17 December 2006

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 24 July to 26 August 2006. On 24 July 2006, the scientists participated in a day-long aircraft safety class and pool session. On 25 July 2006, the team practiced the field methods and data collection procedures over the waters of Cape Cod Bay. The survey track lines were surveyed from 26 July to 26 August 2006.

The study area (Figure 1) extended from New Jersey, USA (74º 20'N 39º 40'W), eastward to the Gulf of St. Lawrence (58º 30'W), and northward to the Bay of Fundy (45º 30'N).

The team was based out of Woods Hole, MA (Otis Air Force base) from 24 July to 03 August; Portland, ME from 4-6 August; Bar Harbor, ME from 7-13 August; Yarmouth, Nova Scotia from 14-17 August; Halifax, Nova Scotia from 18-25 August, and back to Otis on 26 August.

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 were flown at 600 feet (183m) above the water surface, at about 110 knots (200 km per hour). Ideally, surveying was conducted when Beaufort sea state conditions were at or below four, and when there was at least two miles of visibility, however, some effort was flown at Beaufort sea states of 5 and 6.

There were two pilots and five scientists onboard. Three scientists were on-effort observers searching using the naked eye for cetaceans, turtles and other species. 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 28º view on both sides of the track line. The bubble window observers concentrated searching from straight down (0º) up to about 45º from the track line; the area from 45º to the horizon (90º) was also searched, though less frequently. Handheld binoculars were available to confirm species identifications or group size, if needed. When a cetacean, seal, turtle, basking shark, or sunfish 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 (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.),
7. Animal behavior (swimming, charging, breaching, diving, feeding, logging, milling, and socially active)
8. If the animal appeared to react to the plane (yes or no),
9. If the animal was diving (yes or no), and
10. Comments, if any.

Boats and other fish species were also recorded opportunistically. 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 their data to the recorder via the intercom.

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

1. Initials of person in the two pilot seats, and three observation stations,
2. Beaufort sea state,
3. Water turbidity (clear, moderately clear, and turbid),
4. Percentage of cloud cover (0-100%),
5. 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, etc.,
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. Plane location was collected 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); 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 date, time, latitude, longitude, sea surface temperature, and plane's speed and course.

The circle-back line transect method used to collect data 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 (≤ 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 groups. 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 observer 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 recorded, 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 recorded, observers went back on-effort and started searching again. At the same time, 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 34 days in this survey:

a) 18 days were used to collect the data for this survey. These flights included 6762 nautical miles of on-effort track line (Figure 1), which included 168 nmi of track lines that were re-flown during 81 circle-backs;
b) 1 day was used for a flight safety class;
c) 1 day was used for in-plane training for the observers and pilots;
d) 2 days were used to transit from one airport base to another in bad weather; and
e) 12 days had bad weather where no flights were attempted.

During the total on-effort survey track lines that were part of the single and leading legs (6594 nmi), 42% of the total track line length (2736 nmi) were surveyed in Beaufort sea states of 2 or less (Table 2).

During the on-effort survey days, there were 15 species of identifiable cetaceans seen, which included: whales: fin, sei, pilot, minke, right, humpback, sperm, and beaked; dolphins: white-sided, white-beaked, common, Risso's, spotted, and bottlenose; and harbor porpoises (Table 1). In addition, harbor seals, leatherback, loggerhead, and green turtles were also seen (Table 1). In total, then number of groups (and individuals) detected during the single and leading leg portion of the track lines were: 567 groups (4278 individuals) of cetaceans; 68 groups (203 individuals) of seals; 57 groups (57 individuals) of sea turtles; and 439 groups (598 individuals) of sharks, rays, and sunfish (Table 1).

On the eighty-one (81) circle-backs that were performed, the species detected on the leading legs included: 58 cetaceans, 15 sea turtles, 1 seal, and 15 fish, which included basking sharks and sunfish (Table 1). 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 3 to 19. 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
Nicholas Toth	Aircraft Commander Part I	NOAA/AOC, Tampa, FL
Gregg Lamontagne	Aircraft Commander Part II	NOAA/AOC, Tampa, FL
Mark Sweeney	Co-Pilot Parts I & II	NOAA/AOC, Tampa, FL
Debra Palka	Chief Scientist /Recorder	NOAA/NEFSC, Woods Hole, MA
Virginie Chadenet	Observer	Contractor for NOAA/NEFSC, Woods Hole, MA
Robert DiGiovanni	Observer	Contractor for NOAA/NEFSC, Woods Hole, MA
Peter Duley	Observer	Integrated Statistics, Woods Hole, MA
Misty Niemeyer	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.

List of Tables and Figures

Table 1. Sightings detected during the 2006 Aerial Survey.

Species	Sightings from the single and leading legs					Sightings from the leading legs	Sightings from the trailing legs
	Number of groups	Number of Animals	Mean Group size	Max group size	Min Group size		
Beaked whales	2	8	4	7	1	0	0
Bottlenose dolphin	1	20	20	20	20	0	0
Common dolphin	76	1917	25.2	130	1	3	2
Fin / Sei Whale	16	19	1.2	3	1	0	0
Fin Whale	33	41	1.2	3	1	8	3
Harbor Porpoise	189	533	2.8	20	1	25	6
Humpback Whale	39	49	1.3	2	1	4	2
Minke Whale	25	26	1	2	1	6	1
Pilot Whale	48	552	11.6	100	1	3	3
Risso's dolphin	28	360	12.9	35	1	1	1
Right Whale	16	20	1.2	3	1	0	1
Sei Whale	2	2	1	1	1	0	0
Sperm whale	2	2	1	1	1	0	0
Spotted dolphin	1	2	2	2	2	1	0
White-beaked dolphin	5	46	9.2	35	1	2	3
White-sided dolphin	34	379	11.4	50	1	2	3
Unid dolphin	36	288	8	50	1	2	1
Unid whale	14	14	1	1	1	1	1
Total Cetaceans	567	4278	6.4	130	1	58	27
Green Sea Turtle	1	1	1	1	1	1	0
Leatherback Sea Turtle	3	3	1	1	1	2	0
Loggerhead Sea Turtle	49	49	1	1	1	12	13
Unid Sea Turtle	4	4	1	1	1	0	0
Total Sea Turtles	57	57	1	1	1	15	13
Harbor seal	55	190	3.5	60	1	1	0
Unidentified seal	13	13	1	1	1	0	0
Total Seals	68	203	2.3	60	1	1	0
Hammerhead sharks	4	4	1	1	1	0	0
Basking sharks	80	84	1	4	1	7	6
Blue shark	36	36	1	1	1	0	0
Manta rays	12	18	1.5	4	1	0	0
Cownosed rays	9	123	13.7	70	1	0	0
Sunfish	298	333	1.1	10	1	8	12
Total identified fish	439	598	3.6	70	1	15	18
Total Sightings	1131	5136	4.8	130	1	89	58

Table 2. Distribution of the length of track lines (nmi), single and leading legs, surveyed by Beaufort sea state.

Beaufort sea state	0	1	2	3	4	5	6	Total
Trackline length (nmi)	407.1	669.1	1659.5	2532.0	936.3	283.6	106.7	6594.3
% of total	6.17	10.15	25.17	38.40	14.20	4.3	1.62	100.00

Figure 1. Track lines surveyed during July 26 to August 26, 2006 aerial abundance survey. Color of track line indicates the Beaufort sea state the track line was surveyed in. Depth contours are displayed and labeled.

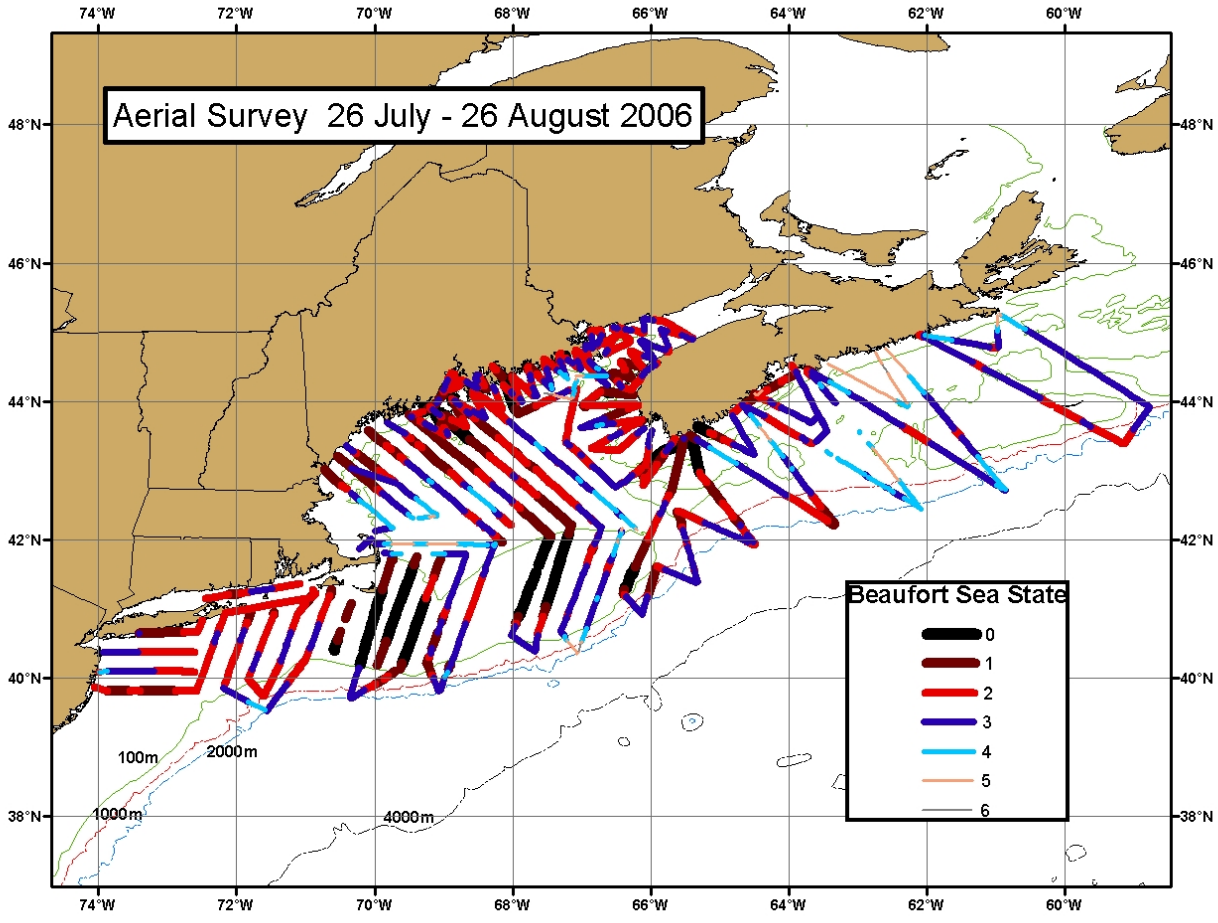

Figure 2. Circle-back procedure used to collect data to estimate g(0). Text provides more information on each step.

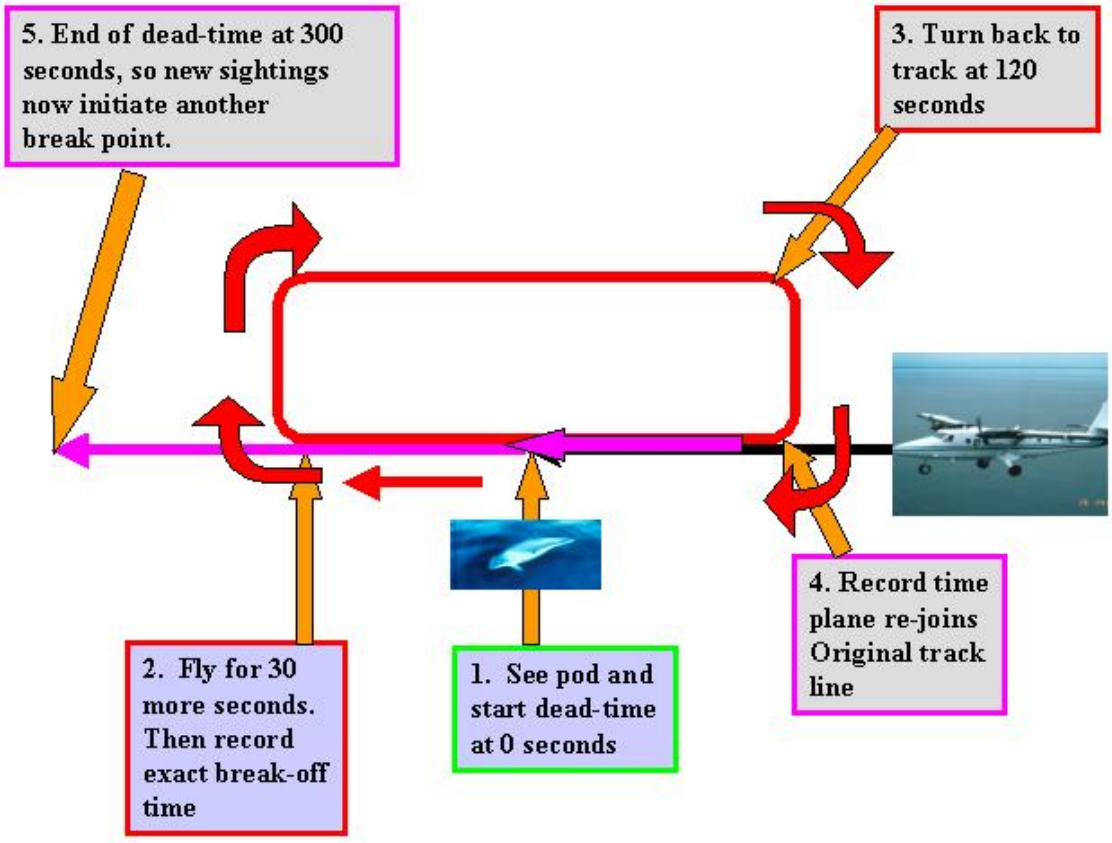

Figure 3. Distribution of pilot whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

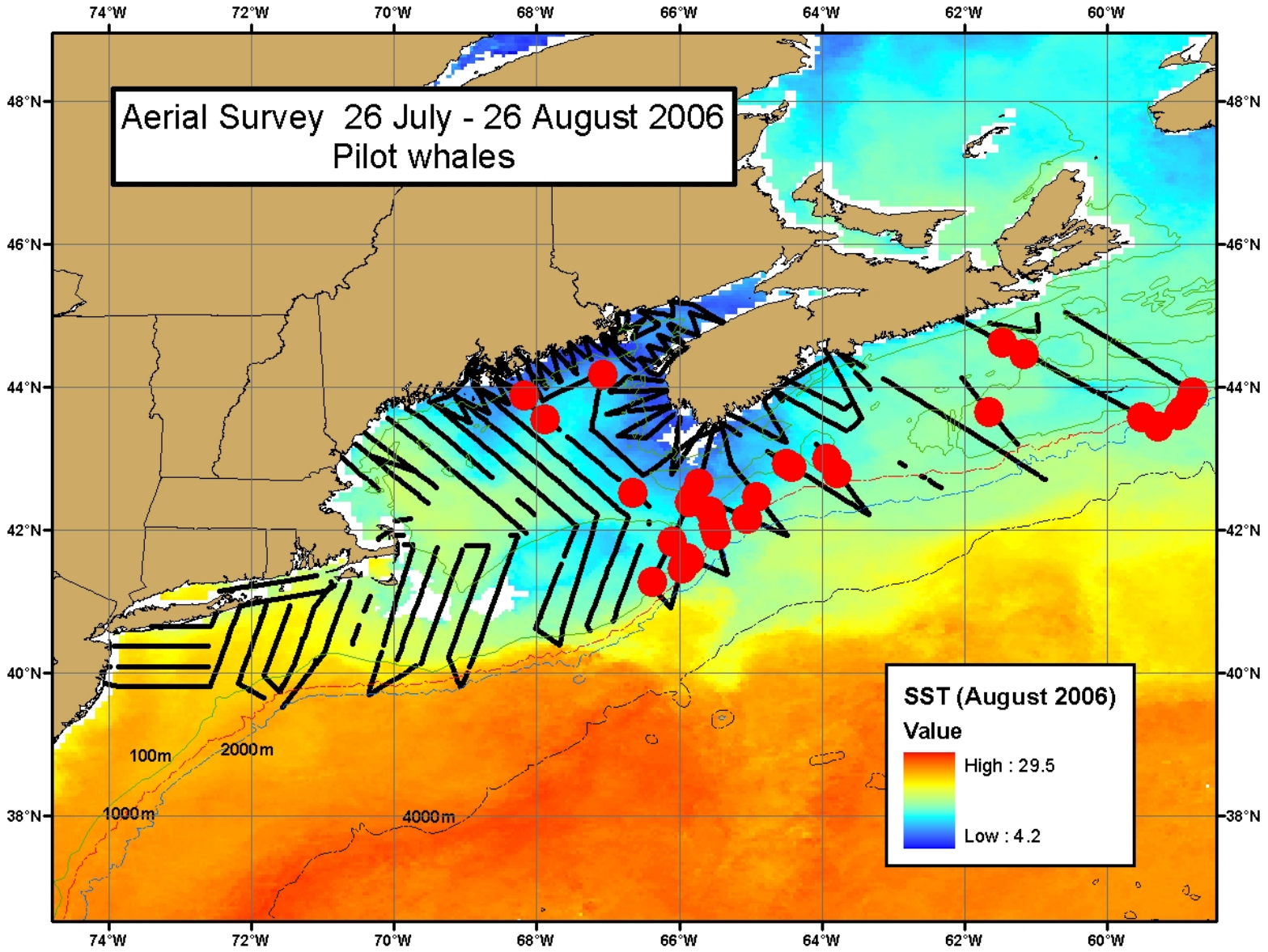

Figure 4. Distribution of white-sided dolphins detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

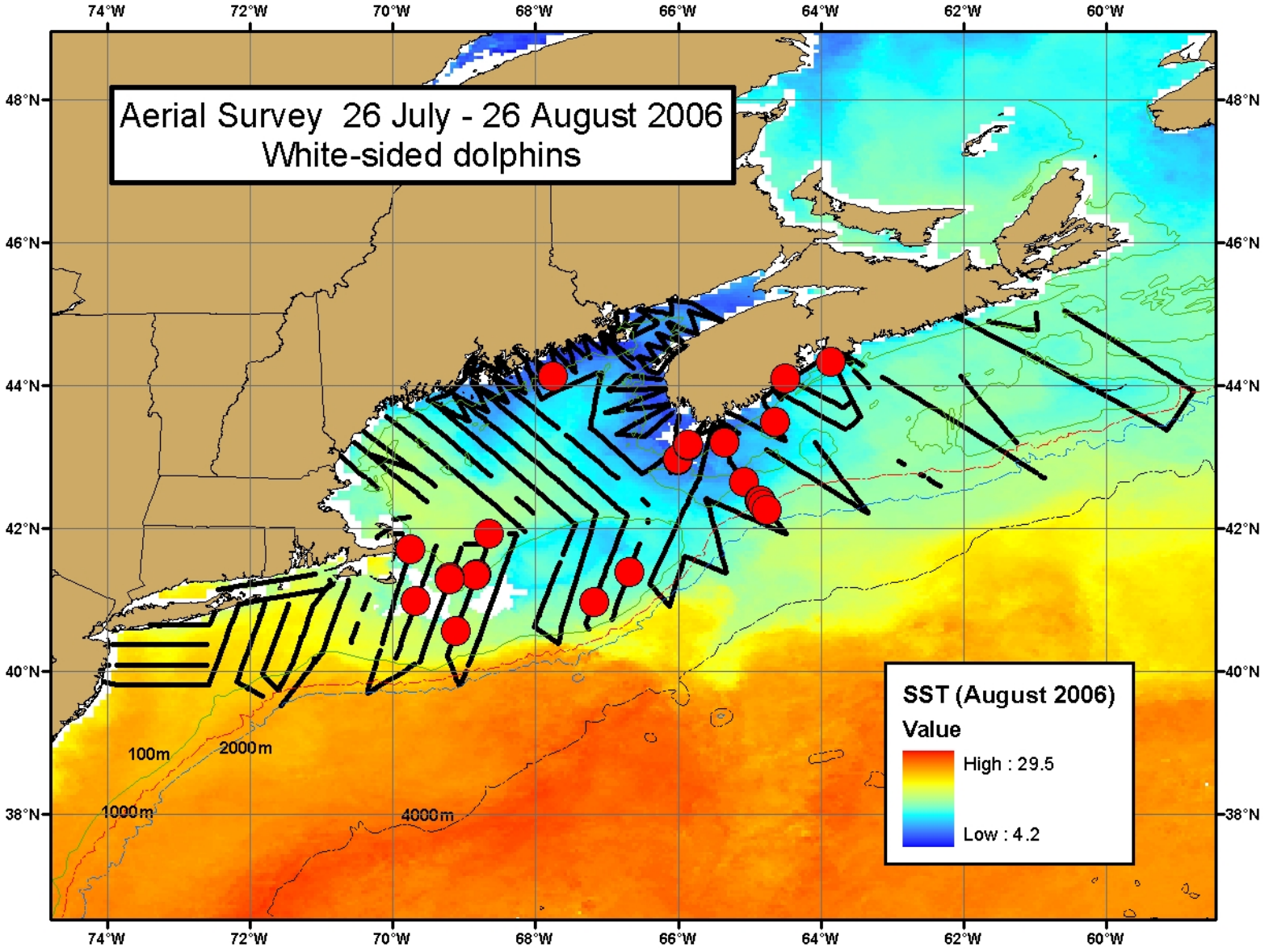

Figure 5. Distribution of common dolphins detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

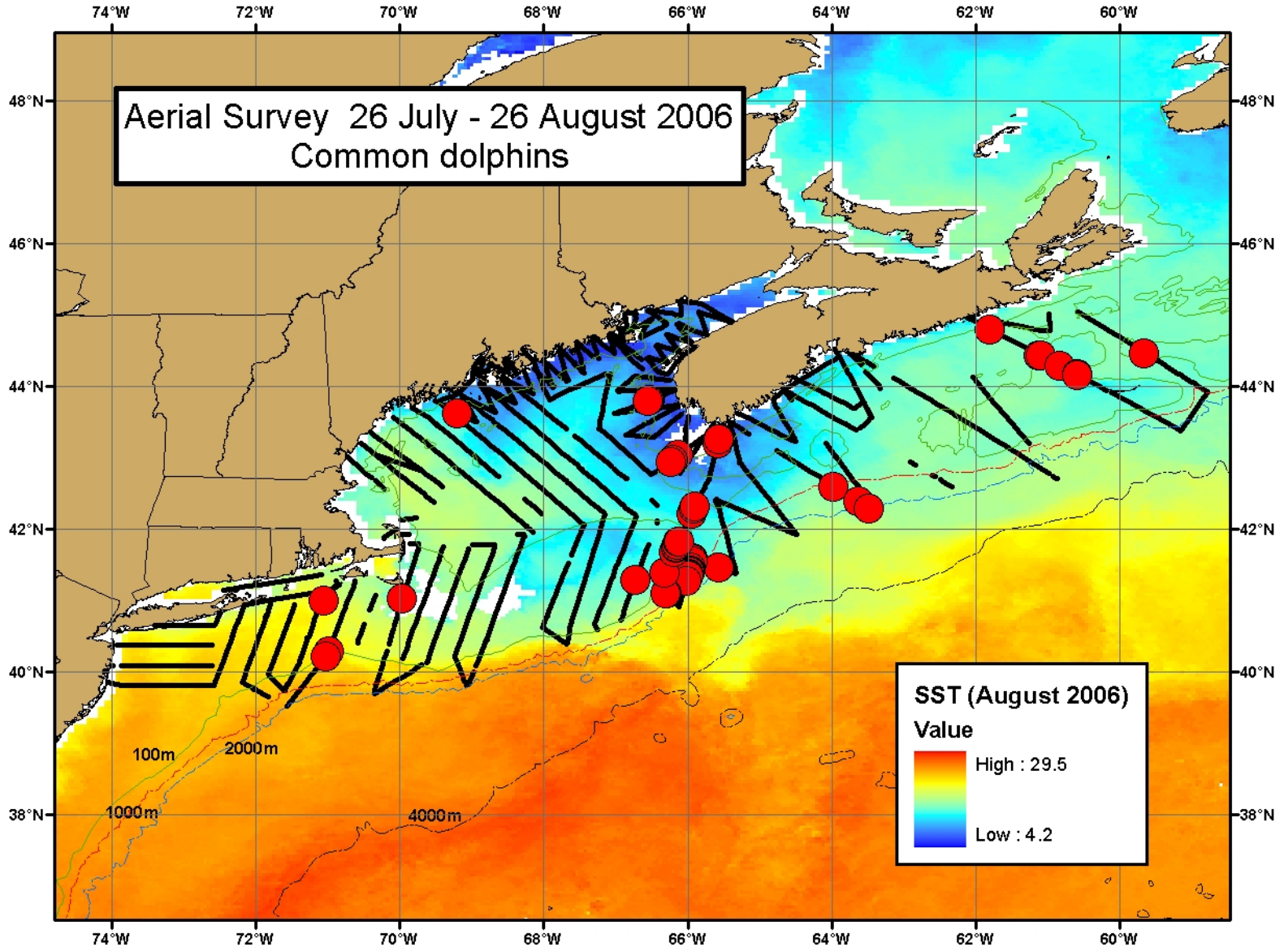

Figure 6. Distribution of Risso's dolphins detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

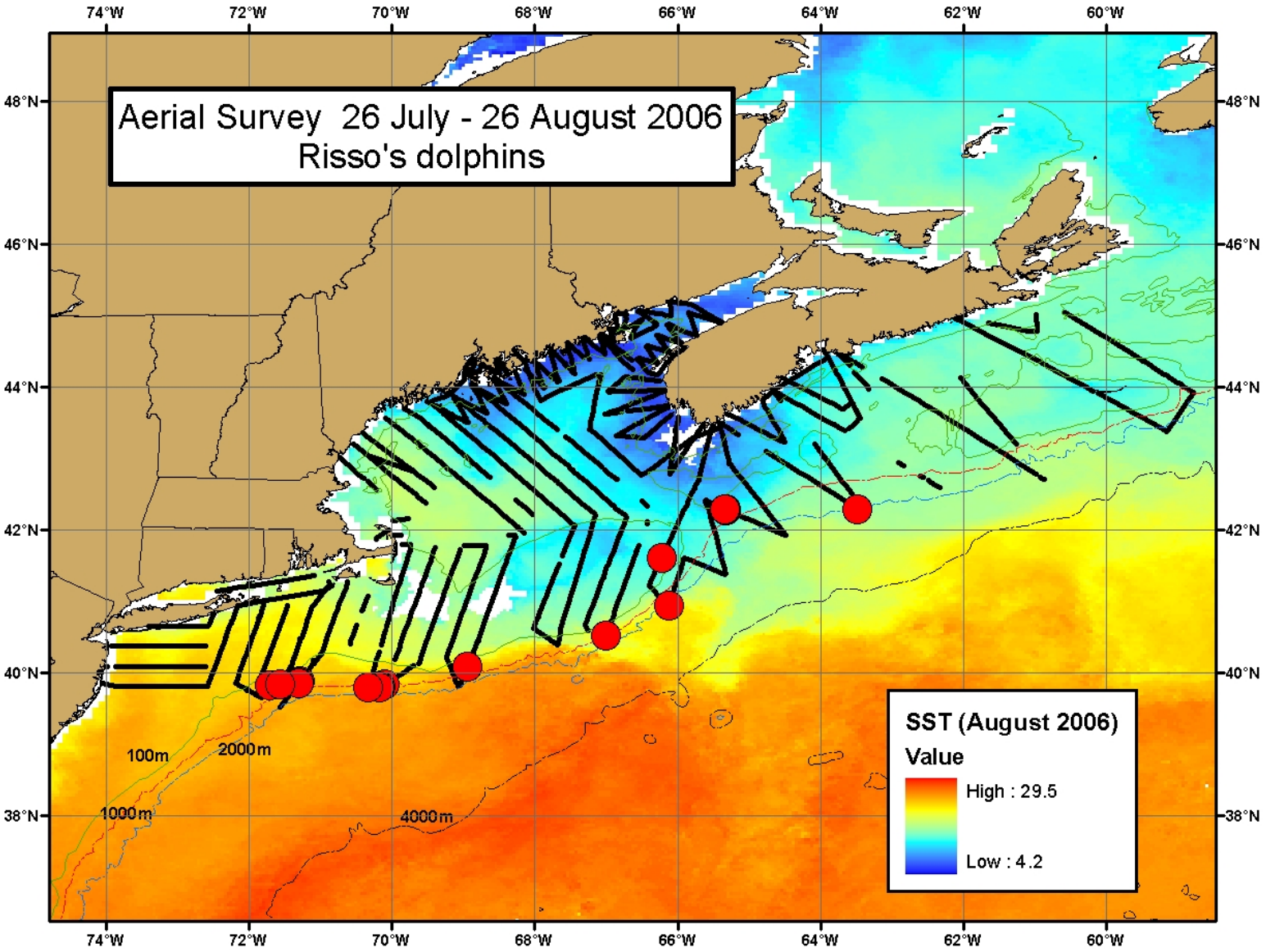

Figure 7. Distribution of unidentified dolphins detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

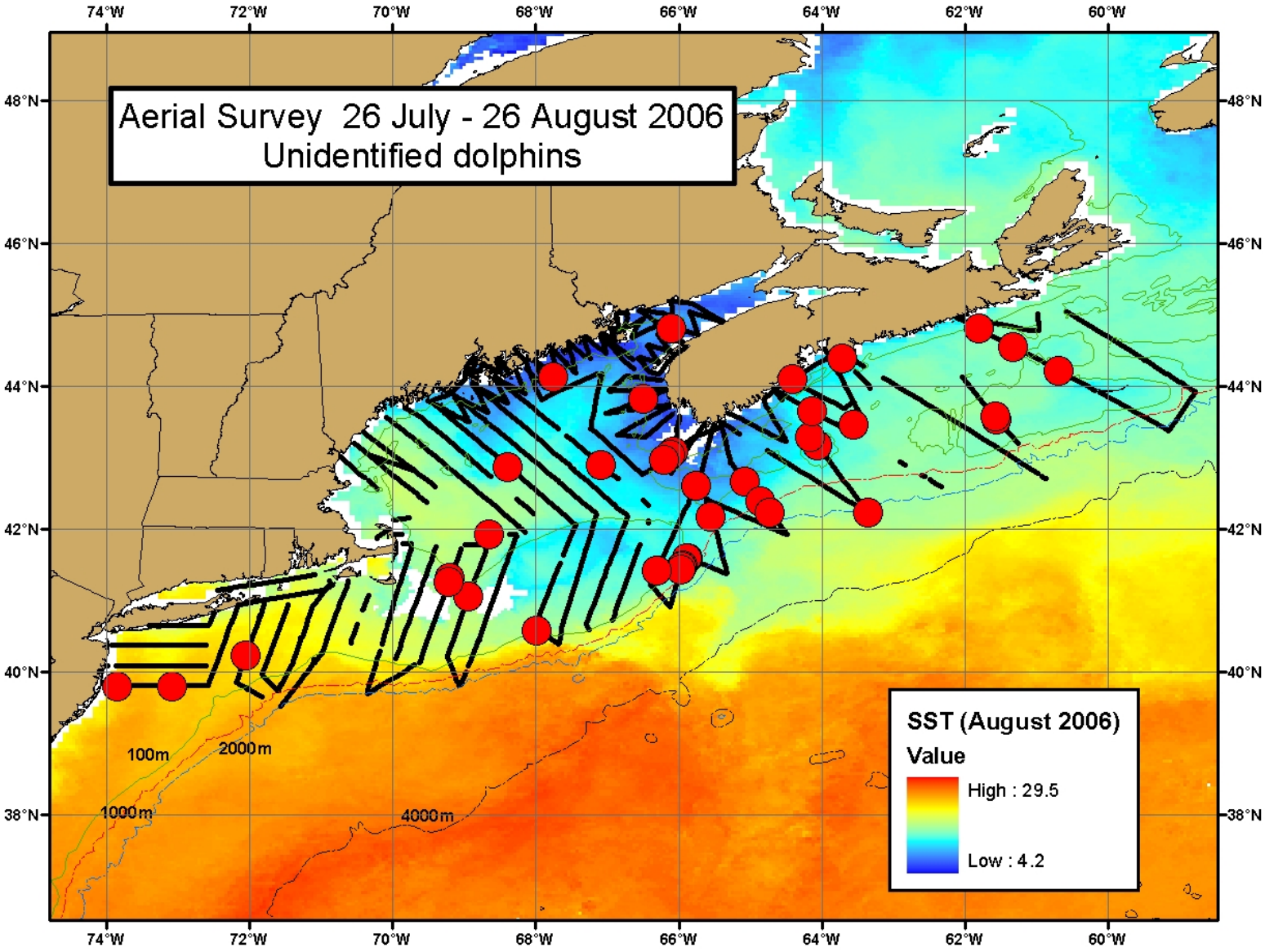

Figure 8. Distribution of bottlenose, spotted, and white-beaked dolphins detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

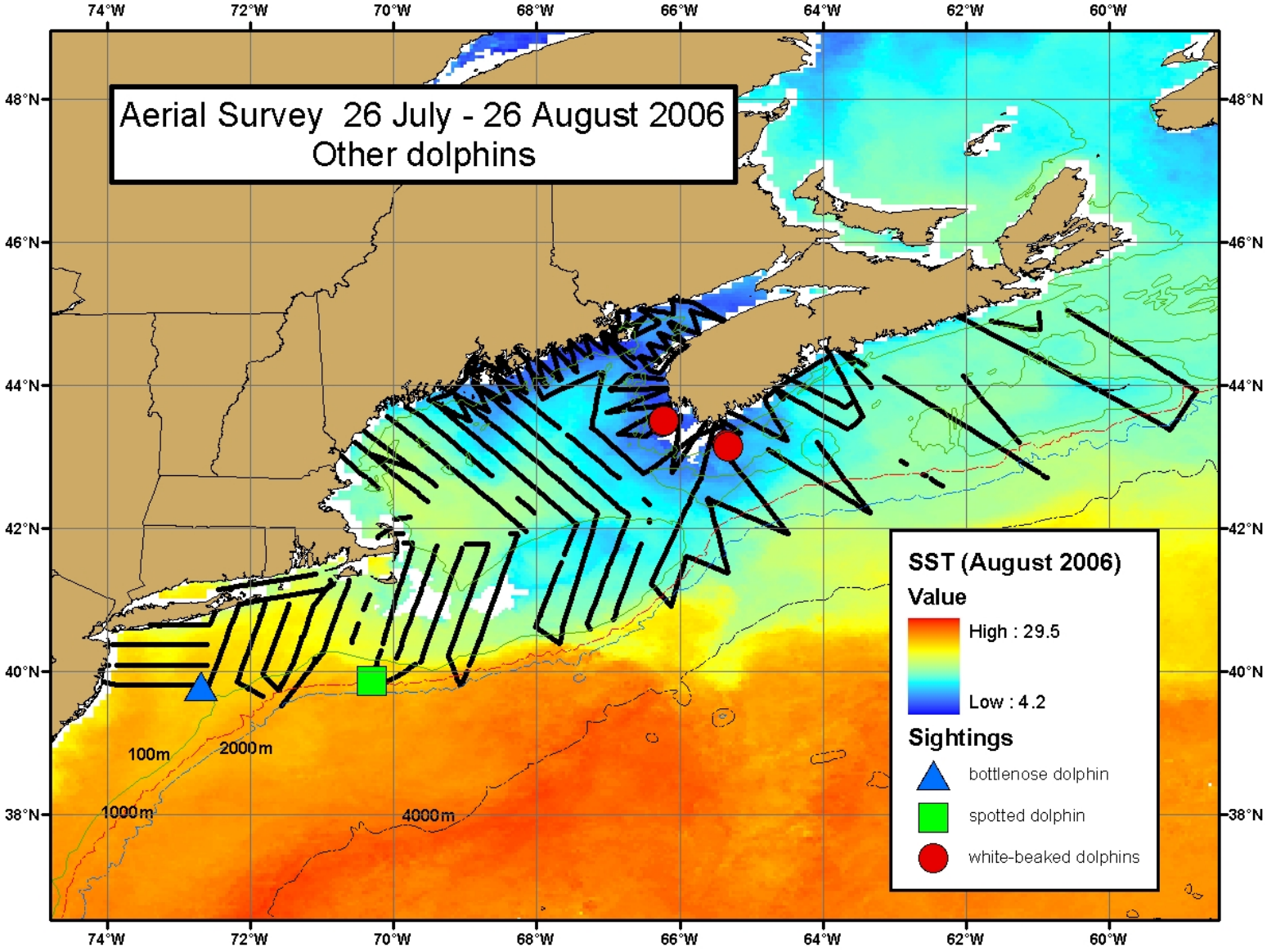

Figure 9. Distribution of humpback whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

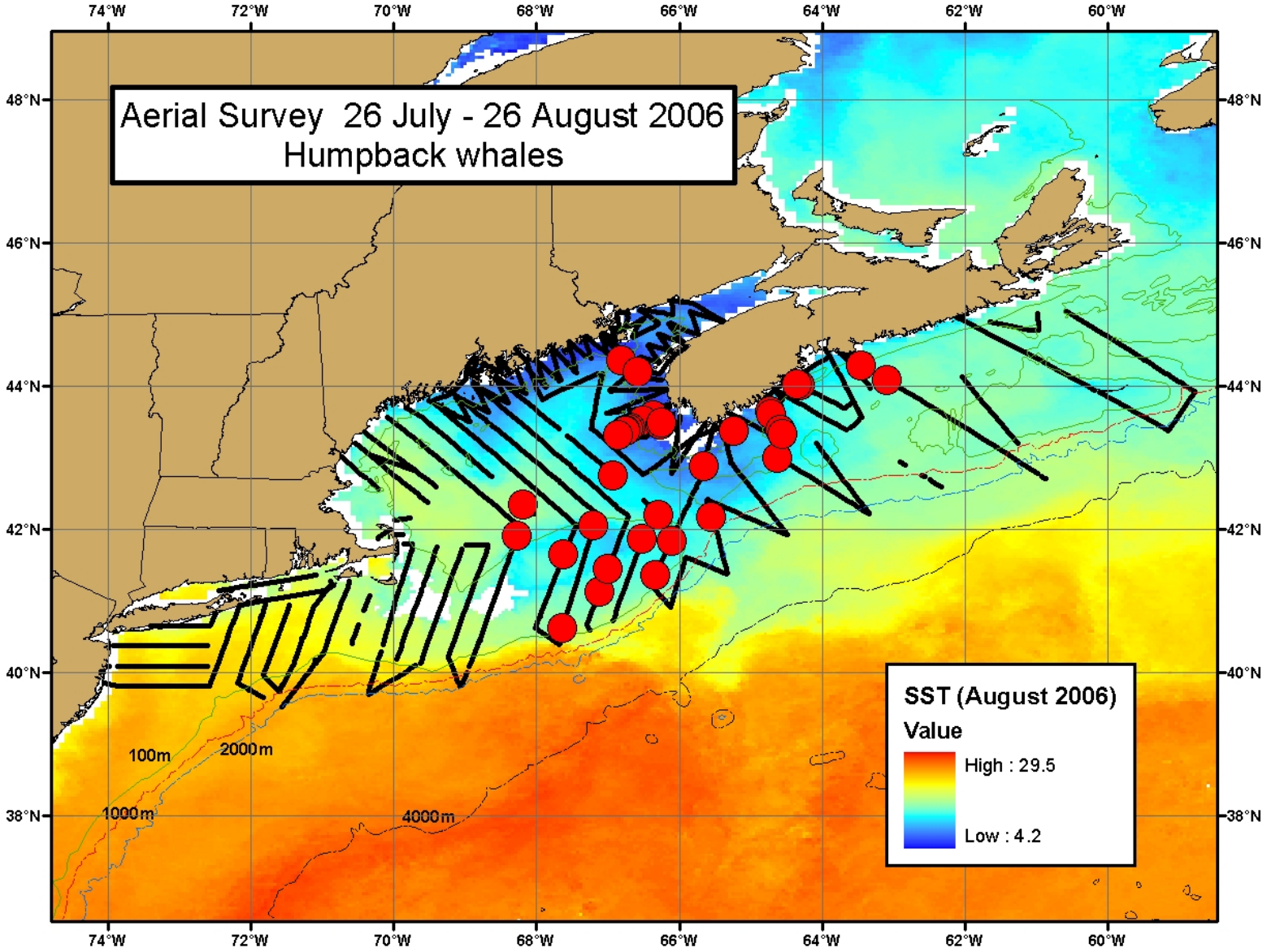

Figure10. Distribution of fin and sei whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

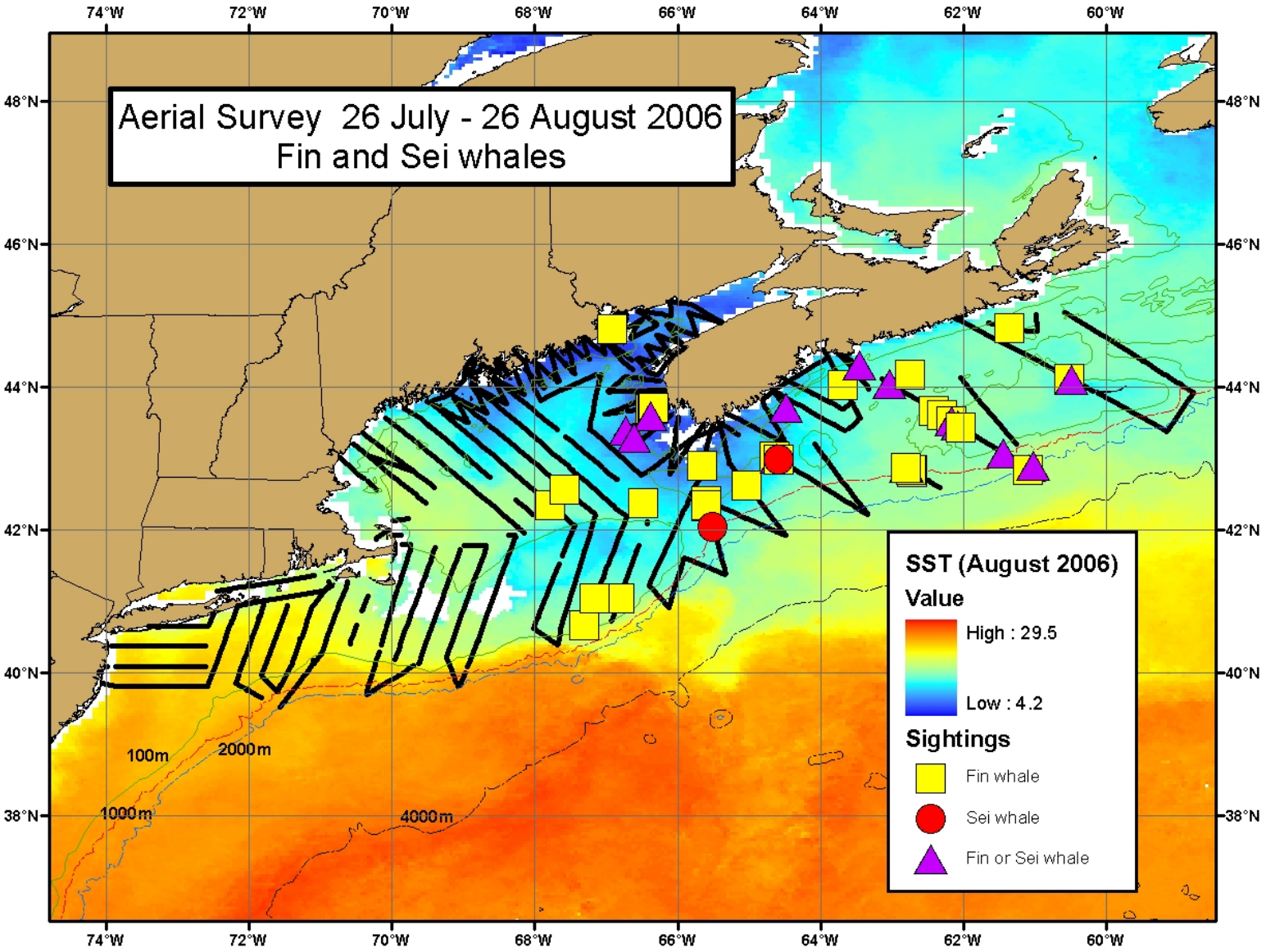

Figure 11. Distribution of minke whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

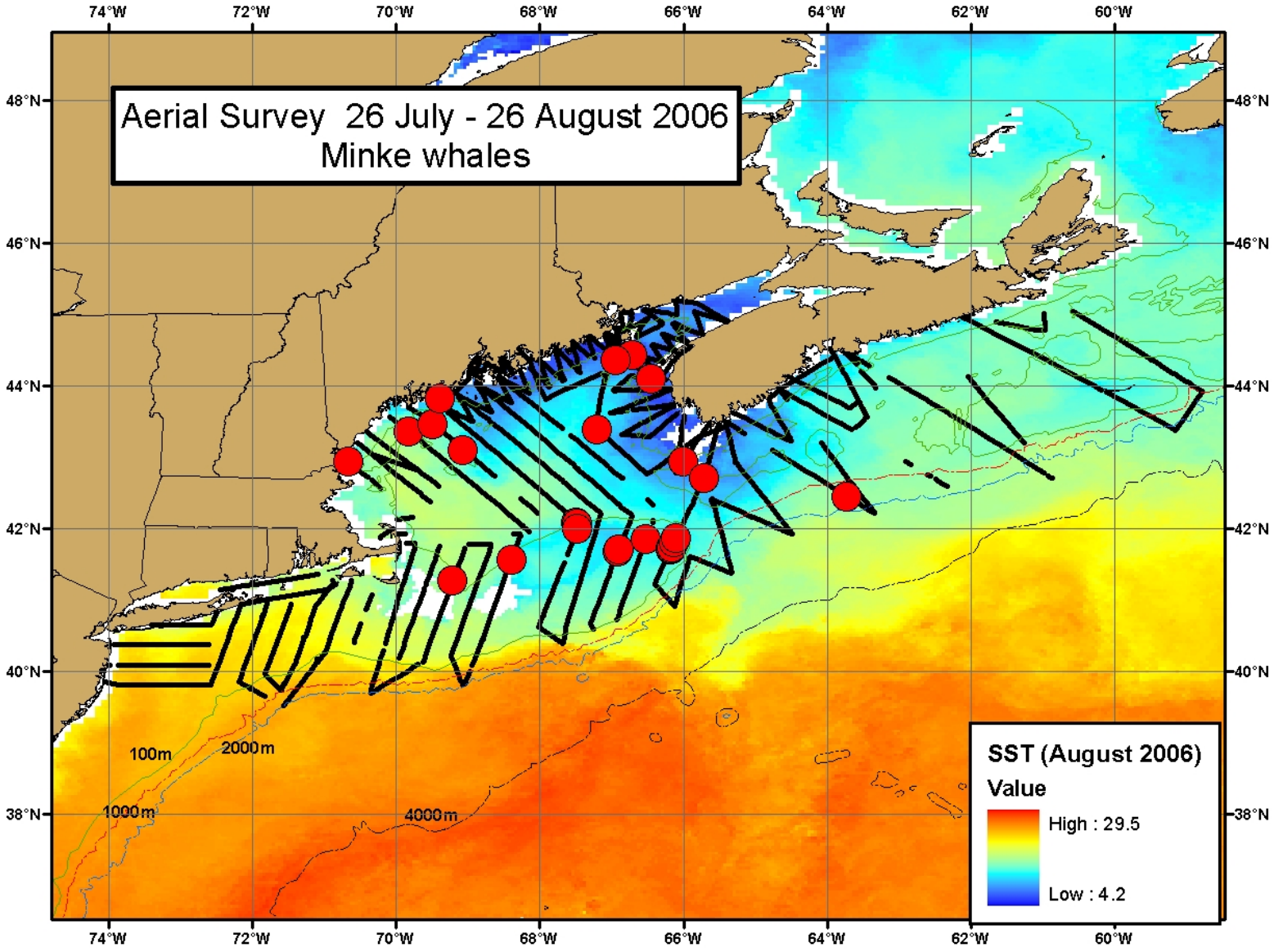

Figure 12. Distribution of unidentified whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

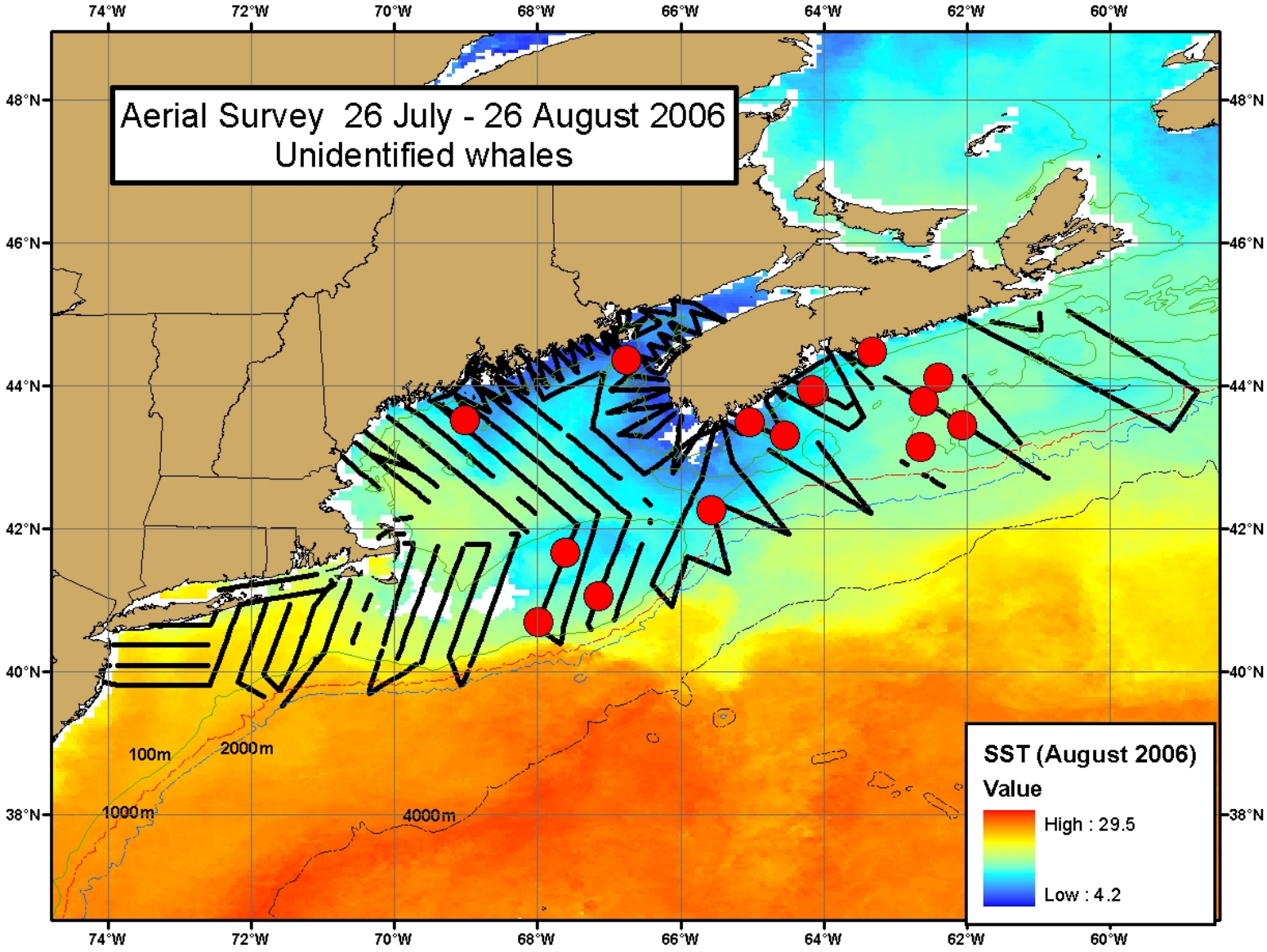

Figure 13. Distribution of beaked, right, and sperm whales detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

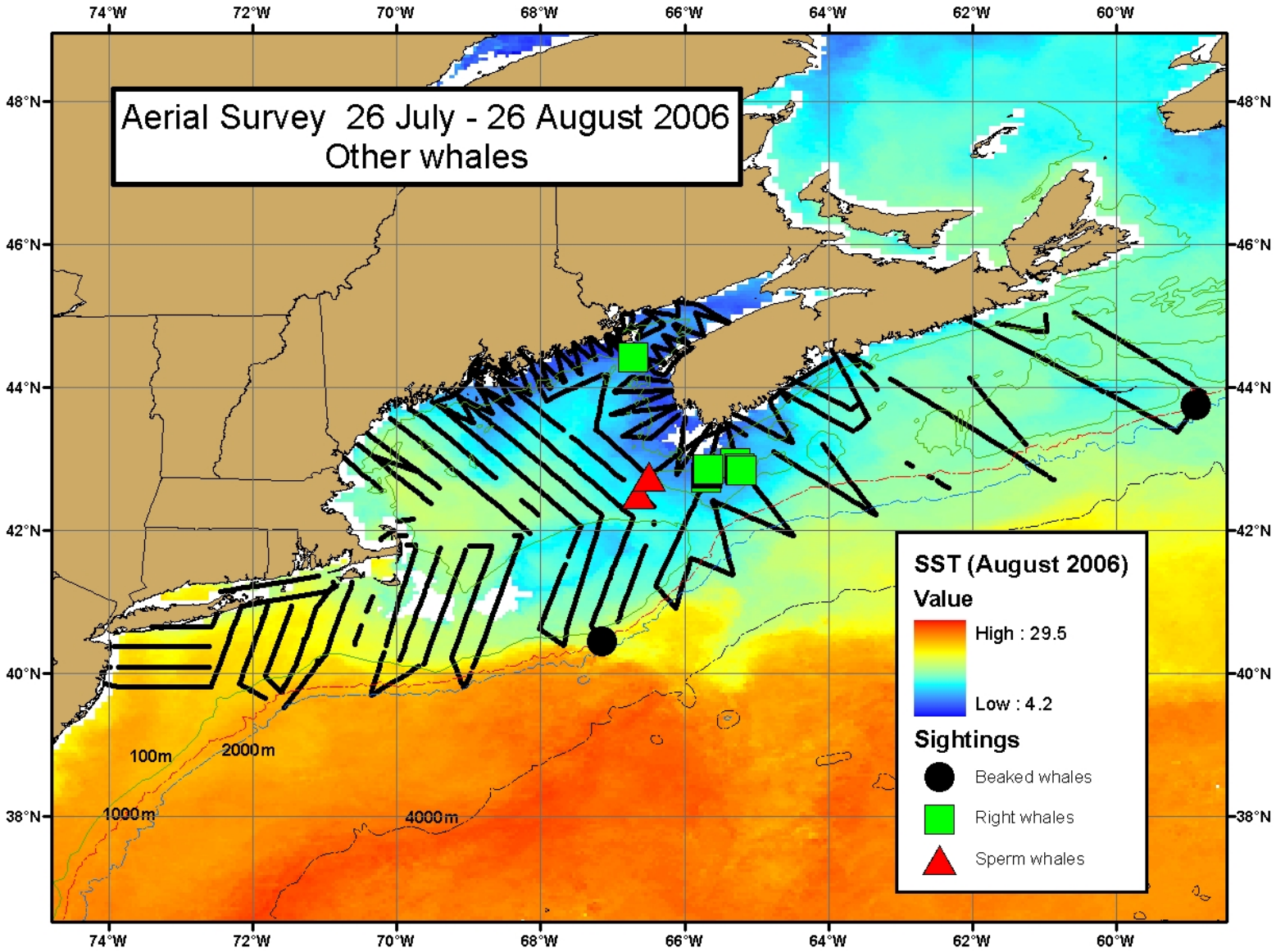

Figure 14. Distribution of seals detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

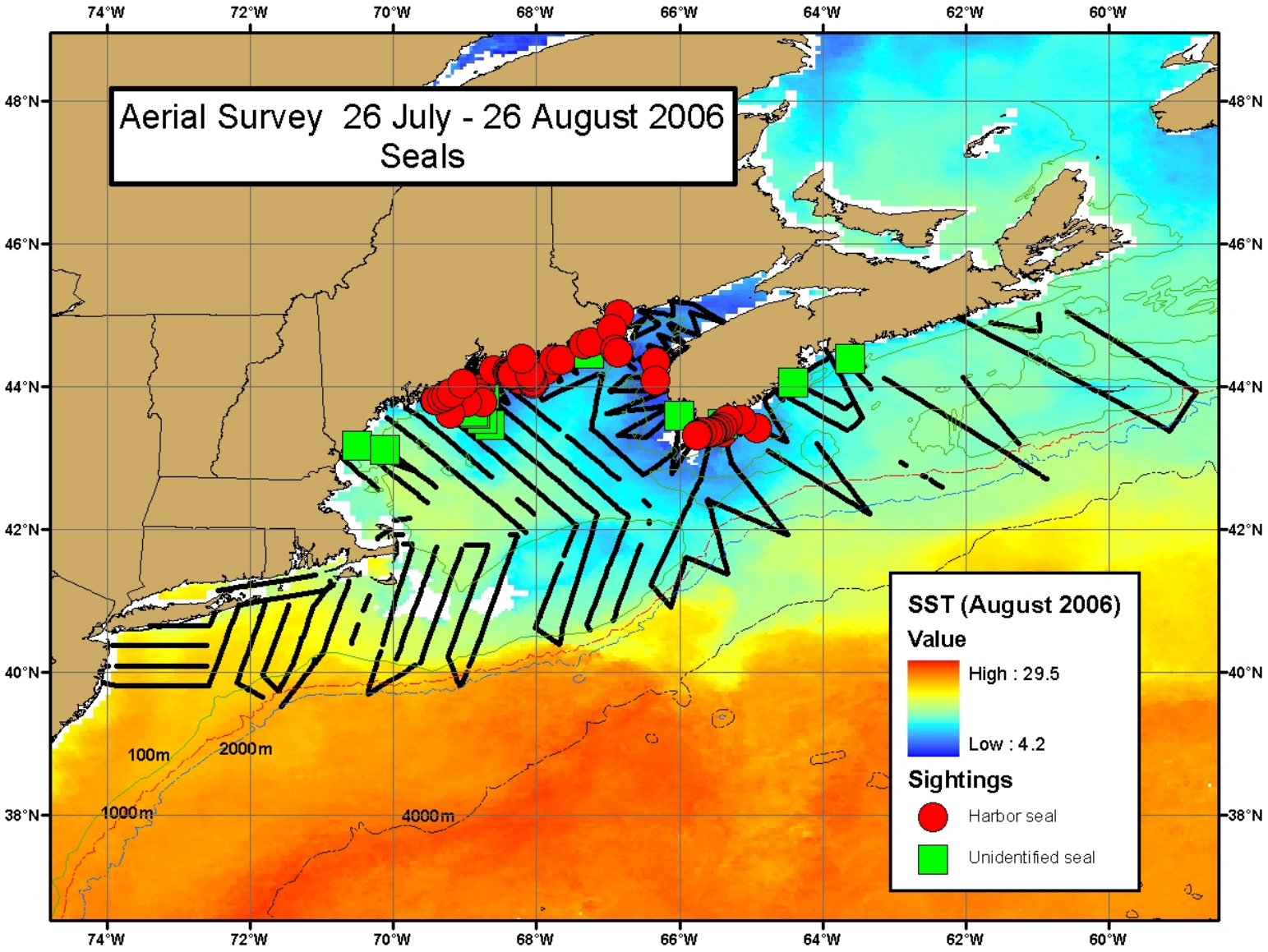

Figure 15. Distribution of turtles detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

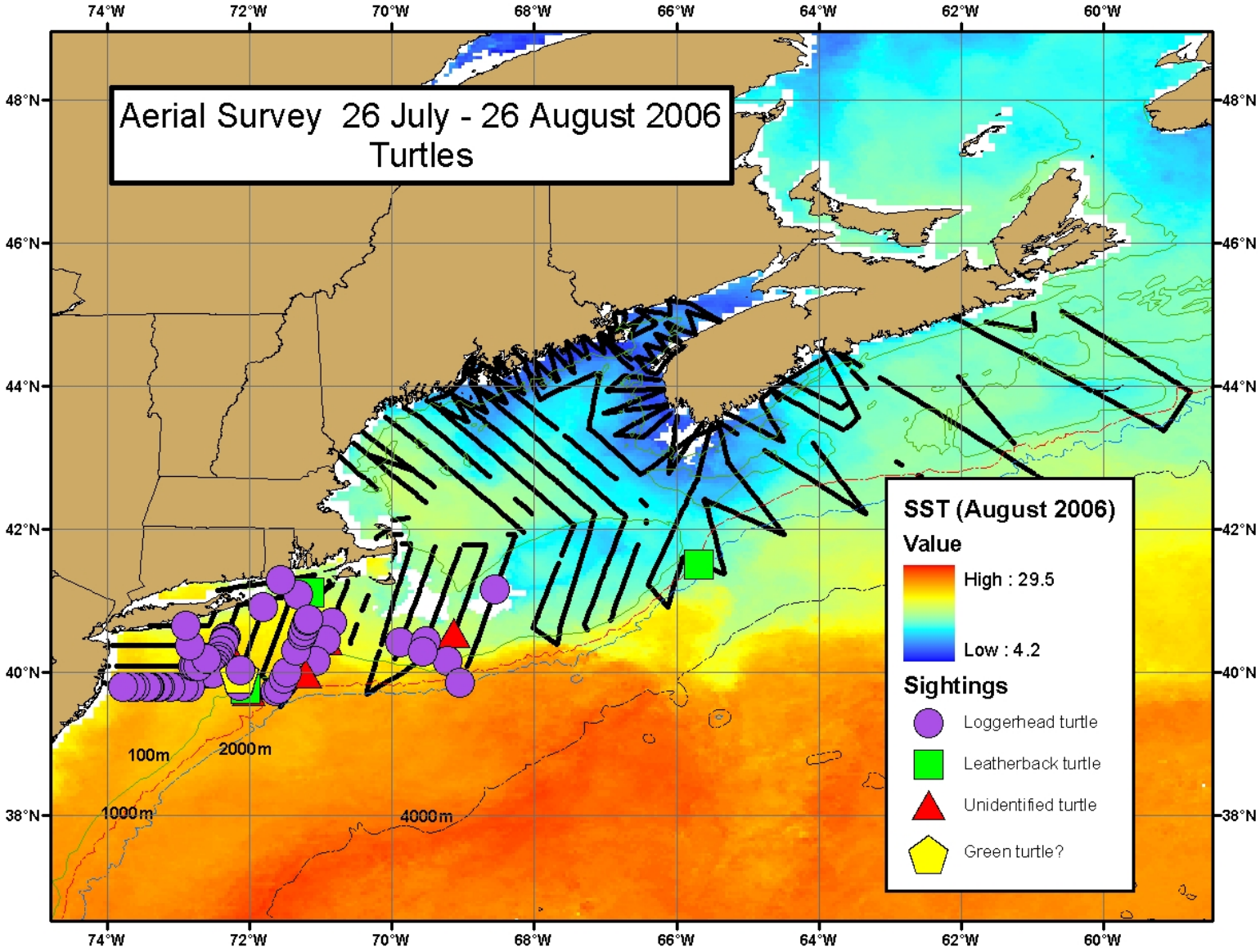

Figure 16. Distribution of harbor porpoises detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

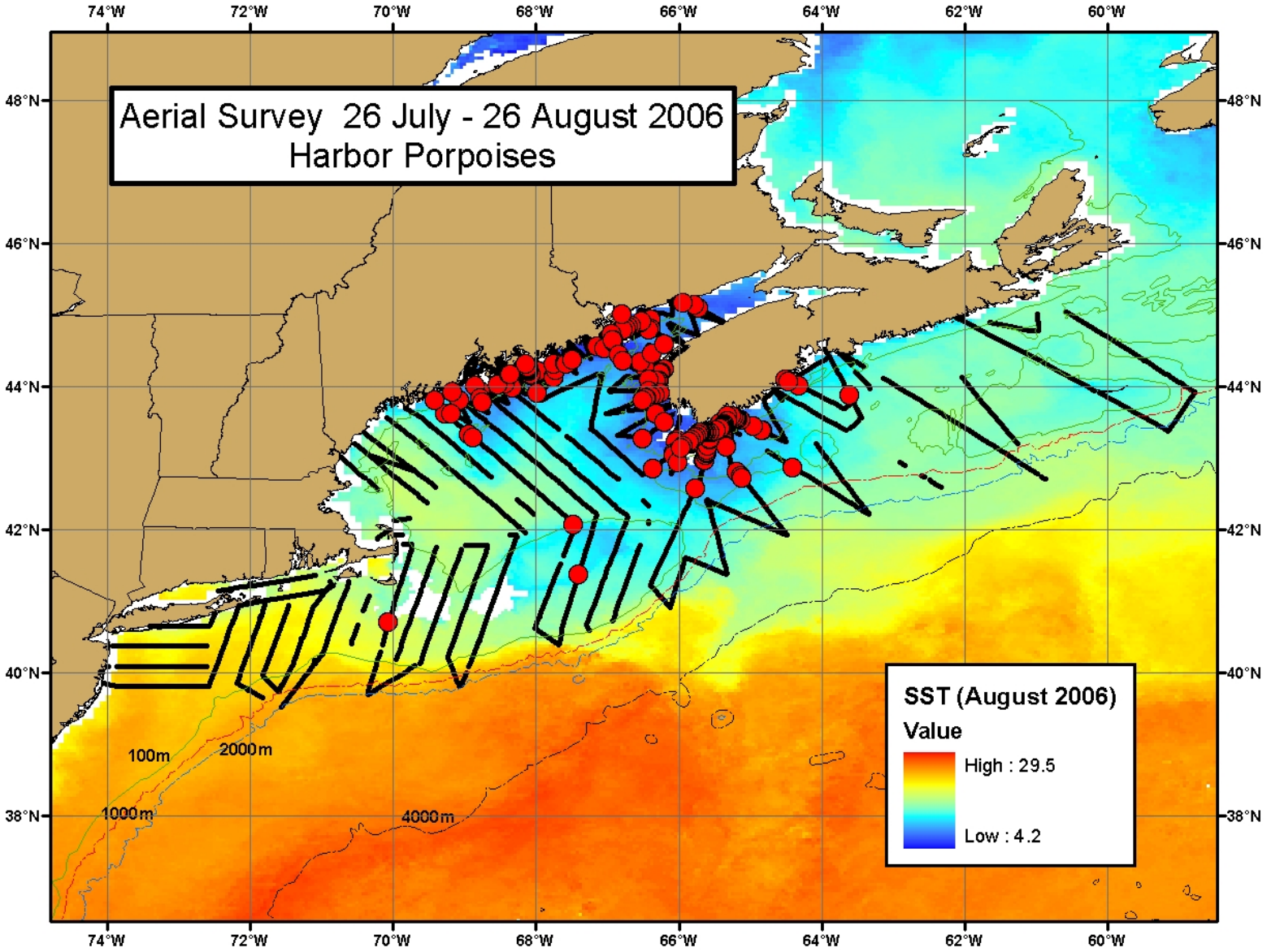

Figure 17. Distribution of basking sharks detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

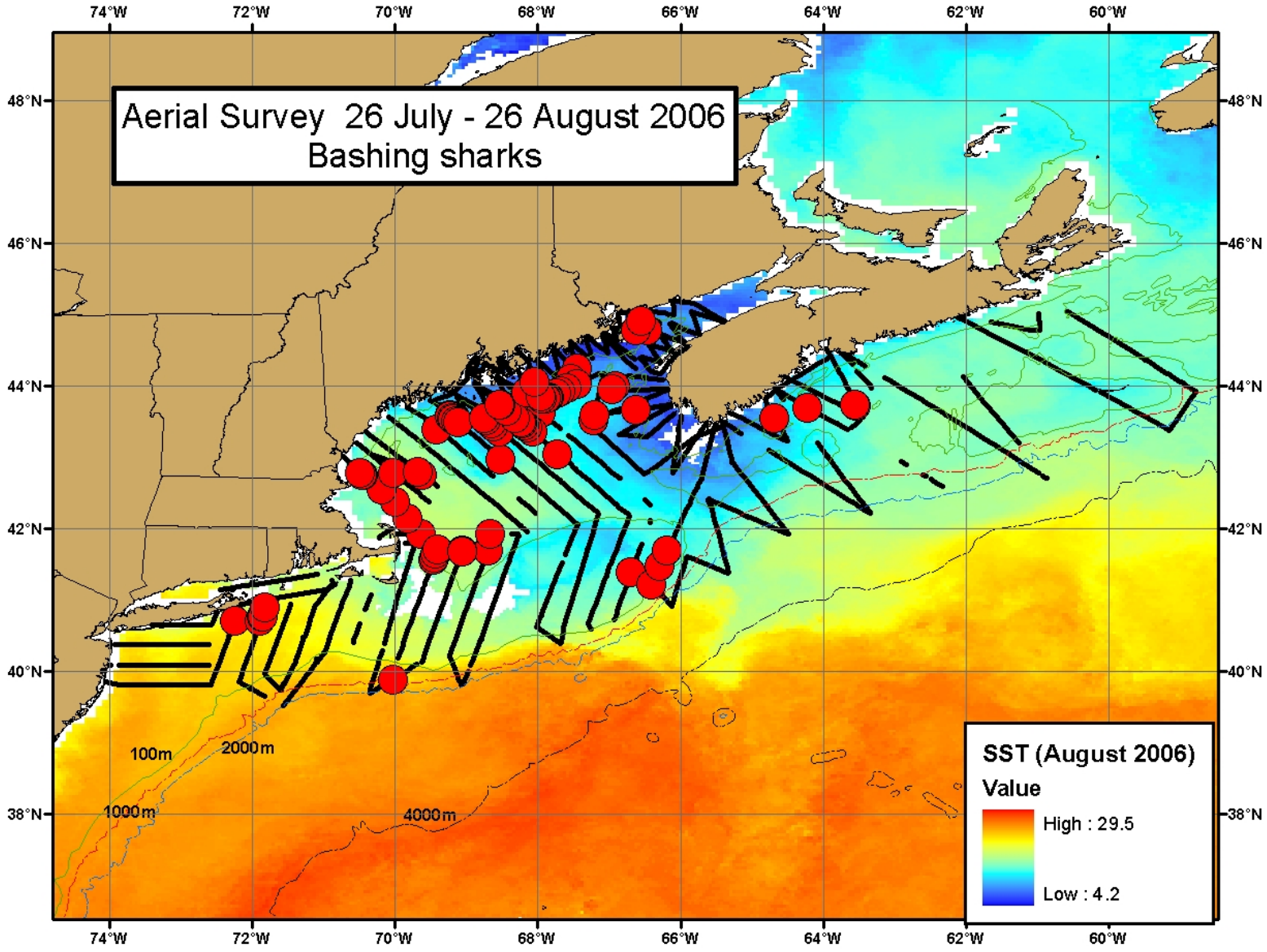

Figure 18. Distribution of sunfish (mola mola) detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.

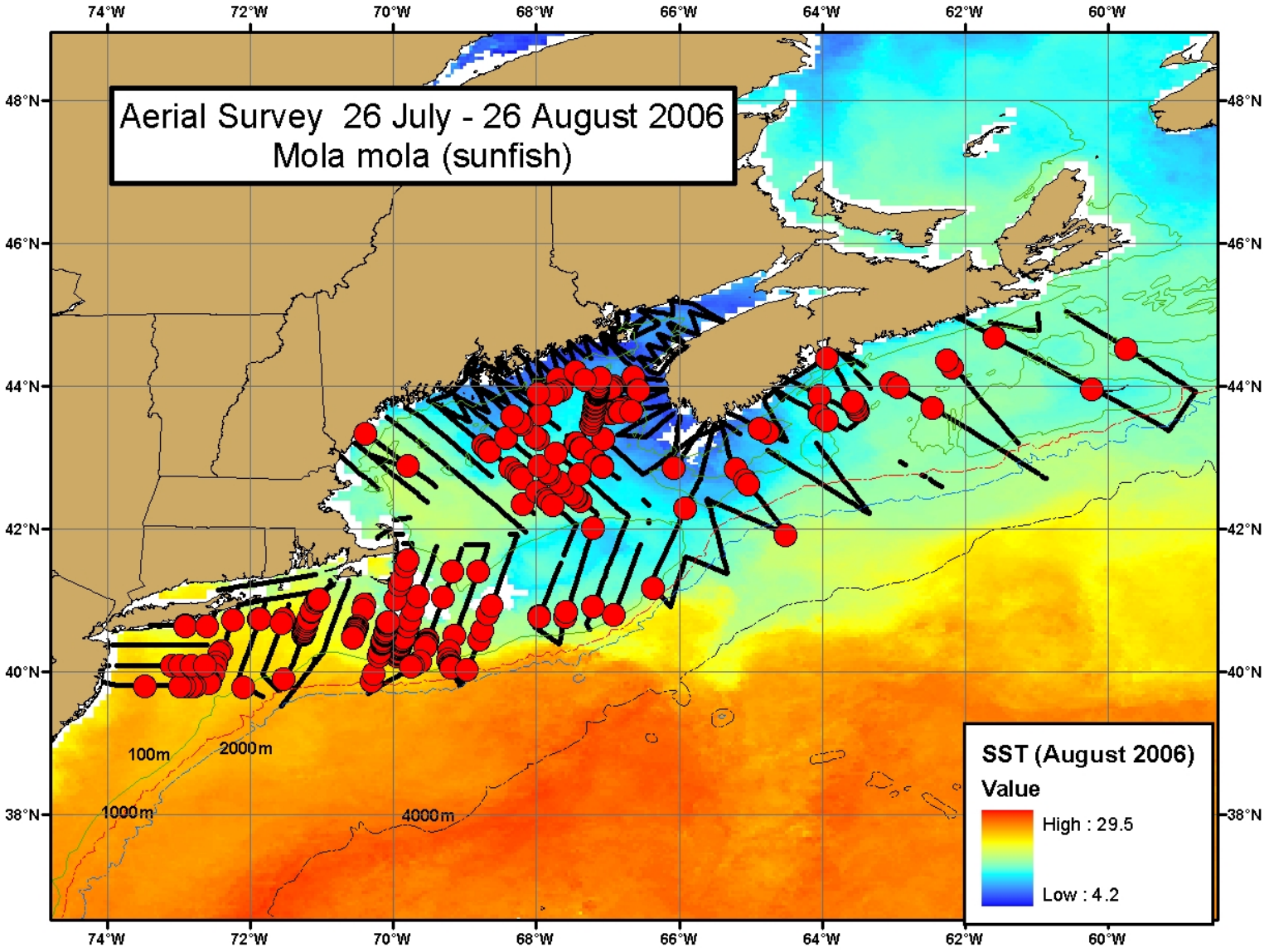

Figure 19. Distribution of blue sharks, hammerhead sharks, manta rays, cownose rays and skates detected during the aerial survey conducted from 26 July to 26 August 2006. Average August 2006 sea surface temperature in background.