EARLY WARNING SYSTEM 2004

Aerial Surveys to Reduce Ship/Whale Collisions In the North Atlantic Right Whale Calving Ground

FINAL REPORT
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INTRODUCTION

There are still only about 300 North Atlantic right whales *(Eubalaena glacialis*) in the world, despite international protection since 1937. Failure of the North Atlantic stock to show signs of recovery can be attributed to several factors, including the effects of human activity on mortality rates (Knowlton and Kraus, 2001). Ship strikes account for the largest number of confirmed deaths (Knowlton and Kraus, 2001). Of 62 right whale mortalities documented from 1970 through 2004, 21 (33.9%) were due to collisions with vessels (Knowlton and Kraus, 2001; unpublished data, New England Aquarium). If this source of mortality is not eliminated, recent models predict extinction for right whales (Fujiwara and Caswell, 2001).

Calving right whales give birth and winter primarily in the coastal waters of the southeast U.S. between Savannah, Georgia, and West Palm Beach, Florida, with an area of high-density occurring along 100 kilometers (km) of coastline between Brunswick, Georgia, and St. Augustine, Florida. Three major ship channels transect this high-density area. Since 1988, a total of 7 vessel/whale collisions are known to have occurred in this region, resulting in 4 mortalities while 3 animals survived with extensive scarring (unpublished data, New England Aquarium). Commercial vessel traffic in this federally designated critical habitat has increased substantially over the past 40 years (Knowlton *et al*., 1997). Port expansions and diversions of military traffic to local bases from bases closed elsewhere augment this trend.

The three major entrance channels serve three commercial shipping ports and two military bases. The channel at the northern end of the high-density area extends 8 nautical miles (nm) (14.6 km) offshore and serves the port of Brunswick, Georgia. The channel centered in the area at the GA/FL border is the St Marys entrance channel, which runs 14 nm (25.9 km) offshore and serves the Kings Bay Naval Submarine Base, as well as the port of Fernandina Beach, Florida. The southernmost channel is the St. Johns River entrance channel, which runs 4 nm (7.28 km) offshore and serves the port of Jacksonville, Florida and the Mayport Naval Base. This is by far the busiest channel in the area with all forms of large vessel traffic, including container ships, car carriers, tankers, bulk freighters, as well as Coast Guard and U.S. Naval vessels.

The Brunswick and the St. Marys entrance channels are dredged annually to maintain required depths. This occurs during the winter to avoid impacts to the sea turtles that frequent the area in the summer. Dredged material is usually removed from the channels and carried to offshore disposal sites using ocean-going hopper dredges. These vessels work continuously, often making many transits from the channels to the disposal sites within a 24-hour period. Consequently, dredging activities increase the vessel traffic in these channels and the critical habitat significantly.

During the 1994 calving season (December 1993 through March 1994), the first comprehensive aerial surveys, referred to as the Early Warning System (EWS) surveys, were conducted to locate right whales and provide whale detection and reporting services to all mariners in the calving ground, including the U.S. Navy, the U.S. Army Corps of

Engineers, the U.S. Coast Guard, port authorities and harbor pilots. These groups have used the sighting information in their efforts to avoid collisions with right whales.

From 1994 to 2002 the New England Aquarium's (NEAq) EWS surveys covered the majority of the high-density area and provided daily coverage of the three shipping channels within it. Prior to the start of the 2003 calving season, surveys in the southeastern United States were redesigned to allow for more daily coverage of a larger area. For the 2003 season, the New England Aquarium's EWS surveys were extended eastward to a maximum of 35 nm from the coast and reduced in latitudinal range. This redesigned survey area is often referred to as the Central EWS survey area.

In addition, prior to the 2004 calving season all survey aircraft and crew used during the EWS surveys were held to newly imposed NOAA Fisheries safety regulations. Survey aircraft were all certified 14 CFR, Part 135 (airline, aircraft less than 10 seats). In addition, pilots and observers underwent intense pre season training. Observers and pilots attended an aircraft ditching course and sea survival training. Pilots also attended FAA Part 135 ground school and passed all associated check rides. A second pilot in command (SIC) was also added to each survey flight to ensure a higher safety margin during survey operations. The addition of a second pilot reduced the number of scientific personnel for all surveys that were conducted in a Cessna 337 due to weight and balance constraints. For this reason all surveys flown during the 2004 season were conducted without a dedicated data recorder.

This report describes the results of the EWS (Central) right whale aerial surveys in the 2004 season (December 6, 2003 – March 31, 2004). The U.S. Army Corps of Engineers, U.S. Coast Guard and the U.S. Navy provide funding for the EWS surveys with support from NOAA Fisheries.

METHODS

Aerial Surveys

Surveys were flown daily, December 6, 2003 through March 31, 2004. The surveys covered the southern end of Cumberland Island GA, approximately 6.5 nm (12 km) north of the St. Marys River entrance, to Jacksonville, FL, approximately 6.5 nm (12km) south of the St. Johns River entrance. Twelve east/west transects were flown perpendicular to the coast 3 nm (5.5 km) intervals from 0.5 nm (0.9km) off the shoreline out to approximately 32 nm (60km) from the shore. A total of 406.5 on-transect nm (761 km) were flown during each completed survey.

Necessary conditions for all flights included a minimum ceiling of 1000 feet (305 meters), visibility greater than 3 nm (5.5 km) and winds less than 17 knots. Surveys were conducted in a 14 CFR Part 135 certified twin engine Cessna 337. The aircraft was equipped with GPS, full IFR (instrument flight rules) instrumentation, aircraft mounted marine radio, life raft, flares, a medical kit, a waterproof VHF marine radio, a registered removable 406mHz EPIRB, aircraft mounted ELT, satellite phone and 4 emergency immersion suits (when water temperature reached below 50 degrees Fahrenheit).

The survey was flown at an altitude of 1000 feet (305m) above sea level. The survey team consisted of a pilot in command (PIC), pilot second in command (SIC), and two observers positioned on each side of the aircraft in the rear seats. Each observer was individually equipped with, but not limited to a Nomex flight suit, FAA approved survival vest, strobe light, rescue streamer, combo-edge knife and Personal Locator Beacon (PLB) with GPS. The observers scanned the water surface out to at least 2 NM (3.7 km). In order to maintain standardized sighting effort, the PIC and SIC were instructed not to alert the observers to any sightings, but were allowed to report a sighting after it had been passed by the aircraft if missed by the observers. The distance of each right whale sighting from the flight track was measured using GPS positions of the sighting and the transect line.

All right whale sightings were recorded into a digital voice recorder and entered into a computerized logging program. Logger 2000 was created by the International Fund for Animal Welfare (IFAW) and designed for compatibility with the Right Whale Consortium database, curated by the University of Rhode Island (URI). During surveys, Logger 2000 downloaded data directly from the aircrafts GPS. Every 10 seconds Logger 2000 would download the time, position (latitude and longitude), altitude, heading and speed of the aircraft into a database. In addition to the automatically downloaded data, the recorder could manually enter sighting information into the database. Beaufort, visibility, cloud cover and weather were also recorded. No other marine species sightings were logged during flights due to the change in configuration of aircraft personnel with the addition of a second pilot and loss of the data recorder position.

All sightings of vessels (larger than 100 ft) were recorded without breaking transect in order to maximize flight time available for investigating right whale sightings. Large vessels were recorded with an estimate of direction, heading and distance from the transect in order to plot locations.

When sightings of right whales occurred, the aircraft left the transect line at a right angle to the sighting and flew directly over the whale(s) to obtain an exact GPS location of the whale(s). The aircraft then circled the whale(s), allowing observers to obtain photographic identifications of the individuals sighted. High-resolution digital images were obtained at an altitude of 1000 ft using a digital Nikon D1X camera with a fixed 400mm Nikkor lens. At the conclusion of photographic work on each sighting, the aircraft returned to the transect line at the point of departure. These methods conformed to research protocols followed by the North Atlantic Right Whale Consortium as approved by NOAA Fisheries.

Notification of Agencies

During the EWS season, all right whale sightings were reported to the Fleet Area Control and Surveillance Facility (FACSFACJAX) at Naval Air Station Jacksonville. All right whale sightings were reported directly from the survey aircraft via satellite phones. This near real time data is forwarded to the NAVTEX system via the U.S. Coast Guard (USCG), and is received automatically by all military and commercial shipping. The USCG also transmits Notice to Mariners over VHF marine-band radio channel 16. A right whale user group, which included local, state, federal, non-profit and commercial interests was provided with pagers and received sighting information from FACSFACJAX almost immediately via the pager system.

Photographic Identification

Photographers attempted to obtain high quality images of the entire callosity pattern of every right whale and any other scars or markings that were obvious on the body. The image numbers were recorded by date, time, right whale letter for the day and photographer. Digital metadata time was synchronized to the GPS and the computer-logging program (Logger 2000) times at the start of each survey for accuracy.

Photographs of right whale callosity patterns were used as a basis for identification and cataloging of individuals, following methods developed by Payne *et al*. (1983) and Kraus *et al*. (1986b). Photographs taken during the survey effort were used to classify individuals on the basis of callosity patterns, topography, pigmentation and scars. Final matches will be confirmed using photographs from the North Atlantic Right Whale Consortium database, archived at NEAq.

One or two good quality digital images of each right whale considered to be a new individual for the season were emailed to the New England Aquarium office in Boston for preliminary identification. The ids were shared with the NEAq team as well

as other researchers from Florida Marine Research Institute (FMRI), Marineland, Marine Resources Council and Wildlife Trust (who also sent images to NEAq for id's). This allowed for an up-to-date tally of the number of mother/calf pairs during the season. Intermatching of non-mother/calf pairs was also initiated during the season. Photographs of all individuals were downloaded at the end of the day to look for entanglement or other injuries.

Distribution

Sightings of all right whales were recorded by time and location within the study area. Integration of the right whale sightings data collected during these surveys with previously collected data will help to further identify high-use areas within the southeast region. All right whale sightings for the season were plotted and displayed as individuals, pairs, M/C pairs, and groups of 3 or more right whales. Ship traffic was also plotted to visually compare right whale sightings versus ship traffic recorded by the aerial survey effort.

Sighting Distance

Sighting distance for each right whale sighting event was also determined. The distance was calculated by using the exact GPS position of the whale(s) and the exact position of where the aircraft broke from the transect line, also determined by GPS. Sighting events that occurred while the survey aircraft was not on transect were not included in the analysis.

Demographics

An analysis of the sex and age composition of the 2004 wintering population of right whales in the survey area was conducted using data from the aerial surveys and the existing catalog of identified right whales from the western north Atlantic. Right whales previously identified in their calving year were classified as juveniles (J) 1-9 yrs, or adults (A) >9 yrs. Whales that were not first sighted as calves were classified as unknown (U) age until their ninth year in which they become classified as an adult (A). All calving females were classified as adults regardless of age. Sexes were determined by one or all of the following methods: 1) direct observation of the genital area (F/M), 2) association with a calf (F), 3) by the testing of biopsy samples for a genetic marker unique to the Y chromosome (f/m) (Brown *et al*., 1994).

Calving Intervals and Rates

Right whale cows in this population have been monitored since 1980, and records of calf production are documented in the North Atlantic Right Whale Catalog (Kraus *et al*., 2001). Data collected on reproductive females (cows) that gave birth in the study

area during the survey period were used to update information on calving intervals, rates of reproduction, time frame and location of calving.

Associations and Behaviors

Data collected on the visible associations and behaviors of all right whales sighted during survey effort were recorded. The survey team remained on site until quality images of each whale in the sighting were obtained. During this time all visible associations and behaviors were recorded with as much detail as possible. The whale(s) heading was also recorded.

The time spent at each sighting is directly correlated to the survey teams ability to obtain photographic documentation of the event. Once the digital images were obtained the survey aircraft returned to effort regardless of whales' association and/or behaviors. Exceptions were made in the event of a ship/whale interaction or "close calls", entanglements, and events that caused concern for the welfare of the whale(s) (whales in a shipping channel or river).

Whales are considered associated if within several body lengths of each other and coordinating their movement at the surface (Hamilton, 2002). Associations were described as one of the following types.

1. SAG (surface active group)
2. M/C (mom/calf pair)
3. Echelon feed
4. Other
5. Not associated

Behaviors were also recorded when observed. Photographers attempted to capture photographic evidence of the behaviors for later confirmation.

A whale or group of whales were also given a heading if it was determined that the whale(s) had traveled a significant distance while the survey team was on site.

Vessel Sightings

All large (greater than 100 ft) vessels sighted during a survey were entered into Logger 2000. The aircraft did not break transect during large vessel sightings in order to maximize time available for survey effort. The position (latitude and longitude) of the aircraft was recorded when perpendicular to the vessel. The vessel was recorded with a bearing and estimated distance from the aircraft. The vessel's true position was later calculated using the estimated distance from the aircraft's position and these data were maintained in a separate database.

Vessels recorded included commercial and military vessels. Small commercial vessels were also recorded; this includes tugs, pilot boats and dredge crew and survey vessels. All entries include type of vessel, time, converted latitude/longitude position and heading. Appendix 3 contains a chart on which positions for all commercial and military vessels are plotted.

During a sighting event, if a vessel was determined to have the potential for a "close call" with a whale or group of whales the vessel was contacted directly by the survey aircraft in an attempt to prevent the threat of an interaction.

RESULTS

Survey Effort

The survey team was on-site for 117 days (6 December 2003- 31 March 2004) during the right whale calving season. During the 2004 season 80 surveys were conducted. The first survey was conducted on December 7, 2003 and the last survey occurred on March 31, 2004.

Some surveys were conducted with favorable conditions throughout the duration of the survey, where as others were flown with favorable conditions part of the time. Favorable conditions were considered to consist of a Beaufort force 3 or less and visibility of at least 2 nautical miles.

During the 2004 season, 65 complete surveys (>90% of survey area flown) and 15 partial surveys (50% - 90% of survey area flown) were flown. Thus, some measure of aerial coverage was provided 68% of the days. When a partial survey was conducted effort priority was given to the shipping channels (St. Marys Channel and St. Johns Channel) and the immediate surrounding area.

Of the 15 partial surveys flown during the season all but 3 surveys covered both channels. One of the three surveys was limited to covering a single channel due to dense fog. Two of the three were due to unforeseen occurrences. The first was a result of a live stranded right whale calf on Amelia Island on 3 February 2004 (see page 14). The second instance occurred on 17 March 2004 when the NEA survey aircraft altered its traditional survey effort to confirm a public sighting of an entangled right whale off of St. Augustine, FL (see page 14). In both cases adjacent survey teams (FMRI on 3 February and Wildlife Trust on 17 March) covered the second channel. Thus, on 14 of the 15 occasions that partial surveys were flown, both channels received full aerial coverage.

To evaluate how much of the available effort for the season was conducted in favorable sighting conditions (Beaufort < 4 and visibility > 2 nm) the number of days on site was multiplied by the on-transect miles per survey (Table 1). There are 406.5 on-transect miles to be flown per survey, so there were 47,561 nautical miles available to be flown during the 2004 season (117 days x 406.5nm). During the 2004 season 29,984 of the available 47,561 nm were flown (63%). Of the 29,984 nm of track line that were flown, 23,203 nm were flown in favorable conditions (77%). This represented 49% of the total miles available to be flown during the season.

Table 1:
Survey Effort 2003-2004

Number of Available Survey Days	Number of Surveys Flown/ Percent	Number of Full Surveys	Number of Partial Surveys	Number of Available Transect Miles (nm)	Number of Transect Miles Flown (nm)/Percent	Percent of Transect Miles Flown in Beaufort ≤3	Number of Transect Miles Flown in Beaufort ≤ 3/ Percent of Total Available
117	80	65	15	47,561	29,984		23,203
	68%				63%	77%	49%

Sightings and Photo-identifications

There were 102 right whale sighting events of 181 right whales (including calves) in the central EWS survey area during the 2004 season (Appendix 4). Of the 16 females known to have given birth in 2004, 15 were documented in the SEUS. 13 of the 15 documented cow/calf pairs were documented by the central EWS surveys. All 102 sightings were reported to the EWS pager system via FACSFACJAX and 100 of the sightings were photo documented.

Of the 100 right whale sighting events that were photo-documented, 34 of the sightings were of single whales (includes pregnant females), 31 mom/calf pairs, 21 pairs (not mom/calf), 10 were whales associated in SAGs and 4 were in a group of at least 3 whales (not associated in a SAG).

The first documented sighting in the SEUS in the 2003 – 2004 season was reported by the central EWS survey on 9 December 2003. As the coastal, southern progression of right whales continued, the number of right whale sightings increased from 1 to a maximum of 6 sightings per day with as many as 10 individual whales. Sightings continued throughout the season with the last right whale sighting reported by the Central EWS on March 25, 2004. The temporal occurrence of right whales in the survey area peaked in early March (Figure 1).

All photo-documented right whale sightings from the 2004 season are plotted on a chart of the study area in Appendix 2. All sightings of right whales are detailed in a table in Appendix 4 with the date, time, location, association and behavior type where applicable of each whale. Also included are the catalog identification numbers.

Table 2:
Demographics of known Right Whales in the SEUS
2003-2004

Right Whale	Age	Age Class	Sex	Last Calving
1123*	23	A	Ff	2001
1142*		A	Ff	2001
1266*		A	Ff	2001
1281*		A	Ff	2001
1301	21	A	Ff	2003
1321*		A	F	1998
1509*		A	Ff	2001
1611	18	A	Ff	2001
1701*	17	A	Ff	2001
1705*	17	A	Ff	1996
1812*		A	Ff	2002
1817		A	Ff	2003
1911*	15	A	F	2001
2145*	13	A	Ff	2001
2330*		A	Ff	
2427	10	A	m	
2503	9	A	f	
2614*	8	A	Ff	
2660	8	J	f	
2710	7	J	Ff	
3123	3	J	f	
3139	3	J	U	
3301	1	J	U	
3302	1	J	U	
3308	1	J	U	
3317	1	J	U	
3346**	1	J	M	
3351	1	J	U	
BK02***		U	U	
BK03***		U	U	
BK04***		U	U	
BK05***		U	U	
BK06***		U	U	
BK08***		U	U	

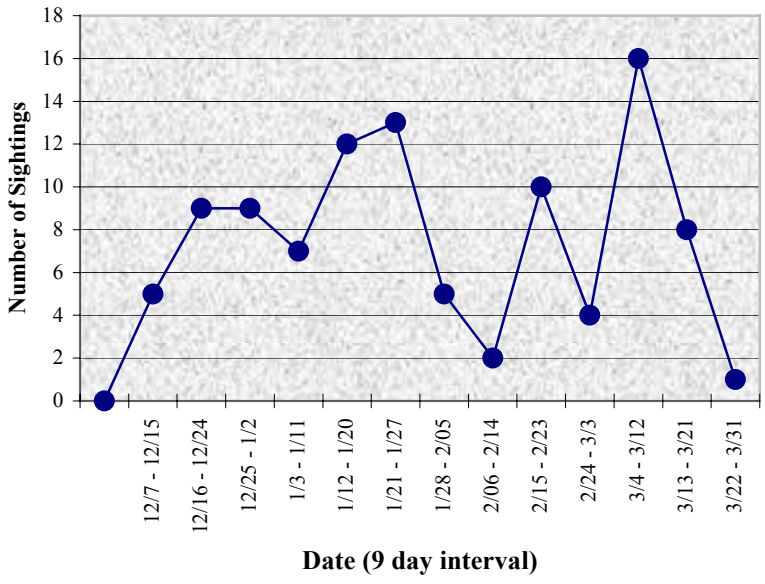
BK09***		U	U	
BK10***		U	U	
BK11***		U	U	
CT01***		U	U	
CT03***		U	U	
CT04***		U	U	
CT05***		U	U	
CT06***		U	U	
CT08***		U	U	
CT09***		U	U	
CT10***		U	U	
CT11***		U	U	

* 2004 Cow/Calf pairs

** Entangled whale photographed outside of the central EWS survey area

*** Unknown, unique individual

Figure 1:
Temporal Occurrence of Right Whales in the SEUS



Sighting Distances

The sighting distances for each right whale sighting event are summarized by 1/10 nm increments in Figure 2. Sighting events that occurred while the survey aircraft was not on transect were not included in this analysis.

The mean sighting distance, without considering Beaufort sea state conditions as a factor is 0.9 nm. A summary of sighting distances where Beaufort sea state was considered is shown in Figure 3. Analysis of Beaufort sea state and sighting distances shows a mean of 0.8 nm during times of Beaufort 3 or less. While the mean during times of Beaufort 4 or greater is 0.9 nm the number of such sightings are lower (n = 67 and 8, respectively), however, only 23% of the surveys were flown in a Beaufort 4 or greater. Only 11% of the sightings were detected in the higher sea state suggesting indicating a reduced total sighting ability in the higher sea state

Figure 2:
Right Whale Sighting Distance

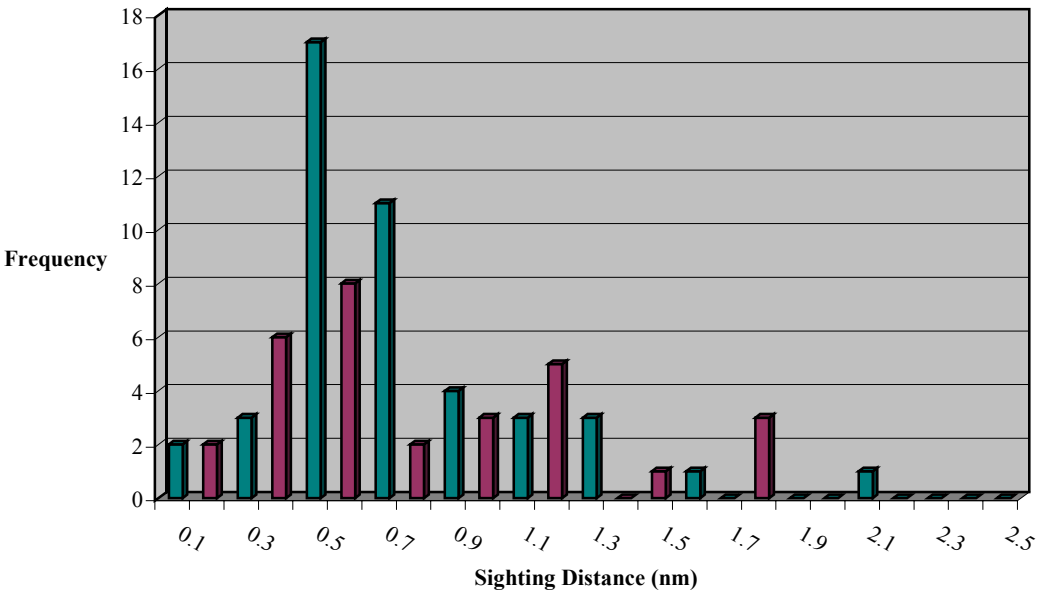
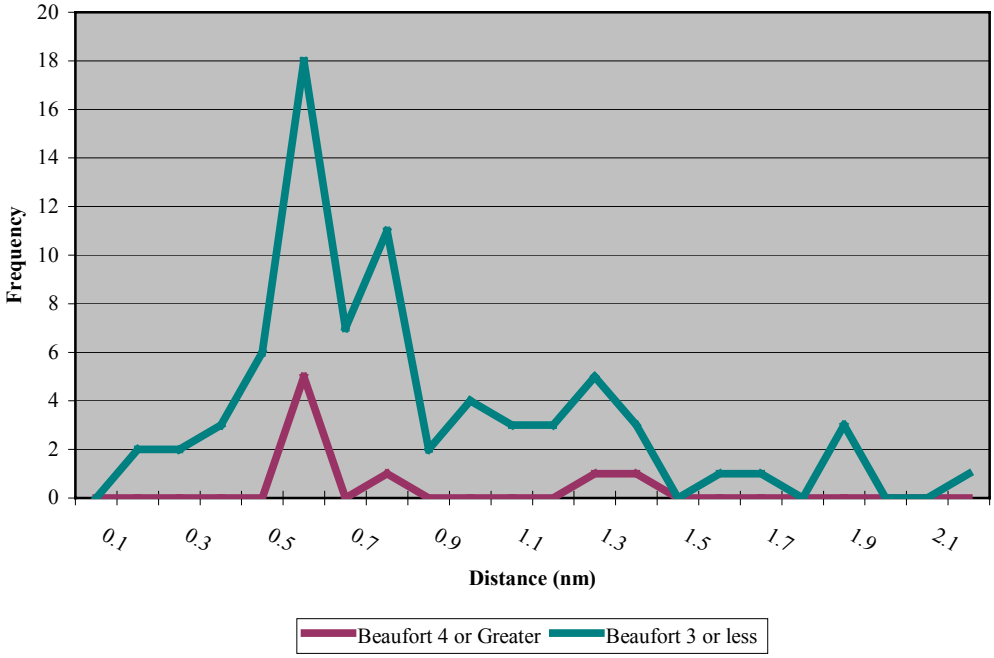


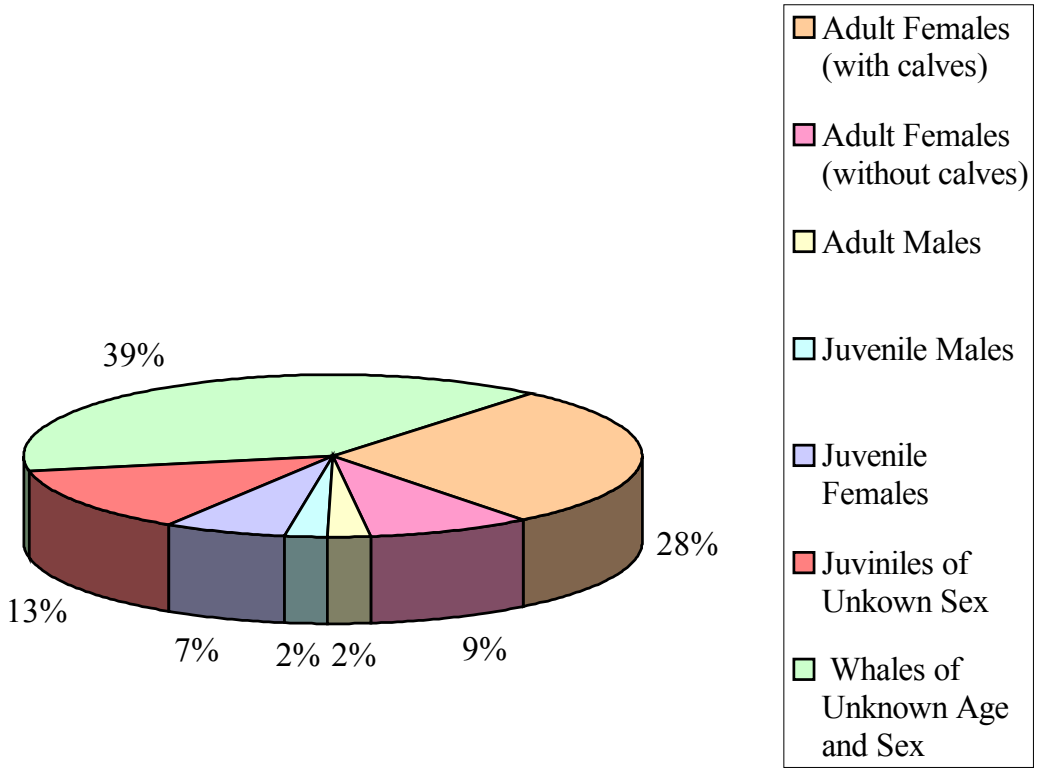
Figure 3:
Right Whale Sighting Distances with Beaufort Considered



Demographics

A summary of the demographic structure within the Central EWS 2004 survey area is given in Figure 4. This figure indicates that calving females with their newborn calves primarily utilized the area. However, Figure 4 illustrates that juveniles also frequently were observed. In addition, inter-matches of unidentified whales, thought to be juveniles, are currently underway.

Figure 4:
Demographics of Right Whales Documented in the Central EWS 2004



Calving Intervals and Rates

Preliminary data from the 2004 calving season shows the calving interval ranged from 2-8 years with a mean of 3.58 years. Table 2 includes the year of the last calving event for each of the 13 adult, female right whales identified in the central EWS in 2004.

During the 2004 season, two female right whales (catalog #2330 and catalog #2614) gave birth for the first time. Catalog #2330 is an adult, female of unknown age while catalog #2614 is an 8-year-old female previously cataloged as a juvenile (J). These data will update these females from a non-reproductive to a reproductive status.

One known reproductive female, catalog #1812 had been previously documented in 2002 with a calf. This female was seen in 2004 with a new calf. The 2002 calf of catalog #1812 was a known mortality in 2002. This represents only the fourth documented case of a two-year calving interval in the population.

Associations and Behaviors

During the 2004 season all right whale behaviors described were observed and documented except for echelon feeding.

Behaviors noted in the calving ground during are as follows: apparent nursing (NURS), belly to belly contact (BEL/BEL), body contact not belly to belly (BOD CNT), breach (BRCH), lobtail (LBTL), defecation (DEFCN), mouth open (MOPN), rolling (ROLL), associated with Bottlenose Dolphins (w/BODO), entangled (ENTGL) and SAG (surface active group).

Appendix 4 summarizes all behaviors and associations observed during each right whale sighting event.

Vessel Sightings

During the 2004 season the Central EWS survey team observed and documented three “close calls” (1nm or less) between right whales and vessel traffic. In addition, on three more occasions the survey aircraft contacted vessel traffic directly to alert them to the close proximity of right whales. Table 3 summarizes those events.

Table 3: Ship and Whales

Date	Time	Origin or Destination of Vessel	Number of Whales (calves)	Vessel Type	Communication	Closest Distance	Vessels Action/ Whales Reaction
30-Dec-03	1440	Jacksonville	2 (0)	Coast Guard Cutter	Yes, via VHF	1 nm	Course change to the south/No reaction observed
14-Jan-04	1511	Jacksonville	3 (0)	Tug and Barge	Yes, via VHF	2 nm	Determined no action was needed/No reaction observed
21-Jan-04	1120	Jacksonville	1 (0)	Container Ship	Yes via VHF	.25 nm	Vessel was transiting a narrow channel and unable to alter/No reaction observed
25-Jan-04	1441	Jacksonville	1(0)	Large Merchant	Yes, via VHF	100yards	Vessel was transiting a narrow channel and unable to alter, speed was slowed/No reaction observed
19-Feb-04	1400	N/A	1(0)	Tug and Barge	Yes, via VHF	2 nm	Determined no action was needed/No Reaction observed
09-Mar-04	0935	N/A	1(0)	Tug and Barge	Yes, via VHF	Unknown	Determined no action was needed/Unknown

Entangled Whales

On 17 March 2004 the Central EWS survey aircraft altered its survey effort to respond to a public report of a "possible" entangled right whale. The survey team verified the sighting as an entangled right whale (3348) and alerted the proper disentanglement first responders for the area. The survey aircraft stayed on scene and worked in coordination with disentanglement team members to attach a telemetry buoy to the whale.

Strandings

On the morning of 3 February 2004 a live right whale calf stranded on Amelia Island, FL. During this event two survey aircraft (NEA and FMRI) covered the Central EWS survey area multiple times in an effort to locate the stranded whale's mother. Through the identity of the calf's mother was unknown the survey effort concentrated on locating a "possible" mother. The stranded calf's mother is still unknown but may be determined at a later date by the genetic samples that were obtained.

Unusual Events

During the 2004 Central EWS season, two unique events occurred that had not been previously documented in the calving grounds. Documentation of right whales entering and traveling up rivers is rarely known to occur in this species. On two occasions during the season the Central EWS survey team identified, documented and reported the presence of right whales in the St Johns River. The survey team verified the first report on 21 January 2004 and the second on 25 January 2004. In both cases the whales entered and swam beyond the breakwater of the St Johns River. During both instances the survey aircraft stayed on scene until stand-by law enforcement vessels arrived. Both right whales have been identified (3308 and 3302) as yearlings that were first documented in the Southeast with their mothers in 2003.

Discussion

The critical habitat of the coastal waters of the southeastern United States is currently the only known calving ground for the Northern Right Whale. For the past 10 years there has been extensive survey effort in the calving ground in the form of Early Warning System surveys (EWS). Originally, the EWS surveys were designed to reduce the potential for ship strikes in the calving ground. However, over the past 10 years, the EWS surveys have proven to be more than a conservation tool to reduce the threat of ship strikes. In addition to the main objective of the EWS, these surveys have contributed hundreds of photo documented right whale sightings. These data play a critical role in the understanding of right whale habitat, distribution, associations and reproduction.

Identification of all the right whales photographed in the southeast in 2004 is currently underway. Currently 16 M/C pairs have been documented in 2004 (data from Center for Coastal Studies, Florida Marine Research Institute, New England Aquarium and Wildlife Trust aerial survey effort and data from Marine Resources Council, Southeast Fisheries Science Center, Virginia Institute of Marine Science and the Volunteer Sighting Network). At least 15 of these M/C pairs are known to have been in the calving ground during the 2004 season. This season also produced the fourth known documentation of a two-year calving interval. One right whale cow that gave birth in 2002 but lost her calf returned to the southeast calving grounds in 2004 with a new calf.

Of the 15 M/C pairs known to be in the southeast calving ground during the 2004 season, nine (60%) of them had previously calved in 2001. The Central EWS team documented 13 (86%) of the known M/C pairs in the southeast, eight (62%) of which had previously calved in 2001. The mean calving interval using preliminary, contributed data for all known M/C pairs (15 plus one not documented in the southeast) in 2004 is 3.58 years. This indicates an improvement in reproductive rates when compared to the average calving intervals documented in the late 1990's. The mean calving interval for this population between 1993-1998 was over 5 years and had increased from 3.67 between 1980-1998 (Kraus et al., 2001).

Data collected during the season allows for a better understanding of how the critical habitat in the southeast is being utilized by the population. Though it appears that mothers and their calves primarily use the area throughout the entire winter, the presence of non-cow/calf pairs (69 sightings) suggest that the critical habitat is also extremely important for a diverse group of whales in the population. The apparent large number of juveniles, and adult females with their yearlings, suggest that the calving ground is sometimes an important winter habitat for some male and non-reproductive female right whales. Currently underway is the analysis of the unknown whales documented in 2004. With further analysis and the confirmed identifications of the whales, a clearer understanding of the use and importance of the southeast critical habitat can be achieved.

The teamwork of many agencies and interests is essential to the effectiveness of these surveys in mitigating collisions with right whales. The ability of the survey team to alert FACSFACJAX, Naval Air Station, Jacksonville from as far as 32 nm from shore is

the crucial catalyst to this network. This allows FACSFACJAX the ability to acknowledge the right whale sightings data from the survey team and initiate many notifications via pagers and the NAVTEX system. The U. S. Coast Guard (USCG) Office of Aids to Navigation in Miami transmits the NAVTEX notification. The USCG also transmits Notice to Mariners over VHF marine-band radio. In addition, NOAA Fisheries updates the Mandatory Ship Reporting (MSR) system. Simultaneously, the Harbor Pilot Associations at the ports of Jacksonville, Fernandina and Brunswick monitor pagers for updated information transmitted and relay this information to ships being piloted to/from their respective ports. This transmission of near-real time data, which propels a chain reaction of alerts and notifications along the coastline of the southeastern United States, is what distinguishes these aerial surveys as a meaningful conservation tool. However, on numerous occasions during the 2004 season all survey aircraft were unable to make direct contact with FACSFACJAX via aviation radios for reasons that are unknown. This led to the installation of a satellite phone to improve communication. Due to the newly implemented Part 135 certification for survey aircraft, an external antenna for the phone could not be installed. Therefore, communications were frequently not possible with FACSFACJAX and team ground contacts, and right whale sightings went unreported for as long as one hour after the sighting had occurred. Communication is a key factor in the implementation and effectiveness of the EWS surveys. These communication problems need to be recognized and resolved for the EWS surveys to continue to serve as a conservation tool for right whales in the southeast United States.

In some cases the EWS surveys have proven to be an effective tool in the prevention of ship strikes in the calving ground. However, the EWS surveys still face limitations in their ability to prevent ship strikes on a constant basis. Limited to daylight hours these surveys are also limited by reduced visibility and weather too severe for survey aircraft to be launched. In addition, telemetry data (Slay *et al*., 1997) indicate that the EWS surveys may locate only 50% of the right whales in the area when conditions are favorable.

For comprehensive protection of right whales in the calving ground, a vessel alerting system that is not based on the ability of a survey team to visually locate, on a daily basis, the presence of all right whales in the area is needed. Aerial surveys should be recognized as a tool for collecting data on the distribution and occurrence of right whales but not as a system that can consistently prevent ship strikes over an extended period of time. The communication of right whale sightings from the EWS surveys to the shipping community has likely reduced the potential for ship strikes. It also provides continuing education and awareness to mariners, but it is not an infallible plan to eliminate the potential for ships to kill right whales in the southeast United States.

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FACSFAC JAX, Naval Air Station Jacksonville went to great lengths to keep the system running efficiently. Lt Josh Russell and Kenneth Conley of Naval Air Station Jacksonville were always available for support. The U.S. Coast Guard displayed a great willingness to help with the effort, as did the U.S. Army Corps of Engineers, South Atlantic Division and the U.S. Navy. On more than one occasion during the 2004 season the cooperation of the St. Johns Bar pilots and the Cumberland Sound pilots was invaluable. The assistance of Wayne McFee of the National Ocean Service, and Barb Zoodsma of NOAA Fisheries was greatly appreciated through out the course of the season.

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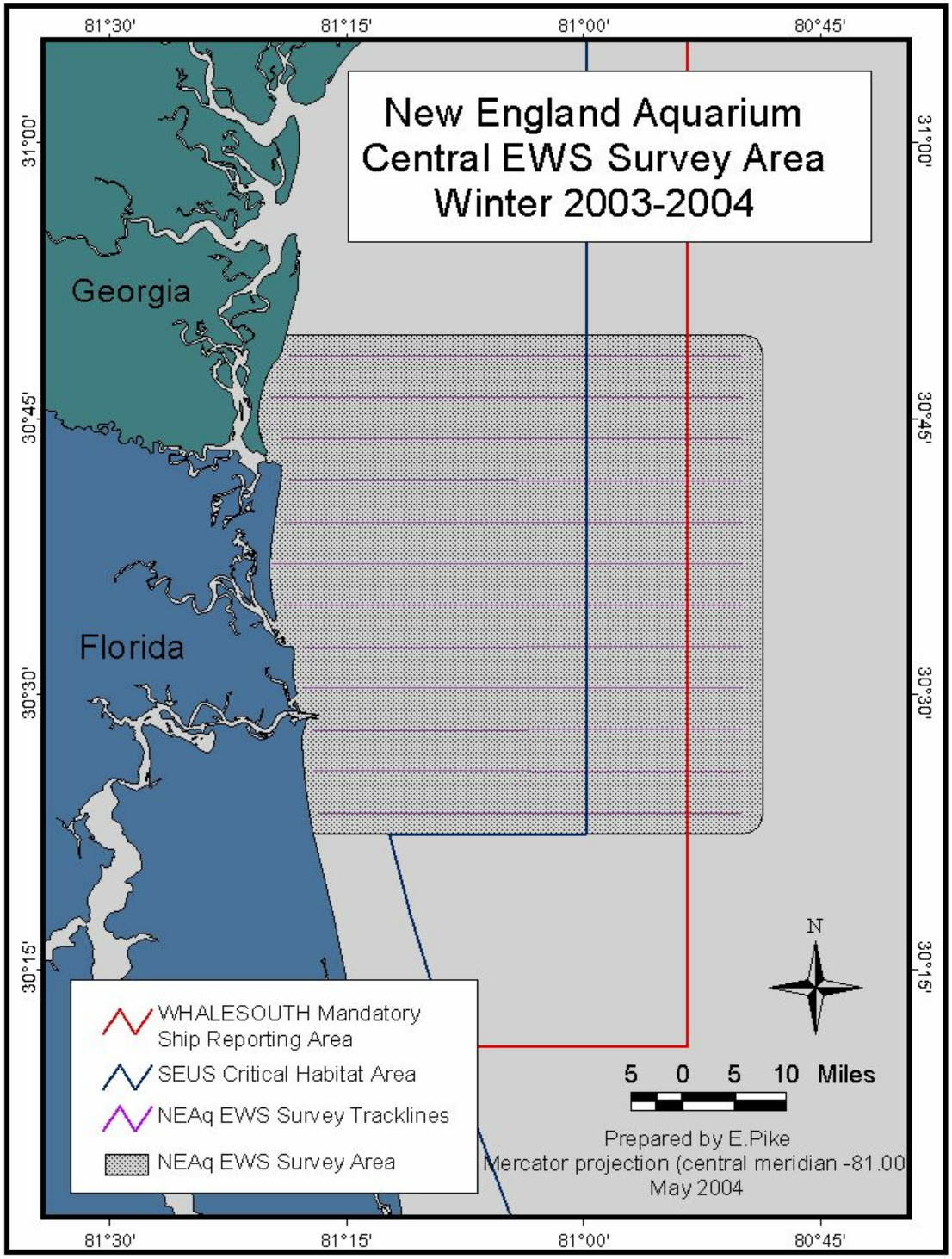
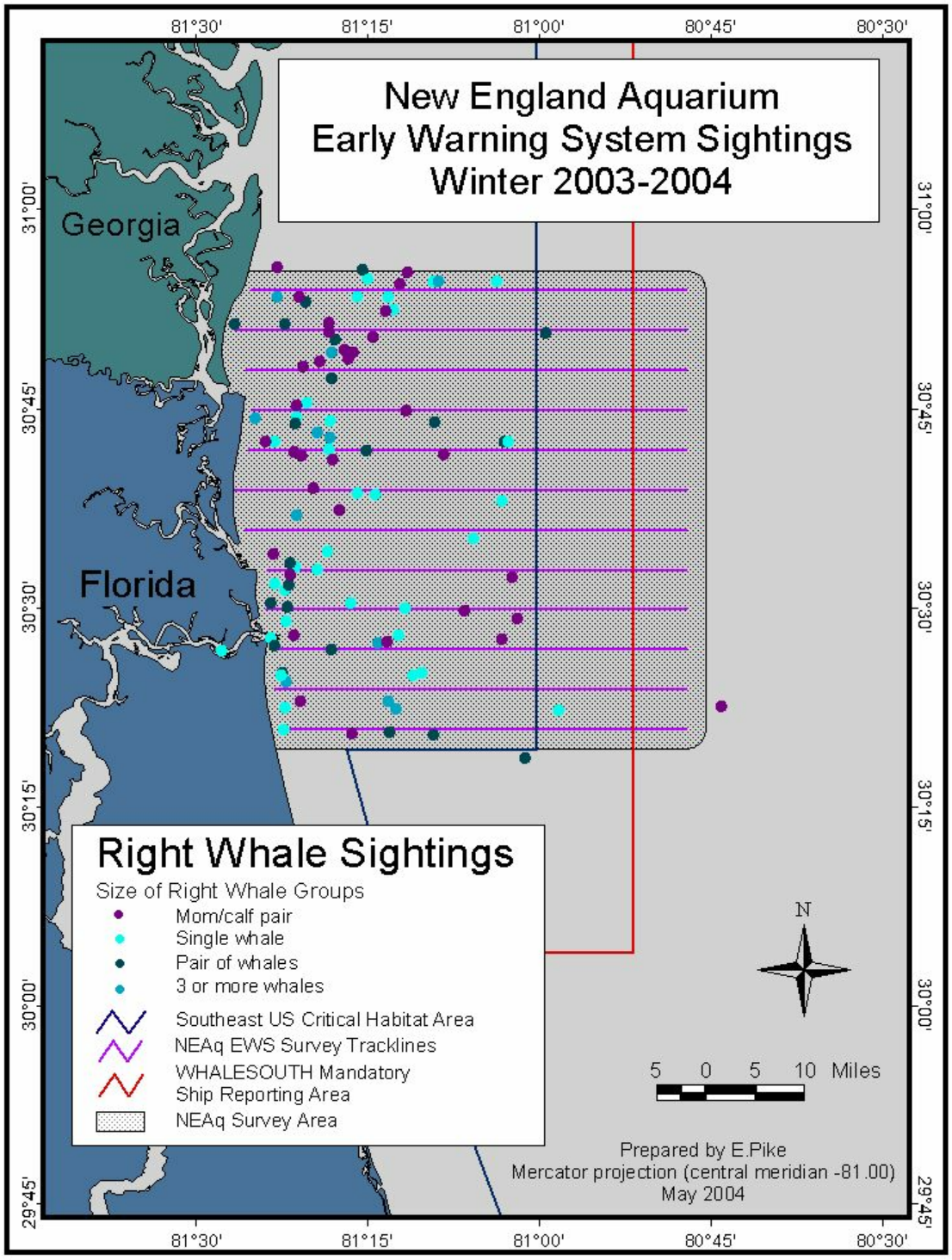
With extreme gratitude we thank the EWS pilots Ron Salmon, and Robert Murphy and co-pilots Mike Murphy and Abram Karl of Environmental Aviation Services for their dedication and many long hours. Also, Ed Coffman of Orion Aviation for the use of his aircraft and willingness to accommodate our ongoing effort.

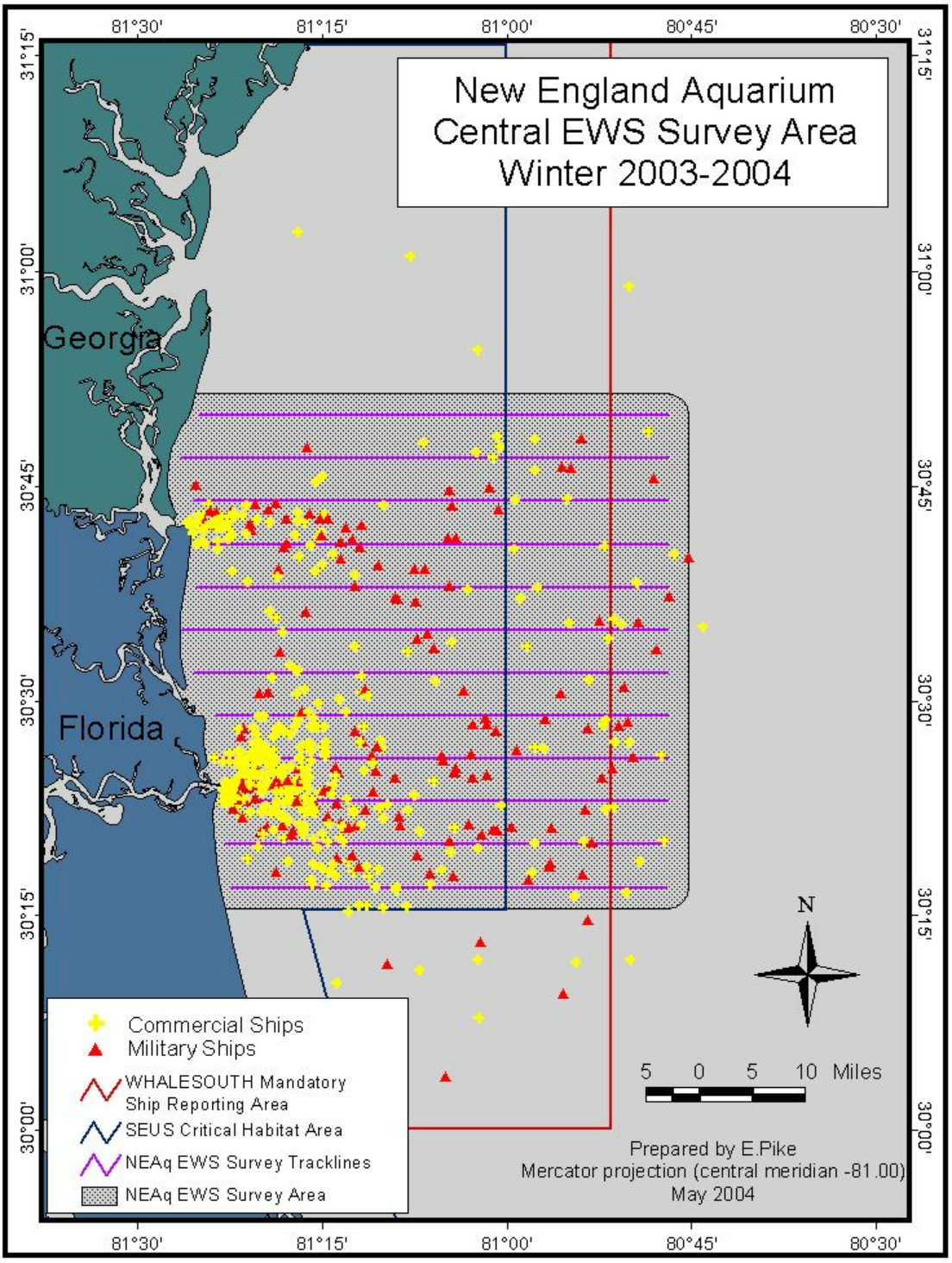
Appendix 1


New England Aquarium
Central EWS Survey Area
Winter 2003-2004
Georgia
Florida
81°30'
81°15'
81°00'
80°45'
31°00'
30°45'
30°30'
30°15'
N
5 0 5 10 Miles
WHALESOUTH Mandatory Ship Reporting Area
SEUS Critical Habitat Area
NEAq EWS Survey Tracklines
NEAq EWS Survey Area
Prepared by E.Pike
Mercator projection (central meridian -81.00
May 2004

Appendix 2


New England Aquarium
Early Warning System Sightings
Winter 2003-2004
Georgia
Florida
81°30'
81°15'
81°00'
80°45'
80°30'
31°00'
30°45'
30°30'
30°15'
30°00'
29°45'
Right Whale Sightings
Size of Right Whale Groups
Mom/calf pair
Single whale
Pair of whales
3 or more whales
Southeast US Critical Habitat Area
NEAq EWS Survey Tracklines
WHALESOUTH Mandatory
Ship Reporting Area
NEAq Survey Area
N
5 0 5 10 Miles
Prepared by E.Pike
Mercator projection (central meridian -81.00)
May 2004

Appendix 3


New England Aquarium
Central EWS Survey Area
Winter 2003-2004
81°30'
81°15'
81°00'
80°45'
80°30'
31°15'
31°00'
30°45'
30°30'
30°15'
30°00'
Georgia
Florida
N
5 0 5 10 Miles
Commercial Ships
Military Ships
WHALESOUTH Mandatory Ship Reporting Area
SEUS Critical Habitat Area
NEAq EWS Survey Tracklines
NEAq EWS Survey Area
Prepared by E.Pike
Mercator projection (central meridian -81.00)
May 2004

Appendix 4

Year	Month	Day	Time	Latitude	Longitude	EGNO	Association Type	Behavior
2003	12	9	0947	30.770	-81.293	1321 1123	other	
2003	12	9	1234	30.722	-81.3	1123 1321	other	
2003	12	15	1107	30.673	-81.35	1321	alone	W/BODO
2003	12	15	1114	30.665	-81.353	1301 3301	other	
2003	12	15	1552	30.642	-81.382	CT13	alone	W/BODO
2003	12	16	0914	30.817	-81.337	BK10 2660	other	W/BODO W/BODO
2003	12	16	1005	30.792	-81.303	1705	M/C	
2003	12	16	1304	30.632	-81.248	1817 3317	other	
2003	12	16	1437	30.435	-81.363	CT14	alone	
2003	12	21	1036	30.692	-81.335	1509	M/C	
2003	12	23	1246	30.465	-81.382	1701	alone	
2003	12	23	1336	30.342	-81.365	3123 BK08 2427	SAG	SAG, ROLL, BOD CNT SAG SAG, ROLL, BOD CNT
2003	12	23	1456	30.352	-81.372	3123	alone	
2003	12	24	1450	30.457	-81.368	2503	alone	
2003	12	28	0959	30.668	-81.302	3123	alone	BRCH, MOPN, W/BODO
2003	12	29	1441	30.348	-81.373	1321	alone	W/BODO
2003	12	30	1337	30.392	-81.218	1321	M/C	
2003	12	30	1438	30.463	-81.218	CT12 BK11	SAG	SAG, ROLL, W/BODO SAG, ROLL, W/BODO
2003	12	30	1452	30.485	-81.353	CT15	alone	W/BODO
2004	1	1	0913	30.773	-81.24	1705	M/C	
2004	1	1	1012	30.633	-81.306	2660	alone	W/BODO
2004	1	1	1251	30.504	-81.306	CT12	alone	W/BODO
2004	1	1	1301	30.482	-81.32	BK08	alone	BRCH
2004	1	3	0944	30.847	-81.247	2660	alone	W/BODO
2004	1	3	1036	30.823	-81.262	2660	alone	W/BODO
2004	1	4	1133	30.857	-81.255	2710 1611	other	
2004	1	4	1216	30.753	-81.3	CT11 3308 BK11 BK08 CT12 3139	SAG	SAG SAG SAG SAG SAG SAG
2004	1	5	0912	30.823	-81.378	CT16 BK08 3308 BK11 CT15	other	
2004	1	8	1029	30.654	-81.321	BK09 CT11 3139 CT18	SAG	SAG, W/BODO SAG, W/BODO SAG, W/BODO SAG, W/BODO

Appendix 4

Year	Month	Day	Time	Latitude	Longitude	EGNO	Association Type	Behavior
2004	1	9	1152	30.490	-81.36	BK09 CT17 BK11 CT18	other	
2004	1	12	1113	30.585	-81.327	1701	M/C	
2004	1	14	1155	30.316	-81.359	1705	M/C	NURS
2004	1	14	1406	30.306	-81.205	CT15 CT18 CT19	other	
2004	1	14	1450	30.316	-81.218	CT11 CT15 CT18	SAG	SAG, BEL/BEL, ROLL SAG, BEL/BEL, ROLL SAG
2004	1	14	1518	30.280	-81.37	3308	alone	
2004	1	14	1520	30.308	-81.368	*	alone	
2004	1	15	1307	30.395	-81.052	1266	M/C	
2004	1	17	0929	30.840	-81.2	1701	M/C	W/BODO
2004	1	17	1105	30.630	-81.355	2145	M/C	
2004	1	17	1123	30.647	-81.36	CT10 CT11 CT12 CT18	SAG	SAG SAG, BEL/BEL SAG, BEL/BEL SAG, BEL/BEL
2004	1	20	1135	30.490	-81.36	3139 BK09	other	
2004	1	21	0957	30.743	-81.317	1705	M/C	
2004	1	21	1038	30.380	-81.46	3308	alone	
2004	1	21	1225	30.440	-81.388	CT10 BK08	SAG	SAG, ROLL, BOD CNT SAG, ROLL, BOD CNT
2004	1	21	1252	30.400	-81.355	1812	M/C	
2004	1	22	1041	30.317	-81.345	1812	M/C	
2004	1	22	1215	30.757	-81.282	1701	M/C	
2004	1	22	1404	30.753	-81.268	1701	M/C	NURS
2004	1	22	1421	30.747	-81.275	1701	M/C	
2004	1	22	1504	30.620	-81.298	1705	other	
2004	1	24	1324	30.430	-81.107	1266	M/C	
2004	1	25	0919	30.737	-81.342	1701	M/C	
2004	1	25	1307	30.502	-81.385	1705	M/C	W/BODO
2004	1	25	1419	30.397	-81.388	3302	alone	
2004	1	30	0935	30.855	-81.188	1701	M/C	
2004	1	30	1016	30.790	-81.367	3346 3317	other	
2004	1	30	1458	30.277	-81.27	1321	M/C	MOPN
2004	2	3	1332	30.807	-81.21	BK08	alone	
2004	2	5	1414	30.557	-81.288	1812	M/C	
2004	2	10	1114	30.642	-81.397	1701	M/C	W/BODO
2004	2	10	1439	30.440	-81.272	1321	M/C	
2004	2	18	1437	30.433	-81.193	1142	M/C	

Appendix 4

Year	Month	Day	Time	Latitude	Longitude	EGNO	Association Type	Behavior
2004	2	19	1035	30.667	-81.15	2660 1611	other	
2004	2	19	1200	30.578	-81.262	2614	alone	
2004	2	19	1353	30.400	-81.202	*	alone	W/BODO
2004	2	20	1109	30.688	-81.35	2145	M/C	
2004	2	20	1508	30.275	-81.152	CT09 CT17	SAG	SAG, W/BODO, BOD CNT SAG, W/BODO, BOD CNT
2004	2	21	1357	30.390	-81.232	3351 BK02 BK06	SAG	SAG, ROLL, W/BODO SAG, ROLL, W/BODO SAG, ROLL, W/BODO, DFCN
2004	2	22	1136	30.550	-81.35	3351 BK02 BK06	SAG	SAG, ROLL, BOD CNT SAG, ROLL, BOD CNT SAG, ROLL, BOD CNT
2004	2	23	1406	30.672	-81.412	3351 BK02 BK06	other	
2004	2	23	1617	30.387	-81.383	2660 1611	other	
2004	3	1	1423	30.245	-81.018	BK02 BK06	other	
2004	3	2	0943	30.778	-80.988	BK05 CT21	other	
2004	3	2	1058	30.625	-81.343	1701	M/C	W/BODO
2004	3	3	1424	30.278	-81.215	BK02 BK04	other	
2004	3	4	1221	30.577	-81.235	1281	alone	
2004	3	5	1135	30.522	-81.093	1281	alone	
2004	3	5	1413	30.348	-81.182	3351	alone	
2004	3	6	0848	30.823	-81.217	CT20	alone	MOPN
2004	3	6	1032	30.642	-81.048	CT08 BK04	other	ROLL
2004	3	6	1045	30.642	-81.042	3302	alone	
2004	3	7	1133	30.310	-80.065	1509	M/C	
2004	3	7	1310	30.472	-81.037	1123	M/C	
2004	3	7	1456	30.568	-81.052	1911	alone	
2004	3	8	1049	30.352	-81.168	1911	alone	
2004	3	9	0935	30.417	-81.365	CT07	alone	W/BODO
2004	3	9	1113	30.682	-81.19	1281	M/C	NURS
2004	3	9	1429	30.627	-81.137	1281	M/C	DFCN
2004	3	11	1438	30.305	-80.967	BK03	alone	
2004	3	12	937	30.843	-81.143	3351 CT04 CT06		
2004	3	12	958	30.843	-81.152	3302	alone	
2004	3	13	0920	30.843	-81.058	CT03	alone	
2004	3	14	1003	30.805	-81.22	1281	M/C	
2004	3	15	1019	30.823	-81.347	2614	M/C	W/BODO
2004	3	15	1104	30.780	-81.303	2330	M/C	
2004	3	15	1503	30.382	-81.3	CT01 CT04	other	W/BODO, BRCH, LBTL, ROLL W/BODO, BRCH, LBTL, ROLL

Appendix 4

Year	Month	Day	Time	Latitude	Longitude	EGNO	Association Type	Behavior
2004	3	15	1658	30.860	-81.378	2614	M/C	
2004	3	17	1121	29.840	-81.222	3346	alone	ENTGL
2004	3	18	1024	30.420	-81.028	1911	M/C	
2004	3	25	0948	30.790	-81.442	1611 2660	other	

* id is currently unknown