CRUISE RESULTS

NOAA Twin Otter
Cruise No. TO07-01

North Atlantic Marine Mammal and Turtle Aerial Abundance Survey

ABSTRACT

During 30 July to 29 August 2007, the Northeast Fisheries Science Center conducted an abundance survey using an airplane and ship in waters from Cape Hatteras, North Carolina to the Bay of Fundy, from the coast line to beyond the 2000 m depth contour. The shipboard survey (using the *R/V Henry Bigelow*) was concentrated in the coastal waters in the Gulf of Maine, and the aerial survey (using the NOAA Twin Otter) covered the rest of the area. The aerial results are reported in this document; while the shipboard results are reported in a companion paper. The primary objective for the aerial survey is to determine the spatial distribution and abundance of cetaceans and sea turtles in the study region. The airplane flew at 600 feet above the water surface at about 110 knots and the circle-back (Hiby) data collection methods were used, where circles were performed on groups of cetaceans and turtles that had 5 or less animals per group. There were about 8,900 km of on-effort track lines that were conducted in Beaufort 3 or less and will be used in the abundance estimates. On these track lines, there were 15 species of identifiable cetaceans, 4 turtle species detected. There were 98 circle-backs performed on 20 species/species groups that can be used to estimate *g(0)* for these species. The abundance estimates using these data are underway.

CRUISE PERIOD AND AREA

The aerial survey was conducted during 30 July to 28 August 2007. The study area extended from Cape Hatteras, North Carolina to the Bay of Fundy, from the coast to about the 2000 m depth contour (Figure 1).

OBJECTIVES

The primary objective is to determine the spatial distribution and abundance of cetaceans and sea turtles in the study region. The aerial survey was coordinated with a shipboard survey. Each platform covered separate regions, except for two small areas which were surveyed simultaneously by both platforms on the same day on the same track lines.

METHODS

The aerial survey (Figure 1) were conducted on the NOAA DeHavilland Twin Otter DHC-6, Series 300 aircraft over Atlantic waters off the east coast of the US and Canada. Track lines were flown 183 m (600 ft) above the water surface, at

about 200 kph (110 knots), when Beaufort sea state conditions were below four, and when there was at least two miles of visibility. Some effort was flown in Beaufort sea states of four but they were not used in the abundance estimate.

There were two pilots and five scientists onboard. Three scientists were observers searching with the naked eye. One scientist was on rest. The fifth scientist recorded the data. Scientists rotated positions at the end of track lines or about every 30-40 minutes. Two observers, located behind the two pilots, were looking through large bubble windows, where one observer was on each side of the plane. The third observer was at the back of the plane lying on the ground looking through a belly window. The belly window observer was limited to approximately a 28º view on both sides of the track line. The bubble window observers searched from straight down to the horizon.

When a cetacean, seal, turtle, sunfish, and basking shark was observed the following data were collected: time animal passed perpendicular to the window; species identification; group size; angle of declination from the track line, measured by inclinometers or marks on the windows; cue (animal, splash, blow, footprint, birds, vessel/gear, windrows, or other); swim direction (0º indicates swimming parallel to the track line in the direction the plane was flying, 90º indicates swimming perpendicular to the track line and towards the right, etc.); if the animal appeared to react to the plane (yes or no); if the animal was diving (yes or no), and; comments, if any. Boats and other fish species were also recorded opportunistically. Species identifications were recorded only when the observers were certain of the identification; otherwise, “species” was identified to the lowest taxonomic level possible (e.g. fin or sei whale, or just unidentified whale).

At the beginning of each leg, and when conditions changed the following data were collected: initials of person in the two pilot seats and three observation stations; Beaufort sea state recorded to one decimal place; water color (deep blue, blue, greenish blue, green, light green, yellowish green, yellow green, green yellow, greenish yellow or yellow) or water turbidity (clear, moderately clear or turbid); percentage of cloud cover (0-100%); angle glare started and ended at (0-359º), where 0º was the track line in the direction of flight and 90º was directly abeam to the right side of the track line; magnitude of glare (none, slight, moderate, and excessive); and subjective overall quality for each observer (excellent, good, moderate, fair, and poor), where data collected in poor conditions indicated conditions were so poor the data should not be used.

In addition, the location of the plane and sea surface temperature was recorded. Plane location was measured with a GPS that was attached to the data entry program. Sea surface temperature was measured using an infra-red temperature sensor that was located in the belly of the aircraft. Sightings and effort data were collected by a computer program called VOR.exe (Lovell and Hiby ..).

To estimate *g(0)*, the probability of detecting a group on the track line, the Hiby circle-back data collection method (Hiby 1999) was used for harbor porpoises only in 1999, and for all species in 2002, 2004, 2006, and 2007. This method is comparable to the shipboard two-independent team method. The

aerial circle-back method modifies standard single-plane line transect methods by circling back and re-surveying a portion of the track line (Figure 3). The re-surveyed track lines are called “trailing” legs, track lines that initiated the circle are called “leading” legs, while the track lines between the circles are called “single-plane” legs. As in the case of two teams on a ship, *g(0)* can be estimated using the aerial data collected during the leading and trailing legs, as they are comparable to data collected by two teams. The trailing legs correspond to times when a second team is on effort, while the leading legs correspond to times when the primary team is on effort at the same time as the second team, and the single-plane legs correspond to times when the primary team is on effort as a single team. Thus, *g(0)* can be estimated using data collected when both teams are on effort, that is using the data from the trailing and leading legs.

The criterion that started a circle-back was a single small group (≤ 5 animals) of cetaceans or turtles were seen within a 30 second time period. The detailed circle-back procedure was as follows (Figure 2):

1. Time and location of an initial sighting when it passed abeam of the plane was marked and started a 30-second timer,
2. During the 30-seconds, additional sightings were recorded as usual. If more than one additional sighting of the same species that triggered the circle were recorded during this time, then the circle-back procedure was aborted (because the density may be too high to accurately determine if a group of animals was the same group on both the leading and trailing legs of the track line).
3. At the end of the 30-seconds, if the criterion in number 2 was passed, the plane started to circle back and the observers went off effort. The time leaving the track line was marked, which started another timer for 120 seconds.
4. During this 120 seconds the plane circled back 180º and traveled parallel to the original track line about 0.8 nmi away, in the opposite direction, and on either side of the original track line.
5. At the end of the 120 seconds, the plane started to fly back to the track line.
6. When the plane intercepted the original track line, the time was marked, observers went back on effort, started searching again, and a 5-minute timer was started.
7. Sightings were then recorded as usual.
8. The circle-back procedure was not initiated again until a sighting was made after the 5-minute timer had expired. This was to insure forward progress on the track line.

RESULTS

Of the 30 days allocated to this project, the first day was used to train the observers and to conduct a training flight. An additional 20 days had sufficiently good weather to conduct the survey. The study area was about 315,000 km^2.

There were about 8,900 km of on-effort track lines (Table 1) that were conducted in Beaufort 3 or less and will be used in the abundance estimates.

During the on-effort survey days, there were fifteen species of identifiable cetaceans seen: whales: fin, sei, pilot (short-fin and long-fin), minke, right, beaked (all species) and humpback whales; white-sided, Risso's, striped, common, northern bottlenose and bottlenose (coastal and offshore) dolphins; and harbor porpoises. In addition, harbor seals, leatherback, loggerhead, Ridley's and green turtles were also seen (Table 2).

Ninty-eight (98) circle-backs were performed for 3 bottlenose dolphins, 2 common dolphins, 1 fin/sei whale, 5 fin whales, 4 Risso's dolphins, 1 green turtle, 15 harbor porpoises, 9 humpback whales, 10 leatherback turtles, 26 loggerhead turtles, 8 minke whales, 1 northern bottlenose dolphin, 14 ocean sunfishes, 3 pilot whales, 3 right whales, 2 sei whales, 5 sperm whales, 3 unidentified dolphins, 2 unidentified turtles, and 5 unidentified whales.

The locations of sightings by species are displayed in Figure 3. Note, some groups of animals were detected on both the leading and trailing legs of a circle and so are displayed twice on these maps.

LITERATURE CITED

Hiby, L. 1999. The objective identification of duplicate sightings in aerial survey for porpoise. Pages 179-189 *in*: Garner *et al.* (eds). Marine Mammal Survey and Assessment Methods. Balkema, Rotterdam.

Table 1. Lengths of track line (in km) and area (in km^2) of each stratum covered by the aerial surveys.

Stratum	Area (km^2)	Trackline lengths (km)		
		Single and leading legs	Trailing legs	Total
North	234,954	6,312	326	6,638
MidAtl	80,049	2,153	71	2,224
TOTAL	315,003	8,465	397	8,862

Table 2. Number of groups and individuals of the species detected during the combination of the leading and single legs, and during the trailing legs.

Species	Single and Leading Legs		
	Number of groups	Number of Animals	Mean group size
Beaked whales	2	6	3
Bottlenose dolphin	15	64	4.3
Common dolphin	64	2428	37.9
Fin / Sei Whale	4	4	1
Fin Whale	15	22	1.5
Harbor Porpoise	131	363	2.8
Humpback Whale	37	57	1.5
Minke Whale	13	14	1.1
Northern bottlenose dolphin	1	2	2
Pilot Whale	20	183	9.2
Right Whale	6	6	1
Risso's dolphin	31	243	7.8
Sei Whale	2	2	1
Sperm Whale	6	8	1.3
Striped Dolphin	1	130	130
White Sided Dolphin	11	335	30.5
Unid animal	24	42	1.8
Unid dolphin	39	525	13.5
Unid whale	24	38	1.6
Total Marine Mammals	446	4472	
Green Sea Turtle	1	1	1
Leatherback Sea Turtle	13	13	1
Loggerhead Sea Turtle	122	123	1
Ridley's Sea Turtle	2	2	1
Unid Sea Turtle	14	14	1
	152	153	
Basking sharks	61	62	1
Blue sharks	14	14	1
Hammerhead sharks	34	47	1.4
Sunfish	280	291	1
Total identified fish	389	414	
Total Sightings	987	5039	

Figure 1. Tracklines surveyed by the Twin Otter that were conducted in Beaufort sea state 3 or below.

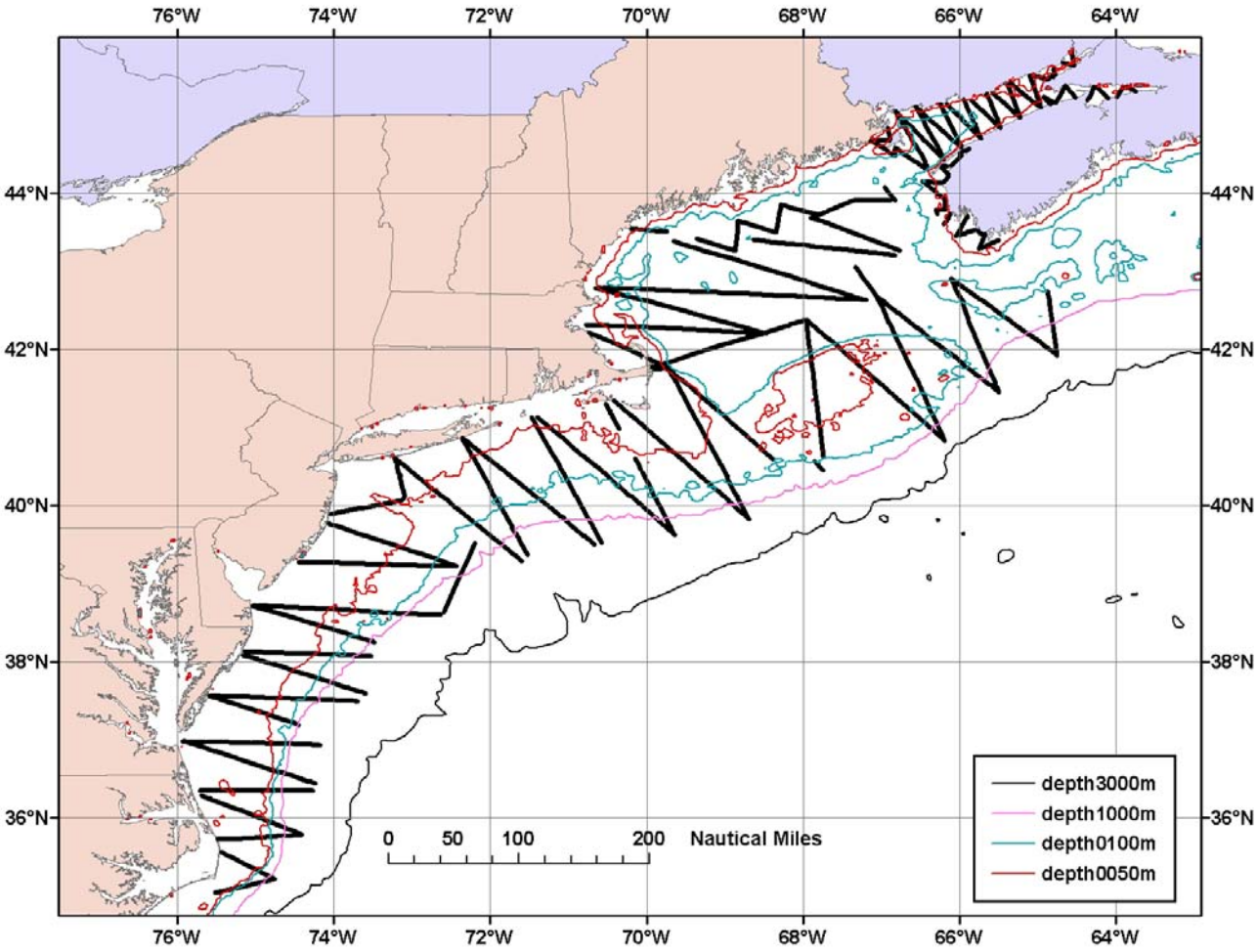

Figure 2. Diagram of how the circle-back technique was performed.

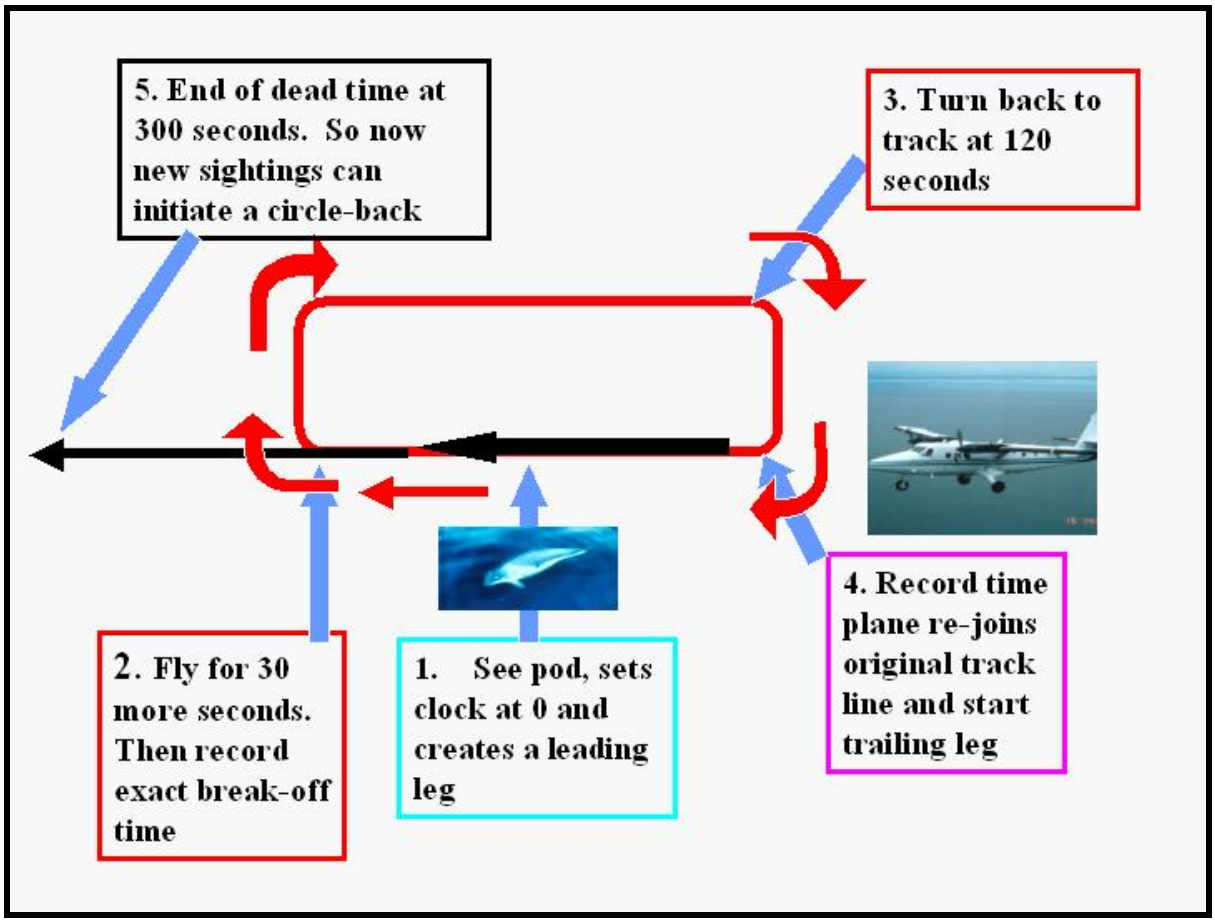

Figure 3. Location of sightings of cetaceans and turtles detected.