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27 January 2009 (AFAST Final Rule)

Marine Species Monitoring

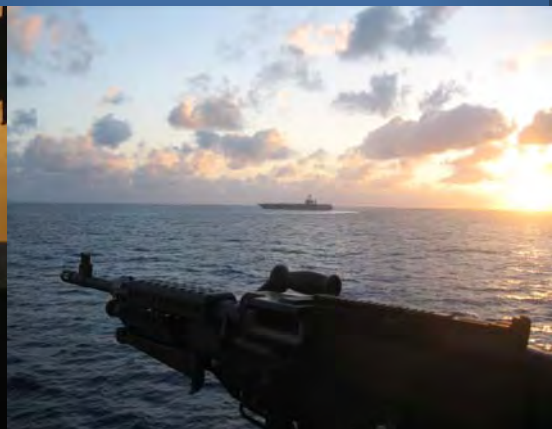
For The U.S. Navy's

Atlantic Fleet Active Sonar Training (AFAST)

Annual Report 2009

Final

04 January 2010



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List Of Acronyms

AMR	Adaptive Management Review
ARP	acoustic recording package
AS	aerial survey
ASW	anti-submarine warfare
BiOP	ESA Biological Opinion
COMPTUEX	Composite Training Unit Exercises
CNO	Chief of Naval Operations
CREEM	Centre for Research into Ecological and Environmental Modeling
dB	decibel
EIS	Environmental Impact Statement
DoN	Department of the Navy
ESA	Endangered Species Act
ft	feet
FY	fiscal year
GUNEX	Gunnery Exercise, Surface-to-Surface
HARP	high-frequency acoustic recording package
HQ	headquarters
JTFEX	Joint Task Forces Exercises
ITA	Incidental Take Authorization
LOA	Letter of Authorization
M3R	Marine Mammal Monitoring on Navy Ranges
MFAS	mid-frequency active sonar
MMO	marine mammal observer
MMPA	Marine Mammal Protection Act
MMPI	marine mammal PhotoID
MTE	Major Training Exercise
nm	nautical mile
NMFS	National Marine Fisheries Service
NOAA	National Oceanographic and Atmospheric Administration
NUWC	Naval Undersea Warfare Center
OEIS	Overseas Environmental Impact Statement
ONR	Office of Naval Research
PAM	passive acoustic monitoring
PMAP	Protective Measures Assessment Protocol
PTS	permanent threshold shift
R&D	research and development
RL	receive level
TTS	temporary threshold shift
VS	vessel survey

INTRODUCTION

Background

The U.S. Navy developed Range Complex specific Monitoring Plans to provide marine mammal and sea turtle monitoring as required under the Marine Mammal Protection Act (MMPA) of 1972 and the Endangered Species Act (ESA) of 1973. In order to issue an Incidental Take Authorization (ITA) for an activity, Section 101(a) (5) (a) of the MMPA states that National Marine Fisheries Service (NMFS) must set forth "requirements pertaining to the monitoring and reporting of such taking." The MMPA implementing regulations at 50 CFR Section 216.104 (a) (13) note that requests for Letters of Authorization (LOAs) must include the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species and of the level of taking or impacts on populations of marine mammals that are expected to be present. While the Endangered Species Act (ESA) does not have specific monitoring requirements, recent Biological Opinions issued by National Marine Fisheries Service (NMFS) also have included terms and conditions requiring the Navy to develop a monitoring program. Therefore, as part of the issuance of an LOA in early 2009 (NMFS 2009), the Navy published a Monitoring Plan with specific monitoring objectives for the Atlantic Fleet Active Sonar Training (AFAST) (DoN 2009).

Based on discussions with NMFS, Range Complex Monitoring Plans were designed as a collection of focused "studies" to gather data that will attempt to address the following questions that are described more fully in the AFAST Monitoring Plan:

1. Are marine mammals and sea turtles exposed to mid-frequency active sonar (MFAS), especially at levels associated with adverse effects (i.e., based on NMFS' criteria for behavioral harassment, TTS, or PTS)? If so, at what levels are they exposed?

2. If marine mammals and sea turtles are exposed to MFAS in the AFAST study area, do they redistribute geographically as a result of continued exposure? If so, how long does the redistribution last?

3. If marine mammals and sea turtles are exposed to MFAS, what are their behavioral responses to various levels?

4. Is the Navy's suite of mitigation measures for MFAS (e.g., Protective Measures Assessment Protocol (PMAP), major exercise measures agreed to by the Navy through permitting) effective at avoiding TTS, injury, and mortality of marine mammals and sea turtles?

Monitoring methods proposed for the Range Complex Monitoring Plans include a combination of research elements designed to support both Range Complex specific monitoring, and contribute information to a larger Navy-wide science-based program. These research elements include visual surveys from vessels or airplanes, passive acoustic monitoring (PAM), and marine mammal observers (MMO). Each monitoring technique has advantages and disadvantages that vary temporally and spatially, as well as support one particular study objective better than another (DoN 2009). The Navy intends to use a combination of techniques so that detection and observation of marine animals is maximized, and meaningful information can be derived to answer the research questions proposed above. This also includes incorporation of new techniques (e.g. photo-ID) if warranted.

In addition to Fleet funded Monitoring Plans described above, the Chief of Naval Operations (CNO) Environmental Readiness Division (N45) and the Office of Naval Research (ONR) have developed a coordinated Science & Technology and Research & Development program focused on marine mammals and sound. Total investment in this program for fiscal year (FY) 2009 was approximately $22 million, and continued funding at levels greater than $14 million is foreseen in subsequent years. Several significant projects relative to Navy operational impact or lack of impact to marine mammals are currently funded and ongoing within some Navy Range Complexes.

Report Objective

Design of the Range Complex specific Monitoring Plans represented part of a new Navy-wide and regional assessment, and as with any new program, there are many coordination, logistic, and technical details that continue to be refined. The scope of the Range Complex Monitoring Plans was to layout the background for monitoring, as well as defines initial procedures to be used in meeting certain study objectives derived from NMFS-Navy agreements.

Overall, and in support of the above statement, this report has two main objectives:

1) Under the AFAST LOA, present data and results from the Navy-funded marine mammal and sea turtle monitoring conducted in the AFAST study area during the period from 27 January 2009 to 1 August 2009. Because one full year of monitoring has not occurred from the January 2009 promulgation of the AFAST LOA, this report is meant to be a status report on Navy's accomplishments over the past seven months of effort. Included in this assessment are reportable metrics of monitoring as requested by NMFS. Given the relatively new start of this ambitious program, this first report will focus mostly on summarizing collected data, and providing a brief description of the major accomplishments from techniques used this year.

2) Set the foundation for adaptive management review with NMFS for incorporation of proposed revisions to the Navy's FY 2010 AFAST Monitoring Plan based on actual lessons learned from FY 2009. This can include data quality in answering the original study questions, assessment of logistic feasibility, availability of monitoring resources, use of new techniques not originally incorporated in this year's Monitoring Plan, and any other pertinent information.

SECTION I- ATLANTIC FLEET ACTIVE SONAR TRAINING (AFAST)

The AFAST study area consists of the range complexes' at-sea operating areas, and adjacent waters along the U.S. East Coast and Gulf of Mexico (**Figure I-1**).

There are forty-three species of marine mammals that may be observed either seasonally or year-round in the AFAST study area; seven are endangered. In addition, there are six species of threatened and endangered sea turtles that may occur either seasonally or year-round in parts of the AFAST study area (Reviewed in DoN, 2005, 2007, 2008a, 2008b, and 2008c).

Part I- AFAST Monitoring Plan Accomplishments

AFAST STUDY QUESTIONS OVERVIEW

The goal of the AFAST Monitoring Plan is to implement field methods chosen to address the long term monitoring objectives outlined in the Introduction. In the AFAST monitoring plan (DoN 2009), the Navy proposed to implement a diversity of field methods to gather monitoring data for marine mammals and sea turtles in Navy training areas. Specifically, the Navy proposed to use visual surveys (aerial and vessel), deploy passive acoustic monitoring devices, and put marine mammal observers aboard Navy vessels to meet its goals in FY09. Studies were specifically designed to meet the questions outlined in the Introduction section of this document. **Table I-1** from the final AFAST Monitoring Plan shows the FY 2009 monitoring objectives as initially agreed upon by the NMFS and Navy.

LONGITUDINAL BASELINE MONITORING

In June 2007 a protected marine species monitoring program was initiated in Onslow Bay off the North Carolina Coast. The Navy contracted with a consortium of researchers from Duke University, the University of North Carolina at Wilmington, the University of St. Andrews, and the NMFS Northeast Fisheries Science Center to conduct a pilot study analysis and subsequently develop a survey and monitoring plan that prescribes the recommended approach for data collection including surveys (aerial/shipboard, frequency, spatial extent, etc.), passive acoustic monitoring, photo identification and data analysis (standard line-transect, spatial modeling, etc.) necessary to establish a fine-scale seasonal baseline of protected species distribution and abundance.

The program now consists of year-round multi-disciplinary monitoring through the use of shipboard and aerial visual surveys (24 days each annually), photo identification studies, biopsy sampling, and passive acoustic monitoring. Passive acoustic monitoring is accomplished through use of a towed array during shipboard surveys as well as long-term deployment of High-frequency Acoustic Recording packages. Surveys are conducted year-round using established track lines and standard distance sampling techniques. The detailed plan for the Onslow Bay monitoring program is included as **Appendix A**. In addition, the Year 1 annual report for Onslow Bay is included as **Appendix B**. Although the plan and annual report pre-date the AFAST Letter of Authorization and specific monitoring requirements, they serve as important background information and set the stage for how AFAST requirements are currently being addressed.

The initial intent of the Onslow Bay monitoring program was to support development of an Undersea Warfare Training Range. However, this has evolved into providing a fixed site for the overall AFAST monitoring program designed to provide meaningful data on potential long-term effects to marine species that may be chronically exposed to training. In addition to the Onslow Bay site, an additional site was added off the coast of Jacksonville. The monitoring at these two sites provides a longitudinal baseline of marine species distribution and abundance in Navy training areas during periods when training is not occurring at the site. In addition, these sites are being used as areas to conduct coordinated ASW exercise monitoring when a training event occurs at the site(discussed below). Monitoring both during and outside of training events is intended to gathering important data that will begin to answer the questions outlined in the Introduction.

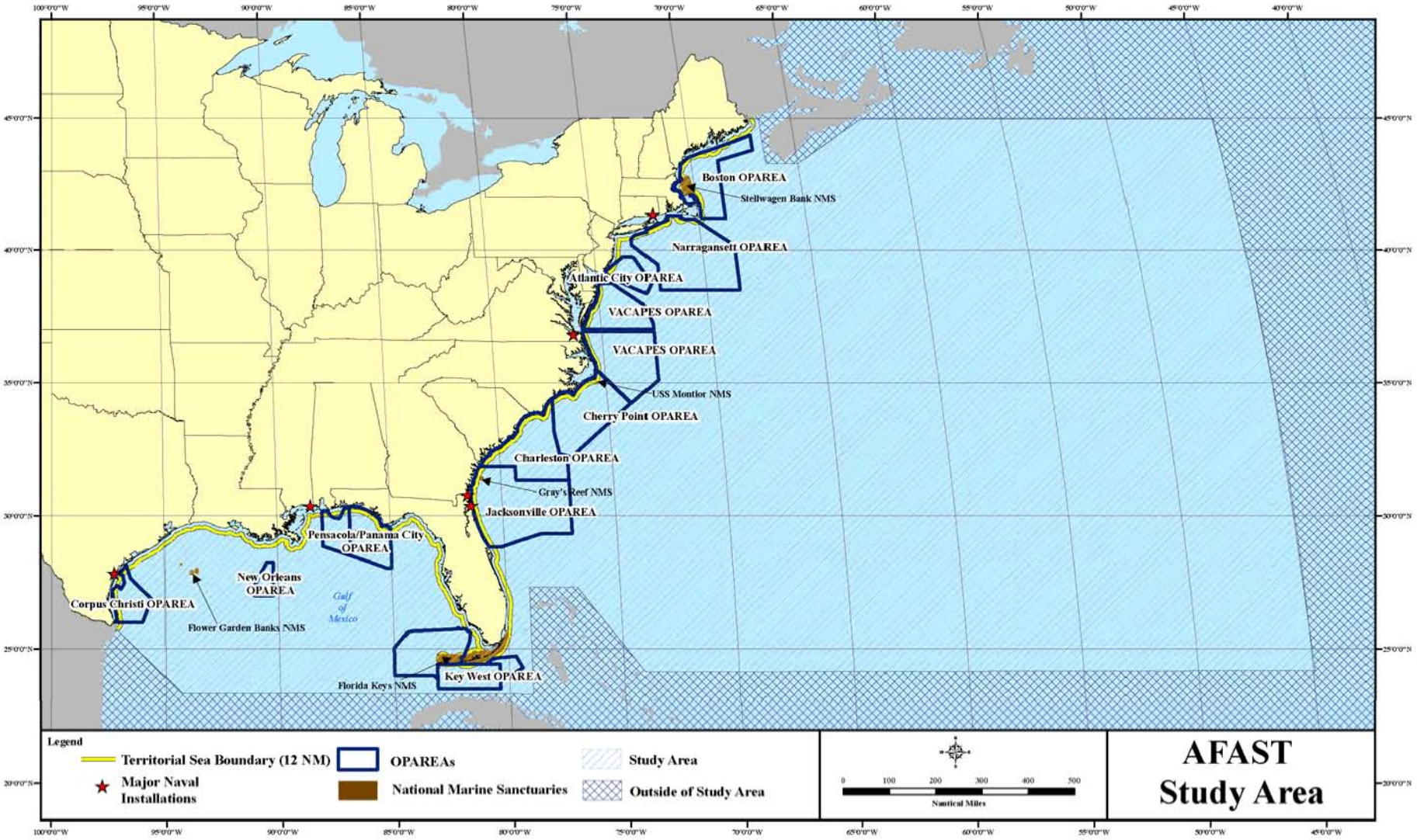

Figure I-1. AFAST Study Area.

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Table I-1. FY09 AFAST monitoring obligations under AFAST Final Rule, LOA and BiOP

STUDY 1 and 3 (exposures and behavioral responses)		
Aerial Surveys During Training Events	- 30 hours of active sonar during SEASWITI, shallow COMPTUEX, or ULT exercises.	Adaptive Management Review for FY10 (AMR)
Marine Mammal Observers (MMO)	- 60 hours during SEASWITI or ULT exercises.	
Vessel surveys During Training Events (study 3 only)	- 100 hours during SEASWITI, shallow COMPTUEX, or ULT exercises.	
STUDY 2 (geographic redistribution)		
Aerial Surveys Before And After Training Events	- 40 hours during SEASWITI, shallow COMPTUEX, or ULT exercises.	AMR
Aerial Surveys Onslow Bay	- 100 hours	
Vessel Surveys Onslow Bay	- 125 hours	
Aerial Surveys Jacksonville	- 100 hours	
Vessel Surveys Jacksonville	- 125 hours	
Passive Acoustics	Installation of a total of 4 HARPs and use of pop-up buoys for exercise monitoring. Begin recording and data analysis.	
STUDY 4 (mitigation effectiveness)		
MMO/ Lookout Comparison	- 40 hours during SEASWITI, shallow COMPTUEX, or ULT exercises.	AMR
Aerial Surveys Before And After Training Events	- 40 hours during SEASWITI, shallow COMPTUEX, or ULT exercises.	

AFAST MONITORING ACCOMPLISHMENTS FOR 2009

During 2009, USFF implemented aerial and vessel surveys, deployed marine mammal observers on a Navy platform and deployed passive acoustic recording devices. The majority of monitoring effort for 2009 has been conducted in two locations, Onslow Bay and JAX. These locations serve as primary study areas for longitudinal baseline monitoring efforts discussed above. These sites will also be the primary locations for coordinated ASW exercise monitoring events, which are discussed below.

Major accomplishments from the U.S. Fleet Forces's FY 2009 compliance monitoring in the AFAST study area include:

- Aerial Visual Surveys
    - Completed monthly aerial surveys at Onslow Bay and JAX (except April and May due to inclement weather) sites to obtain longitudinal data trends.
- Vessel Visual Survey
    - Completed monthly vessel surveys at Onlsow Bay (except for May due to inclement weather). Vessel surveys began in July 2009 at JAX.
    - Obtained photo-ID and biopsy samples from the Onslow Bay site.
    - Conducted strip transect sea bird counts concurrent with the marine mammal surveys.
- Passive Acoustic Monitoring
    - Four HARPs were purchased and deployed (2 in Onslow Bay and 2 in Jacksonville).
    - Towed array was used during vessel surveys in Onslow Bay that allowed for visual species verification of acoustic detections.
- Marine mammal observers
    - MMOs were successfully deployed on a Navy cruiser involved in training events off the coast of Florida.

Table I-2 presents a summary of the major accomplishments for Navy funded marine species monitoring within the AFAST study area. As briefly mentioned in the Introduction, because one full year of monitoring has not occurred from the January 2009 promulgation of the AFAST LOA, this report is meant to be a status report on Navy's accomplishments over the past seven months of effort. Monitoring is currently being planned for coordinated ASW exercises in September and December. These efforts will accomplish aerial surveys and vessel surveys before, during and after. In addition, the aerial and vessel surveys at Onslow Bay and JAX (study 2) will continue as scheduled.

Table I-2. U.S. Navy funded monitoring accomplishments within the AFAST study area from January 2009 to August 2009.

Study Type	Description of U.S. Navy EIS/LOA monitoring	Associated event type	Description of U.S. Navy R&D funded monitoring	MMPA/ESA requirement	Total accomplished
Aerial surveys –during training event (studies 1 and 3)	n/a	SEASWITI, shallow COMPTUEX, or ULT	n/a	30 hours	0 hours
Aerial surveys –before and after training event (studies 2 and 4)	n/a	SEASWITI, shallow COMPTUEX, or ULT	n/a	40 hours	0 hours
Aerial surveys –Onslow Bay and JAX (study 2)	1) Monthly surveys in Onslow Bay 2) Monthly surveys in JAX	n/a	n/a	100 hours (Onslow Bay) 100 hours (JAX)	91.2 hours (Onslow Bay) 53.9 hours (JAX)
Vessel surveys –during training event (study 3)	n/a	SEASWITI, shallow COMPTUEX, or ULT	n/a	100 hours	0 hours
Vessel surveys— Onslow Bay and JAX (study 2)	1) Monthly surveys in Onslow Bay 2) 4 days in Cape Hatteras 3) July surveys in JAX	n/a	n/a	125 hours (Onslow Bay) 125 hours (JAX)	66 hours (Onslow Bay) 26.5 hours (Cape Hatteras) 15 hours (JAX)
Marine Mammal Observers (studies 1 and 3)	60 hours from 27-30 April 2009	ULT	n/a	60 hours	60 hours
Passive Acoustic Monitoring (study 2)	1) Deployment of 4 HARPS (2 in Onslow Bay and 2 in Jacksonville) 2) Use of pop-up buoys for exercise monitoring 3) Use of towed array during vessel surveys	shallow COMPTUEX (pop-up buoys)	n/a	Deploy up to four devices and use pop-up buoys	Deployed four high frequency recording packages (HARPs) , used pop-up buoys in conjunction with exercise, and a total of ~20 hours of towed array recording effort in Onslow Bay and JAX

AFAST AERIAL VISUAL SURVEYS

Aerial surveys are planned monthly in both Onslow Bay and JAX. However, in JAX no surveys were flown during April and May due to adverse weather conditions. A summary of the results is presented below. For more detailed information, see **Appendix C** (Onslow Bay) and **Appendix D** (JAX), which are a compilation of the individual monthly trip reports.

***Onslow Bay January to August 2009*:** surveys were conducted on 16 days during this period, representing 91.2 total survey hours and 130 tracklines surveyed. A summary of the sightings is presented in Table I-3 and Figures I-2, I-3, and I-4.

Table I-3. Summary of marine species sightings seen from the observer aircraft in Onslow Bay during Jan to Aug 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Bottlenose Dolphin	*Tursiops truncatus*	26	456
Spotted Dolphin	*Stenella frontalis*	20	665
Unidentified Delphinid		4	41
Loggerhead Sea Turtle	*Caretta caretta*	173	196
Leatherback Sea Turtle	*Dermochelys coriacea*	1	1
Unidentified Sea Turtle		25	28
Unidentified Shark		14	18
Manta Ray	*Manta birostris*	19	24
Ocean Sunfish	*Mola mola*	6	6

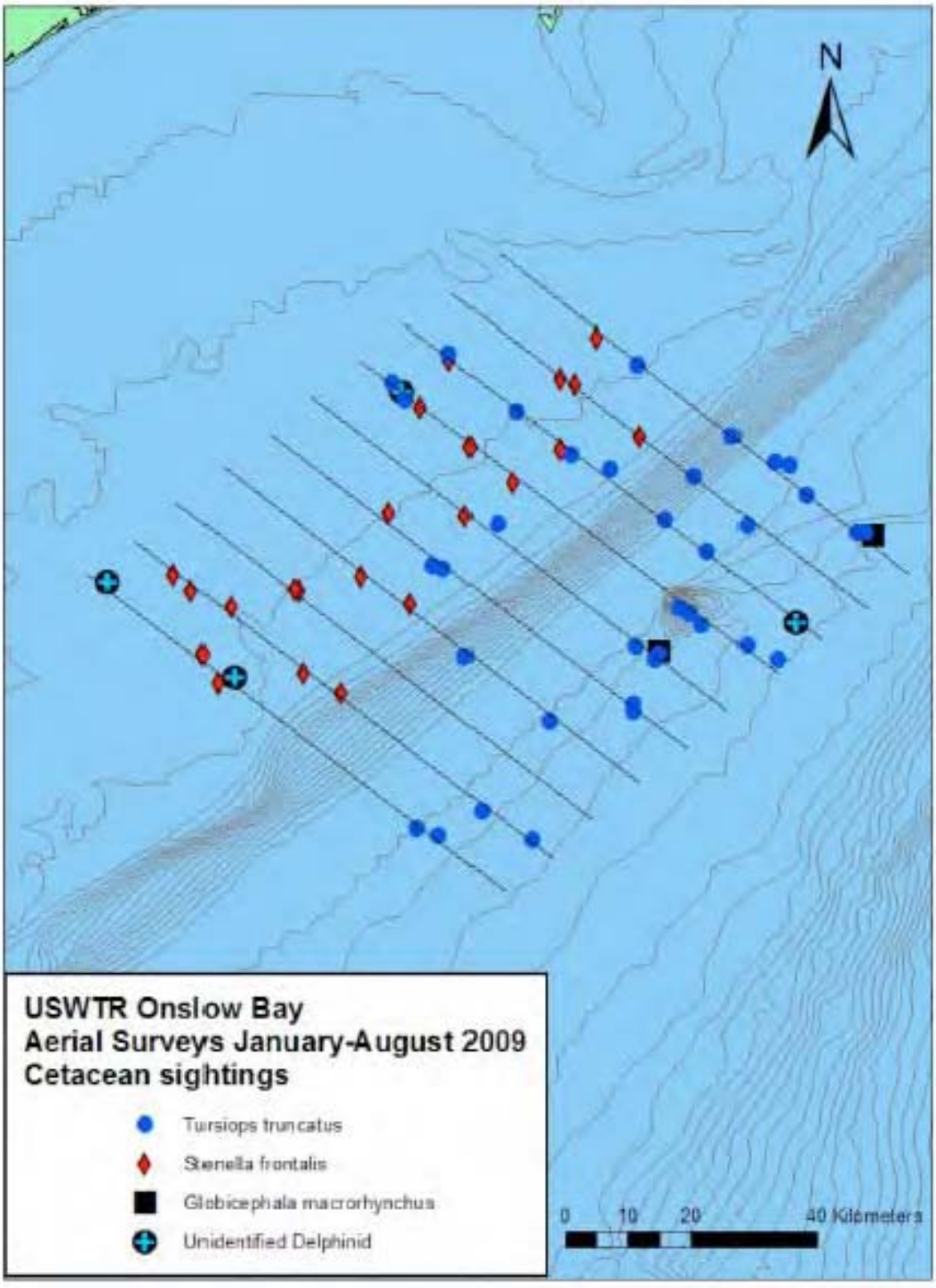

Figure I-2. Locations of cetacean sightings from aerial surveys conducted in Onslow Bay, January to August 2009.

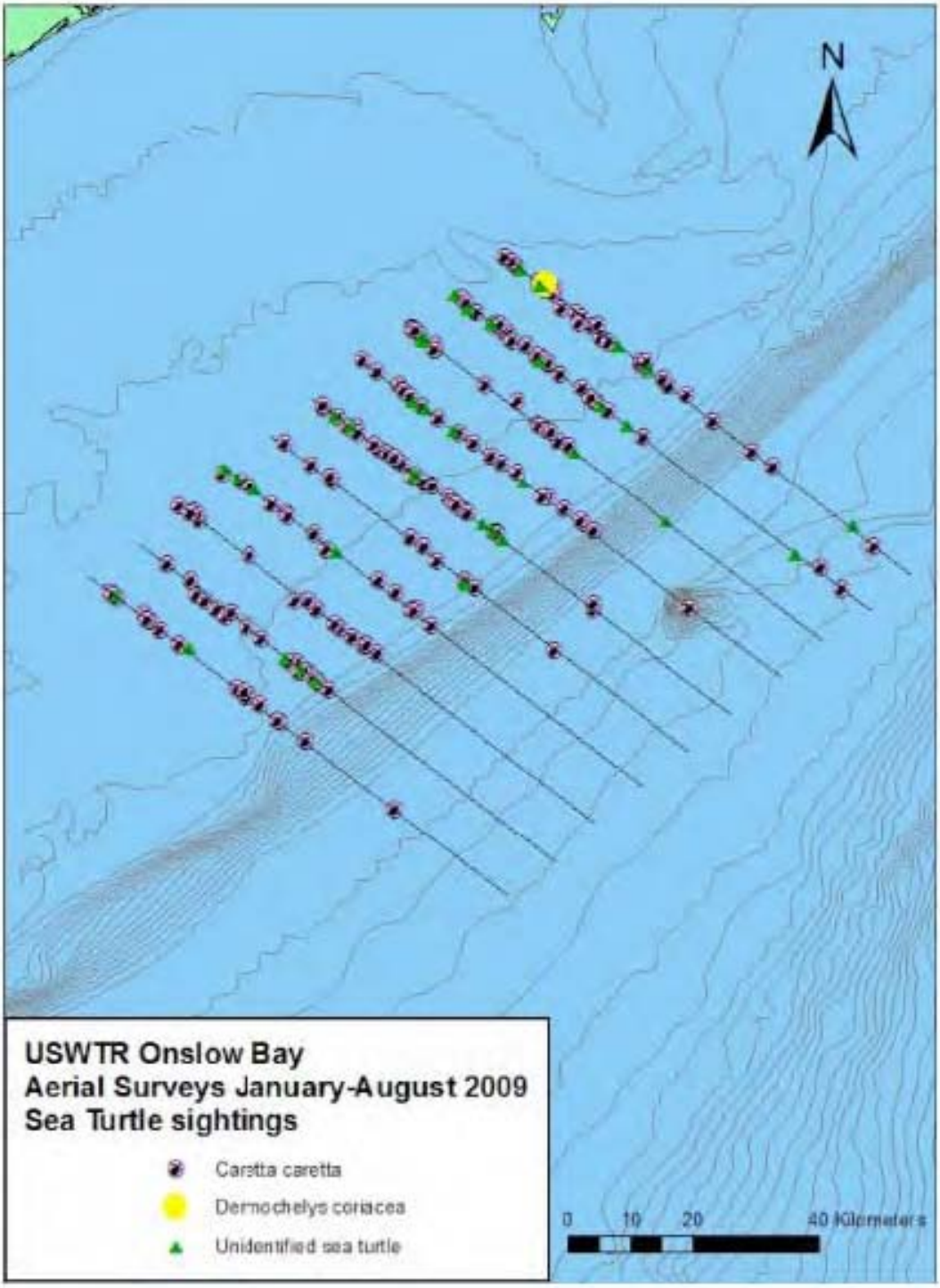

Figure I-3. Locations of sea turtle sightings from aerial surveys conducted in Onslow Bay, January to August 2009.

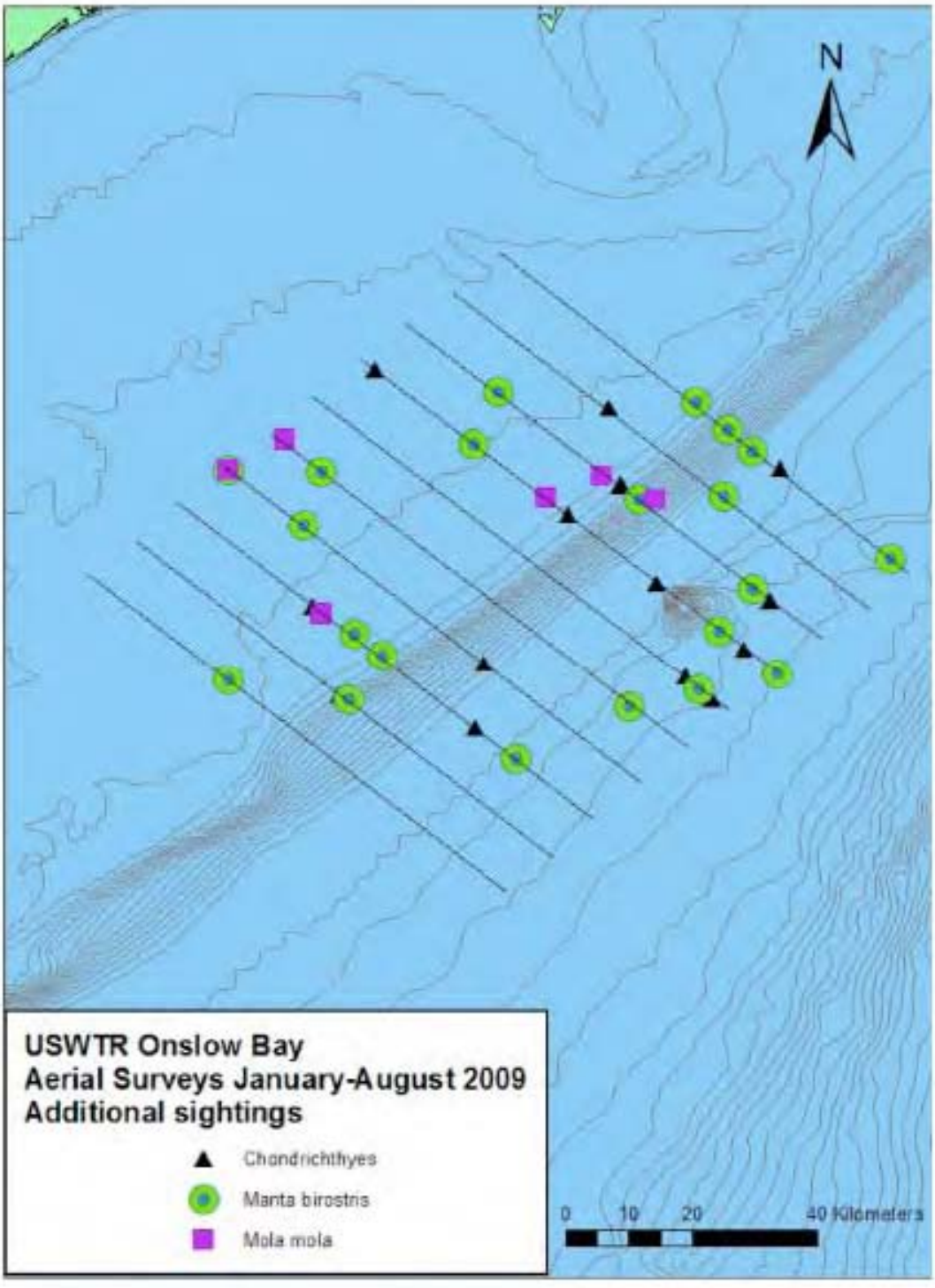

Figure I-4. Locations of additional sightings from aerial surveys conducted in Onslow Bay, January to August 2009.

JAX January to August 2009: surveys were conducted on 11 days during this period, representing 53.9 total survey hours and 75 tracklines surveyed. A summary of the sightings is presented in **Table I-4 and Figures I-5, I-6, and I-7**.

Table I-4. Summary of marine species sightings seen from the observer aircraft in JAX during Jan to Aug 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Minke Whale	*Balaenoptera acutorostrata*	4	6
Risso's Dolphin	*Grampus griseus*	3	51
Bottlenose Dolphin	*Tursiops truncatus*	23	227
Spotted Dolphin	*Stenella frontalis*	9	173
Unidentified Delphinid		8	17
Loggerhead Sea Turtle	*Caretta caretta*	263	328
Leatherback Sea Turtle	*Dermochelys coriacea*	1	1
Unidentified Sea Turtle		29	34
Hammerhead Shark	*Sphyrna sp.*	13	14
Unidentified Shark		7	7
Manta Ray	*Manta birostris*	9	9
Ocean Sunfish	*Mola mola*	3	3

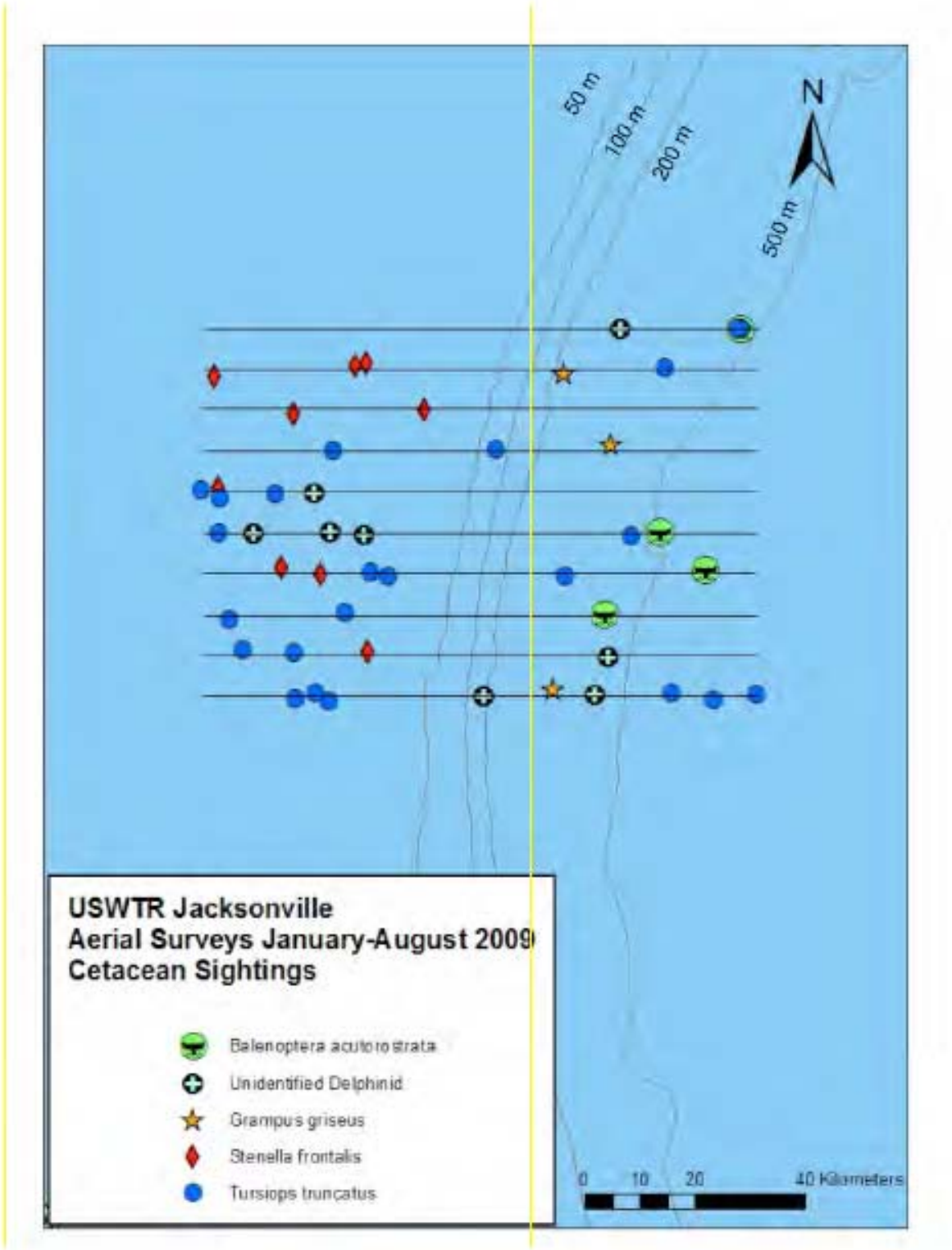

Figure I-5. Locations of cetacean sightings from aerial surveys conducted in JAX, January to August 2009.

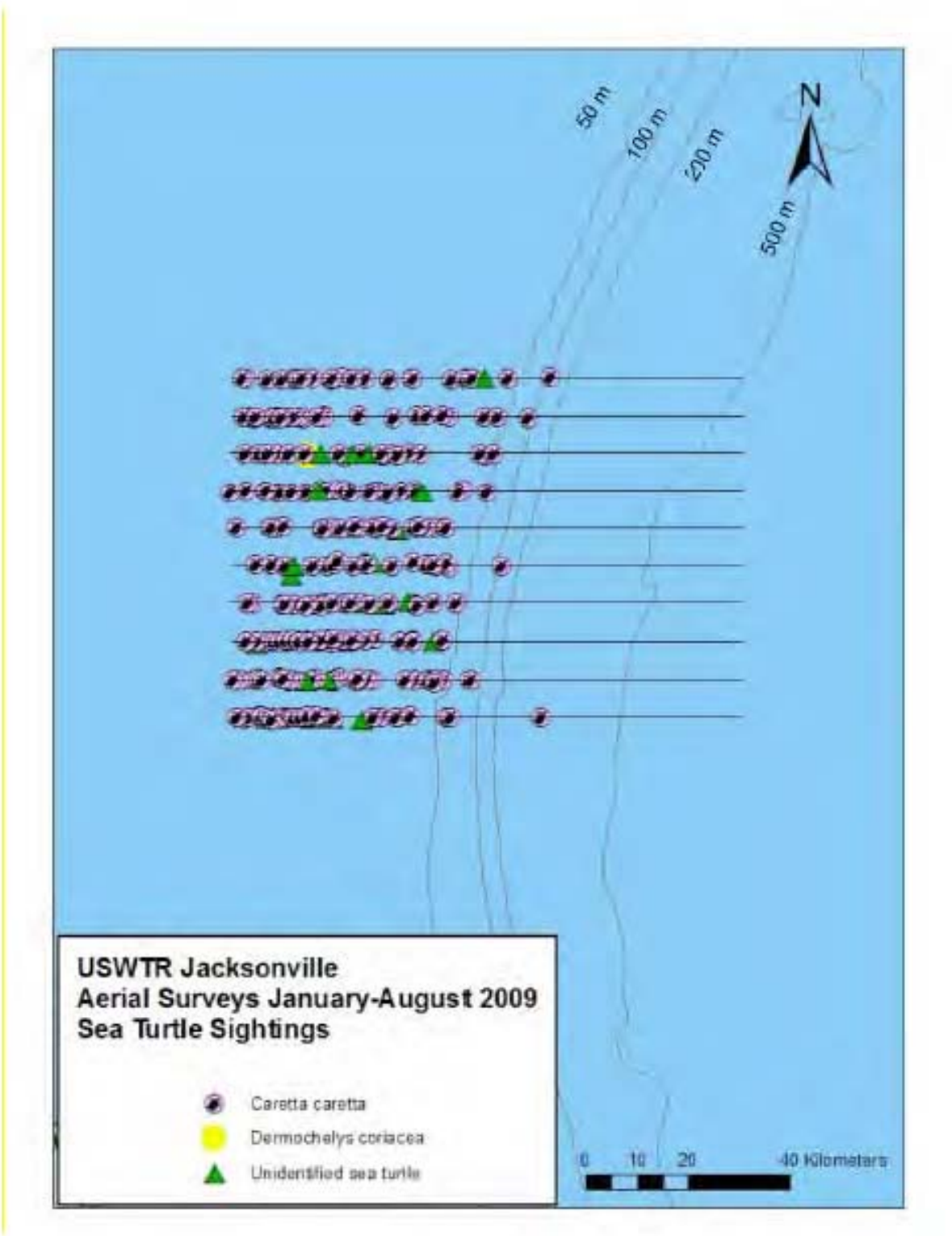

Figure I-6. Locations of sea turtle sightings from aerial surveys conducted in JAX, January to August 2009.

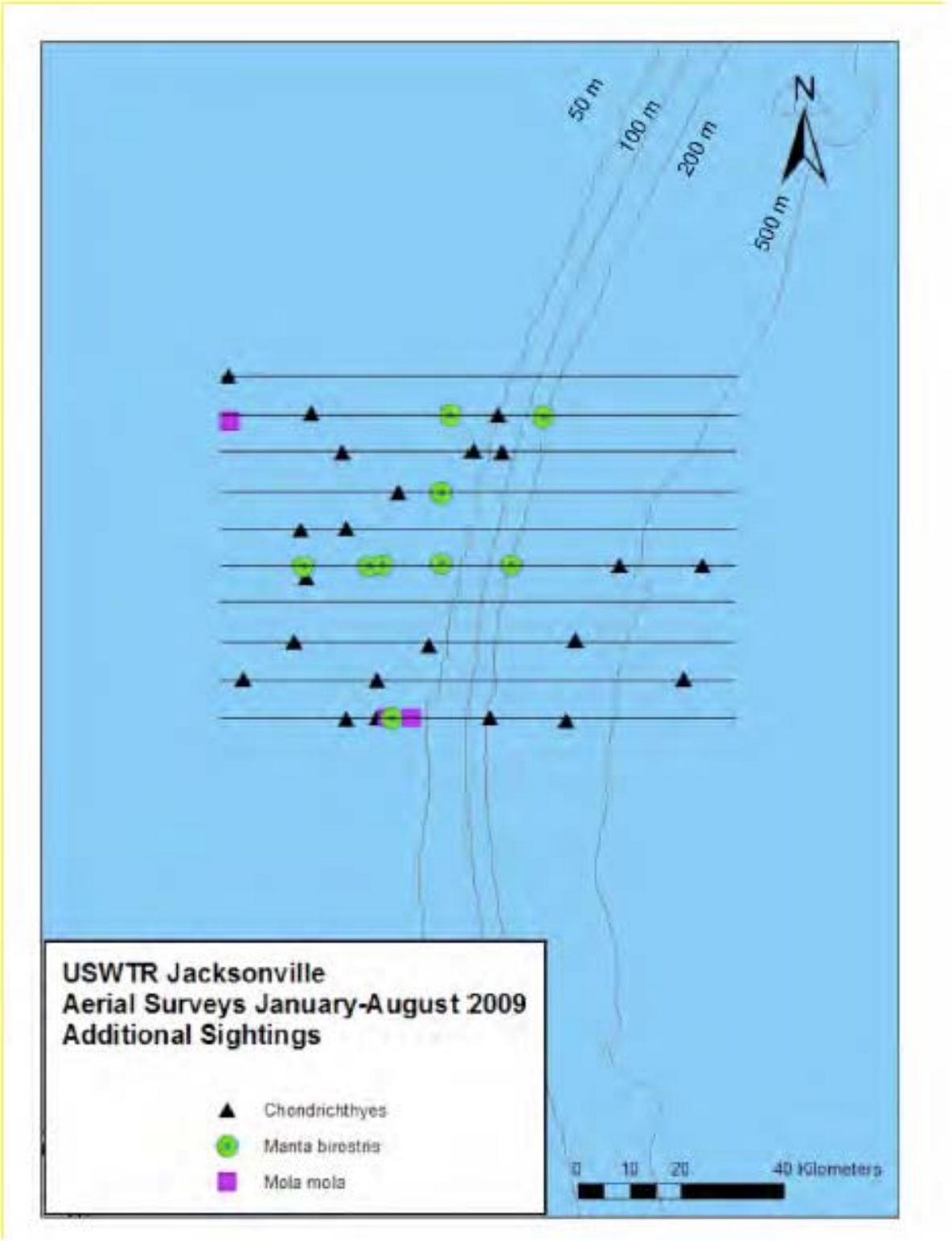

Figure I-7. Locations of additional sightings from aerial surveys conducted in JAX, January to August 2009.

AFAST VESSEL VISUAL SURVEYS

Vessel surveys were conducted monthly in Onslow Bay (except for May due to adverse weather conditions). In addition, surveys were conducted during July in Cape Hatteras to gather additional sighting data in order to improve the probability of detection function being used to calculate marine mammal densities in Onslow Bay. Vessel surveys were conducted in JAX during the month of July. There was a delay in beginning the JAX surveys due to finding an appropriate vessel. A summary of the results is presented below. For more detailed information, see **Appendix C** (Onslow Bay) and **Appendix D** (JAX), which are a compilation of the individual monthly trip reports.

***Onslow Bay January to August 2009*:** surveys were conducted on 15 days during this period, representing 66 total survey hours and 15 tracklines surveyed. A summary of the sightings is presented in **Table I-5 and Figure I-8**.

Table I-5. Summary of marine species sightings seen from the observer vessel in Onslow Bay during Jan to Aug 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Bottlenose Dolphin	*Tursiops truncatus*	9	49
Spotted Dolphin	*Stenella frontalis*	13	147
Rissos Dolphin	*Grampus griseus*	1	24
Unidentified Delphinid		1	
Loggerhead Sea Turtle	*Caretta caretta*	41	41

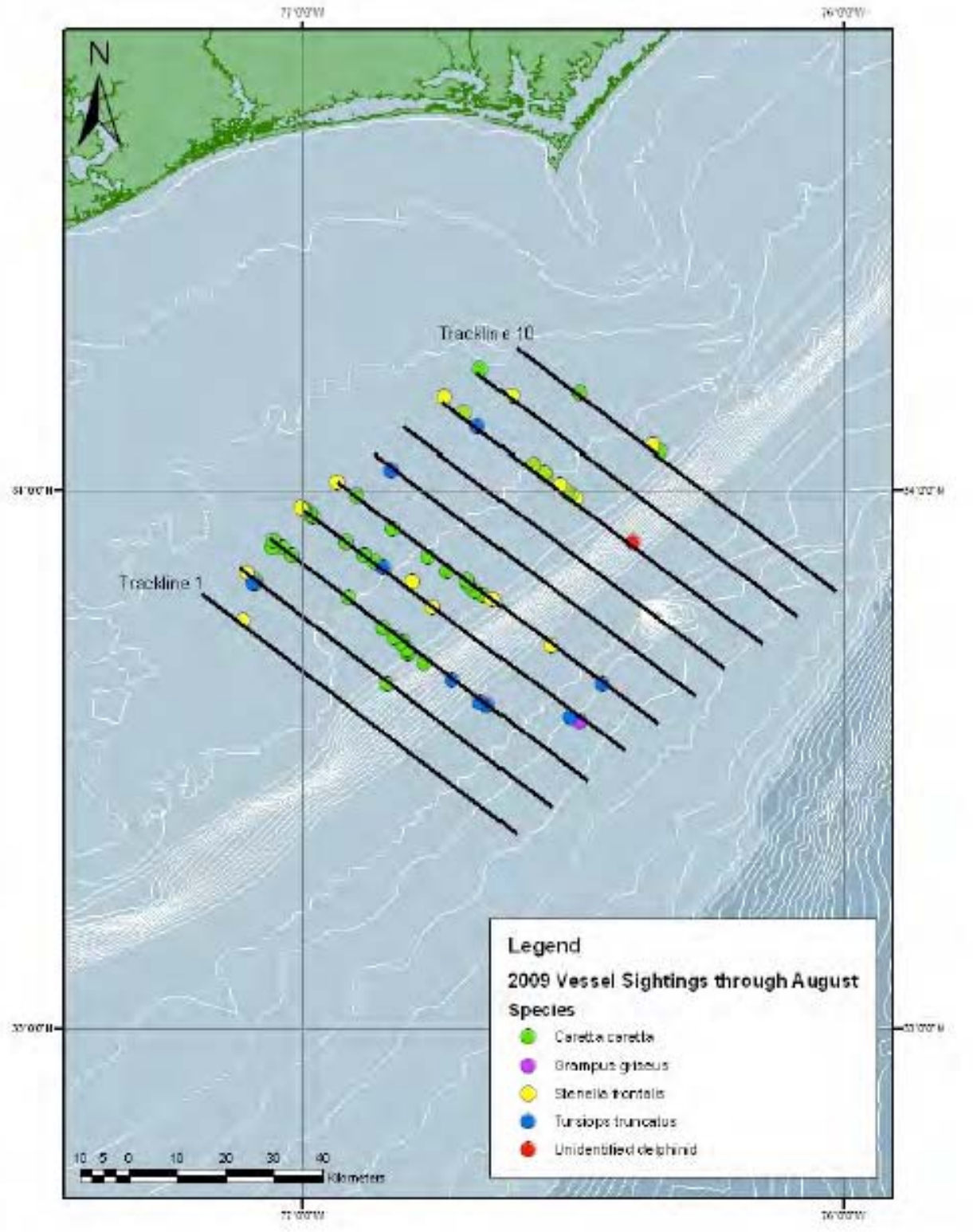

Figure I-8. Locations of sightings from vessel surveys conducted in Onslow Bay, January to August 2009.

***Cape Hatteras July 2009*:** surveys were conducted on 4 days during the month of July, representing 26.5 total survey hours. A summary of the sightings is presented in **Table I-6 and Figure I-9**.

Table I-6. Summary of marine species sightings seen from the observer vessel in Cape Hatteras during July 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Bottlenose Dolphin	*Tursiops truncatus*	23	497
Rissos Dolphin	*Grampus griseus*	1	34
Unidentified Delphinid		1	2
Pilot Whale	*Globicephala sp.*	9	213
Loggerhead Sea Turtle	*Caretta caretta*	2	2

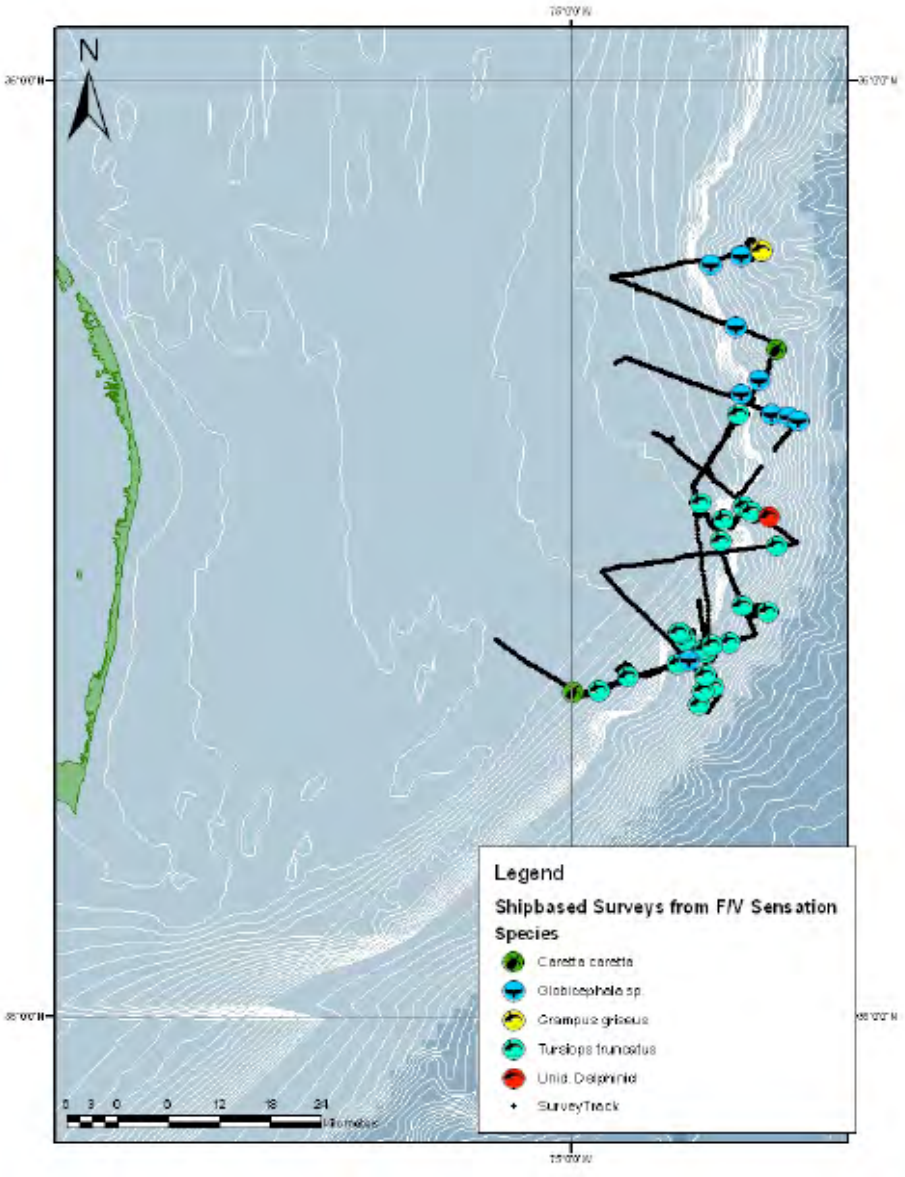

Figure I-9. Locations of sightings from vessel surveys conducted in Cape Hatteras, July 2009.

JAX July 2009: surveys were conducted on 2 days during the month of July, representing 15 total survey hours and 2 tracklines surveyed. A summary of the sightings is presented in **Table I-7 and Figure I-10**.

Table I-7. Summary of marine species sightings seen from the observer vessel in JAX during July 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Bottlenose Dolphin	*Tursiops truncatus*	1	6
Spotted Dolphin	*Stenella frontalis*	1	4
Unidentified Delphinid		2	5
Loggerhead Sea Turtle	*Caretta caretta*	2	2

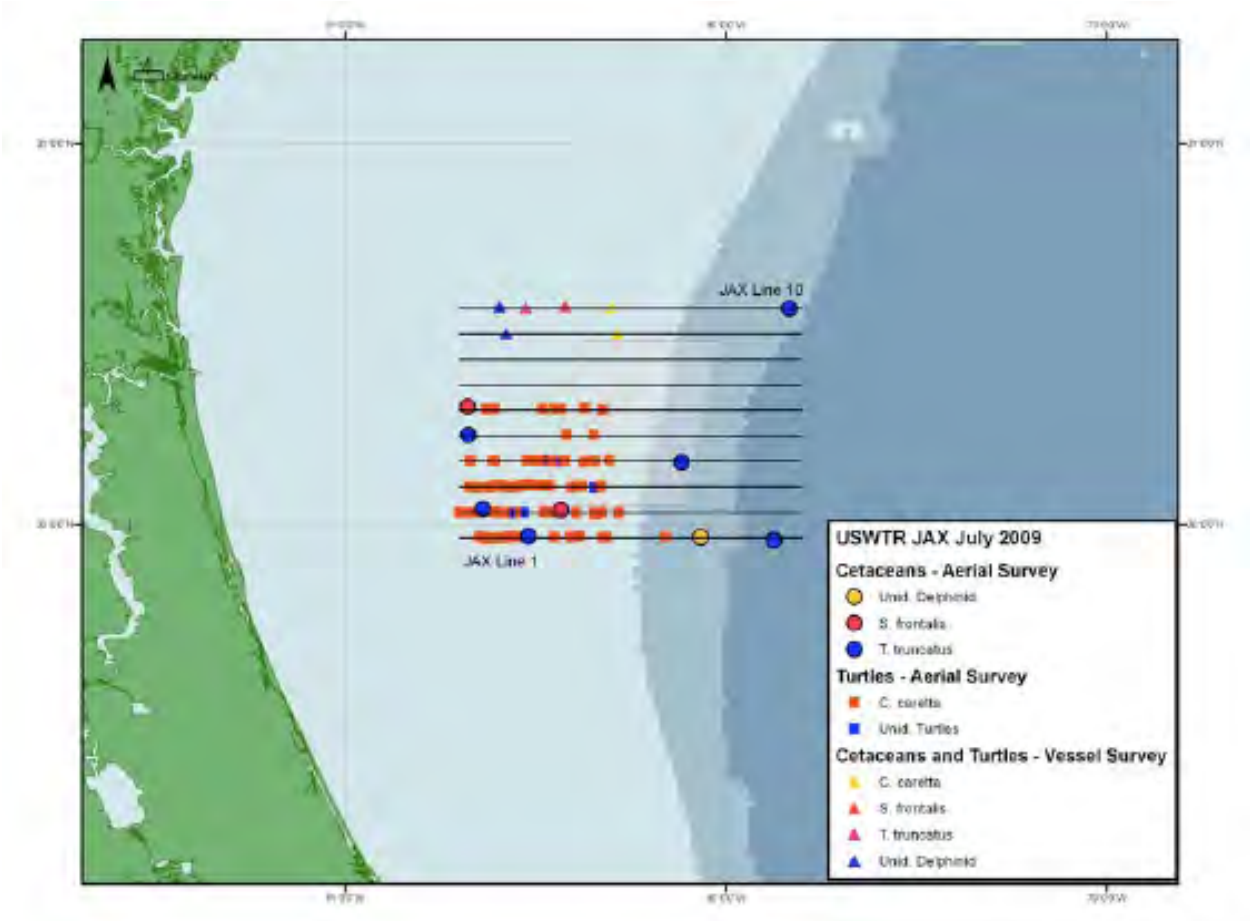

Figure I-10. Locations of sightings from aerial and vessel surveys conducted in JAX, July 2009.

AFAST MARINE MAMMAL OBSERVERS (MMOs)

Two Navy marine mammal biologists embarked on the *USS HUE CITY* during UNITAS GOLD in April 2009. MMOs both embarked and returned to Mayport, FL on the HUE CITY, observing transit and training within the Jacksonville Range Complex from 27-30 April 2009. For additional details see **Appendix E** for the UNITAS 09 trip report.

MMOs conducted visual observations from the bridge wings of the *USS HUE CITY* during daylight hours. They worked alongside the Navy lookouts, conducting visual searches for marine species. Twenty marine mammal and fifteen sea turtle sightings were recorded by the MMOs (**Table I-8**). **Figure I-11** shows a generalized ship track and the sightings that were made. All of the marine mammal sightings were of dolphins, primarily bottlenose and spotted. Most of the sea turtle sightings were of unidentified hardshell sea turtles, although there were two confirmed sightings of loggerhead sea turtles and one confirmed sighting of a leatherback sea turtle. On 28 April at ~1420, one of the helicopters reported back to the *USS HUE CITY* that they sighted a pod of whales more than 5 nautical miles away from the ship. However, due to the distance and the time lag in the reporting, the sighting was unable to be confirmed by the MMOs.

Table I-8. Marine Mammal Observer Sighting Data from UNITAS 09.

Common Name	Scientific Name	# of Sightings	# of individuals
Bottlenose Dolphin	*Tursiops truncatus*	2	11
Atlantic Spotted Dolphin	*Stenella frontalis*	5	12
Spotted Dolphin	*Stenella spp.*	2	7
Bottlenose/Atlantic Spotted Dolphins	*Tursiops truncatus* *Stenella frontalis*	2	14-24
Unidentified Delphinid		9	59
Loggerhead Sea Turtle	*Caretta caretta*	2	2
Leatherback Sea Turtle	*Dermochelys coriacea*	1	1
Unidentified Sea Turtle		12	14

The Navy sought expert advice on how to go about assessing lookout effectiveness and received feedback cautioning that it is not a difficult task, but that it is easy to do incorrectly. Therefore, it was determined that in order to address the question correctly, it was necessary to spend some time designing a proper study that would allow the Navy to collect the right type of data. Navy has begun the process of involving scientists from NMFS and researchers from the Center for Research in Ecological and Environmental Modelling (CREEM) to design a study to answer the question.

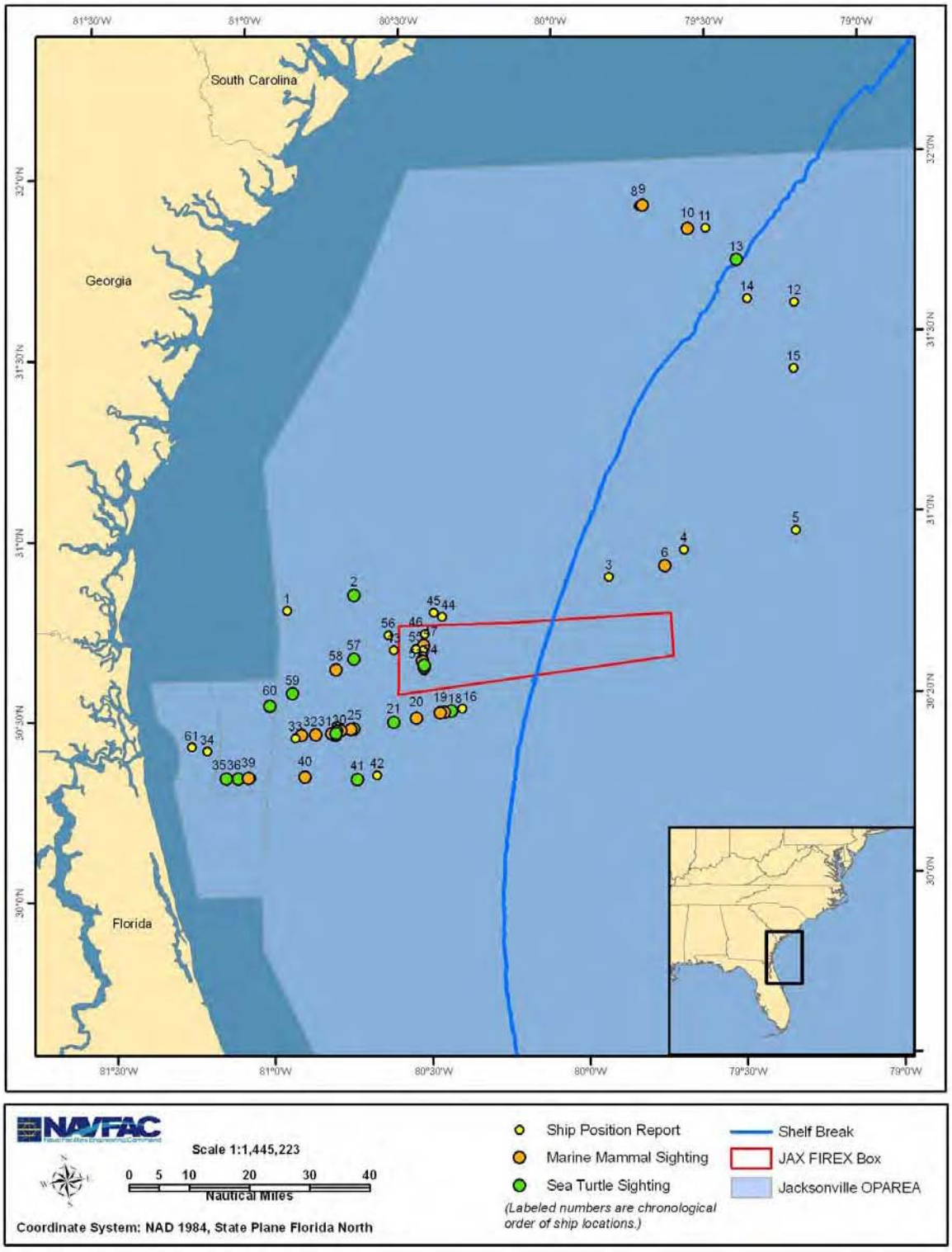

Figure I-11. Vessel locations at sighting and position reports during UNITAS 09.

AFAST PASSIVE ACOUSTIC MONITORING (PAM)

Two passive acoustic systems are used during monitoring in Onslow Bay and JAX - a multi-element towed array used during vessel surveys and bottom mounted high frequency acoustic recorders. Analysis of all the acoustic data has not been completed.

Onslow Bay: the towed array was deployed on 14 days of surveys in Onslow Bay during the months of Feb, March, April, June and July for a total of 15 hours of recording effort. A total of 37 acoustic detections were made, 19 of which were identified to species (*Tursiops truncatus, Stenella frontalis, and Physeter macrocephalus)*. A single HARP was redeployed in Onslow Bay for the reporting period (**Table I-9, Figure I-12**), previous deployments were made on 09 Oct 2007 and 28 May 2008.

Table I-9. Deployment details for the Onslow Bay HARP, April 2009.

Deployment Date	Retrieval Date	Latitude	Longitude	Depth	Sampling Rate	Duty Cycle	Expected data
24-Apr-09	Early Sept 2009	33.78951	-76.5192	570 ft	200 kHz	5-min on/ 5-min off	~2tb

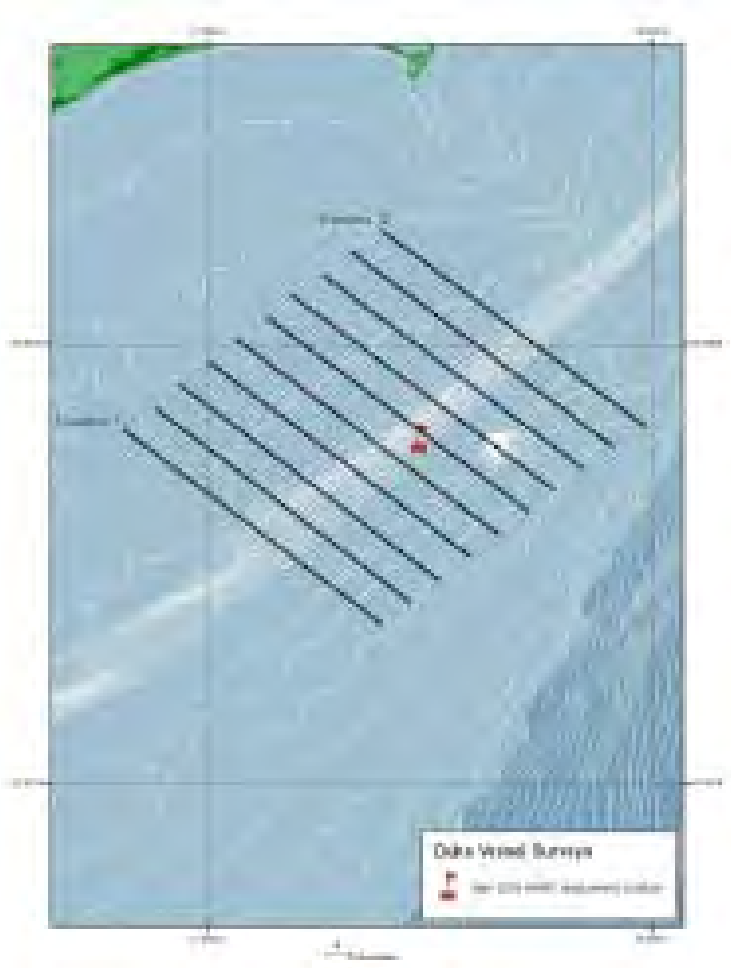

Figure I-12. Location of HARP deployment in Onslow Bay, April 2009.

JAX: the towed array was deployed on 2 days of surveys in JAX during the month of July for a total of 4.9 hours of recording effort. A total of 4 acoustic detections were made, 2 of which were identified to species (*Tursiops truncates and Stenella frontalis)*. Two HARPs were deployed in JAX during the reporting period (**Table I-10, Figure I-13**).

Table I-10. Deployment details for the JAX HARPS, March 2009.

	Deployment Date	Retrieval Date	Latitude	Longitude	Depth	Sampling Rate	Duty Cycle	Expected data
JAX 1	30-Mar-09	Sept 14-23	30.2582	-80.4280	40m	200 kHz	5-min on/ 10-min off	~2tb
JAX 2	30-Mar-09	Sept 14-23	30.2784	-80.2164	80m	200 kHz	5-min on/ 10-min off	~2tb

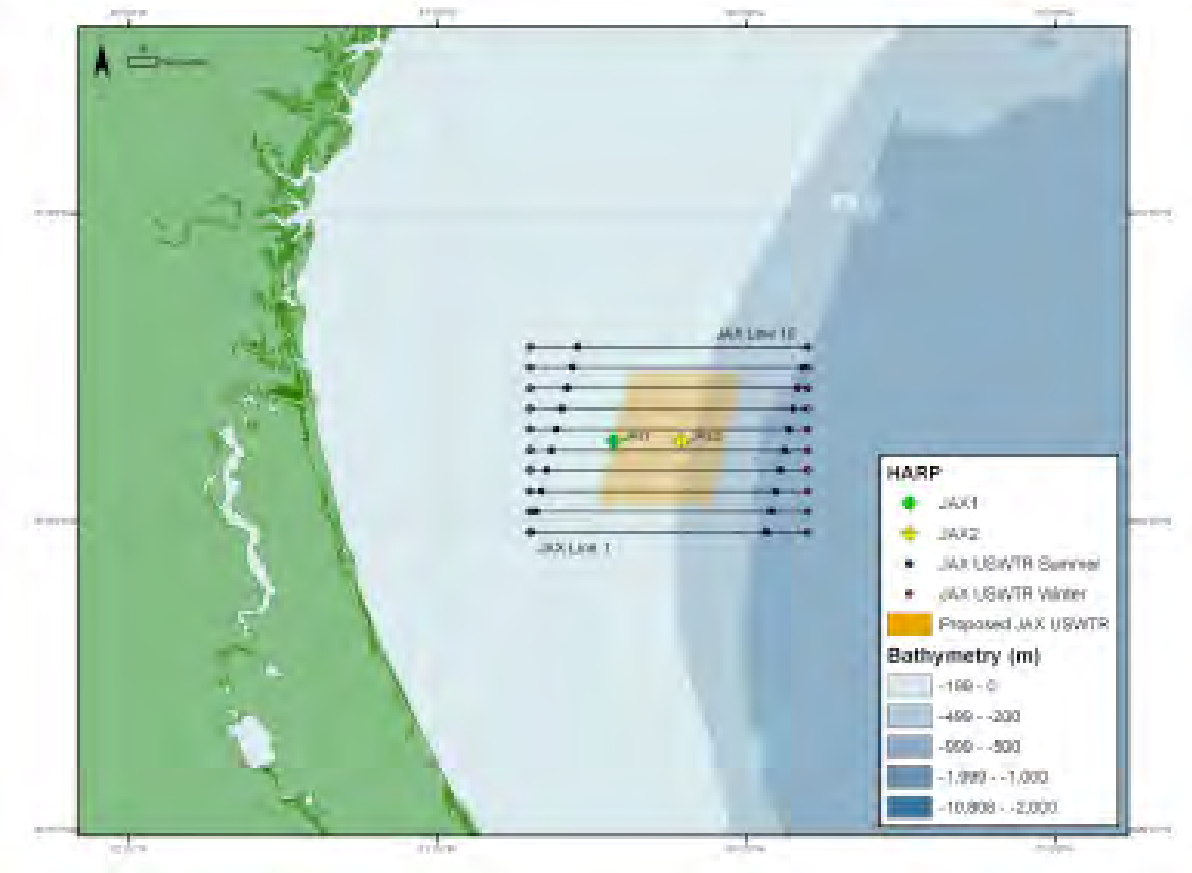

Figure I-13. Location of HARPS deployed in JAX, March 2009.

COORDINATED ASW EXERCISE MONITORING

Coordinated ASW exercise monitoring events are one of the primary components being used to address specific monitoring questions posed in the AFAST monitoring plan and Letter of Authorization. A pilot project was conducted in July 2008 at the Onslow Bay location incorporating shipboard and vessel visual surveys and an array of passive acoustic monitoring "pop-up" buoys developed by Cornell University. The pop-ups were deployed approximately 10 days prior to the planned 2-day ASW exercise and remained active for up to a week following the exercise. **Figure I-14** shows the locations of the pop-ups relative to the exercise box as well as the long-term HARP deployment.

Despite some challenges this was a successful pilot study and the design and coordination has been refined based on lessons learned from the experience. This early pilot study not only provided data points that will be used in future analysis, but also provided proof-of-concept data for determining the feasibility of using diverse field methods in the AFAST study area. Based upon lessons learned from these surveys and input from NMFS, the Navy shaped the studies in the AFAST monitoring plan with proven field methods that would provide visual and acoustic data to support scientific assessment on the potential effects from Navy training on marine species.

A similar effort is currently underway at the Jacksonville USWTR location in conjunction with a Sept 2009 ASW training exercise and we anticipate conducting focused intensive monitoring efforts like this approximately twice per year.

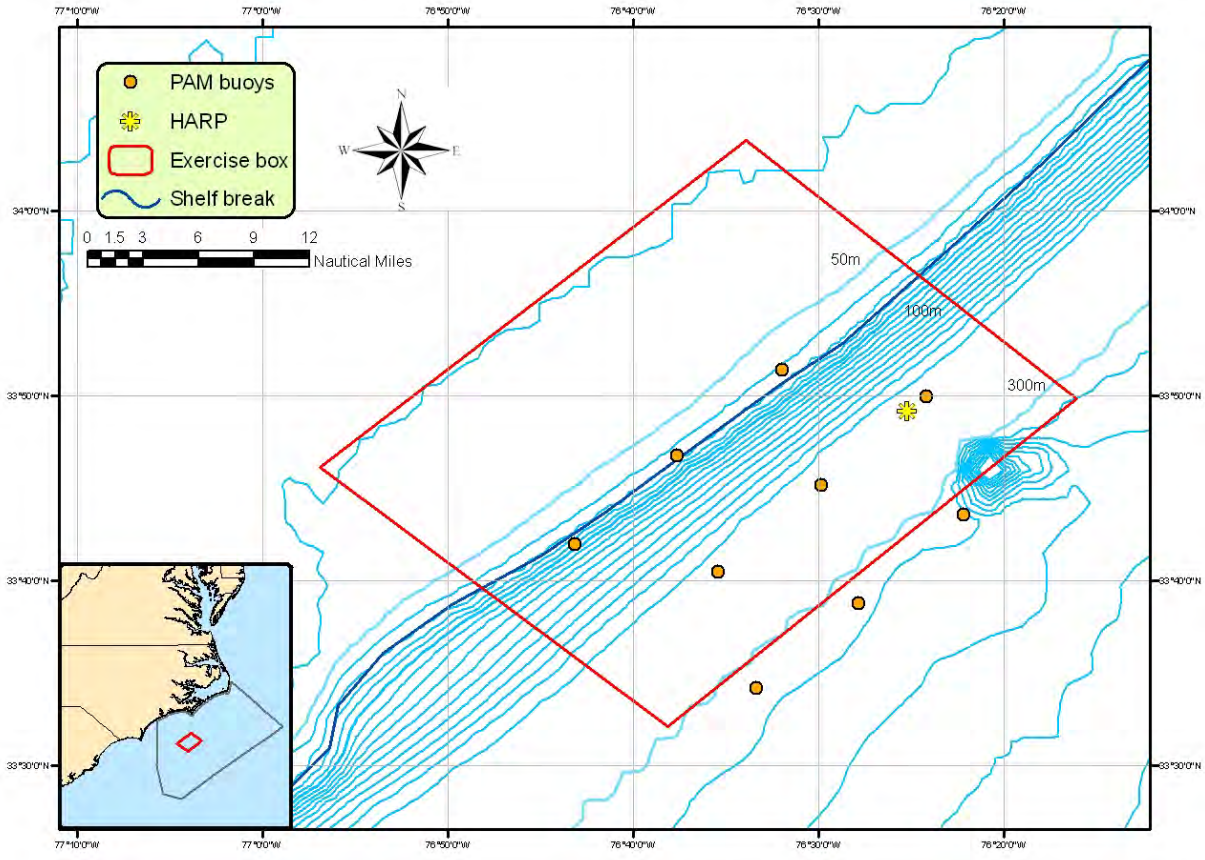

Figure I-14. Location of Onslow Bay exercise monitoring, July 2008.

Part II- AFAST Adaptive Management Recommendations

Adaptive management is an iterative process of optimal decision making in the face of uncertainty, with an aim to reducing uncertainty over time via system monitoring. Within the natural resource management community, adaptive management involves ongoing, real-time learning and knowledge creation, both in a substantive sense and in terms of the adaptive process itself. Adaptive management focuses on learning and adapting, through partnerships of managers, scientists, and other stakeholders who learn together how to create and maintain sustainable ecosystems. Adaptive management helps science managers maintain flexibility in their decisions, knowing that uncertainties exist and provides managers the latitude to change direction will improve understanding of ecological systems to achieve management objectives; and is about taking action to improve progress towards desired outcomes.

In March, 2009, the Navy convened government and academic researchers to review the Navy's range complex monitoring plans. This diverse group of experts reviewed the methods that currently exist for monitoring, methods expected to be available in five years and the Navy's current plans. The team reinforced that the current methods being used by the Navy for monitoring were robust and strongly recommended that Navy continue to use a diversity of methods simultaneously. For AFAST monitoring, as well as monitoring conducted in other range complexes, the Navy was successful in using a diversity of field methods to gather visual and acoustic data towards answering the questions posed by Navy and NMFS.

The Navy's adaptive management of the AFAST Monitoring Plan will involve close coordination with NMFS to align marine mammal monitoring with the Plan's overall objectives as stated within earlier sections of the Plan and in the Introduction of this report.

Scheduling monitoring, that involves civilian aircraft and ships operating concurrently with multiple Navy aircraft and ships in the same area, requires extensive pre-survey coordination between multiple Navy commands. The USFF operational community provided critical interface and coordination that was instrumental in allowing for researchers to conduct monitoring in close-proximity to Navy assets. The USFF operational community also provided berthing for Navy MMOs on surface vessels.

Cancellations or major date shifts in Navy training events based on logistics, fiscal, or operational needs were challenging to overcome. These kind of changes are difficult to predict and more importantly, more difficult to reschedule from a monitoring prospective when contracts have been awarded, survey equipment has been purchased, rented or relocated; personnel availability and transport arranged; and fixed date contracts put into place.

Specific challenges faced were: 1) low densities of animals precluded large sample sizes; 2) weather delays and/or cancellations; 3) Navy operational delays and/or event cancellations; and 4) and the number of monitoring hours are difficult to predict and manage vice monitoring a set number of events.

In view of lessons learned during implementation of the FY09 AFAST Monitoring Plan, and as part of the Navy's adaptive management review for AFAST, a modification of the FY09 Plan is shown in **Table I-11**. **Table I-12** shows the revised proposed AFAST monitoring plan for 2010.

Table I-11. Navy's adaptive management review for AFAST showing edits to FY09 monitoring and proposed 2010 monitoring (strike through are deletions and red font are additions).

STUDY 1 and 3 (exposures and behavioral responses)		
Aerial Surveys During Training Events	- ~~30 hours of active sonar during~~ 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	Adaptive Management Review for FY10 (AMR)
Marine Mammal Observers (MMO)	- ~~60 hours during~~ 2 events in conjunction with SEASWITI or ULT exercises.	
Vessel surveys During Training Events (study 3 only)	- ~~100 hours during~~ 2 events in conjunction with SEASWITI, shallow COMPTUEX, or ULT exercises.	
Passive Acoustics	- 2 deployments of pop-up buoys in conjunction with SEASWITI, shallow COMPTUEX, or ULT exercises.	
STUDY 2 (geographic redistribution)		
Aerial Surveys Before And After Training Events	- ~~40 hours during~~ 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	AMR
Aerial Surveys Onslow Bay	- ~~100 hours~~ 24 days	
Vessel Surveys Onslow Bay	- ~~125 hours~~ 24 days	
Aerial Surveys Jacksonville	- ~~100 hours~~ 24 days	
Vessel Surveys Jacksonville	- ~~125 hours~~ 24 days	
Passive Acoustics	FY 09: Installation of a total of 4 HARPs and use of pop-up buoys for exercise monitoring. Begin recording and data analysis. FY10: Continue recording and data analysis for the 4 HARPS.	
STUDY 4 (mitigation effectiveness)		
MMO/ Lookout Comparison	- 40 hours ~~during SEASWITI, shallow COMPTUEX, or ULT exercises.~~	AMR
Aerial Surveys Before And After Training Events	- ~~40 hours during~~ 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	

Table I-12. Navy's final proposed 2010 monitoring plan for AFAST.

STUDY 1 and 3 (exposures and behavioral responses)		
Aerial Surveys During Training Events	- 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	Adaptive Management Review for 2011 (AMR)
Marine Mammal Observers (MMO)	- 2 events in conjunction with SEASWITI or ULT exercises.	
Vessel surveys (study 3 only)	- 2 events in conjunction with SEASWITI, shallow COMPTUEX, or ULT exercises.	
Passive Acoustics	- 2 deployments of pop-up buoys in conjunction with SEASWITI, shallow COMPTUEX, or ULT exercises.	
STUDY 2 (geographic redistribution)		
Aerial Surveys Before And After Training Events	- 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	AMR
Aerial Surveys Onslow Bay	- 24 days	
Vessel Surveys Onslow Bay	- 24 days	
Aerial Surveys Jacksonville	- 24 days	
Vessel Surveys Jacksonville	- 24 days	
Passive Acoustics	Continue recording and data analysis for the 4 HARPS.	
STUDY 4 (mitigation effectiveness)		
MMO/ Lookout Comparison	- 40 hours	AMR
Aerial Surveys Before And After Training Events	- 1 event in conjunction with a SEASWITI, shallow COMPTUEX, or ULT exercise.	

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APPENDICES

Appendix A USWTR Monitoring Plan

Survey Plan for Monitoring the Proposed USWTR in Onslow Bay

Revised July 2007

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1. Aims

The General Purpose of the project, as specified in the Scope of Work, is as follows:

> The proposed baseline study and monitoring program must provide site-specific pre-installation baseline data in order to develop meaningful monitoring for marine protected species (marine mammals and sea turtles) over time. Baseline data sought includes species distribution, abundance, density estimates, and seasonal movement and habitat usage patterns specific to Onslow Bay and the proposed USWTR area. Regular monitoring to assess trends in species composition, distribution, and abundance will be based on the data collected in the baseline study.

Therefore the aim of this document is to produce a coherent plan to estimate density and document patterns of distribution and seasonal residency of species of interest in the proposed USWTR site and adjacent waters.

2. Species of interest in Onslow Bay

Our focus is on all protected species occurring in the proposed USWTR site, but in preparing this monitoring plan we paid particular attention to the following species: sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius* and *Mesoplodon spp.*), humpback and other balaenopterid whales (*Megaptera novaeangliae* and *Balaenoptera spp.*), right whales (*Eubalaena glacialis*) and several genera of pelagic odontocetes (*Stenella spp.*, *Tursiops truncatus*, *Globicephala spp.*, *Grampus griseus*, and *Delphinus delphis*), as well as leatherback (*Dermochelys caretta*) and loggerhead (*Caretta caretta*) sea turtles. A

number of other species occur in the area but they are unlikely to be encountered in sufficient numbers to obtain precise estimates of abundance (*e.g*. dwarf and pygmy sperm whales, *Kogia spp*.).

3. Survey Area

As the consequences of activity inside the USWTR area may extend outside the range itself, we propose to survey an area that extends 10 nautical miles in each direction from the boundaries of the USWTR. The USWTR area is 25 nm long and 20 nm wide, so the entire monitoring area is 45 nm long and 40 nm wide. The total survey area is thus 1800 square nautical miles, with 28% of this area within the USWTR itself.

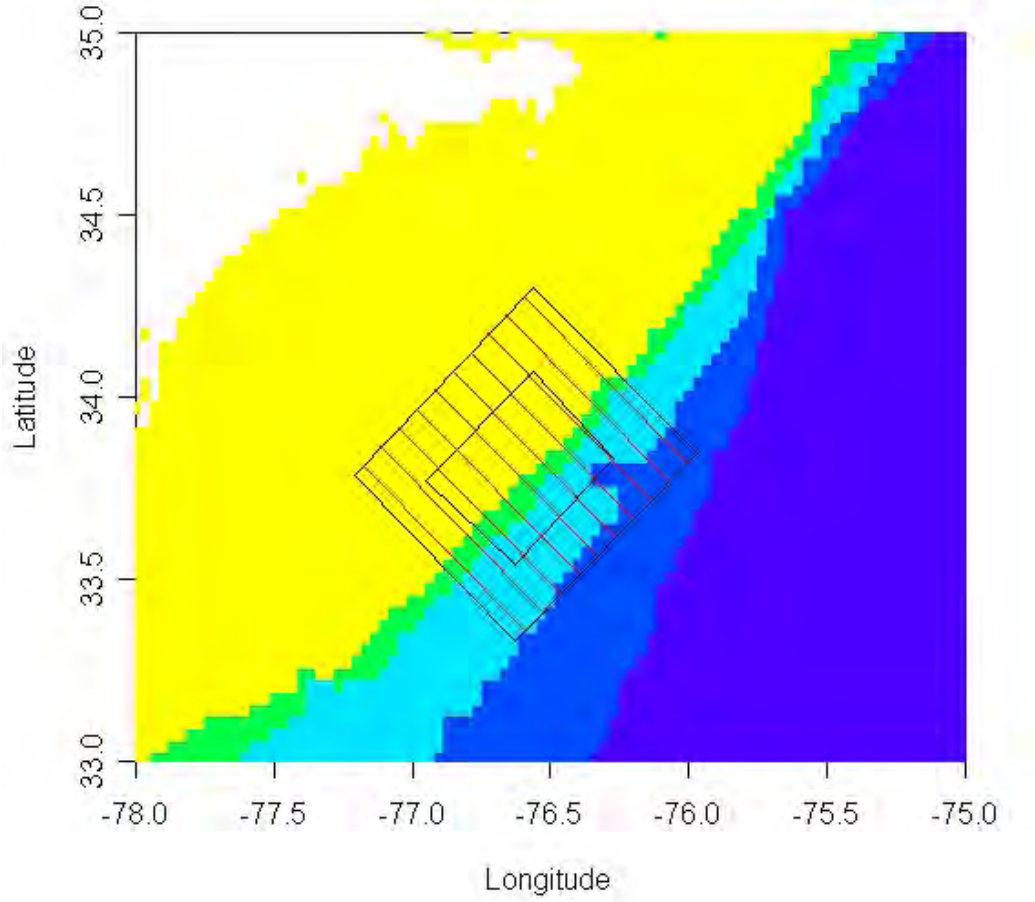

Figure 1. Survey area in Onslow Bay, encompassing the proposed USWTR site (inner box). Ten transect lines are depicted in red, each approximately 40 nm in length. Bathymetry is depicted by color: yellow is less than 100 m deep, green is between 100 and 500 m, pale-blue is between 500 and 1000 m, medium blue is between 1000 and 2000 m, and deep blue is deeper than 2000 m deep. Land is indicated in white.

This survey area incorporates a variety of habitats from the shallow waters of the shelf to the continental slope. The Gulf Stream meanders through the eastern portion of the survey area, flowing towards the northeast.

We have established ten 40-nm long transect lines that cross the survey area, oriented parallel to the short axis of the USWTR boundaries, as shown in Figure 1 (*i.e.* approximately from NW to SE). The transect lines are spaced approximately 5 nautical miles apart. Transect lines begin 2.5 nm within the north and south borders and provide an effective transect width that covers the entire box. This yields a total of 400 nm of survey track line. These ten transect lines will be surveyed by both aerial and shipboard platforms.

4. General Approach

We initially investigated the use of a Before-After Control-Impact Paired (BACI-P) study design in which monitoring surveys would commence in both the USWTR and a paired control site before training exercises commenced and then continue in both areas after the range became operational. To determine whether this approach could reliably detect an effect of training activities within the proposed USWTR, we simulated the movement and behavioural responses of a number of species over the eastern Atlantic seaboard of the U.S. The aim of the simulations was to determine whether avoidance or fatal exposure (as a worse case scenario) to mid-frequency sonar in the USWTR could be detected statistically given a realistic level of monitoring. The results of this simulation modelling (Paxton et al. 2005) indicated that it would be difficult, if not impossible to detect demographic effects of the USWTR (if any should occur) at any realistic sampling intensities. In fact, in the absence of daily sampling, reliable detection of even the worst possible effects of the USWTR was deemed unlikely. Therefore, in this monitoring plan we have placed emphasis on documenting species occurrence, estimating densities, and establishing patterns of residency so that we can better understand patterns of use for species inhabiting the USWTR area prior to the commencement of training exercises. We anticipate a re-evaluation of this monitoring approach after collection of two or three years of baseline data.

5. Survey Methods

As noted above, the monitoring program must yield reliable information on marine mammal occurrence, densities and distribution in the USWTR and adjacent waters. Every survey method has scientific and logistical advantages and disadvantages; by combining multiple methodologies we hope to ensure the most complete and effective monitoring program. The use of multiple approaches also helps to overcome the biases that are associated with particular survey methods. We describe some of the most important sources of bias below.

During line transect surveys *availability bias* is caused when animals are submerged (and thus undetectable) while they are within sighting range from the survey platform. Aerial surveys tend to suffer from larger availability bias than shipboard surveys because animals are within detectable range of fast-moving platforms for much shorter periods than from slow-moving platforms. Availability bias is particularly problematic for deep-diving species, such as beaked and sperm whales (Barlow and Gisiner 2006).

In addition to availability bias, line transect surveys are often also subject to *perception bias* because observers fail to see some animals which are at the surface within the field of view and thus available for detection. Conventional distance sampling methods (Buckland et al. 2001) avoid this bias but require that all available animals on the transect line are detected (this is often referred to as the assumption that g(0)=1).

Table 1 summarizes the main potential biases and issues arising from line transect surveys of the main species of interest, together with a summary of the survey method we propose to address these issues.

5.1. Aerial Surveys

5.1.1 General Considerations

Aerial line-transect surveys provide high quality data on the distribution and density of both marine mammals and sea turtles and are possible even when sea states hamper vessel surveys. We will employ aerial surveys year-round, and complement this approach with shipboard surveys during months in which such work is feasible (see below).

During aerial surveys we will pay particular attention to the methodological issues associated with perception bias. The most successful methods of dealing with failure of the g(0)=1 assumption involve use of two teams of independent observers surveying the same animals (see Laake and Borchers, 2004). However, in addition to being substantially more demanding in execution (requiring double the number of observers and a survey platform on which pairs of observers can be isolated from one another) double-platform methods involve substantially more complex analysis methods and relatively large sample sizes for reliable estimation. Most of our survey effort will, therefore, use single-observer team survey methods which satisfy, as nearly as possible the g(0)=1 assumption. We will employ a four-seat aircraft with a NOAA-certified pilot and co-pilot in each front seat and left and right observers in the two rear seats.

Table 1. Biases associated with line transect surveys, by species. "Availability bias" arises when animals are unavailable for detection (e.g. submerged) while within detectable range; "Perception bias" arises when available animals are not observed within detection range.

Species	**Bias from aerial line transect survey?**	**Bias from ship line transect survey?**	**Other issues**	**Suggested Mode of Survey**
Sperm whales	Yes; availability bias	Yes; availability bias	Can be detected acoustically	Aerial plus ship with acoustics
Beaked whales	Yes; availability bias	Yes; availability bias	May be detected acoustically	Aerial plus ship with acoustics
Migrating baleen whales	Likely; availability bias	Likely not		Aerial and ship
Fin whales	Likely; availability bias	Likely not		Aerial and ship
Pelagic dolphins	Yes; availability and perception bias for individuals but not schools	Likely for individuals and small schools: availability and perception bias.	May respond to ship before detection. Species identification may be problematic	Aerial or ship
Sea Turtles	Yes; availability and perception bias	Yes; availability and perception bias		Aerial and ship

We hope to supplement this approach with some double-platform effort to estimate g(0). We may also explore use of the *cue-counting* method. A "cue" is any instantaneous detectable manifestation of animal presence; a whale blow is a cue; a whale breaking the surface is a cue, a whale fluking is a cue, and so on. The cue-counting method involves recoding the distance to every detected cue, whether or not it comes from an animal

previously detected. This can be viewed as a moving point transect method in which cue density per unit time, rather than animal density, is estimated. Estimated cue density per unit time is then converted to animal density by dividing it by an estimate of cue rate per animal. We will explore the costs and benefits of the double-platform and cue-counting approaches when field work commences this summer.

Because it is likely that the transect line will be obscured, or partially obscured, from observers' view in the aircraft, we are not confident that it will be possible to search in a way that all available animals on the transect line will be detected. However, while it is unlikely that all available animals at small *perpendicular* distances from the transect line can be detected, it may be possible to ensure that all available animals at small *radial* distances are detected. Therefore, we propose to use radial-distance based distance sampling methods on the aerial survey.

Depending on shipboard sample sizes, it may be possible to combine shipboard and aerial estimates in analyses so that they are equally unbiased. For many species perception and availability bias will be lower for shipboard surveys so it may be possible to use the aerial survey estimates as indices of abundance and to estimate the relative bias of the index by comparison with shipboard estimates over a period of time.

5.1.2 Aerial Survey Monitoring Plan

We propose to fly each trackline during every month of the year. We anticipate that this level of survey effort will require three field days each month. Aerial surveys will be conducted monthly beginning in June, 2007. Data to be collected during these surveys is presented in Appendices A and B.

We have calculated very approximate estimates of the expected number of sightings for the aerial survey using our estimated level of survey effort and previous surveys conducted in this area (McLellan et al. 1999). These calculations come from a modified version of the simulations used previously by Paxton et al. (2005). Table 2 shows the estimates obtained from simulating three years of surveys in the proposed survey region shown in Figure 1. Our calculations suggest that some species will be detected very infrequently with this level of aerial survey effort.

It should be noted that the estimated detection rates from the simulations are based on relatively few observations, as sample sizes from previous surveys (McLellan et al. 1999) were quite small. The information shown in Table 2 should, therefore, be interpreted with caution and used as no more than a rough guide. One of the most important functions of the baseline aerial survey effort will be to establish year-round baseline information on species occurrence and density and their patterns of seasonal variation.

Aerial surveys will be conducted in accordance to *NOAA Fisheries- Southeast Region (SER) Minimum Aircraft and Crew Provisions Right Whale Data Collection Activities*. Surveys will be carried out in over-wing, twin-engine aircraft, Cessna 337 airplanes, which are maintained under provisions of 14 Code of Federal Regulations (CFR) Part 135. Each plane will be equipped with the necessary electronic positioning equipment and safety gear required to conduct marine mammal surveys. Two pilots will be used for each flight. Both pilots will meet requirements as specified in 14 CFR Part 135; the pilot-in-command will meet or exceed all additional NOAA requirements.

Surveys will be flown at an altitude of 300 m and an airspeed of 160 km/hr. Surveys will be flown only under safe operating conditions. Two observers, one positioned on each side of the aircraft, will carry out surveys. Observers and coordinators will have appropriate egress and sea survival training and be equipped with all NOAA required safety gear. The plane will be equipped and the pilots will fly tracklines coordinates with a Global Navigation System (GPS) to permit precise trackline fidelity. Each observer will use an independent GPS to record the precise time and geographic position of all sightings. The left and right observers record sightings independently. When a sighting cue is encountered, the radial and horizontal sighting angle, determined *via* wing-strut marks, will be recorded. At this point, if the observer requires additional identification and count information, the track will be broken to allow the plane to close on the sighting. In this closing mode, the precise location of the sighting will be determined and all relevant biological information will be collected. In these cases, the observer who first encounters the sighting will take the "lead" and that observer's GPS will mark the break in effort, all points relevant to the sighting, and the point at which the team goes back on effort on a trackline. These sightings can provide an additional check on the ability of observers to determine sightings cues while on effort on the trackline. All data sightings will be manually recorded in real time on sighting data sheets. This recording method gives precise locations while giving the observer the opportunity to continuously record information while still circling the sighting. Many different methods are employed to record aerial survey data. When using O2 Cessna's, there is a strong commitment to reduce the amount of equipment in the observer cockpit. Having the observers store locations on individual GPSs and record other data on datasheets on clipboards reduces the amount of electronics, wires and clutter in the plane. Back on ground, the observers will download data from the GPS units and transcribe their sighting data into a digital spreadsheet. A unified data set that takes both the left and right side observations into account is then generated. Specific sightings from both the left and right side will be entered in temporal order. This provides an opportunity to edit and clarify any disparate data. A unified waypoint and sightings spreadsheet is produced and forwarded to the research team with regular uploads to the OBIS website.

UNCW holds NOAA Scientific Permit No. 948-1692-00, which authorizes aerial and shipboard surveys for all cetaceans encountered in the western North Atlantic (expiration date 5/21/2011).

The aerial surveys will be conducted by the research team from the University of North Carolina Wilmington and coordinated by William McLellan. Details of this survey team are provided in Appendix C.

Table 2. Expected monthly mean "daily" sightings from simulations (mean from three trials). The asterisk denotes number of groups not individuals.

Species	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Sperm whales	1.00	0.33	0.33	0.33	0	0	0		0	0	0.33	1.00
Beaked whales	1.00	0	1.00	0.67	0.33	1.00	0.33	0.33	0	0.67	0.33	0.33
Baleen whales	0	0	0	75	2	0	0	0	2	10	23	1
Fin whales	10	27	30	30	37	22	0	0	0	0	6	11
Cold-water dolphins*	10	15	19	15	21	10	0	0	0		3	7
Warm-water dolphins*	2	4	3	2	2	2	1	2	1	1	3	1
Leatherback turtles	0	0	0	0	0	0	0.33	0.33	0.67	0.33	0	0

*Schools

5.2. Vessel Surveys

5.2.1 General Considerations

Vessel-based survey platforms provide a greater probability of sighting deep-diving species, especially beaked whales, which may be missed during 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. Vessel-based platforms allow for biopsy sampling to ensure that all species encountered are correctly identified, as described below.

To ensure maximum detection rates, we will employ a traditional single visual survey team, supplemented by acoustic monitoring using a towed hydrophone array. The towed array will facilitate compilation of an acoustic library of species-specific recordings, which will be useful for the passive acoustic monitoring component of this research program (see below).

The use of a shipboard platform will also allow us to monitor the use of the USWTR and adjacent areas by individual animals using photo-identification techniques. Species for which this approach is feasible include sperm whales, beaked whales, humpback whales, bottlenose dolphins, spotted dolphins, pilot whales and Risso's dolphins. These methods can be used to examine seasonal and inter-annual patterns of residency. This information will be critical to interpreting any changes in density documented in the USWTR area.

Our ship-board surveys will be used primarily to estimate density and secondarily to facilitate collection of biopsy samples and photographs for individual identification. Ship-board surveys will provide the following information: species-specific patterns of occurrence, data that can be used to generate species-specific estimates of density; and information on residency patterns and stock structure of marine mammals.

5.2.2 Vessel Survey Monitoring Plan

We plan to survey every trackline each month during the summer (June – October), when we anticipate a total of six survey days per month. Sea conditions are conducive to vessel surveys during this period; it is harder to conduct such surveys in the winter, when there are fewer workable sea days. Vessel surveys will commence in June, 2007.

For these vessel line transect surveys, we will employ the M/V Sensation, a 53' charter vessel based in Morehead City, NC. At a survey speed of 10 knots, the vessel can cover approximately two transect lines each day, and we will survey every transect line each month. We will also survey each trackline at least once in the winter (November to May), when we have allocated 10 days for vessel surveys. These winter surveys will be opportunistic in nature, taking advantage of the brief windows of good weather during this season.

Whilst on effort during vessel line transect surveys, we will employ a team of six researchers plus the vessel captain. Two observers will use 7 x 50 hand-held binoculars to search ahead of the vessel. The captain will monitor the trackline with naked eye. A dedicated recorder will enter information on sightings and environmental conditions into a laptop that will have a feed to a GPS unit. Data will be recorded using software (VisSurvey) developed and modified for our surveys by Dr. Lance Garrison (NOAA/SEFSC). Data to be collected during these line transect surveys is presented in Appendix D.

To prepare for these surveys, 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 has extensive experience as a shipboard observer for NOAA and who has received training from the CREEM group at the University of St. Andrews, Scotland. Observers were instructed in line transect theory, field methods, data collection protocols, and species identification.

While conducting these line transect surveys, we will also tow a hydrophone array approximately 150 m behind the M/V Sensation to record the presence of vocalizing marine mammals. This towed array will consist of four elements, each with a frequency response between 2-100 kHz and a sensitivity of -165 dB re 1V/µPa. The array will be connected to a MOTU Traveler, which will digitize the incoming sounds. The MOTU Traveler is capable of processing sounds at 24-bit resolution and a maximum sampling rate of 192 kHz. Collecting data at this resolution and sampling rate will allow for comparisons between data collected by the array and that collected by the HARPs (see 5.3 below).

Incoming acoustic signals will be monitored in real-time with the software program *Ishmael* by a dedicated acoustician. When sounds of interest (marine mammal whistles, echolocation clicks, burst-pulses, unusual or unidentified sounds, etc.) occur, continuous recordings will be made onto the laptop or an external hard drive using *Ishmael*. In addition, we will use the software program *WhalTrak2* (operated on a second computer) in conjunction with *Ishmael* to help localize sound producing marine mammals. *Ishmael* is capable of localizing vocalizing animals via beam-forming and phone-pair algorithms, and *WhalTrak2* is capable of plotting these angles in reference to the ship's location. *WhalTrak2* is also capable of keeping a log of the ship's position (via a GPS feed), localizations made, and any comments entered by the acoustician. The visual line-transect observers will not be informed of the presence or location of any vocalizing marine mammal until it is certain the animals are behind the vessel.

Finally, after each vessel survey, recordings will be analyzed using a MATLAB-based acoustical software program called *Triton*, developed in John Hildebrand's lab at the Scripps Institute of Oceanography. These array recordings will be used to describe

species-specific vocalizations, so that we can determine which species are recorded by the HARPs.

Seabird counts will be made concurrently during these surveys by an experienced observer who will record seabirds in a 90 degree bow-beam arc within 300 m of the survey vessel. Observations will be made on the side of the vessel with the best visibility (Tasker et al. 1984). Sighting distances will be estimated using a handheld rangefinder (Heinemann 1981) and recorded as within 100, 200 or 300 m of the vessel. We will record the number of individuals and their behavior (sitting, flying, or foraging), together with associations with other marine species. The presence of ship-following birds will be noted separately to avoid biases in quantitative analyses. Data will be recorded on a dedicated laptop computer (separate from that used for marine mammal sightings).

As stated above, the vessel line transect survey team will consist of six individuals. Four individuals will rotate through the marine mammal observer and recorder stations on 30-minute watches (one observer will be at a rest station). A fifth researcher will monitor the passive acoustic monitoring system towed behind the vessel at all times while underway. This individual will be in the main cabin, visually isolated from the line transect survey crew. The sixth individual will be responsible for seabird sightings.

In addition to the line-transect surveys, at least one day each month will be devoted entirely to photo-identification and biopsy sampling. On these days we will employ a research platform that is capable of deploying a small rigid-hull inflatable, from which we can more readily collect biopsy samples (when appropriate) and photographs for individual identification. During these surveys, we will employ the R/V Cape Fear, a 70' research vessel based in Wilmington, NC.

All shipboard surveys will be conducted under NOAA Scientific Permit No. 948-1692-00, held by UNCW, which authorizes aerial and shipboard surveys for all cetaceans encountered in the western North Atlantic (expiration date 5/21/2011). Biopsies will be conducted under the authorization of the SEFSC/NOAA Fisheries Permit (Appendix E).

The surface vessel surveys will be conducted by the research team from Duke University and coordinated by Kim Urian. Details of the personnel comprising this survey team are included as Appendix F.

5.3. Passive acoustic monitoring

5.3.1 General Considerations

We will supplement traditional visual surveys from aircraft and ships with passive acoustic monitoring in the proposed USWTR. This approach will allow continuous monitoring over long periods and is particularly useful during periods of inclement weather. Passive acoustic monitoring prior to instrumentation of the USWTR will help to identify the full spectrum of vocalizing marine mammals that inhabit this area.

Traditionally, this approach has been limited to species that vocalize at relatively low frequencies, such as baleen whales. More recently, however, remotely deployed passive acoustic monitoring systems, known as High-frequency Acoustic Recording Packages (HARPs) have been developed by John Hildebrand at the Scripps Institution of Oceanography. These devices can monitor areas for long time periods (months) and provide information on the use of these areas by a variety of vocalizing marine mammals. These techniques are now being used in a cost-effective manner in many inaccessible areas, such as remote seamounts in the Pacific Ocean.

The HARPs can sample at 200 KHz and typically collect several terabytes of data during their deployment (which subsequently requires a labor-intensive analysis). A full description of the technical specifications of the HARPs is provided by Wiggins and Hildebrand (2007).

We will employ HARPs in the USWTR to provide detailed information on the seasonal occurrence and relative density of vocalizing marine mammals, particularly those that are difficult to survey using traditional visual techniques. This approach will also facilitate assessment of the efficacy of visual monitoring techniques during aerial and ship-board surveys by comparing which species are detected by the two methods. We will use species-specific vocalizations obtained from the towed array and vessel surveys (see above) to ground-truth the specific identity of vocalizing marine mammals detected by the HARPs.

Due to the large number of acoustic detections we expect during these deployments, we propose to place one HARP within the USWTR and a second unit in an adjacent control site (see below). This will allow us to compare and contrast the number of vocalizing marine mammals in the USWTR and a similar area once construction begins and training exercises commence. Unlike the situation with traditional visual surveys, we *may* have sufficient statistical power to detect an effect of the USWTR with this passive acoustic monitoring approach.

5.3.2 Passive Acoustic Monitoring Plan

We will deploy a single HARP on a mooring within the USWTR during the summer of 2007. We will deploy a second unit at a control site well outside the USWTR, likely to the southwest of Cape Fear. Both units will be deployed from the R/V Cape Fear. We will ensure that both units are situated in similar environments (e.g. depth, position

relative to the Gulf Stream and bottom type). The units will be moored at depths of approximately 200 m. The units will record continuously (*i.e*. no duty cycle) for approximately three months. In late October or early November, we will employ the R/V Cape Fear again to retrieve the HARPs. Once the units are onboard, we will download the data (approximately 2 terabytes) at sea, a process that takes about three hours, and then redeploy each unit. In the second deployment, we will employ a duty cycle of 15 minutes on and 15 minutes off, thus extending the recording duration of the units to six months. We will retrieve the HARPs again in March or April of 2008.

The HARPs will be provided by Dr. John Hildebrand of the Scripps Institute of Oceanography (SIO), who will also provide technical assistance in analysis. The research team from Duke University will be responsible for the deployment and retrieval of the units and will work with SIO to fully analyze the data. Andrew Read will be responsible for coordinating this aspect of the monitoring program.

6. Disposition of Data and Samples

Each research team will be responsible for editing data on a timely basis. Monthly data summaries from the aerial surveys and vessel surveys will be provided to the NTR and to the analytical team at the University of St. Andrews by the University of North Carolina Wilmington and Duke University, respectively. In addition, the NTR will receive monthly reports of all activities (purchases, field work, analysis, and reporting).

In addition, survey tracks and the location of sightings will be posted monthly on OBIS-SEAMAP (http://seamap.env.duke.edu/). The University of St. Andrews will estimate density and abundance from both data sets and make this information available at the end of the contract period.

Duke University and the Scripps Institution of Oceanography will provide estimates of the number of vocalizing marine mammals at the USWTR at the end of the contract period.

All biopsy samples will be provided to Dr. Patty Rosel (NOAA/SEFSC) for species identification and archiving. Photographic catalogs of individually distinctive marine mammals will be housed at Duke and shared with researchers at NOAA and elsewhere. Hard (or digital) copies of these catalogs will be provided to the Navy at the end of the project period.

We will provide the Navy with an Annual Report at the end of the project period. Prior to submission of this Report, we will hold a formal Program Review with Navy and NOAA personnel to brief them on progress and challenges. We also intend to hold an interim Program Review in November 2007, approximately half-way through the project period.

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Appendix A

Date:_____ Observers: 12 34 Pilot: 3 Co-Pilot: 4 Page ____ of ____

Flight Origin: Wilmington VA Beach

Time	Waypoint #	Event	Heading	Track #	Obsrv #	Alt(ft)	Visibility	BSS	Cloud	Glare L	Glare R	Angle	Sighting Cue	Species	Reliability	Min #	Max #	Best Est	Calves Y/N	Avoid Y/N	Pho/Vid (Y/N)	Comments

Appendix B.

Codes for Variables on 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)
2.0 = Sighting-breaking track/off effort (real time)
2.2 = Sighting of commercial fishing vessel
2.4 = Sighting of marine mammal (real location)
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=recorder 3=observer left side 4=observer right side

Reliability of Species ID:
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

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

Glare:
1 = none
2 = 0-25% of half circle viewing area
3 = 25-50% of half circle viewing area
4 = >50% of half circle viewing area

* Enter 9 in appropriate fields where data was not recorded

Appendix C. Aerial Survey Team (UNCW).

Dr. D. Ann Pabst (Project Leader)
Duties: Dr. Pabst will provide scientific and fiscal oversight during all aspects of the project. She will provide grant management during the course of the project and will be responsible for the development of interim and final reports.
Qualifications: Dr. Pabst is full Professor at UNCW. She holds a Ph.D. from Duke University and has over 25 years of experience working with marine mammals. She has directed or served on over 30 graduate and post-graduate student committees. She has managed over 40 large granted projects from inception to completion. She has served as the Secretary for the Society for Marine Mammalogy and is currently an Associate Editor for Marine Mammal Science.

William McLellan (Aerial Survey Team Leader & Marine Mammal Observer)
Duties: Mr. McLellan will supervise all aspects of the aerial surveys from observer hiring to project completion. He will insure data quality by performing edits on the entire database. He will provide quality assurance for the project and trouble shoot any situations that arise during the project's term. He will be available to fly in the event of a down observer.
Qualifications: William McLellan has 24 years of experience working with marine mammals. He is a NOAA Fisheries Certified marine mammal observer and has conducted over 12 months of high seas marine mammal experience working in three oceans on numerous marine mammal survey and fisheries related projects. He has managed 9 separate aerial survey projects directed at determining marine mammal distribution and abundance in the waters of the mid-Atlantic. He is the North Carolina State Stranding Coordinator and the Large Whale Mortality Team Leader for the mid-Atlantic and has direct experience with all but two species of marine mammals in the north Atlantic ocean.

Observer/Coordinator TBA (Aerial Surveys and Marine Mammal Observer)
Duties: The Coordinator/Observer will first monitor weather and sea state conditions to determine when the best conditions are available in the USWTR monitoring site. They will inform William McLellan of a possible weather window and a decision to fly will be made. They will contact Orion Aviation and make arrangements for a plane and crew to be onsite for the duration of the aerial effort. They will coordinate the flight schedule with the other observer, and finally, they will fly the survey effort. The coordinator will be responsible for the data to be entered in all appropriate data files and provide the first edit of the database. They will forward high quality digital images to all cetacean catalogues operating in the Atlantic should appropriate sightings occur, including the Right Whale Catalog, the Humpback Catalog, and the Mid-Atlantic Bottlenose Dolphin Catalog. They will be responsible for all equipment used for data analysis and reporting (computers, plotting software, website service, database management at Duke, OBIS interface, etc.).

Qualifications: The current pool has been reduced down to two individuals (from an initial pool of over 65 applicants). The remaining two individuals have between 3 & 5 years experience flying marine mammal specific aerial surveys. They both have taken on positions of responsibility in their respective programs. We are waiting on the results of the international background check required by federal grants before we can offer this position.

Observer TBA (Aerial Surveys and Marine Mammal Observer)
Duties: The Observer will be aboard all flights. They will assist in all aspects of data entry and data editing. They will assist in digital image manipulations and manage all gear related to the aerial survey effort while in the plane (GPS, cameras, flight suits, emergency egress equipment, raft, satellite phone, etc.). The Observer will aid Duke Marine Lab vessel survey efforts as needed.
Qualifications: The current pool has been reduced to three individuals (from an initial 55 applicants) for this position. The remaining three individuals have between 2-3 years of experience flying marine mammal specific aerial surveys. We are waiting on the results of the international background check required by federal grants before we can offer this position.

Appendix D. Data fields to be collected for Duke shipboard surveys for USWTR monitoring program.

Date
Observer
- Starboard
- Port

Data recorder
Port of origin
Track number/ID
Time
Waypoint
Event:
- On effort/track
- Off effort
- Break transect
- Change in environmental conditions
- Sighting-marine mammal
- Sighting-sea turtle
- Sighting-fishing vessel-commercial
- Sighting-fishing vessel-recreational
- Sighting-large vessel
- Opportunistic sighting

Heading
Sighted by Captain, Recorder, Starboard-Observer, Port-Observer
BSS
Visibility
Cloud Cover
Glare
- Left
- Right

Wind speed/Direction
Wave height
Temperature
Depth

Range/Distance
Bearing/Angle
Activity
Sighting cue
Species code
Reliability of Species ID
Best estimate of group size
Number of calves

Appendix E. Shipboard Survey Team (Duke University).

Andrew Read (Principal Investigator & Marine Mammal Observer)
Duties: Dr. Read is responsible for all scientific aspects of this aspect of the monitoring plan, including project oversight, design and reporting. In addition, Dr. Read will act as an observer and be responsible for collecting biopsy samples.
Qualifications: Dr. Read is the Rachel Carson Associate Professor of Marine Conservation Biology at Duke University. He holds a Ph.D. in marine biology from the University of Guelph in Canada and has been conducting research on marine mammals for over 25 years. Dr. Read is President-Elect of the Society for Marine Mammalogy, a member of the Scientific Committee of the International Whaling Commission, the Committee of Scientific Advisors of the Marine Mammal Commission, and the IUCN Cetacean Specialist Group.

Kim Urian (Survey Team Leader & Marine Mammal Observer)
Duties: Ms. Urian is responsible for all aspects of survey logistics and planning and is responsible for the photo-identification component of this monitoring plan. She is also responsible for data quality control and dissemination. She will also act as an observer.
Qualifications: Kim Urian has 18 years of experience in marine mammal research and is an expert in photo-identification. She has conducted previous line transect surveys for marine mammals in Onslow Bay for UNCW and the Woods Hole Oceanographic Institution. Ms. Urian holds a bachelor's degree in biology from the University of Colorado and a Master's degree in marine biology from UNCW.

Danielle Waples (Marine Mammal Observer)
Duties: Ms. Waples will act as an observer during line transect surveys and as a photographer during photo-ID surveys. She is responsible for biopsy sample preservation and dissemination.
Qualifications: Danielle Waples has 20 years experience in marine mammal research. For the past seven years she has worked as a Research Associate at Duke University Marine Lab with Dr. Andy Read. In addition to her work at Duke, Ms. Waples has worked as a marine mammal observer for NOAA-SWFSC, in the Bay of Fundy for the Woods Hole Oceanographic Institution, and in the Mediterranean Sea on the Littoral Warfare Advanced Development (LWAD) project for Marine Acoustics, Inc. She received her undergraduate degree in human biology from Stanford University and holds a Master's degree in marine sciences from the University of California at Santa Cruz.

Lynne Williams (Acoustician)
Duties: Ms. Williams is responsible for passive acoustic monitoring during surveys.
Qualifications: Ms. Williams has seven years of experience conducting marine mammal bio-acoustics. She holds undergraduate and Master's degrees in marine biology from UNCW. The research for her master's thesis was on manatee vocalizations. She has

spent the past year working in the laboratory of Dr. John Hildebrand at the Scripps Institute of Oceanography. Ms. Williams is currently a Ph.D. student at Duke.

Lucie Hazen (Project Manager & Marine Mammal Observer)
Duties: Ms. Hazen is responsible for project management, including execution of the spending plan. She will also act as a marine mammal observer.
Qualifications: Ms. Hazen worked previously as a fisheries observer for the NOAA Pacific Islands Fisheries Science Center. Ms. Hazen has two years of experience in marine mammal research project management at Duke. Prior to that she completed a Masters degree at the School of Aquatic & Fisheries Science at the University of Washington (UW). She also holds an undergraduate degree in Biology from UW.

Lesley Thorne (Seabird Observer)
Duties: Ms. Thorne will conduct seabird observations and analyses.
Qualifications: Ms. Thorne has seven years of experience conducting marine mammal and seabird surveys. She has conducted field work in the Bay of Fundy, Onslow Bay and the Gulf of Mexico. She holds a bachelor's degree in ecology from the University of Guelph in Canada and is currently a Ph.D. student at Duke.

Alternate observers will be chosen for survey when required from a pool of researchers at DUML and elsewhere. There were more than twenty participants at the observer training session, so we will have a number of trained observers to act as alternate observers.

Appendix F. NOAA/SEFSC Biopsy Permit

U.S. Department of Commerce
National Oceanic & Atmospheric Administration
National Marine Fisheries Service

Southeast Fisheries Science Center
3209 Frederic Street
Pascagoula, MS 39568

228-762-4591
Keith.D.Mullin@noaa.gov

10 April 2007

Andrew J. Read, Ph.D.
Duke University
135 Duke Marine Lab Road
Beaufort, N.C. 28516

Dear Andy,

By this letter, you are hereby designated to act as co-investigator for the Southeast Fisheries Science Center under MMPA Permit No. 779-1633-02 to conduct biopsy sampling and Level B harassment of marine mammals in the Atlantic Ocean, Gulf of Mexico and Caribbean Sea. This authorization shall be subject to the following conditions:

1. A copy of this permit shall be in your possession during the proposed work.

2. A written and tabular summary of the work you conduct under the permit should be provided to me by 1 February 2008. Please read the permit and note the research conditions relating to activities authorized under the permit (e.g., photo-identification studies and biopsy sampling) and the detailed reporting requirements.

3. No commercial photography or film-making activities may be conducted while working under this permit nor shall the research be conducted from a vessel engaged in commercial activities, without prior permission from the NMFS Permits Division, Office of Protected Resources. Please note the photography/filming restrictions in Section E for further details.

4. This authorization is in force until 31 December 2007.

Thank you and good luck.

Sincerely,

Keith D. Mullin, Ph.D.
Research Fishery Biologist

Enclosure (Permit No. 779-1633-02)

cc: M. Payne, NMFS Office of Protected Resources

Technical Proposal for further Monitoring of Protected Species in the Proposed Onslow Bay and Jacksonville USWTRs – February 2009 to January 2010
Task Order 0047, Modification 1

February 5 2009

Andrew Read & David Johnston
Center for Marine Conservation
Nicholas School of the Environment, Duke University
Beaufort, NC

D. Ann Pabst & William A. McLellan
Biology and Marine Biology
University of North Carolina Wilmington
Wilmington NC

1. Aims

This document amends earlier technical proposals to conduct further aerial and shipboard surveys and passive acoustic deployments in two proposed USWTR on the east coast of the US, with the aim to document patterns of distribution and seasonal residency of protected species. These data will eventually be critical to estimating density of protected species in these USWTRs. Our general approach is to replicate the survey plan used to monitor the proposed USWTR site in Onslow Bay, NC during 2007, 2008 and 2009.

2. Species of interest in the shelf waters of eastern Florida

At present, very little is known about the occurrence and density of cetaceans in the shelf waters of eastern Florida, and in the proposed JAX USWTR. In fact, there is considerably less knowledge about the distribution of cetaceans in this area than was the case prior to the commencement of the current monitoring program in Onslow Bay in 2007. Species that may be encountered include: sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius* and *Mesoplodon spp*.), humpback and other balaenopterid whales (*Megaptera novaeangliae* and *Balaenoptera spp*.) and several genera of pelagic odontocetes (*Pseudorca crassidens*, *Peponocephala electra*, *Stenella spp*., *Tursiops truncatus*, *Globicephala spp.*, *Grampus griseus*, and *Delphinus delphins*), as well as leatherback (*Dermochelys caretta*) and loggerhead (*Caretta caretta*) sea turtles. Furthermore, the proposed JAX USWTR is located directly offshore of the calving habitat of endangered North Atlantic right whales (*Eublaena glacialis*). Right whales use the near-shore shelf waters of central Florida each winter to give birth to and nurse their calves. The current minimum population estimate (N_{min}) used in U.S. management (based on a count of known individuals alive during 2001) is 313 individuals, and it is believed that the true abundance of North Atlantic right whales is not much greater than this number (Waring et al. 2007). The species is listed as *Endangered* under the U.S. Endangered Species Act and as a *Strategic Stock* under the U.S. Marine Mammal Protection Act.

3. Species of interest in Onslow Bay

Our focus is on all protected species occurring in the proposed USWTR site, but in preparing this monitoring plan we paid particular attention to the following species: sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius* and *Mesoplodon spp*.), humpback and other balaenopterid whales (*Megaptera novaeangliae* and *Balaenoptera spp*.), right whales (*Eubalaena*

glacialis) and several genera of pelagic odontocetes (*Stenella spp.*, *Tursiops truncatus*, *Globicephala spp.*, *Grampus griseus*, and *Delphinus delphins*), as well as leatherback (*Dermochelys caretta*) and loggerhead (*Caretta caretta*) sea turtles.

4**. Survey Areas**

Onslow Bay USWTR
As the consequences of activity inside the USWTR area may extend outside the range itself we propose to survey an area that extends 10 nautical miles in each direction from the boundaries of the USWTR. The USWTR area is 25 nm long and 20 nm wide, so the entire monitoring area is 45 nm long and 40 nm wide. The total survey area is thus 1800 square nautical miles, with 28% of this area within the USWTR itself.

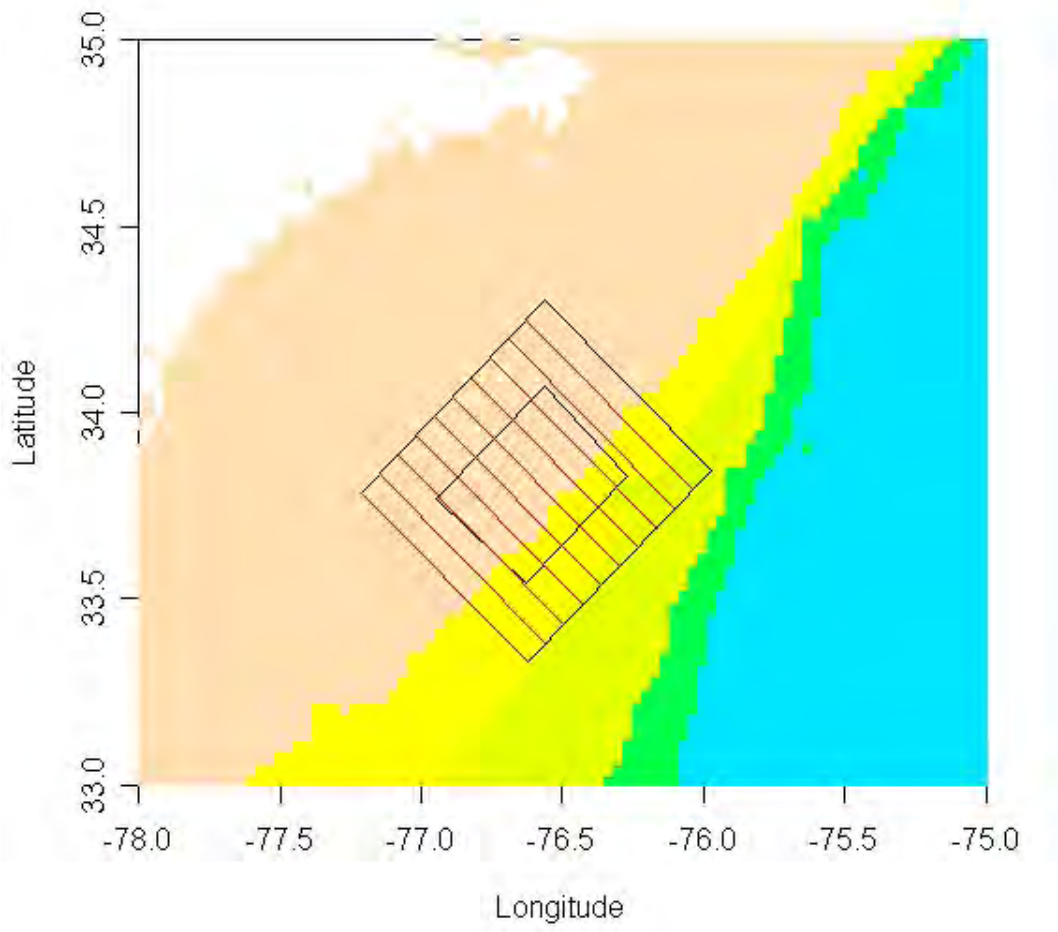

Figure 1. Survey area in Onslow Bay, encompassing the proposed USWTR site (inner box). Ten transect lines are depicted in red, each approximately 40 nm in length. Bathymetry is depicted by color: beige is less than 100 m deep, yellow is between 100 and 500 m, green-yellow is between 500 and 1000 m, green is between 1000 and 2000 m, and blue is between 2000 and 3000 m deep. Land is indicated in white.

This survey area incorporates a variety of habitats from the shallow waters of the shelf to the continental slope. The Gulf Stream meanders through the eastern portion of the survey area, flowing towards the northeast.

We have established ten 40-nm long transect lines that cross the survey area, oriented parallel to the short axis of the USWTR boundaries (e.g. approximately from NW to SE). The transect lines are spaced approximately 5 nautical miles apart. Transect lines begin 2.5 nm within the north and south borders and provide an effective transect width that covers the entire box. This yields a total of 400 nm of survey track line. These ten transect lines will be surveyed by both aerial and shipboard platforms.

JAX USWTR
We will survey an area similar in size and configuration to that monitored in Onslow Bay (see above.). The survey region extends 5 - 10 nautical miles beyond the east/west boundaries of the JAX USWTR, depending on the season and lines surveyed – see below. The proposed USWTR area is 25 nm long and 20 nm wide and the approximate area of the entire survey range during winter is 1,674 nm^2

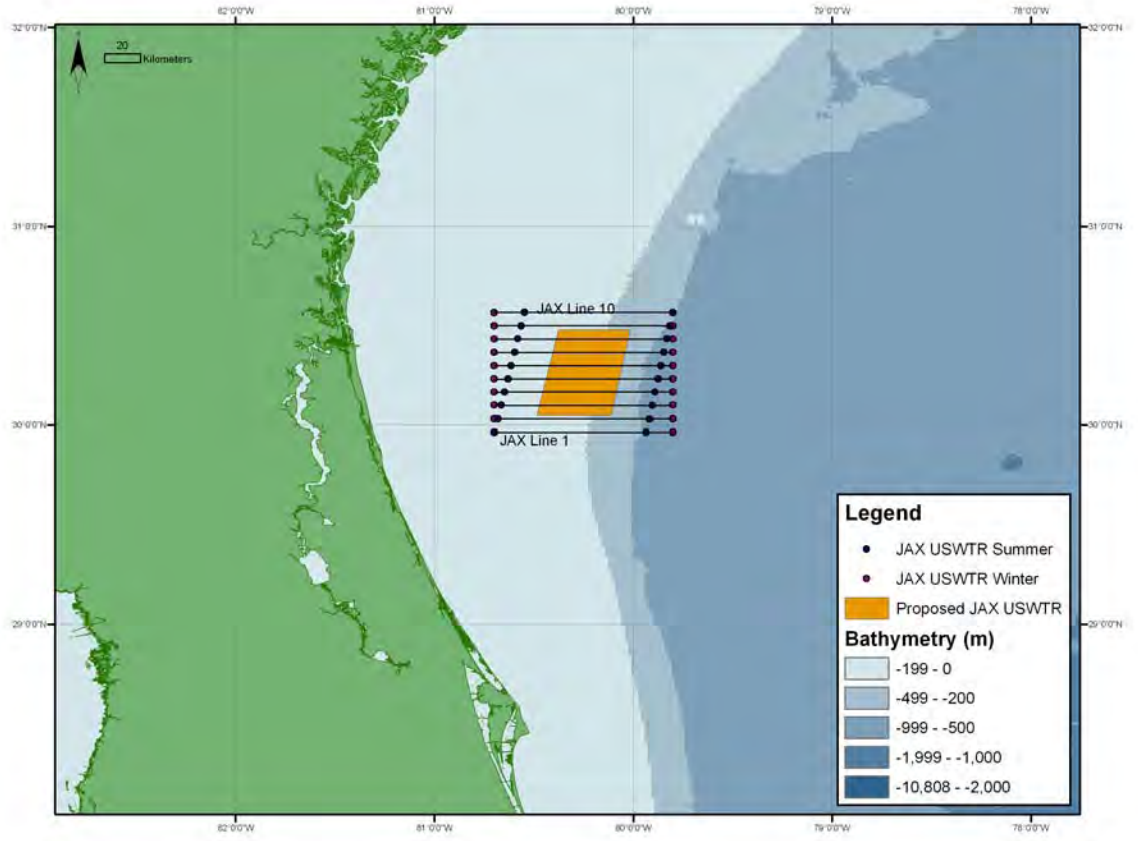

Figure 1. Location of the proposed JAX USWTR and potential survey tracklines for protected species monitoring.

This survey area incorporates a variety of habitats from the shallow waters of the continental shelf (less than 200m) to the deeper Blake Plateau (approximately 500m). For winter surveys, we have established ten transect lines (46.5 nm long for winter; 40 nm long for summer – see figure 2) that cross the proposed USWTR oriented parallel to the short axis of the USWTR boundaries

(*e.g.* approximately from NW to SE) and perpendicular to the dominant environmental variables that may affect the distribution of cetaceans (primarily bathymetry and the Gulf Stream). The transect lines are spaced approximately 4 nautical miles apart. The extended winter survey lines are designed to cover areas inshore of the USWTR that are not covered by ongoing aerial surveys for right whales during the winter months. These ten transect lines will be surveyed by both aerial and shipboard platforms.

5. General Approach

Previous research for the Onslow Bay region examined the potential efficacy of a Before-After Control-Impact Paired (BACI-P) study design, in which monitoring surveys would commence in both the USWTR area and a paired control site before training exercises commenced and then continue in both areas after the range became operational. The aim of the simulations was to determine whether avoidance or fatal exposure (as a worse case scenario) to mid-frequency sonar in the USWTR could be detected statistically given a realistic level of monitoring. The results of this simulation modelling (Paxton et al. 2005) indicated that it would be difficult, if not impossible, to detect demographic effects of the USWTR (if any should occur) at any realistic sampling intensities. In fact, in the absence of daily sampling, reliable detection of even the worst possible effects of the USWTR was unlikely. The results of our surveys in Onslow Bay have substantiated these model outputs, revealing low densities of cetaceans in the USWTR and surrounding area. Given the paucity of data on the occurrence and density of marine mammals at the JAX USWTR site, and the low densities documented for the Onslow Bay site, we believe that a BACI-P approach will not be feasible for either area. Thus, we will continue to conduct a monitoring plan for both sites site that places emphasis on documenting species occurrence, estimating densities, and establishing patterns of residency.

6. Survey Methods

The monitoring program must yield reliable information on marine mammal occurrence, densities and distribution in the JAX USWTR and adjacent waters. Every survey method has scientific and logistical advantages and disadvantages; by combining multiple methodologies we hope to ensure the most complete and effective monitoring program. The use of multiple approaches also helps to overcome the biases that are associated with particular survey methods. The combination of multiple approaches has worked extremely well in Onslow Bay and we replicate that philosophy here.

Survey Team and Project Management

The surface vessel and aerial surveys will be conducted by a dedicated research teams stationed in Beaufort NC and the Jacksonville area. The JAX team will be coordinated locally by a team leader employed by the University of North Carolina, Wilmington (UNCW). Dr. David Johnston from Duke University will be responsible for overall project management, data integration and reporting.

6.1. Aerial Surveys

Aerial line-transect surveys provide high quality data on the distribution and density of both marine mammals and sea turtles and are possible even when sea states hamper vessel surveys. We will employ a four-seat aircraft with a pilot and co-pilot in each front seat and left and right observers in the two rear seats.

For this monitoring plan modification, we propose to fly on 24 survey days from July 2009 through January 2010 (Task 5). Aerial surveys will be conducted in accordance to *NOAA Fisheries- Southeast Region (SER) Minimum Aircraft and Crew Provisions Right Whale Data Collection Activities*. Surveys will be carried out in over-wing, twin-engine aircraft, Cessna 337 airplanes, which are maintained under provisions of 14 Code of Federal Regulations (CFR) Part 135. Each plane will be equipped with the necessary electronic positioning equipment and safety gear required to conduct marine mammal surveys. Two pilots will be used for each flight. Both pilots will meet requirements as specified in 14 CFR Part 135; the pilot-in-command will meet or exceed all additional NOAA requirements.

Surveys will be flown at an altitude of 300 m and airspeed of 160 km/hr. Surveys will be flown only under safe operating conditions. Two observers, one positioned on each side of the aircraft, will carry out surveys. Observers and coordinators will have appropriate egress and sea survival training and be equipped with all NOAA required safety gear. The plane will be equipped and the pilots will fly tracklines coordinates with a Global Positioning System (GPS) to permit precise trackline fidelity.

Each observer will use an independent GPS to record the precise time and geographic position of all sightings. The left and right observers record sightings independently. When a sighting cue is encountered, the radial and horizontal sighting angle, determined *via* wing-strut marks, will be recorded. At this point, if the observer requires additional identification and count information, the track will be broken to allow the plane to close on the sighting. In this closing mode, the precise location of the sighting will be determined and all relevant biological information will be collected. In these cases, the observer who first encounters the sighting will take the "lead" and that observer's GPS will mark the break in effort, all points relevant to the sighting, and the point at which the team goes back on effort on a trackline. These sightings can provide an additional check on the ability of observers to determine sightings cues while on effort on the trackline.

All data sightings will be manually recorded in real time on sighting data sheets. This recording method gives precise locations while allowing the observer the opportunity to continuously record information while circling the sighting. Many different methods are employed to record aerial survey data. When using O2 Cessna's, there is a strong commitment to reduce the amount of equipment in the observer cockpit. Having the observers store locations on individual GPS units and record other data on datasheets on clipboards reduces the amount of electronics, wires and clutter in the plane. Back on ground, the observers will download the GPS units and transcribe their sighting data into a digital spreadsheet. A unified data set that takes both the left and right side observations into account is then generated. Specific sightings from both the left and right side will be entered in temporal order. This provides an opportunity to edit and clarify any disparate data. A unified waypoint and sightings spreadsheet is produced and forwarded to the research team with regular uploads to the OBIS website.

The UNCW holds NOAA Scientific Permit No. 948-1692-00, which authorizes aerial and shipboard surveys for all cetaceans encountered in the western North Atlantic (expiration date 5/21/2011).

6.2. Vessel Surveys

Vessel-based survey platforms provide an increased probability of sighting deep-diving species, especially beaked whales, which may be missed during 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. Vessel-based platforms allow for biopsy sampling to ensure that all species encountered are correctly identified, as described below.

To ensure maximum detection rates, we will employ a traditional single visual survey team, supplemented by acoustic monitoring using a towed hydrophone array. The towed array will facilitate compilation of an acoustic library of species-specific recordings, which will be useful for the passive acoustic monitoring component of this research program (see below).

The use of a shipboard platform will also allow us to monitor the use of the USWTR and adjacent areas by individual animals using photo-identification techniques. These methods can be used to examine seasonal and inter-annual patterns of residency. This information will be critical to interpreting any changes in density documented in the USWTR area.

Our vessel surveys will be used primarily to estimate density and collect *in situ* habitat data such as sea surface temperature and depth, for each sighting and secondarily to facilitate collection of biopsy samples and photographs for individual identification. Furthermore, our vessel surveys will allow us to collect oceanographic data (e.g. temperature, salinity, productivity profiles) that will provide an ecological context for visual detections of cetaceans and provide data for further acoustic modeling and interpretation. Vessel surveys will provide the following information: species-specific patterns of occurrence, data that can be used to help generate species-specific estimates of density; and information on habitat associations, residency patterns and stock structure of marine mammals.

For this amendment to the original monitoring plans, we will to conduct a total of 24 survey days from July 2008 through January 2010 (Task 5). These surveys will take advantage of the brief windows of good weather that occur in these offshore waters. Vessel surveys will commence in January 2009. We will employ a charter vessel based in the Jacksonville region for these surveys.

Whilst on effort during vessel line transect surveys, we will employ a team of four or five researchers plus the vessel captain. Two observers will use 7 x 50 hand-held binoculars and naked eye to search ahead of the vessel. A dedicated center recorder will monitor the trackline region and enter information on sightings and environmental conditions into a laptop that will have a feed to a GPS unit. A fourth researcher will monitor the towed hydrophone array.

Sea surface temperature and depth data will be collected automatically while underway and logged to the laptop computer to facilitate analyses of habitat associations. When possible, oceanographic profiles will be obtained while underway during surveys (XBT drops) and at predetermined stations (CTD casts).

While conducting these line transect surveys, we will tow a hydrophone array approximately 150m behind the vessel to record the presence of vocalizing marine mammals. This towed array will consist of four elements, each with a frequency response between 2-100 kHz and a sensitivity of -165 dB re 1V/ìPa. The array will be connected to a MOTU Traveler, which will digitize the incoming sounds. The MOTU Traveler is capable of processing sounds at 24-bit resolution and a maximum sampling rate of 192 kHz. Collecting data at this resolution and sampling rate will

allow for comparisons between data collected by the array and those collected by the High Frequency Acoustic Recording Packages, or HARPs (see 5.3 below).

Incoming acoustic signals will be monitored in real-time with the software program *Ishmael* by the onboard acoustician. When sounds of interest (marine mammal whistles, echolocation clicks, burst-pulses, unusual or unidentified sounds, etc.) occur, recordings will be made onto the laptop or an external hard drive using *Ishmael*. In addition, we will use the software program *WhalTrak2* (operated on a second laptop computer) in conjunction with *Ishmael* to help localize sound producing marine mammals. *Ishmael* is capable of localizing vocalizing animals via beam-forming and phone-pair algorithms, and *WhalTrak2* is capable of plotting these angles in reference to the ship's location. *WhalTrak2* is also capable of keeping a log of the ship's position (via a GPS feed), localizations made, and any comments entered by the acoustician. The visual line-transect observers will not be informed of the presence or location of any vocalizing marine mammal until it is certain the animals are behind the vessel.

In addition, whenever possible, seabird counts will be made concurrently during these surveys. A dedicated observer will record seabirds in a 90-degree bow-beam arc within 300m of the survey vessel. Observations will be made on the side of the vessel with the best visibility (Tasker et al. 1984). Sighting distances will be estimated using a handheld rangefinder (Heinemann 1981) and recorded as within 100, 200 or 300m of the vessel. We will record the number of individuals and their behavior (sitting, flying, or foraging), together with associations with other marine species. The presence of ship-following birds will be noted separately to avoid biases in quantitative analyses. Data will be recorded on a digital voice recorder.

All shipboard surveys will be conducted under NOAA Scientific Permit No. 948-1692-00, held by the UNCW and NOAA General Authorization No. 808-1798 as amended, both of which authorize aerial and shipboard surveys for all cetaceans likely to be encountered in the western North Atlantic. Biopsies will be conducted under the authorization of the SEFSC/NOAA Fisheries Permit.

6.3. Passive acoustic monitoring

We are currently supplementing traditional visual surveys from aircraft and ships with passive acoustic monitoring in both proposed USWTR sites. This approach allows continuous monitoring over long periods and is particularly useful during periods of inclement weather. Passive acoustic monitoring prior to instrumentation of both USWTRs will help to identify the full spectrum of vocalizing marine mammals that inhabit these areas.

For this monitoring plan modification, we will employ one further HARP in the Onslow Bay USWTR site to provide detailed information on the seasonal occurrence and relative density of vocalizing marine mammals, particularly those that are difficult to survey using traditional visual techniques (Task 6). This approach will also facilitate assessment of the efficacy of visual monitoring techniques during aerial and shipboard surveys by comparing which species are detected by the two methods. We will use species-specific vocalizations obtained from the towed array and vessel surveys (see above) to ground-truth the specific identity of vocalizing marine mammals detected by the HARPs. We will employ a chartered research vessel to deploy and retrieve the HARP.

This amendment also includes support for deployments of Cornell Pop-Up units in the JAX and Onslow USWTRs. We will employ a chartered research vessel to deploy and retrieve

pop-up recording units in the USWTR sites during planned exercises. This will include deployment and recovery of multiple pop-up units for 1 exercise per site (Task 7).

7. Disposition of Data and Samples

The field research team will be responsible for editing data on a timely basis and transmitting it digitally to David Johnston at Duke for reporting uses and integration on a monthly basis. Monthly data summaries from the aerial surveys and vessel surveys will be provided to the NTR. In addition, the NTR will receive monthly reports of all activities (purchases, field work, analysis, and reporting).

In addition, survey tracks and the location of sightings will be posted on OBIS-SEAMAP (http://seamap.env.duke.edu/) on a quarterly basis. All biopsy samples will be provided to Dr. Patricia Rosel (NOAA/SEFSC) for species identification and archiving. Photographic catalogs of individually distinctive marine mammals will be housed at Duke and shared with researchers at NOAA and elsewhere. Hard (or digital) copies of these catalogs will be provided to the Navy at the end of the project period. We will provide the Navy with an Annual Report at the end of the project period. Prior to submission of this Report, we will hold a formal Program Review with Navy and NOAA personnel to brief them on progress and challenges. We also intend to hold an interim Program Review in November 2009.

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Appendix B Onslow Bay Monitoring Year One Final Report

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

Final Report, Year 1 (June 2007 - June 2008)

October 1, 2008

Executive Summary

This document comprises the first annual progress report to the Department of the Navy on a monitoring program for protected marine species at the proposed site of an Undersea Warfare Training Range (USWTR) in Onslow Bay, North Carolina. The report describes the results of a monitoring program that combines aerial surveys, vessel-based surveys, passive acoustic monitoring and density estimation. As a result of the first year of work, preliminary estimates of the density of marine mammals and sea turtles have been generated from the aerial and ship-based survey efforts. This monitoring program provides important baseline data that will help assess future variation in the density, abundance and distribution of marine mammals, sea turtles and seabirds over time. These baseline data includes species distribution, abundance, density estimates, and some information on seasonal movement and habitat usage patterns specific to Onslow Bay and the proposed USWTR area.

Study Area

The proposed USWTR area in Onslow Bay is 25 nm (46 km) long and 20 nm (37 km) wide. The survey area consisted of a box that extends 20 nm in each direction from the proposed USWTR itself. Ten 40-nm (74- km) long transect lines were established that crossed the survey area, oriented parallel to the short axis of the USWTR boundaries and perpendicular to the primary bathymetric and prevailing oceanographic features influencing the study area. The transect lines were spaced approximately 5 nm (9.3 km) apart. This design yields a total of 400 nm (~740 km) of track line available for surveys; all transect lines were surveyed by both aerial and shipboard platforms.

Aerial Surveys

Personnel from the University of North Carolina at Wilmington carried out aerial surveys of the proposed USWTR site in Onslow Bay. Monthly aerial surveys of designed track lines were flown between June 2007 and June 2008, with a total of 14,387 km surveyed. The goal was to survey the entire USWTR site twice per month. This goal was accomplished for all but four months. Due to inclement weather, in which conditions exceeded Beaufort Sea State (BSS) 3, no surveys were conducted in January 2008, one

survey was flown in December 2007 and February 2008, and 1.4 surveys were flown in March 2008.

Five cetacean species were observed, including: bottlenose dolphins (*Tursiops truncatus*; 33 sightings), spotted dolphins (*Stenella frontalis*; 11 sightings), rough-toothed dolphins (*Steno bredanensis*; 3 sightings), Risso's dolphins (*Grampus griseus*; 3 sightings) and short-finned pilot whales (*Globicephala macrorhynchus*; 3 sightings). In addition, 13 sightings were made of dolphins in which species identity could not be determined with certainty (*i.e*. either *T. truncatus or S. frontalis*, or unidentified delphinids). A total of 268 sea turtles were observed during the study period. Of these, 208 were identified as loggerhead sea turtles (*Caretta caretta*) and the remaining 60 recorded as "unidentified sea turtles". As demonstrated in other aerial survey studies, encounter rates dropped dramatically as BSS increased. In Onslow Bay, as BSS increased from 2 to 3, cetacean sightings decreased from 9.5 to 1.5 per 1000 km surveyed, whereas sea turtle sightings decreased from 36.8 to 8.9 per 1000 km surveyed.

Vessel-Based Surveys and Passive Acoustic Monitoring

Researchers from Duke University conducted vessel-based surveys and passive acoustic monitoring of the proposed USWTR site in Onslow Bay. Observers on surface vessels covered 31 tracklines in approximately 124 hours and 2,300 km of survey effort. Most surveys were conducted in summer; survey effort was limited during winter months due to poor weather conditions. Most (67.5%) survey effort was conducted in Beaufort Sea States 2 and 3. A total of 35 marine mammal sightings were made during vessel surveys (31 while on effort, four while off effort). Four species of cetaceans were observed, including: bottlenose dolphins (24 sightings), Atlantic spotted dolphins (5 sightings), pilot whales (1 sighting), Risso's dolphin (2 sightings). Three sightings of unidentified delphinids were also recorded. In general, bottlenose dolphins, pilot whales and Risso's dolphins were detected in deeper waters than spotted dolphins. No mixed-species groups were observed. Approximately 1000 digital images were taken for species identification and individual recognition purposes. These photographs were instrumental in confirming species identification of sightings made from the aerial platform.

During 13 surveys, a four-element hydrophone array was towed behind the survey vessel. Twelve groups of cetaceans (bottlenose dolphins and spotted dolphins) were detected by the array and also positively identified by the visual observers. These recordings will be used to help identify the species recorded on a bottom-mounted acoustic recording package (see below).

Six hundred seabirds were recorded in approximately 80 hours of dedicated observations between June 2007 and May 2008, yielding a sighting per unit effort (the number of seabirds recorded per hour of effort) between 2.9 and 18.3 per hour. Twenty species of seabird were recorded, with the greatest diversity observed during the month of October. Cory's (*Calonectris diomedea*) and Greater Shearwaters (*Puffinus gravis*) were the species sighted most frequently.

To monitor the occurrence of vocalizing marine mammals, a High Frequency Acoustic Recording Package (HARP) was deployed on two occasions, with the assistance of personnel from the Scripps Institution of Oceanography. The instrument was deployed, recovered and redeployed near the center of the USWTR area, close to the 200-m shelf break. In both deployments the instrument was programmed to record for five-minute periods separated by an inactive interval of five minutes and to record sound at a sample rate of 200 kHz. In an initial analysis of 3.5 months of data from the first HARP deployment, 520 marine mammal vocal events, one mid-frequency sonar event, four probable fish events, and 302 boat events were detected. Analysis of these recordings is ongoing, but at least one species, sperm whales (*Physeter macrocephalus*) was detected by the HARP but not by either the aerial or vessel-based surveys.

Density Estimation

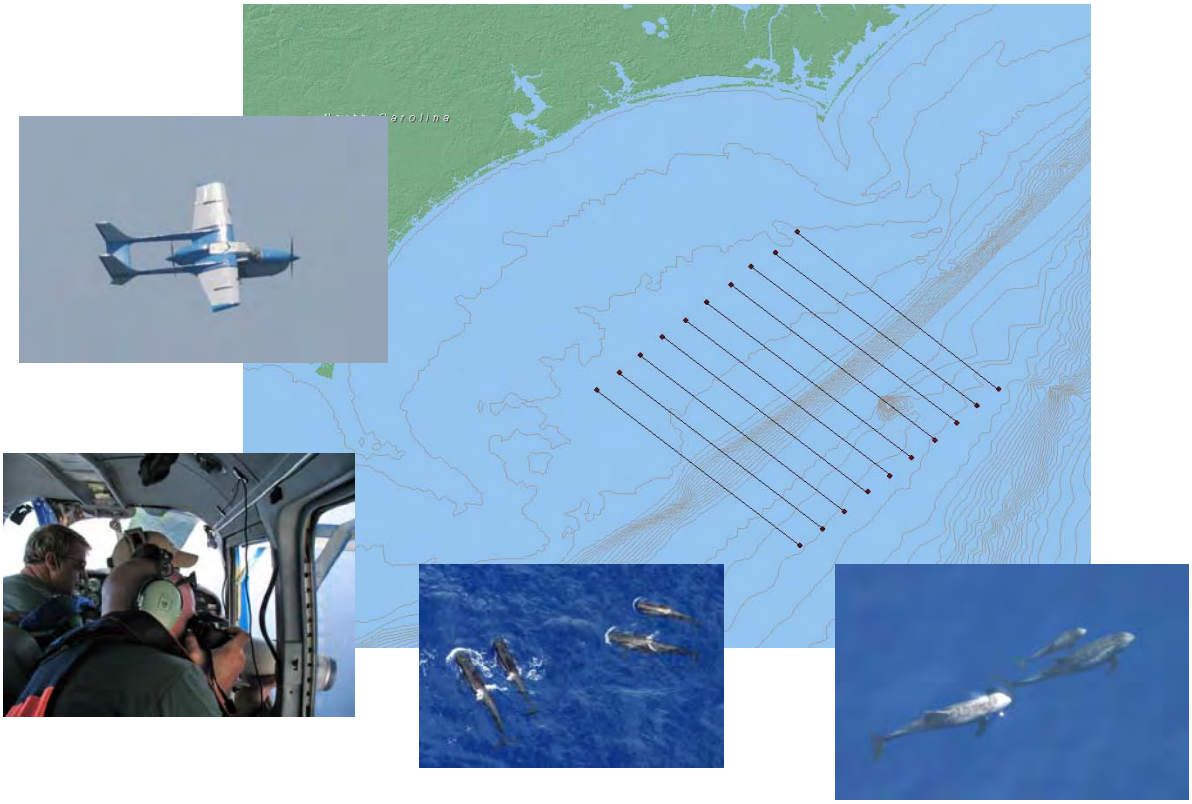
Scientists from the University of St. Andrews conducted analysis of the data from the combined aerial and shipboard surveys of the USWTR from June 2007 through June 2008, together with that of the previous aerial surveys of the UNCW for Onslow Bay conducted in1998/1999. This analysis allowed estimation of approximate surface population sizes of bottlenose dolphins, spotted dolphins, pilot and beaked whales combined, loggerhead turtles, as well as provided some insights into the environmental correlates of the distributions of these animals.

Abundance for the USWTR core region and a surrounding outer area was estimated by first fitting a detection function to the multi-platform survey data and then modelling the resultant estimated densities using a logistic general additive model. The estimated probability of presence was then multiplied by the estimated non-zero density to obtain an estimated overall abundance. Detection functions were not fitted to all of the sightings data owing to a paucity of data (shipboard whale sightings) or oddly distributed data (turtle sightings).

Estimates were made for the USWTR core region and the outer region for June 1998 (extrapolated), June 1999, June 2007 and June 2008 and for each month from July 2007 to June 2008. Estimated bottlenose dolphin numbers varied between 0 (95% CI: 0 – 0, August 2007) to approximately 320 (0 – 2160, January 2008) for the inner region and 0 (0 – 0, August 2007) to *circa* 1140 (930 – 4800, Jan 2008) for the outer region. Estimated spotted dolphin numbers varied from 0 (0 – 00 in 1998 to *circa* 10 (0 – 610) in 2007/2008 in the inner region and 0 (0 – 410, 1998) to 55 (10 – 1400, 2008) in the outer region. Pilot and beaked whale numbers were very low (< 10) throughout the survey period. Estimated loggerhead turtle numbers varied from *circa* 10 (10 – 40, August/September 2007) to 140 (100 – 270, March 2008) in the inner region and 20 (10 – 60, August 2007) to 330 (210 – 500, March 2008) for the outer region. All the above estimates assumed perfect detection on the trackline. There was no evidence of a systematic decline in any species in the last ten years. There was evidence that the abundance of bottlenose dolphins fluctuated with season (perhaps in response to temperature), as did the presence of loggerhead turtles. Spotted dolphins only appeared in the shallower parts of the region.

Given the relatively small number of sightings made during this first year of survey effort, conclusions about the estimated densities of marine mammals and sea turtles in Onslow Bay should be regarded as extremely tentative. Nonetheless it seems reasonable to conclude that the region as a whole has relatively few marine mammals and sea turtles (save perhaps loggerhead turtles). However, the results described here all assume that g(0) (detection probability) is 1.0 on the trackline. This is unlikely to be true, especially for smaller cetaceans, so these values likely underestimate the true abundance of these species in the region.

AERIAL SURVEYS OF THE PROPOSED UNDER SEA WARFARE TRAINING RANGE (USWTR) IN ONSLOW BAY, NORTH CAROLINA, JUNE 2007 TO JUNE 2008



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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 June 2007 and June 2008. The aerial surveys were carried out by the University of North Carolina Wilmington. The goal was to survey the entire USWTR site twice per month. This goal was accomplished for all but three months. Due to inclement weather, where Beaufort Sea State (BSS) exceeded 3, no surveys were conducted in January 2008, one complete survey was flown in December 2007 and February 2008, and 1.4 surveys were flown in March 2008. A total of 853 cetaceans and 268 sea turtles were observed while on effort in the study area. No right whales (*Eubalena glacialis*) were observed within the site, nor were any other baleen whale species, pinniped or any other marine mammal or sea turtle listed as "Endangered" under the U.S. Endangered Species Act.

Five cetacean species were observed in the survey site including: bottlenose dolphins (*Tursiops truncatus*; 33 sightings of 459 individuals), spotted dolphins (*Stenella frontalis*; 11 sightings of 177 individuals), rough-toothed dolphins (*Steno bredanensis*; 3 sightings of 41 individuals), Risso's dolphins (*Grampus griseus*; 3 sightings of 19 individuals) and short-finned pilot whales (*Globicephala macrorhynchus*; 3 sightings of 53 individuals). In addition, 13 sightings of 104 individuals where species identity could not be established with 100% certainty (*i.e. Tursiops/S. frontalis* or "unidentified delphinids") were made. A total of 268 sea turtles were observed during the study period. Of these, 208 were identified as loggerhead sea turtles (*Caretta caretta*) and the remaining 60 labeled as "unidentified sea turtles". As previously demonstrated in other aerial survey studies, sightings drop off dramatically as the BSS increase. In the present study, as the BSS increased from 2 to 3, cetacean sightings decreased from 9.48 to 1.52 per 1000 km surveyed, whereas sea turtle sightings decreased from 36.8 to 8.9 per 1000 km surveyed.

In addition to cetaceans and sea turtles, several sightings were made of other pelagic marine vertebrates including manta rays, ocean sunfish and sharks. 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.

Methodology

Survey design and logistics

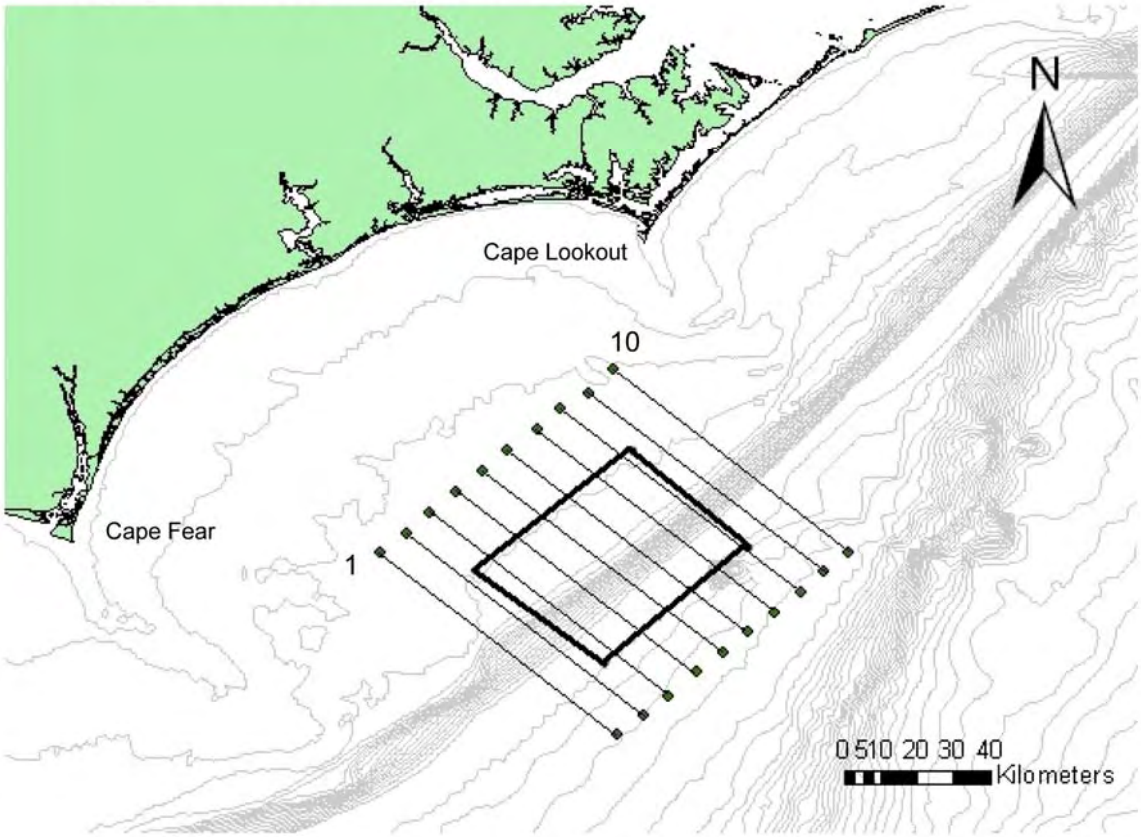
The University of North Carolina Wilmington (UNCW) provided experienced aerial observers and contracted Orion Aviation, Siler City, NC, to provide planes and certified pilots. Surveys were conducted using NOAA – SER Minimum Aircraft and Crew Provisions Guidelines, which require that aircraft are CFR 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. 1 and Table 1). 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 4 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 1. Coordinates for track line end points of the Onslow Bay, NC survey site

	Western End Point		Eastern End Point	
Trackline	Latitude	Longitude	Latitude	Longitude
10	34.2724	-76.6104	33.8157	-76.0252
9	34.2119	-76.6721	33.7679	-76.0870
8	34.1723	-76.7431	33.7154	-76.1456
7	34.1198	-76.8017	33.6653	-76.2104
6	34.0673	-76.8726	33.6152	-76.2783
5	31.0148	-76.9342	33.5626	-76.3399
4	33.9671	-77.0020	33.5149	-76.4047
3	33.9146	-77.0666	33.4575	-76.4724
2	33.8620	-77.1249	33.4074	-76.5370
1	33.8119	-77.1926	33.3596	-76.6017

Figure 1. 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 own GPS unit, data sheet (see Appendix A), voice recorder, and binoculars, and each 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, as well as the break track way point, were recorded. After breaking track, 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 cameras used were an F100 Nikon with an 80-400 mm vibration reduction lens, and 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 original location on the track line and the survey continued. 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. Unless the species identity could be unequivocally established, the designation "unidentified delphinids" or *"Tursiops/Stenella frontalis"* were used. "Unidentified delphinids" was used when delphinids were observed but the species identity of the observed animals could not be established. Unidentifiable species were often the result of high BSS conditions where a clear set of images could not be obtained. *Tursiops/Stenella frontalis* was used when species ID could be narrowed to either of these two morphologically similar species, but exact species could not be diagnosed. 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.

All cetaceans encountered during the first year were also reviewed for species ID during two joint meetings of the UNCW and Duke University Marine Lab (DUML) USWTR survey teams. The best images and field notes for each sighting were displayed in chronological order and each team member was asked to record their species ID and the diagnostic characters that they used to make that identification. Each sighting was then discussed to achieve a final species identification. This process allowed for a more rigorous analysis of each sighting and further development of our list of key diagnostic features for each species. If a consensus could not be reached by the group, or if the images did not allow for a species level identification, the sighting was given the label of unidentified delphinid or *Tursiops/Stenella frontalis*. A total of three cetacean sightings were recorded in which no images were collected; all these sightings were labeled unidentified delphinid.

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 rounded 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 2 and 3 for examples) were sent to DUML for inclusion in the monthly progress report compiled and sent by DUML to Geo-Marine Inc. (Plano, TX).

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 2. Example of May effort table submitted to Duke University Marine Lab.

Date	Line	Sea State	Miles flown
25-May-08	10	3 to 4	40
25-May-08	9	3 to 4	40
25-May-08	8	3 to 4	40
25-May-08	7	3 to 4	40
25-May-08	6	3 to 4	40
25-May-08	5	3 to 4	40
26-May-08	1	2	40
26-May-08	2	2	40
26-May-08	3	2	40
26-May-08	4	2	40
26-May-08	5	2	40
26-May-08	6	2	40
26-May-08	10	2 to 3	40
26-May-08	9	3	40
26-May-08	8	3	40
26-May-08	7	2 to 3	40
27-May-08	1	2 to 3	40
27-May-08	2	2 to 3	40
27-May-08	3	2 to 3	40
27-May-08	4	2 to 3	40

Table 3. Sighting summary table of USWTR aerial surveys in Onslow Bay for May 2007.

Date	Time	On / Off Effort	Track Line	Latitude	Longitude	Observer	Species	Group Size	Notes
25-May-08	9:52	On Effort	10	34.084476	-76.366981	3	*Caretta caretta*	1	
25-May-08	11:13	On Effort	7	33.966150	-76.600401	3	Chondrichthyes	1	
26-May-08	9:05	On Effort	2	33.474283	-76.632099	3	*Tursiops truncauts*	13	Traveling in groups of 2 or 3
26-May-08	11:00	On Effort	6	33.635981	-76.309018	3	*Tursiops truncauts*	13	One mom / calf pair in group
26-May-08	11:23	On Effort	6	33.842253	-76.600234	3	*Tursiops truncauts*	23	One mom / calf pair in group
26-May-08	14:19	On Effort	10	34.214515	-76.514231	3	*Stenella frontalis*	11	Lots of tactile interactions
26-May-08	15:31	On Effort	8	33.821327	-76.276022	3	*Globicephala macrorhynchus*	9	Widely spaced group
26-May-08	16:06	On Effort	7	33.952922	-76.574205	4	*Tursiops truncauts*	6	Feeding on large school of fish
27-May-08	9:57	On Effort	2	33.515733	-76.689246	3	*Tursiops truncauts*	12	Animal traveling in two groups
27-May-08	10:41	On Effort	3	33.592923	-76.655650	4	*Globicephala macrorhynchus*	12	Two calves and one juvenile
27-May-08	11:13	On Effort	4	33.595927	-76.508913	3	*Grampus griseus*	5	Traveling slowly at the surface

Data storage

All data obtained during a flight (GPS coordinates, voice recordings, 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 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 2007 to June 2008 except for December 2007 and February 2008 (10 lines or one full set each month), March 2008 (14 lines), and January (no surveys flown due to weather) for a total of 14,387 km (Table 4). In addition, a preliminary aerial survey consisting of two track lines was conducted in June 2007. 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: 556 km (3.9%), BSS 2: 5096 km (35.4%), BSS 3: 6631 km (46.1 %), BSS 4: 2103 km (14.6%)(Fig. 2a – 2c)]. Effort was terminated at BSS greater than 4. The sighting rates dropped off dramatically as BSS increased, with 7 sightings made in a BSS 1 (12.6 sightings/1000 km flown), 49 in a BSS 2 (9.6 sightings/1000 km flown), 10 in a BSS 3 (1.51 sightings/1000 km flown) and zero sightings in a BSS 4 (Fig. 3a - c). The survey conducted on 24 June 2008 illustrates the influence of sea state on sighting rates. Six

lines flown in the morning in a BSS 3 yielded no sightings, whereas four lines flown in a BSS of 2 in the afternoon yielded eight cetacean sightings (Fig. 4).

Table 4. Track lines and km flown during aerial surveys of the proposed USWTR site in Onslow Bay, NC, between June 2007 and June 2008. Track line numbers listed in the order flown. *On March line 8 was flown both in the NW and the SE direction. June 6th, 2008 survey aborted due to low ceiling.

Date	Track Lines Flown (AM)	Track Lines Flown (PM)	Daily Total km flown
26-Jun-2007	10 and 9	none	147.5
17-Jul-2007	10 to 5	4 to 1	723.5
18-Jul-2007	5 to 10	4 to 1	740.0
6-Aug-2007	none	10 to 5	253.5
7-Aug-2007	1 to 6	7 to 10	740.4
8-Aug-2007	4 to 1	none	298.5
24-Sep-2007	1 to 6	10 to 7	743.2
25-Sep-2007	5 to 10	4 to 1	681.0
14-Oct-2007	1 to 6	7 to 10	743.5
15-Oct-2007	1 to 6	7 to 10	756.5
17-Nov-2007	4 and 3	2 and 1	299.5
18-Nov-2007	10 to 5	4 to 1	742.0
19-Nov-2007	10 to 5	none	447.5
12-Dec-2007	6 to 1	none	447.0
12-Dec-2007	10 to 7	none	297.0
25-Feb-2008	10 and 9	1 to 4	446.5
29-Feb-2008	5 to 8	none	294.0
11-Mar-2008	5 to 7	10 to 8*	521.0
13-Mar-2008	1 to 4	10 to 7	594.0
25-Apr-2008	10 to 5	4 to 1	735.0
26-Apr-2008	1 to 4	10 to 5	738.7
25-May-2008	10 to 5	none	448.4
26-May-2008	1 to 6	10 to 7	743.9
27-May-2008	1 to 4	none	295.5
6-Jun-2008	1/2 of 5	none	39.0
24-Jun-2008	5 to 10	4 to 1	738.7
25-Jun-2008	5 to 10	4 to 1	731.8

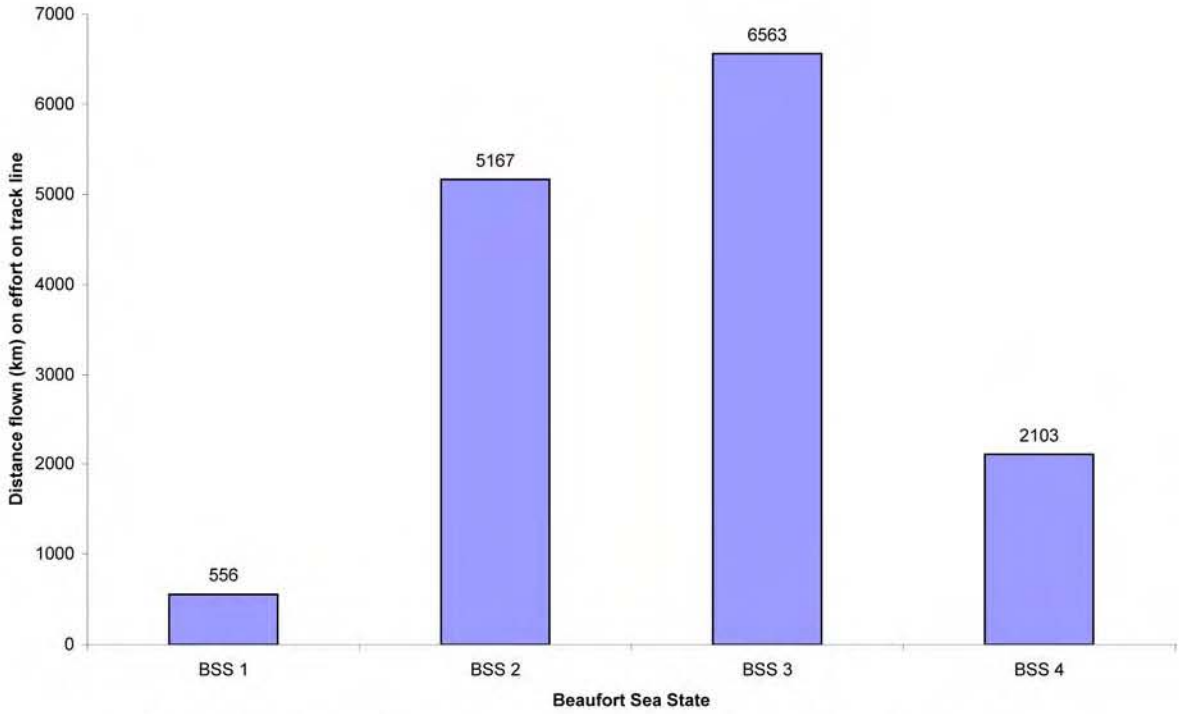


Figure 2a. Total distance surveyed per Beaufort Sea State during the June 2007 - June 2008 UNCW USWTR aerial surveys.

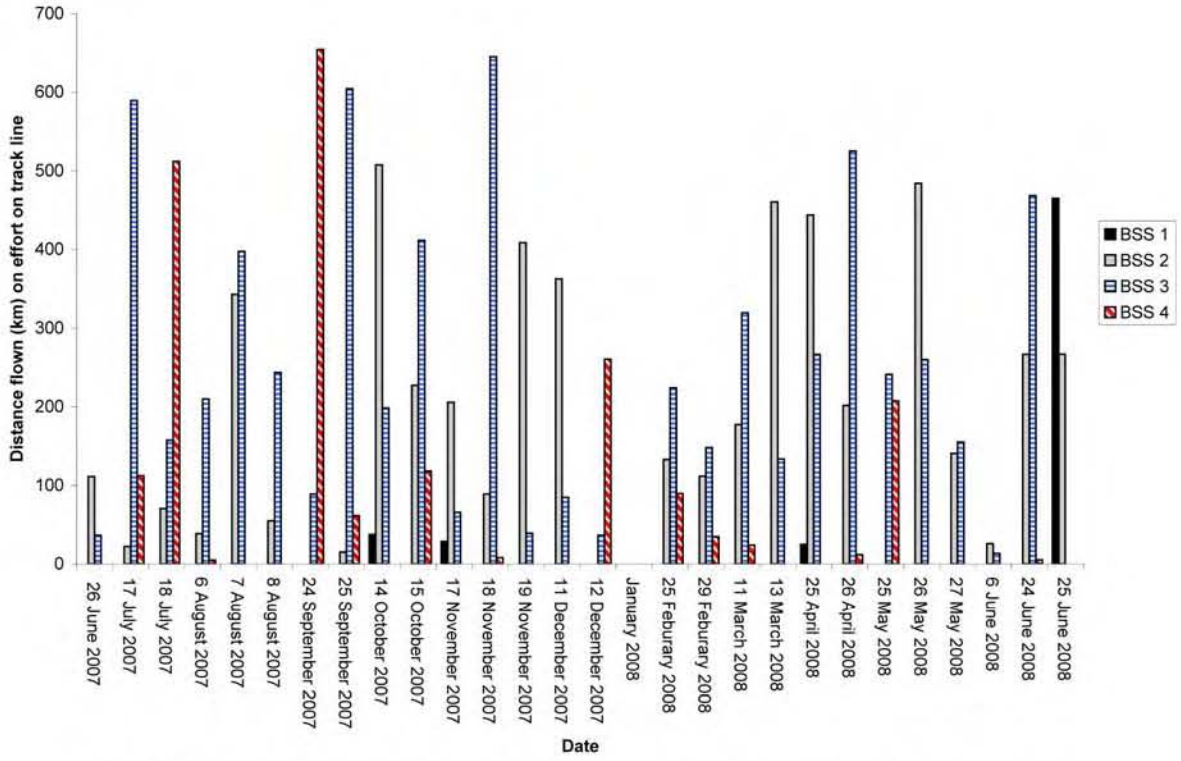


Figure 2b. Effort by Beaufort Sea State for each survey day during the June 2007 - June 2008 UNCW USWTR aerial surveys.

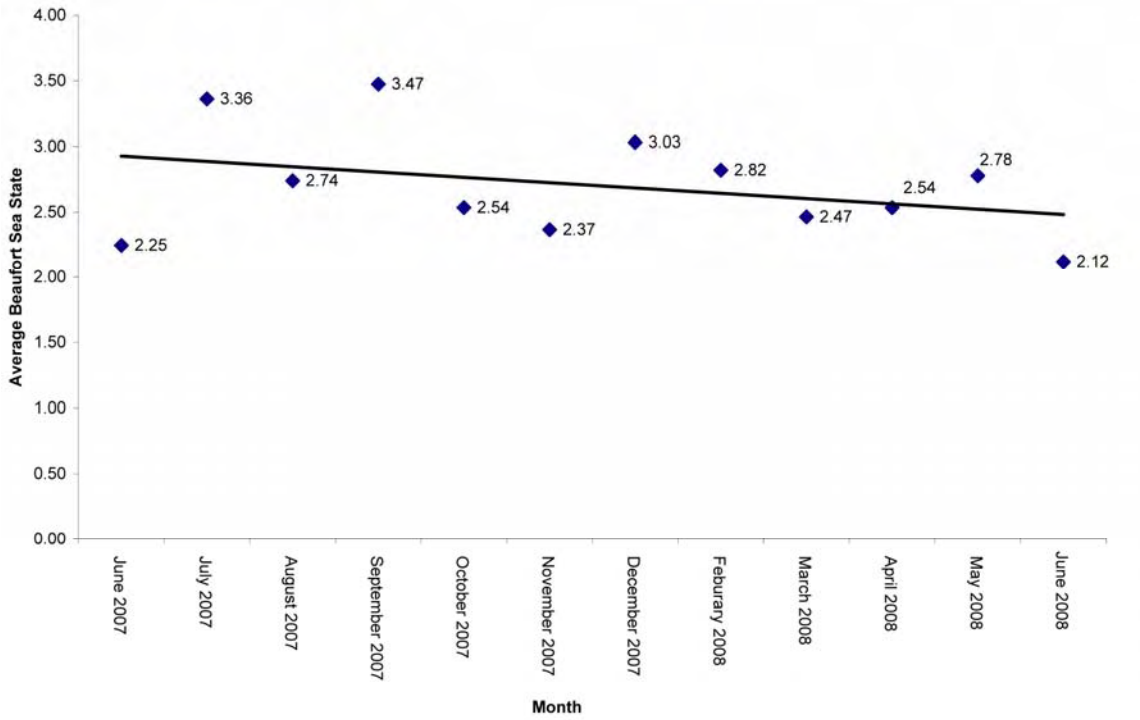


Figure 2c. Average Beaufort Sea State for each month during the June 2007 - June 2008 UNCW USWTR aerial survey in Onslow Bay, NC. Values were calculated using the formula AvgBSS = [(Time @ BSS1 * 1)+(Time @ BSS2 * 2)+……./Total time flown]

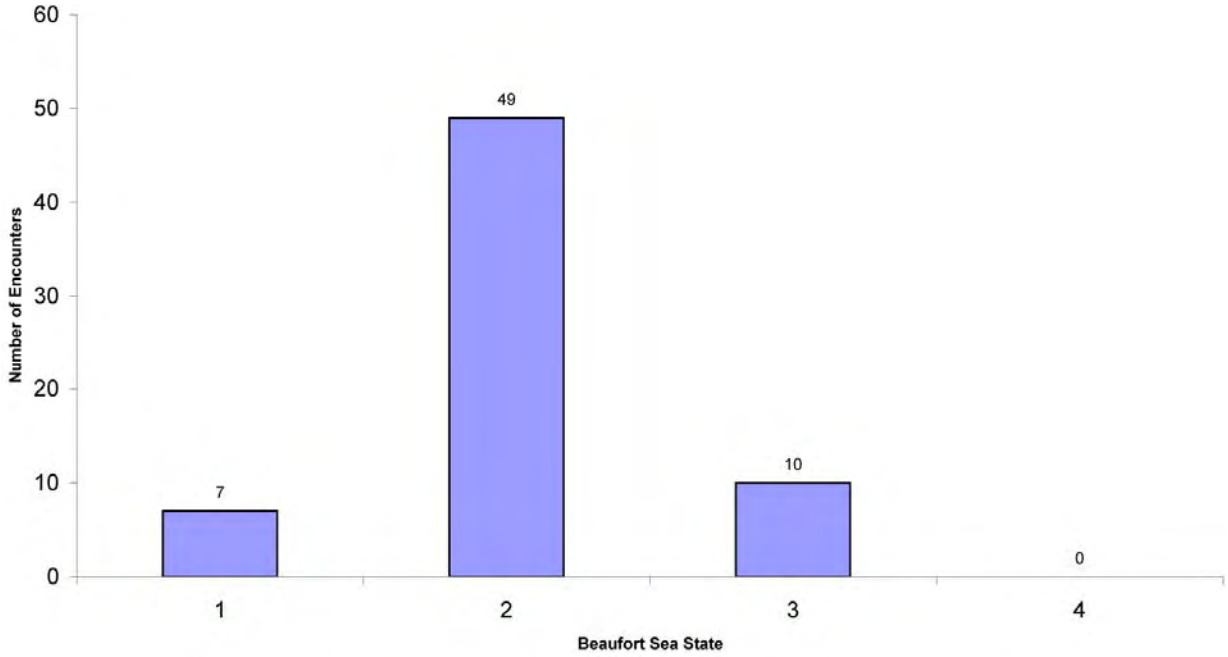


Figure 3a. Total number of cetacean sightings per Beaufort Sea State in the proposed USWR site in Onslow Bay, North Carolina from June 2007 - June 2008.

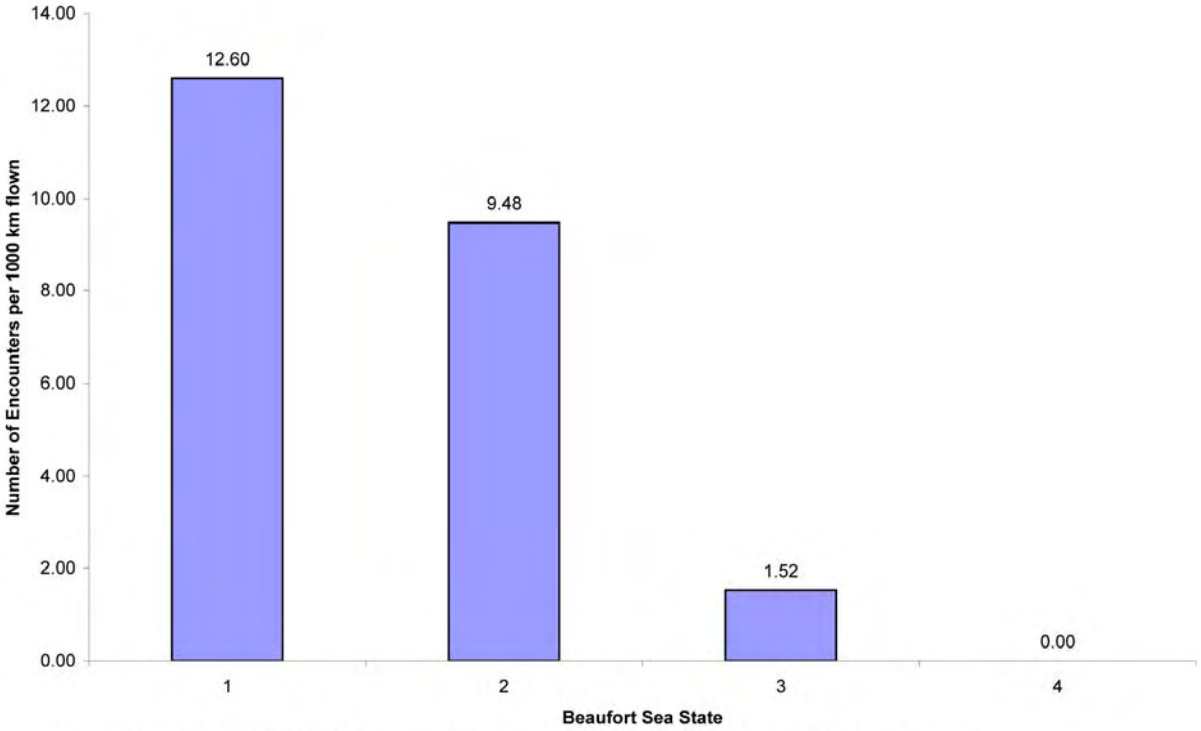


Figure 3b. Cetacean sightings per 1000 km flown by Beaufort sea state from June 2007 - June 2008 in the proposed USWTR site in Onslow Bay, North Carolina.

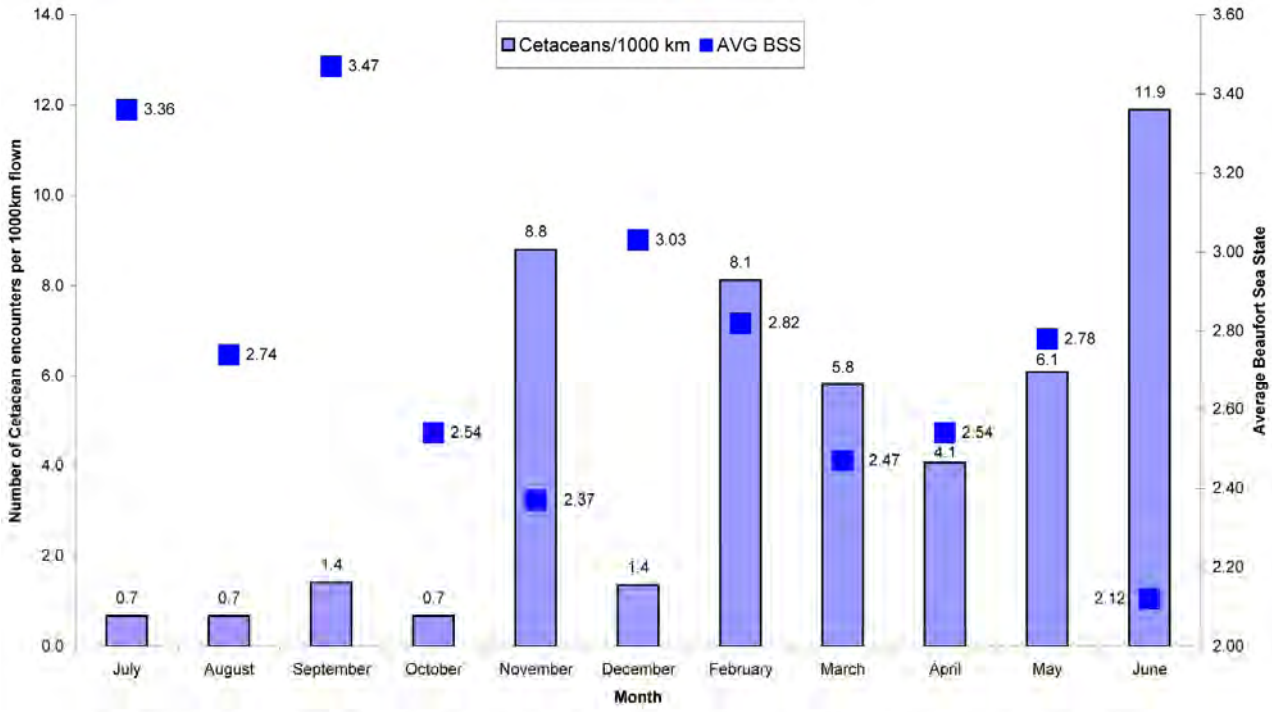


Figure 3c. Cetacean sightings per 1000 km surveyed and the average Beaufort Sea State per month.

The mean sighting distance for all cetacean sightings was 0.84 km (SD=0.69) 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). When plotting average sighting distances, outliers were removed from the data. An outlier was defined as a value in excess of more than three standard deviations from the mean. Three sighting distances which were considered outliers were removed from these calculations (i.e. sighting distances calculated at 3.7, 4.5, and 6.5 km from the trackline).

A reviewer suggested we perform a Hiby fly back or circle back, in which a single plane repeats a segment of track line already flown to obtain duplicate sightings to reduce the coefficient of variation of the results obtained (Hiby, 1999). On 11 March 2008 we performed a modified Hiby flyback in which track line 8 was initially flown west to east and then immediately flown in the east to west in its entirety. Sightings were similar between the initial and the return survey of track line 8 for fishes. Turtles were only observed on one leg (Fig. 6).

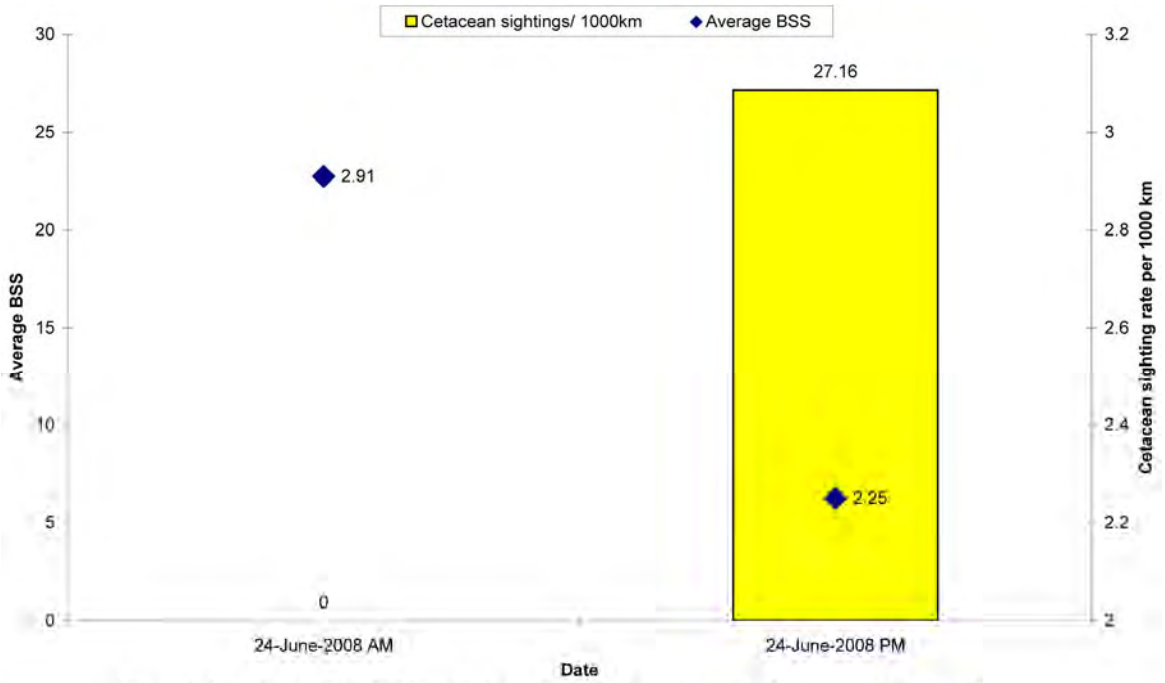


Figure 4. Variation in Beaufort Sea State and cetacean sighting rates between morning and afternoon flights on June 24 2008.

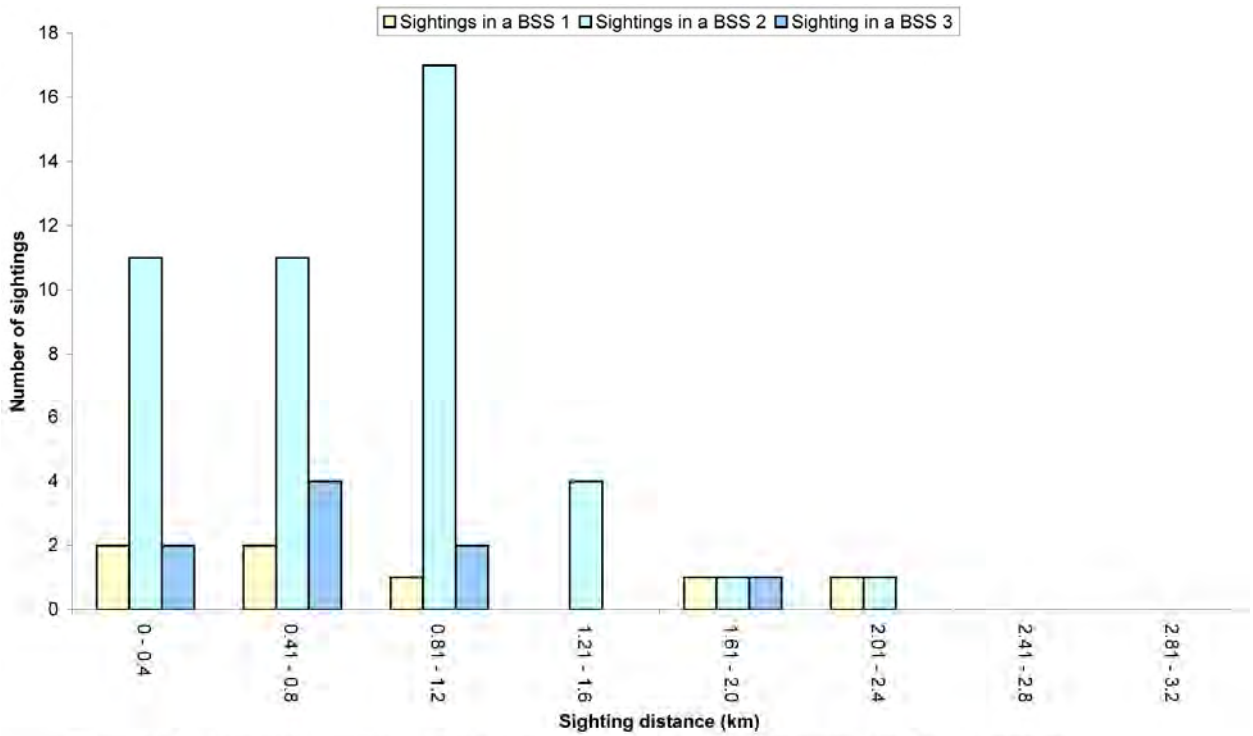


Figure 5a. Cetacean sighting distances by Beaufort Sea State. A total of 61 sightings are graphed (2 outliers removed and 3 delphinid sightings that distance could not be calculated).

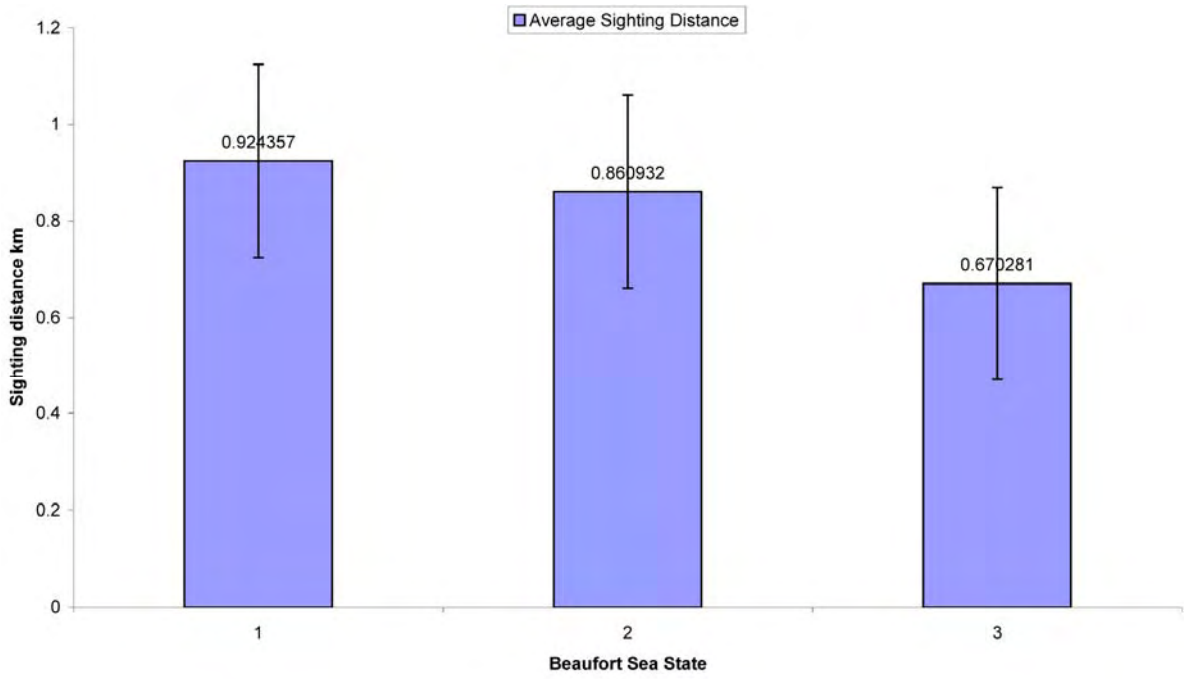


Figure 5b. Mean sighting distance by Beaufort sea state for all cetacean encounters in the Onslow Bay, NC proposed USWTR site.

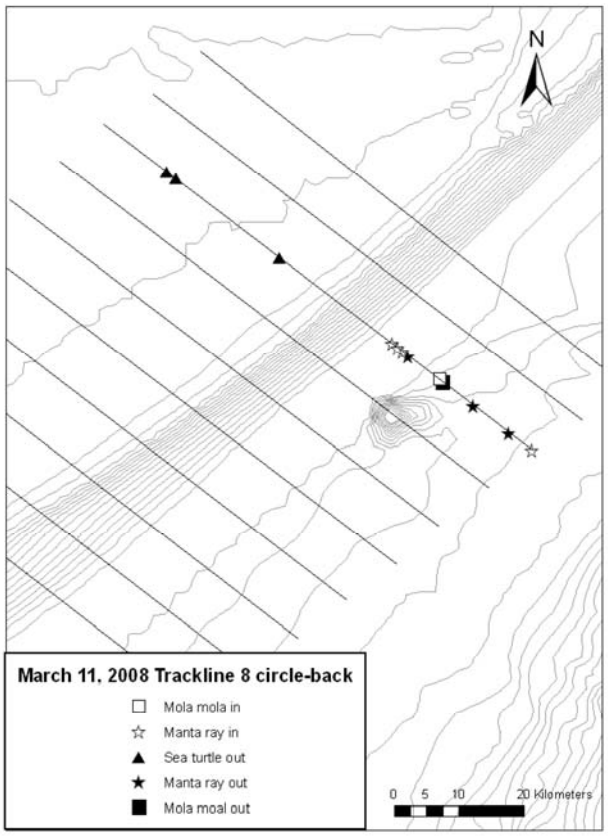


Figure 6. Sightings during circle-back conducted on March 11, 2008.

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. Two North Atlantic right whales (*Eubalena glacialis*) were encountered during transit out to the survey site on November 17th, 2007, approximately 47 km southeast from shore and 40 km northwest from the inshore, westernmost boundary of the survey area.

A total of 853 individual cetaceans in 66 sightings were encountered while on effort in the survey area (Table 5). The highest number of sightings occurred in June 2008, followed by November 2007, May 2008, and March 2008. Highest species diversity was also observed in May and June 2008. Sightings for each month are summarized in Appendix 6. Summaries for each individual sighting are in Appendix 7. 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.

Table 5. Total number of sightings and individuals for each species by month for the Onslow Bay, NC USWTR survey site.

		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**

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Bottlenose dolphins (*Tursiops truncatus*) (Table 6, Fig. 7)

The bottlenose dolphin was the most commonly observed cetacean species during the present study, based both upon number of sightings and number of individuals. This species was observed 33 times for a total of 461 individuals. Group size ranged between 1-80 individuals (mean=14). Bottlenose dolphins were seen in October, November, December, (no survey January), 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. 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). Encounters occurred in September, October, November, December, April, and May (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	Sighting Cue	Min #	Max #	Best #	Calf Y/N
26-Jun-07	11:22	13	33.929194	-76.171245	SE	10	1	45	3	60	90	80	N
14-Oct-07	9:33	8	33.483661	-76.759508	SE	1	2	90	2	35	42	40	N
17-Nov-07	10:13	14	33.913005	-76.947197	SE	4	1	90	3	3	4	3	N
17-Nov-07	10:32	20	33.713446	-76.671020	SE	4	2	90	3	16	20	18	N
17-Nov-07	10:41	22	33.686476	-76.604707	SE	4	1	90	3	9	9	9	N
17-Nov-07	11:08	30	33.668959	-76.731080	NW	3	2	60	3	23	25	23	N
18-Nov-07	9:36	15	33.766869	-76.079809	NW	10	3	90	3	2	3	3	N
19-Nov-07	9:46	14	33.689801	-76.496961	SE	5	1	110	3	4	4	4	N
19-Nov-07	9:52	18	33.668711	-76.465009	SE	5	1	100	3	8	10	8	Y
19-Nov-07	10:14	25	33.783959	-76.491535	NW	6	2	90	3	4	6	5	N
19-Nov-07	12:22	80	33.824244	-76.041044	NW	10	3	60	3	37	45	40	N
11-Dec-07	12:57	34	33.768400	-76.875538	NW	3	1	90	3	1	1	1	N
11-Mar-08	10:52	34	33.760469	-76.352189	SE	7	2	90	3	15	16	15	N
13-Mar-08	11:40	26	33.861341	-76.985223	SE	3	3	90	3	4	7	5	N
13-Mar-08	15:50	77	33.784879	-76.257041	NW	8	3	90	3	12	16	13	N
25-Apr-08	10:31	23	34.142246	-76.696676	SE	8	3	90	2	3	3	3	N
25-Apr-08	14:30	62	33.598467	-76.508261	SE	4	1	90	3	10	13	12	N
26-Apr-08	10:54	17	33.623796	-76.544074	NW	4	3	90	3	10	20	15	N
26-Apr-08	11:25	26	33.943435	-76.970047	NW	4	1	110	3	4	4	4	N
26-Apr-08	13:49	41	33.896252	-76.249675	NW	9	2	90	3	8	10	9	N
26-May-08	9:05	12	33.47428	-76.63210	NW	2	2	90	1	12	14	13	N
26-May-08	11:00	38	33.63598	-76.30902	NW	6	1	90	3	12	15	13	Y
26-May-08	11:23	41	33.84225	-76.60023	NW	6	3	80	3	20	25	23	Y
26-May-08	16:06	73	33.95292	-76.57421	NW	7	3	90	3	6	7	6	N
27-May-08	9:57	10	33.515733	-76.689246	NW	2	4	90	3	5	12	12	N
24-Jun-08	14:15	32	33.800619	-76.781757	SE	4	3	120	3	4	7	7	N
24-Jun-08	15:52	59	33.398254	-76.639548	NW	1	2	90	3	25	25	25	N
25-Jun-08	9:48	7	33.584993	-76.363913	SE	5	1	90	3	6	10	9	Y
25-Jun-08	11:15	26	33.941355	-76.457001	NW	8	2	90	3	2	2	2	N
25-Jun-08	12:48	48	34.083751	-76.361075	NW	10	3	90	3	1	1	1	N
25-Jun-08	14:55	61	33.646071	-76.546472	SE	4	4	90	3	13	15	14	N
25-Jun-08	15:55	72	33.541729	-76.695676	SE	2	3	90	3	11	12	11	N
25-Jun-08	16:09	77	33.368079	-76.621439	NW	1	2	45	3	14	16	15	N

Table 6. All *Tursiops truncatus* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

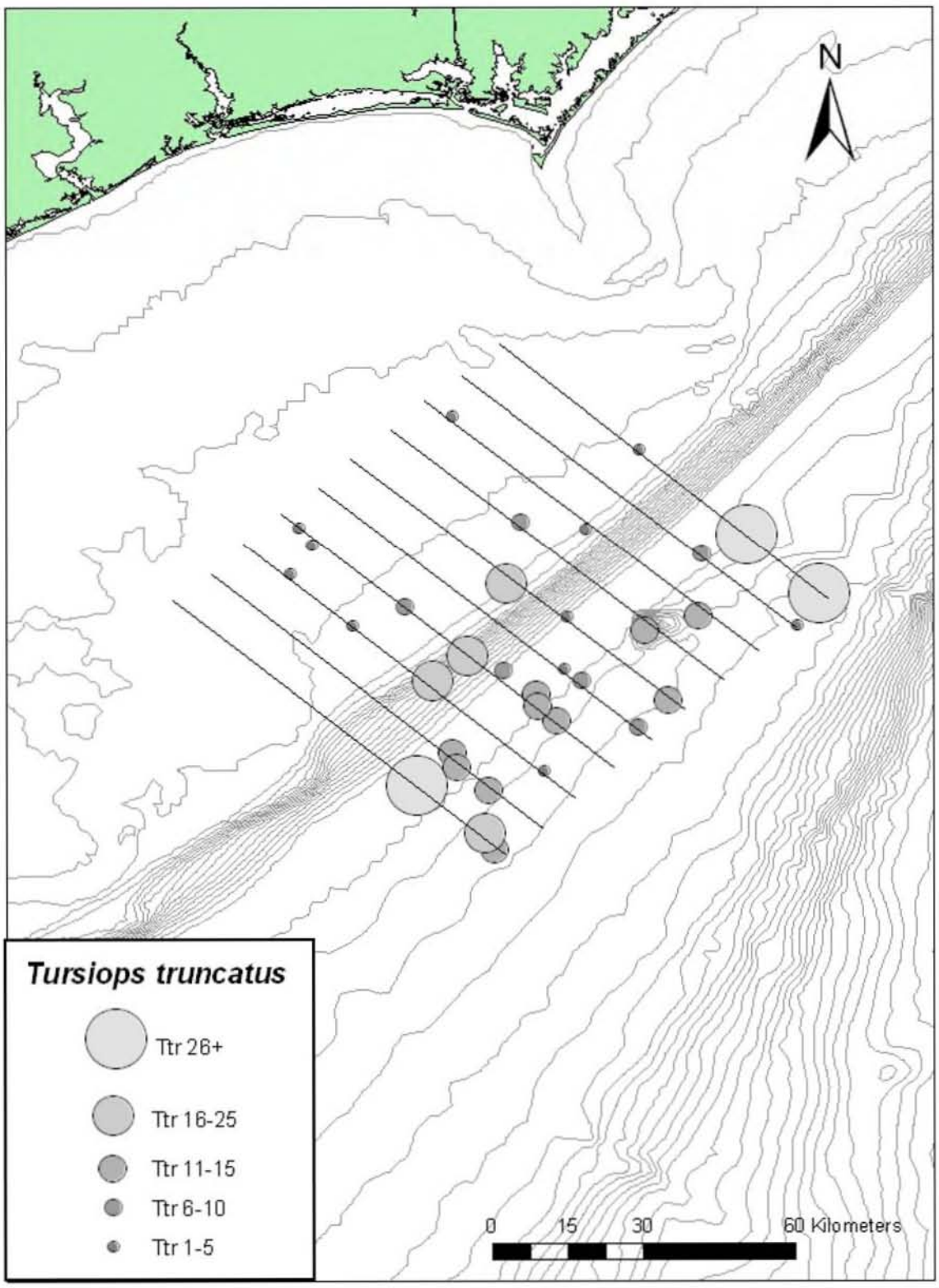

Figure 7. Bottlenose dolphin (*Tursiops truncatus*) sightings indicating group size.

Atlantic spotted dolphins (*Stenella frontalis*) (Table 7, Fig. 8)

The spotted dolphin was the second most commonly encountered species in the survey area. Groups of spotted dolphins were sighted 11 times for a total of 177 individuals. This species was encountered in September, February, March, May, and June. Group size ranged between 4 and 36 (mean group size = 16). 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. 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	Sighting Cue	Min #	Max #	Best #	Calf Y/N
25-Sep-07	11:01	24	34.089353	-76.540134	SE	9	3	100	3	4	4	4	N
29-Feb-08	10:02	5	33.966286	-76.880373	SE	5	2	110	3	7	9	8	N
29-Feb-08	10:18	13	33.812978	-76.653357	SE	5	3	90	3	5	8	7	N
29-Feb-08	11:17	35	34.036700	-76.707461	SE	7	1	100	2	24	30	27	Y
29-Feb-08	11:28	39	33.946793	-76.572190	SE	7	2	90	3	23	29	26	N
11-Mar-08	14:32	63	34.189870	-76.657393	NW	9	3	90	2	30	40	36	N
26-May-08	14:19	53	34.21452	-76.51423	SE	10	3	30	3	11	12	11	N
24-Jun-08	14:00	28	33.937103	-76.964589	SE	4	2	90	3	4	6	5	N
24-Jun-08	14:22	35	33.772186	-76.741641	SE	4	2	90	3	34	37	35	Y
24-Jun-08	16:15	63	33.744705	-77.09179	NW	1	1	90	3	10	10	10	N
25-Jun-08	10:24	15	34.050011	-76.858224	NW	6	2	90	3	8	8	8	Y

Table 7. All *Stenella frontalis* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

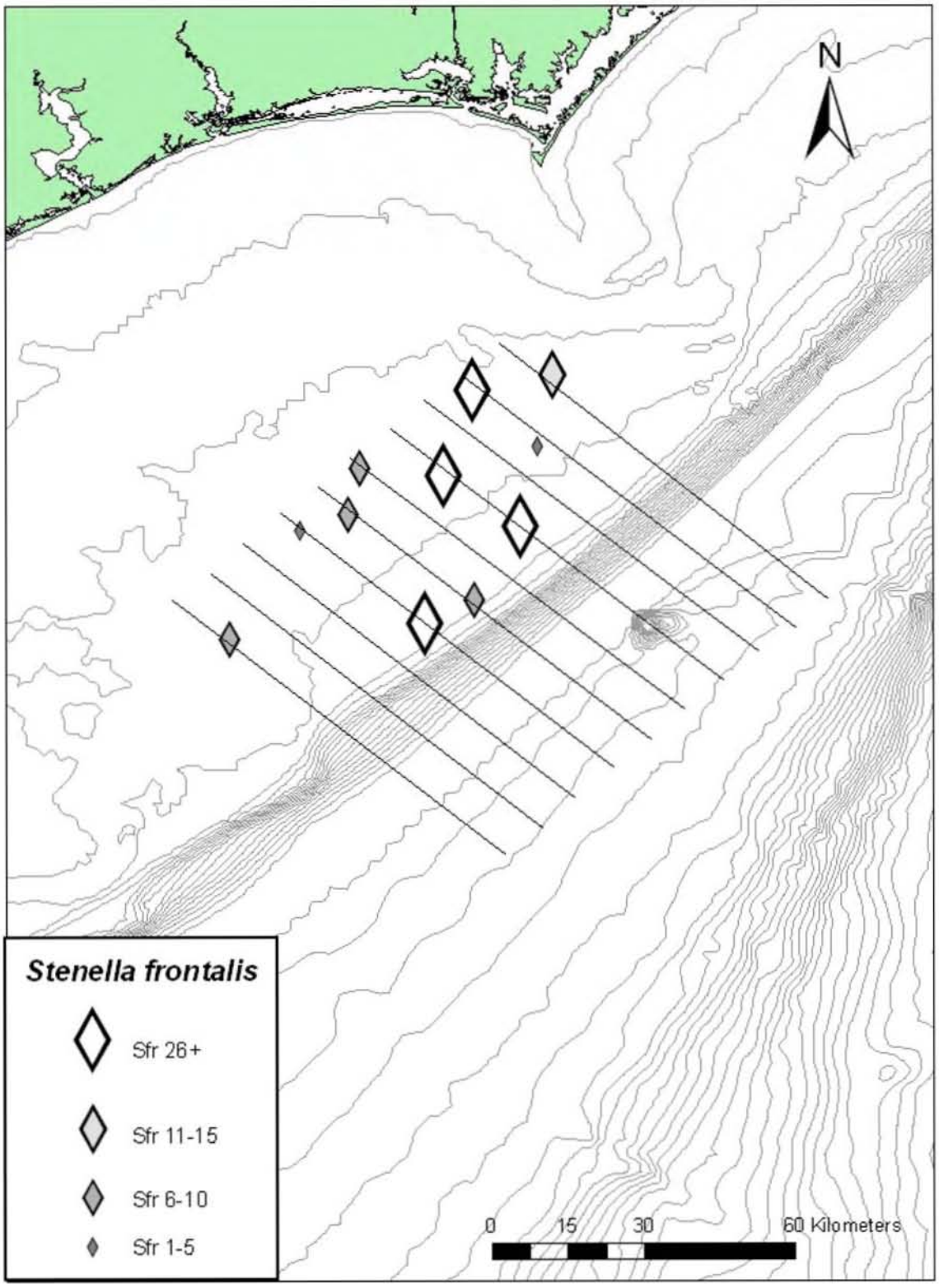

Figure 8. Spotted dolphin (*Stenella frontalis*) sightings indicating group size.

Short-finned pilot whales (*Globicephala macrorhynchus)* (Table 8, Fig. 9)

Short-finned pilot whales were encountered three times, once in June 2007 and twice during May 2008, for a total of 53 individuals. Calves were observed in June 2007 and during one encounter in May 2008. All three sightings of this species were offshore of the continental shelf break. 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	Sighting Cue	Min #	Max #	Best #	Calf Y/N
26-Jun-07	11:51	20	33.861928	-76.193985	NW	9	3	45	3	28	35	32	Y
26-May-08	15:31	68	33.82133	-76.27602	SE	8	3	90	3	5	12	9	N
27-May-08	10:41	18	33.592923	-76.65565	SE	3	2	90	3	12	12	12	Y

Table 8. All G*lobicephala macrorhynchus* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

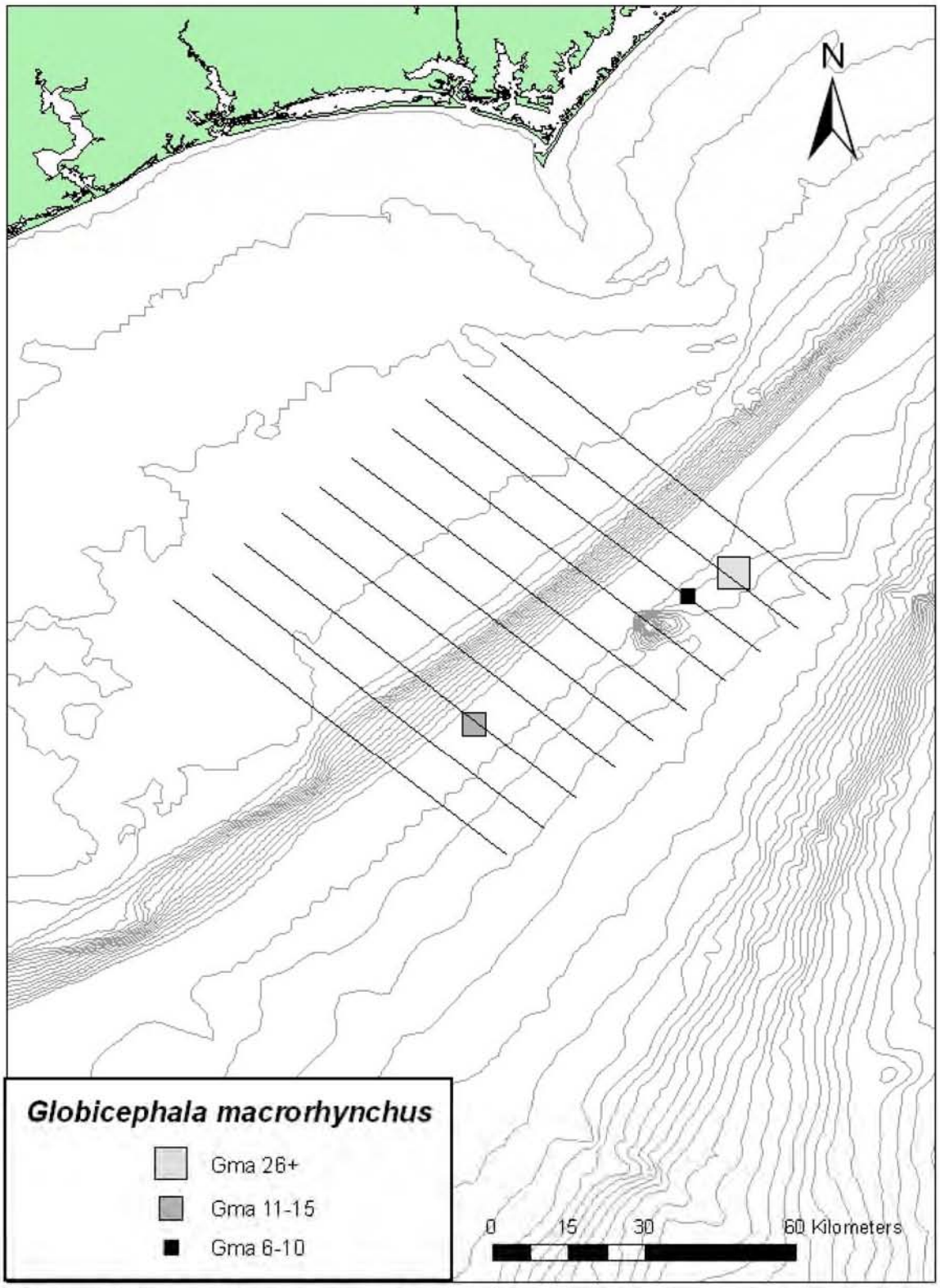

Figure 9. Short finned pilot whales (*Globicephala macrorhynchus*) sightings indicating group size.

Rough-toothed dolphins (*Steno bredanensis*) (Table 9, Fig. 10)

Three groups of rough-toothed dolphins were observed for a total of 40 individuals. One encounter occurred in April 2008 and two in June 2008. The group size ranged from 5 to 26 (mean = 13). A small calf was seen during one of the June sightings. All sightings of this species occurred offshore of the continental shelf break. This species was not observed during the 1998/1999 aerial surveys of the proposed USWTR site (McLellan *et al*. 1999). No stock estimate for *S. bredanensis* in the western north Atlantic is available.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #	Calf Y/N
25-Apr-08	10:56	29	33.806142	-76.266700	SE	8	3	90	3	24	28	26	N
24-Jun-08	15:34	53	33.516511	-76.66473	SE	2	3	120	4	7	10	9	N
24-Jun-08	14:52	47	33.551987	-76.594555	NW	3	2	60	3	3	5	5	Y

Table 9. All *Steno bredanensis* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

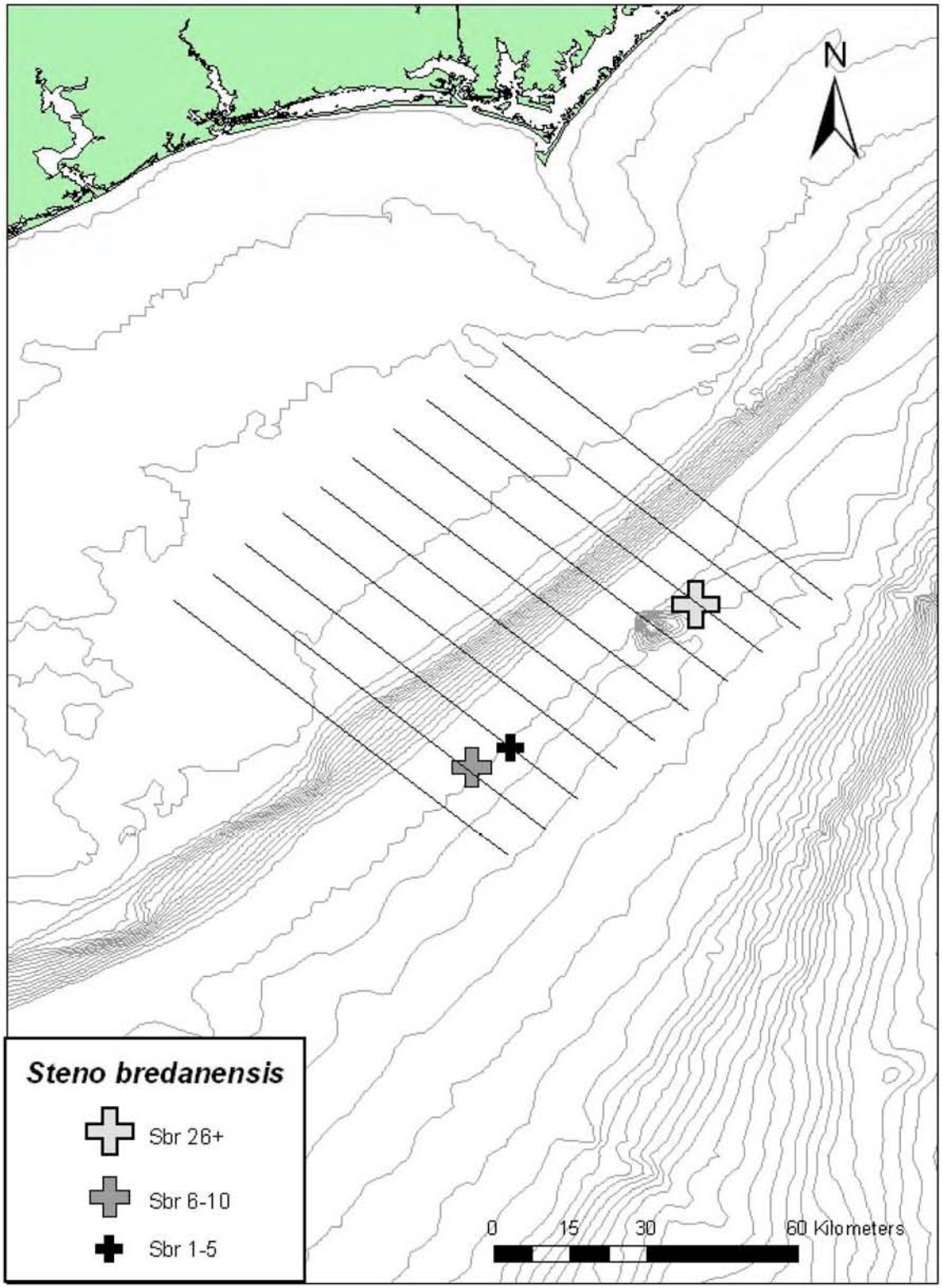

Figure 10. Rough-toothed dolphin (*Steno bredanensis*) sightings indicating group size.

Risso's dolphins *(Grampus griseus)* (Table 10, Fig. 11)

This species was encountered three times, once in May 2008 and twice in June 2008, for a total of 20 individuals. Group sizes for the three encounters were 5, 10, and 5 (average group size = 7). All encounters occurred in waters offshore of the continental shelf break. A very small 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). Risso's dolphins can be found 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	Sighting Cue	Min #	Max #	Best #	Calf Y/N
27-May-08	11:13	25	33.595927	-76.508913	NW	4	3	90	3	4	5	5	N
25-Jun-08	12:15	45	33.831817	-76.037992	NW	10	1	90	3	8	12	10	Y
25-Jun-08	15:03	64	33.593274	-76.507083	SE	4	2	90	3	5	5	5	Y

Table 10. All *Grampus griseus* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

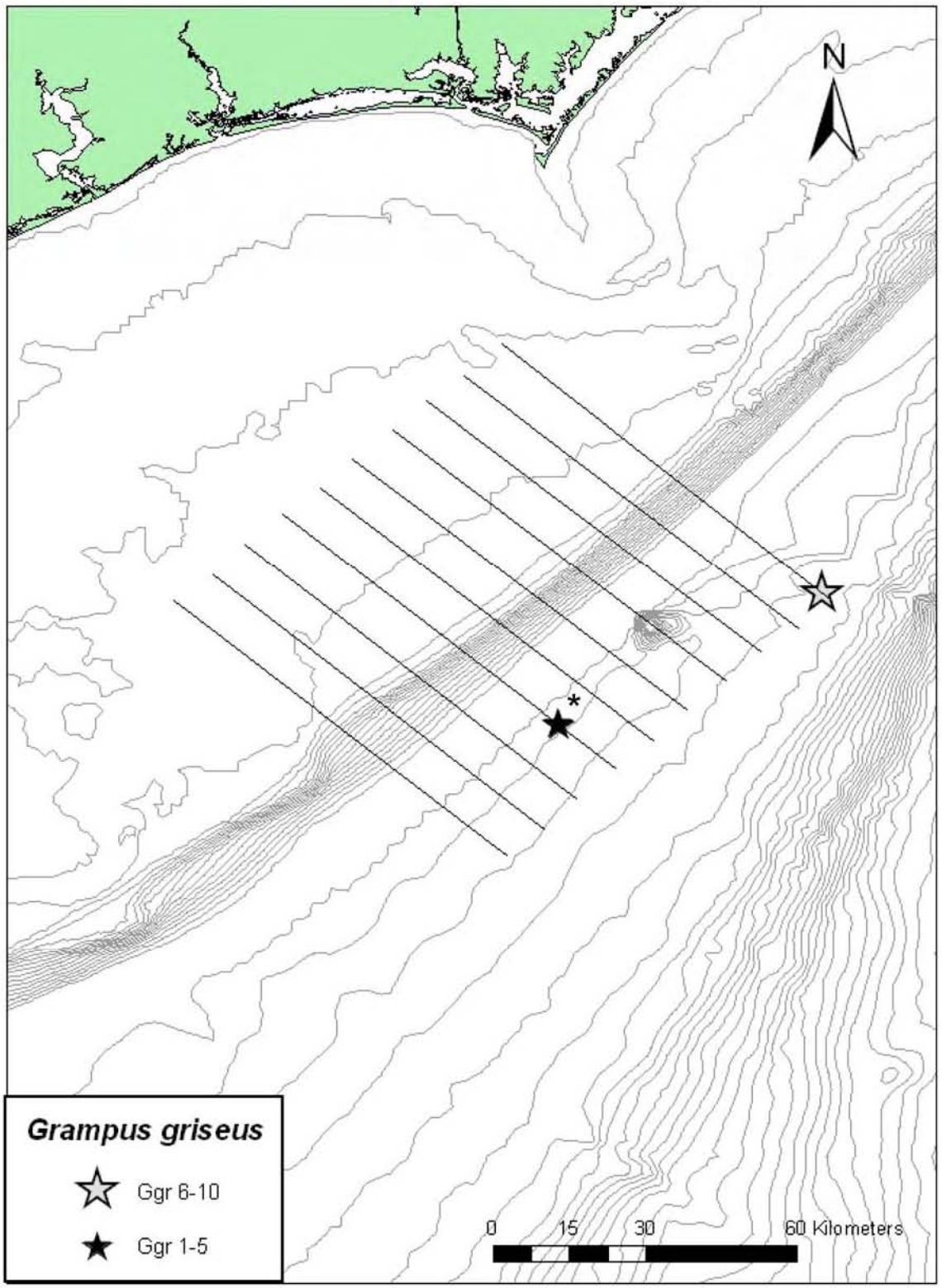

Figure 11. Risso's dolphin (*Grampus griseus*) sightings indicating group size. * Indicates that there are 2 sightings at this location each of 5 animals.

Tursiops/Stenella frontalis (Table 11, Fig. 12)

In two sightings of a total of five individuals, species identity could be narrowed down to *Tursiops truncatus* or *Stenella frontalis*. In these cases, the designation *Tursiops/Stenella frontalis* was used.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #	Calf Y/N
24-Jun-08	14:48	43	33.507569	-76.532724	NW	3	1	90	3	2	2	2	N
13-Mar-08	11:12	18	33.786004	-77.024951	NW	2	1	90	3	3	3	3	N

Table 11. All *Tursiops/ Stenella frontalis* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

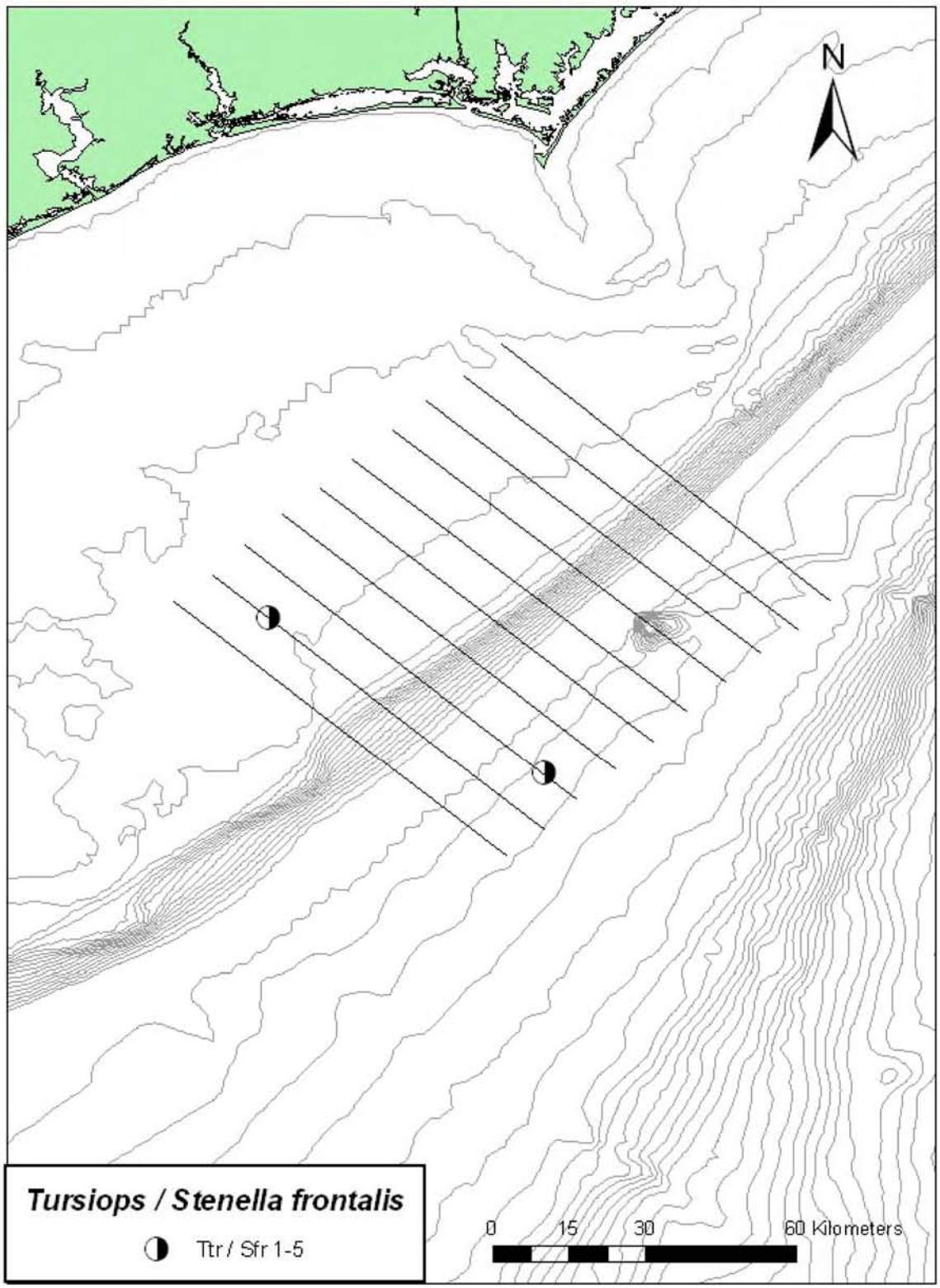

Figure 12. Bottlenose dolphin / Spotted dolphin (*Tursiops / Stenella frontalis*) sightings indicating group size.

Unidentified delphinids (Table 12, Fig. 13)

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 97 unidentified delphinids in 11 sightings were recorded. Group size of unidentified delphinids ranged between 1 and 22 (mean=8).

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #	Calf Y/N
18-Jul-07	10:06	23	33.883485	-76.373307	NW	8	1	90	3	4	7	6	N
7-Aug-07	11:07	21	33.705724	-76.394329	NW	6	3	30	3	2	4	3	N
25-Sep-07	10:43	21	34.159464	-76.597856	SE	9	1	90	3	5	7	6	N
19-Nov-07	9:34	10	33.761658	-76.603021	SE	5	3	90	3	14	23	20	Y
19-Nov-07	10:29	30	33.916486	-76.681417	NW	6	2	80	3	11	12	11	N
19-Nov-07	11:10	44	33.804399	-76.385545	SE	7	2	120	3	22	25	22	N
19-Nov-07	11:47	66	34.134283	-76.692483	NW	8	2	90	3	3	3	3	N
25-Feb-08	14:06	48	33.671971	-76.995668	SE	1	2	110	3	6	9	7	N
25-Feb-08	14:45	57	33.721963	-76.944112	NW	2	1	90	3	11	15	13	N
11-Mar-08	14:08	57	34.072139	-76.473937	NW	9	3	90	3	5	7	5	N
25-Jun-08	11:54	30	34.022289	-76.418861	SE	9	3	90	3	1	1	1	N

Table 12. All unidentified delphinid sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

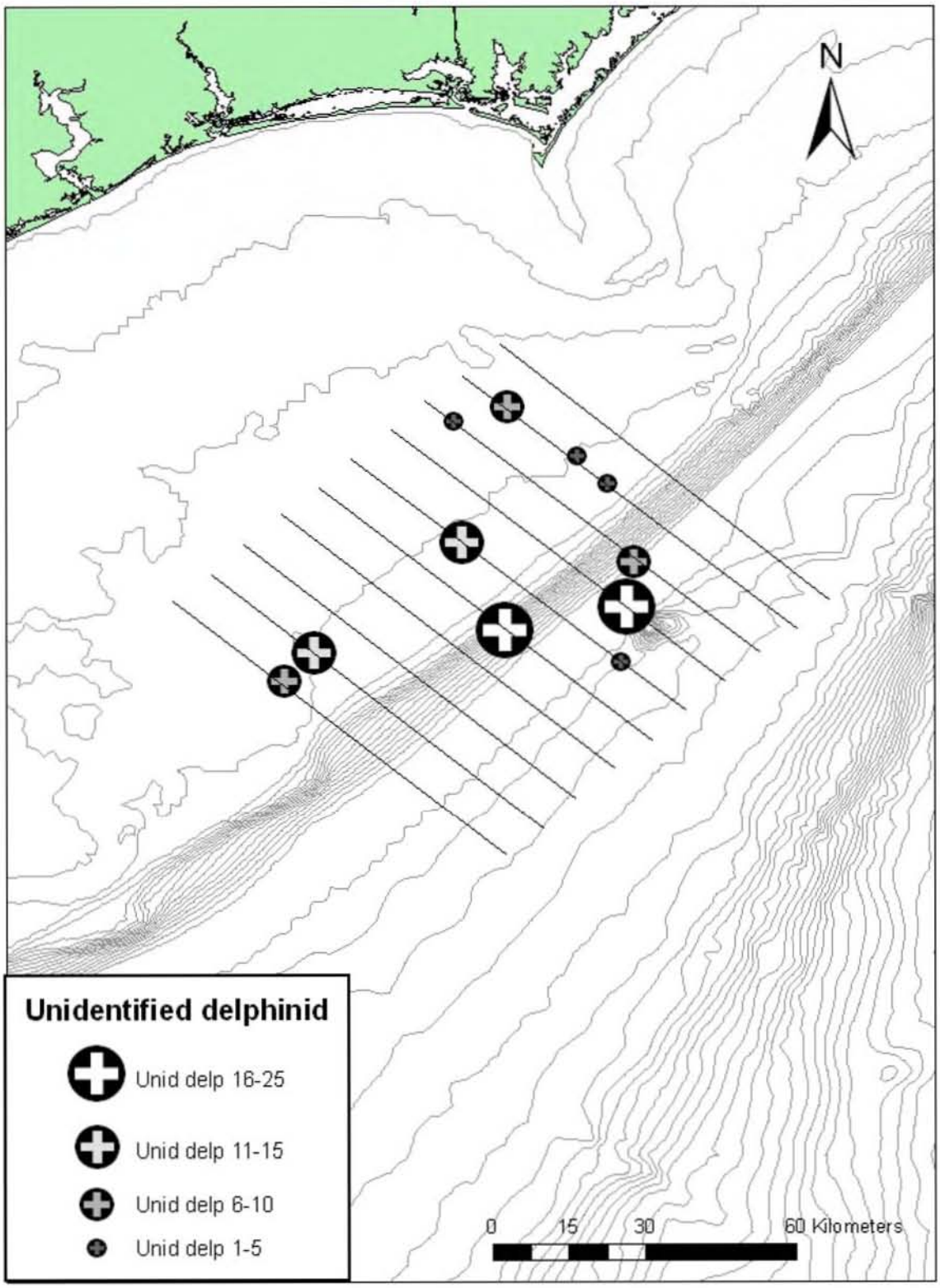

Figure 13. Unidentified delphinid sightings indicating group size.

Sea Turtle Sightings (Tables 13 and 14, Figs. 14 and 15a-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*), leather back (*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 268 sea turtles were seen in the survey area between June 2007 and June 2008. Of these, 208 were identified as loggerhead sea turtles and the remaining 60 labeled as "unidentified sea turtles". Hence, the only sea turtle species positively identified in the study area was the loggerhead turtle. In contrast to the 1998/1999 surveys, no leatherback sea turtles were seen (McLellan *et al*. 1999). Sea turtles were seen during all months surveyed except in August 2007, although abundance fluctuated throughout the year. The lowest densities were observed between July and October (0.0 to 3.5 sea turtles /1000 km) and the highest densities occurred between November and March (35.9 to 63.7 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	Sighting Cue	Min #	Max #	Best #
26-Jun-07	10:49	12	34.198552	-76.515018	SE	10	3	90	3	1	1	1
26-Jun-07	11:06	16	34.158743	-76.479518	SE	10	1	90	3	1	1	1
26-Jun-07	11:10	18	34.136318	-76.436727	SE	10	2	90	3	1	1	1
26-Jun-07	11:39	16	33.887715	-76.117205	SE	10	3	90	3	1	1	1
26-Jun-07	12:10	23	33.948014	-76.319892	NW	9	2	90	3	1	1	1
26-Jun-07	12:16	25	34.051203	-76.459225	NW	9	2	30	3	1	1	1
26-Jun-07	12:21	26	34.154647	-76.592118	NW	9	3	30	3	1	1	1
26-Jun-07	12:24	28	34.208053	-76.665405	NW	9	3	60	3	1	1	1
26-Jun-07	12:17	28	34.069589	-76.483684	NW	9	3	60	3	1	1	1
26-Jun-07	12:21	30	34.157549	-76.595846	NW	9	4	90	3	1	1	1
18-Jul-07	8:50	6	33.783169	-76.628061	SE	5	1	90	3	1	1	1
24-Sep-07	9:40	6	33.726151	-77.078952	SE	1	3	90	3	1	1	1
24-Sep-07	9:56	7	33.419931	-76.677856	SE	1	2	100	3	2	2	2
24-Sep-07	10:31	15	33.868707	-77.009495	SE	3	1	90	3	1	1	1
25-Sep-07	14:56	42	33.481771	-76.507232	NW	3	2	90	3	1	1	1
14-Oct-07	15:26	49	34.073449	-76.613081	NW	8	1	90	3	1	1	1
14-Oct-07	15:38	46	34.152089	-76.592553	SE	9	1	90	3	1	1	1
17-Nov-07	10:03	7	33.916902	-76.936368	SE	4	3	90	3	1	1	1
17-Nov-07	10:25	17	33.840586	-76.834218	SE	4	1	90	3	1	1	1
17-Nov-07	10:25	18	33.838469	-76.831379	SE	4	1	90	3	1	1	1
17-Nov-07	10:49	15	33.607221	-76.525800	SE	4	2	90	3	1	1	1
17-Nov-07	10:53	16	33.518437	-76.407462	SE	4	2	60	3	1	1	1
17-Nov-07	11:12	21	33.713736	-76.803719	NW	3	4	60	3	1	1	1
17-Nov-07	11:18	34	33.834663	-76.969675	NW	3	3	90	3	1	1	1
17-Nov-07	11:20	36	33.845537	-76.975936	NW	3	1	90	3	1	1	1
17-Nov-07	11:20	24	33.851705	-76.984646	NW	3	1	90	3	1	1	1
17-Nov-07	11:23	25	33.899050	-77.047241	NW	3	3	60	3	1	1	1
17-Nov-07	15:00	41	33.478111	-76.629145	SE	2	1	60	3	1	1	1
17-Nov-07	15:23	44	33.656229	-76.987350	NW	1	1	90	3	1	1	1
18-Nov-07	10:01	18	34.114387	-76.542791	NW	9	3	90	3	1	1	1
18-Nov-07	10:01	19	34.121617	-76.552489	NW	9	2	60	3	1	1	1
18-Nov-07	11:35	38	33.852760	-76.586283	SE	6	1	60	3	1	1	1
18-Nov-07	11:43	39	33.692515	-76.379708	SE	6	2	90	3	1	1	1
18-Nov-07	9:20	11	34.028677	-76.295084	SE	10	2, 3	90	3	2	2	2
19-Nov-07	9:23	5	33.956730	-76.857000	SE	5	2	100	3	1	1	1
19-Nov-07	9:24	6	33.933040	-76.826040	SE	5	2	90	3	1	1	1
19-Nov-07	9:27	8	33.873515	-76.748801	SE	5	1	100	3	1	1	1
19-Nov-07	10:07	18	33.657321	-76.331965	NW	6	3	90	3	1	1	1
19-Nov-07	10:41	24	34.001463	-76.789518	NW	6	2	90	3	1	1	1
19-Nov-07	10:43	26	34.038649	-76.837006	NW	6	3	90	3	1	1	1
19-Nov-07	10:43	25	34.028100	-76.822347	NW	6	2	90	3	2	2	2

Table 13. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
19-Nov-07	10:48	29	34.104149	-76.782757	SE	7	3	90	3	1	1	1
19-Nov-07	10:50	30	34.060311	-76.714242	SE	7	3	90	3	1	1	1
19-Nov-07	11:29	40	33.829620	-76.287666	NW	8	2	60	3	1	1	1
19-Nov-07	11:44	44	34.100959	-76.648564	NW	8	1	60	3	1	1	1
19-Nov-07	11:44	43	34.089744	-76.633873	NW	8	2	60	3	1	1	1
19-Nov-07	11:45	45	34.119055	-76.673604	NW	8	3	60	3	2	2	2
19-Nov-07	12:43	56	34.173875	-76.483219	NW	10	2	60	3	1	1	1
11-Dec-07	11:21	5	33.978966	-76.754569	SE	6	2	90	3	1	1	1
11-Dec-07	11:22	6	33.960016	-76.728545	SE	6	3	90	3	1	1	1
11-Dec-07	12:01	14	33.902819	-76.784864	NW	5	2	45	3	1	1	1
11-Dec-07	12:02	15	33.922376	-76.808914	NW	5	1	45	3	1	1	1
11-Dec-07	12:03	16	33.949767	-76.847100	NW	5	1	90	3	1	1	1
11-Dec-07	12:04	17	33.978302	-76.886442	NW	5	2	45	3	1	1	1
11-Dec-07	12:10	20	33.950338	-76.983337	SE	4	2	90	3	1	1	1
11-Dec-07	12:11	21	33.924820	-76.945994	SE	4	3	45	3	1	1	1
11-Dec-07	12:15	23	33.848555	-76.844525	SE	4	1	90	3	1	1	1
11-Dec-07	12:19	24	33.763228	-76.732795	SE	4	3	60	3	1	1	1
11-Dec-07	13:11	39	33.819721	-77.071867	SE	2	2	30	3	1	1	1
11-Dec-07	13:14	40	33.760561	-76.993192	SE	2	1	60	3	1	1	1
11-Dec-07	13:30	43	33.429349	-76.566824	SE	2	2	90	3	1	1	1
11-Dec-07	13:36	46	33.399423	-76.652542	NW	1	3	90	3	1	1	1
11-Dec-07	13:46	47	33.608441	-76.926040	NW	1	2	90	3	1	1	1
11-Dec-07	11:56	12	33.817022	-76.673977	NW	5	2	45	3	1	1	1
25-Feb-08	14:00	46	33.715809	-77.067712	SE	1	4	45	3	1	1	1
25-Feb-08	14:10	51	33.643969	-76.968326	SE	1	3	90	3	1	1	1
25-Feb-08	14:11	52	33.627420	-76.947433	SE	1	1	45	3	1	1	1
25-Feb-08	14:12	53	33.595705	-76.907372	SE	1	2	90	3	1	1	1
25-Feb-08	14:13	46	33.593514	-76.904367	SE	1	3	90	3	1	1	1
25-Feb-08	14:44	56	33.704444	-76.921813	NW	2	2	60	3	1	1	1
25-Feb-08	14:50	59	33.739632	-76.968623	NW	2	3	110	3	1	1	1
25-Feb-08	14:51	60	33.755905	-76.989600	NW	2	2	90	3	1	1	1
25-Feb-08	15:08	66	33.757079	-76.859000	SE	3	2	90	3	1	1	1
25-Feb-08	15:09	67	33.742300	-76.839083	SE	3	1	90	3	1	1	1
25-Feb-08	15:10	68	33.726409	-76.817917	SE	3	2	60	3	1	1	1
25-Feb-08	15:10	69	33.714628	-76.802946	SE	3	3	60	3	1	1	1
25-Feb-08	10:28	17	34.065983	-76.478760	NW	9	1	90	3	1	1	1
25-Feb-08	10:31	18	34.123859	-76.555769	NW	9	1	90	3	1	1	1
25-Feb-08	10:32	19	34.145283	-76.581694	NW	9	1	90	3	1	1	1
25-Feb-08	14:13	55	33.577871	-76.883429	SE	1	2	60	3	1	1	1
25-Feb-08	14:14	56	33.569219	-76.872214	SE	1	1	90	3	1	1	1
25-Feb-08	14:40	50	33.628072	-76.820910	NW	2	3	90	3	1	1	1
25-Feb-08	14:41	52	33.658245	-76.860604	NW	2	2	90	3	1	1	1

Table 13. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
25-Feb-08	14:41	51	33.649988	-76.848940	NW	2	2	100	3	1	1	1
25-Feb-08	14:42	54	33.674872	-76.883280	NW	2	1	90	3	1	1	1
25-Feb-08	14:42	53	33.664185	-76.868832	NW	2	2	90	3	1	1	1
25-Feb-08	15:40	70	33.760220	-76.729413	NW	4	2	90	3	1	1	1
25-Feb-08	15:41	71	33.782826	-76.757457	NW	4	2	90	3	1	1	1
25-Feb-08	15:47	72	33.898225	-76.912265	NW	4	1	90	3	2	2	2
25-Feb-08	15:49	74	33.921513	-76.946091	NW	4	3	90	3	1	1	1
25-Feb-08	15:50	75	33.952259	-76.984478	NW	4	2	90	3	1	1	1
25-Feb-08	15:51	76	33.962391	-76.998089	NW	4	2	90	3	1	1	1
25-Feb-08	9:58	10	34.021468	-76.290208	SE	10	2	90	3	1	1	1
29-Feb-08	10:59	25	33.877073	-76.620831	NW	6	1	90	3	1	1	1
29-Feb-08	11:13	23	34.096821	-76.771226	SE	7	3	90	3	1	1	1
29-Feb-08	11:26	37	33.992578	-76.634189	SE	7	2	80	2	1	1	1
29-Feb-08	12:10	49	34.016537	-76.537436	NW	8	3	90	3	1	1	1
29-Feb-08	12:13	50	34.090298	-76.636591	NW	8	1	60	2	1	1	1
29-Feb-08	12:16	41	34.137058	-76.694589	NW	8	1	60	3	1	1	1
29-Feb-08	10:11	9	33.910327	-76.794532	SE	5	3	100	3	1	1	1
29-Feb-08	10:14	10	33.862294	-76.733044	SE	5	4	120	3	1	1	1
29-Feb-08	10:15	11	33.849216	-76.716228	SE	5	2	90	3	1	1	1
29-Feb-08	10:28	9	33.759112	-76.595593	SE	5	1	90	3	1	1	1
29-Feb-08	10:59	18	33.880426	-76.625538	NW	6	3	60	3	1	1	1
29-Feb-08	11:01	19	33.929577	-76.689812	NW	6	2	90	3	1	1	1
29-Feb-08	11:04	27	33.987516	-76.768835	NW	6	1	50	3	1	1	1
29-Feb-08	11:43	30	33.865893	-76.468958	SE	7	3	90	3	1	1	1
29-Feb-08	12:07	37	33.960908	-76.467848	NW	8	3	90	3	1	1	1
29-Feb-08	12:13	39	34.072722	-76.612207	NW	8	2	60	3	1	1	1
11-Mar-08	14:25	60	34.101760	-76.527062	NW	9	2	90	3	1	1	1
11-Mar-08	14:26	34	34.128998	-76.563323	NW	9	1	90	3	1	1	1
11-Mar-08	14:45	68	34.106415	-76.656342	SE	8	1	90	3	1	1	1
11-Mar-08	14:46	39	34.097235	-76.644374	SE	8	3	90	3	1	1	1
11-Mar-08	14:51	69	33.987838	-76.500356	SE	8	2	90	3	1	1	1
11-Mar-08	10:19	28	33.941895	-76.706830	NW	6	2	90	3	1	1	1
13-Mar-08	10:29	3	33.690528	-77.034445	SE	1	2	90	3	1	1	1
13-Mar-08	10:30	4	33.666827	-77.002034	SE	1	2	80	3	1	1	1
13-Mar-08	10:30	4	33.670405	-77.007007	SE	1	3	90	3	1	1	1
13-Mar-08	10:30	5	33.660947	-76.994096	SE	1	4	90	3	1	1	1
13-Mar-08	10:32	5	33.640002	-76.965591	SE	1	2	90	3	1	1	1
13-Mar-08	10:35	8	33.577643	-76.885553	SE	1	2	90	3	1	1	1
13-Mar-08	11:04	10	33.638187	-76.832356	NW	2	2	60	3	1	1	1
13-Mar-08	11:07	14	33.696147	-76.907157	NW	2	2	90	3	1	1	1
13-Mar-08	11:08	15	33.715254	-76.931251	NW	2	1	60	3	1	1	1
13-Mar-08	11:08	14	33.725537	-76.943865	NW	2	3	45	3	2	2	2

Table 13. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
13-Mar-08	11:09	15	33.738198	-76.961708	NW	2	3	45	3	2	2	2
13-Mar-08	11:10	16	33.758592	-76.991068	NW	2	1	90	3	1	1	1
13-Mar-08	11:10	16	33.763760	-76.997739	NW	2	2	45	3	1	1	1
13-Mar-08	11:28	19	33.822268	-77.072626	NW	2	1	60	3	1	1	1
13-Mar-08	11:35	24	33.894190	-77.039983	SE	3	3	120	3	1	1	1
13-Mar-08	11:54	31	33.818510	-76.941352	SE	3	1	90	3	1	1	1
13-Mar-08	11:56	32	33.762967	-76.868429	SE	3	3	70	3	1	1	1
13-Mar-08	11:57	33	33.745760	-76.846872	SE	3	2	90	3	1	1	1
13-Mar-08	11:58	34	33.731587	-76.828109	SE	3	2	90	3	1	1	1
13-Mar-08	11:58	24	33.731335	-76.827821	SE	3	3	45	3	1	1	1
13-Mar-08	11:59	35	33.721446	-76.814439	SE	3	3	80	3	1	1	1
13-Mar-08	11:59	36	33.713228	-76.803469	SE	3	3	90	3	1	1	1
13-Mar-08	11:59	25	33.720685	-76.813442	SE	3	2	90	3	1	1	1
13-Mar-08	11:59	26	33.711992	-76.801866	SE	3	2	90	3	3	3	3
13-Mar-08	12:00	37	33.705982	-76.793862	SE	3	3	90	3	1	1	1
13-Mar-08	12:35	46	33.757093	-76.721320	NW	4	3	90	3	1	1	1
13-Mar-08	12:35	47	33.767341	-76.734565	NW	4	3	80	3	1	1	1
13-Mar-08	12:36	48	33.777541	-76.748227	NW	4	3	90	3	1	1	1
13-Mar-08	12:36	51	33.790214	-76.765515	NW	4	2	120	3	1	1	1
13-Mar-08	12:36	34	33.788117	-76.762402	NW	4	2	60	3	2	2	2
13-Mar-08	12:36	33	33.776304	-76.746537	NW	4	1	90	3	2	2	2
13-Mar-08	12:36	49	33.782877	-76.755154	NW	4	2	100	3	3	3	3
13-Mar-08	12:37	52	33.799393	-76.779584	NW	4	2	90	3	1	1	1
13-Mar-08	12:37	36	33.808073	-76.791050	NW	4	2	90	3	1	1	1
13-Mar-08	12:37	35	33.801156	-76.781997	NW	4	3	45	3	3	3	3
13-Mar-08	12:38	38	33.815803	-76.800762	NW	4	2	60	3	1	1	1
13-Mar-08	12:39	53	33.843327	-76.835880	NW	4	2	90	3	1	1	1
13-Mar-08	12:41	54	33.869286	-76.871837	NW	4	2	90	3	1	1	1
13-Mar-08	12:42	55	33.903207	-76.916701	NW	4	2	90	3	1	1	1
13-Mar-08	12:43	56	33.923307	-76.943257	NW	4	1	90	3	1	1	1
13-Mar-08	14:37	62	34.084271	-76.369455	SE	10	3	90	3	1	1	1
13-Mar-08	16:13	64	33.828254	-76.421067	NW	7	1	90	3	1	1	1
13-Mar-08	15:35	73	34.050852	-76.583907	SE	8	2	90	3	1	1	1
13-Mar-08	16:17	66	33.908466	-76.525853	NW	7	1	60	3	2	2	2
13-Mar-08	16:18	67	33.920770	-76.541856	NW	7	1	90	3	1	1	1
25-Apr-08	15:16	68	33.699603	-76.913412	SE	2	2	90	3	1	1	1
25-Apr-08	9:30	6	34.226247	-76.550562	SE	10	2	90	3	1	1	1
25-Apr-08	9:31	7	34.202171	-76.519496	SE	10	3	100	3	1	1	1
25-Apr-08	12:29	45	33.978820	-76.886837	NW	5	2	90	3	3	3	3
25-Apr-08	12:30	46	34.006749	-76.923791	NW	5	1	90	3	1	1	1
25-Apr-08	14:05	55	33.963843	-76.997228	SE	4	2	60	3	4	4	4
25-Apr-08	14:07	57	33.912055	-76.928270	SE	4	1	90	3	1	1	1

Table 13. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
25-Apr-08	14:11	51	33.841318	-76.834407	SE	4	3	100	3	1	1	1
25-Apr-08	14:56	60	33.742811	-76.842367	NW	3	1	90	3	1	1	1
25-Apr-08	15:02	63	33.848403	-76.980264	NW	3	1	90	3	1	1	1
25-Apr-08	15:04	65	33.900994	-77.049010	NW	3	1	90		1	1	1
25-Apr-08	15:11	73	33.805849	-77.051328	SE	2	3	60	3	1	1	1
25-Apr-08	15:22	77	33.586656	-76.767691	SE	2	2	60	3	1	1	1
25-Apr-08	15:53	75	33.716171	-77.067002	NW	1	3	100	3	1	1	1
25-Apr-08	15:54	76	33.737397	-77.094942	NW	1	2	90	3	1	1	1
25-Apr-08	10:11	13	34.073360	-76.489050	NW	9	2	45	3	1	1	1
25-Apr-08	10:12	14	34.092997	-76.514980	NW	9	1	45	3	1	1	1
25-Apr-08	10:21	19	34.151728	-76.592705	NW	9	2	90	3	1	1	1
26-Apr-08	9:40	4	33.571828	-76.877501	SE	1	3	45	3	1	1	1
26-Apr-08	11:22	19	33.927167	-76.949187	NW	4	1	90	3	1	1	1
26-Apr-08	14:05	39	34.109861	-76.537195	NW	9	3	60	3	1	1	1
25-May-08	9:52	3	34.084476	-76.366981	SE	10	3	90	3	1	1	1
25-Jun-08	11:24	22	34.030124	-76.557663	NW	8	1	90	3	1	1	1
25-Jun-08	11:28	23	34.119785	-76.674444	NW	8	3	90	3	1	1	1
25-Jun-08	11:30	24	34.141838	-76.706209	NW	8	2	90	3	1	1	1
25-Jun-08	12:57	40	34.227066	-76.547078	NW	10	2	60	3	1	1	1
25-Jun-08	14:43	47	33.864234	-76.864912	SE	4	2	30	3	1	1	1
25-Jun-08	15:40	57	33.821112	-77.071023	SE	2	2	90	3	1	1	1

Table 13. All *Caretta caretta* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
17-Jul-07	9:23	13	34.137272	-76.698453	SE	8	1	80	3	1	1	1
18-Nov-07	11:05	30	33.971949	-76.605786	NW	7	1	90	3	1	1	1
18-Nov-07	11:21	33	34.114596	-76.797563	NW	7	1	90	3	1	1	1
18-Nov-07	10:01	19	34.118188	-76.547824	NW	9	3	100	3	2	2	2
18-Nov-07	10:06	21	34.210804	-76.670548	NW	9	1	90	3	1	1	1
18-Nov-07	10:25	25	33.988466	-76.498948	SE	8	1	90	3	1	1	1
19-Nov-07	10:06	23	33.631831	-76.300344	NW	6	2	100	3	1	1	1
19-Nov-07	10:25	28	33.845835	-76.583383	NW	6	1	90	3	1	1	1
19-Nov-07	11:03	43	33.928928	-76.550851	SE	7	2	50	3	1	1	1
19-Nov-07	11:39	61	33.986705	-76.497194	NW	8	3	90	3	1	1	1
19-Nov-07	11:42	62	34.060781	-76.596606	NW	8	2	90	3	1	1	1
19-Nov-07	11:44	63	34.085720	-76.628691	NW	8	1	90	3	1	1	1
19-Nov-07	11:44	64	34.093141	-76.638238	NW	8	3	90	3	1	1	1
19-Nov-07	12:01	71	34.134669	-76.566239	SE	9	1	90	3	1	1	1
19-Nov-07	12:02	50	34.113337	-76.536738	SE	9	3	120	3	1	1	1
19-Nov-07	12:04	74	34.089472	-76.504803	SE	9	2	130	3	1	1	1
19-Nov-07	12:04	75	34.077454	-76.488677	SE	9	2	90	3	1	1	1
19-Nov-07	12:45	86	34.217612	-76.540934	NW	10	3	90	3	1	1	1
19-Nov-07	10:43	35	34.026617	-76.820152	NW	6	1	90	3	1	1	1
19-Nov-07	10:43	36	34.037068	-76.834922	NW	6	2	90	3	1	1	1
11-Dec-07	11:20	14	33.999740	-76.783103	SE	6	1	90	3	1	1	1
11-Dec-07	11:21	15	33.994008	-76.775170	SE	6	2	90	3	1	1	1
11-Dec-07	11:23	16	33.944754	-76.707362	SE	6	2	90	3	1	1	1
11-Dec-07	11:59	23	33.876332	-76.751658	NW	5	2	110	3	1	1	1
11-Dec-07	12:02	24	33.933258	-76.824034	NW	5	1	70	3	1	1	1
11-Dec-07	12:03	25	33.946295	-76.842407	NW	5	2	90	3	1	1	1
11-Dec-07	12:04	26	33.961291	-76.863156	NW	5	2	90	3	1	1	1
11-Dec-07	12:10	29	33.963326	-77.001498	SE	4	1	90	3	1	1	1
11-Dec-07	12:14	22	33.880464	-76.886076	SE	4	3	90	3	1	1	1
11-Dec-07	12:48	35	33.712732	-76.802921	NW	3	1	90	3	2	2	2
11-Dec-07	12:48	34	33.711655	-76.801515	NW	3	2	90	3	2	2	2
11-Dec-07	12:59	39	33.773844	-76.884149	NW	3	2	90	3	1	1	1
11-Dec-07	13:01	40	33.817619	-76.938246	NW	3	1	90	3	1	1	1
11-Dec-07	13:14	43	33.762471	-76.995615	SE	2	2	90	3	1	1	1
11-Dec-07	13:45	49	33.582341	-76.891415	NW	1	3	90	3	1	1	1
11-Dec-07	13:46	51	33.606924	-76.924000	NW	1	1	100	3	1	1	1
11-Dec-07	13:46	50	33.596768	-76.910756	NW	1	2	90	3	1	1	1
11-Dec-07	13:47	52	33.628461	-76.951878	NW	1	3	110	3	1	1	1
11-Dec-07	13:48	53	33.635656	-76.961371	NW	1	1	90	3	1	1	1
11-Dec-07	13:54	54	33.778799	-77.147813	NW	1	1	100	3	1	1	1
11-Dec-07	13:55	55	33.787924	-77.160951	NW	1	1	100	3	1	1	1
11-Dec-07	11:57	21	33.831360	-76.692843	NW	5	2	100	3	1	1	1

Table 14. All sea turtle sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
29-Feb-08	10:58	17	33.861495	-76.599101	NW	6	4	90	3	1	1	1
29-Feb-08	12:08	38	33.987571	-76.500696	NW	8	4	90	3	1	1	1
13-Mar-08	11:07	13	33.700427	-76.912456	NW	2	3	90	3	1	1	1
13-Mar-08	12:39	39	33.840675	-76.832206	NW	4	2	45	3	1	1	1
25-Apr-08	15:10	72	33.833348	-77.087089	SE	2	1	90	3	1	1	1
25-Apr-08	10:20	18	34.135162	-76.570719	NW	9	1	90	3	1	1	1
24-Jun-08	15:18	40	33.808172	-77.050635	SE	2	2	90	3	1	1	1
24-Jun-08	16:24	48	33.788085	-77.159783	NW	1	2	3	3	1	1	1
24-Jun-08	15:18	40	33.808172	-77.050635	SE	2	2	90	3	1	1	1
24-Jun-08	16:24	48	33.788085	-77.159783	NW	1	1	90	3	1	1	1
25-Jun-08	11:24	22	34.030124	-76.557663	NW	8	1	90	3	1	1	1
25-Jun-08	11:28	23	34.119785	-76.674444	NW	8	3	90	3	1	1	1
25-Jun-08	11:30	24	34.141838	-76.706209	NW	8	2	90	3	1	1	1
25-Jun-08	12:57	40	34.227066	-76.547078	NW	10	2	60	3	1	1	1
25-Jun-08	14:43	47	33.864234	-76.864912	SE	4	2	30	3	1	1	1
25-Jun-08	15:40	57	33.821112	-77.071023	SE	2	2	90	3	1	1	1
25-Jun-08	10:15	13	33.917010	-76.677743	NW	6	2	90	3	1	1	1
25-Jun-08	11:31	28	34.165043	-76.738923	NW	8	3	70	3	1	1	1
25-Jun-08	11:47	34	34.156079	-76.594370	SE	9	3	90	3	1	1	1
25-Jun-08	11:48	35	34.138573	-76.570716	SE	9	2	90	3	1	1	1
25-Jun-08	12:54	50	34.170840	-76.475191	NW	10	2	90	3	1	1	1
25-Jun-08	12:57	51	34.221733	-76.539953	NW	10	2	90	3	1	1	1
25-Jun-08	15:52	70	33.582281	-76.761493	SE	2	3	90	3	1	1	1

Table 14. All sea turtle sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

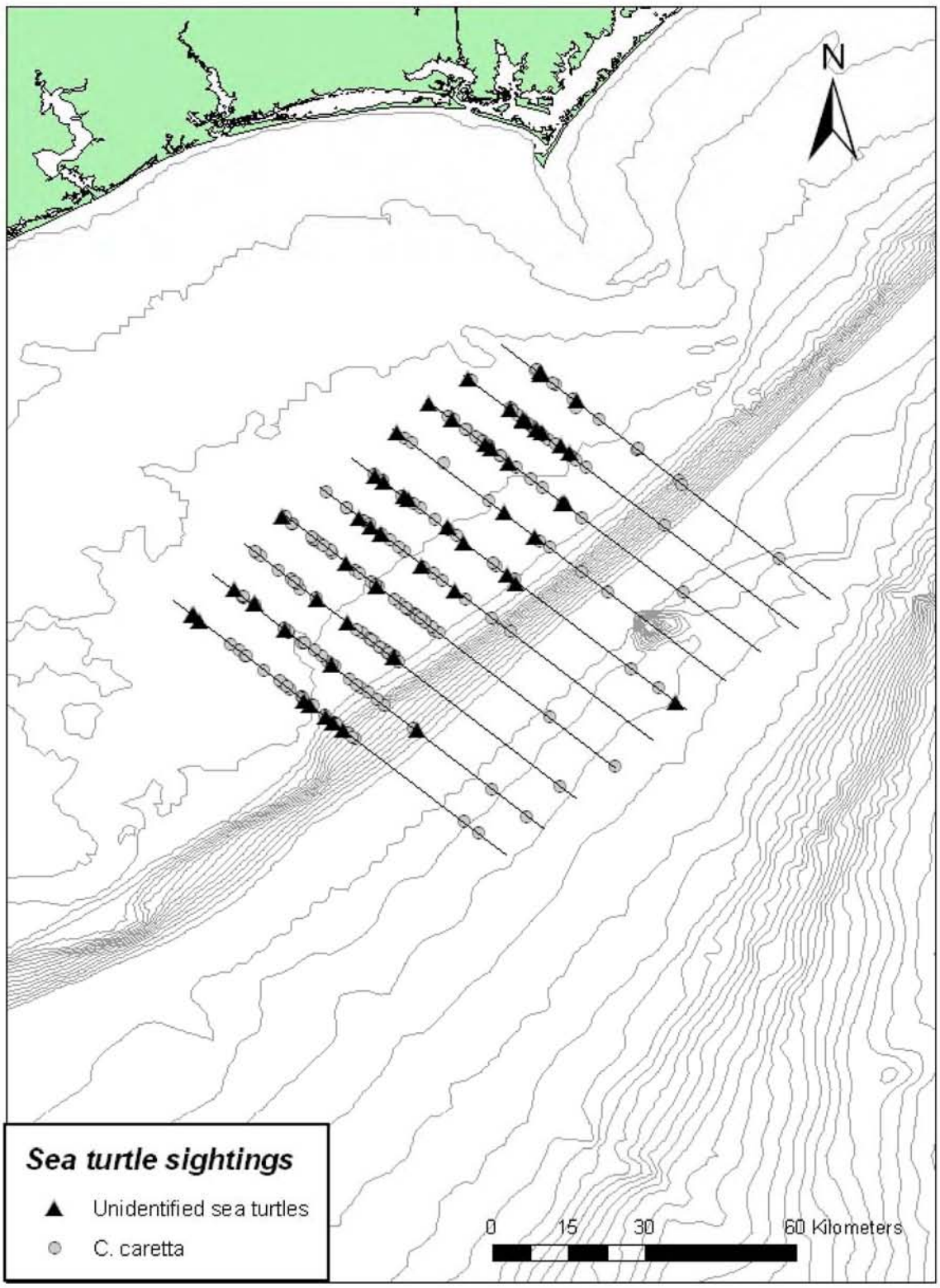

Figure 14. Unidentified sea turtle and loggerhead sea turtle sightings.

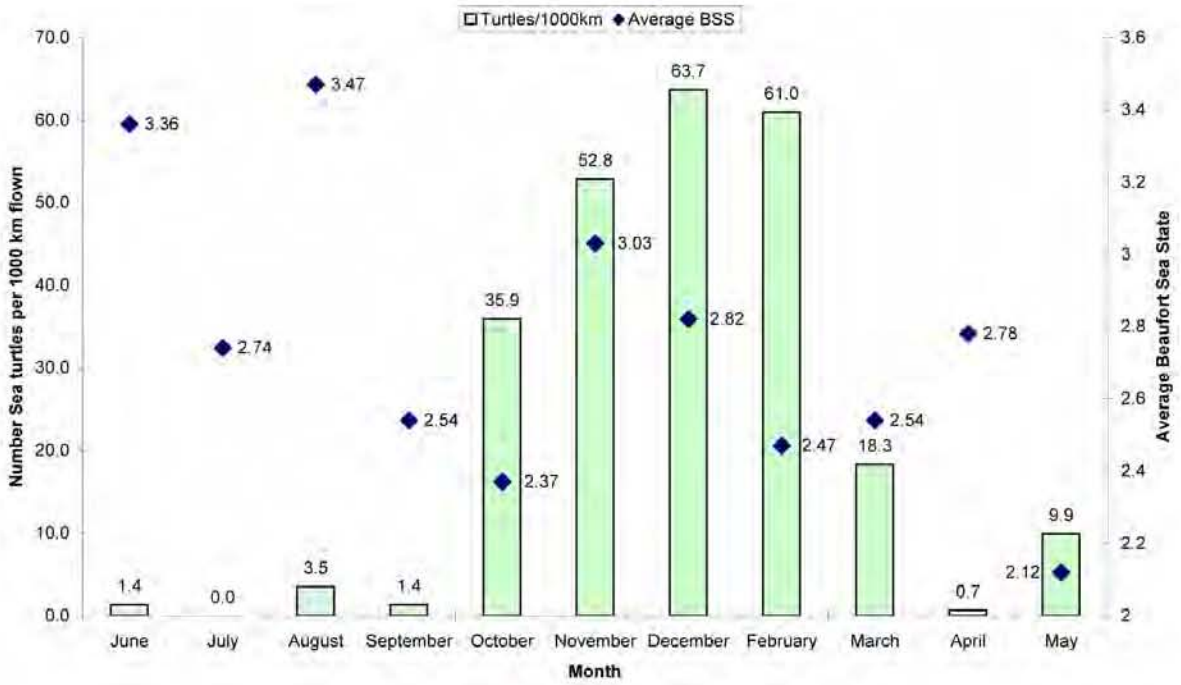

Figure 15a. Number of sea turtles seen per 1000 km flown during aerial surveys conducted at the proposed USWTR site in Onslow Bay, NC between June 2007 and June 2008.

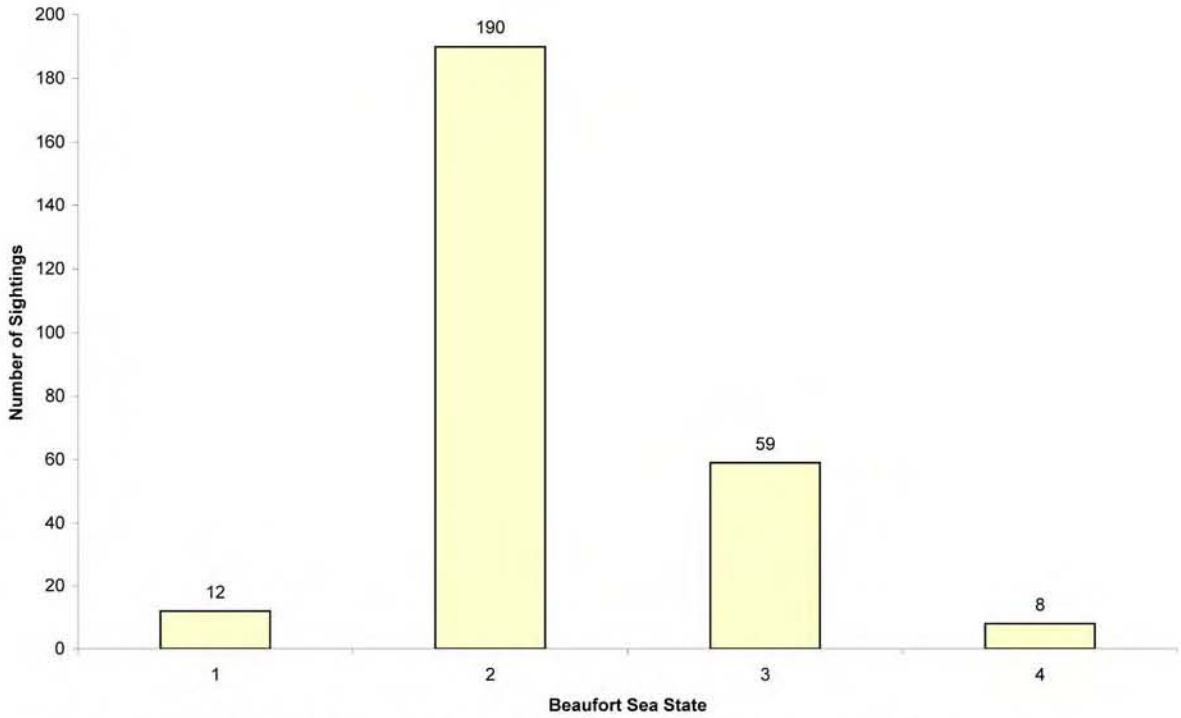

Figure 15b. Total number of sea turtle sightings by Beaufort Sea State in the proposed USWTR site in Onslow Bay, North Carolina during June 2007 - June 2008.

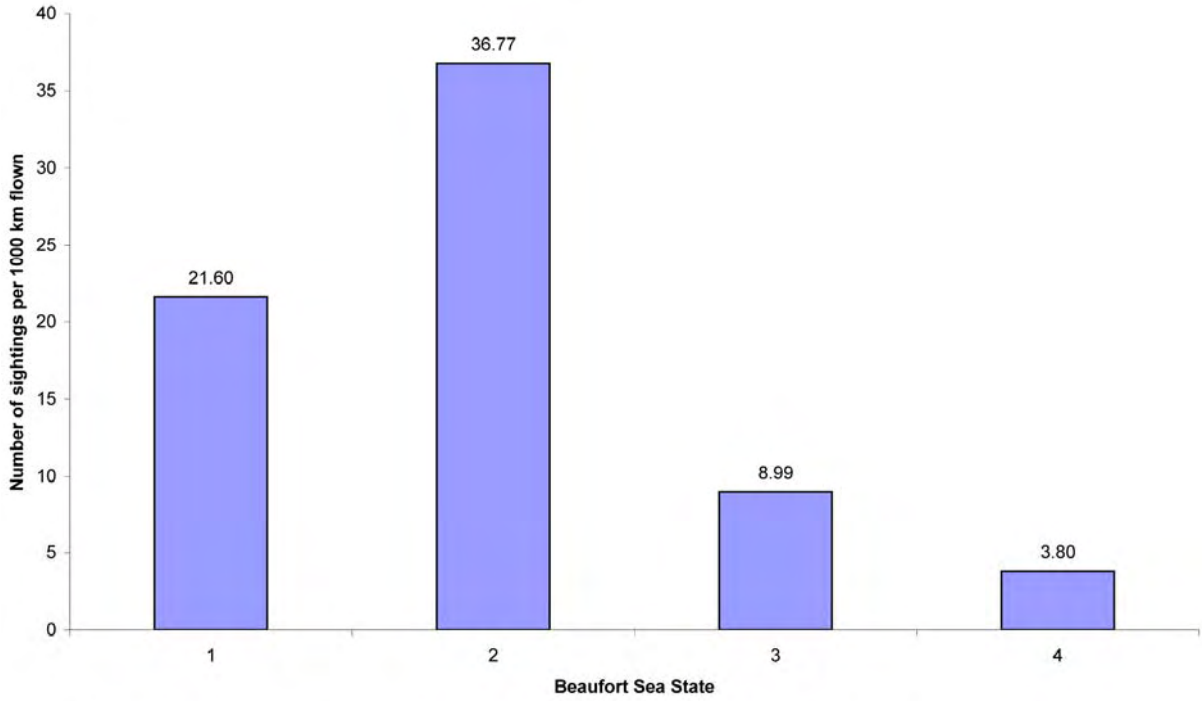

Figure 15C. Turtle sightings per 1000 km flown by Beaufort Sea State from June 2007 - June 2008 in the proposed USWTR site in Onslow Bay, North Carolina.

Other Marine Vertebrate Sightings (Fig. 16)

Chondrichtian fishes

Sharks were observed 12 times throughout the survey period; hammerhead sharks (*Sphyrna* spp.) were the most commonly sighted species (n=9) (Table 15).

Manta rays (*Manta birostris*), were observed 16 times. The majority of sightings (n=12) occurred during the March surveys (Table 16).

Other

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

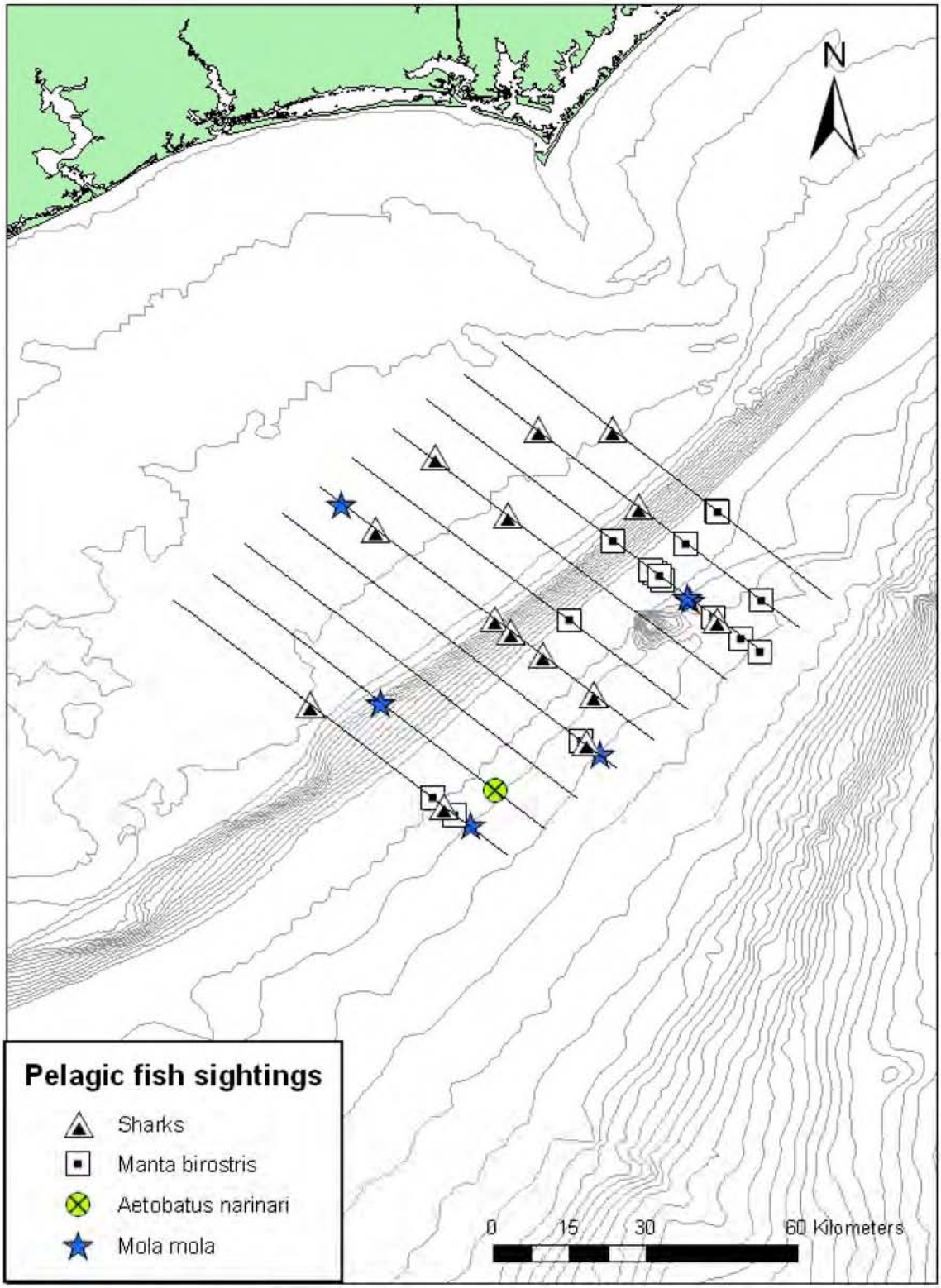

Figure 16. Pelagic fish species sightings observed in Onslow Bay, NC USWTR proposed location.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
19-Nov-07	9:31	7	33.779074	-76.622973	SE	5	1	90	3	1	1	1
19-Nov-07	10:50	39	34.069181	-76.728993	SE	7	1	90	3	2	2	2
19-Nov-07	12:02	72	34.120057	-76.545933	SE	9	1	90	3	1	1	1
11-Dec-07	13:38	48	33.445632	-76.713235	NW	1	2	90	3	1	1	1
25-Feb-08	10:24	15	33.982593	-76.366774	NW	9	2	90	3	1	1	1
29-Feb-08	10:10	6	33.940335	-76.835061	SE	5	3	90	3	1	1	1
11-Mar-08	9:52	23	33.715483	-76.537974	SE	5	2	90	3	1	1	1
13-Mar-08	10:32	6	33.628617	-76.950755	SE	1	3	90	3	1	1	1
25-Apr-08	12:17	41	33.757103	-76.594525	NW	5	1	90	3	2	2	2
25-May-08	11:13	18	33.96615	-76.600401	NW	7	1	90	3	1	1	1
25-Jun-08	9:44	6	33.646379	-76.446961	SE	5	3	90	3	1	1	1
25-Jun-08	15:07	52	33.559897	-76.461445	SE	4	1	90	3	1	1	1

Table 15. All shark sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #	Comments
24-Sep-07	15:56	14	33.918773	-76.411349	SE	8	2	90	3	1	1	1	Manta Ray
25-Sep-07	9:21	10	33.777154	-76.489689	NW	6	2	90	3	1	1	1	Manta Ray
15-Oct-07	9:00	9	33.476036	-76.620023	NW	2	1	90	3	1	1	1	Spotted Eagle Ray
11-Dec-07	12:29	26	33.563070	-76.467683	SE	4	2	60	3	1	1	1	Manta Ray
11-Mar-08	13:57	30	33.915239	-76.280784	NW	9	2	90	3	1	1	1	Manta Ray
11-Mar-08	14:58	70	33.850148	-76.322100	SE	8	1	90	3	1	1	1	Manta Ray
11-Mar-08	15:02	73	33.781697	-76.231406	SE	8	2	60	3	1	1	1	Manta Ray
11-Mar-08	15:04	74	33.744428	-76.182765	SE	8	2	60	3	1	1	1	Manta Ray
11-Mar-08	15:07	45	33.720514	-76.150117	NW	8	1	90	3	1	1	1	Manta Ray
11-Mar-08	15:15	77	33.861743	-76.335525	NW	8	2	90	3	1	1	1	Manta Ray
11-Mar-08	15:15	48	33.868505	-76.344256	NW	8	1	80	3	1	1	1	Manta Ray
11-Mar-08	15:15	47	33.857030	-76.329143	NW	8	3	90	3	1	1	1	Manta Ray
13-Mar-08	10:41	7	33.462454	-76.733200	SE	1	2	90	3	1	1	1	Manta Ray
13-Mar-08	14:43	65	33.974459	-76.227783	SE	10	2	90	3	1	1	1	Manta Ray
13-Mar-08	14:43	46	33.971680	-76.224445	SE	10	2	90	3	1	1	1	Manta Ray
13-Mar-08	15:05	52	33.813835	-76.147014	NW	9	3	90	3	1	1	1	Manta Ray
25-Jun-08	16:16	66	33.430343	-76.693036	NW	1	1	90	3	1	1	1	Manta Ray

Table 16. All ray sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Sighting Cue	Min #	Max #	Best #
8-Aug-07	10:13	15	33.411883	-76.664571	NW	1	2	90	3	1	1	1
11-Dec-07	12:05	27	33.984582	-76.895008	NW	5	3	90	3	1	1	1
11-Mar-08	15:00	72	33.814097	-76.274118	SE	8	2	60	3	1	1	1
11-Mar-08	15:13	46	33.819542	-76.278470	NW	8	2	90	3	1	1	1
13-Mar-08	12:22	43	33.538583	-76.434512	NW	4	3	100	3	1	1	1
25-Apr-08	15:20	76	33.631182	-76.824754	SE	2	1	90	3	1	1	1

Table 17. All *Mola mola* sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Vessel Sightings

Commercial (Table 18, Fig. 17)

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
17-Jul-07	8:35	7	34.163089	-76.465062	SE	10	5	45	1	Large Container Vessel Heading South
17-Jul-07	9:14	16	34.131651	-76.568242	NW	9	5	45	1	Large Contianer Vessel (possible resight)
17-Jul-07	10:08	19	34.074873	-76.745012	NW	7	2	90	1	Container vessel, 0.5 NM off
17-Jul-07	13:03	37	33.815690	-76.800494	SE	4	4	90	1	Large tanker, ~ 4 NM off
17-Jul-07	13:36	44	33.734081	-76.830549	NW	3	3	45	1	Transport vessel heading south
6-Aug-07	12:38	10	34.160002	-76.466282	SE	10	4	90	1	Container vessel ~1.5 miles off
6-Aug-07	13:05	19	33.909795	-76.271022	NW	9	4	30	1	Conatiner vessel heading south
6-Aug-07	13:37	25	33.883304	-76.365213	SE	8	4	45	1	Resight of large cargo vessel on line 9
6-Aug-07	14:49	38	33.789122	-76.636289	NW	5	5	45	1	Conatiner vessel ~1.5 - 2 miles off
24-Sep-07	9:55	9	33.433266	-76.696337	SE	1	3	45	1	Car carrier 3.5 nm, heading N
24-Sep-07	10:15	12	33.653157	-76.853828	NW	2	4	80	1	Container vessel, 4 nm off
25-Sep-07	8:51	4	33.921644	-76.808241	SE	5	3	110	1	Container vessel, 2 NM off
25-Sep-07	8:54	6	33.860589	-76.723806	SE	5	1	45	1	Container vessel on track line
25-Sep-07	8:57	5	33.799134	-76.643618	SE	5	3	100	1	Freighter, ~ 2 NM off
25-Sep-07	10:18	14	33.935540	-76.431647	NW	8	3	90	1	Container vessel, 2.5 NM off
25-Sep-07	14:37	38	33.767156	-76.733429	SE	4	4	30	1	Commercial transport vessel: RORO
25-Sep-07	15:22	56	33.815327	-76.988273	NW	3	4	90	1	Container vessel, 3 NM off
14-Oct-07	9:16	7	33.744909	-77.110551	SE	1	5	80	1	Unid medium sized vessel ~ 4 miles off
14-Oct-07	10:02	11	33.683243	-76.893646	NW	2	4	90	1	Tanker heading south ~ 4 miles off
14-Oct-07	10:58	22	33.873086	-76.877594	NW	4	3	90	1	Conatiner vessel ~ 2 miles off
15-Oct-07	13:55	44	33.961245	-76.599022	SE	7	3	90	2	Ocean tug and tow ~3.5 miles off
15-Oct-07	14:18	50	33.805262	-76.259113	NW	8	4	90	1	Large tanker ~3.5 miles off
15-Oct-07	14:56	57	33.913173	-76.278233	SE	9	4	90	1	Container vessel ~ 4 miles off
17-Nov-07	11:06	28	33.664156	-76.738450	NW	3	3	90	1	Tanker, ~2.5 NM off
17-Nov-07	11:14	32	33.739619	-76.839638	NW	3	3	90	1	Container vessel 3 NM off
17-Nov-07	14:57	40	33.548434	-76.717855	SE	2	5	30	1	Container vessel ~1.5 miles off
18-Nov-07	9:19	11	34.054119	-76.327538	SE	10	4	90	1	Container vessel, ~3 NM off
18-Nov-07	11:39	38	33.766328	-76.478141	SE	6	3	90	3	Tug, barge and third vessel ~ 2.5 NM off
18-Nov-07	15:36	52	33.759589	-76.865459	NW	3	4	45	1	Container vessel , ~1mile off
18-Nov-07	16:16	57	33.451887	-76.721871	NW	1	4	30	1	Container vessel heading north
19-Nov-07	9:30	6	33.810310	-76.664391	SE	5	4	90	1	Container vessel, 3 NM off
19-Nov-07	9:32	8	33.770066	-76.611010	SE	5	4	90	1	Container vessel, 3.5 NM off
19-Nov-07	10:25	21	33.850875	-76.590502	NW	6	4	60	1	Transport vessel stationary
19-Nov-07	12:41	84	34.131168	-76.426563	NW	10	3	90	2	Tug and barge, ~ 1.5 NM off
25-Feb-08	10:23	14	33.977955	-76.360265	NW	9	3	90	1	Container vessel 3 NM off
25-Feb-08	10:29	17	34.085899	-76.506323	NW	9	3	90	1	Container vessel, ~5 NM
11-Mar-08	10:32	31	34.058266	-76.718650	SE	7	3	45	2	Tug and barge
11-Mar-08	10:38	14	33.935371	-76.561714	SE	7	4	110	1	Container vessel, ~1 3/4 miles off
11-Mar-08	13:57	55	33.896805	-76.257795	NW	9	3	30	1	Large container vessel
11-Mar-08	15:23	79	34.018460	-76.541758	NW	8	4	30	1	Large container vessel
13-Mar-08	11:52	30	33.839642	-76.967066	SE	3	4	80	2	Tug and barge
13-Mar-08	14:44	47	33.952484	-76.198122	SE	10	2	30	1	Container vessel stationary
25-Apr-08	12:00	36	33.670443	-76.350071	SE	6	3	80	1	Container vessel

Table 18. All commercial vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
25-Apr-08	14:58	62	33.780995	-76.892178	NW	3	1	70	1	Container vessel
25-Apr-08	15:13	74	33.773450	-77.009268	SE	2	5	45	1	Research boat
25-Apr-08	15:14	75	33.746507	-76.974308	SE	2	5	60	1	Transport/ cargo vessel
26-Apr-08	10:26	10	33.822235	-76.945419	SE	3	5	45	1	Large research vessel
25-May-08	10:09	7	33.774146	-76.099131	NW	9	3	45	1	Large cargo vessel
26-May-08	8:35	3	33.771146	-77.138047	SE	1	2	30	2	Tug and barge
26-May-08	9:40	20	33.85642	-76.99182	SE	3	1	90	2	Tug and barge
26-May-08	10:20	23	33.873287	-76.875076	NW	4	4	30	2	Tug and barge resight
26-May-08	10:31	26	33.951996	-76.850759	SE	5	3	45	1	Tug and barge resight
26-May-08	14:43	59	33.85382	-76.07484	SE	10	3	90	1	Yacht
24-Jun-08	11:24	17	34.167813	-76.611538	SE	9	3	90	1	Large vessel
24-Jun-08	11:28	18	34.079963	-76.494669	SE	9	3	90	1	Container vessel
24-Jun-08	15:27	41	33.619519	-76.808501	SE	2	45	1	1	Container vessel
25-Jun-08	10:12	11	33.869459	-76.614478	NW	6	120	4	1	Container vessel
25-Jun-08	11:45	28	34.202044	-76.660157	SE	9	4	30	1	Cargo vessel
25-Jun-08	11:51	37	34.076816	-76.490015	SE	9	150	1	2	Tug and barge

Table 18. All commercial vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

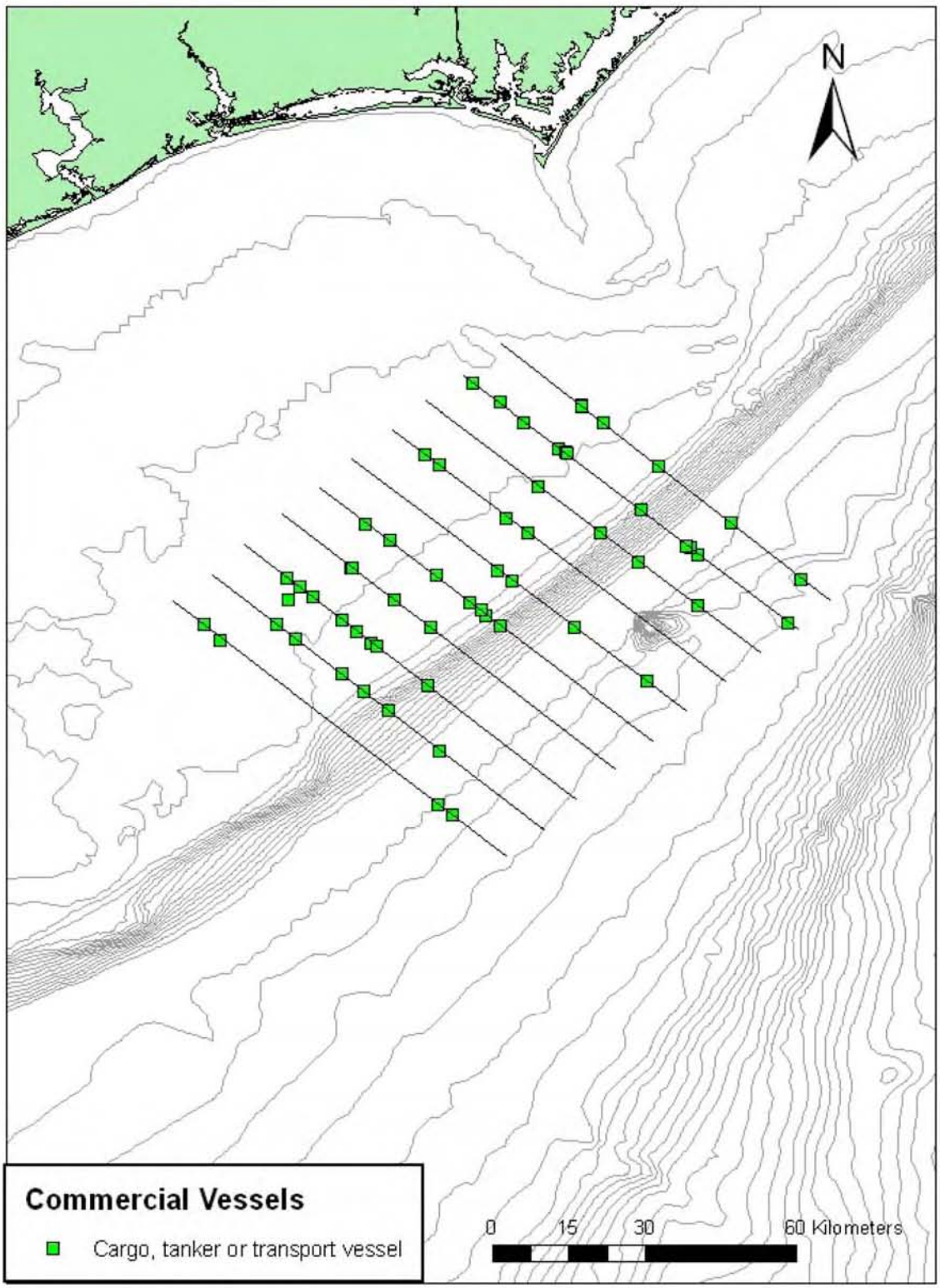

Figure 17. Location of Commercial vessels observed in Onslow Bay, NC USWTR proposed location.

Military (Table 19, Fig. 18)

Six U.S. Navy vessels were observed in the study site.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
26-Jun-07	11:11	10	34.124544	-76.420892	SE	10	4	30	1	Military vessel, ~ 1/2 - 1 mile off
18-Nov-07	10:16	23	34.172512	-76.739990	NW	9	4	90	1	Navy vessel, ~ 4 NM off, stationary
11-Dec-07	13:20	42	33.621663	-76.814648	SE	2	5	90	1	Navy frigate ~2 miles off
13-Mar-08	12:05	38	33.593884	-76.650770	SE	3	4	60	2	Aircraft carrier and tanker
13-Mar-08	15:04	51	33.802262	-76.133573	NW	9	4	30	1	Military tanker
25-Apr-08	14:20	53	33.656682	-76.590546	SE	4	4	90	1	Navy vessel

Table 19. All military vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

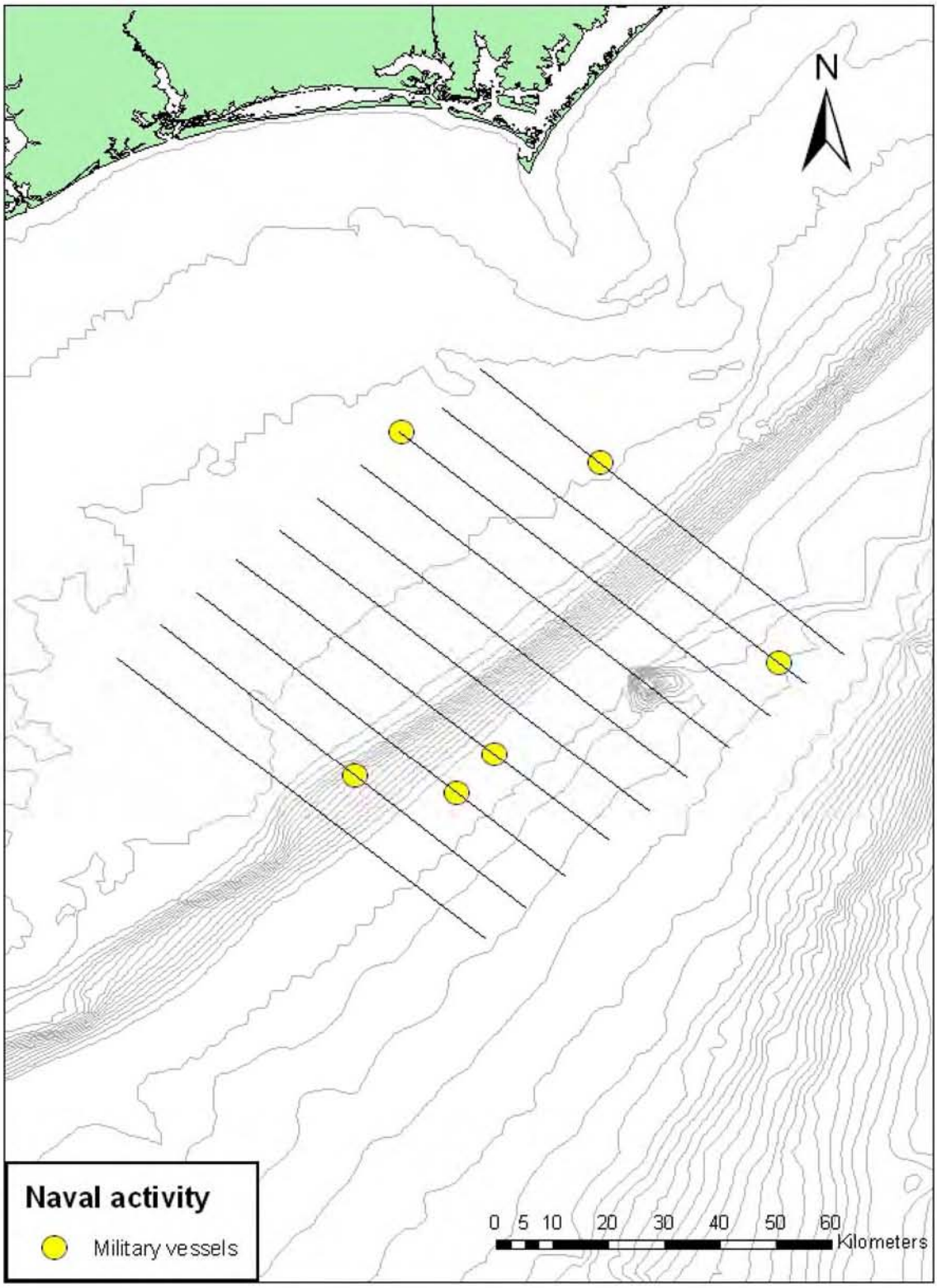

Figure 18. Location of Naval vessels observed in the Onslow Bay NC USWTR proposed location.

Recreational (Table 20, Fig. 19)

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
26-Jun-07	10:47	10	34.244672	-76.573145	SE	10	3	90	1	Fishing vessel, ~ 3 NM off
26-Jun-07	10:48	11	34.219190	-76.539714	SE	10	2	90	1	Recreational vessel, ~ 400 m off
26-Jun-07	11:13	19	34.079172	-76.360674	SE	10	3	120	1	Small fishing vessel, ~ 500 m off
26-Jun-07	12:13	26	33.991028	-76.377964	NW	9	2	75	1	Head boat, 2 NM off track line
26-Jun-07	12:13	24	33.996445	-76.384962	NW	9	2	30	1	1 Recreational vessel 60ft, gear out
26-Jun-07	12:14	27	34.011907	-76.406309	NW	9	2	85	1	Fishing vessel, ~ 2/3 NM off
26-Jun-07	12:21	27	34.165695	-76.608122	NW	9	4	60	1	Recreational vessel ~ 1/2 mile off
17-Jul-07	8:31	5	34.267309	-76.579856	SE	10	4	45	1	Commercial fishing vessel, ~ 3/4 mile off
17-Jul-07	9:13	15	34.120066	-76.551848	NW	9	3	30	1	Commercial fishing vessel ~1 mile off
17-Jul-07	10:06	18	34.029459	-76.685393	NW	7	3	90	1	17 foot sportfishing vessel, ~ 1.0 NM off
17-Jul-07	10:25	26	33.831504	-76.560904	SE	6	3	45	1	Commercial fishing vessel ~1/2 mile off
17-Jul-07	12:58	36	33.922335	-76.941578	SE	4	2	30	1	Recreational fishing vessel ~200m off
17-Jul-07	13:34	43	33.692554	-76.775909	NW	3	2	45	1	Commercial fishing vessel ~1/2 mile off
17-Jul-07	13:58	45	33.667330	-76.870410	SE	2	2	90	2	2 sport fishing vessels, 0.75 and 2 NM
18-Jul-07	9:19	15	33.926358	-76.686413	NW	6	1	60	1	~200m off
18-Jul-07	9:36	19	33.971490	-76.608240	SE	7	3	90	1	Small sport fishing vessel, 3 NM off
18-Jul-07	9:41	20	33.870871	-76.478091	SE	7	3	100	1	Small sport fishing vessel, 1.5 NM off
18-Jul-07	10:57	39	34.031992	-76.300644	NW	10	3	90	1	Small sport fishing vessel, 1.5 NM off
18-Jul-07	10:58	40	34.044508	-76.315991	NW	10	2	90	1	Small sport fishing vessel, 500 m off
18-Jul-07	11:03	42	34.165599	-76.470186	NW	10	3	90	1	Small sport fishing vessel, 2.0 NM off
18-Jul-07	14:01	54	33.664496	-76.867985	SE	2	3	90	1	Sport fishing vessel, ~1.75 NM off
18-Jul-07	14:31	57	33.632676	-76.959681	NW	1	2	90	1	Fishing vessel, anchored, ~1.25 NM off
6-Aug-07	12:40	12	34.127540	-76.423425	SE	10	2	130	1	Small sport fishing vessel ~ 3/4 NM off
6-Aug-07	13:04	18	33.892911	-76.250656	NW	9	3	30	1	Recreational fishing vessel, ~3/4 mile off
6-Aug-07	13:07	17	33.954071	-76.329252	NW	9	2	150	1	Sport fishing vessel, ~ 1/2 mile off
6-Aug-07	13:10	20	34.005759	-76.397894	NW	9	4	45	2	2 Commercial fishing vessels
6-Aug-07	13:15	21	34.123883	-76.554898	NW	9	4	60	1	Fishing vessel, stationary ~3/4 mile off
6-Aug-07	13:17	22	34.159095	-76.601344	NW	9	4	60	2	2 Commercial fishing vessels, stationary
6-Aug-07	13:34	21	34.143629	-76.580861	SE	8	3	100	1	Aport fishing vessel, ~1.5 mile off
6-Aug-07	14:48	37	33.776769	-76.620641	NW	5	4	45	1	Recreational fishing vessel ~1 mile off
6-Aug-07	14:51	35	33.835007	-76.695666	NW	5	3	100	1	Sport fishing vessel, ~ 2 NM off
7-Aug-07	10:45	20	33.868864	-76.731489	SE	5	3	90	1	Sport fishing vessel, ~ 2 NM off
7-Aug-07	14:00	32	33.991371	-76.631464	SE	7	4	90	1	Small recrational vessel ~3/4 miles off
7-Aug-07	14:00	33	33.978255	-76.615234	SE	7	3	60	1	Headboat stationary ~ 1/2 mile off
7-Aug-07	14:04	35	33.893234	-76.511857	SE	7	1	90	1	Fishing vessel on track line
7-Aug-07	14:05	36	33.872032	-76.482031	SE	7	1	90	1	Sport fishing vessel
7-Aug-07	14:50	43	34.043319	-76.439008	SE	9	4	60	1	Recreational fishing vessel heading NW
8-Aug-07	9:53	11	33.743713	-76.972664	SE	2	3	90	1	Sport fishing vessel, ~ 1.75 miles off
24-Sep-07	10:31	13	33.862263	-76.998902	SE	3	4	60	1	Commercial fishing vessel, ~ 1/2 mile off
24-Sep-07	11:17	18	33.935103	-76.957816	NW	4	3	85	1	Unidentified vessel, 2 NM off
24-Sep-07	14:49	3	34.142197	-76.442316	SE	10	1	45	1	Commercial fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
24-Sep-07	14:50	30	34.121424	-76.416458	SE	10	2	90	1	Small recreational fishing vessel, 2 NM off
24-Sep-07	14:52	31	34.087002	-76.373357	SE	10	3	80	2	2 recreational fishing vessels, ~ 2 NM off
24-Sep-07	15:28	11	33.975756	-76.359291	NW	9	3	45	1	Stationanry fishing vessel
24-Sep-07	15:32	34	34.041586	-76.449855	NW	9	3	90	1	Headboat ~ 3 NM off
25-Sep-07	8:55	7	33.839758	-76.696130	SE	5	5	90	1	Recreational fishing vessel ~ 1.5 miles off
25-Sep-07	9:52	14	33.875500	-76.483890	SE	7	2	60	1	Recreational fishing vessel ~300 m off
25-Sep-07	11:19	25	33.984730	-76.378347	SE	9	4	60	1	Commercial fishing vessel ~1/5 mile off
25-Sep-07	11:20	26	33.974368	-76.364214	SE	9	3	90	1	Recreational fishing vessel, ~ 1.5 NM off
25-Sep-07	11:43	29	33.995897	-76.253990	NW	10	3	100	1	Recreational fishing vessel, ~ 1.5 NM off
25-Sep-07	11:55	28	34.251255	-76.592719	NW	10	4	90	1	Commercial fishing vessel, ~ 1/5 mile off
25-Sep-07	14:35	46	33.798573	-76.775632	SE	4	1	90	1	Recreational fishing vessel, anchored
25-Sep-07	14:39	47	33.730426	-76.688823	SE	4	3	90	3	3 recreational fishing vessel,~ 2-3 NM off
14-Oct-07	9:59	13	33.627829	-76.822557	NW	2	3	90	1	Headboat
14-Oct-07	10:06	12	33.768509	-77.004988	NW	2	3	90	1	Recreational fishing vessel ~ 3 miles off
14-Oct-07	10:07	13	33.786821	-77.028580	NW	2	3	90	1	Recreational fishing vessel ~ 2 miles off
14-Oct-07	10:08	14	33.813609	-77.063177	NW	2	3	90	1	Small vessel
14-Oct-07	10:18	17	33.847997	-76.975520	SE	3	2	90	1	Small vessel
14-Oct-07	10:22	18	33.754821	-76.856458	SE	3	1	90	1	Large headboat
14-Oct-07	10:26	19	33.675526	-76.759837	SE	3	3	90	5	Small vessels
14-Oct-07	10:51	22	33.727175	-76.683448	NW	4	3	90	2	Hatteras vessels
14-Oct-07	10:51	20	33.727309	-76.683810	NW	4	4	90	1	Recreational fishing vessel ~ 2 miles off
14-Oct-07	10:51	19	33.718828	-76.672490	NW	4	3	90	2	2 Recreational fishing vessels ~300m off
14-Oct-07	10:59	23	33.880935	-76.888324	NW	4	3	90	1	Head boat ~ 2.5 miles off
14-Oct-07	11:42	29	33.818193	-76.539023	NW	6	3	90	1	Recreational vessel ~ 2 miles off
14-Oct-07	14:48	37	33.986762	-76.627193	SE	7	3	90	3	Fishing vessel
14-Oct-07	14:52	38	33.914604	-76.528939	SE	7	2	90	1	Fishing vessel
14-Oct-07	14:53	40	33.888439	-76.496570	SE	7	1	90	1	Recreational fishing vessel stationary
14-Oct-07	14:54	39	33.872339	-76.477630	SE	7	3	90	3	Fishing vessel
14-Oct-07	15:19	45	33.924132	-76.422679	NW	8	3	90	1	Recreational fishing vessel ~ 2miles off
14-Oct-07	15:21	46	33.976921	-76.484028	NW	8	3	90	1	Recreational fishing vessel ~ 2miles off
14-Oct-07	15:22	47	33.981867	-76.491726	NW	8	2	90	1	Recreational fishing vessel ~ 1.5 mile off
14-Oct-07	15:25	48	34.041652	-76.572455	NW	8	2	90	1	Headboat ~ 3/4 miles off trackline
14-Oct-07	15:29	50	34.125504	-76.681264	NW	8	3	90	2	2 Sport fishing vessel ~ 2.5 miles off
14-Oct-07	15:45	53	34.022906	-76.420746	SE	9	3	90	2	2 fishing vessels (1 and 1.5 miles off)
14-Oct-07	15:46	47	33.994003	-76.383432	SE	9	2	90	1	Fishing vessel
14-Oct-07	16:14	58	34.068075	-76.346431	NW	10	3	90	1	Sport fishing vessel ~2 miles off
14-Oct-07	16:22	60	34.218854	-76.540777	NW	10	3	90	3	3 sport fishing vessels ~ 3 miles off
15-Oct-07	8:30	4	33.811788	-77.190716	SE	1	2	90	1	Small vessel
15-Oct-07	8:31	7	33.789118	-77.162718	SE	1	3	90	1	Recreational fishing vessel ~2 miles off
15-Oct-07	8:35	5	33.726939	-77.078909	SE	1	2	90	1	Small vessel
15-Oct-07	9:27	14	33.845900	-76.970280	SE	3	3	90	1	Small vessel
15-Oct-07	10:02	18	33.757720	-76.726587	NW	4	4	90	3	Large vessels

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
15-Oct-07	10:07	19	33.876672	-76.889745	NW	4	2	90	1	Recreational fishing vessel ~3/4 miles off
15-Oct-07	10:51	31	33.816949	-76.541147	NW	6	3	90	2	2 Recreational fishing vessel
15-Oct-07	10:52	32	33.849101	-76.581621	NW	6	3	90	1	Recreational fishing vessel ~2 miles off
15-Oct-07	10:58	27	33.962576	-76.734049	NW	6	2	90	1	Hatteras boat
15-Oct-07	13:54	43	33.988985	-76.634419	SE	7	3	90	1	Sports fishing vessel ~3 miles off trackline
15-Oct-07	13:57	35	33.920142	-76.541383	SE	7	3	90	3	Small vessels
15-Oct-07	14:00	46	33.871428	-76.474880	SE	7	1	90	1	Passed over fishing vessel
15-Oct-07	14:25	51	33.947154	-76.447124	NW	8	2	90	2	2 recreational fishing vessels ~1 mile off
15-Oct-07	14:30	52	34.037844	-76.565580	NW	8	3	90	1	Fishing vessel ~1.5 miles off
15-Oct-07	14:48	56	34.066152	-76.476875	SE	9	2	90	1	Recreational fishing vessel ~1.5 miles off
15-Oct-07	14:51	40	34.004433	-76.395177	SE	9	2	90	1	Small vessel
15-Oct-07	15:27	61	34.247962	-76.576353	NW	10	3	90	1	Sports fishing vessel ~ 2miles off
18-Nov-07	9:10	10	34.237677	-76.559812	SE	10	3	90	1	Fishing vessel
18-Nov-07	10:04	20	34.172587	-76.621002	NW	9	3	90	1	Headboat, 2 NM off
18-Nov-07	11:06	31	33.978828	-76.615242	NW	7	4	100	1	Sport fishing, ~ 1 NM off stationary
18-Nov-07	11:32	37	33.914119	-76.671784	SE	6	4	60	1	Stationary recreational fishing vessel
18-Nov-07	11:32	36	33.913944	-76.671552	SE	6	3	90	1	Headboat ~ 1.75 NM off, stationary
18-Nov-07	15:56	62	33.668112	-76.871934	SE	2	3	90	1	Sailing vessel, ~ 1.75 NM off
19-Nov-07	11:04	34	33.904767	-76.521150	SE	7	3	60	1	Recreational fishing vessel
19-Nov-07	11:05	35	33.877133	-76.485115	SE	7	2	60	1	Stationary Recreational fishing vessel
19-Nov-07	12:08	76	33.977666	-76.363153	SE	9	3	90	1	Recreational vessel, ~2.5 NM off
19-Nov-07	12:47	87	34.248820	-76.579081	NW	10	2	80	1	Sport fishing vessel, ~0.5 NM off
11-Dec-07	12:13	30	33.897262	-76.907786	SE	4	4	90	1	Small recreational vessel, 2.5 NM off
11-Dec-07	12:21	25	33.730095	-76.688251	SE	4	4	60	1	Recreational fishing vessel stationary
11-Dec-07	12:36	29	33.456405	-76.471972	NW	3	3	30	1	Staionary recreational fishing vessel
11-Dec-07	13:20	41	33.635364	-76.832863	SE	2	5	90	1	Stationary recreational fishing
25-Feb-08	9:51	9	34.176539	-76.485178	SE	10	4	3	1	Recreational fishing vessel
25-Feb-08	13:57	45	33.762250	-77.128517	SE	1	3	90	1	Recreational fisherman
25-Feb-08	14:51	61	33.764180	-76.999938	NW	2	4	90	1	Recreational fishing vessel
25-Feb-08	15:48	73	33.905370	-76.923209	NW	4	4	90	1	Recreational fishing vessel
29-Feb-08	10:38	19	33.562342	-76.338956	SE	5	4	60	1	Recreational fishing vessel
29-Feb-08	11:07	29	34.043021	-76.838591	NW	6	2	90	1	Recreational fishing vessel
29-Feb-08	11:24	26	34.013892	-76.662347	SE	7	3	90	1	Tug and Barge
11-Mar-08	9:44	5	33.878659	-76.754109	SE	5	4	110	1	Small Recreational fishing vessel
11-Mar-08	9:49	22	33.770859	-76.611372	SE	5	3	90	1	Commercial fishing vessel
11-Mar-08	10:12	9	33.791571	-76.508419	NW	6	4	120	1	1 1/4 miles off trackline
11-Mar-08	10:13	10	33.811962	-76.534551	NW	6	4	90	1	Recreational vessel ~2 miles off
11-Mar-08	10:14	27	33.829816	-76.558607	NW	6	4	45	1	Recreational fishing vessel ~ 1 mile off
11-Mar-08	10:35	13	34.009566	-76.653544	SE	7	3	100	1	Recreational vessel ~1 mile off
11-Mar-08	10:40	32	33.892748	-76.503556	SE	7	4	90	1	Stationary recreational fishing vessel
11-Mar-08	10:40	15	33.891742	-76.502400	SE	7	3	90	1	Recreational fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
11-Mar-08	13:34	25	34.043946	-76.316582	SE	10	4	3	1	Recreational fishing vessel
11-Mar-08	13:42	50	33.890850	-76.120605	SE	10	2	90	1	Commercial fishing vessel
11-Mar-08	14:01	31	33.989109	-76.376014	NW	9	3	2	1	Recreational fishing vessel
11-Mar-08	14:03	33	34.015532	-76.410432	NW	9	4	2	1	Recreational fishing vessel
11-Mar-08	14:26	61	34.112919	-76.541914	NW	9	2	90	1	Recreational fishing vessel
11-Mar-08	14:42	38	34.158606	-76.725740	SE	8	4	1	1	Recreational fishing vessel
11-Mar-08	14:53	41	33.951972	-76.454552	SE	8	3	90	1	Recreational fishing vessel
11-Mar-08	15:18	50	33.927193	-76.421275	NW	8	3	1	1	Recreational fishing vessel
11-Mar-08	15:28	51	34.113747	-76.665677	NW	8	3	4	1	Recreational fishing vessel
11-Mar-08	15:30	80	34.149875	-76.713433	NW	8	4	60	1	Recreational fishing vessel
13-Mar-08	10:33	6	33.611073	-76.929433	SE	1	4	90	1	Recreational fishing vessel
13-Mar-08	10:34	7	33.595774	-76.911092	SE	1	3	80	1	Recreational fishing vessel
13-Mar-08	11:03	12	33.631086	-76.823306	NW	2	3	75	1	Recreational fishing vessel
13-Mar-08	11:05	12	33.667029	-76.869367	NW	2	3	30	1	Recreational fishing vessel
13-Mar-08	11:05	11	33.653905	-76.852671	NW	2	4	45	1	Commercial fishing vessel
13-Mar-08	11:06	13	33.674007	-76.878753	NW	2	4	90	1	Recreational fishing vessel
13-Mar-08	11:52	29	33.846360	-76.977698	SE	3	2	90	1	Recreational fishing vessel
13-Mar-08	12:36	50	33.789197	-76.764003	NW	4	3	90	1	Recreational fishing vessel
13-Mar-08	12:38	37	33.814529	-76.799151	NW	4	3	45	1	Recreational fishing vessel
13-Mar-08	14:30	44	34.217625	-76.539520	SE	10	3	30	1	Recreational fishing vessel
13-Mar-08	14:40	63	34.031276	-76.301735	SE	10	1	90	1	Recreational fishing vessel
13-Mar-08	14:40	64	34.018722	-76.285432	SE	10	3	110	1	Recreational fishing vessel
13-Mar-08	15:14	69	33.995730	-76.383551	NW	9	4	90	1	Recreational fishing vessel
13-Mar-08	15:14	53	33.986402	-76.371040	NW	9	2	60	1	Recreational fishing vessel
13-Mar-08	15:15	70	34.009959	-76.402875	NW	9	3	90	1	Recreational fishing vessel
13-Mar-08	15:39	74	33.977627	-76.487445	SE	8	2	90	1	Small Commercial fishing vessel
13-Mar-08	15:41	58	33.947801	-76.447570	SE	8	1	45	1	Recreational fishing vessel
13-Mar-08	15:42	59	33.932509	-76.427725	SE	8	4	45	1	Recreational fishing vessel
13-Mar-08	16:21	83	33.978472	-76.616680	NW	7	2	90	1	Recreational fishing vessel
25-Apr-08	9:27	3	34.270468	-76.606513	SE	10	3	45	1	Recreational fishing vessel
25-Apr-08	9:28	5	34.253006	-76.585106	SE	10	2	100	1	Recreational fishing vessel
25-Apr-08	9:41	5	34.005452	-76.266806	SE	10	4	45	1	Recreational fishing vessel
25-Apr-08	10:04	14	33.947924	-76.323134	NW	9	3	60	2	Two recreational fishing vessels
25-Apr-08	10:48	26	33.934234	-76.430213	SE	8	3	45	1	Commercial fishing vessel
25-Apr-08	10:49	27	33.920588	-76.412144	SE	8	4	60	1	Recreational fishing vessel
25-Apr-08	10:49	24	33.920286	-76.411804	SE	8	3	60	1	Recreational fishing vessel
25-Apr-08	11:22	31	33.854108	-76.454840	NW	7	4	60	4	Four recreational fishing vessels
25-Apr-08	11:23	41	33.867119	-76.471973	NW	7	3	45	1	Recreational fishing vessel
25-Apr-08	11:35	32	34.096520	-76.771453	NW	7	3	80	1	Recreational fishing vessel
25-Apr-08	11:52	44	33.831822	-76.561443	SE	6	3	60	1	Recreational fishing vessel
25-Apr-08	11:52	35	33.836238	-76.567317	SE	6	4	90	1	Recreational fishing vessel
25-Apr-08	11:53	45	33.812798	-76.536533	SE	6	2	45	1	Recreational fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
25-Apr-08	12:18	43	33.784292	-76.630322	NW	5	3	70	1	Recreational fishing vessel
25-Apr-08	12:24	50	33.897052	-76.778688	NW	5	4	45	1	Recreational fishing vessel
25-Apr-08	12:25	44	33.918491	-76.806987	NW	5	3	45	1	Recreational fishing vessel
25-Apr-08	14:06	56	33.945673	-76.972998	SE	4	1	60	1	Recreational fishing vessel
25-Apr-08	14:16	58	33.730142	-76.687392	SE	4	4	90	1	Recreational fishing vessel
25-Apr-08	14:16	52	33.733233	-76.691441	SE	4	2	80	4	Four recreational fishing vessels
25-Apr-08	14:22	55	33.620979	-76.544014	SE	4	3	90	2	Recreational fishing vessels
25-Apr-08	14:53	69	33.671032	-76.749026	NW	3	3	60	1	Recreational fishing vessels
25-Apr-08	14:57	61	33.762963	-76.868556	NW	3	2	60	1	Recreational fishing vessel
25-Apr-08	15:02	64	33.856511	-76.990834	NW	3	3	90	1	Recreational fishing vessel
25-Apr-08	15:19	69	33.640277	-76.836556	SE	2	2	80	1	Recreational fishing vessel
26-Apr-08	9:35	3	33.681631	-77.021151	SE	1	4	90	1	Recreational fishing vessel
26-Apr-08	10:24	11	33.867035	-77.004079	SE	3	3	90	2	Recreational fishing vessels
26-Apr-08	10:24	9	33.852878	-76.985466	SE	3	1	60	1	Recreational fishing vessel
26-Apr-08	10:25	12	33.838854	-76.967226	SE	3	2	45	1	Recreational fishing vessel
26-Apr-08	10:34	11	33.667052	-76.743331	SE	3	2	0	1	Recreational fishing vessel
26-Apr-08	11:10	21	33.691064	-76.636700	NW	4	1	90	1	Recreational fishing vessel
26-Apr-08	11:10	16	33.690637	-76.636114	NW	4	2	45	1	Recreationl fishing vessel
26-Apr-08	11:11	22	33.711877	-76.664236	NW	4	4	60	1	Recreational fishing vessel
26-Apr-08	11:11	17	33.712163	-76.664578	NW	4	1	45	1	Recreationl fishing vessel
26-Apr-08	11:18	24	33.845573	-76.840835	NW	4	2	90	1	Recreational fishing vessel
26-Apr-08	11:20	18	33.891248	-76.901442	NW	4	1	90	1	Stationary recreational fishing vessel
26-Apr-08	13:25	33	34.107549	-76.397735	SE	10	1	90	1	Recreational fishing vessel
26-Apr-08	13:26	34	34.096137	-76.382956	SE	10	2	45	2	Two recreational fishing vessels
26-Apr-08	13:29	35	34.034919	-76.304454	SE	10	3	30	1	Recreational fishing vessel
26-Apr-08	13:29	26	34.034280	-76.303645	SE	10	4	60	1	Recreational fishing vessel
26-Apr-08	13:30	27	34.014620	-76.278693	SE	10	3	90	1	Recreational fishing vessel
26-Apr-08	13:32	36	33.967640	-76.218440	SE	10	4	90	1	Recreational fishing vessel
26-Apr-08	13:57	45	33.949933	-76.326067	NW	9	4	90	1	Recreational fishing vessel
26-Apr-08	13:58	46	33.965731	-76.346932	NW	9	2	60	1	Recreational fishing vessel
26-Apr-08	13:59	47	33.982810	-76.369527	NW	9	3	60	1	Recreational fishing vessel
26-Apr-08	13:59	36	33.978975	-76.364365	NW	9	1	45	1	Recreational fishing vessel
26-Apr-08	14:00	37	33.996795	-76.387871	NW	9	5	60	1	Recreational fishing vessel
26-Apr-08	14:05	48	34.111829	-76.539840	NW	9	1	80	1	Head boat anchored
26-Apr-08	14:23	51	33.950066	-76.450786	SE	8	3	70	1	Recreational fishing vessel
26-Apr-08	14:26	52	33.888715	-76.370540	SE	8	1	90	1	Recreational fishing vessel
26-Apr-08	15:06	60	33.977141	-76.752888	SE	6	3	30	1	Recreational fishing vessel
26-Apr-08	15:09	61	33.923480	-76.682089	SE	6	2	90	1	Recreational fishing vessel
26-Apr-08	15:12	62	33.850299	-76.585676	SE	6	3	60	1	Recreational fishing vessel
26-Apr-08	15:40	67	33.859896	-76.729903	NW	5	4	60	1	Recreational fishing vessel
25-May-08	9:51	4	34.109852	-76.399853	SE	10	4	60	1	Recreational fishing vessel
25-May-08	10:13	8	33.844213	-76.187116	NW	9	3	90	1	Recreational fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

Date	Time	Way Point	Latitude	Longitude-1	Heading	Track Number	Angle out	Degree Forward	Best #	Comments
26-May-08	15:17	57	34.072254	-76.610876	SE	8	1	60	1	Recreational fishing vessel
26-May-08	15:22	58	33.980721	-76.492015	SE	8	3	30	2	Recreational fishing vessel
26-May-08	15:26	59	33.895324	-76.381290	SE	8	2	45	1	Recreational fishing vessel
27-May-08	9:32	4	33.649237	-76.980501	SE	1	4	45	1	Recreational fishing vessel ~200m off
27-May-08	11:33	20	33.813598	-76.797694	NW	4	2	90	1	Recreational fishing vessel
24-Jun-08	10:19	6	33.919611	-76.679065	NW	6	45	3	1	Sailing vessel
24-Jun-08	10:36	9	33.992606	-76.635817	SE	7	100	4	1	Recreational fishing vessel
24-Jun-08	10:42	10	33.882690	-76.493237	SE	7	90	4	1	Recreational fishing vessel
24-Jun-08	10:50	11	33.712926	-76.272021	SE	7	70	3	1	Head boat
24-Jun-08	11:15	17	34.103057	-76.651772	NW	8	90	1	1	Recreational fishing vessel
24-Jun-08	12:07	21	34.226897	-76.553544	NW	10	2	45	1	Recreational fishing vessel
24-Jun-08	12:09	22	34.264817	-76.600080	NW	10	2	45	1	Recreational fishing vessel
25-Jun-08	9:29	3	33.942266	-76.833045	SE	5	45	2	1	Recreational fishing vessel
25-Jun-08	9:33	3	33.860613	-76.728798	SE	5	5	60	1	Recreational fishing vessel
25-Jun-08	10:40	19	34.028028	-76.681291	SE	7	90	2	1	Recreational fishing vessel
25-Jun-08	10:40	20	34.014335	-76.663604	SE	7	90	2	2	2 recreational fishing vessels
25-Jun-08	10:47	21	33.884286	-76.489791	SE	7	45	1	1	Recreational fishing vessel
25-Jun-08	11:46	33	34.173875	-76.618006	SE	9	100	2	1	Unidentified vessel (dive boat?)
25-Jun-08	11:50	36	34.104337	-76.525562	SE	9	100	2	1	Recreational fishing vessel
25-Jun-08	11:52	29	34.068556	-76.479370	SE	9	3	60	1	Recreational fishing vessel
25-Jun-08	12:57	52	34.230605	-76.551700	NW	10	120	3	1	Recreational fishing vessel
25-Jun-08	12:58	53	34.245909	-76.570117	NW	10	110	3	3	3 recreational fishing vessels
25-Jun-08	12:59	41	34.272554	-76.606153	NW	10	3	60	1	Recreational fishing vessel
25-Jun-08	14:40	58	33.906189	-76.920889	SE	4	90	1	1	Recreational fishing vessel
25-Jun-08	14:42	46	33.884001	-76.891471	SE	4	3	45	1	Recreational fishing vessel
25-Jun-08	14:43	59	33.848977	-76.844841	SE	4	120	3	1	Recreational fishing vessel
25-Jun-08	15:46	58	33.710026	-76.926794	SE	2	2	30	1	Recreational fishing vessel
25-Jun-08	15:51	59	33.600248	-76.786104	SE	2	1	45	1	Sailboat
25-Jun-08	16:28	67	33.680552	-77.018734	NW	1	2	60	1	Recreational fishing vessel

Table 20. All fishing vessel sightings in the proposed USWTR site in Onslow Bay, NC for surveys conducted from June 2007 to June 2008.

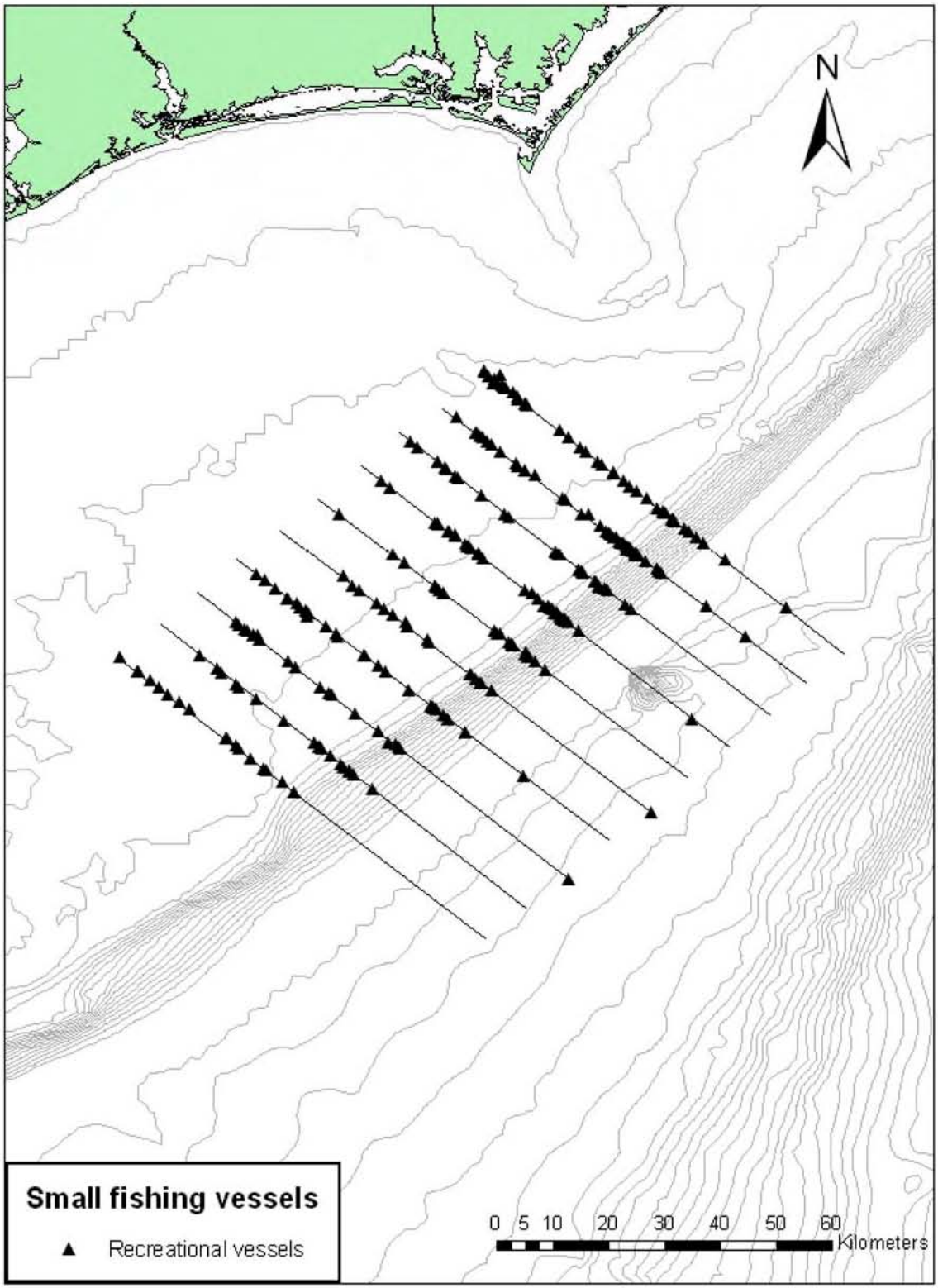

Figure 19. Location of recreational vessels observed in the Onslow Bay NC USWTR proposed location.

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Date:_____ **Observer Side:**_____ **GPS#:**_____ **Page**___ **of** _____

Pilot/Co-Pilot_____ **Observers Left/Right:**_____ **Hobbs:**_____

Time	Waypoint #	Event	Heading	Track #	Visibility	BSS	Cloud	Glare L	Glare R	Vertical Angle	Horizontal degree	Sighting Cue	Species	Reliability	Min #	Max #	Best Est	Calves Y/N	Avoid Y/N	Pho/Vid (Y/N)	
																		.			

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

Appendix C

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

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

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:

26 June 2007 Sighting # 1

Initial Sighting on Track
Time: 10:52 WP#: 6 Lat: 34.15206 Long: -76.45457 Track Line: 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 65
Observer: PBN Observer Side: Right

Time and Position of Sighting (Estimated)
Time: 10:52 WP #: 7 Lat: 34.16203 Long: -76.48301 Beaufort Sea State: 2
Species: Unidentified cetacean Features used in species ID: N/A
Numbers (Low/ High/ Best): 3 / 4 / 3 Calves observed? No
Photographer: N/A Frame Numbers: N/A Spacer: N/A Representative Images: N/A
Calculated Distance from Track Line: 2.8 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Three dolphin-sized animals were sighted on the right side. Broke track and flew to area of sighting cue. Animals believed to be large dolphins or other cetacean species. Plane circled three times on side of plane where animals were initially seen. We then circled at between 750 and 1000 ft on the opposite side of line as animals' movement would have crossed track line. Waypoint # 8 Animals spotted again approximately 1 mile off the right side of the plane. Unable to relocate animals for photo documentation and species identification.

26 June 2007 Sighting # 2

Initial Sighting on Track

Time: 11:21 WP: 12 Lat: 33.97076 Long: -76.22106 Track Line: 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 45
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 11:22 WP #:13 Lat: 33.92919 Long: -76.17125 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust gray dolphins with short stocky rostrum, white area on dorsal caudal peduncle, gradually tapering body
Numbers: (Low/ High/ Best): 60 / 90 / 80 Calves observed? No
Representative Image(s): 2776, 3685, 3887, 4089, 4190, 4594
Photographer: PBN Frame Numbers: 453 to 4796 Spacer: 4897
Calculated Distance from Track Line: 6.5 km

Final Time and Position of Sighting
Time: 11:35 WP#: 14 Lat: 33.93683 Long: -76.17852
Calculated Distance Traveled: 1.1 km

Behavior and Additional Comments:
Brownish dolphins active at the surface. Dolphins active below surface – spinning, overlapping each other and changing direction sharply. Pairs of dolphins were very active swimming parallel to each other and changing direction. Estimate multiple groups of 20+ animals. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 June 2007 Sighting # 3

Initial Sighting on Track
Time: 11:50 WP: 19 Lat: 33.85745 Long: -76.20297 Track Line: 9
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 45
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 11:51 WP #: 20 Lat: 33.86192 Long: -76.19399 Beaufort Sea State: 2
Species: *Globicephala macrorhynchus* Features used in species ID: Large black cetaceans with bulbous melons and rounded dorsal fins, short pectorals fins clearly visible.
Representative Images: 67116, 73112, 78127, 91140
Numbers: (Low/ High/ Best): 28 / 35 / 32 Calves observed? Yes
Photographer: PBN Frame Numbers: 4998 to 110159 (55 images) Spacer: None
Calculated Distance from Track Line: 1.0 km

Final Time and Position of Sighting
Time: 12:03 WP#: 21 Lat: 33.87344 Long: -76.18783
Calculated Distance Traveled: 1.4 km

Behavior and Additional Comments:
Initial sighting animals were in loose groups of 2 to 3 in a horizontal line.
Mix of adults and young animals. Towards end of sighting animals moved into two groups within 100m. Also sighted another group of 6-10 animals (included in low/high/best numbers) within a couple of hundred meters. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

18 July 2007 Sighting #1

Initial Sighting on Track
Time: 10:01 WP: 22 Lat: 33.88693 Long: -76.36988 Track Line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 10:06 WP #:23 Lat: 33.88348 Long: -76.37331 Beaufort Sea State: 3
Species: Unidentified delphinid Features used in species ID: Animals were most likely *Tursiops truncatus* judging from features observed from the plane, but since no images were obtained species identification cannot be made with 100% certainty, hence the designation ”unidentified delphinids” is used in this case.
Numbers: (Low/ High/ Best): 4 / 7 / 6 Calves observed? No
No images obtained
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting
Time: 10:08 WP#: 24 Lat: 33.88526 Long: -76.36339
Calculated Distance Traveled: 0.9 km

Behavior and Additional Comments:
Animals sighted directly under plane swimming parallel to each other heading away from the track line. When we circled the area of the sighting we were unable to relocate the animals to photograph or confirm the species.

7 August 2007 Sighting # 1

Initial Sighting on Track
Time: 11:06 WP: 20 Lat: 33.70546 Long: -76.39396 Track Line: 6
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 30
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 11:07 WP # 21 Lat: 33.70572 Long: -76.39433 Beaufort Sea State: 2
Species: Unidentified delphinids Features used in species ID: N/A
Numbers: (Low/ High/ Best): 2 / 4 / 3 Calves observed? No
Photographer: PBN Frame Numbers: 1 to 2 Spacer: 3 Representative Images: N/A
Calculated Distance from Track Line: 0.04 km

Final Time and Position of Sighting
Time: 11:29 WP#: 22 Lat: 33.69614 Long: -76.38772
Calculated Distance Traveled: 1.2 km

Behavior and Additional Comments:
Animals initially sighted moving away from track-line. Actual position was taken as plane flew directly over animals after which there was no re-sight. Circled area the animals were last seen at between 750 and 1000 ft altitude. The animals were moving fast at the surface with racing shallow dives and low angled explosive leaps. The two photos taken are blurry but do show distinct dark/light aspect discussed below. The dolphins observed exhibited long sleek, torpedo shaped bodies with narrow peduncles, with a gray/brown dorsal side and white/light flanks and ventral side, with white extending up on top of peduncle. Dashed line indicates approximate area plane covered attempting to re-sight animals.

25 September 2007 Sighting # 1

Initial Sighting on Track
Time: 10:43 WP: Left 21 Lat: 34.15946 Long: -76.59785 Track line: 9
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Same as above
Species: Unidentified delphinids Features used in species ID: N/A
Numbers: (Low/ High/ Best): 5 / 7 / 6 Calves observed? No
Photographer: N/A Frame Numbers: N/A Spacer: N/A Representative Images: N/A
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting
Time: Same as above – not re-sighted WP#: Same as above – not re-sighted
Calculated Distance traveled: N/A

Behavior and Additional Comments:
Small group of unidentified dolphins traveling towards track line. Animals appeared uniformly grey. Group not re-sighted after we broke track.

25 September 2007 Sighting # 2

Initial Sighting on Track
Time: 10:58 WP: Left 23 Lat: 34.09045 Long: -76.52966 Track line: 9
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 100
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 11:01 WP #: 24 Lat: 34.08935 Long: -76.54013 Beaufort Sea State: 3
Species: *Stenella frontalis* Features used in species ID: highly spotted appearance, lighter flanks and ventral side, overall slender appearance, and appendage shape (thin, sickle shaped fluke, and small, slender dorsal fin)
Numbers: (Low/ High/ Best): 4 / 4 / 4 Calves observed? No
Representative Images: 8, 13, 27, 59, 65
Photographer: RJM Frame Numbers: 1 to 65 Spacer: 66 Calculated Distance from Track Line: 1.0 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Group of four *Stenella frontalis* traveling parallel to the track line, about 200 meters off. From the plane, animals appeared brown/grey with visibly lighter areas on the flanks and on the peduncle.
Photographs taken during circling allowed for identification to species. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

14 October 2007 Sighting #: 1

Initial Sighting on Track
Time: 09:30 WP: 7 Lat: 33.47865 Long: -76.75892 Track line: 1
On/Off Effort: On Sighting Cue: Splash
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: WAM Observer Side: Left

Time and Position of Sighting
Time: 09:33 WP #: 8 Lat: 33.48366 Long: -76.75950 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Species identification based on overall appearance (somewhat stocky, slate gray, with lighter areas on caudal peduncle and dorsal thorax) observed in the field as well as from good quality photographs obtained.
Numbers: (Low/ High/ Best): 35 / 42 / 40 Calves observed? No
Representative Images: 8, 11, 16, 27
Photographer: PBN Frame Numbers: 1 to 41 Spacer: 42
Calculated Distance from Track Line: 0.6 km

Final Time and Position of Sighting
Time: 09:38 WP#: 9 Lat: 33.48450 Long: -76.76177

Behavior and Additional Comments:
Dolphins initially heading Southwest, movements during encounter less uni-directional and included several dolphins taking coordinated turns. Animals split up into three distinct groups, which joined at the end of the encounter. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

17 November 2007 Sighting # 1

Initial Sighting on Track
Time: 09:34 WP: 8 Lat: 34.09924 Long: -77.23202 Track line: N/A
On/Off Effort: Off Sighting Cue: White water
Vertical Angle: 2 Horizontal Bearing in Degrees: 30
Observer: LLL Observer Side: Left

Actual Time and Position of Sighting
Time: 09:35 WP #: 10 Lat: 34.11094 Long: -77.21801 Beaufort Sea State: 1
Species: *Eubalena glacialis* Features used in species ID; Large, rotund, black whales with characteristic callosities, large square pectoral fins, double blow
Numbers: (Low/ High/ Best): 2 / 2 / 2 Calves observed? No
Representative Images: 46, 52, 76
Photographer: RJM Frame Numbers: 1 to 110 Spacer: N/A (changed cards after Egl encounter)
Calculated Distance from Track Line: 1.8 km

Time and Position of Sighting
Time: 09:52 WP#: 11 Lat: 34.12420 Long: -77.20407
Calculated Distance traveled: 2.0 km

Behavior and Additional Comments:
Two adult right whales traveling together, apparently heading north. At one time, a sport fishing vessel passed the whales within ¼ mile at high speed. Circled animals at 1000 ft altitude. No avoidance reaction noted.

17 November 2007 Sighting # 2

Initial Sighting on Track
Time: 10:04 WP#: 13 Lat: 33.90739 Long: -76.92276 Track line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 10:13 WP #: 14 Lat: 33.91301 Long: -76.94720 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Gradually tapering body, uniformly gray, *Tursiops*-like dorsal and pectoral fins
Numbers: (Low/ High/ Best): 3 / 4 / 3 Calves observed? No
Representative Images: 4, 11, 15
Photographer: RJM Frame Numbers: 2 to 24 Spacer: 25, 26
Calculated Distance from Track Line: 2.3 km

Final Time and Position of Sighting
Time: 10:21 WP#: 15 Lat: 33.91400 Long: -76.94028
Calculated Distance traveled: 0.7 km

Behavior and Additional Comments:
Right off the track line, “skinny” in appearance, bright white ventral side. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

17 November 2007 Sighting # 3

Initial Sighting on Track
Time: 10:31 WP#: 10 (R) Lat: 33.70922 Long: -76.66014 Track line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 10:32 WP #: 20 (L) Lat: 33.71345 Long: -76.67102 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Short, stocky rostrums, gradually tapering bodies, overall gray coloration, white on dorsal caudal peduncle.
Numbers: (Low/ High/ Best): 16 / 20 / 18 Calves observed? No
Representative Images: 35, 36, 44
Photographer: RJM Frame Numbers: 27 to 53 Spacer: 54
Calculated Distance from Track Line: 1.1 km

Final Time and Position of Sighting
Not recorded
Calculated Distance traveled: N/A

Behavior and Additional Comments:
Dolphins behave and look like *Tursiops truncatus*, some with white on ventral side of caudal peduncle. Dolphins in two main groups, with about seven to 10 individuals in each group. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

17 November 2007 Sighting # 4

Initial Sighting on Track
Time: 10:38 WP#: 12 (R) Lat: 33.67650 Long: -76.61501 Track line: 4
On/Off Effort: On Sighting Cue: Dark shape under water
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 10:42 WP #: 22 Lat: 33.68648 Long: -76.60471 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust, gray, with white/lighter area on caudal peduncle
Numbers: (Low/ High/ Best): 9 / 9 / 9 Calves observed? No
Representative Images: 64, 65
Photographer: RJM Frame Numbers: 55 to 68 Spacer: 69-70
Calculated Distance from Track Line: 1.5 km

Final Time and Position of Sighting
Time: 10:44 WP#: 23 Lat: 33.69524 Long: -76.60556
Calculated Distance traveled: 1.0 km

Behavior and Additional Comments:
Looks like a group of *Tursiops truncatus*: robust, gray, with white/lighter area on caudal peduncle. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

17 November 2007 Sighting # 5

Initial Sighting on Track
Time: 11:06 WP#: 29 Lat: 33.67079 Long: -76.7392 Track line: 3
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 60
Observer: RJM Observer Side: R

Time and Position of Sighting
Time: 11:08 WP #: 30 Lat: 33.66896 Long: -76.73108 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust, stocky dolphins with gradually tapering bodies, short rostrums, lighter area on dorsal caudal peduncle.
Numbers: (Low/ High/ Best): 23 / 25 / 23 Calves observed? No
Representative Images: 78, 85
Photographer: RJM Frame Numbers: 71 to 90 Spacer: 91
Calculated Distance from Track Line: 0.8 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Dolphins in four to five sub-groups. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

18 November 2007 Sighting # 1

Initial Sighting on Track
Time: 09:35 WP#: 14 Lat: 33.76496 Long: -76.08201 Track line: In transit from 10 to 9
On/Off Effort: Off Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 09:36 WP #: 15 Lat: 33.76686 Long: -76.07981 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust, stocky dolphins, short rostrums, gradually tapering body, white area on dorsal caudal peduncle
Numbers: (Low/ High/ Best): 2 / 3 / 3 Calves observed? No
Representative Images: 15, 18, 21
Photographer: PBN Frame Numbers: 1 to 21 Spacer: 22
Calculated Distance from Track Line: 0.3 km

Final Time and Position of Sighting
Time: 09:40 WP#: 16 Lat: 33.76381 Long: -76.07506
Calculated Distance traveled: 0.6 km

Behavior and Additional Comments:
Two animals swimming in close proximity to each other. Many “zig zags” and strong surfacings. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

18 November 2007 Sighting # 2

Initial Sighting on Track
Time: 10:08 WP#: 21 Lat: 34.19695 Long: -76.72245 Track line: In transit between 9 and 8
On/Off Effort: Off Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 110
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 10:13 WP #: 27 Lat: 34.20727 Long: -76.71849 Beaufort Sea State: 3
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 2 / 2 / 2 Calves observed? No
Representative Images: N/A
Photographer: N/A – no images taken Frame Numbers: N/A
Calculated Distance from Track Line: 1.2 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Two unidentified dolphins, which we were unable to relocate. Position reported for "Actual Time and Position of Sighting" is the estimated location of dolphins when initially sighted.

18 November 2007 Sighting # 3

Initial Sighting on Track
Time: 10:42 WP#: 27 Lat: 33.65711 Long: -76.19892 Track line: In transit between 8 and 7
On/Off Effort: Off Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 120
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 10:44 WP#: 28 Lat: 33.66277 Long: -76.19807 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Robust, stocky dolphins with gradually tapering bodies and short rostrums
Numbers: (Low/ High/ Best): 15 / 23 / 20 Calves observed? No
Representative Images: 45, 46, 53, 55, 56, 57
Photographer: PBN Card #: 1 Frame Numbers: 23 to 59 Spacer: 60
Calculated Distance from Track Line: 0.6 km

Final Time and Position of Sighting
Time: 10:45 WP#: 29 Lat: 33.66212 Long: -76.19703
Calculated Distance Traveled: 0.1 km

Behavior and Additional Comments:
Animals sighted on right. Long dispersed line of animals. Biggest group consisted of approximately five dolphins. Formed into groups of three to four during encounter – still traveling in a dispersed line. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

18 November 2007 Sighting # 4

Initial Sighting on Track
Time: 11:08 WP#: 31 Lat: 33.98997 Long: -76.63126 Track line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 4 Horizontal Bearing in Degrees: 100
Observer: PBN Observer Side: Right

Time and Position of Sighting (Estimated)
Time: 11:10 WP #: 32 Lat: 33.98763 Long: -76.59155 Beaufort Sea State: 3
Species: Unidentified marine vertebrate Features used in species ID: N/A
Photographer: N/A – no images obtained
Calculated Distance from Track Line: 3.7 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
A body was observed about one mile off the right side. We broke track to investigate but were unable to relocate.

19 November 2007 Sighting # 1

Initial Sighting on Track
Time: 09:33 WP#: 9 Lat: 33.76293 Long: -76.60171 Track line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 09:34 WP #: 10 Lat: 33.76166 Long: -76.60302 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: Species ID could not be established
Numbers: (Low/ High/ Best): 14 / 23 / 20 Calves observed? Yes
Representative Images: N/A
Photographer: RJM Card #: 1 Frame Numbers: 1 to 22 Spacer: 23
Calculated Distance from Track Line: 0.2 km

Final Time and Position of Sighting
Time: 09:38 WP#: 11 Lat: 33.76312 Long: -76.60751
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments:
Spread out group. Individuals with white dorsal peduncle (*Tursiops truncatus*?). At least one mother/calf pair. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 2

Initial Sighting on Track
Time: 09:46 WP#: 13 Lat: 33.68801 Long: -76.49910 Track line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 110
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 09:46 WP #: 14 Lat: 33.68980 Long: -76.49696 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Short rostrums, white area on caudal peduncle, body gradually tapering towards flukes
Numbers: (Low/ High/ Best): 4 / 4 / 4 Calves observed? No
Representative Images: 25, 31, 32, 33
Photographer: RJM Card #: 1 Frame Numbers: 24 to 35 Spacer: 36
Calculated Distance from Track Line: 0.3 km

Final Time and Position of Sighting
Time: 09:49 WP#: 15 Lat: 33.68984 Long: -76.49962
Calculated Distance Traveled: 0.3 km

Behavior and Additional Comments:
Slow surface travel, spread out, long down times. One dolphin appears *real* light. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 3

Initial Sighting on Track
Time: 09:50 WP#: 17 Lat: 33.66096 Long: -76.46282 Track line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 100
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 09:52 WP #: 18 Lat: 33.66871 Long: -76.46501 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Gray color, with light caudal peduncle.
Numbers: (Low/ High/ Best): 8 / 10 / 8 Calves observed? Yes
Representative Images: N/A - all images distant and out of focus
Photographer: RJM Card #: 1 Frame Numbers: 37 to 57 Spacer: 58
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 09:57 WP#: 19 Lat: 33.66397 Long: -76.46321
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments:
Dolphins spread out. Gray color, with light caudal peduncle. One mother/calf pair. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 4

Initial Sighting on Track
Time: 10:13 WP#: 24 Lat: 33.77940 Long: -76.49418 Track line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 10:14 WP #: 25 Lat: 33.78396 Long: -76.49154 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Gray bodies, white peduncle area – indicative of *Tursiops truncatus*.
Numbers: (Low/ High/ Best): 4 / 6 / 5 Calves observed? No
Representative Images: N/A – all Photographer: RJM Frame Numbers: 59 to 75 Spacer: 76 images distant and out of focus
Calculated Distance from Track Line: 0.6 km

Final Time and Position of Sighting
Time: 10:21 WP#: 26 Lat: 33.78147 Long: -76.49614
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments:
Long dive times – evasive maneuver in response to plane? Four to five individuals together, one singleton a distance away. Circled animals at between 750 and 1000 ft.

19 November 2007 Sighting # 5

Initial Sighting on Track
Time: 10:29 WP#: 29 Lat: 33.92059 Long: -76.67939 Track line: 6
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 80
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 10:30 WP #: 30 Lat: 33.91649 Long: -76.68142 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 11 / 12 / 11 Calves observed? No
Representative Images: N/A – all images distant and/or out of focus
Photographer: RJM Card #: 1 Frame Numbers: 77 to 83 Spacer: N/A – changed card
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting
Time: 10:37 WP#: 32 Lat: 33.91190 Long: -76.67596
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments:
Aerial behavior consisting of multiple high leaps was observed. The group was spread out over hundreds of meters. A dolphin approached and interacted with a piece of *Sargassum*. Dolphins split into two groups (4 and 7 individuals, respectively). Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 6

Initial Sighting on Track
Time: 10:52 WP#: 40 Lat: 34.02480 Long: -76.66977 Track line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Not recorded
Beaufort Sea State: 2
Species: Unidentified marine vertebrate Features used in species ID: N/A
Numbers: (Low/ High/ Best): ? Calves observed? No
Photographer: N/A - no images obtained
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Sighting of unidentified "body" (could have been a cetacean or a shark) more or less on the track line. Unable to relocate or to establish species identity.

19 November 2007 Sighting # 7

Initial Sighting on Track
Time: 11:10 WP#: Not recorded Track line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 120
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:10 WP #: 44 Lat: 33.80440 Long: -76.38555 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 22 / 25 / 22 Calves observed? No
Representative Images: N/A – all images distant and out of focus
Photographer: RJM Card #: 2 Frame Numbers: 1 to 46 Spacer: 47
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting
Time: 11:15 WP#: 45 Lat: 33.80348 Long: -76.38563
Calculated Distance Traveled: 0.1 km

Behavior and Additional Comments:
Two distinct groups, separated by 200 m. Slow travel a few meters below surface. Long down times. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 8

Initial Sighting on Track
Time: 11:46 WP#: 65 Lat: 34.13667 Long: -76.69469 Track line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:47 WP #: 66 Lat: 34.13428 Long: -76.69248 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 3 / 3 / 3 Calves observed? No
Representative Images: N/A – images distant and/or out of focus
Photographer: RJM Frame Numbers: 48 to 55 Spacer: 56
Calculated Distance from Track Line: 0.33 km

Final Time and Position of Sighting
Time: 11:50 WP#: 67 Lat: 34.13198 Long: -76.68411
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments:
Three unidentified dolphins, spread out. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

19 November 2007 Sighting # 9

Initial Sighting on Track
Time: 12:21 WP#: 79 Lat: 33.83212 Long: -76.03973 Track line: 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 60
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 12:22 WP #: 80 Lat: 33.82424 Long: -76.04104 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Short rostrums, dark gray cape, lighter gray flanks
Numbers: (Low/ High/ Best): 37 / 45 / 40 Calves observed? No
Representative Images: 57, 58
Photographer: RJM Frame Numbers: 57 to 86 Spacer: 87
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 12:27 WP#: 81 Lat: 33.82587 Long: -76.03839
Calculated Distance Traveled: 0.3 km

Behavior and Additional Comments:
Animals divided in four groups with between six and fifteen individuals in each.
Animals separated by a few hundred meters, swimming in a line. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

11 December 2007 Sighting # 1

Initial Sighting on Track
Time: 12:52 WP#: 30 Lat: 33.76967 Long: -76.87654 Track line: 3
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 12:57 WP #: 34 Lat: 33.76840 Long: -76.87553 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Sturdy grey animal, with short rostrum
Numbers: (Low/ High/ Best): 1 / 1 / 1 Calves observed? No
Representative Images: None obtained
Photographer: N/A – no images obtained
Calculated Distance from Track Line: 0.2 km

Final Time and Position of Sighting
Time: 12:58 WP#: 35 Lat: 33.76769 Long: -76.87483
Calculated Distance Traveled: 0.1 km

Behavior and Additional Comments:
A single animal was initially seen swimming parallel to the plane heading Northwest. The survey team broke track and circled the animal to determine species. Positive identification of the bottlenose dolphin was made and no photographs were taken. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 February 2008 Sighting # 1

Initial Sighting on Track
Time: 14:02 WP#: 47 Lat: 33.66223 Long: -76.99553 Track line: 1
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 110
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 14:06 WP #: 48 Lat: 33.67197 Long: -76.99567 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 6 / 9 / 7 Calves observed? No
Representative Images: 3, 7, 17
Photographer: PBN Frame Numbers: 1 to 23 Spacer: 24-25
Calculated Distance from Track Line: 1.1 km

Final Time and Position of Sighting
Time: 14:09 WP#: 49 Lat: 33.67652 Long: -76.99292
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments:
Traveling in loose echelon formation. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 February 2008 Sighting # 2

Initial Sighting on Track
Time: 14:45 WP#:60 Lat: 33.71961 Long: -76.94130 Track line: 2
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 14:47 WP #: 61 Lat: 33.72402 Long: -76.93654 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 11 / 15 / 13 Calves observed? No
Representative Images: N/A
Calculated Distance from Track Line: 0.7 km
Photographer: PBN Card #: 8 GB Frame Numbers: 26 to 53 Spacer: 54
Representative Images: N/A

Final Time and Position of Sighting
Time: 14:48 WP#:62 Lat: 33.72292 Long: -76.93753
Calculated Distance Traveled: 0.2 km

Behavior and Additional Comments:
Loose grouping, well spaced. At least one juvenile in the group. Some leaping/breaching observed. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

29 February 2008 Sighting # 1

Initial Sighting on Track
Time: 10:01 WP#: 4 Lat: 33.96936 Long: -76.87355 Track line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 110
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 10:02 WP #: 5 Lat: 33.96629 Long: -76.88037 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Dorsal fin shape and placement, white rostrum tip, spotted appearance
Numbers: (Low/ High/ Best): 7 / 9 / 8 Calves observed? No
Representative Images: 20, 28
Photographer: RJM Frame Numbers: 1 to 30 Spacer: 31
Calculated Distance from Track Line: 0.7 km

Final Time and Position of Sighting
Time: 10:08 WP#: 6 Lat: 33.97091 Long: -76.88685
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments:
Dispersed group, traveling in singles, pairs and threes. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

29 February 2008 Sighting # 2

Initial Sighting on Track
Time: 10:17 WP#: 12 Lat: 33.80597 Long: -76.65815 Track line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 10:18 WP #:13 Lat: 33.81298 Long: -76.65336 Beaufort Sea State: 3
Species: *Stenella frontalis* Features used in species ID: Spotted appearance, white blaze on flank, white rostrum tip, overall body shape
Numbers: (Low/ High/ Best): 5 / 8 / 7 Calves observed? No
Representative Images: 36, 38, 55
Photographer: RJM Frame Numbers: 32 to 57 Spacer: 58
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time:10:25 WP#: 14 Lat: 33.8104 Long: -76.65896
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments:
Very spread out group, singles and pairs. Non-directional movement, no calves seen from the air. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

29 February 2008 Sighting # 3

Initial Sighting on Track
Time: 11:16 WP#: 34 Lat: 34.04125 Long: -76.69906 Track line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 11:17 WP #: 35 Lat: 34.03670 Long: -76.70746 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: White blaze on flanks, presence of spots dorsal fin shape and placement
Representative Images: 62, 67, 68, 71
Numbers: (Low/ High/ Best): 24 / 30 / 27 Calves observed? Yes
Photographer: RJM Frame Numbers: 59 to 85 Spacer: 86
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Two tightly packed groups separated by a couple of hundred meters. At least one mother/calf pair observed. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

29 February 2008 Sighting # 4

Initial Sighting on Track
Time: 11:27 WP#: 38 Lat: 33.97303 Long: -76.60936 Track line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 130
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:28 WP #: 39 Lat: 33.94679 Long: -76.57219 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: White rostrum tip, lighter blaze on flanks, alternating "bands" or areas of light and dark coloration on dorsal side of body
Numbers: (Low/ High/ Best): 23 / 29 / 26 Calves observed: No
Representative Images: 91, 94, 99, 100, 102, 105, 118, 126
Photographer: RJM Frame Numbers: 87 to 133 Spacer: 134
Calculated Distance from Track Line: 4.5 km

Final Time and Position of Sighting
Time: 11:30 WP#: 40 Lat: 33.96366 Long: -76.56958
Calculated Distance Traveled: 1.9 km

Behavior and Additional Comments:
Very tight group, circling tight – on a bait ball? The group eventually broke up into three smaller groups, spread out over a couple of hundred meters. The group split up further, into singles and pairs. Possible avoidance reaction to the aircraft observed. Circled animals at between 750 and 1000 ft.

11 March 2008 Sighting # 1

Initial Sighting on Track
Time: 10:53 WP#: 33 Lat: 33.76278 Long: -76.33524 Track Line: 7
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 10:53 WP #: 34 Lat: 33.76047 Long: -76.35219 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Animals were robust and showed light coloration on the peduncle consistent with *Tursiops truncatus*.
Numbers (Low/ High/ Best): 15 / 16 / 15 Calves observed? No
Representative Images: 4, 7, 14
Photographer: PBN Frame Numbers: 1 to 20 Spacer: 21
Calculated Distance from Track Line: 1.6 km

Final Time and Position of Sighting
Time: 10:57 WP#: 35 Lat: 33.76543 Long: -76.35758
Calculated Distance Traveled: 0.6 km

Behavior and Additional Comments:
Animals were seen first about a ½ mile off track line heading towards the line (roughly south). They were traveling in a line as singles with some groups of two or three and were loosely spaced. Circled animals at between 750 and 1000 ft. No signs of disturbance or avoidance of the plane were noted.

11 March 2008 Sighting # 2

Initial Sighting on Track
Time: 14:06 WP#: 56 Lat: 34.07035 Long: -76.48395 Track line: 9
On/Off Effort: On Sighting Cue: Body
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 14:08 WP #: 57 Lat: 34.07214 Long: -76.47394 Beaufort Sea State: 2
Species: Unidentified delphinid Features used in species ID: N/A
Numbers: (Low/ High/ Best): 5 / 7 / 5 Calves observed? No
Representative Images: N/A
Photographer: PBN Frame Numbers: 21 to 81 Spacer: 82
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 14:22 WP#: 58 Lat: 34.06348 Long: -76.44946
Calculated Distance Traveled: 2.5 km

Behavior and Additional Comments:
Animals were moving very fast spending most of the time just below the surface and spent little time exposed when taking a breath. There was a lot of space between the individuals and we did not observe any occasions when the animals would form into groups of two or more. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

11 March 2008 Sighting # 3

Initial Sighting on Track
Time: 14:32 WP#: 62 Lat: 34.19558 Long: -76.65213 Track line: 9
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 14:23 WP #: 63 Lat: 34.18987 Long: -76.65739 Beaufort Sea State: 3
Species: *Stenella frontalis* Features used in species ID: White rostrum tips, light blaze on flanks, some individuals heavily spotted
Numbers: (Low/ High/ Best): 30 / 40 / 35 Calves observed? No
Representative Images: 94, 102, 107, 108, 112, 114, 121, 129, 135, 136, 156
Photographer: PBN Frame Numbers: 83 to 157 Spacer: 158 Calculated Distance from Track Line: 0.8 km

Final Time and Position of Sighting
Time: 14:38 WP#: 64 Lat: 34.19153 Long: -76.66280
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments:
Animals were interacting with one another at the surface in two dense groups. Saw many animals turning on their side or upside down as well as active surfacing events. Groups were traveling southeast, opposite of the survey plane. Animals began traveling more directed/noticeably as the encounter continued. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

13 March 2008 Sighting # 1

Initial Sighting on Track
Time: 10:52 WP#: 10 Lat: 33.40348 Long: -76.53284 Track Line: In transit between 1and 2
On/Off Effort: Off Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 110
Observer: PBN Observer Side: Left

Time and Position of Sighting
Not recorded
Species: Unidentified Delphinid Features used in species ID: N/A
Numbers (Low/ High/ Best): 1 / 2 / 1 Calves observed? No
Photographer: N/A – no images obtained
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments
Opportunistic sighting of one, potentially two, unidentified dolphin(s) during transit between offshore ends of track lines 1 and 2. The plane did not break track, hence, the exact position of the animals cannot be established.

13 March 2008 Sighting # 2

Initial Sighting on Track
Time: 11:11 WP#: 17 Lat: 33.78600 Long: -77.02495 Track line: 2
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:12 WP #: 18 Lat: 33.78600 Long: -77.02509 Beaufort Sea State: 2
Species: *T. truncatus/S. frontalis* Features used in species ID: N/A
Representative Images: 2, 3, 16 - 19
Numbers: (Low/ High/ Best): 3 / 3 / 3 Calves observed? No
Photographer: RJM Frame Numbers: 1 to 21 Spacer: 22
Calculated Distance from Track Line: 0.01 km

Final Time and Position of Sighting
Time: 11:25 WP#: 19 Lat: 33.79058 Long: -77.02509
Calculated Distance Traveled: 0.5 km

Behavior and Additional Comments:
Initially dove for several minutes, brief surface intervals, “long” dive times. Looks like *Tursiops truncatus*, slow swimming, sturdy, grey. The pair swam belly to belly for a distance before diving. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

13 March 2008 Sighting # 3

Initial Sighting on Track
Time: 11:37 WP#: 25 Lat: 33.85306 Long: -76.98408 Track Line: 3
On/Off effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:40 WP #: 26 Lat: 33.86134 Long: -76.98522 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Uniform grey and sturdy
Numbers: (Low/ High/ Best): 4 / 7 / 5 Calves observed? No
Representative Images: 23, 26, 36 - 38
Photographer: RJM Frame Numbers: 22 to 39 Spacer: 40
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 11:51 WP#: 27 Lat: 33.86319 Long: -76.99237
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments:
Spread out, subsurface, one dolphin observed with a fish in its mouth, one juvenile observed. Looked like *Tursiops*, uniform grey and sturdy. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

13 March 2008 Sighting # 4

Initial Sighting on Track
Not recorded
Track line: In transit between 10 and 9
On/Off Effort: Off Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 14:54 WP #: 49 Lat: 33.45850 Long: -76.08279 Beaufort Sea State: 2
Species: *Tursiops/S. frontalis* Features used in species ID: N/A
Numbers: (Low/ High/ Best): 6 / 7 / 7 Calves observed? Yes
Representative Images: 50, 51, 52
Photographer: PBN Frame Numbers: 46 to 55 Spacer: 56
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments:
Opportunistic sighting which occurred during transit between offshore ends of track lines 10 and 9. Slow surface travel. Looks like *Tursiops truncatus*. At least one mother/calf pair present in group. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

13 March 2008 Sighting # 5

Initial Sighting on Track
Time: 15:49 WP#: 60 (R) Lat: 33.79359 Long:-76.24798 Track line: 8
On/Off Effort: On Sighting Cue: Body
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 15:50 WP #: 77 (L) Lat: 33.78488 Long: -76.25704 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust, sturdy looking animals. Short and blunt rostrums
Numbers: (Low/ High/ Best): 12 / 16 / 15 Calves observed? No
108 Representative Images: 62-65, 69, 71, 72, 75 – 84, 89
Photographer: RJM Frame Numbers: 57 to 107
Calculated Distance from Track Line: 1.3 km

Final Time and Position of Sighting
Time: 15:57 WP#: 78 (L) Lat: 33.79132 Long: -76.25838
Calculated Distance Traveled: 0.7 km

Behavior and Additional Comments:
When first encountered, animals were grouped up in one group. Slow travel, lots of tactile interaction. Broke up into three smaller groups. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 April 2008 Sighting # 1

Initial Sighting on Track
Time: 10:28 WP#: 22 Lat: 34.137876 Long: 76.697346 Track Line: 8
On/Off Effort: On Sighting Cue: Splash
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 10:31 WP #: 23 Lat: 34.142246 Long: 76.696676 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: short rostrum, overall stocky appearance, light gray coloration with darker gray cape dorsally
Numbers (Low/ High/ Best): 3 / 3 / 3 Calves observed? No
Representative Images: 46, 59, 60
Photographer: PBN Card #: 1 Frame Numbers: 36-61 Spacer: 62
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting
Time: 10:38 WP#: 24 Lat: 34.14173 Long: 76.68058
Calculated Distance traveled: 1.5 km

Behavior and Additional Comments
Animals traveling in a dispersed line, surfacing very quickly and moving fast. When first encountered, animals were traveling parallel to the track-line. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 April 2008 Sighting # 2

Initial Sighting on Track
Time: 10:55 WP#: 28 Lat: 33.80687 Long: 76.263807 Track Line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 10:56 WP #: 29 Lat: 33.806142 Long: 76.2667 Beaufort Sea State: 2
Species: *Steno bredanensis* Features used in species ID: Sloping forehead, long rostrum, white lower jaw, large pectorals, and a large triangular and erect dorsal fin.
Numbers (Low/ High/ Best): 24 / 28 / 26 Calves observed? No
Representative Images: 71-73, 77, 78, 80-86
Photographer: PBN Card #: 1 Frame Numbers: 63-86 Spacer: 87
Calculated Distance from Track Line: 0.3 km

Final Time and Position of Sighting
Time: 11:00 WP#: 30 Lat: 33.80272 Long: 76.268908
Calculated Distance traveled: 0.4 km

Behavior and Additional Comments
Animals traveling slowly just sub-surface. Animals in groups of 5 or 6 and few pairs – this grouping stayed the same for the entire encounter. The general impression of overall behavior was that it was distinctly *different* as compared to that of the two other dolphin species encountered so far in the USWTR (*Tursiops truncatus* and S*tenella frontalis*). Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 April 2008 Sighting # 3

Initial Sighting on Track
Time: 11:05 WP#: 33 Lat: 33.720092 Long: 76.151712 Track Line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 5 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting (Estimated)
Time: 11:06 WP #: 34 Lat: 33.727066 Long: 76.169633 Beaufort Sea State: 3
Species: Unidentified Marine Vertebrate Features used in species ID: N/A
Numbers (Low/ High/ Best): 1 / 1 / 1 Calves observed? No
Representative Images: N/A
Frame Numbers: None taken Spacer: None
Calculated Distance from Track Line: 1.8 km Photographer: N/A Card #: 1

Final Time and Position of Sighting
N/A animal not re-sighted after initial sighting

Behavior and Additional Comments
Unable to resight animal after initial sighting cue. Note that the latitude and longitude given for the sighting is the *estimated* location.

25 April 2008 Sighting # 4

Initial Sighting on Track
Time: 14:23 WP#: 60 Lat: 33.593157 Long: 76.507016 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 14:30 WP #: 62 Lat: 33.598467 Long: 76.508261 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Stocky body tapering gradually towards the flukes, overall grey with darker grey cape, short rostrum, light area on dorsal peduncle
Numbers (Low/ High/ Best): 10 / 13 / 12 Calves observed? No
Representative Images: 89-91, 114, 118, 119, 120, 123, 124
Photographer: PBN Card #: 1 Frame Numbers: 88-125 Spacer: 126
Calculated Distance from Track Line: 0.6 km

Final Time and Position of Sighting
Time: 14:35 WP#: 63 Lat: 33.598544 Long: 76.501084
Calculated Distance traveled: 0.7 km

Behavior and Additional Comments
Originally only two animals sighted swimming parallel to one another. Upon relocating animals found a group of 10 to 13 animals in a loosely associated group at the surface interacting with one another. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 April 2008 Sighting # 5

Initial Sighting on Track
Time: 15:55 WP#: 82 Lat: 33.754493 Long: 77.117432 Track Line: 1
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting (Estimated)
Time: 16:00 WP #: 83 Lat: 33.754524 Long: 77.109181 Beaufort Sea State: 2
Species: Unidentified Marine Vertebrate Features used in species ID: N/A
Numbers (Low/ High/ Best): 6 / 6 / 6 Calves observed? No
Representative Images: No images taken
Calculated Distance from Track Line: 0.8 km

Final Time and Position of Sighting:
N/A - Animals not re-sighted after initial observation

Behavior and Additional Comments
Unable to relocate after original sighting, no pictures taken.

Appendix D - UNCW Aerial Survey Sighting Summary

26 April 2008 Sighting # 1

Initial Sighting on Track

Time: 10:52 WP#: 16 Lat: 33.619196 Long: 76.542062 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting

Time: 10:54 WP #: 17 Lat: 33.623796 Long: 76.544074 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Light area on dorsal surface of caudal peduncle, overall stocky impression with body gradually tapering towards flukes,
Numbers (Low/ High/ Best):10/20/15 Calves observed? No
Representative Images: 2, 19, 28, 29, 34
Photographer: RJM Card #: 1 Frame Numbers: 1-60 Spacer: 61
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting

Time: 11:06 WP#: 18 Lat: 33.620975 Long: 76.547019
Calculated Distance traveled: 0.4 km

Behavior and Additional Comments

Two groups, one with 7 to 9 individuals. Lots of time spent underwater swimming greater distances. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 April 2008 Sighting # 2

Initial Sighting on Track

Time: 11:23 WP#: 25 Lat: 33.942430 Long: 76.969566 Track Line:
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 110
Observer: RJM Observer Side: Right

Time and Position of Sighting

Time: 11:25 WP #: 26 Lat: 33.943435 Long: 76.970047 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Looks like *Tursiops truncatus*
Numbers (Low/ High/ Best): 4 / 4 / 4 Calves observed? No
Representative Images: 54, 64, 69, 71
Photographer: RJM Card #: 1 Frame Numbers: 43-71 Spacer: 72
Calculated Distance from Track Line: 0.1 km

Final Time and Position of Sighting

Time: 11:30 WP#: 27 Lat: 33.940982 Long: 76.966646
Calculated Distance traveled: 0.4 km

Behavior and Additional Comments

Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 April 2008 Sighting # 3

Initial Sighting on Track
Time: 13:43 WP#: 40 Lat: 33.899138 Long: 76.258527 Track Line:
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 13:49 WP #: 41 Lat: 33.896252 Long: 76.249675 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Overall stocky appearance with body gradually tapering towards flukes, short rostrum, gray coloration, lighter area on dorsal surface of caudal peduncle, dorsal fin diagnostic of *Tursiops truncatus*.
Numbers (Low/ High/ Best): 8/10/9 Calves observed? No
Representative Images: 78, 83, 84, 85, 97, 98
Photographer: RJM Card #: 1 Frame Numbers: 72-101 Spacer: 102
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 13:54 WP#: 42 Lat: 33.905679 Long: 76.247605
Calculated Distance traveled: 1.0 km

Behavior and Additional Comments
Tight group, surface travel. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 May 08 Sighting # 1

Initial Sighting on Track
Time: 09:03 WP#: 11 Lat: 33.48363 Long: -76.63709 Track Line: 2
On/Off Effort: On Sighting Cue: Splash
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 09:03 WP #: 12 Lat: 33.474728 Long: -76.63210 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Gray, sturdy animals with short, blunt rostrums.
Numbers (Low/ High/ Best): 12/14/13 Calves observed? No
Representative Images: 20, 21, 23, 27
Photographer: RJM Card #: 1 Frame Numbers: 1 to 36 Spacer: 37
Calculated Distance from Track Line: 1.1 km

Final Time and Position of Sighting
Time: 09:14 WP#: 13 Lat: 33.47141 Long: -76.64319
Calculated Distance traveled: 1.1 km

Behavior and Additional Comments
Shallow swim, slowly just beneath the surface, some turning on their sides. Gray, sturdy, light dorsal caudal peduncle – looks like *Tursiops*. Encountered more and more dolphins, several pairs, one trio. Some fast traveling and quick surfacings. Circled animals at between 750 and 1000 ft. No avoidance reaction noted. The calculated distance from track line (1.093 km) and the calculated distance traveled (1.093 km) are the actual numbers, by coincidence they are the same.

26 May 2008 Sighting # 2

Initial Sighting on Track
Time: 10:55 WP#: 37 Lat: 33.64292 Long: -76.31364 Track Line: 6
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:00 WP #: 38 Lat: 33.63598 Long: -76.30902 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Sturdy, light gray animals with darker gray cape, short, blunt rostrum.
Numbers (Low/ High/ Best): 12/15/13 Calves observed? Yes
Representative Images: 38, 39
Photographer: RJM Card #: Frame Numbers: 38 to 43 Spacer: 44
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 11:12 WP#: 39 Lat: 33.64201 Long: -76.31417
Calculated Distance traveled: 0.8 km

Behavior and Additional Comments
Dolphins traveling in singles and pairs, coloration pattern suggestive of *Tursiops*. Animals were split into two sub-groups, one mother/calf pair observed. Group difficult to follow. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 May 2008 Sighting # 3

Initial Sighting on Track
Time: 11:22 WP#: 40 Lat: 33.85749 Long: -76.61129 Track Line: 6
On/Off Effort: On Sighting Cue: Body
Vertical Angle: 3 Horizontal Bearing in Degrees: 80
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 11:23 WP #: 41 Lat: 33.84225 Long: -76.60023 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Short rostrum, light gray flanks with darker gray cape
Numbers (Low/ High/ Best): 20/25/23 Calves observed? Yes
Representative Images: 51, 76, 94
Photographer: RJM Card #: 1 Frame Numbers: 45 to 96 Spacer: No
Calculated Distance from Track Line: 2.0 km

Final Time and Position of Sighting
Time: 11:36 WP#: 42 Lat: 33.84992 Long: -76.60478
Calculated Distance traveled: 1.0 km

Behavior and Additional Comments
Dispersed and slowly traveling group. Lots of white bellies showing, as well as some white rostrum tips. Sub-groups separated by 10's to 100's of meters. Traveling at a "leisurely" pace. One mother –calf pair observed. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 May 2008 Sighting # 4

Initial Sighting on Track
Time: 14:17 WP#: 52 Lat: 34.20038 Long: -76.51738 Track Line: 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 50
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 14:19 WP #: 53 Lat: 34.21452 Long: -76.51423 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Spotted appearance, long rostrum with white tip, blaze on flank
Numbers (Low/ High/ Best): 11 / 12 / 9 Calves observed? No
Representative Images: 147, 148, 155, 156, 157, 158, 160
Photographer: RJM Card #: 1 Frame Numbers: 137 to 160 Spacer: 161
Calculated Distance from Track Line: 1.6 km

Final Time and Position of Sighting
Time: 14:25 WP#: 54 Lat: 34.21637 Long: -76.51139
Calculated Distance traveled: 0.3 km

Behavior and Additional Comments
Animals were split into two sub-groups. Several dolphins “on” each other, rolling, lots of tactile interaction observed. Milling. White bellies showing. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 May 2008 Sighting # 5

Initial Sighting on Track
Time: 15:30 WP#: 67 Lat: 33.81997 Long: -76.28082 Track Line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 15:31 WP #: 68 Lat: 33.82133 Long: -76.27602 Beaufort Sea State: 3
Species: *Globicephala macrorhynchus* Features used in species ID: Large black animals, with bulbous melons and short angular pectoral fins clearly visible.
Numbers (Low/ High/ Best): 5/ 12 / 9 Calves observed? No
Representative Images: 177, 178, 179
Photographer: RJM Card #: 1 Frame Numbers: 162 to 180 Spacer: 181
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting
None taken

Behavior and Additional Comments
Very spread out group, traveling in ones and twos. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

26 May 2008 Sighting # 6

Initial Sighting on Track
Time: 16:05 WP#: 65 Lat: 33.953939 Long: -76.582045 Track Line: 7
On/Off Effort: On Sighting Cue: Splash
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting
Time: 16:06 WP #: 73 Lat: 33.95292 Long: -76.57421 Beaufort Sea State: 3
Species: *Tursiops truncatus* Features used in species ID: Gray, sturdy animals with blunt rostrum
Numbers (Low/ High/ Best): 6 / 7 / 6 Calves observed? No
Representative Images: 217, 228, 242
Photographer: RJM Card #: 1 Frame Numbers: 182 to 243 Spacer: 244
Calculated Distance from Track Line: 0.7 km

Final Time and Position of Sighting
Time: 16:17 WP#: 74 Lat: 33.96578 Long: -76.56110
Calculated Distance traveled: 1.9 km

Behavior and Additional Comments
Dolphins feeding on large school of fish, charging through the school. Fish looks fairly large (50-70 cm) Two to three dolphins at a time at the back edge of school, two to three dolphins 100 m to the side or behind school. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

27 May 2008 Sighting # 1

Initial Sighting on Track
Time: 9:56 WP#: 9 Lat: 33.523432 Long: 76.685647 Track Line: 2
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 4 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 9:57 WP #: 10 Lat: 33.515733 Long: 76.689246 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Images showing rostrum shape, dorsal coloration and dorsal fin shape
Numbers (Low/ High/ Best): 5 / 11 / 12 Calves observed? No
Representative Images: 3, 4, 7, 8, 9, 10, 13, 15, 16, 18, 20, 26
Photographer: PBN Card #: 1 Frame Numbers: 2 to 26 Spacer: 27
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 10:02 WP#: 11 Lat: 33.513852 Long: 76.692635
Calculated Distance traveled: 0.4 km

Behavior and Additional Comments
Animals seen traveling in relatively close group heading away from the trackline. Found two groups of animals, one with about 4 animals and the other with about 7 animals but probably more animals swimming under one another. Animals were seen swimming upside down showing bellies to the surface. Upon circling animals the distance between the two groups decreased. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

27 May 2008 Sighting # 2

Initial Sighting on Track
Time: 10:40 WP#: 17 Lat: 33.597114 Long: 76.650571 Track Line: 3
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 10:41 WP #: 18 Lat: 33.592923 Long: 76.65565 Beaufort Sea State: 2
Species: *Globicephala macrorhynchus* Features used in species ID: Photos showing squared off head, black body coloration, dorsal and pectoral fin shape
Numbers (Low/ High/ Best): 10 / 12 / 12 Calves observed? Yes
Representative Images: 35, 43, 45, 52, 59
Photographer: PBN Card #: 1 Frame Numbers: 28 to 70 Spacer: 71
Calculated Distance from Track Line: 0.7 km

Final Time and Position of Sighting
Time: 10:45 WP#: 19 Lat: 33.595499 Long: 76.654216
Calculated Distance traveled: 0.3 km

Behavior and Additional Comments
Animals in a tight linear group and showed no changes with plane present. Two small calves observed and one juvenile. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

27 May 2008 Sighting # 3

Initial Sighting on Track
Time: 11:00 WP#: 24 Lat: 33.597154 Long: 76.507192 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 11:13 WP #: 25 Lat: 33.595927 Long: 76.508913 Beaufort Sea State: 3
Species: *Grampus griseus* Features used in species ID: Photos showing coloration/ scarring on animals side. Also round melon without rostrum, and long pectoral fins, tall falcate dorsal fin
Numbers (Low/ High/ Best): 4 / 5 / 5 Calves observed? No
Representative Images: 81, 98, 101, 103, 110, 113, 120
Photographer: PBN Card #: 1 Frame Numbers: 72 to 133 Spacer: 134
Calculated Distance from Track Line: 0.2 km

Final Time and Position of Sighting
Time: 11:21 WP#: 26 Lat: 33.592403 Long: 76.509597
Calculated Distance traveled: 0.4 km

Behavior and Additional Comments
Initially 3 animals seen swimming away from the trackline in a loose horizontal line
5 animals in total seen upon relocating group, all were traveling at a very slow rate of speed. Some of the animals were dark in color and a few with very light heads and sides. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 1

Initial Sighting on Track
Time: 13:54 WP#: 27 Lat: 33.934722 Long: 76.957584 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 14:00 WP #: 28 Lat: 33.937103 Long: 76.964589 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Spots visible, blaze on flank, white rostrum tip
Numbers (Low/ High/ Best): 4 / 6 / 5 Calves observed? No
Representative Images: 33, 35, 38, 43, 44, 45, 68, 72
Photographer: PBN Card #: 1 Frame Numbers: 26 to 76 Spacer: 77
Calculated Distance from Track Line: 0.7 km

Final Time and Position of Sighting
Time: 14:07 WP#: 28 Lat: 33.943832 Long: 76.963251
Calculated Distance Traveled: 0.8 km

Behavior and Additional Comments
Animals traveling in a close group heading towards the trackline when first sighted. Animals relocated on right side of plane. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 2

Initial Sighting on Track
Time: 14:13 WP#: 31 Lat: 33.79267 Long: 76.771215 Track Line: 4
On/Off Effort: On Sighting Cue: 3
Vertical Angle: 3 Horizontal Bearing in Degrees: 120
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 14:15 WP #: 32 Lat: 33.800619 Long: 76.781757 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Robust grey animals, short rostrum tip
Numbers (Low/ High/ Best): 4 / 7 / 7 Calves observed? No
Representative Images: 101, 102, 116, 118, 131-136, 138, 145, 146, 147, 148
Photographer: PBN Card #: 1 Frame Numbers: 79 to 150 Spacer: 151
Calculated Distance from Track Line: 1.3 km

Final Time and Position of Sighting
Time: 14:20 WP#: 33 Lat: 33.792216 Long: 76.769888
Calculated Distance traveled: 1.4 km

Behavior and Additional Comments
Initial observation had animals traveling quickly and breaking hard at the surface causing a disturbance. Some animals cut back on their path and hung out in an area before continuing on. Upon circling animal began to circle around in one area not traveling a particular direction. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 3

Initial Sighting on Track
Time: 14:22 WP#: 34 Lat: 33.774027 Long: 76.745051 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 14:22 WP #: 35 Lat: 33.772186 Long: 76.741641 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Flank blaze present, white rostrum tip, spotted pattern clearly visible
Numbers (Low/ High/ Best): 34 / 37 / 35 Calves observed? Yes
Representative Images: 161, 171, 173, 177, 186, 189, 193, 194, 198, 199, 200
Photographer: PBN Card #: 1 Frame Numbers: 152 to 203 Spacer: 204
Calculated Distance from Track Line: 0.4 km

Final Time and Position of Sighting
Time: 14:25 WP#: 36 Lat: 33.771411 Long: 76.745038
Calculated Distance traveled: 0.3 km

Behavior and Additional Comments
Large group of animals traveling in smaller groups of 2 or 5, loose grouping originally but group tightened up some upon circling. Animals spent most of the time below the surface. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 4

Initial Sighting on Track
Time: 14:48 WP#: 42 Lat: 33.507385 Long: 76.534704 Track Line: 3
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 14:48 WP #: 43 Lat: 33.507569 Long: 76.532724 Beaufort Sea State: 2
Species: *T. truncatus/S. frontalis* Features used in species ID: Sharp, pointed dark dorsal cape (cape edge close to blow hole), grey body
Numbers (Low/ High/ Best): 2 / 2 / 2 Calves observed? No
Representative Images: 207, 208, 216, 217, 218, 221
Photographer: PBN Card #: 1 Frame Numbers: 206 to 222 Spacer: 223
Calculated Distance from Track Line: 0.2 km

Final Time and Position of Sighting
Time: 14:49 WP#: 44 Lat: 33.509441 Long: 76.531364
Calculated Distance traveled: 0.2 km

Behavior and Additional Comments
Two animals traveling in close proximity to one another. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 5

Initial Sighting on Track
Time: 14:51 WP#: 46 Lat: 33.550452 Long: 76.593091 Track Line: 3
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 60
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 14:52 WP #: 47 Lat: 33.551987 Long: 76.594555 Beaufort Sea State: 2
Species: *Steno bredanensis* Features used in species ID: Long thin rostrum, with white lower jaw. Large dorsal fin set far forward on body, large triangular pectorals. Thin, concave, darker dorsal cape.
Numbers (Low/ High/ Best): 3 / 5 / 5 Calves observed? Yes
Representative Images: 228-230, 234, 235-238, 246
Photographer: PBN Card #: 1 Frame Numbers: 224 to 247 Spacer: 248
Calculated Distance from Track Line: 0.1 km

Final Time and Position of Sighting
Time: 14:54 WP#: 48 Lat: 33.551045 Long: 76.595054
Calculated Distance traveled: 0.1 km

Behavior and Additional Comments
Animals traveling together in a single group. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 6

Initial Sighting on Track
Time: 15:34 WP#: 52 Lat: 33.508931 Long: 76.667731 Track Line: 2
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 120
Observer: RJM Observer Side: Left

Time and Position of Sighting
Time: 15:35 WP #: 53 Lat: 33.516511 Long: 76.66473 Beaufort Sea State: 2
Species: *Steno bredanensis* Features used in species ID: Large dorsal fin set far forward on body, large triangular pectorals.Long thin rostrum, with white lower jaw.
Numbers (Low/ High/ Best): 7 / 10 / 10 Calves observed? No
Representative Images: 262, 267, 268-270, 273, 274, 276, 277, 296, 297
Photographer: PBN Card #: 1 Frame Numbers: 250 to 303 Spacer: End card 1
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 15:40 WP#: 54 Lat: 33.516134 Long: 76.651189
Calculated Distance traveled: 1.3 km

Behavior and Additional Comments
Animals in a well spaced group traveling fast and splashing while surfacing. Animals appeared to be chasing something because most of the animals were changing directions and diving while we were circling them. We observed a shark of roughly the same size as the dolphins in the same area. Pictures revealed that the shark may be interacting with dolphins. Judging from the long thin tail, broad head, and large spade shaped pectoral fins the observed shark may have been a thresher shark. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 7

Initial Sighting on Track
Time: 15:50 WP#: 58 Lat: 33.395708 Long: 76.647814 Track Line: 1
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 15:52 WP #: 59 Lat: 33.398254 Long: 76.639548 Beaufort Sea State: 2
Species: *Tursiops truncates* Features used in species ID: Grey animals, short rostrum, gradually tapering peduncle.
Numbers (Low/ High/ Best): 25 / 25 / 25 Calves observed? No
Representative Images: 3, 6, 8, 9, 11, 34, 45
Photographer: PBN Card #: 2 Frame Numbers: 1 to 50 Spacer: 51
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 15:56 WP#: 60 Lat: 33.401374 Long: 76.644092
Calculated Distance traveled: 0.5 km

Behavior and Additional Comments
Animals traveling slowly and on their side sometimes very close to the surface. Many single animals in loose groups and a few groups of 2 or 3. Animals formed into pairs swimming belly to belly. Group not traveling in any definite direction. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

24 June 2008 Sighting # 8

Initial Sighting on Track
Time: 16:15 WP#: 62 Lat: 33.74109 Long: 76.099344 Track Line: 1
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: PBN Observer Side: Right

Time and Position of Sighting
Time: 16:15 WP #: 63 Lat: 33.744705 Long: 76.09179 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Flank blaze and color pattern consistent with *S. frontalis*. White rostrum tip.
Numbers (Low/ High/ Best): 10 / 10 / 10 Calves observed? No
Representative Images: 54, 60, 61, 68, 69, 73, 74, 77
Photographer: PBN Card #: 2 Frame Numbers: 52 to 82 Spacer: 83
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting
Time: 16:21 WP#: 64 Lat: 33.744849 Long: 76.089426
Calculated Distance traveled: 0.2 km

Behavior and Additional Comments
Tight group of approximately 10 animals just below the surface not traveling very fast. Animal spread out and then reformed into 2 groups during sighting. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

Appendix D - UNCW Aerial Survey Sighting Summary

25 June 2008 Sighting # 1

Initial Sighting on Track

Time: 09:47 WP #: 7 R Lat: 33.584993 Long: -76.368037 Track Line: 5
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer Side: Right

Time and Position of Sighting

Time: 09:47 WP#: 7 L Lat:33.584993 Long: -76.352499 Beaufort Sea State: 1
Species: *Tursiops truncatus* Features used in species ID: Grey, robust animals, with short rostrums, and gradually tapering peduncles
Numbers (Low/ High/ Best): 6/10/9 Calves observed? Yes
Representative Images: 311, 316, 321, 323, 324, 327
Photographer: RJM Card #: 1 Frame Numbers: 308 to 331 Spacer 332
Calculated Distance from Track Line: 0.4 km

Final Time and Position of Sighting

None taken

Behavior and Additional Comments

Looks like Tursiops from the air; sturdy, gray, white peduncle. Slow travel, 1 mother/calf pair, group spread out. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 2

Initial Sighting on Track

Time: 10:22 WP #:14 Lat: 34.057055 Long:-76.860306 Track Line 6
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: PBN Observer side: Left

Time and Position of Sighting

Time: 10:24 WP#:15 Lat: 34.050011 Long: -76.858224 Beaufort Sea State: 2
Species: *Stenella frontalis* Features used in species ID: Distinctive spotted and coloration pattern, white rostrum tip, lighter flank blaze
Numbers (Low/ High/ Best): 8/8/8 Calves observed? Yes
Representative Images: 337, 338, 345, 346, 362, 363
Photographer: RJM Card #: 1 Frame Numbers: 332 to 368 Spacer 369
Calculated Distance from Track Line: 0.8 km

Final Time and Position of Sighting

None taken

Behavior and Additional Comments

Looks like spotted dolphins, 1 mother/calf pair – calf looks young (i.e. small). Slow surface travel. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 3

Initial Sighting on Track

Time: 11:12 WP #: 25 Lat: 33.949522 Long: -76.459364 Track Line: 8
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees:: 90
Observer: PBN Observer side: Left

Time and Position of Sighting

Time: 11:15 WP#: 26 Lat: 33.941355 Long:-76.457001 Beaufort Sea State: 1
Species: *Tursiops truncatus* Features used in species ID: Short, blunt rostrum, robust body
Numbers (Low/ High/ Best): 2/2/2 Calves observed? No
Representative Images: 369, 370, 380, 388
Photographer: RJM Card #: 1 Frame Numbers: 369 to 389 Spacer 390
Calculated Distance from Track Line: 0.9 km

Final Time and Position of Sighting

None taken

Behavior and Additional Comments

Looks like *Tursiops* (fairly large, sturdy, short rostrum). Leisurely travel, tactile interaction – swimming close to each other. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 4

Initial Sighting on Track

Time: 11:54 WP #:30 Lat: 34.022289 Long:-76.418861 Track Line: 9
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: RJM Observer side: right

Time and Position of Sighting

Time: N/A – not re-sighted after break track
Species: Unidentified delphinid Features used in species ID: N/A
Numbers (Low/ High/ Best): 1 Calves observed? No
Best images used for species ID: None taken
Calculated Distance from Track Line: N/A

Final Time and Position of Sighting

None taken

Behavior and Additional Comments

Lone un-identified delphinid, not re-sighted after breaking track

25 June 2008 Sighting # 5

Initial Sighting on Track
Time: 12:14 WP # 34 Lat: 33.819674 Long:-76.019607 Track Line 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer side: Right

Time and Position of Sighting
Time: 12:15 WP#: 45 Lat: 33.831817 Long: -76.037992 Beaufort Sea State: 1
Species: *Grampus griseus* Features used in species ID: Rounded head with cleft in middle of melon, multiple white scratches and rake marks, some individuals with completely white head, lighter "suspenders' on flanks.
Numbers (Low/ High/ Best): 8/12/10 Calves observed? Yes
Representative Images: 393, 425, 494, 497, 499, 501, 508, 509
Photographer: RJM Card #: 1 Frame Numbers: 390 to 517 Spacer: 518
Calculated Distance from Track Line: 2.2 km

Final Time and Position of Sighting
None taken

Behavior and Additional Comments
Group spread out over 1 to 2 km, traveling in pairs or singles. A very small calf observed very close to larger individual, and a slightly larger calf observed swimming 30-40 m off the side of the group never "mingling" with the other members. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 6

Initial Sighting on Track
Time: 12:47 WP # 38 right Lat: 34.084891 Long: -76.361621 Track Line 10
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 1 Horizontal Bearing in Degrees: 90
Observer: RJM Observer side: Right

Time and Position of Sighting
Time: 12:48 WP#: 48 left Lat: 34.083751 Long: -76.361075 Beaufort Sea State: 1
Species: *Tursiops truncatus* Features used in species ID: Robust, grey single animal with a short rostrum
Numbers (Low/ High/ Best): 1/1/1 Calves observed? No
Representative Images: 536, 538, 539, 541, 542
Photographer: RJM Card #: 1 Frame Numbers: 533 to 546 Spacer 547
Calculated Distance from Track Line: 0.1 km

Final Time and Position of Sighting
None taken

Behavior and Additional Comments
Single dolphin interacting with whitish object in the water, looks like a piece of trash (see images). Dolphin looks like *Tursiops* (uniformly gray, sturdy). Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 7

Initial Sighting on Track

Time: 14:54 WP #: 60 Lat: 33.634163 Long: -76.559943 Track Line:4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 4 Horizontal Bearing in Degrees: 90
Observer: PBN Observer side: Left

Time and Position of Sighting

Time: 14:55 WP#: 61 Lat: 33.646071 Long: -76.546472 Beaufort Sea State: 1
Species: *Tursiops truncatus* Features used in species ID: Large, grey, sturdy looking animals, with short rostrums, lighter coloration on caudal peduncle
Numbers (Low/ High/ Best): 13/15/14 Calves observed? No
Representative Images: 548, 549, 550, 551, 552, 554, 555, 558, 560
Photographer: RJM Card #: 1 Frame Numbers: 547 to 561 Spacer: 562
Calculated Distance from Track Line: 1.8 km

Final Time and Position of Sighting

Not recorded

Behavior and Additional Comments

Group of *Tursiops* spread out in three sub-groups over about 200 meters. Milling; non-directional travel, belly-to-belly swimming. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 8

Initial Sighting on Track

Time: 15:01 WP #: 50 Lat: 33.592171 Long: -76.501968 Track Line: 4
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 90
Observer: RJM Observer side: Right

Time and Position of Sighting

Time: 1503 WP#: 64 Lat: 33.593274 Long: -76.507083 Beaufort Sea State: 1
Species: *Grampus griseus* Features used in species ID: Large robust animals. Rounded head with cleft through middle of melon, multiple scratch marks, lighter area on flanks (‘suspenders’)
Numbers (Low/ High/ Best): 5/5/5 Calves observed? Yes
Representative Images: 562, 563, 565, 566, 568, 570, 571, 577, 580, 581, 582, 583
Photographer: RJM Card #: 1 Frame Numbers: 562 to 583
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting

Not recorded

Behavior and Additional Comments

Slow travel, one mother/calf pair, one individual with white head. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 9

Initial Sighting on Track
Time: 15:54 WP #: 71 Lat: 33.534094 Long: -76.699321 Track Line 2
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 3 Horizontal Bearing in Degrees: 90
Observer: PBN Observer side: Left

Time and Position of Sighting
Time: 15:55 WP#: 72 Lat: 33.541729 Long: -76.695676 Beaufort Sea State: 2
Species: *Tursiops truncatus* Features used in species ID: Grey, sturdy animals. Short rostrum, gradually tapering body
Numbers (Low/ High/ Best): 11/12/11 Calves observed? No
Representative Images: 588, 594, 599, 602
Photographer: RJM Card #: 1 Frame Numbers: 581 to 602 Spacer
Calculated Distance from Track Line: 0.9

Final Time and Position of Sighting
Not recorded

Behavior and Additional Comments
Fats surface travel, including leaping. Looks like *Tursiops*. Pretty tight group. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

25 June 2008 Sighting # 10

Initial Sighting on Track
Time: 16:09 WP #: 76 Lat: 33.372752 Long: -76.620278 Track Line 1
On/Off Effort: On Sighting Cue: Body part
Vertical Angle: 2 Horizontal Bearing in Degrees: 45
Observer: PBN Observer Side: Left

Time and Position of Sighting
Time: 16:09 WP#:77 Lat: 33.368079 Long: -76.620278 Beaufort Sea State: 1
Species: *Tursiops truncatus* Features used in species ID: Grey, robust, tapered body, short rostrum
Numbers (Low/ High/ Best): 5/5/5 Calves observed? No
Representative Images: 604, 605, 607, 610, 611, 612, 614, 616
Photographer: RJM Frame Numbers: 604 to 616 Spacer 603
Calculated Distance from Track Line: 0.5 km

Final Time and Position of Sighting
None taken

Behavior and Additional Comments
Three of the dolphins swimming next to each other, when diving they line up vertically in a staggered fashion. One of these three was a smaller, juvenile sized dolphin. Circled animals at between 750 and 1000 ft. No avoidance reaction noted.

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

_____

_____

_____

_____

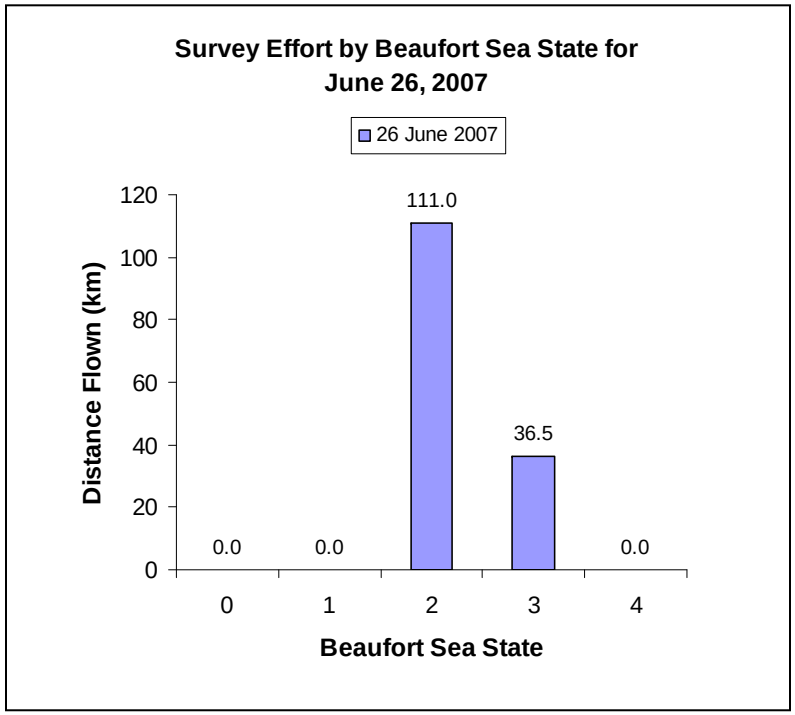
_____

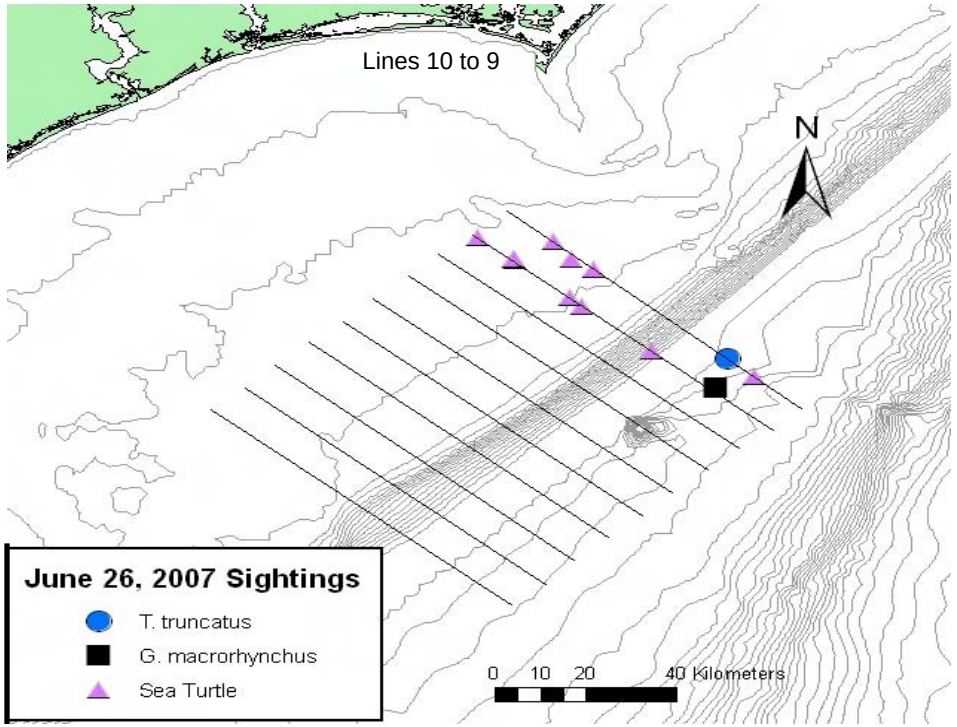
_____

_____

26 June 2007

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	80	2	10
Globicephala macrorhynchus	1	32	2	9
Sea Turtle	8	1	2	
Sea Turtle	2	1	3	





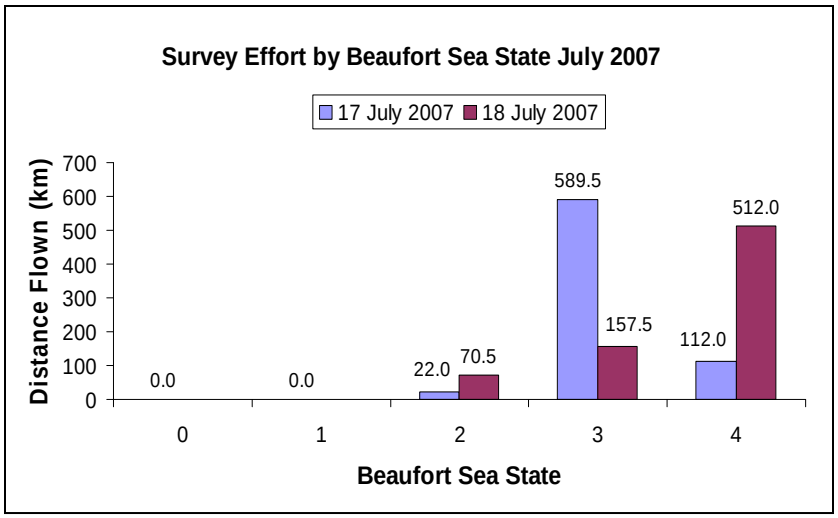
Appendix G

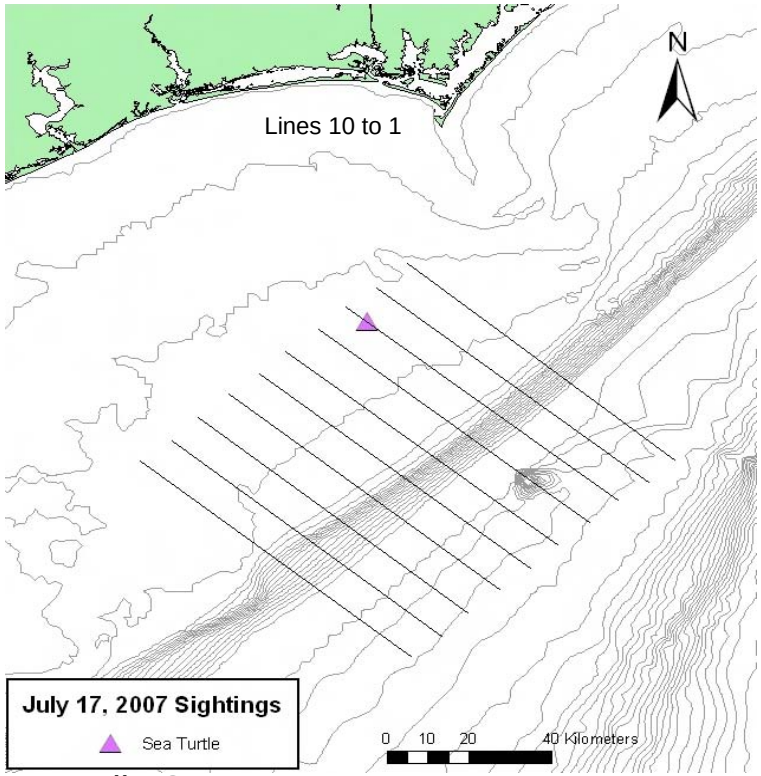
17 July 2007

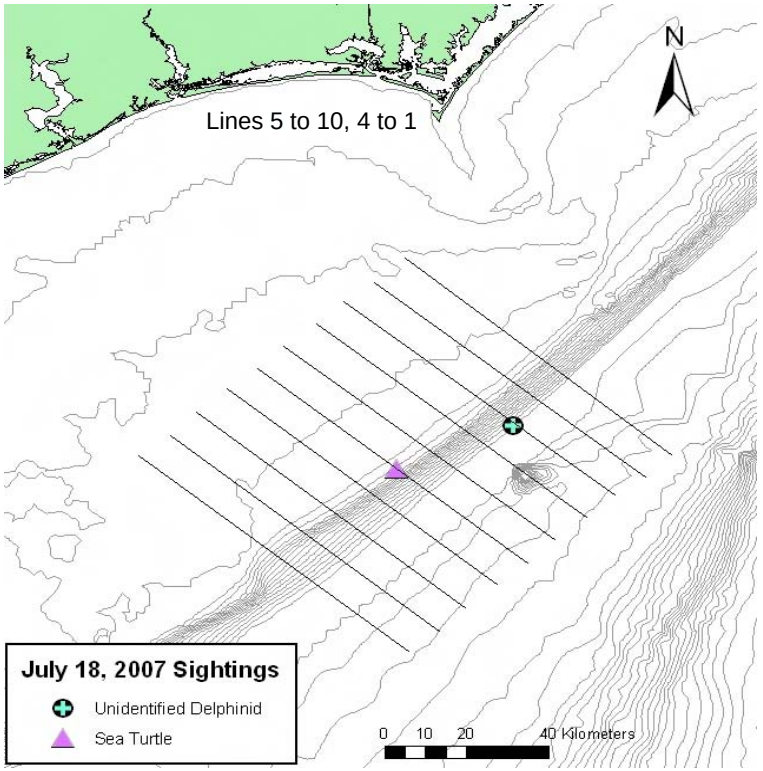
Species	# of sightings	# of individuals	BSS
Sea Turtle	1	1	3

18 July 2007

Species	# of sightings	# of individuals	BSS	Line
Unidentified Delphinid	1	6	3	8
Sea Turtle	1	1	4	





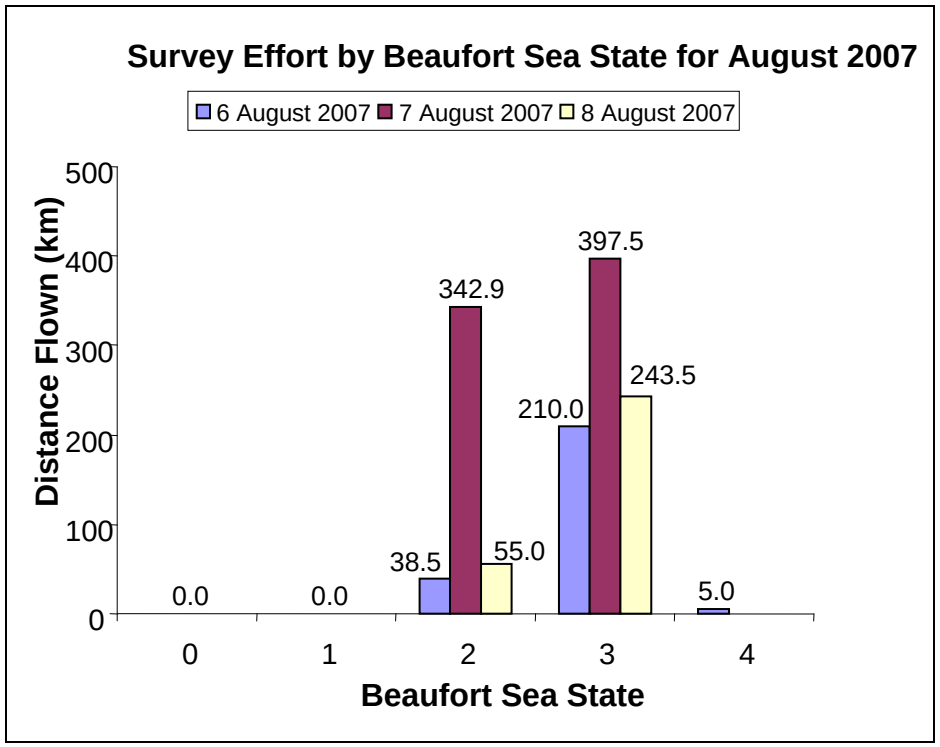


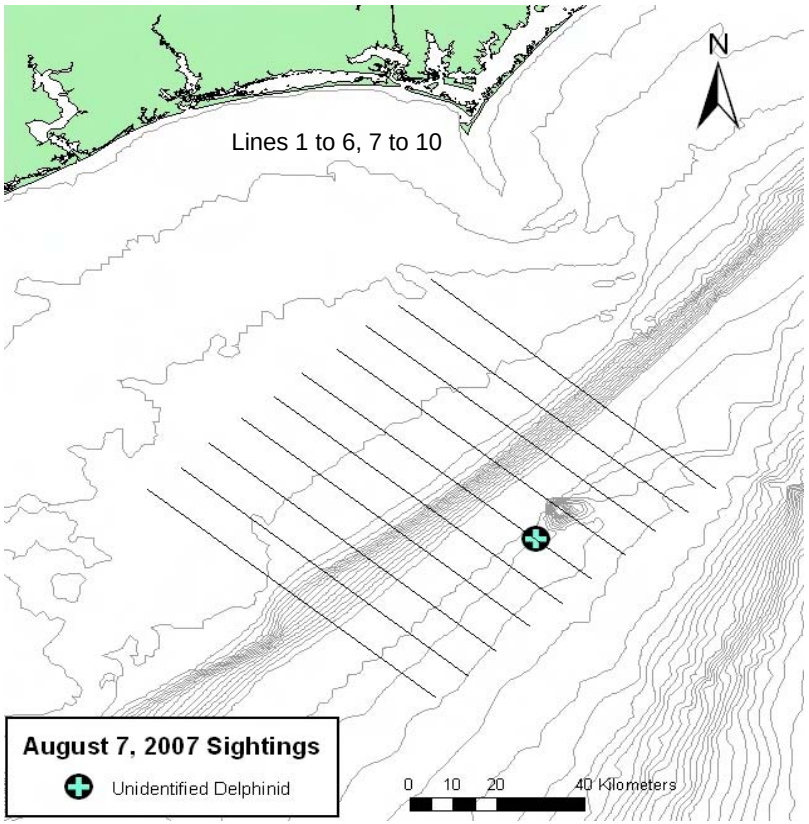
Appendix G

7 August 2007

Species	# of sightings	# of individuals	BSS	Line
Unidentified Delphinid	1	3	2	6

August 6 and 8 had no cetacean or sea turtle sightings





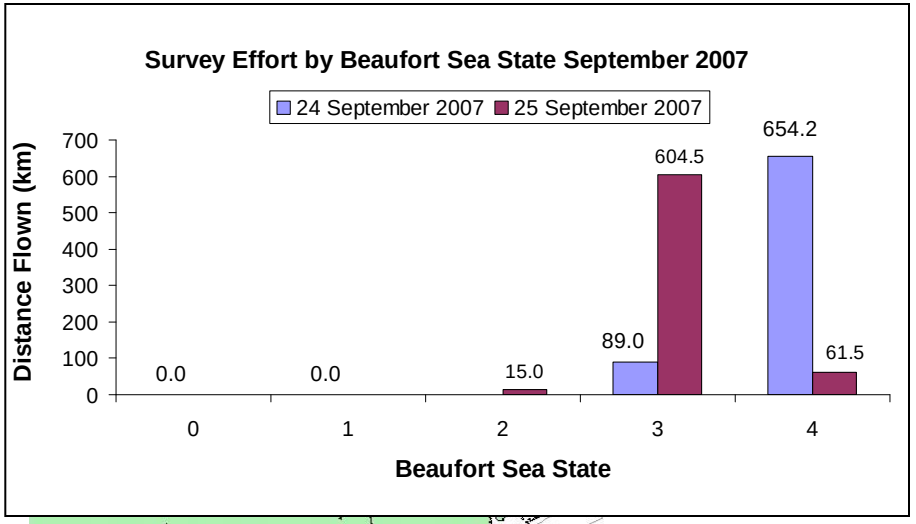
Appendix G

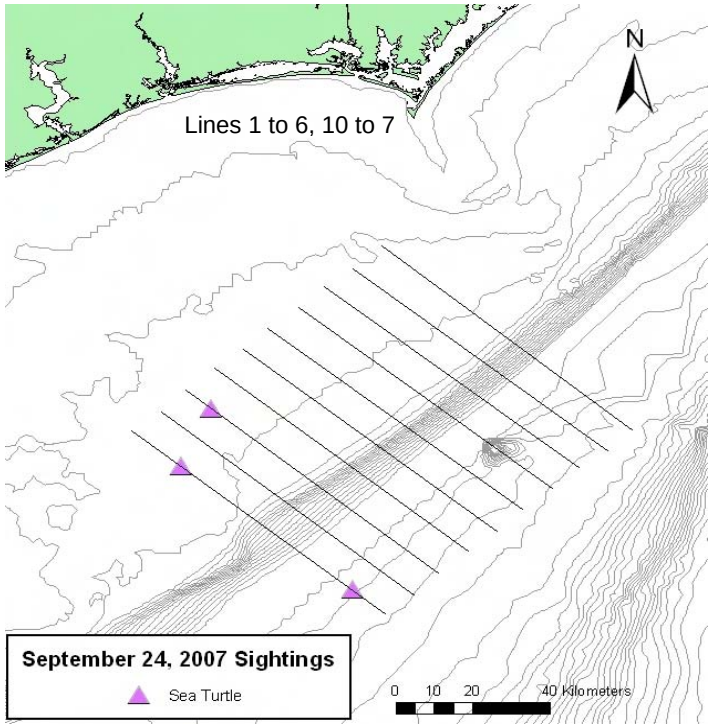
24 September 2007

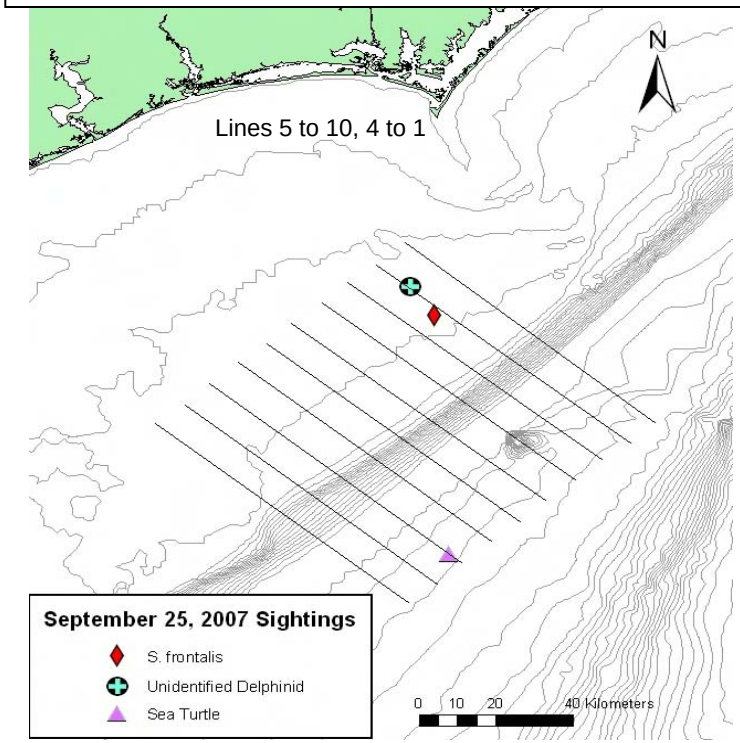
Species	# of sightings	# of individuals	BSS
Sea Turtle	3	1-2	4

25 September 2007

Species	# of sightings	# of individuals	BSS	Line
Stenella frontalis	1	4	3	9
Unidentified Delphinid	1	6	3	9
Sea Turtle	1	1	3	





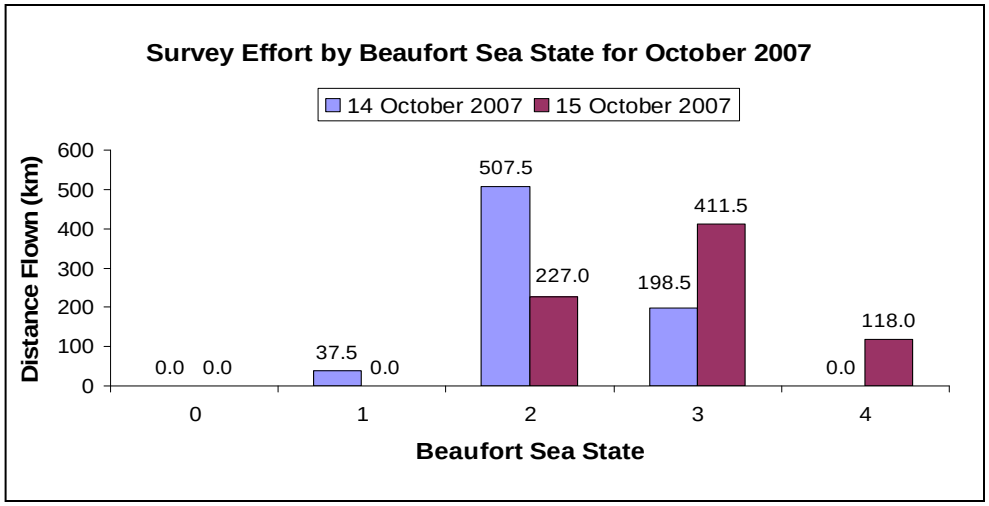


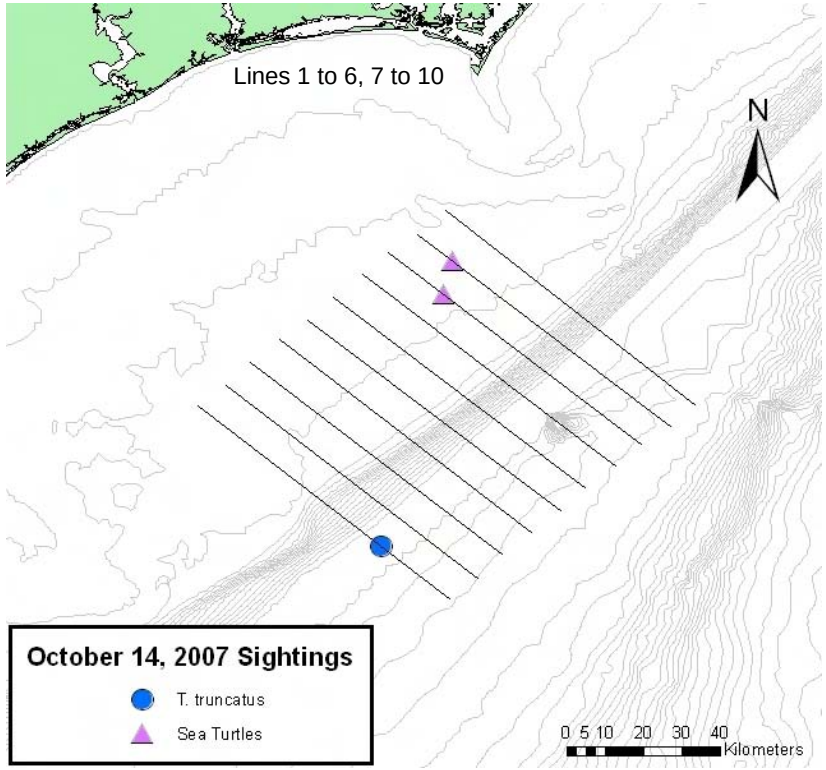
Appendix G

14 October 2007

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	40	2	1
Sea turtle	2	2	2	

15 October 2007 - no cetacean or sea turtle sightings





Appendix G

17 November 2007

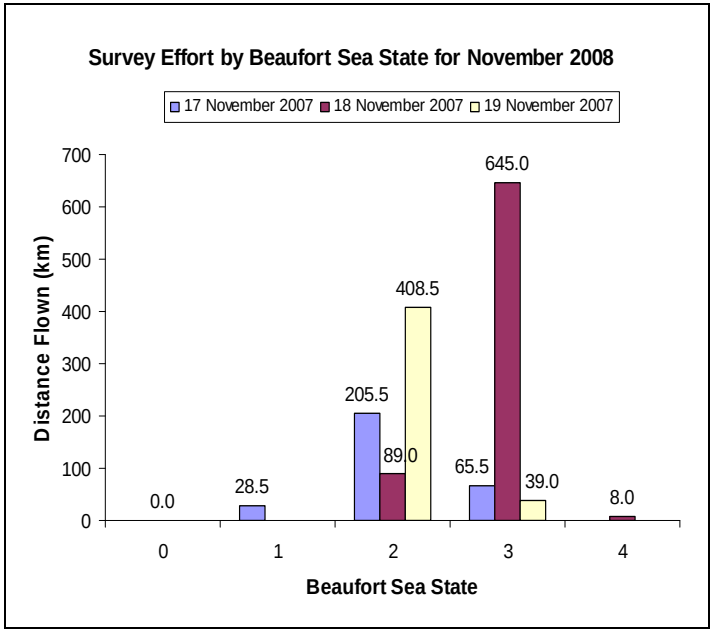
Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	3	2	4
Tursiops truncatus	1	9	2	4
Tursiops truncatus	1	18	2	4
Tursiops truncatus	1	23	2	3
Sea Turtles	1	1	1	
Sea Turtles	10	1	2	
Sea Turtles	1	1	3	

18 November 2007

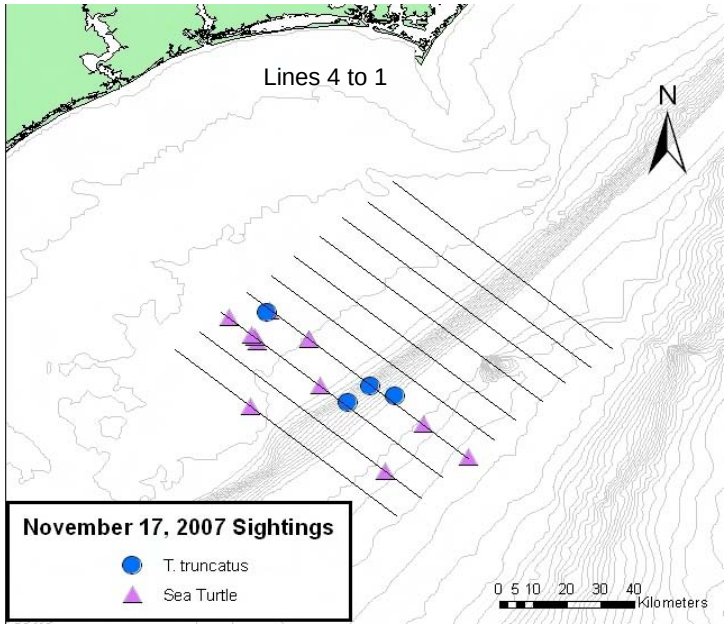
Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	3	2	9
Sea Turtles	1	1	2	
Sea Turtles	6	1-2	3	
Sea Turtles	1	2	4	

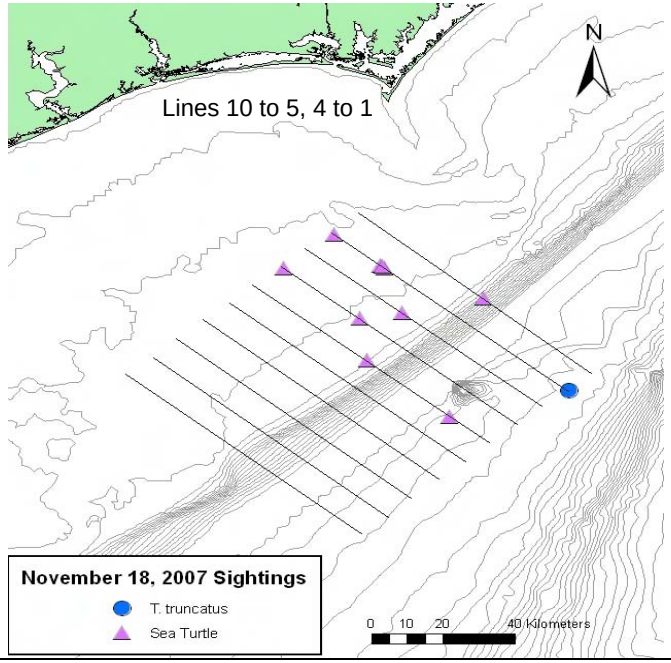
19 November 2007

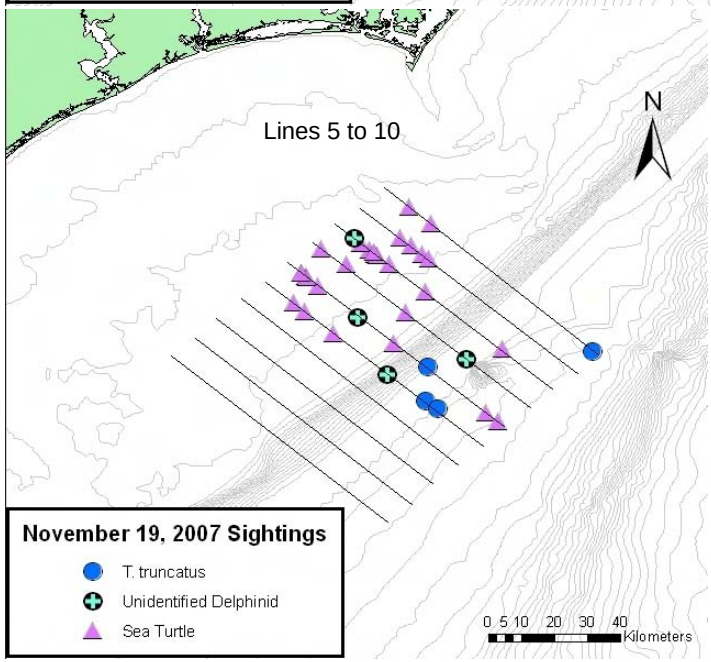
Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	4	2	5
Tursiops truncatus	1	5	2	6
Tursiops truncatus	1	8	2	5
Tursiops truncatus	1	40	2	10
Unidentified Delphinid	1	3	2	8
Unidentified Delphinid	1	11	2	6
Unidentified Delphinid	1	20	2	5
Unidentified Delphinid	4	22	2	7
Sea Turtles	25	1-2	2	
Sea Turtles	2	1	3	

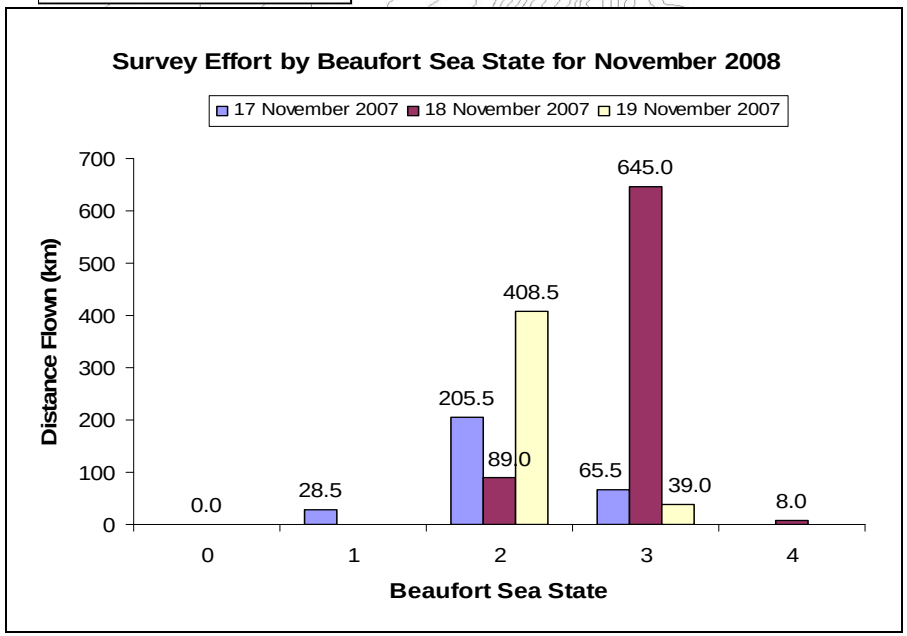


Appendix G


Lines 4 to 1
N
November 17, 2007 Sightings
T. truncatus
Sea Turtle
0 5 10 20 30 40
Kilometers


Lines 10 to 5, 4 to 1
N
November 18, 2007 Sightings
T. truncatus
Sea Turtle
0 10 20 40 Kilometers


Lines 5 to 10
N
November 19, 2007 Sightings
T. truncatus
Unidentified Delphinid
Sea Turtle
0 5 10 20 30 40
Kilometers

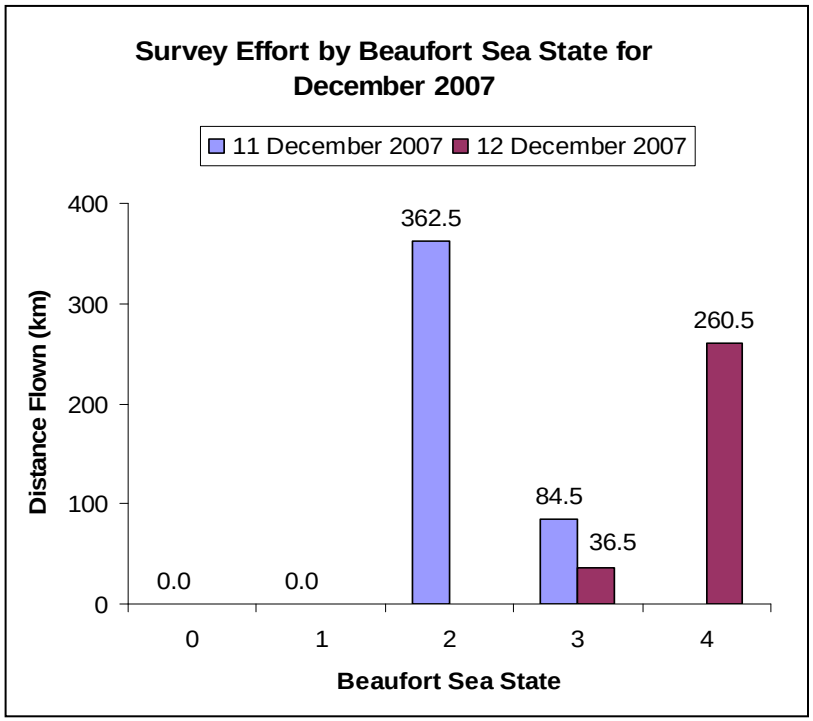

Survey Effort by Beaufort Sea State for November 2008
17 November 2007
18 November 2007
19 November 2007
Distance Flown (km)
700
600
500
400
300
200
100
0
0.0
28.5
205.5
89.0
408.5
65.5
645.0
39.0
8.0
0
1
2
3
4
Beaufort Sea State

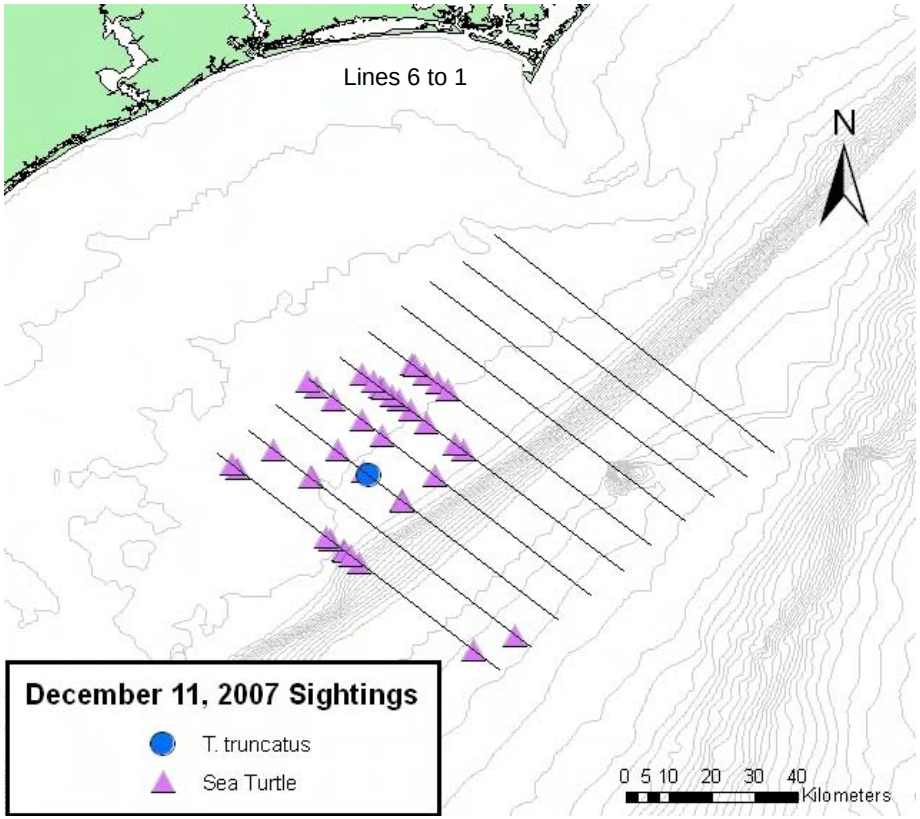
Appendix G

11 December 2007

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	1	2	3
Sea Turtle	53	1-2	2	
Sea Turtle	1	1	3	

12 December 2007 no cetacean or sea turtle sightings





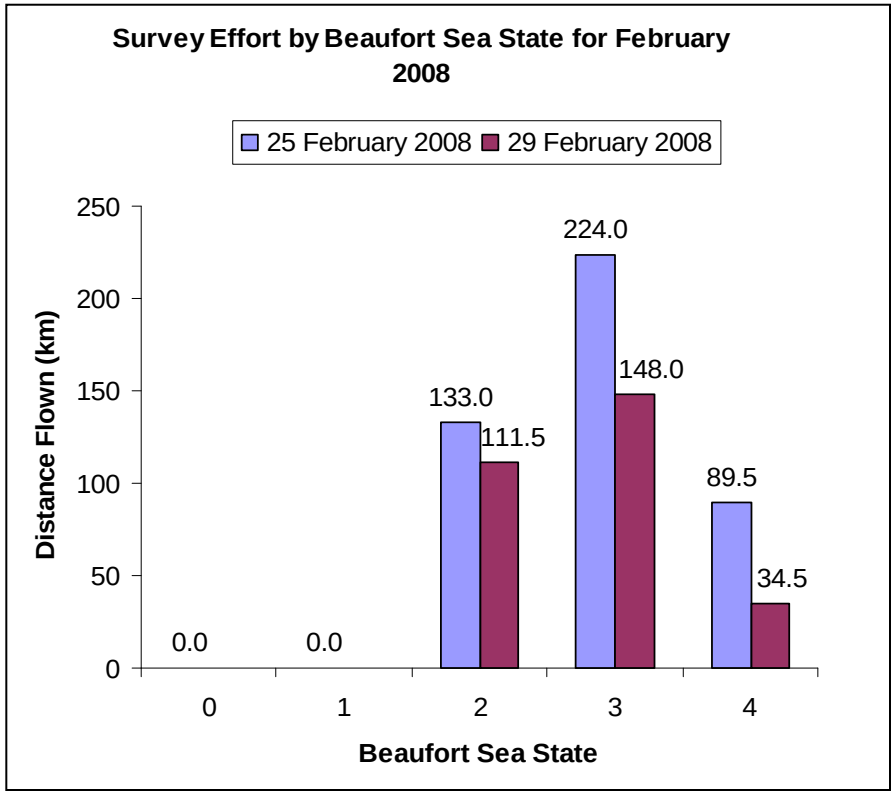
Appendix G

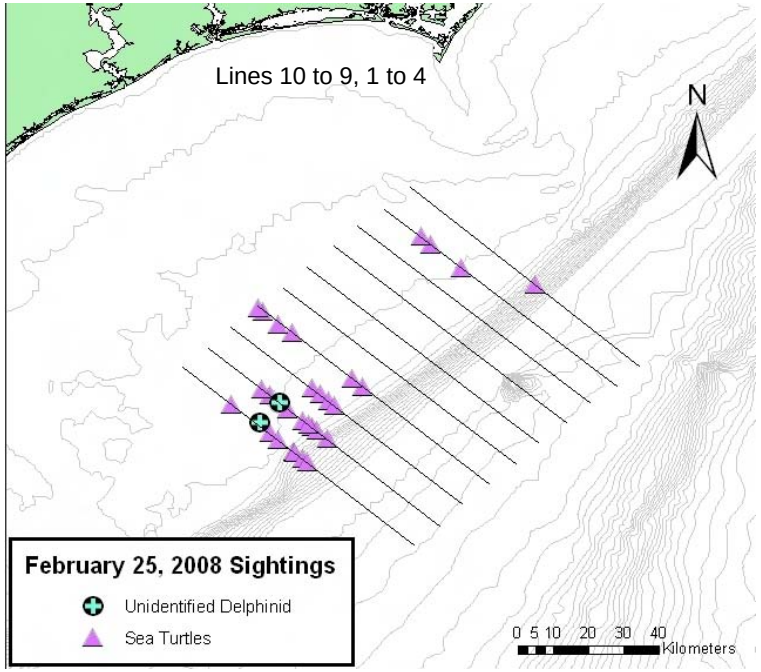
25 February 2008

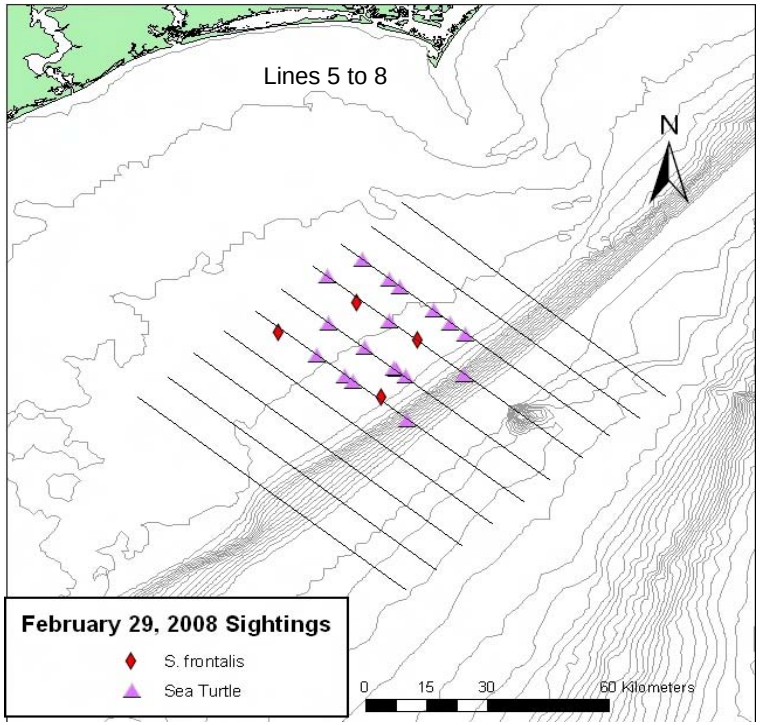
Species	# of encounters	# of individuals	BSS	Line
Delphinid	1	13	2	2
Delphinid	1	7	2	1
Sea Turtle	12	1	2	
Sea Turtle	16	1-2	3	
Sea Turtle	1	1	4	

29 February 2008

Species	# of encounters	# of individuals	BSS	Line
Stenella frontalis	1	8	2	5
Stenella frontalis	1	27	2	7
Stenella frontalis	1	26	2	7
Stenella frontalis	1	7	3	5
Sea Turtle	6	1	2	
Sea Turtle	12	1	3	







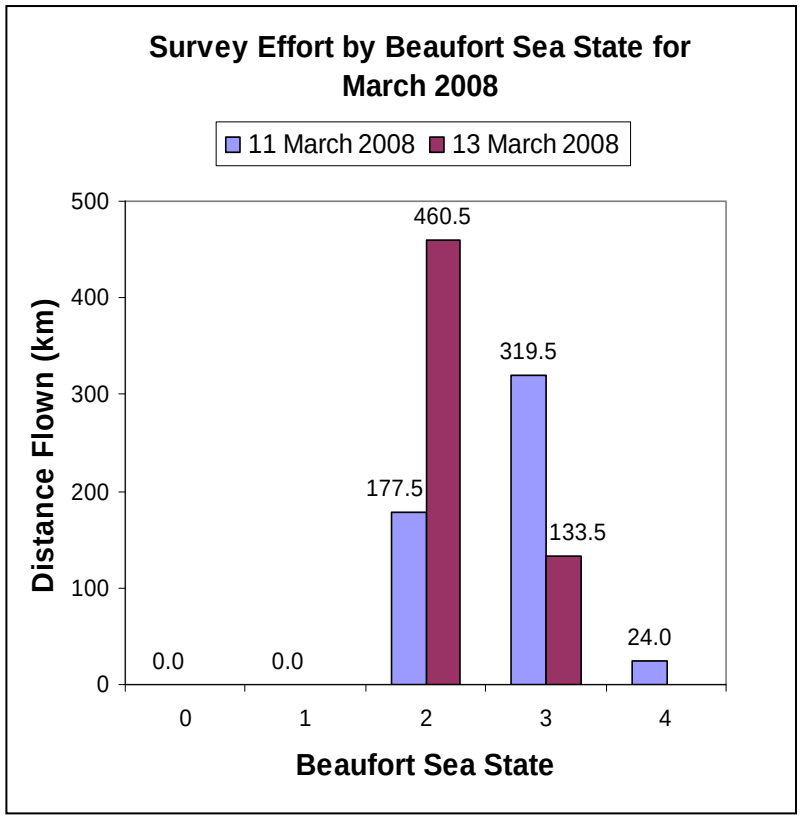
Appendix G

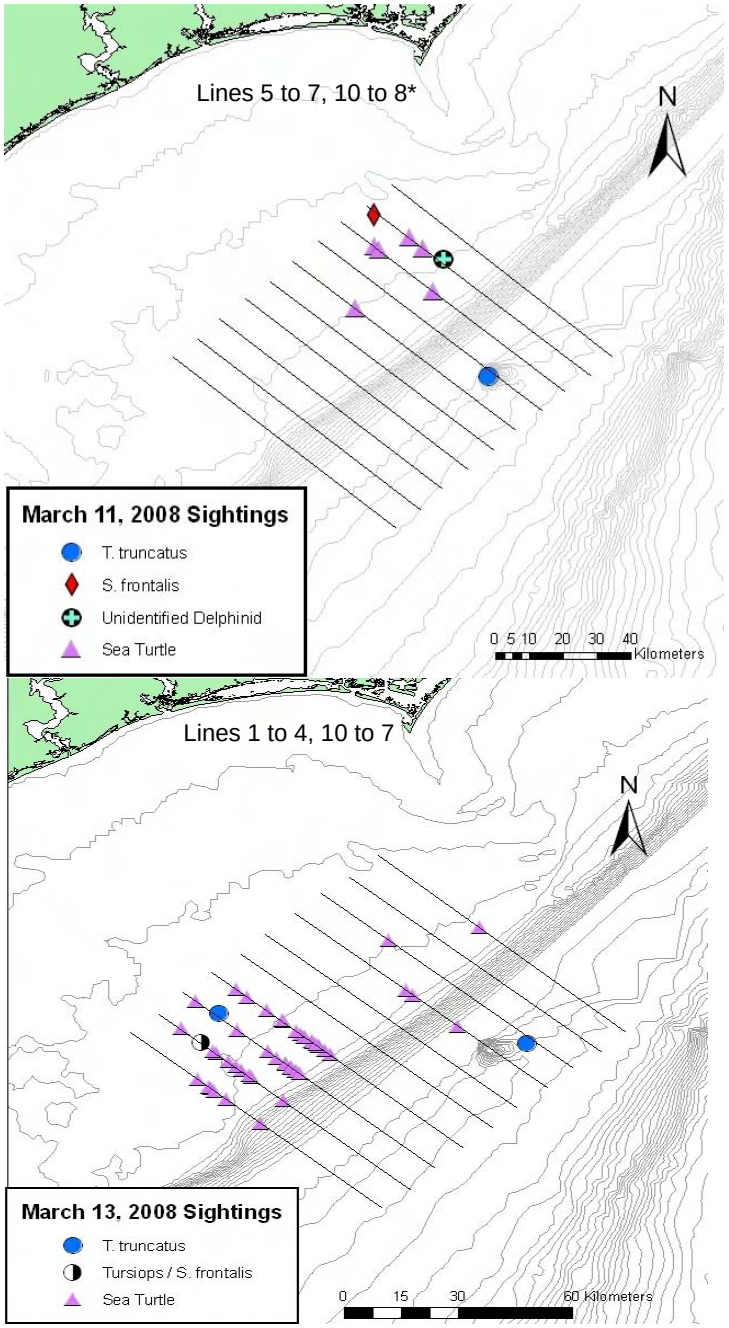
11 March 2008

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	15	3	7
Stenella frontalis	1	36	2	9
Unidentified Delphinid	1	5	2	9
Sea Turtle	5	1	2	
Sea Turtle	1	1	3	

13 March 2008

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	5	2	3
Tursiops truncatus	1	13	2	8
Tursiops/ Stenella frontalis	1	3	2	2
Sea Turtle	44	1-3	2	
Sea Turtle	3	1-2	3	





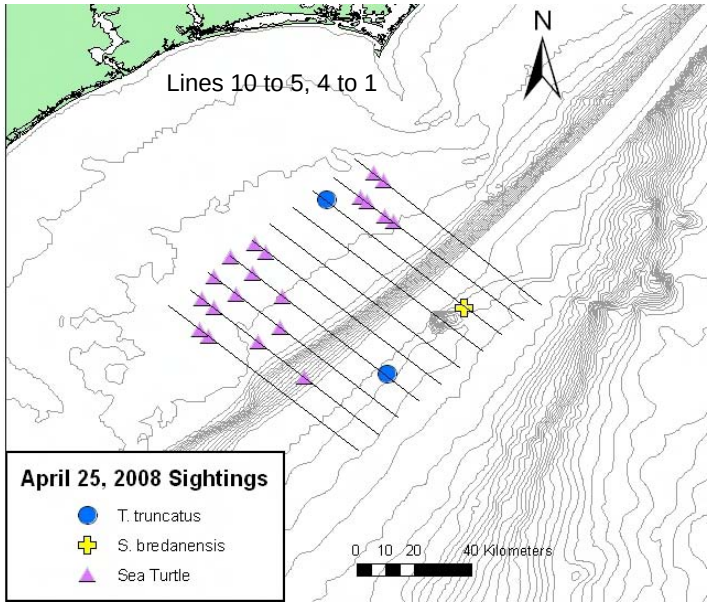
Appendix G

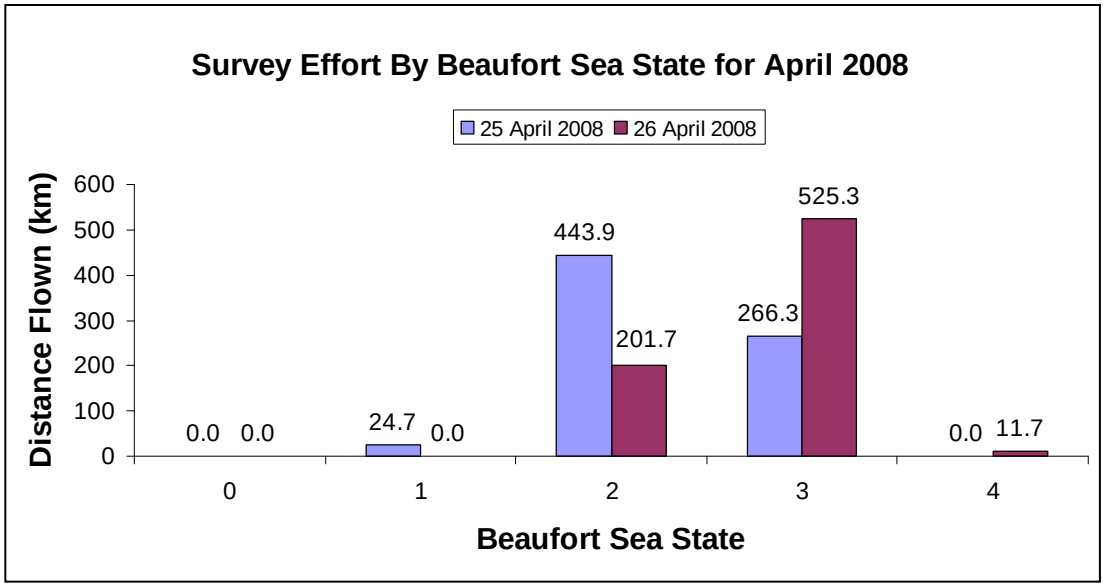
25 April 2008

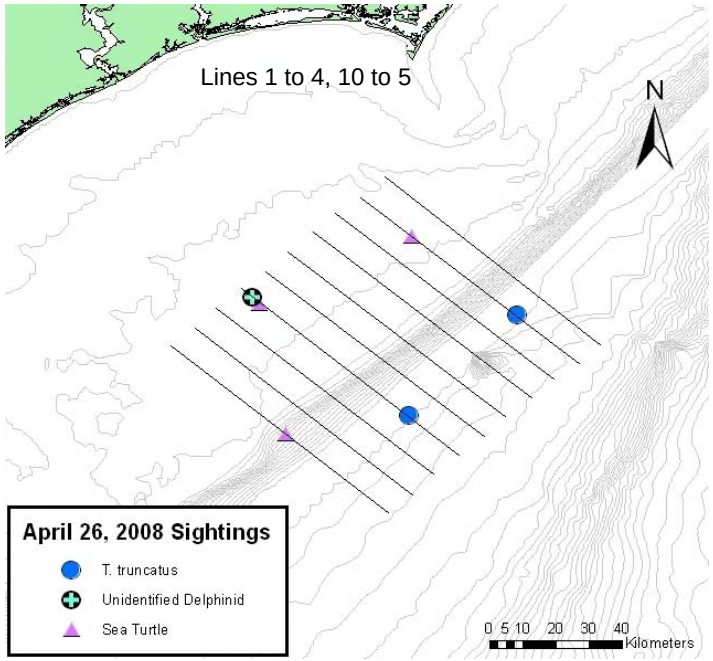
Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	3	2	8
Tursiops truncatus	1	12	3	4
Steno bredanensis	1	26	2	8
Sea Turtle	11	1	2	
Sea Turtle	1	3	2	
Sea Turtle	1	4	2	
Sea Turtle	4	1	3	

26 April 2008

Species	# of sightings	# of individuals	BSS	Line
Tursiops truncatus	1	15	2	4
Tursiops truncatus	1	9	2	9
Tursiops truncatus	1	4	2	4
Sea Turtle	3	1	3	







Appendix G

25 May 2008

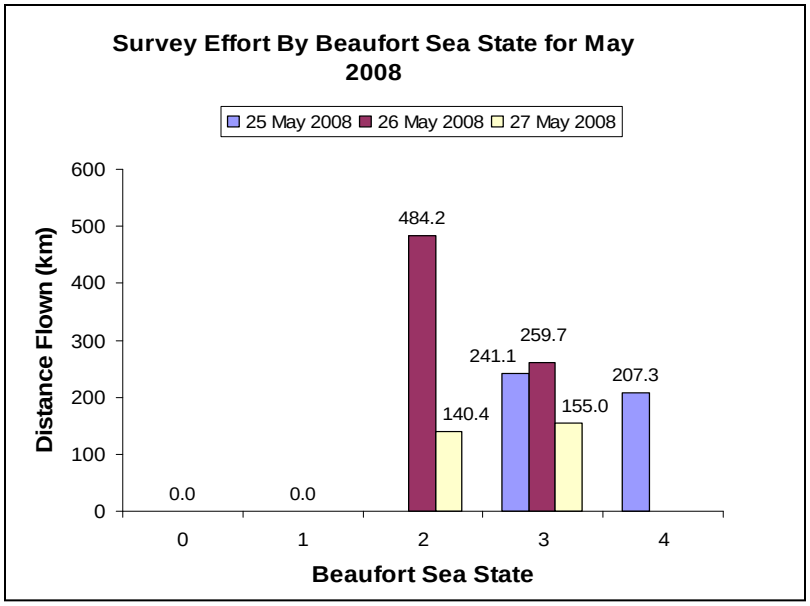
Species	# of sightings	# of individuals	BSS
Sea turtle	1	1	3

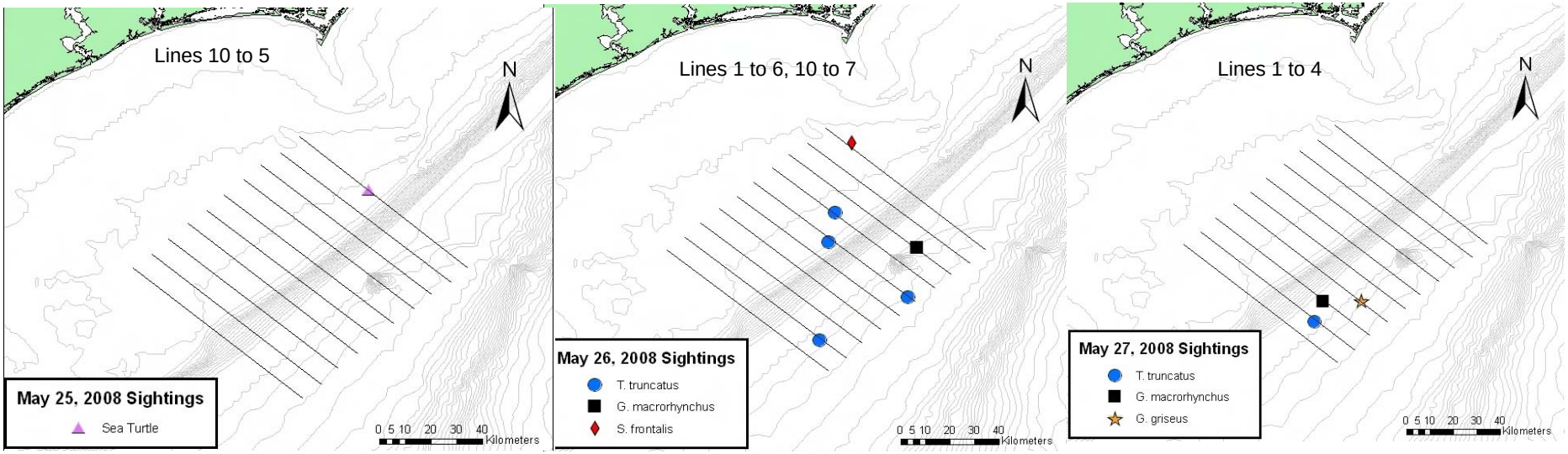
26 May 2008

Species	# of sightings	# of individuals	BSS	Line
Globicephala macrorhynchus	1	9	3	8
Stenella frontalis	1	11	2	10
Tursiops truncatus	1	13	2	6
Tursiops truncatus	1	13	2	2
Tursiops truncatus	1	23	2	6
Tursiops truncatus	1	6	3	7

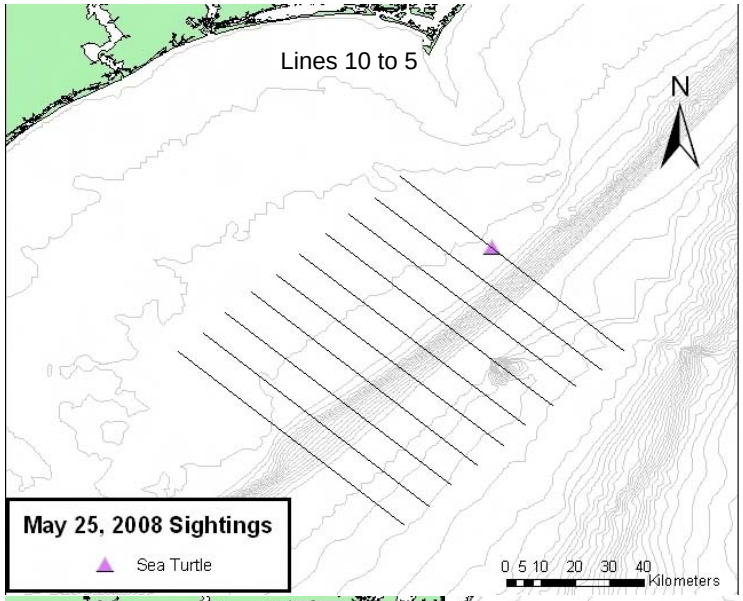
27 May 2008

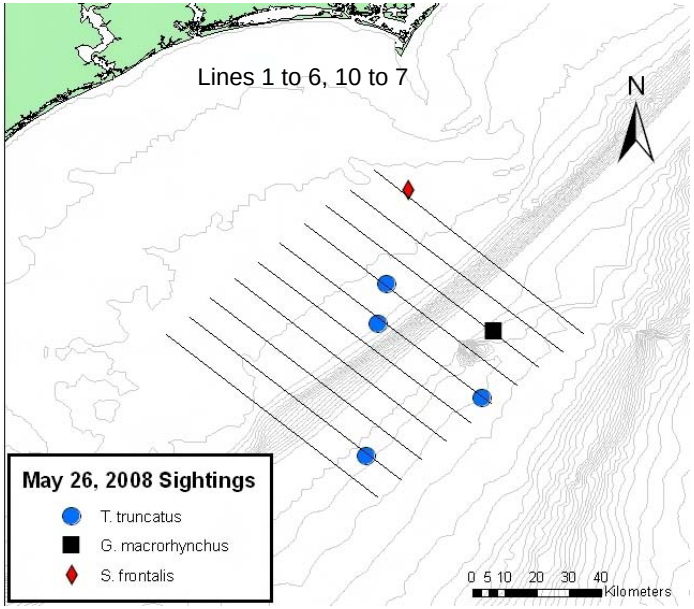
Species	# of sightings	# of individuals	BSS	Line
Grampus griseus	1	5	3	4
Globicephala macrorhynchus	1	12	2	3
Tursiops truncatus	1	12	2	2

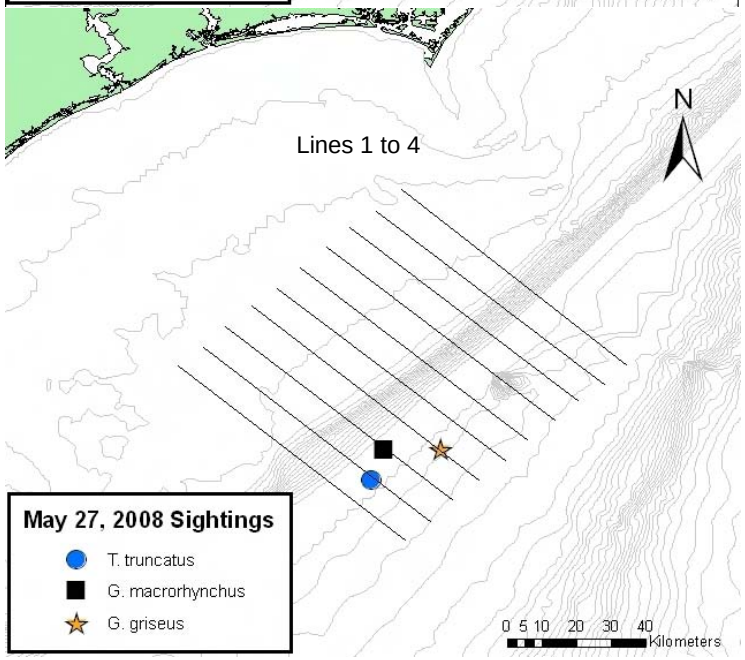


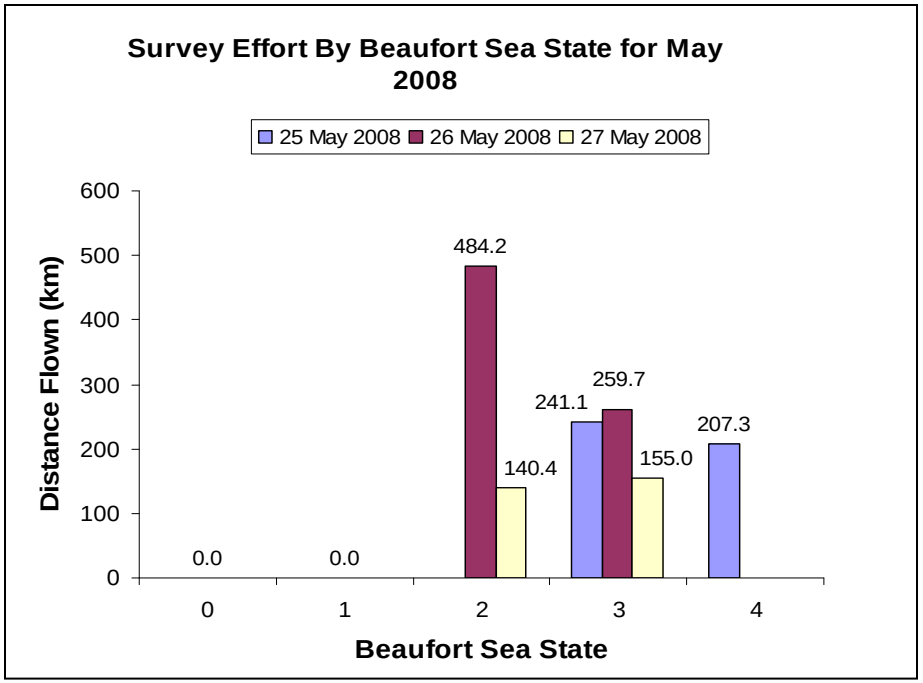


Appendix G


Lines 10 to 5
N
May 25, 2008 Sightings
Sea Turtle
0 5 10 20 30 40
Kilometers


Lines 1 to 6, 10 to 7
N
May 26, 2008 Sightings
T. truncatus
G. macrorhynchus
S. frontalis
0 5 10 20 30 40
Kilometers

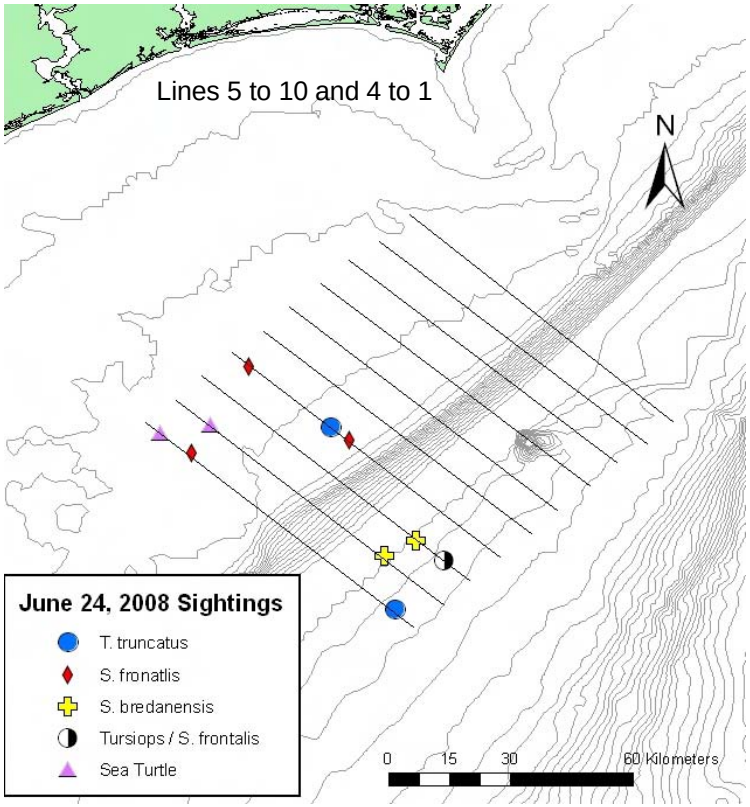

Lines 1 to 4
N
May 27, 2008 Sightings
T. truncatus
G. macrorhynchus
G. griseus
0 5 10 20 30 40
Kilometers

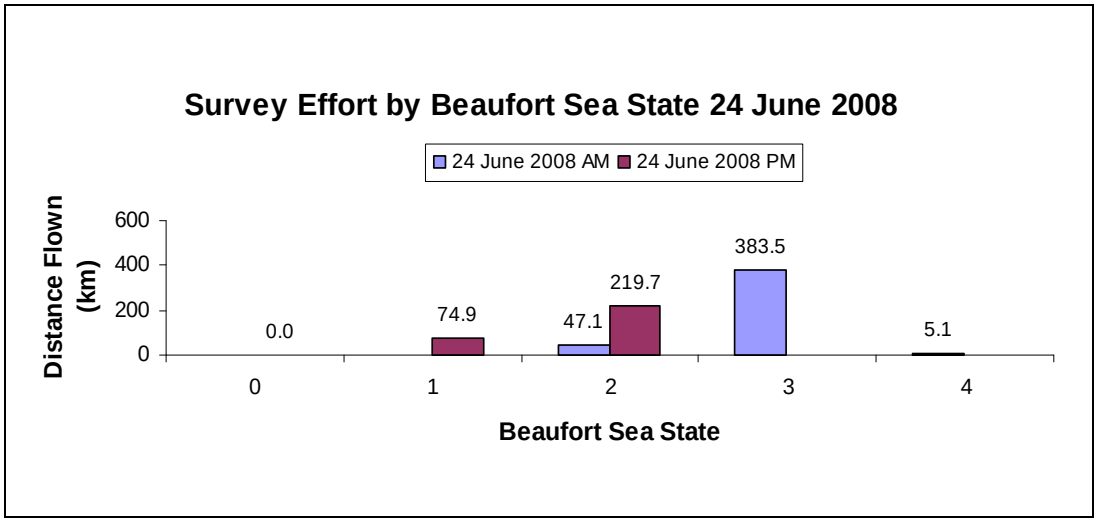

Survey Effort By Beaufort Sea State for May 2008
25 May 2008
26 May 2008
27 May 2008
Distance Flown (km)
600
500
400
300
200
100
0
0.0
0.0
484.2
140.4
241.1
259.7
155.0
207.3
0
1
2
3
4
Beaufort Sea State

Appendix G

24 June 2008

Species	# of sightings	# of individuals	BSS	Line
Steno bredanensis	1	9	2	2
Steno bredanensis	1	5	3	3
Stenella frontalis	1	5	2	4
Stenella frontalis	1	35	2	4
Stenella frontalis	1	10	2	1
Tursiops truncatus	1	7	2	4
Tursiops / Stenella frontalis	1	2	2	3
Tursiops truncatus	1	25	2	1
Sea Turtle	2	1	2	

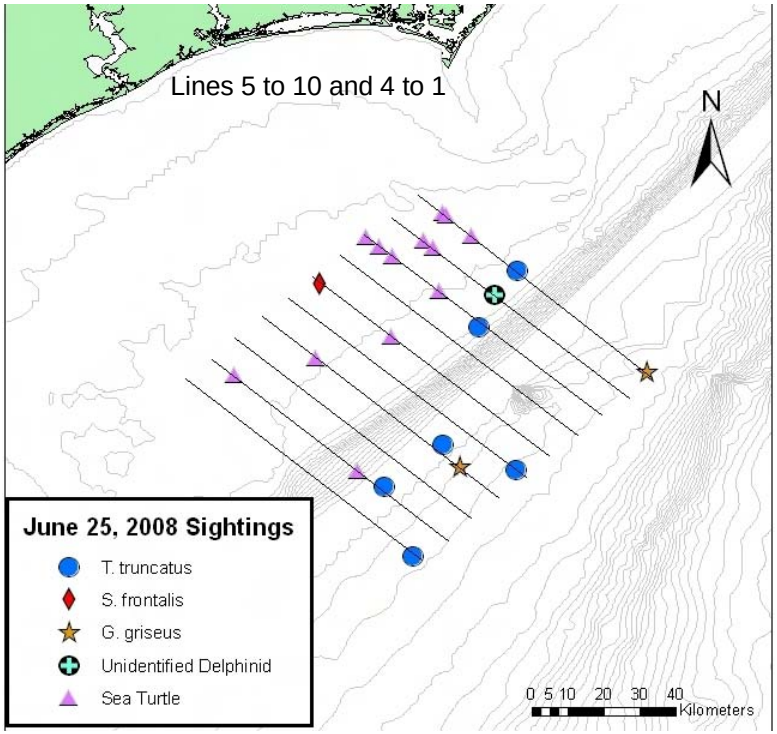


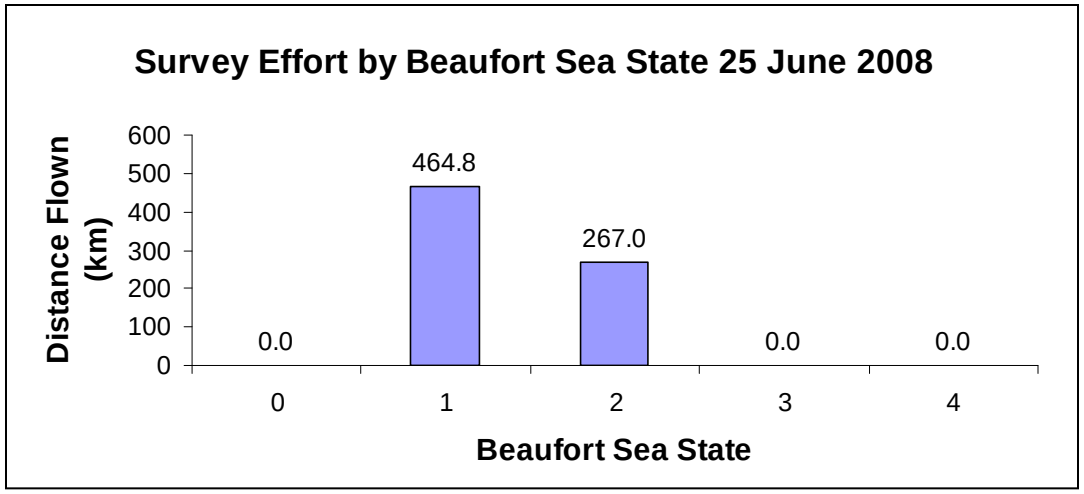


Appendix G

25 June 2008

Species	# of sightings	# of individuals	BSS	Line
Grampus griseus	1	10	1	10
Grampus griseus	1	5	1	4
Tursiops truncatus	1	2	1	8
Tursiops truncatus	1	14	1	4
Tursiops truncatus	1	11	2	2
Tursiops truncatus	1	15	1	1
Tursiops truncatus	1	9	1	5
Tursiops truncatus	1	1	1	10
Stenella frontalis	1	8	2	6
Unidentified Delphinid	1	1	2	9
Sea Turtle	10	1	1	
Sea Turtle	3	1	2	





Appendix G

VESSEL-BASED SURVEYS AND PASSIVE ACOUSTIC MONITORING OF THE PROPOSED UNDER SEA WARFARE TRAINING RANGE (USWTR) IN ONSLOW BAY, NORTH CAROLINA, JUNE 2007 TO JUNE 2008

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Dave Johnston
Kim Urian
Lynne Williams
Lesley Thorne
Lucie Hazen
Danielle Waples

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Submitted to:
The Department of the Navy
Norfolk, VA

Vessel-based Surveys and Passive Acoustic Monitoring

Introduction

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. Vessel-based platforms allow for biopsy sampling to ensure that all species encountered are correctly identified, as described below.

To ensure maximum detection rates, we employed a traditional visual survey approach, supplemented by passive acoustic monitoring using a towed hydrophone array. The towed array facilitated compilation of an acoustic library of species-specific recordings, which will be useful for the passive acoustic monitoring component of this research program (see below).

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

We have also collected information on the occurrence and density of seabirds using a traditional strip transect approach.

At present, our vessel-based surveys have been used primarily to estimate density. Observations made during these surveys have allowed preliminary estimation of the density and abundance of marine mammals and sea turtles in the proposed USWTR area (see below). Survey tracks and the locations of sightings from the vessel-based surveys from June-December 2007 have been posted on OBIS-SEAMAP (http://seamap.env.duke.edu/).

Methods

Study Area

The survey 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 – see Figure 1). We established ten 40-nm (74 km) long transect lines that cross the survey area, oriented parallel to the short axis of the USWTR boundaries and perpendicular to the primary bathymetric and prevailing 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.

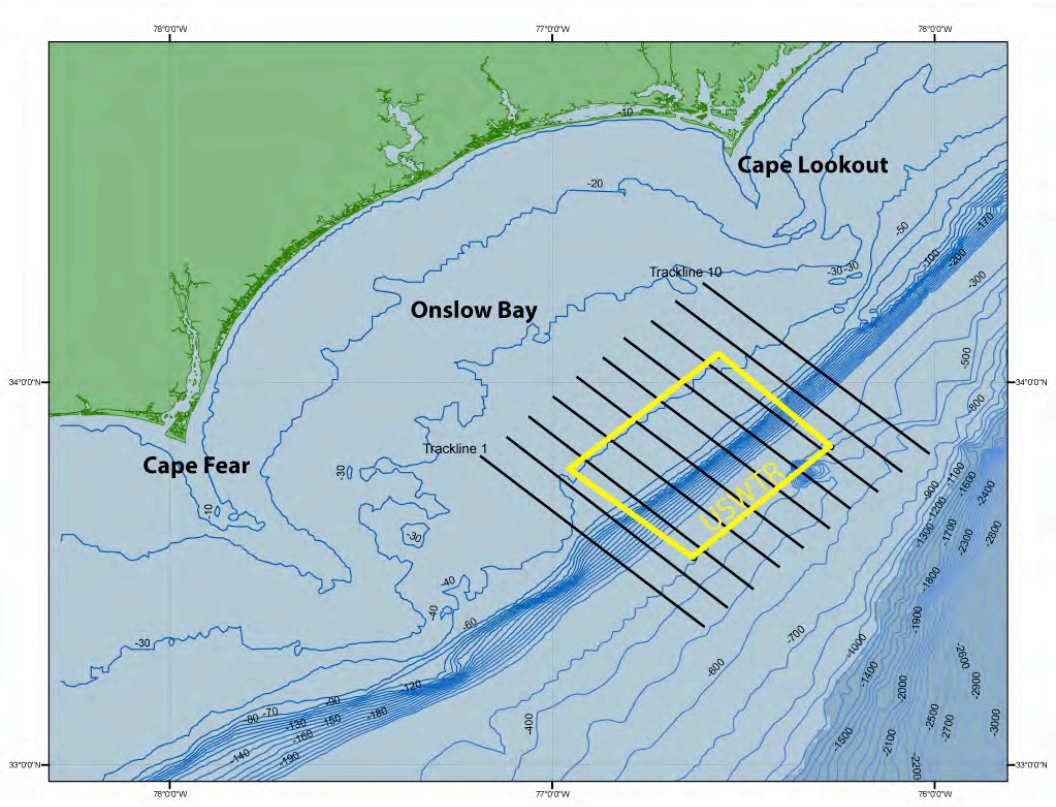

Figure 1. Map of the study area, the proposed Undersea Warfare Training Range (USWTR) and the basic bathymetry of Onslow Bay.

Vessel Survey Data collection

Visual surveys

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

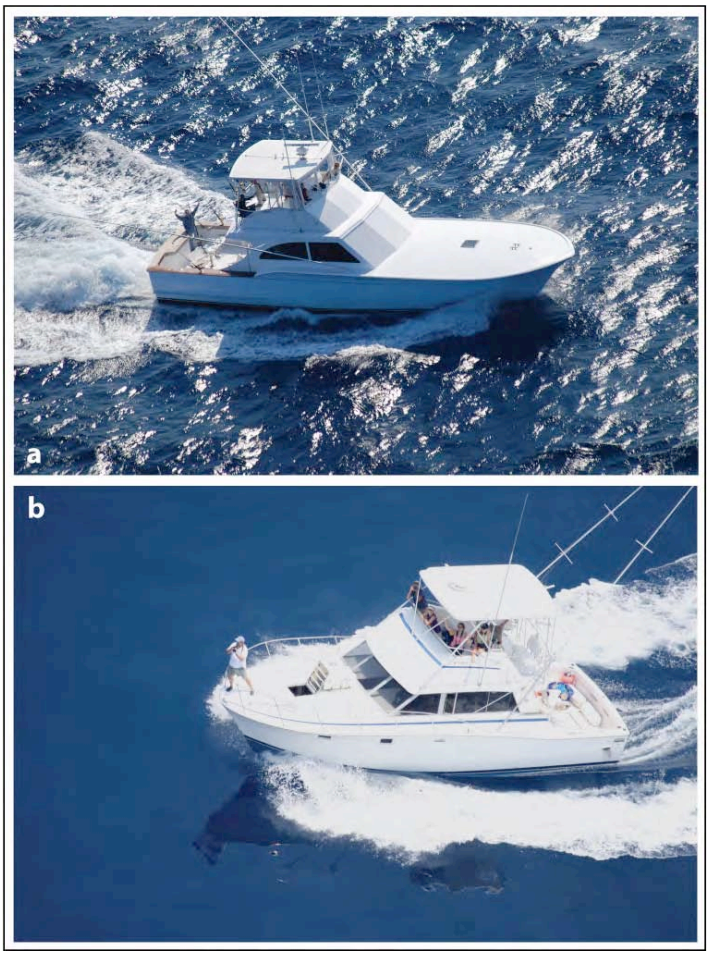

Figure 2. Aerial photogrpahs of the M/V Sensation (a) and the R/V Cetus (b).

Visual surveys were conducted from the flying bridge (5.0m and 4.2m above waterline for the *Sensation* and *Cetus* respectively) by naked eye and 7x50 binoculars. To prepare for these surveys, 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 has extensive experience as a shipboard observer for NOAA and who received training from the CREEM group at the University of St. Andrews, Scotland. Observers were instructed in line transect theory, field methods, data collection protocols, and species identification.

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 present and behavior of each cetacean encounter were recorded. Each primary

observer estimated group size independently; these values were averaged at the end of the survey to generate an overall estimate of group size. Environmental conditions (weather and sea state, depth and sea surface temperature) were collected every 30 minutes, or when 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. Whenever possible, photographs of encountered cetaceans were obtained for species identification confirmation and individual photo-identification. Photographs were obtained with Canon or Nikon digital SLRs equipped with 100-300mm zoom lenses. Photographs were shot in 24-bit color at a resolution of 3072 X 2048 pixels and saved in jpg format.

Seabird counts were conducted concurrent with marine mammal observations. An experienced observer recorded seabirds in a 90 degree bow-beam arc within 300 meters of the ship on the starboard side of the ship (Tasker *et al*. 1984). As with mammal sightings, the observer recorded the time and location of the sighting. Species identification, abundance, general behavior (sitting, flying, or foraging), and associations with other marine species were recorded for each bird sighting, and 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

Whenever possible, a four-element array was towed behind the survey vessel to allow acoustic detection of cetaceans in the vicinity of the survey vessel. The towed array (Seiche Instruments, UK) consisted of 4 hydrophone elements with approximate linear sensitivity to frequencies between 1kHz and 100 kHz. The array was towed approximately 150m behind the ship 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 using two or more hydrophone elements using *Ishmael* and *Whaltrak* software.

Bottom-mounted Recorder

To develop a time-series of acoustic monitoring data in the USWTR study area, we employed a High Frequency Acoustic Recording Package or HARP (Wiggins and Hildebrand 2007). This instrument combines high and low frequency hydrophone elements for detecting the vocalizations of both odontocete and mysticete whales and can sample at rates high enough to capture the echolocation clicks of many odontocetes. The instrument was deployed, recovered and redeployed near the center of the USWTR box, close to the 200m shelf break. The first deployment was at N 33.791 and W -76.524 at a depth of 162m; the second deployment (currently underway) was at N 33.811 and W -76.428 at a depth of 232m (see Figure 3). In both deployments the instrument was programmed to record for 5-minute periods separated by an inactive interval of five minutes and to record sound at a sample rate of 200 kHz.