22 August 2002

AERIAL SURVEY RESULTS

NOAA TWIN OTTER AIRCRAFT
Circle-Back Method Experimental Abundance Survey

CRUISE PERIOD AND AREA

The survey was conducted on the NOAA DeHavilland Twin Otter DHC-6, Series 300 aircraft from 19 July to 16 August 2002. The flights were based out of Otis Airbase from 19 July to 02 August 2002, and based out of Hancock County/Bar Harbor Airport in Trenton, Maine from 02 August to 16 August 2002. The southern border of the study area was south of Long Island, NY, the northern border was in the Bay of Fundy north of St. John, New Brunswick, the western border was the US coast line, and the eastern border was about 64.5°W (west of Halifax, Nova Scotia) (Figure 1).

OBJECTIVES

The primary objective of this survey is to determine the feasibility of the Circle-back method that estimates abundance of cetaceans and turtles which includes an estimate of g(0), the probability of detecting a group on the track line. First, the practice issues of conducting the survey in the field will be assessed, then the analytical issues will be investigated after the data are collected. The secondary objective is to estimate the abundance of animals using this new method. The third objective is to collect surface water temperature information during the survey to be used in a description of the habitat of the different species of cetaceans and turtles.

METHODS

Track lines, that were approximately 15 nautical miles apart, were flown 600 feet above the water surface, at about 110 knots, when Beaufort sea state conditions were under 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 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 laying 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 40° from the track line; the area from 40° to the horizon (90°) was also searched, though less frequently. When a cetacean, seal, turtle, shark, or tuna were 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,
5. Cue (animal, splash, blow, footprint (or ripple), birds, vessel/gear, windrows, or other),
6. Swim direction animals were heading towards (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),
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.

At the beginning of each leg, and when conditions change 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 starts and ends 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 was recorded every two seconds, and the sea surface temperature was recorded every minute. 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 were collected by a separate program called linear.exe and were put into a separate file that contained the time and temperature.

The circle-back method modifies standard 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 ($\leq$ 10 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 used is 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 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.

RESULTS

This survey was comprised of the following:

a) 14 days of on-effort surveying that covered 4156 nautical miles of track line in 69.5 flight hours (Table 1),
b) 1 day of transiting (02Aug02) between Otis Airbase and the Bar Harbor airport that was also used to practice the circle-back technique for the two new pilots (2.1 hours of flight),
c) 1 day of transiting (16Aug02) from Bar Harbor back to Otis and to investigate a possible right whale sighting south of Cashes Ledge (2.3 hours of flight). This was in weather conditions not suitable for surveying, and
d) 1 day (15Aug02) searching for a dead unidentified whale off of Maine to confirm the id (2.6 hours of flight), again in weather conditions not suitable for surveying.

The proposed survey lines north of Grand Manan, New Brunswick, Canada were not completed because we ran out of good weather days.

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

There were a total of 91 groups of animals that were seen during the leading leg of a circle; of which 33 were groups of harbor porpoises, 8 white-sided dolphins, and 11 fin or fin/sei whales (Table 1). Though a circle was initiated by either a cetacean or turtle sighting, other species were also seen during the leading leg of a circle; for example, 6 groups of harbor seals, and 5 groups of *mola molas* (Table 1).

The location of sightings by species are displayed in Figures 3 to 10. 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. In addition, off-effort sightings are also displayed on the maps.

Preliminary indications of the feasibility of this methodology is it is a practical way of collecting the data. Not all circles were sufficient to be used in the analysis, because it was not possible to get close enough to the original track line in time for the observers to have a chance to possible detect the group that was originally seen on the leading leg. Most of these unusable circles were at the beginning of the survey, before we put a plotter GPS in the cockpit for the pilots to see their exact path, and at times when the winds were high (nearly Beaufort 4) and blowing nearly perpendicular to the track line. At this time, it is not possible to quantify the number of usable circles. This will be evaluated in the analysis phase of this project.

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.

SCIENTIFIC PERSONNEL

Name	Title	Organization and Location
Debra Palka	Chief Scientist	NMFS, NEFSC, Woods Hole, MA
Rod Hobbs	Research Fishery Biologist	NMFS, National Marine Mammal Laboratory, Seattle, WA
Rob DiGiovanni	Contractor	Riverhead Foundation for Marine Research and Preservation, Riverhead, NY
Virginie Chadenet	Contractor	Quebec, Canada
Dennis Wakeham	Research Technician (Volunteer)	Department of Fisheries & Oceans, St. John's, Newfoundland, Canada
John Lawson	Research Scientist (Volunteer)	Department of Fisheries & Oceans, St. John's, Newfoundland, Canada

REFERENCES

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. For each day surveying was conducted during 2002, the length of track line surveyed, in nautical miles (length (nmi)), number of groups detected, and number of circles that will provide information on g(0) for the species. The number of groups includes some groups counted twice, that is those groups that were detected on both the leading and trailing part of a circle.

	July									August					No. of circles	Total sight-ings
	20	21	22	25	26	27	28	30	31	4	8	9	10	12		
length (nmi)	164	301	408	353	218	433	385	221	270	21	440	313	189	440	-	4156
Porpoises																
harbor porpoise	0	0	0	0	1	2	0	0	0	4	39	54	12	6	33	118
Dolphins																
bottlenose	0	2	2	0	0	0	0	1	3	0	2	0	0	0	3	10
common	0	0	11	0	0	1	1	0	0	0	0	0	0	0	4	13
risso	0	0	0	0	0	0	2	0	2	0	7	0	0	8	1	19
whitesided	0	0	0	1	1	12	22	1	4	0	12	1	2	23	8	79
unid dolphin	1	3	2	0	0	0	4	1	0	0	2	2	0	6	4	21
Whales																
beaked	0	0	1	0	0	0	0	0	0	0	3	0	0	0	0	4
fin	0	1	4	5	2	9	13	2	2	0	2	1	0	3	9	44
sei	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	1
fin/sei	0	0	1	2	2	1	0	0	0	0	0	0	0	0	2	6
humpback	0	0	2	0	1	0	11	0	2	0	2	0	0	1	4	19
minke	0	2	1	1	0	2	0	0	0	0	1	0	0	3	2	10

	July									August					No. of circles	Total sight-ings
	20	21	22	25	26	27	28	30	31	4	8	9	10	12		
pilot	0	0	0	0	0	4	4	0	0	0	4	0	0	8	2	20
right	0	0	0	0	0	4	0	0	0	0	3	0	0	0	2	7
sperm	0	0	6	0	0	0	0	0	0	0	0	0	0	1	1	7
unid whale	0	0	0	2	1	1	9	0	1	0	3	1	0	2	2	20
Turtles																
leatherback	0	0	2	0	0	0	0	0	0	0	0	0	0	4	2	6
logger	0	1	0	0	0	0	2	0	0	0	0	0	0	4	1	7
ridleys	1	1	0	0	0	0	0	0	0	0	0	0	0	0	2	2
unid turtle	0	0	0	0	0	0	0	1	0	0	0	0	0	1	1	2
Seals																
harbor seal	0	0	0	0	0	0	0	0	0	0	34	24	4	3	6	65
Fish																
bashing shark	0	0	16	15	0	9	1	1	0	0	11	21	0	0	0	74
blue shark	0	0	2	0	0	2	0	0	2	0	1	3	0	0	0	10
hammerhead	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	2
manta ray	3	1	0	0	0	0	0	0	1	0	0	0	0	0	0	5
mola mola	31	12	15	4	1	35	32	54	8	0	10	15	5	30	0	252
tuna	0	2	0	1	0	2	2	0	1	0	0	0	0	0	0	8

	July									August					No. of circles	Total sight-ings
	20	21	22	25	26	27	28	30	31	4	8	9	10	12		
unid shark	0	0	1	0	0	2	2	1	2	0	2	15	0	28	0	53
unid animal	0	0	0	1	0	0	0	0	2	0	3	0	0	0	1	6
TOTAL	36	25	66	32	9	86	105	62	32	4	142	137	23	131	91	890

Figure 1. Proposed track lines for the July-August 2002 aerial survey to investigate the circle-back methodology.

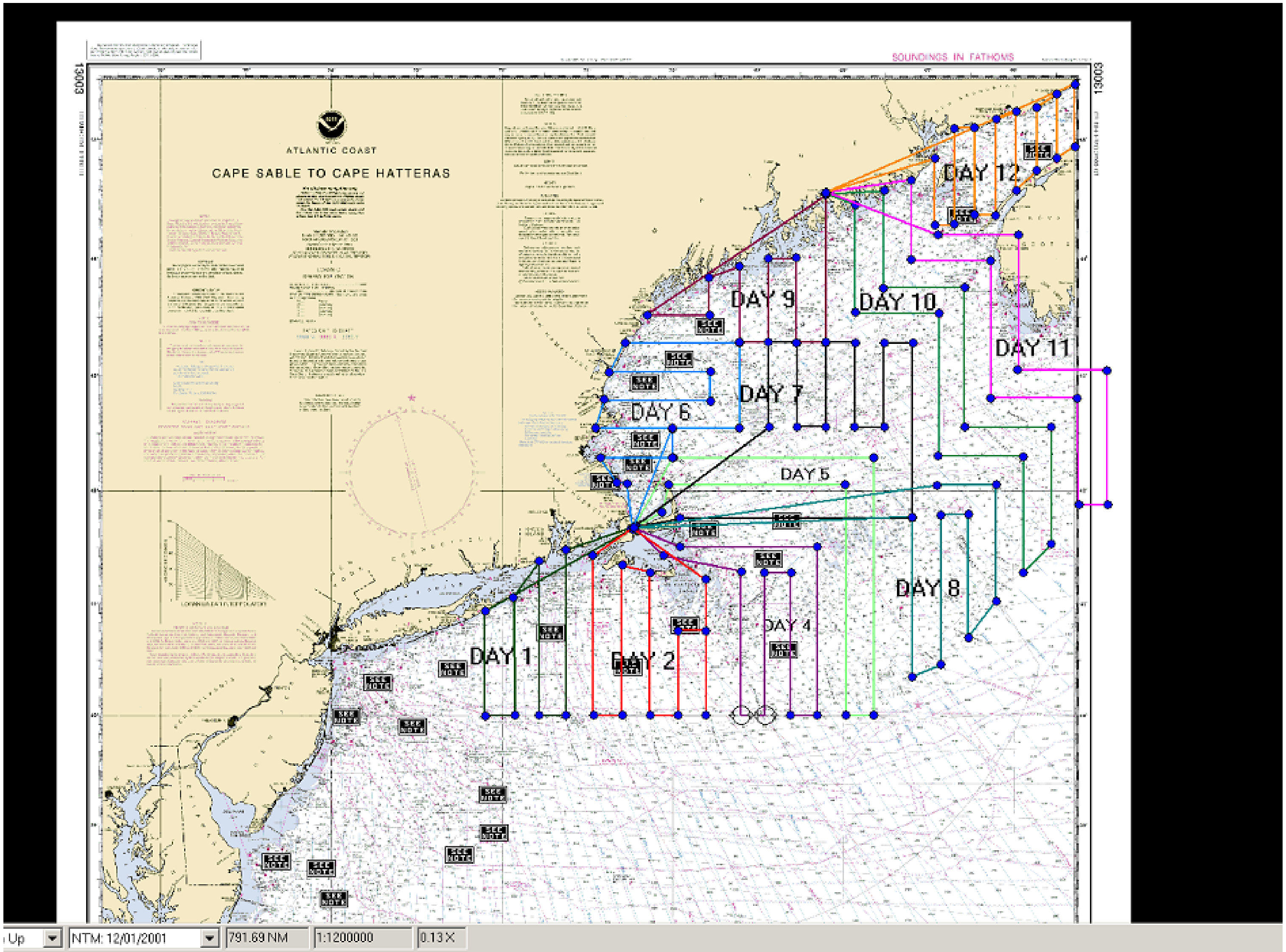

Figure 2. Diagram of the circle-back procedure.

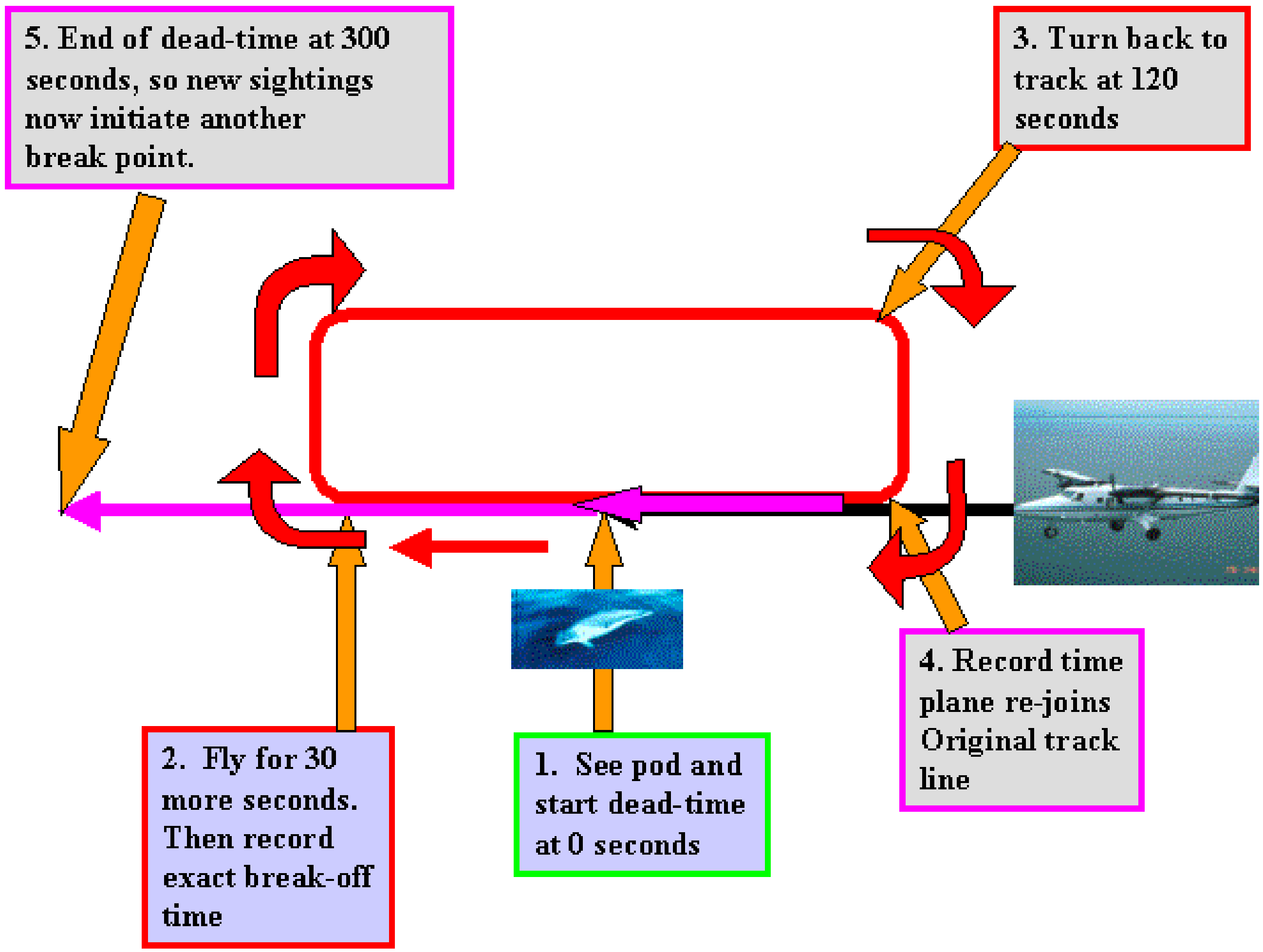

Figure 3. Location of track lines actually surveyed, all sightings (small green dots), and harbor porpoise sightings (large blue squares). Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

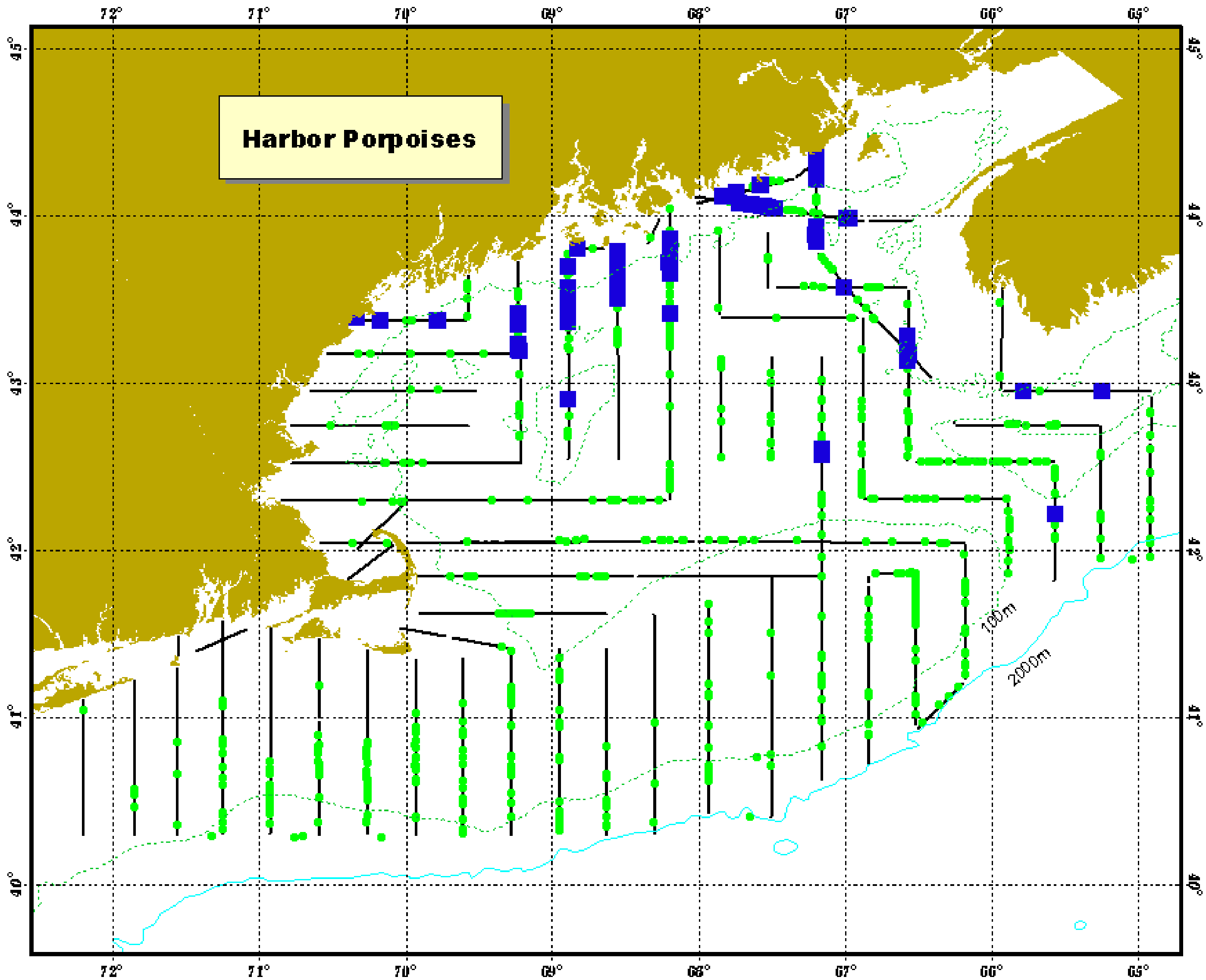

Figure 4. Location of track lines actually surveyed, all sightings (small green dots), and right whale sightings (large blue squares). Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

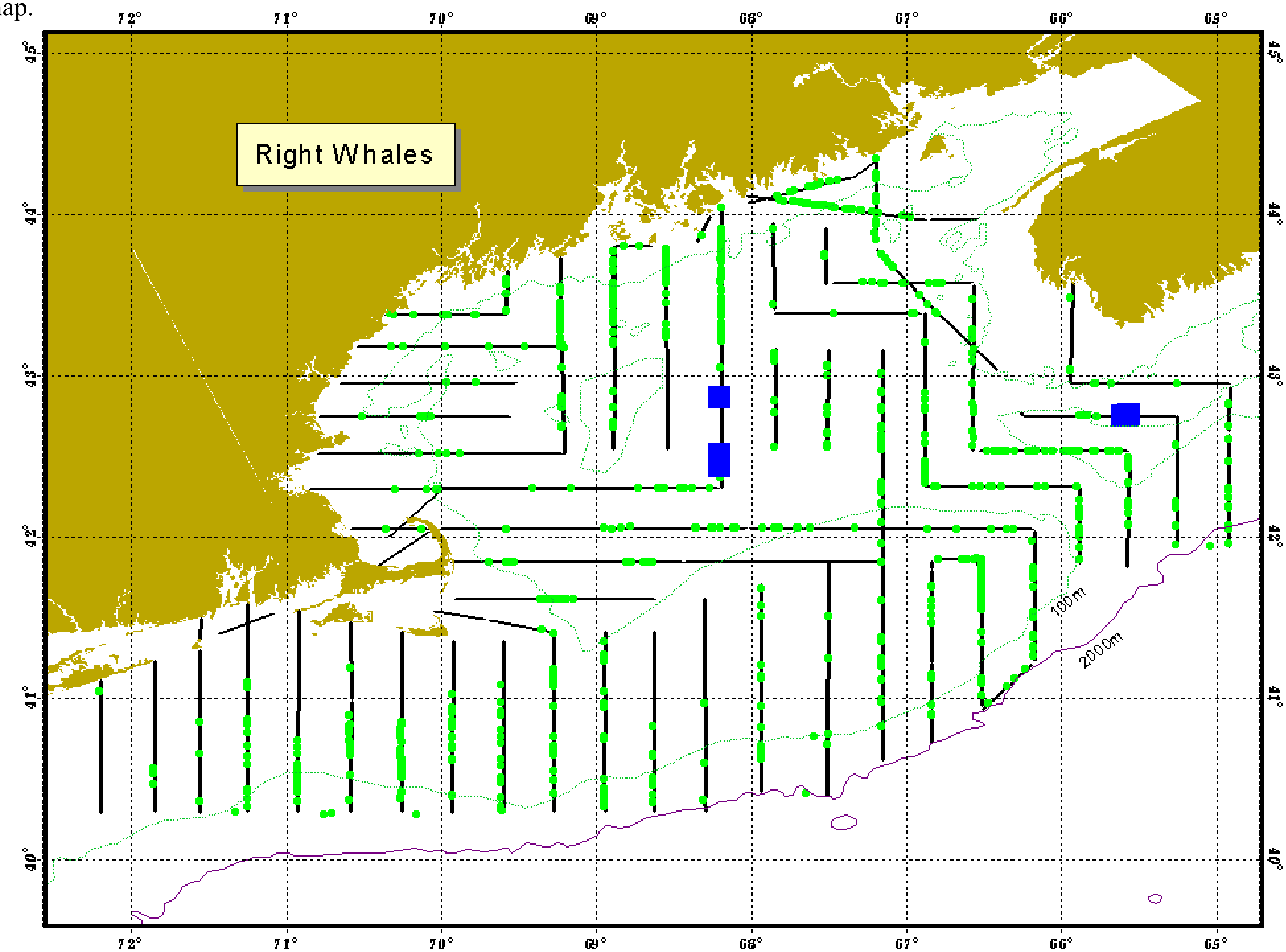

Figure 5. Location of track lines actually surveyed, all sightings (small green dots), and white-sided dolphin sightings (large blue squares). Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

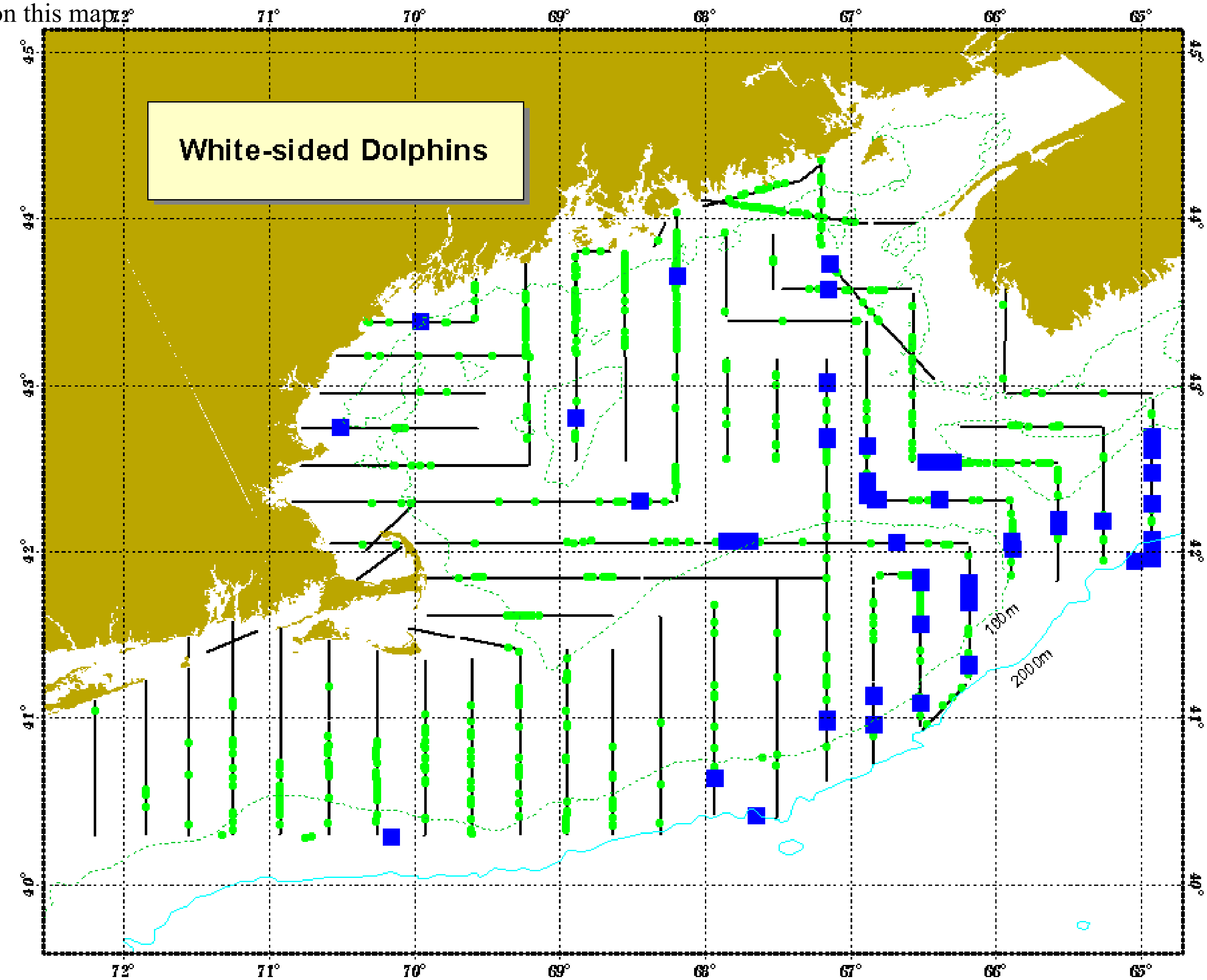

Figure 6. Location of track lines actually surveyed, all sightings (small green dots), and turtles. Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

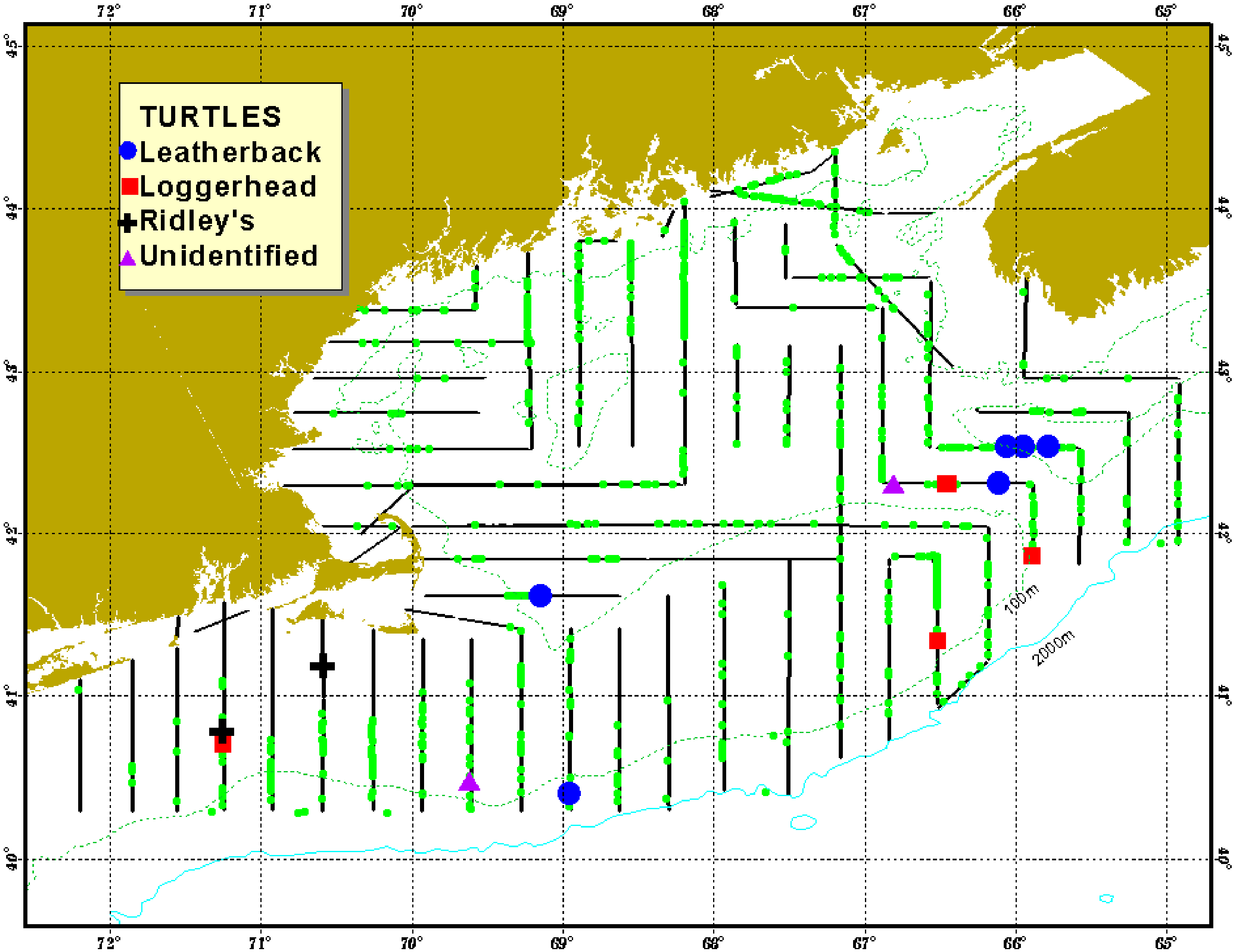

Figure 7. Location of track lines actually surveyed, all sightings (small green dots), and fin or sei whales. Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

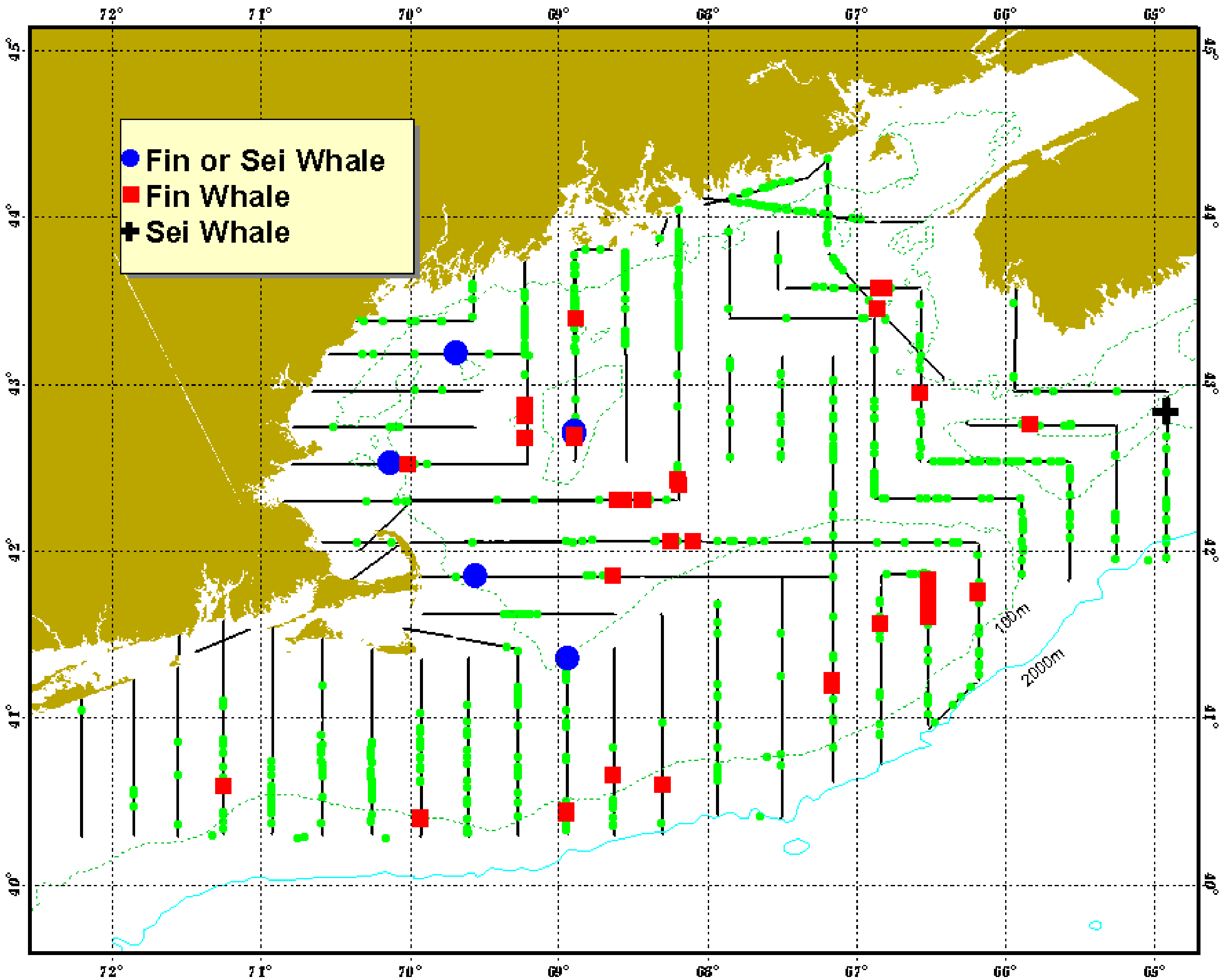

Figure 8. Location of track lines actually surveyed, all sightings (small green dots), and several dolphin species. Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

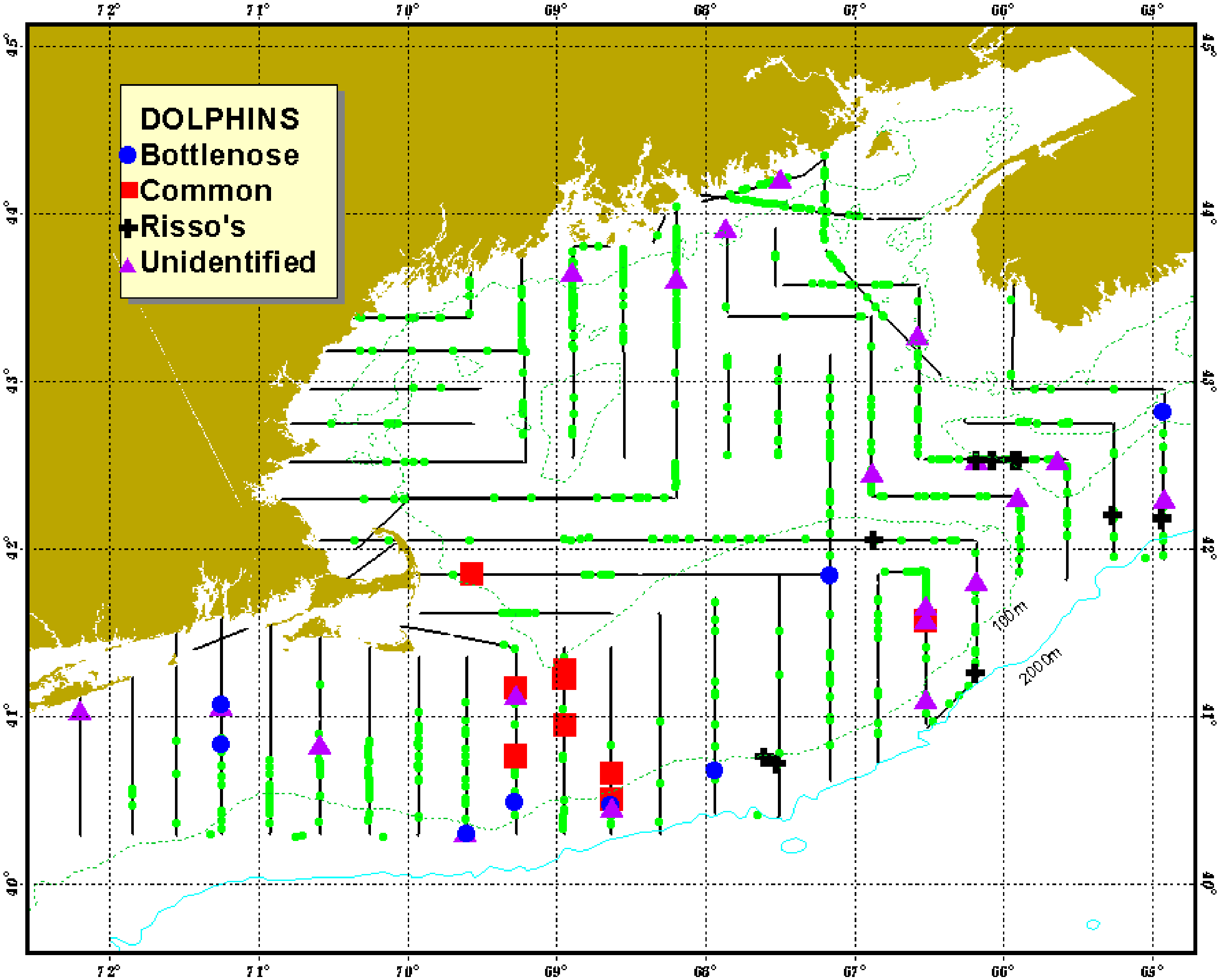

Figure 9. Location of track lines actually surveyed, all sightings (small green dots), and several whales species. Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.

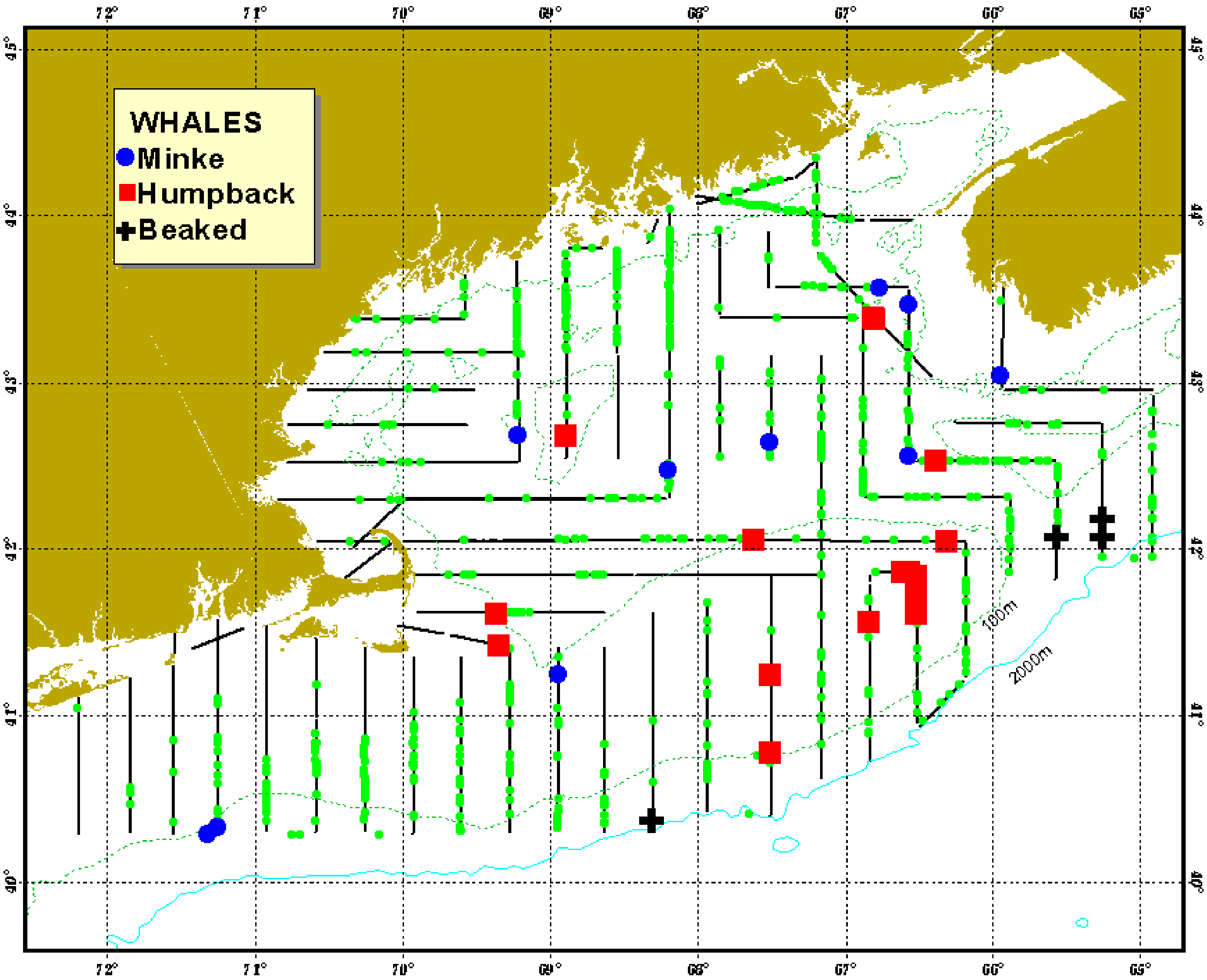

Figure 10. Location of track lines actually surveyed, all sightings (small green dots), and several whales species. Note, some groups of animals were detected twice, once on the leading leg, and again on the trailing leg, and so are displayed twice on this map.