CRUISE RESULTS

Aerial survey
Cruise No. TO10-01

North Atlantic Shelf Marine Mammal and Turtle Aerial Abundance Survey;
part of the AMAPPS project

ABSTRACT

During 17 August to 26 September 2010, the Northeast Fisheries Science Center (NEFSC) conducted an aerial abundance survey targeting marine mammals and sea turtles. The NEFSC's survey covered waters from Long Island, New York, USA to the mouth of the Gulf of St. Lawrence, Canada, and from the coast line to about the 2000 m depth contour. This aerial survey was a component of the AMAPPS project, where the Southeast Fisheries Science Center's aerial survey covered Atlantic Ocean waters from the southern tip of Florida to Long Island, New York and also targeted marine mammals and sea turtles. The results from the NEFSC aerial survey are reported in this document. The airplane flew at 600 feet above the water surface at about 110 knots. The circle-back (Hiby) data collection methods were used, where circles were performed on groups of cetaceans and turtles that had five or less animals per group. Within the study area of 325,072 km^2, there were about 9,210 km of on-effort track lines, of which 8,300 km were conducted in sea state conditions less than Beaufort 4. On these track lines, there were 15 species of identifiable cetaceans, and 4 turtle species detected. There were 99 circle-backs performed on 15 species/species groups that can be used to estimate *g(0)* for these species, where *g(0)* is defined as probability of detecting a group on the trackline.

CRUISE PERIOD AND AREA

An aerial survey was conducted 17 August to 26 September 2010. The study area extended from Long Island, New York, USA to the mouth of the Gulf of St. Lawrence, Canada, from the coast line to just beyond the 2000 m depth contour (Figure 1).

OBJECTIVES

The objectives of the NEFSC aerial survey are 1) to estimate abundance of cetaceans and turtles in waters north of New Jersey and shallower than 2000m and 2) to investigate how the animal's distribution and abundance relate to its physical and biological ecosystem. This survey is part of the AMAPPS project. Additions parts of the AMAPPS project that were conducted during the summer of 2010 include a cetacean and turtle aerial survey (using the same plane) conducted by the Southeast Fisheries

Science Center and a series of seabird aerial surveys (using other planes) that were conducted by the Fish and Wildlife Service.

The cetacean and turtle abundance estimates will form part of the information essential to assess the impact of anthropogenic threats on those populations. It is also important in determining appropriate management actions to ensure the favorable conservation status of cetacean populations and in monitoring whether the management actions are having the desired effect. The cetacean data from the line transect aerial survey will be analyzed to estimate abundance which can then be used to calculate PBR, the Potential Biological Removal level. The PBR level can then be compared to levels of bycatch to assess the status of a cetacean population.

The spatially-explicit distribution and abundance of cetaceans and turtles will be compared to physical and biological features of their environment. Physical features that will be investigated include the bottom water depth, slope and sediment type. Biological features include surface chlorophyll levels and indirect measurements such as the surface water temperature, currents and fronts.

METHODS

The aerial survey (Figure 1) were conducted on a DeHavilland Twin Otter DHC-6 aircraft over Atlantic Ocean 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 five, and when there was at least two miles of visibility.

There were two pilots and five scientists onboard. Three scientists were observers searching with the naked eye. One scientist was at 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 30º view on both sides of the track line. The bubble window observers searched from straight down to the horizon, with a concentration on waters between straight down (0º) and about 60º up from straight down.

When a cetacean, seal, turtle, sunfish, or basking shark was observed the following data were collected:

- time animal passed perpendicular to the observer; species identification; best estimate of the group size;
- angle of declination between the track line and location of the animal group (measured by inclinometers or marks on the windows, where 0º is straight down);

- cue (animal, splash, blow, footprint, birds, vessel/gear, windrows, disturbance, 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.
- the size of the turtle (small: < 40 cm; medium: 40-79 cm; large: ≥ 80 cm).

Other fish species were also recorded opportunistically. Species identifications were recorded to the lowest taxonomic level possible. This resulted in a species only when the observers were certain of the identification; otherwise, the group was identified to a higher level of identification (e.g. fin or sei whale, or unidentified whale).

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

- initials of person in the two pilot seats and three observation stations;
- Beaufort sea state recorded to one decimal place;
- 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 (excellent, good, moderate, fair, and poor), where data collected in poor conditions indicated conditions were so poor that that part of the track line should not be used in analyses.

In addition, the location of the plane and sea surface temperature was recorded. Plane location was measured every two seconds 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, version 8.75 originally created by 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 animals that were in groups of five or less animals. 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 2). The re-surveyed track lines are called "trailing" legs, sections of the track lines that initiated the circle are called "leading" legs, while the sections of 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 that was seen within a 30 second time period. 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 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 41 days allocated to this project, 16 days had sufficiently good weather to conduct the survey. The study area was about 325,072 km^2. There were about 9,210 km of "on-effort" straight-line track lines, e.g., single and leading legs (Table 1A). Of which about 8,300 km (90%) were surveyed in Beaufort 3 or less (Table 1B).

On the "on-effort" track lines, there were fifteen species of identifiable cetaceans seen: whales: blue, fin, pilot (short-fin or long-fin), minke, right, sperm, beaked (all species) and humpback whales; dolphins: white-sided, white-beaked, Risso's, striped, common, and bottlenose (coastal or offshore) dolphins; and harbor porpoises. In addition, gray seals, leatherback, loggerhead, Ridley's and green turtles, basking sharks, blue sharks, sunfish and manta rays were also seen (Table 2).

Ninty-nine (99) circle-backs were performed for 37 harbor porpoises, 11 leatherback turtles, 10 unidentified dolphins, 7 loggerhead turtles, 8 minke whales, 7 fin whales, 6 humpback whales, 4 green turtles, 3 Ridley's turtles, and one each of beaked whale, bottlenose dolphin, Risso's dolphin, striped dolphin, unidentified turtle, and unidentified whale.

The locations of sightings seen on the leading and single transect legs, by species, are displayed in Figures 3 to 16, where porpoises are in Figure 3, dolphins in Figures 4-6, whales in Figures 7-10, seals in Figure 11, sea turtles in Figures 12-13, and other species in Figures 14-16.

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.

LIST OF TABLES

LIST OF FIGURES

Table 1. Lengths of on-effort track lines covered during summer 2010 NEFSC aerial abundance survey.

A) Lengths of single, leading and trailing track lines (in km) and area (in km^2).

	Trackline lengths (km)		
Area (km^2)	Single and leading legs	Trailing legs	Total
325,072	9,210	397	9,604

B) Lengths (km) of on-effort single and leading track lines surveyed during various Beaufort sea states.

	Beaufort sea states						
	0	1	2	3	4	5	Total
Lengths(km)	17.7	1257.6	3085.8	3938.1	894.7	16.3	9210.2
Percent	0.19	13.66	33.5	42.76	9.71	0.18	100

Table 2. Number of groups and individuals, and mean group size of the species detected during the leading and single legs, while on-effort.

	Single and leading legs		
Species	**Number of groups**	**Number of animals**	**Mean group size**
Beaked whales	4	7	1.8
Blue whale	1	1	1.0
Bottlenose dolphin	7	200	28.6
Common dolphin	21	840	40.0
Fin / sei whale	1	1	1.0
Fin whale	20	20	1.0
Harbor porpoise	168	741	4.4
Humpback whale	32	41	1.3
Minke whale	14	16	1.1
Pilot whale	5	35	7.0
Right whale	1	1	1.0
Risso's dolphin	6	115	19.2
Sperm whale	3	6	2.0
Striped dolphin	3	137	45.7
White-beaked dolphin	1	17	17.0
White-sided dolphin	10	185	18.5
Unidentified animal	1	8	8.0
Unidentified dolphin	60	420	7.0
Unidentified whale	15	18	1.2
Total cetaceans	**373**	**2809**	**7.5**
Gray seal	1	1	1.0
Unidentified seal	20	22	1.1
Total seals	**21**	**23**	**1.1**
Green turtle	6	6	1.0
Kemp's Ridley turtle	5	5	1.0
Leatherback turtle	20	20	1.0
Loggerhead turtle	30	30	1.0
Unidentified turtle	8	8	1.0
Total turtles	**69**	**69**	**1.0**
Basking sharks	36	36	1.0
Blue sharks	8	8	1.0
Sunfish	178	198	1.1
Manta ray	12	14	1.2
Total identified fish	**222**	**242**	**1.1**
Total sightings	**685**	**3143**	**4.6**

Figure 1. Tracklines surveyed by the Twin Otter that were flown in various Beaufort sea states.

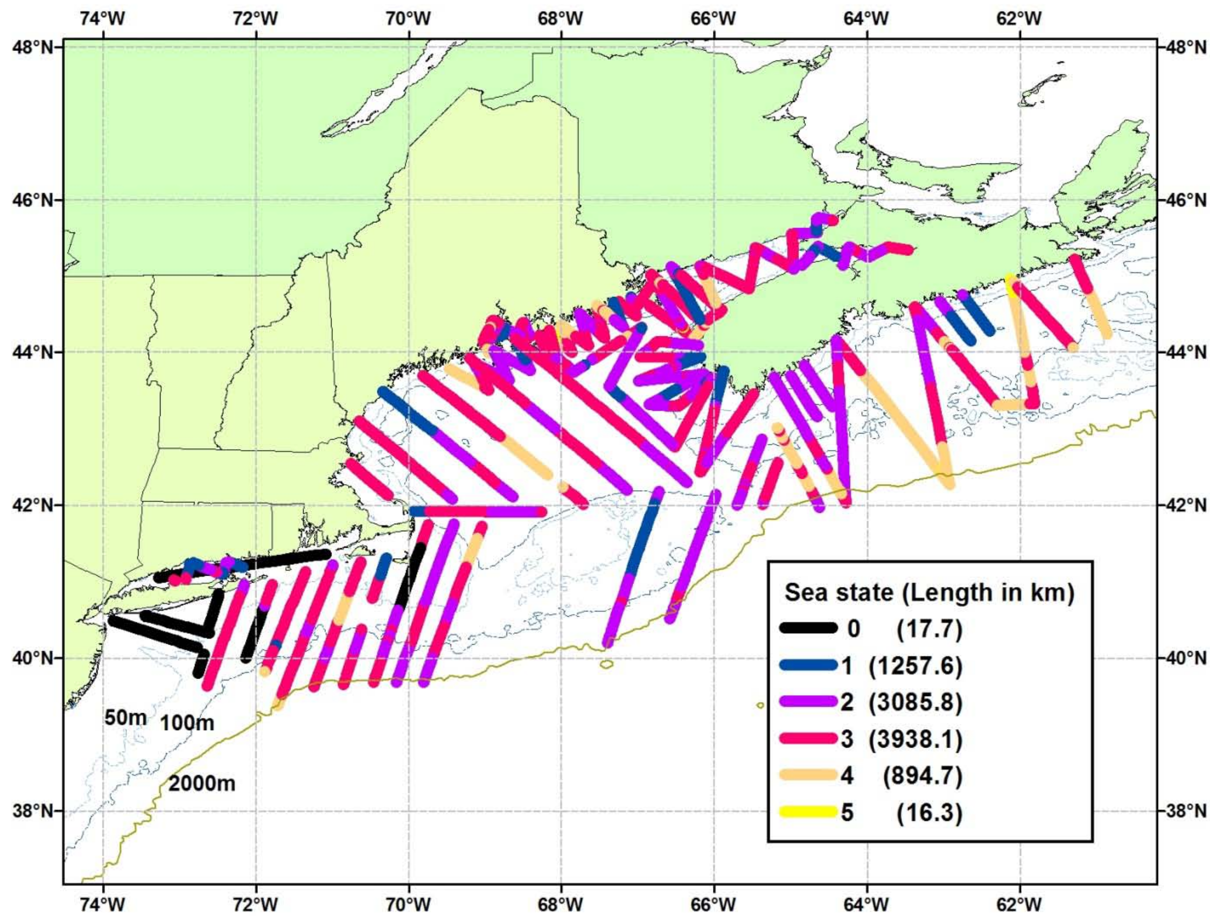

Figure 2. Diagram of how the circle-back technique was performed.

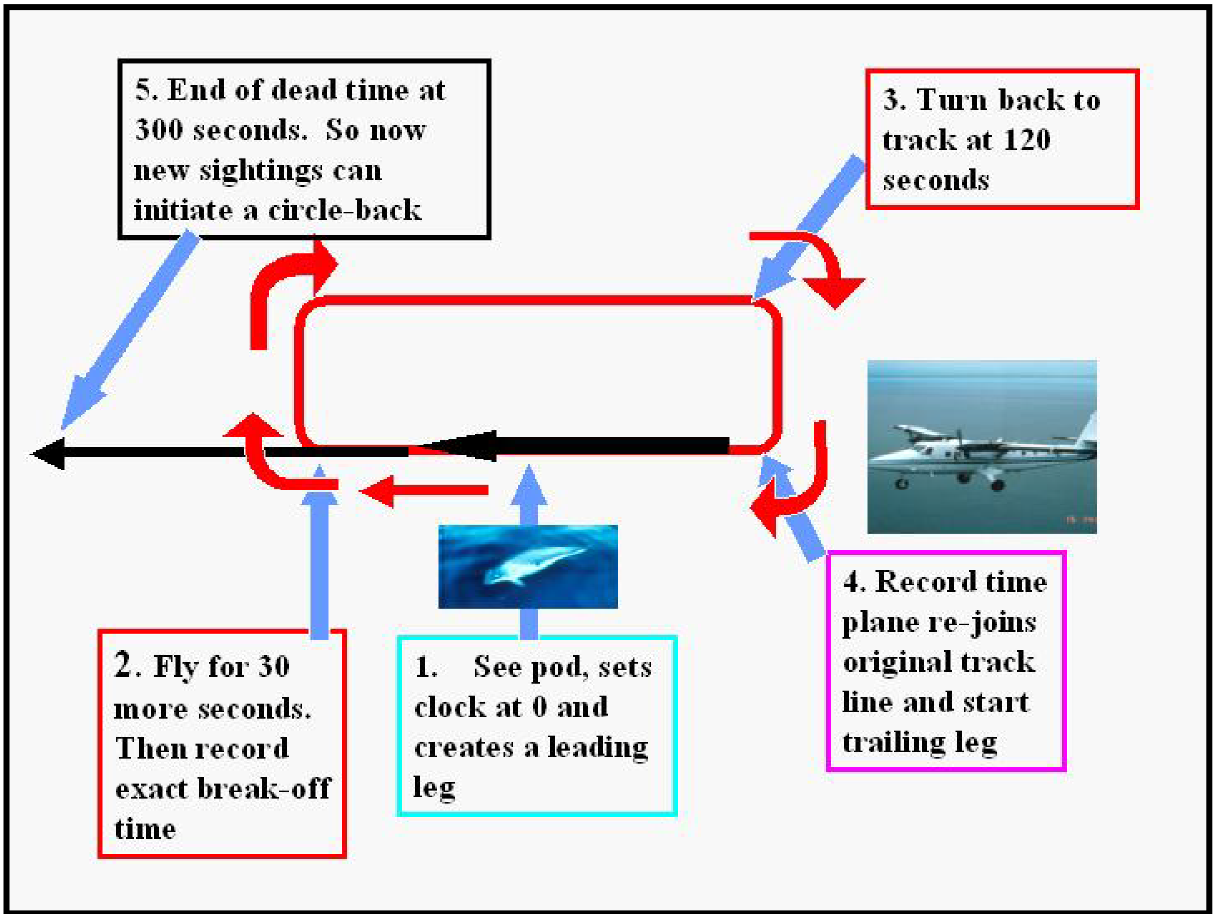

Figure 3. Location of harbor porpoise sightings detected during 17 August – 26 September 2010.

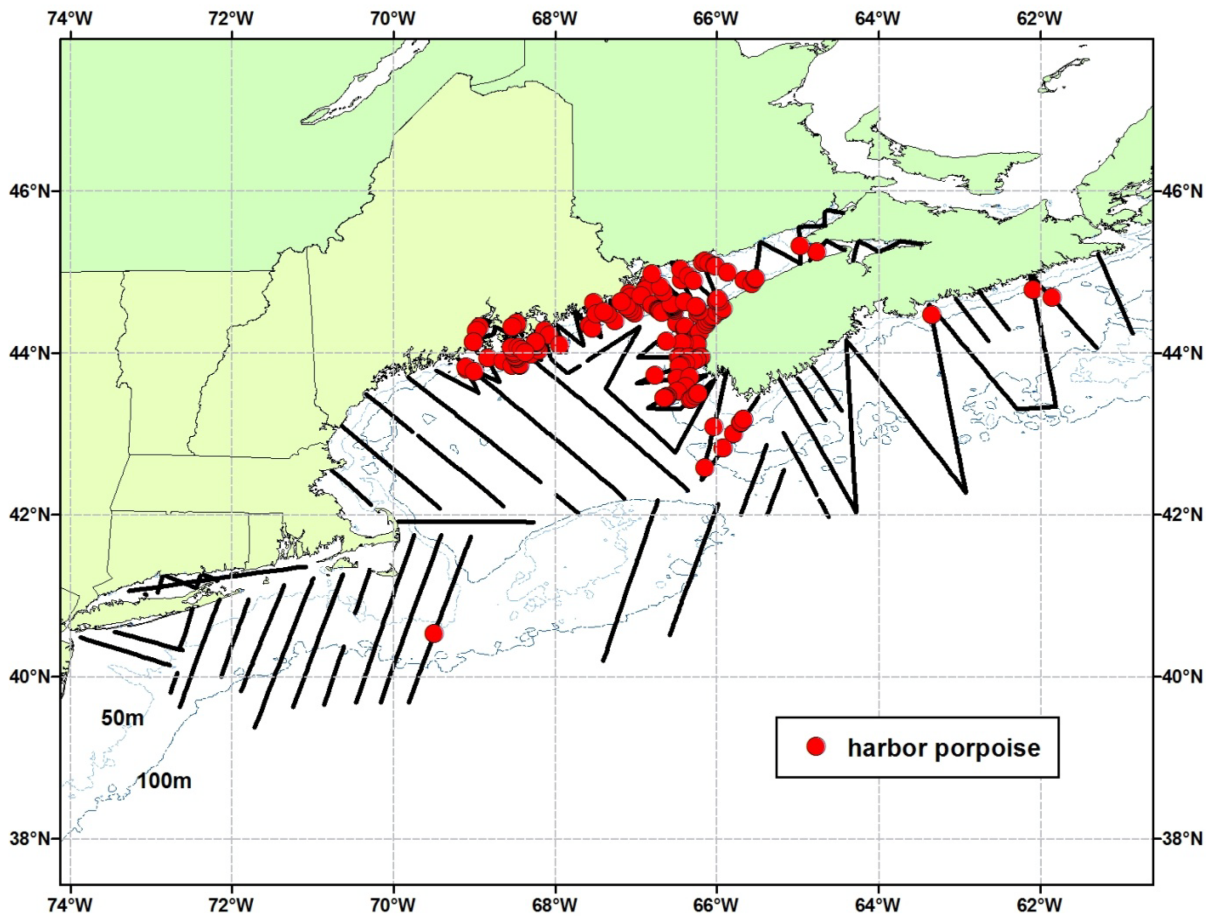

Figure 4. Location of white-sided and common dolphin sightings detected during 17 August – 26 September 2010.

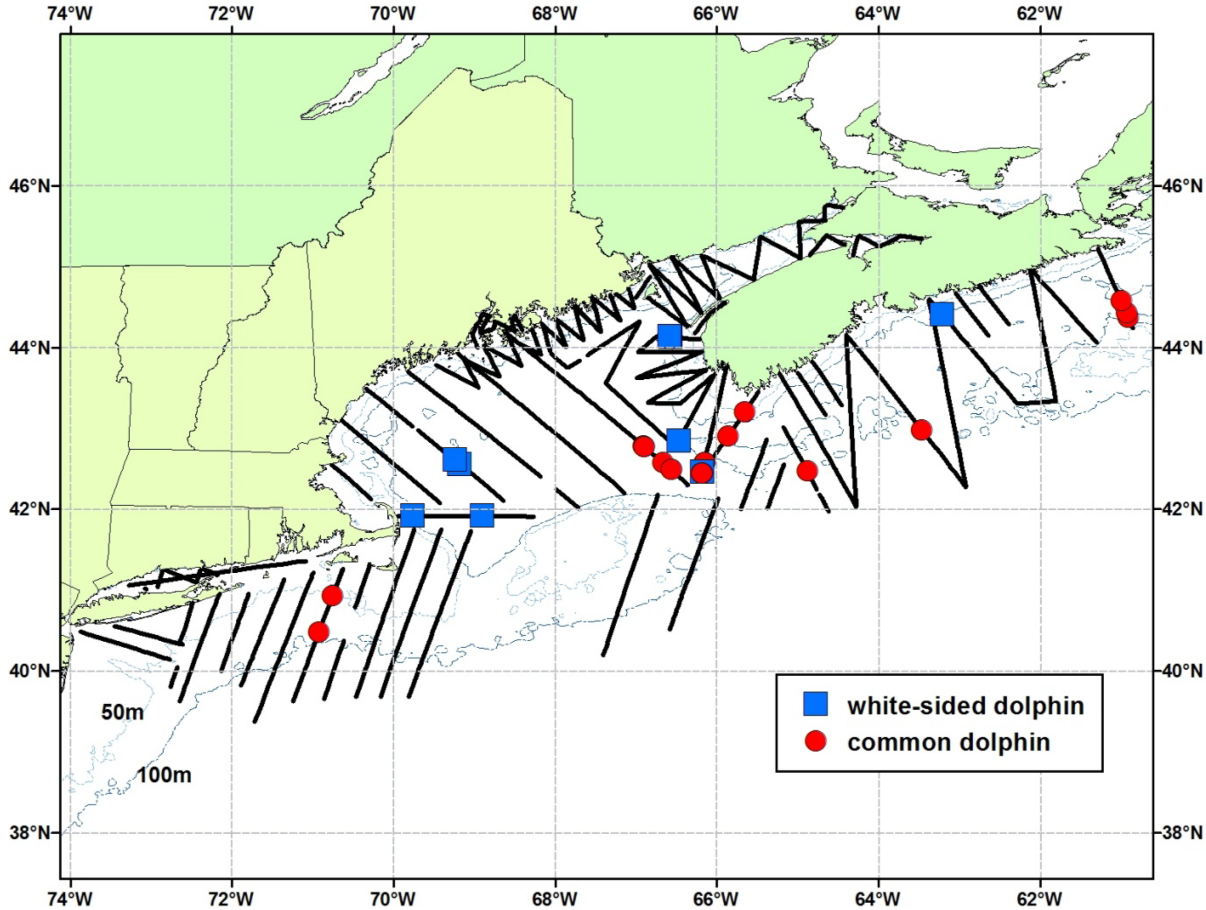

Figure 5. Location of Risso's dolphins, pilot whales, and white-beaked dolphin sightings detected during 17 August – 26 September 2010.

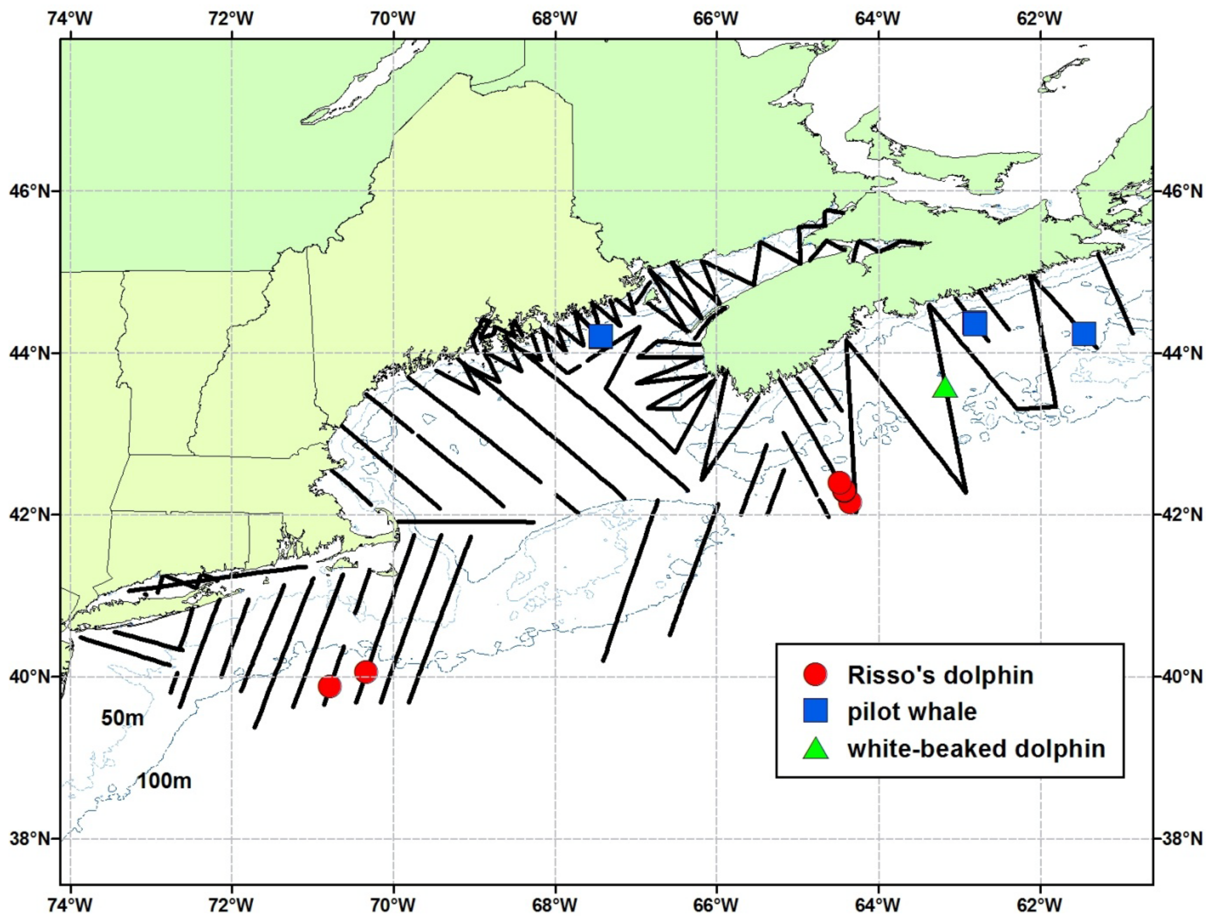

Figure 6. Location of striped dolphins and unidentified dolphin sightings detected during 17 August – 26 September 2010.

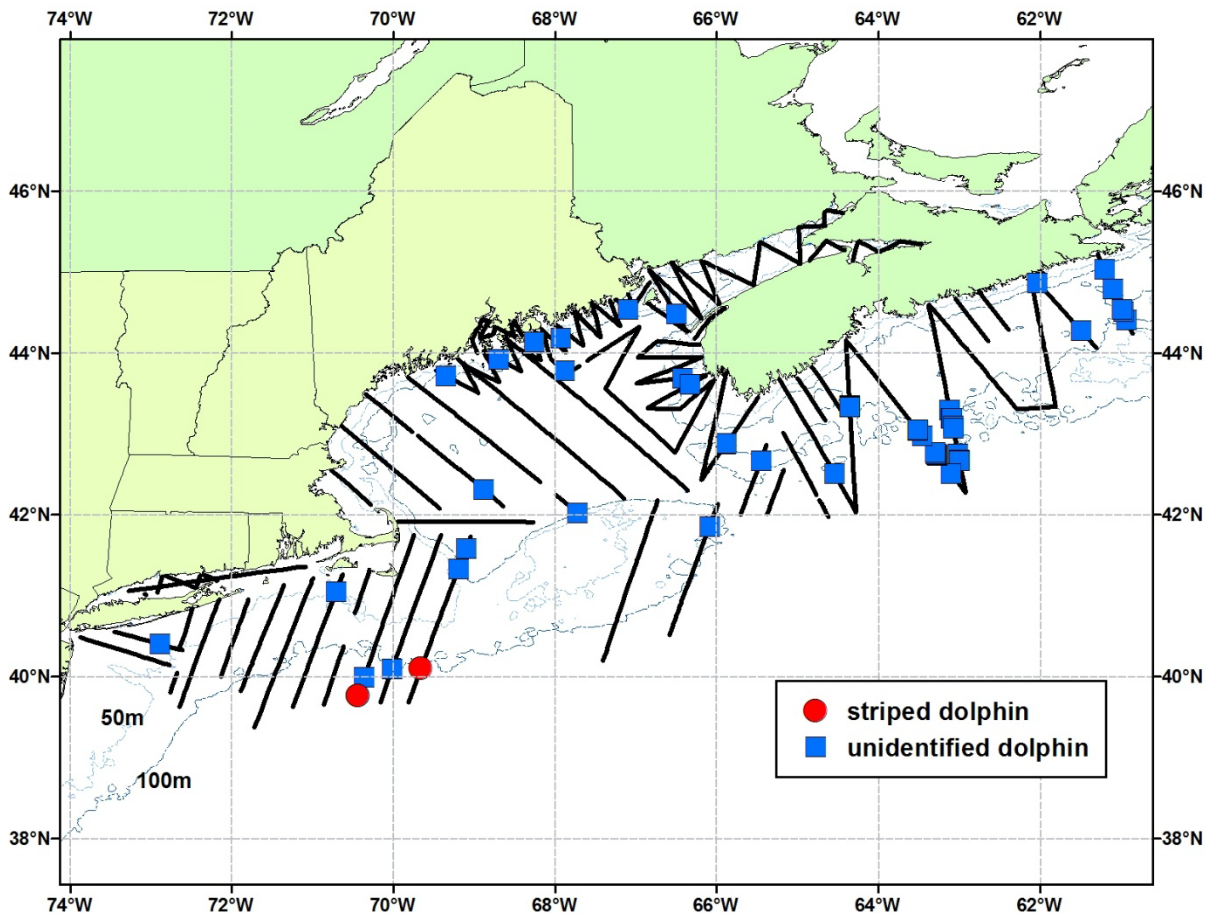

Figure 7. Location of humpback whale sightings detected during 17 August – 26 September 2010.

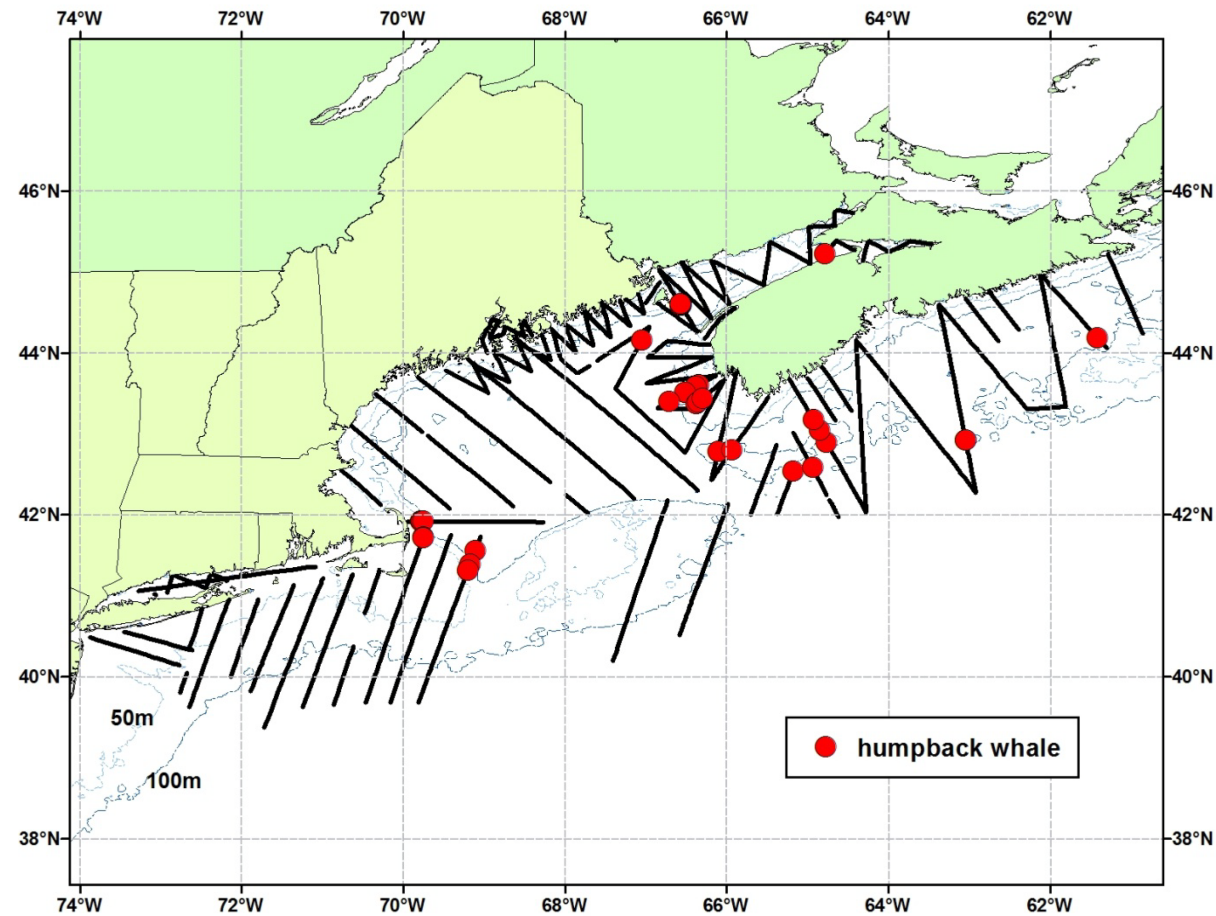

Figure 8. Location of minke whale sightings detected during 17 August – 26 September 2010.

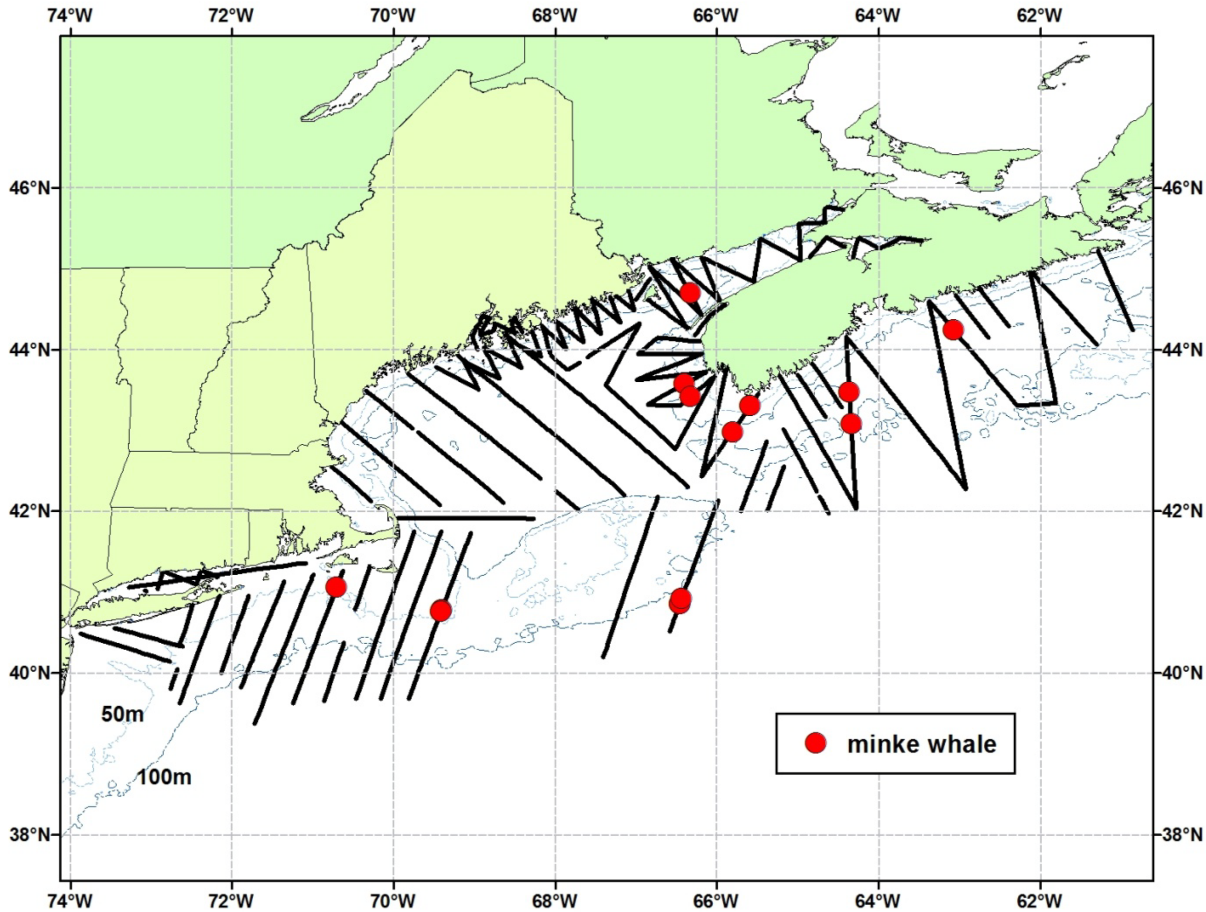

Figure 9. Location of fin whale sightings detected during 17 August – 26 September 2010.

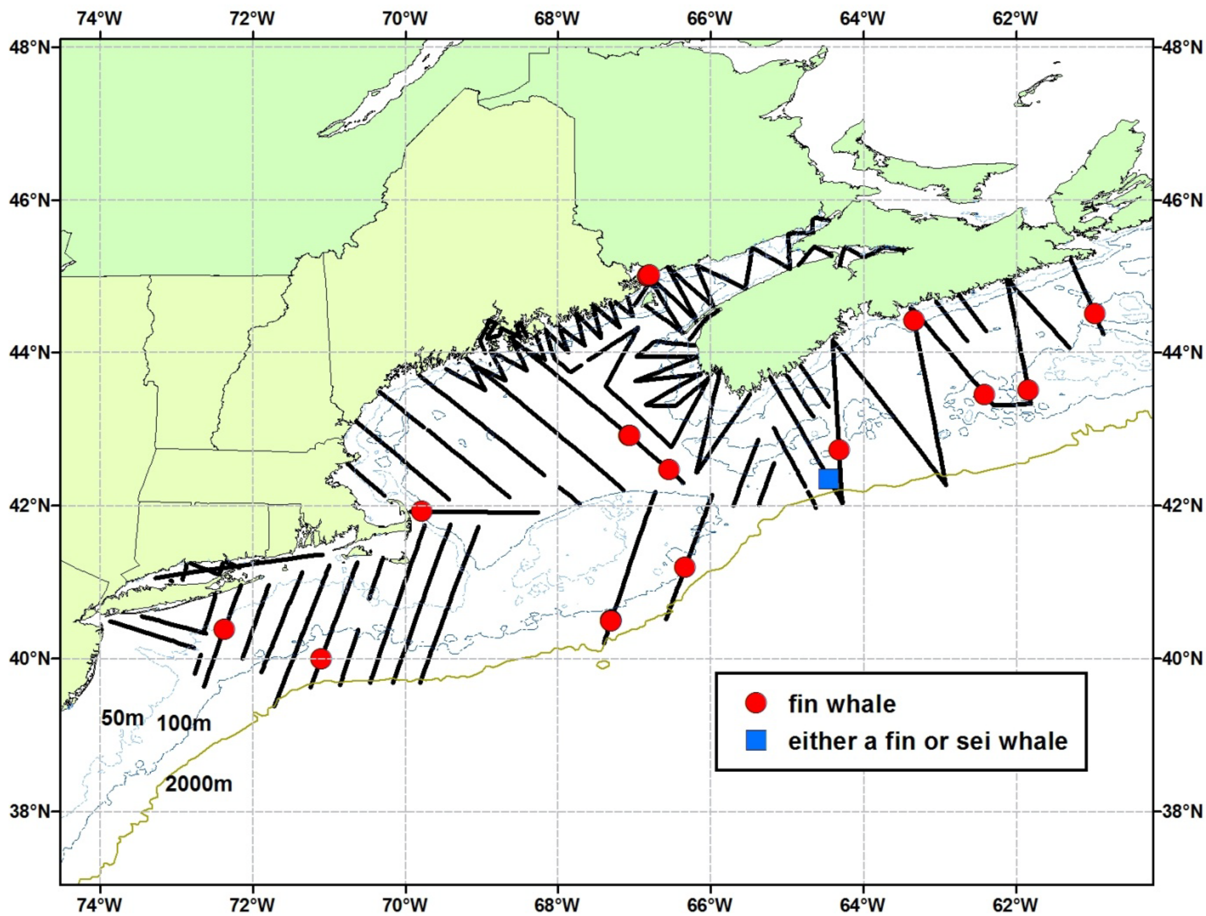

Figure 10. Location of beaked, blue, right, and sperm whales sightings, in addition to unidentified whale sightings detected during 17 August – 26 September 2010.

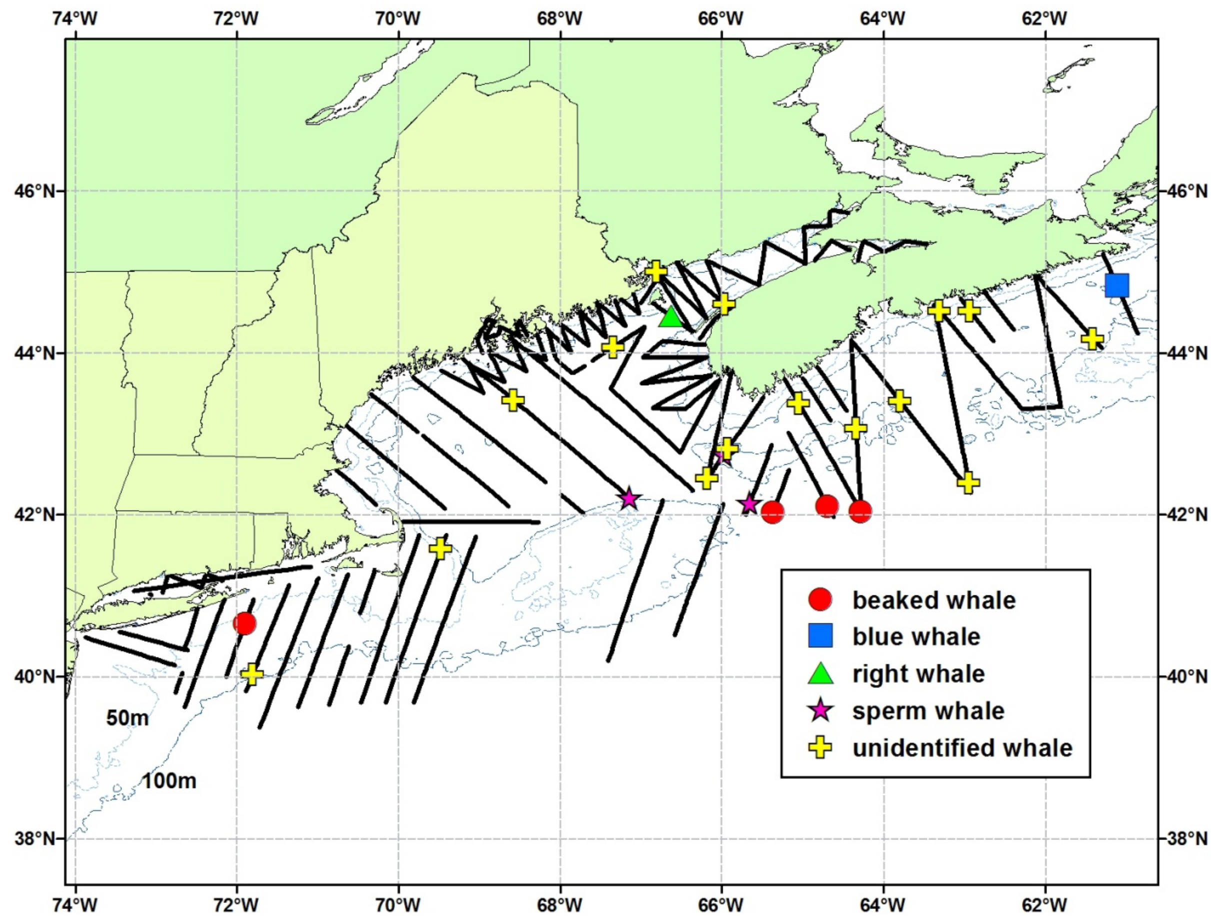

Figure 11. Location of seal sightings detected during 17 August – 26 September 2010.

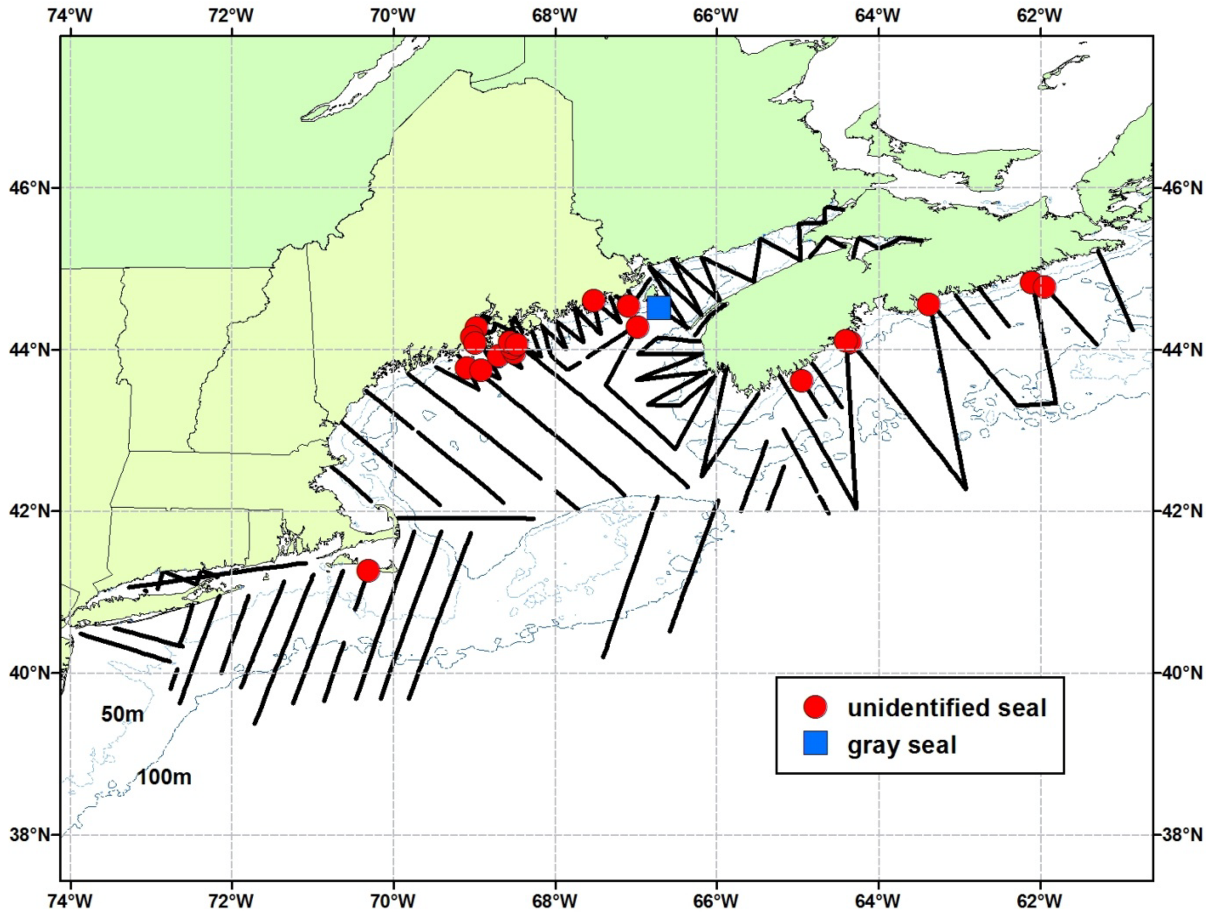

Figure 12. Location of leatherback and loggerhead turtle sightings detected during 17 August – 26 September 2010.

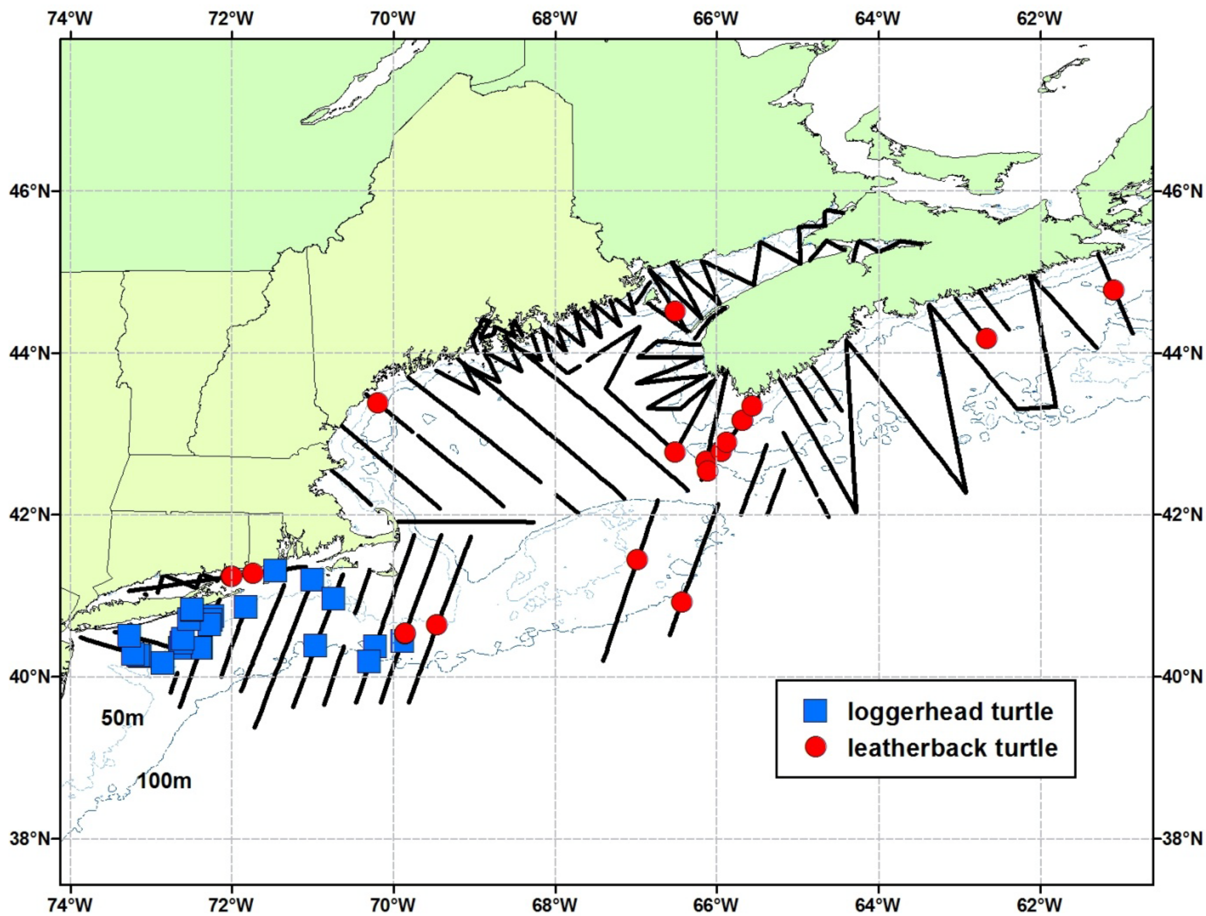

Figure 13. Location of green, Ridley's and unidentified turtle sightings detected during 17 August – 26 September 2010.

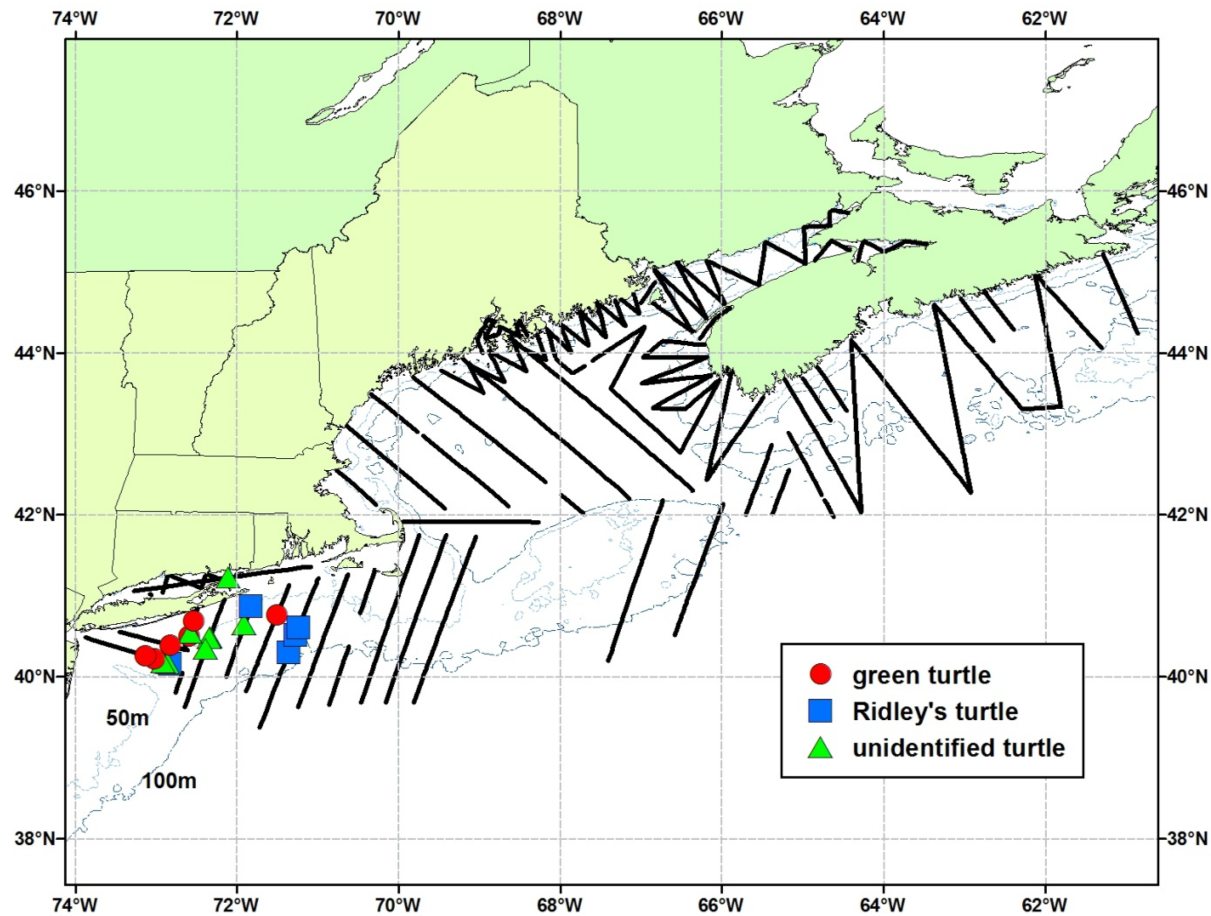

Figure 14. Location of basking shark sightings detected during 17 August – 26 September 2010.

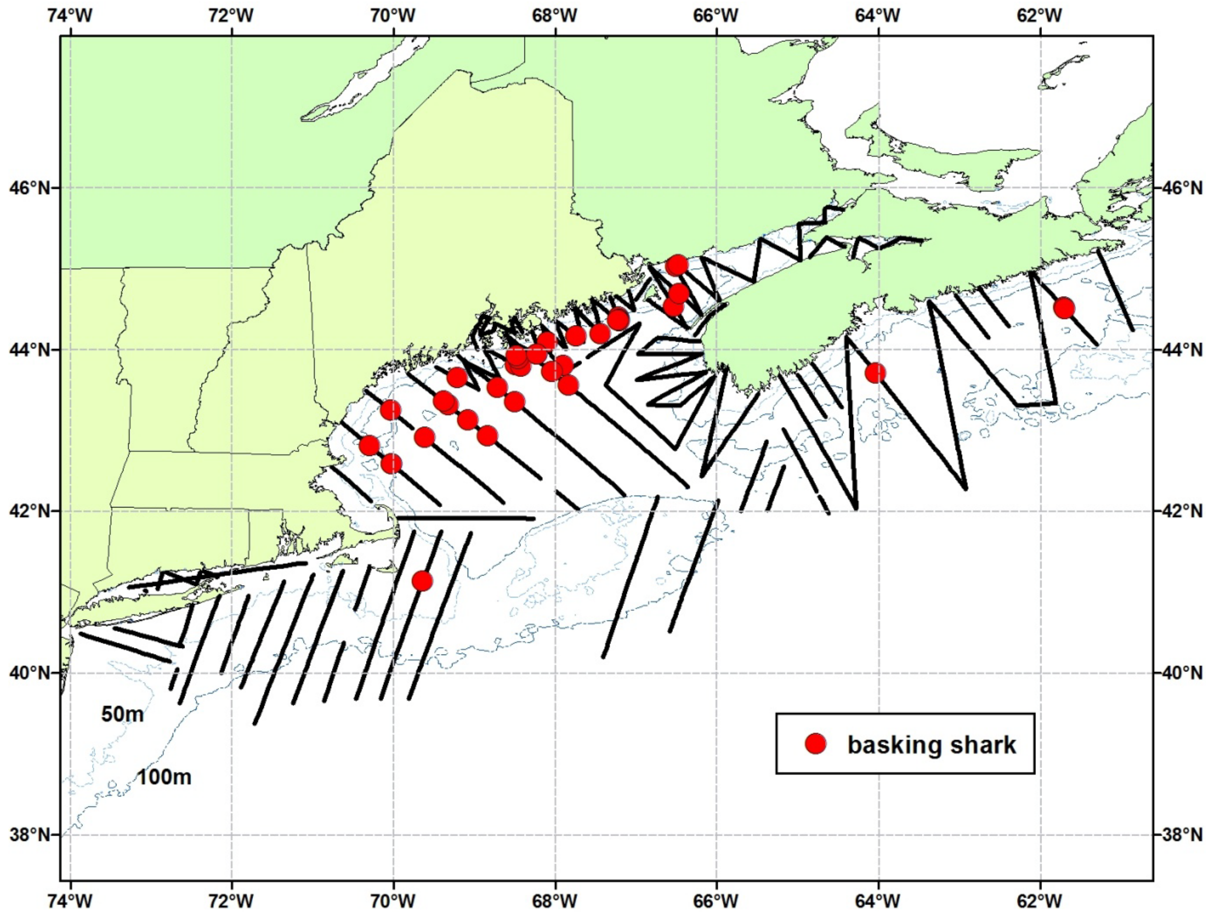

Figure 15. Location of sun fish sightings detected during 17 August – 26 September 2010.

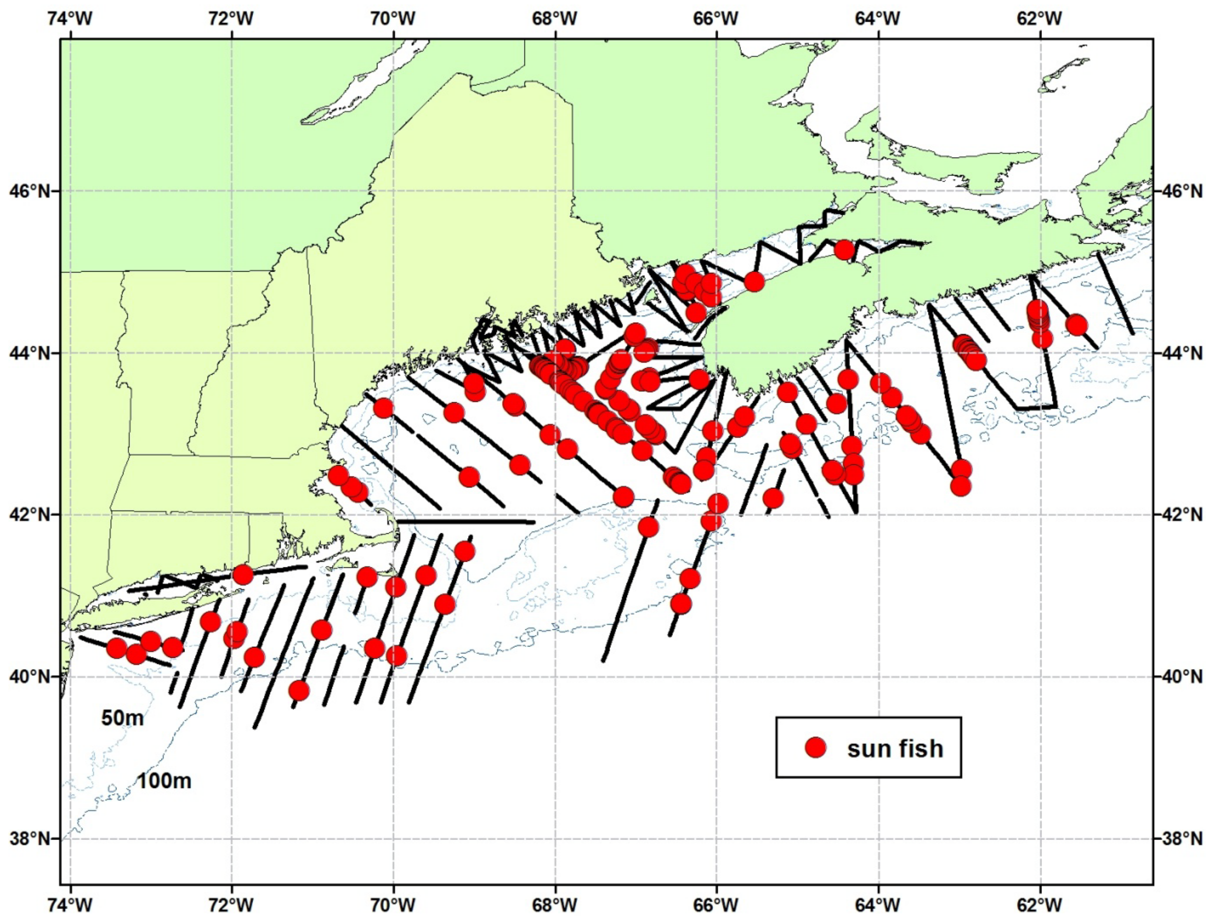

Figure 16. Location of blue shark, manta ray, tuna, unidentified shark and unidentified ray sightings detected during 17 August – 26 September 2010.