Shipboard habitat survey during March – April 2014: Northeast Fisheries Science Center

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SUMMARY

During 11 March – 3 April and 7 April – 1 May 2014, the Northeast Fisheries Science Center (NEFSC) with the help from staff at Integrated Statistics, Inc and Woods Hole Oceanographic Institution conducted a shipboard survey to document the relationship between the distribution and abundance of cetaceans, sea turtles and sea birds and their physical and biological environment. The study area included waters from Cape Cod, MA to North Carolina, and from the southern tip of Nova Scotia to the US Atlantic coastline. Track lines were surveyed at about 10 kts (18.5 km/hr), using the two-independent visual team line transect methodology to collect marine mammal and turtle data, while the one-team strip transect methodology was used to collect sea bird distribution and abundance data. At the same time passive acoustic hydrophones were used to detect vocal cetaceans. In addition, physical and biological oceanographic data were collected using a bongo net, visual plankton recorder (VPR), Multiple Opening/Closing Net Environmental Sensing System (MOCNESS), Isaacs-Kidd midwater trawl (IKMT), Conductivity, Temperature, and Depth Profiler (CTD), multifrequency echosounder (EK60), Van Veen benthic grab, and beam trawl. Over 4000 km of on-effort track lines were surveyed during the daytime with about 150 hours of passive acoustic recordings. The upper visual team detected 3,713 individuals within 626 groups of 31 species (or species groups) of cetaceans, seals and large fish. In addition 54 groups of vocally-active odontocetes from 5 species (or species groups) were heard with the hyrophones. Common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*) were the most regularly detected small cetacean species. Fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) were the most common large whales. One loggerhead turtle (*Caretta caretta*) and an unidentified hard shell turtle were also detected. About 6940 birds within 2491 groups of 62 species (or species groups) were detected while on effort. Seven species comprised about 75% of the total birds seen. In declining order of abundance these were: Herring Gull (*Larus argentatus*), Northern Gannet (*Morus bassanus*), Dovekie (*Alle alle*), Great Black-backed Gull (*Larus marinus*), Atlantic Puffin (*Fratercula arctica*), Northern Fulmar (*Fulmarus glacialis*) and Red Phalarope (*Phalaropus fulicarius*). Over 510 physical and biological oceanographic collection stations were sampled. This included 64 casts of the CTD, 127 bongo deployments, 13 VPR deployments, 2 Isaac-Kidd midwater trawl (IKMT) deployments, 3 MOCNESS deployments, 70 beam trawl deployments and 233 bottom sediment grabs. In addition, 10 bottom-mounted marine autonomous recording units (MARUs) were deployed during this cruise, of which 9 were retrieved in September 2014.

OBJECTIVES

The overall goal of both legs was to document the relationship between the distribution and abundance of cetaceans, sea turtles and sea birds within the study area relative to their physical and biological environment. To do so the specific objectives were, within the study area: (1) determine the distribution and abundance of cetaceans, sea turtles and sea birds; (2) collect vocalizations of cetaceans using passive acoustic towed hydrophone arrays; (3) determine the distribution and relative abundance of plankton, micronekton, and benthic species, (4) collect hydrographic and meteorological data, (5) document spring baleen whale migration by deploying bottom-mounted marine autonomous recording units (MARUs) and (6) when possible, collect biopsy samples and photo-identification pictures of cetaceans.

The institutions that were involved in this survey included:

- Northeast Fisheries Science Center, Woods Hole, Protected Species Branch
- Northeast Fisheries Science Center, Woods Hole, Oceanography Branch
- Northeast Fisheries Science Center, Sandy Hook, Behavioral Ecology Branch
- Northeast Fisheries Science Center, Narragansett, Oceanography Branch
- Woods Hole Oceanographic Institution, Woods Hole, MA
- Integrated Statistics, Inc., Woods Hole, MA

CRUISE PERIOD AND AREA

The cruise period was divided into two legs: 11 March – 3 April and 7 April – 1 May 2014.

The study area included waters from around Cape Cod, MA (about 42° N latitude), to north of North Carolina (about 35° 30’ N latitude), east of the southern tip of Nova Scotia (about 65° W longitude), and west of the US coast (about 76° W longitude). This is waters shallower than about 2000 m which includes waters within the US and Canadian economic exclusive zones (EEZ). This study area was divided into five spatial strata that represent different habitats, an offshore shelf break area (between the 100 and 2000 m depth contours) and four onshore Bureau of Ocean Energy Management (BOEM) wind energy areas (WEA): BOEM-MA, BOEM-NY, BOEM-NJ, and BOEM-VA (Figure C1).

METHODS

VISUAL MARINE MAMMAL-TURTLE SIGHTING TEAM

A line transect survey was conducted during daylight hours (approximately 0700 – 1900 with a one hour break at lunchtime) using the two independent team procedure. Surveying was conducted during acceptable weather conditions (Beaufort six and below) while traveling at about 10 knots, as measured over the ground.

Scientific personnel formed two independent visual marine mammal-sea turtle sighting teams. The teams were on the flying bridge (13.7 m above the sea surface) and bridge wing (11.8 m above the sea surface). The flying bridge team was composed of two on-effort observers who searched using 25x150 powered binoculars and the bridge wing team consisted of one on-effort observer who also searched using 25x150 powered binoculars. Both teams reported their sightings data to a single recorder stationed inside the bridge using a different radio frequency for each observation team so that the two teams were independent of each other. In addition there were two off-effort team members that rotated in. All six scientists rotated, 30 minutes per station, between left flying bridge observer, right flying bridge observer, recorder, right bridge wing observer, off-effort station 1 then off-effort station 2. In total, a scientist was on-effort for 2 hrs and off-effort for 1 hr. The composition of the teams changed every leg.

The right flying bridge observer surveyed waters from 90° abeam on the right side of the boat to about 10° to the left of the track line, where 0° indicates the track line ahead. The left flying bridge observer surveyed waters from 90° abeam on the left side of the boat to about 10° to the right of the track line. Thus, there was an overlap of 10° to either side of the forward track line. The right bridge wing observer surveyed waters from as far as they could see to the left side of the boat (about 60° left of the track line) to 90° abeam on the right side. In addition, when the recorder was not entering data, the recorder surveyed with naked eye for 90° abeam right to 90° abeam left.

Position, date, time, ship's speed and course, water depth, surface temperature, salinity, and conductivity, along with other variables (Table C1) were obtained from the ship's Science Computer System (SCS). These data were routinely collected and recorded every second at least while during visual survey operations. Sightings and visual team effort data were entered by the scientists onto hand held data entry computerized systems called VisSurv-NE (version 4) which was initially developed by L. Garrison and customized by D. Palka.

At times when it was not possible to positively identify a species or when training the observers on species identifications and the group was within 3 nmi of the track line, survey effort was discontinued (termed went off-effort) and the ship headed in a manner to intercept the animals in question. When the species identification and group size information were obtained, the ship proceeded back to the point on the track line where effort ended (or close to this point).

For either team, when an animal group (porpoise, dolphin, whale, seal, turtle or a few large fish species) was detected the following data were recorded into VisSurv-NE:

1) Time sighting was initially detected, recorded to the nearest second,

2) Species composition of the group,

3) Radial distance between the team's platform and the location of the sighting, estimated either visually when not using the binoculars or by reticles when using binoculars,

4) Bearing between the line of sight to the group and the ship's track line; measured by a polarus mounted near the observer or at the base of the binoculars,

5) Best estimate of group size,

6) Direction of swim,

7) Number of calves,

8) Initial sighting cue,

9) Initial behavior of the group, and

10) Comments on unusual markings or behavior.

At the same time, the location (latitude and longitude) of the ship when this information was entered was recorded by the ship's GPS via the SCS system which was connected to the data entry computers.

The following effort data were recorded every time one of the factors changed (at least every 30 min when the observers rotate):

1) Time of recording,

2) Position of each observer, and

3) Weather conditions: swell direction relative to the ship's travel direction and height (in meters); apparent Beaufort sea state in front of the ship; presence of light or thick haze, rain or fog; amount of cloud coverage; visibility (i.e., approximate maximum distance that can be seen); and glare location and strength within the glare swath (none, slight, moderate, severe).

VISUAL SEABIRD SIGHTING TEAM

From an observation station on the flying bridge, about 13.7 m above the sea surface, one on-effort observer conducted a visual daylight survey for marine birds, approximately 0700 – 1900 with a one hour break at lunchtime. In addition there was one off-effort observer who rotated to with the on-effort observer every 2 hrs. Data collection procedures employed a modified 300 m strip and line-transect methodology. Data on seabird distribution and abundance were collected by identifying and enumerating all birds seen within a 300 m arc on one side of the bow while the ship was underway. Seabird observers maintained a visual unaided eye watch of the 300 m survey strip, with frequent scans of the perimeter using hand-held binoculars for cryptic and/or hard to detect species. Binoculars were used for distant scanning and to confirm identification. Ship-following species were counted once and subsequently carefully monitored to prevent re-counts. All birds, including non-marine species, such as herons, doves, and Passerines, were recorded.

Operational limits are higher for seabird surveys compared to marine mammal and sea turtle surveys. As a result, seabird survey effort was possible in sea states up to and including Beaufort 7. Seabird survey effort was suspended, however, if the ship's speed over ground fell below six knots. Standardized seabird data collection effort continued during "repositioning transits" — transits between waypoints that could span a few hours to all day — even though there was no corresponding visual marine mammal survey effort.

All data were entered in real time into a Panasonic Toughbook laptop running *SeeBird (vers 4.3.6),* a data collection program developed at the Southwest Fisheries Science Center. The software was linked to the ship's navigation system via a serial/RJ-45 cable. The following data were collected for each sighting:

1) species identification,
2) number of birds within a group,
3) distance between the observer and the group,
4) angle between the track line and the line of sight to the group,
5) behavior,
6) flight direction,
7) flight height,
8) age, sex and, if possible, molt condition.

The sighting record received a corresponding time and GPS fix once the observer accepted the record and the software wrote it to disk. *Seebird* also added a time and location fix every 5 minutes. *Seebird* incorporates a time synchronization feature to ensure the computer clock matches the GPS clock to assist with post-processing of the seabird data with the ship's SCS data. All data underwent a quality assurance and data integrity check each evening and saved to disk and to an external backup dataset.

PASSIVE ACOUSTIC DETECTION TEAM

The passive acoustic team consisted of two people who operated the system in two-hour shifts, from approximately 0700 – 1900 or later. The deployment time for the hydrophone array varied greatly each day depending on weather conditions. Typical deployment was at 0700, but this was sometimes delayed due to poor weather. The hydrophone array was usually retrieved from 1130 – 1230 for the midday bongo/CTD casts. Daytime data collection ended at approximately 1900, at the end of the visual survey day. The acoustic team collected data during all hours when the visual team was on-effort, except along inshore track lines, where shallow bottom depths (50 m and less) prohibited safe deployment of the array.

The acoustic team also collected data on some occasions when weather conditions prevented the visual team from operating, as well as during several long transits between track lines. Night recordings were also collected opportunistically, which was determined by oceanographic sampling priorities.

The hydrophone array used in this survey was constructed in 2012 – 2013, and was comprised of two modular, oil-filled sections, separated by 30 m of cable. The end section consisted of 3 "mid-frequency" elements (APC International, 42-1021), 2 "high-frequency" elements (Reson, TC 4013), and a depth sensor (Keller America, PA7FLE). The in-line section of the array consisted of three "mid-frequency" elements (APC International, 42-1021). The array was towed 300 m behind the ship. Array depth typically varied between 8 – 12 m at the survey speed of 10 kts. Sound speed data at the tow depth of the array were extracted from morning and midday CTD casts.

Acoustic data were routed to a custom-built Acoustic Recording System that encompassed all signal conditioning, including A/D conversion, filtering, and gain. Data were filtered at 1000 Hz, and variable gain between 20 – 40 dB was added, depending on the relative levels of signal and noise. The recording system incorporated two National Instruments soundcards (NI USB-6356). One soundcard sampled the six "mid-frequency" channels at 192 kHz, the other sampled the two "high-frequency" channels at 500 kHz, both at a resolution of 16 bits. Digitized acoustic data were recorded directly onto laptop and desktop computer hard drives using the software program Pamguard (http://www.pamguard.org/home.shtml), which also recorded simultaneous GPS data, continuous depth data, and allowed manual entry of corresponding notes. Two channels of analog data were also routed to an external RME Fireface 400 soundcard and a separate desktop computer, specifically for the purpose of real-time detection and tracking of vocal animals using the software packages WhalTrak and Ishmael. Whenever possible, vocally-active groups that were acoustically tracked were matched with visual detections in real-time, for assignment of unambiguous species classification. Communication was established between the acoustic team and the visual team situated on the flying bridge to facilitate this process.

In addition to collecting towed array data, the passive acoustic team, together with the ship's crew, also deployed ten Marine Autonomous Recording Units (MARUs) along survey track lines on the shelf break. Details for deployment methodology can be found in the GG 14-02 Cruise Announcement.

HYDROGRAPHIC, PLANKTON, AND BENTHIC CHARACTERISTICS

Nearly continuously day and night, the EK60 multi-frequency echosounders were recording active acoustic backscatter to determine the distribution and abundance of plankton, micronekton, and fish which will be used to characterize spatial distributions of potential prey and investigate relationships among predator (marine mammals), prey, and oceanography. In addition, the ship's SCS logger system recorded oceanographic data from the ship's sensors nearly continuously.

During the daytime, Conductivity, Temperature, and Depth Profilers (CTD) and bongo nets were deployed several times during the visual survey time periods to characterize the spatial distribution of plankton.

During nighttime when the visual teams were off-effort, one of two types of sampling procedures was followed. When offshore on the shelf break, the canyon and inter-canyon regions were sampled. When in the inshore shelf BOEM WEAs, benthic sampling occurred.

Continuous Active Acoustic Sampling

Active acoustic data were collected with the ship's multifrequency (18, 38, 120, and 200 kHz) scientific Simard EK60 echo sounders and split-beam transducers mounted downward-looking on the retractable keel. Data were collected to 3000 m, regardless of bottom depth. The ping interval was set to 2 pings per second, but the actual ping rates were slower due to two-way travel time and signal processing requirements of the EK60. The EK60 was synchronized to the Simrad ES60 on the bridge, the RDI Acoustic Doppler Current Profiler (ADCP), and Simrad ME70 multibeam to alleviate acoustic interference among acoustic instruments. At daily intervals throughout the survey EK60 data were recorded in passive mode to assist with noise removal processing procedures. Survey speeds for underway acoustic data collection were 10 kts or less.

The EK60 system was calibrated using the standard target method at the Newport Naval Anchorage on the first day of leg 2. A 38.1-mm tungsten carbide with 6% cobalt binder sphere was suspended at about 20 m range from the transducers and was used to calibrate all frequencies. A wireless calibration system, consisting of three remotely controlled downriggers, and automated software were used to initially position the target under the split-beam transducers and the software automatically moved the sphere throughout the acoustic beams. The data were collected and then the Simrad Lobe program was used during data playback for each EK60 individually.

Daytime Sampling

During the daytime, SEACAT 19+ CTDs were used to measure water column conductivity, temperature and depth. The CTD was mounted on a 322 conducting core cable allowing the operator to see a real time display of the instrument depth and water column temperature, salinity, density and sound speed on a computer monitor in the ship's Dry Lab. Once a day, a vertical CTD profile was conducted, where a Niskin bottle was attached to the wire above the CTD. The Niskin bottle was used to collect a sample of water which will be used to calibrate the conductivity sensor of the CTD. The calculated sound speeds from the vertical profiles were used for the daily calibration of the acoustic sensors. Additional vertical profiles to delimitate sound speed were conducted as needed for further acoustic calibrations.

A 61 cm bongo plankton net equipped with two 333µm nets with the CTD mounted on the wire 1 m above the nets was deployed approximately three times a day: once before the day's surveying started (about 0500 – 0530), at lunch time (about 1200 when the ship stopped surveying), and again after surveying was completed for the day (approximately 1900, depending on weather and the time of sunset). The bongo was towed in a double oblique profile using standard ECOMON protocols. The ship's speed through the water was approximately 1.5 kts. Wire out speed was 50 m/min and wire in speed was 20 m/min. Tows were to within 5 m of the bottom or to 200 m depth, if the bottom depth exceeded 205 m. Upon retrieval, samples were rinsed from the nets using seawater and preserved in 5% formaldehyde and seawater. Samples were transported to the Narragansett, RI National Marine Fisheries Science (NMFS) lab for future identification.

Nighttime shelf break Sampling

When the ship was not in one of the BOEM benthic sampling areas, physical and biological sampling of the water column was conducted employing a combination of underway and station-based sampling. The goal was to sample two site types: shelfbreak canyons and shelfbreak inter-canyon regions, where the top priority was canyons. The amount of time available each night for sampling, the target site, and the gear to be deployed was determined by the vessel's position at the end of each day's visual surveying, the ships location in the BOEM benthic sampling areas, and the desired start location the following day, the distance to the targeted sampling area, and the bottom depth.

Sampling equipment included:

- EK60 multifrequency echosounder for plankton, micronekton, and fish distribution.
- ADCP (Acoustic Doppler Current Profiler) for currents, synchronized to the EK60 to minimize interference. (Note: ADCP was turned off for Leg II due to interference with passive acoustic operations).
- CTDs for hydrography. (max depth 1500 m).
- 1 m MOCNESS (Multiple Opening Closing Net Environmental Sensing System) with color VPR (Video Plankton Recorder) and strobes attached to collect zooplankton and ground-truth EK60 acoustic data (max depth 1000 m).
- IKMT (Isaacs Kidd Midwater Trawl) to collect zooplankton and micronekton and ground-truthing EK60 data (max depth 600 m).
- V-fin black and white VPR to collect images of zooplankton and ground-truth EK60 acoustic data (max depth 600 m).

Canyons (aka Z-type surveys)

When possible, canyons were surveyed acoustically at night then surveyed again by the visual teams during the day either before or after the acoustic surveys. Acoustic survey transects were positioned half-way up a canyon and near the canyon head and included both ADCP and EK60 data collection. In each canyon, a series of 5 CTD casts (Seabird 19+) were made along the mid-canyon line to near-bottom (targeting one cast on the rim on each side, one about half way down each side to the max depth axis, and one in the axis). Also at night usually after the acoustic surveys, nets were deployed to ground truth the acoustic finds.

Inter-canyon shelf break

Shelf break inter-canyon surveys consisted of a transect running across the shelf break from the 90 to 1000 m isobaths . ADCP, EK60, and towed hydrophone data were conducted continuously during a pass and then regularly spaced CTD casts were made in the opposite direction along the second pass of the same transect. The target was roughly 3 nmi distances between CTD stations. If possible, net samples were to be taken after the CTD casts.

Nighttime Inshore Benthic Sampling:

A series of benthic sampling stations was laid out within five BOEM WEAs so as to characterize benthic habitats in those areas. Three kinds of benthic data were sought on each station: benthic infaunal assemblages, sediment textures, and benthic epifaunal assemblages.

At each of the stations three major sampling activities occurred: a CTD (vertical or diagonal bongo cast, as desired), three replicate Van Veen grabs, and a beam trawl. Repositioning of the ship was not undertaken between sampling activities at each station. The order of the three activities at each station was not critical and was altered as circumstances dictated.

Benthic Grab Sampling

Three replicate grabs for grain size and benthic infaunal analysis were taken at each of station using either a 0.04 m^2 or 0.10 m^2 Young-modified Van Veen grab sampler. The grab sampler was cocked and lowered over the side and sent down to the bottom at the fastest speed allowable by the winch till it hit the bottom, then it was brought back up and lowered onto its wooden stand. The lids on top of the Van Veen buckets were opened and the sample inspected for adequacy of the sample. Success or failure of the grab was reported immediately to the bridge. No more than three unsuccessful attempts were made to obtain any sample.

Grabs were recorded and if successful, a photo of its surface was taken, then a 3 cm diameter plastic core tube was used to take a subsample of at least 5 cm depth for grain size analysis. That tube was capped on top, carefully removed from the grab, capped on the bottom, recorded, labeled, and stored upright in a freezer. Unsuccessful grabs for each replicate were recorded in the Notes block for the appropriate replicate on the Benthic Grab Field Log sheet.

After the grain size core sample was obtained, the rest of the sample was dropped into a dishpan under the grab sampler stand by opening the grab jaws. The grab sampler jaws were washed out with a small quantity of clean salt water (not exceeding the receiving pan’s capacity) with a squeeze bottle or hose, as necessary, to wash any remaining sample from the inside of the jaws into the receiving pan. The sample in the pan with any wash water was then removed for sieving. More thorough washing of the grab with water from a hose was done, if needed, once the pan was removed. The grab was re-cocked to prepare for the next deployment at this point.

Grain size analyses were performed by standard geological sieving methods at the NEFSC J.J. Howard Lab and recorded both in Wentworth size classes and by the standard Folk classification scheme.

Samples from the 0.04 m^2 grab were sieved in their entireties through a 1.0 mm (standard #18) sieve, a small quantity at a time using salt water from a hose and gently agitating it to allow material finer than 1.00 mm to pass through and be discarded. Samples from the 0.20 m^2 grab were divided in half, one half being sieved as above, and the other half discarded so as to make sample sizes roughly comparable with 0.04 m^2 grabs. Where present, samples were pre-screened through a coarser sieve to remove that material and reduce the sample size. Any organisms in that very coarse fraction were retained, but inanimate coarse material was discarded. Material retained by the 1.0 mm screen was collected in labeled polypropylene jars. These samples were preserved in 10% buffered formalin in seawater with Rose Bengal dye. Following cruises, these were transferred to 70% denatured ethanol for examination. Benthic infauna in these will be identified to genus level by a benthic sorting contractor outside NOAA.

Trawl Sampling

One beam trawl sample was performed at each station, time permitting. A 2 m beam trawl with ¼ inch mesh net was deployed on a single 0.25" trawl wire. Trawling was done at a speed of about 2 kt using a scope of 2:1. The first trawl (B87 station in the MA BOEM WEA) was performed for 20 minutes. This was reduced to 5 minutes in the two subsequent MA BOEM WEA stations (B92 and B86) due to the size and complexity of the catch, then increased to 6 minutes at B85 (also in the MA BOEM WEA). All subsequent trawls in all of the sampled BOEM WEAs were performed for 7 minutes. Unsuccessful trawls were repeated after adjustments of weight and scope until successful. The catch was sorted to the lowest practicable taxon. Each taxon was weighed as a group. Individual weights were not taken. Total lengths of individual fish were determined to the nearest centimeter. Carapace widths of brachyuran crabs were also measured. IDs, sizes, species weights, and individual counts were recorded on trawl log forms. Catches were discarded following on-board processing.

RESULTS

Scientists involved in this survey are detailed in Table C2.

<u>*VISUAL MARINE MAMMAL-TURTLE SIGHTING TEAM*</u>

The visual marine mammal and turtle team surveyed about 4,014 km while on effort during 33 of the 41 possible sea-days; the weather conditions were too poor to survey on the other 8 sea-days. (Figure C2; Table C3). About 64% of the survey track lines were conducted in acceptable weather conditions, Beaufort sea states 4 or less, similar to that when conducting a summer survey. However, given this was not summertime, there was considerable more surveying in worst sighting conditions (Beaufort sea states of 5 and 6).

During the on-effort track lines, 23 cetacean species or species groups, 2 turtle species or species groups, 3 seal species or species groups, and 3 fish species or species groups were recorded (Tables C4 and C5). For cetaceans, the upper team detected 577 groups (3,661 individuals) and the lower team detected 278 groups (2,027 individuals). For turtles, the upper team detected 1 group (1 individual) and the lower team detected 2 groups (2 individuals). Nineteen and 8 seals was detected by the upper and lower teams. In addition, 4 (2) basking shark groups and 22 (4) ocean sunfish groups was detected by the upper (and lower) teams. Note some, but not all, groups of animals detected by one team were also detected by the other team.

Distribution maps of sighting locations of the cetaceans, turtles, seals and fish are displayed in Figures C3 – C12. Note these are locations of sightings seen by one or both teams. The most abundance species were common dolphins (*Delphinus delphis*) and bottlenose dolphins (*Tursiops truncatus*), displayed in Figure C3. The most numerous whales included fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*), displayed in C8. Species detected in both the inshore BOEM WEAs and offshore shelf break include common dolphins, fin whales, sei whales (*Balaenoptera borealis*), humpback whales, and minke whales (*Balaenoptera acutorostrata*). Species detected in mostly the inshore BOEM WEAs include harbor porpoises (*Phocoena phocoena*), white-sided dolphins (*Lagenorhynchus acutus*), and right whales (*Eubalaena glacialis*). Species detected mostly on the offshore shelf break include bottlenose dolphins, Atlantic spotted dolphins (*Stenella frontalis*), striped dolphins (*Stenella coeruleoalba*), pilot whales (*Globicephala spp.*), Risso's dolphins (*Grampus griseus*), beaked whales (*Mesoplodon spp.*), sperm whales (*Physeter macrocephalus*), blue whales (*Balaenoptera musculus*), and bottlenose whales (*Hyperoodon ampullatus*). Nearly all of the basking sharks (*Cetorhinus maximus*) and sunfish (*Mola mola*) were on the offshore shelf break, while seals were close to shore (Figure C11). Only two turtles were detected, a loggerhead turtle (*Caretta caretta*) off North Carolina in waters that were x degrees, and an unidentified hardshelled turtle near the EEZ on the US side in waters that were x degrees (Figure C12).

VISUAL SEABIRD SIGHTING TEAM

The NOAA ship *Gordon Gunter's* flying bridge provided a stable platform and afforded good visibility for the seabird team. Seabird survey effort was conducted on 34 days; however, data collection effort was truncated on several days due to weather constraints. Nomenclature of species identifications followed that reported in The Clements Checklist of Birds of the World. 6th edition, Cornell University Press 2007, with electronic updates to 2013.

About 6,940 birds were seen while on effort (Table C6). This survey recorded 50 species of birds and 12 unidentified species groups (e.g., unidentified shearwater or unidentified storm-petrel). About 40% of the species most frequently seen includes Herring Gulls (*Larus argentatus*) and Northern Gannets (*Morus bassanus*; Figure C13). Distributions of a variety of other species are displayed in Figures C14 – C18. The relatively high species diversity is partly attributable to the onset of spring migration occurring towards the end of the cruise, resulting in a number of displaced non-marine species. At least 15 species can be included in the latter category, including Brown Thrasher, American Robin, and Dark-eyed Junco. Diversity was sparse in the offshore avifauna, primarily alcids and a few gulls. Moreover, with the exception of a scattering of Wilson's Storm-Petrels (Figure C17), austral breeders had not yet arrived from their southern hemisphere nesting grounds (e.g., no Great Shearwaters were seen). Throughout the shelf break survey lines, seabird distribution was patchy, yet often predictable. For example, high numbers of alcids, particularly Atlantic Puffin (Figure C16) and Dovekie (Figure C15), often occurred over the 900 to 1000 m depth isobaths. Storm-petrels (Figure C17) were occasionally found in small scale clusters, often concentrating in upwelling areas seaward of the shelf break. Red Phalaropes (Figure C16), often in association with storm-petrels, also frequently occurred in dense patches along the shelf break, which accounts for their high relative abundance but low encounter rate. Northern Gannet and Herring Gull (Figure C13) were widespread throughout the study area, with the latter species being seen daily. The age distribution of Northern Gannets strongly favoured adults: only seven immatures, primarily second year types, were seen (about 0.9%). This is a typical Northern Gannet winter age class distribution in the northwest Atlantic Ocean, the immature birds tending to winter farther south. Black-capped Petrel (Figure C17) is a tropical and sub-tropical species traditionally associated with warm Gulf Stream water. However, several of the nine Black-capped Petrels we saw were over water less than 10°C, including one as far north as Nova Scotia, which is very rare.

This year's survey provides valuable additional distributional data on Bermuda Petrel (aka Cahow; Figure C17). One photographed at Georges Canyon is not only a first for Canada, but also the most northerly sighting of this endangered seabird. Its status in North American waters remains poorly known, based on a handful of sightings off North Carolina and inferred from recently deployed data-loggers. With an estimated global population of around 350 birds, it remains very rare anywhere in the north Atlantic Ocean.

The seabird team also collected useful distributional information in areas that historically have received little systematic observer effort at this time of year. Towards the end of Leg 2, spring migrants such as Pomarine, Parasitic and Long-tailed Jaegers (Figure C18), and Arctic Tern, began to arrive. Data obtained on this cruise clarifies the temporal distribution for several seabirds, including all three jaegers and Arctic Tern. Migrants of these species were seen flying north, slightly earlier than what was generally realised, for example.

All other seabirds were regularly occurring northwest Atlantic Ocean species; however, compared to summer surveys, relatively few Procellariiformes (shearwaters, petrels, etc.; Figure C17) were seen. The preponderance of ducks, loons and gulls on this year's survey is not only a reflection of seasonality, but also because of the time spent surveying at the near shore WEA's. Of the non-marine species observed, seven were Passerines (e.g., songbirds), rounding out with a raptor (Osprey), woodpecker (Northern Flicker) and a Great Blue Heron (Figure C18). The most abundant Passerine was Song Sparrow, with up to four at one time on the fantail, followed by Dark-eyed Junco.

PASSIVE ACOUSTIC DETECTION TEAM

Over the course of the survey, acoustic monitoring effort was conducted on 17 out of 33 survey days, with a total of 113.7 h of daytime recording on survey track lines. In addition, evening/nighttime recordings were made opportunistically on 10 occasions, for a total of 29.4 h (Figure C19, Table C7). The hydrophone array was not deployed on days during which shallow, coastal lines were surveyed.

Real-time monitoring resulted in the detection of 54 groups of vocally-active odontocetes (Figure C19). Of these, approximately 11% corresponded to simultaneous visual detection of groups, allowing for species assignment (Table C8). In some cases, large schools of dolphins that covered a broad spatial range were difficult to localize accurately in real-time, making a direct comparison with visual sighting locations impossible. Additionally, in many cases it was impossible in real time to acoustically differentiate between subgroups of animals that were visually distinguished and counted as separate sightings, resulting in an underestimate of acoustic detections as compared to visual detections. Both of these issues will be addressed in post-processing analyses.

Sperm whales were detected in real-time on 8 of 17 acoustic survey days, for a total of 19 vocally-active groups (Figure C20, Table C9). In most cases, these acoustic events represent multiple individuals. Total number of individual sperm whales will be calculated through localization and tracking in post-processing analyses.

Two Marine Autonomous Recording Units (MARUs) were deployed on Leg 1 of the survey, and eight units were deployed during Leg 2 (Figure C1). All of the units, except one (number 9) were recovered in September 2014.

Post-processing of passive acoustic data will be conducted to extract all acoustic events, localize individual groups and compare visual and acoustic detection rates, and evaluate performance of species-specific classifiers.

HYDROGRAPHIC/BONGO/PLANKTON SAMPLES

Continuous Active Acoustic Sampling

Nearly continuously, day and night, active acoustic multifrequency (18, 38, 120, and 200 kHz) backscatter data from scientific EK60 echosounders and split-beam transducers were collected to characterize spatial distributions of potential prey and investigate relationships among predator (marine mammals), prey, and oceanography. Backscatter data were recorded to 3000 m, regardless of bottom depth. The EK60 was calibrated on 7 April 2014 in the bay near the Newport Naval Station.

Active acoustic data were collected on a portable hard drive, which was sent to the NEFSC and the data were archived at the NEFSC at the completion of each leg. Data are also archived at NOAA's National Geophysical Data Center (NGDC) in Boulder, CO.

Problems were encountered with ADCP data collection. Attempts were made between the cruise legs to address these issues, from which it was determined that the ping rate was very slow, even slower than expected given that the system was slaved to the EK60. Further analysis after the cruise will be necessary to determine whether the slow ping rate led to the poor data quality.

Sampling Stations

During both legs, in the day and night over 512 sampling stations were conducted. This included 64 casts of the CTD, 127 bongo deployments, 13 VPR deployments, 70 beam trawl deployments, 233 bottom grabs, 2 IKMT, deployments, and 3 MOCNESS deployments (Table C10; Figure C21).

At night after the visual teams were off-effort, oceanographic sampling was successfully conducted at 7 shelf break canyon sites and 1 shelf break non-canyon site (Table C11). Due to poor weather conditions and equipment failures, net deployment was limited during both legs of the cruise (Table C10). However, MOCNESS and IKMT tows were conducted where possible and the catch was largely comprised of krill, mesopelagic fish, and small zooplankton.

A single shelf break survey was conducted along a transect running across the shelf break from the 90 to 1000 m isobaths (Table C11). ADCP, EK60, and towed hydrophone data were conducted continuously during one pass and seven regularly spaced (~1.4 nmi) CTD casts made in the opposite direction along the second pass. The target was roughly 3 nmi distances between CTD stations. No net samples were taken during this operation.

CTD data (Table C10) were obtained with three Seabird Electronics SBE Model 19+ profiling CTDs (s/n 4493, 4758, and 7037) and a Seabird Electronics SBE Model 9/11+ CTD (s/n 2727). Sea water samples were also obtained for the purpose of correcting conductivity. A more detailed report of the CTD station data can be found at the following website: http://www.nefsc.noaa.gov/HydroAtlas/2014/MAR_AMAPPS_GU1402/CTD_REPORT_2014002GU.pdf.

Shelf Break Habitat Descriptions

The Mid Atlantic Bight inshore stations showed very low amounts of zooplankton. Samples did have some marine snow and many chain diatoms in the background of the surface images. Hudson Canyon also had low zooplankton numbers but had large quantities phytoplankton in the form of centrics. Plankton was largely Calanoid copepod and small Euphausiids. Very little gelatinous zooplankton was present in the form of *Bolinopsis sp*. and small hydromedusa.

The Georges Bank shelf break transect was dominated by large quantities of marine snow intermixed with phytoplankton (Figure C22). Images from the VPR were so densely populated with multiple blobs of this matrix that the depth of field had to be minimized in the processing program to limit the number of regions of interest (ROIs) pulled from each image (Figure C23). High densities of marine snow can interfere with the zooplankton counts by obscuring images. For example: numerous small gravid copepods present along the Georges Bank shelf break transect were contained in images within the matrix of the marine snow and thus were classified as marine snow not copepoda. The transect was characterized by cooler temperatures and lower salinities on the Georges Bank which transitioned to much warmer temperatures and higher salinities off Georges Bank. A slight theremocline developed around 50 m depth off Georges Bank. The entire transect showed very high chlorophyll counts in the top 50 m and increased turbidity values on the bank near the bottom.

Corsair Canyon was also dominated by marine snow but had less phytoplankton intermixed. Much of the marine snow appeared to be the remnants of larvacean nets but few active nets were seen (Figure C24). Zooplankton counts were low and consisted of copepod (mostly *C. finmarchicus*), Euphausiids, and *Bolinopsis sp.* Oceanography was consistent across both canyon transects. The canyon had cooler temperatures and lower salinities at the surface transitioning gradually to warmer temperatures and higher salinities by 100 m depth. There was no noticeable thermocline. Cholophyll and turbidity values showed very patchy distributions (Figure C25).

Offshore stations had diverse species but very low zooplankton concentrations. Shrimp, *Calanus finmarchicus*, Euphausiids, a variety of ctenophora, small hydromedusa, and small siphonophores. Noticeably lacking were the large quantities of salps seen in this area during the summer months.

Inshore Benthic Habitat Descriptions

A list of 100 stations was originally planned for the two legs of this cruise, but weather and time limitations reduced the actual number visited to 70 for grab samples and 62 for beam trawls (Figure C26). Results from the infaunal analysis of grab samples were not available for this report.

The results of sediment grain size analysis are depicted in Figure C27. As anticipated, the primary Folk sediment class in most samples was sand with varying amounts of mud and/or gravel. Replicate grabs from the same station were sometimes consistent (belonging to the same class), suggesting uniformity of sediment type over the spatial span of 284 ± 209 m (mean ± SD) between the first and last grabs at each station. Others stations had varied sediments within that span, even ranging from sand (<0.01% gravel) to sandy gravel (30 – 80% gravel) within the same spatial span, indicating small-scale heterogeneity. Gravel content was always the heterogeneous element in these variable stations. Figure C27 distinguishes stations with homogeneous and heterogeneous sediments. Homogeneous sand predominated in the MA WEA, particularly in its eastern half. Elsewhere**,** sand-gravel mixes (homogeneous and heterogeneous) predominated. NY, NJ, and VA WEAs all had at least one heterogeneous station with at least one replicate of gravel-dominated (sandy gravel: 30 - 80% gravel by wt.) sediments.

The results of beam trawling for epibenthic and demersal fauna are presented in Table C12. Important taxa, comprising ≥ 10% of total catch numbers, ≥ 10% of total catch weight, or occurring in ≥ 50% of catches within each WEA, are listed individually. Sand shrimp (*Crangon septemspinosa*) were invariably the most numerous catch, were the heaviest catch in New Jersey and New York, and occurred in every trawl but one. Assemblages were otherwise similar in all WEAs, featuring sand dollars, smallmouth founder, and various skate species among others. The presence of fig (monkey dung) sponges (*Suberites ficus*) and Bryozoans in a few MA WEA samples suggest hard substrate. These trawl locations and areas of sediments dominated by gravel (sG) bear further investigation as possible venues for potentially sensitive hard-bottom patches.

DISPOSITION OF DATA

All visual and passive acoustic data collected will be maintained by the Protected Species Branch at the Northeast Fisheries Science Center (NEFSC) in Woods Hole, MA. Visual sightings data will be archived in the NEFSC's Oracle database and later will be submitted to SEAMAP OBIS.

All hydrographic data collected will be maintained by the Fishery Oceanography Branch at the NEFSC in Woods Hole, MA. Hydrographic data can be accessed through the Oceanography web site http://www.nefsc.noaa.gov/epd/ocean/MainPage/ioos.html or the NEFSC's Oracle database.

All plankton samples collected will be maintained by the Fishery Oceanography Branch at the NEFSC in Narragansett RI. Plankton samples will be sent to Poland for identification. Plankton data can be accessed through the NEFSC's Oracle database after about March 2014.

All VPR data will be processed and maintained Fishery Oceanography Branch at the NEFSC in Woods Hole, MA. VPR oceanographic data and images are currently available by request only.

All benthic data are processed and maintained at the NEFSC J.J. Howard Lab in Sandy Hook, NJ.

All active acoustic data will be archived and maintained by the Data Management Services (DMS) branch at the NEFSC. In addition, all EK60 data will be archived and maintained at NOAA's NGDC in Boulder, CO.

PERMITS

NEFSC was authorized to conduct the marine mammal related research activities during this survey under US Permit No. 17355 issued to the NEFSC by the NMFS Office of Protected Resources, Canadian Species at Risk Permit license number 330996, and Canadian Foreign Fishing Vessel License no 000005 issued under IDR-423.

ACKNOWLEDGEMENTS

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Table C1. Scientific Computer System (SCS) data collected continuously every second during the survey and stored in a user created file.

Date (MM/DD/YYYY)	
Time (hh:mm:ss)	TSG-Conductivity (s/m)
EK60-38kHz-Depth (m)	TSG-External-Temp (ºC)
EK60-18kHz-Depth (m)	TSG-InternalTemp (ºC)
ADCP-Depth (m)	TSG-Salinity (PSU)
ME70-Depth (m)	TSG-Sound-Velocity (m/s)
ES60-50kHz-Depth (m)	MX420-Time (GMT)
Doppler-Depth (m)	MX420-COG (º)
Air-Temp (ºC)	MX420-SOG (Kts)
Barometer-2 (mbar)	MX420-Lat (DDMM.MM)
YOUNG-TWIND-Direction (º)	MX420-Lon (DDMM.MM)
YOUNG-TWIND-Speed (Kts)	Doppler-F/A-BottomSpeed (Kts)
Rel-Humidity (%)	Doppler-F/A-WaterSpeed (Kts)
Rad-Case-Temp (ºC)	Doppler-P/S-BottomSpeed (Kts)
Rad-Dome-Temp (ºC)	Doppler-P/S-WaterSpeed (Kts)
Rad-Long-Wave-Flux (W/m^2)	High-Sea Temp (ºC)
Rad-Short-Wave-Flux (W/m^2)	POSMV – Time (hhmmss)
ADCP-F/A – GroundSpeed (Kts)	POSMV – Elevation (m)
ADCP-F/A – WaterSpeed (Kts)	POSMV – Heading (º)
ADCP-P/S – GroundSpeed (Kts)	POSMV – COG (Kts)
ADCP-P/S – WaterSpeed (Kts)	POSMV – SOG (Kts)
Gyro (º)	POSMV – Latitude (DDMM.MM)
POSMV – Quality (1=std)	POSMV – Longitude (DDMM.MM)
POSMV – Sats (none)	POSMV – hdops (none)

Table C2. Scientific personnel involved in the two legs of this survey. FN = Foreign National.

Personnel	Team	Organization
Leg 1		
Debra Palka	Chief Scientist	NMFS, NEFSC, Woods Hole, MA
Cristina Bascunan	Oceanography	NMFS, NEFSC, Woods Hole, MA
Michael Lowe	Oceanography	Integrated Statistics, Woods Hole, MA
Michael Force (FN)	Seabird	Integrated Statistics, Woods Hole, MA
Peter Duley	Visual mammal	NMFS, NEFSC, Woods Hole, MA
Jennifer Gatzke	Visual mammal	Integrated Statistics, Woods Hole, MA
Samara Haver	Passive acoustic	Integrated Statistics, Woods Hole, MA
Peter Plantamura	Oceanography	NMFS, NEFSC, Sandy Hook, NJ
Betty Lentell	Visual mammal	Integrated Statistics, Woods Hole, MA
Nicholas Metheny	Visual mammal	Integrated Statistics, Woods Hole, MA
Todd Pusser	Visual mammal	Integrated Statistics, Woods Hole, MA
Chris Tremblay	Passive acoustic	Integrated Statistics, Woods Hole, MA
Dan Vendatullia	Oceanography	Integrated Statistics, Woods Hole, MA
Harvey Walsh	Oceanography	NMFS, NESFC, Narragansett, RI
Tim White	Seabird	Integrated Statistics, Woods Hole, MA
Leg 2		
Jennifer Gatzke	Chief Scientist	Integrated Statistics, Woods Hole, MA
Elisabeth Broughton	Oceanography	NMFS, NEFSC, Woods Hole, MA
Genevieve Davis	Passive acoustic	Integrated Statistics, Woods Hole, MA
Michael Force (FN)	Seabird	Integrated Statistics, Woods Hole, MA
Betty Lentell	Visual mammal	Integrated Statistics, Woods Hole, MA
Eric Matzen	Visual mammal	Integrated Statistics, Woods Hole, MA
Melissa Warden	Visual mammal	Integrated Statistics, Woods Hole, MA
John Rosendale	Oceanography	NMFS, NEFSC, Sandy Hook, NJ
Eric Matzen	Visual mammal	Integrated Statistics, Woods Hole, MA
Nicholas Metheny	Seabird	Integrated Statistics, Woods Hole, MA
Todd Pusser	Visual mammal	Integrated Statistics, Woods Hole, MA
Chris Tremblay	Passive acoustic	Integrated Statistics, Woods Hole, MA
Kimberly Gogan	Oceanography	Teacher-at-sea
Brian Dennis	Oceanography	Volunteer
Jerome Prezioso	Oceanography	NMFS,NEFSC, Narragansett, RI

Table C3. Within each Beaufort sea state condition, total length of visual teams' track lines while on effort (in km).

	Track line length (km) within Beaufort sea state levels							
Conditions	0	1	2	3	4	5	6	Total
On effort	70.4	149.1	748.7	625.9	972.6	965.9	481.2	4013.8
Cumulative percentage	0.02	0.05	0.24	0.40	0.64	0.88	1.00	

Table C4. Number of groups and individuals of cetacean species detected by the upper and lower marine mammal - turtle visual teams during on-effort track lines on the NOAA ship *Gordon Gunter* survey conducted during 8 Mar – 28 Apr 2014. Note, some, but not all, groups detected by one team were also detected by the other team.

		number of groups		number of individuals	
Species		lower	upper	lower	upper
Atlantic spotted dolphin	*Stenella frontalis*	0	1	0	7
Blue whale	*Balaenoptera musculus*	0	1	0	1
Bottlenose dolphin spp.	*Tursiops truncatus*	8	24	165	272
Bottlenose whale	*Hyperoodon ampullatus*	2	0	6	0
Common dolphin	*Delphinus delphis*	40	84	1009	1993
Cuvier's beaked whale	*Ziphius cavirostris*	5	3	6	8
Fin whale	*Balaenoptera physalus*	11	40	11	62
Fin/sei whales	*B. physalus or B. borealis*	5	22	6	26
Harbor porpoise	*Phocoena phocoena*	4	13	6	15
Humpback whale	*Megaptera novaeangliae*	20	41	32	60
Killer whale	*Orcinus orca*	1	1	2	4
Minke whale	*B. acutorostrata*	1	11	1	14
Pilot whales spp.	*Globicephala spp.*	27	44	202	256
Right whale	*Eubalaena glacialis*	9	18	11	26
Risso's dolphin	*Grampus griseus*	11	19	41	84
Sei whale	*Balaenoptera borealis*	10	4	10	4
Sowerby's beaked whale	*Mesoplodon bidens*	0	1	0	3
Sperm whale	*Physeter macrocephalus*	24	32	28	39
Striped dolphin	*Stenella coeruleoalba*	4	7	183	139
True's beaked whale	*Mesoplodon mirus*	0	1	0	3
White-sided dolphin	*Lagenorhynchus acutus*	12	20	120	188
Unid. Dolphin	*Delphinidae*	29	52	130	297
Unid. Whale	*Mysticeti*	49	121	51	139
Unid. Mesoplodon	*Mesoplodon spp.*	6	17	7	21
TOTAL CETACEANS		278	577	2,027	3,661

Table C5. Number of groups and individuals of large fish, turtles, and seals detected by the upper and lower marine mammal - turtle visual teams during on-effort track lines on the NOAA ship *Gordon Gunter* survey conducted during 8 Mar – 28 Apr 2014. Note, some, but not all, groups detected by one team were also detected by the other team.

		number of groups		number of individuals	
Species		lower	upper	lower	upper
Basking shark	*Cetorhinus maximus*	2	4	2	5
Ocean sunfish	*Mola mola*	4	22	4	23
Shark spp.		1	3	1	3
Loggerhead turtle	*Caretta caretta*	1	1	1	1
Unid turtle	*Chelonioidea*	1	0	1	0
Gray seal	*Halichoerus grypus*	4	13	4	14
Harbor seal	*Phoca vitulina*	2	4	2	4
Unid seal	*Pinniped*	2	2	2	2
TOTAL ALL SPECIES		295	626	2,044	3,713

Table C6. Number of groups and individual birds detected on effort during the NOAA ship *Gordon Gunter* survey conducted during 8 Mar – 28 Apr 2014.

Species		Number of groups	Total individuals	Relative abundance	Frequency
Herring Gull	*Larus argentatus*	532	1088	15.68	21.36
Northern Gannet	*Morus bassanus*	484	778	11.21	19.43
Dovekie	*Alle alle*	203	936	13.49	8.15
Great Black-backed Gull	*Larus marinus*	201	279	4.02	8.07
Atlantic Puffin	*Fratercula arctica*	150	228	3.29	6.02
Northern Fulmar	*Fulmarus glacialis*	146	313	4.51	5.86
Red Phalarope	*Phalaropus fulicarius*	121	1281	18.46	4.86
Bonaparte's Gull	*Chroicocephalus philadelphia*	88	339	4.89	3.53
Razorbill	*Alca torda*	84	228	3.29	3.37
White-winged Scoter	*Melanitta fusca*	52	217	3.13	2.09
Common Loon	*Gavia immer*	50	65	0.94	2.01
Sooty Shearwater	*Puffinus griseus*	42	131	1.89	1.69
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	40	58	0.84	1.61
Manx Shearwater	*Puffinus puffinus*	35	43	0.62	1.41
Thick-billed Murre	*Uria lomvia*	29	41	0.59	1.16
Wilson's Storm-Petrel	*Oceanites oceanicus*	26	235	3.39	1.04
Common Murre	*Uria aalge*	24	34	0.49	0.96
Pomarine Jaeger	*Stercorarius pomarinus*	24	25	0.36	0.96
Black Scoter	*Melanitta americana*	23	138	1.99	0.92
Red-throated Loon	*Gavia stellata*	18	23	0.33	0.72
Long-tailed Duck	*Clangula hyemalis*	10	35	0.50	0.40
Black-capped Petrel	*Pterodroma hasitata*	9	9	0.13	0.36
unidentified Passerine	*Passerine sp.*	9	9	0.13	0.36
Surf Scoter	*Melanitta perspicillata*	8	65	0.94	0.32
Laughing Gull	*Leucophaeus atricilla*	7	96	1.38	0.28
unidentified phalarope	*Phalaropus sp.*	7	76	1.10	0.28
Lesser Black-backed Gull	*Larus fuscus*	6	6	0.09	0.24
Common Eider	*Somateria mollissima*	5	14	0.20	0.20
Long-tailed Jaeger	*Stercorarius longicaudus*	5	6	0.09	0.20
Iceland Gull	*Larus glaucoides*	5	5	0.07	0.20
unidentified shearwater	*Puffinus sp.*	3	10	0.14	0.12
Song Sparrow	*Melospiza melodia*	3	6	0.09	0.12

Species		Number of groups	Total individuals	Relative abundance	Frequency
Dark-eyed Junco	*Junco hyemalis*	3	3	0.04	0.12
unidentified alcid	*sp.*	3	3	0.04	0.12
Double-crested Cormorant	*Phalacrocorax auritus*	2	62	0.89	0.08
Black-legged Kittiwake	*Rissa tridactyla*	2	13	0.19	0.08
Arctic Tern	*Sterna paradisaea*	2	4	0.06	0.08
Brown-headed Cowbird	*Molothrus ater*	2	2	0.03	0.08
Red-breasted Merganser	*Mergus serrator*	2	2	0.03	0.08
unidentified *Pterodroma*	*Pterodroma sp.*	2	2	0.03	0.08
unidentiifed Skua	*Stercorarius sp.*	2	2	0.03	0.08
unidentified storm-petrel	*Oceanodroma/Oceanites sp.*	2	2	0.03	0.08
unidentified duck	*sp.*	1	8	0.12	0.04
Leach's/Band-rumped Storm-Petrel	*Oceanodroma leucorhoa/castro*	1	2	0.03	0.04
Canada Goose	*Branta canadensis*	1	1	0.01	0.04
Green-winged Teal	*Anas crecca*	1	1	0.01	0.04
Bermuda Petrel	*Pterodroma cahow*	1	1	0.01	0.04
Audubon's Shearwater	*Puffinus lherminieri*	1	1	0.01	0.04
Great Blue Heron	*Ardea herodias*	1	1	0.01	0.04
Osprey	*Pandion haliaetus*	1	1	0.01	0.04
unidentified shorebird	*sp.*	1	1	0.01	0.04
Glaucous Gull	*Larus hyperboreus*	1	1	0.01	0.04
unidentified large gull	*Larus sp.*	1	1	0.01	0.04
Parasitic Jaeger	*Stercorarius parasiticus*	1	1	0.01	0.04
South Polar Skua	*Stercorarius maccormicki*	1	1	0.01	0.04
Black Guillemot	*Cepphus grylle*	1	1	0.01	0.04
unidentified murre	*Uria sp.*	1	1	0.01	0.04
Northern Flicker	*Colaptes auratus*	1	1	0.01	0.04
Brown Thrasher	*Toxostoma rufum*	1	1	0.01	0.04
American Robin	*Turdus migratorius*	1	1	0.01	0.04
Eurasian Starling	*Sturnus vulgaris*	1	1	0.01	0.04
Red-winged Blackbird	*Agelaius phoeniceus*	1	1	0.01	0.04
Total		2491	6940		

Table C7. Summary of passive acoustic recording effort during the NOAA ship Gordon Gunter March – April 2014 survey.

	Leg 1	Leg 2	Total
Days w/ acoustic effort	7	10	17
Daytime recording time (hh:mm)	54:06	61:33	115:39
Nights w/ acoustic effort	3	7	10
Evening/night recording time (hh:mm)	4:36	24:46	29:22

Table C8. Summary of acoustic events detected in real-time during the NOAA ship Gordon Gunter March - April survey. Species were assigned to acoustic detections when acoustic localization and tracking resulted in direct correspondence with visual sightings. Groups without species assignment include both those that were not visually detected, as well as groups that could not be definitively linked to visual sightings in real-time. Note that in many cases, acoustic detections include multiple individuals (in the case of sperm whales) or multiple subgroups (in the case of delphinids).

	Leg 1	Leg 2	Total
Bottlenose dolphin	0	1	1
Common dolphin	1	2	3
Pilot whales	1	1	2
Sperm whales	6	13	19
Groups without species assignment	11	18	29
Total	19	35	54

Table C9. Summary of acoustic detections of sperm whales. Note that most detections include multiple animals.

	Leg 1	Leg 2	Total
Days w/ sperm whale detections	3	5	8
Number of groups detected	6	13	19

Table C10. The number of hydrographic and oceanographic sampling stations attempted.

Sampling type	Leg 1	Leg 2	Total
CTD only	51	13	64
Bongo + CTD	86	41	127
VPR + CTD	9	4	13
IKMT + CTD	2	0	2
MOCNESS	3	0	3
Beam Trawl	53	17	70
Grabs	156	77	233
Total	360	152	512

Table C11. Oceanographic sampling at the shelf break canyon and non-canyon areas.

Canyon	Transect Type	Date	Time (Local)	Leg	EK60	CTD	MOC	IKMT	VPR
Baltimore (night)	Canyon (Z)	3/20/14	2118	I	X	X		X	
Baltimore (day)	Canyon (Z)	3/21/14	0700	I	X				
Washington (night)	Canyon (Z)	3/21/14	2225	I	X	X	X		
Washington (day)	Canyon (Z)	3/22/14	0700	I	X				
Norfolk	Canyon (Z)	3/22/14	2250	I	X	X			X
North of Washington	Cross-shelf	3/28/14	1934	I	X	X			
Wilmington	Canyon (Z)	3/29/14	1817	I	X	X			
Hudson	Canyon (Z)	4/1/14	1652	I	X	X			
Atlantis	Canyon (Z)	4/13/14	2158	II	X	X			
Munson	Canyon (Z)	4/21/14	2219	II	X				

Table C12. Beam trawl summary for epibenthic and demersal fauna.

VA WEA, 12 trawls, 29 taxa		VA	VA	VA
common name	taxonomic name	%count	%wt	%freq
sand shrimp	*Crangon septemspinosa*	**43.4%**	3.0%	**100.0%**
snails unclassified	Gastropoda	**14.3%**	3.1%	**100.0%**
dwarf surf clam	*Mulinia lateralis*	**13.7%**	**16.8%**	**83.3%**
spotted hake	*Urophycis regia*	7.1%	7.3%	**100.0%**
smallmouth flounder	*Etropus microstomus*	4.8%	1.5%	**100.0%**
searobin	*Prionotus* sp.	4.5%	1.6%	**100.0%**
sand dollar	*Echinarachnius parma*	1.6%	2.5%	**50.0%**
sea slug	Opisthobranchia	0.9%	0.2%	**75.0%**
white shrimp	*Litopeneaus setiferus*	0.8%	0.2%	**50.0%**
sand lance	*Ammodytes* sp.	0.5%	0.9%	**50.0%**
goby	Gobiidae	0.5%	0.1%	**66.7%**
rock sea bass	*Centropristis philadelphica*	0.4%	0.3%	**75.0%**
freckled skate	*Leucoraja lentiginosa*	0.1%	**15.7%**	16.7%
rosette skate	*Leucoraja garmani*	0.0%	**18.9%**	8.3%
clearnose skate	*Raja eglanteria*	0.0%	**12.2%**	8.3%
SUBTOTAL		92.6%	84.1%	--
14 additional taxa		7.4%	15.9%	--

MA WEA, 23 trawls, 59 taxa		MA	MA	MA
common name	taxonomic name	%count	%wt	%freq
sand shrimp	*Crangon septemspinosa*	**70.5%**	5.7%	**95.7%**
sand dollar	*Echinarachnius parma*	**17.4%**	**47.6%**	39.1%
pandalid shrimp	Pandalidae	0.5%	0.1%	**52.2%**
monkey dung sponge	*Suberites ficus*	0.1%	**15.4%**	26.1%
little skate	*Raja erinacea*	0.3%	**15.8%**	34.8%
SUBTOTAL		88.9%	84.6%	--
54 additional taxa		11.1%	15.4%	--

NJ WEA, 13 trawls, 24 taxa		NJ	NJ	NJ
common name	taxonomic name	%count	%wt	%freq
sand shrimp	*Crangon septemspinosa*	**92.5%**	**34.0%**	**100.0%**
sea slug	Opisthobranchia	3.2%	3.3%	**100.0%**
smallmouth flounder	*Etropus microstomus*	0.7%	1.5%	**100.0%**
sand dollar	*Echinarachnius parma*	0.6%	6.5%	**61.5%**
thorny skate	*Amblyraja radiata*	0.1%	**31.8%**	30.8%
SUBTOTAL		97.1%	77.2%	--
19 additional taxa		2.9%	22.8%	--

NY WEA, 10 trawls, 19 taxa		NY	NY	NY
common name	taxonomic name	%count	%wt	%freq
sand shrimp	*Crangon septemspinosa*	**95.3%**	**40.5%**	**100.0%**
sea slug	Opisthobranchia	1.9%	2.9%	**70.0%**
sand dollar	*Echinarachnius parma*	1.8%	**20.9%**	**100.0%**
snails unclassified	Gastropoda	0.5%	0.5%	**70.0%**
hermit crab	*Pagurus* spp.	0.1%	0.2%	**80.0%**
smallmouth flounder	*Etropus microstomus*	0.1%	0.2%	**60.0%**
thorny skate	*Amblyraja radiata*	0.1%	**16.6%**	**60.0%**
comb jellies	Ctenophora	0.01%	**11.7%**	10.0%
SUBTOTAL		99.7%	93.6%	--
11 additional taxa		0.3%	6.4%	--

RIMA WEA, 4 trawls, 20 taxa		RIMA	RIMA	RIMA
common name	taxonomic name	%count	%wt	%freq
sand shrimp	*Crangon septemspinosa*	**96.3%**	**21.8%**	**100.0%**
true crabs	Brachyura	1.2%	2.7%	**50.0%**
sand dollar	*Echinarachnius parma*	0.5%	**25.6%**	25.0%
American sand lance	*Ammodytes americanus*	0.5%	4.9%	**50.0%**
pipefish	Sygnathidae	0.1%	0.1%	**75.0%**
silver hake	*Merluccius bilinearis*	0.1%	0.5%	**75.0%**
ocean pout	*Zoarces americanus*	0.1%	2.6%	**75.0%**
clam unlass.	Pelecypoda	0.0%	0.4%	**50.0%**
SUBTOTAL		98.7%	58.6%	--
12 additional taxa		1.3%	41.4%	--

Table C1. Proposed track lines (blue lines), benthic sampling stations (green circles), and deployment sites for the bottom mounted Marine Autonomous Recording Units (MARUs; red stars). Also shown are the location of the Bureau of Ocean Energy Management wind energy areas (BOEM WEAs in pink), the shelf break stratum (between the 100 and 2000 m depth contours) and the US exclusive economic zone (EEZ) line.

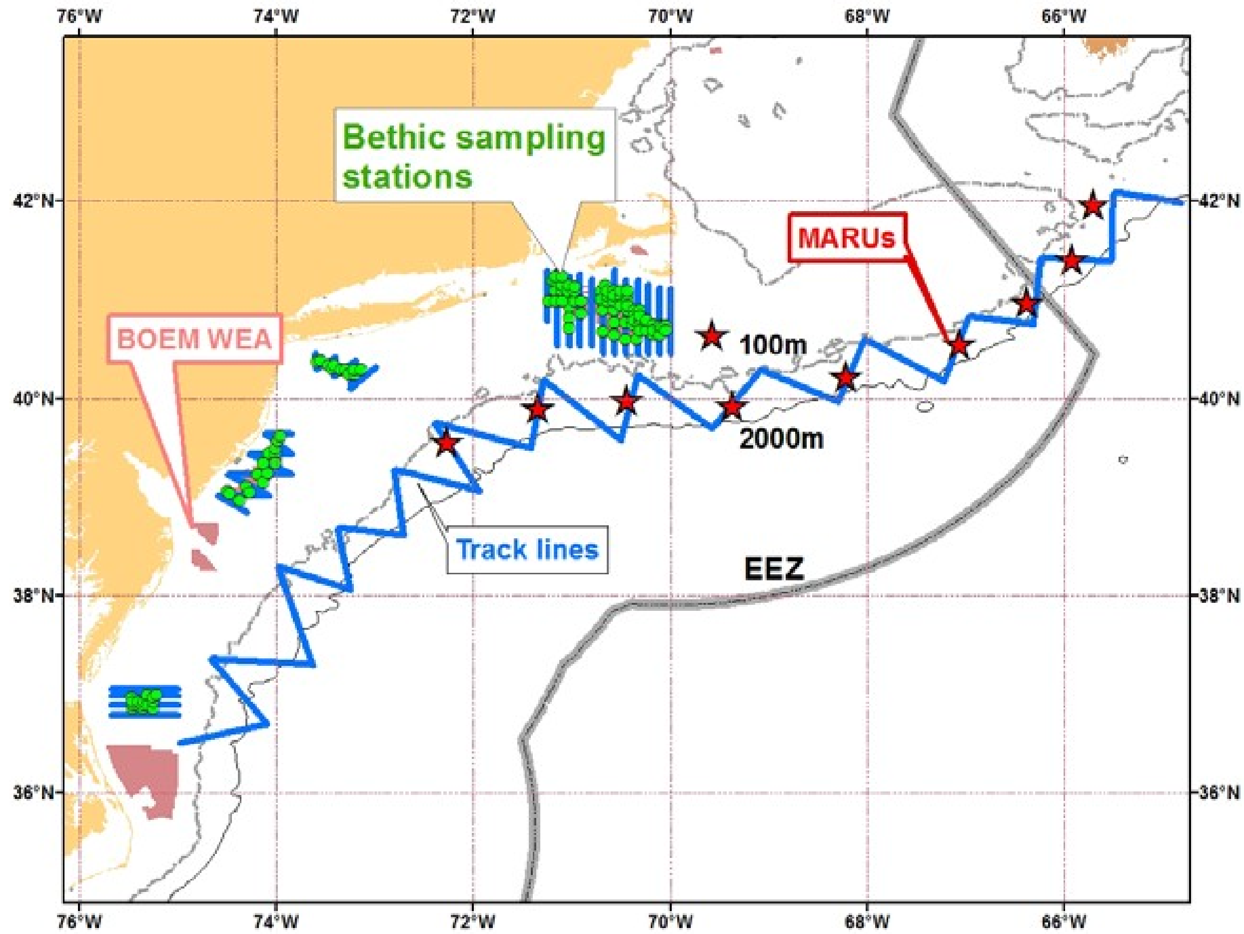


Figure C2. Location of and Beaufort sea states of the completed track lines (colored lines) and the actual locations of the Marine Autonomous Recording Units (MARUs; pink stars). Also shown are the location of the Bureau of Ocean Energy Management wind energy areas (BOEM WEAs in blue), the 100 and 2000 m depth contours and the US exclusive economic zone (EEZ) line.

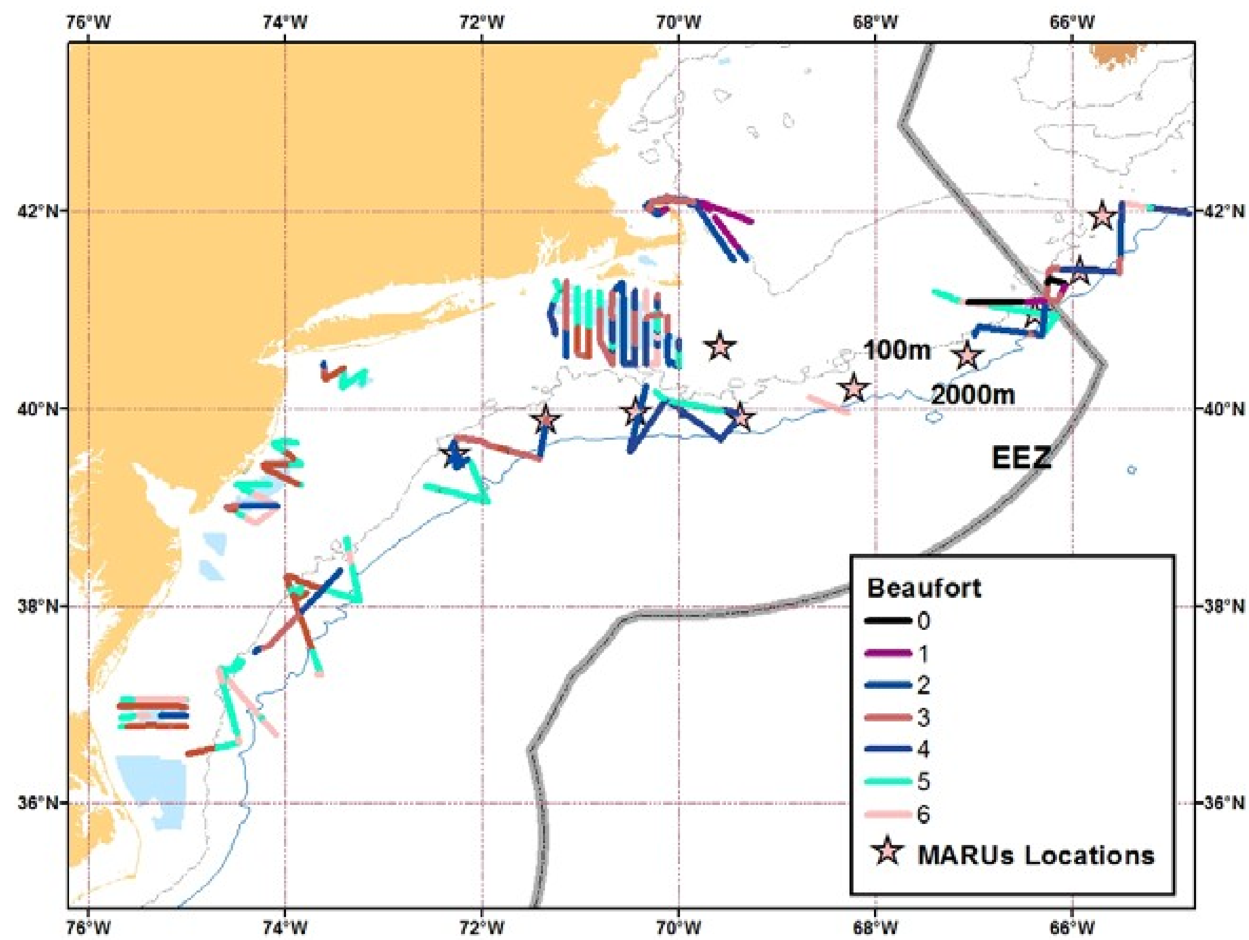
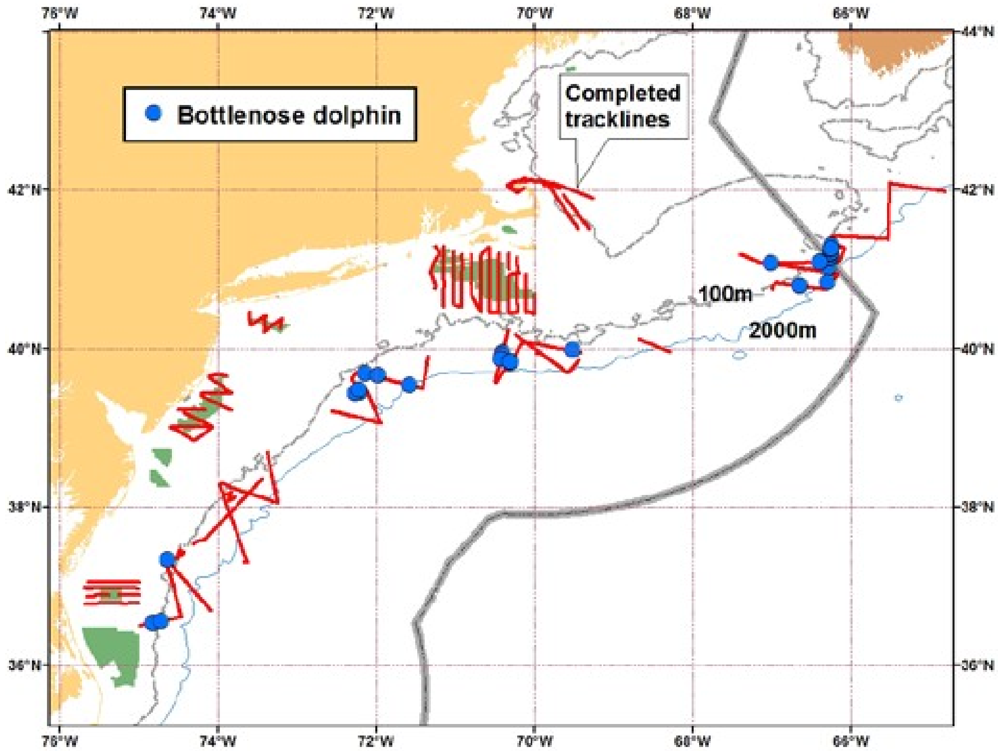


Figure C3. Location of bottlenose spp. dolphin (*Tursiops truncatus*; top) and common dolphin (*Delphinus delphis*; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.



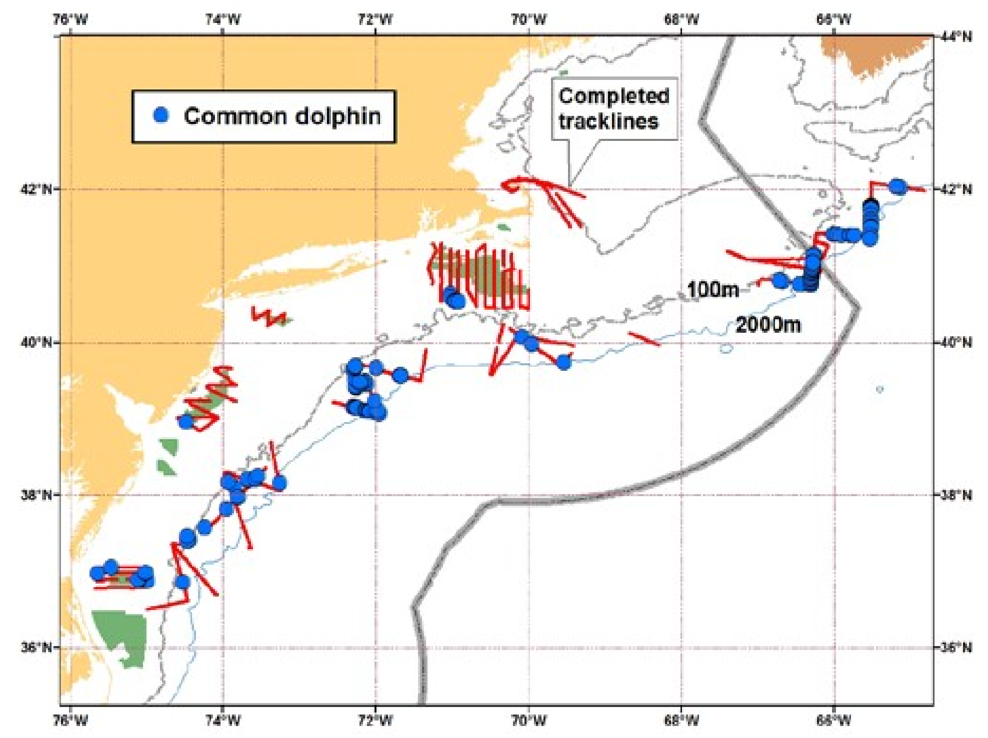


Figure C4. Location of harbor porpoise (*Phocoena phocoena*; top) and white-sided dolphin (*Lagenorhynchus acutus*; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.

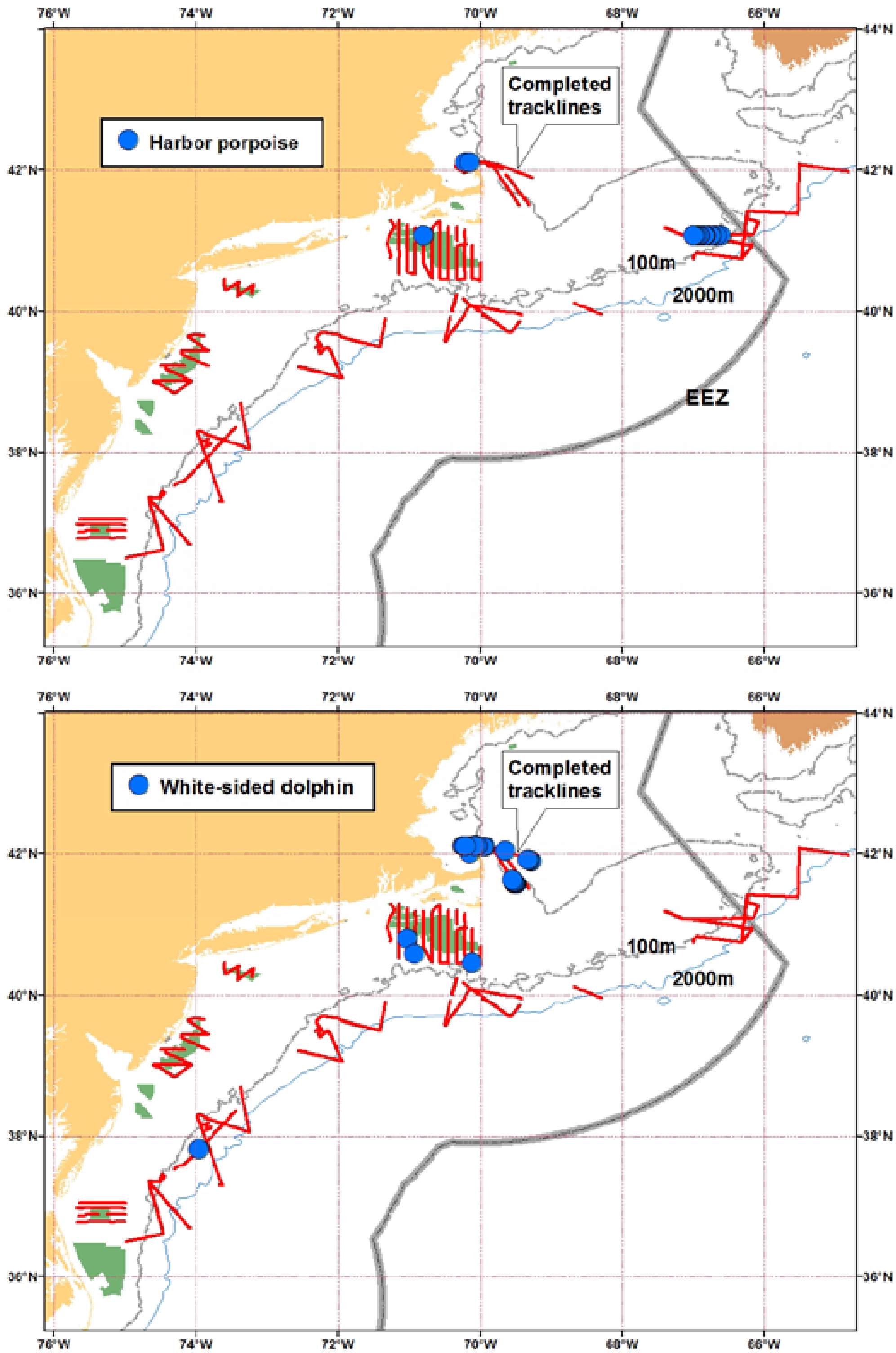
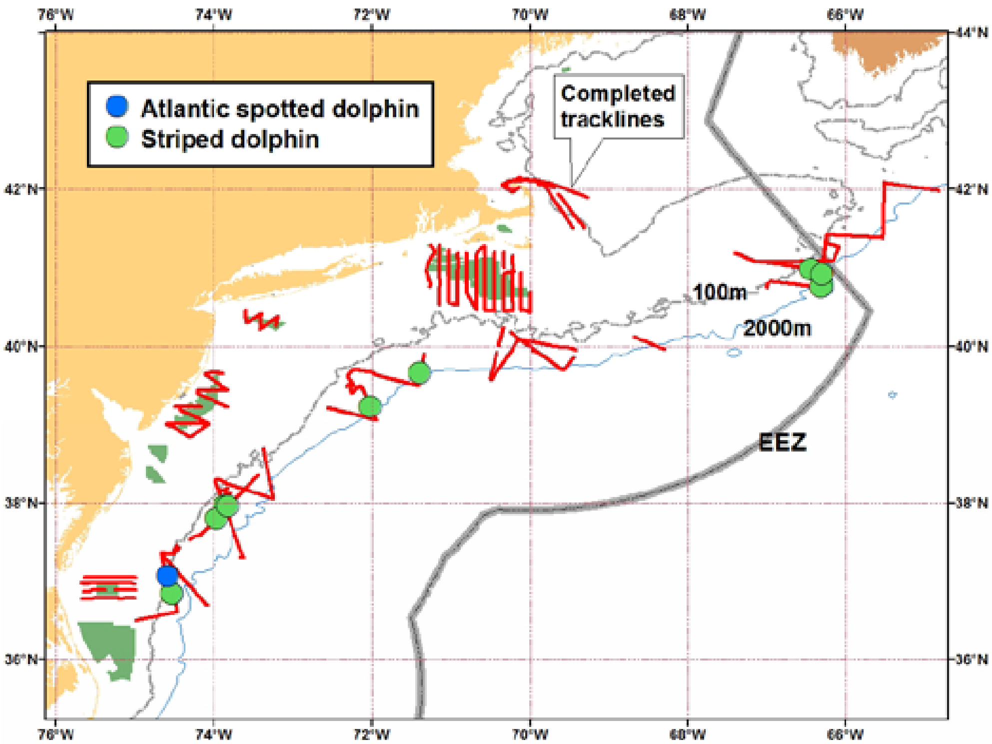


Figure C5. Location of Atlantic spotted dolphins (*Stenella frontalis*), and striped dolphins (*Stenella coeruleoalba*) (top) and unidentified dolphin (bottom) sightings detected by the upper and/or lower team during on-effort tracklines.



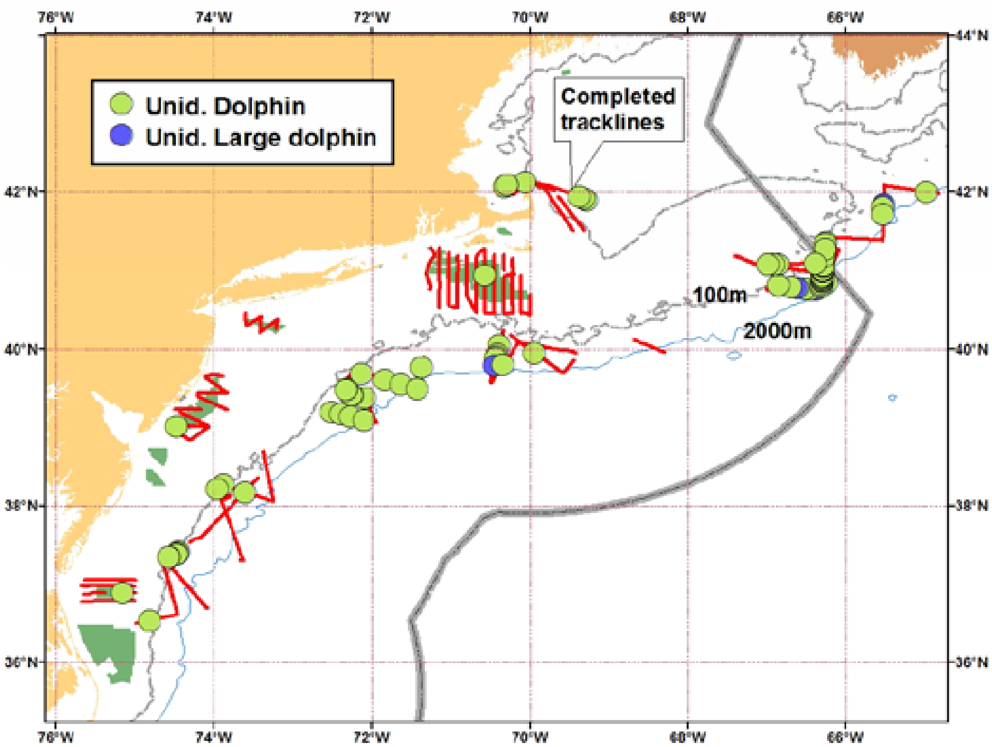
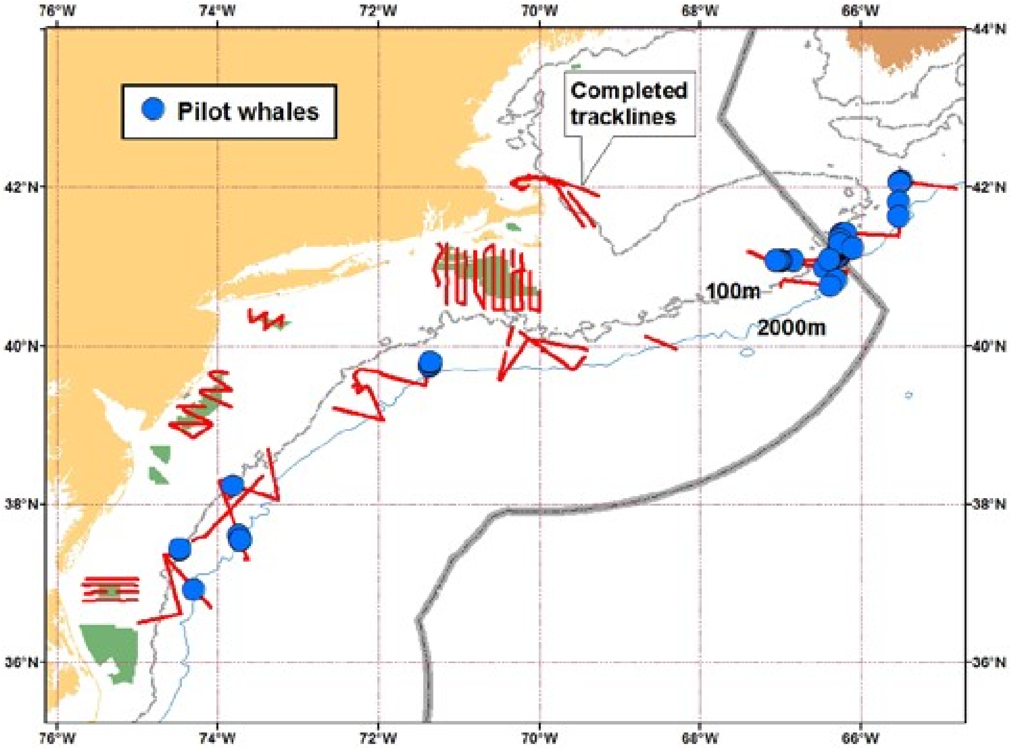


Figure C6. Location of pilot whale spp. (Globicephala spp.; top) and Risso's dolphin (*Grampus griseus*; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.



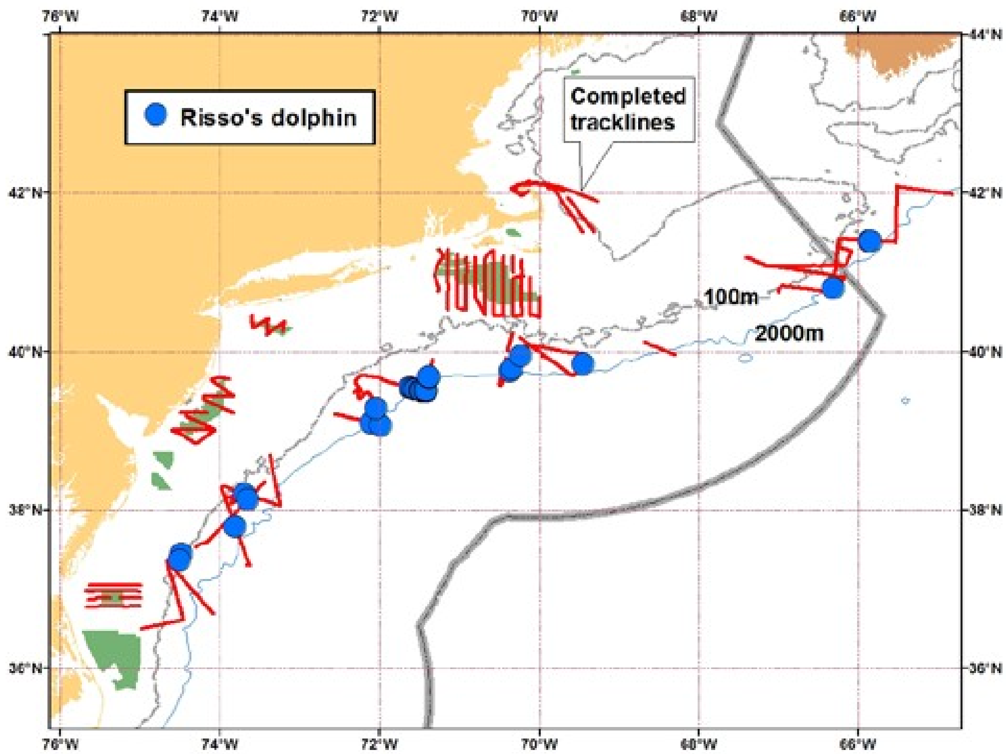


Figure C7. Location of Cuvier's beaked whales (*Ziphius cavirostris*), Sowerby's beaked whales (*Mesoplodon bidens*), True's beaked whale (*Mesoplodon mirus*), unidentified Mesoplodant and unidentified Ziphiid sightings detected by the upper and/or lower team during on-effort tracklines.

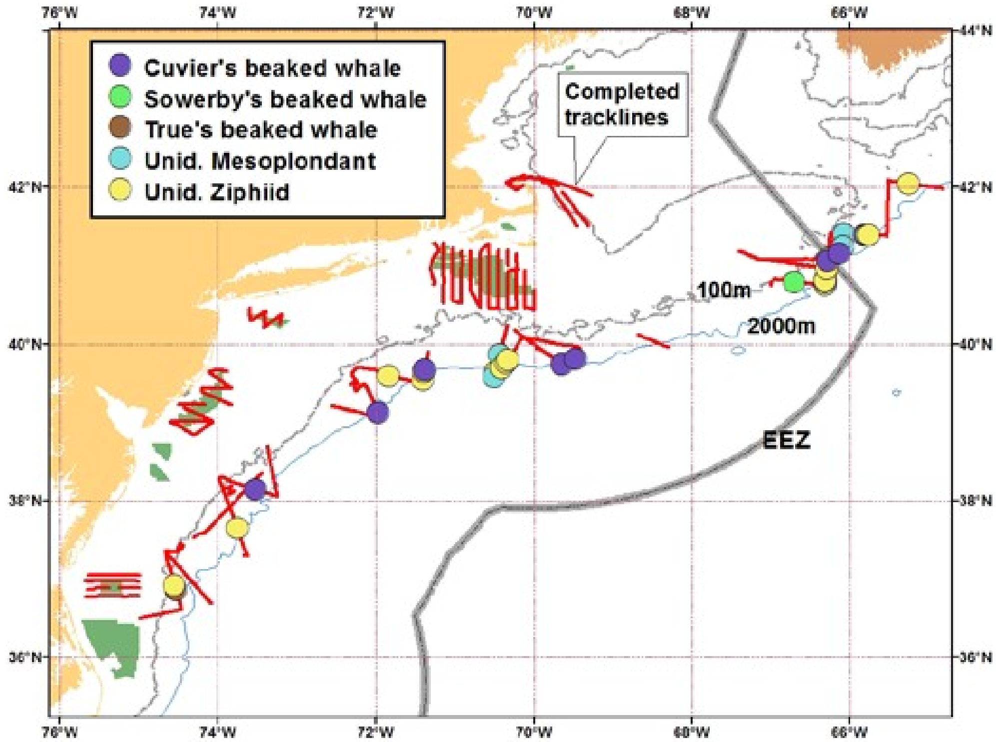


Figure C8. Location of fin whales (*Balaenoptera physalus*), and sei whales (*Balaenoptera borealis*; top) and humpback whale (*Megaptera novaeangliae*; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.

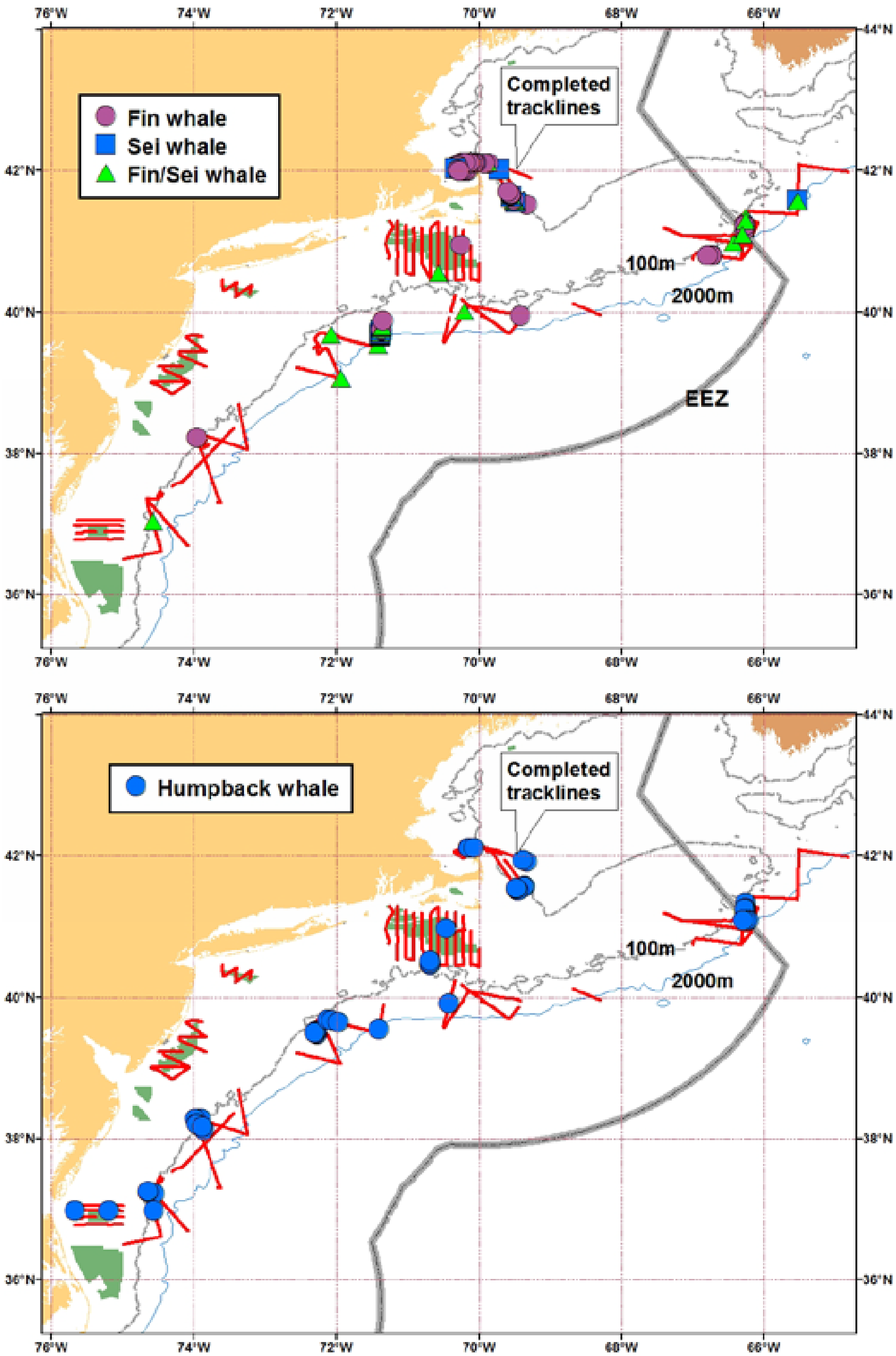
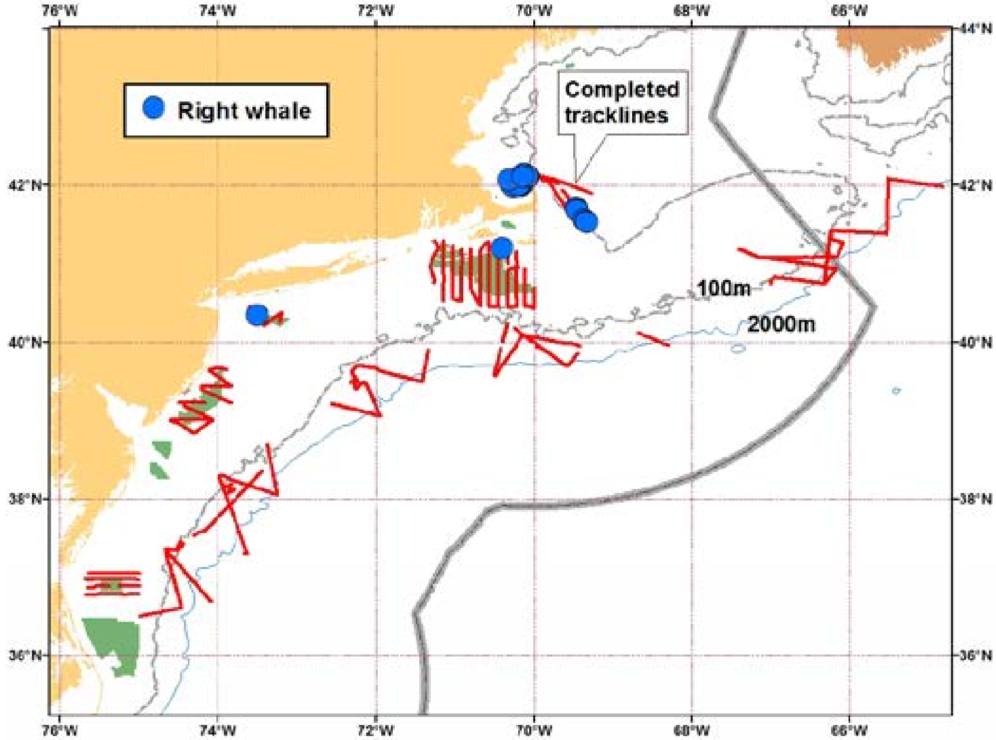


Figure C9. Location of right whale (*Eubalaena glacialis*; top) and sperm whale (*Physeter macrocephalus*; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.



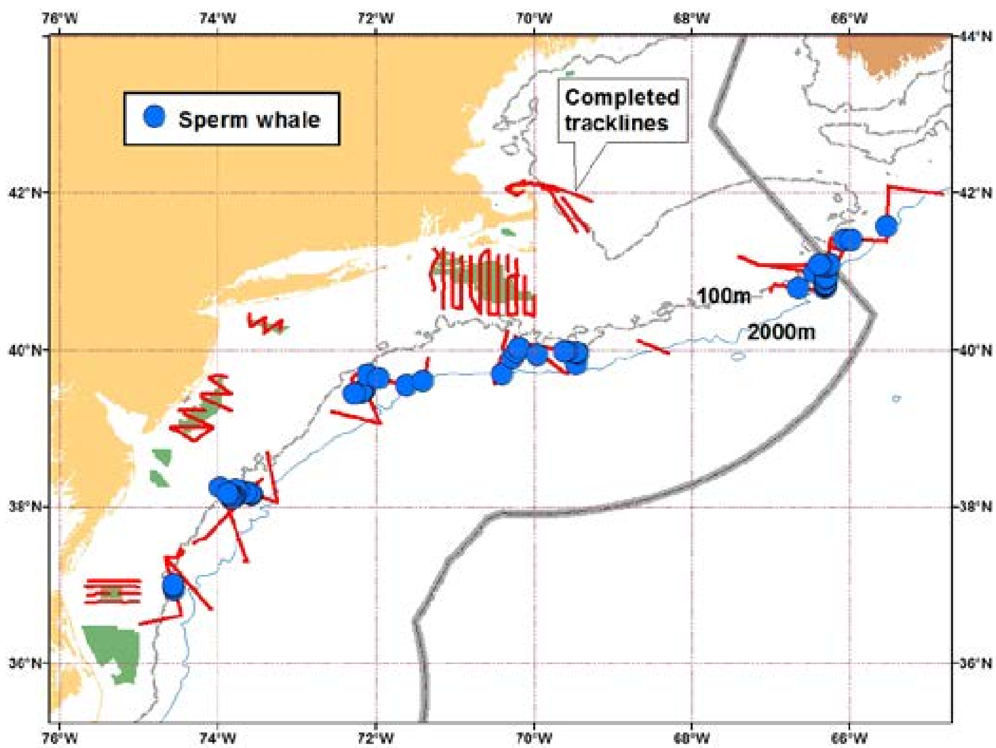


Figure C10. Location of blue whales (*Balaenoptera musculus*), bottlenose whales (*Hyperoodon ampullatus*), killer whales (*Orcinus orca*) and minke whales (*Balaenoptera acutorostrata;* top) and unidentified whale (bottom) sightings detected by the upper and/or lower team during on-effort tracklines.

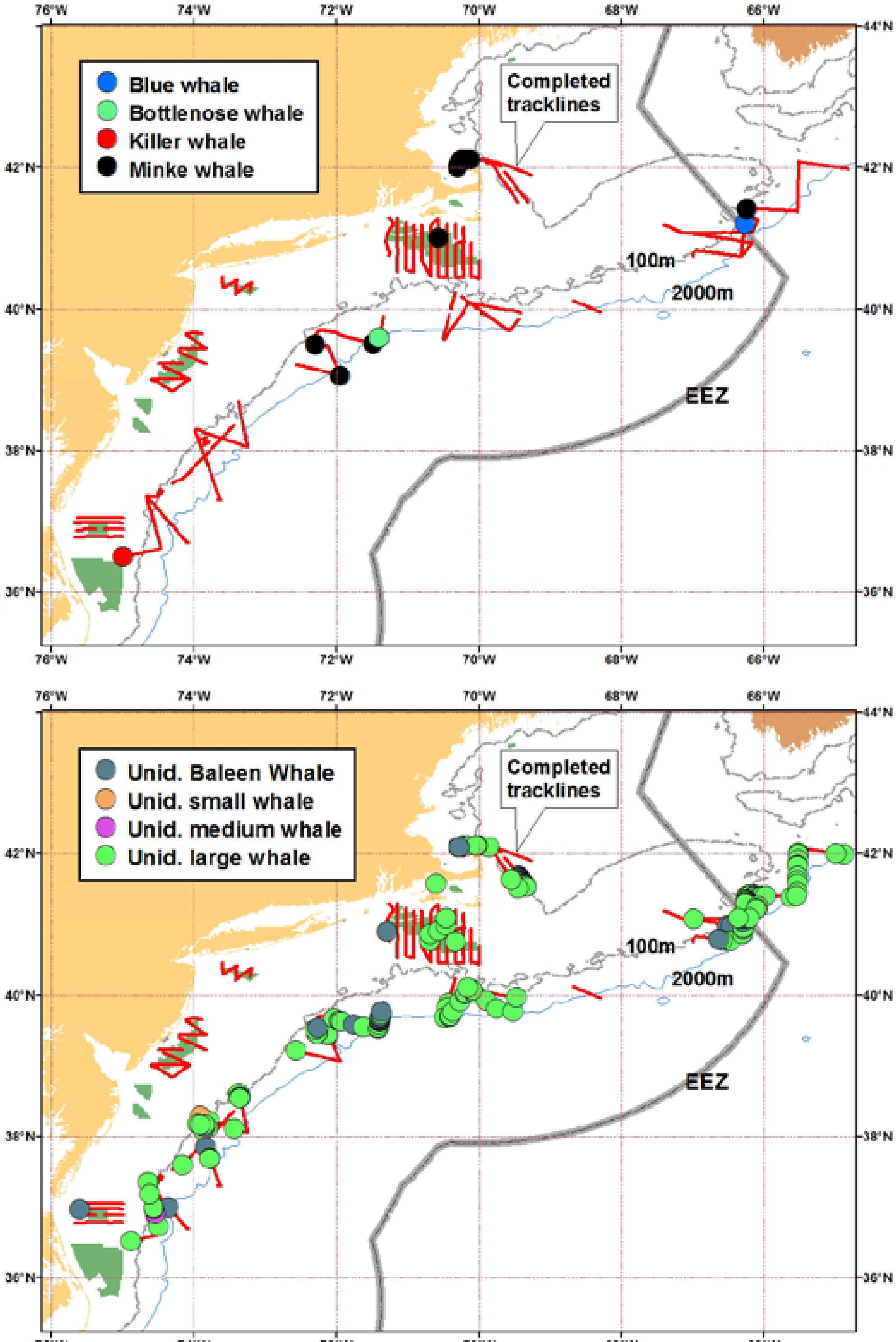


Figure C11. Location of basking sharks (*Cetorhinus maximus*), sunfish (*Mola mola*) and unidentified sharks (top), gray seals (*Halichoerus grypus*), harbor seals (*Phoca vitulina*) and unidentified seal (Pinniped; bottom) sightings detected by the upper and/or lower team during on-effort tracklines.

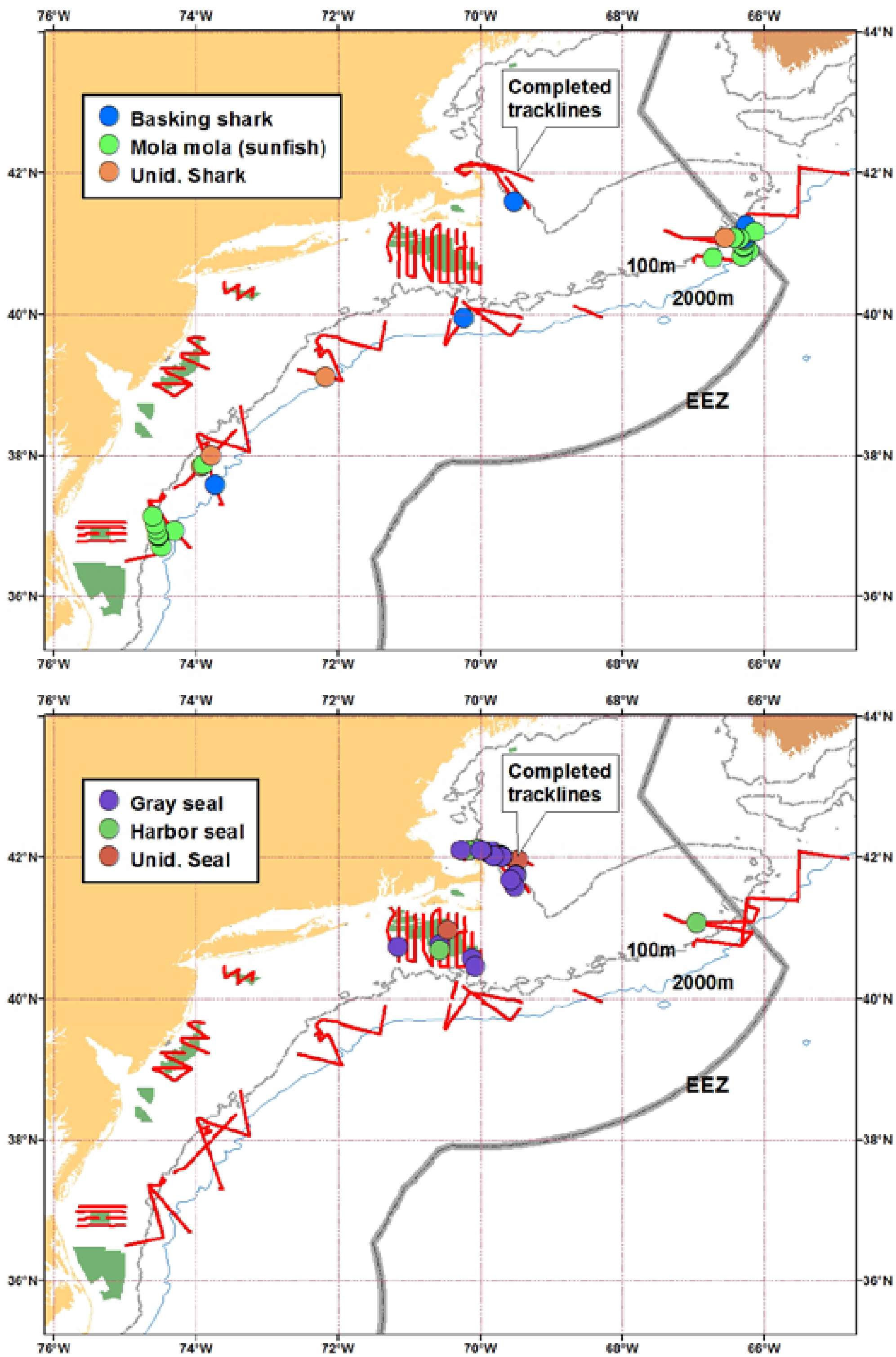


Figure C12. Location of loggerhead turtle (*Caretta caretta*), and unidentified hardshell turtle sightings detected by the upper and/or lower team during on-effort tracklines.

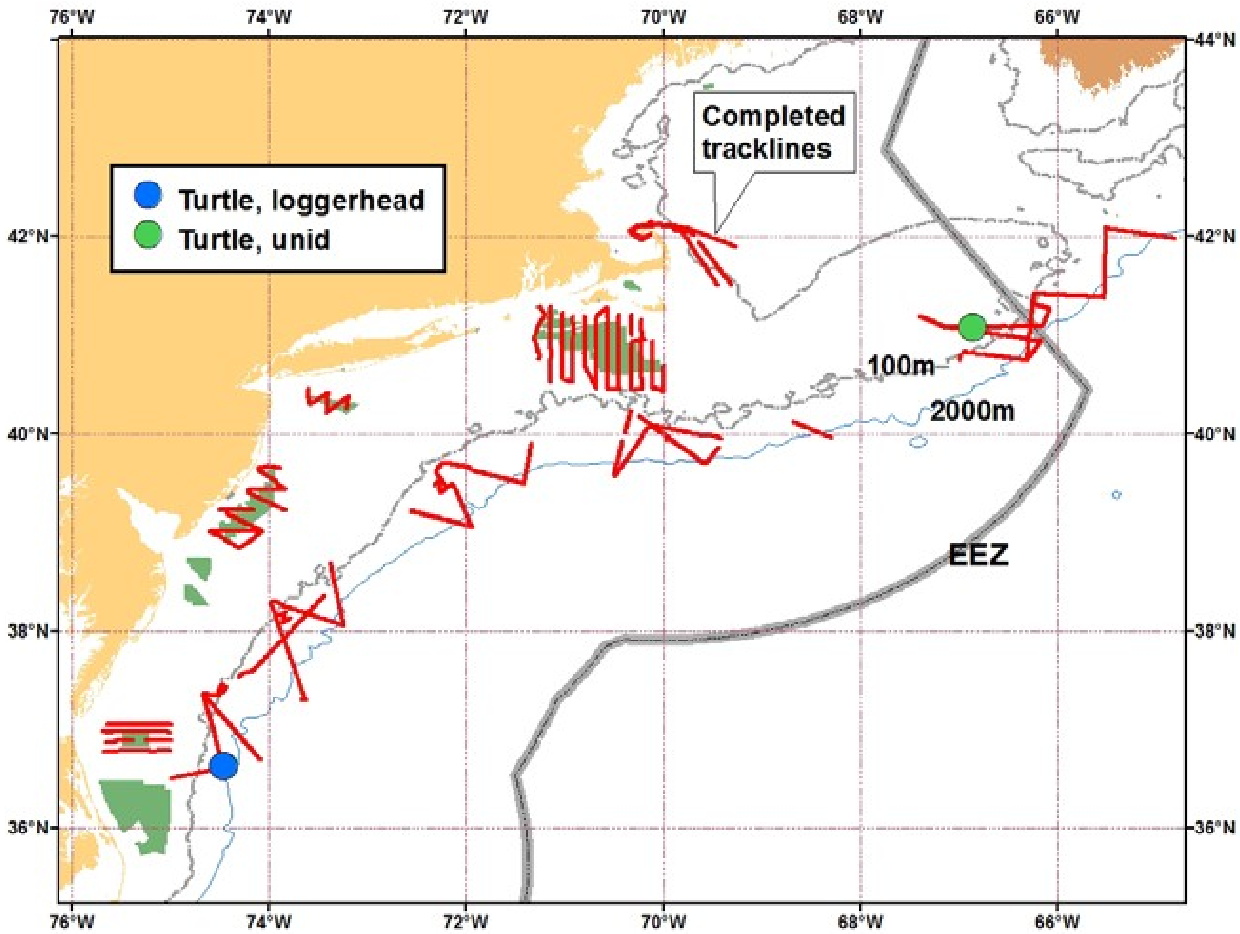
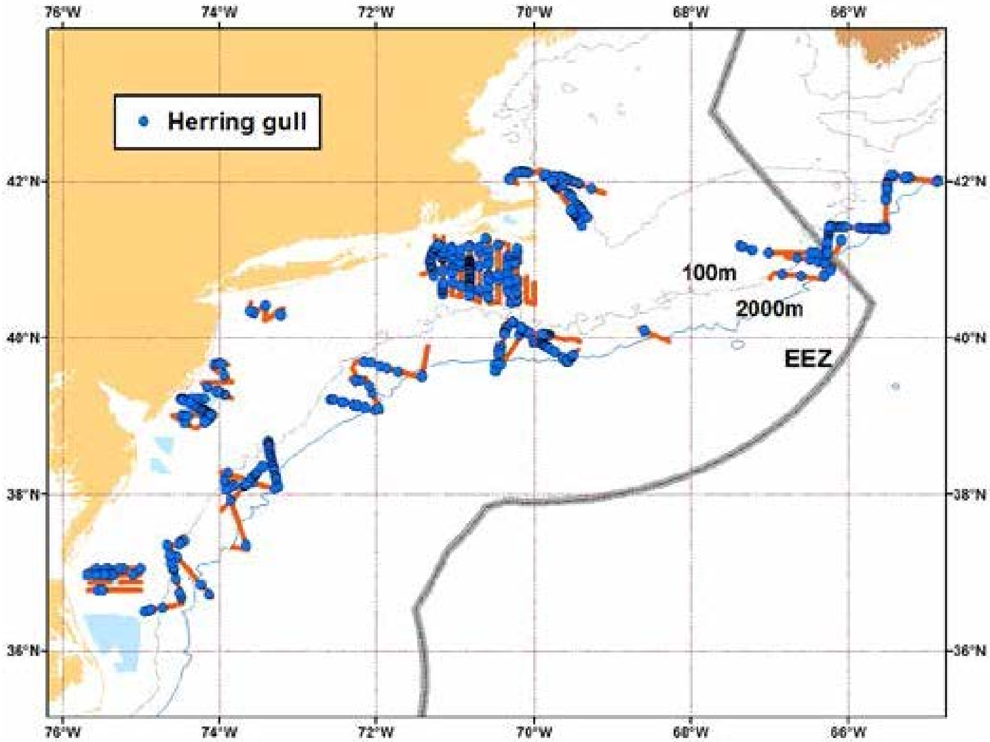


Figure C13. Location of Herring Gull (*Larus argentatus*; top) and Northern Gannet (*Morus bassanus*; bottom) sightings detected by the seabird team.



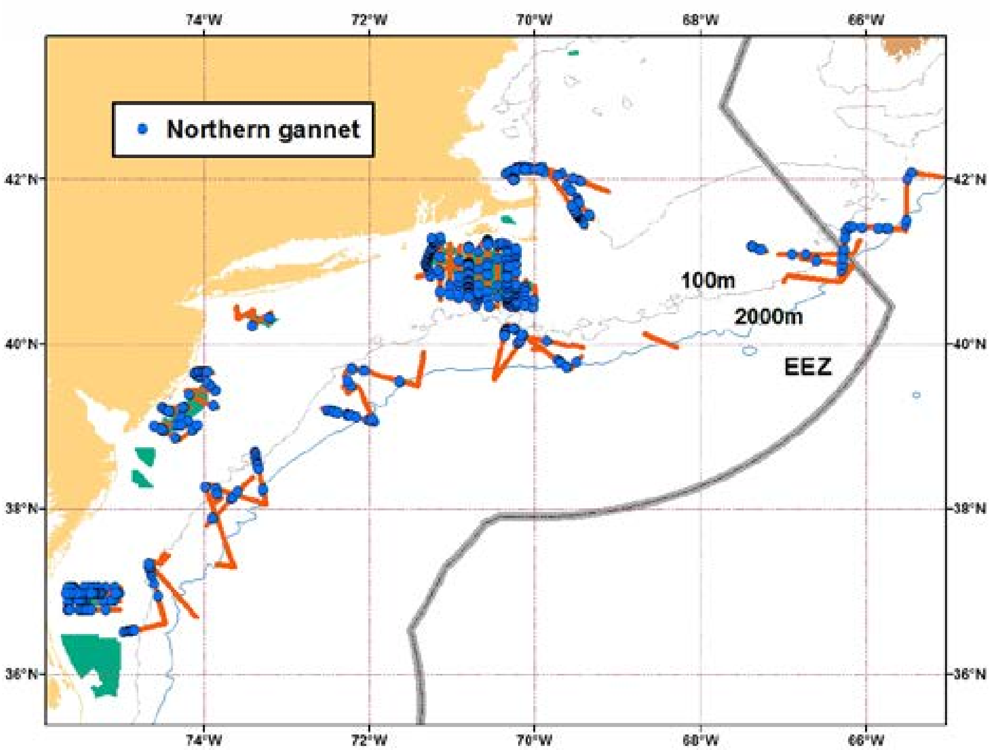


Figure C14. Location of Great Black-backed Gull (*Larus marinus*; top), and Northern Fulmar (*Fulmarus glacialis*; bottom) sightings detected by the seabird team.

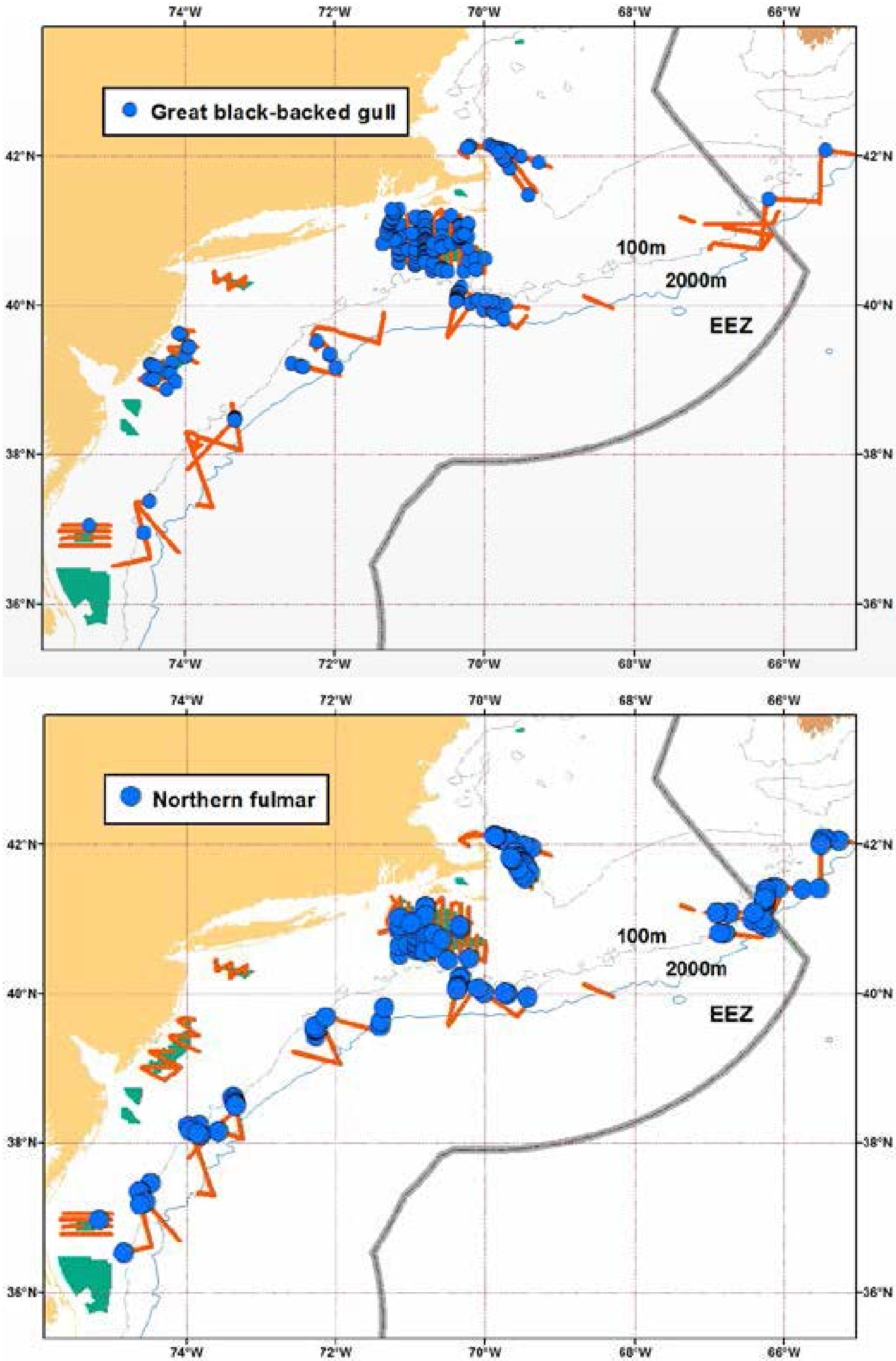


Figure C15. Location of Bonaparte's Gull (*Chroicocephalus philadelphia*; top), and Dovekie (*Alle alle*; bottom) sightings detected by the seabird team.

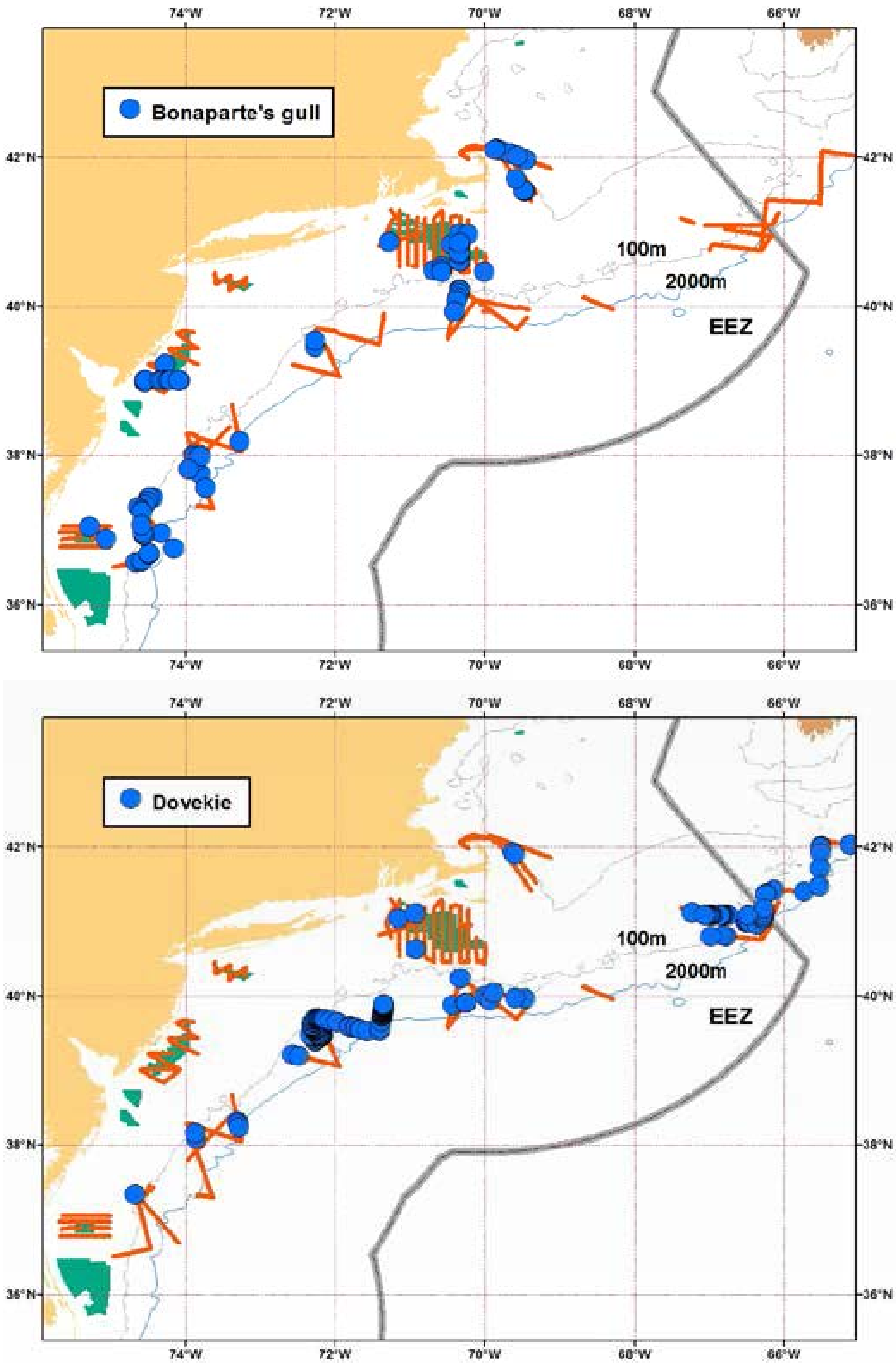


Figure C16. Location of Atlantic puffin (*Fratercula arctica*; top), and Red phalarope (*Phalaropus fulicarius*; bottom) sightings detected by the seabird team.

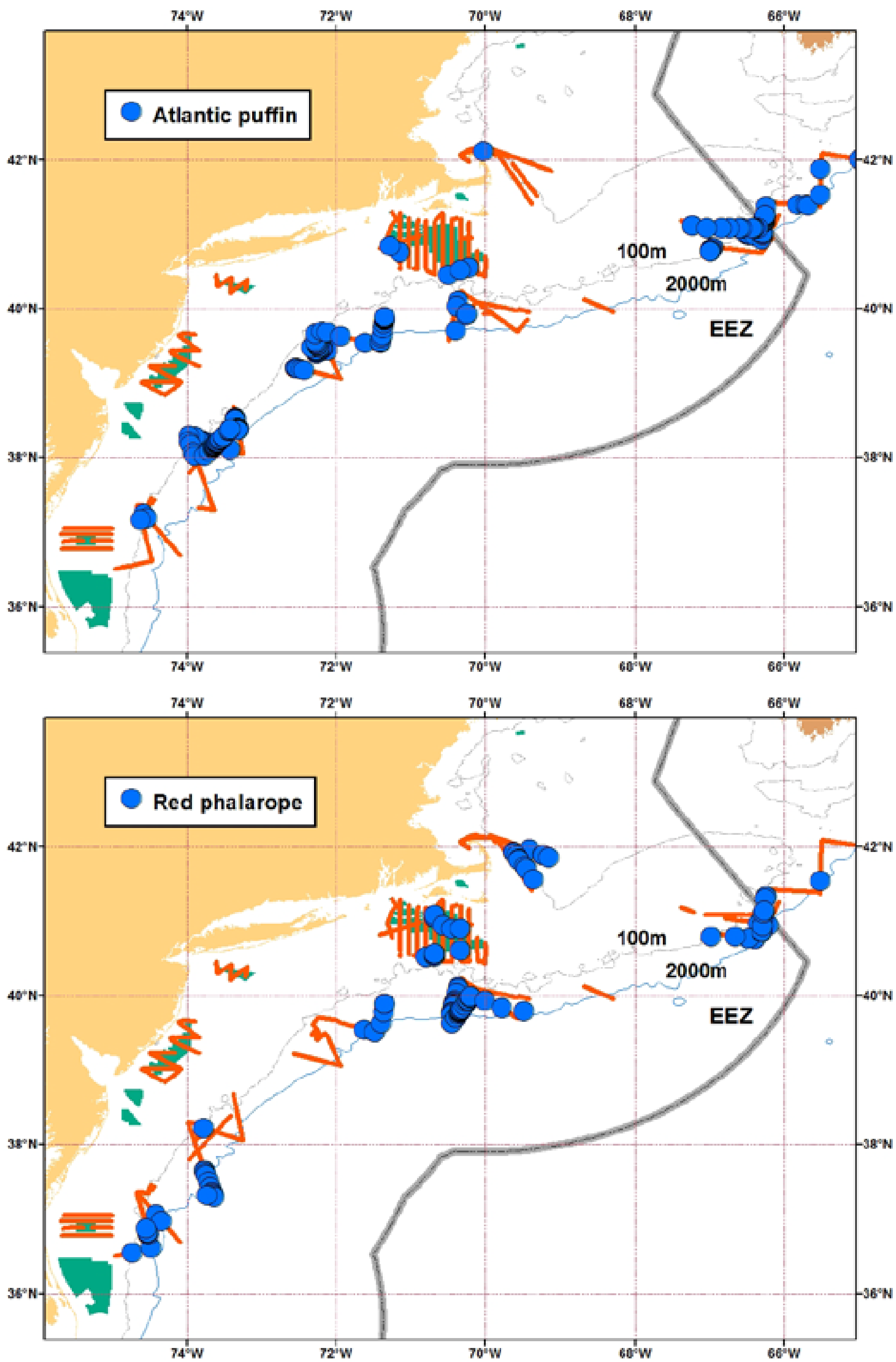


Figure C17. Location of various petrel and storm-petrel sightings (top) and shearwaters (bottom) detected by the seabird team.

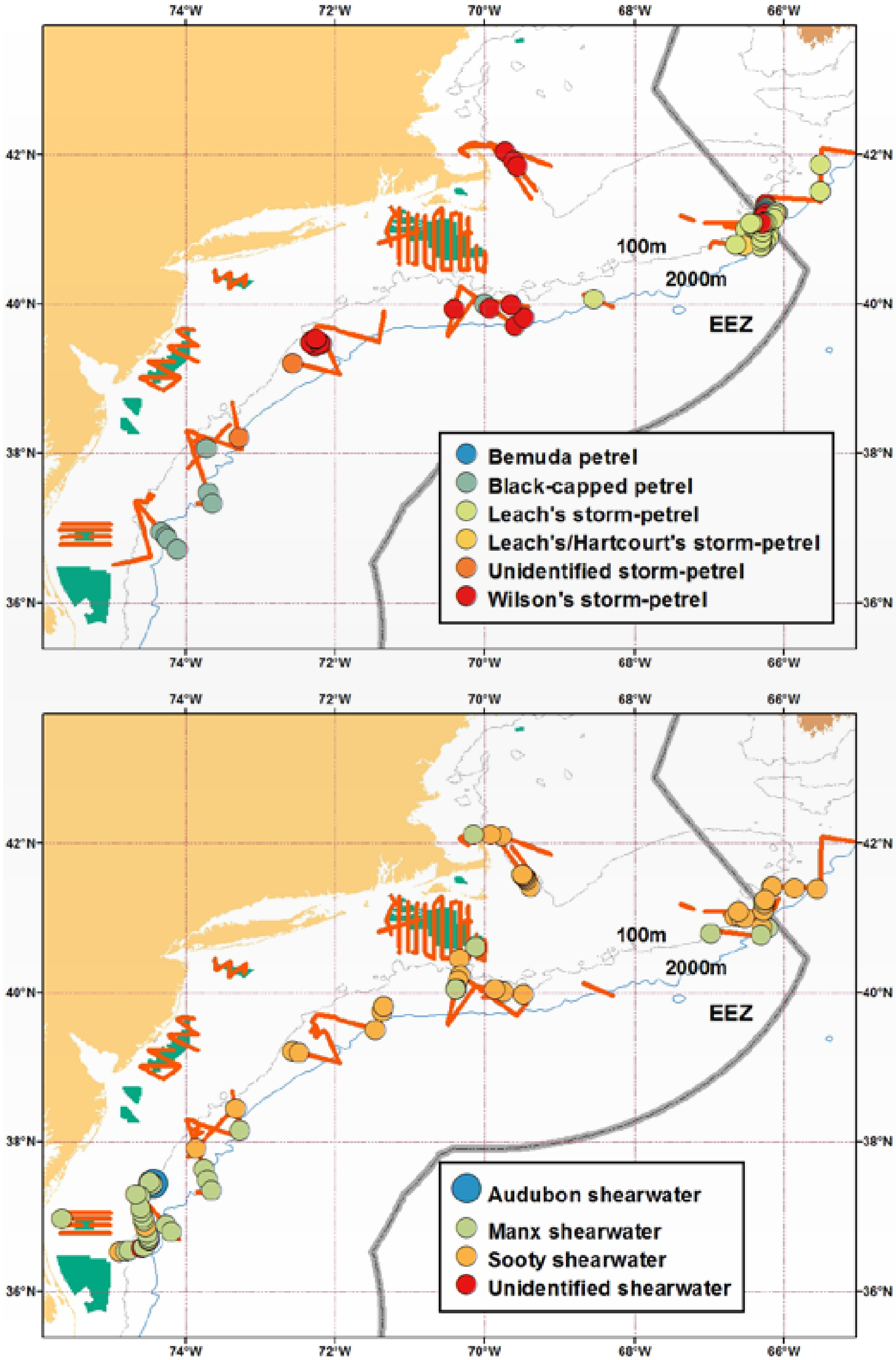


Figure C18. Location of petrel and jaeger sightings (top), and various shore bird (bottom) sightings detected by the seabird team.

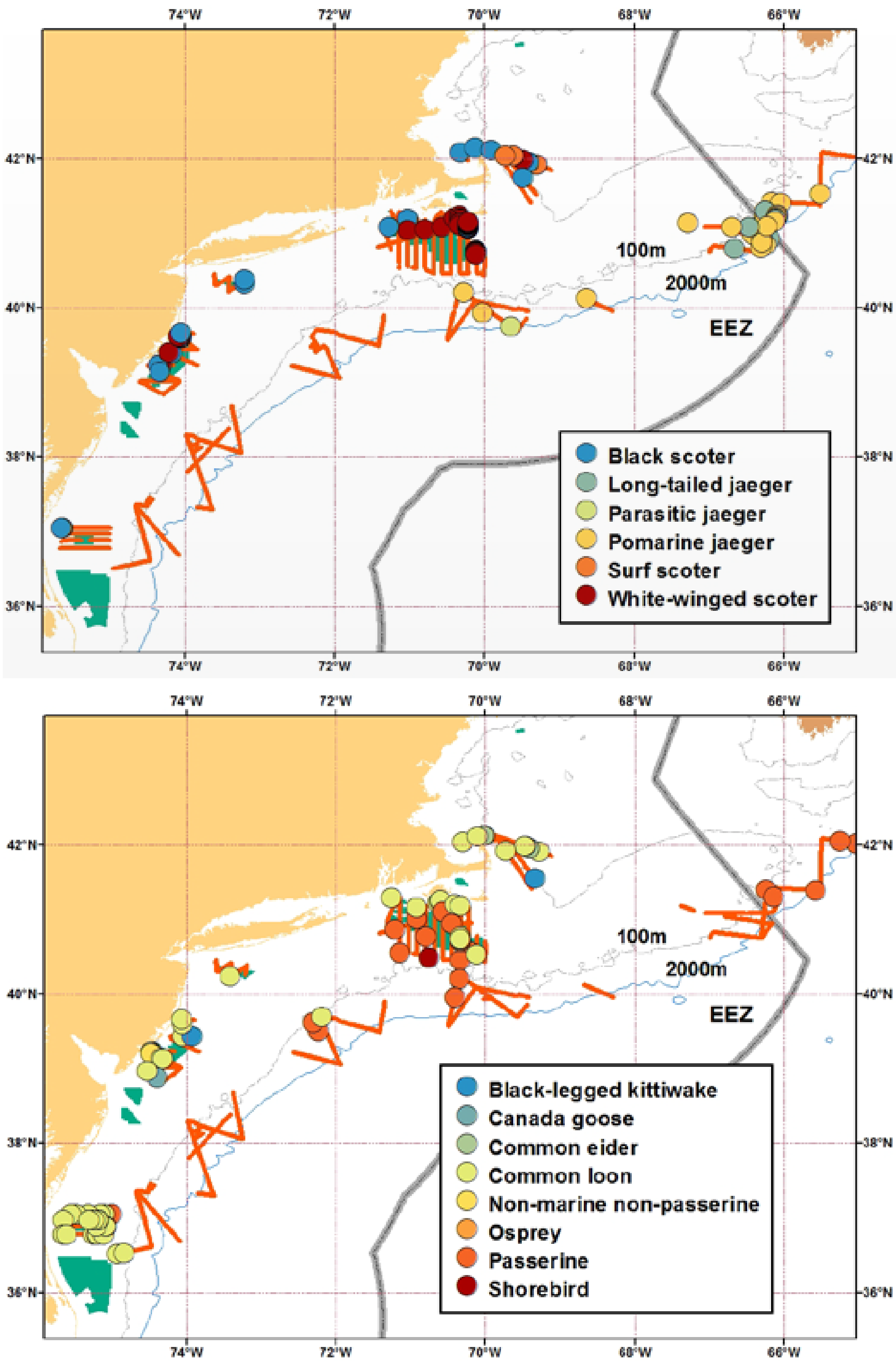


Figure C19. Acoustic recording effort. Pink lines indicate trackline coverage when the hydrophone array was deployed and acoustic data were collected. Green lines indicate tracklines where the hydrophone array was not deployed due to the shallow water depth.

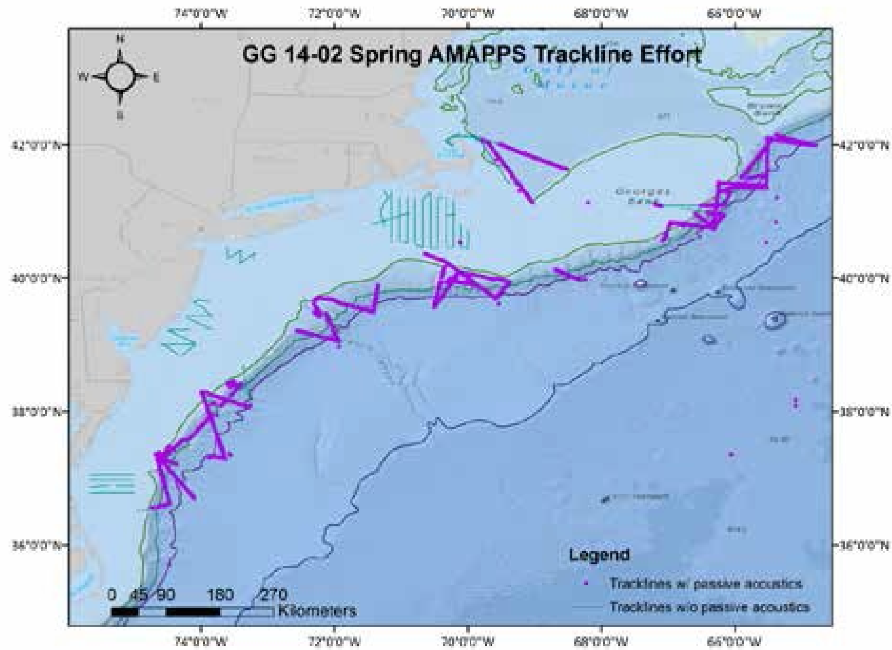


Figure C20. Acoustic detection of sperm whales. Pink lines indicated recording effort; green squares indicate the locations of sperm whales that were acoustically detected in real-time.

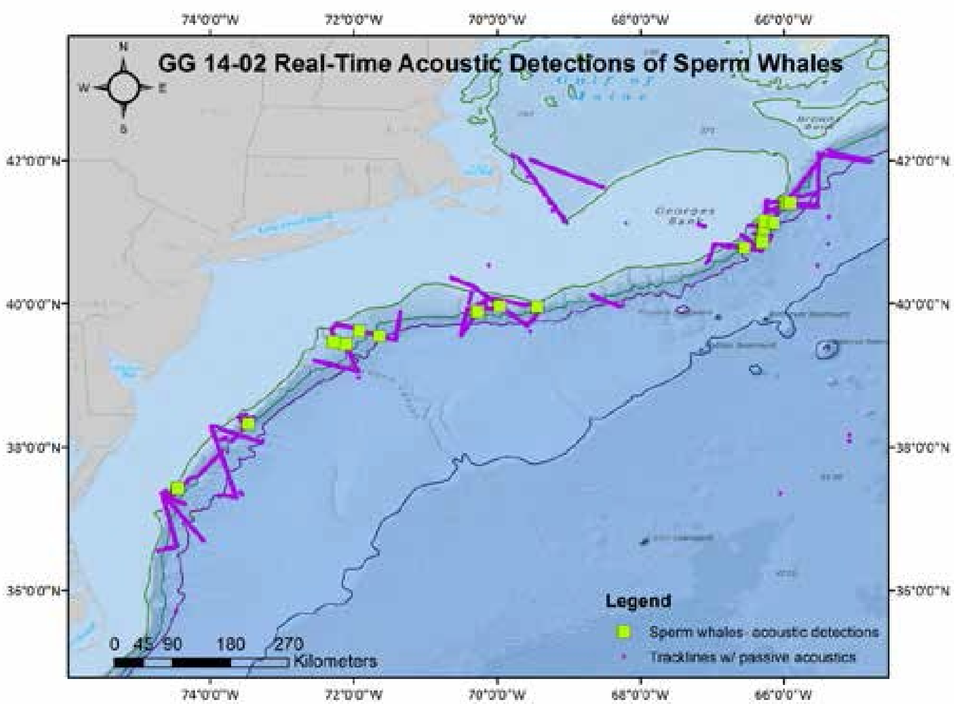


Figure C21. Overall view of the locations of the deployment of CTDs, bongos, visual plankton recorders (VPR), Isaac's-Kidd mid-water trawls (IKMT), and the MOCNESS.

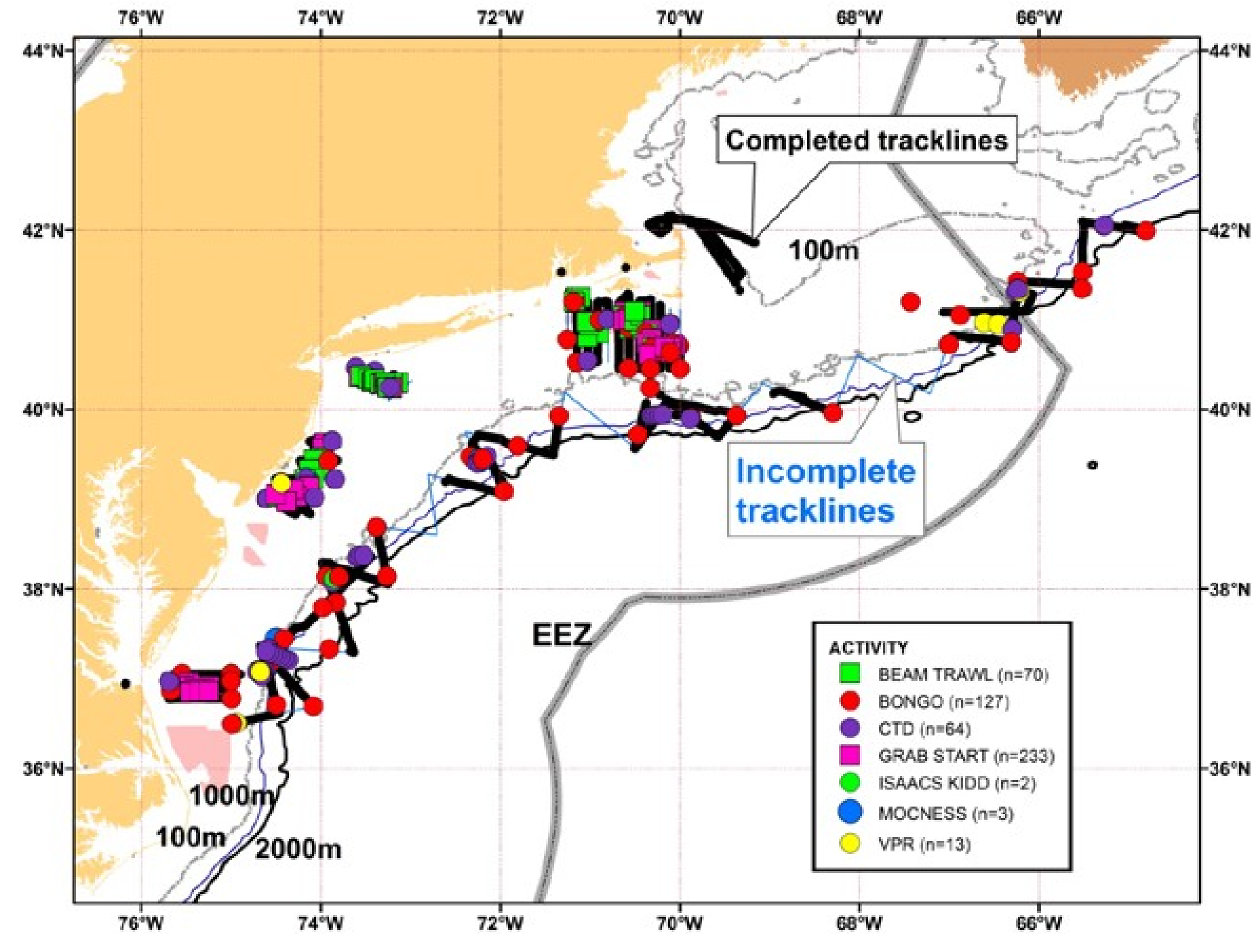


Figure C22. Oceanography from the VPR cross break transect from the southern flank of Georges Bank.

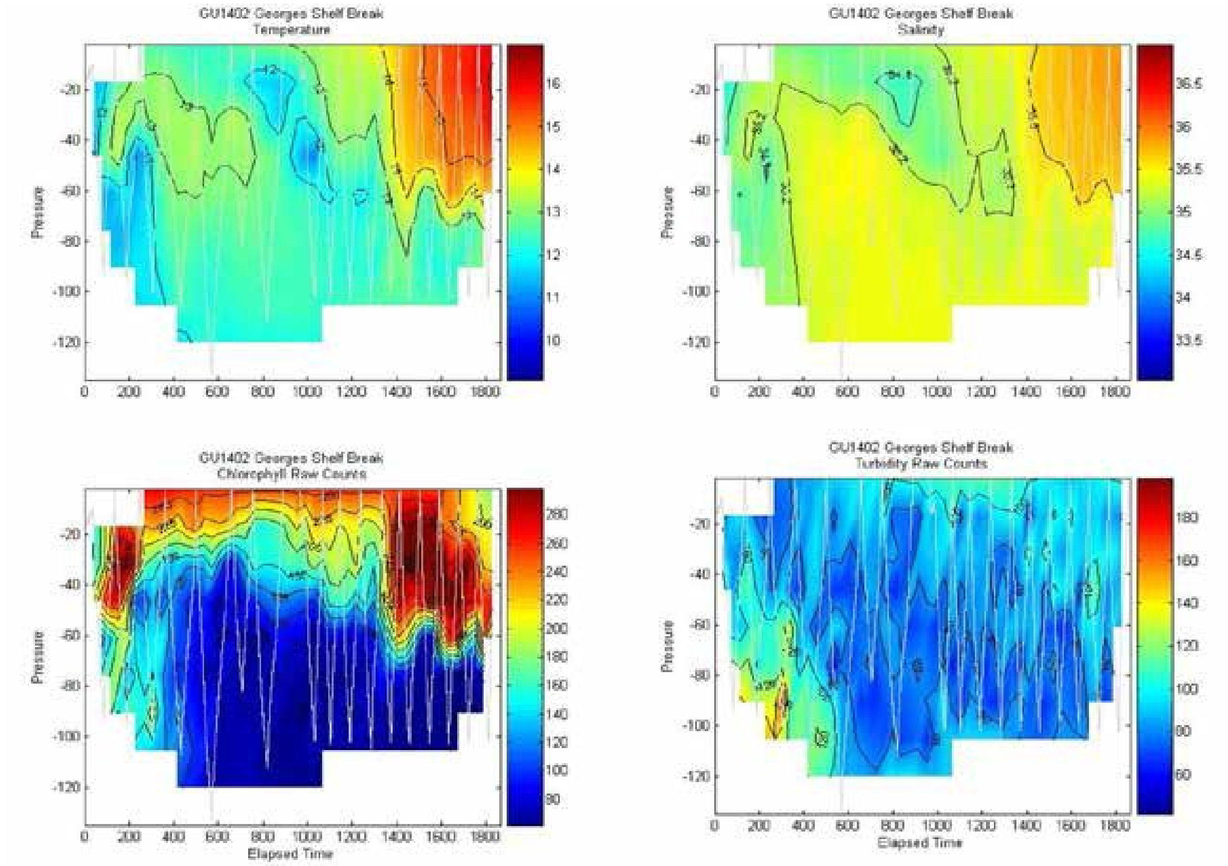


Figure C23. VPR marine snow images from Hudson Canyon with a background of centric diatoms (A) and marine snow from the Mid Atlantic bight with a background of chain diatoms (B). This phytoplankton was not enumerated by the VPR image processing software but was indicated in the chlorophyll values.

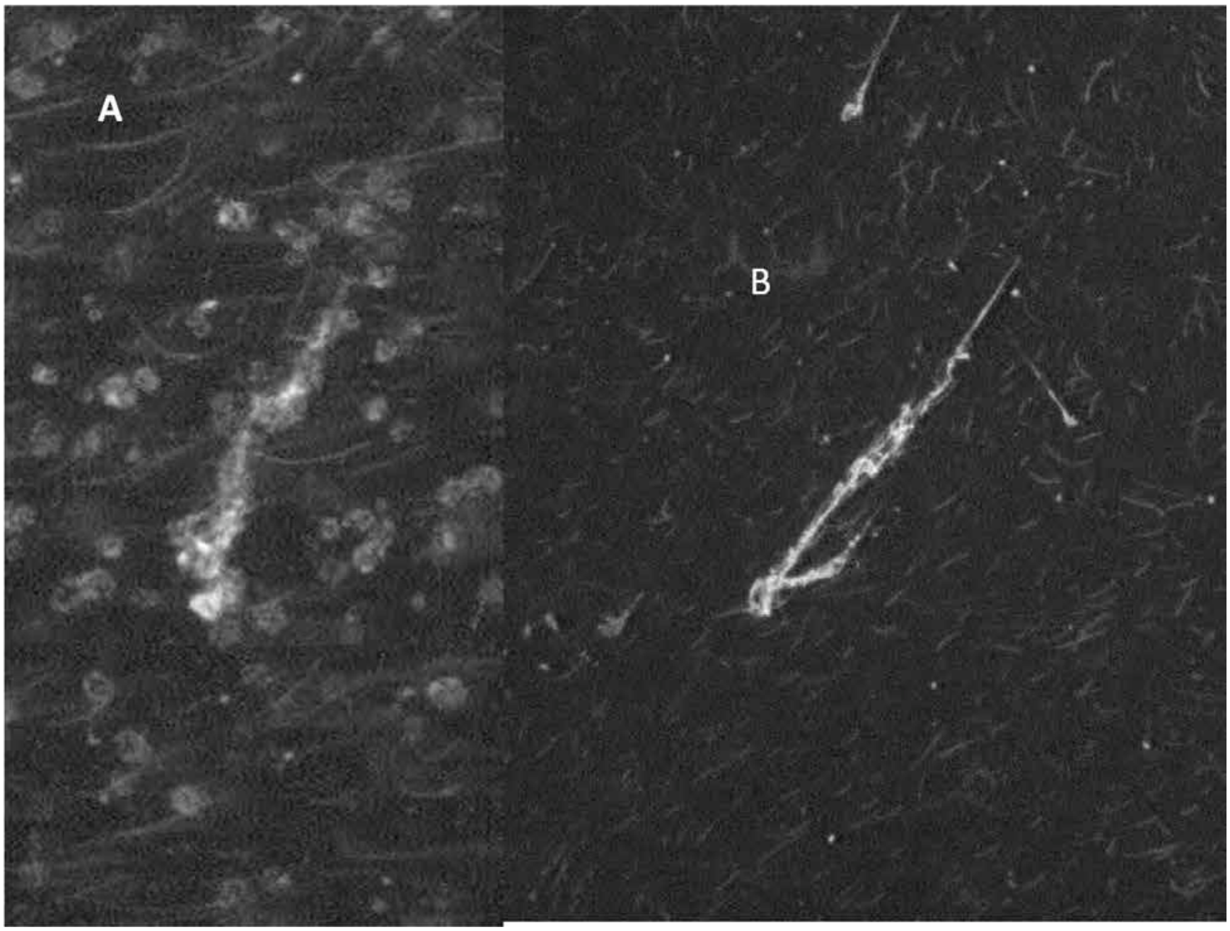


Figure C24. Marine snow from the Georges Bank shelf break transect (A) showing a gravid copepoda (B) and Corsair Canyon showing both marine snow (D) and marine snow combined with larvacean feeding nets (C).

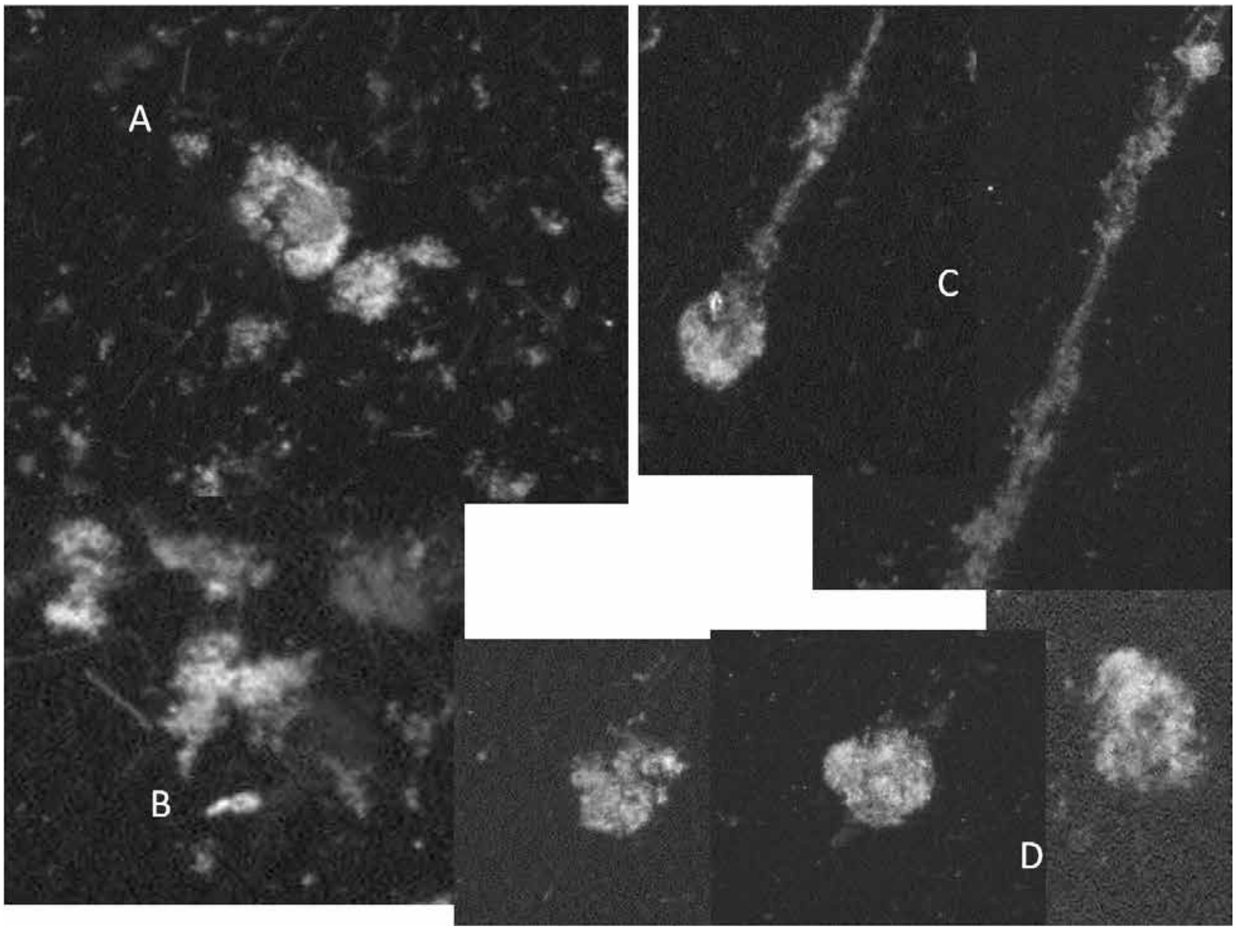


Figure C25. Transect from Corsair Canyon starting with a transect across the mouth of the canyon from SW to NE and continuing to a mid canyon transect from NE to SW.

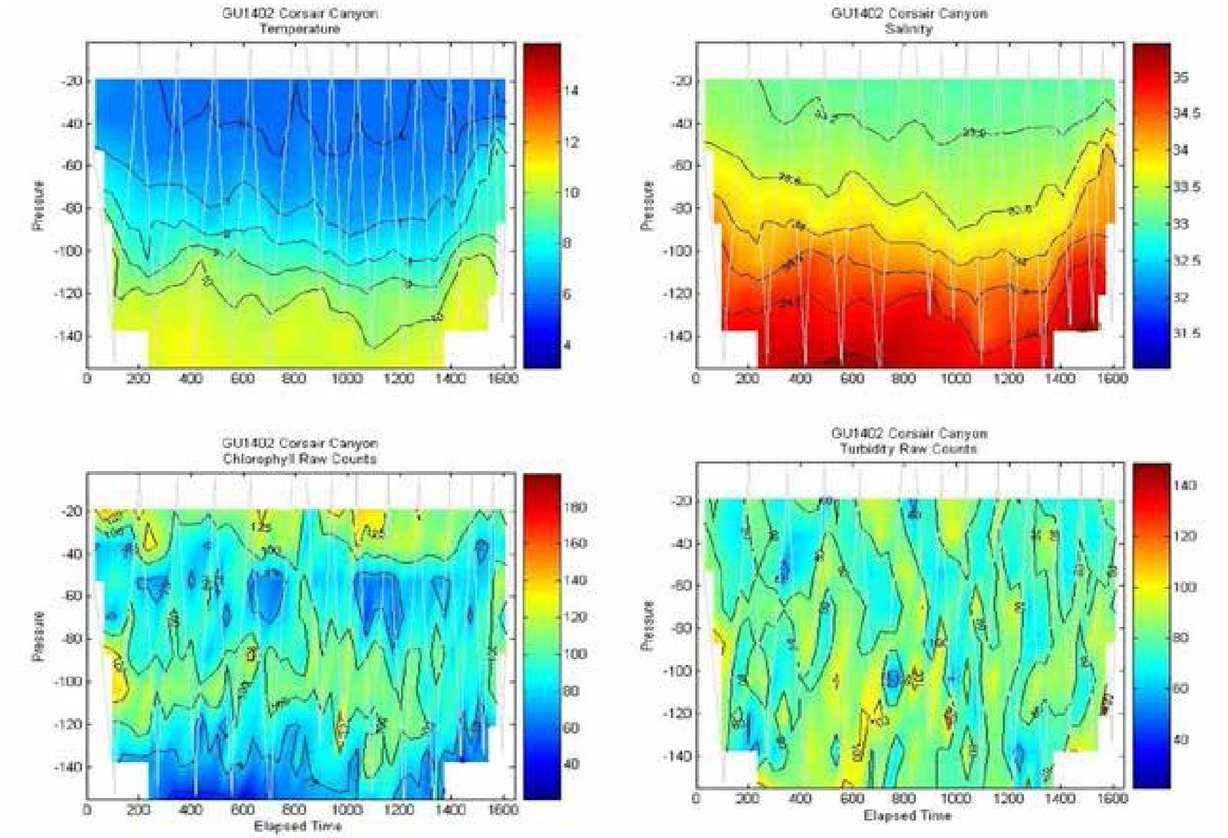


Figure C26. Locations of the completed BOEM WEA benthic stations.

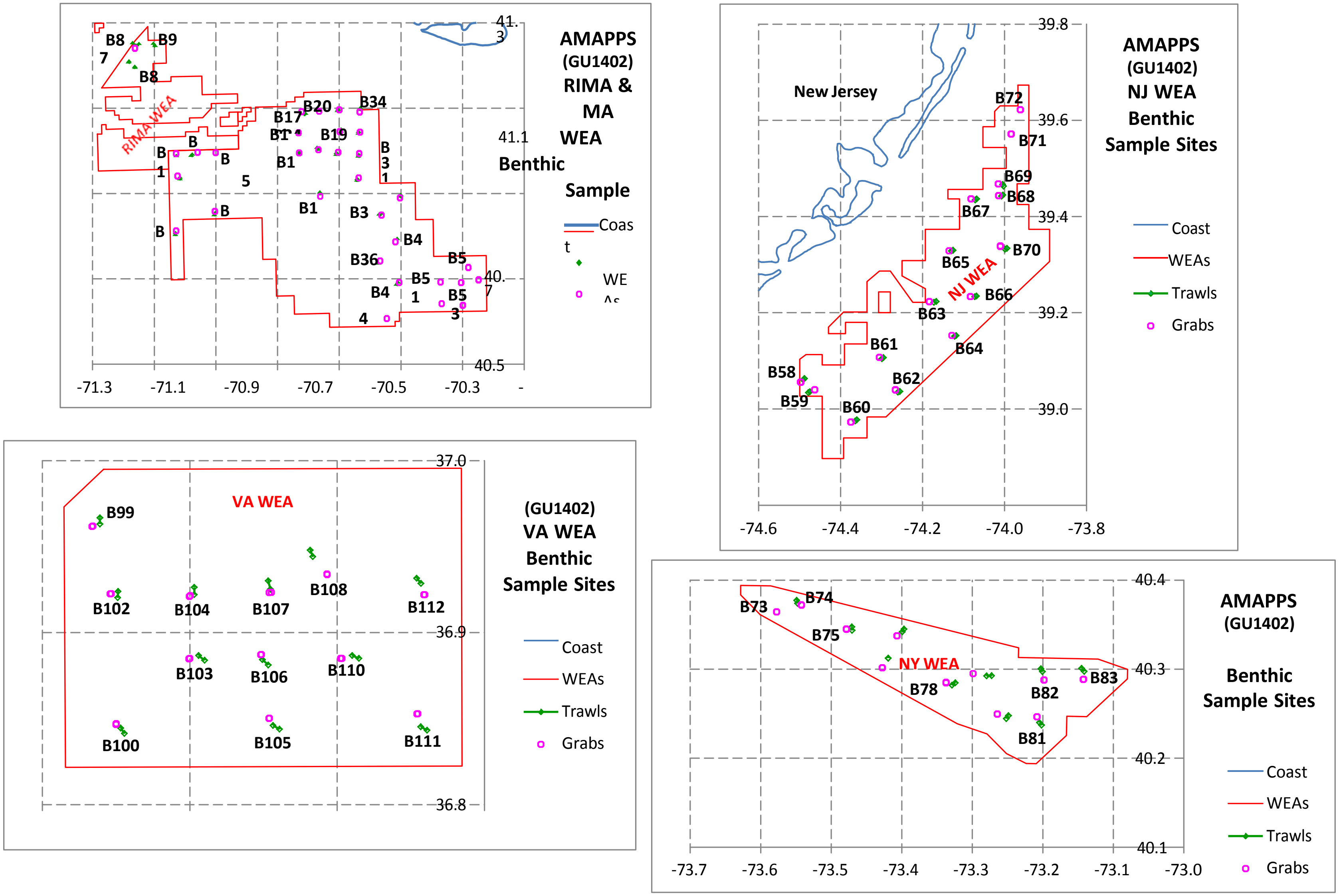


Figure C27. Sediment Grain Size Classification Summary. Folk classes: mS – muddy sand (5-30% mud); S – sand; (g)S – slightly gravelly sand (0.01 – 5% gravel); gS – gravelly sand (5-30% gravel