

**Survey Plan for Monitoring the Proposed USWTR in Onslow Bay**

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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.

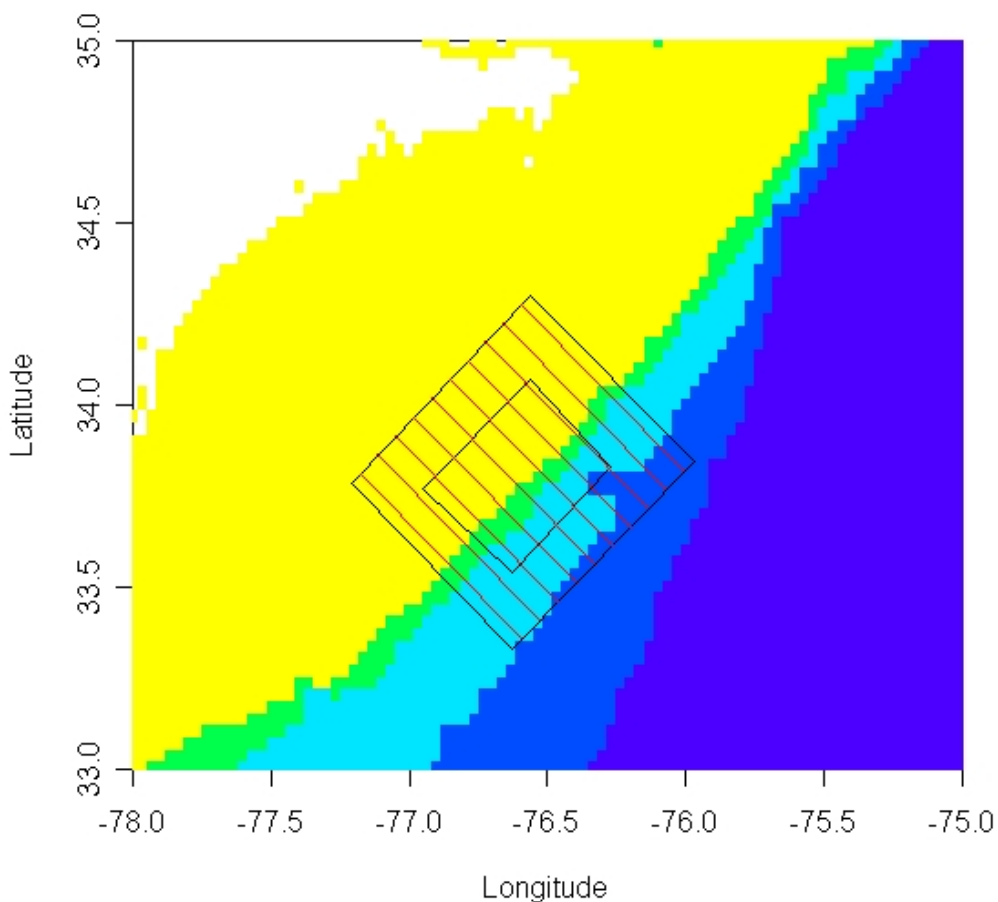
**2. Species of interest in Onslow Bay**

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.

USWTR Monitoring Plan

**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.

<b>Species</b>	<b>Bias from aerial line transect survey?</b>	<b>Bias from ship line transect survey?</b>	<b>Other issues</b>	<b>Suggested Mode of Survey</b>
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.

## USWTR Monitoring Plan

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 trackline 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.

## USWTR Monitoring Plan

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



## USWTR Monitoring Plan

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/ $\mu$ Pa. 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*

## USWTR Monitoring Plan

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.

## References

- Barlow, J. & R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. *Journal of Cetacean Management and Research* 7: 239-249.
- Buckland, S.T., D.R. Anderson, K.P. Burnham, J.P. Laake, D.L. Borchers & L. Thomas. 2001. *Introduction to Distance Sampling*. OUP. Oxford.
- Heinemann D. 1981. A range finder for pelagic bird censusing. *Journal of Wildlife Management* 45: 489-493.
- Laake, J.L. & D.L. Borchers. 2004. Methods for incomplete detection at distance zero. In Buckland, S.T., Anderson D.R., Burnham, K.P, Laake, J.L., Borchers, D.L. and Thomas, L. (eds) *Advanced Distance Sampling*. Oxford University Press, Oxford.
- McLellan, W.A., S.G. Barco, E.M. Meagher, S.D. Zvalaren & D.A. Pabst. 1999. *Offshore Aerial Surveys of Two Mid-Atlantic Sites: Wallops Island and Onslow Bay*. UNCW.
- Paxton, C., K. Newman, & D. Borchers. 2005. *Investigating the Survey Designs and Analyses to Assess the Potential Effects of USWTR on the Large Marine Fauna of the Eastern Atlantic Seaboard*. Unpublished Report. CREEM.
- Tasker, M.L., P.H. Jones, T. Dixon & B.F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. *Auk* 101: 567-577
- Wiggins, S.M. & J.A. Hildebrand. 2007. High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. *International Symposium on Underwater Technology 2007 and International Workshop on Scientific Use of Submarine Cables & Related Technologies 2007*, Tokyo, Japan, Institute of Electrical and Electronics Engineers, pp. 551-557, 17-20 April, 2007.



# USWTR Monitoring Plan

## Appendix B.

### Codes for Variables on Aerial Survey Data Sheet

**Date:** YYYYMMDD

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

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**Event:**

- |  |  |
|--|--|
| 1.1 = On effort/on track                 | 2.0 = Sighting-breaking track/off effort (real time)         |
| 1.2 = Off effort                         | 2.2 = Sighting of commercial fishing vessel                  |
|  | 2.4 = Sighting of marine mammal (real location)              |
| 3.1 = Change in environmental conditions | 2.7 = Sighting of sea turtle (real location)                 |
|  | 2.8 = Sighting of large vessel (Military, commercial, etc..) |
| 10.0 = Opportunistic sighting(s)         | 2.9 = Unidentified sighting, requires comments               |

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**Sighted by:** 1=pilot    2=recorder    3=observer left side    4=observer right side

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**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.).

## USWTR Monitoring Plan

**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](mailto: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,

A handwritten signature in black ink, appearing to read "Keith D. Mullin".

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**

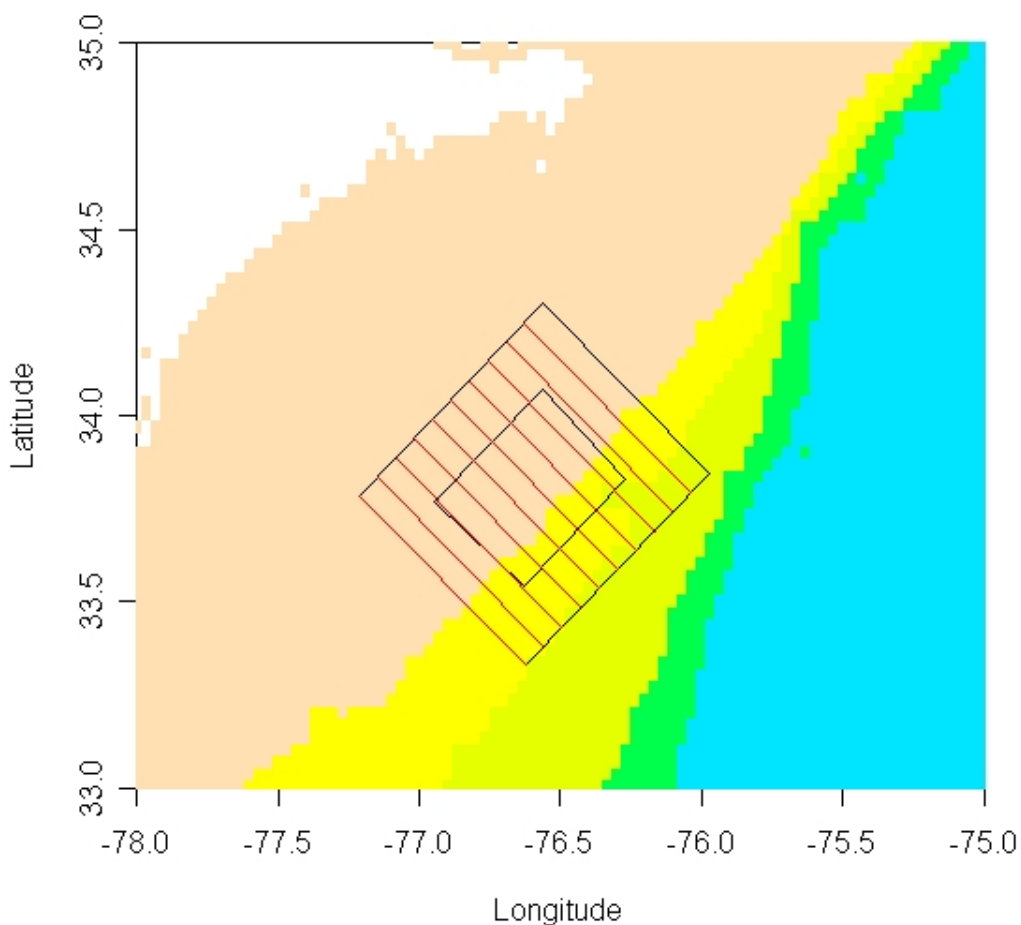
Our focus is on all protected species occurring in the proposed USWTR site, but in preparing this monitoring plan we paid particular attention to the following species: sperm whales (*Physeter macrocephalus*), beaked whales (*Ziphius* and *Mesoplodon spp.*), humpback and other balaenopterid whales (*Megaptera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



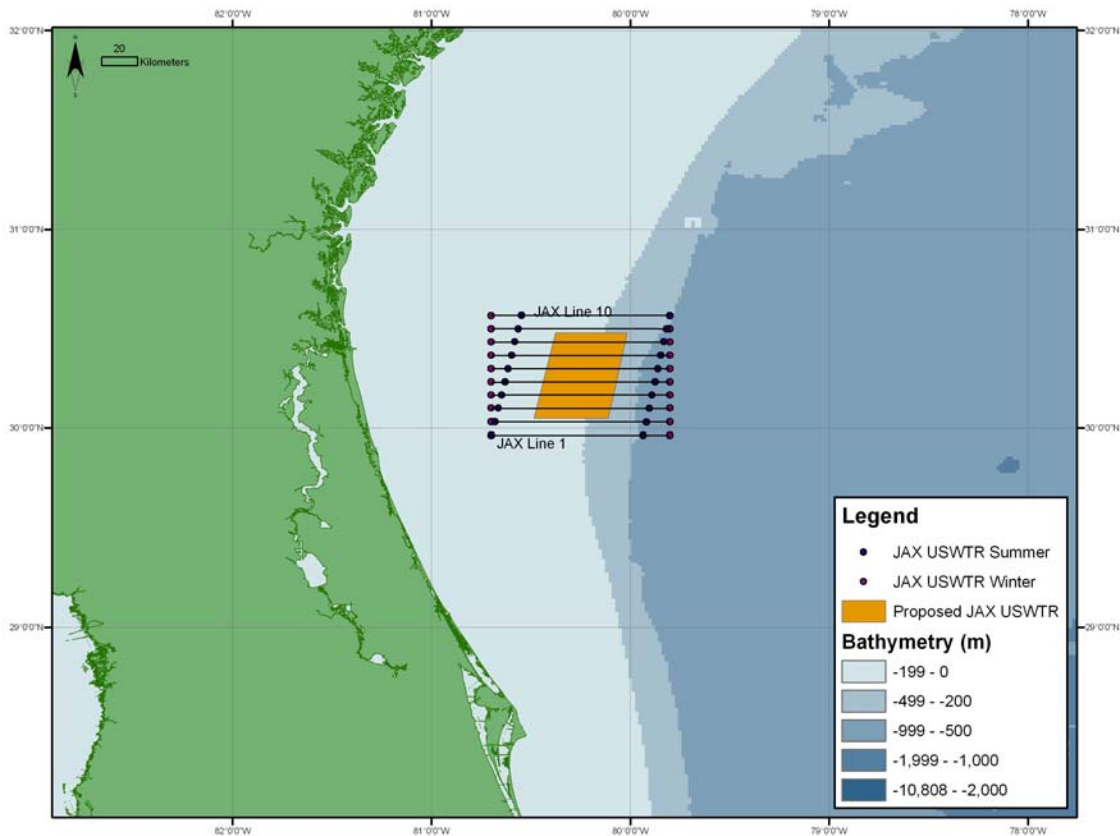
## USWTR Monitoring Plan

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<sup>2</sup>



**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 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/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 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.

## References

- Barlow, J. & R. Gisiner. 2006. Mitigating, monitoring and assessing the effects of anthropogenic sound on beaked whales. *Journal of Cetacean Management and Research* 7: 239-249.
- Buckland, S.T., Anderson, D.R., Burnham, K.P., Laake, J.P., Borchers, D.L. & L. Thomas. 2001. *Introduction to Distance Sampling*. OUP. Oxford.
- Heinemann D. 1981. A range finder for pelagic bird censusing. *Journal of Wildlife Management* 45: 489–493.
- Laake, J.L. & D.L. Borchers. 2004. Methods for incomplete detection at distance zero. In Buckland, S.T., Anderson D.R., Burnham, K.P, Laake, J.L., Borchers, D.L. and Thomas, L. (eds) *Advanced Distance Sampling*. Oxford University Press, Oxford.
- McLellan, W.A., Barco, S.G., Meagher, E.M., Zvalaren, S.D. & D.A. Pabst. 1999. *Offshore Aerial Surveys of Two Mid-Atlantic Sites: Wallops Island and Onslow Bay*. UNCW.
- Paxton, C., Newman, K & Borchers, D. 2005. *Investigating the Survey Designs and Analyses to Assess the Potential Effects of USWTR on the Large Marine Fauna of the Eastern Atlantic Seaboard*. Unpublished Report. CREEM.
- Tasker M.L., P.H. Jones, T. Dixon & B.F. Blake. 1984. Counting seabirds at sea from ships: a review of methods employed and a suggestion for a standardized approach. *Auk* 101: 567–577
- Waring GT, Josephson E, Fairfield-Walsh CP, Maze-Foley K, editors. 2007. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2007*. NOAA Tech Memo NMFS NE 205; 415 p
- Wiggins, S.M. & J.A. Hildebrand. 2007. High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring. *International Symposium on Underwater Technology 2007 and International Workshop on Scientific Use of Submarine Cables & Related Technologies 2007*, Tokyo, Japan, Institute of Electrical and Electronics Engineers, pp. 551-557, 17-20 April, 2007.