20 August 2004

AERIAL SURVEY RESULTS

NOAA TWIN OTTER AIRCRAFT
Circle-Back Abundance Survey

CRUISE PERIOD AND AREA

The survey was conducted on the NOAA DeHavilland Twin Otter DHC-6, Series 300 aircraft (N57 RF) from 12 June to 12 July 2004. The study area (Figure 1) extended between the state border between Virginia and North Carolina (36°N) to the Bay of Fundy (45°N) and from the US Atlantic shoreline to the entrance of the Gulf of St. Lawrence. (58°W).

The team was based out of Woods Hole, MA (Otis Air Force base) on June 12; Salisbury, Maryland from June 13 to 18; back to Woods Hole, MA (Otis Air Force base) from June 19 to 28; Portland, Maine on June 29 to 30; Bar Harbor, Maine from July 1 to July 7; Halifax, Nova Scotia from July 8 to July 9; Yarmouth, Nova Scotia from July 10 to 11, and back to Otis on July 12th.

OBJECTIVES

The objective of this survey was to describe the habitat of and estimate the abundance of cetaceans and turtles that are in the study area.

METHODS

Track lines, that were approximately 15 to 20 nautical miles apart, were flown 600 feet above the water surface, at about 110 knots, when Beaufort sea state conditions were at or below four, and when there was at least two miles of visibility.

There were two pilots and five scientists on board. Three scientists were observers searching for cetaceans, turtles, and seals using the naked eye. One scientist was on rest. The fifth scientist recorded the data. The recorder worked at this position for the entire survey. The other four scientists rotated between the three observation stations and the rest position. Rotations occurred 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 28° view on both sides of the track line and these sightings were recorded as negative degrees when on the left side of the plane

and as positive degrees when on the right side. The bubble window observers concentrated searching from straight down (0°) up to about 45° from the track line; the area from 45° to the horizon (90°) was also searched, though less frequently. Handheld binoculars were available to confirm species identifications, if desired. When a cetacean, seal, turtle, shark, or tuna was observed the following data were collected:

1. Time animal passed perpendicular to the window,
2. Species,
3. Group size,
4. Angle of declination from the track line, measured by inclinometers or marks on the windows,
5. Cue (animal, splash, blow, footprint, birds, vessel/gear, windrows, or other),
6. Swim direction (0° indicates swimming parallel to the track line in the direction the plane was flying, 90° indicates swimming perpendicular to the track line and towards the right, etc.),
7. If the animal appeared to react to the plane (yes or no),
8. If the animal was diving (yes or no), and
9. Comments, if any.

The two observers in bubble windows recorded the time of the sighting and the observation position by tapping a key on an external keyboard that was at each bubble window and was attached to the main data entry computer. The rest of the information was relayed to the data recorder via the intercom system. The observer in the belly window reported all its data to the recorder via the intercom.

At the beginning of each leg, and when conditions changed the following data were collected:

1. Initials of person in the two pilot seats, and three observation stations,
2. Beaufort sea state,
3. Water color (deep blue, blue, greenish blue, green, light green, yellowish green, yellow green, green yellow, greenish yellow or yellow),
4. Percentage of cloud cover (0-100%),
5. Angle glare started and ended at (0-359°), where 0° was the track line in the direction of flight and 90° was directly abeam to the right side of the track line,
6. Magnitude of glare (none, slight, moderate, and excessive),
7. Subjective overall quality for each observer (excellent, good, moderate, fair, and poor), where data collected in poor conditions should not be used.

In addition, the location of the plane and sea surface temperature was recorded every two seconds. 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; thus resulting in three types of files: gps, effort, and sightings. Temperature data, collected on a separate computer by a program called altitude.exe, were put into a separate file that contained the time, latitude, longitude, sea surface temperature, plane's altitude, speed, course, pitch and roll.

The circle-back method modifies standard single-plane line transect methods by circling back and re-surveying a portion of the track line (referred to as the trailing portion of track line) after a small group ($\leq$ 5 animals) of cetaceans or turtles were seen on the original track line (referred to as the leading portion of the track line). The purpose of this procedure is to compare the presence (or absence) and location of sightings on the leading portion of the track line to that on the trailing portion of the track line to estimate the probability of detecting each group. Details are outlined in Hiby (1999). The 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 two additional sightings 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 portion of the track line).
3. At the end of the 30-seconds, 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 180° 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.

A test of the ability of the observers to measure accurate angles was conducted over the Yarmouth Airport in Nova Scotia. Yarmouth was chosen because the airport was not busy. This test used the runway as a fixed point to compare the real angle to an observer's estimated angle (Figure 3). To start, the aircraft was positioned on the numbers on the runway and the GPS location was recorded. Then the aircraft took off heading down the runway (into the wind). Once airborne and, with the approval of the tower, the aircraft climbed to survey altitude (600 feet) and circled back parallel to the runway (downwind) at survey speed (110 knots). Once the runway numbers were perpendicular to the aircraft the sight button was hit and the estimated angles recorded. The aircraft then proceeded past the end of the runway and turned back in a racetrack pattern and headed into the wind on the opposite side of the runway. The same procedure was followed once the runway numbers were sighted again. The first pass should be approximately 0.25 miles off the runway and the second pass should be less, thus the belly window can see the numbers. Then the aircraft crossed mid-field to put the opposite observer on the numbers and the above pattern was followed in reverse.

RESULTS

Of the 31 days allocated to this survey:

a) 13 days were used to conduct the survey. These flights include 4163 nautical miles of on-effort track line (Figure 1), 722 nmi of off-effort transiting between track lines, and 148 nmi of track lines that were re-flown during 70 circle-backs;
b) 1 day was used for training the observers and pilots;
c) 2 days were used for a 100-hour plane service;
d) 5 days had short attempts to survey, but the flights were cancelled due to poor weather;
e) 1 bad weather day was used to test observer measurement accuracy;
f) and 9 days had bad weather where no flights were attempted.

The high priority areas, mid-Atlantic to Bay of Fundy waters, were surveyed (Figure 1). The lower priority area, east of Nova Scotia, Canada was not completed due to a lack of time.

Survey track lines in Canadian waters were flown during July 7 and 11, 2004. The rest of the survey track lines were in US waters.

During the on-effort survey days, there were ten species of identifiable cetaceans seen: fin, sei, pilot, minke, right, and humpback whales, white-sided, common, and bottlenose dolphins, and harbor porpoises (Table 1). In addition, harbor seals, leatherback, loggerhead, and green turtles were also seen (Table 1).

There were 297 groups of cetaceans and seals, and 140 sea turtle groups detected during the leading leg portion of the track lines (Table 1). Seventy circle-backs were performed that were triggered by 2 bottlenose dolphins, 4 common dolphins, 4 fin whales, 18 harbor porpoises, 2 humpback whales, 4 leatherback turtles, 19 loggerhead turtles, 4 minke whales, 4 pilot whales, 3 unidentified dolphins, 3 unidentified turtles, and 3 unidentified whales. The numbers of additional groups detected during the trailing leg of the circle-back are tallied in the last column in Table 1.

The locations of sightings by species are displayed in Figures 4 to 7. 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.

DISPOSITION OF THE DATA

These data will be maintained by the Protected Species Branch of the Northeast Fisheries Science Center at Woods Hole, MA, and will be available from the NEFSC's Oracle database.

PERSONNEL

Name	Title	Organization and Location
Scott Sandof	Aircraft Commander Part I	NOAA/AOC, Tampa, FL
Gregg LaMontagne	Aircraft Commander Part II	NOAA/AOC, Tampa, FL
John Neuhaus	Co-Pilot Part I	NOAA/AOC, Tampa, FL
Nick Toth	Co-Pilot Part II	NOAA/AOC, Tampa, FL
Robert DiGiovanni	Scientific Team Leader	Contractor for NOAA/NEFSC, Woods Hole, MA
Misty Neumeyer	Data Recorder	Integrated Statistics, Woods Hole, MA
Virginie Chadenet	Observer	Contractor for NOAA/NEFSC, Woods Hole, MA
Keri Lodge	Observer	Integrated Statistics, Woods Hole, MA
Brendan Hurley	Observer	Integrated Statistics, Woods Hole, MA

REFERENCE

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. Sightings detected during the 2004 Aerial Survey

Species	Number of groups	Number of Animals	Mean Group size	Max group size	Min Group size	Additional number of groups seen in circle-back
Bottlenose dolphin	4	8	2.0	4	1	1
Common dolphin	81	792	9.8	50	1	7
Fin / Sei Whale	8	10	1.3	2	1	0
Fin Whale	16	22	1.4	5	1	0
Harbor Porpoise	84	144	1.7	15	1	9
Harbor Seal	24	26	1.1	2	1	3
Humpback Whale	13	14	1.1	2	1	2
Minke Whale	8	8	1.0	1	1	1
Pilot Whale	24	104	4.3	14	1	3
Right Whale	3	5	1.7	3	1	1
Sei Whale	2	4	2.0	3	1	0
White Sided Dolphin	3	42	14	23	8	2
Unid animal	3	3	1.0	1	1	0
Unid dolphin	11	105	7.5	35	1	0
Unid marine mammal	1	1	1.0	1	1	0
Unid whale	12	14	1.3	3	1	1
Total Marine Mammals	297	1302	4.4	50	1	30
Green Sea Turtle	4	4	1	1	1	1
Leatherback Sea Turtle	12	12	1	1	1	3
Loggerhead Sea Turtle	116	117	1	2	1	11
Unid Sea Turtle	8	8	1	1	1	0
Total Sea Turtles	140	141	1	2	1	15
Basking sharks	141	166	1.2	4	1	1
Blue shark	4	4	1.0	1	1	0
Sunfish	218	218	1.0	1	1	3
Total identified fish	363	388	1.1	4	1	4
Total Sightings	800	1831	2.3	50	1	49

Figure 1. Track lines surveyed during June 12 to July 12, 2004 aerial survey.

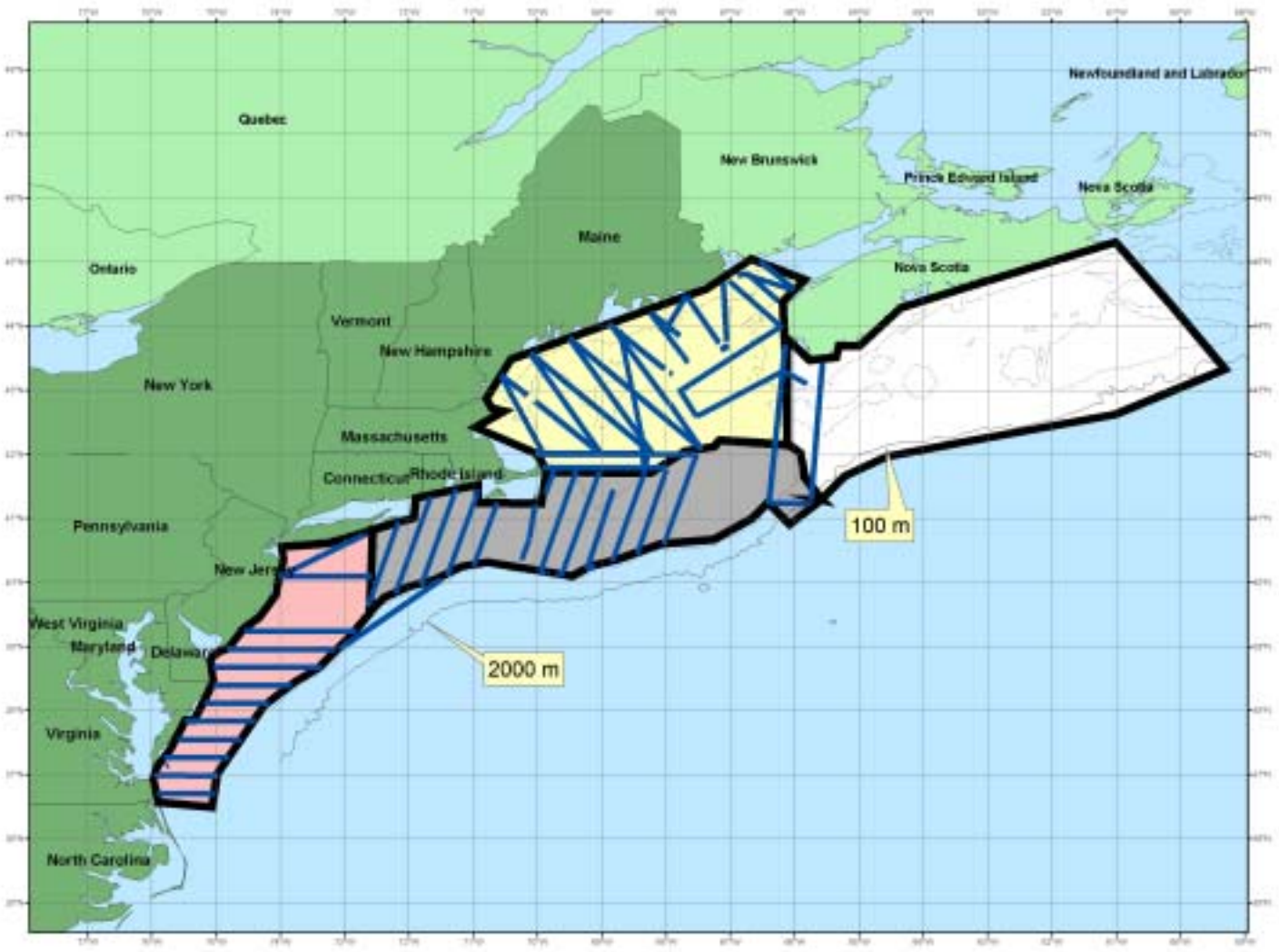

Figure 2. Circle-back procedure.

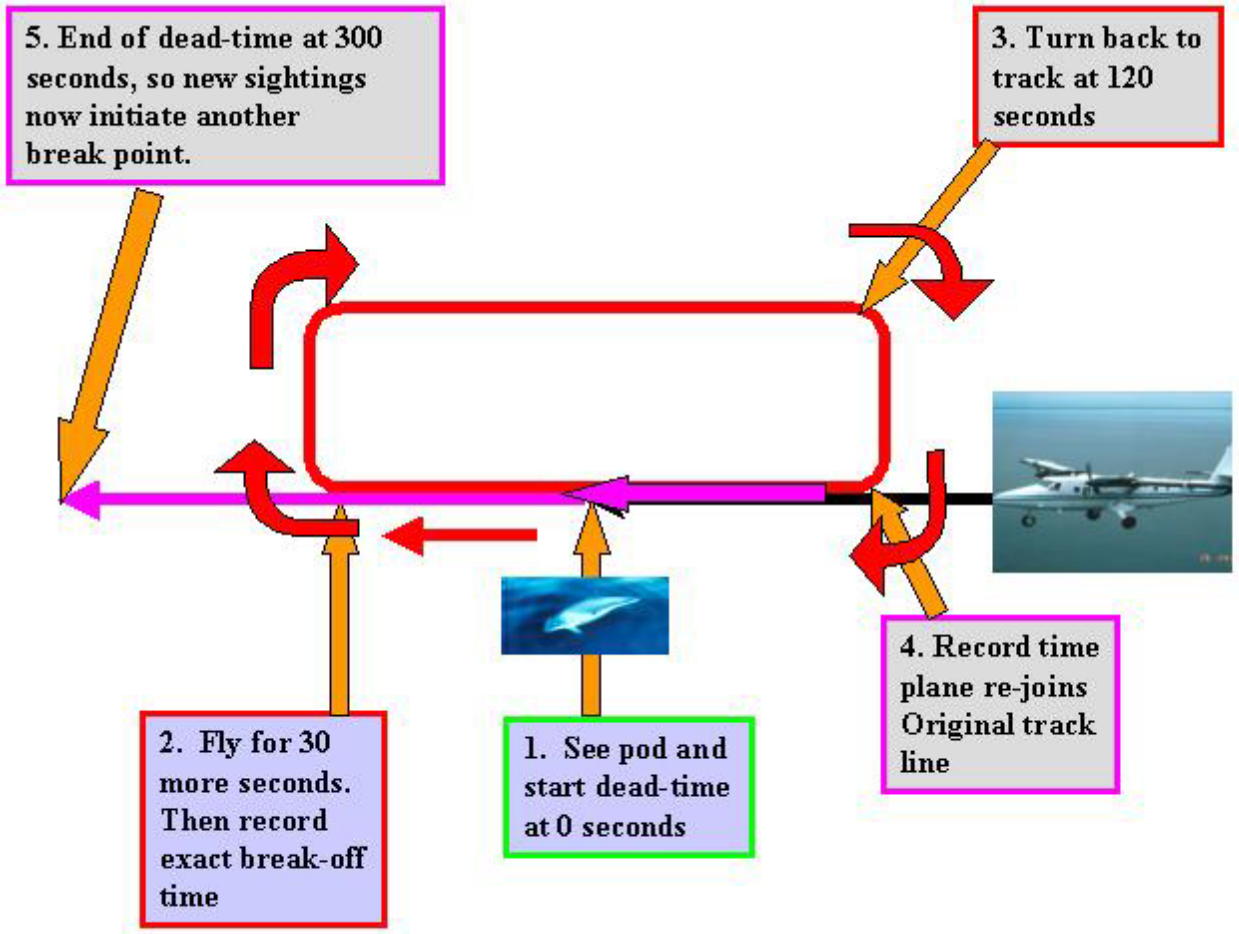

Figure 3. Procedure to test accuracy of observer measurements.

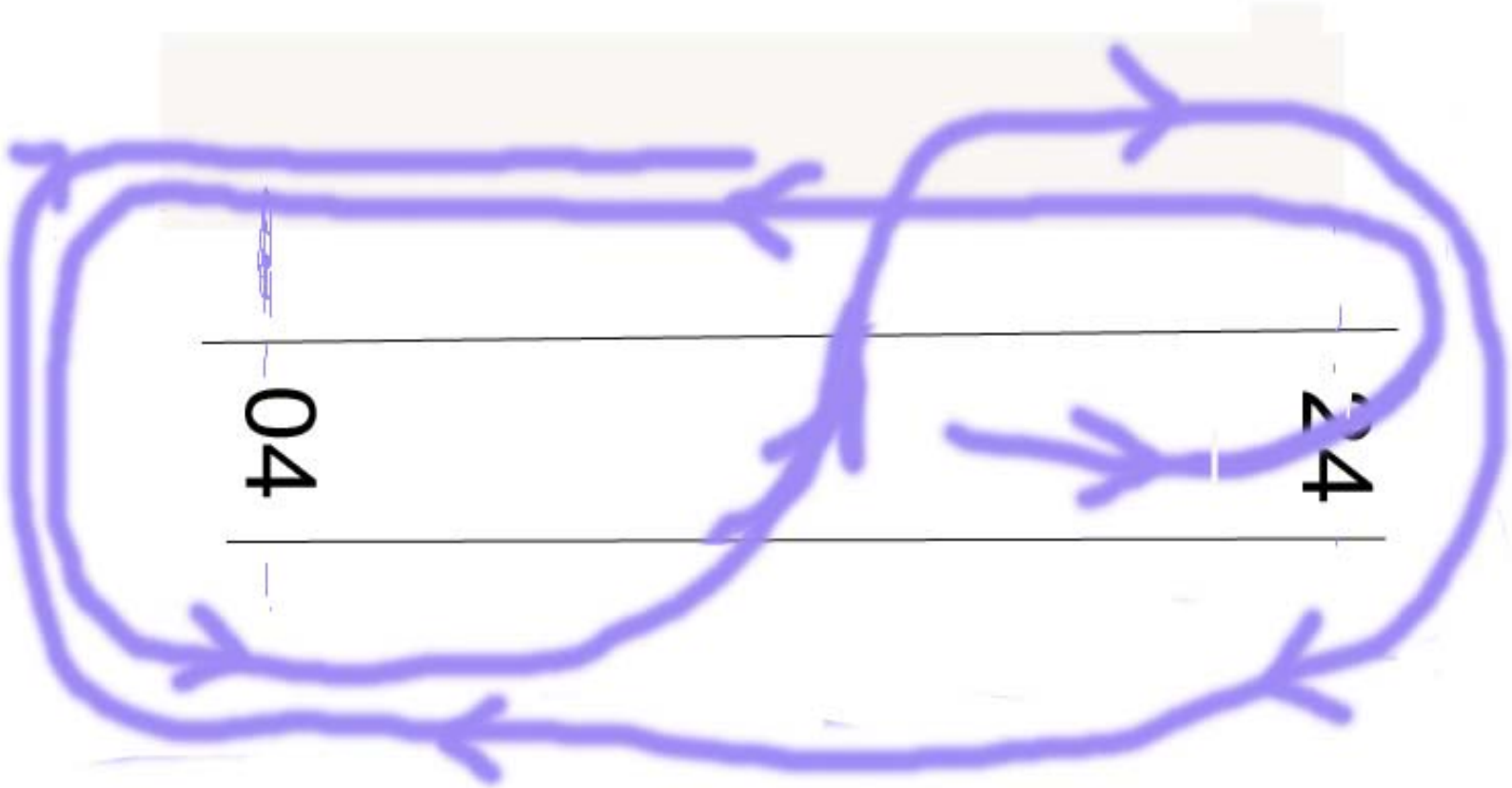

Figure 4. Locations of common dolphins, bottlenose dolphins and harbor seals.

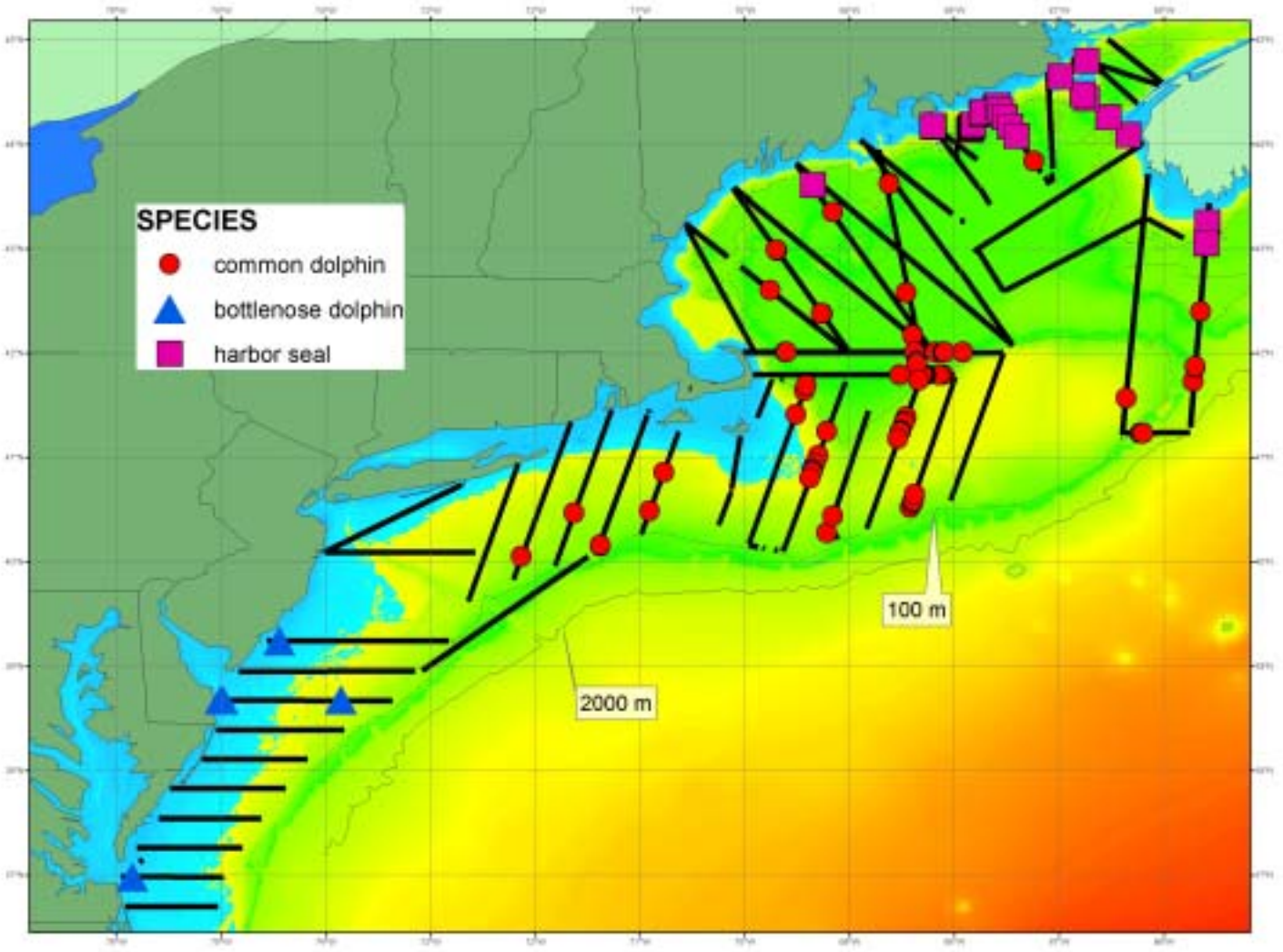

Figure 5. Locations of harbor porpoises, pilot whales, and white-sided dolphins.

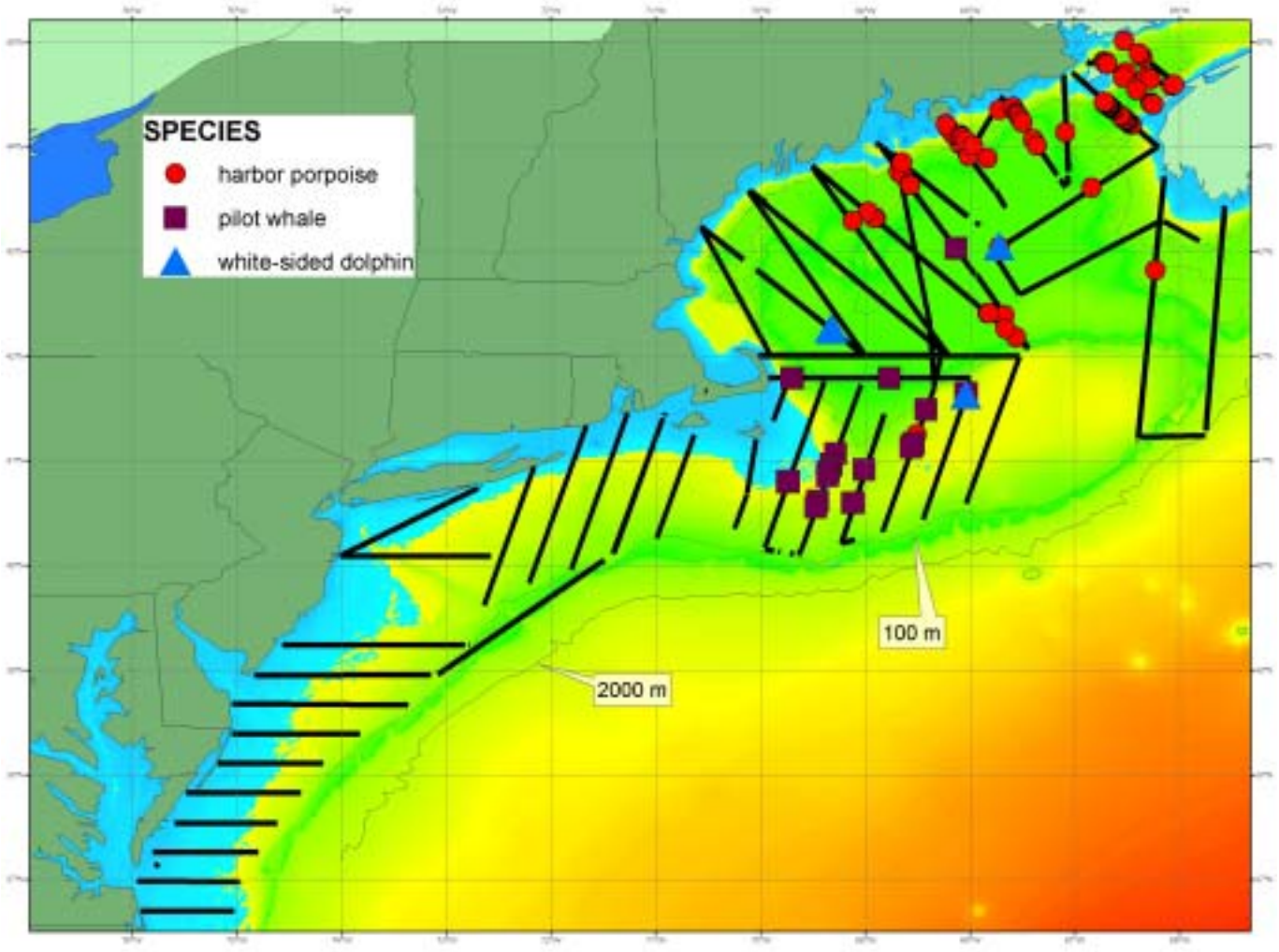

Figure 6. Locations of right, humpback, minke, fin and sei whales.

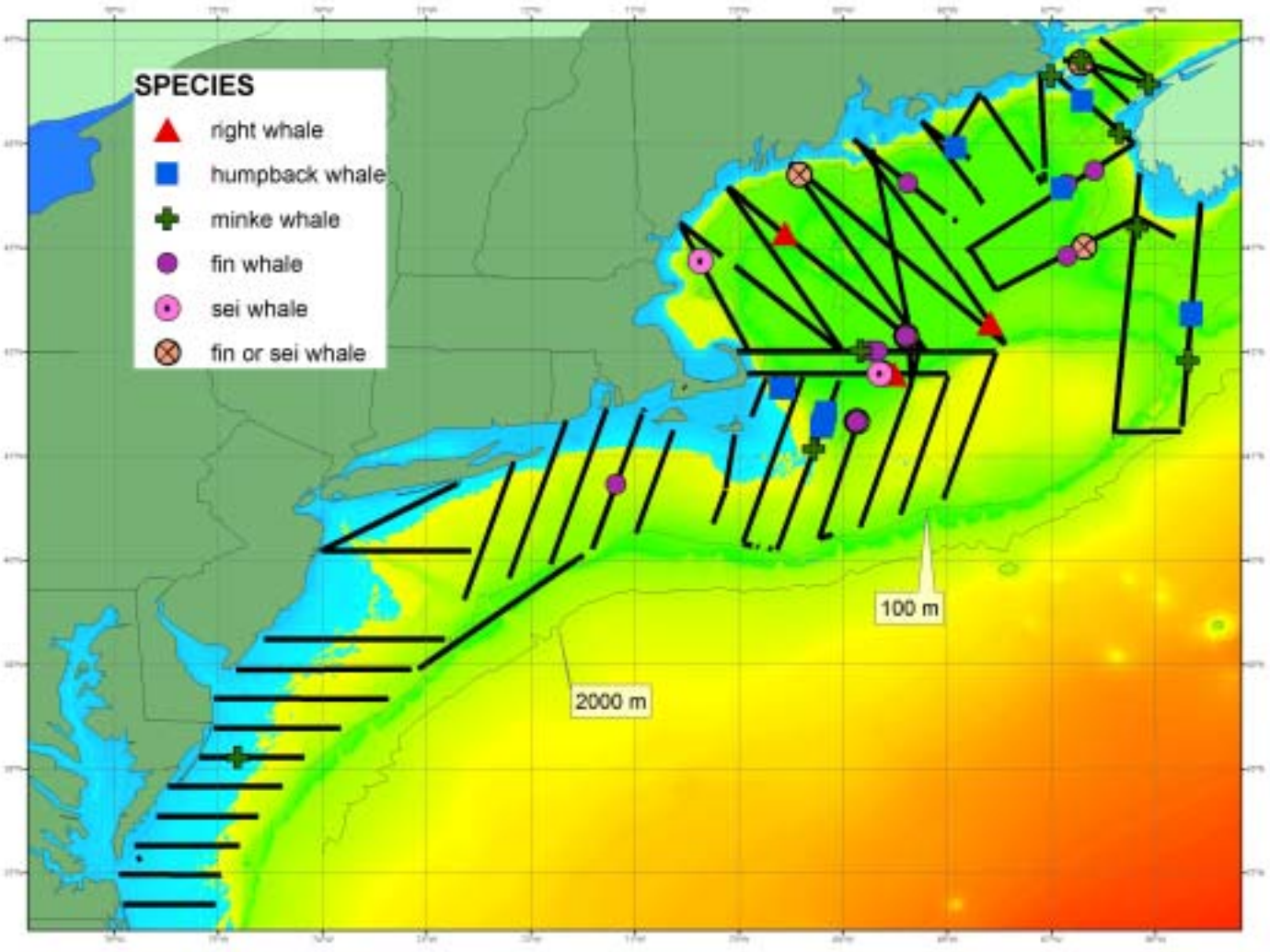

Figure 7. Locations of loggerhead, green and leatherback turtles.