

## Executive Summary

Right whales were present in the Cape Cod Bay Critical Habitat area and in state waters west of the critical habitat and along the outer coast of Cape Cod between Chatham and Race Point for 134 days from 19 December 2000 to 1 May 2001. There were a total of 545 sightings of right whales of which 452 were photographed during 32 aerial survey days and 33 vessel trips. All sightings were reported upon completion of each survey to the National Marine Fisheries Service Sighting Advisory System. These aerial and vessel surveys are the principle source of right whale sightings for the NMFA/SAS in the winter months for waters in the northeast north of latitude 41°N.

A total of 87 right whales were seen in Cape Cod Bay and adjacent waters. Of these 75 were matched an individual in the Right Whale photo-identification catalogue. The 12 whales not in the catalogue included seven calves that migrated from the southeast US calving ground with their mothers, three whales that are new to the catalog and two whales that were seen several times but not matched yet.

The highlight of the season was the observation of seven mother calf pairs, the first year since 1997 that calves have taken up residency in Cape Cod Bay. The first mother calf pair was recorded on 26 March, 47 days after their last sighting in the southeast US calving ground. The last mother calf pairs were seen 29 March. Mothers and calves were resident in Cape Cod Bay for 34 days. The mean maximum transit time between the calving ground in the southeast US and Cape Cod Bay for the seven mothers with calves was  $40 \pm 5$  days. There was an eighth mother identified, she was seen in Florida with a calf, but no calf was recorded during all three sightings over 17 days in Cape Cod Bay, she has likely lost her calf. Of the 31 mothers identified in all areas in 2001, 18 mothers have been seen at least once in Cape Cod Bay over the last twenty years and 11 (61%) of those were seen in Cape Cod Bay in 2000. This indicates, assuming a 12 to 13 month gestation, that a portion of this year's mothers were feeding in Cape Cod in the early part of their gestation in 2000.

The season of occurrence of right whales in Cape Cod Bay is generally considered to extend from early January through mid-May based on data collected between 1984 and 1991. However, during two pre-season surveys flown on 13 December 1998 and 19 December 2000, right whales were recorded in the critical habitat. Over the last four years right whale sightings have been few in number after the end of April. These data indicate the seasonal residency of right whales, for at least the last four years, is December to the end of April. There are now sufficient data to reevaluate the dates gear restrictions are required in the critical habitat to assess if they reflect current presence of right whales.

In 2001, there were nine sightings of a total of 32 identified right whales in nearby adjacent waters outside the critical habitat area. These whales were seen in state waters west of the critical habitat along the Manomet and Plymouth shore and east of the outer Cape from Chatham to Race Point. The records extralimital to the critical habitat represented the only sighting of three right whales and the last sighting of 12 animals. The other 17 whales were seen in the critical habitat area before and after the extralimital record. These data indicate that the present boundaries of the critical habitat may need to be reevaluated to assess if they reflect the recent distribution and movements of right whales. The present boundaries were based on historical data collected prior to 1991; expanded survey efforts over the last four years have been more effective at covering the periphery of the critical habitat.

Cape Cod Bay has long been known as an important winter and spring feeding ground. Since 1980, 72% of the cataloged right whales have been seen in Cape Cod and Massachusetts Bays. Over just the last four years of this program, 51% (n=153) of the catalogued population in the western North Atlantic have been recorded in the winter and spring in Cape Cod Bay and adjacent waters.

### **Acknowledgments**

We are most grateful to all of our dedicated colleagues who spent the winter and spring in planes and on boats in Cape Cod Bay to make this work possible. Aerial observers included Ginny Eaton (CCS intern), Bill Hoffman (DMF), Brian Kelly (DMF), Jeremy King (DMF), Dan McKiernan (DMF). Thanks to Peter Hanlon (MEP) who contributed photographs of right whales from the USCG helicopter. Thank you to Amy Knowlton and Philip Hamilton at the New England Aquarium for confirming matches of right whales to the NEAq catalogue. Special appreciation is extended to Chandler Lofland, Jack O'Brien and John Ambroult who kept our plane flying smoothly all season. We would also like to extend our thanks to Captain Russell Webster of the USCG, Group Woods Hole, for providing us with a pre- and post-flight call-in service to make sure we landed safely and on hard ground. Special thanks to Ed Lyman, John Woods and Marc Costa who kept all the boats shipshape under winter conditions. John Woods and Ed Lyman deserve an extra thank you for a nighttime cruise to deploy acoustic monitoring equipment in the Bay.

Oceanographic sampling and photo-identification efforts aboard R/V *Shearwater* were carried out skillfully by Stormy Mayo, Ed Lyman, Amy DeLorenzo, and Moriah Bessinger (CCS intern) under a myriad of weather conditions from snow to brilliant sunshine. We would also like to thank Jon Alberts (WHOI), David Mattila (CCS) and David Morin (CCS) for captaining the R/V *Gannet* for biopsy darting and photo identification, and Beth Pike (NEAq) for help with data collection. Thank you to Jooke Robbins and David Mattila who took time out of a humpback cruise to obtain photographs and a biopsy sample of a right whale mother and calf. Many thanks to Peter Borrelli, John Shea, Jan Young and Charlie Westcott for keeping everything running smoothly on the administrative end of the project. A special thanks to Jennifer Beaudin Ring, and her assistant Noah, for proofing sighting data, preparation of the figures for this report and stimulating discussions on Cape Cod Bay right whales.

The vessel and aerial surveys were conducted under a Scientific Permit to Take Marine Mammals No. 633-1483-01 issued by the NMFS to Dr. Charles Mayo. This permit is valid until 31 March 2004. A report of our research activities for 2001 will be submitted to the NMFS permitting office. The data collected on this project are archived at CCS, NEAq and URI. A contract from the Massachusetts Division of Marine Fisheries and a grant from the Massachusetts Environmental Trust supported this work. The habitat portion of the program was supported by a grant to Dr. Mayo from the Massachusetts Environmental Trust.

**Abbreviations used in the text:** **ESA** – Endangered Species Act; **DMF** - Massachusetts Division of Marine Fisheries; **CCS** - Center for Coastal Studies; **NEAq** - New England Aquarium; **URI** - University of Rhode Island; **USCG** - United States Coast Guard; **MEP** – Massachusetts Environmental Police, **MET** – Massachusetts Environmental Trust, **NM** - nautical mile, **NMFS** - National Marine Fisheries Service; **NEFSC** - Northeast Fisheries Science Center; **NERO** - Northeast Regional Office; **SAS** - Sighting Advisory System, NMFS; **WHOI** - Woods Hole Oceanographic Institution, **SE** – standard error.

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## Introduction

Despite international protection from commercial hunting since 1937, the North Atlantic right whale, *Eubalaena glacialis*, is one of the rarest large whales in the world. No more than 350 remain (CeTAP 1982, Brownell *et al.* 1986, Kraus *et al.* 1988, NMFS 1991, Knowlton *et al.* 1994). The northern right whale is listed as "endangered" under the Endangered Species Act (ESA) of 1972. Scientists and conservationists have long been concerned about the status of the North Atlantic right whale population and its slow rate of growth (about 2.5% per year in the 1980s, Knowlton *et al.* 1994). Recent analyses showing a decrease in the reproductive rate, an increase in the calving interval (Kraus *et al.* 2001), and a decline in the survival rate (Caswell *et al.* 1999) suggest we should view the present situation in the 1990s with greater concern.

The apparent failure of this population to recover has been attributed to a variety of factors including mortality from collisions with ships and entanglements in fixed fishing gear (Kraus 1990, Kenney and Kraus 1993, Knowlton and Kraus 2001). There have been 45 right whale deaths reliably documented since 1970. Of those 45, 16 right whale fatalities were due to ship strikes, and three were the result of entanglement in fixed fishing gear, 13 were of natural causes (calf mortalities) and 13 of unknown cause (Knowlton and Kraus 2001). Ship collisions kill more right whales than any other documented causes of mortality and one half of the ship collision mortalities have been recorded in the 1990s. Caswell *et al.* (1999) estimate that if human related mortality is not reduced this population could become extinct in less than 200 years.

Right whales are known to occur in Cape Cod Bay, Massachusetts, and adjacent waters\* in all months of the year, with the peak of occurrence from February through April (Schevill *et al.* 1986, Winn *et al.* 1986, Hamilton and Mayo 1990, Payne *et al.* 1990, Brown 1994). Expanded surveillance and monitoring efforts over the last four years have demonstrated that Cape Cod Bay is an important winter and spring feeding and socializing area from December to May (Brown and Marx 1998, 1999, 2000).

The Cape Cod Bay ecosystem is one of five known seasonal high-use habitat areas for this species in the western North Atlantic. Cape Cod Bay was federally designated a Critical Habitat for the North Atlantic right whale in 1994 (Federal Register 59 [FR](#) 28793, [Figure 1](#)). This is in recognition of its seasonal importance as an area for feeding, socializing and as a nursery area for cows and calves (Kraus and Kenney 1991), including a number of cows that are rarely seen in the other three northern habitat areas (Knowlton *et al.* 1992, Brown 1994). Cape Cod Bay has a long history as an important habitat area for right whales. Photographic identifications date from 1959 (Hamilton *et al.*, 1997) to the present, however, whaling records provide evidence of right whales in this area from at least the early 1600s.

Right whales are slow moving (particularly when accompanied by a calf), difficult to see when feeding at or just below the surface, and do not always avoid approaching vessels, especially when socializing or feeding near the surface. These factors, set against the moderate level of ship traffic in the region, make the right whale vulnerable to collisions with vessels in Massachusetts waters. Knowlton and Kraus (2001) documented two right whales that have likely been killed by collisions with ships near this area, one in 1986 (found off Provincetown), the second in 1996 (found near Wellfleet). A third right whale was found dead in Cape Cod Bay in April 1999. A necropsy was performed and the cause of death was blunt trauma, likely the result of a collision with a ship (Brown and Marx 1999). This number of mortalities, however, is the minimum count because not all

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\* Adjacent waters includes the federal waters of the Cape Cod Bay Critical Habitat and those waters over- and adjacent to-Stellwagen Bank in Massachusetts Bay (e.g. Stellwagen Basin), as well as waters east of Cape Cod.

carcasses are found and recovered.

Right whales are also at risk of entanglement in fixed fishing gear in the area. Some fishing activity is either prohibited (gill nets) or use of modified gear is required in the Cape Cod Bay Critical Habitat area. These modifications include sinking ground line between lobster pots, at least two pots per vertical line, twin orange flag markers on buoy stick and a 500lb break away link at the buoy (322 CMR 12.05 Critical Habitat gear restrictions during January 1 to May 15). Most of the fixed fishing gear in the Cape Cod Critical Habitat area is located in the northern margins along tracklines one, two and three (Table 1, Figure 1) in depths greater than 30 fathoms. There is fixed fishing gear set to the west of the western margin of the Critical Habitat in state waters, that is not subject to the above gear restrictions because it is outside the critical habitat area. A few right whales have been reported west of the critical habitat area in the past (Figure 12 and Brown and Marx 1998, 1999).

Over the last twenty years, 72% of the cataloged population of right whales have been photo-documented in Cape Cod and Massachusetts Bays at some time during their lives (CCS and NEAq, unpublished data). These photographic data have been collected during by various means. Recent survey efforts include twice weekly aerial surveillance flights and weekly vessel-based habitat studies annually from January to mid-May in 1998 to 2001 (Brown and Marx 1998, 1999, 2000 and this report). Prior to 1998, there were weekly vessel surveillance and limited aerial surveys in the winter and spring in 1997 (Hamilton *et al.* 1997, Mayo 1997) and annual studies on foraging of right whales in the winter and spring since 1984 (Mayo and Marx, 1990). Researchers gathered opportunistic sightings from whale watching vessels from April through October until 1996. The latter platform, which yielded many valuable sightings of right whales (including some rarely seen mothers with calves) in the late spring, summer and fall (NEAq unpublished data), and reports of entanglements, is no longer available due to a 500 yard exclusion zone around right whales for non-permitted vessels.

While the use of the Cape Cod Bay ecosystem by right whales has occurred for hundreds of years, human activities have only impacted the area relatively recently. In order to gain a better understanding of both the spatial and temporal distribution of individually identified right whales in Cape Cod Bay, an extensive surveillance and monitoring research program was undertaken in the winter and spring of 1998 (Brown and Marx 1998), 1999 (Brown and Marx 1999), 2000 (Brown and Marx 2000) and 2001 (this report). The Massachusetts Division of Marine Fisheries and the Massachusetts Environmental Trust support this effort. The research directly addresses concerns identified by the Right Whale Conservation Plan submitted by the Commonwealth of Massachusetts to federal courts in 1996, the Northeast Implementation Team; and supported goals in the federal Atlantic Large Whale Take Reduction Plan, the Right Whale Recovery Plan (NMFS 1991), and the ESA. The objectives of the 2001 surveillance, monitoring and management program were:

- I) To document the right whales in the Cape Cod Bay Right Whale Critical Habitat area and adjacent waters from January through mid-May, 2001, using photo-identification techniques to identify individual whales. These data provide information on the age, sex, reproduction, distribution, abundance and patterns of habitat use (residency) of right whales in Cape Cod Bay and help refine long-term, range-wide analyses on presumed mortality, incidence of scarring and demographics. Photographic and sighting data were integrated into the right whale photo-identification catalogue at the New England Aquarium and the sighting database at the University of Rhode Island.

- II) To provide sighting data to the National Marine Fisheries Sighting Advisory System. Sighting locations of right whales were reported promptly to NMFS/SAS at the completion of each survey. The goal was to ultimately reduce the probability that right whales will be killed by collisions with large vessels by providing near "real-time" sighting data within Massachusetts waters to port authorities, commercial and military vessels, and other maritime operations. The DMF/CCS program is the principle source of right whale sighting data from January through March.
- III) To monitor right whales in the study area for evidence of entanglement. Each right whale encountered was examined visually for any evidence of attached gear. The disentanglement team was on standby ready for immediate dispatch in the event an entangled whale was reported.
- IV) To describe the distribution and abundance of any other marine mammals and shipping activity in Cape Cod Bay and adjacent waters from January through mid-May, 2001.
- V) To collect oceanographic information on weekly vessel cruises, from January to mid-May, 2001, designed to develop an understanding of the characteristics of the habitat to which right whales respond. These oceanographic data, combined with data from past habitat studies in Cape Cod Bay by the Center for Coastal Studies, provide additional information on the conditions which are believed to cue the movements and activities of right whales in Cape Cod Bay and adjacent waters.

Here we report on the results of the research activities in 2001 as described above in objectives I through IV. All photographs of right whales collected during oceanographic sampling (objective V) have been incorporated with the analysis of aerial photographs and their identifications are included in this report. The data and results of the oceanographic sampling program (objective V) are contained in the report submitted to the Massachusetts Environmental Trust. (Mayo, C.A., A. DeLorenzo and E. Lyman. 2001b. Monitoring the Habitat of the North Atlantic Right Whale in Cape Cod Bay in 2001.)

## **Methods**

### **I) Aerial Surveys**

Aerial surveys were conducted from January through mid-May 2001 in the Cape Cod Bay Critical Habitat and adjacent waters (Figure 1, Table 1a, 1c, 1d). There was one pre-season survey on December 19, 2000. The aerial survey protocol for Cape Cod Bay, as described in Kraus *et al* (1997), was adopted with some modifications. Fifteen tracklines were flown latitudinally (east - west) at 1.5 nautical mile (nm) intervals from the mainland to the Cape Cod shoreline (Figure 1). An additional trackline, 25 nm in length, paralleled the outer coast of Cape Cod from east of Chatham to the eastern end of trackline one at a distance of about three nm from shore (Figure 1, trackline number 16). The east-west flight pattern in Cape Cod Bay was chosen for scientific and safety reasons. In these latitudes, winter aerial surveys are hampered by low sun angles in the early and late hours of a survey day and glare is a significant factor in sightability of marine mammals. On east-west tracklines, although glare was a factor in one of the forward quadrants, there was always a section of the survey swath that could be observed without being compromised by glare. It was also safer to have the aerial survey tracklines begin and end near land. A total of 320 nm of 'on-trackline' miles were flown during each completed survey (Tables 1a and 2). "On-trackline" miles are those miles flown while surveying due east or due west in Cape Cod Bay and along the outer coast of Cape Cod, but excludes all miles flown between tracklines (cross legs) or while circling.

The surveys were flown under VFR (visual flight rules) conditions up to and including Beaufort sea state four. Surveys were aborted in Beaufort sea state five and/or when visibility decreased below two miles in fog, rain or snow. All aerial surveys originated at Chatham Airport, Chatham, MA. They were conducted in a Cessna 337 Skymaster (5382S), a twin engine, high-wing aircraft with retractable landing gear. The aircraft was equipped with two GPS (global positioning system) navigation systems, full IFR (instrument flight rules) instrumentation, marine VHF radio with external antenna, and wing-tip mounted VHF tracking antennas. Safety equipment included a life raft, four survival suits, signal flares, a medical kit, a waterproof VHF radio, a portable EPIRB, and an aircraft mounted ELT (emergency locator transmitter). All occupants wore aircraft approved PFDs (personal floatation device) during the entire flight.

Surveys were conducted at a standard altitude of 750 feet (229 meters) and a ground speed of approximately 100 knots, using methodology developed by CeTAP (Scott and Gilbert 1982, CeTAP 1982). The survey team consisted of a pilot, data recorder, and two observers positioned on each side of the aircraft in the rear seats. The two rear seat observers scanned the water surface from 0° - 90°, out to at least two nautical miles and reported sightings when they were abeam of the aircraft. In order to maintain a standardized sighting effort, the pilot and data recorder were instructed not to alert the observers to any sightings of marine mammals until after it had been passed by the aircraft and clearly missed by the observers. The turn at the end of each trackline was initiated and completed about 1.5 nm from shore in Cape Cod Bay to maximize the opportunity to observe any whales near shore.

For three surveys (8, 13 and 18 January), a different set of tracklines were used (Table 1b). These tracklines were set 2nm apart and the aircraft was flown at an altitude of 1000 feet (300 meters). This is similar to a change in aerial survey protocol used in flights over the southeast US calving ground and by NMFS in their Gulf of Maine surveys (C. Slay and T. Cole pers. comm respectively). In Cape Cod Bay, the total trackline distance decreased from 320 nm to 230 nm. These tracklines were tried to see if sightability of right whales would improve since at greater altitude, the surface of the water essentially moves by more slowly. We were also interested to determine if more time could be devoted to other adjacent water areas such as the vicinity of the Boston sewage outfall and south of Nantucket Island. Persons walking on the beach on the south side of Nantucket Island near the airport have reported sightings of right whales near shore in previous years.

All sightings of marine animals except birds were recorded. Sightings identified as species other than right whales were counted, logged and passed without breaking the trackline and circling in order to maximize flight time available for investigating right whale sightings. Sightings of all vessels in the area were recorded by location and type. At sightings identified as right whales, as well as sightings of large whales, which were not immediately identified by species, the aircraft broke track at right angles to the sighting and circled over the animal to obtain photographs. Photographs were obtained of as many individual right whales within a given aggregation as possible. For each right whale, behavior and interaction with other whales or any nearby vessels or fishing gear was noted. In a few instances, when right whales were spotted from the plane in close vicinity to R/V *Shearwater*, the vessel was contacted from the plane and photographs were taken from the vessel so that the plane could devote more time to surveying. The right angle distance of each sighting from the flight track was determined from GPS positions.

At the conclusion of photographic work at each sighting, the aircraft returned to the trackline at the point of departure using the GPS position recorded in the log. These methods conform to research protocols followed by the North Atlantic Right Whale Consortium (CCS, NEAq, URI, and



WHOI) and approved by the US NMFS. Trackline and sighting data from the daily logs were entered into the Right Whale Initiative DBase program designed for compatibility with the Right Whale Consortium database. Copies of the daily logs from the aerial surveys are on file at CCS and URI.

## II) Vessel Surveys

CCS maintains two research vessels: the 40' (12m) twin diesel engine R/V *Shearwater* and the 28' (8.5m) twin outboard engine R/V *Gannet*. The R/V *Shearwater* has been used successfully for oceanographic sampling and photo-identification in the winter and spring surveillance program in Cape Cod Bay, 1997 - 2000. The R/V *Gannet* was used for additional photo-identification, biopsy sampling and rapid response to entangled whales.

Dr. Charles 'Stormy' Mayo, associate scientist Ed Lyman, research assistant Amy DeLorenzo and intern Moriah Bessinger conducted the oceanographic sampling. (The collection and analysis of the oceanographic sampling was made possible by a three-year grant to Dr. Mayo from the Massachusetts Environmental Trust.) The R/V *Shearwater* is equipped with oceanographic sampling equipment including a CTD profiler (conductivity, temperature, depth), plankton nets, surface plankton pump, and flow meter. These oceanographic data will be used to develop an understanding of the characteristics of the habitat to which the right whales respond.

Although the primary objective of these vessel cruises was habitat sampling, some photographs were collected opportunistically of right whales in the vicinity of the boat during sampling and on transits to and from sampling sites. Photographs of right whales obtained during habitat studies were integrated with the photographs collected during aerial surveillance and included in this report in analyses of residency, capture rates, demographics, and life history. The vessel sighting data were included in the report to the NMFS/SAS system. Sighting data from the daily vessel logs were entered into the Right Whale Initiative DBase program as opportunistic surveys.

CCS is the only institution on the U.S. east coast with federal authorization from NMFS to perform disentanglements of large whales, and in 1996 the Center developed a Rapid Response Rescue Program with the US Coast Guard to enable disentanglement of whales at sea. In the event an entangled whale was seen during aerial surveys, CCS was contacted from the aircraft and the vessel dispatched immediately to assess the situation and proceed with disentanglement protocols. During vessel surveys in which the R/V *Shearwater* was used, the equipment required for response to a disentanglement was on board at all times.

Additional vessel trips were conducted using R/V *Gannet* to provide supplemental photo-identification and collect biopsy samples (see below). Photographic efforts were directed in particular toward calves whose callosity pattern is not sufficiently developed to obtain individual identifications from aerial photographs. Vessel based photography captures the more subtle distinguishing features such as lip ridges. Surveys on the R/V *Gannet* followed systematic north – south tracklines spaced at 4nm, were conducted at a speed of 12 knots, in sea conditions of sea state of Beaufort four or less and visibility of greater than two nm. The team consisted of three or four experienced right whale researchers. Positions included a helmsperson/data recorder and two observers on watch. Watch positions were rotated as required to reduce fatigue and exposure to cold. The two observers were positioned on the flybridge or at the bow and each one scanned the water surface out from the bow, to the port and starboard respectively, to a perpendicular distance of three nm. All sightings of marine animals (except birds) were counted and recorded. The location of each sighting was determined using a GPS navigation system. The vessel sighting data were included in

the report to the NMFS/SAS system. Sighting data from the daily vessel logs were entered into the Right Whale Initiative DBase program as dedicated shipboard surveys.

### **III) Notification of Agencies**

Prior to and following an aerial survey, both Group Woods Hole (US Coast Guard) and Air Station Cape Cod at Otis Air National Guard Base were notified of our planned survey, departure time, estimated return and a verbal summary of what was seen. Following the completion of each aerial survey, the number of right whales seen and the location of these sightings were reported to the NMFS Sighting Advisory System coordinator. The NMFS/SAS office disseminates this information by fax, Navtex, and marine weather radio to the appropriate agencies and mariners. Prior to reporting to the NMFS/SAS, any other whale research vessels operating in Cape Cod Bay and adjacent waters were contacted, additional sightings were added to the report if from an area not already included in the CCS report. A daily summary of the location and number of right whale sightings was faxed to DMF and to the NMFS/SAS coordinator in Woods Hole, MA.

### **IV) Photographic Methods**

#### **i) Identification Photographs**

During aerial and shipboard surveys, photographs were taken on Kodak Kodachrome 200ASA color slide film, using hand-held 35-mm cameras equipped with 300-mm telephoto lenses and motor drives. From the air, photographers attempted to obtain good perpendicular photographs of the entire rostral callosity pattern and back of every right whale encountered as well as any other scars or markings. From the boat, photographers attempted to collect good oblique photographs of both sides of the head and chin, the body and the flukes. The data recorder on both platforms was responsible for keeping a written record of the roll and frame numbers shot by each photographer in the daily log.

#### **ii) Photo-analysis and Matching**

Photographs of right whale callosity patterns are used as a basis for identification and cataloging of individuals, following methods developed by Payne *et al* (1983) and Kraus *et al* (1986). The cataloging of individually identified animals is based on using high quality photographs of distinctive callosity patterns (raised patches of roughened skin on the top and sides of the head), ventral pigmentation, lip ridges, and scars (Kraus *et al* 1986). NEAq has curated the catalogue since 1980 and to the best of their knowledge, all photographs of right whales taken in the North Atlantic since 1935 have been included in NEAq's files. This catalogue allows scientists to enumerate the population, and, from resightings of known individuals, to monitor the animals' reproductive status, births, deaths, scarring, distribution and migrations. Since 1980, a total of 22,247 sightings of 411 individual right whales have been archived, of which 301 are thought to be alive, as of December 2000 (A. Knowlton, NEAq, pers. comm.)

The matching process consists of separating photographs of right whales into individuals and inter-matching between days within the season. To match different sightings of the same whale, composite drawings and photographs of the callosity patterns of individual right whales are compared to a limited subset of the catalogue that includes animals with a similar appearance. For whales that look alike in the first sort, the original photographs of all probable matches are examined for callosity similarities and supplementary features, including scars, pigmentation, lip crenulations, and morphometric ratios. A match between different sightings is considered positive when the callosity pattern and at least one other feature can be independently matched by at least two experienced researchers (Kraus *et al* 1986). Exceptions to this multiple identifying feature requirement include whales that have unusual callosity patterns, large scars or birthmarks, or deformities so unique that matches from clear photographs can be based on only one feature.

Preliminary photo-analysis and inter-matching was carried out at CCS, with matches confirmed using original photographs cataloged and archived at NEAq.

### iii) Photographic Data Archiving

Upon completion of the matching process, all original slides were returned to CCS and incorporated into the CCS catalogue of identified right whales to update existing files, using the same numbering system as NEAq, in archival quality slide sheets. NEAq archives copies of photographs representing each sighting. Copies of photographs of individuals that are better than existing records, and photographs of newly identified whales, will be included in the NEAq master files as "type specimens" for future reference. The master files are maintained in fireproof safes at NEAq. All catalogue files are available for inspection and on-site use by contributors and collaborators.

## **V) Collection of Biopsy Samples**

Techniques for the collection of skin and blubber biopsy samples from individually identified right whales is well established (Brown *et al* 1991). All biopsy sampling efforts were carried out in conjunction with photo-identification efforts. Once adequate photographs for individual identification were obtained, the boat approached the whale for a biopsy attempt. A slow parallel approach, similar to that used to obtain identifying photographs, has been shown to cause minimal disturbance to the whale (Brown *et al* 1991). Cylindrical biopsy tips, made of stainless steel were used. They have a flared rim with a stop collar to prevent deep penetration. The stop collar also ensures rebound or release from the whale. Biopsy tips were attached to an arrow and sterilized prior to sampling to eliminate risk of infection. Right whales were darted at a range of about 5-15 meters (~15-50') using a crossbow with a draw weight of 68kg (150 lbs.). Arrows were retrieved through the use of floatation collars. Tissue samples were extracted from the dart using sterile forceps, the skin portion was diced and placed in a sterile, labeled tube, half filled with a preservative solution of saturated salt and 20% DMSO (dimethylsulfoxide).

Each right whale encountered on a particular day received a field identification number (e.g. "A" 30 Mar 01), which is used to identify the sample until the whale is matched to a specific individual in the right whale catalogue. Upon return to shore, samples were stored in a refrigerator until shipped to the laboratory at Trent University (Peterborough, Ontario) to be incorporated into ongoing genetic analyses. Occasionally, there was a portion of blubber attached to the skin biopsy. The blubber portion was separated from the skin with a scalpel and frozen in a glass vial. In 2001, these samples were sent to Jon Lien at Memorial University to be integrated with his ongoing studies on pregnancy determination.

## **VI) Data Management, Analysis, and Interpretation**

### i) Data Management

Aerial survey data and sighting data from vessel trips were transcribed from standardized field forms and recorded in computerized DBase files for each of the daily surveys in on-site computers. Copies of the daily logs and computerized data files have been sent to URI for entry into the Right Whale Consortium sighting database. Data were proofed three times, first from printouts generated after data-entry, during processing at URI, and finally when preparing charts of sighting data with GIS.

### ii) Data Analysis and Interpretation

All sightings are incorporated into the right whale catalogue and Consortium database to be integrated with existing data on life histories for each individual identified by CCS. Integration of the sighting data collected during these surveys with previously collected data are used to describe the number, age, sex, and reproductive status of the right whales using the Cape Cod Bay habitat area

in 2001. Sighting data from the aircraft are charted to establish patterns of distribution and assess the seasonal and spatial residency patterns of right whales in the critical habitat and adjacent waters. The data on vessel locations are charted and compared with the locations of right whales to assess the level of overlap between right whales and vessels in the area. The exact location of fishing activity was not recorded during the aerial surveys, rather observers record the trackline number and the beginning and end of the fixed gear on that trackline. Following discussions between the researchers and state biologist Dan McKiernan, it was determined that counting and recording of fishing activity on every flight would take away observer effort from obtaining marine mammal sightings and identification photographs of right whales. Since fishing effort is already documented by other agencies, the protocol was changed, the general location of fixed fishing gear along the trackline was recorded on the first flight of the month.

We used the individual identifications of right whales obtained during this study, to examine capture rate, residency and number of days between first and last sighting in Cape Cod Bay. An analysis of the age and sex composition of the winter and spring population was carried out using data from all CCS surveys to assess demographics and habitat use patterns. Right whales, first identified as calves, ranging in age from one to eight years of age were classified as juveniles, individuals age nine or older were classified as adults (based on classifications by Hamilton *et al.* 1996). Whales that were not first sighted as calves were classified as unknown age for the first eight years of their sighting history and as adults thereafter. All females who have calved are classified as adult. Sexes were assigned based on one of three methods: 1) direct observation of the genital area; 2) by association with a calf; 3) by testing biopsy samples with a sex specific DNA marker (Brown *et al.* 1994).

## Results and Discussion

### Aerial Surveys

In 2001, the right whale aerial surveillance team was in position to survey Cape Cod Bay for 135 days from 1 January through 15 May. Our first flight of the Bay, however, was conducted prior to the beginning of the season on December 19, 2000; five right whales were seen that day (Table 2 and Figure 2). Our next flight was conducted on 5 January; eight whales were seen (Table 2 and Figure 3). There were a total of 29 aerial surveys conducted for the season in the Cape Cod Bay Critical Habitat Area (Figures 2-9, Table 2) plus one additional flight on 2 February to respond to entangled right whale #2223 reported from *R/V Shearwater* (Table 2, reported on below). The last day on which we saw right whales in Cape Cod Bay was 1 May, for a minimum residency time of 134 days (19 December 2000 to 1 May 2001).

On four days during the season, additional tracklines were flown the same day as a survey of Cape Cod Bay to cover areas adjacent to the main survey area (Table 2: 13 January, 20 March, 29 March and 16 April). These surveys were directed to areas where fishermen or research colleagues had reported right whales. Right whales were located on two of these flights: on 20 March west of Stellwagen Bank north of the traditional survey area but in the critical habitat (Figure 5b) and the entangled right whale #2223 on 16 April east of Pollock Rip (Figure 6b).

After the departure of right whales from Cape Cod Bay, two surveys were conducted in adjacent waters. The first one was over Stellwagen Basin/ Wildcat Knoll (Table 1d) where right whales have aggregated in the spring. No right whales were seen during the one survey on 3 May (Table 2). The second flight over the Great South Channel was planned for 10 May. In the spring we coordinate a three-plane flight in the Great South Channel with the NEFSC and NERO aerial survey teams using the tracklines laid out for the SCOPEX project (South Channel Ocean Productivity

EXperiment, Kenney *et al.* 1995). CCS flew its portion of the tracklines one day late (11 May) due to mechanical problems (Figure 7b). Fifteen right whales were seen, of which six had been identified earlier in the year in Cape Cod Bay (Appendix II). This last flight on 11 May brought the flight total for the season to 32 days and 117.6 hours in the air to cover 8752 nautical miles of trackline (Table 2).

The systematic pre-set tracklines in the Cape Cod Bay Critical Habitat area (Figure 1, Table 1a) were surveyed on average in approximately 4 hours for those surveys that were not aborted due to an increase in wind speed, sea state (above Beaufort 4) or decrease in sighting conditions (to visibility less than two nm). Completed surveys ranged in duration from about three and a half to five hours depending on the number of right whales encountered and the amount of circling required to obtain photographs.

There were three flights (8, 13 and 23 January) on which an alternative trackline pattern was used, tracks were spaced at 2nm, and the plane was flown at an altitude of 1000 feet (Table 1b). After three flights, the impression of the observers was: 1) they had less ability to see sub-surface feeding right whales from the higher altitude; 2) the area or swath under the plane blocked from their view was wider; and 3) whales were being missed. We returned to the standard flight pattern on January 23 (Table 1a). The time we were hoping to free up to survey the adjacent areas such as the Boston sewage outfall turned out to not be practical. The airspace around the Boston sewage outfall is quite close to Logan airspace and very crowded with commercial aircraft; our flight there on 13 January was diverted by Logan air traffic control before we reached the outfall because of heavy air traffic. The second reason for freeing some flight time to cover the area south of Nantucket was not needed in 2001; there were no sightings of right whales reported from the beach walkers this year.

The DMF provided four state biologists to fill one of the observer positions on over a third of the flights during the season. These biologists have flown in previous years of this program and have been trained in aerial observation techniques for marine mammals, aerial photography techniques for right whales and data collection. Annual participation maintains those skills. The following roster provides the number of flights and accumulated hours during the season for each observer in 2001. These state biologists are well trained in right whale survey techniques and could be called upon to verify and obtain documentation of an out-of-season (mid-May to December) right whale event.

State biologist	Number of flights	Hours flown
B. Hoffman	5	19.5
B. Kelly	2	5.8
J. King	2	7.6
D. McKiernan	2	6.6
Total	11	39.5

### Vessel Surveys

In 2001, the right whale habitat sampling team was in position in Cape Cod Bay for 135 days from 1 January through 15 May. There were a total of 33 vessel days in Cape Cod Bay in 2001 (Table 3). Shipboard surveys for habitat sampling were carried out on board the R/V *Shearwater* on 29 days and 16 of these occurred on the same day as an aerial survey. The R/V *Gannet* was used on four days to provide additional photo-identification effort in Cape Cod Bay, in particular of calves, to collect biopsy samples from individual right whales and to respond to an entangled whale (Table 3).

The number of oceanographic sampling trips (29) exceeds the weekly planned total of 19 trips because the same researchers were conducting additional sampling efforts to monitor Cape Cod Bay. There were 18 CCS habitat sampling trips, one cruise with representatives from Congress, and 10 Bay monitoring trips. There was one nighttime cruise on 8 March to deploy bottom mounted autonomous acoustic sensors (pop-ups) in five locations in Cape Cod Bay (see report in Addendum).

The vessel crew located the first right whales (5) during a Bay-monitoring trip on 19 December 2000, the same day as the aircraft. The last day right whales were observed from the vessel was on 23 April (Table 3). The photos collected on the vessel have been compared to the ones obtained from the aircraft and were taken through the same matching process as detailed above. The vessel based right whale photo-identification efforts were augmented because opportunistic photography of right whales was conducted on all of these trips.

The primary purpose of these habitat sampling cruises was to collect oceanographic data in the Cape Cod Bay Critical Habitat area weekly to compare concentrations of right whales from aerial surveys with the food resource. The results and discussion of the oceanographic sampling are contained in a report submitted to the Massachusetts Environmental Trust (Mayo, DeLorenzo, Lyman and Bessinger 2001b). An evaluation of the food resource and right whale distribution and movement is presented in Mayo, C., M. Brown, A. DeLorenzo, and M. Bessinger. 2001a. Using Food Density to Predict Right Whale Occurrence and Movements in Cape Cod Bay: 2001.

### **Sightings and Photo-identifications**

In 2001, from all aerial and shipboard efforts combined, there were a total of 545 right whale sightings, of which 452 were photographed and analyzed for this report (Tables 2 and 3). Of those 452 photographed sightings, 433 were from Cape Cod Bay and along the outer coast of Cape Cod between Chatham and Provincetown (whales photographed from Trackline 16). There was one photographed sighting of the entangled whale, #2223, off Pollock Rip (Table 2, 16 April) and 18 photographed sightings were from one aerial survey of the Great South Channel (Tables 2 and 3).

To date, of those 452 sightings, 397 (88%) have been matched to an individual right whale. There are 33 (8%) photographed sightings that remain to be matched. These photographs are either of low quality, or the whale is only partially photographed and may only be matched if we collect other photographs of that whale in the future. These photographs will be reexamined for possible matches as more photos are added to the catalogue. There are 19 (4%) photographed sightings that are unmatchable. These photographs are not of sufficient quality to be matched because: 1) they are too blurry; 2) the whale was photographed while submerged subsurface feeding so the details of the callosity pattern are distorted by the water because the whale was too deep or the surface too rough.

### **Right Whale Identifications**

A total of 96 right whales were identified in 2001 (Appendix II). There were 87 right whales identified in Cape Cod Bay and another nine that were only seen in the Great South Channel. Of the 87 right whales identified in Cape Cod Bay, seven of those were calves of the year. Three whales have not yet received an identification number and are new to the right whale catalogue (#s 98-443, 01-178, 01-185). One of these three whales, 98-443, was also seen in Cape Cod Bay in 1998, and 01-178 was seen in the Bay of Fundy in 2000. Two whales, 01-41 and 01-401, are inter matched with multiple sightings, but have yet to be matched to an individual in the catalog. Of the remaining 75 right whales, all were matched to an individual in the catalogue and just one (#2310) was new to Cape Cod Bay in 2001 (Appendix I). In addition, among the 33 photographed sightings there are at least eight right whales from Cape Cod Bay and three from the Great South Channel that do not

match any of the above whales. Thus the total minimum count of right whales analyzed for the 2001 program (as of 29 October 2001) is 107 individuals.

There were seven right whales who returned to Cape Cod Bay after a three to eleven year gap in their sighting record for this area (Appendix I): #s 1281 (last seen 1995), 1613 (last seen 1989), 1710 (last seen 1991), 1946 (last seen 1997), 2150 (last seen 1991), 2330 (last seen 1993), 2746 (last seen 1997).

There were eight first time residents identified in 2000: 1624, 1630, *1817*, 1971, *2540*, 2608, *2617*, and *2709*. The four italicized whales were seen again in 2001. Of the nine first time residents identified in 1999: #s 1716, *1812*, 1981, 2710, 2740, 2750, 2760 (99-5), 2910 (99-42), 2920 (99-183), the four underlined whales were seen again in 2001, the four italicized ones in 2000. There were nine first time residents of Cape Cod Bay identified in 1998 (1162, 1270, *1701*, ***1968***, ***2223***, ***2240***, ***2271***, ***2503***, and ***2705***). The five italicized whales were seen again in 1999, the underlined whales were also seen in 2000 and the bold ones in 2001.

There were 50 right whales seen in both 2000 and 2001 (Appendix I). Of the 153 right whales to have been documented in Cape Cod Bay in the last four years, 12 % (n= 18) have been seen four years in a row. Of these 18 right whales, the number of years of subsequent sightings in Cape Cod Bay ranged from four to seven ( $x = 5.3$  SE  $\pm 1.2$ ). There appear to be some regular annual visitors among the whales seen over the last four years in the Cape Cod Bay critical habitat area (Appendix I).

### **Sightings outside the Cape Cod Bay Critical Habitat**

There were a number of right whales documented outside the margins of the Cape Cod Bay Critical Habitat area either along the outer coast of the Cape between Chatham and Race Point or in state waters west of the critical habitat area along the Manomet and Plymouth shore. Figure five shows the location of right whales off Truro on the outer coast of the Cape starting the last two weeks of March. The actual timing of right whales using this area is not clear because there were no aerial surveys from 23 February to 16 March because of poor weather and mechanical problems with the plane. The whales moved out of this location in early April and back again mid April. During this latter part of the season, right whales were also seen in state waters west of the critical habitat (Figures 6a, 6b and 7a). Sighting records for 2001 and sighting histories for the animals described below can be examined in Appendices I and II.

1. On 17 March 2001 one right whale, #2143, was seen east of the critical habitat off Truro (Figure 5b). It was travelling sub surface heading to the northwest. This was the only sighting of #2143, a 10 year old female that was seen in Cape Cod Bay in 2000.
2. On 20 March 2001 four right whales (#s 1317, 1968, 2201 and 2479) were seen sub surface feeding and skim feeding east of the critical habitat off Truro (Figure 5b). This was the only sighting of 1968 and the last sighting for 2201, 2479 and 1317, first seen in Cape Cod Bay on the 5<sup>th</sup> and 8<sup>th</sup> of January and 15<sup>th</sup> of March respectively.
3. On 20 March 2001 we received reports of right whales from CCS researchers on board the R/V *Gannet* who were surveying for humpbacks for humpbacks on Stellwagen Bank. The plane diverted to an area north of state waters (Figure 5b) and photographed nine right whales of which seven were matched to a cataloged whale (#s 1424, 1609, 1613, 1708, 1820, 2048, and 2350). This was the first sighting of 2350 and the last sighting for 1424 and 1609.
4. On 29 March, nine right whales (#s 1817, 2027, 2048, 2223, 2304, 2425, 2430, 2503, 2720, were seen west of the critical habitat, northeast of Plymouth (Figure 6a). One of these



- whales was the entangled whale (#2223): a telemetry buoy was attached that day (see below). This was the last sighting for five of the seven whales: 1817, 2027, 2425, 2430, 2503, and the only sighting of 2720.
5. On 10 April, one right whale (#2406) was recorded just west of the critical habitat, north of the eastern end of the Cape Cod Canal (Figure 6b). This whale was seen six times during the season between 19 December 2000 and 20 April 2001. There was a vessel heading toward this whale, the Captain was contacted by observers on the plane and the vessel changed course to avoid a close approach to the whale (see below).
  6. On 16 April, two right whales were seen sub surface feeding east of Nauset light. One of these whales has just been identified as # 2350 (this sighting not shown on Appendix II) who was seen 20 March on the south west corner of Stellwagen Bank (see 3 above).
  7. On 17 April, three right whales were seen west of the critical habitat off Manomet Point (Figure 6b). These two were mother #2145 and her calf; the third whale was 2740, a juvenile male that was echelon feeding with the mother at the surface.
  8. On 29 April, three right whales were seen east of Highlands feeding in a slick with visible plankton and diving birds (Figure 7a). Two of the whales were mother # 1602 and her calf, the third whale is yet to be matched. This was the last sighting of 1602 and her calf in this area.
  9. On 1 May, the last day right whales were seen in Cape Cod Bay, there were two whales sighted and both were actually outside of the critical habitat. The first whale was seen east of the Highlands in Truro, and the second west of the critical habitat off Plymouth (Figure 7a). Only the Plymouth whale was identified as # 2746, a juvenile female that was skim feeding in area with fixed fishing gear. This whale was seen entangled in the Bay of Fundy on 9 July 2000, some gear was removed and a telemetry buoy attached. The buoy and gear were retrieved and the whale was resighted in the Bay of Fundy on 20 July 2000 free of gear with no visible scarring (A. Knowlton pers. comm.).

In 2001, there were nine sightings of a total of 32 identified right whales in nearby adjacent waters outside the critical habitat (Figures 5b, 6a, 6b 7a). Of these 32 whales, the records extralimital to the critical habitat represented the only sighting of three right whales and the last sighting of 12 animals. The other 17 whales were seen in the critical habitat area both before and after the extralimital record. These data indicate that the present boundaries of the critical habitat may require reevaluation to assess if they reflect the recent distribution and movements of right whales. The present boundaries were based on historical data collected prior to 1991; expanded survey efforts over the last four years have been more effective at covering the periphery of the critical habitat (Figure 12 and there is evidence to indicate that distribution and movement patterns may have shifted (Mayo *et al.* 2001a).

### **Seasonality of Right Whales in Cape Cod Bay**

The season of occurrence of right whales in Cape Cod Bay in the winter and spring is generally considered to extend from early January through mid-May. In 1998, when right whales were recorded on 4 January, this was the earliest documented sighting of right whales in the wintertime. However, when two pre-season surveys were flown on 13 December 1998 and 19 December 2000, right whales were encountered in Cape Cod Bay. On the latter end of the season, sightings of right whales are few in number after mid April. These data indicate that the seasonal residency of right whales for at least the last four years is December to May. There are now sufficient data for managers to reevaluate the dates for which gear restrictions are required in the Cape Cod Bay Critical Habitat. Presently gear restrictions are in place from 1 January through 15 May. From the last four years of data, it would be reasonable to reevaluate the timing of gear restrictions to better reflect right whale presence in Cape Cod Bay.



In the last two years, we have witnessed a dramatic departure of right whales from Cape Cod Bay. For example in 2000, there were 36 whales seen on 7 April and three on 11 April. In 2001, 16 right whales were seen on 29 April, but only two on 1 May, both of which were outside the critical habitat. Right whales are thought to migrate as single animals or mother calf pairs. There appears to be a herd-like behavior of departing right whales. This may be a result of collapse in the food resource in the Bay. Mayo *et al.* (2001a) provides some preliminary analysis on the subject that may shed light on the nature of the food resource and provide a means to predict departure.

Year	Date 1 <sup>st</sup> survey	Last survey with right whales	# days of minimum residency	Date 2 <sup>nd</sup> to last survey
1998	04 Jan 1998 (9)*	21 April 1998 (1)*	108 [75]**	19 April 1998 (3)*
1999	13 Dec 1998 (5)	02 May 1999 (1)	140 [86]	01 May 1999 (3)
2000	20 Jan 2000*** (1)	11 April 2000 (3)	82 [86]	07 April 2000 (36)
2001	19 Dec 2000 (5)	01 May 2001****(2)	134 [87]	29 April 2001 (16)

\* Number in parentheses is the number of right whales photographed from the airplane that survey day.

\*\* Number in square brackets is the minimum number of right whales for the season in CCB.

\*\*\* Inclement weather at the beginning of January 2000 precluded any earlier flights.

\*\*\*\* The sightings on 1 May were outside of the critical habitat (see section above). The last day right whales were seen in the critical habitat was 29 April.

### Sightings between habitat areas

There were a total of 17 records of 24 right whales (including the seven calves) seen both in the southeast US and Cape Cod Bay (see table below). The mean number of days between sightings in the two areas was 40 (SE  $\pm$  9) for all records and 40  $\pm$  5 days for mothers with calves. The number of days between sightings ranged from 22 to 67. The record of 10 days between sightings, set in 2000 by whale # 2010 (10 year old male) remains unbeaten (Brown and Marx 2000).

Catalogue Number	Southern sighting (off the coast of Florida)	Northern sighting (CCB)	Days between sightings
2320 adult female	16 Dec 00	29 Jan 01	43
1428 adult male	17 Jan 01	8 Mar 01	45
1708 adult male	27 Jan 01	15 Mar 01	45
1703 adult female	06 Feb 01 with calf	26 Mar 01 with calf	47
1817 adult female	06 Feb 01	20 Mar 01	41
2140 adult male	10 Feb 01	15 Mar 01	32
1901 adult male	11 Feb 01	17 Mar 01	33
1968 adult female	11 Feb 01	20 Mar 01	36
2330 adult female	11 Feb 01	20 Apr 01	67
1710 adult female	19 Feb 01 with calf	6 Apr 01 with calf	45
2350 adult unknown	25 Feb 01	20 Mar 01	22
1602 adult female	28 Feb 01 with calf	4 Apr 01 with calf	34
2050 adult female	28 Feb 01 with calf	6 Apr 01 with calf	36
1281 adult female	01 Mar 01 with calf	04 Apr 01 with calf	33
2145 adult female	03 Mar 01 with calf	11 Apr 01 with calf	38
2123 adult female	02 Mar 01 with calf	04 Apr 01 <i>no calf</i>	32
2150 adult female	14 Mar 01 with calf	29 Apr 01 with calf	45

In the last four years, a total of 32 right whales (not including calves) were identified in both the southeast US and Cape Cod Bay in the same year. One whale, #2123, was documented in more than one year (1998 and 2001). There were two instances of right whales making the reverse migration from CCB to the southeast in 2000 (Brown and Marx 2000). In the first three years, most of the whales left the southeast in January arriving in Cape Cod Bay in February to early March (Brown and Marx 1998, 1999, 2000). In 2001, most of the whales left in February and arrived in March some 40 days later, the later departure and arrival likely a result of the prevalence of mothers with calves. These sightings provide some information on the timing of the migration of right whales through the mid-Atlantic region and the impact on proposed seasonal management plans for the shipping industry. The table below summarizes the maximum transit time over the last four years (calves are not included in the total for 2001 because their movements are dictated by that of their mothers at this life stage).

Year	Number and sex ratio of transiting whales (male - ♂; female - ♀)	Range of days between sightings (days)	Mean number of days between sightings
1998	6 whales; 3 ♂, 2 ♀, 1 unknown	30 – 56	46 ± 9
1999	4 whales; 1 ♂, 3 ♀	33 – 65	55 ± 15
2000	9 whales; 5♂, 4♀	10 – 86	41 ± 22
2001	17 whales; 4 ♂, 12♀, 1 unknown	22 – 67	40 ± 9

Photographs from the other aerial survey efforts by researchers at the NERO and NEFSC of NMFS through June have not yet been fully analyzed thus it was not possible to document movements of right whales between Cape Cod Bay and nearby waters at this time. We are able to document a few movements for the right whales that were seen in the Great South Channel by the DMF/CCS plane. The results of from the one aerial survey on 11 May are shown in Appendix II. Of the 15 whales identified offshore, six were previously seen in Cape Cod Bay in 2001. Of the remaining nine whales, all but one were male and four have never been seen in Cape Cod Bay. These results demonstrate, even from just this one survey, that right whales transit between the two areas, across the Boston shipping lanes. Movements of right whales between the Cape Cod Bay and the Great South Channel are further supported in previous years (Brown and Marx 1999, 2000).

### **Mother calf pairs**

Seven mother calf pairs were recorded in Cape Cod Bay in 2001, the first pair was seen on 26 March and the last pair on 29 April (minimum of 34 days residency). This is the first year since 1997 in which calves have been seen in this area. There was an eighth mother identified, #2123 that was last seen in Florida with a calf on 2 March, but she was seen alone during all three sightings over 17 days in Cape Cod Bay (4-20 April, Appendix II) and has likely lost her calf. There were four calf mortalities documented along the coast between Florida and New York in 2001. Two of those mortalities were recorded after #2123's last sighting with her calf. One dead calf was observed on March 17<sup>th</sup> off the coast of South Carolina, a second on the same day off Virginia (NEAq unpublished data). Only the carcass of the second calf was recovered. The cause of death was attributed to a ship strike. DNA samples were obtained and will be analyzed to hopefully determine the calf's mother.

The presence of eight mothers in Cape Cod Bay represents 26% of the known reproduction of right whales in 2001 (total number of calves recorded = 31, 30 calves were seen in Florida, one additional one in Bay of Fundy, NEAq unpublished data). One of these mothers, #2150, had not been seen anywhere since 1994 (Appendix I). Of the 31 mothers, 13 have never been seen in Cape

Cod Bay at anytime during their sighting histories. Of the 18 mothers that have been seen in Cape Cod Bay over the last twenty years, 11 (61%) were seen in Cape Cod Bay in 2000 (Brown and Marx 2000). This indicates that, assuming a 12 to 13 month gestation (Best 1994), a portion of this year's mothers were feeding in Cape Cod in the early part of their gestation.

### Capture Rates and Residency

Of the 87 right whales identified or captured in Cape Cod Bay and matched to an individual in the catalogue or a calf with its mother, 22 (26 %) were photographically captured on just one day (see below). The greatest number of days on which a whale was captured was 13; two whales had this sighting profile #s 2750, an adult male and 2645, a five year old female (Appendix II). Their Cape Cod Bay sighting histories spanned 132 days and 76 days respectively. Other whales with long sighting records were #2304, an eight year old male and #2740, a four year old female (Appendix II). In 2000, the greatest number of sightings (12) and the longest residency whales were 1802, a 12 year old adult female, #1911, an 11 year old female, #2320, a female of unknown age, and #1608, a 14 year old adult female. One of these whales, #1911, was not seen in Cape Cod Bay in 2001, but was seen in the southeast US with a calf.

Days Photo'd	1	2	3	4	5	6	7	8	9	10	11	12	13
No. Photo'd (n = 87)	22	19	12	7	5	8	1	2	2	4	1	1	2

There were 65 (right whales captured on more than one day (Appendix II). The number of days between first and last sighting was calculated for all right whales seen more than once that were not seen elsewhere between their first and last sighting in Cape Cod Bay. The number of days between first and last sighting for 65 right whales ranged from 2 to 68 days, with the mean being 28 days (SE ± 19). There are substantial gaps in the sighting records of several right whales (Appendix II) which indicates that some animals are moving in and out Cape Cod Bay more than once during the winter and spring. These whales could be aggregating in another area or travelling offshore, perhaps returning to Cape Cod Bay when food conditions are most favorable. In 2000, one whale transited between the southeast US and Cape Cod Bay in no more than 10 days. The habits of these right whales could possibly be determined from satellite-monitored tagging studies. Another technique that might prove useful would be deployment of bottom mounted hydrophones to census right whales acoustically or concurrent aerial surveys in near by waters that are considered favorable for right whale. At the present time there are no other surveys in the northeast until the end of March.

### Demographics

The demographic profile of right whales in Cape Cod Bay in 2001 was similar to previous years (see table below). Of the 87 right whales, there were slightly more males (40) than females (30) identified (10 of unknown sex), but there was no significant difference from a one to one sex ratio ( $P = 0.232$ ). When these data were compared with the sex of right whales identified in this area in 2000 with those seen in 1999 or 1998, there was no significant difference from unity in any. With respect to age, the sample was dominated by 72% adults ( $n = 57$ ), 17% juveniles ( $n = 13$ ) and 10% of unknown age ( $n = 10$ ). This age structure is not significantly different from the right whale catalogue ( $P = 0.214$ , Hamilton *et al* 1998) or from the age structure observed in Cape Cod Bay in any year.

Year	Minimum # id'd	Adults/Juveniles	# Unknown age	Males/Females	# Unknown sex
1998	75	58 / 15	2	28 / 38	9
1999	86	55 / 23	8	37 / 35	14
2000	86	64 / 15	7	42 / 36	8
2001	87	57 / 13	17	40 / 30	10

The details of the demographic structure of the population broken down by age and sex in bi-weekly intervals are presented in Table 4. Of note is the shift in the last six weeks of the field season from a population of right whales dominated by males to one dominated by females. This shift in the latter part of the season was also observed in 1998 and 1999 (Brown and Marx 1998, 1999), but not in 2000 when the whales were gone from Cape Cod Bay by 7 April (Brown and Marx 2000).

### **Biopsy Samples**

Biopsy samples were collected on two days in Cape Cod Bay in 2001. On 5 April, we collected a biopsy sample from the calf of #1602. On 11 April, the CCS humpback survey team (Jooke Robbins and David Mattila) collected the second sample from the calf of mother # 2145 off Wood End. The number of right whales sampled this year was small because several right whales had already been sampled in previous years, or earlier in the season on the southeast US calving grounds. These samples have been incorporated into ongoing genetic and pregnancy analyses.

### **Notification of Agencies**

At the completion of each aerial survey, the data on the number of right whales and their location were relayed via cell phone to the NMFS/SAS office in Woods Hole. The verbal data transmission was followed by a fax to the DMF office in Boston and to the NMFS/SAS coordinator in Woods Hole showing a table of sightings with a chart of locations. For vessel trips, positions of right whales were relayed via cell phone at the completion of each excursion. The DMF/CCS surveys are the principal source of right whale sighting information in the winter months.

### **Sighting Distances**

The perpendicular distance from the aircraft at which right whales were sighted was determined by recording the exact position on the trackline when whales were initially sighted and then recording the exact position as the first pass was made directly over the animals. The number of sightings within each distance in 1/10<sup>th</sup> nm intervals is shown in Figure 13. A total of 82 sightings were used in this analysis (secondary sightings that were made after the plane had already broken track were not included). Sighting distances ranged from the trackline to 2.9 nm away. The average sighting distance was 0.68 nm. Seventy-six percent of the sightings were within one nm of the trackline and 13 percent were made between one and one and a half nm, and 11 percent at between 1.5 nm and 2.8 nm.

### **Other sightings**

There were seven other species of cetaceans, two species of pinnipeds and one species of shark sighted while performing these surveys (Tables 2 and 3, Figures 8 and 9). Fin whales, *Balaenoptera physalus*, were the most numerous large whale encountered and white-sided dolphins, *Lagenorhynchus acutus*, the most numerous toothed whale followed by harbor porpoise, *Phocoena phocoena*. Of note is the sighting of a beluga whale, *Delphinapterus leucas* from the aircraft on 12 February. The closest known beluga habitat area is in the St. Lawrence River at the mouth of the Saguenay River in Quebec, Canada. The beluga was photographed and the sighting reported to the Group for Research and Education of Marine Mammals in Tadoussac, Quebec, who maintain records of beluga whales. Extralimital records of belugas have been reported as far south as coastal waters of New Jersey (Reeves and Katona 1980).

The sighting database also contains coded entries for vessel traffic observed in the area. Commercial and military vessel traffic were compiled for the season and plotted on a single chart to show their distribution relative to right whale sightings and the critical habitat area (Figure 10).

## Human Impacts

Entanglement Report (for further information see the rescue page on [www.coastalstudies.org](http://www.coastalstudies.org))

On Friday, February 2, 2001, an entangled right whale was sighted by researchers aboard the *R/V Shearwater*, during a routine habitat survey in Cape Cod Bay. The whale was sighted at 0950 hr at position 42° 00.6'N x 70° 10.3'W. The entanglement was described as a single line wrap on the body, one meter behind the blowholes. The line appeared to be approximately 3/8" and light blue-green in color. No gear was seen on the tailstock or trailing behind the whale. The crew followed the whale for over an hour to determine the extent of injury. They saw no signs of chafing or raw areas on the skin around the line, and the line did not appear to be tightly wrapped. Shipboard photographs were taken, but crewmembers could not see the flippers; they requested aerial assistance to help assess the entanglement. The CCS aerial team had not scheduled a survey for the day; the pilot was not available until mid-afternoon. In the interim, US Coast Guard helicopter with MEP officer, Peter Hanlon, aboard, assisted with attempts to relocate the entangled whale. Officer Hanlon took photos of all the right whales seen from the helicopter; these photographs were examined the next day, but there were no photos of the entangled whale. The CCS aerial team was able to take over the search at approximately 1430 hr, allowing the Coast Guard helicopter crew to resume their previous mission. The survey team conducted a thorough search of the area, and although there were several right whales in the area, the entangled whale was not re-sighted that day.

The entangled whale identified as #2223, a nine-year-old female named Calvin. On August 18, 2000, this whale was reported as entangled by crewmembers aboard a NOAA plane conducting photogrammetry research in the Bay of Fundy. The entanglement was described as approximately "200 feet of floating line trailing from right pectoral flipper. Line color is white or pale yellow." Although the gear was initially characterized as "white or pale yellow", an observer on that NOAA flight acknowledged that the line could have been any light color, including green or blue, as it was only seen through the water, never above the surface. The observer also acknowledged that the line could have been coming from the right side of the mouth, rather than the flipper. Photos taken at the time confirm this. The light greenish line comes from the right side of the mouth and runs across the back to the left flipper. There were no subsequent confirmed sightings of #2223 in the Bay of Fundy. Post-season photo-analysis revealed that the NEAq team had seen #2223 from their research vessel earlier in the season on 25 July and 8 August 2000. No entangling lines were reported, but fresh entanglement scars indicate that Calvin was probably already entangled at that time.

The whale was seen four more times by the DMF/CCS aerial team during the winter and spring 2001 (Appendix II). On 4 February observers in the plane saw the whale in an aggregation of 12-15 other right whales. It appeared to be behaving normally; she was on 30 minutes dives, spending less than two minutes on the surface between dives, as were the other whales. The plane spent approximately 1.5 hours circling over the whales. The disentanglement team was notified, but conditions were not conducive to a disentanglement attempt being undertaken that day.

On 17 March Calvin was spotted from the plane off Wood End light. The disentanglement team responded but was not successful that day. They were successful on 29 March at attaching a telemetry buoy and removing about 200' of trailing line that had not been visible in photographs. Calvin was located on 16 April on a flight out to Pollock Rip east of Monomoy (Figure 6b). The last transmission from the telemetry buoy was on 5 May. On 8 May, the telemetry buoy and entangling lines were found floating in the Great South Channel. The buoy and gear were recovered by the crew from International Fund for Animal Welfare's boat, *S/V Song of the Whale*. Calvin was last seen and photographed on 8 June in the Great South Channel by the NMFS/SAS team and was free of gear.

### Vessel interactions

There were no known collisions between vessels and right whales in Cape Cod Bay during the 2001 field season. There were two events that are worth describing anecdotally in this report.

1. The following describes the reaction of two right whales to an oncoming fishing vessel. During a standard aerial survey of Cape Cod Bay on Saturday, 17 March 2000, the CCS aerial survey team had just finished photographing a pair of right whales at 1331hr at position 42° 01.3'N x 70° 10.5'W. The whales were engaged in social behavior very close to shore between Long Point and Wood End light. As the plane departed the area to resume surveying, observers noticed a fishing vessel southeast of Herring Cove, heading along the shore toward Provincetown Harbor. The observers could see that the vessel was about the same distance from the shore as the whales, and realized that if neither the vessel nor the whales changed course, there was the possibility of a collision. The plane flew over the vessel in an attempt to see the name to contact them on marine radio and notify them of the situation. The observers were unable to identify the vessel on the initial pass; however, while circling the observers saw that the two whales had stopped their social behavior and were swimming side by side steadily to the southeast. Within three minutes the fishing vessel passed through the area where the whales had originally been sighted, but by that time the two whales had moved approximately 200' to the southeast. The observers on the plane were not able to make any radio contact with the dragger.

2. The following describes the reaction of the Captain of a tug and tow to right whale information relayed by observers on the survey airplane. During a standard aircraft survey of Cape Cod Bay on April 10 2001, observers photographed a subsurface feeding right whale on the western side of the Bay at position 41° 50.1'N x 70° 29.2'W (on trackline 12 about 0.6 nm east of the western edge of the critical habitat). When photography of the whale was complete, (identified as #2406), a northbound tug and tow was sighted which had just come out of the Cape Cod Canal. The vessel was heading directly toward the whale, the plane flew over to get the their exact position (41° 48.9'N x 70° 29.3'W), name (*Barker Girls*), and attempted to make radio contact. An observer on the airplane hailed the vessel on channel 13 and notified them of the whale approximately 1 nm ahead of their bow. It was explained that the whale was feeding just beneath the surface and, thus, almost impossible to see and suggested that they alter course to the east, which the captain did immediately. The tug and tow left the whale approximately ¼ mile to port.

When the observers returned to the Chatham airport after completing the survey, Cape Cod Canal traffic was contacted and asked to inform canal traffic of a subsurface feeding right whale on the western side of Cape Cod Bay. Although there are no designated shipping lanes in Cape Cod Bay, most of the traffic going in and out of the east end of the Canal travels a similar route through the area the whale was seen. Operators are in communication with transiting ships in the canal and they receive right whale reports via fax from the NMFS/SAS office, which are relayed to vessels. Even though these faxed reports are often several hours to several days old, it provides a level of awareness for Captains and bridge crews that help elicit their fast reaction when contacted from the plane with information on right whales in their immediate vicinity.

## Summary

The data collected over the last four years provide a basis for examining and reevaluating the historic distribution and seasonality of occurrence upon which the original designation of the Cape Cod Bay Critical Habitat and subsequent management actions were based. The primary management action has been directed toward reducing the potential for serious injury or mortality from entanglement in fishing gear by instituting gear restrictions in the Cape Cod Bay Critical Habitat from January to mid-May. It has been assumed that right whales are present in the locations and at the times historic observations placed them based on research between 1984 and 1991.

During the last four years right whales have been identified in two areas outside the boundaries of the critical habitat (Figures 11, 12). During the 2001 field season, a co-occurrence of right whales and high concentrations of plankton was identified in these same areas (Mayo *et al.* 2001a, 2001b). One area is in state waters west of the western boundary of the critical habitat along the Manomet and Plymouth shore. The second area, also in state waters, is located east of Highlands and along the outer shore of Cape Cod from Chatham to Race Point. These areas are not included within the boundaries of the critical habitat, thus not subject to gear restrictions, but have been used by a few right whales over the last four years (Figures 11, 12). It is difficult, however, to evaluate the significance of these extralimital sightings relative to existing management schemes without correcting the sighting data for survey effort.

There are two questions that bear further investigation. Do the existing boundaries of the Cape Cod Bay Critical Habitat area reflect current usage patterns of right whales? Do the gear restrictions in the Cape Cod Bay Critical Habitat area from January to mid-May adequately reflect the season of occurrence and pattern of distribution of right whales? Although right whales are seen outside of the critical habitat in space and time, it is not known, relative to the critical habitat, just how important these extralimital areas are to right whales. For example are right whales being identified in these areas as they approach or leave the critical habitat or are these extralimital areas being used for feeding for several days to weeks at a time? There are varying levels of vulnerability to human activities based on the behavior of the whales.

There are analyses that could help assess the extent to which these extralimital areas are used. For example, to assess if the existing boundaries of the critical habitat reflect current usage patterns, data from systematic aerial surveys, which extend beyond the boundaries, could be used to develop effort-corrected maps of right whale sightings to show where concentrations of right whale are located. Effort-corrected sighting data can be examined on various time scales to assess both the season of occurrence and the location of high-use areas within, and extralimital to, the critical habitat. The existing boundaries of the critical habitat were meant to reflect 95% of the right whale distribution (Kraus and Kenney 1991). These analyses will help determine if right whales are using extralimital areas more than 5% of the time.

Mayo (*et al.* 2001a) has developed a preliminary model using data from 2001 to predict right whale occurrence based on the quality of the food resource. Correlation of right whale sightings with data on the habitat will help determine if right whale occupancy outside of the critical habitat is based on an a high quality food resource or if these extralimital sightings are of migrating whales perhaps heading toward the critical habitat. These analyses will provide managers with information to evaluate, and, if necessary, refine conservation strategies and management plans that provide protection to right whales while taking into consideration minimizing impact to human activities in the area.

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## Addendum from Research Collaborators

The following reports are from Chris Clark and Sara Wetmore on their respective projects on right whales either in Cape Cod Bay or using samples obtained during studies in Cape Cod Bay respectively. These summaries are not for citation without prior contact with the authors.

Christopher W. Clark. Cornell Lab of Ornithology Bioacoustics Research Program, Sapsucker Woods Rd., Ithaca, NY 14850, 607-254-2408, [cwc2@cornell.edu](mailto:cwc2@cornell.edu)

Right whales are known to produce a great variety of sounds. Some of these sounds are communicative and mediate social interactions between individuals. Several of the most common sound types are associated with different social activities. This includes frequency-modulated up sweeps used for long-range contact and complex sequences of screams produced by groups of sexually active animals. The number of individuals in the Northern Right Whale population is precariously low, and there is an urgent need to reduce mortality due to various human impacts. Present mechanisms for monitoring right whales rely on visual methods which limit the ability to sample right whales throughout large areas throughout the year. The objective of this project was to apply existing passive acoustic techniques to sample the distribution and relative density of right whales in Cape Cod Bay and the Great South Channel areas. Furthermore, these locations and the periods of sampling were intentionally chosen so as to coincide with ongoing aerial and vessel surveys conducted by the Center for Coastal Studies, IFAW and NMFS.

Five autonomous seafloor acoustic recorders (i.e., “pop-ups”) were deployed in Cape Cod Bay on 8 March. Each unit recorded continuously in the 5-1000Hz frequency band. Three units were deployed 5 miles west of south Truro and 5 miles south of Wood End light in a triangular array, allowing acoustic location and tracking of whales out to ranges of at least 3-5 miles. The other two units were deployed 3 miles to the west of Race Point (unit #21) and 10 miles to the north of Sandwich (unit #5). All five units were recovered on 10 April. The Three array units and unit # 5 collected data through 2 April, while unit #21 collected data through 10 April.

Analysis of right whale sounds is ongoing. Detections of right whale sounds have been completed for all of unit #21 and half of the 3-channel array data which is also being processed for acoustic locations and whale tracks. Preliminary findings reveal large fluctuations in acoustic activity throughout the 24-32 day sampling periods. Many thousands of right whale sounds, sometimes at high rates (e.g., 200-300 calls/h), have been located on the array. This includes contact calls as well as surface active group sounds, slaps and gunshots. It also includes fin whale sounds (calls and songs) and the sounds of various vessels and machines. Comparisons of right whale acoustic locations and tracks with aerial survey and vessel observation results are just beginning. This project was undertaken in collaboration with IFAW and CCS. IFAW provided funding for pop-up construction and data analysis, and logistical support for pop-up recovery, while CCS provided logistical support for pop-up deployment. Further deployments are planned for the 2002 right whale season.

Sara Wetmore: Graduate Student, Department of Biology, University of Massachusetts, 100 Morrisey Blvd., Boston, Mass 02125. swetmore@whsun1.wh.who.edu

- In 1999, Ms. Wetmore described her analysis of stable isotopes in right whales (Brown and Marx 1999). The following is a summary of what she learned about stable isotope signatures from a baleen sample (collected from the right whale known as Staccato who died in Cape Cod Bay as the result of a ship strike in 1999), as well as from plankton samples and skin samples from right whales in Cape Cod Bay and the Canadian habitat areas of Bay of Fundy and Roseway Basin.

Plankton isotopic signatures exhibited significant differences between areas over time when 11 years of data were combined. More specifically, the Bay of Fundy (Canada) area was significantly different from both the Nova Scotian Shelf and Roseway Basin (Canada) areas in carbon composition. Plankton compositions were not significantly different between years within each of the foraging areas sampled, although sample sizes were generally small. There were significant differences in the two right whale tissues studied (blubber and skin), but there were no significant differences in right whale biopsy samples collected in different areas over time. In this study, animals could only be estimated as not feeding in a certain area instead of accurately placed as feeding in one area versus another. This was based on the significant differences that were found between the Bay of Fundy and the Nova Scotian Shelf/Roseway Basin areas when all years were combined. Animals of different sex, sexual maturity and age were not significantly different in either isotope.

Investigations of Staccato's tissues revealed that blubber carbon was less enriched when compared to other tissues. It was then determined that blubber nitrogen could be representative of signatures at the time of fasting, due to the fact that blubber had the fastest turnover of all tissues studied. Blubber nitrogen signatures therefore suggested that Staccato was fasting or potentially starving prior to death, a fact that agrees with data from the necropsy report. Investigations of Staccato's baleen suggested an appropriate baleen growth rate (24-26 cm/year) that compared well with previous estimates. The baleen growth rate also allowed for estimates of length of time represented by the baleen, which in this case was equivalent to approximately 9.5-10.3 years. Thus, baleen in right whales holds a dietary history whose duration is shorter than that found in the longer baleen of bowhead whales. Isotopic trends in the baleen data were identified. The trends might be indicating that the isotopic signatures of the baleen were part of a larger periodicity. Future studies are needed to determine if this is the case, but it will be difficult since even the longest piece of right whale baleen is only capable of representing about a 10-year period.

Table 1a. Aerial survey tracklines flown over Cape Cod Bay, December, 2000 - mid May, 2001. (Tracklines end approximately 1.5 nm from land). For location of tracklines, cross reference by trackline number with figure 1.

Trackline Number	Latitude	Longitude West End	Longitude East End	Trackline Length (nm)
1	42 06.5	70 38.0	70 10.0	21
2	42 05.0	70 37.0	70 14.0	17
3	42 03.5	70 38.0	70 15.0	17
4	42 02.0	70 36.0	70 07.7	21
5	42 00.5	70 34.3	70 06.9	21
6	41 59.0	70 35.2	70 06.6	22
7	41 57.5	70 34.4	70 06.6	21
8	41 56.0	70 31.6	70 06.3	19
9	41 54.5	70 30.8	70 03.1	21
10	41 53.0	70 30.0	70 03.1	20
11	41 51.5	70 30.0	70 02.1	21
12	41 50.0	70 30.0	70 02.1	21
13	41 48.5	70 30.0	70 02.2	21
14	41 47.0	70 29.0	70 04.1	20
15	41 45.5	70 26.0	70 11.0	11
Subtotal trackline miles in Cape Cod Bay, tracks 1-15				294
16*	41 45.5		69 53.0	26
Total trackline miles, tracks 1-16				320

\* Trackline 16 begins at this point, east of Chatham, continues northeast parallel to the outer coast of Cape Cod approximately 3 nautical miles offshore, and joins the eastern end of trackline 1.

Table 1b. Aerial survey tracklines flown over Cape Cod Bay, 8 January through 18 January, 2001.

Trackline Number	Latitude	Longitude West End	Longitude East End	Trackline Length (nm)
1	42 06.0	70 36.3	70 09.2	20
2	42 04.0	70 35.9	70 08.9	20
3	42 02.0	70 33.9	70 08.4	19
4	42 00.0	70 34.4	70 06.5	21
5	41 58.0	70 31.8	70 06.2	19
6	41 56.1	70 32.0	70 06.6	19
7	41 54.0	70 29.6	70 06.2	18
8	41 52.0	70 30.3	70 03.7	20
9	41 50.0	70 30.3	70 03.3	20
10	41 48.0	70 30.0	70 06.2	18
11	41 46.0	70 25.0	70 10.6	11
Subtotal trackline miles in Cape Cod Bay, tracks 1-11				204
12*	41 45.5		69 53.0	26
Total trackline miles, tracks 1-12				230

\* Trackline 12 begins at this point, east of Chatham, continues northeast parallel to the outer coast of Cape Cod approximately 3 nautical miles offshore, and joins the eastern end of trackline 1.

Table 1c. Tracklines on Stellwagen Bank, 29 March 2001.

Trackline Number	Latitude	Western Longitude	Eastern Longitude	Distance (nm)
1	42 08.0	70 22.0	70 11.0	8
2	42 10.0	70 22.0	70 11.0	8
3	42 12.0	70 20.0	70 11.0	7
4	42 14.0	70 20.0	70 11.0	7
5	42 16.0	70 20.0	70 11.0	7
6	42 18.0	70 20.0	70 13.0	5
7	42 20.0	70 22.0	70 13.0	7
8	42 22.0	70 22.0	70 16.0	5
9	42 24.0	70 30.0	70 16.0	10
10	42 26.0	70 30.0	70 24.0	5
Total				69
Cross Legs				18
Total				87

Table 1d. Tracklines on Stellwagen Basin/Wildcat Knoll, 3 May 2001.

Stellwagen Basin:

Trackline Number	Latitude	Western Longitude	Eastern Longitude	Distance (nm)
1	42 14.0	70 30.0	70 19.0	8
2	42 17.0	70 30.0	70 19.0	8
3	42 20.0	70 30.0	70 19.0	8
4	42 23.0	70 30.0	70 19.0	8
5	42 26.0	70 30.0	70 19.0	8
Total				40
Cross Legs				12
Total				52

Wildcat Knoll:

Trackline Number	Northern Latitude	Southern Latitude	Longitude	Distance (nm)
1	42 38.0	42 07.0	70 05.0	31
2	42 38.0	42 07.0	70 01.0	31
3	42 38.0	42 05.0	69 57.0	33
Total				95
Cross Legs				6
Total				101

Table 2. Number of marine mammals and other animals seen, hours and trackline miles surveyed during aerial surveillance of Cape Cod Bay and adjacent waters, December 2000 - May 2001.

Survey#	Season 2001	Eg Sighted	Eg Photo'd	Ba	Bb	Bp	Mn	UNBA	UNLW	UNSW	La	Pp	DI	UNDO	UNSE	Cm	Hours Surveyed	Trackline Miles	Tracks Completed
CCS220	19-Dec-00	5	5	0	0	3	0	1	0	0	0	0	0	0	1	0	3.6	320	1-16
CCS221	5-Jan-01	8	8	0	0	2	0	0	0	0	0	0	0	3	0	0	3.5	309	1-14,16
CCS222	8-Jan	10	10	0	0	3	0	0	0	0	0	0	0	0	0	0	2.8	230	1-12*
CCS223	13-Jan	5	5	0	0	0	0	0	0	0	0	0	0	0	1	0	2.9	230	1-12*
CCS224	18-Jan	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	2.5	230	1-12*
CCS225	23-Jan	3	2	0	0	0	1	0	0	0	60-90	0	0	0	0	0	4.1	309	1-14,16
CCS226	24-Jan	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3.8	320	1-16
CCS227	29-Jan	10	10	0	0	3	0	0	0	0	0	0	0	0	0	0	3.8	299	2-16
CCS228	1-Feb	6	5	0	0	4	0	0	0	0	0	0	0	0	2	0	3.8	309	1-14, 16
CCS229	2-Feb	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	1.5	n/a	none**
CCS230	4-Feb	13	12	0	0	3	0	0	0	0	90-110	0	0	0	0	0	3.6	123	1-5, 16
CCS231	12-Feb	8	7	0	0	3	0	0	0	0	0	0	1	0	0	0	3.5	294	1-15
CCS232	14-Feb	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1.8	147	3-8,16
CCS233	16-Feb	7	6	0	0	6	0	0	0	0	0	0	0	0	1	0	3.8	299	2-16
CCS234	22-Feb	9	9	0	0	4	0	0	1	0	0	0	0	0	0	0	4.2	320	1-16
CCS235	17-Mar	30	28	0	0	7	0	0	1	0	0	0	0	0	6	0	5.7	145	1-6, 16***
CCS236	20-Mar	13	12	1	0	21	0	0	3	0	6	0	0	0	11	0	3.2	309	1-14, 16
CCS237	26-Mar	5	5	1	0	12	2	1	0	0	0	0	0	40-60	0	0	4.0	281	1-16****
CCS238	29-Mar	14	14	0	0	12-13	2	0	0	0	0	0	0	5-10	0	0	3.5	123	1-5, 16****
CCS239	4-Apr	29	22	1	0	9	3	0	0	0	0	8	0	0	1	1	5.0	320	1-16
CCS240	6-Apr	10	10	1	0	2	2	0	0	0	20-30	0	0	0	0	0	3.6	309	1-14, 16
CCS241	10-Apr	21	17	0	0	2	0	0	0	0	0	0	0	0	0	0	4.7	309	1-14, 16
CCS242	11-Apr	12	11	0	0	15	6	1	0	0	95-145	0	0	17-22	0	0	4.0	320	1-16
CCS243	16-Apr	17	16	1	0	9	0	1	0	0	0	1	0	0	0	0	4	309	1-14, 16
CCS244	17-Apr	16	15	0	0	16	7	1	1	1	120-145	1	0	0	0	0	3.8	309	1-14, 16
CCS245	18-Apr	12	12	0	0	8	3	0	2	0	0	5	0	50-66	2	0	3.7	268	1-12, 16
CCS246	23-Apr	14	14	2	0	5	3	0	1	0	14	28-33	0	10-20	0	0	4.4	320	1-16
CCS247	29-Apr	16	16	0	0	5	21-22	0	1	0	0	0	0	0	0	0	3.5	309	1-14, 16
CCS248	1-May	2	2	2	0	5	5	1	1	0	0	1	0	19-29	3	0	3.4	320	1-16
CCS250	7-May	0	0	1	0	2	1	0	0	0	0	8-9	0	0	0	0	3.3	320	1-16
Total Cape Cod Bay		306	283	11	0	163-164	56-57	6	10	1	395-540	52-58	1	144-210	28	1	108.9	8010	
Adjacent waters																			
CCS223	13-Jan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.7	46	toward Boston Harbor Outfall
CCS236	20-Mar	9	8	0	0	0	0	0	1	0	0	0	0	0	0	0	0.5	9	west of Stellwagen Bank
CCS238	29-Mar	0	0	1	0	7	4	0	0	0	30-40	0	0	5	0	0	1.0	87	Stellwagen Bank (Table 1c)
CCS243	16-Apr	1	1	2	0	0	2	8-10	0	0	0	0	0	0	0	0	0.3	36	east of Pollock Rip
CCS249	3-May	0	0	4	0	4	15	0	0	0	30	6	0	118-165	0	0	3.0	292	Stellwagen Basin/Wildcat Knoll (Table 1d)
CCS251	11-May	19	18	5	1	3	89-119	0	0	0	0	3	0	658-807	0	7	3.2	272	Great South Channel
Total adjacent waters		29	27	12	1	14	110-140	8-10	1	0	60-70	9	0	781-977	0	7	7.7	742	
Total all surveys		335	310	23	1	177-178	166-197	14-16	11	1	455-610	61-77	1	925-1187	28	8	117.6	8752	

\*Temporary tracklines flown, altitude of 1000 feet (Table 1b.).

\*\* This flight was conducted in response to the sighting of an entangled whale in Cape Cod Bay.

\*\*\* This survey was incomplete due to an attempted rescue of an entangled whale.

\*\*\*\* Western portion of southern tracklines skipped due to an incoming squall.

Table 3. Number of marine mammal sightings and hours collected at sea during shipboard surveys and vessel- based habitat sampling cruises of Cape Cod Bay, December 2000-May 2001.

Survey	Date	Eg sighted	Eg photo'd	Ba	Bp	Mn	UNLW	La	Pp	UnDo	Pv	Pg	UNSE	Hours at Sea	Miles Surveyed
GN049	29-Mar	5	3	0	1	0	0	0	0	0	0	0	0	10.5	22.9*
GN051	5-Apr	9	5	0	0	0	0	2	0	0	1	0	0	7.8	57.8
GN053	16-Apr	15	15	0	1	0	0	0	1	0	0	0	0	7.3	44.2
GN055	1-May	0	0	0	1	0	0	0	2	0	2	0	0	4.5	44.7
Total shipboard surveys		29	23	0	3	0	0	2	3	0	3	0	0	15.1	169.6
SW172	19-Dec-00	5	0	0	0	0	0	0	0	0	0	0	0	8.5	
SW173	8-Jan-01	4	2	0	0	0	0	0	0	0	5	0	0	10.5	
SW174	13-Jan-01	8	6	0	0	0	0	0	0	0	0	0	0	8.6	
SW180	23-Jan-01	4	0	0	0	1	0	200-300	0	0	0	0	0	8.3	
SW181	24-Jan-01	4	1	0	0	0	0	0	0	0	1	0	0	9.2	
SW182	29-Jan-01	7	0	0	0	0	0	0	0	0	2	0	0	5.4	
SW183	30-Jan-01	3	0	0	0	0	1	0	0	0	1	0	0	5.1	
SW184	2-Feb-01	10	8	0	0	0	0	0	0	0	7	0	0	10	
SW185	9-Feb-01	9	9	0	0	0	0	0	5-10	0	2	0	0	5	
SW186	14-Feb-01	3	3	0	1	0	0	0	0	0	0	0	0	4	
SW187	16-Feb-01	10	10	0	0	0	0	0	1	0	2	0	2	8.1	
SW188	2-Mar-01	1	0	0	0	0	2	30-60	0	0	0	1	1	12.1	
SW189	8-Mar-01	6	6	0	0	0	0	0	1	0	0	0	0	6.5	
SW191	15-Mar-01	23	21	0	0	0	0	0	3-6	0	1	0	0	4	
SW192	16-Mar-01	10	8	0	1	0	0	0	2	0	1	0	2	10.1	
SW194	20-Mar-01	8	7	0	3	4	1	0	33-53	0	0	0	4	9.5	
SW195	26-Mar-01	4	2	0	2	4	0	100-200	37-77	30-50	4	0	1	8	
SW196	29-Mar-01	11	4	0	0	0	0	0	1	0	0	0	2	11	
SW197	4-Apr-01	7	3	0	1	0	0	0	0	10	0	0	0	12.5	
SW198	5-Apr-01	5	0	0	0	0	0	0	2-4	0	0	0	0	8.5	
SW199	6-Apr-01	8	8	0	1	0	0	0	10-13	0	2	1	4	8	
SW200	9-Apr-01	2	2	0	1	0	1	0	4-6	0	0	0	2	7.3	
SW201	10-Apr-01	11	7	0	0	0	0	0	0	0	0	0	0	4	
SW202	11-Apr-01	11	5	1	0	0	2-3	0	0	0	0	0	1	6.8	
SW203	23-Apr-01	7	7	0	0	0	1	0	0	0	0	0	0	7.8	
SW204	1-May-01	0	0	1	3	0	2	0	12-22	0	0	0	5	9.3	
SW205	2-May-01	0	0	0	0	0	0	0	0	0	0	0	0	9.5	
SW206	4-May-01	0	0	1	1	0	0	0	0	0	0	0	0	6	
SW207	8-May-01	0	0	0	0	0	0	0	0	0	0	0	0	7	
Total opportunistic		181	119	2	14	9	10-11	330-560	111-196	40-60	28	2	24	94.1	n/a
Total all surveys		210	142	2	17	9	10-11	332-562	114-199	40-60	31	2	24	109.2	169.6

\*Survey protocol ended after 3 hrs. due to entangled whale

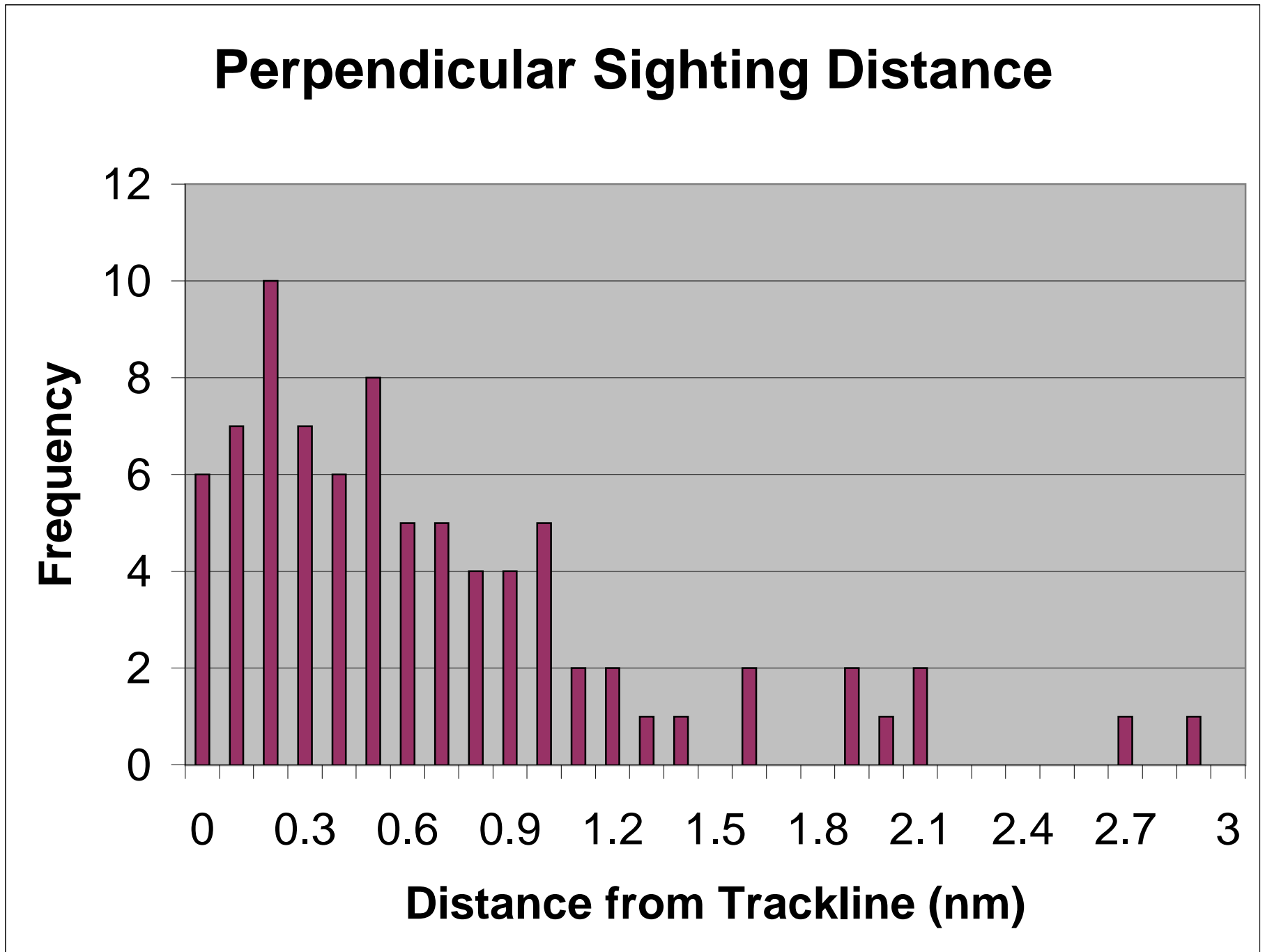


Table 4. Number of surveys, demographic composition and number of right whales identified in Cape Cod Bay from aerial and shipboard surveys in two-week intervals during late December 2000, and from January and mid-May 2001.

Two week intervals	Dec-00	1-14 Jan	15-28 Jan	29 Jan- 11 Feb	12-25 Feb	26 Feb- 11 Mar	12-25 Mar	26 Mar- 8 Apr	9-22 Apr	23 Apr- 6 May	7-15 May*	Total
a) Surveys												
Aerial	1	3	3	4	4	0	2	4	5	4	2	32
R/V <i>Shearwater</i>	1	2	2	4	2	2	3	5	3	4	1	29
R/V <i>Gannet</i>								2	1	1		4
b) Demographics												
Male	3	11	5	13	12	4	22	10	10	3	10	
Female	1	1	2	3	6	1	13	15	12	8	2	
Unknown Sex		2	1	2	1	1	6	7	8	6	2	
Calf												
Juvenile	2	5	2	7	8	1	8	7	6	6	2	
Adult	2	8	5	11	11	4	28	17	16	5	8	
Unknown Age		1	1			1	5	3	3	1	4	
c) Resightings												
New Sightings	4	11	3	6	10	4	22	20	5	2	9	
Resightings		3	5	12	9	2	19	12	25	15	5	
Total right whales id'd in Cape Cod Bay												
	4	14	8	18	19	6	41	32	30	17	14	

\*This interval represents one week; all sightings listed are from the Great South Channel.

Figure 13. Perpendicular sighting distances from Cape Cod Bay aerial surveys, 2001.



Appendix I

Confirmed right whale identifications in Cape Cod Bay in 1998-2001 and the sighting histories of those 153 individuals, plus 7 calves and 5 uncataloged whales.

Abbreviations are listed at bottom of page.

EGNO	Sex	Y1980	Y1981	Y1982	Y1983	Y1984	Y1985	Y1986	Y1987	Y1988	Y1989	Y1990	Y1991	Y1992	Y1993	Y1994	Y1995	Y1996	Y1997	Y1998	Y1999	Y2000	Y2001	
1004	F	OF					G		SMF		S	SFO			FS	S	M	S	SF	M		G		
1013	F	MF			M		SM				M					MJ		M	SM		M	M		
1014	F	MF		M	MOF					MGF	M	MS	SM				M	MS	M	M	M			
1019	M	F		GB			MF	M	B	G		M			F		MF	MGF	M	MGN	MG	S		
1027	F	F		BF	BF	SA	MG	MGBF	B	MBF	SMF	B	B		MF	F	MF	MF	MGF	MF	MF	MOF	M	
1033	M		M	B			M	B	B	B					F	M	M	MF		M				
1039	F	O						B			M	MS		M		M	M	SM	M	MF	F	OS		
1042	U	GB	G		B			M	GB	B	GB		B					M	MO	MN	G			
1102	M	B	GO	B				B	G	B	B	B	B		F	F	MF	MF	F	MF			G	
1112	M	F	GF	BF	F	MJ	MO	B	F		FM	F		M	FJ	F	M	F	GF		F	MF		
1113	M		F	B		O		B	B	GB	B		B		M		M		B	N	F	M	S	
1114	F		GF		B	F		GB	MB			SM	M	M	M	M	MFS	SMF	F	M	F	MGF		
1121	M		GF	GB		MF			F	GF	GF	FB		F	F	MF	F	MFO	MF	M	F	F		
1130	M	GF	GF	F		M		B	B	GB	BJO	MF	B		F	F	FB	SMGF	MF	MF	MOF	M		
1131	M		GF	GF	GB	F	MG			B	F	F	B		F	F	F	MF	F	O	MGF	MOF		
1133	M		GF		B	BF	MG			B	GB	B			F	MF		M	F	AF	GN	M		
1136	M		F	GF		F	G	B	B	GFB	B	F	MB	F	F	MFJ	F	MF	MF	F	M			
1140	F		GF	F				M	SMGF	G		SMFJ				SMF	M	M	M	M	M	M	MG	SA
1146	M	B	GF		M	MBF			MF	MGB	MGBF			F	F	FJ	F	MF	F	M		MF		
1150	M	O	MF	B	M		MF	F	B	FB	F		MFB	F	F	MF	F	FO	MF	MF	MGF	MBF	M	
1158	F		F	F		MF		M	G	G	SGF	M	F	M	F	F	MF	S	MFS	SAF	MGF	FS	S	
1162	M	B	F										B			F	F		F	M	OF	F		
1167	M		F	F			G	MB	B	GB	B		B	F	SF	F	SGF	F	F	F	F	AMOF	M	
1170	M		F	F	MF	MGF	F	M		GF	F	F	B	F	F	F	F	FO	MF	MAF	MGF	GF	M	
1208	F		M				MG			G	GS	SAG	N	S			S	SF		M	O	M		
1209	F	M		M	B			B	F	F	SB	S	M		F	FJ	F	F	F	MF	GF	AOF	M	
1239	M		G	F				B	GB	GB	GB		B	M	F	F	F	MFO	F	G	MF			
1240	F			F			F			G	SB	S	F		F	F	F	F	SF	M	MF	MO		
1241	F			F	MF	MF	F	GF		JF	SF	F	MFB	M	F	FS	SF	M	MF	MOF	F	MF	M	
1245	F			F	MF	F	MFO	A	F	F	F	F		F	OFS	SF	FS	SAMF	F	MF	F	MGF		
1249	M			OF	F	MG	M	MB	B	GB	B	B	BF		MF	F	MF	MFO	F	MF	MGF	MF	S	
1267	F			J	F			GBF	B	BF	GFB	FS	M		MF	MF	MF	SMF	MF	MF	MGF	GOF	S	
1270	M	G		B		B				B	B	B								M				
1271	M			B	B			MF		GB	B	B	B			F	F	OF	F	M	GF	MGF		
1280	U			GB		G	MB	MB	MB	B			M	M	M	M			M	M	O	AM		
1281	F		G	B			SM	MA	SF		G	F		B	M	SF	F	MF	SF	F	F	OFS	SM	
1301	F				MF	AM		MB		BS	SF	M	B	BS		F	MF	MF	FS	SAF	MF	MGBS	S	
1306	M				MF		F	G	M	GF	GF	B	B	F	F	F	F	SFO	F	F	GF	MGOF	GM	
1310	F				GF		G	MF					FJ		O			M	S	M				
1311	M				GF		M	GB		GB	B		B	SB	F	MF	F		M		G	SMG	M	
1317	M				SM	MBJ		GB	B	M	SB		B			OF	F	F	MF	F	MGF	MGF	M	
1327	M				MG	M	G	M	MBF	M	MB	B	B	GB	F	MF	F	F	FO	F	F	MGF	MGOF	M

B-Browns Bank, F-Bay of Fundy, O-Gulf of Maine, G-Great South Channel, J-Jeffreys Ledge, M-Cape Cod and Mass. Bays, A-Mid Atlantic, N-North, S-Southeast US.

Appendix I

Confirmed right whale identifications in Cape Cod Bay in 1998-2001 and the sighting histories of those 153 individuals, plus 7 calves and 5 uncataloged whales.

Abbreviations are listed at bottom of page.

EGNO	Sex	Y1980	Y1981	Y1982	Y1983	Y1984	Y1985	Y1986	Y1987	Y1988	Y1989	Y1990	Y1991	Y1992	Y1993	Y1994	Y1995	Y1996	Y1997	Y1998	Y1999	Y2000	Y2001
1328	U				G					B	F	B	G	MBF	F	F	M	M	F		M	MG	M
1403	M					F		F		GB	B		B	MF		F	F	SM	F	F	GF	M	S
1405	F					SF	F			GF	F	F	F	F	F	F	F	SMF	SF	M	M		
1406	F					SMF	MOF			MB	FA		MF	MF	MFA	SMF	MF	M	MF	MF	MF	MOF	
1407	F	B	G	M		SF				F	SMF				SOAF	F			M	M	O	MOGS	S
1409	M					F		B	B	GB	B	B	B		SMF	F	MF	S				M	S
1411	M					SF		G		B	MB	B	B		F		F	F	MF	M		M	M
1424	M		M		B	B	S	M	G	GB	GB	M	B	M	MF	F	F	SMF	F	MAF	MF	GOF	M
1425	F			G		F	M		M	B	M	M		M	MFS	SGAF	MF	MF	F	A	M		S
1427	M					F	JM		GB	GB	B	B	B	MF	MF	F	MF	FO	MGF	FM	MG	S	M
1428	M		G			MGO	M	GB		MG	F	FB	B	F	F	F	MF	SMF	F	M		MOF	SM
1430	F					M	M	MB	MB	MG	B			SM	F	MF	MF	MNS	S	MGN	MO	MO	
1503	F						F	M	M	MB		F		M	F	F	SFM	MF	BF	MG	MF	MOF	M
1505	M						MF	AM		GOB	B	B	MF		MSF	FJ	MF	SMF	MF	MOF	M		
1507	M						JOF	M	GMF	GOF	F	FB	MB	F	MF	F	F	MFO	MF	MGFJ	MGF	MOF	M
1509	F	GB				M	M	SM		B	SJM	M	M	SMJ		M	MN	MNS	SF	M	MG	MS	SA
1511	M		G		B	G	M	MBF	B	B	B								F		M	MO	G
1514	M						MG			MB	B	B	B				M			M		OF	
1601	F							SF	M	GF	F	F	MB		S	F	MF	F	SF	M	G	SO	S
1602	F							SMF	MF	SMF	F		M	M	MFS	SF	MFS	SMFO	F	MF	GF	MGFS	SM
1603	M							SGJMF	M		B	S	M		SF	F	MF	F	F	M	GF	SMF	M
1606	M							MF	G	F	B				F	F	F	SMF	F	M	MF	M	
1608	F							SM	GM		F	F	MF	MF	F	F	MF	MFO	F	MF	MGF	MF	M
1609	M							SM	F	F	F		B		F	F	F	SF			JMF	GFB	M
1611	F							SM	SF	B	B		B			F	F	MFO	SF	MGF	MF	OFS	S
1613	M							SJM			FM	F			S	F	F	S	BF	F	F	SAGF	M
1622	F							M	M	GBS	S	M	SM				F	MS	SMO	M	MG	M	M
1624	M							B		GB	GB				F	F			F		G	MG	
1630	U							B	B						F	F	F		F		F	MOG	
1701	F								F	F	B	B	FB		FS	F	FS	SF	OF	MF	MGF	FS	S
1703	F								F		F	F			SF	SF	F	SF	MF	S	SGF	MOS	SM
1704	F								SMGF	SMF	F	BM	MF	MF	MF	MF	MOF	MFOS	SMF	M	M		
1705	F								SMF	GF	GF	SF	F	OF	OFS	SFJ	FS	SF	F		GF	MOF	
1706	F								SMF	F	F	F	F		SMF	FJ	SF	MF	MFS	MF	MGF	ASGF	M
1708	M								GB	B	B		M	M			M	F	F	F	MG	MGF	SM
1709	M								M	JB	B	B	B	M	SF	F	F	F	F	SMF			
1710	F								SM				JM					S				GS	SM
1711	F								SM	GB	MB						F	SMF	F	M	SMG	MS	S
1712	M								SAM		B	B	B			F	F	F	M		MF	S	S
1716	M								B	B	B	B			F	F	F	F	F	G	MF	GF	
1802	F									MGF	MF	MF	MF	F	SMF	F	MF	MFS	F	MF	MGF	MGOF	S
1803	M									JF		F	F	S	SMF	F	F	M	OF	S	MGF	F	M

B-Browns Bank, F-Bay of Fundy, O-Gulf of Maine, G-Great South Channel, J-Jeffreys Ledge, M-Cape Cod and Mass. Bays, A-Mid Atlantic, N-North, S-Southeast US.

Appendix I

Confirmed right whale identifications in Cape Cod Bay in 1998-2001 and the sighting histories of those 153 individuals, plus 7 calves and 5 uncataloged whales.

Abbreviations are listed at bottom of page.

EGNO	Sex	Y1980	Y1981	Y1982	Y1983	Y1984	Y1985	Y1986	Y1987	Y1988	Y1989	Y1990	Y1991	Y1992	Y1993	Y1994	Y1995	Y1996	Y1997	Y1998	Y1999	Y2000	Y2001
1804	M									GO	F	F	F	F	F	F	F	F	MF	SF	MGF	AMGF	M
1812	F									B	B		B		SF	F	F	S	F		MGF	MOGBF	
1817	F									B	SB		S	S	SF	SF	FS	SF	F	S	G	MFS	SM
1820	U									B	B	B	B		M	F		SMF	MF	M	MF	MOF	M
1901	M										SGF		S	SF	SF	SF		SMF	SMF	F	MGOF	SOFB	SGM
1909	F									SJM	MJ	B	M	M	SMF	F	SF	F	MF	MF	SMOGF	GOF	
1911	F									F	M				F	MF	M	MF	MF	SMGF	MF	S	
1934	F									SMO		B	M	SF	MF	MF	M	MF	MGF	MGF			
1946	F									SGJF	F		M	SF	F	F	FS	SMF	F	F		OF	M
1968	F									GF		B	B	S	F	F	OF	F	M	MF	MFS	SM	
1971	M									F	F		F	F	F	F	F	F	GF	F	GF	MSAOBF	
1980	M									B								SM		M		SMG	
1981	U									F	F				S	F	F	SOF	FS	F	MGF	F	
2010	M										FJ	M	M	S	F	F	F	SF	MF	SM	MGF	SMOB	M
2027	M										MJF				F	F	F		MFO	F	M	MF	M
2040	F										MJF				F	F	F			O	G	MF	S
2048	M										F	F			F	F	MF	M	F	F	MF	SGOB	M
2050	F										M		M	SM		MF	SMF	MF	MGF	MGF	MGFS	SM	
2114	F										S	SB		M	F	MF			F	M	GF	FB	
2123	F											F	MF	SF	FS	FS	SMFO	SMF	SMAF	MGF	MF	SM	
2135	M											MF	MF	SF	F	F	SMOF	GF	MF	MJOGF	SMF		
2140	M										S	F	F	S	MF	F	SMF	F	MF	MGF	GF	SM	
2143	F											SF	F	F	F	F	FO	MF	F	GF	SMF	M	
2145	F											MF	F	MF	F	F	MOF	M	MF	MF	SMF	SM	
2150	F											M			F							SM	
2158	M											F	MF	F	F	MF	MF			SM	MF	MOF	M
2201	M												SF	SMF	F	MF	SFO	F	SF	MF	GF	M	
2209	M												SMJ	M	F	MF	SMFO	F	AF	MGFS	MGOF	M	
2212	M												SJM	M		F	F	F	MF				
2215	M												SB	MF	F	MF	SMFO	MF	SMF	MGOF	MF	M	
2223	F												F	F	F	F	O	F	MGF	MGFS	MF	MG	
2240	F												SF	SF	F	F	SFO	F	MG	OGF	MOF	S	
2271	M												SF	F	F	F	SMOF	F	M	MGF	AGOF	M	
2303	M													SF	SMF	MF	SF	M	SAF	MGF	GF		
2304	M													M	F	F	MF	F	F	MOF	MGO	M	
2310	M													F	F	F	F	FS		F	F	M	
2320	F													S	F	F	SF	SMF	S	GF	MOBFS	M	
2330	F													M		F	F	F	SF	F	GF	SM	
2340	M													F	F	M	F	F		MGF	MGF	M	
2350	U													F	F	MF		F		MGF		SM	
2406	U													A	SMF	M	F	F	MF	MGF	MGOF	M	
2425	F														SGAF	MF				MF	MGF	SMGF	M

B-Browns Bank, F-Bay of Fundy, O-Gulf of Maine, G-Great South Channel, J-Jeffreys Ledge, M-Cape Cod and Mass. Bays, A-Mid Atlantic, N-North, S-Southeast US.

Appendix I

Confirmed right whale identifications in Cape Cod Bay in 1998-2001 and the sighting histories of those 153 individuals, plus 7 calves and 5 uncatalogued whales.

Abbreviations are listed at bottom of page.

EGNO	Sex	Y1980	Y1981	Y1982	Y1983	Y1984	Y1985	Y1986	Y1987	Y1988	Y1989	Y1990	Y1991	Y1992	Y1993	Y1994	Y1995	Y1996	Y1997	Y1998	Y1999	Y2000	Y2001
2427	M															M	F	MFO	F	F	GF	MF	M
2430	F															F	MF	F	F	F	MGFS	MF	M
2460	F															F	MF	F			GF	MOF	M
2470	U															F	F	MF	F	MF	MGF	MGF	S
2479	U															F	F	MF	MF	MF	MGF	MF	M
2503	F																SFM	F	F	MF	F	MF	M
2510	U															M				MN		G	S
2540	M															F	F	F	F	F	F	MOF	M
2602	M																	SMFOA	F	F	F	MF	M
2605	F																	SF	F	MF	F	F	G
2608	M																	AF	F	F	F	MF	
2614	F																	SMF		M	GF		
2617	U																	SF	SF	F	F	MF	M
2630	U																	F	F	MAF	MF	GF	
2645	F																	SAMF	SMF	F	MS	MF	M
2701	F																		SF	SMF	F	A	
2704	M																	S	SMF	MF			
2705	U																		SF	SMF	F	F	M
2709	M																		SF	SF	F	MF	M
2710	U																	S	SF	F	MF	F	G
2720	U																		F	MF		MF	M
2740	M																		SF	F	MF	F	M
2746	F																	S	SMF	F	F	F	M
2750	M																		SF	F	MGF	MF	M
2760	U																		F	GFM	MOF	MF	
2910	U																				M	F	
2920	U																				SMG	MG	M
98-443																					M		M
01-41																							M
01-178																						F	M
01-185																							M
01-401																							M
1281ca																							M
1602ca																							M
1703ca																							M
1710ca																							M
2050ca																							M
2145ca																							M
2150ca																							M

B-Browns Bank, F-Bay of Fundy, O-Gulf of Maine, G-Great South Channel, J-Jeffreys Ledge, M-Cape Cod and Mass. Bays, A-Mid Atlantic, N-North, S-Southeast US.

Appendix II. Sighting records of right whales (n=96) identified in Cape Cod Bay, December 2000 to mid May 2001. F (female), M (male), A (adult), J (juvenile), U (unknown).

Id #	Sex	Age	19-Dec-00	5-Jan-01	8-Jan	13-Jan	23-Jan	24-Jan	29-Jan	1-Feb	2-Feb	4-Feb	9-Feb	12-Feb	14-Feb	16-Feb	22-Feb	8-Mar	15-Mar	16-Mar	17-Mar	20-Mar	26-Mar	29-Mar	4-Apr	5-Apr	6-Apr	9-Apr	10-Apr	11-Apr	16-Apr	17-Apr	20-Apr	23-Apr	29-Apr	1-May	11-May	# of days sighted	
2010	M	11	x			x																x																2	
2406	M	7	x			x																x					x												6
2750	M	4	x			x	x		x	x												x	x				x						x		x			13	
1241	F	19	x					x				x																							x	x			4
1167	M	A				x						x	x																										3
2310	M	A				x		x																		x							x						8
2460	F	U				x		x																		x													8
1170	M	20				x	x					x																											6
1150	M	A				x			x																														2
2602	M	5				x							x	x																									6
2201	M	9				x																																	8
1820	U	A				x							x	x																								11	
2479	U	7				x																																	8
1803	M	13				x																																	4
2740	M	4				x																																	11
01-41	U	U				x	x																																2
1503	F	16				x																																	3
2709	M	4				x																																	7
2320	F	A				x																																	5
2027	M	11				x																																	4
1311	M	18				x																																	5
2705	M	4				x																																	3
2223	F	9				x																																	5
2304	M	8				x																																	12
1507	M	16				x																																	2
2645	F	5				x																																	13
2340	M	A				x																																	4
1706	F	14				x																																	2
2158	M	10				x																																	2
2617	F	5				x																																	3
1411	M	17				x																																	1
2215	M	9				x																																	4
1327	M	A				x																																	1
1027	F	A				x																																	3
1428	M	A				x																																	1
1804	M	13				x																																	2
1328	M	A				x																																	1
2430	F	U				x																																	3
2140	M	10				x																																	1
2427	M	7				x																																	2
1708	M	14				x																																	2
2503	F	6				x																																	2
01-178	U	U				x																																	1
1622	F	A				x																																	1
2540	M	U				x																																	2
2048	M	11				x																																	5
1317	M	18				x																																	2
01-185	U	U				x																																	3
2143	F	10				x																																	1
1901	M	12				x																																	2
1424	M	A				x																																	2
1608	F	15				x																																	4
1609	M	15				x																																	2
1613	M	15				x																																	3
1306	M	A				x																																	1
1968	F	12				x																																	1
2350	U	A				x																																	1
2920	U	U				x																																	1
1209	F	A				x																																	2
1817	F	A				x																																	2
1703	F	14				x																																	10
1703ca	U	0				x																																	10
1946	F	12				x																																	1
2425	F	7				x																																	3
2720	U	U				x																																	6
2209	M	9				x																																	2
98-443	U	U				x																																	2
1602	F	15				x																																	