CRUISE REPORT

NOAA Ship *Gordon Gunter* Cruise GU17-03

July – August 2017

GoMMAPPS Summer 2017 Research Cruise

U.S Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
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January 2018

As part of the Gulf of Mexico Marine Assessment Program for Protected Species (GoMMAPPS), the Southeast Fisheries Science Center (SEFSC) conducted shipboard surveys of the oceanic waters (>100 m) of the Gulf out to the U.S. Exclusive Economic Zone (EEZ). The survey was conducted between 2 July and 25 August 2017 onboard the NOAA Ship *Gordon Gunter* along prescribed tracklines in a "double saw-tooth" configuration (Figure 1). A total of 7,480 km of survey effort were planned. Tracklines were spaced at 120 km and oriented to be perpendicular to bathymetry (Figure 1).

The cruise was segmented into three legs of approximately 16 days in duration as follows:

Date	Location	Days at Sea
DEP: 2 Jul 2017	Key West, FL	16
ARR: 17 Jul 2017	Pascagoula, MS	
DEP: 21 Jul 2017	Pascagoula, MS	16
ARR: 05 Aug 2016	Pascagoula, MS	
DEP: 09 Aug 2016	Pascagoula, MS	17
ARR: 25 Aug 2017	Pascagoula, MS	

Due to a funding/contracting issue, a return to Key West on July 4th was needed to pick up a contractor. The manner in which we executed our first two operational survey days allowed us to do so with minimal impact to the survey. Survey participants are listed in Table 1 and daily survey operations are summarized in Table 2.

Overall, the main goal of this cruise was to collect data on the distribution and abundance of marine mammals using visual survey teams and passive acoustic detections. Twenty-one species of cetaceans are known to routinely inhabit the U.S. waters of the Gulf of Mexico (GOM). In the continental shelf waters (20 m to 200 m), the most common cetacean species are bottlenose and Atlantic spotted dolphins. Though other species of baleen whales are occasionally sighted, Bryde's whales are the only baleen whale resident to the GOM and are most readily found in a small strip of water in the northeastern GOM, from De Soto Canyon southward along the continental slope, usually between depths of 180 m and 360 m. Oceanic waters (>200 m) are inhabited by 20 species that include sperm whales, dwarf and pygmy sperm whales, beaked whales, and large (e.g., killer whales, short-finned pilot whales, Risso's dolphins) and small (e.g., pantropical spotted dolphins) delphinids.

Cruise objectives

The specific objectives of this survey were to:

1. Conduct a dual-team visual line transect survey to estimate the abundance and spatial distribution of cetacean stocks in U.S. Gulf of Mexico waters

2. Conduct passive acoustic surveys simultaneous with visual surveys to provide supplemental information on cetacean abundance and spatial distribution
3. Collect tissue samples for genetic and other analyses from select cetacean encounters
4. Collect data on the distribution and abundance of seabirds and other marine life
5. Collect plankton samples at night using towed sampling equipment
6. Periodically collect oceanographic and environmental data utilizing scientific echosounders (EK60) to quantify acoustic backscatter from small fish and zooplankton
7. Collect vertical profiles of hydrographic parameters (e.g., temperature, salinity, oxygen concentration) using CTD and XBTs
8. Recover and redeploy autonomous acoustic moorings

Visual Survey Operations

During the survey, the independent observer approach with Distance sampling was implemented to estimate the detection probabilities for marine mammal sightings. This method used two teams of visual marine mammal observers that operate independently of one another and was similarly employed during other SEFSC surveys in 2004, 2011, 2013, and 2016. Marine mammal sightings were defined as systematic records of cetaceans consisting of one or more individuals observed at the same location and time.

During the independent observer approach, one survey team was stationed on the vessel's flying bridge with a height above water of 13.9 m. The second team was stationed on the bridge deck and was located on the bridge wings, observing from a lower vantage point of 11.2 m above water. Both visual survey teams utilized pedestal mounted, 25x150 mm "bigeye" binoculars located on the port and starboard sides of the ship. A centralized data recorder was located inside the ship's chemistry laboratory and communicated with both teams via discreet VHF channels. Using the bigeye binoculars, observers relayed the bearing and radial distance of sightings to the data recorder. The location of groups sighted close to the ship without bigeye binoculars were estimated in degrees and meters.

Visual survey effort commenced daily at approximately 0700 and ended at 1900 (EDT for leg 1 and CDT for legs 2 and 3) depending on operational requirements and survey conditions. Survey speed was typically 18 km hr^{-1} (10 kt) but varied with ship traffic and sea conditions such as ocean currents. Data were recorded by the centralized data recorder using a custom written visual data acquisition program (VisSurvey) installed on a networked laptop.

Observers were considered "on effort" whenever the ship was on a prescribed trackline or transit line, at survey speed, and the visual team was actively searching for cetaceans through the bigeyes. Whenever an observer suspected or had in fact seen a marine mammal, a cue (marine mammal, splash, blow, etc.) was immediately entered in the data program and the team went "off effort." A cue is a time and location stamp in the database which captures the spatial and temporal data of a sighting. This survey was conducted in "passing mode" whereby the ship maintains a steady course and speed while the visual teams identify the sighting to species level if possible and count the number of individuals in a sighting. Under certain circumstances, a "closing mode" technique was employed. Closing mode entails maneuvering the ship to more closely approach a sighting. This survey mode was used sparingly and was

restricted to sightings of special interest, including killer whales and Bryde's whales, as determined by the Field Party Chief (FPC). After sightings were identified to the lowest taxonomic level possible and group size enumerated, the encounter was closed and the sighting was entered in the visual data program by the data recorder. Group size estimates were recorded independently for each observer. Observers were instructed to only enter values for sightings they observed entirely. Group size was counted as the minimum, maximum, and best number of animals for each sighting.

Observers were considered to be off effort whenever the ship was maneuvering and turning onto a new trackline, if other operations were taking place (e.g., safety drills, small boat deployment, biopsying, etc.), during bad weather (rain, sea state >6, poor visibility due to fog, lightning within 4 nm), and whenever not actively searching for cetaceans through the bigeyes (naked-eye observations were included as off effort). Sightings observed under such conditions were recorded as off effort. Off-effort sightings may also have included sightings detected by non-mammal observers, mammal observers off duty, or other crew (including ship's crew).

For each encounter, time, position, bearing and reticle, species, group size, behavior, bottom depth, sea surface temperature, and associated animals (e.g., seabirds, fish) were recorded. An attempt was made to photograph animals that closely approached the ship.

Basic survey parameters were automatically recorded by the survey program every minute and include the ship's position, heading, effort status, observer positions, and environmental conditions (e.g., wind speed, sea surface temp, etc.). At the start of the survey day and at 20-minutes time intervals thereafter, the survey program prompts observers for an update of the subjective environmental variables (e.g., glare, sea state, cloud cover, etc.) and sighting conditions.

Visual Survey Results

During this cruise, 7,302.1 km of trackline were visually surveyed on effort (Table 2, Figure 1). Sighting conditions were fair to good throughout most of the survey, with sea states of 2-4 on most survey days (Figure 2). There were 338 marine mammal sightings from 12 confirmed species during the survey, not including unidentified taxa (Table 3). A diverse suite of oceanic dolphin and small whale species were encountered including pantropical spotted dolphins (*Stenella attenuata*), Risso's dolphins (*Grampus griseus*), pygmy/dwarf sperm whales (*Kogia* sp.), beaked whales (Unid. Ziphiids and Mesoplodonts), and pilot whales (*Globicephala* sp.; Table 3, Figures 3 and 5). Continental shelf species included common bottlenose dolphins (*Tursiops truncatus*) and Atlantic spotted dolphins (*Stenella frontalis;* Figure 3). There were a total of 69 sperm whale (*Physeter macrocephalus*) sightings (Figure 4). During this cruise, sperm whale sightings were entered as soon as the observer finished counting individuals seen at the location of the cue, as opposed to spending approximately 10 minutes counting animals that may surface after the initial cue detection as had been done in previous SEFSC surveys. Therefore, sperm whale group size estimates and group definitions are likely not comparable between this survey and previous studies in the Gulf of Mexico. These differences will be accounted for when estimating abundance.

Notable sightings included a single Bryde's whale (*Balaenoptera edeni*) sighted in the western GOM. Though there are a few sightings of either Bryde's or Sei whales reported in the western GOM during the 1990's, there has not been a verified sighting of Bryde's whales in the

western GOM (Figure 4). Given the importance of the single verified Bryde's whale sighting in the western GOM, dedicated fine-scale tracklines were surveyed on 20 August in an attempt to increase effort in the area (Figure 1); however, no additional sightings were recorded. Another notable sighting was a group of killer whales (*Orcinus orca*) (Figure 5), in which photographs of certain individuals were matched to photo-identification records from previous sightings in the GOM in 2001 (SEFSC unpublished data).

Marine mammal biopsy sampling

Biopsy operations during this survey were limited to sightings of special interest as determined by the FPC. Tissue samples were collected from the small boat with a crossbow fitted with a custom designed sampling dart and head to extract a small core of skin and blubber. All sampling was conducted by personnel with training and experience to collect biopsy samples from wild cetaceans and as authorized by the MMPA permit. Two biopsy samples were collected during this cruise, both from Bryde's whales (Figure 4). They were subsampled for future analyses including genetics (skin stored in DMSO), stable isotopes (skin frozen at -80°C), and contaminants (blubber frozen at -80°C).

Passive Acoustic Survey

Towed Array

Passive acoustic surveys were conducted concurrent with visual surveys using a towed array during daylight hours when environmental conditions allowed. Passive acoustic surveys were suspended during portions of the tracklines that occurred in water depths shallower than 75 m and during nearby lightning storms. Passive acoustic monitoring for odontocetes was conducted using a modular towed hydrophone array deployed approximately 300 m behind the ship and initially weighted with 15 lbs lead wire. Hydrophone depth varied depending on survey speed, ship turns, and current. The hydrophone array towed at 9 ± 1.5 m depth at standard survey speed of 10 kts for the entire first leg of the cruise. Prior to the second leg, an additional 15 lbs of lead wire weight were added to the array cable, bringing the average tow depth to 12 ± 1.3 m for the second and third legs.

The custom-built modular towed hydrophone array was deployed in one of two configurations: 1) as only a five-element mixed-frequency oil-filled end array or 2) as a combination of a 4-element mid-frequency oil-filled inline array, 30 m mid-line cable, and the five-element end array (Rankin *et al.* 2013). The five-element end array included paired pre-amplifier and hydrophone elements capable of recording a broad range of frequencies. Sensors 1, 3, and 5 were optimized for greater detection ranges for mid-frequency recordings by using APC International 42-1021 hydrophones with custom-built pre-amplifiers. The APC 42-1021 hydrophones have a -212 dB re V/uPa sensitivity with a flat frequency response (+/- 4 dB) from 1 to 45 kHz. The corresponding pre-amplifiers provided a highpass filter with 45 dB gain above 5 kHz. Sensors 2 and 4 were optimized for recording the full bandwidth of high-frequency echolocation signals by using Reson TC4013 hydrophones with custom-built pre-amplifiers. The TC4013 hydrophones have a -212 dB re V/uPa sensitivity with a flat frequency response (+/- 2 dB) from 5 to 160 kHz. The corresponding pre-amplifiers provide a high-pass filter with 50 dB gain above 5 kHz. The 4-element inline array included the same APC 42-1021 hydrophones and custom built pre-amplifiers as used in the end array. Additionally, a Keller 7SE pressure sensor

was incorporated ahead of the hydrophones in the end array, and data were digitized using a Measurement Computing USB-1208LS A/D converter and recorded in the software program Pamguard (v.1.15.03; Gillespie *et al.* 2008). However, on August 15, 2017, the pressure sensor malfunctioned and depth data were not collected for the remaining 10 days of the cruise.

During the period from July 2 to July 11, the five-element end array was deployed. Data from sensors 1, 2, 4, and 5 were digitized for recording with a custom 12 channel SailDAQ soundcard (www.sa-instrumentation.com, accessed Jan. 12, 2018) sampling 16 bits at 500 kHz, yielding a recording bandwidth of 1-250 kHz. SailDAQ output from sensors 1 and 5 were then routed through a custom Magrec amplifier and Mark of the Unicorn (MOTU) Traveler mk3 audio interface for real-time aural monitoring. During the period from July 12 to July 28 at 12:49 UTC, the combined inline and end arrays were deployed. Data from sensors 1 and 4 on this array were digitized for recording with the SailDAQ soundcard sampling 16 bits at 500 kHz along with the 4 previously described channels from the end array. From July 12 to July 22, data from sensors 1 and 4 on the inline array and data from sensors 5, 6, 8, and 9 (previously denoted 1, 2, 4, and 5) of the end array were digitized and sensors 5 and 9 were aurally monitored. However, there appeared to be a short in the circuit for sensor 6 when the inline array and midline cable were included and recordings of this hydrophone were not good. From July 23 to July 28 at 12:49 UTC, only sensors 1, 4, 5, 8, and 9 were recorded. On July 28, a leak occurred in the connector between the inline array and the midline cable and these components were removed. During the period from July 28 at 13:34 UTC to the end of the cruise, only the five-element end array was deployed, in the same configuration as described for data collection from July 2 to July 11.

Acoustic signals were monitored by a team of two acoustic technicians who rotated through a primary and on-call secondary position every 1 to 2.5 hours while the array was deployed. Pamguard was used to control the SailDAQ, to record acoustic data and metadata to hard-disk, and for real-time monitoring including logging effort and encounter details and obtaining bearings to acoustic detections. All acoustic data were continuously recorded as four minute, multi-channel wav files to 2 TB external SATA hard drives. Acoustic field technicians continuously monitored data aurally and visually through spectrographic analysis using both Pamguard and Ishmael (Mellinger 2001) software and detected and localized acoustically-active odontocetes in real-time using Pamguard's automated click detectors, hyperbolic bearing calculator, and manual target motion analyses as well as Ishmael's hyperbolic bearing calculator for manually-selected whistles. Acoustic localizations were mapped and compared with visual sighting locations using a custom-written acoustic version of VisSurvey. The acoustic VisSurvey version is capable of receiving and plotting visual sighting information along with acoustic bearings and localizations to improve correlation of acoustic and visual detections in real-time. Metadata describing acoustic encounters included individual click detections with corresponding time, localization, and localization quality information.

Sonobuoys

Directional sonobuoys were used for acoustic detection, localization, and recording of low-frequency sounds produced by baleen whales which are too low in frequency to be detected by the towed array system. Sonobuoys were deployed during daylight hours concurrent with visual surveys. The sonobuoy deployment strategy was to 1) deploy a single

sonobuoy at predetermined stations where the trackline intersected the 250 m isobath and 2) opportunistically deploy at least two sonobuoys spaced 5 km apart within 2 km of all visually-sighted baleen whales.

The expendable Directional Frequency Analysis and Ranging (DIFAR) sonobuoys contain a compass in the sensor head and transmit three types of continuous signals back to the ship on a VHF radio carrier in an analog multiplexed format. The three signals are acoustic sound pressure, east/west particle velocity, and north/south particle velocity. The acoustic signal frequency range is approximately 10 Hz to 4,000 Hz, which is well suited for large whale vocalizations that have their greatest sound energy concentrated below 1,000 Hz. Prior to deployment, all sonobuoys were programmed for DIFAR mode, a hydrophone depth of 122 m, and a broadcast duration of 8 hours. The VHF radio signals transmitted by the sonobuoys were received by two omni-directional antennas (Diamond X30 144 MHz [primary] and MORAD Custom 168 MHz [backup]) mounted on the aft mast of the ship at 26 m above the waterline. The signal gain from the 144 MHz and 168 MHz antennas was enhanced by Advanced Receiver Research custom 140-144 MHz and P160VDG 160-170 MHz preamplifiers and DC injectors, respectively. The radio reception ranges from the sonobuoys (indicated by the presence of the DIFAR pilot tones at 7.5 and 15 kHz) reached up to 40 km, though signal quality typically began to deteriorate at approximately 20-25 km. When the ship was running at survey speed (approximately 10 kts) each sonobuoy could be received and recorded for one to two hours before the ship moved out of radio reception range; however, sonobuoy sites were often located near transect turns and could be received for over two hours in these cases.
The amplified sonobuoy signals were split in the lab and received on up to three WinRadios (G39WSBe), each tuned to the broadcast frequency programmed for one of the deployed sonobuoys. Analog signals from the three WinRadios were digitized with an RME Fireface UC audio interface sampling 16 bits at 48 kHz. Using Pamguard (Gillespie *et al.* 2008) v1.15.08 software with a custom DIFAR demultiplexing module (Miller *et al.* 2015), digitized acoustic data were recorded directly to computer hard drives as 1 or 2 channel, 48 kHz wav files and were stored on 2 TB SATA disks housed in an external RAID enclosure. Additionally, Pamguard DIFAR and Logger modules were used to record sonobuoy deployment locations, ship trackline from GPS, recording effort, and metadata logs. The two acoustic field technicians only cursorily monitored the recordings for data quality and received radio signal strength while focusing their effort on towed array monitoring.

Passive Acoustics Results

During the survey, over 481 hours of acoustic data were recorded with the towed array yielding over 6.74 TB of data and 545 cetacean detections (Table 2, Figure 6). During real-time monitoring, acoustic detections were broadly categorized as Risso's dolphin clicks, sperm whale clicks, dwarf/pygmy sperm whale clicks, unidentified Ziphiid clicks, unidentified delphinid vocalizations (whistles and clicks), or unidentified odontocetes (clicks only; Table 4, Figure 6). Preliminary acoustic detections include 11 Risso's dolphin encounters, 131 sperm whale encounters, 4 dwarf/pygmy sperm whale encounters, and 28 unidentified beaked whale encounters. Sperm whale encounters may represent either individuals or groups of individuals. Additional unidentified odontocete encounters may be identified as beaked whale encounters in post-processing. Unidentified acoustic detections of odontocetes were made throughout the

survey and were correlated with visual sightings when localization was possible. These recordings with visually-verified species identifications will be reanalyzed and verified in post processing to develop acoustic species classification algorithms for acoustic species identification. Acoustic data will also be used to improve estimates of sperm whale and beaked whale abundance.

Over the course of the survey, 33 sonobuoys were deployed (Table 2, Figure 7), yielding 133 hours of recordings. Of these sonobuoys, 28 were deployed at predetermined stations and five were deployed opportunistically. Two sets of stations were close enough to be recorded as pairs plus two of the opportunistic buoys were close enough to stations for paired recordings, yielding a total of four sonobuoy pairs that may allow call localizations. All deployed sonobuoys successfully broadcast radio signals; however, the first 8 do not have usable recordings due to recording system issues at the start of the cruise. Sonobuoy data were only sporadically monitored in real-time, yielding 2 probable Bryde's whale detections. Post-processing will include baleen whale call detection, and localization when possible.

Passive Acoustic Mooring

As part of Scripps Institution of Oceanography (SIO) researcher Dr. John Hildebrand's continuing efforts to document the long-term occurrence of acoustically active cetaceans in the northern Gulf of Mexico since 2010, two long-term passive acoustic monitoring buoys deployed along the shelf break (roughly 1,000-m isobath) of the West Florida Shelf were refurbished during this cruise. The High-frequency Acoustic Recording Packages (HARPs) were deployed to continuously record sounds up to 100 kHz for 11 months with the objective of documenting the presence of acoustically active sperm whales, Bryde's whales, beaked whales and dolphins. Two of SIO's five long-term HARPs, at the Dry Tortugas and De Soto Canyon sites, were recovered and redeployed during the first leg of the survey (Table 2, Figure 8). Additionally, a Low-frequency Acoustic Recording Package (LARP), deployed to continuously record sounds up to 1 kHz for one year as part of a collaborative SEFSC-SIO project to monitor Bryde's whales, was recovered during the third leg of the survey (Table 2, Figure 8).

Scientific Echosounder (EK60) Data Collection

EK60 data were collected only at night beginning at sunset and until the commencement of acoustic survey effort the following day. The backscatter data are stored on hard drives for archiving and further analysis. Unfortunately, a calibration of the EK60 was not possible during this cruise. Gulf of Mexico cetacean surveys conducted prior to 2017 collected EK60 data throughout both day and night; this may have impacted detectability of some species (e.g. beaked whales, striped dolphins) and should be considered when comparing data between current and historic datasets.

Environmental Data

Environmental data were collected at predetermined stations using a conductivity, temperature and depth sensor (CTD) unit and expendable bathythermographs (XBT). CTD casts recorded vertical profiles of salinity, temperature, and oxygen content to a maximum depth of 500 m. XBT profiles recorded temperature to a maximum depth of 760 m. Environmental data including water temperature, salinity, and weather conditions (e.g., wind speed, wind direction)

were continuously collected *in situ* via the ship's Scientific Computer System (SCS) and recorded in the visual marine mammal sighting database. CTD casts were made daily, typically at the end of the mammal survey day and at each plankton towing station as conditions allowed. Data were collected on a total of 133 CTD stations (Figure 9). XBT casts were made at regular intervals along the trackline throughout the cruise at stations typically spaced 15-20 km apart. A total of 225 XBT stations were sampled (Figure 9).

Plankton Sampling

Plankton samples were taken using a 90 cm bongo net, tows from the surface to 25 m depth. A mechanical flowmeter was affixed in each net to calculate the volume of water sampled. Stations were conducted during the evening, placed along the survey line completed by the daytime mammal observers. Samples from the right bongo net were kept, with the left net used as a duplicate and discarded if not needed. Samples were inspected live on board using a stereomicroscope, and taxa of interest were identified, measured, photographed, and preserved. Samples were preserved in 95% ethanol, which was refreshed after 24 hours.

From 136 plankton tows, approximately 2500 larval fish were sorted on board and preserved, including the following taxa: snapper (Lutjanidae), grouper (Serranidae), billfish (Istiophoridae, Xiphiidae), tuna (Scombridae), and lionfish (*Pterois* spp.). Eleven larvae were visually identified as Atlantic bluefin tuna (*Thunnus thynnus*), which will be verified through DNA analysis.

Atlantic bluefin tuna (ABT), *Thunnus thynnus*, is the highest-valued Atlantic tuna species on the global fisheries market today. ABT are known to spawn in the Gulf of Mexico during summer (May and June), but the numbers of spawning individuals and the geographic extent of spawning are unknown (Block 2005). Given the highly migratory behavior of this species, its management is a complex, international concern. ABT are overfished throughout their range in the Atlantic Ocean, and current population levels are at a historic low. Previous plankton sampling expeditions have found small numbers of ABT larvae adjacent to the Gulf of Mexico, and in months outside of the known spawning time. It is critical to define possible alternative spawning sites and times and assess the potential contribution to the overall spawning activity in the region.

Seabird Survey

Seabird observers conducted counts of all birds detected within a 300 m strip transect during the second and third legs of the cruise. During leg 2, at least 1,339 birds were counted over 15 days, and at least 2,536 individuals were counted over 16 days of leg 3. Over 20 species of seabirds were detected on each leg (Table 5). Additional information is available in the GoMMAPPS seabird trip reports (https://www.boem.gov/GOMMAPPS/, accessed Jan. 12, 2018).

Data and Sample Disposition

All data collected during GU17-03 including visual survey data, passive acoustic data, EK60 data, SCS data, XBT and CTD data are archived and managed at the Southeast Fisheries Science Center (SEFSC) in Miami, FL with backup copies at the SEFSC Pascagoula Laboratory. Biopsy sub-samples for genetics are archived at the SEFSC Marine Mammal Molecular Genetic

Laboratory in Lafayette, LA pending analyses. The sub-samples for stable isotopes and contaminants are archived at the SEFSC Pascagoula Laboratory. The data presented here are preliminary and subject to change as further auditing and analyses continue.

Permit and Funding Source

The Southeast Fisheries Science Center was authorized to conduct marine mammal research activities during the cruise under MMPA Research Permit No. 14450-04, issued to the SEFSC by the NMFS Office of Protected Resources. This study was funded by the U.S. Department of the Interior, Bureau of Ocean Energy Management through Interagency Agreement M17PG00013 with the U.S. Department of Commerce, National Oceanic and Atmospheric Administration (NOAA).

References

Block, B.A., Teo, S.L.H., Walli, A., Boustany, A., Stokesbury, M.J.W., Farwell, C.J., Weng, K.C., Dewar, H, and Williams, TD. (2005). “Electronic tagging and population structure of Atlantic bluefin tuna,” Nature 434, 1121-1127.

Gillespie, D., Gordon, J., Mchugh, R., Mclaren, D., Mellinger, D., Redmond, P., Thode, A., Trinder, P., Deng, X. Y., and 30. (2008). "PAMGUARD: Semiautomated, open source software for real-time acoustic detection and localisation of cetaceans," Proceedings of the Institute of Acoustics 30.

Mellinger, D. K. (2001). "Ishmael 1.0 User's Guide. NOAA Technical Report OAR-PMEL-120," (NOAA Pacific Marine Environmental Laboratory, Seattle), p. 30.

Miller, B., Barlow, J., Calderan, S., Collins, K., Leaper, R., Olson, P., Ensor, P., Peel, D., Donnelly, D., Andrews-Goff, V., Olavarria, C., Owen, K., Rekdahl, M., Schmitt, N., Wadley, V., Gedamke, J., Gales, N., and Double, M. (2015). "Validating the reliability of passive acoustic localisation: a novel method for encountering rare and remote Antarctic blue whales," Endangered Species Research 26, 257-269.

Rankin, S., Barlow, J., Barkley, Y., and Valtierra, R. (2013). "A Guide to Constructing Hydrophones Arrays for Passive Acoustic Data Collection During NMFS Shipboard Cetacean Surveys," in *NOAA-TM-NMFS-SWFSC-511*.

Table 1. List of Participants

Name	Legs	Affiliation	Duty
Anthony Martinez	1, 2, 3	SEFSC	Field Party Chief
Jesse Wicker	1, 2, 3	CIMAS	Marine mammal observer
Laura Dias	1, 2, 3	CIMAS	Data manager/Marine mammal Obs.
Katrina Ternus	1, 2, 3	IAP Worldwide Services, Inc.	Acoustician
Melissa Soldevilla	1	SEFSC	Acoustician
Matt Maiello	1	SEFSC	Marine mammal observer
Carrie Sinclair	1, 2	SEFSC	Marine mammal observer
Lauren Noble	1	IAP Worldwide Services, Inc.	Marine mammal observer
Errol Ronje	3	IAP Worldwide Services, Inc.	Marine mammal observer
Melody Baran	1 (7/04), 2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Mary Applegate	1, 2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Heidi Malizia	1, 2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Thomas Ninke	1, 2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Carol Roden	2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Rachel Hardee	2, 3	IAP Worldwide Services, Inc.	Marine mammal observer
Mridula Srinivasan	1	OST	Marine mammal observer
Tina Yack	2, 3	IAP Worldwide Services, Inc.	Acoustician
Sarah Privoznik	1	CIMAS	Plankton operations
Alanna Mnich	2	CIMAS	Plankton operations
Akihiro Shiroza	3	CIMAS	Plankton operations
Chris Haney	2, 3	GoMMAPPS Volunteers	Bird observer
Jeff Gleason	2	USFWS	Bird observer
Dan Bauer	3	GoMMAPPS Volunteers	Bird observer

Affiliations: SEFSC = NOAA Southeast Fisheries Science Center; CIMAS = Cooperative Institute for Marine and Atmospheric Studies; OST = NOAA Office of Science and Technology; USFWS = United States Fish and Wildlife Service, Lacombe, LA

Table 2. Daily survey operations and effort during GU17-03 including the visual and acoustic effort, the average sea state, number of marine mammal sightings, number of marine mammal biopsies collected, number of acoustic detections from the towed array, number of sonobuoys deployed, and the number of Acoustic Recording Packages (HARPs and LARPs) deployed or recovered.

Survey Leg	Date	Visual Effort (km)	Ave. sea state	Num. sights	Num. biopsies	Acoustic Effort (hr)	Num. Ac. Dets.	Num. SBs	ARP deploy/ recover
Leg 1	2 Jul	0	NA	0	0	0	0	0	0
	3 Jul	127.9	3.0	12	0	8.4	12	1	0
	4 Jul	156.0	2.8	4	0	9.0	9	1	0
	5 Jul	171.3	4.3	2	0	10.4	14	1	0
	6 Jul	209.1	3.3	5	0	12.8	10	2	0
	7 Jul	136.8	2.7	2	0	7.8	9	0	1
	8 Jul	214.3	2.4	9	0	12.4	16	1	0
	9 Jul	210.5	2.0	15	0	12.5	13	0	0
	10 Jul	169.9	2.4	15	0	12.5	10	1	0
	11 Jul	208.6	3.1	4	0	12.7	6	1	0
	12 Jul	215.1	3.0	6	0	11.1	8	0	0
	13 Jul	222.0	3.6	4	0	12.5	13	1	0
	14 Jul	161.4	3.2	11	0	12.5	7	1	0
	15 Jul	201.9	2.3	12	0	13.6	14	0	0
	16 Jul	29.1	2.4	5	0	2.8	5	2	1
Leg 2	22 Jul	69.9	2.9	4	0	4.9	7	0	0
	23 Jul	168.8	2.5	15	1	12.0	16	2	0
	24 Jul	226.8	3.5	7	0	12.8	16	1	0
	25 Jul	217.2	3.2	7	0	12.5	16	0	0
	26 Jul	213.7	2.9	9	0	12.4	14	1	0
	27 Jul	191.4	2.5	14	0	12.2	16	1	0
	28 Jul	170.7	1.8	32	0	11.6	15	0	0
	29 Jul	207.3	3.9	4	0	12.5	14	1	0
	30 Jul	184.3	3.8	3	0	12.6	12	0	0
	31 Jul	223.7	3.5	9	0	12.5	16	0	0
	1 Aug	208.7	3.9	1	0	12.6	8	1	0
	2 Aug	136.6	3.6	3	0	11.9	7	0	0
	3 Aug	205.0	4.4	4	0	12.1	9	0	0
	4 Aug	87.6	3.7	0	0	4.9	0	1	0
Leg 3	10 Aug	124.5	3.0	3	0	7.9	8	0	0
	11 Aug	187.3	2.1	11	0	12.1	10	0	0
	12 Aug	152.0	2.6	12	0	12.0	21	1	0
	13 Aug	112.3	2.1	8	0	7.5	9	0	1

	14 Aug	204.9	3.1	11	0	12.1	13	2	0
	15 Aug	203.2	4.3	5	0	12.0	13	0	0
	16 Aug	166.2	5.0	6	0	12.2	15	1	0
	17 Aug	124.3	4.4	5	0	11.9	16	0	0
	18 Aug	220.3	2.8	13	0	12.1	26	2	0
	19 Aug	150.5	1.9	24	1	12.2	41	2	0
	20 Aug	190.8	3.1	15	0	12.1	12	2	0
	21 Aug	209.3	3.2	1	0	15.0	6	1	0
	22 Aug	202.9	3.5	5	0	17.8	20	2	0
	23 Aug	108.3	4.4	1	0	16.6	23	0	0
	24 Aug	0	NA	0	0	0.0	0	0	0
Total		**7302.1**	**3.1**	**338**	**2**	**481.4**	**545**	**33**	**3**

Table 3. Marine mammal sightings during each leg of GU17-03

Species	Leg 1	Leg 2	Leg 3	Total
Atlantic spotted dolphin	2	1	4	7
Bottlenose dolphin	9	14	11	34
Bottlenose/Spotted dolphin	2	0	0	2
Bryde's whale	1	1	1	3
Clymene dolphin	0	0	1	1
Cuvier's beaked whale	2	0	1	3
False killer whale	1	0	0	1
Killer whale	0	1	0	1
Melon-headed whale	0	3	0	3
Melon-headed/Pygmy killer whale	1	1	1	3
Melon-headed whale+Pygmy/Dwarf sperm whale	0	0	1	1
Pantropical spotted dolphin	11	6	10	27
Pilot whales	1	2	6	9
Pygmy killer whale	0	0	1	1
Pygmy/Dwarf sperm whale	0	11	4	15
Risso's dolphin	9	1	1	11
Sperm whale	18	19	32	69
Spinner dolphin	1	1	0	2
Stenella sp.	12	12	8	32
Unid. Baleen Whale	0	1	0	2
unid. dolphin	24	23	18	65
unid. Dolphin+unid. Odontocete	1	0	0	1
unid. large whale	2	2	3	7
Unid. Mesoplondont	0	3	1	4
Unid. Odontocete	5	7	12	24
unid. small whale	2	0	2	4
Unid. Ziphiid	2	3	2	7
Grand Total	**106**	**112**	**120**	**338**

Table 4. Towed array marine mammal acoustic detections during each leg of GU17-03

Species	Leg 1	Leg 2	Leg 3	Total
Sperm whale	13	41	77	131
Kogiidae	1	1	2	4
Ziphiidae	6	7	15	28
Risso's dolphin	9	1	1	11
Odontocete	46	28	28	102
Delphinid	72	88	110	270
Total	146	166	233	545

Table 5. Seabird species detections during GU17-03

Leg 2 species	Leg 3 species
Wilson's Storm-petrel	Wilson's Storm-petrel
Leach's Storm-petrel	Leach's Storm-petrel
Band-rumped Storm-petrel	Band-rumped Storm-petrel
Fea's Petrel	Black-capped Petrel
Black-capped Petrel	Great Shearwater
Great Shearwater	Cory's Shearwater
Cory's Shearwater	Audubon's Shearwater
Audubon's Shearwater	White-tailed Tropicbird
[probable White-tailed] Tropicbird	Magnificent Frigatebird
Magnificent Frigatebird	Brown Booby
Brown Booby	Masked Booby
Masked Booby	Red-footed Booby
Red-footed Booby	Laughing Gull
Laughing Gull	Sandwich Tern
[probable Herring] Gull	Royal Tern
Sandwich Tern	Black Tern
Royal Tern	Sooty Tern
Black Tern	Bridled Tern
Sooty Tern	Common Tern
Bridled Tern	Forster’s Tern
Brown Noddy	Pomarine Jaeger
Parasitic Jaeger	Brown Pelican
Pomarine Jaeger	*Phalaropus* sp.
Brown Pelican	

Figure 1. Planned survey tracklines and accomplished survey effort during GU17-03

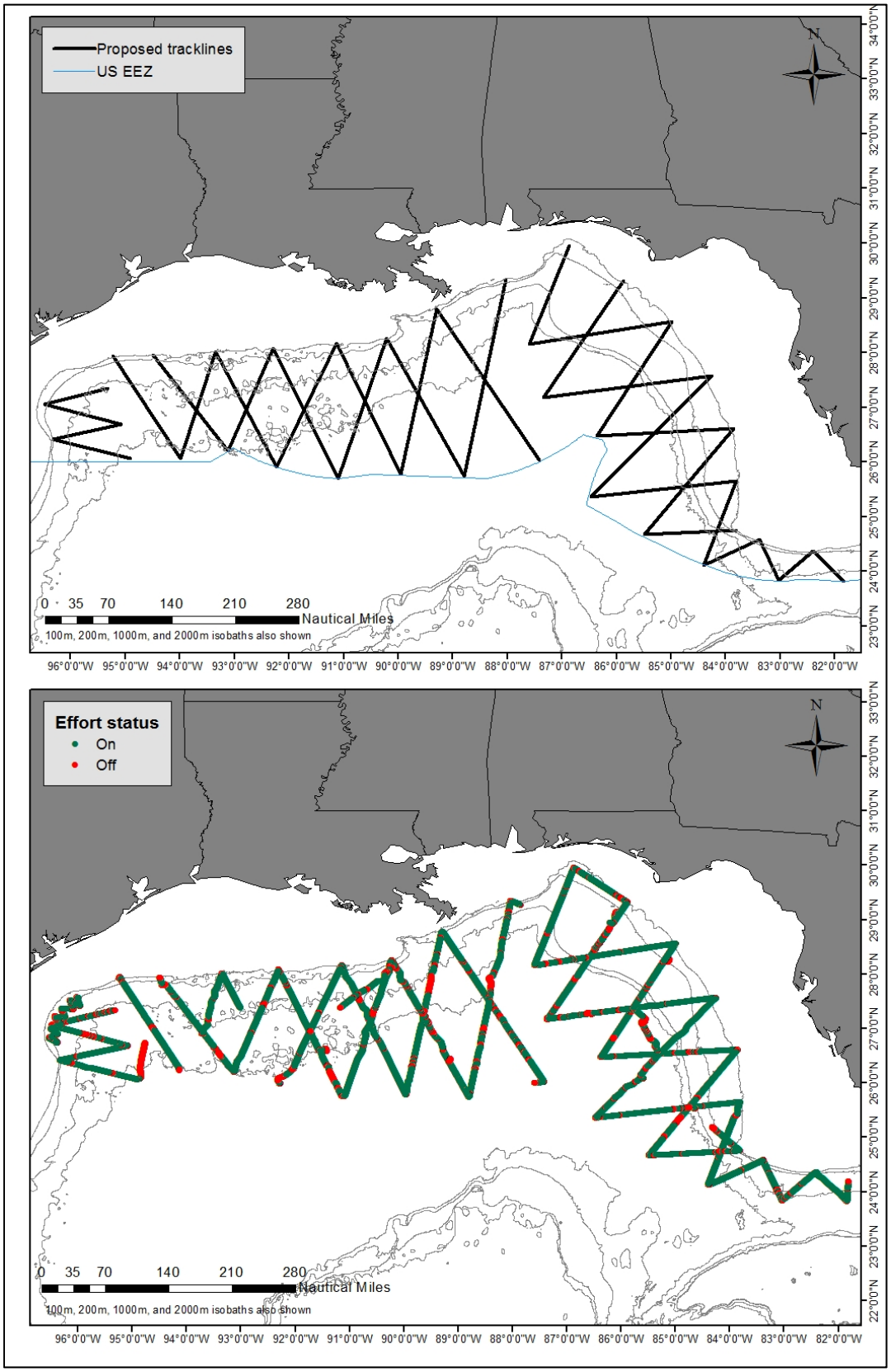

Figure 2. Sea state conditions on the trackline during survey effort for GU17-03

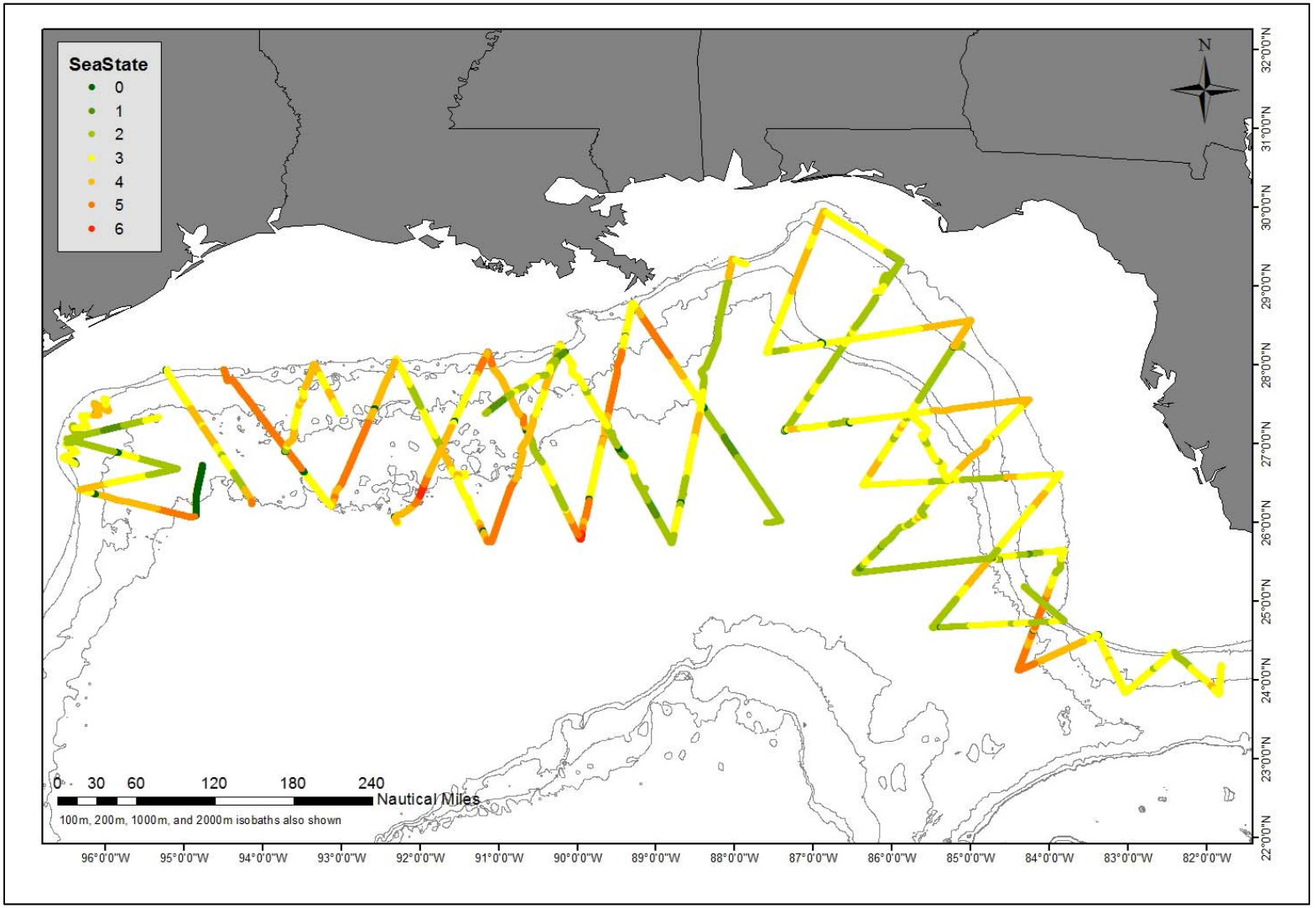

Figure 3. Dolphin sighting locations during GU17-03

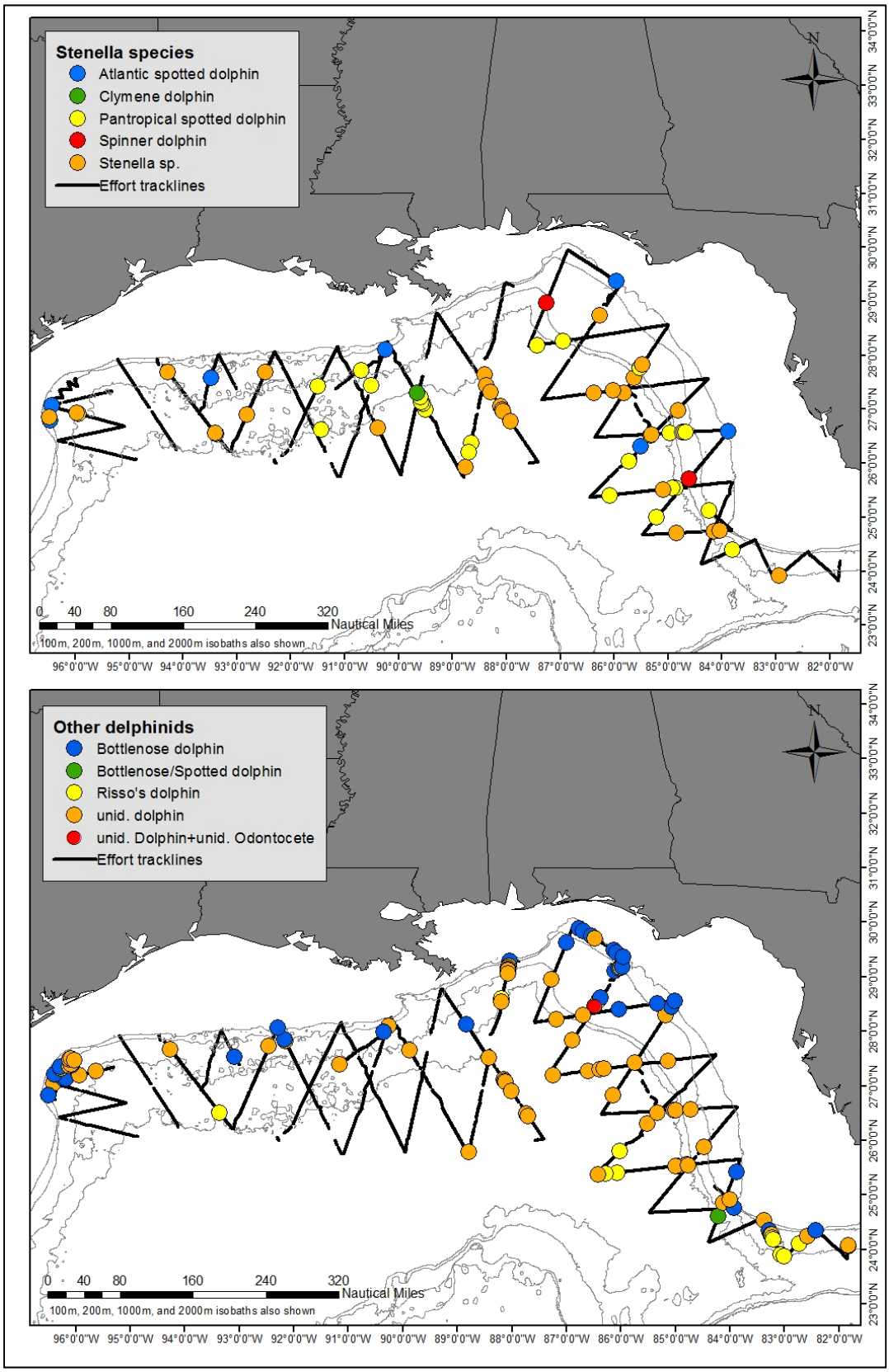

Figure 4. Bryde's and sperm whale sightings during GU17-03

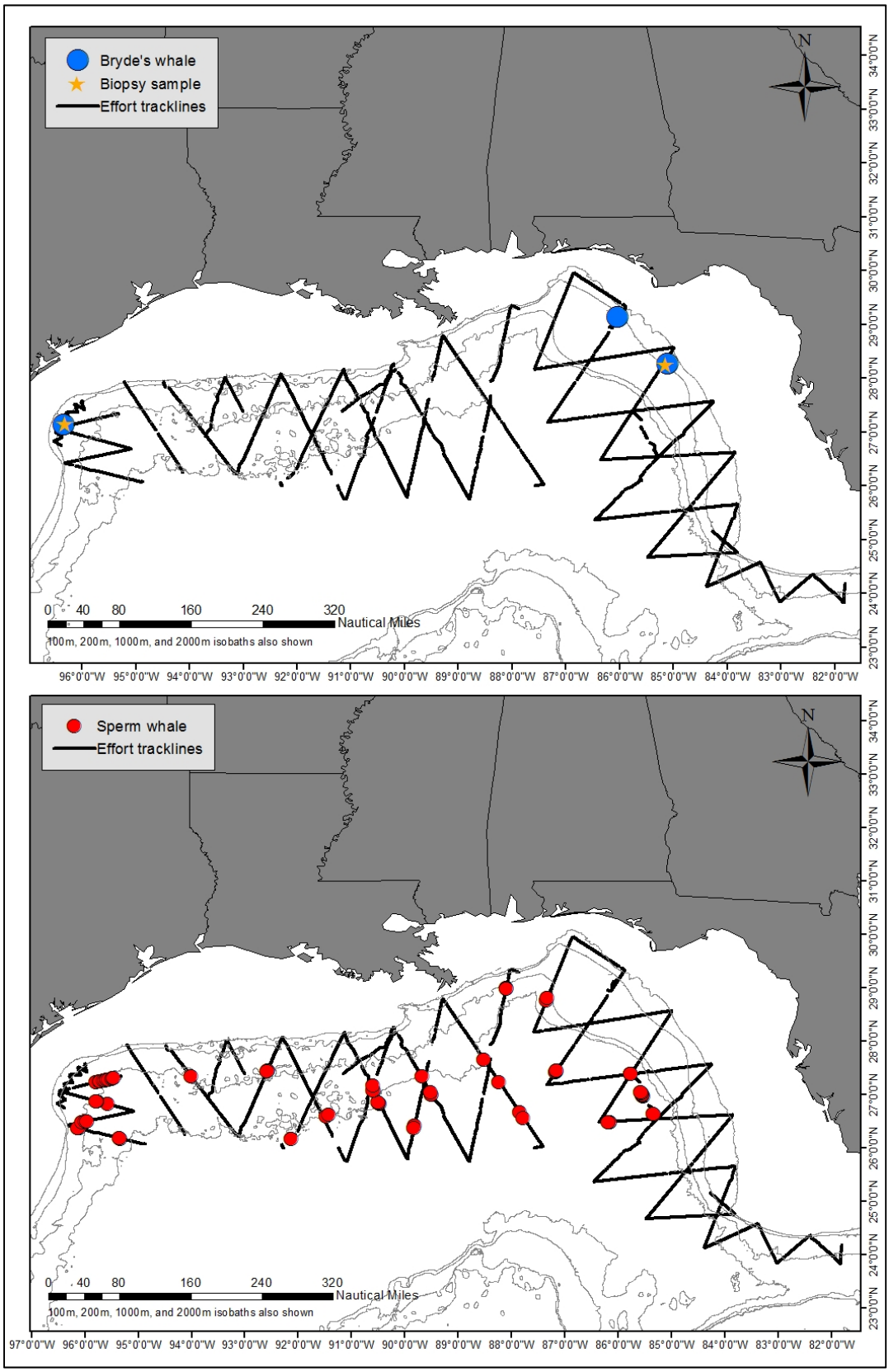

Figure 5. Small whale sightings during GU17-03

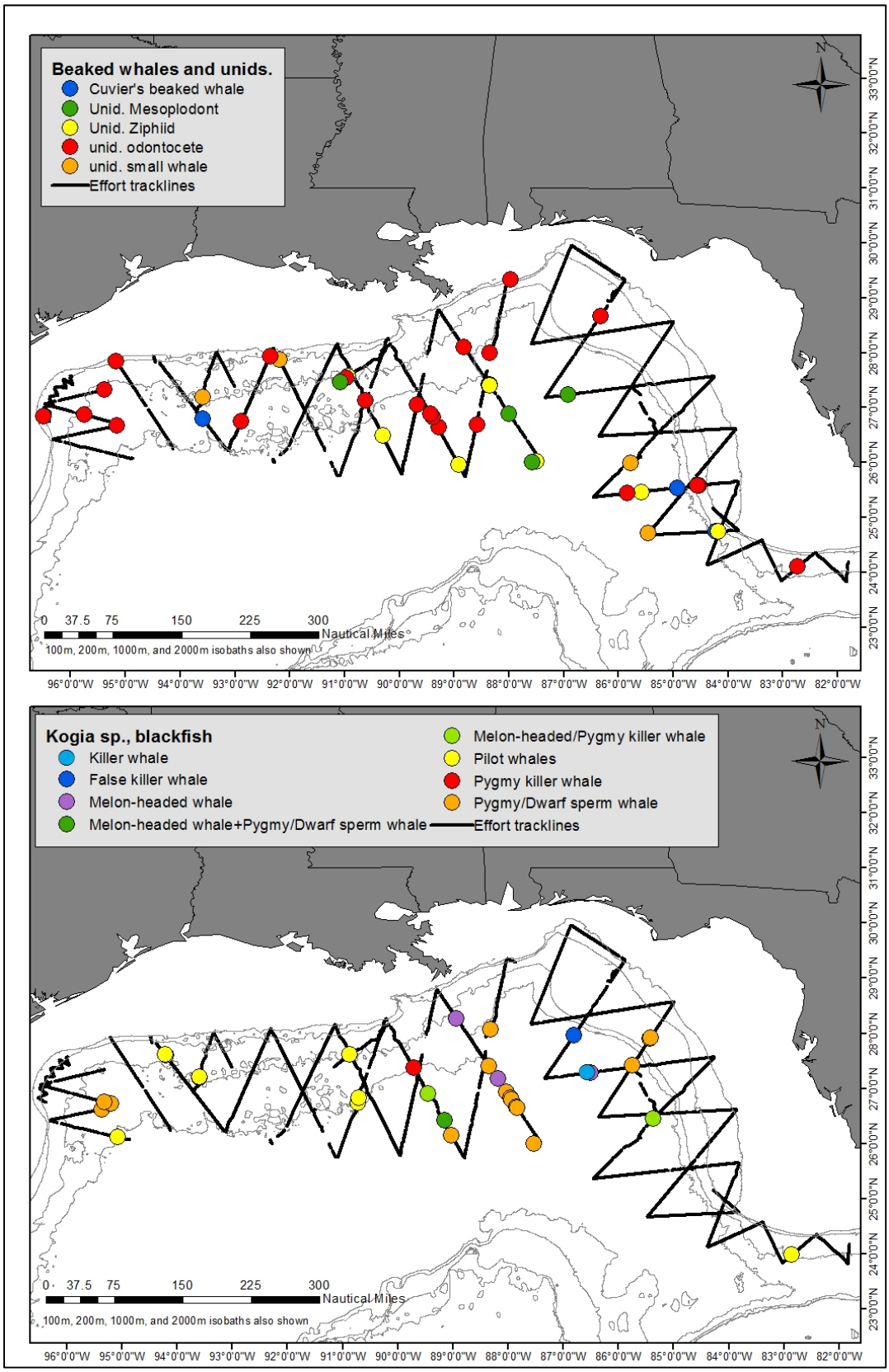

Figure 6. Passive acoustic towed array survey effort and detections during GU17-03

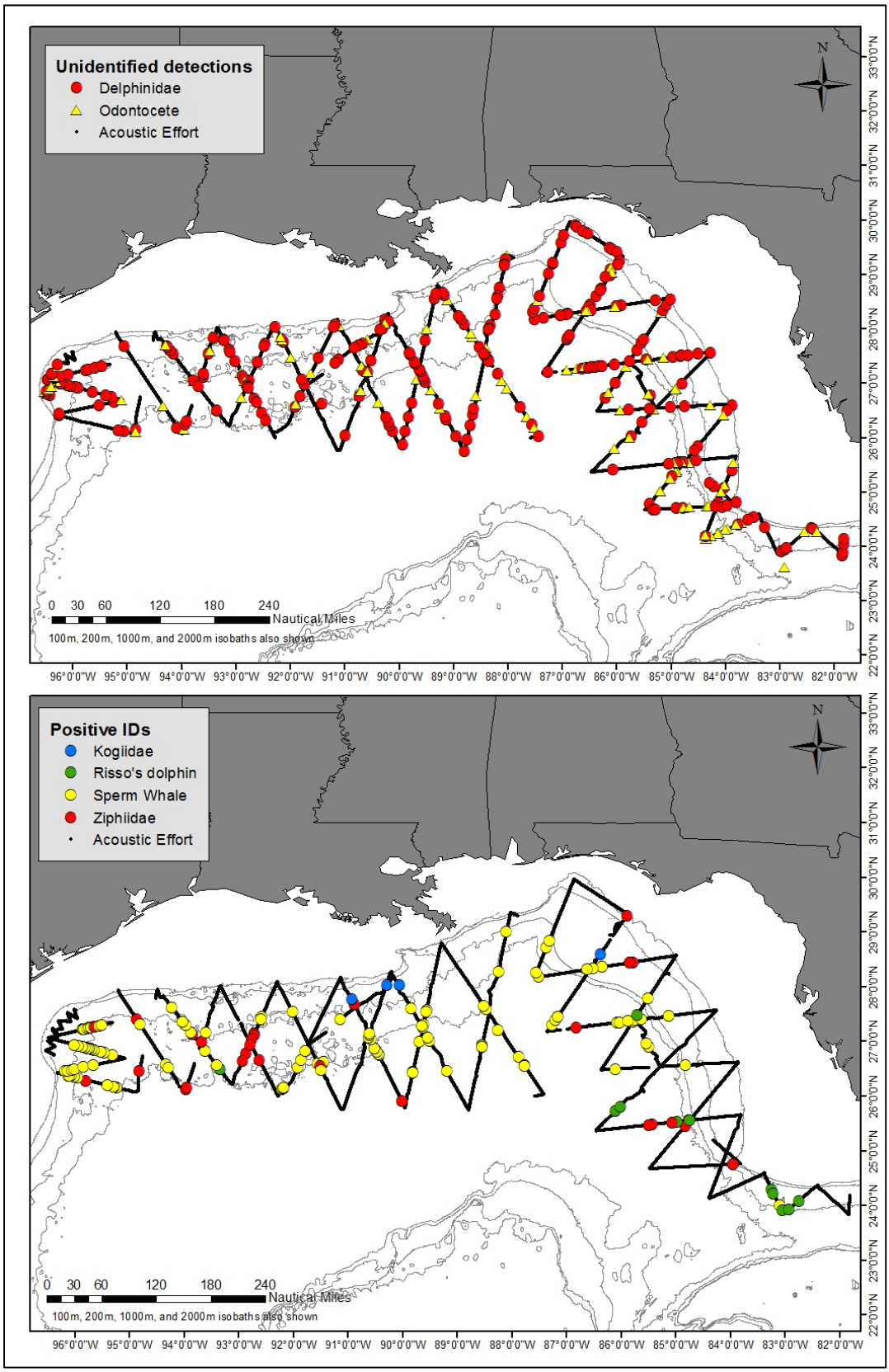

Figure 7. Sonobuoys deployed during GU17-03

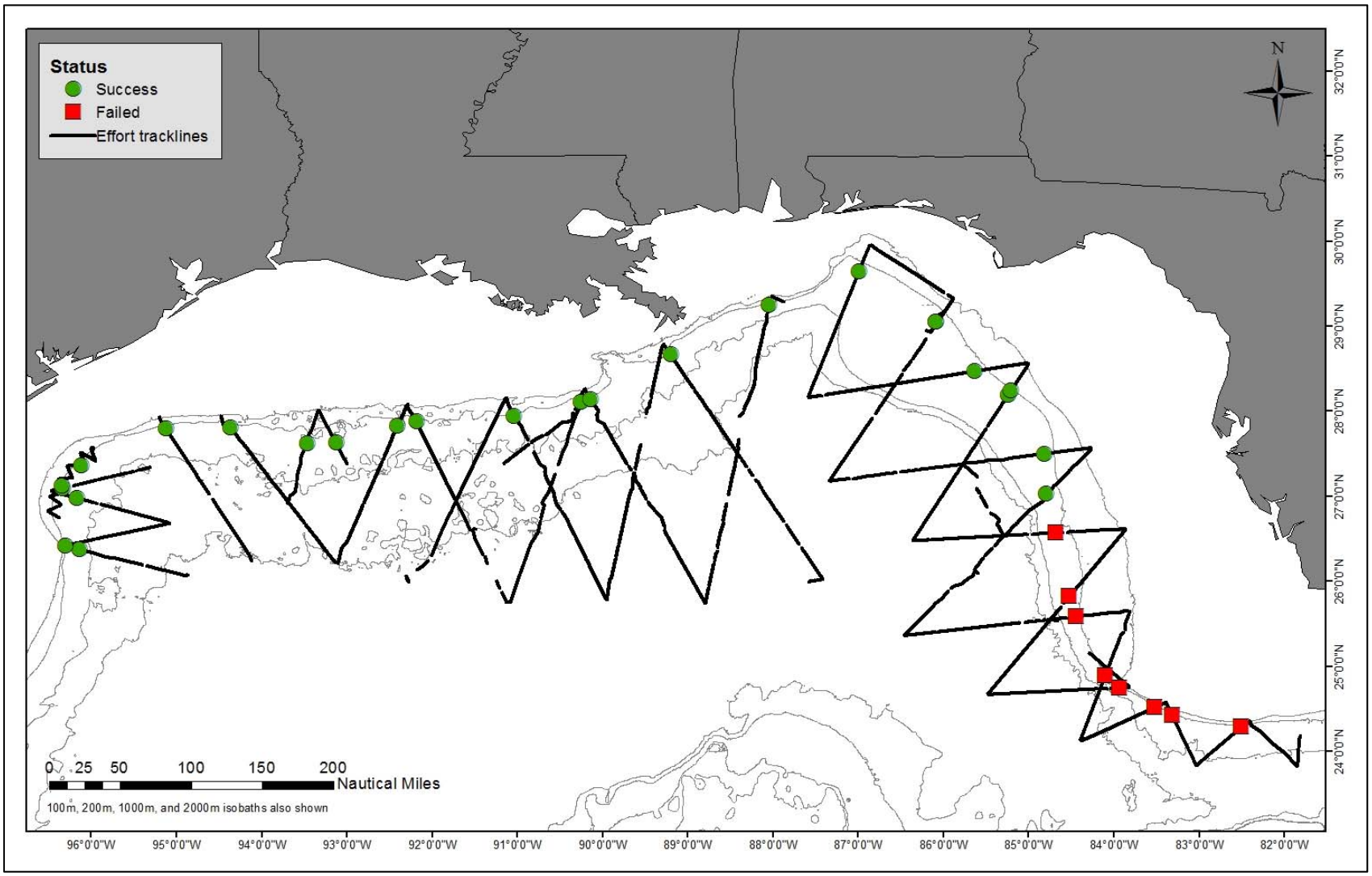

Figure 8. Acoustic moorings deployed or recovered during GU17-03

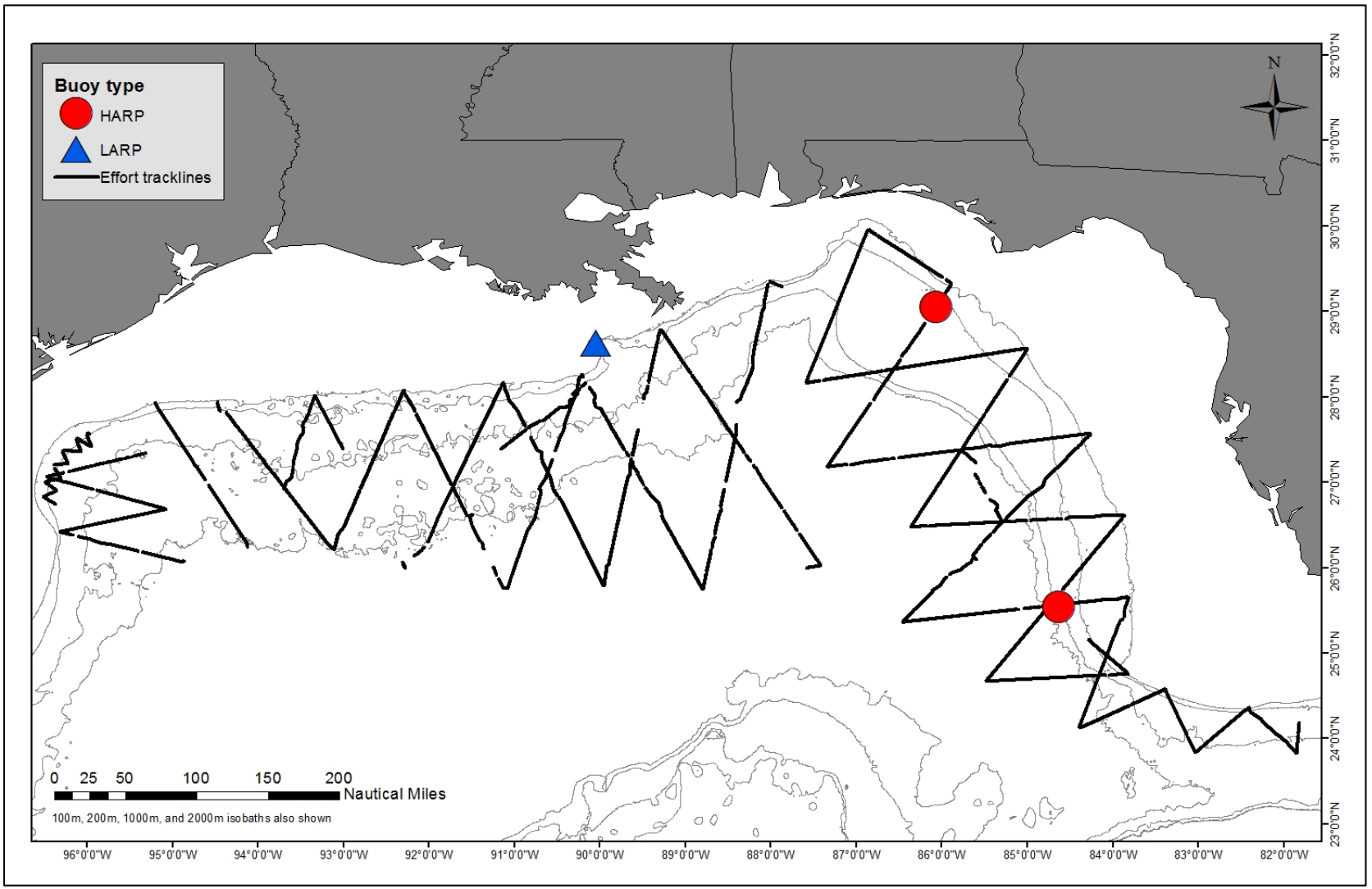

Figure 9. Hydrographic profile sampling stations during GU17-03