

Three individuals were traveling side by side.

No calves were observed.

31 May 2009 Sighting # 1

Initial sighting on Track

Time: 9:46 WP#: 22 Lat: 33.986694 Long: -76.497497
Vertical Angle: 3 Horizontal Bearing in Degrees: 100 Sighting Cue: Splash
On/Off Effort: On Trackline: 8 Beaufort Sea State: 2
Observer: REH Observer side: Right

Actual Time and Position of Sighting

Time: 9:47 WP#: 23 Lat: 33.984991 Long: -76.505104
Species: *Tursiops truncatus* Numbers (Low/High/Best): 10/10/10
Features used in Species ID: Short rostrum, broad-based dorsal fin, uniform gray coloration, broad flukes, light-colored peduncles
Representative images used for Species ID: 7712,7727,7730,7748,7753,7795,7798,7813,15,16
Photographer: REH Frame numbers: 7704 - 7817 Spacer: 7818 and 7819
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 10:14 WP#: 24 Lat: 33.963670 Long: -76.518260
Calculated Distance Traveled: 2.6 km

Behavior and Additional Comments

Group loosely packed, traveling at a moderate rate of speed, fairly good size, light-colored peduncles, surfacing fairly frequently.

No calves were observed.

Sunday, May 31, 2009 Sighting # 2

Initial sighting on Track

Time: 11:07 WP#: 41 Lat: 33.698041 Long: -76.646557
Vertical Angle: 3 Horizontal Bearing in Degrees: 100 Sighting Cue: Splash
On/Off Effort: On Trackline: 4 Beaufort Sea State: 2
Observer: REH Observer side: Right

Actual Time and Position of Sighting

Time: 11:08 WP#: 42 Lat: 33.694609 Long: -76.657794
Species: *Tursiops truncatus* Numbers (Low/High/Best): 8/10/9
Features used in Species ID: Short rostrum, broad-based dorsal fin, uniform gray coloration with a shoulder blaze trailing behind dorsal fin, light-colored peduncle, broad flukes
Representative images used for Species ID: 7841, 7843, 7844, 7851, 7871
Photographer: REH Frame numbers: 7820 - 7885 Spacer: 7886
Calculated distance from Trackline: 1.1 km

Final Time and Position of Sighting

Time: 11:36 WP#: 43 Lat: 33.715870 Long: -76.657162
Calculated Distance Traveled: 2.4 km

Behavior and Additional Comments

Two or three sub-groups of animals initially seen, after circling more animals joined the group which then fanned out into pairs or single animals, spending time below the surface but surfacing frequently, traveling slowly.

No calves were observed.

31 May 2009 Sighting # 3

Initial sighting on Track

Time: 11:43 WP#: 45 Lat: 33.594028 Long: -76.530503
Vertical Angle: 3 Horizontal Bearing in Degrees: 100 Sighting Cue: Splash
On/Off Effort: On Trackline: 4 Beaufort Sea State: 1
Observer: REH Observer side: Right

Actual Time and Position of Sighting

Time: 11:51 WP#: 46 Lat: 33.590568 Long: -76.505697
Species: *Tursiops truncatus* Numbers (Low/High/Best): 12/18/15
Features used in Species ID: Light-colored peduncle, short rostrum, uniform gray coloration, robust thoracic region, some individuals with shoulder blaze terminating behind dorsal fin
Representative images used for Species ID: 7839, 7896, 7899, 7921, 7922, 7923, 7933, 7935
Photographer: REH Frame numbers: 7887 - 7935 Spacer: 7936
Calculated distance from Trackline: 2.3 km

Final Time and Position of Sighting

Time: 11:51 WP#: 47 Lat: 33.590568 Long: -76.505697
Calculated Distance Traveled: 0.0 km

Behavior and Additional Comments

Animals very active at the surface, swimming in a tight bunch, lots of interactions between animals, rolling, showing bellies and milling in one position.

No calves were observed.

Monday, June 1, 2009 Sighting # 1

Initial sighting on Track

Time: 10:02 WP#: 6 Lat: 33.821909 Long: -76.687911
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 5 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 10:05 WP#: 7 Lat: 33.821909 Long: -76.687911
Species: *Tursiops truncatus* Numbers (Low/High/Best): 3/3/3
Features used in Species ID: Stubby rostrum, relatively wide fluke, gray uniform coloration, light caudal peduncle area
Representative images used for Species ID: 7953, 7962
Photographer: PBN Frame numbers: 7937 - 7970 Spacer: 7971
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: N/A WP#: N/A Lat: N/A Long: N/A
Calculated Distance Traveled: N/A

Behavior and Additional Comments

Animals were originally traveling leisurely, but then displayed possible avoidance behaviors, becoming more evasive, and diving as we circled over them. Evasive behavior continued throughout sighting and animals were not relocated for a final position.

No calves were observed.

Monday, June 1, 2009 Sighting # 2

Initial sighting on Track

Time: 10:52 WP#: 17 Lat: 34.055790 Long: -76.723429
Vertical Angle: 2 Horizontal Bearing in Degrees: 125 Sighting Cue: Body
On/Off Effort: Off Trackline: 7 Beaufort Sea State: 1
Observer: WEM Observer side: Right

Actual Time and Position of Sighting

Time: 10:57 WP#: 18 Lat: 34.064991 Long: -76.73628
Species: *Stenella frontalis* Numbers (Low/High/Best): 3/3/3
Features used in Species ID: White rostrum tip, lighter blaze below dorsal fin, fusiform body shape with rapidly - narrowing peduncle
Representative images used for Species ID: 8014, 8015, 8020, 8025
Photographer: PBN Frame numbers: 7972 - 8040 Spacer: 8041
Calculated distance from Trackline: 1.6 km

Final Time and Position of Sighting

Time: 11:02 WP#: 19 Lat: 34.06864 Long: -76.721988
Calculated Distance Traveled: 1.4 km

Behavior and Additional Comments

Animals were traveling leisurely at the surface, and taking nearly vertical dives from the surface.

Calves were observed

Monday, June 1, 2009 Sighting # 3

Initial sighting on Track

Time: 11:03 WP#: 21 Lat: 34.045533 Long: -76.709924
Vertical Angle: 2 Horizontal Bearing in Degrees: 110 Sighting Cue: Body
On/Off Effort: On Trackline: 7 Beaufort Sea State: 1
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 11:05 WP#: 22 Lat: 34053559 Long: -76.718352
Species: *Stenella frontalis* Numbers (Low/High/Best): 6/8/7
Features used in Species ID: White rostrum, blaze below dorsal fin, alternating light and dark bands starting at rostrum, long rostrum
Representative images used for Species ID: 8043, 8056, 8072
Photographer: PBN Frame numbers: 8042 - 8091 Spacer: 8092
Calculated distance from Trackline: 1.2 km

Final Time and Position of Sighting

Time: 11:06 WP#: 23 Lat: 34.049906 Long: -76.714795
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Two distinct groups observed, one with a minimum of 4 animals and the second with at least 2 individuals.

No calves were observed.

Monday, June 1, 2009 Sighting # 4

Initial sighting on Track

Time: 11:39 WP#: 34 Lat: 33.957429 Long: -76.453764
Vertical Angle: 3 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 2
Observer: PBN Observer side: Right

Actual Time and Position of Sighting

Time: 11:42 WP#: 35 Lat: 33.964068 Long: -76.450177
Species: *Tursiops truncatus* Numbers (Low/High/Best): 2/2/2
Features used in Species ID: Wide fluke, short rostrum, light caudal peduncle, dark cape close to blowhole, well-defined crease between melon and rostrum
Representative images used for Species ID: 8129, 8131 - 8133
Photographer: PBN Frame numbers: 8093 - 8138 Spacer: 8139
Calculated distance from Trackline: 0.8 km

Final Time and Position of Sighting

Time: 11:47 WP#: 36 Lat: 33.966795 Long: -76.445969
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Final position was approximate, and recorded at the last known position that the animal was observed.

No calves were observed.

Monday, June 1, 2009 Sighting # 5

Initial sighting on Track

Time: 12:25 WP#: 48 Lat: 33.927656 Long: -76.17715
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 8 Beaufort Sea State: 2
Observer: HJF Observer side: Left

Actual Time and Position of Sighting

Time: 12:27 WP#: 49 Lat: 33.927627 Long: -76.170854
Species: *Tursiops truncatus* Numbers (Low/High/Best): 26/30/28
Features used in Species ID: Light caudal peduncle, light blaze terminating at the caudal margin of dorsal fin, robust body, short rostrum, gray coloration with darker gray cape
Representative images used for Species ID: 8143, 8167 - 8171, 8214, 8223, 8259
Photographer: PBN Frame numbers: 8140-8321 Spacer: 8322
Calculated distance from Trackline: 0.6 km

Final Time and Position of Sighting

Time: 12:33 WP#: 50 Lat: 33.932266 Long: -76.1703559
Calculated Distance Traveled: 0.4 km

Behavior and Additional Comments

Distinct subgroups with a few outlying individuals were observed. The two main groups, separated by approximately 200m, consisted of one group with at least 17 individuals, while another coupe of approximately 6 individuals were displaying many simultaneous aerial behaviors.
No calves were observed

Monday, June 1, 2009 Sighting # 6

Initial sighting on Track

Time: 15:44 WP#: 76 Lat: 33.764760 Long: -76.996388
Vertical Angle: 3 Horizontal Bearing in Degrees: 60 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 1
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 15:47 WP#: 77 Lat: 33.665030 Long: -76.986169
Species: *Stenella frontalis* Numbers (Low/High/Best): 13/15/13
Features used in Species ID: Alternating bands of light and dark, white rostrum tip, light blaze below dorsal fin
Representative images used for Species ID: 8338, 8369, 8382
Photographer: REH Frame numbers: 8326 - 8396 Spacer: 8397 - 8399
Calculated distance from Trackline: 0.8 km

Final Time and Position of Sighting

Time: 16:16 WP#: 78 Lat: 33.663027 Long: -76.990255
Calculated Distance Traveled: 0.4 km

Behavior and Additional Comments

Group of approximately 13 in fairly close proximity hanging at surface with slow to moderate rate of travel, fanning out into a single file in ones or twos. After initial few circles group more widely spaced, difficult to relocate-possible avoidance.
No calves were observed.

Tuesday, June 2, 2009 Sighting # 7

Initial sighting on Track

Time: 16:41 WP#: 83 Lat: 33.436162 Long: -76.700086
Vertical Angle: 2 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 1
Observer: REH Observer side: Right

Actual Time and Position of Sighting

Time: 16:42 WP#: 84 Lat: 33.437666 Long: -76.695101
Species: *Tursiops truncatus* Numbers (Low/High/Best): 35/40/35
Features used in Species ID: Short rostrum, darker gray cape, wide flukes, light-colored caudal peduncle
Representative images used for Species ID: 8417, 8428, 8552
Photographer: REH Frame numbers: 8400 - 8587 Spacer: 8588 and 8589
Calculated distance from Trackline: 0.5 km

Final Time and Position of Sighting

Time: 17:03 WP#: 85 Lat: 33.463124 Long: -76.682449
Calculated Distance Traveled: 3.0 km

Behavior and Additional Comments

3-4 subgroups hanging at surface splashing with little directional travel. Each group with between 10-15 animals, belly showing and interaction with some tail slapping, splitting into groups of 4-6.

No calves were observed.

Monday, June 1, 2009 Sighting # 8

Initial sighting on Track

Time: 17:14 WP#: 87 Lat: 33.661438 Long: -76.992118
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 1
Observer: REH Observer side: Right

Actual Time and Position of Sighting

Time: 17:15 WP#: 88 Lat: 33.665030 Long: -76.986169
Species: *Unidentified Delphinid* Numbers (Low/High/Best): 10/12/11
Features used in Species ID: Although images were somewhat blurry, the following characteristic were observed: white rostrum tip, light blaze below dorsal fin, alternating light and dark bands
Representative images used for Species ID: 8601
Photographer: REH Frame numbers: 8590 - 8622 Spacer: 8623 and 8624
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 17:28 WP#: 89 Lat: 33.663027 Long: -76.990255
Calculated Distance Traveled: 0.4 km

Behavior and Additional Comments

First sighted as 3 individuals well spaced below trackline. Tight group observed with splashing at surface, 10+ animals upon circling. Based on characteristics observed, species was likely Stenella frontalis. However, few and blurry images were obtained, hence the designation of unidentified Delphinid. No calves were observed.

Tuesday, June 2, 2009 Sighting # 1

Initial sighting on Track

Time: 9:41 WP#: 8 Lat: 33.829613 Long: -76.699445
Vertical Angle: 3 Horizontal Bearing in Degrees: 60 Sighting Cue: Body
On/Off Effort: On Trackline: 5 Beaufort Sea State: 1
Observer: RJM Observer side: Left

Actual Time and Position of Sighting

Time: 9:43 WP#: 9 Lat: 33.824363 Long: -76.702676
Species: *Tursiops truncatus* Numbers (Low/High/Best): 7/9/8
Features used in Species ID: Uniform gray coloration, light-colored peduncle, broad flukes

Representative images used for Species ID: 8627, 8638, 8642, 8653, 8658
Photographer: HJF Frame numbers: 8625 - 8659 Spacer: 8660 and 8661
Calculated distance from Trackline: 0.7 km

Final Time and Position of Sighting

Time: 10:04 WP#: 10 Lat: 33.819708 Long: -76.708385
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments

Loose groups traveling in single file formation in ones or two's. Animals very elusive traveling mainly well below the surface and only surfacing briefly. Upon resighting animal only found 2 animals - still being elusive.

No calves were observed.

Tuesday, June 2, 2009 Sighting # 2

Initial sighting on Track

Time: 11:01 WP#: 26 Lat: 33.79862 Long: -77.04353
Vertical Angle: 3 Horizontal Bearing in Degrees: 110 Sighting Cue: Body
On/Off Effort: On Trackline: 2 Beaufort Sea State: 1
Observer: HJF Observer side: Right

Actual Time and Position of Sighting

Time: 11:03 WP#: 27 Lat: 33.79092 Long: -77.0461
Species: *Stenella frontalis* Numbers (Low/High/Best): 3/6/5
Features used in Species ID: White-tipped rostrum, dramatic difference in coloration between smaller, more uniformly colored animal and larger animal with spotting and distinct blaze
Representative images used for Species ID: 8705c, 8712c, 8713c, 8714c
Photographer: HJF Frame numbers: 8662 - 8715 Spacer: 8716
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 11:21 WP#: 28 Lat: 33.78057 Long: -77.03863
Calculated Distance Traveled: 1.2 km

Behavior and Additional Comments

Initial group of 5 or 6 but upon resight only a pair seen - pair traveling slowly at the surface with most of time spent deep to the surface.

No calves were observed.

Tuesday, June 2, 2009 Sighting # 3

Initial sighting on Track

Time: 11:35 WP#: 30 Lat: 33.48153 Long: -76.63095
Vertical Angle: 1 Horizontal Bearing in Degrees: 90 Sighting Cue: Body
On/Off Effort: On Trackline: 1 Beaufort Sea State: 1
Observer: HJF Observer side: Right

Actual Time and Position of Sighting

Time: 11:36 WP#: 31 Lat: 33.47349 Long: -76.63398
Species: *Tursiops truncatus* Numbers (Low/High/Best): 20 / 28 / 25
Features used in Species ID: Short rostrum, robust body appearance, light-colored peduncle, broad flukes, narrow blaze that terminates behind the dorsal fin.
Representative images used for Species ID: 8723c, 8724c, 8725c, 8733c, 8761c, 8764c, 8766c
Photographer: HJF Frame numbers: 8717 to 8771 Spacer: 8772
Calculated distance from Trackline: 0.9 km

Final Time and Position of Sighting

Time: 11:44 WP#: 32 Lat: 33.46859 Long: -76.63349
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments

Multiple smaller groups of 2 to 4 animals traveling slowly and surfacing frequently. initially only a few animals seen while circling group size grew to 25 animals.

Calves were observed

Appendix E

Notes on the Sighting Summary Sheet

The Sighting Summary, adapted from the Sighting Data Sheet used in the field (Fig. 3), integrates data gathered in the field with results from lab analyses to provide a full summary of each marine mammal sighting. A Sighting Summary was completed for all sightings, including sightings made while off-effort during transits between survey legs, as well as sighting cues which where never relocated.

The Sighting Summary sheet is broken into four sections; "Initial Sighting on Track", "Time and Position of Sighting", "Final Time and Position of Sighting", and "Behavior and Additional Comments". Each section and sub headings will be detailed below.

Initial Sighting on Track

Time*:* The time the break track GPS way-point was taken

WP#: GPS way-point number of the break track

Lat/Long: The latitude and longitude associated with the break track way-point

Track Line: The track line surveyed when the sighting was made

On/Off Effort: Whether the sighting was made during an active survey track line (i.e. On effort) or during transit BETWEEN track lines (i.e. off effort). Sightings made during off effort transit to and from the range are NOT included in the sighting summaries.

Sighting Cue: Whether the initial sighting was a splash, a breach or body part.

Vertical Angle: Vertical "angle" between 1 and 4, the lower edge of view ("1") to the horizon ("4"). A subjective and relative measure of how far away from the track line the initial sighting occurred.

Horizontal Bearing in Degrees: The horizontal degrees from front to back (0 to 180) at which the sighting occurred.

Observer: Three lettered initial of the observer who made the sighting

Observer Side: On which side of the plane in the direction of travel the sighting occurred.

Time and Position of Sighting

Time*:* The time the GPS way-point was taken while relocating animals and circling above

WP#: GPS way-point number of the sighting

Lat/Long: The latitude and longitude associated with the way point obtained while circling over animals

Beaufort Sea State: The sea state observed during the sighting

Species: Scientific binomial name of the marine mammal species involved in the sighting. When species identity could not be established unequivocally, the next higher taxonomic level to which identity could be established was used. If a cetacean was identified as a dolphin but images obtained during the encounter were not sufficient to establish species ID, the designation "unidentified delphinid" or "*T. truncatus/S. frontalis*" was used. The next higher level used was unidentified cetacean. If a large body was observed but

it could not be established whether a cetacean, fish/shark or turtle was involved in the sighting, the designation “unidentified marine vertebrate” was used.

Criteria used to identify species: Which species specific diagnostic features were used in classifying a sighting to species.

Best images used for species ID: The images obtained during the sighting that best displayed the features used to establish species.

Numbers (Low/ High/ Best): Low, high, and best estimate of number of animals involved in the sighting.

Calves observed? Whether any calves were observed during the encounter. A conservative measure was used, in that only animals roughly half the size of the associated larger animal (the presumed mother) were designated as calves.

Calculated Distance from Track Line: The distance between the break track way-point and the initial sighting way-point. For more information on how distance was calculated and errors inherent in this method, refer to the “Methods” section.

Photographer: Three lettered initials of observer seated in the right camera seat.

Card #: Memory card on which the photos from the particular sighting was made.

Frame Numbers: Starting and ending frame number

Spacer: Image used to separate sighting to clarify when one sighting ends and the next begins. Image typically of interior of plane or a 45 degree angle shot of the horizon.

Final Time and Position of Sighting

Time: WP#: Lat: Long: Calculated Distance traveled: ➔ see section above

Behavior and Additional Comments

Any behavioral notes obtained during the sighting (*e.g.* group formation, relative travel speed, feeding events or presumed copulation attempts, presence of other cetaceans or sharks in or around the animal(s) in the sighting, interaction with inanimate objects such marine debris). This section also includes notes on altitude of the survey plane during the encounter as well as any indications (or lack thereof) of the animal(s) reacting evasively to the presence of the plane.

Appendix F

Date:_____

USWTR Daily Plane Log Sheet

Pilot in Command:_____ Second in Command:_____

Observers:_____

Plane:_____

Time take off: _____ HOBBS Start:_____

Land for lunch:_____

Track Lines and Direction (e.g. N to S) Flown:_____

Take off after lunch:_____ HOBBS Stop:_____

Land:_____ HOBBS Total:_____

Track Lines and Direction (e.g. N to S) Flown:_____

Overall weather:_____

General Observations

_____

_____

_____

_____

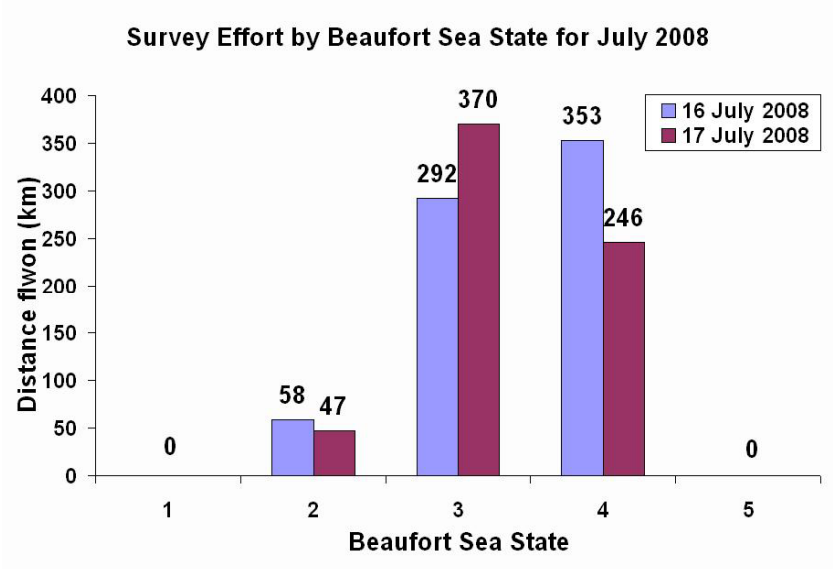
_____

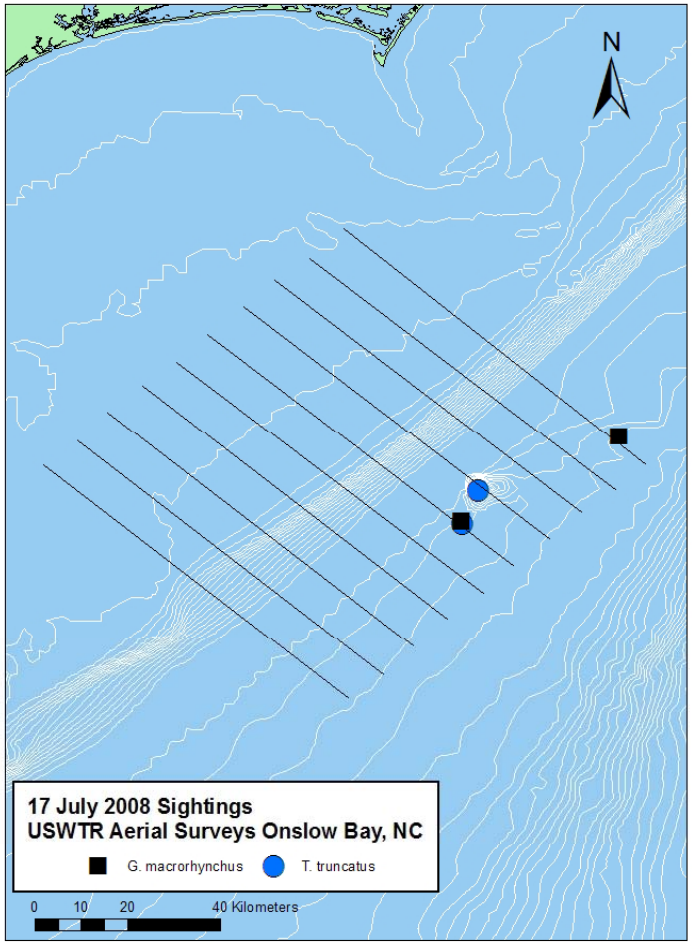
_____

_____

July 17. 2008

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Globicephala macrorhynchus	1	18	2	10
Globicephala macrorhynchus	1	12	1	6
Tursiops truncatus	1	30	1	7
Tursiops truncatus	1	12	1	6



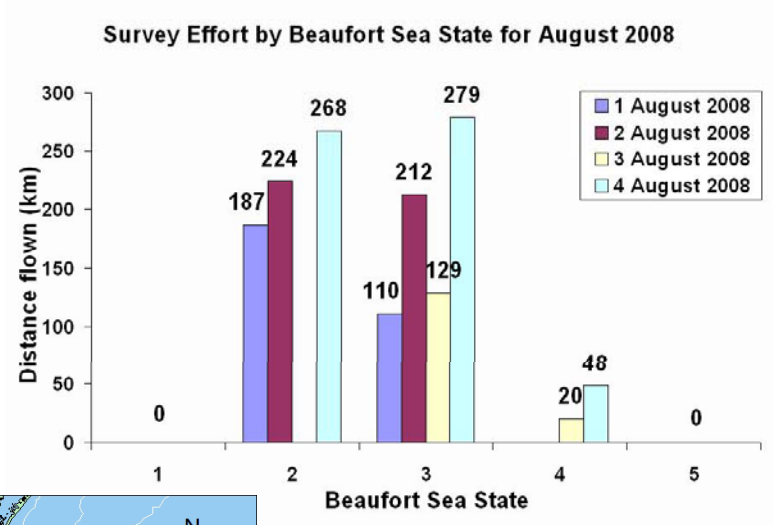


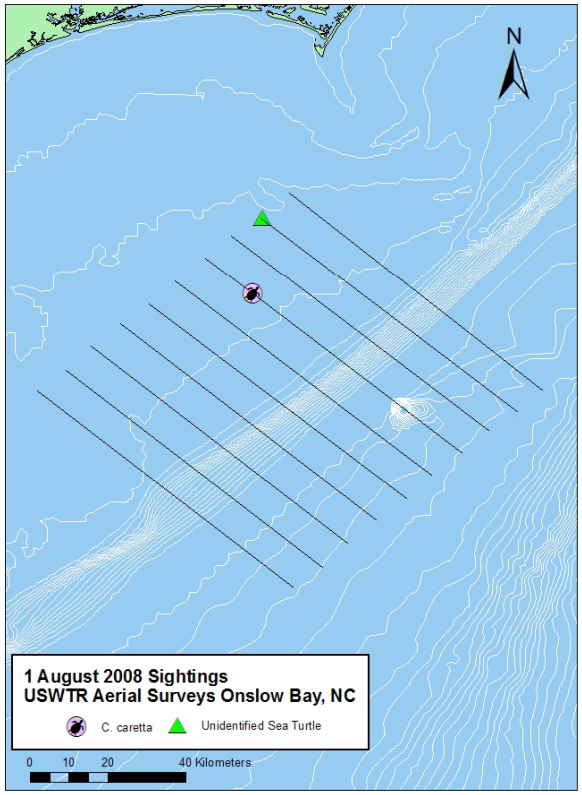
August 1, 2008

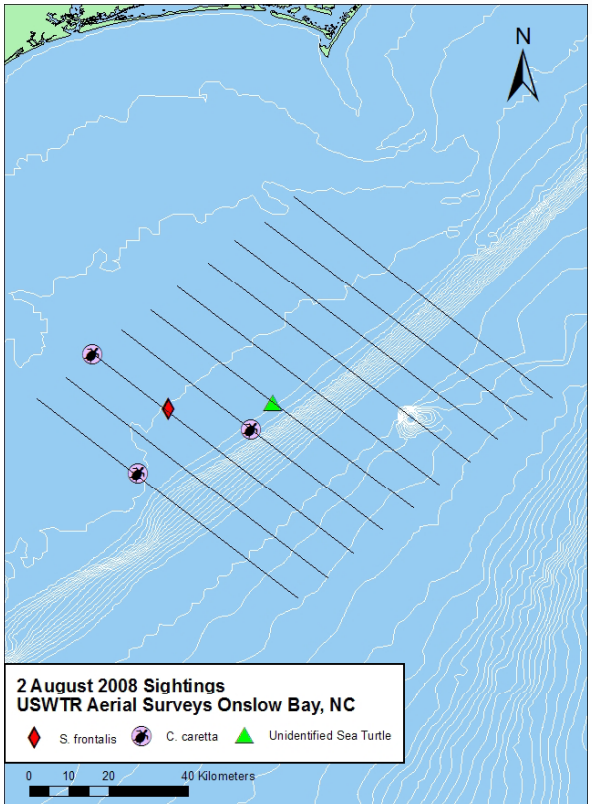
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Sea Turtle	2	2	2	-

August 2, 2008

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Stenella frontalis	1	22	2	3
Sea Turtle	4	4	2 to 3	-

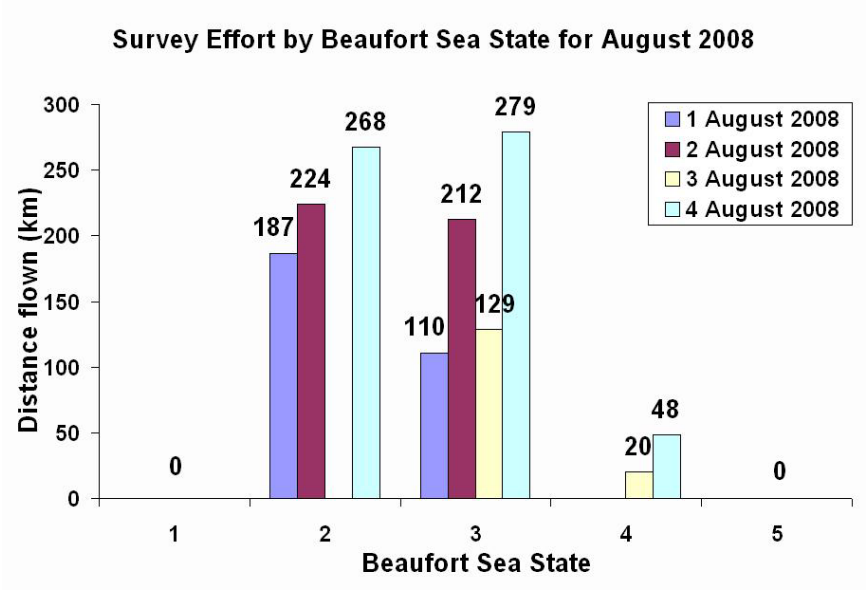


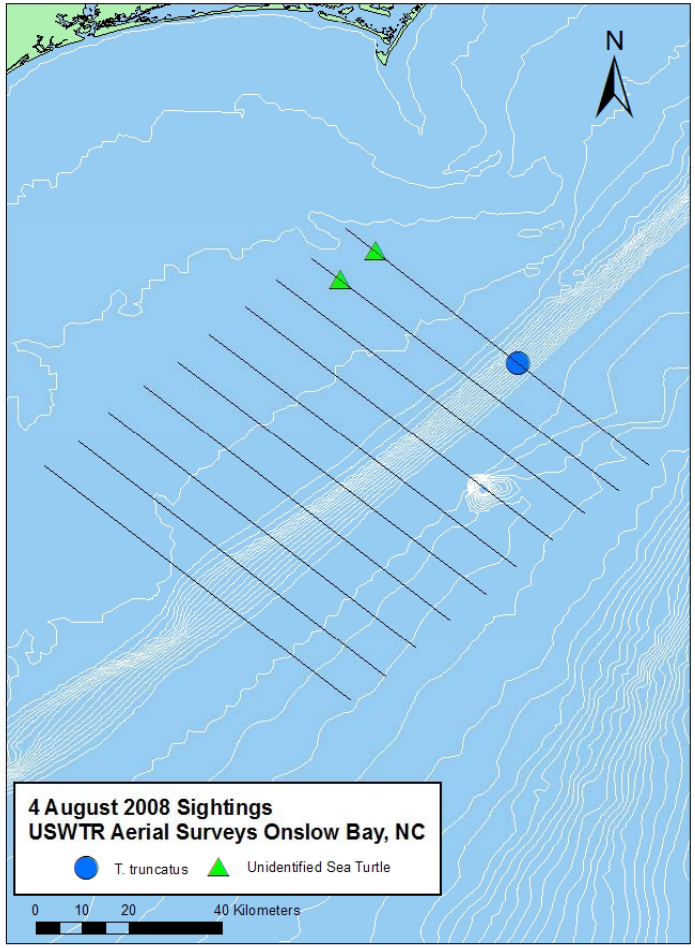




August 4, 2008

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	9	2	10
Sea Turtle	2	2	2	-



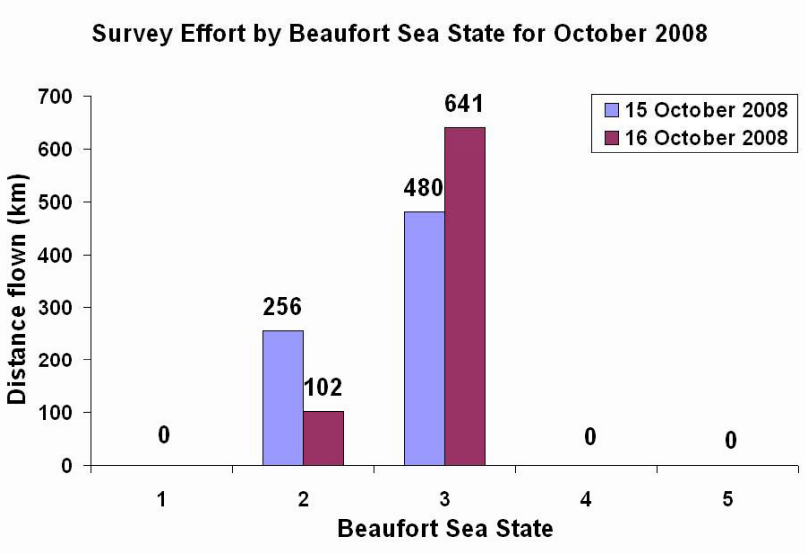


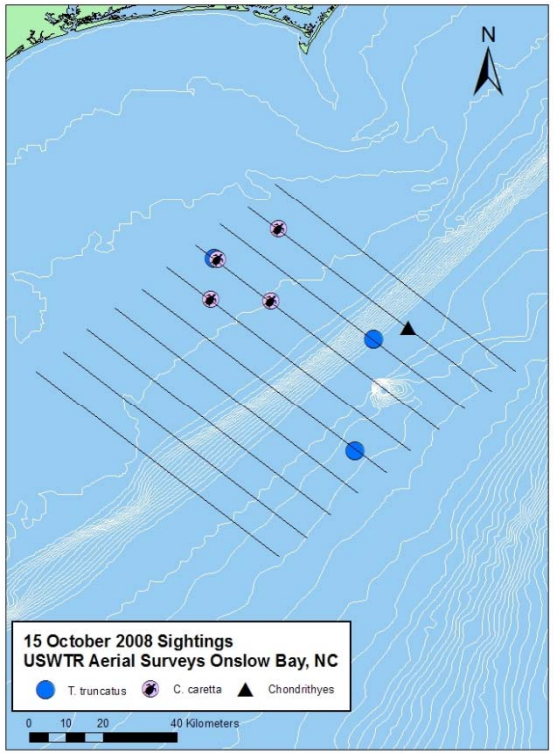
October 15, 2008

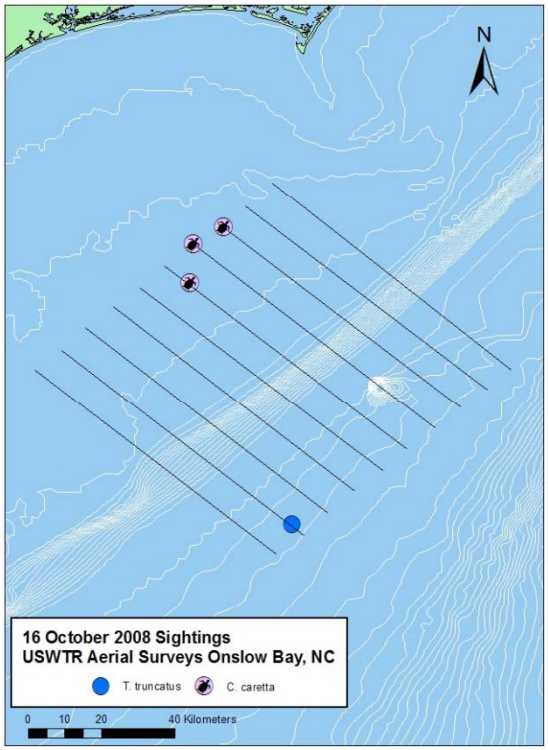
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	25	3	5
Tursiops truncatus	1	3	2	7
Tursiops truncatus	1	19	3	8
Sea Turtle	4	5	2 to 3	-
Chondrichthyes	1	1	2	9

October 16, 2008

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	1	2	2
Sea Turtle	3	3	2 to 3	-





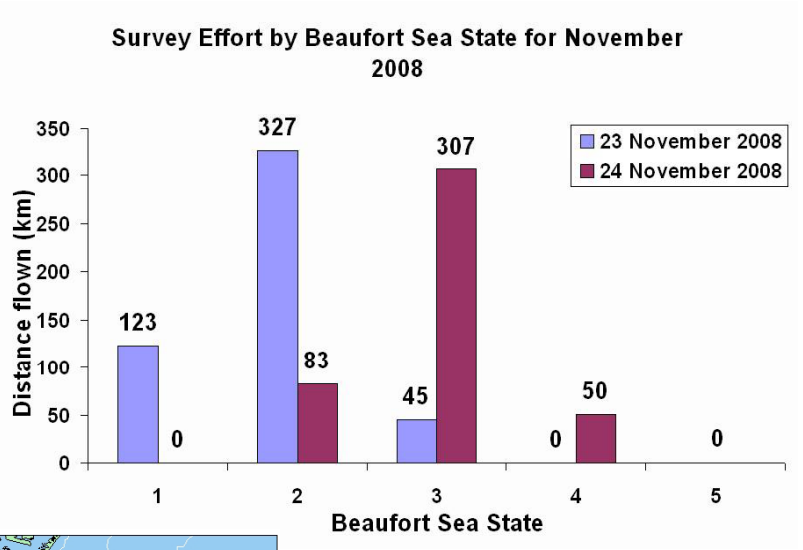


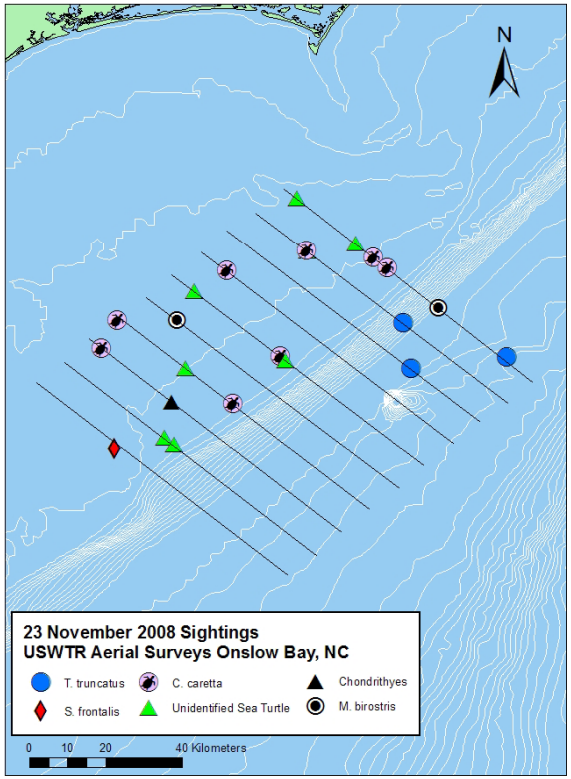
November 23, 2008

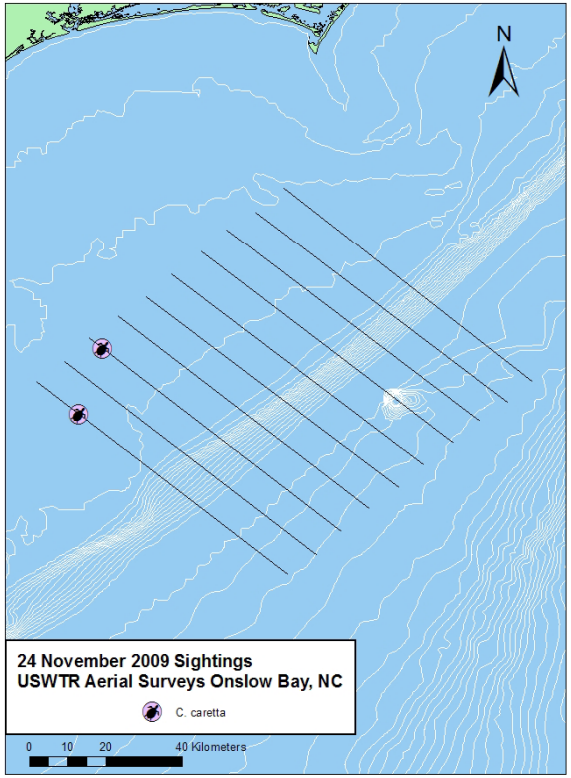
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	45	2	10
Tursiops truncatus	1	13	2	10
Tursiops truncatus	1	21	2	8
Stenella frontalis	1	30	2	1
Sea Turtle	16	17	1 to 2	-
Manta birostris	2	3	1 to 2	-
Chondrichthyes	1	1	1	-

November 24, 2008

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Sea Turtle	2	2	2	-

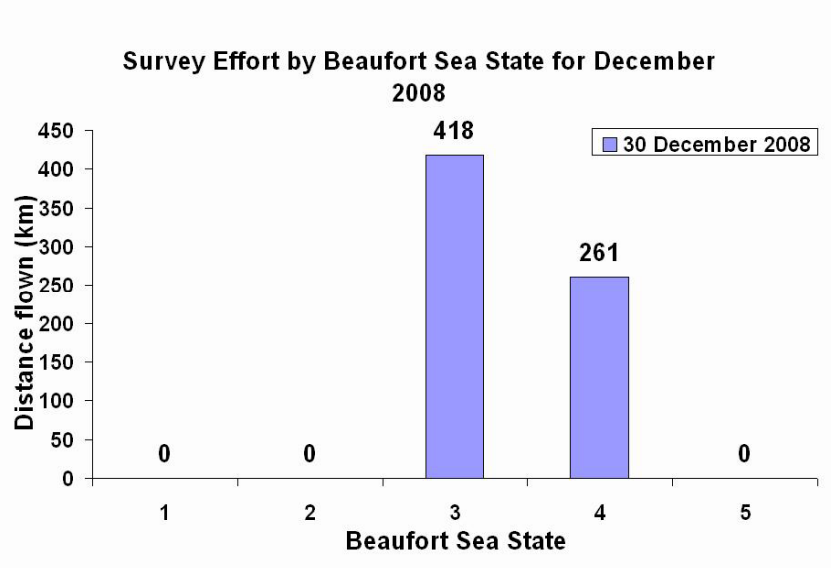


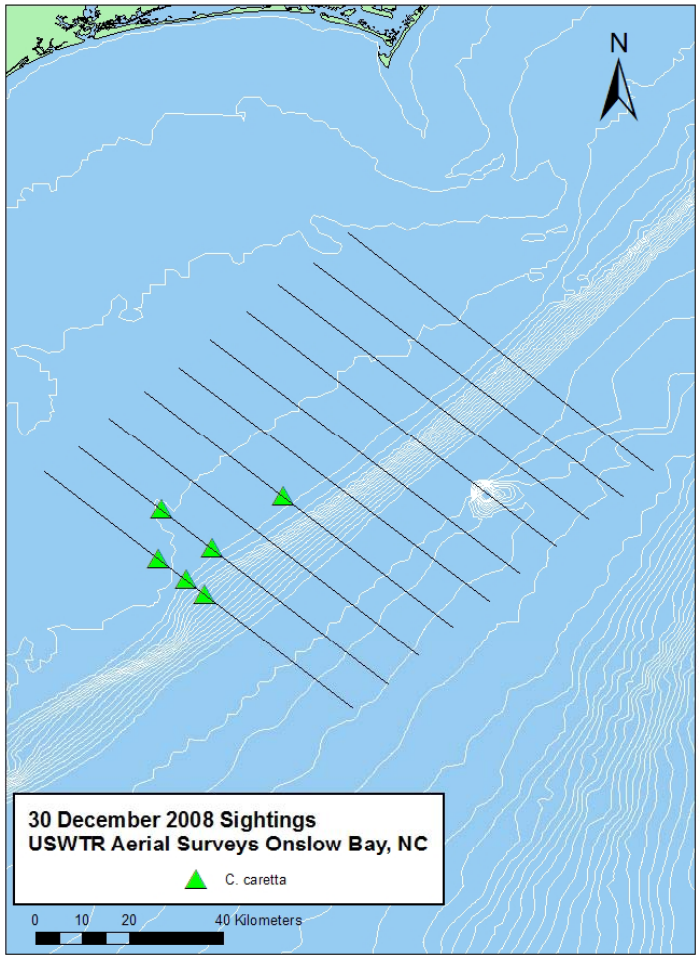




December 30, 2008

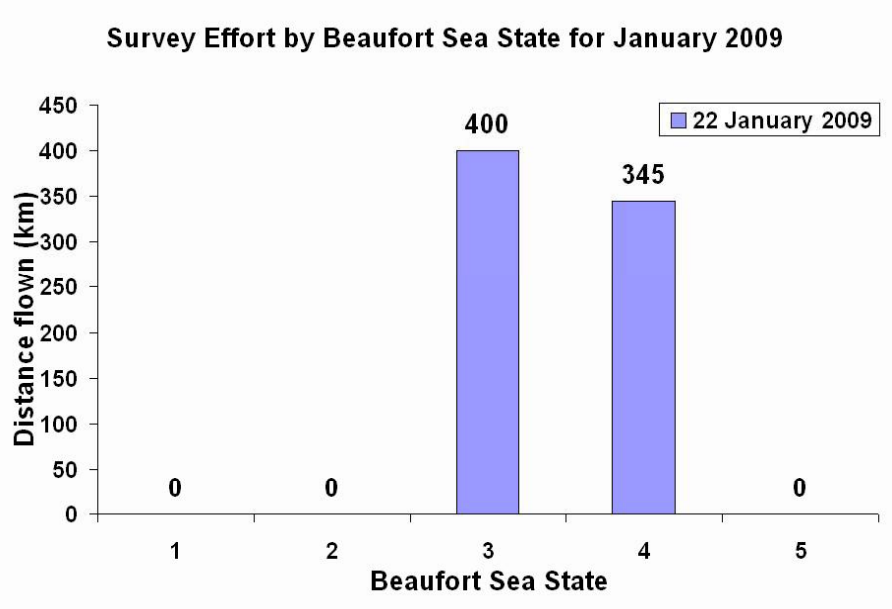
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Sea Turtle	6	6	3	-

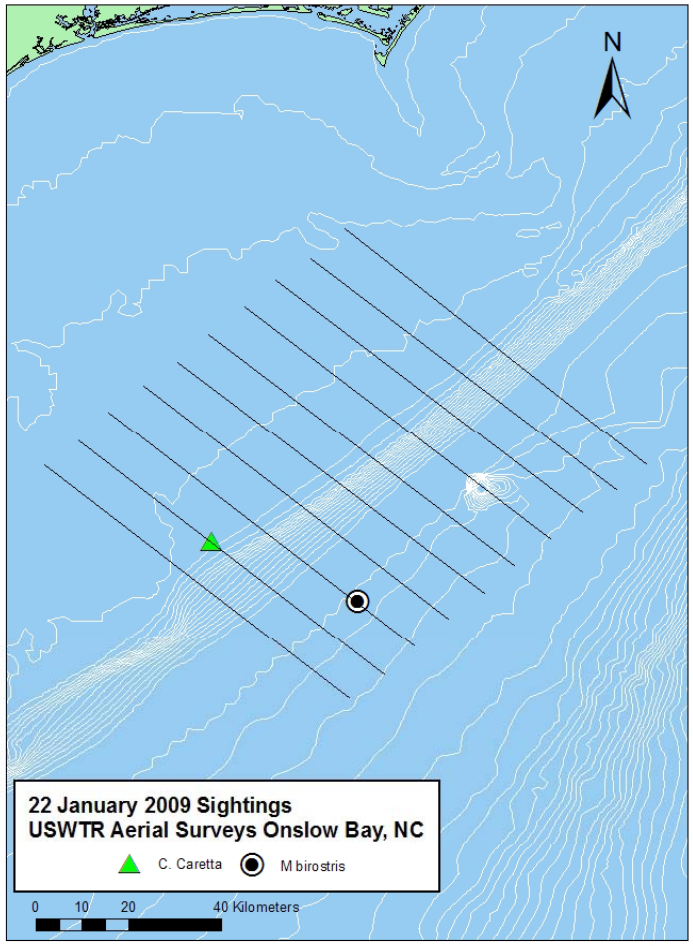




January 22, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Sea Turtle	1	2	3	-
Manta birostris	1	2	3	-



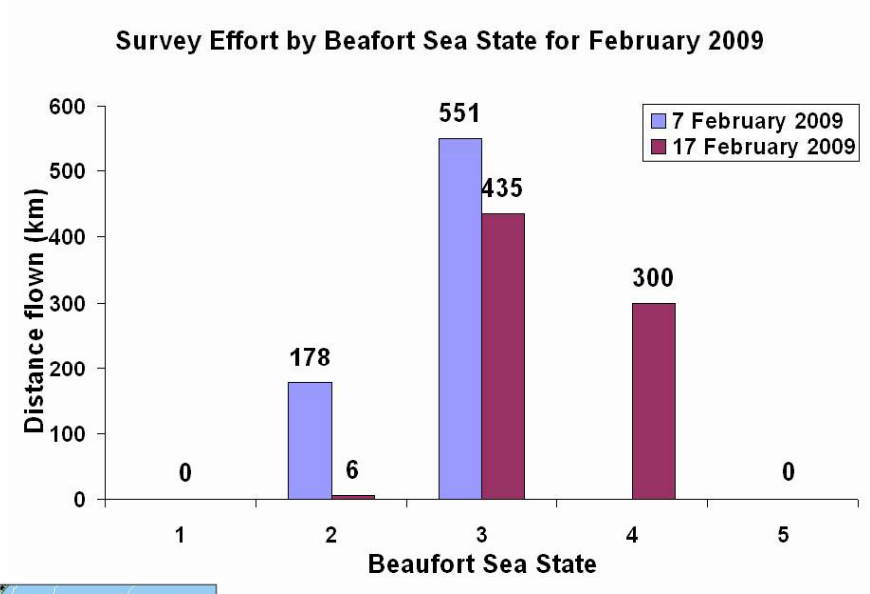


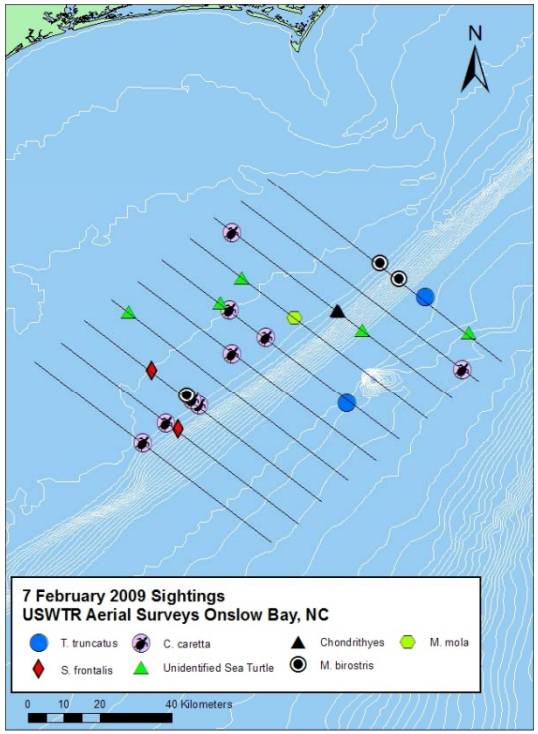
February 7, 2009

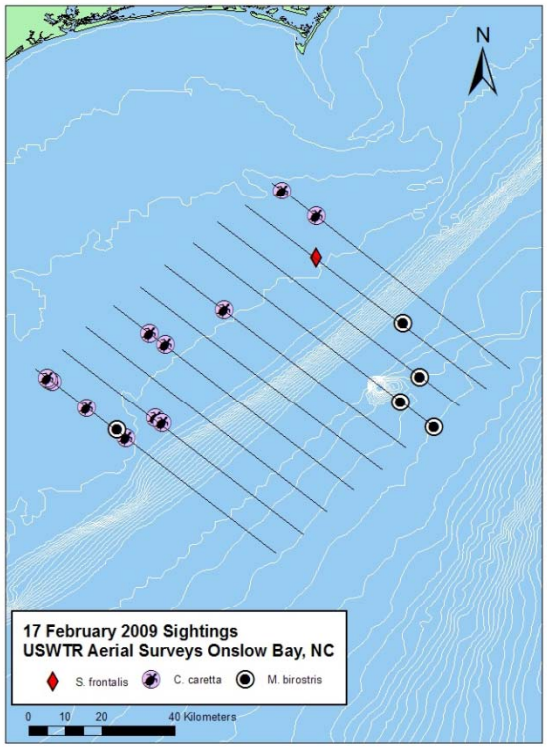
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	50	3	6
Tursiops truncatus	1	30	3	10
Stenella frontalis	1	40	3	3
Stenella frontalis	1	90	3	2
Sea Turtle	13	16	2 to 3	-
Manta birostris	3	4	3	-
Chondrichthyes	2	2	2	-
Mola mola	1	1	3	-

February 17, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Stenella frontalis	1	30	3	9
Sea Turtle	12	12	3 to 4	-
Manta birostris	5	8	3 to 4	-

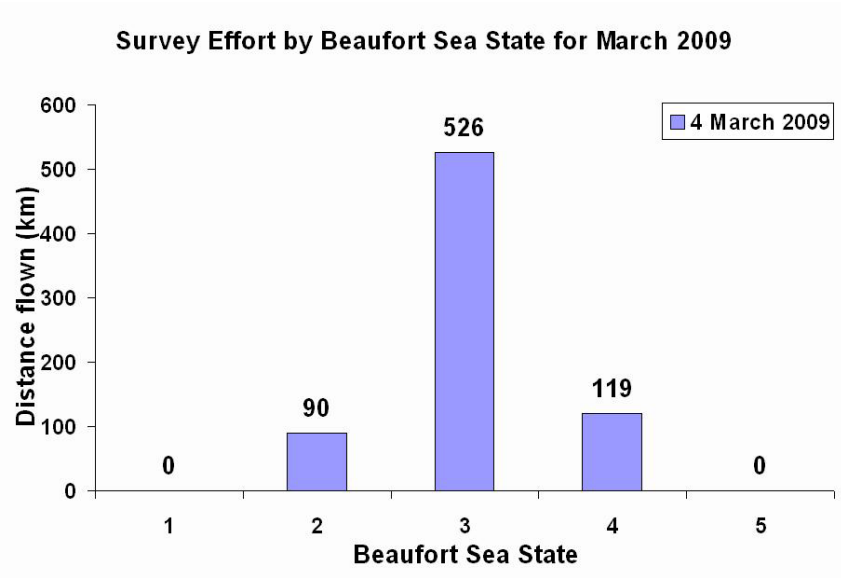


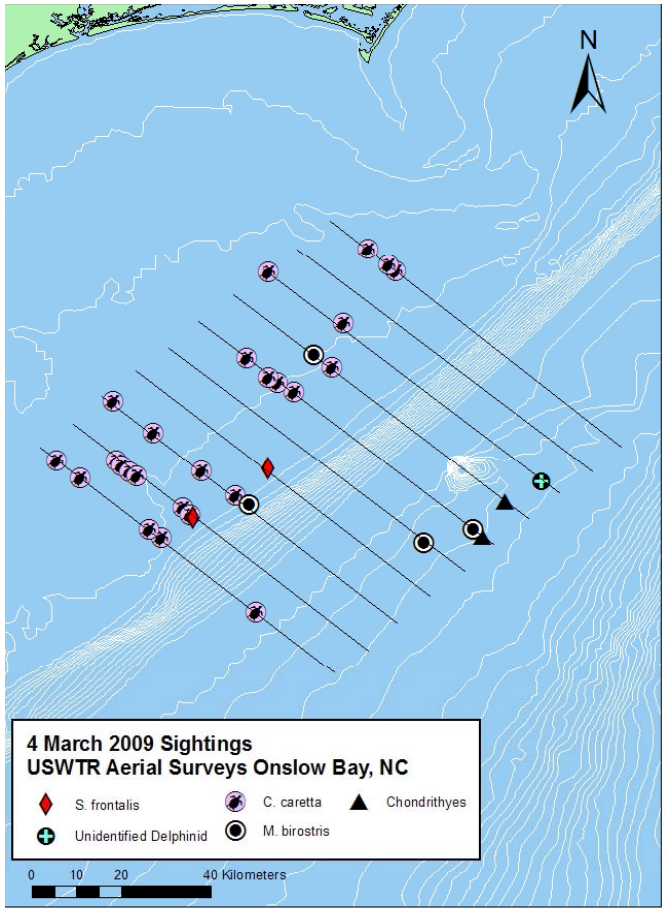




March 4, 2009

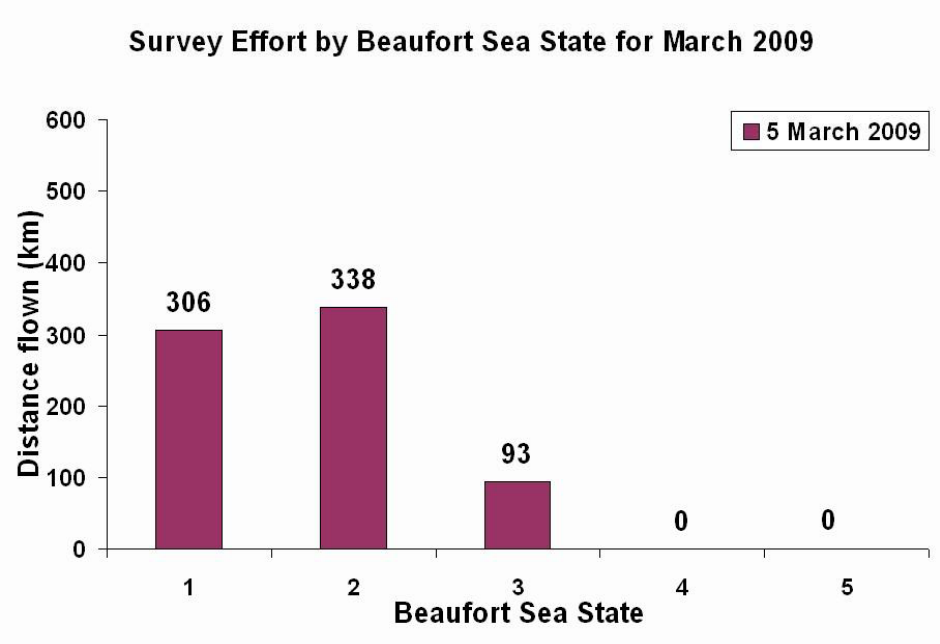
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Stenella frontalis	1	15	3	4
Stenella frontalis	1	100	2	2
Unidentified Delphinid	1	3	4	8
Sea Turtle	25	28	2 to 3	-
Manta birostris	4	4	3	-
Chondrichthyes	2	2	3 to 4	-

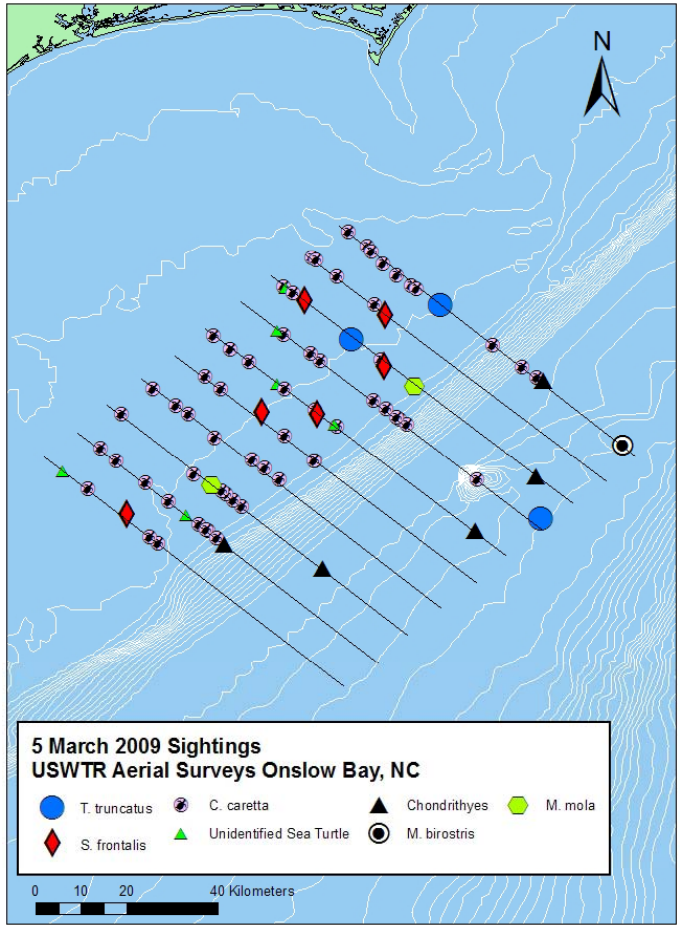




March 5, 2009

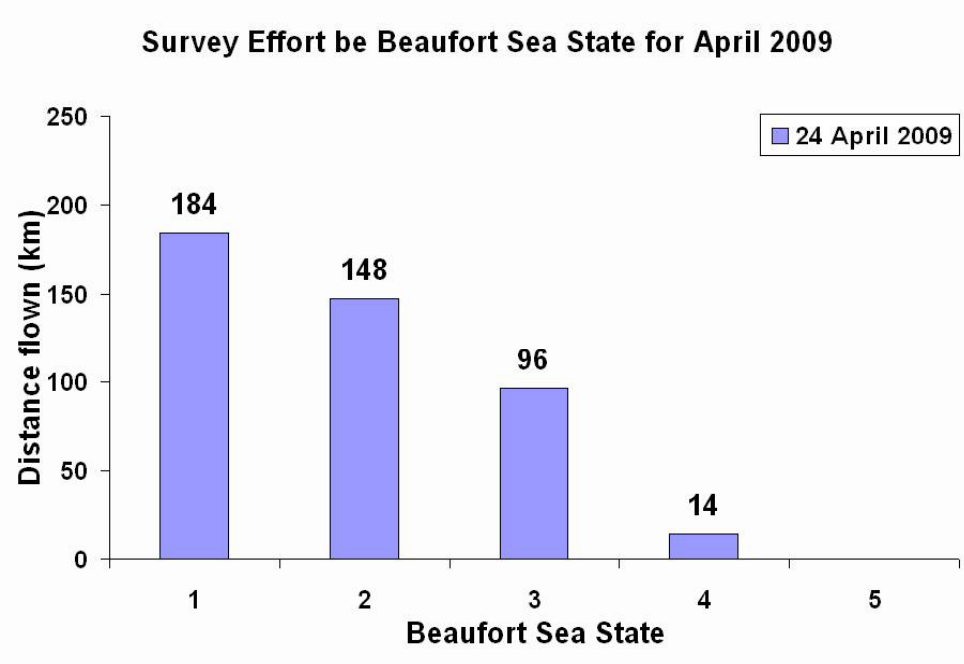
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	4	1	10
Tursiops truncatus	1	2	1	8
Tursiops truncatus	1	5	2	7
Stenella frontalis	1	20	1	9
Stenella frontalis	1	25	1	8
Stenella frontalis	1	8	2	8
Stenella frontalis	1	24	2	6
Stenella frontalis	1	35	2	5
Stenella frontalis	1	30	1	1
Sea Turtle	67	77	1 to 2	-
Manta birostris	1	1	3	-
Chondrichthyes	5	9	1 to 3	-
Mola mola	2	2	1	-

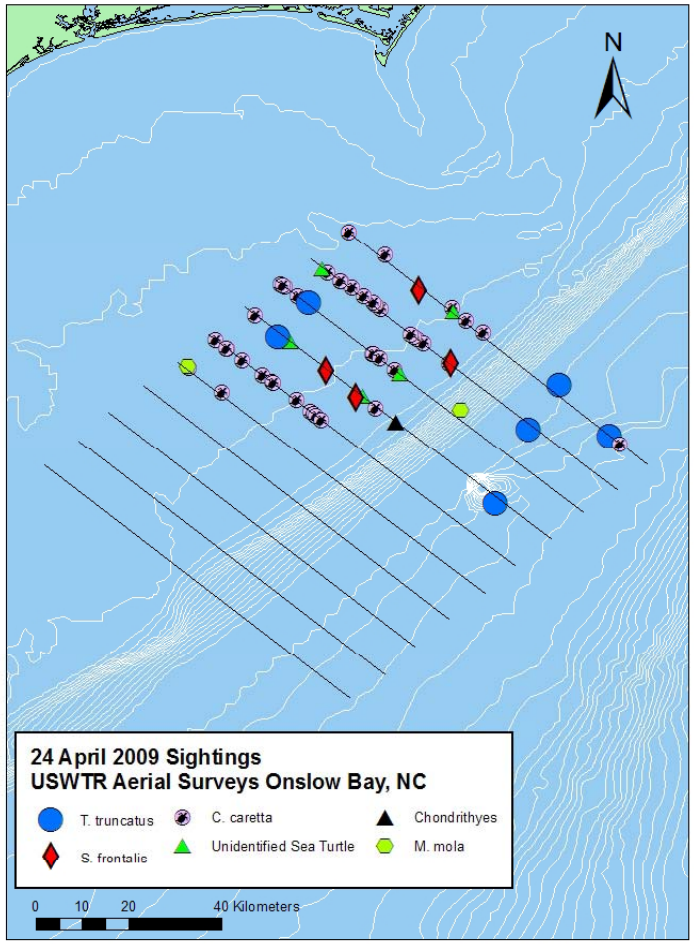




April 24, 2009

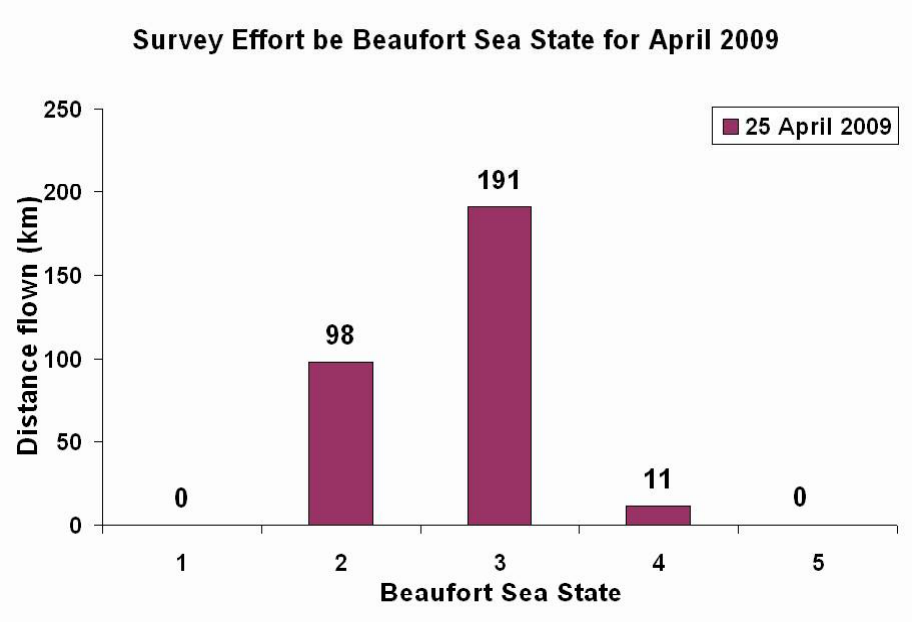
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	10	1	10
Tursiops truncatus	1	10	1	10
Tursiops truncatus	1	15	1	9
Tursiops truncatus	1	2	1	8
Tursiops truncatus	1	32	3	7
Tursiops truncatus	1	9	1	7
Stenella frontalis	1	10	1	7
Stenella frontalis	1	55	1	10
Stenella frontalis	1	80	1	9
Stenella frontalis	1	37	1	7
Sea Turtle	48	57	1 to 2	-
Chondrichthyes	1	1	1	-
Mola mola	2	2	1 to 2	-

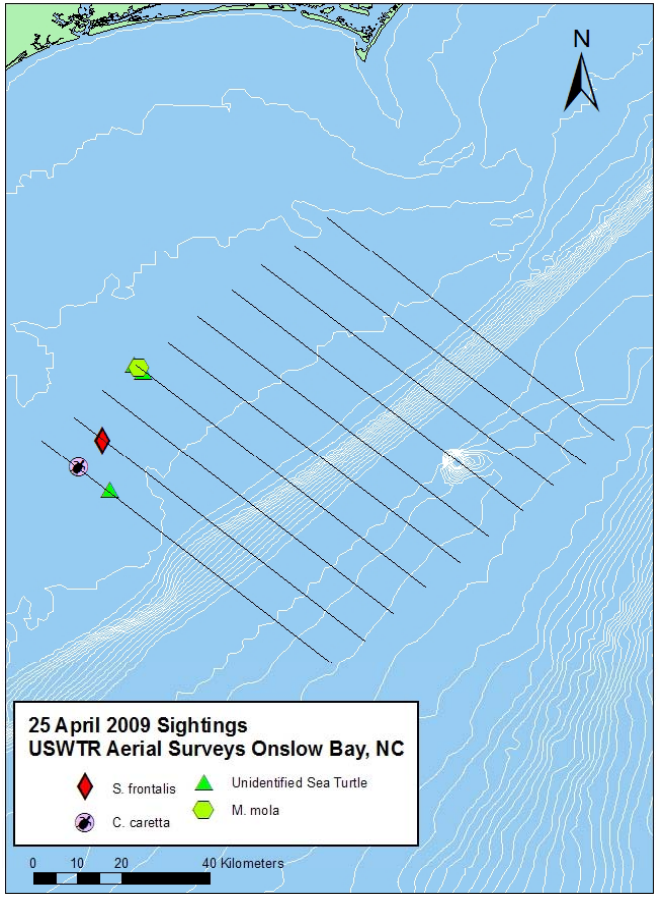




April 25, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Stenella frontalis	1	16	2	2
Sea Turtle	4	4	2	-
Mola mola	1	1	2	-



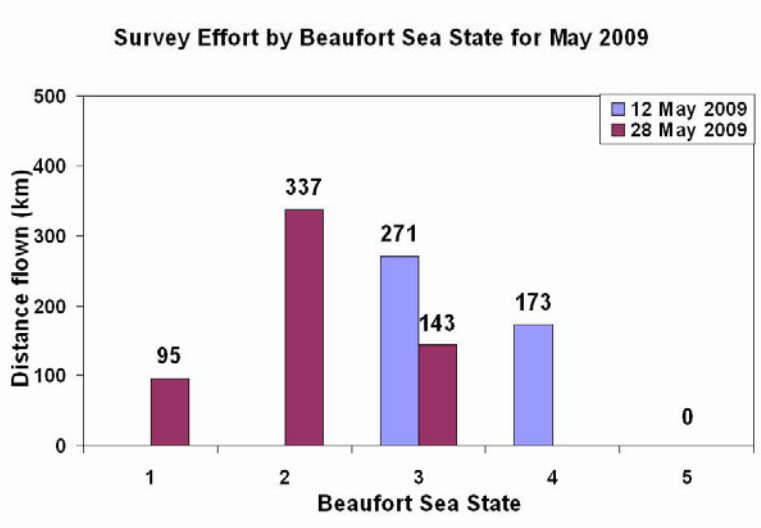


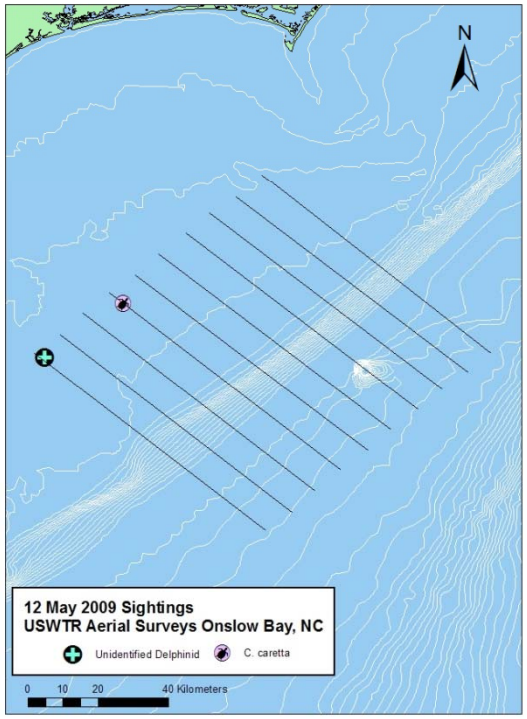
May 12, 2009

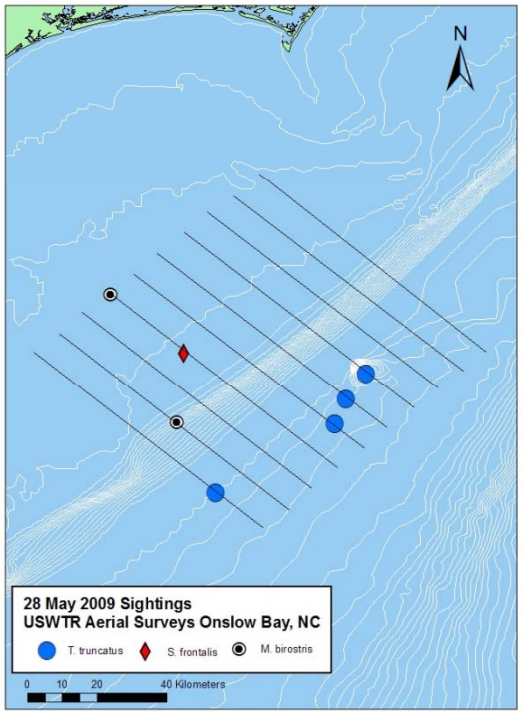
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Unidentified Delphinid	1	26	3	1
Sea Turtle	1	1	3	-

May 28, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	60	2	1
Tursiops truncatus	1	40	2	5
Tursiops truncatus	1	35	1	6
Tursiops truncatus	1	10	2	7
Stenella frontalis	1	25	1	4
Manta birostris	2	2	1 to 2	-





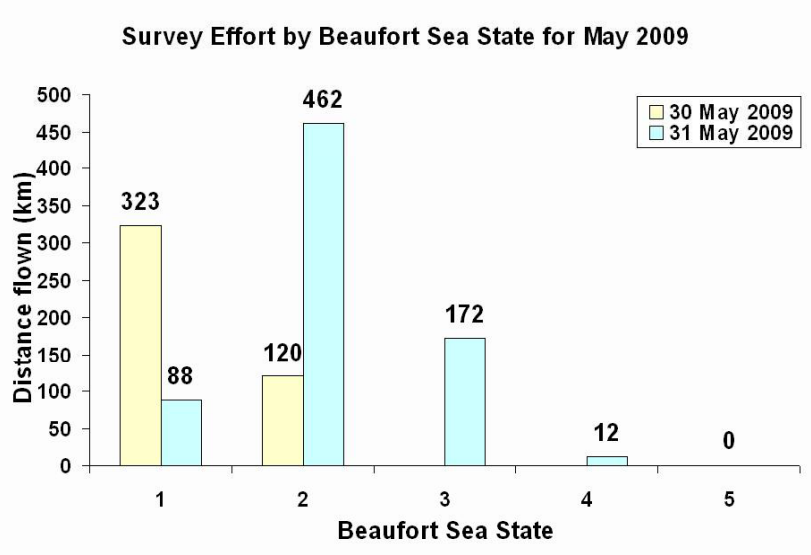


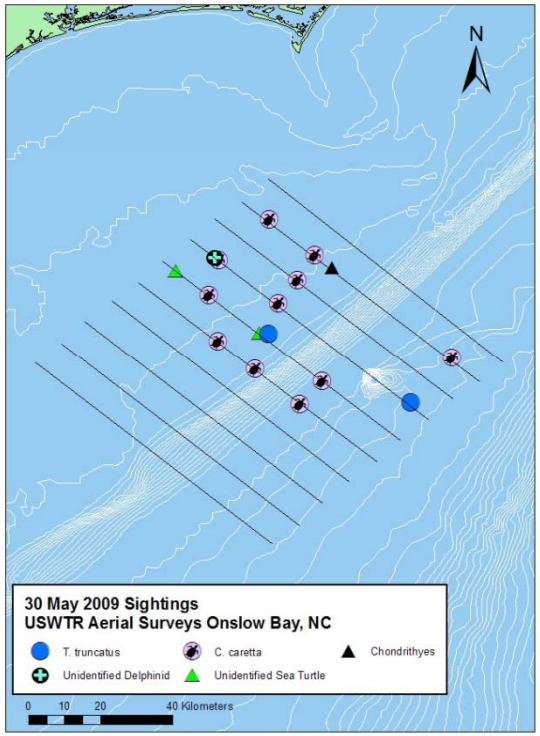
May 30, 2009

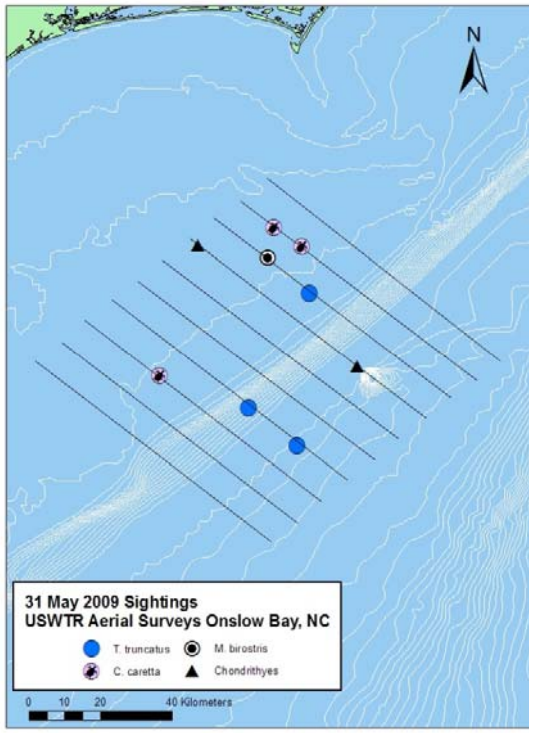
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	4	1	7
Tursiops truncatus	1	3	1	6
Unidentified Delphinid	1	1	1	7
Sea Turtle	13	13	1 to 2	-
Chondrichthyes	1	1	2	-

May 31, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	10	2	8
Tursiops truncatus	1	9	2	4
Tursiops truncatus	1	15	2	4
Sea Turtle	3	3	2	-
Chondrichthyes	1	1	1 to 2	-
Manta birostris	1	1	2	-

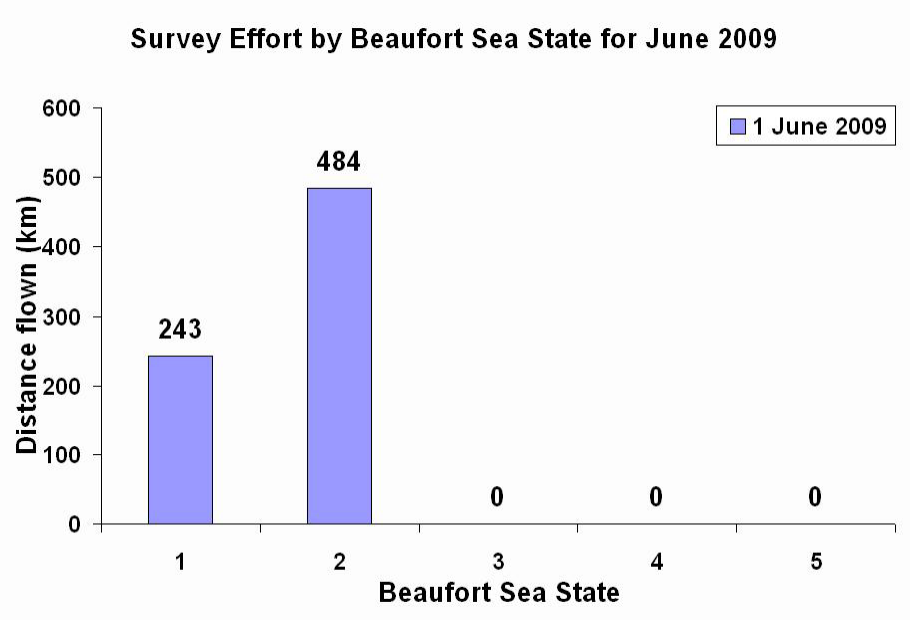


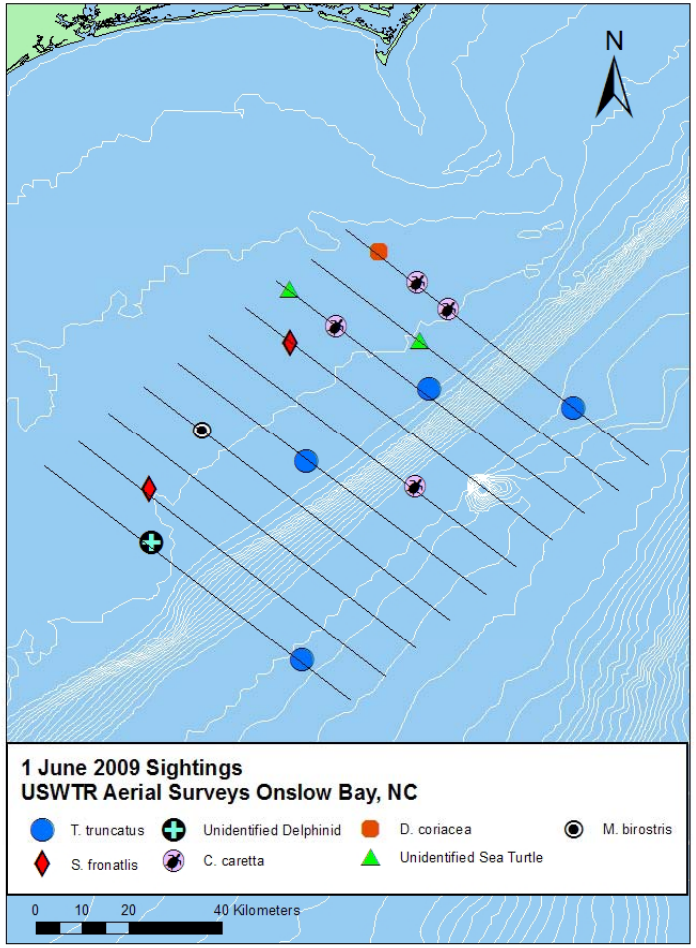




June 1, 2009

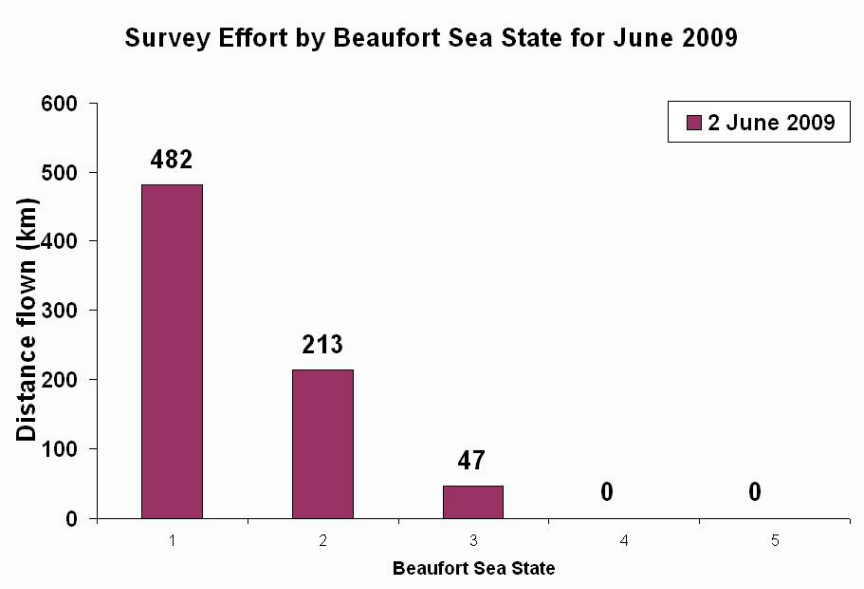
Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	3	2	5
Tursiops truncatus	1	2	2	8
Tursiops truncatus	1	28	2	8
Tursiops truncatus	1	35	1	1
Stenella frontalis	1	7	1	7
Stenella frontalis	1	13	1	2
Unidentified Delphinid	1	11	2	1
Sea Turtle	7	7	1 to 2	-
Manta birostris	1	1	1	-

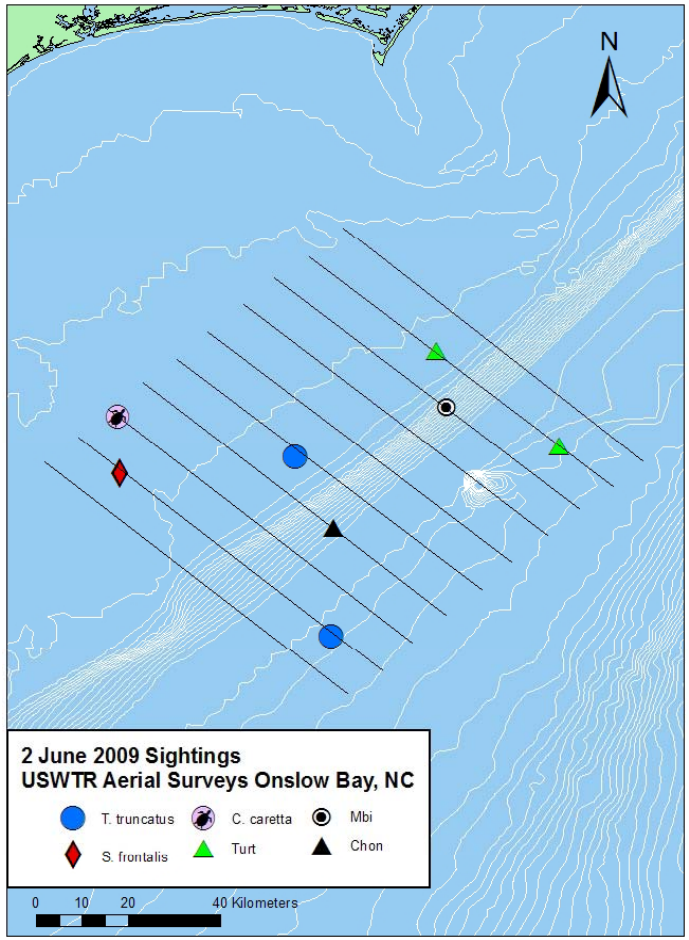




June 2, 2009

Species	Number of Sightings	Number of Individuals	Beaufort Sea State	Line number
Tursiops truncatus	1	8	1	5
Tursiops truncatus	1	25	1	2
Stenella frontalis	1	5	1	2
Sea Turtle	3	3	1 to 2	-
Chondrichthyes	1	1	1	-
Manta birostris	1	1	1	-





VESSEL-BASED SURVEYS AND PASSIVE ACOUSTIC MONITORING OF THE PROPOSED UNDER SEA WARFARE TRAINING RANGE (USWTR) IN ONSLOW BAY, NORTH CAROLINA JULY 2008 THROUGH JUNE 2009

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Methodology

Study Area

The study area consists of a box approximately 37% larger than the proposed USWTR; the USWTR area itself is 25 nm (46 km) long and 20 nm (37 km) wide (approximately from NW to SE; Fig. 1). We survey ten 40 nm (74 km) long transect lines oriented parallel to the short axis of the USWTR boundaries and perpendicular to the prevailing bathymetric and oceanographic features influencing the study area. The transect lines are spaced approximately 5 nm (9.3 km) apart. This design yields a total of 400 nm (741 km) of track line available for surveys and all ten transect lines were surveyed by both aerial and shipboard platforms.

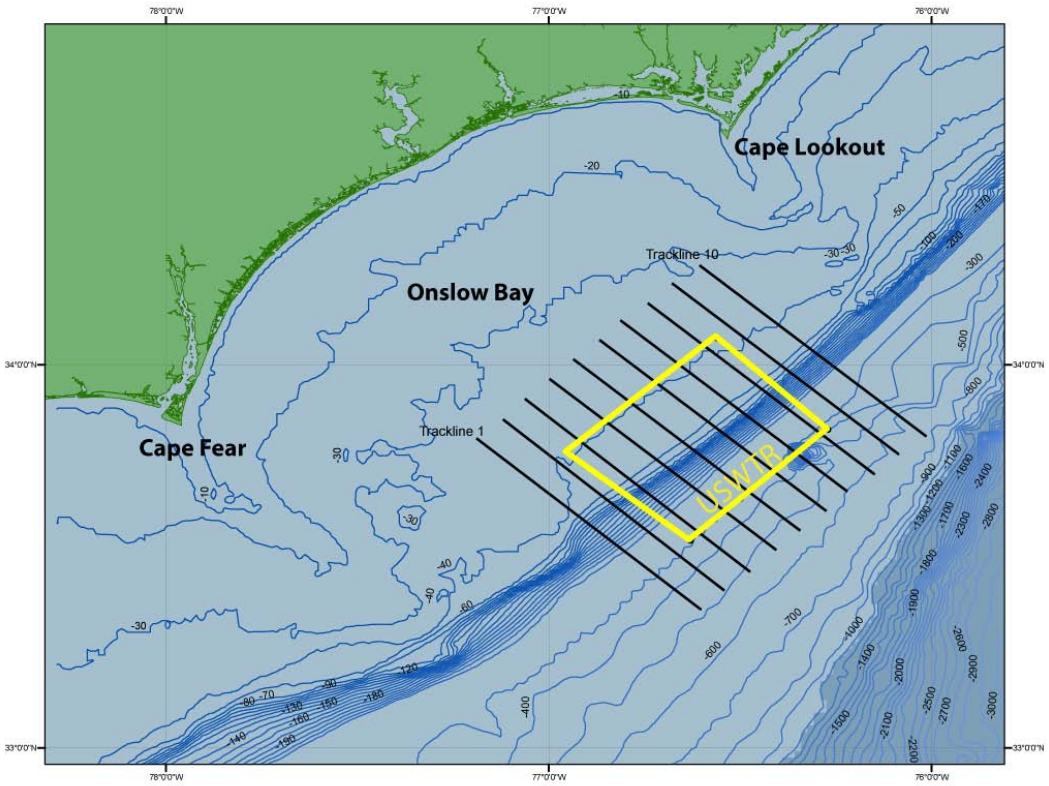


Figure 1. Map of the study area, the proposed Undersea Warfare Training Range (USWTR; yellow box) and bathymetry of Onslow Bay.

Vessel Survey Data Collection

Visual Surveys

Vessel-based survey platforms provide a greater probability of sighting deep-diving species than aerial surveys (Barlow and Gisiner 2006). Shipboard observers are also more likely to be able to confirm species identity, particularly for animals that are difficult to distinguish from the air. Additionally, vessel-based platforms allow for biopsy sampling and photographic identification.

To ensure maximum detection rates, we employed a traditional visual survey approach, supplemented by passive acoustic monitoring using a towed hydrophone array.

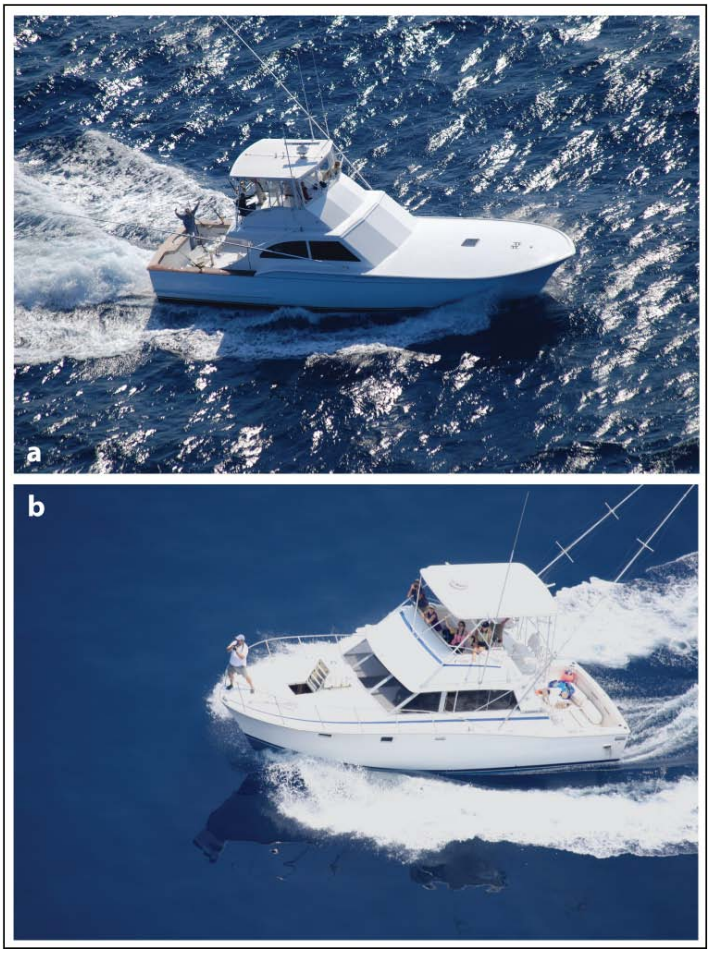


Figure 2. Aerial photogrpahs of the F/V *Sensation* (a) and the R/V *Cetus* (b).

Visual surveys for cetaceans and other marine megafauna were conducted from two survey platforms: the F/V *Sensation* (Fig. 2a), a 16m offshore fishing vessel and the R/V *Cetus* (Fig. 2b), a modified 12 m offshore fishing vessel.

Observations were made from the flying bridge (5.0m and 4.2m above waterline for the *Sensation* and *Cetus*, respectively) by naked eye and 7x50 binoculars. At the start of Year One a classroom training exercise was held for all marine mammal observers at the Duke University Marine Laboratory in

Beaufort, NC on April 24th, 2007.
The workshop was led by Ms. Erin LaBrecque, who received training from the Centre for Research into Ecological and Environmental Modeling (CREEM) group at the University of St. Andrews, Scotland, and who has extensive experience as a NOAA shipboard observer. Observers were instructed in line transect theory, field methods, data collection protocols, and species identification. Training of new observers in Year Two continued on an as-needed basis.

Two observers (port and starboard) scanned constantly from straight ahead to 90˚ abeam either side of the trackline. A center observer monitored the trackline, coordinated with the vessel skipper and acted as data recorder for sightings and environmental conditions. Observations were conducted following standard distance sampling/line transect methods for cetaceans, similar to those employed in Barlow (2006). During ship surveys, the location, species and behavior of each cetacean group were recorded. If turtles were encountered, the location and species were recorded. Each observer estimated group size independently and individual estimates were averaged at the end of the survey to generate an overall estimate of group size. Environmental conditions (weather, sea state, depth and sea surface temperature) were recorded every 30 minutes or more frequently if sighting conditions changed. Both sighting and environmental data were input into an at-sea data collection system (Vis-Survey, developed by Dr. Lance Garrison, NOAA/SEFSC) linked with the onboard GPS.

A shipboard platform allows us to monitor the use of the USWTR and adjacent areas by individual animals using photo-identification techniques. This approach is feasible for sperm whales, beaked whales, humpback whales, bottlenose dolphins, spotted dolphins, pilot whales and Risso's dolphins. Photo identification can provide information on patterns of seasonal, annual and inter-annual residency. Such information will be critical to interpreting any future changes in density in the USWTR area.

Thus, whenever possible, photographs of cetaceans were obtained for species confirmation and individual photo-identification. Photographs were taken with Canon or Nikon digital

SLRs (equipped with 100-300 mm zoom lenses) in 24-bit color at a resolution of 3072 X 2048 pixels and saved in jpg format.

Seabird counts were conducted by an experienced observer who recorded seabirds in a 90-degree bow-beam arc in a 300-meter strip on the starboard side of the ship (Tasker *et al.* 1984). The observer recorded the time and location of each bird sighting. Species identification, abundance, general behavior (sitting, flying, or foraging), and associations with other marine species were recorded for each sighting. The presence of ship-following birds was noted separately to avoid biases in quantitative analyses.

Passive Acoustic Monitoring

Passive acoustic data were collected in the proposed range using two methods: towed hydrophone array and bottom-mounted recorder.

Towed Array

A four-element array was towed behind the survey vessel at a speed of 10 knots to allow acoustic detection of nearby cetaceans. The towed array (Seiche Instruments, UK) consisted of four hydrophone elements with approximate linear sensitivity to frequencies between 1kHz and 100 kHz. The array was towed 150m behind the vessel and acoustic signals were routed to an analog-to-digital converter/mixer (MOTU Traveler, MOTU, Cambridge, MA) sampling at 192 kHz. These signals were then passed to two personal laptop computers outfitted with software for real-time visualization/recording (*Ishmael* 1.0) and spatial localization (*WhalTrak* 2.0) of cetacean sounds. A trained acoustician monitored the array and made recordings of all potential cetacean sounds detected, as well as other novel sounds. When possible, the acoustician attempted to localize cetacean vocalizations with time difference of arrival (TDOA) techniques involving two or more hydrophone elements and using *Ishmael* and *Whaltrak* software.

Bottom-mounted Recorder

To collect a time-series of acoustic data in the USWTR study area, a High Frequency Acoustic Recording Package or HARP (Wiggins and Hildebrand 2007) was employed. This instrument combined high and low frequency hydrophone elements for detecting the

vocalizations of both odontocete and mysticete whales and sampled at rates high enough to capture the echolocation clicks of many odontocetes. The HARP was deployed near the center of the USWTR box, close to the 200 m shelf break. In Year Two the second deployment was at 33.811°N and -76.428°W at a depth of 232 m; and the third deployment was at 33.790°N and -76.519°W at a depth of 174 m (see Fig. 3). In all deployments, the instrument was programmed to record at a sample rate of 200 KHz for five-minute periods separated by an inactive interval of five minutes.

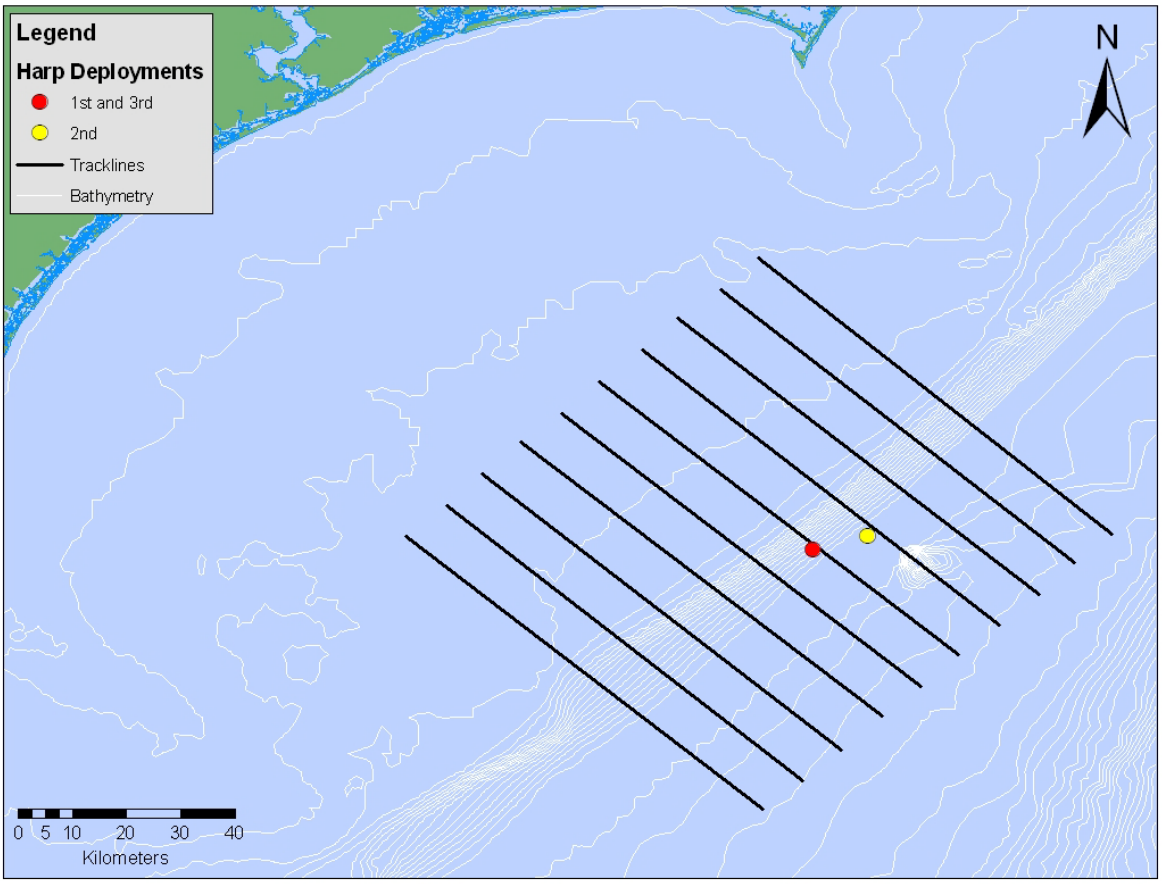


Figure 3. Location of HARP deployments in Onslow Bay, NC.

Data Analysis

Vessel survey effort and sighting data were compiled and mapped using ArcGIS 9.2 to illustrate the location of effort and sightings within the study area. In addition, the statistical distributions of survey effort, sea state and marine mammal sightings by synoptic depth and sea surface temperature were examined using JMP 8.0. The sighting data (including radial distance and bearing estimates for each cue) were forwarded to the CREEM at the University

of St. Andrews, UK for density estimation. Vessel based survey tracks and sighting locations from June-December 2007 have been posted on OBIS-SEAMAP (http://seamap.env.duke.edu/).

Acoustic Analysis

Towed hydrophone array recordings were analyzed with the sound analysis software program *Adobe Audition 2.0*. Selections of whistles and clicks with positive species identifications from concurrent visual observations were saved for future analysis of species-specific patterns. Discriminant function analyses (DFAs) will be performed to look for species-specificity in the whistles after measuring several parameters including, but not limited to, start, end, minimum, and maximum frequency; duration; number of inflection points; and number of steps. This approach is similar to that used by Oswald *et al.* (2003). We also plan to look for species-specific patterns, such as consistent peaks and notches, in the recorded clicks using techniques, similar to those employed by Soldevilla *et al.* (2008). Analyses of variance (ANOVAs) will be used to examine if there are species-specific frequency differences in peaks and notches of echolocation clicks. In addition, techniques that combine both whistles and clicks into a single classifying analysis will be explored, such as combining certain parameters of each call type into a single DFA. Inclusion of both call types may increase classification rates.

Marine mammal sounds were located in the HARP data using Long-Term Spectral Averages (LTSAs; Wiggens and Hildebrand 2007). LTSAs provide a way to examine hours to weeks of data on the same spectrogram, allowing for rapid review of large data sets. LTSAs made using a MATLAB-based acoustic program called *Triton* (Hildebrand Lab at Scripps Institution of Oceanography) were used to look for odontocete whistle and click events in the HARP data from the second (30 May 2008 – 10 September 2008) and third deployments (24 April 2009 – 9 August 2009; Fig. 4). These LTSAs were manually inspected in *Triton* for high-energy locations denoting whistle and click events. Whistle and click detectors built into the *Triton* software will be used to help find additional vocal events.

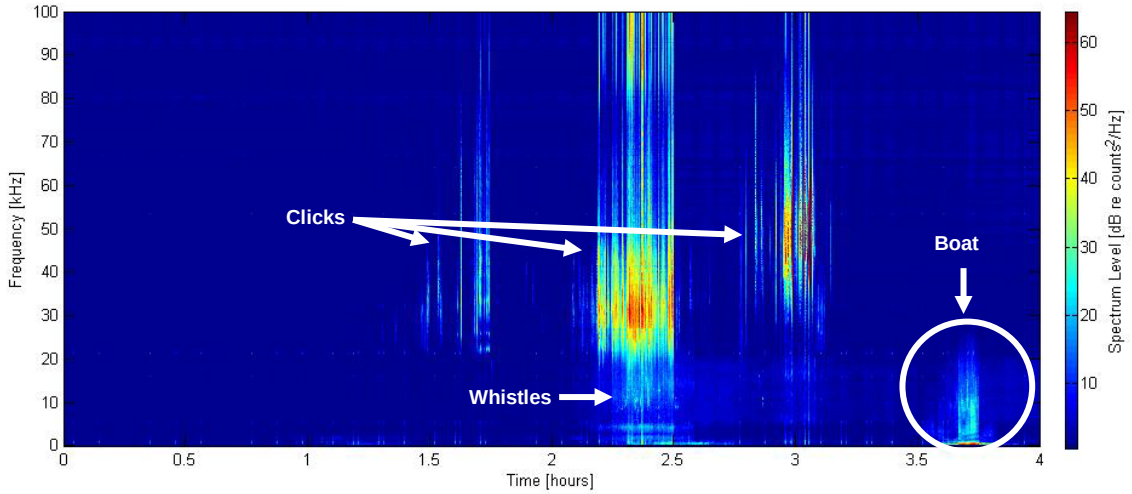


Figure 4. Example of a Long-Term Spectral Average (LTSA) produced using Triton software. This LTSA shows instances of unidentified odontocete vocalizations (clicks and whistles).

Once all whistles have been detected using both methods, loud and clear whistles with acceptable signal-to-noise ratios will be chosen for further analysis. The same parameters used in determining species-specific differences will be measured in these newly selected whistles. These values will then be processed using a combination of DFAs and Classification and Regression Trees (CART) to determine to which species the whistles most likely belong.

Once all click events have been detected, we will select one click from each click train for further analysis. The selected clicks will be examined for peaks and notches that occur within frequency ranges determined by towed array data for different species (if found). This examination will help determine which species produced the clicks.

At this point, for those instances when both whistles and clicks are detected in a single vocal event, the predicted species identification for both the whistles and clicks from that same event will be compared to determine if the same species was selected. In addition to determining the likely vocalizing species in this way, exploratory techniques that combine both whistles and clicks into a single classifying analysis will be tested.

Over the next few months, the HARP data from all three HARP deployments will be decimated to look for baleen whales. Once these analyses are complete and (1) all calls present in the HARP data have been found and (2) the species to which those calls most likely belong have been determined, the vocal events will be sorted by species to look for diel and seasonal patterns in their vocalizations.

Data Storage

All acoustic, visual survey and photographic data are archived on digital media and backed up on a Duke University network server.

Results

Vessel Survey Effort

Between 1 July 2008 and 30 June 2009, 21.75 tracklines were surveyed (Table 1) totaling approximately 102 hours of marine mammal surveys (85 hours on effort, 17 hours off effort) and 70 hours of on effort seabird surveys.

Surveys were conducted in Beaufort Sea States 0 to 4. Most survey effort (73%) was conducted in Beaufort 2 and 3; 19% of effort was conducted in optimal (Beaufort 0 and 1) sighting conditions (Fig. 5).

Table 1. Vessel survey effort. Year 1 includes June 2007 through June 2008. Year 2 includes July 2008 through June 2009.

Trackline	Year 1	Year 2
1	0.66	1
2	1.5	2
3	3	3
4	4	2
5	4	4
6	3	1.75
7	4.25	1
8	2.25	1.25
9	3	4
10	3.5	1.75
Total	**29.16**	**21.75**

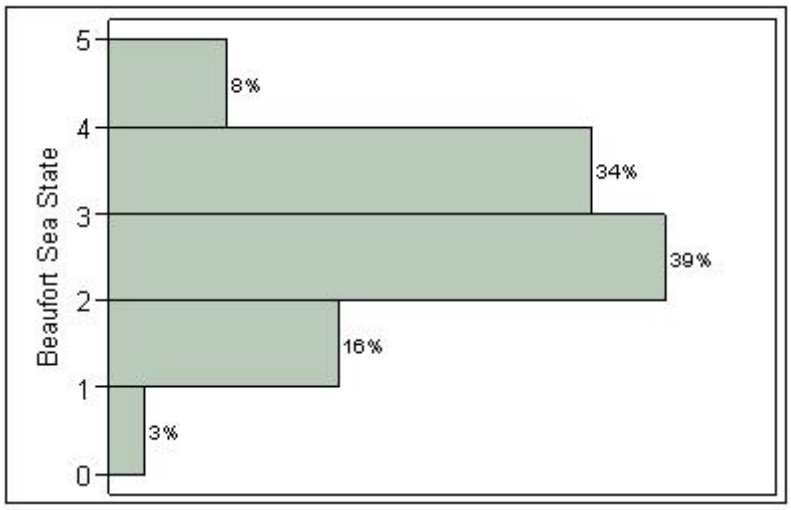


Figure 5. Distribution of sea state conditions (% of total effort) for vessel surveys during Year Two.

Marine Mammal and Sea Turtle Line Transect Sightings

Thirty-three marine mammal sightings were made during vessel surveys (29 while on effort, 4 while off effort) in Year Two (Table 2). Two species of cetaceans were detected visually in the study area: bottlenose dolphins (*Tursiops truncatus,* n=14; all on effort*)* and Atlantic spotted dolphins (*Stenella frontalis*, n=17; 14 on effort). In addition, the crew made two sightings of unidentified delphinids (one on effort). No mixed-species groups were observed (Table 3). The sightings per unit effort was, not surprisingly, highest in a Beaufort Sea State of 0, but sightings were consistently made in conditions as high as Beaufort 4 (Figure 6).

A total of 49 loggerhead sea turtle (*Caretta caretta*) were sighted during vessel surveys (43 on effort, 6 off effort) from 1 July 2008 through 30 June 2009 (Table 2, Table 4, Fig. 12).

Table 2. Vessel-based cetacean and sea turtle sightings made in the USWTR study area, July 2008 through June 2009.

Date	Vessel	Trackline	Depth (m)	Temp (°C)	Species	Group Size	Effort
7/2/08	Cetus	9	n/a	n/a	*Caretta caretta*	1	On
7/2/08	Cetus	9	n/a	n/a	*Caretta caretta*	1	On
7/2/08	Cetus	9	99.0	20.0	*Caretta caretta*	1	On
7/15/08	Sensation	3	521.2	28.8	*Tursiops truncatus*	1	On
7/16/08	Sensation	5	23.4	29.3	*Tursiops truncatus*	2	On
7/16/08	Sensation	5	42.6	29.2	*Tursiops truncatus*	2	On
7/25/08	Cetus	7	n/a	n/a	*Tursiops truncatus*	31	On
7/25/08	Cetus	7	n/a	n/a	*Caretta caretta*	1	On
7/25/08	Cetus	7	n/a	n/a	*Stenella frontalis*	5	On
8/12/08	Sensation	1	374.9	28.2	*Tursiops truncatus*	42	On
8/15/08	Sensation	5	n/a	n/a	*Caretta caretta*	1	On
8/15/08	Sensation	5	34.7	27.9	*Stenella frontalis*	2	On
8/19/08	Sensation	2	294.4	28.4	*Tursiops truncatus*	90	On
8/27/08	Sensation	8	35.8	28.2	Unid. Delphinid	2	Off
8/27/08	Sensation	10	482.8	28.6	Unid. Delphinid	2	On
8/27/08	Sensation	8	34.9	28.2	*Stenella frontalis*	4	On
9/29/08	Sensation	9	40.2	26.3	*Caretta caretta*	1	On
9/29/08	Sensation	9	36.0	26.2	*Stenella frontalis*	4	On
9/29/08	Sensation	9	33.3	26.1	*Caretta caretta*	1	Off
9/29/08	Sensation	9	33.3	26.1	*Stenella frontalis*	7	On
11/24/08	Cetus	9	39.7	24.3	*Stenella frontalis*	6	On
11/24/08	Cetus	9	36.9	23.5	*Stenella frontalis*	5	On
2/21/09	Sensation	5	43.9	17.7	*Caretta caretta*	1	On
2/21/09	Sensation	5	37.1	16.1	*Caretta caretta*	1	On
2/21/09	Sensation	5	35.8	16.1	*Caretta caretta*	1	On
2/21/09	Sensation	5	40.0	16.0	*Caretta caretta*	1	On
2/21/09	Sensation	5	42.4	16.4	*Caretta caretta*	1	On
2/21/09	Sensation	5	42.2	16.7	*Caretta caretta*	1	On
2/21/09	Sensation	5	43.0	16.9	*Caretta caretta*	1	On
2/21/09	Sensation	5	43.3	17.3	*Caretta caretta*	1	On
2/21/09	Sensation	5	245.1	19.9	*Tursiops truncatus*	4	On
2/21/09	Sensation	5	43.0	16.9	*Caretta caretta*	1	On
2/25/09	Sensation	6	70.2	17.6	*Caretta caretta*	1	On
2/25/09	Sensation	6	34.7	14.6	*Tursiops truncatus*	2	On
3/5/09	Sensation	3	47.9	19.1	*Caretta caretta*	1	On
3/5/09	Sensation	3	41.3	17.4	*Caretta caretta*	1	On
3/5/09	Sensation	3	47.9	19.1	*Caretta caretta*	1	On
3/5/09	Sensation	3	33.5	14.9	*Caretta caretta*	1	On
3/5/09	Sensation	3	34.0	15.2	*Caretta caretta*	1	On
3/5/09	Sensation	3	36.8	15.7	*Caretta caretta*	1	On
3/5/09	Sensation	3	42.8	18.4	*Caretta caretta*	1	On
3/5/09	Sensation	3	43.2	19.1	*Caretta caretta*	1	On

3/5/09	Sensation	3	43.5	19.1	*Caretta caretta*	1	On
3/5/09	Sensation	3	43.7	19.1	*Caretta caretta*	1	On
3/5/09	Sensation	3	44.1	19.1	*Caretta caretta*	1	On
3/5/09	Sensation	3	63.5	19.6	*Caretta caretta*	1	On
3/5/09	Sensation	3	37.5	15.3	*Caretta caretta*	1	On
4/24/09	Cetus	8	39.9	23.8	*Stenella frontalis*	3	On
4/24/09	Cetus	8	37.4	23.8	*Caretta caretta*	1	On
4/24/09	Cetus	8	31.8	22.2	*Stenella frontalis*	17	On
4/24/09	Cetus	8	34.3	22.2	*Caretta caretta*	1	On
4/24/09	Cetus	8	37.3	24.4	*Caretta caretta*	1	On
4/24/09	Cetus	8	37.9	23.8	*Caretta caretta*	1	On
4/24/09	Cetus	8	39.0	23.8	*Stenella frontalis*	3	On
4/24/09	Cetus	8	39.9	23.8	*Caretta caretta*	1	On
4/24/09	Cetus	8	39.9	23.8	*Caretta caretta*	1	Off
4/27/09	Sensation	4	33.3	22.1	*Caretta caretta*	1	On
4/27/09	Sensation	4	35.3	22.1	*Stenella frontalis*	5	On
4/27/09	Sensation	4	35.1	22.1	*Caretta caretta*	1	Off
4/27/09	Sensation	4	34.0	21.9	*Caretta caretta*	1	Off
4/27/09	Sensation	4	42.8	21.6	*Stenella frontalis*	26	Off
4/27/09	Sensation	4	36.8	22.1	*Caretta caretta*	1	On
4/27/09	Sensation	4	37.7	21.9	*Caretta caretta*	1	On
4/27/09	Sensation	4	407.8	23.8	*Tursiops truncatus*	6	On
4/27/09	Sensation	4	33.5	21.9	*Caretta caretta*	1	On
4/27/09	Sensation	4	35.8	21.9	*Caretta caretta*	1	On
4/28/09	Sensation	2	33.5	22.7	*Stenella frontalis*	3	Off
4/28/09	Sensation	2	63.3	24.4	*Caretta caretta*	1	On
4/28/09	Sensation	2	34.2	22.1	*Tursiops truncatus*	3	On
4/28/09	Sensation	2	34.0	22.3	*Caretta caretta*	1	Off
4/28/09	Sensation	2	33.3	22.2	*Caretta caretta*	1	Off
4/29/09	Sensation	5	35.7	22.0	*Stenella frontalis*	11	Off
4/29/09	Sensation	5	409.7	26.0	*Tursiops truncatus*	26	On
4/29/09	Sensation	5	51.2	25.5	*Stenella frontalis*	12	On
6/1/09	Sensation	3	235.9	26.1	*Tursiops truncatus*	4	On
6/1/09	Sensation	3	223.1	26.1	*Tursiops truncatus*	3	On
6/1/09	Sensation	3	158.4	25.7	*Tursiops truncatus*	8	On
6/2/09	Cetus	10	49.3	9.9	*Caretta caretta*	1	On
6/2/09	Cetus	10	40.8	9.9	*Stenella frontalis*	27	On
6/2/09	Cetus	10	33.9	9.9	*Caretta caretta*	1	On
6/24/09	Cetus	9	35.0	9.0	*Stenella frontalis*	26	On
6/24/09	Cetus	9	30.3	9.0	*Caretta caretta*	1	On

Table 3. Number of cetacean sightings and mean group size for Year 1 and Year 2 for each species observed.

Species	Sightings		Mean Group Size
	Year 1	Year 2	
Globicephala sp.	1	0	**40**
Grampus griseus	3	0	**35.7**
Stenella frontalis	6	17	**8.7**
Tursiops truncatus	23	14	**10.8**
Unid. Delphinid	3	2	**1.6**
Total:	**36**	**33**	

Table 4. Number of sea turtle sightings per year for each species observed.

Species	Sightings	
	Year 1	Year 2
Caretta caretta	19	49
Unid. Turtle	1	0
Total:	20	49

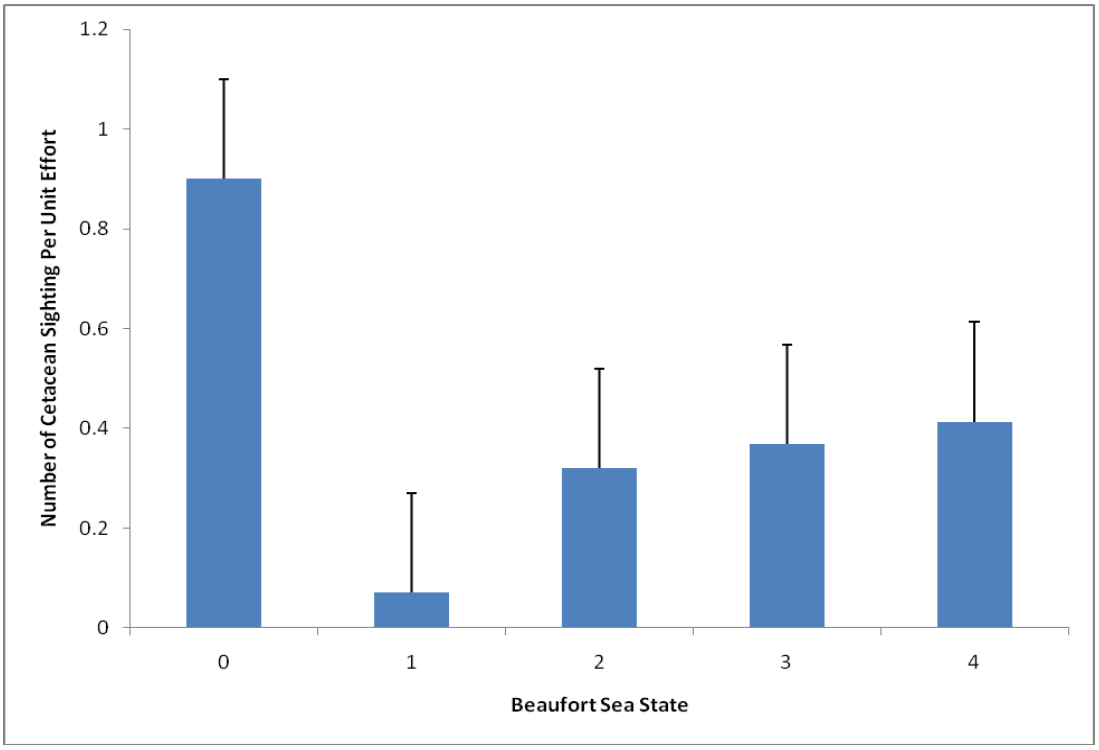


Figure 6. Number of cetacean sightings in Year Two corrected for hours on effort in each Beaufort sea state.

Descriptive statistics for bottlenose dolphins and spotted dolphins are presented in Figures 7 and 8 respectively. In general, bottlenose dolphins were detected in waters deeper than spotted dolphins (mean water depth of 217m *versus* 38m respectively). Mean group size for bottlenose dolphins was slightly greater than for spotted dolphins (15 *versus* 10 individuals per group).

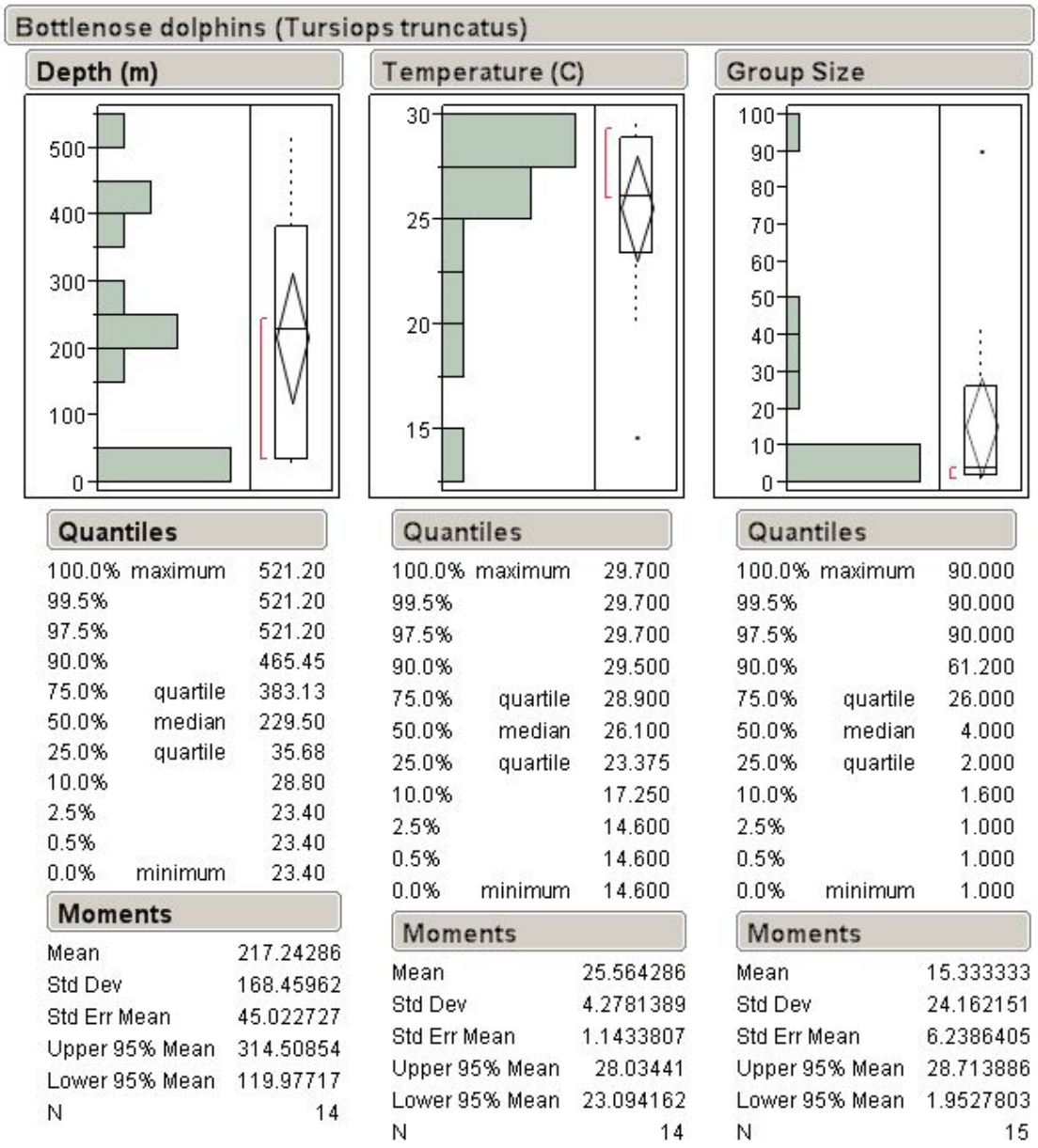


Figure 7. Descriptive statistics for depth, sea surface temperature, and group size estimates for bottlenose dolphin (*Tursiops truncatus*) sightings during vessel line transects surveys in the USWTR study area (July 2008 through June 2009).

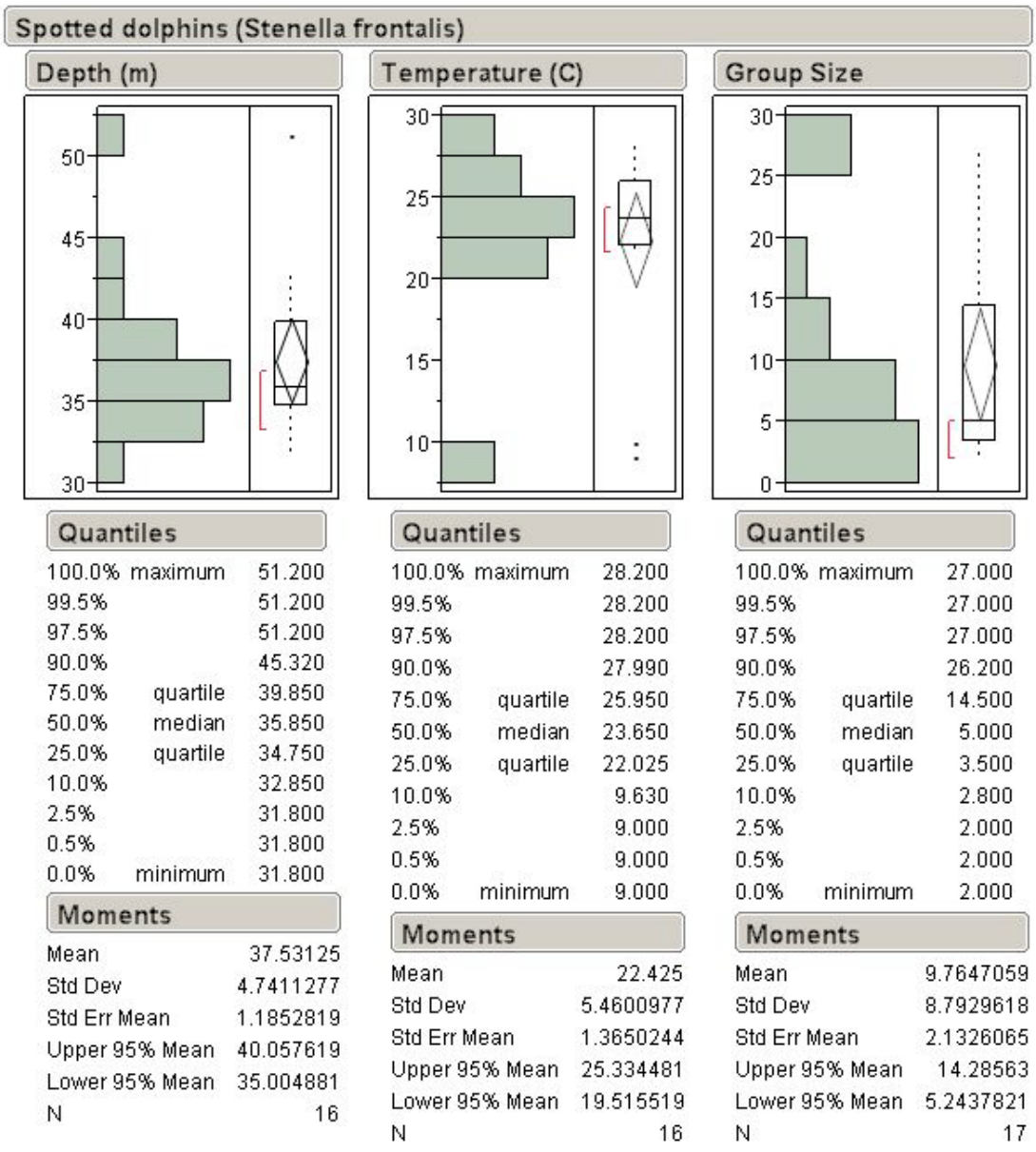


Figure 8. Descriptive statistics for depth, sea surface temperature, and group size estimates for Atlantic spotted dolphins (*Stenella frontalis*) sightings during vessel line transects surveys in the USWTR study area (July 2008 through June 2009).

Distributions and Habitat Associations of Cetaceans

The distributions of marine mammal sightings, by species, are presented in Figures 9 through 11. In general, spotted dolphin sightings were restricted to shallow shelf waters, whereas bottlenose dolphin distributions ranged over a large area with most animals detected in deeper waters. This trend was consistent in both years of the monitoring program.

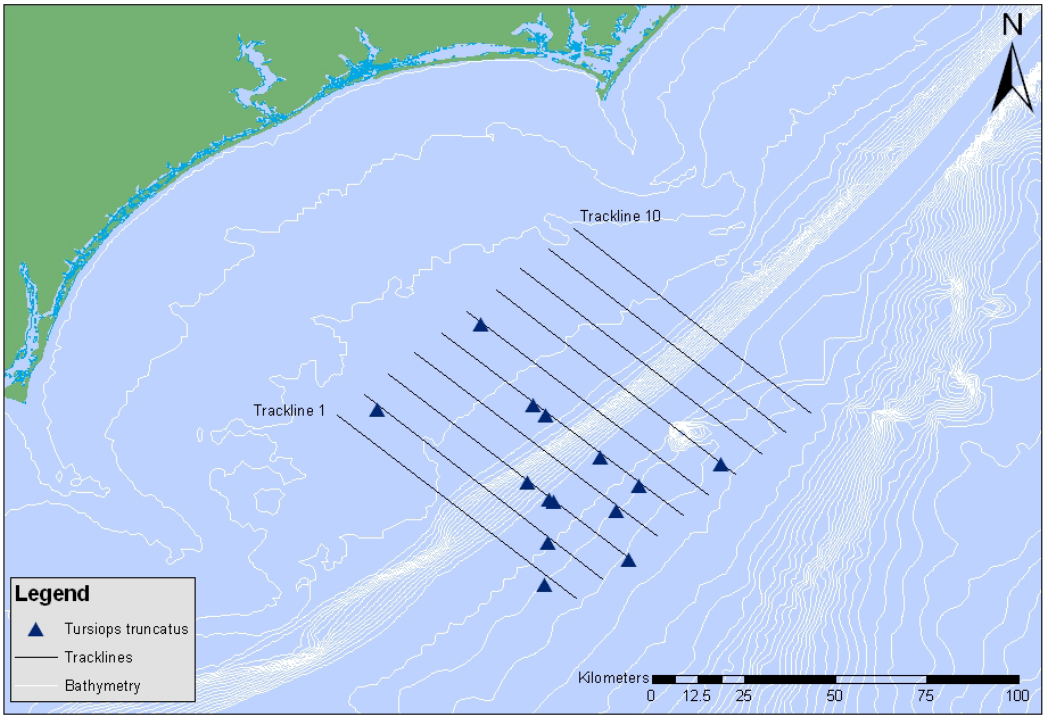


Figure 9. Distribution of bottlenose dolphin (*Tursiops truncatus*) sightings made during vessel-based surveys in Onslow Bay, NC, July 2008 through June 2009.

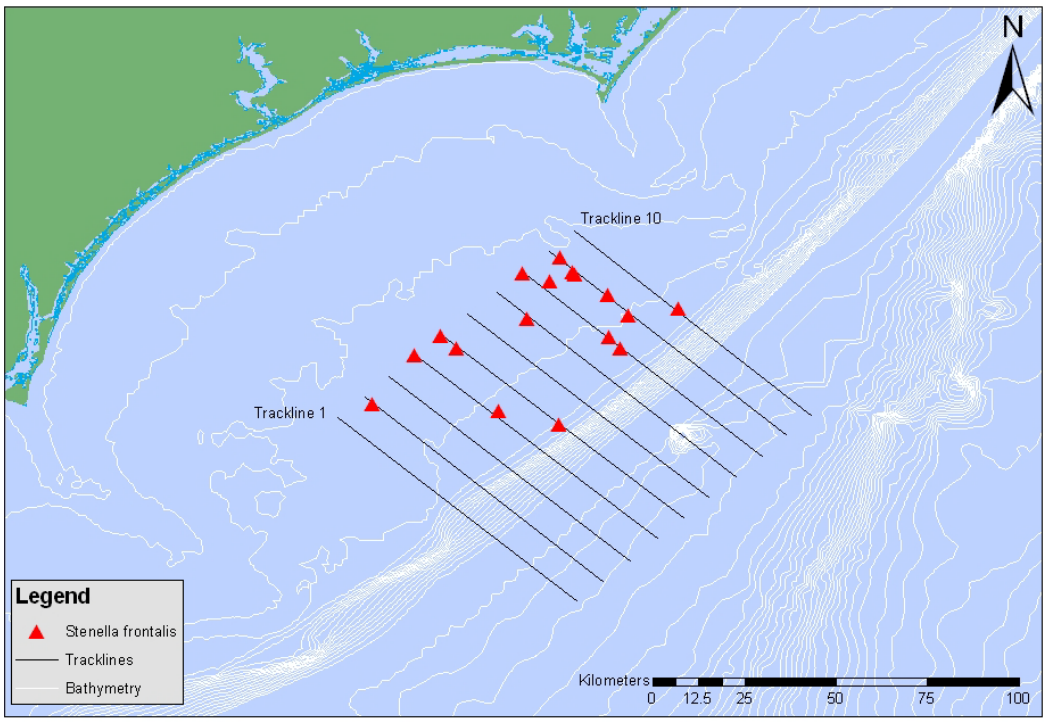


Figure 10. Distribution of Atlantic spotted dolphin (*Stenella frontalis*) sightings made during vessel-based surveys in Onslow Bay, NC, July 2008 through June 2009.

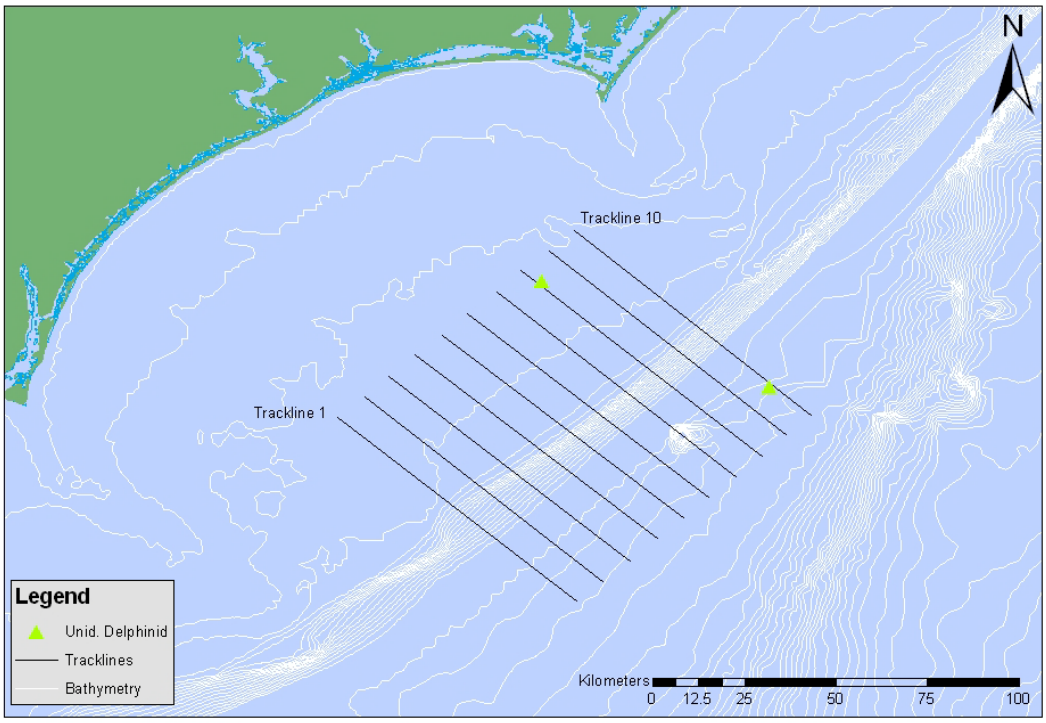


Figure 11. Distribution of other cetacean sightings made during vessel-based surveys in Onslow Bay, NC, July 2008 through June 2009.

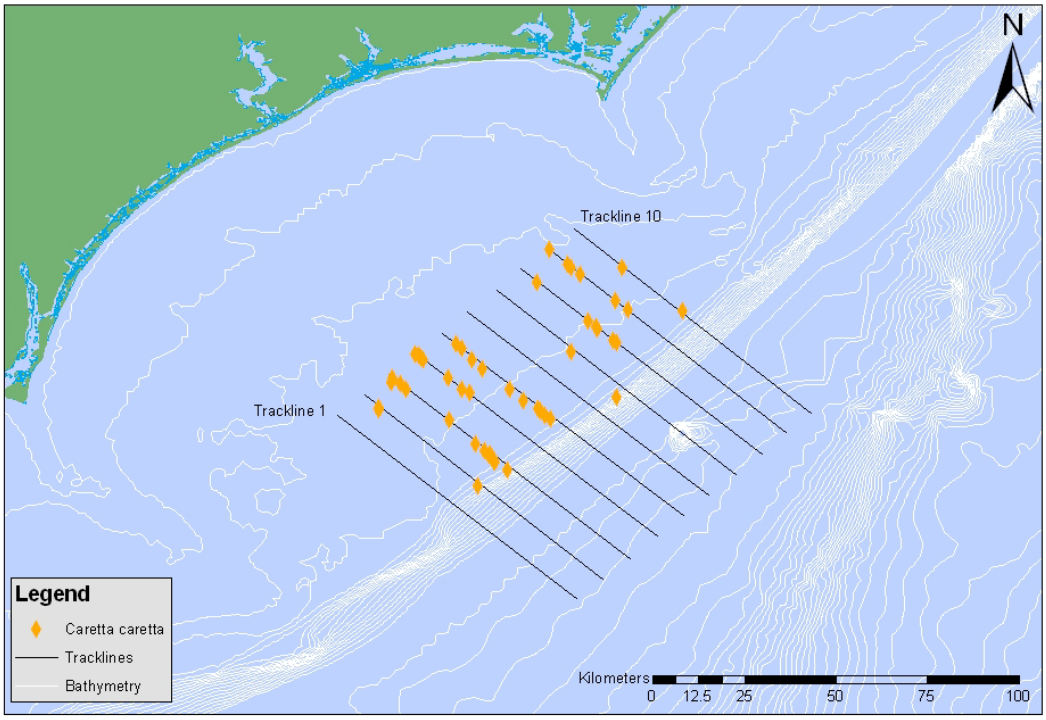


Figure 12. Distribution of loggerhead sea turtle (*Caretta caretta*) sightings made during vessel-based surveys in Onslow Bay, NC, July 2008 through June 2009.

Seasonality of Effort and Sightings

Due to unfavorable survey conditions, there was no effort in four months during Year Two. Trends in seasonality are therefore difficult to interpret (Figs. 13,14). Sea turtle presence appears to peak in February through April, however with no survey effort in January and May this apparent peak may be exaggerated.

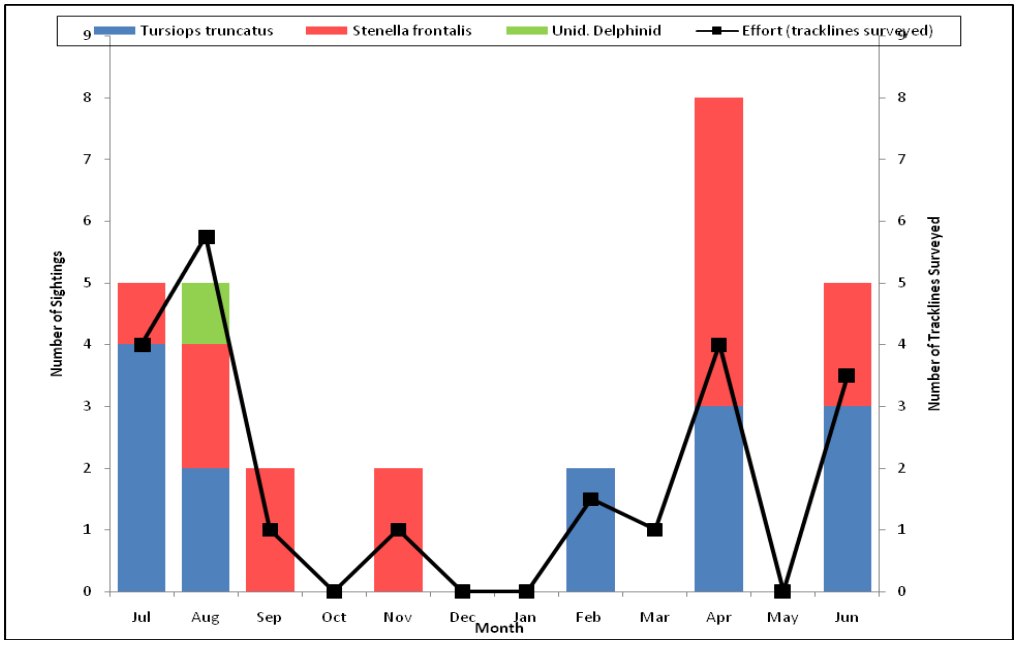


Figure 13. Number of cetacean sightings by month and effort (number of tracklines surveyed) in Year Two.

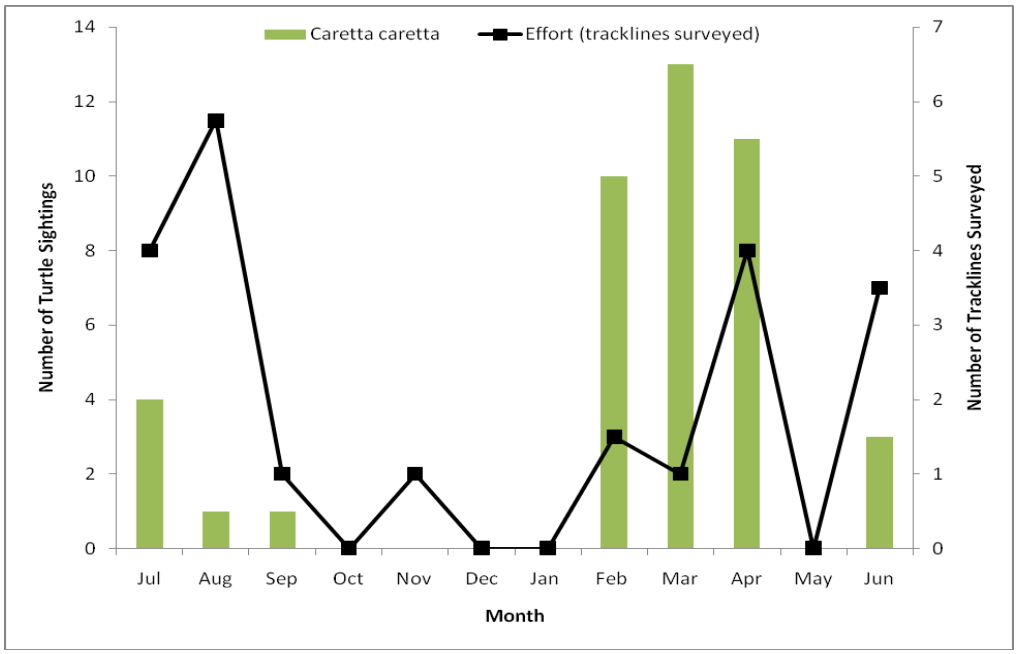


Figure 14. Number of turtle sightings by month displayed with effort (number of tracklines surveyed) in Year Two.

Photographic Effort

Approximately 970 digital images were taken for species confirmation and individual identification. Every attempt was made to photograph all animals encountered, primarily to validate species identification, but also to develop photo-identification catalogs for cetacean species in Onslow Bay. Of the 33 cetacean sightings recorded in Year Two, images were obtained from all but seven encounters. In addition, images taken during the vessel-based surveys have been used to identify diagnostic features and for comparison with images taken on the aerial surveys to improve species identification.

Images taken during surveys in Onslow Bay in Year Two were added to photo-identification catalogs for bottlenose and spotted dolphins. In Year Two, more groups of spotted dolphins were encountered and 26 new identifications were added to the catalog of spotted dolphins (Table 6). However, no pilot whales or Risso's dolphins were observed during the reporting period for Year Two (Tables 5 and 6).

To date, there have been no re-sightings of any individuals photographed, within years or between years. Images of bottlenose and spotted dolphins identified from the USWTR surveys were compared to dorsal fin images taken during monthly surveys conducted in 2000-2003 in the coastal waters up to 15 miles offshore from Masonboro Inlet to New River Inlet. Although there were re-sightings of animals within those surveys, no matches were found to the dolphins identified from the USWTR surveys. Images of the dorsal fins of stranded cetaceans were also compared to photo-identification catalogs for Onslow Bay, but no matches have been found to date.

Table 5. Number of individual identifications from images taken during vessel-based surveys in Onslow Bay, July 2008 through June 2009.

Species	Sightings	Images	Unique IDs	Total Catalog Size
Tursiops truncatus	14	271	26	78
Stenella frontalis	17	698	26	29

Table 6. Comparison of photo-identification effort between Year 1 (June 2007-July 2008) and Year 2 (July 2008 through June 2009).

	Year 1			Year 2		
	Sightings	Images	Unique IDs	Sightings	Images	Unique IDs
Tursiops truncatus	24	472	52	14	271	26
Stenella frontalis	5	76	3	17	698	26
Globicephala spp.	1	105	8	0	0	0
Grampus griseus	2	182	5	0	0	0

Passive Acoustic Monitoring

From 1 July 2008 to 30 June 2009, 17 USWTR line-transect surveys were conducted with the towed hydrophone array. During these surveys, 20 groups of animals positively identified by the visual observers were recorded. Of these 20 groups, seven were visually identified as offshore bottlenose dolphins and 13 were identified as Atlantic spotted dolphins (Table 7). Further spectral analysis (measuring different parameters mentioned above) will be conducted over the next few months.

Table 7. Number of recordings made using towed array between 1 July 2008 – 30 June 2009. Total monitoring time was 70.6 hours.

Species	Total # of Days Detected	Total # of Detections	Total Duration of Recordings (h:mm)
Stenella frontalis	10	13	6:07
Tursiops truncatus	6	7	3:52
Unidentified	9	15	4:45

During this past year, the HARP data from the second and third deployments have been analyzed using LTSAs to look for high-energy events (such as whistles and clicks). In the second HARP deployment 595 marine mammal vocal events and 19 mid-frequency sonar events were found. Most of the marine mammal vocal events have not yet been identified to

species (more *in situ* data collection with the towed array is needed), but it was possible to classify eight events as probable sperm whales (one of which consisted of a coda), one as a probable pilot whale, and 20 as probable Risso's dolphins (see Figure 15 for an example of Risso's clicks found in both the towed array and HARP data). The duration of the 595 odontocete vocal events in the second HARP ranged from one minute to just over 10.5 hours, with an average duration of 35 minutes. In the third HARP deployment 399 marine mammal vocal events were found using the LTSAs. As with the data from the second HARP deployment, most of the marine mammal vocal events have not yet been identified to species, but it was possible to classify eight events as probable sperm whales, seven as probable Risso's dolphins, and one as a possible beaked whale. The duration of the 399 odontocete vocal events in the third HARP ranged from one minute to just over 8.5 hours, with an average duration of 36 minutes. These results are summarized in Table 8 and Figures 16-21.

Table 8. Number of days recorded and total number, number of days with, and percentage of hours with vocal events for all HARP deployments to date.

HARP Deployment	# Days Recorded	# Days with Vocal Events	# Hours Recorded	# 1-Hr Bins with Vocal Events	Total # of Vocal Events
1	99	95	2344	924	561
2	104	100	2473	769	595
3	107	93	2559	540	399

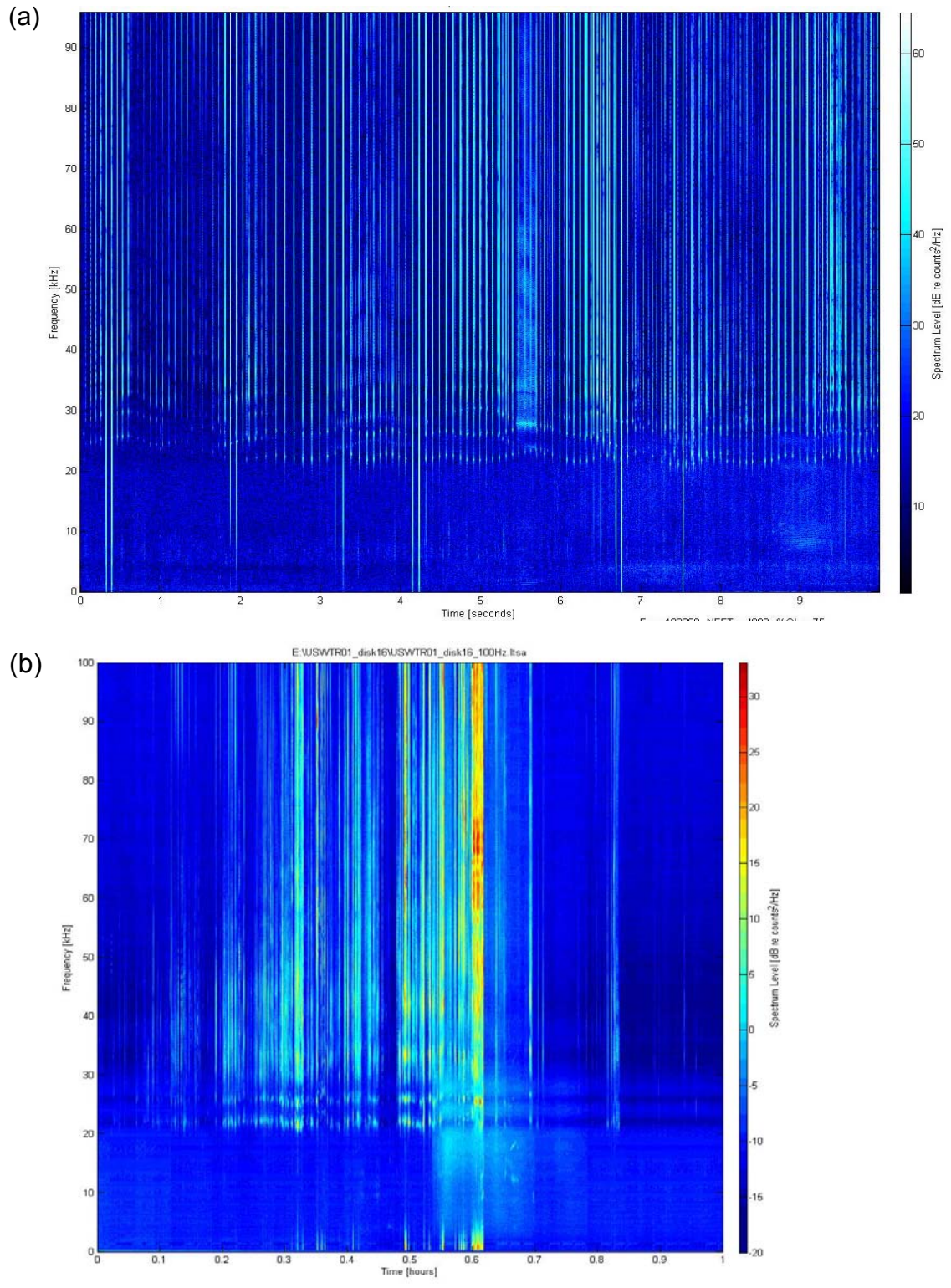
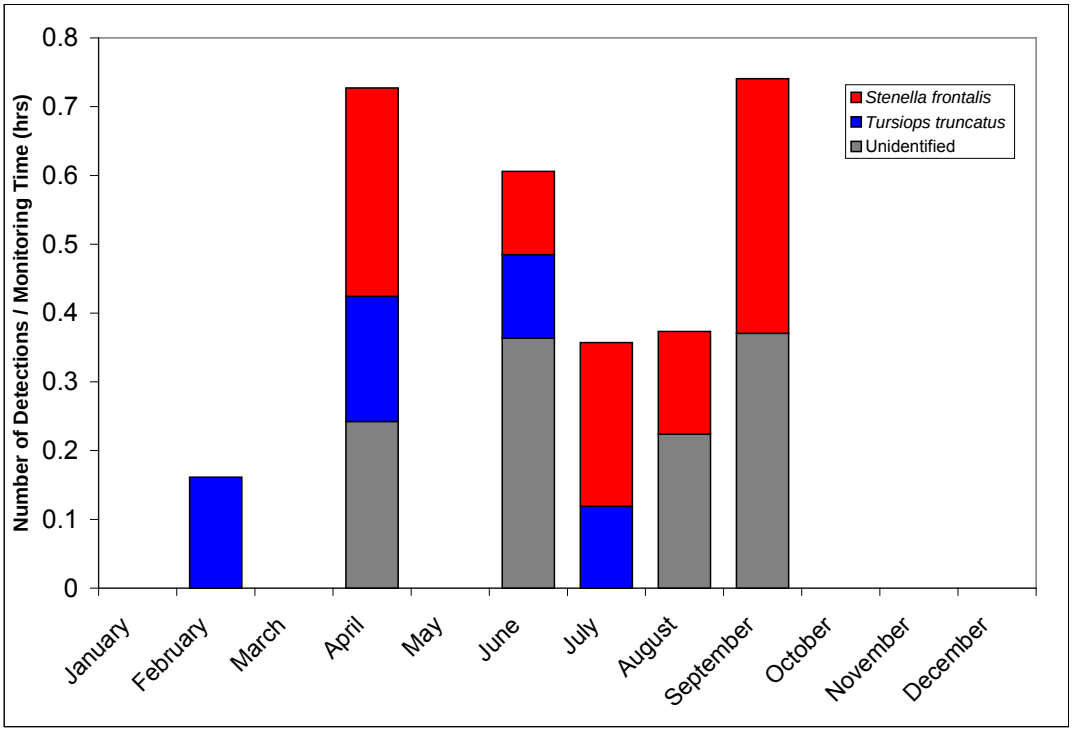


Figure 15. Spectrograms showing (a) Risso's clicks recorded on the towed array and (b) probable Risso's clicks recorded on the HARP. Similar patterns have been described for Risso's dolphins off Southern California (Soldevilla *et al.* 2008).

(a)



(b)

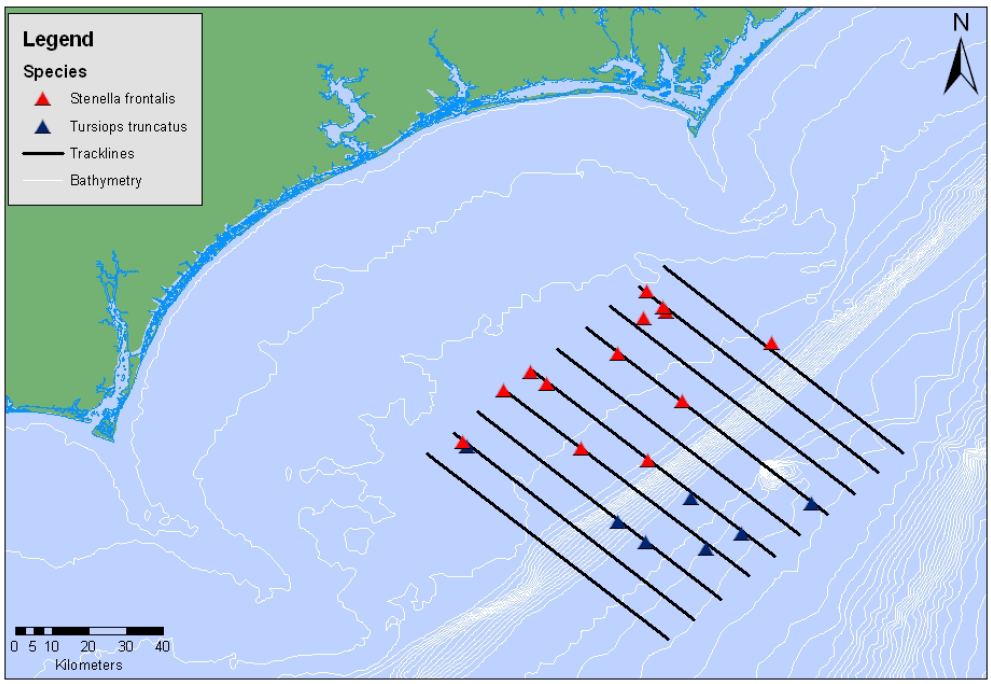


Figure 16. (a) Number of detections from the HARP per monitoring time (hrs) for each species by month and (b) distribution of known species recorded by the array and positively identified by visual observers.

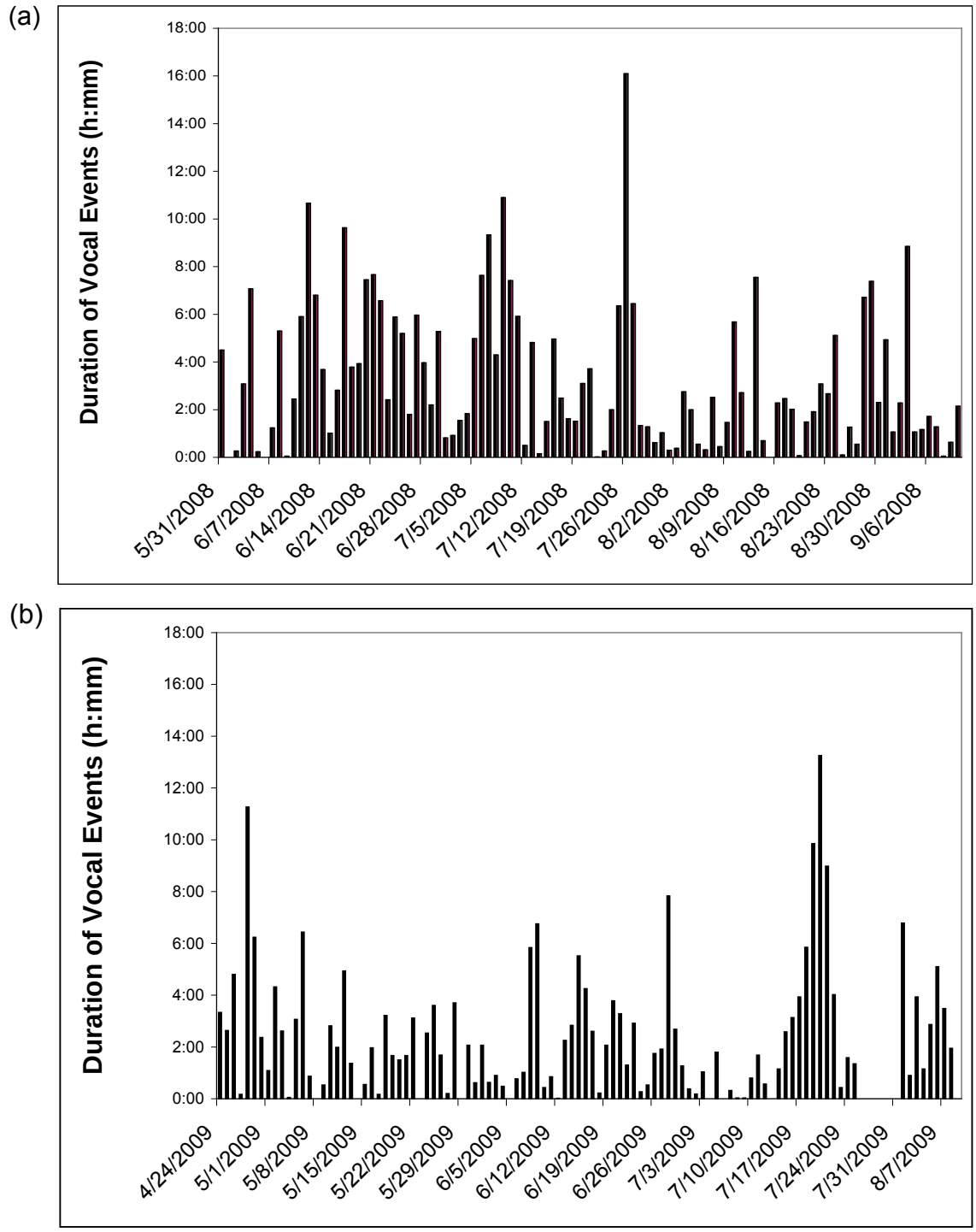


Figure 17. Total duration of vocal events (whistles and clicks) for each day during the (a) second HARP deployment and (b) third HARP deployment. Vocal events were found using LTSAs.

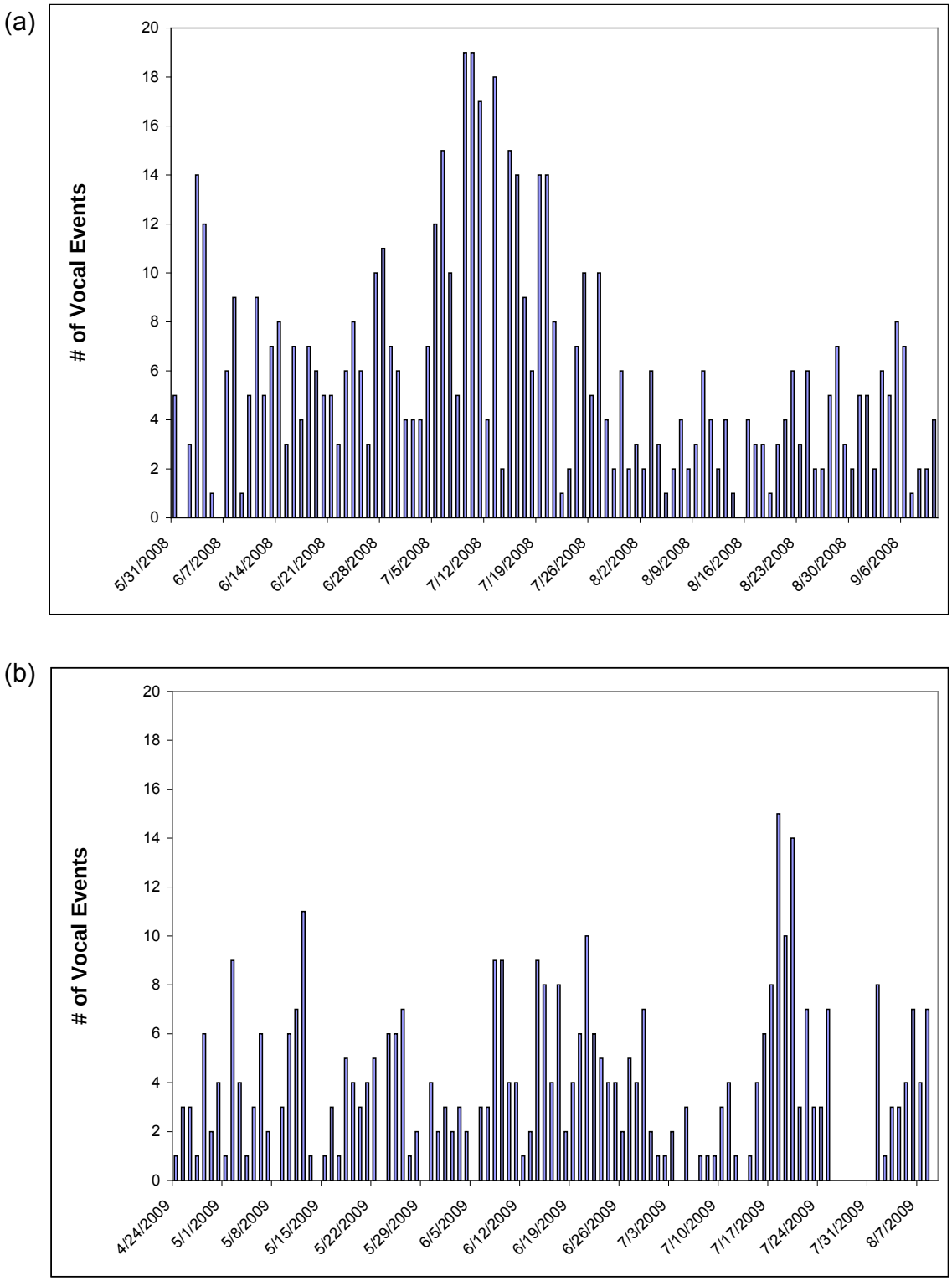
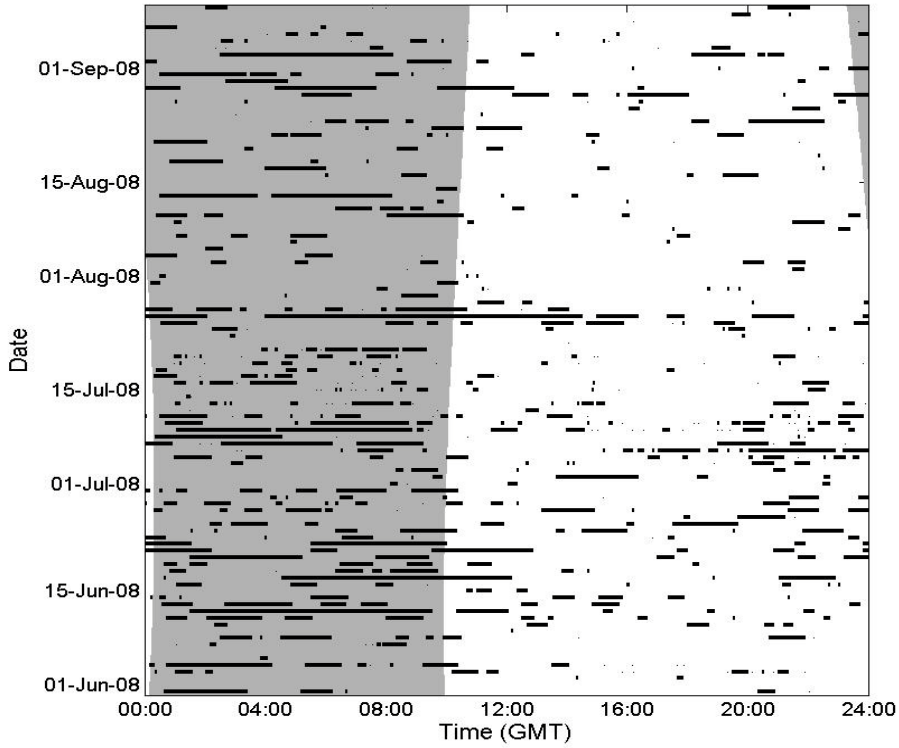


Figure 18. Total number of vocal events (whistles and clicks) for each day during (a) the second HARP deployment and (b) the third HARP deployment. Vocal events were found using LTSAs.

(a)



(b)

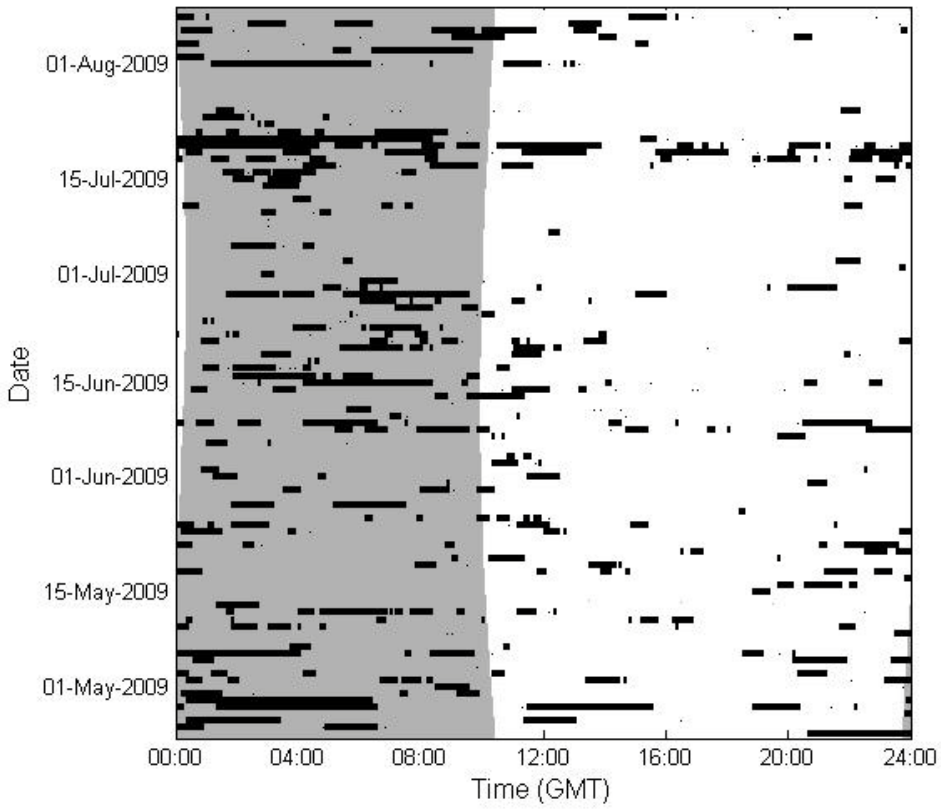


Figure 19. Time of vocal events for (a) the second HARP deployment and (b) the third HARP deployment. Shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil).

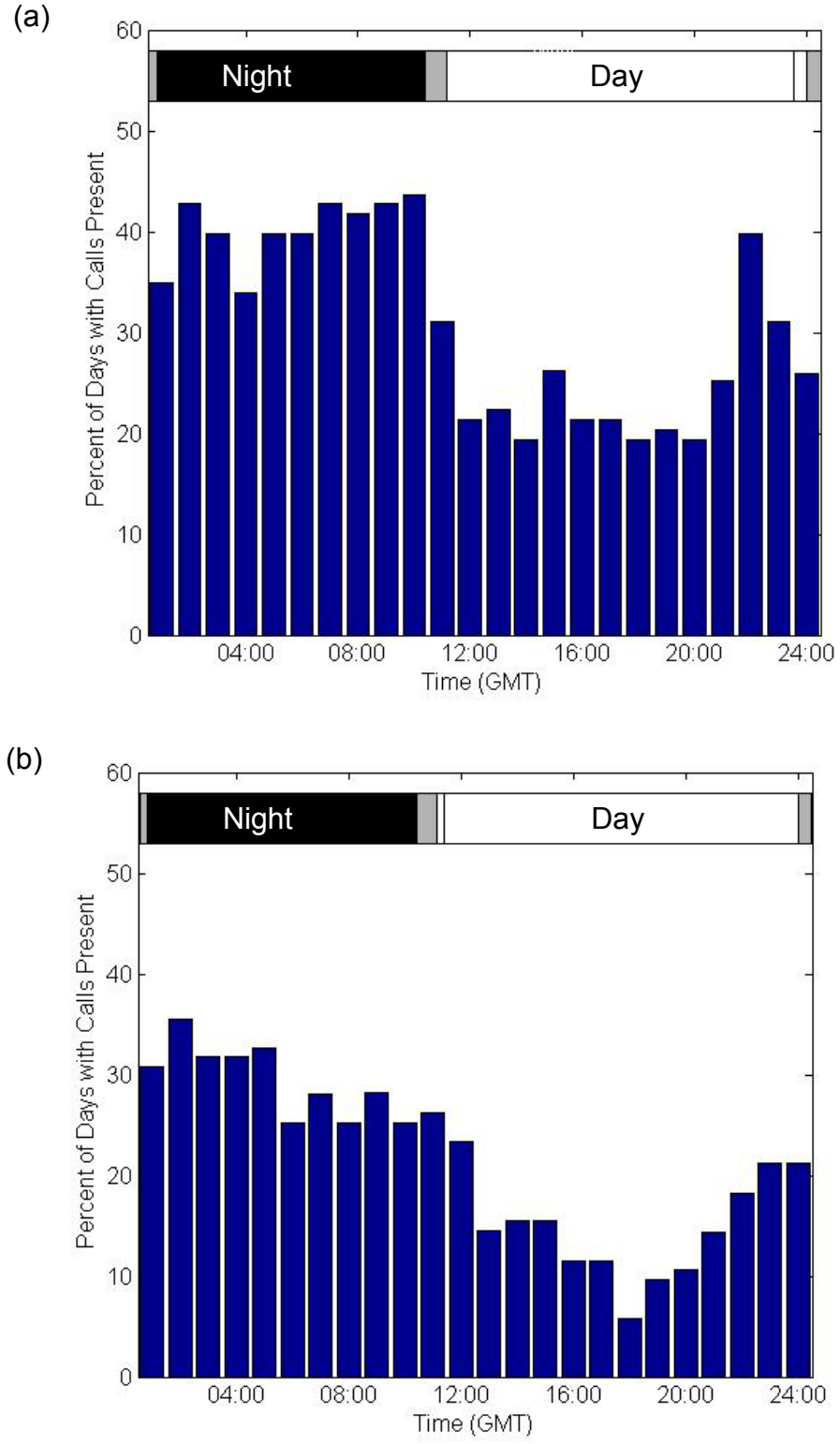


Figure 20. Number of days with calls (normalized by total number of hours recorded by each HARP) by time of day (GMT) for (a) the second HARP deployment and (b) the third HARP deployment.

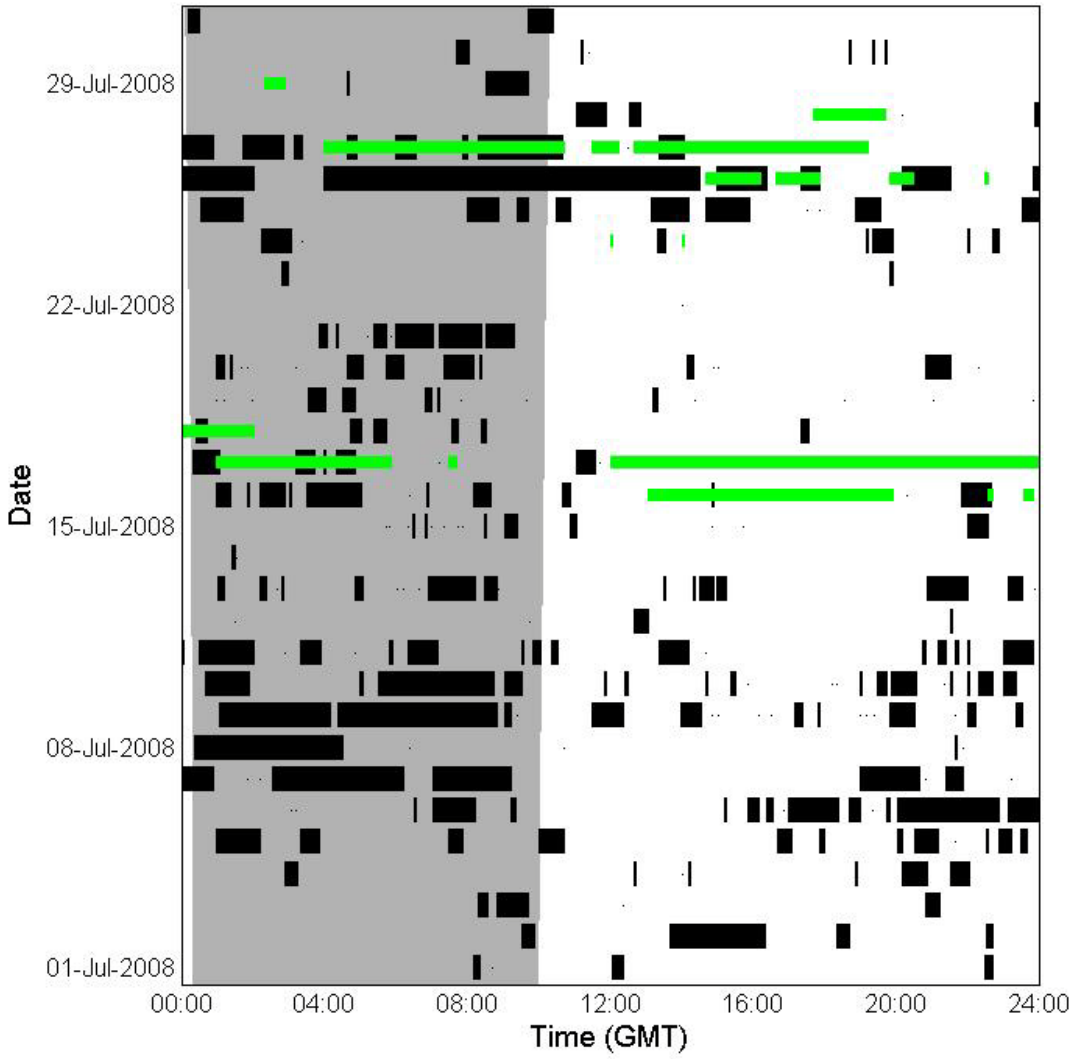


Figure 21. Time of vocal events (black bars) and sonar events (green bars) for the second HARP deployment during July 2008. Shading indicates periods of darkness, determined from the U.S. Naval Observatory (http://aa.usno.navy.mil).

Seabird Observations

During Year Two of Onslow Bay surveys, a total of 788 birds were recorded in approximately 70 hours of seabird observations (Table 9). The sightings-per-unit-effort (SPUE) ranged between 0.72 and 61.64 and was highest in February. A total of 23 bird species were identified, with the largest number of species observed during the months of August 2008 and April 2009. The highest diversity values were observed in July and August of 2008, and in April and June of 2009.

Table 10 shows the species of seabird observed in each survey month. Cory's Shearwaters (*Calonectris diomedea*) were the most commonly sighted species, but Greater Shearwaters (*Puffinus gravis*), Common Terns (*Sterna hirundo*) and Wilson's Storm Petrels (*Oceanites oceanicus)* were also observed frequently. Phalaropes (*Phalaropus* sp.) were also common though it was often not possible to identify these birds to the species level.

The mean depth, sea surface temperature and distance to continental shelf for each observed seabird species is shown in Table 11. Most bird species were associated with warmer Gulf Stream waters, but Northern Fulmars (*Fulmarus glacialis*), Red Phalaropes (*Phalaropus fulicarius*) and Northern Gannets (*Morus bassanus*) were observed in cooler shelf waters. Black-capped Petrels (*Pterodroma hasitata)* and Wilson's Storm Petrels were typically observed in deep waters closer to the continental shelf. The distribution of seabirds observed during surveys in Onslow Bay is shown in Figures 22 through 26.

Figure 27 shows the seasonal SPUE by species in Onslow Bay during both years of seabird surveys. Overall, the highest SPUE values were observed in the fall, followed by the winter and spring. The lowest values of SPUE were observed in summer. Cory's Shearwaters and Common Terns comprised a large proportion of the fall SPUE, whereas Phalaropes accounted for a large proportion of the winter SPUE. Sightings were more evenly distributed among species in the summer and spring. Audubon's Shearwaters (*Puffinus lherminieri*), Greater Shearwaters, Cory's Shearwaters and unidentified Shearwater species were most frequently observed in the summer, but also observed in spring. Black-capped Petrels, Wilson's Storm Petrels and unidentified Phalarope species were observed during spring months.

Table 9. Seabird sighting statistics by month during surveys in Onslow Bay, NC from June 2008 through June 2009. The sighting per unit effort (SPUE) was calculated by dividing the total number of birds observed by the total number of hours surveyed, while diversity was calculated using the Shannon Diversity Index.

Month	Number of Species Observed	Total Number of Birds Observed	Diversity	Total Hours Surveyed	SPUE by Month
Jun-08	5	35	1.17	7.83	4.47
Jul-08	8	49	1.69	14.95	3.28
Aug-08	12	156	1.48	19.68	7.93
Sep-08	5	146	1.11	4.57	31.97
Nov-08	1	2	0.00	2.77	0.72
Jan-09	1	3	0.00	0.63	4.74
Feb-09	8	187	1.17	3.05	61.64
Apr-09	12	195	1.74	14.78	13.19
Jun-09	6	14	1.63	1.12	12.54
OVERALL	**23**	**788**	**1.11**	**69.38**	**15.61**

Table 10: Seabird sightings by month from June 2008 through June 2009 during surveys in Onslow Bay, NC.

Month	Jun-08	Jul-08	Aug-08	Sep-08	Nov-08	Jan-09	Feb-09	Apr-09	Jun-09	TOTAL
Audubon's Shearwaters (*Puffinus lherminieri*)	10	5	13	1			5	7	3	**44**
Cory's Shearwaters (*Calonectris diomedea*)	12	11	56	50				0	2	**131**
Greater Shearwaters (*Puffinus gravis*)	1	4	7					62		**74**
Manx Shearwaters (*Puffinus puffinus*)	0	1	0	10		1	2	1	1	**16**
Unidentified Shearwaters (*Puffinus* sp.)	2	11	10	5			1	6	1	**36**
Black-capped Petrels (*Pterodroma hasitata)*	0		1	9				13		**23**
Leach's Petrel (*Oceanodroma leucorhoa*)	0		0					0	1	**1**
Wilson's Storm Petrels (*Oceanites oceanicus)*	2	12	3					48	1	**66**
Unidentified Storm Petrels	0	1	0					6	1	**8**
Bridled Terns (*Onychoprion anaethetus)*	0	1	33					2		**36**
Sooty Terns (*Onychoprion fuscatus*)	0	1	1					5		**7**
Arctic Tern (Sterna paradisaea)	0		1					2	4	**7**
Black Tern (*Chlidonias niger*)	0		0					0		**0**
Common Tern (*Sterna hirundo*)	0		2	70				4		**76**
Unidentified Tern	0		5					8		**13**
White-tailed Tropicbirds (*Phaethon lepturus)*	1		0					0		**1**
Parasitic Jaeger (*Stercorarius parasiticus*)	0		1					3		**4**
Pomarine Jaeger (*Stercorarius pomarinus*)	0		0					14		**14**
Unidentified Jaeger (*Stercorarius* sp.)	0		0					6		**6**
Red Phalarope (*Phalaropus fulicarius*)	0		0				31	2		**33**
Red-necked Phalarope (*Phalaropus lobatus*)	0	2	1					0		**3**
Unidentified Phalarope (*Phalaropus* sp.)	6		20				74	0		**100**
Northern gannet (*Morus bassanus*)	0		0				2	0		**2**
Northern fulmar (*Fulmarus glacialis*)	0		0				2	0		**2**
Herring gull (*Larus argentatus*)	0		0				3	0		**3**
Bonaparte's Gull (*Chroicocephalus philadelphi*)	0		0				64	0		**64**
Unidentified Gull	0		0		2	2	1	0		**5**
Common Loon	0		0				1	0		**1**
Falcon (*Falco* sp.)	0		0					0		**0**
Great Blue Heron (*Ardea herodias*)	0		1					0		**1**
Mourning Dove (*Zenaida macroura*)	0		0					0		**0**
Unidentifed bird	1		1				2	3		**7**
Unidentified swallow	0		0					0		**0**
Unidentified sparrow	0		0	1				0		**1**
Unidentified sandpiper	0		0					3		**3**
TOTAL	**35**	**49**	**156**	**146**	**2**	**3**	**188**	**195**	**14**	**788**

Table 11. Mean depth, sea surface temperature (SST) and distance to continental shelf for commonly sighted seabird species from surveys in Onslow Bay, NC

Species	Mean SST	Mean depth (m)	Mean distance to shelf (km)
Audubon's Shearwater (*Puffinus lherminieri*)	78.70	-284.65	54.09
Black Tern (*Chlidonias niger*)	77.80	-217.67	66.37
Black-capped Petrel (*Pterodroma hasitata)*	78.83	-529.41	28.69
Bridled Tern (*Onychoprion anaethetus)*	80.63	-196.17	75.15
Common Tern (*Sterna hirundo*)	78.22	-100.25	79.00
Cory's Shearwater (*Calonectris diomedea*)	82.59	-188.86	66.24
Greater Shearwater (*Puffinus gravis*)	80.97	-246.18	60.64
Manx Shearwater (*Puffinus puffinus*)	80.40	-331.82	43.30
Northern fulmar (*Fulmarus glacialis*)	61.47	-43.00	89.20
Northern gannet (*Morus bassanus*)	63.84	-48.00	82.78
Parasitic Jaeger (*Stercorarius parasiticus*)	78.27	-304.25	57.65
Pomarine Jaeger (*Stercorarius pomarinus*)	75.66	-234.64	63.88
Red Phalarope (*Phalaropus fulicarius*)	62.39	-40.43	94.06
Red-necked Phalarope (*Phalaropus lobatus*)	81.21	-344.00	50.45
Sooty Tern (*Onychoprion fuscatus*)	80.40	-193.00	62.87
White-tailed Tropicbird (*Phaethon lepturus)*	79.21	-307.21	52.35
Wilson's Storm Petrel (*Oceanites oceanicus)*	82.72	-609.00	11.99

Table 12. Species codes for seabirds observed on Onslow Bay surveys

Seabird Species	Species Code
Arctic Tern (*Sterna paradisaea*)	ARTE
Audubon's Shearwater (*Puffinus lherminieri*)	AUSH
Black Tern (*Chlidonias niger*)	BLTE
Black-capped Petrel (*Pterodroma hasitata)*	BCPE
Bridled Tern (*Onychoprion anaethetus)*	BRTE
Common Tern (*Sterna hirundo*)	COTE
Cory's Shearwater (*Calonectris diomedea*)	COSH
Greater Shearwater (*Puffinus gravis*)	GRSH
Leach's Petrel (*Oceanodroma leucorhoa*)	LESP
Manx Shearwater (*Puffinus puffinus*)	MASH
Northern Fulmar (*Fulmarus glacialis*)	NOFU
Northern Gannet (*Morus bassanus*)	NOGA
Parasitic Jaeger (*Stercorarius parasiticus*)	PAJA
Pomarine Jaeger (*Stercorarius pomarinus*)	POJA
Red Phalarope (*Phalaropus fulicarius*)	REPH
Red-necked Phalarope (*Phalaropus lobatus*)	RNPH
Sooty Tern (*Onychoprion fuscatus*)	SOTE
Unidentified Jaeger (*Stercorarius* sp.)	UNJA
Unidentified Phalarope (*Phalaropus* sp.)	UNPH
Unidentified Shearwater (*Puffinus* sp.)	UNSH
Unidentified Storm Petrel	UNSP
Unidentified Tern	UNTE
Wilson's Storm Petrel (*Oceanites oceanicus)*	WISP
White-tailed Tropicbird (*Phaethon lepturus)*	WTTR

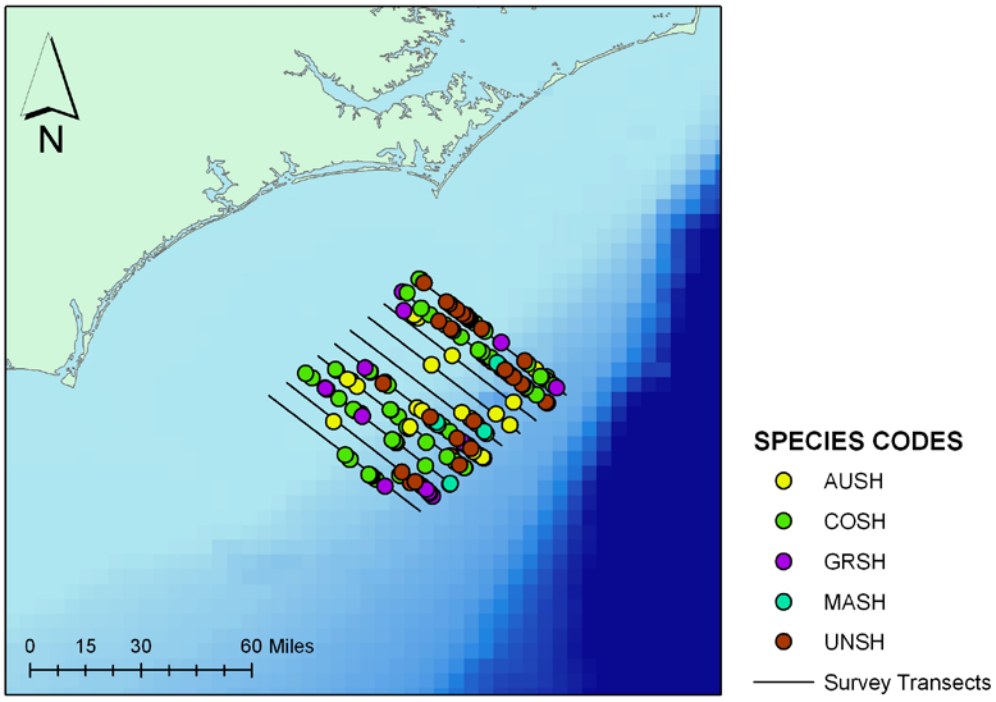


Figure 22: Distribution of Shearwater species observed during surveys in Year Two in Onslow Bay, NC. Seabird codes are listed in Table 12.

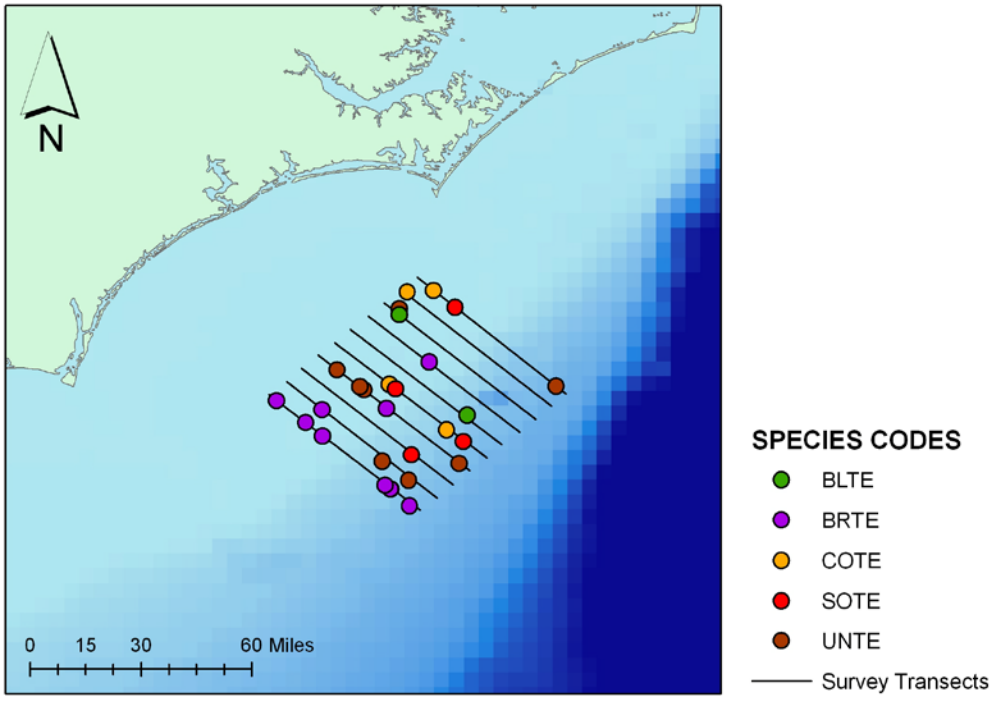


Figure 23: Distribution of Tern species observed during surveys in Year Two in Onslow Bay, NC. Seabird codes are listed in Table 12.

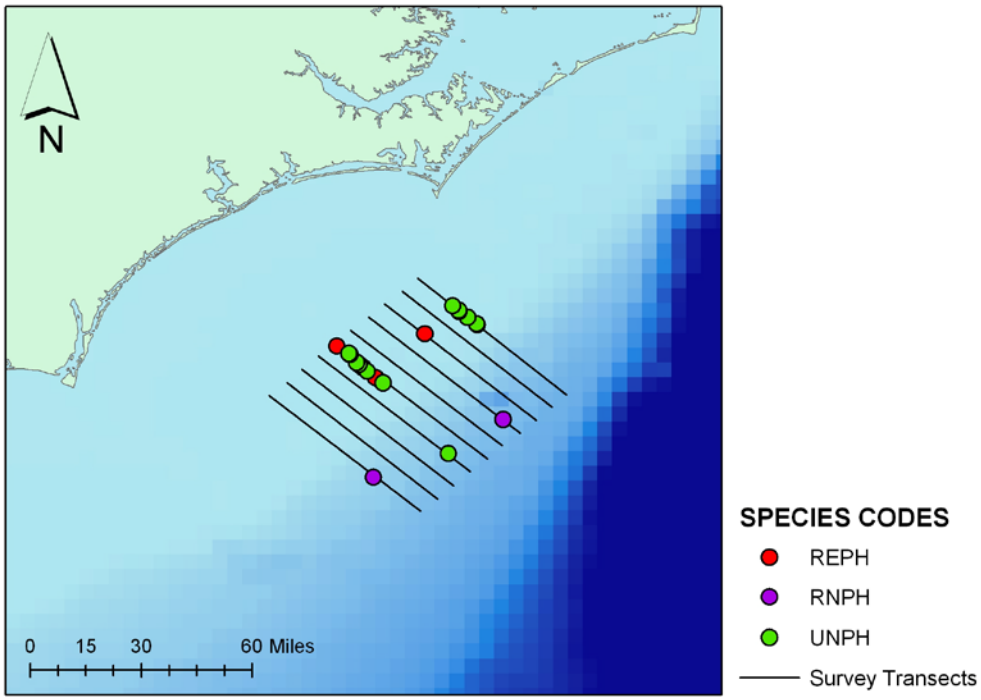


Figure 24. Distribution of Phalarope species observed during surveys in Year Two in Onslow Bay, NC. Seabird codes are listed in Table 12.

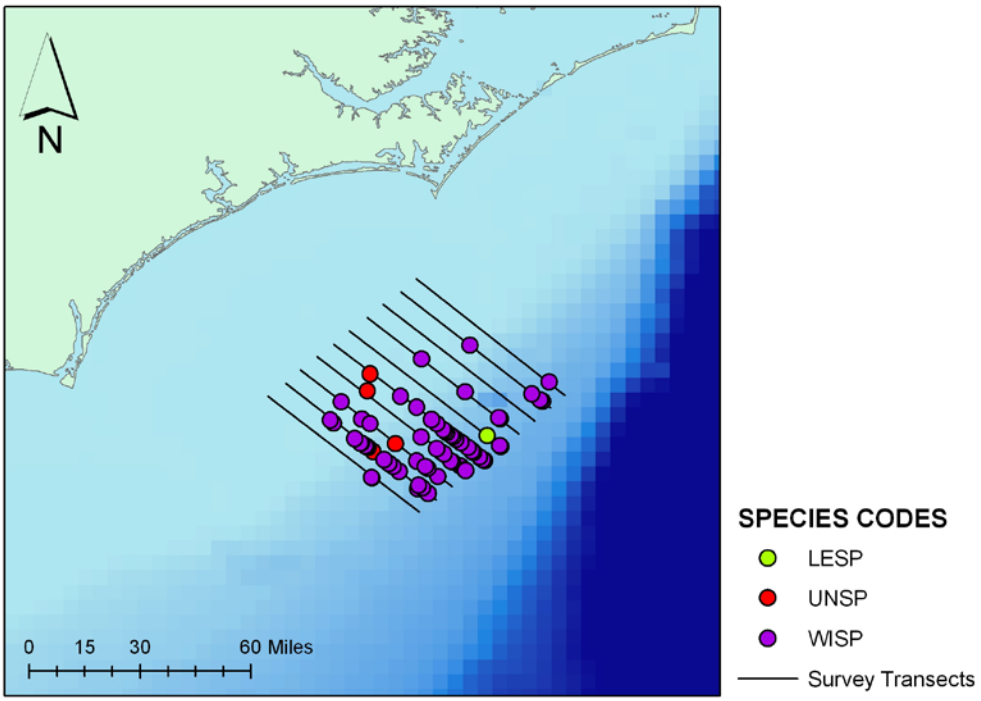


Figure 25. Distribution of Storm Petrel species observed during surveys in Year Two Onslow Bay, NC. Seabird codes are listed in Table 12.

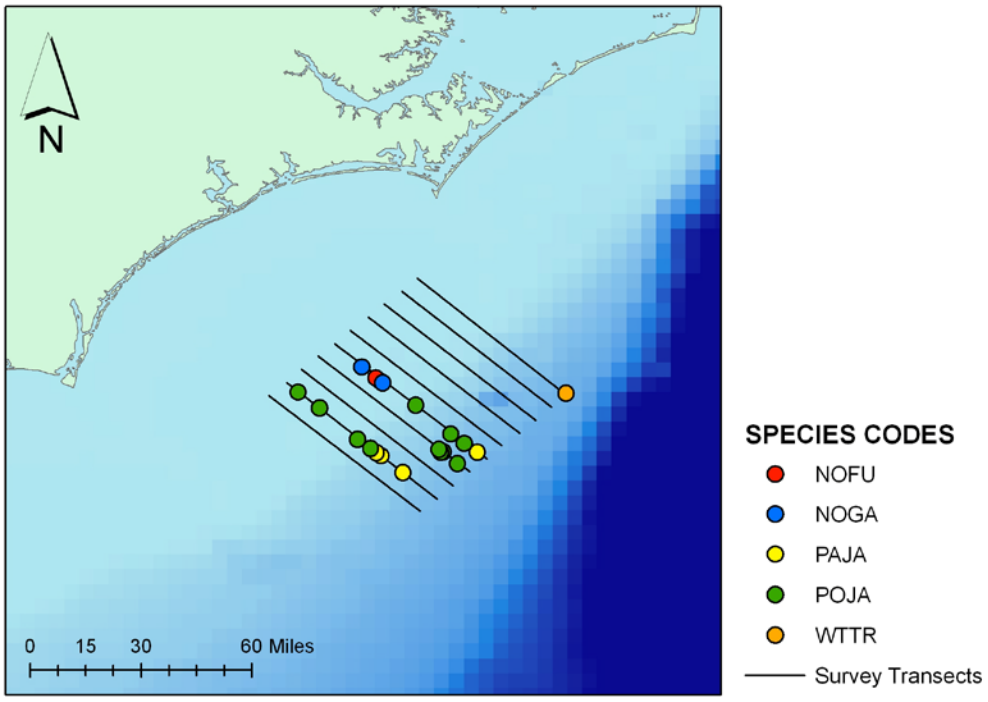


Figure 26: Distribution of seabird species uncommonly observed during Year Two surveys in Onslow Bay, NC. Seabird codes are listed in Table 12.

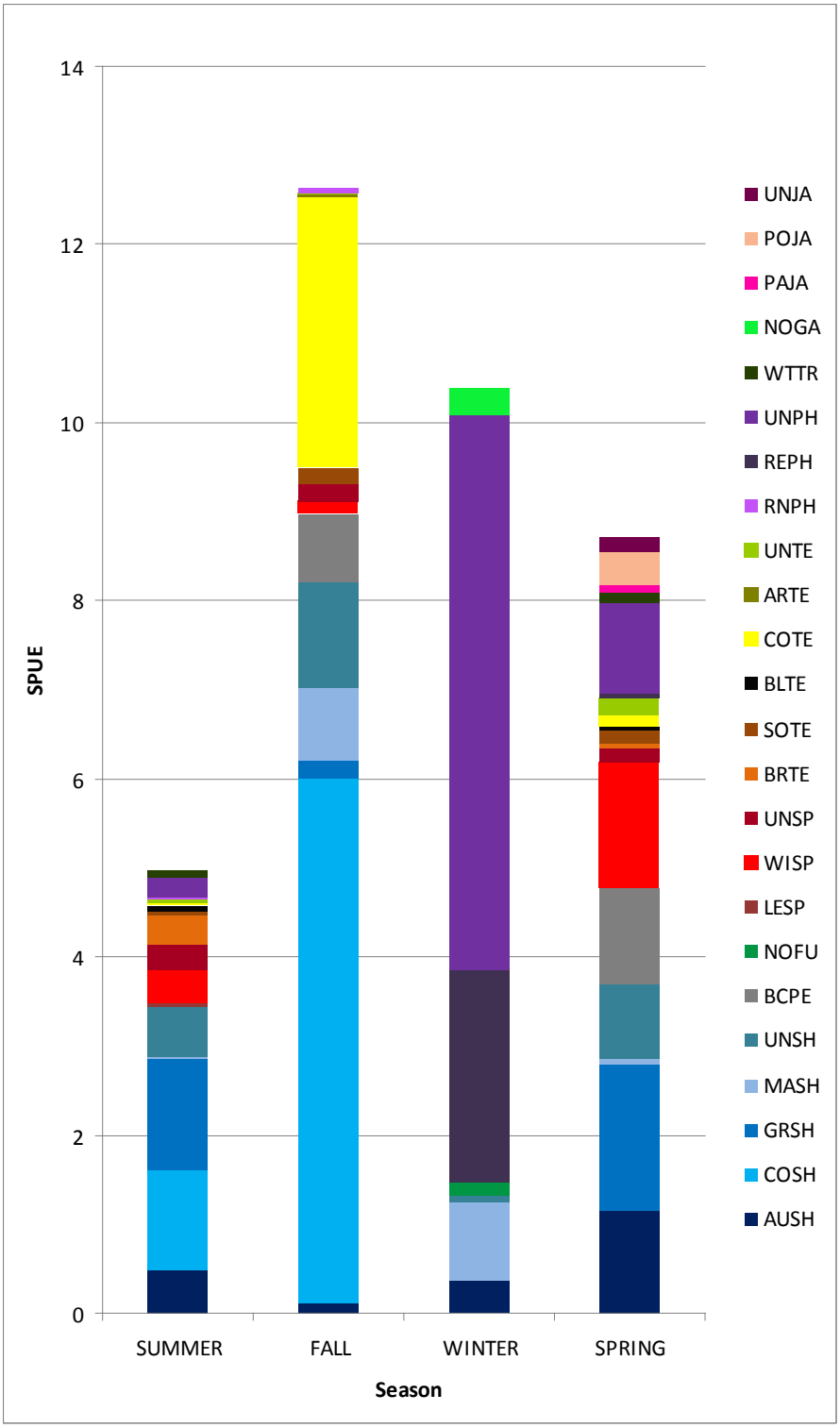


Figure 27. Seasonal sightings per unit effort (SPUE) by species in Year One and Year Two of Onslow Bay surveys. Seabird codes are listed in Table 12. Seasons were defined as follows: Summer (June, July and August); Fall (September, October and November); Winter (December, January and February); and Spring (March, April and May).

Vessel Sightings

A total of 118 vessels were encountered in the study area during vessel surveys, ranging from small recreational boats to large cargo vessels. The number of each category of vessels sighted, classified by category, is presented in Figure 28.

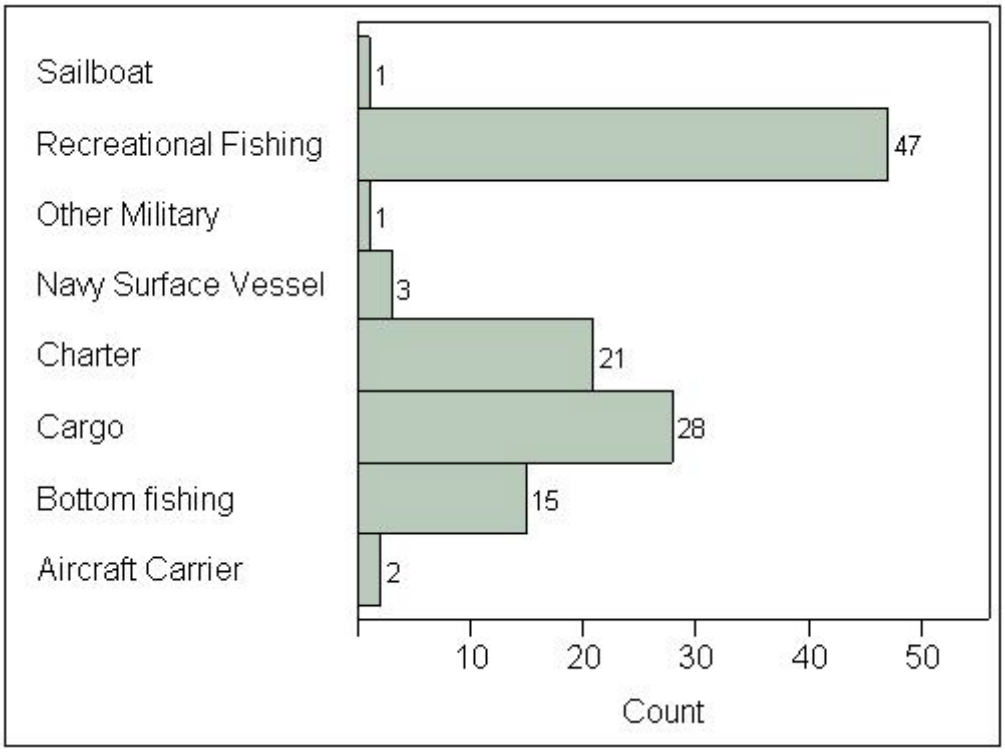


Figure 28. Distribution of vessels observed during surveys in Onslow Bay, NC, July 2008 through June 2009.

Acknowledgements

We thank Joel Bell (Naval Facilities Engineering Command Atlantic) for support and guidance and Jason See (GeoMarine, Inc.) for contract administration. Keith Mullin and Kathy Foley allowed us to work under their biopsy permit (779-1633). Dr. Lance Garrison modified VisSurvey for our use. For assistance with the HARP we thank Dr. John Hildebrand, Chris Garsha and Tim Boynton. For the shipboard surveys, we thank Matt Besch, Pete Zook, Ryan McAlarney, Peter Nilsson and numerous other observers. A special thanks goes to Captain Dale Britt for his expertise and good nature. Surveys were conducted under NOAA Scientific Permit No. 948-1692-00, held by the UNCW.

Analysis of the UNCW and Duke University Aerial and Shipboard Surveys of the USWTR on the Atlantic Coast of the USA for the period June 2007 to August 2009 (also including analysis of the UNCW aerial survey data 1998 – 1999)

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CREEM, University of St Andrews

Abstract

Analysis of the data from the combined aerial and shipboard surveys of the USWTR carried out by Duke University and the University of North Carolina at Wilmington for the period June 2007 through August 2009, combined with that of the earlier aerial surveys of the UNCW for Onslow Bay 1998/1999, allowed estimation of density surfaces for bottlenose dolphins *Tursiops truncatus*, spotted dolphins, *Stenella frontalis*, pilot and beaked whales combined, and loggerhead turtles *(Caretta caretta)* as well as providing some evidence of the environmental correlates of the animals distributions.

Detection functions were estimated from the multi-platform, multi-year USWTR survey data with additional data from the UNCW right whale surveys as well as the 1998/1999 UNCW aerial surveys of Wallop Island as well as additional sightings data from the shipboard surveys that took place off Cape Hatteras. Abundance for the USWTR region and an outer margin of 20 nm about it, was estimated using the estimated detection probabilities and separately estimating (a) animal presence/absence using a logistic general additive model and (b) estimating density given presence. Detection functions were not fitted to all of the detected species owing to a paucity of data (shipboard whale sightings).

Depending on the best fitted spatial models used, estimates were obtained as an average over the entire time period, for each year or for each month. At the highest resolution, estimates were obtained for the USWTR core region and the outer region for September 1998 through to July 1999 and June 2007 through to August 2009. Estimated bottlenose dolphin numbers varied between 20 (95% CI: 10 – 90, August 2008) and c. 100 (30 – 180, Jan 2008) for the inner region and from 60 (30 – 240, August 2008) to 290 (80 – 540, May 1999) for the outer region. Estimated spotted dolphin numbers varied from 0 (0 – 0) in 1998/1999 to 400 (110 – 1200) in January 2009 in the inner region and from 0 (0 – 0) in 1998/1999 to c. 920 (260 – 2700, in January 2009) in the outer region. Spotted dolphins only appeared in the shallower parts of the region of interest from 2007.

Pilot and beaked whale numbers were very low (< 10, 2 – 14) throughout the survey period. Estimated loggerhead turtle numbers varied from 2 (2 – 6, July 1999) to 270 (50 – 800, March 2009) in the inner region and from 5 (1 – 13, July 1999) to 530 (90 – 1600, March 2009) in the outer region. All the above estimates assumed perfect detection on the trackline. Small sample sizes result in very little power to detect trend in abundance but there was no evidence of a systematic decline in any species in the last ten years and substantial evidence for an increase in spotted dolphin numbers.

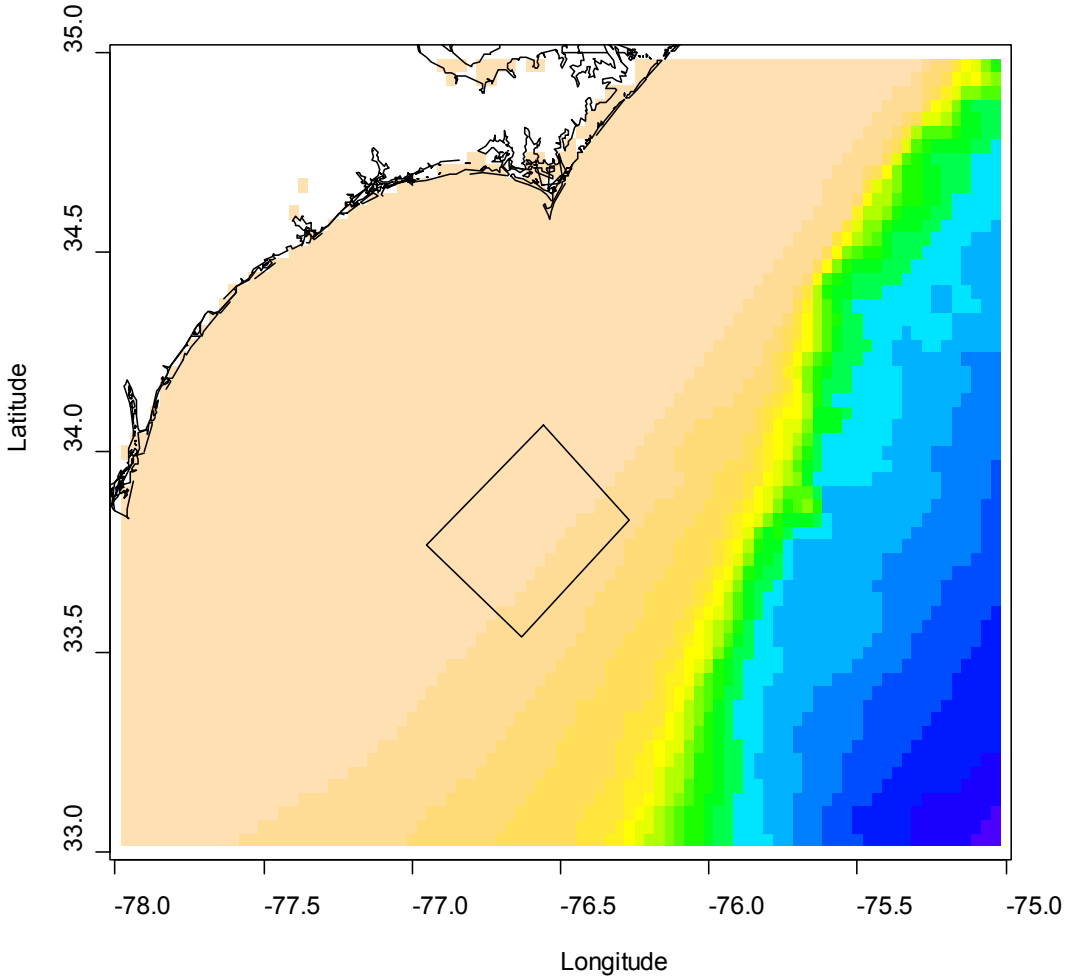
There was evidence that the abundance of bottlenose dolphins fluctuated with season (perhaps in response to temperature), as did the presence of loggerhead turtles who were likely to be associated with water between 18 – 20˚C. *Stenella* dolphins and loggerhead turtles preferred were associated with shallower waters of less than 100m.

Introduction

This document explains the analysis of the USWTR aerial and shipboard survey data for 2007 – 2009, carried out by the University of North Carolina at Wilmington (UNCW) and Duke University respectively. The aim of these surveys was to establish base line data on the density of marine mammals in the USWTR region and if possible to develop a preliminary density surface of animals in the area of interest. Of further interest was the possibility that there could be environmental predictors of the marine animal density as well as any trends in abundance. Given the paucity of actual sightings within the region of interest such an analysis can supply only a preliminary investigation of animal numbers and all conclusions from this analysis should be regarded as tentative. Fortunately further survey data from the area was available from the aerial surveys done by UNCW off Onslow Bay from September 1998 to July 1999. Additionally sightings data undertaken from the same aerial platform was available from the ongoing right whale surveys carried out by UNCW closer to the coastline and the surveys undertaken near Wallop Island in 1998 and 1999. Additional shipboard sightings data was also available from a dedicated survey off Cape Hatteras in 2007.

Thus the analysis undertaken here, aimed to integrate the sightings and effort data from the 1998-1999 Onslow Bay survey (hereafter "Onslow survey"), the current ongoing aerial survey by UNCW (hereafter "USWTR aerial" survey) and the ongoing shipboard survey by Duke University (hereafter "USWTR ship" survey) augmented with sightings alone data from the 1998 – 1999 Wallop Island surveys (hereafter "Wallop" survey), ship sightings data from Cape Hatteras (hereafter "Hatteras" survey) and the ongoing aerial right whale surveys (hereafter "right whale" survey) to increase to precision associated with the estimate of the detection functions and ultimately abundance.

Figure 1. The core USWTR area and depths (m) at 2 minute intervals. Each colour represents 200 m intervals from 4200 m depth (violet in lower right hand corner)

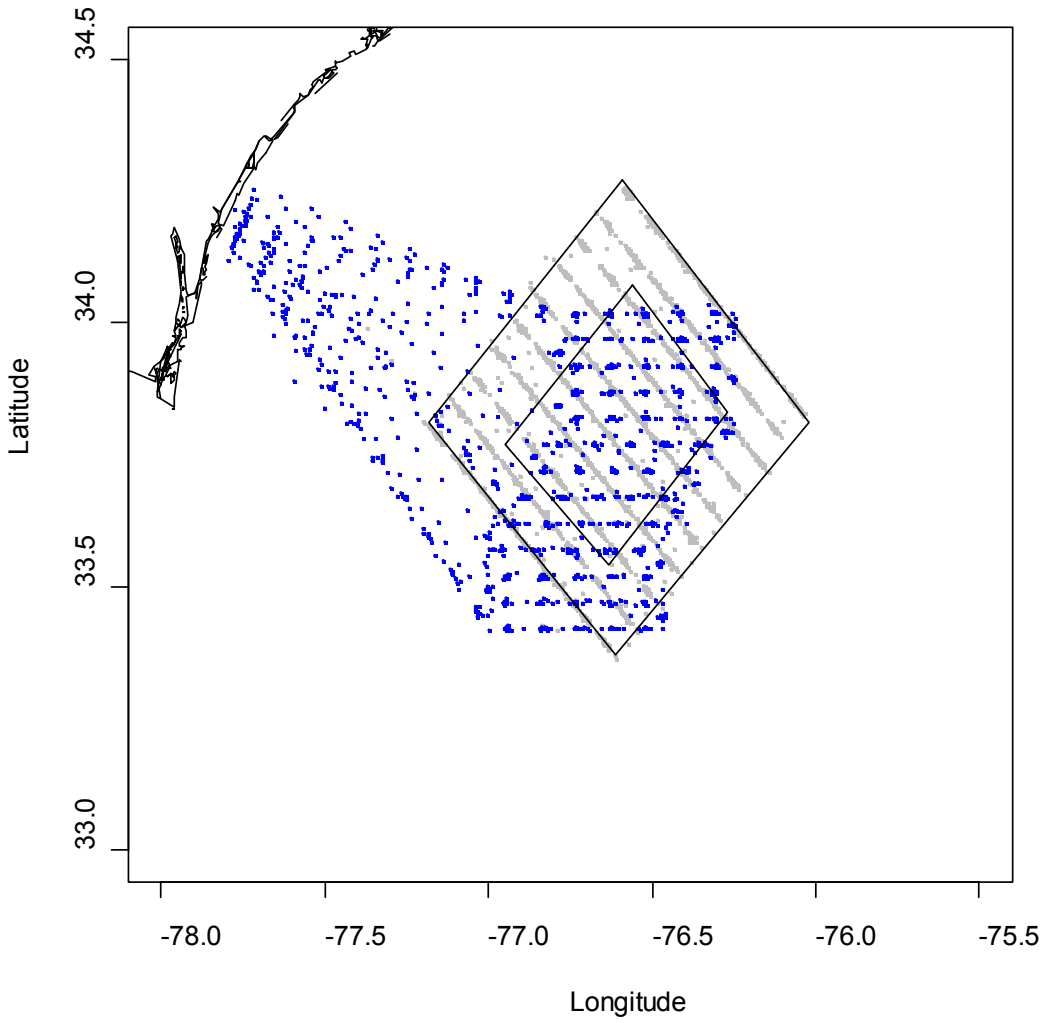


Methods

Area of interest and survey area

The USWTR area is given in figure 1 with approximate boundaries given by the black line. The boundaries are approximately 25 miles long (SW to NE) and 20 miles wide (NW to SE). The survey area extended to outside of this USWTR core by 20 nm (see grey transect lines in figures 2 and 3) so the total survey area is 1800 square nautical miles, with 500 of this (28%) within the USWTR itself. The survey area could be divided into a core region (inside the USWTR) and an outer non-core region. Abundance estimates were obtained for both regions.

Figure 2. Realized aerial effort segments for USWTR 2007/2008 (grey) and Onslow 1998/1999 (blue). Individual points represent the midpoints of each segment.



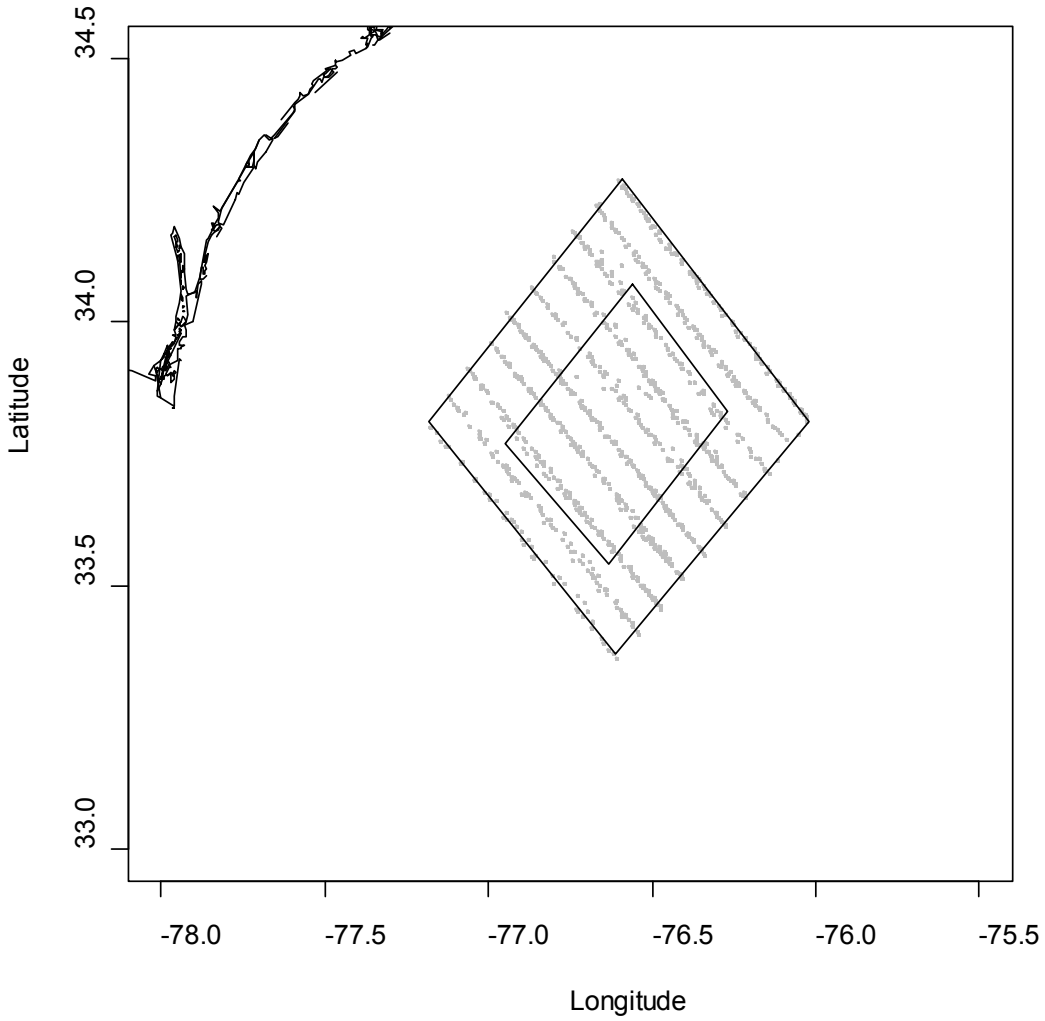
The realized aerial survey effort consisted of 12821 km in 1998/1999 and 31800 km from June through and including August 2009 and can be seen in figure 2.

The area covered by the shipboard survey was almost identical to that of the USWTR aerial survey (Figure 3) except no realized effort was expanded outward from the shore. The total realized effort analysed here was 4294 km. Two vessels were used: the *Sensation* and the *Cetus.* There was no evidence that detection varied between the two (see results). The temporal coverage of the surveys is given in table 1.

Table 1. Temporal Coverage of Surveys (A= Aerial, S = Shipboard)

Month	**1998**	**1999**	**2007**	**2008**	**2009**
Jan		*A*			*A,S*
February				*A*	*A,S*
March		*A*		*A,S*	*A,S*
April		*A*		*A*	*A,S*
May		*A*		*A,S*	*A*
June		*A*	*A,S*	*A,S*	*A, S*
July		*A*	*A,S*	*A,S*	*A, S*
August			*A,S*	*A,S*	*A, S*
September	*A*		*A,S*	*A,S*	
October	*A*		*A,S*	*A*	
November	*A*		*A,S*	*A,S*	
December	*A*		*A*	*A*	

Figure 3. Realized ship effort for USWTR 2007/2008 (grey)



Statistical analysis

Overview

In order to generate a density estimate of each species/taxa of interest and where possible to identify environmental variables driving animal abundance, the data were analysed by first estimating the probability of detection associated with each sighting and then estimating abundance per segment of trackline within the truncation distance. This assumed that detection on the trackline occurred with probability one (see below for discussion). The estimated densities comprised the inputs for a two stage modelling process. First probability of presence is modelled (as a logistic generalized additive model (GAM) and then estimated density given presence is modelled. Predictions are

made for all over the area of interest based on the two models. The product of these two predictions gives an estimated relative abundance surface for the area. Relative because it does not take into account of time spent submerged and imperfect detection on the trackline.

From this an estimate of the total number of animals in the area of interest was obtained. All animal species were initially considered but only 4 taxa were modeled in detail: bottlenose dolphins *Tursiops truncatus*, spotted dolphins *Stenella frontalis*, medium sizes whales (i.e. pilot whales *Globicephala* sp. and ziphids) and loggerhead turtles *Caretta caretta.* It may be that with increased sample sizes, data from other species will become adequate for analysis.

Estimation of Detection Probabilities

In conventional line transect sampling the probability of detection depends only on the perpendicular distance of the sighting to the transect, and at zero perpendicular distance this is assumed to be one (denoted by $g(0) = 1$). In this analysis the effects of covariates, other than perpendicular distance were incorporated into the detection function model. This was achieved by setting the scale parameter in the model to be an exponential function of the covariates (Marques 2001). Thus the probability of detection becomes a multivariate function, $g(y,\boldsymbol{v})$, representing the probability of detection at perpendicular distance y and covariates $\boldsymbol{v}$ ($\boldsymbol{v} = v_1,..,v_Q$ where Q is the number of covariates). Using either a hazard-rate $(1-\exp(-y/\sigma)^{-b})$ or half-normal detection function $(\exp(-y^2/2\ \sigma^2))$ (Buckland et al. 2001), the covariates were incorporated via the scale term, σ, where for sighting j, σ has the form::

$$\sigma_k = \exp\left(\beta_0 + \sum_{q=1}^{Q}(\beta_q v_{kq})\right)$$

here β_0 and β_q (q=1,…,Q) are parameters to be estimated. With this formulation, it is assumed that the covariates may affect the rate at which detection probability decreases as a function of distance, but not the shape of the detection function.

A stepwise backward selection procedure was used (starting from the previous best models) to decide which covariates to include in the model, with a minimum Akaike's Information Criterion (AIC) inclusion criterion. All model selection was

performed in the program *Distance* (v5.0; Thomas *et al*. 2002), and then the final selected models were re-fitted using a set of customized functions (mrds v.1.3.1) in the statistical programming package *R* (*R* Developmental Core Team, 2002). This facilitated estimation of variance within *R* – (see below).

This procedure was followed for dolphins. In the case of aerialsightings of turtles, shipboard sightings of turtles and shipboard sightings of medium whales. The paucity of data required a slightly different approach. Here the sightings were considered as coming from fairly narrow strip half transects of 500, 80 and 200 m width respectively.

Estimation of density surfaces

In most cases the number of transect segments containing sightings was extremely low. This made fitting of models difficult so a variety of modelling approaches were undertaken. The initial aim was to implement a modified version of the 'count model' of Hedley et al. (1999) was used to model the trend in spatial distribution of the different species. The response variable for the model was calculated from the estimated number of individuals for a segment $\hat{N}_i$, for each i^{th} segment. This was calculated using an estimator similar to the Horvitz-Thompson estimator (Horvitz and Thompson 1952), as follows:

$$\hat{N}_i = \sum_{j=1}^{n_i} \frac{s_{ij}}{\int_o^w \hat{g}(y, v_{ij})\pi(y)dy}, \qquad i = 1, \ldots, T,$$

where, for segment i, $\int_0^w \hat{g}(y, v_{ij})\pi(y)dy$ is the estimated probability of detection of the jth detected pod, n_i is the number of detected pods in the segment and s_j is the size of the jth pod. The total number of transect segments is denoted by T. By assumption, $p(y)$, the probability density function of actual (not necessarily observed) perpendicular distances is uniform up to the truncation distance. This is satisfied by randomly located transects.

Having obtained the estimated number of individuals in each segment, the density in segment i, $\hat{D}_i$, was estimated by $\hat{N}_i / a_i$ where a_i is the area of segment i. Segment area was calculated as the length of the segment multiplied by twice the truncation distance used to model the detection function. The survey tracklines were initially divided up into

distinct segments based on when crafts had gone off effort and/or a change in environmental characteristics. A variety of segment lengths was tried in the range of 5 – 13 km. Eventually 10km km was selected as an appropriate compromise between maximising the ratio of non-zero to zero segments, maintaining environmental resolution and giving some measure of spatial independence (see results). In the case of the main USWTR aerial data set this gave 3374 segments. In the case of the Onslow data this meant 1370 segments for the aerial survey with 738 segments for the shipboard survey (143 for *Cetus* and 1045 for *Sensation*).

Attempts to model density directly were unsuccessful because of the high frequency of zeros. Zero-inflated methods were tried but these proved impossible to implement successfully for this data set. Therefore the presence or absence of animals in a particular segment was modeled using a logistic GAM. The predicted probability of presence of animals in a segment was then multiplied by the predicted non-zero density in a segment. Again because of the paucity of the data attempts to model varying non-zero density proved unsuccessful so in all cases the mean of the non-zero density was used. This may introduce a potential bias in that zeros are over represented i.e. some zeros are not true zeros but simply segments of low density where the animals though present were not observed.

The covariates considered in the analyses were longitude (*Lon*) and latitude (*Lat*), sea surface temperature (*Temp*) and depth (*Depth*), day of the year (*Dayofyear*) and year of survey (*Year)*. Unlike previous analyse of data *Dayofyear* was now considered considered as a cyclic cubic spline so the second derivative of the curve for *Dayofyear* would meet at the beginning and end of the year. Sea surface temperatures were taken during the shipboard survey but additional data was needed for the aerial survey and the prediction grid. Sea surface temperatures were obtained from the National Oceanic and Atmospheric Administration (NOAA, http://dss.ucar.edu/datasets/ds277.0/data/oiv2/) at one degree and weekly resolution and were an updated set (based on the analysis of Reynolds *et al*. (2002)). Depths were obtained from the ETOPO2 2 minute resolution relief data available from National Oceanographic and Atmospheric Administration (http://www.ngdc.noaa.gov/mgg/image/2minrelief.html). Temperatures and depths were associated with effort segments by finding the closest point in the temperature and

bathymetry data to the midpoint of the effort segments using great circle distances (and additionally, time for temperature). Finally *Survey* was a factor variable which indicated the platform used (plane, *Cetus* or *Sensation*) but this was only considered in a model if the level associated with surveying from a plane took the lowest value i.e. the use of *Survey* reflects differences in g(0) between aerial and shipboard surveys.

Scatterplots of the explanatory variables are shown in figure 4. Unsurprisingly *Temp* and *Dayofyear* were strongly correlated with each other as were *Lon, Lat* and *Depth* thus the inclusion of only one of these correlated variables in the final models should not be interpreted as necessarily precluding the influence of others. As *Temp* and *Dayofyear* were correlated on *Dayofyear* was used in the abundance analyses.

Unbiased risk estimation implemented in the *mgcv* package (v. 1.5-2, Wood 2009) in *R* (v. 2.9.0) was used for covariate selection in the logistic model, augmented with diagnostic plots, using the principles described in Wood (2001). All covariates were considered for inclusion in the model as 1D smooths of untransformed covariate values. In addition, 2D smooths of *Lat* and *Lon* (as kilometer deviations from the equator and longitude 77˚W) were considered for inclusion into the GAM. A maximum of 4 degrees of freedom (5 knots) were allowed in the selection of 1D smooths for *Depth, Temp* and *Dayofyear*. In the case of *Lat* and *Lon*, 6 degrees of freedom (7 knots) and up to 13 degrees of freedom (14 knots) were allowed in the case of 2D smooths, thus allowing moderate flexibility but reducing the possibility of overfitting. The presence of unexplained spatial variation was checked by inspection of semivariograms of the residuals of the models. Data was fitted to all data across all years.

Due to gaps, changes in direction, stops in search effort along transects and changes in environmental conditions, effort could not always be split into segments of the desired length (see later). Therefore, the size of each segment varied and so the model was weighted by segment area.

The presence only data was modeled in the same way as above although sometimes models had to have smooths removed in order not generate spuriously high results in the bootstrap.

The aim of all the initial models above was to estimate a density surface (see below). To investigate the underlying biological basis of the distributions of the animals,

model selection for *Tursiops, Stenella* and *Caretta* presence-absence models was repeated without *Lon* and *Lat*. Sometimes the final biological model selected corresponded to the density surface only models. In this case sea surface temperature *Temp* was also considered as a variable as a replacement for *Dayofyear*.

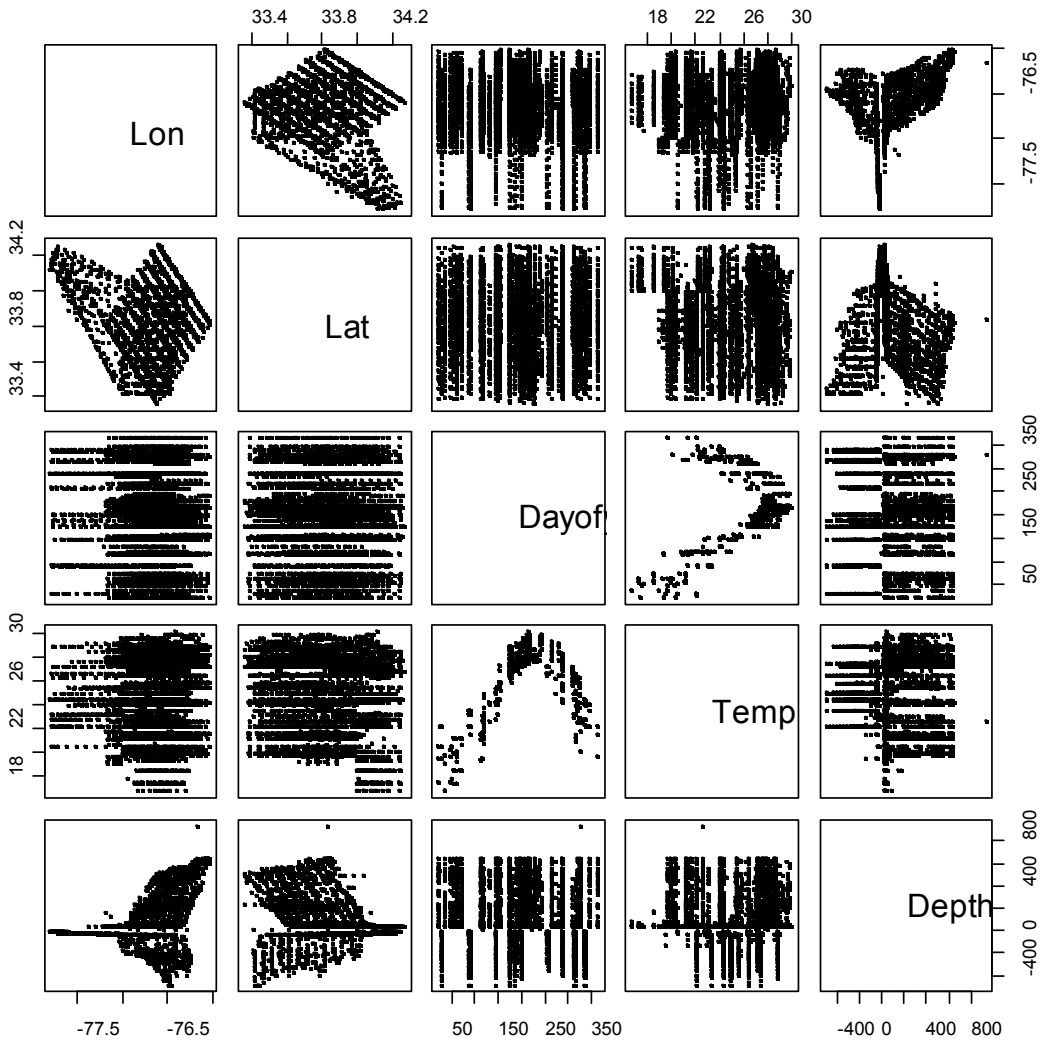
Prediction

The final model was used to predict density of marine animals throughout the survey region over a 2 minute resolution grid that was spanning the inner core USWTR area and the surveyed area around it. Animal abundance was estimated by numerically integrating under this predicted density surface. If survey mode was included in the model, abundance was predicted assuming the survey mode with the largest coefficient in the model as this would reflect the best detection on the trackline. Predictions were made for June of each of the survey years (although June was not surveyed in 1998) to allow comparison between years. Obviously models that did not contain *Dayofyear, Temp* or *Year* produced identical predictions for each of the four years and months.

Variance estimation

Variance estimation was undertaken by bootstrapping the entire process above based on a selection of effort legs. Sometimes models had to be simplified to work without generating unrealistically high estimates in the bootstrap.

Figure 4. Relationship of potential explanatory continuous variables used in density surface modeling.


Lon
Lat
Dayof
Temp
Depth
33.4
33.8
34.2
18
22
26
30
-76.5
-77.5
34.2
33.8
33.4
350
250
150
50
30
26
22
18
800
400
0
-400
-77.5
-76.5
50
150
250
350
-400
0
400
800

Results

Aerial Surveys

In the case of the USWTR and right whale aerial surveys the surveys were carried out from the observation plane flying at a height of 305 m (1000 ft). The aerial surveys from 1998/1999 were carried out with almost precisely the same protocol as the ongoing USWTR surveys except that the plane flew at 230 m (750 ft). Thus the sightings data from these two surveys could be readily combined. Estimates of perpendicular distance were obtained either by reference to direct estimates of distance by observers, trigonometry from the declination angle of the plane to the observed animals or by trigonometry from the position of the plane at first observation of the animals and subsequent location directly above the animals. A total of 2832 sightings were initially available from all surveys (Onslow: 163, Wallop: 229, USWTR: 761 and right whale surveys: 1679). These numbers are for animals that could be assigned to reasonably specific taxonomic categories (see below). However for some sightings (primarily turtles) distance estimates were not available. It was assumed that such sightings occurred at random so detection probabilities (and hence estimated numbers, see below) were allocated to these sightings after estimation of the detection function with a proportion assumed lost due to being beyond the truncation distance (as in the sample of known distance sightings).

Sightings were grouped together based on the a priori similarity of form of the species seen. Table 1 gives the number of sightings before and after truncation, for taxa where there were sufficient numbers to allow further investigation. There were three morphologically similar groups dolphins (all species commonly referred to as dolphins), turtles (all turtles species) and whales (baleanopterids, pilot whales and beaked whales). Future work may allow splitting of these groups.

Table 1. Aerial sightings with distances by species group

Sightings group	**Species within group (where identified)**	**Number of sightings before truncation**	**Truncation distance**	**Number of sightings after truncation**
Dolphins	Bottlenose, common, Risso's, spotted, rough toothed and unidentified dolphins	226	1500 m	215
Whales	Beaked whales, pilot whales, other whales	40	1500 m	35
Turtles	Loggerhead, Leatherback, Kemp's Ridley and unidentified turtles	534*	500 m	419

**Does not include sightings without distances.*

Shipboard Surveys

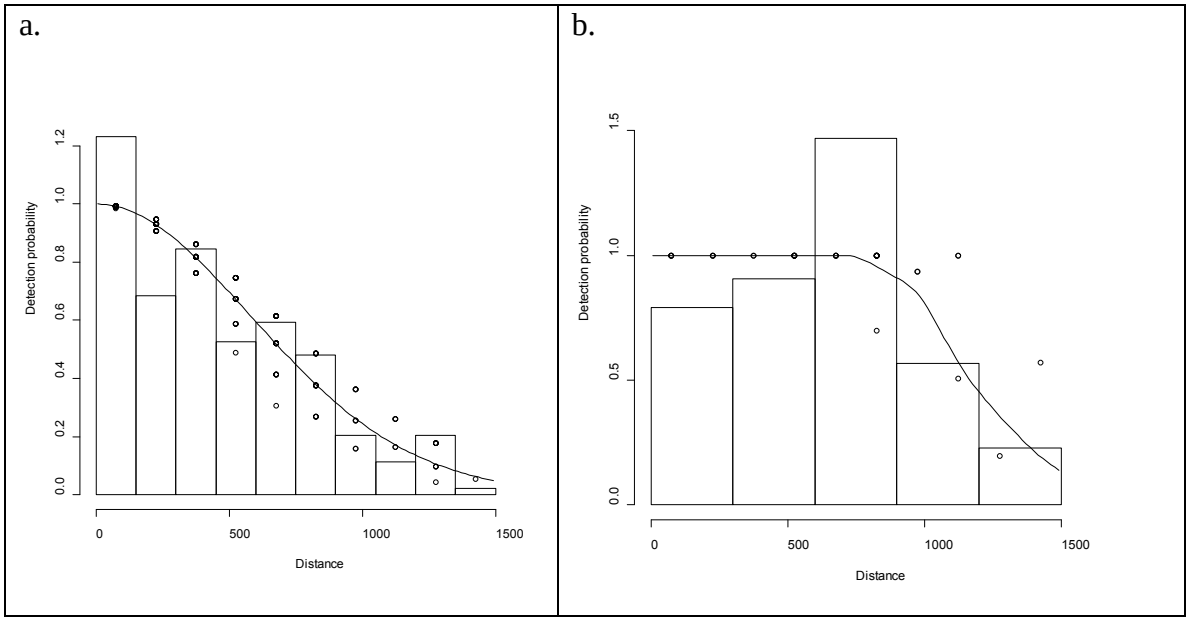
In the case of the shipboard sightings there were few sightings (n = 168) even when complemented by the additional sightings from off Cape Hatteras. Again the sightings were grouped by visual type to determine a detection function (table 2).

Table 2. Shipboard sightings by species group. Includes sightings from aerial surveys off Wallop Island and right whale surveys as well as shipboard surveys off Cape Hatteras.

Sightings group	**Species within group (where identified)**	**Number of sightings before truncation**	**Truncation distance**	**Number of sightings after truncation**
Dolphins	Bottlenose, common, Risso's, spotted, rough toothed and unidentified dolphins	86	300 m	59
Medium whales	Beaked whales and pilot whales	10	200m	6
Turtles	*Loggerhead, Leatherback, Kemp's Ridley* and unidentified turtles	60	80 m	43

**Does not include sightings without distances who are subsequently randomly assigned to be in or out of the truncation distance.*

Figure 5. Aerial survey detection functions for a. dolphins (data binned into 150 m intervals), b. all medium and large whales.

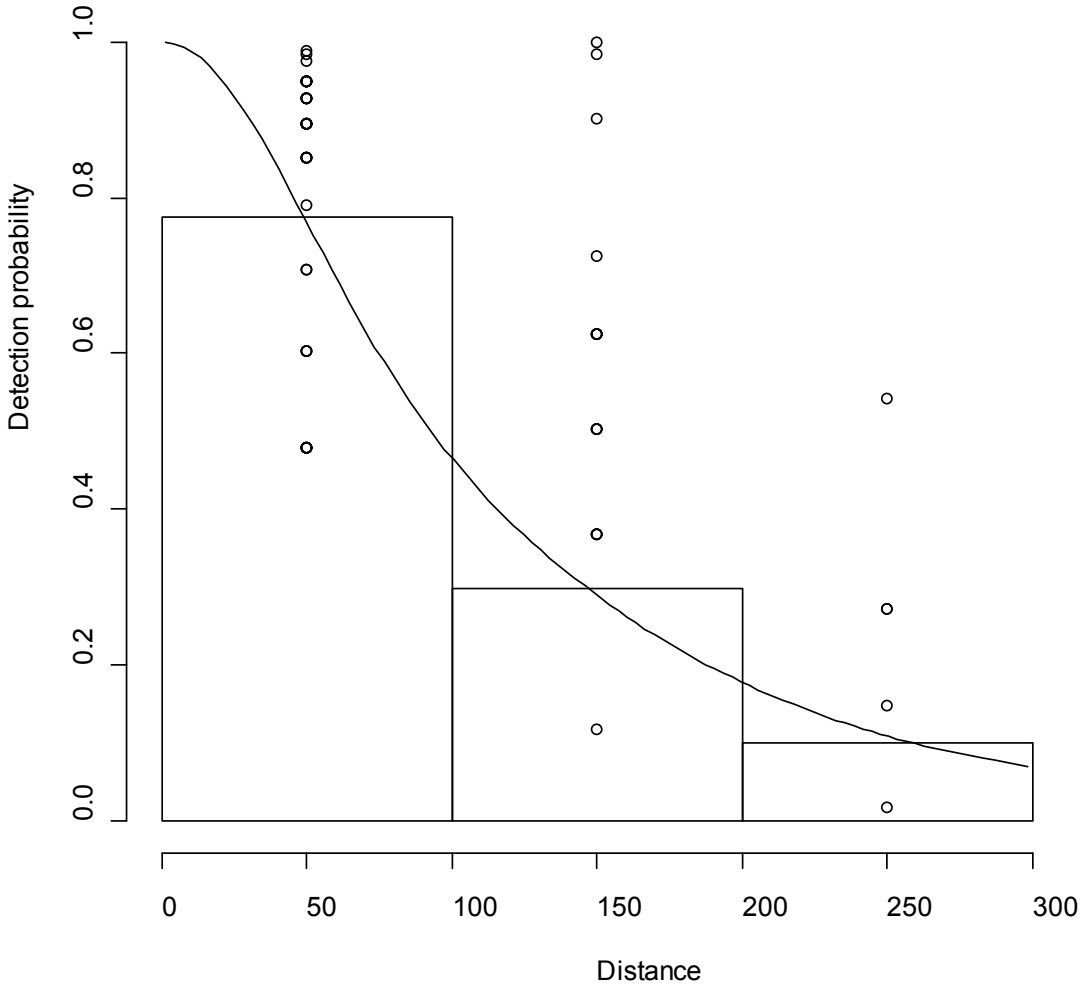


Aerial survey detection functions

In the case of dolphins and turtles, sightings data were fitted in *Distance* initially and then integrated into the whole analysis. Dolphin sightings were binned into 150 m widths and right truncated at 1.5 km. The best fit detection function for dolphins was a half normal function with distance and Beaufort Sea State. The detection function associated with the lowest AIC for medium whales were hazard rate functions with Beaufort sea state (Figure 5).

The perpendicular distance distribution of turtle detections did not conform to the usual assumption of monotonically declining detection probability with increasing distance and so a flat detection function of 1 out to 500m (corresponding to a strip transect survey with a strip of 1000m width) was used in this case. The reasons for the unusual distribution are not known but it may have been caused in part by rounding of distances.

Figure 6. Ship survey detection functions for dolphins



Ship survey detection functions

Dolphin sightings were binned into 100 m widths and right truncated at 300 m. The best fit for dolphins was a half-normal detection function (see Figure 6). Beaufort sea state was included as a variable. Turtles were assumed to be in a strip transect out to 80 m. Medium size whales were also assumed to be in a strip transect to 200 m.

Table 3. Predictive and explanatory biological models for each species. s() indicates a smoothed function of the variable of interest. The final column gives the number of the relevant figure.

Species	**Model**	**Terms in model**	**Figure number**
Tursiops truncatus	Predictive, logistic component	*s(Depth) + s(Dayofyear) + Year*	7
	Explanatory logistic component.	*s(Depth) + s(Dayofyear) + Year*	8
	Non-zero density component	*Year*	7
Stenella frontalis	Predictive, logistic component	*Survey + s(Depth) + s(Dayofyear) + Year*	9
	Explanatory logistic component	*Survey + s(Depth) + s(Dayofyear) + Year*	10
	Non-zero density component	*Year*	9
Collective medium sized whales	Predictive, logistic component.	None	
	Explanatory logistic component	None	
	Non-zero density component	None	
Caretta caretta	Predictive, logistic component.	*Survey + s(Depth) + s(Dayofyear) + Year*	11
	Explanatory logistic component	*Survey + s(Depth) + s(Temp) + Year*	12
	Non-zero density component	*Year*	

Estimation of density surfaces

The final fitted models for predicting abundance and for biological explanation are given in table 3. The best performing models can be found in table 3.

Bottlenose dolphins *Tursiops truncatus*

In the case of bottlenose dolphins only 129 segments had a density greater than zero. Figure 7 shows monthly predicted abundances and their confidence intervals. Estimated bottlenose dolphin numbers varied between 20 (95% CI: 10 – 90, August 2008) and c. 100 (30 – 180, Jan 2008) for the inner region and from 60 (30 – 240, August 2008) to 290 (80 – 540, May 1999) for the outer region. Note that the upper boundary of the estimates are moderately high especially for the outer zone. This is probably caused by edge effects in the bootstrap. Nonetheless it compares favourably with an analysis equivalent to a conventional distance analysis with different encounter rates for each year (i.e. assuming constant but different mean density for each year) had a mean abundance in the USWTR box of 65 (51 - 590).

A depth association can also possibly be discerned (figure 8) but the pattern probably reflects depth as a describing the data spatially rather than a real spatial preference. A difference both across and within years can be seen (figure 7), this is also

seen in the figure. There is however evidence of a difference over the course of the year with numbers peaking in winter (figure 8) presumably as a response to temperature changes. There was no evidence that there was residual spatial correlation in the data.

Figure 7. Estimated abundance of Tursiops a. inside (black) and immediately outside (red) the USWTR region (no error bars shown for clarity, b. the inside abundances with 95% confidence intervals (in blue)

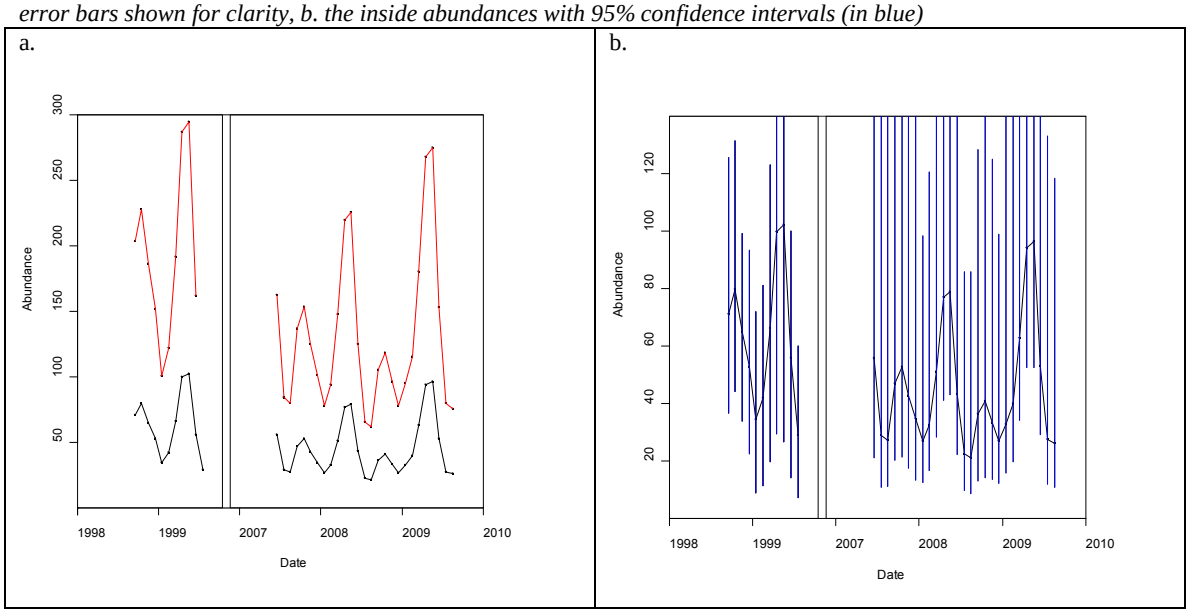
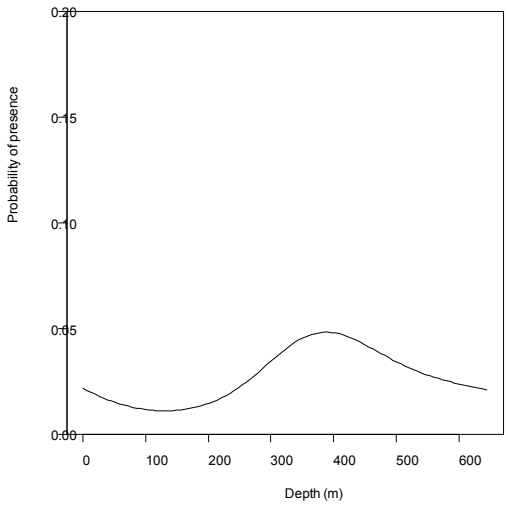


Figure 8. Probability of presence of Tursiops in response to a. Depth, and b. Dayofyear in 2009.

a.



Spotted dolphin Stenella frontalis

In the case of *S. frontalis* there were 51 non-zero segments. A predictive model was fitted consisting of smooths of *Depth, Dayofyear* with *Year* as a factor. Unsurprisingly the estimates were associated with a wide confidence interval. Figure 9 gives the predicted abundances for of each month of interest. Estimated spotted dolphin numbers varied from 0 (0 – 0) in 1998/1999 to 400 (110 – 1200) in January 2009 in the inner region and from 0 (0 – 0) in 1998/1999 to c. 920 (260 – 2700, in January 2009) in the outer region. *Stenella* was not seen in the area during the UNCW 1997 – 1998 surveys and only appeared in 2007 since then its predicted numbers have increased considerably.

If a spatial model of presence absence is based with *Year* only as a predictor then the predctions for the USWTR box are 1998 & 1999 (0, 95% confidence interval 0 – 0), 2007 (5, 0 – 35), 2008 (20, 9 – 44), and 2009 (110, 70, 230). In this case, the use of spatial model has not reduced the variance in the abundance estimates although it does allow elucidation of the specific factors that influence the distribution spotted dolphins.

There was no evidence of spatial correlation in the data except over very small distances (<0.5 km) presumably caused by successive densities of zero across years. Although year considered as a factor, was in the model selected using ubre, the resultant stepping of the predictions looks unrealistic with a sudden jump in numbers between December and January.

The explanatory model consisted of *Temp, Depth* and *Year* although *Temp* explained little of the variation and there is no obvious explanation for the pattern of responses seen. *Stenella frontalis* was strongly associated with shallower water (Figure 10).

Ziphids and pilot whales

In the case of the ziphids and pilot whales only 11 segments has non-zero estimates thus no attempt was made to model density. As the estimates were not based on temporal variables the values did not vary. The best MEAN estimate of these whales abundance is 5 (2 – 8) in the inner zone and 9 (3 – 14) in the outer zone. Little interpretation can be made of these results at this stage but it should be stressed that these numbers represent animals at the surface only.

Figure 9. Estimated abundance of Stenella a. inside (black) and immediately outside (red) the USWTR region (no error bars shown for clarity, b. the inside abundances with 95% confidence intervals (in blue)

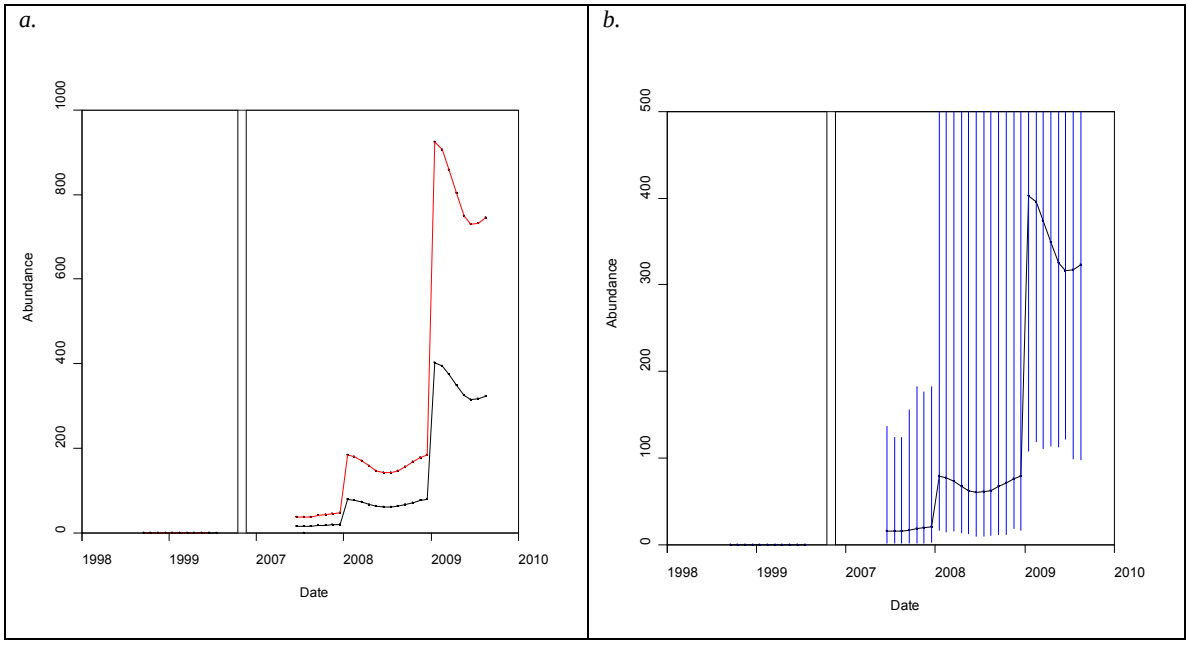
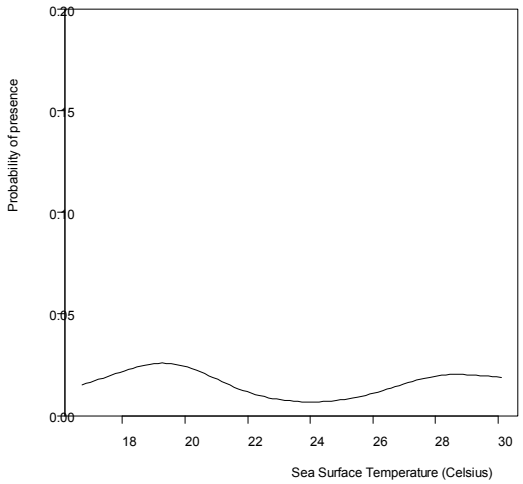


Figure 10. Probability of presence of *Stenella frontalis* in response to *a. Sea surface temperature* and *b. Depth in 2009*..

a.



Caretta caretta

In the case of loggerhead turtles there were 253 non-zero segments. Presence was modelled with smooths of *Depth and Dayof year with Year as a factor.* alone to ensure stability in bootstrap with density if present assumed to be constant. Figure 9 gives the estimates by month. If a constant density surface is assumed then the point estimate of population size in the USWTR box is 44 (18 – 89) outside the USWTR box it is 84(34 – 170)

Explanatory model selection suggested that both *Depth* and *Temp* were significant with turtles were more likely to be present in shallower and surprisingly colder waters (figure 12). This result was also seen in the analysis of the data from last year as well. This could reflect a real temperature preference or reflect an annual cycling. In terms of day of the year this corresponds to a decreased probability of presence in late July. There was no evidence of spatial correlation in the data except over very small distances (<0.5 km) presumably caused by successive densities of zero across years.

Figure 9. Estimated abundance of loggerhead turtles a. inside (black) and immediately outside (red) the USWTR region (no error bars shown for clarity, b. the inside abundances with 95% confidence intervals (in blue)

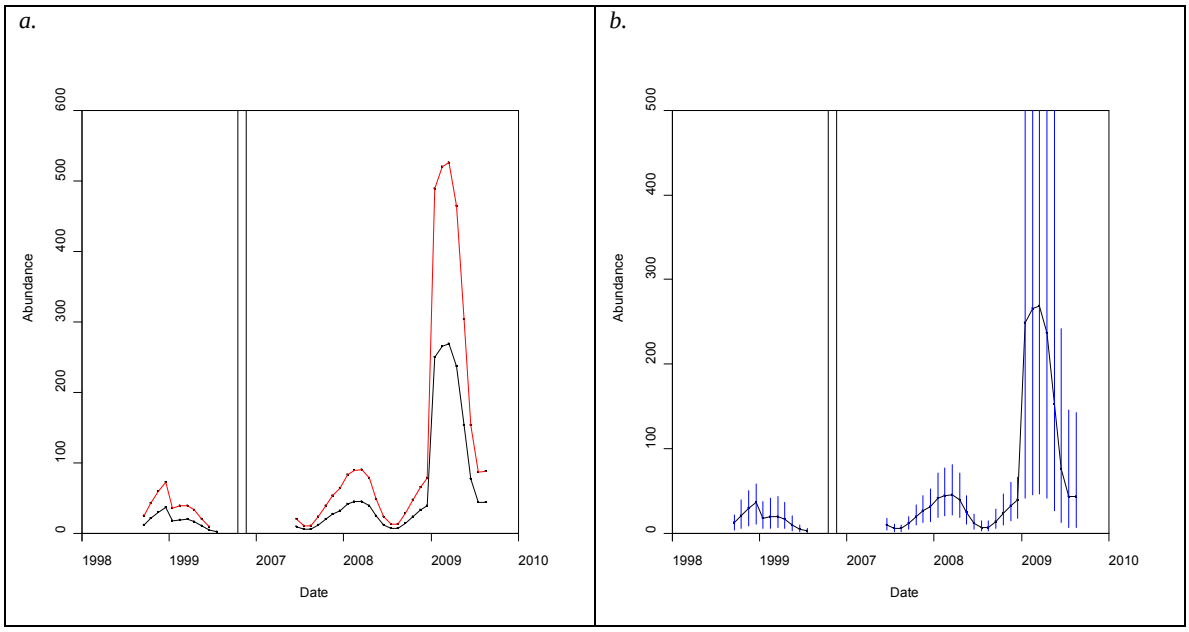
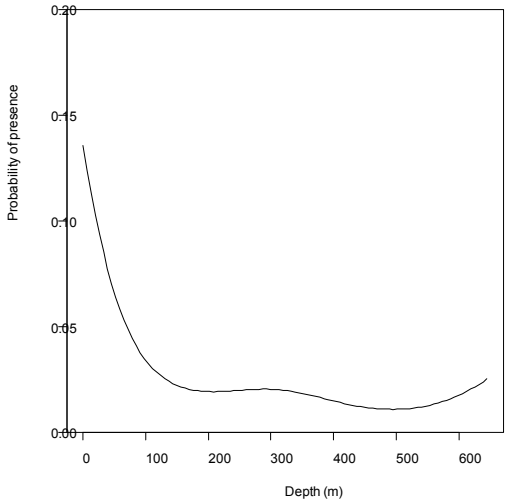


Figure 12. Probability of presence of *Caretta caretta* in response to a. depth and b. sea surface temperature. Rug marks indicate a datum at that covariate value.

a.



Discussion

Given the lack of sightings any conclusions about the reasons for the estimated distributions in the region should be regarded as extremely tentative. The lack of sightings for species other than those analysed above precluded estimates for other species. Nonetheless it seems reasonable to conclude that the region as a whole has few large marine fauna (save perhaps turtles, see below), data are inadequate to estimate trend except in the case of *Stenella* and there is no evidence that any species has reduced in numbers over the time period considered. However the above results are all based on single observers with g(0) (detection probability) assumed to be one on the trackline for the species of interest.

There are two reasons that g(0) may be less than 1. Firstly there is an availability bias associated with the presence of species at the surface. Cetaceans and turtles can spend only a small proportion of their time at the surface (see below). This bias was ameliorated here by only predicting using the factor associated with ships in models that had factors for ship or aircraft (this effectively makes the g(0) estimate for aircraft no more negatively biased than that for ships). The second reason is perception bias: animals are missed on the trackline even if they are at the surface. Smaller cetaceans that don't form highly detectable pods and some of the more cryptic species that are not prominent at the surface may not be detected even when on the trackline. Both availability bias and perception bias tend to be greater for fast-moving observers and are therefore greater for aircraft than for ships (see comparisons of $g(0)$ in Palka 2005a and 2005b)

It might be expected that *Survey* should always appear in the models as $g(0)$ should generally be higher for a ship than a plane. This was not always the case here - due in part to the low power to detect this effect because of the low number of sightings. In the case of bottlenose dolphins, a higher density was associated with aerial surveys! Survey was not included in the final models if this was the case.

Correcting for availability bias due to diving can be done if the expected times of availability and unavailability are known as well as the transit speed of the observation vessel (e.g. Laake et al. 1997, Hedley and Bannister 2004, Paxton et al. submitted). These correction methods break down somewhat as the speed of the survey platform gets closer to that of the animals. They may therefore not work well for shipboard surveys but are

likely to be quite adequate for aerial surveys. They do, however, depend on having reliable estimates of mean times of availability and unavailability. Because mean times were not available for all species, because they may differ within the species groups used in our analysis (groups determined in part by small sample size), and because mean times may be location-dependent, we have not used them here. Instead we correct g(0) bias for aircraft to be no greater than that from ships and accept that density and abundance estimates are likely negatively biased by some unknown amount.

Where it has been investigated *Mesoplodon densirostris* has been found to spend c. 26% of the time underwater (Baird *et al.* 2004) and Barlow (1999) estimated g(0)s of 0.45 and 0.23 for *Mesoplodon* and *Ziphius* respectively.

Forney et al. (1995) estimated $g(0)$ to be 0.67 for smaller dolphin groups and Palka (2005a and b) estimated $g(0)$ for small cetaceans to be in the range 0.58 – 0.95 depending on the craft used.

Where investigated loggerhead turtles have been found to spend c. 90% of their time diving (Houghton et al. 2002) but animals who are just submerged (which can be 60% of the time (Polovina *et al.* 2003) may be amenable to detection especially from air dependent on water opaqueness. g(0) for this species could very considerably and the abundance estimates given here could be severely biased. Further no attempt was made (at this stage) to include sightings of animals recorded only as unspecified turtles.

Numbers in the inner and outer boxes are clearly correlated suggesting that there is no reason to believe animals are being displaced from the USWTR box.

The limited tentative biological conclusions that can be drawn reflect existing knowledge in the literature. The bottlenose dolphins prefer deeper water compared to spotted dolphins and last years finding of an association of loggerhead turtles with cooler waters is confirmed this year.

Recommendations for the future

The USWTR survey work is ongoing, issues of potential interest in USWTR survey work in the future might include:

1. Improving detection function and density estimates by supplementing existing detections with those from future surveys.

2. Investigation of reliable methods for estimating g(0) without double-observer survey. Options include cue-based methods and use of appropriate availability correction methods based on data on availability patterns for each species.
3. Further elucidation of the environmental drivers of cetacean density in the area of interest perhaps by the use of additional variables.
4. Records of water opaqueness may be useful for in the generation of detection functions of turtles.

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