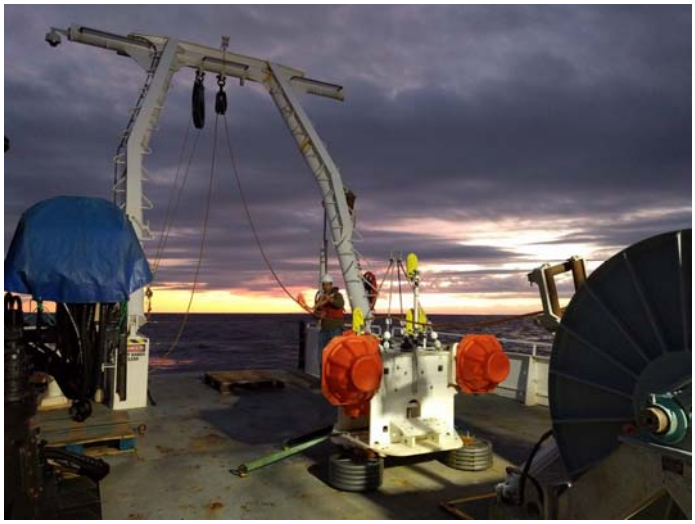
ADEON Recovery/Deployment
Cruise Report
EN626 - RV Endeavor
31 Oct – 16 Nov 2018
Narragansett, RI to Narragansett, RI



Chief Scientist Joseph Warren, Jennifer Miksis-Olds, Carmen Lawrence, Brandyn Lucca, Cassandra Fries, Brianna Cahill, Amanda Lohmann, Cristian Graupe, Rachel Eckley, Hali Rederer, Chloe Nunn, Kathleen Kouba, Julia Notar, Quintin Diou-Cass

Cruise Summary

The cruise – EN626 - RV Endeavor 31 Oct – 16 Nov 2018, from Narragansett, RI and returning to Narragansett, RI – is the third of five cruises planned for ADEON.

The objectives for this cruise were to recover bottom landers at seven sites (Figure 1) along the shelf break (depths ranging from 200 – 900 m roughly), redeploy a bottom lander at each site after downloading its data, collect CTD profiles to characterize hydrographic conditions at the sites, conduct net sampling to collect biological specimens at each site, and conduct fine-scale (roughly 8 km by 8 km) multi-frequency acoustic surveys at each site (Figure 2). We were able to complete the lander turnarounds at all seven locations successfully, but poor weather for a large portion of the trip prevented us from completing all scheduled sampling at all sites (Table 1). In addition, at several ADEON sites we collected animal specimens from net tows for collaborators associated with the DEEP SEARCH project as well as water samples for eDNA analysis for DEEP SEARCH and other collaborators. We were also able to conduct one net trawl at a DEEP SEARCH site (Million Mounds located at 30º 30.25' N 79º 39.58'W). We appreciate the excellent work of the ship's Captain and crew (in all aspects on the boat) in helping us accomplish our cruise objectives. We would also like to thank the five science party members from the UNOLS volunteer program who greatly assisted us with our work on this cruise.

Table 1. Summary of sampling that occurred at each site location during the EN626 research cruise. Weather and sea state prevented us from completing the planned sampling at several locations.

Site	**Lander Recovered and Deployed**	**CTD casts**	**Ring net tows**	**IKMT net tows**	**Fine scale Acoustic Survey**	**Water Samples Taken for DEEP SEARCH**	**eDNA samples collected**	**Fish specimens preserved**
VAC	Yes	3	1	4	No	Yes	Yes	Yes
HAT	Yes	1	0	0	No	Yes	No	No
WIL	Yes	1	1	1	Yes	Yes	No	Yes
SAV	Yes	1	1	1	Yes	Yes	No	Yes
BLE	Yes	2	1	1	Yes	Yes	Yes	Yes
JAX	Yes	1	1	2	Yes	Yes	Yes	Yes
CHB	Yes	1	1	2	No	Yes	Yes	Yes
MMD*	NA	0	0	1	Partial	No	No	No
Cruise Total	7	10	6	12	4+			

* MMD is Million Mounds, a DEEP SEARCH site where we were able to collect samples without impact to ADEON objectives.

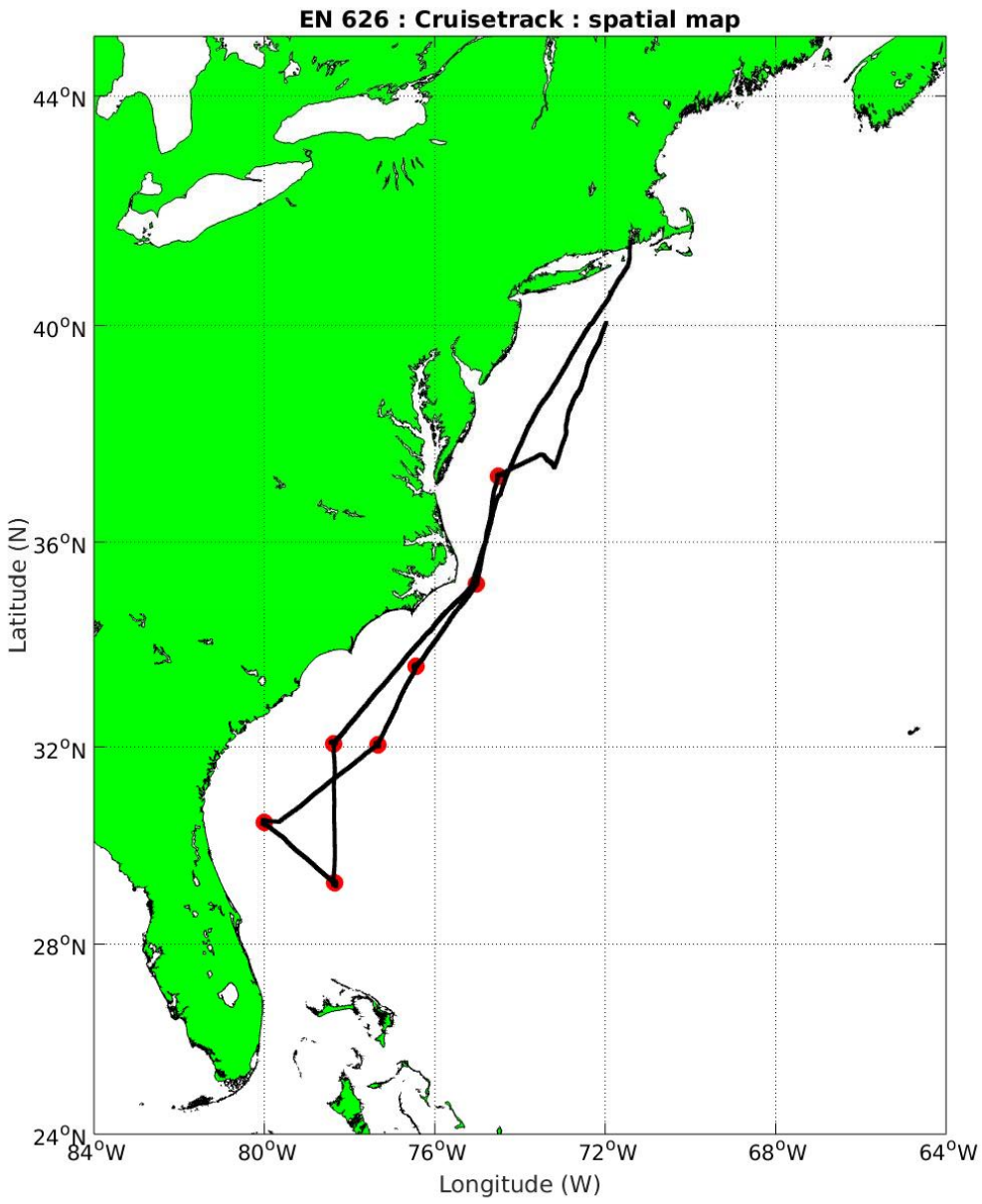


Figure 1. Cruise track for RV Endeavor Cruise #EN626 from 31 Oct – 16 Nov 2018. Site locations are highlighted by red circles.

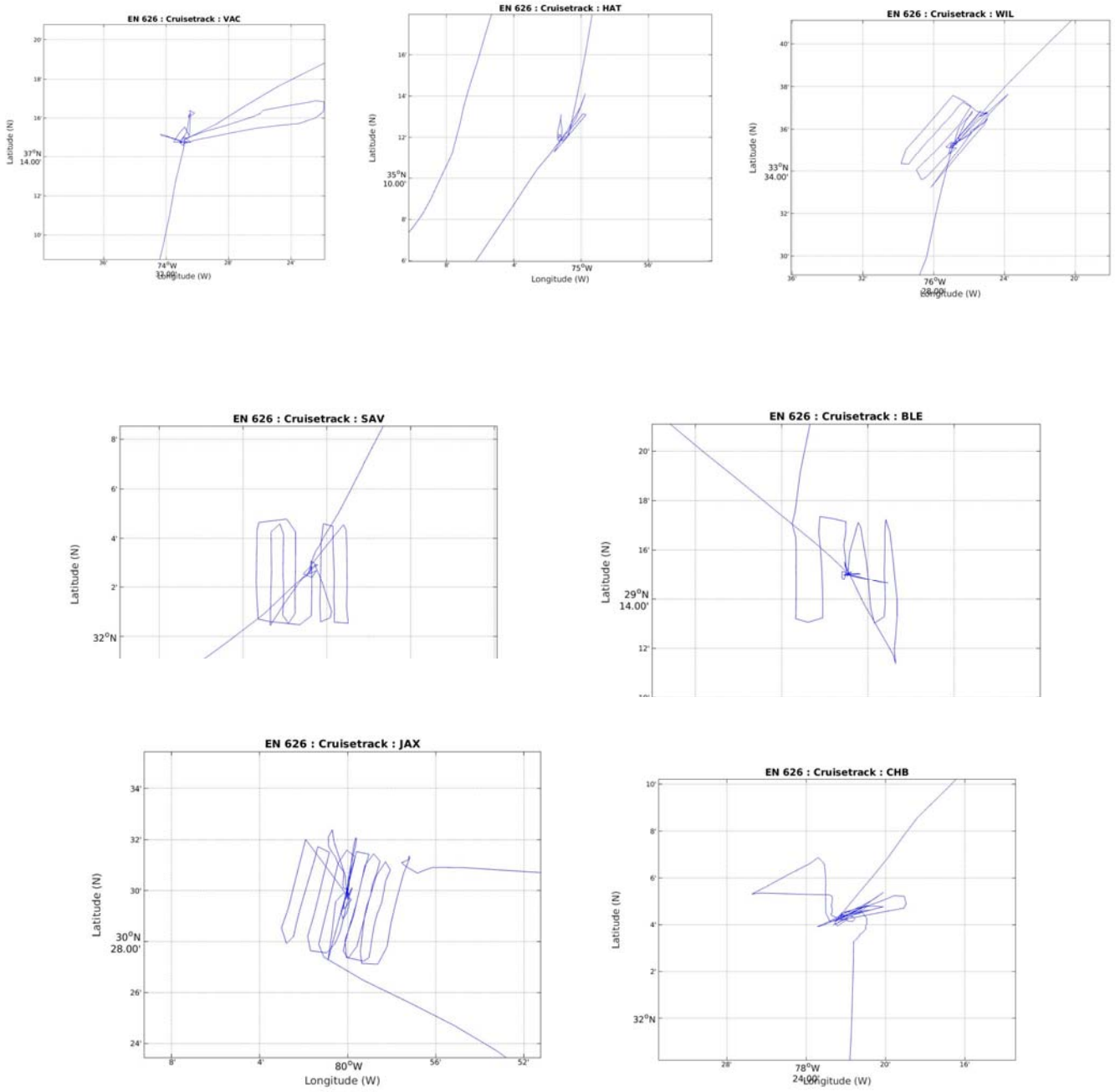


Figure 2. Cruise track for the ship at each site during RV Endeavor Cruise EN626.

Lander Deployment, Retrieval, and Refurbishment – Carmen Lawrence

Upon arrival to each station, the lander was first communicated with via the acoustic releases, and range was established. If the range was within 1km, the landers were released from the anchor. Once the lander was spotted on the surface, the vessel approached the lander on the starboard side aft and hooked the lander via a snap hook line that went to the A-frame of the vessel and to the capstan. The lander was then brought on board through the A-frame and placed on a new anchor.

At three of the seven stations (JAX, HAT and VAC), the AZFP (Acoustic Zooplankton Fish Profilers) with transducers and the VEMCO fish tag receivers were dismounted from the lander for new batteries and data download. They were then installed on the new (spare) lander to be deployed again at the same site. Only the three most shallow ADEON landers are equipped with AZFP and VEMCO sensors due to the depth rating of the sensors.

Lander deployment was performed via the A-frame, winch and quick release. The lander was lifted and suspended over the aft of the vessel and then lowered into the water. Once the lander was fully submerged, the quick release was triggered, and the lander dropped. For each station, range measurements were taken at multiple locations around the lander to triangulate a more precise lander position on the seafloor (Table 2).

Between stations, each lander was refurbished for redeployment. New anodes were added to the hydrophone cages and uprights, the new anchor was installed, and new passive acoustic AMAR hydrophone array and acoustic releases were installed. Much of the hardware showing corrosion was either replaced or cleaned. The location flasher, satellite beacon, and MicroCAT CTDs were refurbished at sea and replaced on each lander once the data had been downloaded and the batteries replaced. Several of the hydrophones also needed to be swapped due to decreased system gain values determined during onboard calibrations.

At station VAC, the lander was communicated with, but the range was off by over 3 km. Several ranges and waypoints were taken to narrow down the position of the lander, and it was found that it had been dragged roughly 1.5 nautical miles to the NE (possibly by fishing activity in the area). There was minimal damage to the lander, except for the tall hydrophone mast, which was missing entirely (Figures 3-5). All sensors were operational and did not seem otherwise damaged.

Table 2: Lander deployment locations, depth and estimated bottom locations

Site	Deployment Location		Drop Date	Time	Estimated Location		Depth
	Latitude	Longitude		(UTC)	Latitude	Longitude	(m)
BLE	29°15.036’N	078°21.064’W	2018-11-06	14:08	29 15.0546 N	078 21.0701 W	868
JAX	30°29.587’N	080°00.177’W	2018-11-07	17:52	30 29.6121 N	080 00.1623 W	317
CHB	32°04.231’N	078°22.424’W	2018-11-04	16:04	32 04.2936 N	078 22.2768 W	401
SAV	32°02.568’N	077°20.885’W	2018-11-08	23:04	32 02.6370 N	077 20.8237 W	790
WIL	33°35.127’N	076°27.034’W	2018-11-10	15:19	33 35.2429 N	076 26.9207 W	460
HAT	35°11.995’N	075°01.187’W	2018-11-11	15:15	35 12.0834 N	075 01.0969 W	291
VAC	37°14.762’N	074°30.872’W	2018-11-12	16:54	37 14.7618 N	074 30.8698 W	212

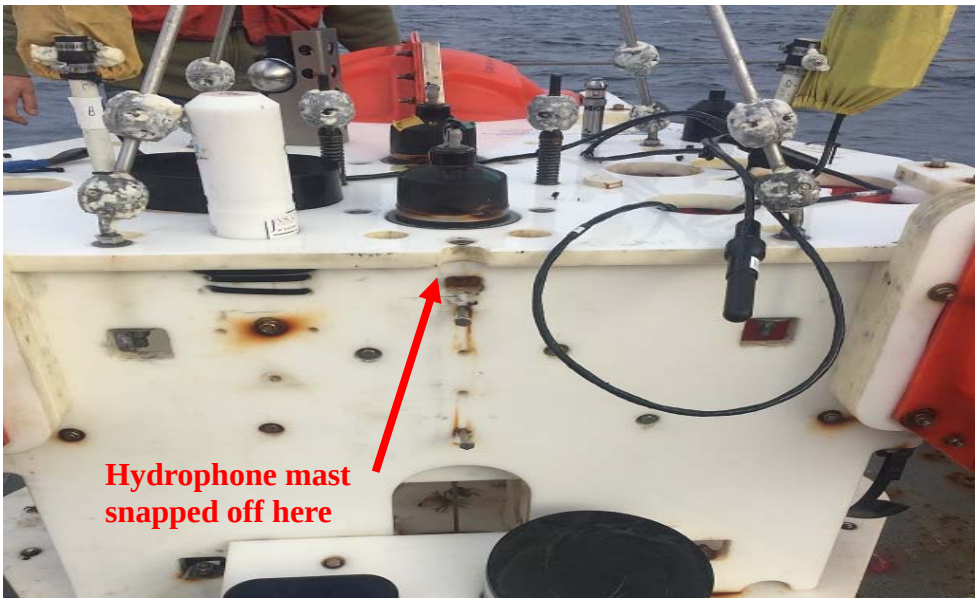


Figure 3. The VAC lander was recovered, but it was missing the tall hydrophone mast. (Photo: Carmen Lawrence)

Figure 4. Damage (scrapes on edges of lander) to VAC lander from possible trawl marks. (Photo: Carmen Lawrence)

Figure 5. More damage to VAC lander from possible trawl activity. (Photo: Carmen Lawrence)

Marine Mammal Observers (MMOs) – Jennifer Miksis-Olds

A dedicated team of Marine Mammal Observers (MMOs) conducted visual surveys from the ship during daylight hours while at the seven ADEON lander locations. MMO watch commenced approximately 5 nm from the lander drop location when the ship reduced speed upon approach during daylight hours. These observations were made to provide a record and ground truth for marine mammals sighted in the area in the lander passive acoustic datasets. Over the course of the cruise, approximately 53.5 on-effort MMO hours were logged (Table 3). Most of the marine mammals sighted during this cruise were small to medium odontocetes. Species confirmed were bottlenose dolphin (Figure 6), common dolphin, and pilot whales.

Table 3. MMO Effort Log for EN626 ADEON Cruise 3.

Date	Local Time Start	Local Time End	Hours Effort	Site
10/31/2018				Transit
11/1/2018				Transit
11/2/2018				Transit
11/3/2018				Transit
11/4/2018	6:17	17:46	11:29	CHB
11/5/2018				Transit
11/6/2018	6:20	12:36	6:16	BLE
11/7/2018	6:17	18:04	11:47	JAX
11/8/2018	16:40	17:40	1:00	SAV
11/9/2018	6:16	9:35	3:19	SAV
11/10/2018	6:25	13:00	6:35	WIL
11/11/2018	6:16	11:30	5:14	HAT
11/12/2018	6:13	13:50	7:37	VAC
11/13/2018				Transit
11/14/2018				Transit
11/15/2018				Transit

Figure 6. Two bottlenose dolphins sighted bow riding off the R/V Endeavor (Photo: Carmen Lawrence).

Multiple Frequency Acoustic Echosounder Data – Joseph Warren

The RV Endeavor (unlike the previous 2017 ADEON cruise aboard the RV Armstrong) does not contain any hull-mounted echosounders. Therefore, a pole-mount (Figure 7) was deployed on the starboard side of the ship (roughly even with the door to the main lab) with an 8 ft vertical arm at the end of which were 38, 70, 120, and 200 kHz transducers. The pole could be raised and lowered by a 3-person team when conditions (sea-state, vessel speed needs) allowed. Surveys running in the direction of sea state and current could be conducted at speeds of 6-7 kts (through the water), however vessel speeds needed to be slower (3-4 kts through the water) when running into currents or sea state or when sea state was elevated. The primary issues with the pole mount were: an inboard-outboard wiggle in the vertical pole when conditions were rough, and wave forces hitting the raised pole during high speed transits. Installation was done under ideal conditions, while disassembly was conducted in somewhat poorer conditions (rain, increased seas). Both installation and disassembly required additional personnel and the use of the ship knuckle crane.

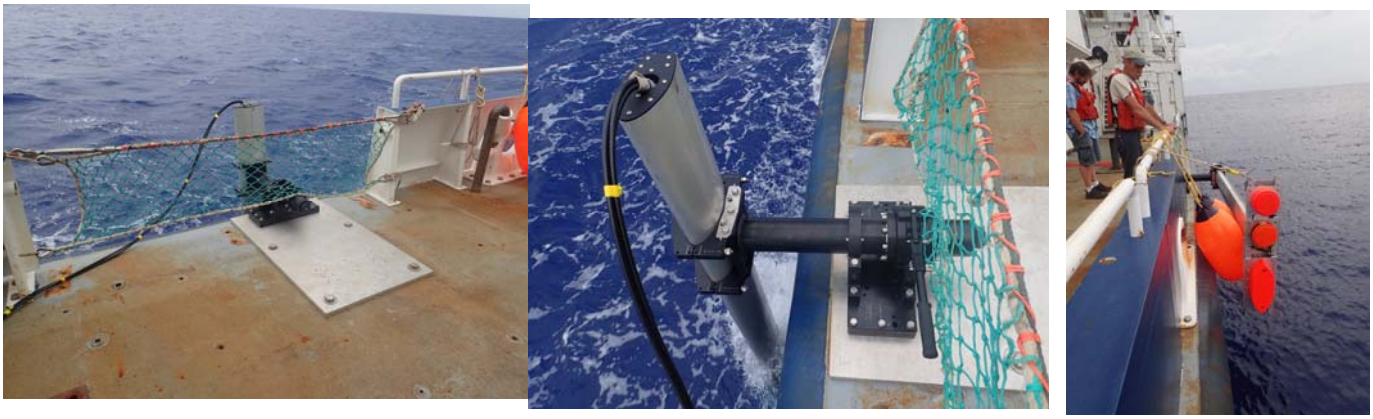


Figure 7. To install the pole-mount system on the ship, a bulwark was removed, and a 4ft x ~2.5ft x 1" aluminum plate was bolted to the deck bolt grid. The pole-mount apparatus was attached to the aluminum plate with the pole in the horizontal position. (Photos: Joseph Warren from EN615 cruise)

Three fishery echosounders were used during this cruise: an ES60 GPTs (Simrad) with a 120kHz-7C transducer and a 38kHz / 200kHz dual-frequency transducer; and a WBT (Simrad) with a 70kHz-18CD transducer. The 70kHz and 120kHz transducers are 3 and 4 sector (respectively) split-beam transducers, the 38 kHz and 200kHz systems are both single-beam transducer. The broadband system (70 kHz) was run in narrowband (CW) mode the majority of the time, although at least one survey transect at each site was run with those systems in broadband mode.

Due to sea state and weather conditions, we were unable to complete a calibration of the system during this trip.

Pulse lengths were 1024 microseconds and ping rate was variable depending on bottom depth, but generally varied between 0.5 – 2 Hz.

At the WIL, SAV, BLE, and JAX survey sites, a fine-scale acoustic grid (Figure 8) was conducted at a speed of 4-5 kn. Survey lines were adjusted for the direction of the sea state. We were unable to conduct any acoustic observations at the VAC and HAT sites, and only a brief (20-30 minutes of data collection) survey was conducted at CHB. We did collect additional echosounder data at the Million Mounds DEEP SEARCH site during a deep IKMT tow.

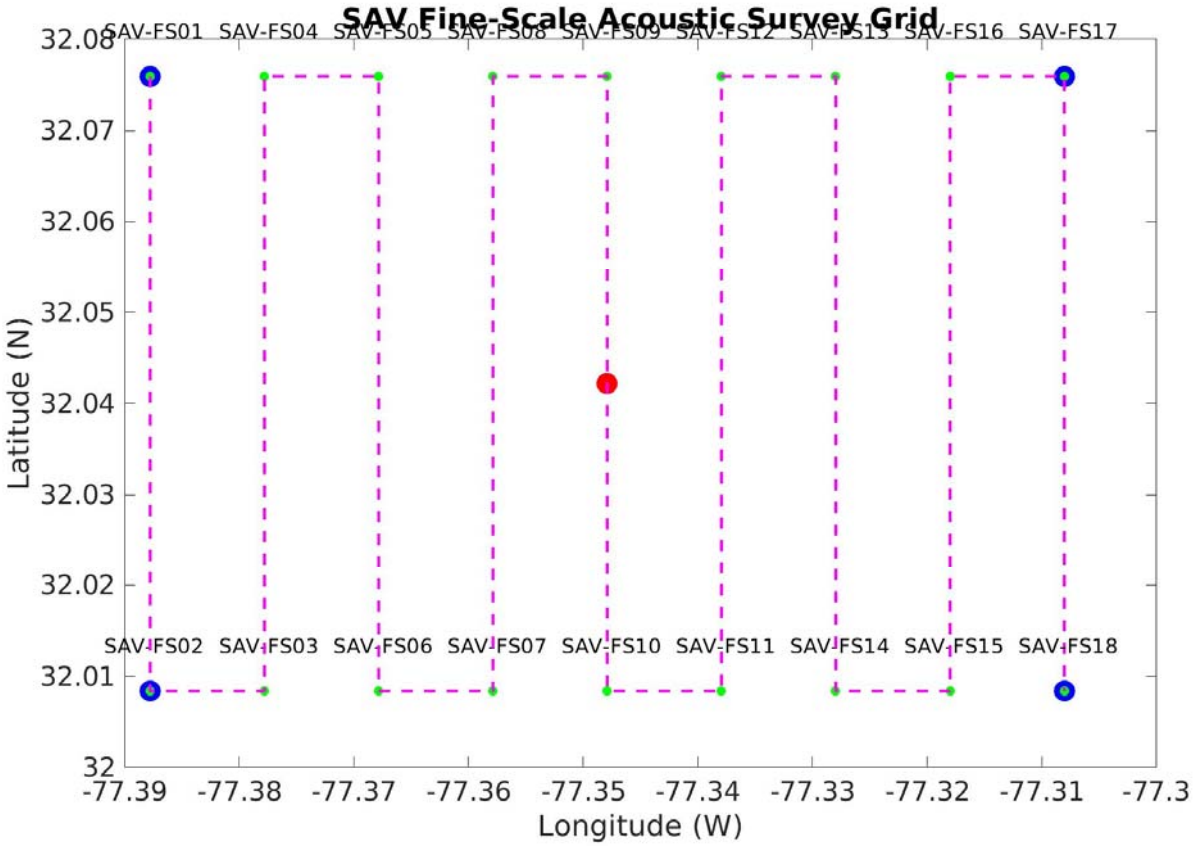


Figure 8. The planned grid for the fine-scale acoustic survey at the SAV site. The red dot at the center represents the location of the bottom lander. The survey grid covers an area roughly 8 km by 8 km. Due to limited night-time (as this cruise was during the summer) some lines were skipped in order to complete the grid before the sun rose.

Net tow sampling – Joseph Warren

Biological specimens were collected at each site using two different nets. A 60 cm diameter, ring-net Bongo pair (one with 1000 µm mesh, the other with 333 µm mesh) was deployed at each site (roughly at the lander location) with a vertical cast to 100 m (Figure 9). Actual net depths may be slightly less than the wire out due to surface currents causing the tow wire to be slightly off-vertical. Zooplankton and larval nekton collected in the ring net were preserved in buffered formalin solution for post-cruise identification and enumeration. Unique or interesting specimens from these tows were occasionally photographed or preserved individually.

A larger net (5 m^2 Isaacs-Kidd Midwater Trawl) was also deployed at each site (Figure 9), typically multiple times per site. One tow was done at the lander location and was targeted to sample the scattering layers observed in the water column on the echosounder. Additional tows were conducted to sample the deep (> 750 m) scattering layers and to collect specimens from the mesopelagic region.

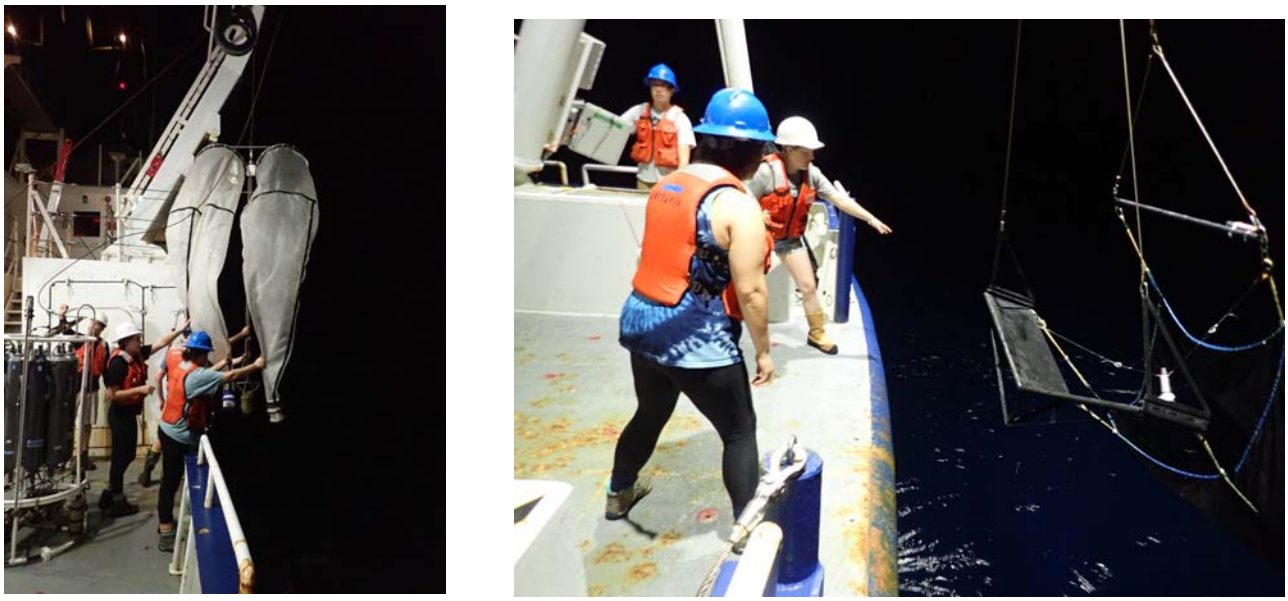


Figure 9. Bongo net (left) being deployed for a vertical cast to a depth of 100 m. The Isaacs-Kidd Midwater Trawl (right) being deployed. Wire-out speeds were 20 – 40 meters per second, and haul-back speeds were 10 to 30 meters per second. Tow depths ranged from ~150 m to 1300 m. (Photos: Joseph Warren)

Animals from these net tows were preserved in formalin solution for post-cruise identification and enumeration. Selected individual animals were removed (noted on the tow data sheet) for photography (Figure 10), individual preservation, or for collaborators with the DEEP SEARCH project for stable isotope and DNA analysis.

Figure *10. Some of the animals collected by net tows during the EN626 cruise. (Photos: Joseph Warren)*

Material Property Measurements of Net-collected Animals – Cassandra Fries

In order to estimate numerical density of organisms from acoustic backscatter data, the animal's Target Strength must be known. Often this is modelled using information about the type of organism (i.e. fish, euphausiid), its size and shape, and other material properties such as the density and sound-speed contrast of the organism with the surrounding seawater. These measurements are most accurate when made on freshly-captured specimens so individual animals were taken from the net catches to be measured. The density contrast (*g*) measurements of 134 specimens were collected while aboard EN626 (Table 4). The density of the individual animals was collected by finding their neutral buoyancy. To find the neutral buoyancy, the animals were placed in a beaker with seawater and a 50:50 mix—consisting of seawater and glycerin—was added until the organisms were suspended. The seawater was collected prior to the experiments, at our Charleston Bump site (CHB) and was used for all measurements. The salinity was noted when collected and was 36.496 ppt. The density of seawater was calculated from the salinity and temperature. The density of the glycerin mixes was also calculated. When an animal was too dense to become buoyant, a mix of 25% seawater to 75% glycerin was used. It was only used twice, for krill and phyllosoma. An ice bath was used for the first measurements done on krill, due to a large temperature difference from depth of collection to the warmer temperature of the experimental seawater and mixes added (about 13 deg. C difference). Freshwater was used when animals were positively buoyant in the seawater, and was used once for salps. After the density of the animal is found, *g* is calculated by the density of the animal divided by the density of seawater.

All animals were collected in IKMTs. After the experiments, animals were sorted and numbered, and photographs were taken of the dorsal and ventral sides. Animals were then placed in cryoviles and frozen for possible further measurements.

Table 4. Inventory by taxa of animals that had their density contrast with seawater (g) measured during the EN626 cruise.

Taxa	**Number of Animals**
Krill	33
Haliporus shrimp	9
UID shrimp	22
Bothus	4
Cyclothone	10
Phyllosoma	7
Pyrosomes	23
Skeleton Shrimp	3
Heteropods	3
Salps	15
Stomotapods	5

TS Measurements – Brandyn Lucca

Ex situ target strength (TS) – the logarithmic measure of the acoustic cross-section of a backscattering target – measurements of several types of organisms were measured. These estimates provide valuable acoustic data for single organisms that can be used to improve quantitative estimates of abundance and biomass of different types of animals as well as validating theoretical acoustic TS models. Model validation allows us to determine the most appropriate model that will best predict the TS of different animals across a frequency spectrum and ultimately allow for further development of target discrimination techniques to identify what we are seeing in the water column. All TS experiments were conducted in a 44-gallon Rubbermaid aquarium with aluminum brackets fitted with two broadband polyurethane transducers (Figure 11). These transducers pinged at both discrete frequencies (35, 38, 42, 60, 70, 75, 120, 130, 150, and 200 kHz) and broadband sweeps (42-65, 20-30, 30-40, 40-50, 50-60, 60-70, 70-80, 110-230, 110-120, 120-130, 130-140, 140-150, 150-160, 160-170, 170-180, 180-190, 190-200, 200-210, 210-220, and 220-230 kHz). These TS measurements were also calibrated using standard techniques and also included measurements of a 38.1 mm tungsten carbide sphere for additional calibration of the data acquisition system.

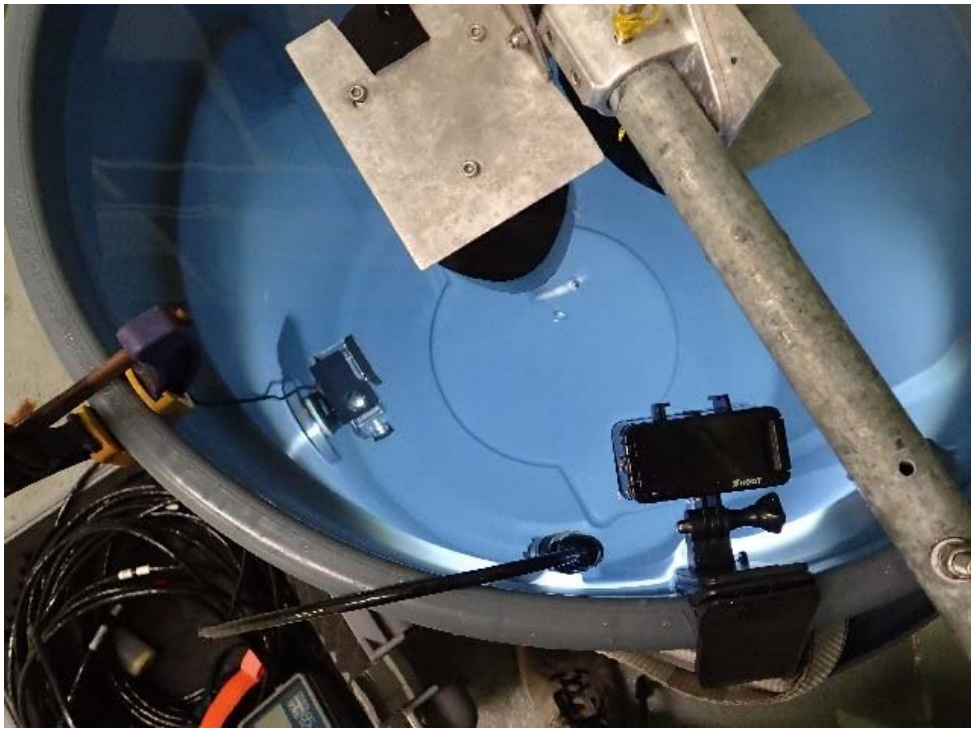


Figure 11. Experimental aquaria set up of broadband transducers, underwater camera to monitor the orientation of the animals, LED lights to increase visibility, and a YSI 85 probe to collect real-time temperature and salinity data which affect the sound speed velocity in water. (Photo: Brandyn Lucca)

All animals used in the experiment were collected from various IKMTs which had a 1 mm mesh cod end. Broadside and ventral photographs of all animals were taken prior to any experiments to help parametrize theoretical TS measurements which are, in part, a function of animal length, height, width, and overall shape (Figure 12). A sub-sample of animals were frozen for future measurements (e.g. mass, calorimetry).

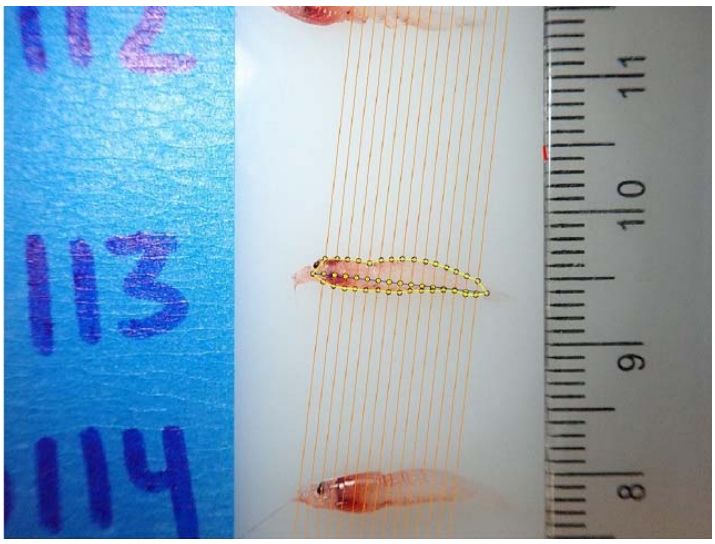


Figure 12. Examples of krill captured from one of the IKMT tows. The yellow outline indicates the hand-drawn shape of animal 0113 using a customized Matlab program. (Photo: Brandyn Lucca).

Animals were tethered to monofilament fishing line (3.5 lbs, 0.007 in thickness) using a single loop around their respective midsections at an approximate depth of 34 cm. A GoPro camera was set up to provide a live-feed of each animal's position in the trash can and to provide photographs that can be used to measure tilt angles relative to the water surface (Figure 13). Images and video were captured at a minimum of 30 FPS since a ping rate of 30 Hz was used.

Figure 13. Photograph of a tethered myctophid caught in a larval net on 08 November 2018. (Photo: Brandyn Lucca)

In total, more than 900 animals were photographed, cataloged, and will be used to parametrize theoretical acoustic models in the future. Of these animals, 16 were used for *ex situ* TS experiments and comprised 1 pyrosome, 1 krill, 4 shrimp, and 10 myctophids.

Biological Sampling for Deep Search collaborators – Rachel Eckley

Animal specimens from ADEON net tows were collected on behalf of researchers in the DEEP SEARCH program by Rachel Eckley, a MS student from Nova Southeastern University in Dr. Tracey Sutton's lab. Rachel also assisted with the processing of net tows and identification of different taxa. Specimens were preserved in either ethanol or frozen whole depending on which scientist requested the samples.

Table 5. Inventory of specimens collected for other researchers during the EN626 cruise.

Taxon	Quantity collected	Preservation method	Requestor
Myctophidae fish	70	ethanol	Andrea Bernard
Hatchetfish	3	ethanol	Ron Eytan
Serrivomer eel	3	ethanol	Ron Eytan
Squid	8	-20 C freezer	Vecchione
Pyrosome	30	-20 C freezer	Lex Berger
Shrimp	80	-20 C freezer	Demopoulos – USGS
Leptocephali	18	ethanol	Cheryl Morrison
Copepod	8	ethanol	Cheryl Morrison

Total specimen collected:	220

Water Sampling – Jennifer Miksis-Olds

A CTD (Figure 14) equipped with a 12 Niskin bottle rosette was deployed at each ADEON location to obtain the sound velocity profile in support of the acoustic propagation portion of the study. In addition, water samples were collected for ADEON's sister project, DEEP SEARCH. DEEP SEARCH water samples were taken in triplicate for Dr. Cheryl Morrison (USGS) at 4 depths: bottom, deep scattering layer, 50-100 m above the deep scattering layer, and at the surface. Water samples were also collected at the deep scattering layer and surface for an environmental DNA (eDNA) study being conducted by Dr. Alison Watts (UNH). In total, 96 liters of water were preserved: 84 liters for DEEP SEARCH and 12 for eDNA.

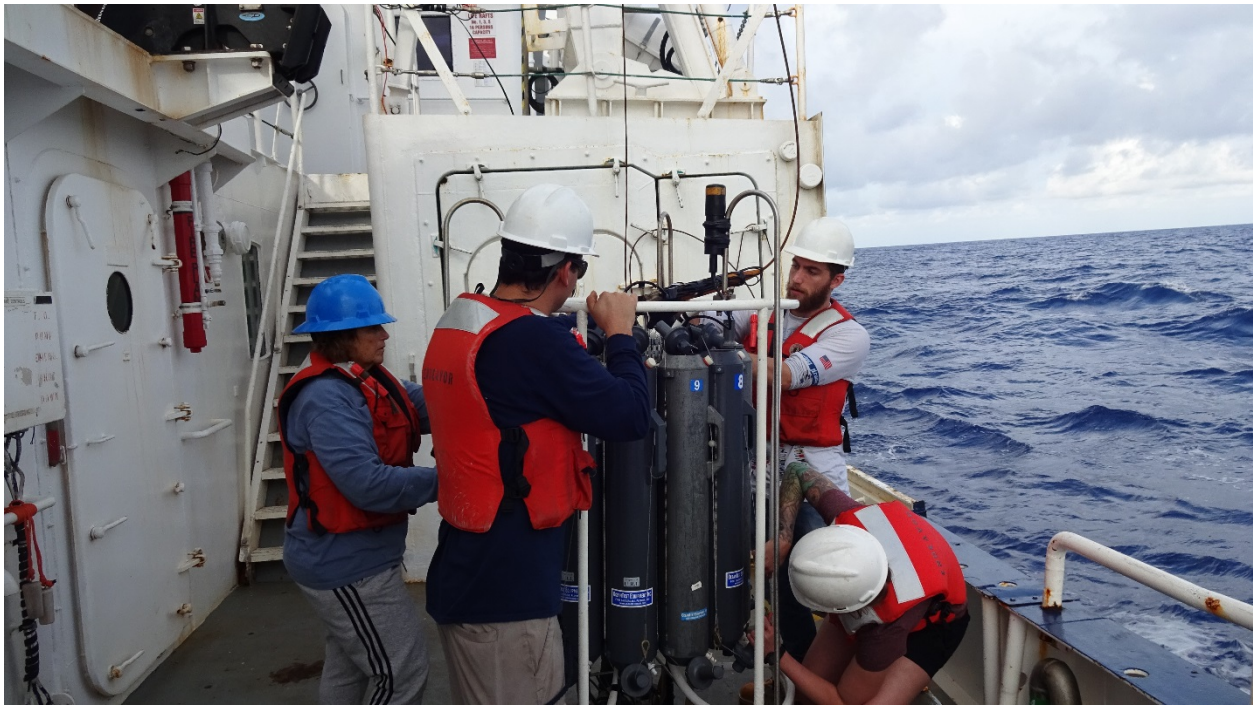


Figure 14. The CTD and water sampling rosette being prepared for deployment by the ADEON team (Photo: Jennifer Miksis-Olds).