CRUISE REPORT

NOAA Ship *Gordon Gunter* Cruise GU18-01

January – March 2018

GoMMAPPS Winter 2018 Research Cruise

U.S Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service
Southeast Fisheries Science Center
75 Virginia Beach Drive
Miami, Florida 33149

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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 deep) of the Gulf out to the U.S. Exclusive Economic Zone (EEZ). The survey was conducted between 14 January and 16 March 2018 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 lines (Figure 1).

The cruise was segmented into four legs, totaling 55 sea-days:

Leg	Date	Location	Days at Sea
1	DEP: 14 Jan 2018	Pascagoula, MS	8
	ARR: 22 Jan 2018	Pascagoula, MS	
2	DEP: 26 Jan 2018	Pascagoula, MS	15
	ARR: 09 Feb 2018	Pascagoula, MS	
3	DEP: 12 Feb 2018	Pascagoula, MS	16
	ARR: 27 Feb 2018	Pascagoula, MS	
4	DEP: 01 Mar 2018	Pascagoula, MS	16
	ARR: 16 Mar 2018	Pascagoula, MS	

Due to a delay in the transfer of incremental funding for FY18, it was not possible to hire the scientific crew needed to operate under the two independent team visual survey approach for legs 1 and 2. Therefore, the first two legs of the survey were conducted with one visual team instead of two. The departure date for leg 1 was delayed from 8 January to 14 January due to weather and ship mechanical issues. Visual operations began the afternoon of 14 January; however, in observance of a government shutdown, the ship began a transit back to Pascagoula on 20 January and leg 2 resumed on 26 January. Legs 3 and 4 were staffed with the full scientific crew in place with both visual teams operating as originally planned. Survey participants are listed in Table 1 and daily survey operations are summarized in Table 2.

Overall, the primary goal of this survey was to collect data on the distribution and abundance of marine mammals in the U.S. waters of the Gulf of Mexico (GOM) using visual survey teams and passive acoustic monitoring. Twenty-one species of cetaceans are known to routinely inhabit continental shelf (20 m to 200 m) and oceanic (>200 m) waters of the U.S. GOM. In the continental shelf waters, the most common cetacean species are common bottlenose and Atlantic spotted dolphins. Oceanic waters are inhabited by species including sperm whales, dwarf and pygmy sperm whales, beaked whales, and other large (e.g., killer whales, short-finned pilot whales, Risso's dolphins) and small (e.g., pantropical spotted dolphins) delphinids. Though other species of baleen whales are occasionally sighted, GOM 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.

Cruise objectives

The specific objectives of this survey were to:

1. Conduct a two-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 simultaneously 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. Periodically collect oceanographic and environmental data utilizing scientific echosounders (EK60) to quantify acoustic backscatter from small fish and zooplankton
6. Collect vertical profiles of hydrographic parameters (e.g., temperature, salinity, oxygen concentration) using CTD
7. Recover and redeploy autonomous acoustic moorings

Visual Survey Operations

The survey design was similar to that conducted during the GoMMAPPS survey in the summer of 2017 (GU17-03), which used the two independent visual observer teams approach, except during the first two legs of GU18-01 when only one visual observer team was operational. During legs 1 and 2, surveys were conducted by a team of three observers stationed on the vessel's flying bridge (height above water = 13.9 m) and consisted of two observers using two pedestal-mounted 25x150 mm "bigeye" binoculars located on the port and starboard sides and a central observer/data recorder performing naked-eye observations.

During legs 3 and 4, the independent teams 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 the summer 2017 GoMMAPPS cruise. During this approach, one survey team with two observers was stationed on the vessel's flying bridge and the second team, also with two observers, was stationed on the wings of the bridge deck (height above water = 11.2 m). Each visual survey team utilized two pedestal-mounted bigeye binoculars located on the port and starboard sides of the ship. A centralized data recorder located inside the ship's chemistry laboratory communicated with both teams via discreet VHF channels to maintain independence of the teams. Throughout all legs, observers used the bigeye binoculars to determine and relay 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. Marine mammal sightings were defined as systematic records of cetacean groups consisting of one or more individuals observed at the same location and time.

Visual survey effort commenced daily at approximately 0700 (CST) and ended at 1730 (CST) for all legs 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 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. Observers scanned the water using the bigeye binoculars from 10° right and left of the ship's bow to the beam (90° left or right depending on the side); i.e., the left observer scanned from 10° right to 90° left and the right observer scanned from 10° left to 90° right. 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 that captures the spatial and temporal data of a sighting. This survey, along with GU1703, was primarily conducted in "passing mode" whereby the ship maintains a steady course and speed along the trackline while the visual teams identify the sighting to species level if possible and count the number of individuals in the sighting. This differs from surveys prior to 2017 and should be considered when comparing these data to historical datasets. Under certain circumstances, a "closing mode" technique was employed. Closing mode entails maneuvering the ship to more closely approach a sighting. Closing mode was used sparingly and was restricted to sightings of special interest, including GOM Bryde's whales, and as determined by the Field Party Chief (FPC). After sightings were identified to the lowest taxonomic level possible and group size enumerated, the sighting was entered in the visual data program by the data recorder. Group size estimates were recorded independently by 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), 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. Sightings observed under such conditions were recorded as off effort. Off-effort sightings may also have included naked-eye observations and 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, 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 temperature, etc.). At the start of the survey day and at 20-minute 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, 5,814.3 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 3-5 on most survey days (Figure 2). There were 143 marine mammal sightings from 11 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*), rough-toothed dolphins (*Steno bredanensis*), beaked whales (Ziphiidae), and pilot whales (*Globicephala* sp.; Table 3, Figures 3 and 4). Continental shelf species included common bottlenose dolphins (*Tursiops truncatus*) and Atlantic spotted dolphins (*Stenella frontalis;* Figure 3a-b). There were a total of 20 sperm whale (*Physeter macrocephalus*) sightings (Figure 3c). 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 detection as had been done in previous SEFSC surveys. Therefore, sperm whale group size estimates and sighting definitions are likely not comparable between this survey and previous studies in the GOM. These differences will be accounted for when estimating abundance.

Marine mammal biopsy sampling

No biopsy samples were collected during GU18-01.

Passive Acoustic Survey

Towed Array

Passive acoustic surveys using a towed array were conducted concurrent with visual surveys 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, in sea states greater than 6, and when lightning storms were within 1 nmi. Passive acoustic monitoring for odontocetes was conducted using a modular towed hydrophone array deployed approximately 300 m behind the ship and weighted with 13.6 kg lead wire. Hydrophone depth was not measured on this cruise due to a faulty pressure sensor in the towed array; depth averaged 12 ± 1.3 m on prior cruises at this speed, tow distance, and weighting.

The custom-built five-element mixed-frequency oil-filled end array (Rankin *et al.* 2013) 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. Data from sensors 1, 2, 4, and 5 were digitized for recording with a custom 12 channel SailDAQ soundcard (*www.sa-instrumentation.com*) sampling 16 bits at 500 kHz, yielding a recording bandwidth of 1-250 kHz. SailDAQ output from sensors 1 and 5 were routed through a custom Magrec amplifier and Mark of the Unicorn (MOTU) Traveler mk3 audio interface for real-time aural monitoring (Appendix A).

Acoustic signals were monitored while the array was deployed, either by a single acoustic technician who continued recording signals when breaks were needed (14 January – 9 February) or by a team of two acoustic technicians who rotated through a primary and on-call secondary position every 1.5-2 hours (12 February – 15 March). The software Pamguard (v.1.15.03; Gillespie *et al.* 2008) 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, 4-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.

Passive Acoustics Results

During the survey, 393 hours of acoustic data were recorded with the towed array (Table 2) yielding over 5.63 TB of data and 198 cetacean detections (Table 2; Figure 4). During real-time monitoring, acoustic detections were broadly categorized as Risso's dolphin clicks, sperm whale clicks, dwarf/pygmy sperm whale (*Kogia* spp.) clicks, beaked whale (Family Ziphiidae) clicks, unidentified delphinid vocalizations (whistles and clicks), or unidentified odontocetes (clicks only; Figure 4, Table 4). Preliminary acoustic detections include four Risso's dolphin encounters, 58 sperm whale encounters, and eight 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. Also, three missed Kogia species encounters were detected in preliminary post-processing. Acoustic detections of unidentified odontocetes and delphinids 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.

Passive Acoustic Mooring

As part of NOAA's Ocean Noise Reference Station Network (NRS) project, the GOM NRS06 buoy was refurbished during this cruise. The NRS buoy was deployed to continuously record sounds up to 2.5 kHz for two years with the objective of collecting calibrated long-term recordings of ambient noise to allow comparisons of noise conditions among sites in US waters and over time. The NRS buoy was recovered and redeployed on 9 March 2018.

Scientific Echosounder (EK60) Data Collection

EK60 data were collected 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. Calibration of the EK60 was not possible during this cruise. GOM 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) 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. CTD casts recorded vertical profiles of salinity, temperature, and oxygen content to a maximum depth of 500 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. Data were collected on a total of 37 CTD stations (Figure 5). Expendable bathythermographs (XBT) were not performed during this survey.

Seabird Survey

Seabird observers conducted counts of pelagic and coastal birds detected within a 300 m strip transect whenever the ship was cruising along tracklines or transit lines. The total count and number of birds observed per day were either within or higher than previously observed ranges on vessel surveys. The number of species detected per leg ranged from 14 to 25. Additional information is available in the GoMMAPPS seabird trip reports (https://www.boem.gov/GOMMAPPS/, accessed 18 Apr. 2018).

Data Disposition

All data collected during GU18-01 including visual survey data, passive acoustic data, EK60 data, SCS data, 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. 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).

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Table 1. List of Participants

Name	Legs	Affiliation	Duty
Anthony Martinez	1, 2, 3, 4	SEFSC	Field Party Chief
Jesse Wicker	3	CIMAS	Marine mammal observer
Laura Dias	2, 3, 4	CIMAS	Data manager/Marine mammal obs.
Katrina Ternus	1, 2, 3, 4	IAP Worldwide Services, Inc.	Acoustician
Matt Maiello	1	SEFSC	Marine mammal observer
Carrie Sinclair	1, 2, 3, 4	SEFSC	Marine mammal observer
Kevin Barry	4	SEFSC	Marine mammal observer
Amy Brossard	1, 2	CIMAS	Marine mammal observer
Melody Baran	1, 2, 3, 4	CIMAS	Marine mammal observer
Mary Applegate	1, 2, 3, 4	CIMAS	Data manager/Marine mammal obs.
Heidi Malizia	3, 4	CIMAS	Marine mammal observer
Thomas Ninke	3, 4	CIMAS	Marine mammal observer
Carol Roden	1, 2, 3, 4	CIMAS	Marine mammal observer
Rachel Hardee	3, 4	CIMAS	Marine mammal observer
Amanda Debich	3, 4	CIMAS	Acoustician
Chris Haney	1, 4	Terra Mar Applied Sciences	Bird observer
Jeff Gleason	3	USFWS	Bird observer
Dan Bauer	1	GoMMAPPS Volunteer	Bird observer
Matt Love	2	GoMMAPPS Volunteer	Bird observer
Jim Panaccione	2	USFWS	Bird observer
Yvan Satgé	3	South Carolina Cooperative Wildlife Research Unit	Bird observer
Jon Andrew	4	GoMMAPPS Volunteer	Bird observer

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

Table 2. Daily survey operations and effort during GU18-01 including the visual and acoustic effort, the average sea state, number of marine mammal sightings, number of acoustic detections from the towed array, and the NRS buoy recovery and redeployment.

Survey Leg	Date	Event	Visual Effort (km)	Ave. sea state	Num. sights	Acoustic Effort (hr)	Num. Ac. Dets.
Leg 1	14 Jan	Departed Pascagoula, MS. 6-day delay in departure due to mechanical issues	32.3	4.0	0	0	0
	15 Jan	Marine Mammal Survey	139.7	3.1	5	10.4	3
	16 Jan	Marine Mammal Survey	160.4	3.9	2	10.3	6
	17 Jan	Off effort – Weather	0	NA	0	0	0
	18 Jan	Marine Mammal Survey	175.5	4.1	0	10.0	4
	19 Jan	Marine Mammal Survey	159.5	4.8	1	9.6	1
	20-21 Jan	Transit back to port due to government shutdown	0	NA	0	0	0
	22-25 Jan	In port-Pascagoula, MS. 1-day delay in departure	0	NA	0	0	0
Leg 2	26 Jan	Departed Pascagoula, MS	0	NA	0	0	0
	27 Jan	Marine Mammal Survey, naked-eye observations only due to weather	0	NA	1	2.9	2
	28 Jan	Marine Mammal Survey	163.8	4.5	1	10.3	2
	29 Jan	Marine Mammal Survey	131.2	5.7	6	0.0	0
	30 Jan	Marine Mammal Survey, off-effort until 1:30 pm due to weather	65.0	4.6	1	4.6	2
	31 Jan	Marine Mammal Survey	171.5	3.2	2	10.4	1
	1 Feb	Marine Mammal Survey	166.0	3.3	2	10.0	3
	2 Feb	Marine Mammal Survey, off-effort after 8:40 am due to weather	26.8	2.1	0	10.0	2
	3 Feb	Marine Mammal Survey, naked-eye observations after	8.5	5.0	0	10.7	9

Survey Leg	Date	Event	Visual Effort (km)	Ave. sea state	Num. sights	Acoustic Effort (hr)	Num. Ac. Dets.
		7:30 am due to weather					
	4 Feb	Marine Mammal Survey	128.9	5.8	1	9.4	8
	5 Feb	Marine Mammal Survey	192.6	3.9	1	11.0	3
	6 Feb	Marine Mammal Survey	186.4	3.8	3	10.7	3
	7 Feb	Marine Mammal Survey	170.7	4.5	6	10.8	7
	8 Feb	Marine Mammal Survey	148.0	5.9	5	10.0	9
	9-11 Feb	In port-Pascagoula, MS	0	NA	0	0	0
Leg 3	12 Feb	Departed Pascagoula, MS	0	NA	0	0	0
	13 Feb	Marine Mammal Survey	145.0	4.2	3	1.9	0
	14 Feb	Marine Mammal Survey	178.5	3.8	1	10.5	4
	15 Feb	Marine Mammal Survey	175.9	3.4	8	11.0	9
	16 Feb	Marine Mammal Survey	173.2	3.0	4	10.7	3
	17 Feb	Marine Mammal Survey	172.6	3.9	10	10.9	11
	18 Feb	Marine Mammal Survey	172.1	4.4	1	10.9	4
	19 Feb	Marine Mammal Survey, naked-eye observations after 9:00 am due to weather	27.6	6.0	1	10.0	7
	20 Feb	Marine Mammal Survey, naked-eye observations until 4:30 pm due to weather	25.4	5.0	2	11.0	10
	21 Feb	Marine Mammal Survey	186.8	5.4	8	10.2	15
	22 Feb	Marine Mammal Survey, naked-eye observations after 2:00 pm due to weather	100.1	3.8	3	10.5	5
	23 Feb	Marine Mammal Survey	186.6	4.1	2	10.8	11
	24 Feb	Marine Mammal Survey, naked-eye	81.6	6.0	4	9.5	5

Survey Leg	Date	Event	Visual Effort (km)	Ave. sea state	Num. sights	Acoustic Effort (hr)	Num. Ac. Dets.
		observations after 1:30 pm due to weather					
	25 Feb	Marine Mammal Survey	177.5	4.8	5	10.7	6
	26 Feb	Marine Mammal Survey	160.5	3.2	7	9.5	3
	27-28 Feb	In port-Pascagoula, MS	0	NA	0	0	0
Leg 4	1 Mar	Departed Pascagoula, MS	0	NA	0	0	0
	2 Mar	Transit to trackline	0	NA	0	0	0
	3 Mar	Marine Mammal Survey	108.3	5.0	5	7.1	6
	4 Mar	Marine Mammal Survey	168.9	5.6	3	10.7	2
	5 Mar	Marine Mammal Survey	164.7	3.3	5	11.0	4
	6 Mar	Marine Mammal Survey	177.7	3.3	0	10.7	0
	7 Mar	Marine Mammal Survey	139.4	4.7	3	10.6	3
	8 Mar	Marine Mammal Survey	170.2	5.3	2	11.0	6
	9 Mar	Marine Mammal Survey, NRS recovery and deployment	64.4	3.8	4	5.0	4
	10 Mar	Marine Mammal Survey	155.3	4.9	5	11.0	4
	11 Mar	Marine Mammal Survey	167.4	2.1	5	10.0	6
	12 Mar	Off effort – Weather	0	NA	0	0	0
	13 Mar	Marine Mammal Survey	62.9	3.5	5	0	0
	14 Mar	Marine Mammal Survey	177.4	5.4	2	11.0	3
	15 Mar	Marine Mammal Survey	67.5	1.7	8	6.0	2
	16 Mar	Arrived in Pascagoula, MS	0	NA	0	0	0
Total			**5814.3**	**4.2**	**143**	**393.4**	**198**

Table 3. Marine mammal sightings during each leg of GU18-01

Species	Leg 1	Leg 2	Leg 3	Leg 4	Total
Atlantic spotted dolphin	0	2	3	1	6
Bottlenose dolphin	0	9	3	16	28
Bottlenose dolphin+Stenella sp.	0	0	1	0	1
Bottlenose/Spotted dolphin	0	0	0	1	1
Bryde's whale+Bottlenose dolphin	0	0	0	1	1
Clymene dolphin	0	1	1	1	3
Cuvier's beaked whale	1	0	0	2	3
Melon-headed whale	0	0	1	1	2
Pantropical spotted dolphin	1	2	10	4	17
Pilot whales	0	0	1	0	1
Risso's dolphin	0	2	1	2	5
Rough-toothed dolphin	2	0	0	1	3
Sei/Bryde's whale	0	1	0	0	1
Sperm whale	3	2	11	4	20
Stenella sp.	0	0	9	4	13
Striped dolphin	0	1	1	0	2
unid. Dolphin	1	7	16	5	29
unid. large whale	0	1	0	0	1
Unid. Mesoplodont	0	0	0	1	1
unid. Odontocete	0	1	0	2	3
Unid. Ziphiid	0	0	1	1	2
Total	**8**	**29**	**59**	**47**	**143**

Table 4. Towed array marine mammal acoustic detections during each leg of GU18-01

Species	Leg 1	Leg 2	Leg 3	Leg 4	Total
Sperm whale	4	16	33	5	58
Ziphiidae	0	1	4	3	8
Risso's dolphin	0	3	0	1	4
Odontocete	3	8	27	13	51
Delphinid	7	23	29	18	77
Total	**14**	**51**	**93**	**40**	**198**

Figure 1. Planned survey tracklines and accomplished survey effort during GU18-01

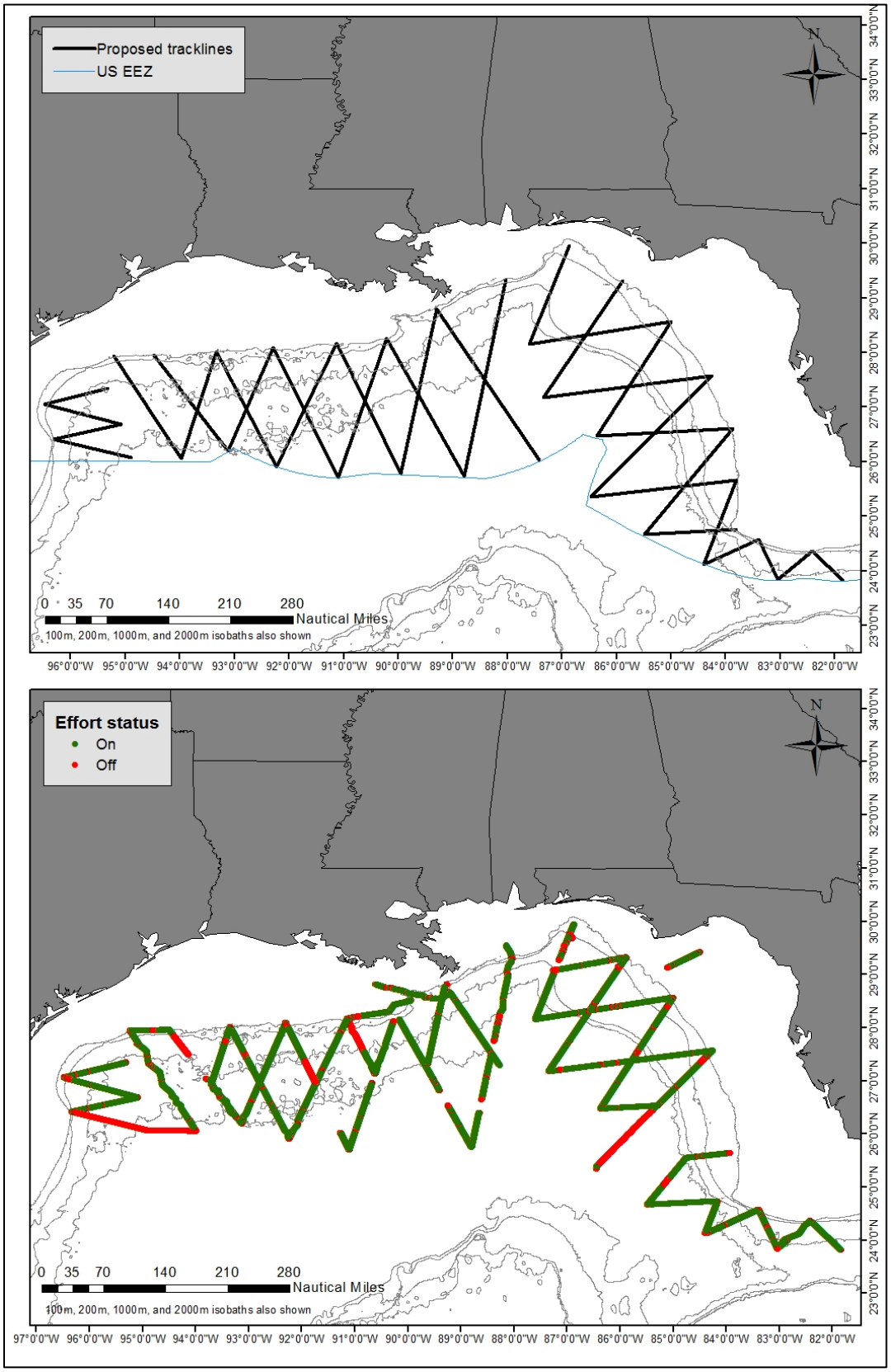


Figure 2. Sea state conditions on the trackline during survey effort for GU18-01

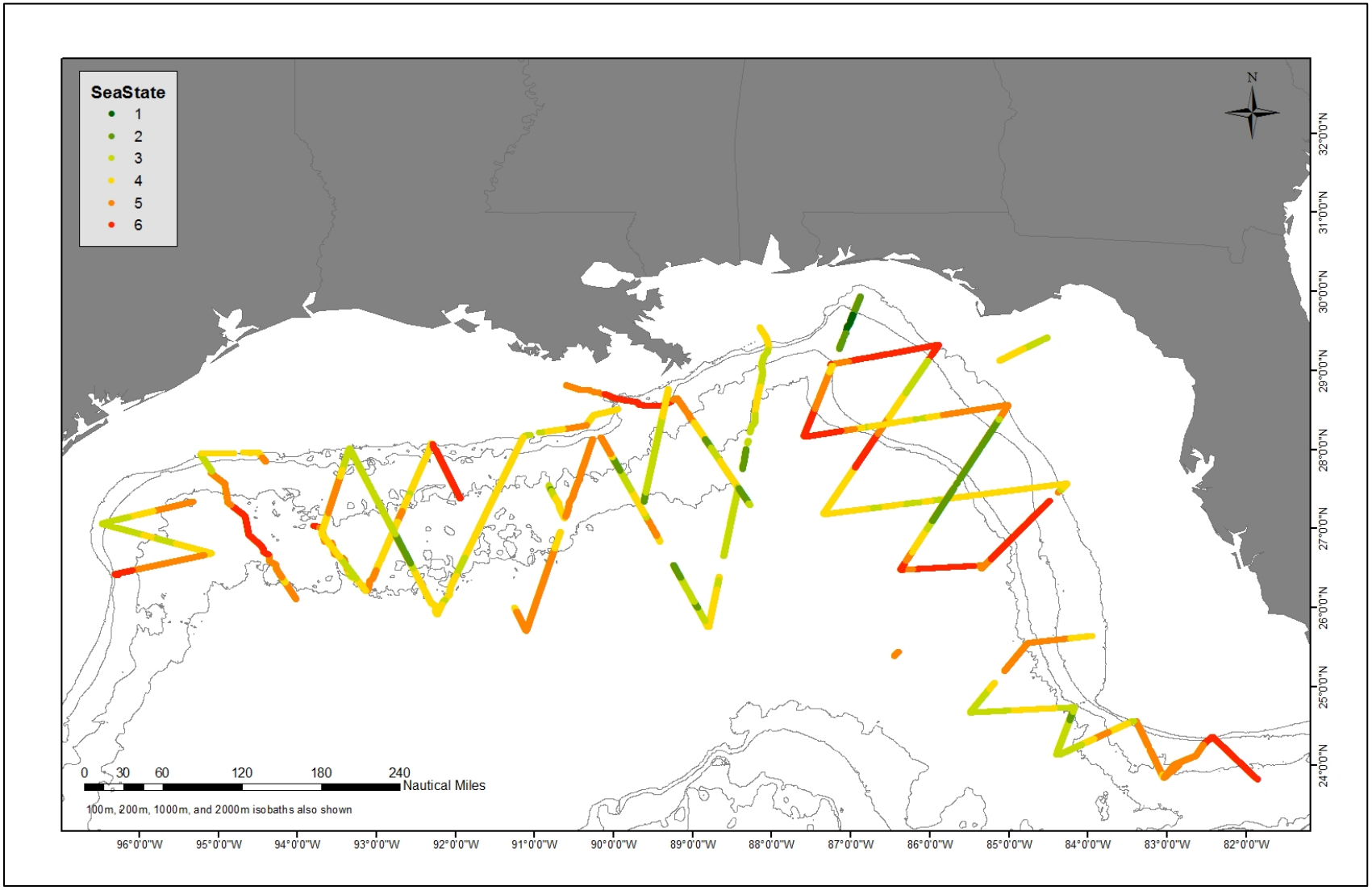
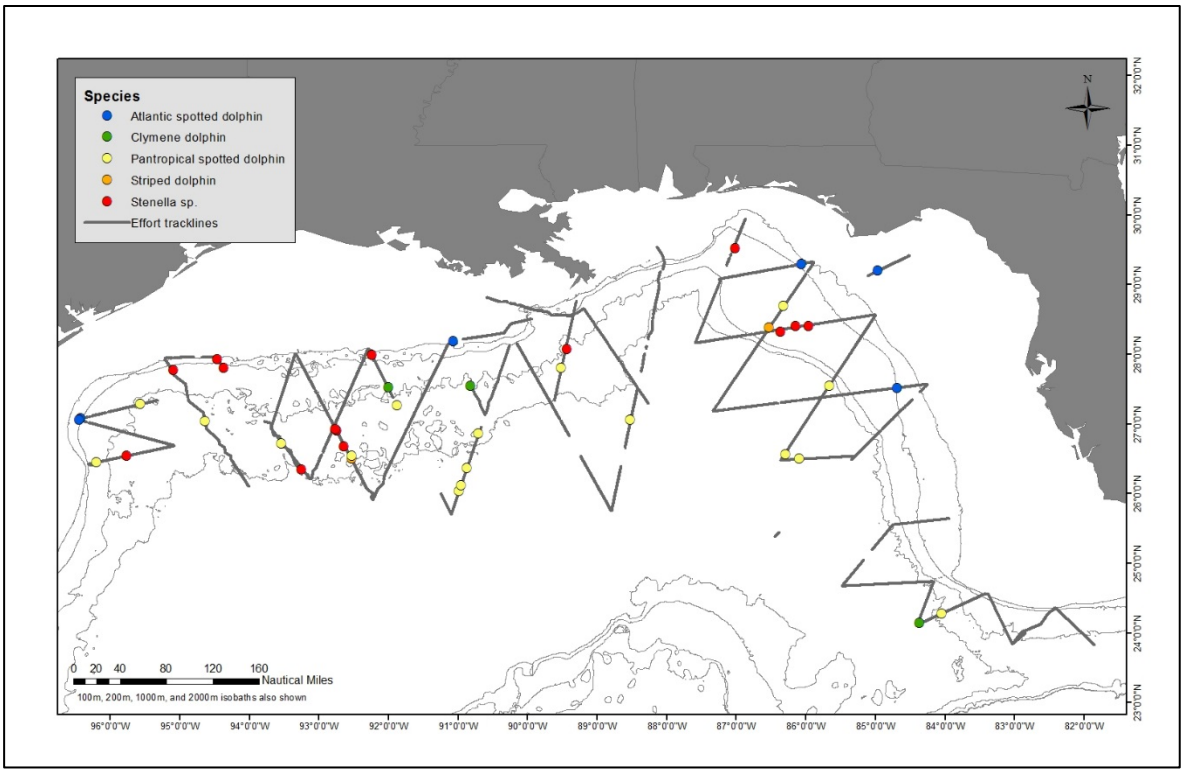
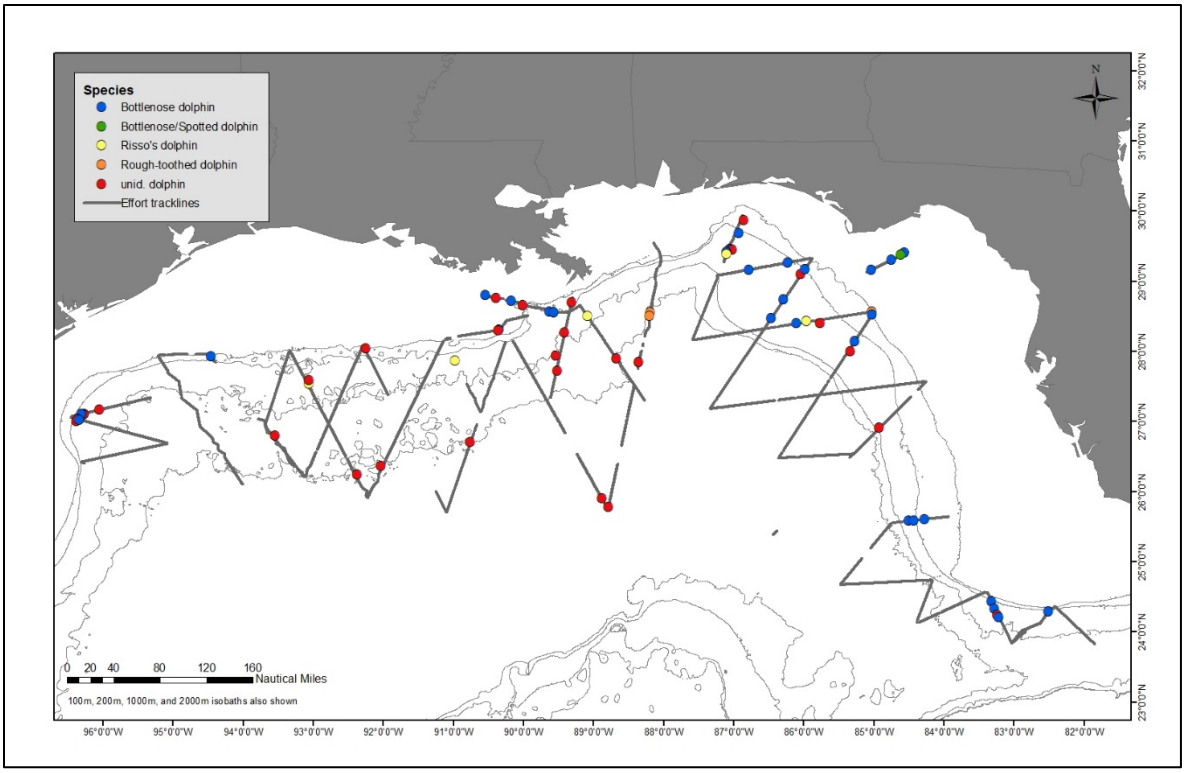


Figure 3. Marine mammal sighting locations by species during GU18-01

a.



b.



C.

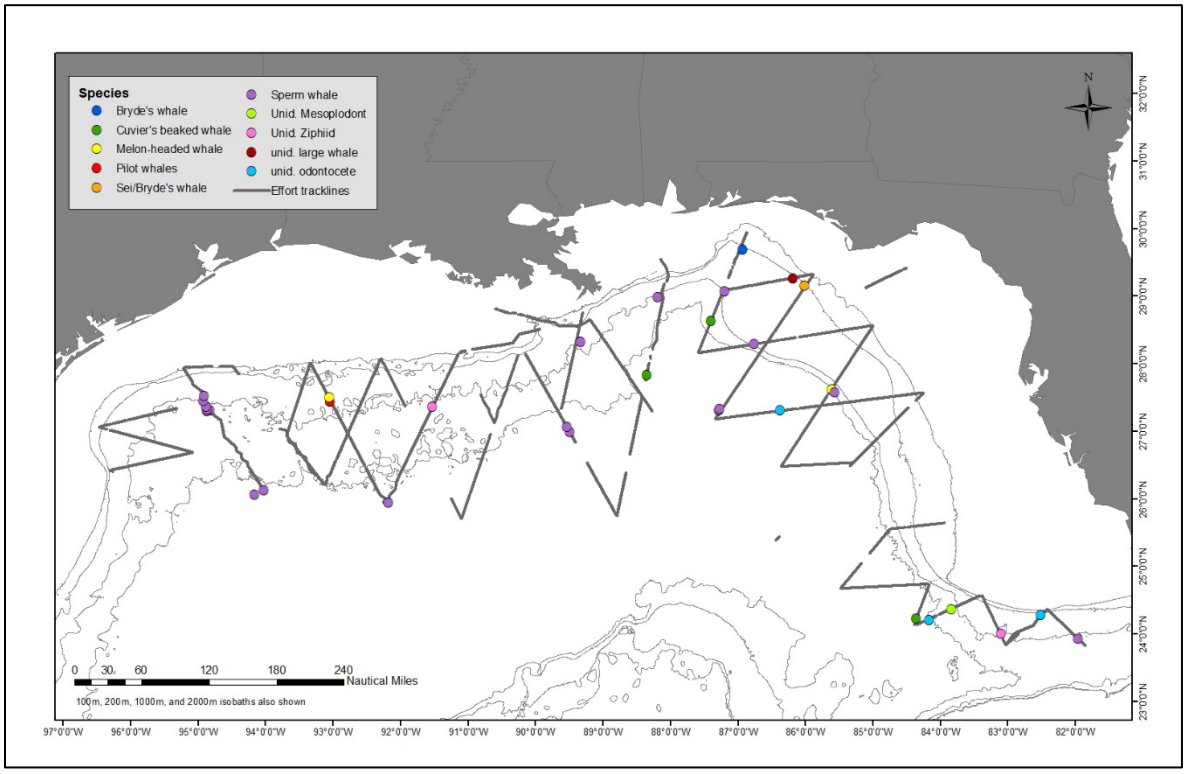

Species
Bryde's whale
Cuvier's beaked whale
Melon-headed whale
Pilot whales
Sei/Bryde's whale
Sperm whale
Unid. Mesoplodont
Unid. Ziphiid
unid. large whale
unid. odontocete
Effort tracklines
N
0 30 60 120 180 240 Nautical Miles
100m, 200m, 1000m, and 2000m isobaths also shown
97°0'0"W
96°0'0"W
95°0'0"W
94°0'0"W
93°0'0"W
92°0'0"W
91°0'0"W
90°0'0"W
89°0'0"W
88°0'0"W
87°0'0"W
86°0'0"W
85°0'0"W
84°0'0"W
83°0'0"W
82°0'0"W
32°0'0"N
31°0'0"N
30°0'0"N
29°0'0"N
28°0'0"N
27°0'0"N
26°0'0"N
25°0'0"N
24°0'0"N
23°0'0"N

Figure 4. Passive acoustic towed array survey effort and detections during GU18-01

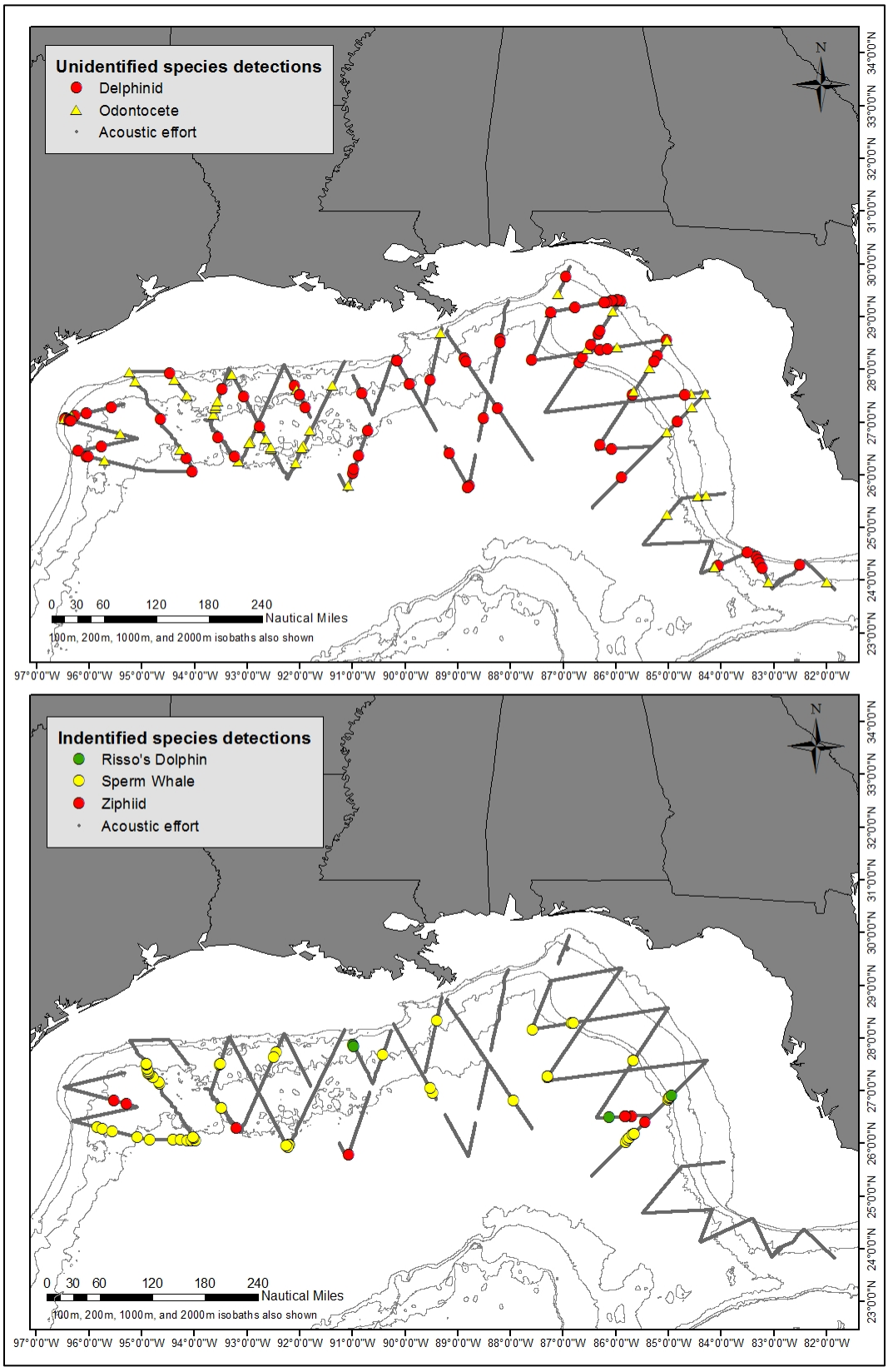
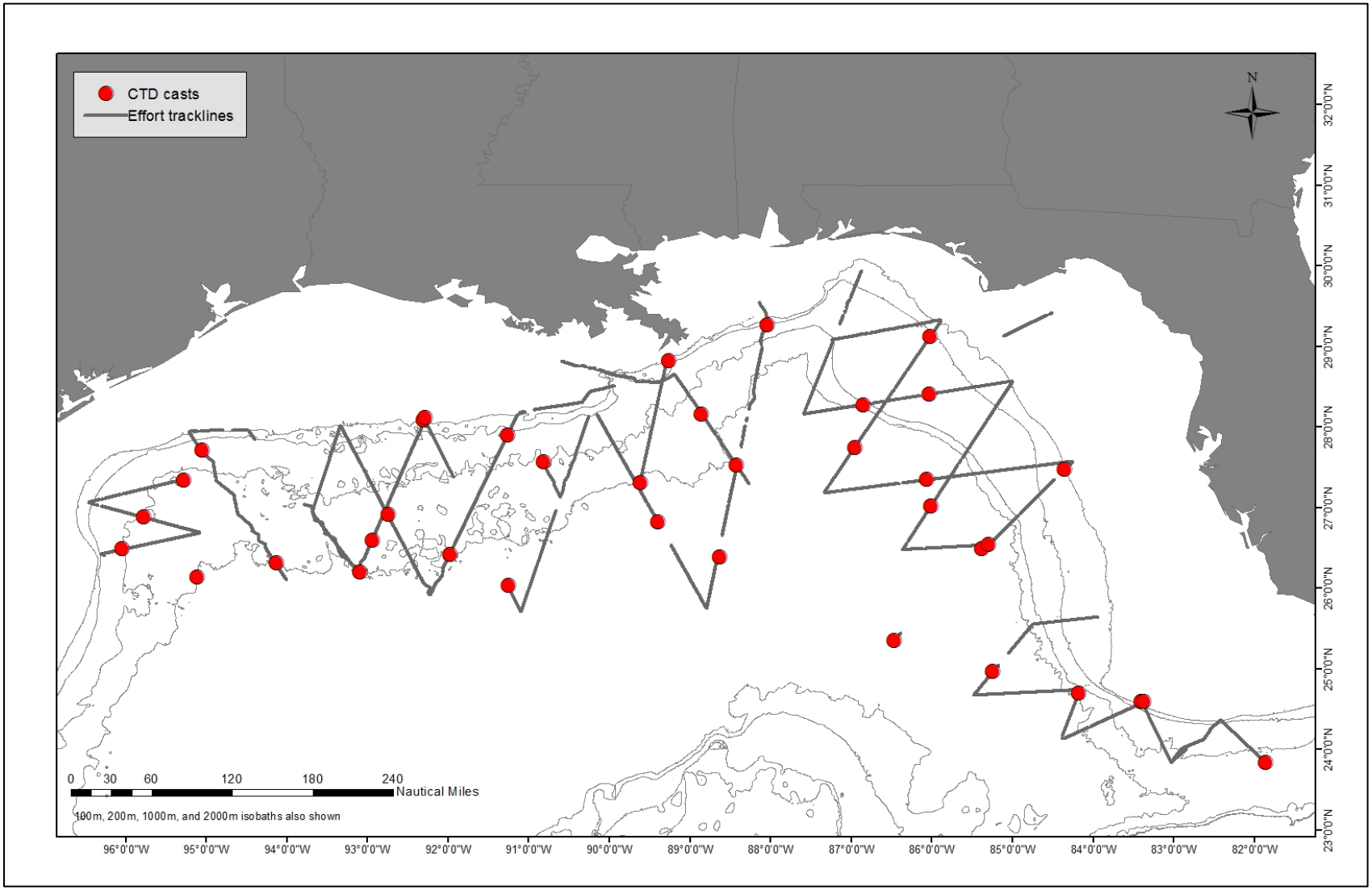
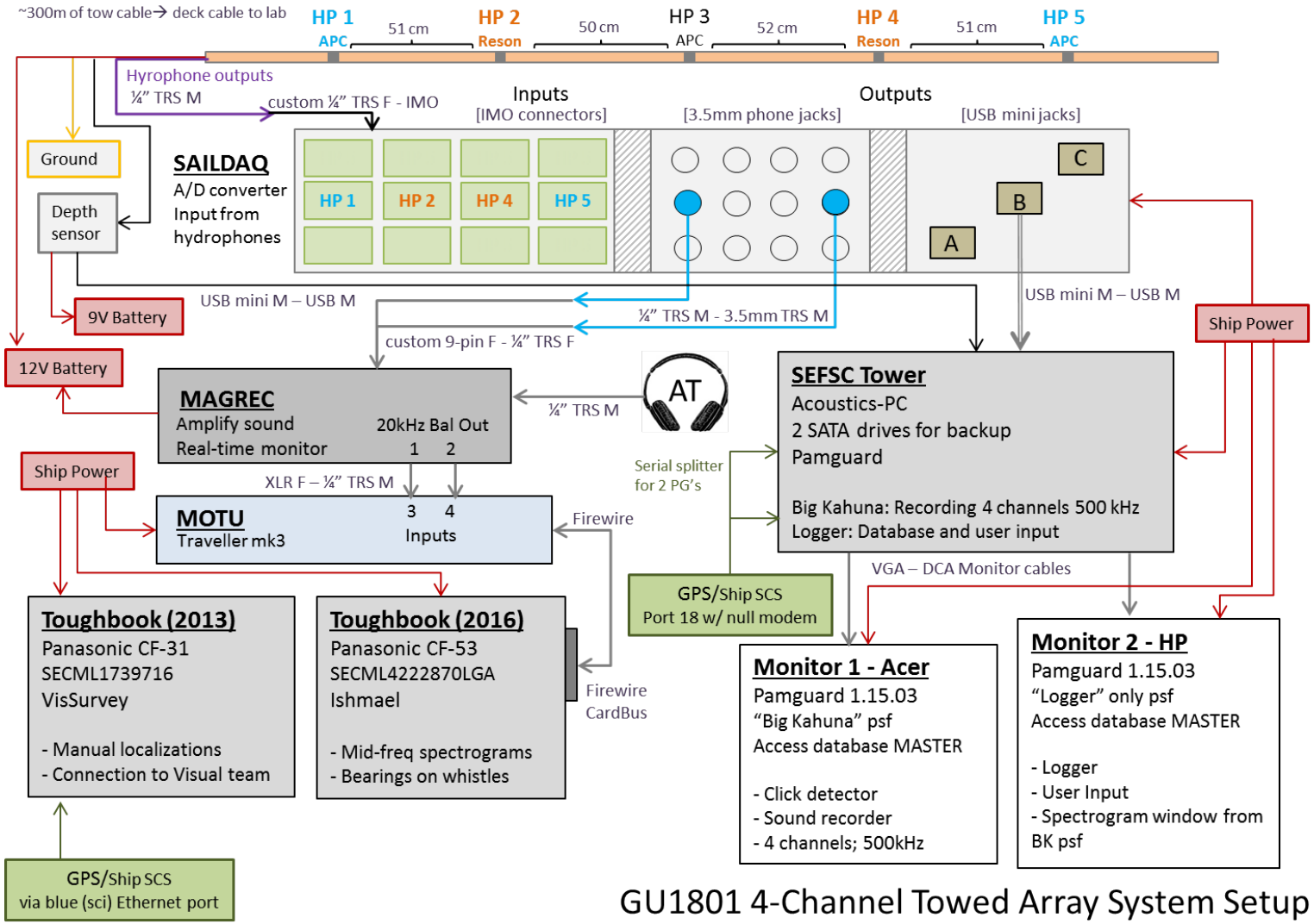


Figure 5. Hydrographic profile sampling stations during GU18-01



Appendix A: Acoustic setup diagram including towed hydrophone array, acoustic recording hardware, data inputs, and software.



GU1801 4-Channel Towed Array System Setup