DEEPEND

DEEP PELAGIC NEKTON DYNAMICS OF THE GULF OF MEXICO

Cruise Report
R/V *Point Sur* cruise DP04

5 August– 19 August 2016

DEEPEND DP04 Cruise Participants on the R/V *Point Sur*

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21. Marshall Kormanec	LUMCON	Technician

Report of
DEEPEND Cruise DP04
5 April – 19 August 2016; USM R/V *Point Sur*, Gulfport, MS
Chief Scientist: Tracey Sutton

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A DEEPEND (Deep Pelagic Nekton Dynamics)
Consortium Report

Available online from the DEEPEND website,
www.deependconsortium.org

Acknowledgements

This was the fourth DEEPEND cruise in the Gulf of Mexico. The success of the cruise was due to the outstanding efforts of the Captain and Crew of the R/V *Point Sur*, LUMCON Marine Operations, the University of Southern Mississippi Department of Marine Science, OKEANUS Science and Technology, Continental Shelf Associates, Sea-Gear Corporation, the San Antonio Zoo, the NSU Oceanic Ecology Lab (R. Milligan, M. Novotny, N. Pruzinsky, K. Ramkissoon, M. Woodstock), and all members of the science party. The cheerfulness, resourcefulness, and hard work of all participants were outstanding. This cruise was supported by the Gulf of Mexico Research Initiative (GOMRI2014-IV-914).

TABLE OF CONTENTS

1 Purpose of the Cruise

The DEEPEND Consortium is an ocean realm field project supported by the Gulf of Mexico Research Initiative (GoMRI). The focus of the DEEPEND Consortium is to develop a quantitative, taxonomically comprehensive assessment of the deep-pelagic faunal assemblages of the northern Gulf of Mexico (GoM hereafter) in the region of the *Deepwater Horizon* oil spill (DWHOS), including examination of longer-term consequences of the DWHOS on these assemblages. The project goals of this third cruise include: 1) quantitative assessment of deep-pelagic nekton (fishes, macrocrustaceans, and cephalopods) and gelatinous zooplankton assemblage structure, abundance, and distribution across a range of biophysical conditions corresponding to the major oceanographic features of the Gulf of Mexico; 2) quantitative acoustic profiling of the fine- and mesoscale distributions of oceanic nekton; 3) collection of nekton, plankton and microbial samples for genomics/genetic analyses to be conducted in five research labs (Nova Southeastern University, Texas A&M University Galveston, Florida International University, Smithsonian Institution/National Museum of Natural History); 4) collection of nekton, and plankton samples for stable isotope, hydrocarbon, otolith microchemistry, parasite, and mercury analyses; 5) collection of particulate organic carbon samples for stable isotope analysis; 6) collection of phytoplankton filtrates (chlorophyll analysis) for remote sensing calibration; 7) collection of *in situ* biophysical oceanographic data for community analyses and assimilation into HYCODE and remote sensing models; 8) collection of fish specimens for genomic fingerprinting of bioluminescent microbial symbionts; and 9) collection of photographic and video content for Outreach & Education efforts. The strategy for DP04 was to sample within three major oceanographic features that occurred in the northern GoM at the time of the cruise: a cyclonic (cold-core) eddy, an anti-cyclonic (warm-core) Loop-Current eddy, and “common” water (Figure 1). Sampling was also conducted to continue a time series of stations sampled from the DWH spill site to DeSoto Canyon.

As with previous DP cruises, sampling/sensing was conducted aboard the R/V *Point Sur*. Scientific participants on this cruise (see frontispiece) included expert taxonomists in the major deep-pelagic nekton faunal groups, genetic taxonomists, acousticians, technicians, an Educator-at-Sea, an outreach/imaging specialist, graduate students, and a professional videographer from the BBC Natural History Unit. Specimens were identified at sea using traditional taxonomic approaches. After the cruise, species counts, molecular analyses, and expert taxonomic evaluation and description of any putative new records or undescribed species will be done in association with the DEEPEND Taxonomic Working Groups.

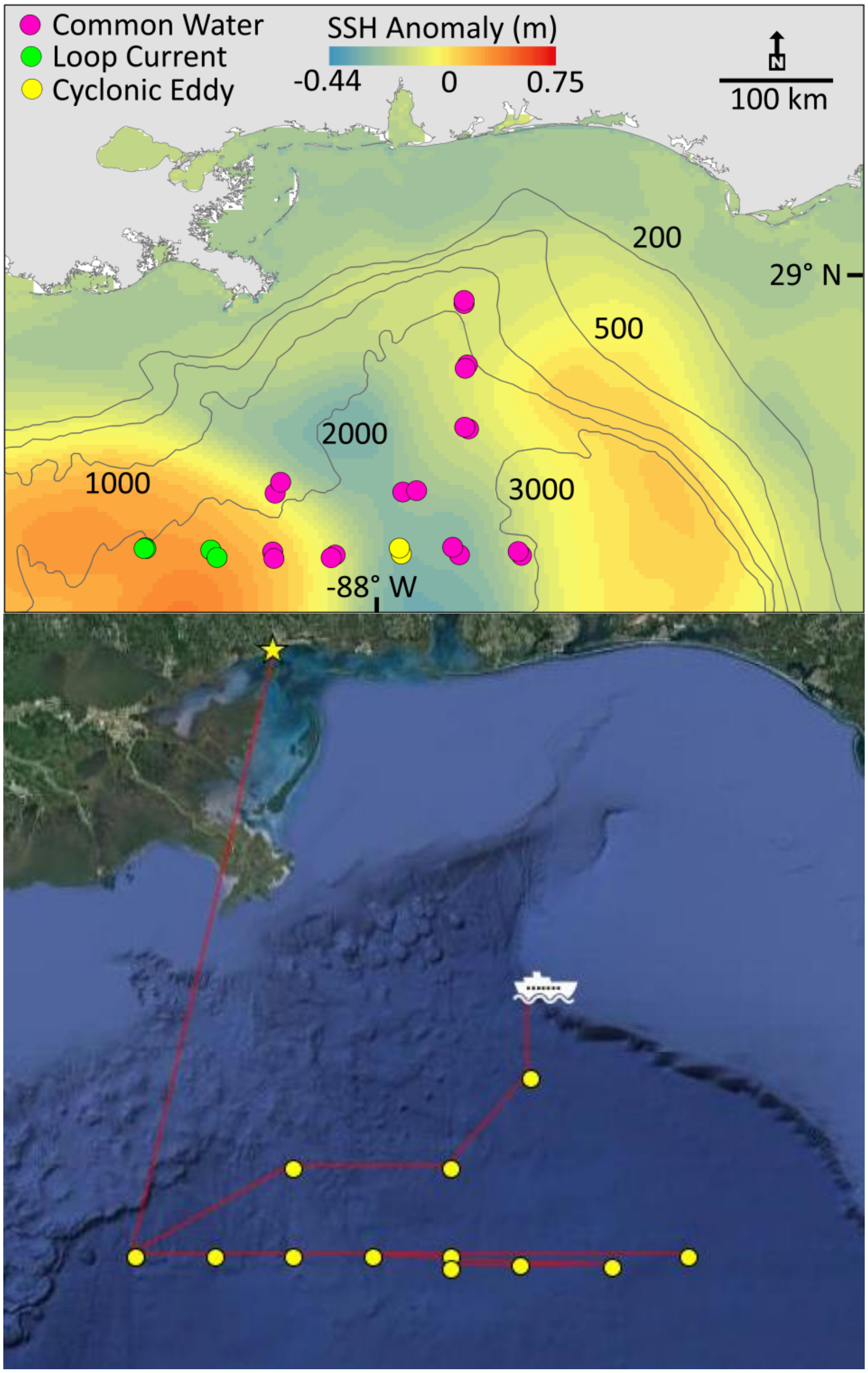


Figure 1. Cruise track of DEEPEND cruise DP04 (5-19 August 2016) relative to mesoscale oceanographic features (top) and seafloor topography (bottom).

2 Narrative

Ship's cruise number: PS_17_03_Sutton
DEEPEND cruise number: DP04

All cruise activity times presented as 24-h clock notation in Central Daylight Time (UTC – 5 h). A map of standardized station names and station order is presented in Figure 2.

05 August 2016: We left Gulfport at 0043 and arrived at Station SW6 (27°00N, 90°00W) at 2240. The MOCNESS was deployed at 2313 (Trawl 057) for a max depth of 928.3 m. The Flow meter stopped working at 400 m.

06 August 2016: The MOCNESS was recovered from Station SW6 at 0302. We conducted a CTD rosette cast at 0415, followed by the deployment of the optics profiler at 0605. The MOC-10 gear was deployed at 0935 (Trawl 058) and recovered onto deck at 1508. Nets 1-5 were fished to a maximum depth of 1515.2 m. The flow meter was intermittent for nets 3 and 4. The samples were unloaded and processing began. The naming conventions for trawl samples remained the same as those used in DP01, DP02, and DP03:
Example: DP04-06AUG16-MOC10-SW6D-057-N1.
Key: Cruise No. – Date – Gear Type - SEAMAP station code + (N = night, D = day) - Trawl No. - Net No.

Gear Types: MOC10: MOC-10 trawls;
TT: Tucker trawl;
NN: Neuston net;
BN: Bongo net;
CTD: Water sample from CTD rosette

Trawl numbers are cumulatively increased across all sampling years and are not restarted each cruise.

The optics profiler was deployed at 1625 followed by a CTD cast conducted at 1713. The MOC-10 gear was deployed again at 2215 (Trawl 059). Nets 1-5 were fished to a maximum depth of 1498.2 m.

07 August 2016: Trawl 059 was recovered to deck at 0320. We left station SW6 at 0343 for station SW4. We arrived at station SW4 (27°00N, 89°00W) at 0900 and deployed the MOCNESS at 1035 (Trawl 060). Nets 1-5 were fished to a maximum depth of 1503.9 m. The MOC-10 was recovered to deck at 1529. A small boat was deployed with the glider at 1619, and at 1943 the small boat was recovered. We conducted a CTD cast of station SW4 at 2004 and the scheduled optical profiler deployment was cancelled. The MOC-10 gear was deployed (Trawl 061) at 2200. Nets 1-5 were fished to a maximum depth of 1502.7 m.

08 August 2016: MOCNESS was recovered from Station SW4 to deck at 0310. We were in route to Station SE1 (27°00N, 88°00W) by 0330. We arrived at Station SE1 and deployed (Trawl 062) the MOCNESS at 1000. Nets 1-5 were fished to a maximum depth of 1498.8 m The MOC-10 gear was recovered to deck at 1447 and at 1500 we were underway to recover the glider. Due to heavy rains and wind we could not recover the glider so we began the return journey to Station SE1 (27°00N, 88°00W) at 1654. A CTD cast of Station SE1 was conducted at 1821 and at 1901 the optical profiler was deployed. The MOC-10 gear was deployed at 2127 (Trawl 063). Nets 1-5 were fished to a maximum depth of 1505.6 m.

09 August 2016: The MOC-10 was recovered from Station SE1 to deck at 0300. Transit to Station SE3 (27°00N, 87°00W) began at 0315 and arrived at 0900. The MOC-10 gear was deployed (Trawl 064) at Station SE3 at 0940 and recovered to deck at 1512. Nets 1-5 were fished to a maximum depth of 1539.8 m. The glider was recovered at 1642 and at 1822 a CTD cast was conducted. The optics profilers was deployed at 1936 and the MOCNESS was deployed at 2155 (Trawl 065). Nets 1-5 were fished to a maximum depth of 1506 m.

10 August 2016: The MOC-10 was recovered to deck at 0330. A second CTD cast of Station SE3 was conducted at 0345 and at 0445 the optics profilers was deployed for a second time at Station SE3. At 0520 we started the transit to Station SE2 (27°00N, 87°00W). We arrived at Station SE2 at 0900 and we had our RAPP winch computer system fail. The wires were replaced and the system was back online at 1005. The MOC-10 gear was deployed (Trawl 066) at 1047. Recovery of the MOC-10 gear was at 1636. Nets 1-5 were fished to a maximum depth of 1497 m. At 1705 a small boat was deployed for the glider and at 1822 the glider was at the surface. The small boat was recovered at 1850. A CTD cast was conducted at 1904 on Station SE2 with the optics profiler deployed at 2017. The MOCNESS was deployed at 2151 (Trawl 067). Nets 1-5 were fished to a maximum depth of 1502.3 m.

11 August 2016: The MOC-10 was recovered to deck at 0310. The vessel left station SE2 at 0337 and headed for station SW3 (27°00N, 88°30W). We reached station SW3 at 0900 and at 1000 the MOCNESS was deployed (Trawl 068). Nets 1-5 were fished to a maximum depth of 1501.8 m. The MOCNESS was recovered to deck at 1532. A CTD cast was conducted of SW3 at 1722 and the optics profiler was deployed at 1835. The MOCNESS was deployed a second time at Station SW3 (Trawl 069) at 2135. Nets 1-5 were fished to a maximum depth of 1515 m.

12 August 2016: The MOC-10 gear was recovered to deck at 0310 and we left station SW3 for station SW5 at 0321. We arrived at station SW5 (27°00N, 89°30W) at 0900. The MOCNESS was deployed (Trawl 070) at 1003 and recovered to deck at 1503. Nets 1-5 were fished to a maximum depth of 1517.6 m. A CTD cast was conducted at 1608 followed by the deployment of the optics profiler at 1731. The MOC-10 was deployed (Trawl 071) at 2145 on station SW5. Nets 1-5 were fished to a maximum depth of 1510.8 m.

13 August 2016: The MOC-10 was recovered to deck t 0310. We left station SW5 for station SW6 (27°00N, 90°00W) at 0320. We arrived at station SW6 at 0900 and deployed the MOCNESS (Trawl 072) at 1000 and recovered to deck at 1554. We left station SW6 for Station B064 (27°30N, 89°00W) at 1719.

14 August 2016: Upon arriving at station B064 (27°30N, 89°00W) a CTD cast was made at 0458 followed by deployment of the optic profiler at 0700. The MOC-10 was deployed at station B064 (Trawl 073) at 0930. Nets 1-5 were fished to a maximum depth of 1512 m. The MOCNESS was recovered to deck at 1533. The optics profiler was deployed a second time at station B064 at 1621 followed by a second CTD cast at 1723. The MOC-10 gear was deployed (Trawl 074) at 2130. Nets 1-5 were fished to a maximum depth of 1496.9 m. Nets 3-5 may not have fished the correct depths.

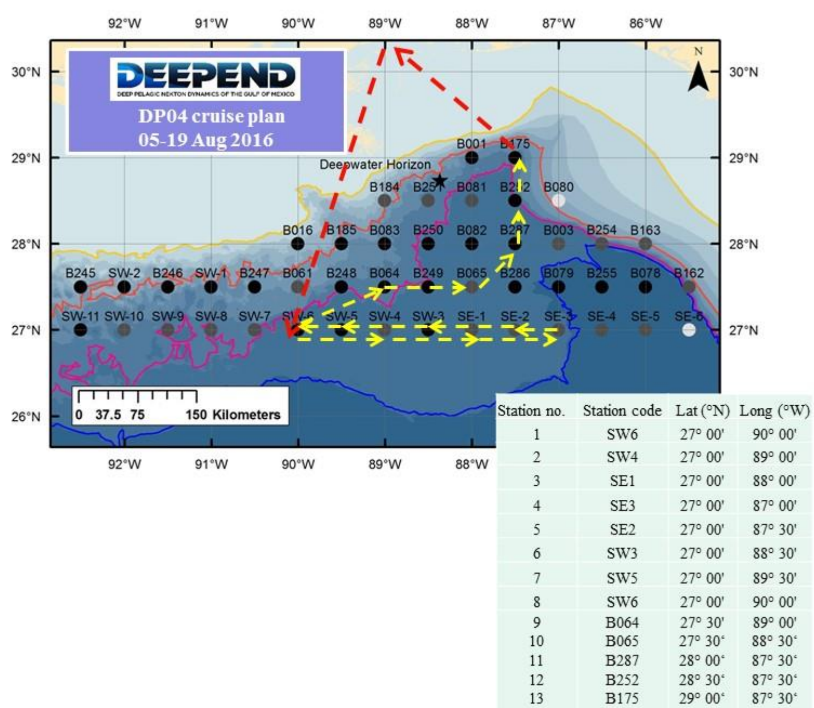
15 August 2016: The MOC-10 was recovered at 0232. We then proceeded to station B065 (27°30N, 88°00W) at 0249 and arrived at 0830. The MOC-10 was deployed (Trawl 075) at 1015 and nets 1-5 were fished to a maximum depth of 1499.1 m before recovery at 1527. A CTD cast was made of station B065 at 1628 with the MOC-10 deployed (Trawl 076) at 2200. Nets 1-5 were fished to a maximum depth of 1503.8 m

16 August 2016: At 0336, the MOC-10 was recovered from station B065. We departed for station B287 (28°00N, 87°30W) at 0349 and arrived at 0940. The MOCNESS was deployed (Trawl 077) at 1040, the nets 1-5 were fished to a maximum depth of 1501 m before recovery to deck at 1539. At 1644 a CTD cast of station B287 was conducted followed by the deployment of the optics profiler at 1804. The MOC-10 was deployed (Trawl 078) at 2145. Nets 1-5 were fished to a maximum depth of 1500.5 m.

17 August 2016: The MOC-10 was recovered to deck from station B287 at 0250. We departed for station B252 (28°30N, 87°30W) at 0315 and arrived at 0840. The MOCNESS was deployed (Trawl 079) at 1000, and nets 1-5 were fished to a maximum depth of 1501.8 m. The MOC-10 gear was recovered to deck at 1529. We left station at 1534 to retrieve our glider, and at 1803 the glider was recovered to deck (28°37N, 87°32W). We made our way back to station B252 (28°30N, 87°30W) and at 1900 the optics profiler was deployed, followed by the CTD at 1930. The MOCNESS was deployed (Trawl 080) at 2150. Nets 1-5 were fished to a maximum depth of 1501.6 m.

18 August 2016: At 0325, the MOC-10 was recovered to deck. We departed station B252 for station B175 (29°00N, 87°30W) at 0337 and arrived at 0800. At 950 the transducer was calibrated and at 1058 the MOCNESS was deployed (Trawl 081) at station B175 and recovered at 1623. Nets 1-5 were fished to a maximum depth of 1500.4 m. A CTD cast was deployed at 1740 followed by the optic profiler at 1918. The MOC-10 was deployed (Trawl 082) at 2145 at station B175.

19 August 2016: At 0300 the MOC-10 was recovered from station B175, with nets 1-5 were fished to a maximum depth of 1498.6 m. At 0319 we started the return journey to Gulfport, and at 1401 we entered the Gulfport channel. We docked at Gulfport state port at 1529.



Station no.	Station code	Lat (°N)	Long (°W)
1	SW6	27° 00'	90° 00'
2	SW4	27° 00'	89° 00'
3	SE1	27° 00'	88° 00'
4	SE3	27° 00'	87° 00'
5	SE2	27° 00'	87° 30'
6	SW3	27° 00'	88° 30'
7	SW5	27° 00'	89° 30'
8	SW6	27° 00'	90° 00'
9	B064	27° 30'	89° 00'
10	B065	27° 30'	88° 30'
11	B287	28° 00'	87° 30'
12	B252	28° 30'	87° 30'
13	B175	29° 00'	87° 30'

Figure 2 - Cruise track of DEEPEND cruise DP04 (30 April – 14 May 2016), with station codes and station order.

3 Operations and Protocols

3.1 Midwater Trawling

Midwater trawling was conducted using a 10-m^2 mouth area MOCNESS (MOC-10 hereafter) unit (Figure 3), leased from OKEANUS Science and Technology (Houma, LA), rigged with six 3-mm mesh nets manufactured for DEEPEND by Sea-Gear Corporation (Melbourne, FL). Each net was fitted with a removable PVC cod end (Figure 4), numbered consecutively to correlate with depth sampled. Sampling was conducted to 1500 m, bottom depth allowing. The first net (Net 0) was fished from the surface to 1500 m, Net 1 from 1500 to 1200 m, Net 2 from 1200 to 1000 m, Net 3 from 1000 to 600 m, Net 4 from 600 to 200 m, and Net 5 from 200 m to the surface (Figure 5) This was the same depth scheme used during the NOAA NRDA Offshore Nekton Sampling and Analysis Program.

Each station was sampled twice, with one deployment centered at solar noon (1000 h -1600 h) and one centered at midnight (2200 h – 0400 h). Ship's speed was kept minimal, between 1 and 2.5 kn. Winch deployment and retrieval speeds (non-zero) ranged from 5-25 m min^{-1}, with 15 m min^{-1} typical. The MOCNESS operator stayed in constant radio contact with the winch operator in order to keep the MOCNESS frame at an optimal angle (between 35-50°).

Figure 3 - 10-m^2 MOCNESS (MOC-10) unit being retrieved (left) and deployed (right) on the R/V *Point Sur* during DEEPEND cruise DP04.

Figure 4 - MOC-10 cod ends.

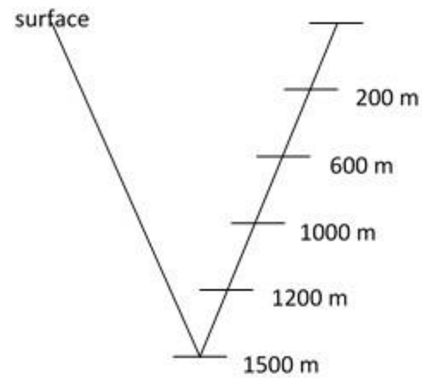


Figure 5 - Depth sampling scheme.

3.2 Near-Surface Sampling

When opportunities arose (e.g., during nighttime CTD casts) neustonic and near-surface organisms were collected via long-handled dipnet for genetic and/or stable isotope analyses.

3.3 IACUC Permit

All field protocols, fish handling and preservation, and removal of fish tissues were conducted in compliance with Florida Atlantic University IACUC protocol (Protocol #A15-06 Trawl surveys of deep-sea fishes) for the study of vertebrates and adhered to the USA legal requirements.

3.4 Hydroacoustics

Multi-frequency (18,38, 70, and 120 kHz) acoustic data were collection continuously during all MOC-10 deployments, CTD casts, bio-optical profiler casts, and while in transit between stations via a pole-mounted transducer (when possible, Figure 6). Mechanical and electrical noise associated with operating the MOC-10 reduced the effective range of each echosounder. The 38, 70, and 120 kHz echosounders collected meaningful data to depths of approximately 1500 m, 400 m, and 100 m, respectively. An 18 kHz EK80 echosounder was used to characterize the entire water column (< 3000 m). The echosounders were calibrated using tungsten and copper spheres at sea following standardized procedures (e.g., Foote et al. 1987).

3.5 CTD Profiling

Sixteen CTD profiles were conducted using the ship's CTD rosette (Figure 7) at twelve stations. Three of the stations were profiled twice, once at dawn and once at dusk, with the remainder being sampled either at dawn or dusk. Maximum profile depths depended on bottom depth and ranged from 275-2000 m.

3.6 Water Collection

Seawater was collected via CTD-mounted Niskin bottles (twelve 12-L bottles) from four depths, with multiple bottles per depth, and distributed according to the plan shown in Figure 8. Carboys were rinsed with Millipore or DOI water and rinsed with the sample water from Niskin bottle. Water from CTD rosette Niskin bottles was then drawn into the clean carboy using a sterilized tube. In the ship's lab, sterilized forceps were used to place PALL GN-6 0.45 um onto a filtration rig. Seawater was filtered at each station with a 1.1 cfm/25.5"Hg-60psi/115V vacuum pump. Triplicate filters were generated at each depth, and then stored at -20C for future molecular processing.

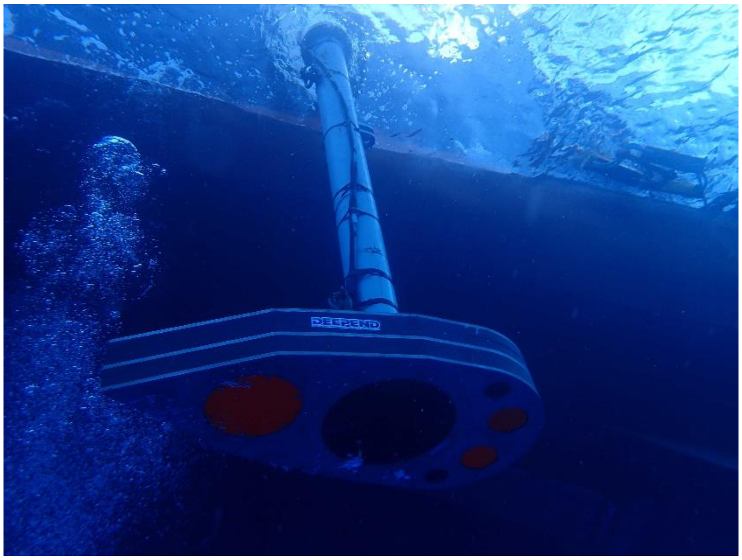


Figure 6 - Hydroacoustics transducer in sensing mode (underwater) on the R/V *Point Sur*.

Figure 7 - R/V *Point Sur* CTD rosette

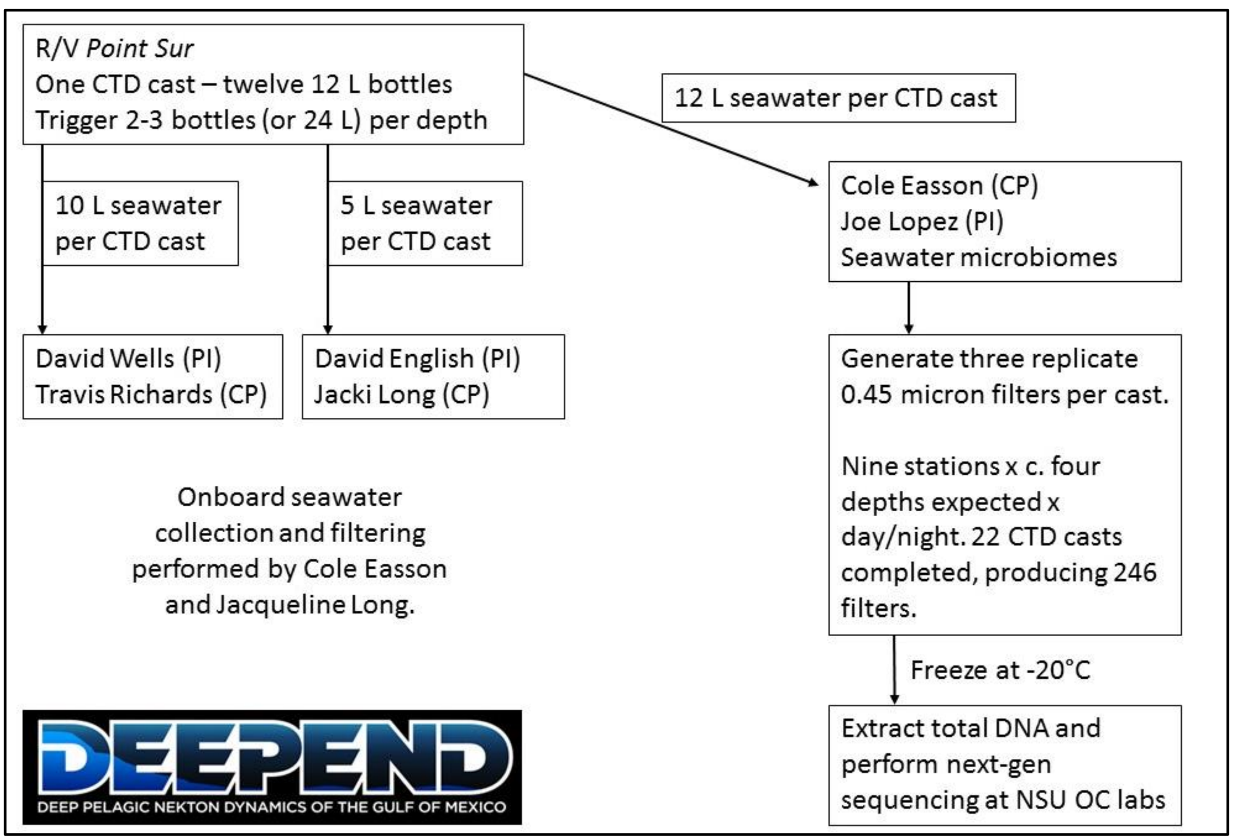


Figure 8 - Distribution and processing of water samples collected during DP04. CP: Cruise Participant; PI: Principle Investigator

3.7 Bio-optical Profiling and Remote Sensing Reflectance Measurement

Water column optical properties were measured with a bio-optical profiler containing a HOBILabs HS2 (Figure 9) and two WETLabs ECO instruments. Profiles were collected for 12 casts (at ten stations). The HS2 records depth and the backscattering of light at two wavelengths (420 and 700 nm) at a scattering angle of ~ 140°. The WETLabs ECO-FLNT measures backscattered red light (650 nm) at ~120° and the stimulated emission of red light (where chlorophyll_a fluoresces). The ECO-FLCD measures UV stimulated fluorescence, which is related to the concentration of dissolved organic material (CDOM). The window of the FLCD was damaged during the cruise so only relative CDOM fluorescence values are available from the profiles.

Figure 9. HS2 bio-optical profiler.

3.8 Sampling on Station

Sampling and sensing operations on station were organized around daytime and nighttime MOC-10 trawling, with these centered on solar noon and midnight, respectively (Table 1). Each MOC-10 deployment took approximately 6 h. MOC-10 sample processing occurred between MOC-10 deployments, as were CTD and bio-optical profiler casts. Transit to the next station generally occurred during the morning interval after day and night MOC-10 deployments at each station. Acoustic profiling was conducted during all hours except during transits, when the transducer boom was raised.

Table 1 - DP04 daily schedule

		1:00	2:00	3:00	4:00	5:00	6:00	7:00	8:00	9:00	10:00	11:00	12:00	13:00	14:00	15:00	16:00	17:00	18:00	19:00	20:00	21:00	22:00	23:00	0:00
		Night MOC; acoustics			CTD		transit				Day MOC; acoustics						CTD		ad hoc (below)				Night MOC; acoustics		
							water filtering												water filtering						
	Institution																								
April Cook	NSUOC				X	X	X	X	X	X							X	X	X	X	X	X			
Chris Valdes	TAS				X	X	X	X	X	X							X	X	X	X	X	X			
Dante Fenolio	SA Zoo				X	X	X	X	X	X							X	X	X	X	X	X			
Jon Moore	FAU				X	X	X	X	X	X							X	X	X	X	X	X			
Gray Lawson	Okeanus	X	X	X							X	X	X	X	X	X							X	X	X
Laura Timm	FIU				X	X	X	X	X	X							X	X	X	X	X	X			
Shaojie Sun	USF				X	X	X	X	X	X							X	X	X	X	X	X			
Ben Binder	FIU	X	X	X							X	X	X	X	X	X							X	X	X
Jon Moore	FAU				X	X	X	X	X	X							X	X	X	X	X	X			
Eddie Hughes		X	X	X							X	X	X	X	X	X							X	X	X
Max Weber	TAMUG				X	X	X	X	X	X							X	X	X	X	X	X			
Heather Judkins	USFSP				X	X	X	X	X	X							X	X	X	X	X	X			
Megan Weber	NSUOC				X	X	X	X	X	X							X	X	X	X	X	X			
Mike Novotny	NSUOC				X	X	X	X	X	X							X	X	X	X	X	X			
Tracey Sutton	NSUOC				X	X	X	X	X	X							X	X	X	X	X	X			
Travis Richards	TAMUG				X	X	X	X	X	X							X	X	X	X	X	X			
Lindsay Freed	NSUOC				X	X	X	X	X	X							X	X	X	X	X	X			
																			ad hoc sampling						
																			acoustic profiling						
																			additional water						
																			optical profiling (done during daylight)						

4 Sample Processing Protocol

4.1 Microbial Genomics Samples

Carboys were rinsed with Millipore or DOI water and rinsed with the sample water from Niskin bottle. Water from CTD rosette Niskin bottles was then drawn into the clean carboy using a sterilized tube. In the ship's lab, sterilized forceps were used to place PALL GN-6 0.45-um filter onto a filtration rig. Seawater was filtered at each station with a 1.1 cfm/25.5" Hg-60psi/115V vacuum pump at low pressure. Triplicate filters were generated at each depth, and then stored at -20°C for future molecular processing.

4.2 Nekton, Micronekton, and Macroplankton Samples

Upon MOC-10 recovery, individual nets were washed down with seawater to assure all collected organisms were concentrated in the cod ends. Cod ends were disconnected from the net one at a time and the contents were poured/washed into 6-L Nalgene bottles filled with pre-chilled seawater. Each Nalgene was numbered to correspond with the net from which samples were collected.

Nalgene bottles were taken inside the ship's lab as they were washed down and stored cold in a refrigeration unit pending processing. Only one sample was processed at a time to prevent cross-sample mixing. "Net 0" (0-1500 m oblique) samples were generally processed first except in cases where live animals suitable for imaging were collected, in which case these samples were processed first. Afterwards, samples were processed in numerical order.

Processing involved the identification, enumeration, weighing (when possible) and measurement of all fish, macrocrustacean, and cephalopod specimens. Once a sample was completely subsampled, then the entire remaining sample was fixed in 10% buffered formalin (v/v formalin:seawater). A running tally was kept of specimens collected for all analyses. In the individual project reports that follow, only data for those portions of samples that were taken for genetic or biochemical analyses are included. The remaining data will be presented after complete laboratory sample work-up.
Tissues or whole samples were taken of each taxon according to a pre-determined protocol. Sample processing for genetic analyses was as follows:

1) for fishes lateral muscle tissue was dissected from the specimens' right side and then stored in 95% non-denatured alcohol;
2) for macrocrustaceans whole specimens were stored in RNALater and frozen;
3) for pteropods whole specimens were stored in 100% isopropanol; and
4) for cephalopods tissue samples were stored in RNALater.

Fish specimens from which tissue was taken (i.e. vouchers) were individually marked with a paired tag matching that of the tissue sample and fixed in formalin.

For stable isotope (SIA), otolith microchemistry (OM), mercury (Hg), and polycyclic aromatic hydrocarbon (PAH) analyses whole specimens and/or tissue samples were frozen at -20°C. Prior to PAH sample collection, reusable 20-ml VOA vials were washed with water and detergent, rinsed three times with deionized water then combusted in an oven at 450°C for 4-5 hours. Aluminum foil was combusted as well in an oven at 450°C for 4-5 hours and used to cover the inside of each VOA vial plastic cap. Samples were deposited in each vial and then frozen. Prior to lipid extraction (i.e. PAHs) samples will be freeze-dried. Lipid extraction of freeze-dried samples will be conducted under high temperature (100°C) and pressure (1500 psi) with a solvent mixture 9:1 v:v cyclohexane : dichloromethane using an Accelerated Solvent Extraction system (ASE 2001, Dionex) following modified EPA methods. Specimens for the remaining analyses (SIA, OM, Hg) were individually bagged and frozen with the corresponding sample labels.

4.3 Water Column Structure at the Stations

Detailed hydrographic analyses are currently ongoing, but the predominant mesoscale oceanographic feature during DEEPEND cruise DP04, as in DP01-DP03, was a large anticyclonic Loop Current eddy (LCE) located in the southwestern portion of the DEEPEND sample grid. This feature was manifest in a positive sea-surface height anomaly (Figure 1). An additional, smaller-scale feature was a cyclonic eddy located to the Northeast of the LCE intrusion (Figure 1 and Figure 2). This feature was manifest in a negative sea-surface height anomaly. Another significant feature was the Mississippi River plume found near the surface to the West of the cyclonic eddy.

Hydrographic structure at depth via analysis of CTD and MOC-10 sensor data for each station is presented in Figure 10 - Figure 24. Depths of the chlorophyll maximum varied from 10 m to 130m, and the shallow depths were associated with Mississippi plume stations while deepest locations were associated with the LCE waters.

(a)

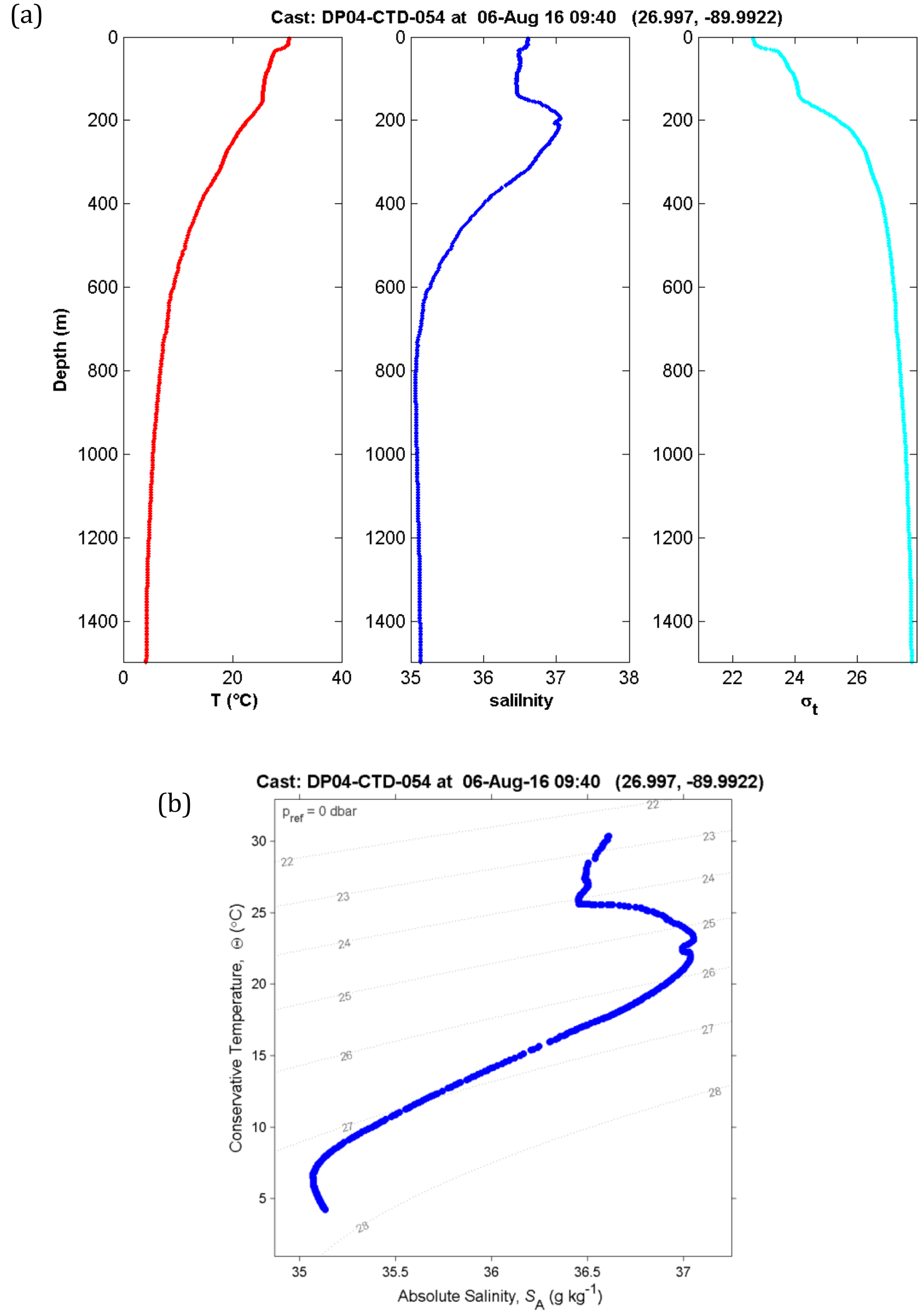
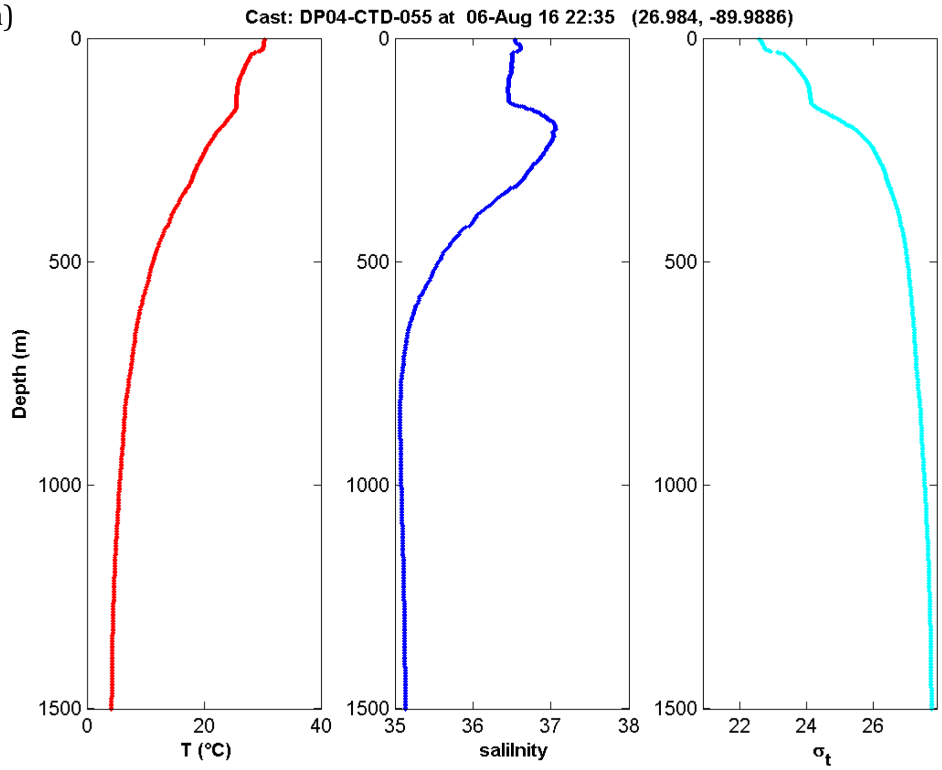


Figure 10. CTD temperature and salinity data from cast CTD-054 at station SW-6-morning. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

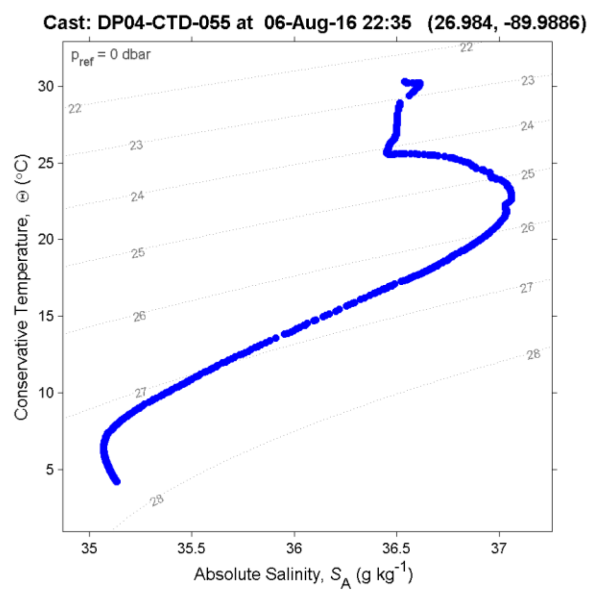
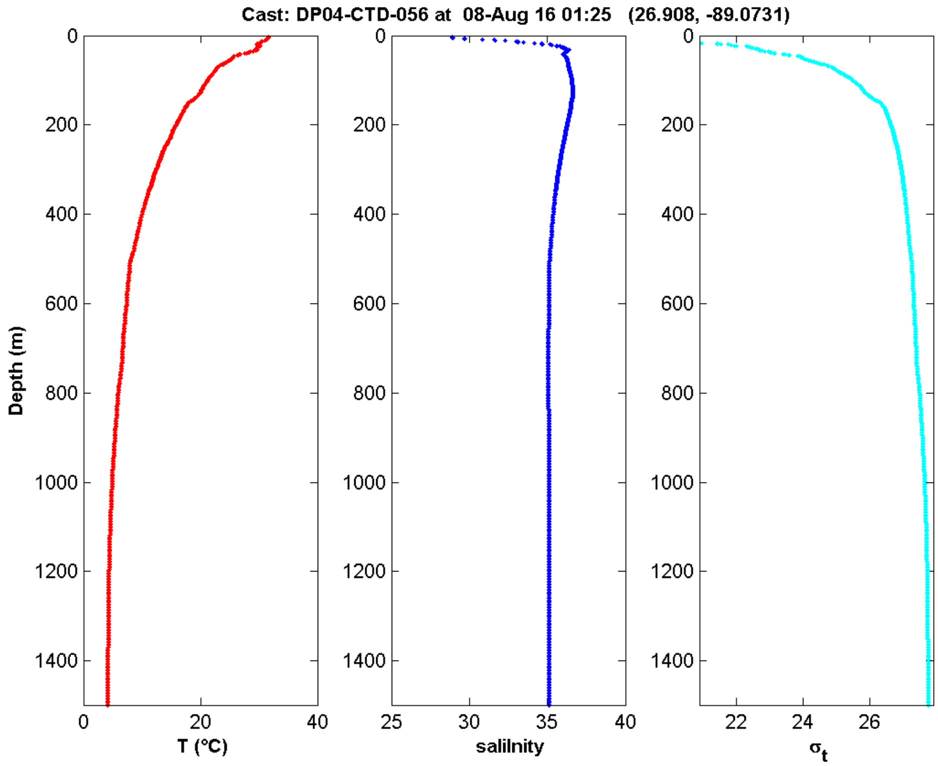


Figure 11. CTD temperature and salinity data from cast CTD-055 at station SW-6-evening. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot

(a)



(b)

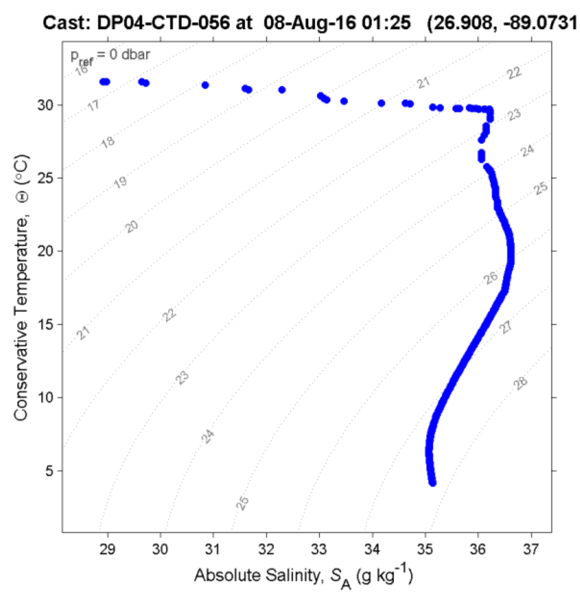
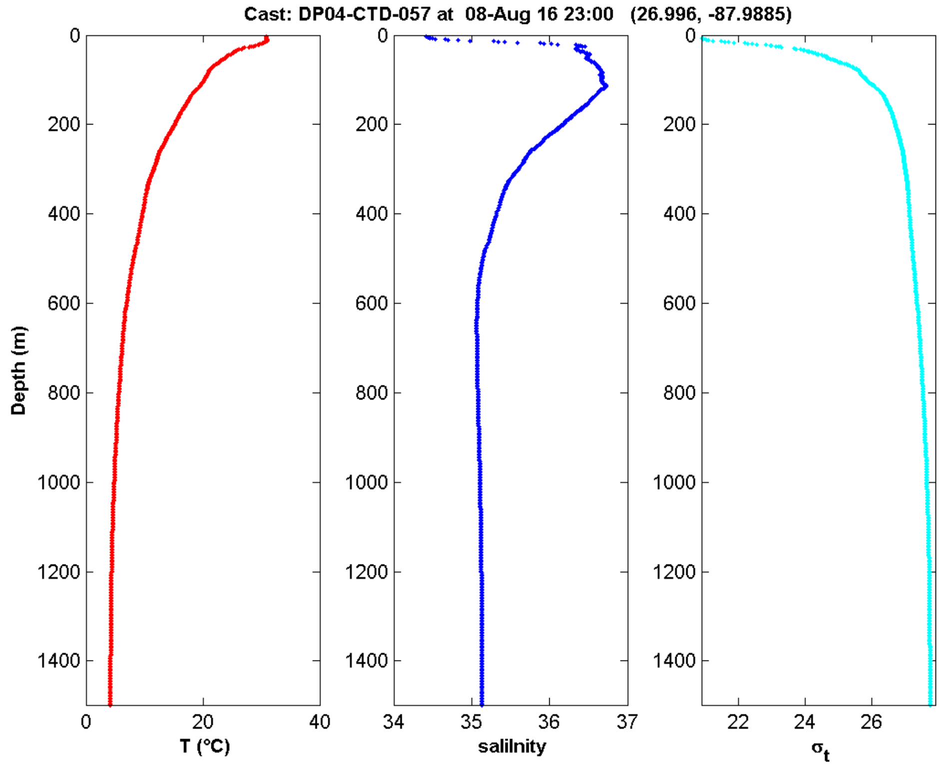


Figure 12. CTD temperature and salinity data from cast CTD-056 at station SW-4-evening. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

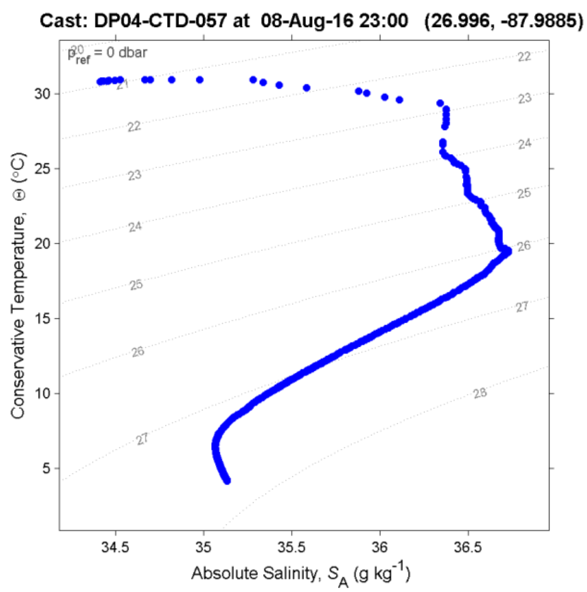
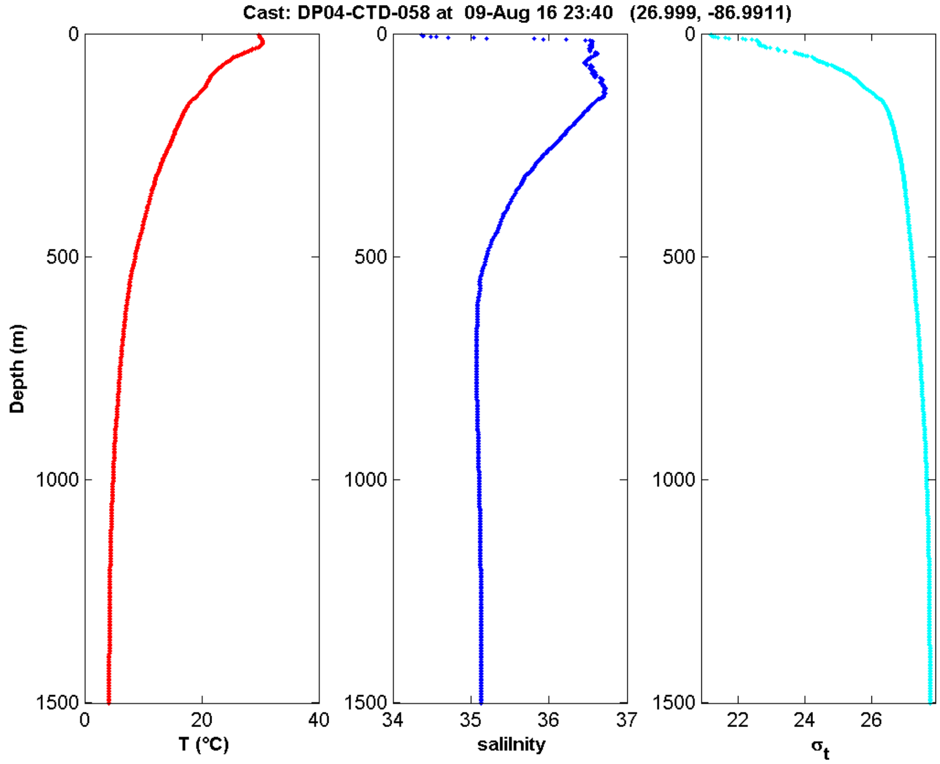


Figure 13. CTD temperature and salinity data from cast CTD-057 at station SE-1. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

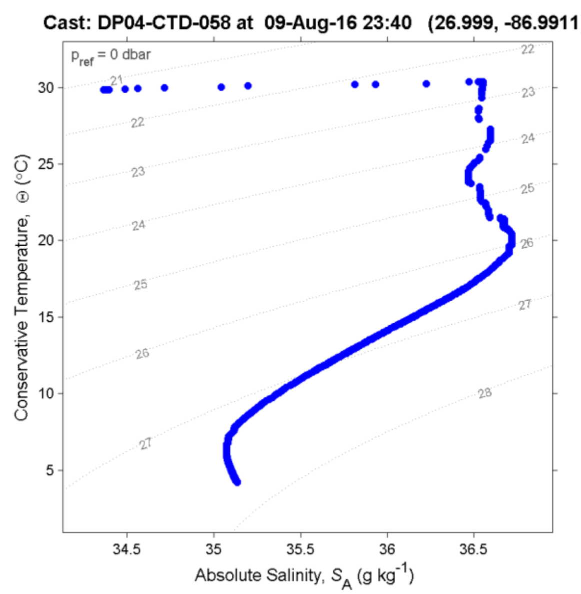


Figure 14. CTD temperature and salinity data from cast CTD-058 at station SE3-evening. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

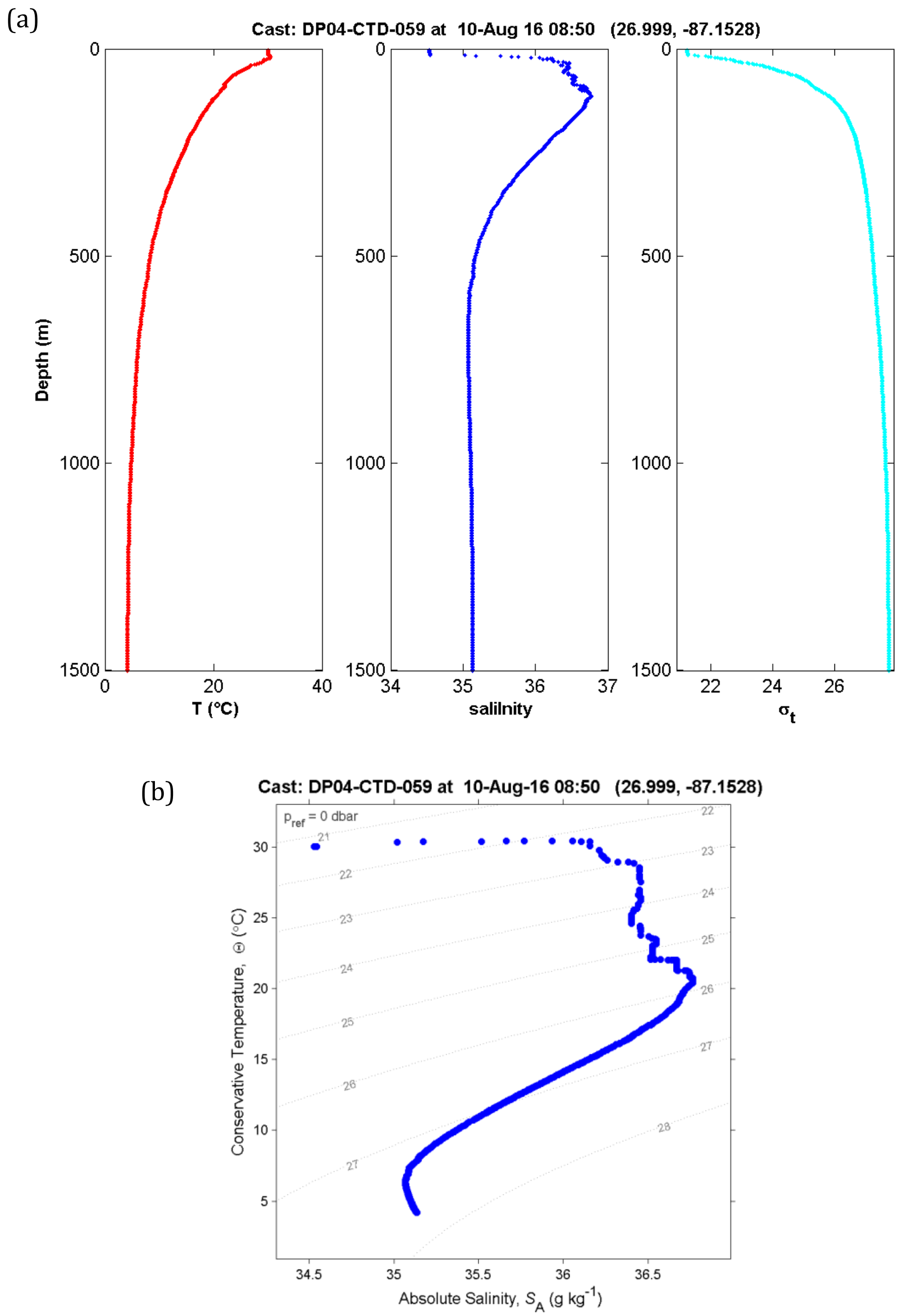
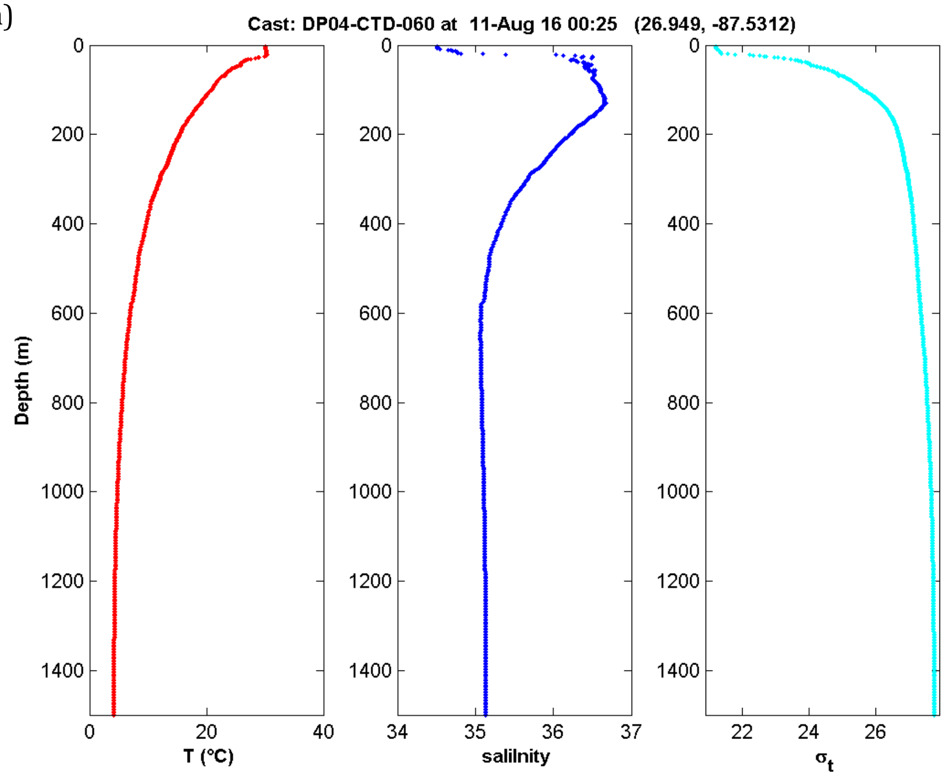


Figure 15. CTD temperature and salinity data from cast CTD-059 at station SE3. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

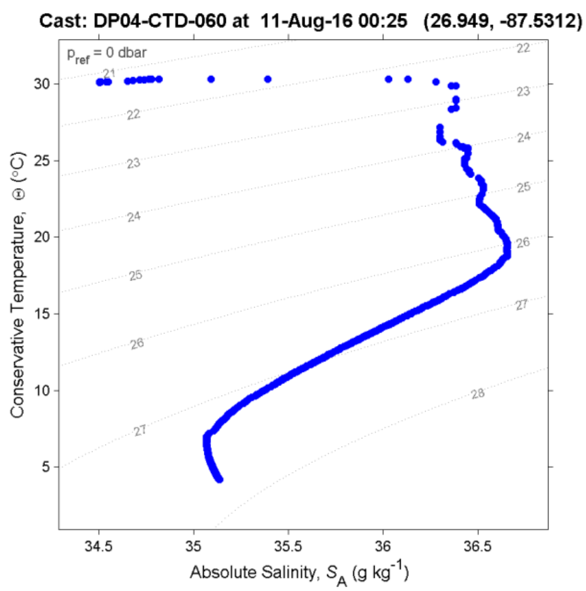
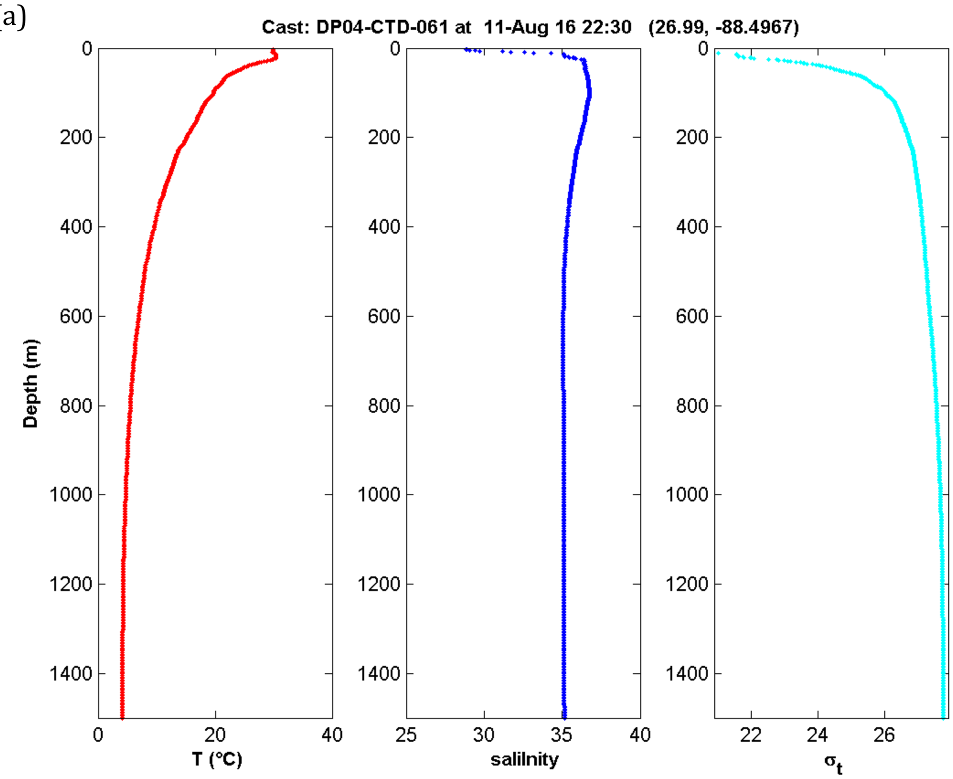


Figure 16. CTD temperature and salinity data from cast CTD-060 at station SE2. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

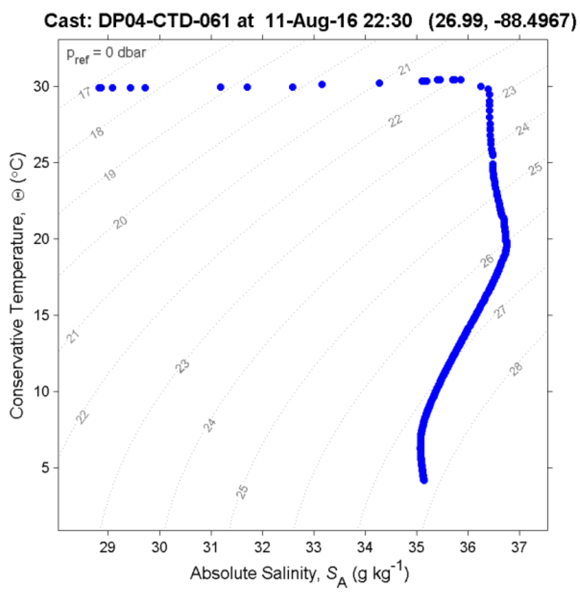
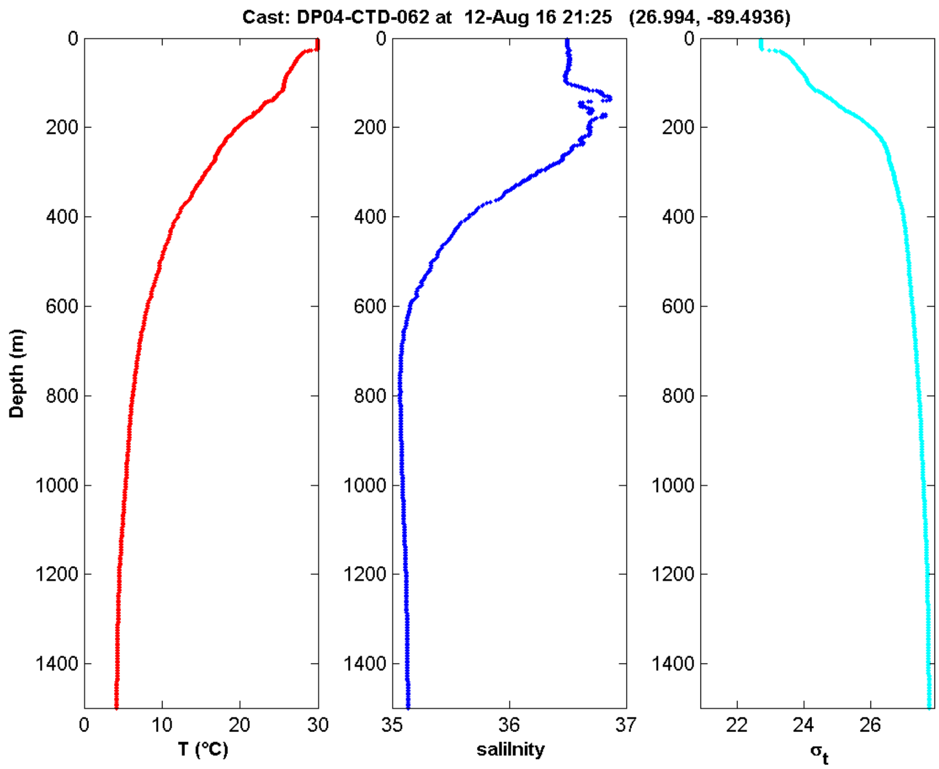


Figure 17. CTD temperature and salinity data from cast CTD-061 at station SW3. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

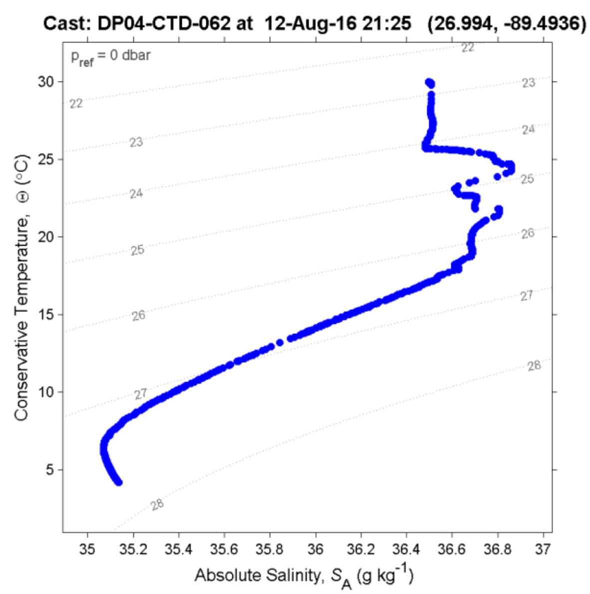
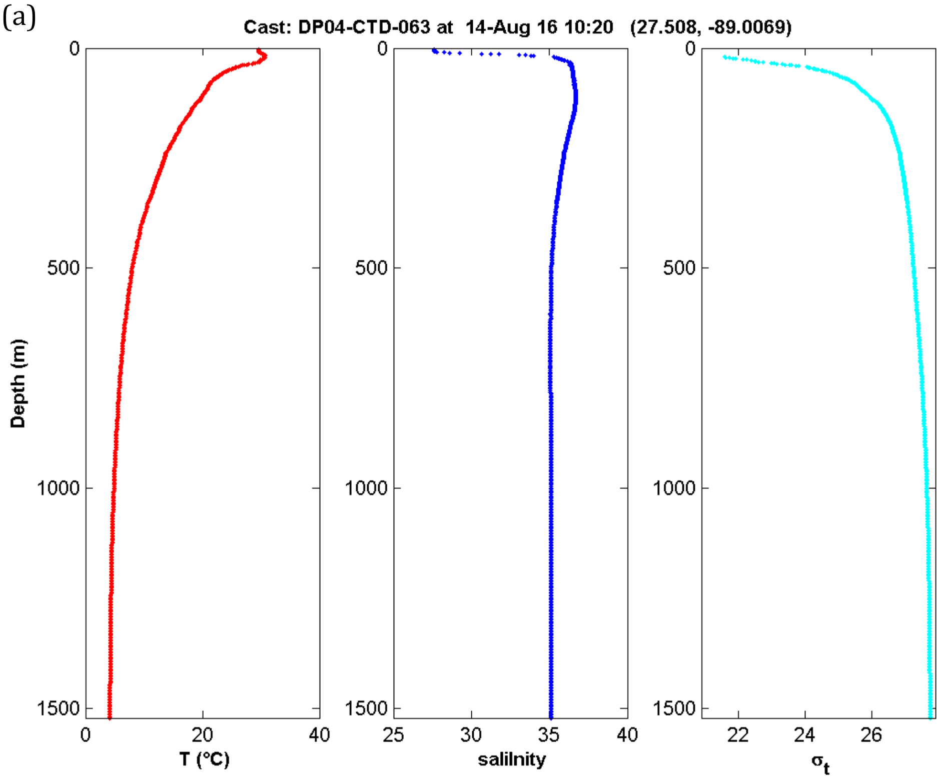


Figure 18. CTD temperature and salinity data from cast CTD-062 at station SW5. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

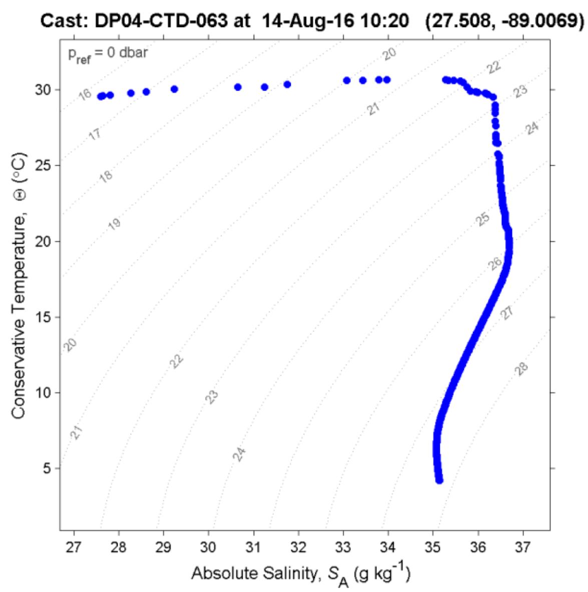
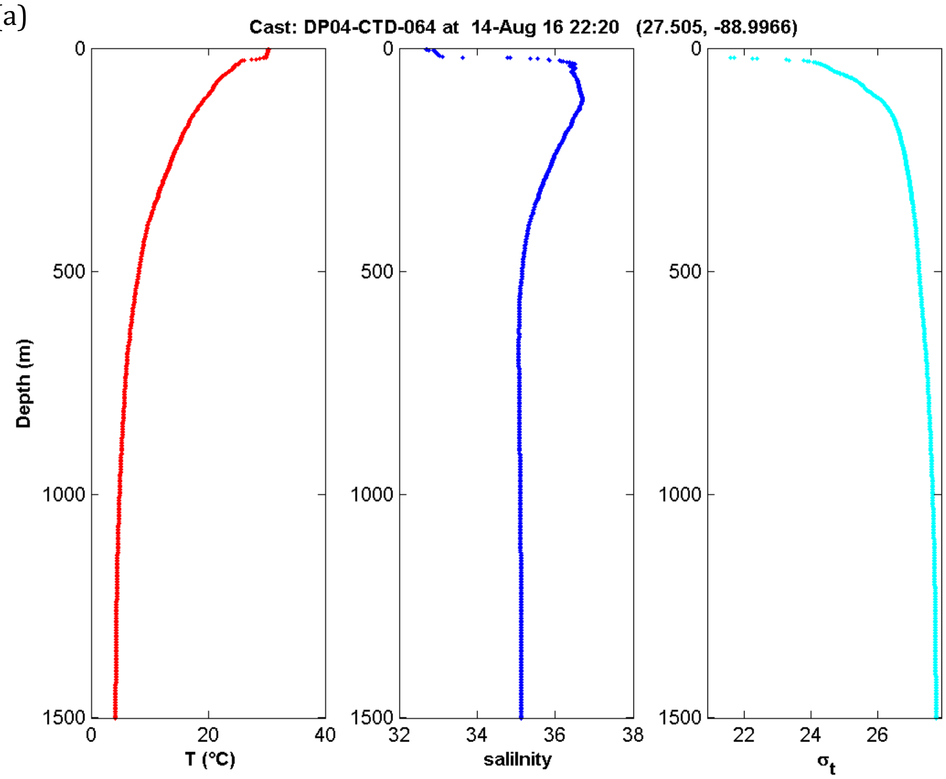


Figure 19. CTD temperature and salinity data from cast CTD-063 at station B064 -dawn. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

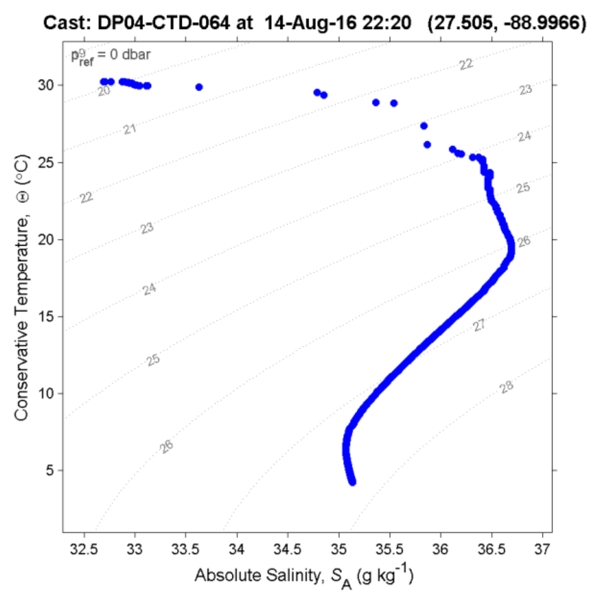


Figure 20. CTD temperature and salinity data from cast CTD-064 at station B064-dusk. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

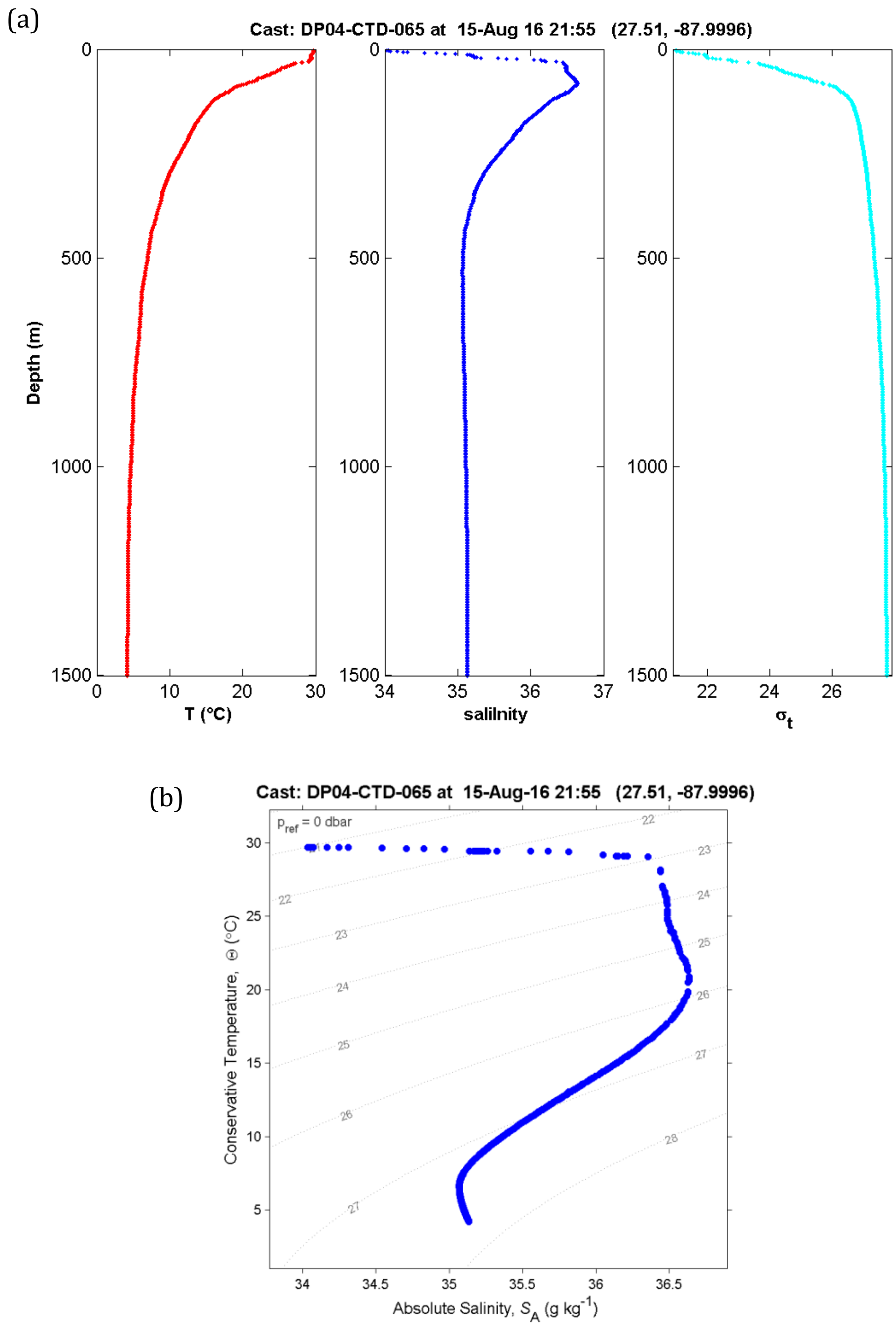


Figure 21. CTD temperature and salinity data from cast CTD-065 at station B065. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

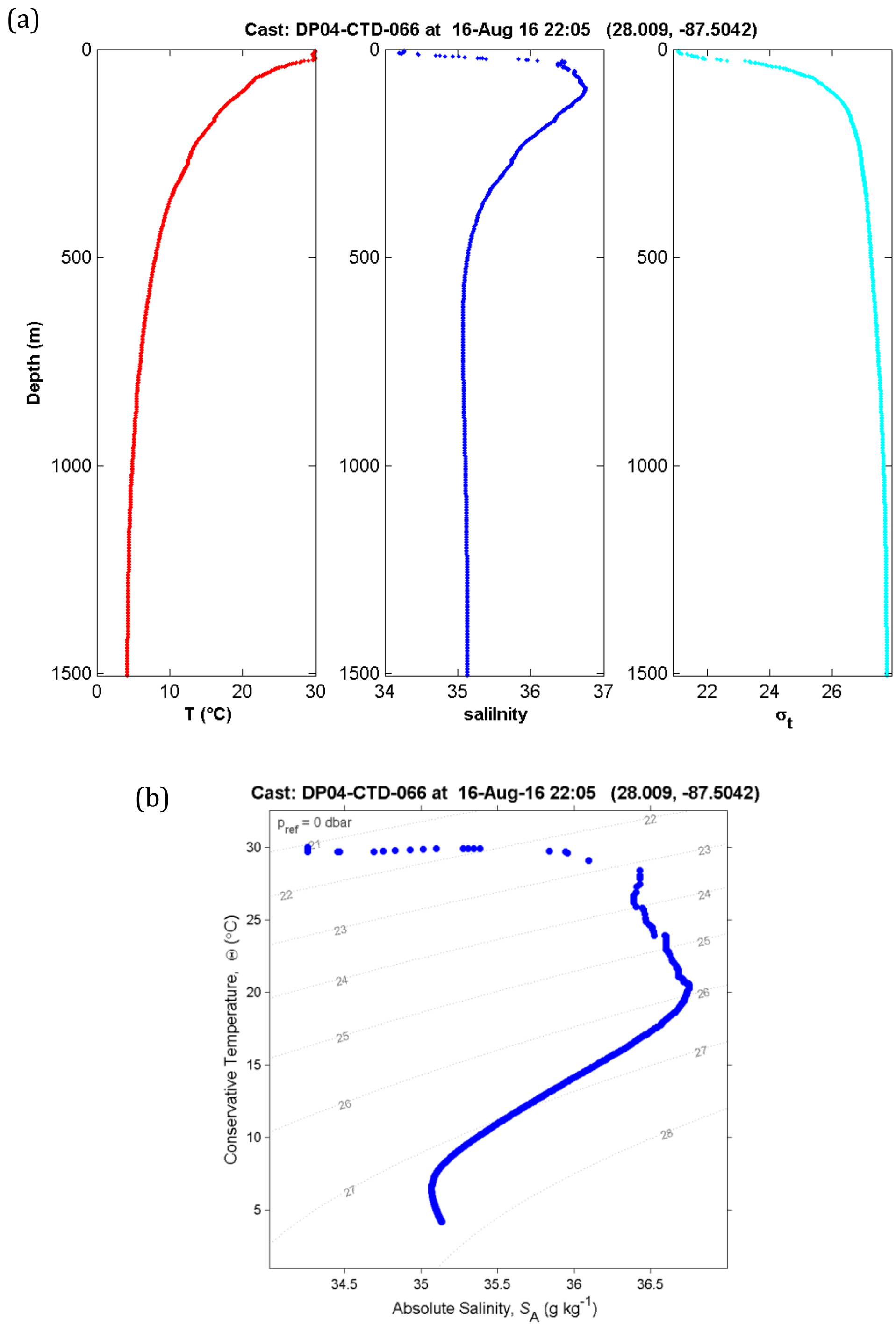
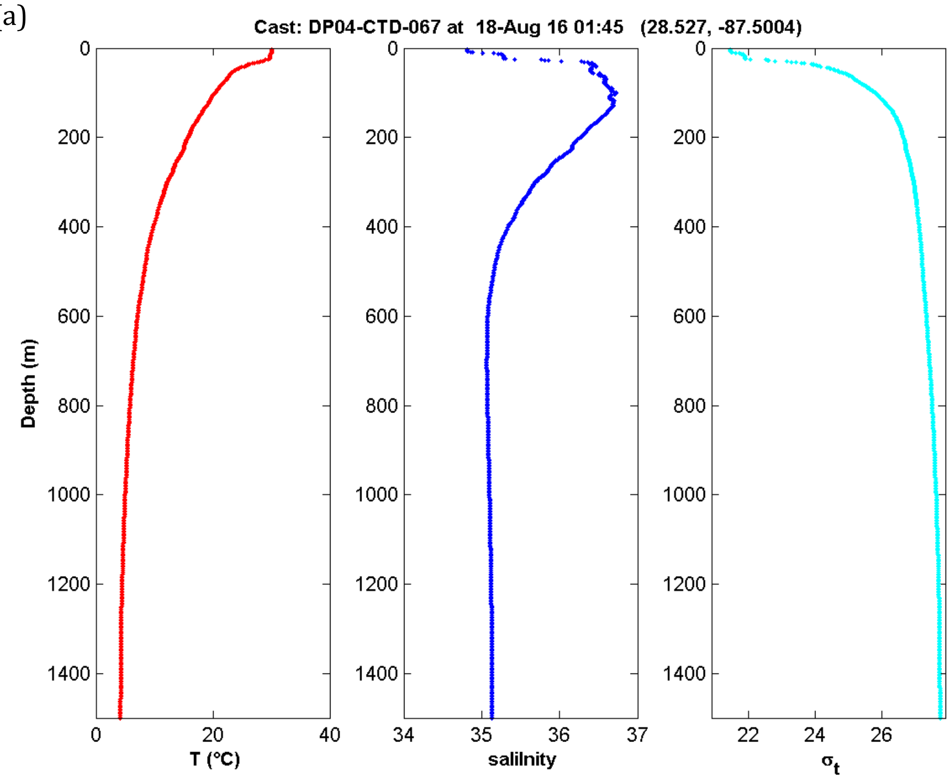


Figure 22. CTD temperature and salinity data from cast CTD-066 at station B287. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

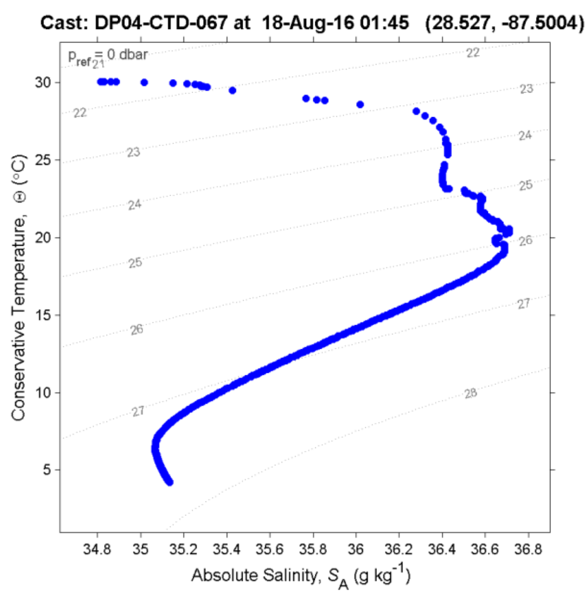
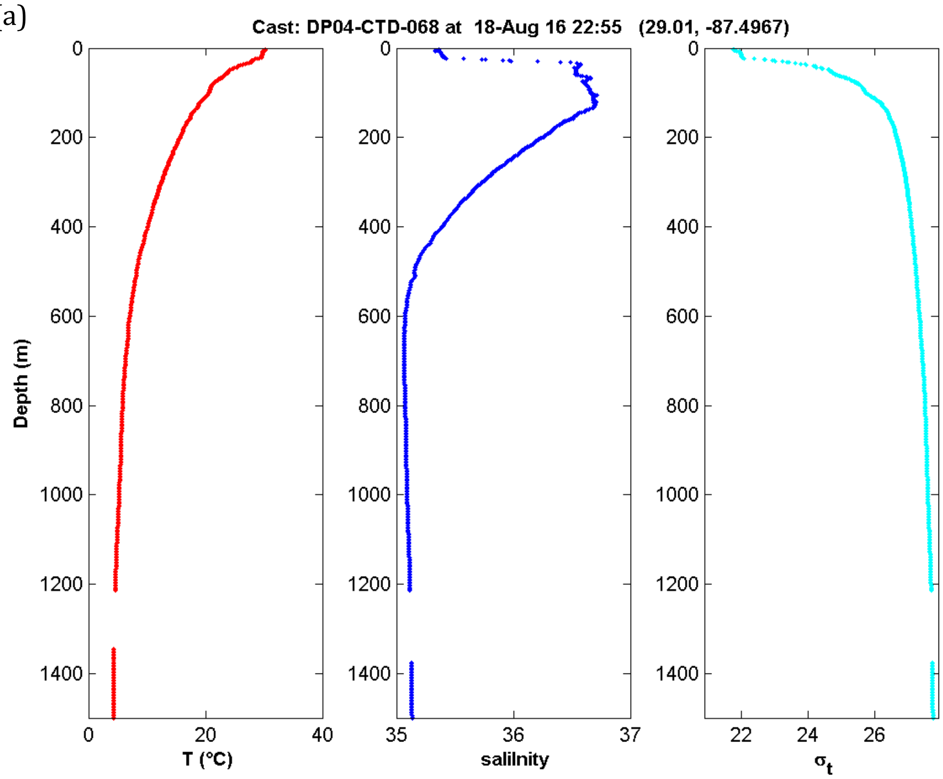


Figure 23. CTD temperature and salinity data from cast CTD-067 at station B252. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

(a)



(b)

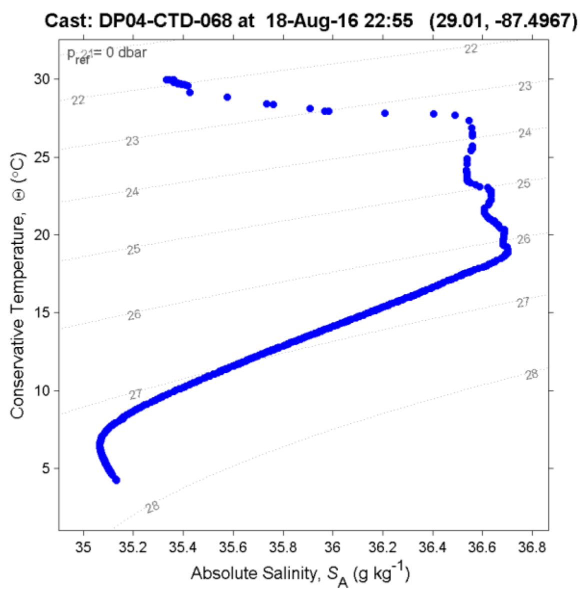


Figure 24. CTD temperature and salinity data from cast CTD-068 at station B175. a) Full-depth CTD temperature, salinity, and density profiles; b) temperature vs. salinity plot.

5 Individual Project Reports

5.1 MOCNESS Sampling

A total of 156 trawl samples were collected during 26 deployments (Table 2; Figure 25). Of these, 112 samples were considered 'quantitative,' having met the criteria of: 1) proper opening and closing at prescribed depths; 2) proper flowmeter (volume) readings; 3) proper net behavior (mouth angle, net speed) during deployment; and 4) no signs of mechanical failure (tears, holes). These samples combined for a cumulative total of ~5 million cubic meters of water filtered. There were 23 "Net 0" samples that fished from the surface to max depth, which we classified as "non-standard," though flow data were taken. The remaining samples fished non-standard depth strata, had flow meter validation errors, or suffered mechanical problems. Specimens for genetic and biochemical analyses (see below) were taken from all trawls.

Table 2. MOC-10 trawl deployment times and locations during DP04

Trawl No	Station ID	Start Date	Tow Start Time (CDT)	Start Lat.	Start Lon.	End Date	Tow End Time (CDT)	End Lat.	End Lon.
57	SW-6	08/05/2016	23:13	27.00	-90.00	8/6/2016	03:02	27.04	-90.07
58	SW-6	08/06/2016	09:38	26.99	-89.99	8/6/2016	14:58	27.06	-90.09
59	SW-6	08/06/2016	22:15	26.99	-89.99	8/7/2016	03:19	27.04	-90.08
60	SW-4	08/07/2016	10:35	26.97	-88.96	8/7/2016	15:24	27.01	-89.08
61	SW-4	08/07/2016	21:59	26.88	-89.03	8/8/2016	03:08	26.99	-88.99
62	SE-1	08/08/2016	09:57	27.01	-87.97	8/8/2016	14:41	26.93	-88.02
63	SE-1	08/08/2016	21:27	26.98	-87.94	8/9/2016	02:55	27.05	-88.08
64	SE-3	08/09/2016	09:45	27.01	-86.98	8/9/2016	15:08	26.92	-87.10
65	SE-3	08/09/2016	21:59	26.99	-86.99	8/10/2016	03:16	26.99	-87.14
66	SE-2	08/10/2016	10:50	27.01	-87.48	8/10/2016	16:09	26.92	-87.59
67	SE-2	08/10/2016	21:52	26.99	-87.51	8/11/2016	03:19	27.06	-87.66
68	SW-3	08/11/2016	10:04	27.01	-88.46	8/11/2016	15:19	26.92	-88.59
69	SW-3	08/11/2016	21:35	26.89	-88.51	8/12/2016	03:02	27.00	-88.60
70	SW-5	08/12/2016	10:10	26.98	-89.46	8/12/2016	15:01	27.02	-89.57
71	SW-5	08/12/2016	21:40	26.93	-89.43	8/13/2016	02:57	26.97	-89.51
072	SW-6	08/13/2016	10:05	26.99	-89.99	8/13/2016	15:48	27.03	-90.11
073	B064	08/14/2016	09:31	27.51	-88.99	8/14/2016	14:40	27.40	-89.0199
074	B064	08/14/2016	21:32	27.51	-89.01	8/15/2016	02:23	27.58	-88.9179
075	B065	08/15/2016	10:20	27.52	-87.98	8/15/2016	15:20	27.42	-87.998
076	B065	08/15/2016	22:01	27.49	-87.97	8/16/2016	03:30	27.46	-87.7878
077	B287	08/16/2016	10:13	28.00	-87.50	8/16/2016	15:24	27.93	-87.4223
078	B287	08/16/2016	21:42	28.03	-87.50	8/17/2016	02:46	27.94	-87.4884
079	B252	08/17/2016	09:59	28.51	-87.53	8/17/2016	15:23	28.44	-87.4203

080	B252	08/17/2016	21:50	28.52	-87.49	8/18/2016	03:21	28.38	-87.4866
081	B175	08/18/2016	10:57	29.01	-87.55	8/18/2016	16:14	28.92	-87.4487
082	B175	08/18/2016	21:44	29.04	-87.45	8/19/2016	02:53	28.95	-87.5474

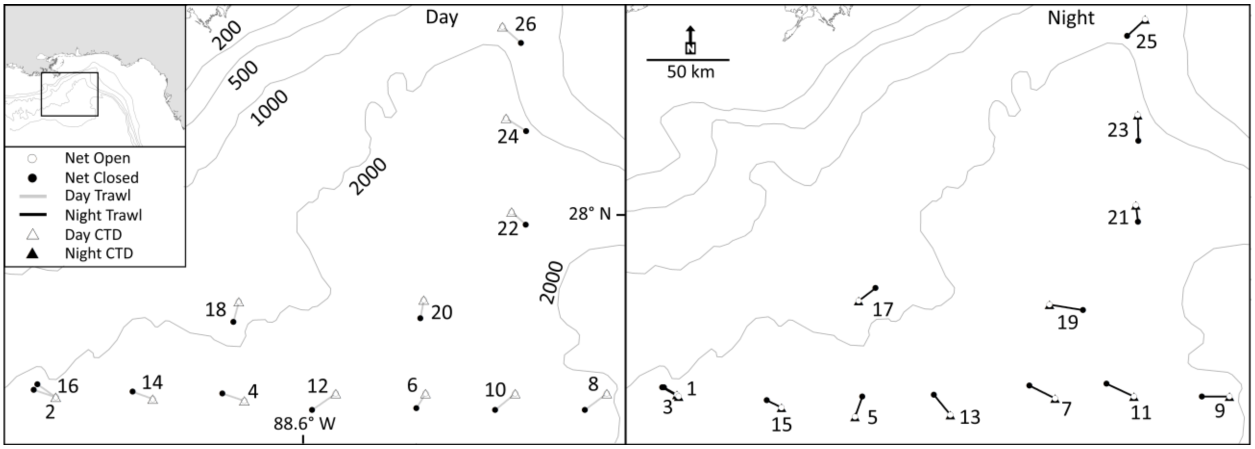


Figure 25. DEEPEND cruise DP04 MOC-10 trawl locations and trajectories.

5.2 Faunal Accounts

3.2.1. Crustacea

Approximately 8500 nektonic crustaceans were sampled, sorted and preserved from nets 0-5 in various fixatives (RNALater, 70% EtOH, or frozen; e.g. Figure 26). A list of all species and total counts can be found in Table 3. A total of 1034 crustaceans (including samples collected from net 0) were identified to lowest taxonomic level possible and preserved in RNALater for studies of population connectivity and in 70% EtOH for barcoding. A total of 21 oplophorid shrimp were collected in RNALater for inclusion on a Bioluminescence and Vision project. Finally, 76 amphipods, isopods, and blind lobster larvae were collected in RNALater for identification in the lab.

The remaining ~5000 crustaceans were identified to genus and stored in 10% formalin for species identification back in the shoreside laboratory. An additional 101 individuals from common species (*Acanthephyra curtirostris, A. purpurea, A. stylorostratis*, *Nematoscelis atlantica/microps*, Sergestes, *Sergia splendens*, *Systellaspis debilis* and *Thysanopoda actifrons/orientalis*) were collected from net 0 of multiple stations inside and outside of the Loop Current. Two parasites were collected: a Benthesicymidae with worms and one parasite taken from the carapace of an *A. purpurea*.

Figure 26 - Amphipod collected during DEEPEND cruise DP04.

5.2.1 Mollusca

A total of 142 cephalopod specimens, representing at least 34 species, were collected. Additionally, 117 heteropod specimens from 7 species along with 1325 pteropod specimens were collected.

5.2.2 Fishes

A total of 13,208 fish specimens were collected from a minimum of 218 species. Analysis is currently ongoing.

Table 3. Crustaceans collected during DEEPEND DP04 cruise with total numbers.

Taxon	N
Acanthephyra sp.	59
Acanthephyra acanthetelsonis	4
Acanthephyra acutifrons	20
Acanthephyra brevirostris	12
Acanthephyra curtirostris	84
Acanthephyra purpurea	139
Acanthephyra stylorostratis	262
Amphipoda	157
Benthesicymidae	1000
Caridea	17
Ephyrina benedicti	5
Ephyrina ombango	6
Eucopia sp.	1800
Eucopia sculpticauda	50
Eupasiphae gilesii	
Euphausiidae	2500
Funchalia villosa	40
Gnathophausia sp.	6
Gnathophausia gigas	6
Gnathophausia ingens	9
Gnathophausia zoea	18

Hymenodora gracilis	123
Hymenopenaeus debilis	20
Isopoda	1
Janicella spinicauda	13
Larvae	461
Lophogastridae	3
Lucaya bigelowi	23
Meningodora mollis	15
Meningodora vesca	16
Mesopenaeus tropicalis	21
Nematoscelis atlantica/microps	11
Nematoscelis sp.	1
Notostomus elegans	32
Notostomus gibbosus	33
Oplophorus sp.	1
Oplophorus spinosus	26
Parapasiphae sulcatifrons	14
Pasiphaea merriami	17
Pasiphaea princeps	1
Pasiphaeidae	1
Penaeidae	63
Phronima	7
Sergestes sp.	610
Sergia sp.	62
Sergia grandis	37
Sergia hansjacobi	22
Sergia regalis	29
Sergia robusta	23
Sergia splendens	251
Sergia talismani	5
Sergia tenuiremis	110
Solenoceridae	1
Stylopandalus richardi	84
Systellaspis cristata	7
Systellaspis debilis	202
Thysanopoda acutifrons/orientalis	23

5.3 Genetic/Genomic Analyses

5.3.1 Pelagic Microbial Assemblages.

A total of 183 pelagic microbial communities were sampled over the course of the cruise. Microbial communities at each station were sampled by 3-4 L CTD water collections at 4-5 depths (n = 3 per depth; Table 4), which were then filtered through PALL GN-6 0.45 micron filters. This sampling was designed to capture the bacterioplankton community within different water masses (Loop Current and common water) and at various depths to understand the natural variation and dynamics within the broader Gulf of Mexico ecosystem. All samples and filters were handled using sterile technique, and filters were stored at -20°C for the duration of the cruise before transport to the NSU molecular microbiology lab (Co-PI Lopez) for DNA processing. Ancillary samples of 24 anglerfish and "esca" (lures) were also sampled and stored in either RNALater or TEM Buffer for microbiome analysis or microscopy, respectively (Table 5). Ten larval anglerfish, representing 3 genera were also collected on this cruise to gain additional insight into the process of bioluminescent symbiont acquisition during these developmental stages. One non-anglerfish specimen (*Photostylus pycnopterus*) was collected as part of this sampling effort due to the hypothesized presence of bioluminescent symbionts in its fin rays.

5.3.2 Crustaceans

A total of 656 crustaceans (including samples collected from net 0) were identified to species and preserved in RNALater for studies of population connectivity (Table 6) and in 70% EtOH for barcoding (Table 7). Nine species were collected for population genetics (*Acanthephyra purpurea, Acanthephyra stylorostratis, Eucopia sculpticauda, Sergia grandis, Sergia robusta, Sergia splendens, Sergia tenuiremis, Stylopandalus richardi, and Systellaspis debilis*), while all others will be used in barcoding studies.

5.3.3 Miscellaneous Crustacean Larvae

A total of 141 larval samples were preserved in 70% EtOH for barcoding, hopefully leading to the identification of the (currently unknown) adult. Approximately 250 stomatopod larvae were preserved in 70% EtOH for identification by a collaborator at University of Hawaii.

5.3.4 Cephalopoda and other Pelagic Mollusca

A total of 52 species of Mollusca were collected for genetic barcoding studies, 33 of which were Cephalopoda (Table 8). An additional 22 individuals from seven cephalopod species were collected for population connectivity studies, including *Bolitaena pygmaea* (n = 2), *Cranchia scabra* (n = 2), *Japetella diaphana* (n = 1), *Mastigoteuthis agassizii* (n = 1), *Pyroteuthis margaritera* (n = 7), *Ornithoteuthis antillarium* (n = 1), and *Vampyroteuthis infernalis* (n = 8).

5.3.5 Gastropoda (pteropods)

After manual micronekton and nekton sorting, 19 heteropods were removed and preserved in ethanol for identification and genetic sequencing.

5.3.6 Fishes

A total of 1058 fish tissue samples were collected for genetic analysis from 196 species (Table 9). All tissues and voucher specimens were individually matched with paired tissue tags. Those specimens not identified to species level were primarily larval forms (e.g., leptocephalus stage) or males for which no key currently exists (e.g., ceratioid anglerfishes). From the total list of fishes, adequate sample size for barcoding (n = 15) was achieved for the following: *Argyropelecus aculeatus* (n = 51), *Caranx crysos* (n = 21), *Ceratoscopelus warmingii* (n = 52), *Chauliodus sloani* (n = 53), *Cyclothone obscura* (n = 50), *Cyclothone pallida* (n = 15), *Dolicholagus longirostris* (n = 15), *Gymnothorax ocellatus* (n = 21), *Nannobrachium lineatum* (n = 16), *Ophichthus gomesii* (n = 21), Scombridae (n=29), *Selene setapinnis* (n = 15), *Sternoptyx diaphana* (n = 49), *Sternoptyx pseudobscura* (n = 42), and *Vinciguerria nimbaria* (n = 14). Following the cruise fish tissue samples were parsed between Eytan's (TAMUG) and Shivji's (NSU OC) labs.

Ancillary samples of anglerfish and "esca" (lures) were also sampled and stored in either RNALater or TEM Buffer for continued analysis of esca microbiomes and symbionts (Table 5). Larval anglerfish were also collected on this cruise in an attempt to gain additional insight into the developmental stage when the bioluminescent symbiont is acquired. The esca lures are examined in the NSU Molecular Microbiology Lab (Co-PI Lopez).

Table 4. Pelagic microbial assemblage samples collected during DEEPEND cruise DP04

Date	Site	Identifier	Depth(m)	Bottle	Replicates
8/6/16	SW-6	CTD054	1499	1	3
			545	6	3
			130	8	3
			2	12	3
8/6/16	SW-6	CTD055	1502	1	3
			516	4	3
			125	7	3
			2	10	3
8/7/16	SW-4	CTD056	1500	1	3
			446	4	3
			43	8	3
			2	12	3
8/8/16	SE-1	CTD057	1485	3	3
			441	4	3
			68	8	3
			2	11	3
8/9/16	SE-3	CTD058	1501	1	3
			444	5	3
			90	7	3
			2	11	3
8/10/16	SE-3	CTD059	1500	3	3
			418	4	3
			86	8	3
			2	10	3
8/10/16	SE-2	CTD060	1500	3	3
			386	5	3
			86	8	3
			2	12	3
8/11/16	SW-3	CTD061	1500	2	3
			359	4	3
			76	8	3
			2	10	3
8/12/16	SW-5	CTD062	1500	3	3
			498	5	3
			110	7	3
			2	11	3
8/14/16	B064	CTD063	1520	2	3
			421	4	3
			97	9	3
			2	10	3
8/14/16	B064	CTD064	1500	1	3
			415	3	3
			95	6	3
			22	9	3

			2	10	3
8/15/16	B065	CTD065	1500	3	3
			334	6	3
			58	7	3
			2	10	3
8/16/16	B287	CTD066	1503	3	3
			340	4	3
			70	8	3
			2	11	3
8/17/16	B252	CTD067	1501	3	3
			415	5	3
			80	7	3
			2	11	3
8/18/16	B175	CTD068	1500	1	3
			374	4	3
			51	7	3
			2	11	3

Table 5. Anglerfish specimens collected during DEEPEND cruise DP04 symbiont analysis.

Date	Site	Trawl	Net	Species	Specimen
8/5/16	SW6N	57	N0	*Cryptopsaras couesii*	Whole body
8/6/16	SW6D	58	N1	Linophrynidae larva	Whole body
8/6/16	SW6N	59	N5	*Cryptopsaras couesii*	Whole body
8/6/16	SW6N	59	N1	Linophrynidae larva	Whole body
8/6/16	SW6N	59	N0	Gigantactinid larva	Whole body
8/7/16	SW4D	60	N3	*Centrophryne spinulosa*	Lure
8/7/16	SW4D	60	N3	*Cryptopsaras couesii*	Whole body
8/8/16	SE1D	62	N0	*Cryptopsaras couesii*	Whole body
8/8/16	SE1D	62	N0	Oneirodidae larva	Whole body
8/8/16	SE1D	62	N0	Oneirodidae larva	Whole body
8/9/16	SE3D	64	N0	Oneirodidae larva	Whole body
8/11/16	SW3N	69	N3	Oneirodidae larva	Whole body
8/12/16	SW5D	70	N3	*Cryptopsaras couesii*	Whole body, Lure in TEM Buffer
8/12/16	SW5N	71	N3	*Cryptopsaras couesii*	Whole body
8/12/16	SW5N	71	N0	*Cryptopsaras couesii*	Whole body
8/14/16	B064D	73	N0	*Cryptopsaras couesii*	Whole body, Caruncles in TEM Buffer
8/15/16	B065D	75	N0	*Ceratias* sp.	No lure, Caruncles in RNALater
*8/15/16	B065D	75	N0	*Photostylus pycnopterus*	Photophores from dorsal fin
8/15/16	B065N	76	N3	Oneirodidae post larva	Whole body
8/16/16	B287N	78	N0	Oneirodidae larva	Whole body
8/16/16	B287N	78	N1	Linophrynidae larva	Whole body
8/17/16	B252D	79	N3	*Cryptopsaras couesii*	Whole body
8/17/16	B252D	79	N3	*Cryptopsaras couesii*	Whole body
8/17/16	B252N	80	N0	*Cryptopsaras couesii*	Lure
8/18/16	B175D	81	N3	*Cryptopsaras couesii*	Whole body

**Photostylus pycnopterus* is not an anglerfish, but of interest to Jon Moore. The photophores on the fin ray are suspected to be symbiotic rather than intrinsic.

Table 6. Specimens collected in RNALater for population genetics.

Taxon	N
Acanthephyra purpurea	49
Acanthephyra stylorostratis	48
Eucopia sculpticada	48
Sergia grandis	29
Sergia robusta	23
Sergia splendens	59
Sergia tenuiremis	55
Stylopandalus richardi	52
Systellaspis debilis	54

Table 7. Specimens collected in ~70% EtOH for barcoding.

Taxon	N
Acanthephyra sp.	2
Acanthephyra acanthetelsonis	4
Acanthephyra acutifrons	2
Acanthephyra brevirostris	3
Acanthephyra curtirostris	1
Acanthephyra purpurea	1
Benthesicymidae	21
Caridea	11
Crustacea	2
Ephyrina benedicti	4
Ephyrina ombango	1
Eucopia sp.	7
Eupasiphae gilesii	3
Euphausiidae	>71
Funchalia villosa	3
Gnathophausia sp.	3
Gnathophausia gigas	1
Gnathophausia ingens	1
Gnathophausia zoea	2
Hippolytidae	1
Hymenodora gracilis	1
Hymenopenaeus debilis	3
Larvae	8
Lophogastridae	2
Lucaya bigelowi	2
Meningodora mollis	1
Meningodora vesca	1
Mesopenaeus tropicalis	1

Notostomus elegans	4
Notostomus gibbosus	3
Parapasiphae sulcatifrons	3
Pasiphaea merriami	4
Pasiphaea princeps	1
Pasiphaeidae	1
Penaeidae	7
Sergestes sp.	24
Sergia sp.	18
Sergia hansjacobi	2
Sergia regalis	4
Sergia talismani	2
Systellaspis cristata	3

Table 8. Cephalopods collected for genetics studies during DEEPEND cruise DP04.

Species	N
Abralia redfieldi	1
Abralia sp.	1
Abraliopsis atlantica	2
Ancistrocheirus leseueri	1
Asperoteuthis acanthoderma	1
Bathyteuthis sp.	1
Bathyteuthis sp. A	1
Bolitaena pygmaea	3
Bolitaeninae sp.	2
Chiroteuthis mega	1
Chiroteuthis sp.	1
Chiroteuthis veranyi	1
Cranchia scabra	1
Cycloteuthis sirventi	2
Echinoteuthis atlantica	1
Galiteuthis armata	1
Grimalditeuthis bonplandi	1
Helicocranchia sp.	3
Heteroteuthis sp.	2
Histioteuthis corona	1
Japetella diaphana	2
Joubiniteuthis portieri	1
Mastigoteuthis atlantica	1
Mastigoteuthis agassizii	1
Mastigoteuthis sp.	1
Octopoteuthis megaptera	1

Octopoteuthis sp.	1
Ommastrephidae	1
Onychoteuthis cf. banksii	2
Ornithoteuthis antillarum	1
Pterygioteuthis gemmata	4
Pyroteuthis margaritera	7
Sandalops melancholicus	1
Selenoteuthis scintillans	1
Spirula spirula	1
Sthenoteuthis pteropus	1
Stigmatoteuthis arcturi	1
Taoniinae	2
Vampyroteuthis infernalis	5
Walvisteuthis jeremiah	1

Table 9. Fish taxa collected for genetics studies during DEEPEND cruise DP04 with taxon comments.

Species/Taxon	N	Comments
Acromycter perturbator	1	
Ahlia egmontis	1	
Aldrovandia oleosa	1	
*Alepisaurus*sp.	2	
Alepisaurus ferox	4	
Alepocephalus sp.	1	
Alepocephalus bairdii	1	
Anoplogaster cornuta	2	
Antigonia combatia	1	
Apogon maculatus	1	
Argyropelecus sp.	1	Type A
Argyropelecus aculeatus	51	
Argyropelecus affinis	5	
Argyropelecus gigas	7	
Argyropelecus hemigymnus	13	
Argyropelecus sladeni	2	
Ariosoma anale	3	
Ariosoma balearicum	1	
Ariosoma coquettei	1	
Aristostomias xenostoma	3	
Astronesthes sp.	1	*A. niger*/*oligoa*, no trace of barbel
Astronesthes micropogon	1	
Astronesthes niger	6	
Astronesthes richardsoni	1	
Astronesthes similus	1	
Astronesthes undescribed TS1	1	
Ataxolepis apus	1	
Avocettina infans	2	
Avocettina infans	1	transforming
Barbantus curvifrons	1	
Barbourisia rufa	1	
*Bassozetus*sp.	3	
Bassozetus sp.	2	*B.* cf. *compressus*
Bathophilus digitatus	1	
Bathophilus pawneei	3	
Bathophilus proximus	1	
*Bathygadus*sp.	1	
Bathylaco nigricans	2	
Bembrops sp.	2	
Bolinichthys photothorax	2	
Bolinichthys supralateralis	11	
Bonapartia pedaliota	3	

Borostomias mononema	3	
Brama sp.	1	
Bregmaceros atlanticus	5	
Bregmaceros undescribed TS1	1	
Bregmaceros undescribed TS1	1	ASH5
Canthidermis sufflamen	1	
Canthigaster sp.	8	
Caranx bartholomaei	1	
Caranx crysos	21	
Centrophryne spinulosa	1	esca study; lure
Ceratias sp.	1	esca study; caruncles removed/ put in RNALater; no lure
Ceratoscopelus warmingii	52	
Cetomimidae	1	
Cetomimus sp.	3	sp. A
Cetostoma regani	3	
Chaenophryne draco	2	
Chauliodus sloani	53	
Chiasmodon niger complex	1	
Chiasmodon niger complex	1	full stomach
Chlorophthalmus agassizi	3	
Coccorella atlantica	4	
Cryptopsaras couesii	1	esca study; lure
Cubiceps pauciradiatus	2	
Cyclothone acclinidens	9	
Cyclothone microdon	1	
Cyclothone obscura	50	
Cyclothone pallida	15	
Cyclothone parapallida	1	
Cyclothone parapallida	1	Type
Diaphus brachycephalus	1	
Diaphus fragilis	1	
Diaphus mollis	3	
Diaphus mollis	1	Type B
Diaphus mollis	1	Type B
Diaphus mollis	5	Types A&B
Diaphus perspicillatus	1	
Diaphus problematicus	3	
Diaphus rafinesquii	2	
Diaphus subtilis	3	
Diaphus taaningi	2	
Diaphus termophilus	3	
Dicrolene sp.	2	
Dicrolene introniger	1	
Dicrolene kanazawai	1	

Diodon holocanthus	2	
Diogenichthys atlanticus	1	
Diplospinus multistriatus	1	
Ditropichthys storeri	4	
Dolicholagus longirostris	15	
Dolichopteryx longipes	2	
Dolopichthys pullatus	1	
Dysalotus alcocki	4	
Dysomma anguillare	5	
Echiostoma barbatum	1	
Epigonus sp.	1	
Epigonus pandionis	2	
Eustomias sp.	1	
Eustomias acinosus	1	
Eustomias schmidti	2	
Eustomias triramis	1	
Eutaeniophorus sp.	1	stomach in jar
Eutaeniophorus festivus	1	Full stomach, contents in vial, transforming
Evermannella sp.	1	
Evermannella sp.	1	sp. A
Evermannella indica	1	
Facciolella sp.	1	
*Facciolella*sp.	1	JAM 3
Flagellostomias boureei	2	
Foetorepus sp.	9	
Gigantactinidae	1	
Gigantactis microdontis	1	
Gigantura chuni	1	
Gigantura indica	2	
Gnathophis sp.	3	
Gonichthys cocco	2	
Gonostoma atlanticum	1	
Gordiichthys randalli	6	
Gymnothorax conspersus	1	*G. kolpos*?
Gymnothorax kolpos	4	
Gymnothorax kolpos	1	*G. conspersus*?
Gymnothorax ocellatus	21	
Gymnothorax sp. JAM1	1	
Helicolenus dactylopterus	6	
Hemanthias aureorubens	1	
Hemicaranx amblyrhynchus	2	sp. A
Heterophotus ophistoma	1	
Himantolophidae	2	
Holtbyrnia sp.	1	

Holtbyrnia innesi	1	
Hoplunnis tenuis	4	
Howella atlantica	9	
Hygophum benoiti	10	
Hygophum macrochir	3	
Ichthyococcus ovatus	3	
Ipnops murrayi	1	
Kaupichthys hyoproroides	1	
Lampadena luminosa	5	
Lampanyctus nobilis	6	
Lampanyctus tenuiformis	2	
Lepidophanes guentheri	1	
Leptochilichthys sp.	1	
Leptostomias gladiator	1	
Lestidiops affinis	7	
Linophryne sp.	1	male attached and DNA taken
Linophryne sp.	1	sp. B
Linophryne sp.	1	sp. C
Linophrynidae	10	
Liopropoma sp.	1	
Lobianchia gemellarii	4	
Lutjanidae	1	
Lutjanus campechanus	1	
Magnisudis atlantica	3	
Malacocephalus sp.	1	
Malacosteus niger	2	
Margrethia obtusirostra	1	
Maulisia sp.	1	
Maurolicus weitzmani	1	
Megalops atlanticus	1	
Melamphaes longivelis	1	
Melamphaes polylepis	1	
Melanocetus sp.	1	
Melanocetus johnsonii	1	
Melanolagus bericoides	2	
Melanonus zugmayeri	3	
Melanostomias tentaculatus	1	
Mentodus facilis	2	
Monomitopus agassizii	1	
Mulloidichthys martinicus	1	
Myctophum selenops	1	
Nannobrachium sp.	1	
Nannobrachium atrum	3	
Nannobrachium cuprarium	2	
Nannobrachium lineatum	16	

Nemichthys curvirostris	2	
Neoscopelus macrolepidotus	1	
Nesiarchus nasutus	3	
Nessorhamphus ingolfianus	1	
Nettastoma melanurum	1	
Nettenchelys pygmaea	5	
Nezumia sp.	1	
Notolychnus valdiviae	4	
Notoscopelus caudispinosus	1	
Notoscopelus resplendens	10	
Odontostomops normalops	2	
Omosudis lowii	12	
Oneirodes sp.	2	
Oneirodidae	8	
Oneirodidae	1	pulled eye
Ophichthus gomesii	21	
Oxyporhamphus micropterus similis	1	
Paralepis brevirostris	1	
Penopus microphthalmus	1	
Peprilus paru	4	
Photonectes leucospilus	2	
Photostomias goodyeari	1	
Photostomias guernei	6	
Photostylus pycnopterus	2	
Photostylus pycnopterus	1	esca study; some light organs removed and given to Lindsay
Physiculus fulvus	2	
Platytroctes apus	1	
Platytroctidae	1	
Platytroctidae	1	sp. A
Pleuronectiformes	2	
Poecilopsetta sp.	1	
Polyipnus sp.	2	
Polyipnus clarus	7	
Polymixia lowei	1	
Porogadus miles	2	
Poromitra "Gibbsi" Keene undescribed JM1	4	
Pristigenys alta	3	
Pristipomoides sp.	6	
Pseudophichthys splendens	1	
Pseudoscopelus sp.	1	
Pseudoscopelus altipinnis	1	
Remora sp.	1	
Rinoctes nasutus	1	

Robinsia catherinae	1	
Scombridae	29	
Scopelarchus analis	1	
Scopelarchus guentheri	3	
Scopelarchus michaelsarsi	1	
Scopelengys tristis	1	
Scopeloberyx opisthopterus	2	
Scopeloberyx robustus	8	
Scopeloberyx sp. JAM1	4	
Scopelogadus beanii	1	
Scopelogadus beanii	1	first one = voucher
Scopelogadus mizolepis	2	
Scopelosaurus smithii	1	
Selene sp.	1	
Selene setapinnis	15	
Serrivomer beanii	1	
Spectrunculus grandis	1	
Sphyraena guachancho	2	
Sternoptyx sp.	1	inbetweener
Sternoptyx diaphana	49	
Sternoptyx pseudobscura	42	
Stomias affinis	4	
Stomias longibarbatus	1	
Stylephorus chordatus	3	
Sudis atrox	2	
Symbolophorus rufinus	2	
Symphysanodon berryi	1	
Synagrops bellus	8	
Synagrops spinosus	6	
Taaningichthys bathyphilus	5	
Taaningichthys paurolychnus	2	
Talismania antillarum	1	
Tiluropsis sp.	1	
Trachurus lathami	3	
Uroconger syringinus	12	
Vinciguerria attenuata	10	
Vinciguerria nimbaria	14	
Vinciguerria poweriae	11	
Xenolepidichthys dalgleishi	2	
Yarrella blackfordi	1	
Zenion hololepis	1	

5.4 Polycyclic Aromatic Hydrocarbon Analysis

A total of 401 tissue samples were collected for PAH analysis. Large fish specimens were dissected at sea and organs/tissues kept separate (guts, liver, muscle, skin, ovaries). Other fish, cephalopod and invertebrate specimens were frozen as whole bodies (Table 10).

Table 10. Specimens collected for PAH analysis on DEEPEND cruise DP04.

Sample	Species	N	Sample Type	Vial No.
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	heart	601
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	liver/spleen	602
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	gills	603
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	whole body	0
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	gills	604
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	heart	605
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	liver/spleen	606
DP04-05AUG16-MOC10-SW6N-057-N0	*Sigmops elongatus*	1	whole body	0
DP04-05AUG16-MOC10-SW6N-057-N4	*Sigmops elongatus*	1	gills	607
DP04-05AUG16-MOC10-SW6N-057-N4	*Sigmops elongatus*	1	heart	608
DP04-05AUG16-MOC10-SW6N-057-N4	*Sigmops elongatus*	1	liver/spleen	609
DP04-05AUG16-MOC10-SW6N-057-N4	*Sigmops elongatus*	1	whole body	0
DP04-05AUG16-MOC10-SW6N-057-N4	*Systellaspis debilis*	1	whole body	611
DP04-05AUG16-MOC10-SW6N-057-N5	*Systellaspis debilis*	1	eggs	610
DP04-06AUG16-MOC10-SW6D-058-N0	*Acanthephyra acutifrons*	1	whole body	612
DP04-06AUG16-MOC10-SW6D-058-N0	*Acanthephyra curtirostris*	1	whole body	613
DP04-06AUG16-MOC10-SW6D-058-N0	*Systellaspis debilis*	1	eggs	614
DP04-06AUG16-MOC10-SW6D-058-N0	*Systellaspis debilis*	1	whole body	615
DP04-06AUG16-MOC10-SW6D-058-N0	*Acanthephyra stylorostratis*	1	eggs	616
DP04-06AUG16-MOC10-SW6D-058-N0	*Acanthephyra stylorostratis*	1	whole body	617
DP04-06AUG16-MOC10-SW6N-059-N0	*Japetella diaphana*	1		
DP04-07AUG16-MOC10-SW4N-061-N0	*Lampanyctus alatus*	1	whole body	618
DP04-07AUG16-MOC10-SW4N-061-N0	*Cyclothone pallida*	8	whole body	619
DP04-07AUG16-MOC10-SW4N-061-N0	*Cyclothone obscura*	7	whole body	620
DP04-07AUG16-MOC10-SW4N-061-N1	*Acanthephyra curtirostris*	1	whole body	621
DP04-07AUG16-MOC10-SW4N-061-N1	*Sigmops elongatus*	1	gills	622
DP04-07AUG16-MOC10-SW4N-061-N1	*Sigmops elongatus*	1	heart	623
DP04-07AUG16-MOC10-SW4N-061-N1	*Sigmops elongatus*	1	liver/spleen	624
DP04-07AUG16-MOC10-SW4N-061-N1	*Cyclothone obscura*	14	whole body	625
DP04-07AUG16-MOC10-SW4N-061-N1	*Sigmops elongatus*	1	ovary	626
DP04-07AUG16-MOC10-SW4N-061-N3	*Acanthephyra stylorostratis*	1	eggs	627
DP04-07AUG16-MOC10-SW4N-061-N3	*Acanthephyra stylorostratis*	1	whole body	628
DP04-07AUG16-MOC10-SW4N-061-N4	*Argyropelecus hemigymnus*	16	whole body	629
DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	gills	630
DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	heart	631

DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	liver/spleen	632
DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	whole body	0
DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	gills	633
DP04-08AUG16-MOC10-SE1D-062-N0	*Chauliodus sloani*	1	gills	634
DP04-08AUG16-MOC10-SE1D-062-N0	*Anoplogaster cornuta*	1	liver/spleen	635
DP04-08AUG16-MOC10-SE1D-062-N0	*Chauliodus sloani*	1	heart	636
DP04-08AUG16-MOC10-SE1D-062-N0	*Chauliodus sloani*	1	whole body	637
DP04-08AUG16-MOC10-SE1D-062-N0	*Chauliodus sloani*	1	liver/spleen	638
DP04-08AUG16-MOC10-SE1D-062-N0	*Chauliodus sloani*	1	whole body	0
DP04-08AUG16-MOC10-SE1D-062-N4	*Lampanyctus alatus*	3	whole body	639
DP04-08AUG16-MOC10-SE1D-062-N4	*Benthosema suborbitale*	6	whole body	640
DP04-08AUG16-MOC10-SE1D-062-N4	*Lepidophanes guentheri*	7	whole body	641
DP04-08AUG16-MOC10-SE1D-062-N4	*Abralia redfieldi*	1		
DP04-08AUG16-MOC10-SE1N-063-N0	*Argyropelecus hemigymnus*	3	whole body	642
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	3	whole body	643
DP04-08AUG16-MOC10-SE1N-063-N0	*Acanthephyra stylorostratis*	1	eggs	644
DP04-08AUG16-MOC10-SE1N-063-N0	*Acanthephyra stylorostratis*	1	whole body	645
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	1	gills	646
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	1	heart	647
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	1	liver/spleen	648
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	1	ovary	649
DP04-08AUG16-MOC10-SE1N-063-N0	*Sternoptyx diaphana*	1	whole body	0
DP04-08AUG16-MOC10-SE1N-063-N0	*Abralia redfieldi*	1		
DP04-08AUG16-MOC10-SE1N-063-N0	*Abralia redfieldi*	1		
DP04-08AUG16-MOC10-SE1N-063-N1	*Japetella diaphana*	1		
DP04-08AUG16-MOC10-SE1N-063-N4	*Argyropelecus aculeatus*	1	gills	650
DP04-08AUG16-MOC10-SE1N-063-N4	*Argyropelecus aculeatus*	1	heart	651
DP04-08AUG16-MOC10-SE1N-063-N4	*Argyropelecus aculeatus*	1	liver/spleen	652
DP04-08AUG16-MOC10-SE1N-063-N4	*Argyropelecus aculeatus*	1	ovary	653
DP04-08AUG16-MOC10-SE1N-063-N4	*Argyropelecus aculeatus*	1	whole body	0
DP04-08AUG16-MOC10-SE1N-063-N4	*Sergia splendens*	1	whole body	654
DP04-08AUG16-MOC10-SE1N-063-N4	*Acanthephyra stylorostratis*	1	whole body	655
DP04-08AUG16-MOC10-SE1N-063-N4	*Systellaspis debilis*	1	eggs	656
DP04-08AUG16-MOC10-SE1N-063-N4	*Systellaspis debilis*	1	whole body	657
DP04-09AUG16-MOC10-SE3N-065-N0	*Sternoptyx pseudobscura*	1	heart	658
DP04-09AUG16-MOC10-SE3N-065-N0	*Sternoptyx pseudobscura*	1	gills	659
DP04-09AUG16-MOC10-SE3N-065-N0	*Sternoptyx pseudobscura*	1	liver/spleen	660
DP04-09AUG16-MOC10-SE3N-065-N0	*Sternoptyx pseudobscura*	1	ovary	661
DP04-09AUG16-MOC10-SE3N-065-N0	*Sternoptyx pseudobscura*	1	whole body	0
DP04-10AUG16-MOC10-SE2D-066-N0	*Lampanyctus alatus*	5	whole body	662
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	gills	663
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	heart	664
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	liver/spleen	665

DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	ovary	666
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	whole body	0
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	gills	667
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	heart	668
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	liver/spleen	669
DP04-10AUG16-MOC10-SE2D-066-N3	*Sigmops elongatus*	1	whole body	0
DP04-10AUG16-MOC10-SE2N-067-N0	*Systellaspis debilis*	1	whole body	670
DP04-10AUG16-MOC10-SE2N-067-N0	*Acanthephyra purpurea*	1	whole body	671
DP04-10AUG16-MOC10-SE2N-067-N0	*Lampanyctus alatus*	4	whole body	672
DP04-10AUG16-MOC10-SE2N-067-N5	*Diaphus mollis*	1	whole body	673
DP04-11AUG16-MOC10-SW3D-068-N0	*Diaphus mollis*	1	whole body	674
DP04-11AUG16-MOC10-SW3D-068-N0	*Argyropelecus hemigymnus*	7	whole body	675
DP04-11AUG16-MOC10-SW3D-068-N0	*Sigmops elongatus*	1	gills	676
DP04-11AUG16-MOC10-SW3D-068-N0	*Sigmops elongatus*	1	heart	677
DP04-11AUG16-MOC10-SW3D-068-N0	*Sigmops elongatus*	1	liver/spleen	678
DP04-11AUG16-MOC10-SW3D-068-N0	*Sigmops elongatus*	1	whole body	0
DP04-11AUG16-MOC10-SW3D-068-N2	*Sternoptyx pseudobscura*	1	gills	679
DP04-11AUG16-MOC10-SW3D-068-N2	*Sternoptyx pseudobscura*	1	heart	680
DP04-11AUG16-MOC10-SW3D-068-N2	*Sternoptyx pseudobscura*	1	liver/spleen	681
DP04-11AUG16-MOC10-SW3D-068-N2	*Sternoptyx pseudobscura*	1	ovary	682
DP04-11AUG16-MOC10-SW3D-068-N2	*Sternoptyx pseudobscura*	1	whole body	0
DP04-11AUG16-MOC10-SW3D-068-N3	*Photostomias guernei*	1	whole body	683
DP04-11AUG16-MOC10-SW3D-068-N3	*Lampanyctus alatus*	2	whole body	684
DP04-11AUG16-MOC10-SW3D-068-N3	*Lepidophanes guentheri*	1	whole body	685
DP04-11AUG16-MOC10-SW3D-068-N3	*Sigmops elongatus*	1	gills	686
DP04-11AUG16-MOC10-SW3D-068-N3	*Sigmops elongatus*	1	heart	687
DP04-11AUG16-MOC10-SW3D-068-N3	*Sigmops elongatus*	1	liver/spleen	688
DP04-11AUG16-MOC10-SW3D-068-N3	*Sigmops elongatus*	1	ovary	689
DP04-11AUG16-MOC10-SW3D-068-N3	*Sigmops elongatus*	1	whole body	0
DP04-11AUG16-MOC10-SW3D-068-N3	*Acanthephyra stylorostratis*	1	whole body	690
DP04-11AUG16-MOC10-SW3D-068-N3	*Acanthephyra curtirostris*	1	whole body	691
DP04-11AUG16-MOC10-SW3D-068-N3	*Acanthephyra purpurea*	1	whole body	692
DP04-11AUG16-MOC10-SW3N-069-N0	*Sigmops elongatus*	1	gills	693
DP04-11AUG16-MOC10-SW3N-069-N0	*Sigmops elongatus*	1	heart	694
DP04-11AUG16-MOC10-SW3N-069-N0	*Sigmops elongatus*	1	liver/spleen	695
DP04-11AUG16-MOC10-SW3N-069-N0	*Sigmops elongatus*	1	whole body	0
DP04-11AUG16-MOC10-SW3N-069-N0	*Sternoptyx pseudobscura*	1	gills	696
DP04-11AUG16-MOC10-SW3N-069-N0	*Sternoptyx pseudobscura*	1	heart	697
DP04-11AUG16-MOC10-SW3N-069-N0	*Sternoptyx pseudobscura*	1	liver/spleen	698
DP04-11AUG16-MOC10-SW3N-069-N0	*Sternoptyx pseudobscura*	1	ovary	699
DP04-11AUG16-MOC10-SW3N-069-N0	*Sternoptyx pseudobscura*	1	whole body	0
DP04-11AUG16-MOC10-SW3N-069-N3	*Japetella diaphana*	1		
DP04-11AUG16-MOC10-SW3N-069-N4	*Argyropelecus hemigymnus*	8	whole body	700

DP04-12AUG16-MOC10-SW5D-070-N0	*Chauliodus sloani*	1	gills	701
DP04-12AUG16-MOC10-SW5D-070-N0	*Chauliodus sloani*	1	heart	702
DP04-12AUG16-MOC10-SW5D-070-N0	*Chauliodus sloani*	1	liver/spleen	703
DP04-12AUG16-MOC10-SW5D-070-N0	*Chauliodus sloani*	1	muscle	704
DP04-12AUG16-MOC10-SW5D-070-N0	*Chauliodus sloani*	1	ovary	705
DP04-12AUG16-MOC10-SW5D-070-N0	*Japetella diaphana*	1		
DP04-12AUG16-MOC10-SW5D-070-N3	*Lampanyctus alatus*	1	whole body	706
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra stylorostratis*	1	eggs	707
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra stylorostratis*	1	whole body	708
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra stylorostratis*	1	eggs	709
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra stylorostratis*	1	whole body	710
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	eggs	713
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	whole body	714
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	eggs	715
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	whole body	716
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	eggs	717
DP04-13AUG16-MOC10-SW6D-072-N0	*Systellaspis debilis*	1	whole body	718
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra purpurea*	1	whole body	719
DP04-13AUG16-MOC10-SW6D-072-N0	*Acanthephyra purpurea*	1	whole body	720
DP04-13AUG16-MOC10-SW6D-072-N2	*Lepidophanes guentheri*	1	whole body	712
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	gills	725
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	heart	726
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	liver/spleen	727
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	ovary	728
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	whole body	0
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	gills	729
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	heart	730
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	liver/spleen	731
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	ovary	732
DP04-13AUG16-MOC10-SW6D-072-N2	*Sternoptyx pseudobscura*	1	whole body	0
DP04-13AUG16-MOC10-SW6D-072-N3	*Chauliodus sloani*	1	gills	711
DP04-13AUG16-MOC10-SW6D-072-N3	*Chauliodus sloani*	1	heart	721
DP04-13AUG16-MOC10-SW6D-072-N3	*Chauliodus sloani*	1	liver/spleen	722
DP04-13AUG16-MOC10-SW6D-072-N3	*Chauliodus sloani*	1	ovary	723
DP04-13AUG16-MOC10-SW6D-072-N3	*Chauliodus sloani*	1	muscle	724
DP04-14AUG16-MOC10-B064N-074-N0	*Malacosteus niger*	1	heart	733
DP04-14AUG16-MOC10-B064N-074-N0	*Malacosteus niger*	1	gills	734
DP04-14AUG16-MOC10-B064N-074-N0	*Malacosteus niger*	1	liver/spleen	735
DP04-14AUG16-MOC10-B064N-074-N0	*Malacosteus niger*	1	muscle	736
DP04-15AUG16-MOC10-B065D-075-N0	*Acanthephyra purpurea*	1	eggs	737
DP04-15AUG16-MOC10-B065D-075-N0	*Acanthephyra purpurea*	1	whole body	738
DP04-15AUG16-MOC10-B065D-075-N0	*Benthosema suborbitale*	1	whole body	739
DP04-15AUG16-MOC10-B065D-075-N0	*Japetella diaphana*	1		

DP04-15AUG16-MOC10-B065D-075-N3	*Echiostoma barbatum*	1	gills	740
DP04-15AUG16-MOC10-B065D-075-N3	*Echiostoma barbatum*	1	heart	741
DP04-15AUG16-MOC10-B065D-075-N3	*Echiostoma barbatum*	1	liver/spleen	742
DP04-15AUG16-MOC10-B065D-075-N3	*Echiostoma barbatum*	1	muscle	743
DP04-15AUG16-MOC10-B065D-075-N3	*Photostomias guernei*	1	whole body	744
DP04-15AUG16-MOC10-B065D-075-N4	*Benthosema suborbitale*	3	whole body	745
DP04-15AUG16-MOC10-B065D-075-N4	*Lepidophanes guentheri*	3	whole body	746
DP04-15AUG16-MOC10-B065N-076-N0	*Acanthephyra stylorostratis*	1	eggs	747
DP04-15AUG16-MOC10-B065N-076-N0	*Acanthephyra stylorostratis*	1	whole body	748
DP04-15AUG16-MOC10-B065N-076-N0	*Ceratoscopelus warmingii*	4	whole body	749
DP04-15AUG16-MOC10-B065N-076-N0	*Diaphus mollis*	1	whole body	750
DP04-15AUG16-MOC10-B065N-076-N0	*Sternoptyx diaphana*	2	whole body	751
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	4	whole body	752
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	gills	753
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	heart	754
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	liver/spleen	755
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	ovary	756
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	whole body	0
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	gills	757
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	heart	758
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	liver/spleen	759
DP04-15AUG16-MOC10-B065N-076-N0	*Argyropelecus aculeatus*	1	whole body	0
DP04-15AUG16-MOC10-B065N-076-N0	*Bolitaena pygmaea*	1		
DP04-15AUG16-MOC10-B065N-076-N3	*Sternoptyx diaphana*	3	whole body	760
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	gills	761
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	heart	762
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	liver/spleen	763
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	ovary	764
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	whole body	0
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	gills	765
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	heart	766
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	liver/spleen	767
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	ovary	768
DP04-15AUG16-MOC10-B065N-076-N4	*Sigmops elongatus*	1	whole body	0
DP04-15AUG16-MOC10-B065N-076-N5	*Diaphus dumerilii*	1	whole body	769
DP04-15AUG16-MOC10-B065N-076-N5	*Diaphus mollis*	1	whole body	770
DP04-15AUG16-MOC10-B065N-076-N5	*Ceratoscopelus warmingii*	3	whole body	771
DP04-15AUG16-MOC10-B065N-076-N5	*Argyropelecus aculeatus*	4	whole body	772
DP04-16AUG16-MOC10-B287D-077-N0	*Ceratoscopelus warmingii*	5	whole body	773
DP04-16AUG16-MOC10-B287D-077-N0	*Benthosema suborbitale*	11	whole body	774
DP04-16AUG16-MOC10-B287D-077-N0	*Cyclothone pallida*	12	whole body	775
DP04-16AUG16-MOC10-B287D-077-N0	*Acanthephyra stylorostratis*	1	whole body	776
DP04-16AUG16-MOC10-B287D-077-N1	*Ceratoscopelus warmingii*	1	whole body	777

DP04-16AUG16-MOC10-B287D-077-N3	*Photostomias guernei*	1	whole body	778
DP04-16AUG16-MOC10-B287D-077-N3	*Sternoptyx diaphana*	4	whole body	779
DP04-16AUG16-MOC10-B287D-077-N3	*Sternoptyx pseudobscura*	2	whole body	780
DP04-16AUG16-MOC10-B287D-077-N3	*Sigmops elongatus*	1	gills	781
DP04-16AUG16-MOC10-B287D-077-N3	*Sigmops elongatus*	1	heart	782
DP04-16AUG16-MOC10-B287D-077-N3	*Sigmops elongatus*	1	liver/spleen	783
DP04-16AUG16-MOC10-B287D-077-N3	*Sigmops elongatus*	1	whole body	0
DP04-16AUG16-MOC10-B287N-078-N0	*Valenciennellus tripunctulatus*	14	whole body	784
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	2	whole body	785
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	1	gills	786
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	1	heart	787
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	1	liver/spleen	788
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	1	ovary	789
DP04-16AUG16-MOC10-B287N-078-N0	*Sternoptyx diaphana*	1	whole body	0
DP04-16AUG16-MOC10-B287N-078-N0	*Ceratoscopelus warmingii*	9	whole body	790
DP04-16AUG16-MOC10-B287N-078-N4	*Valenciennellus tripunctulatus*	7	whole body	791
DP04-16AUG16-MOC10-B287N-078-N4	*Argyropelecus aculeatus*	1	gills	793
DP04-16AUG16-MOC10-B287N-078-N4	*Argyropelecus aculeatus*	1	heart	794
DP04-16AUG16-MOC10-B287N-078-N4	*Argyropelecus aculeatus*	1	liver/spleen	795
DP04-16AUG16-MOC10-B287N-078-N4	*Argyropelecus aculeatus*	1	ovary	796
DP04-16AUG16-MOC10-B287N-078-N4	*Argyropelecus aculeatus*	1	whole body	0
DP04-17AUG16-MOC10-B252D-079-N0	*Acanthephyra curtirostris*	1	whole body	792
DP04-17AUG16-MOC10-B252N-080-N0	*Diaphus mollis*	2	whole body	797
DP04-17AUG16-MOC10-B252N-080-N2	*Onychoteuthis banksii*	1		
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	gills	798
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	heart	799
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	liver/spleen	800
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	ovary	801
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	muscle	802
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	gills	803
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	heart	804
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	liver/spleen	805
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	ovary	806
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	muscle	807
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	gills	808
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	heart	809
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	liver/spleen	810
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	ovary	811
DP04-17AUG16-MOC10-B252N-080-N3	*Chauliodus sloani*	1	muscle	812

5.5 Stable Isotope Analysis

5.5.1 Crustacea

A total of 101 individuals were collected from net 0 from multiple stations inside and outside the Loop Current for stable isotope analyses, including *Acanthephyra curtirostris, A. purpurea, A. stylorostratis*, *Nematoscelis atlantica/microps*, Sergestes, *Sergia splendens*, *Systellaspis debilis* and *Thysanopoda actifrons/orientalis* (Table 11).

Table 11. Crustaceans collected for stable isotope analyses during DEEPEND cruise DP04.

Trawl	Site	Net No.	Species	N	Preservation Method
57	SW6N	4	*Systellaspis debilis*	2	Frozen
58	SW6D	0	*Sergestes* sp.	3	Frozen
58	SW6D	0	*Sergia splendens*	2	Frozen
58	SW6D	1	*Acanthephyra purpurea*	1	Frozen
58	SW6D	3	*Systellaspis debilis*	4	Frozen
58	SW6D	3	*Acanthephyra purpurea*	1	Frozen
59	SW6N	0	*Acanthephyra curtirostris*	1	Frozen
60	SW4D	4	*Sergestes*	3	Frozen
60	SW4D	4	*Thysanopoda acutifrons/orientalis*	3	Frozen
61	SW4N	0	*Acanthephyra stylorostratis*	2	Frozen
61	SW4N	4	*Nematoscelis atlantica/microps*	3	Frozen
63	SE1N	0	*Sergia splendens*	4	Frozen
63	SE1N	0	*Sergestes*	2	Frozen
63	SE1N	0	*Acanthephyra stylorostratis*	3	Frozen
64	SE3D	0	*Sergia splendens*	3	Frozen
64	SE3D	0	*Acanthephyra stylorostratis*	3	Frozen
65	SE3N	0	*Systellaspis debilis*	2	Frozen
65	SE3N	4	*Acanthephyra purpurea*	1	Frozen
66	SE2D	0	*Thysanopoda acutifrons/orientalis*	2	Frozen
66	SE2D	0	*Acanthephyra curtirostris*	1	Frozen
66	SE2D	0	*Sergestes*	1	Frozen
67	SE2N	0	*Acanthephyra purpurea*	1	Frozen
68	SW3D	0	*Acanthephyra curtirostris*	1	Frozen
68	SW3D	0	*Thysanopoda acutifrons/orientalis*	3	Frozen
68	SW3D	0	*Nematoscelis atlantica/microps*	2	Frozen
68	SW3D	0	*Sergestes*	3	Frozen
69	SW3N	0	*Acanthephyra purpurea*	1	Frozen
69	SW3N	0	*Acanthephyra stylorostratis*	2	Frozen
71	SW5N	0	*Thysanopoda acutifrons/orientalis*	3	Frozen
71	SW5N	0	*Nematoscelis atlantica/microps*	1	Frozen
71	SW5N	0	*Sergestes*	1	Frozen
72	SW6D	0	*Acanthephyra purpurea*	2	Frozen
72	SW6D	0	*Acanthephyra stylorostratis*	2	Frozen

73	B064D	0	*Thysanopoda acutifrons/orientalis*	3	Frozen
73	B064D	0	*Sergestes*	2	Frozen
73	B064D	0	*Acanthephyra stylorostratis*	3	Frozen
75	B065D	0	*Thysanopoda acutifrons/orientalis*	3	Frozen
75	B065D	0	*Sergestes*	2	Frozen
76	B065N	0	*Sergia splendens*	2	Frozen
76	B065N	0	*Acanthephyra stylorostratis*	1	Frozen
76	B065N	0	*Sergestes*	2	Frozen
76	B065N	0	*Acanthephyra purpurea*	3	Frozen
77	B287D	0	*Thysanopoda acutifrons/orientalis*	3	Frozen
77	B287D	0	*Nematoscelis atlantica/microps*	3	Frozen
79	B252D	0	*Acanthephyra curtirostris*	1	Frozen
80	B252N	0	*Acanthephyra purpurea*	1	Frozen

5.5.2 Cephalopoda, Gastropoda (pteropods) and Other Pelagic Molusca

Ten cephalopod species were frozen for stable isotope analysis, including *Bolitaena pygmaea* (n = 1), *Histioteuthis corona* (n = 1), Octopoteuthis *megaptera* (n = 1), *Onychoteuthis* cf. *banksii* (n = 1), *Japatella diaphana* (n = 1), *Sthenoteuthis pteropus* (n = 1), *Mastigoteuthis agassizii* (n = 1), *Stigmatoteuthis arcturi* (n = 2), *Pterygiotuethis gemmata* (n = 3), and *Vampyroteuthis infernalis* (n=3). A total of 20 pteropods and 1 heteropod were also frozen for stable isotope analysis.

5.5.3 Fishes

A total of 1183 individuals from 77 fish species/taxon were collected for stable isotope analysis (Table 12). These species encompass a range of trophic levels, vertical distributions, and vertical migration habits.

Table 12. Fishes collected for stable isotope analysis. N = sample number; VM = vertical migrator or non-migrator; E = epipelagic, M = mesopelagic, B = bathypelagic

Species/Taxon	N	VM?	Primary habitat
Anoplogaster cornuta	2	Y	M/B
Argyropelecus aculeatus	10	Y	M
Argyropelecus hemigymnus	51	Y	M
Ariosoma balearicum	57	N	E
Aristostomias sp.	1	Y	M
Aristostomias xenostoma	1	Y	M
Avocettina infans	5	Y	M/B
Benthosema suborbitale	53	Y	M
Bolinichthys photothorax	8	Y	M
Bolinichthys supralateralis	2	Y	M
Bonapartia pedaliota	1	Y	M
Borostomias sp.	1	Y	M/B
Canthigaster sp.	1	N	E
Caranx crysos	10	Y	E
Ceratoscopelus warmingii	54	Y	M/B

Chauliodus sloani	10	Y	M/B
Chlorophthalmus agassizi	3	N	E/M
Cubiceps pauciradiatus	1	N	E/M
Cyclothone acclinidens	65	N	M/B
Cyclothone alba	17	N	M
Cyclothone braueri	8	N	M
Cyclothone obscura	57	N	B
Cyclothone pallida	28	N	M/B
Cyclothone pseudopallida	3	N	M/B
Diaphus dumerilii	40	Y	M
Diaphus lucidus	6	Y	M
Diaphus mollis	15	Y	M
Diaphus splendidus	5	Y	M
Diogenichthys atlanticus	5	Y	M
Diplospinus multistriatus	4	Y	M
Dolicholagus longirostris	6	Y	M
Dolichopteryx longipes	1	N	M/B
Dysalotus alcocki	1	N	B
Echiostoma barbatum	2	Y	M
Eustomias sp.	2	Y	M
Gigantura sp.	1	N	M/B
Gymnothorax ocellatus	12	N	E
Helicolenus dactylopterus	1	N	E
Hoplunnis macrura	4	N	E
Hoplunnis tenuis	6	N	E (larva)
Hygophum benoiti	9	Y	M/B
Hygophum taaningi	12	Y	M
Lampadena luminosa	4	Y	M
Lampanyctus alatus	99	Y	M
Lampanyctus nobilis	1	Y	M
Lampanyctus tenuiformis	1	Y	M
Lepidophanes guentheri	35	Y	M
Leptostomias sp.	3	Y	M
Malacosteus niger	1	N	M
Melamphaes simus	52	Y	M
Myctophum affine	9	Y	M
Nannobrachium	4	Weak	M/B
Nannobrachium lineatum	5	Weak	M/B
Notolychnus valdiviae	27	Y	M
Notoscopelus resplendens	2	Y	M/B
Omosudis lowii	4	Y	M/B
Ophichthus gomesii	13	N	E
Ostraciidae	1	N	E

Paraconger sp.	29	N	E
Photostomias guernei	9	Y	M/B
Photostylus pycnopterus	2	Y	M
Platytroctes apus	1	N	B
Platytroctidae	1	N	B
Pollichthys mauli	25	Y	M
Poromitra "Gibbsi" Keene undescribed JM1	2	Y	M
Rhynchoconger flavus	64	N	E (larva)
Scopelarchus guentheri	2	Y	M
Scopeloberyx opercularis	7	Y	M/B
Scopeloberyx opisthopterus	20	Y	M/B
Scopeloberyx robustus	4	Y	M/B
Sigmops elongatus	43	Y	M/B
Sternoptyx diaphana	47	Y	M/B
Sternoptyx pseudobscura	26	N	M/B
Stomias affinis	6	Y	M/B
Uroconger syringinus	3	N	E (larva)
Valenciennellus tripunctulatus	47	Y	M
Vinciguerria poweriae	3	Y	M

5.5.4 Gelatinous Zooplankton.

Two specimens of the coronate cnidarian, *Periphylla periphylla*, were collected for stable isotope analysis.

5.6 Compound Specific Stable Isotope Analysis

5.6.1 Crustacea

A total of 13 individual crustaceans from 3 taxonomic groups were collected for compound specific stable isotope analysis, including Ostracods (n = 5), *Sergia splendens* (n = 3), and Stomatopods (n = 5).

5.6.2 Cephalopoda

A total of 14 individuals from six species were collected for compound specific stable isotope analysis, including *Bolitaena pygmaea* (n = 3), *Japetella diaphana* (n =1), *Octoteuthis* sp. (n = 1), *Pterygioteuthis gemmata* (n = 3), *Stigmatoteuthis arcturi* (n = 3), and *Vampyroteuthis infernalis* (n = 3).

5.6.3 Fishes

A total of 48 species/taxon from 13 families were collected for compound specific stable isotope analysis (Table 13).

Table 13. Fish species/taxon collected for compound specific stable isotope analysis during DEEPEND cruise DP04.

Species/Taxon	N
Argyropelecus hemigymnus	23
Ariosoma balearicum	25
Avocettina infans	3
Benthosema suborbitale	7
Bolinichthys supralateralis	1
Caranx sp.	3
Caranx crysos	6
Chauliodus sloani	3
Chloroscombrus chrysurus	4
Cyclothone acclinidens	9
Cyclothone alba	13
Cyclothone obscura	15
Cyclothone pallida	23
Cyclothone pseudopallida	19
Diaphus dumerilii	2
Diaphus mollis	4
Diaphus splendidus	1
Diplospinus multistriatus	2
Dolicholagus longirostris	3
Echiostoma barbatum	2
Hygophum macrochir	2
Hygophum taaningi	3
Lampadena luminosa	3
Lampanyctus alatus	6
Lampanyctus nobilis	3
Lepidophanes guentheri	8
Malacosteus niger	1
Melamphaes simus	18
Mentodus facilis	1
Myctophum affine	10
Nannobrachium atrum	1
Nannobrachium lineatum	4
Paraconger sp.	19
Photostomias guernei	3
Photostylus pycnopterus	1
Platytroctidae	1
Poromitra "Gibbsi" Keene undescribed JM1	1
Rhynchoconger flavus	17
Scopeloberyx opercularis	6

Scopeloberyx opisthopterus	4
Scopeloberyx robustus	2
Sigmops elongatus	14
Sternoptyx diaphana	19
Sternoptyx pseudobscura	7
Stomias affinis	1
Valenciennellus tripunctulatus	6
Vinciguerria nimbaria	5
Vinciguerria poweriae	4

5.6.4 Gelatinous Zooplankton.

Three species of gelatinous zooplankton were collected for compound specific stable isotope analysis, including *Atolla* sp. (n = 3), *Periphylla periphylla* (n = 4), and *Pyrosoma atlanticum* (n = 4).

5.7 Otolith Microchemistry Analysis

5.7.1 Fishes

All fishes frozen for stable isotope analysis (Section 5.5.3, Table 12) are available for otolith microchemistry analysis.

5.8 Leptocephalus Identification Key

Approximately 90 of the 183 eel leptocephali species known from the Gulf of Mexico and Caribbean region have been collected. High-resolution photographs were taken of 61 species (e.g., Figure 27). Several specimens do not fit any of the known leptocephali species and may represent either newly found leptocephali species where only the adult is known or the leptocephali may represent species that are entirely unknown to science.

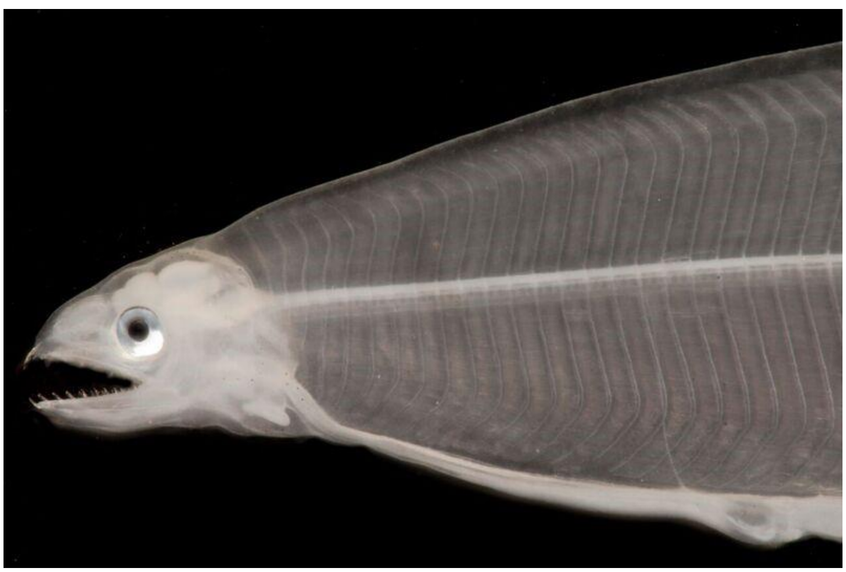


Figure 27 - Image of eel leptocephalus taken during the DEEPEND cruise DP04 for Leptocephalus Identification Key project.

5.9 Hydroacoustic Data

Over 320 GB of acoustic backscatter data were collected during the DP04 cruise. Four Simrad EK-series splitbeam echosounders (18, 38, 70, and 120 kHz) collected data covering 3000 m (18 kHz), 3000 m (38 kHz) and ~ 400 m (70 and 120 kHz) of the water column (Figure 6). Both narrowband and wideband (at 18 and 70 kHz) data were collected opportunistically to examine the potential to use frequency spectra to further describe the scattering responses of mesopelagic fauna. Data were collected during day and night time MOC10 tows at 11 different stations (SW3, SW4, SW5, SW6 (twice), SE2, SE3, B064, B065, B287, B252, B175) and during transits between four station pairs (SW6 to B064, B065 to B287, B287 to B252, B252 to B175, Figure 28). Passive acoustic surveys were conducted in both continuous wave and wideband form during daytime and nighttime operations to characterize the noise (electrical interference) generated by the ship and associated machinery. Additionally, all four echosounders were calibrated using standard tungsten carbide and copper spheres in both narrowband and wideband (18 and 70 kHz) modes following standardized procedures. Acoustic data have undergone preliminary quality control inspection and are currently being scrutinized and analyzed. The data packaging process is underway from the DP04 data for submission to NECI.

Currently, the preliminary analyses of DP04 supports findings from the previous DEEPEND cruises that there is a substantial amount of material transported vertically during migration phases, and large differences among taxonomic groups have been identified (Figure 29). The paper published by D'Elia et al. (2016) has set forth the process to examine the scattering layers at relevant taxonomic resolution and quantify changes in movement patters and distribution at these scales.

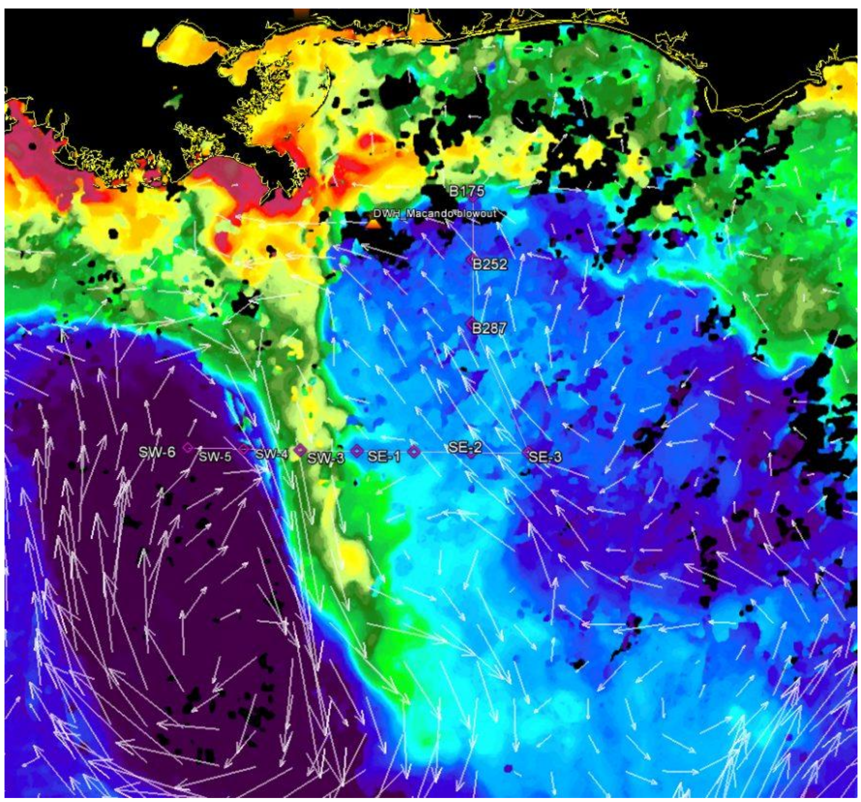


Figure 28. Stations sampled during DEEPEND cruise DP04 (SW-6, SW-5, SW-4, SW-3, SE-1, SE-2, SE-3, B287, B252, and B175).

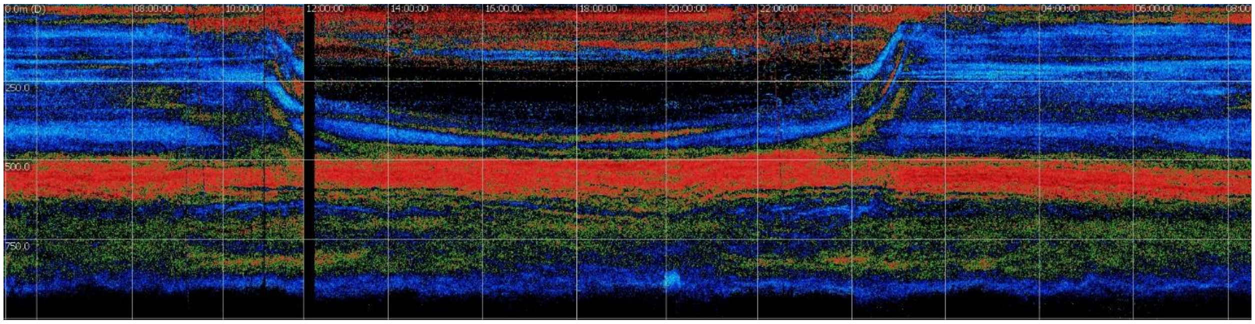


Figure 29. Example of an echogram collected in the station SW-6 representing a descending and ascending migration pattern in the sound scattering layers over 24 consecutive hours.

5.10 Physical Oceanographic Data Collected

Several different types of *in situ* physical oceanographic data were collected during DP04. These data are summarized in Table 14. The data collected from each instrument are described individually in the following sections.

Table 14. Physical oceanographic sampling efforts during the DEEPEND cruise DP04. CTD = Conductivity-Temperature-Density rosette casts; HS2 = <200m optical scattering and fluorometer profile; Rrs = Remote-Sensing Reflectance measurement

Station	Sampling times	CTD	HS2	Rrs
SW6	06-Aug 09:00 to 06-Aug 23:30	2	2	2
SW4	08-Aug 01:00 to 08-Aug 03:00	1	-	-
SE1	08-Aug 22:00 to 09-Aug 01:00	1	1	-
SE3	09-Aug 23:00 to 10-Aug 10:00	2	2	-
SE2	10-Aug 24:00 to 11-Aug 02:00	1	1	-
SW3	11-Aug 22:00 to 11-Aug 24:00	1	1	-
SW5	12-Aug 21:00 to 12-Aug 23:00	1	1	-
B064	14-Aug 10:00 to 14-Aug 24:00	2	1	1
B065	15-Aug 20:00 to 15-Aug 23:00	1		1
B287	16-Aug 20:00 to 16-Aug 23:00	1	1	1
B252	17-Aug 20:00 to 18-Aug 01:00	2	1	1
B175	18-Aug 21:00 to 18-Aug 24:00	1	1	1

5.10.1 CTD and Water Samples

The CTD and water sampling rosette was deployed 16 times at twelve stations during the DEEPEND DP04 cruise (Table 15). From these deployments, 38 water samples (Table 16) were collected by the USF-Optical Oceanography Laboratory for determining chlorophyll-a concentration and the spectral absorption due to total particulate material, ap(λ), detrital material, ad(λ), and colored dissolved organic matter, aCDOM(λ). Water samples from several sample depths were collected using Niskin bottles on the CTD rosette, or from the ship's flow-through (FT) system. Duplicate samples were collected at select stations (see Table 16).

Both particulate (ap(λ)) and detrital (ad(λ)) absorption spectra were determined following the cruise at a shore-based laboratory using the quantitative filter technique. A custom-built spectroradiometer (~330-880nm, <2 nm resolution) was used for measuring the spectral transmission of total particulate material collected on a glass fiber filter (Whatman's GF/F) relative to a wetted blank. The subsequent extraction of the pigments from the particles captured by the filter followed by re-measurement of both filters allows for the separation between the living (phytoplankton) and non-living (detrital) components of the total particulate material. This pigment extraction technique also allows chlorophyll a to be determined fluorometrically. Thus the same water sample is used for the determination of the ap(λ) and ad(λ) absorption spectra, as well as the chlorophyll a concentration.
Seawater samples, filtered first through a GF/F filter and then through a 0.2-μm polycarbonate filter, were used to determine aCDOM(λ). These filtered samples were stored at 5°C for less than two weeks prior to being measured using a Hitachi U3900H UV/Vis spectrophotometer equipped with 10-cm path length cells and using Milli Q water as a reference. Absorption was measured from 200-800 nm at 0.5nm increments.

Table 15. CTD rosette deployments during DEEPEND cruise DP04.

Station	CTD cast ID	Cast time (UTC)	Latitude (decimal degrees)	Longitude (decimal degrees)	Bottom depth (m)	Water Sample Depths (m)
SW6	DP04_CTD-054	06-Aug-16 09:38	26.993	-89.985	2450	2; 130; 545; 1500
SW6	DP04_CTD-055	06-Aug-16 22:34	26.980	-89.982	2475	2; 125; 517; 1501
SW4	DP04_CTD-056	08-Aug-16 01:27	26.902	-89.071	2600	2; 42; 448; 1500
SE1	DP04_CTD-057	08-Aug-16 22:57	26.991	-87.981	2850	2; 72; 441; 1485
SE3	DP04_CTD-058	09-Aug-16 23:35	27.000	-86.989	3036	2; 90; 442; 1502
SE3	DP04_CTD-059	10-Aug-16 08:50	27.007	-87.151	2982	2; 87; 422; 1498
SE2	DP04_CTD-060	11-Aug-16 00:23	26.950	-87.526	2941	2; 86; 386; 1500
SW3	DP04_CTD-061	11-Aug-16 22:29	26.987	-88.500	2630	2; 76; 359; 1501
SW5	DP04_CTD-062	12-Aug-16 21:26	26.989	-89.493	2588	2; 109; 499; 1500
B064	DP04_CTD-063	14-Aug-16 10:19	27.514	-89.006	1527	2; 97; 419; 1520
B064	DP04_CTD-064	14-Aug-16 22:22	27.504	-88.997	1870	2; 22; 95; 415; 1502
B065	DP04_CTD-065	15-Aug-16 21:54	27.514	-88.003	2740	2; 58; 337; 1501
B287	DP04_CTD-066	16-Aug-16 22:07	28.014	-87.508	2949	2; 71; 341; 1505
B252	DP04_CTD-067*	18-Aug-16 01:46	28.529	-87.499	2365	2; 80; 415; 1501
B175	DP04_CTD-068	18-Aug-16 22:57	29.012	-87.494	1698	3; 51; 375; 1501

* The CTD was profiled several times for DP04_CTD-067 due to communication and water sampling problems. The information displayed is from the most complete cast of DP04_CTD-067.

Table 16. Summary of chlorophyll and absorption samples collected during DEEPEND cuise DP04.

Time (UTC)	Latitude (°N)	Longitude (°W)	Cast	Station	Surface (<5 m)	Deep (~20-130m)
06-Aug-16 09:38	26.993	-89.985	DP04_CTD-054	SW6	X	X
06-Aug-16 22:34	26.980	-89.982	DP04_CTD-055	SW6	X	X[D]
08-Aug-16 01:27	26.902	-89.071	DP04_CTD-056	SW4	X	X
08-Aug-16 22:57	26.991	-87.981	DP04_CTD-057	SE1	X	X
09-Aug-16 23:35	27.000	-86.989	DP04_CTD-058	SE3	X	X
10-Aug-16 08:50	27.007	-87.151	DP04_CTD-059	SE3	X	X
11-Aug-16 00:23	26.950	-87.526	DP04_CTD-060	SE2	X	X
11-Aug-16 22:29	26.987	-88.500	DP04_CTD-061	SW3	X[D]	X
12-Aug-16 21:26	26.989	-89.493	DP04_CTD-062	SW5	X	X
14-Aug-16 10:19	27.514	-89.006	DP04_CTD-063	B064	X	X
14-Aug-16 22:22	27.504	-88.997	DP04_CTD-064	B064	X	X
15-Aug-16 21:54	27.514	-88.003	DP04_CTD-065	B065	X	X
16-Aug-16 22:07	28.014	-87.508	DP04_CTD-066	B287	X	X

18-Aug-16 01:46	28.529	-87.499	DP04_CTD-067	B252	X	X
18-Aug-16 22:57	29.012	-87.494	DP04_CTD-068	B175	X[D]	X

[D]: duplicates

5.10.2 Bio-optical (HS2) Data

A HOBILabs HS2 and two WETlabs scattering/fluorescence instruments were used to vertically-profile the water column to a depth of approximately 200 m during 13 deployments at seven stations (Table 17).

Table 17. The locations and times of HS2 (optical scattering and fluorescence) casts during DP04.

Station	HS cast ID	Cast time (UTC)	Latitude (decimal degrees)	Longitude (decimal degrees)
SW-6	DP04_HS2_001	06-Aug-16 11:06	26.997	-89.993
SW-6	DP04_HS2_002	06-Aug-16 21:39	27.015	-90.027
SE-1	DP04_HS2_003	09-Aug-16 00:23	26.986	-87.97
SE-3	DP04_HS2_004	10-Aug-16 00:48	27.004	-86.981
SE-3	DP04_HS2_005	10-Aug-16 10:00	27.024	-87.179
SE-2	DP04_HS2_006	11-Aug-16 01:35	26.953	-87.513
SW-3	DP04_HS2_007	11-Aug-16 23:46	26.967	-88.502
SW-5	DP04_HS2_008	12-Aug-16 22:42	26.972	-89.472
B064	DP04_HS2_009	14-Aug-16 11:45	27.529	-89.008
B287	DP04_HS2_010	16-Aug-16 23:23	28.026	-87.515
B252	DP04_HS2_011	18-Aug-16 00:11	28.501	-87.500
B175	DP04_HS2_012	19-Aug-16 00:09	29.021	-87.489

Since the optical scattering and fluorescence instruments were powered by internal batteries, each could operate and record its measurements independently, thus allowing the instrument cage to be profiled without the need for power and communication cables between the instruments and the ship. Data were processed using a combination of the manufacturer's and custom software. The time stamps of each instrument and distinct surface scattering features were used to synchronize the instruments for each cast. Though fluorescence efficiencies vary, the in situ fluorescence measurements made by the instruments can be combined with discrete water sample measurements to estimate the chlorophyll_a and CDOM concentrations at depths where discrete water samples were not collected (Figure 30).

Unlike the previous DEEPEND cruises, the 6 wavelength HS6 was not available for deployment during DP04. A limitation of the 2 wavelength HS2 is that an accurate estimate of the spectral backscattering shape (assumed to be a power function) can't be made. A linear slope between the 420nm and 700nm measurements can be made, but this will not be directly comparable with the power function slopes reported on the previous DEEPEND cruises. Changes in optical backscattering measured by the HS2 (e.g. Figure 30) can be compared to changes in the in situ particulates at various depths. Combining the scattering information with the fluorescence measurements allows estimation of the relative amounts of scattering and light attenuation from phytoplankton versus other living and non-living particles. Figure 31 shows CTD density, chlorophyll fluorescence, beam attenuation, and dissolve oxygen concentration for the upper 250 m of several DP04 evening casts.

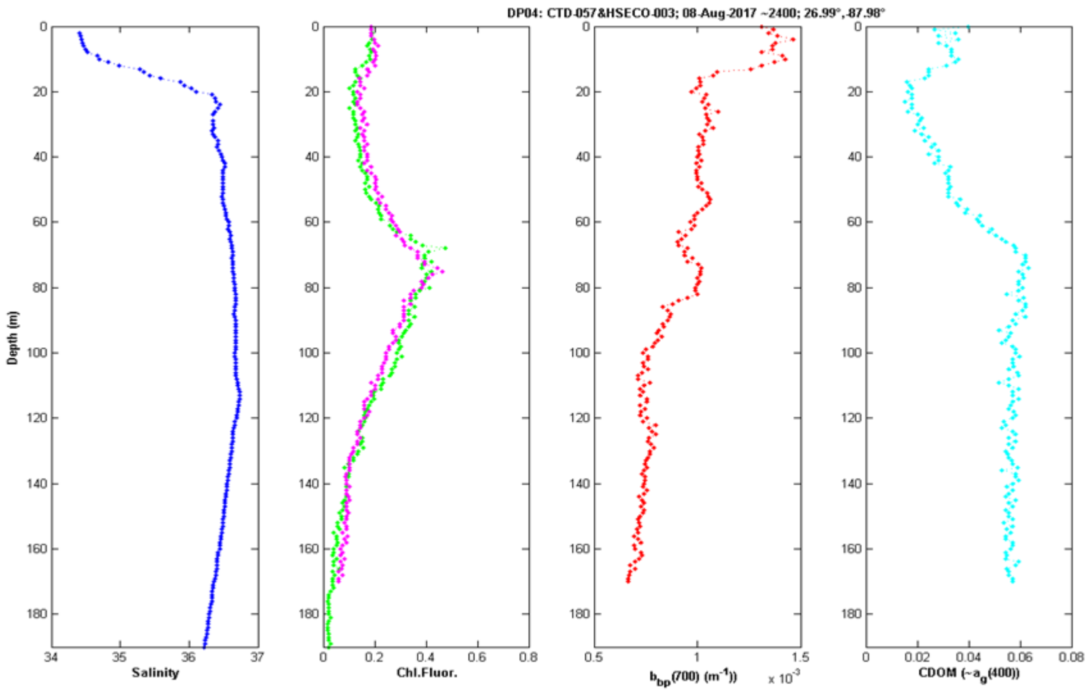


Figure 30. Combination of Bio-optical (scattering and fluorometry) and CTD data at station SE-1 during DP04. Left panel, CTD salinity; 2nd panel, CTD (green dot) and WETLabs ECO (red dot) chl. estimates; 3rd panel, backscattering of 700nm light from the Hydrosca2; right panel, estimated blue light absorbance due to CDOM.

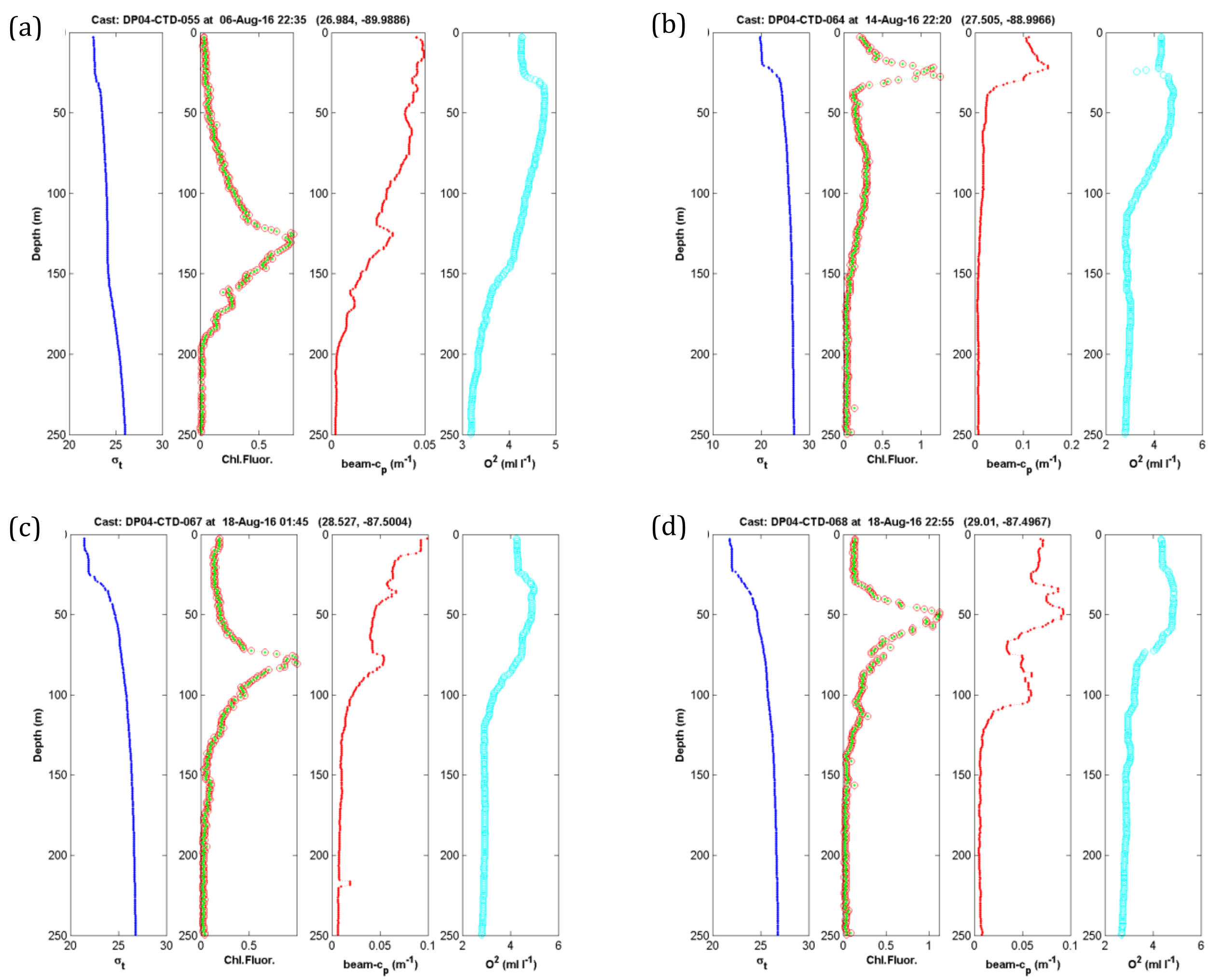


Figure 31. CTD density, chlorophyll fluorescence, beam attenuation, and dissolve oxygen concentration for the upper 250m of several DP04 evening casts. (a) SW6, Loop Current region; (b) B064, offshore Mississippi River plume region; (c) B252, cyclonic eddy & common water near De Soto Canyon. It should be noted that the horizontal scale of the Chl.Fluor. and beam cp profiles is not consistent between stations.

5.10.3 Remote Sensing Reflectance Data

Remote sensing reflectance (Rrs(λ)) measurements were collected from the deck of the R/V Point Sur seven times during DP04 (Table 18). These measurements help relate the near surface water samples to the observations made by ocean color satellites. An ASD, Inc. (PANalytical) HandHeld2-Pro spectroradiometer was used to collect Rrs(λ). Figure 32 shows example Rrs(λ) spectra from several DP04 stations. Though cloudy conditions prevented the collection of Rrs(λ) measurements for about a 1 week portion of DP04 (~06 to 14 Aug), measurements from several different types of surface waters were measured during the cruise.

Table 18. The locations and times of remote sensing reflectance (Rrs(λ)) measurements made during the DEEPEND DP04 cruise.

Station	Rrs ID	Measurement time (UTC)	Latitude (decimal degrees)	Longitude (decimal degrees)
SW-6	DP04_Rrs_001	06-Aug-16 14:37	26.994	-89.990
SW-6	DP04_Rrs_002	06-Aug-16 20:30	27.047	-90.070
B064	DP04_Rrs_003	14-Aug-16 14:54	27.508	-88.998
B065	DP04_Rrs_004	15-Aug-16 20:46	27.443	-88.000
B287	DP04_Rrs_005	16-Aug-16 20:51	27.952	-87.437
B252	DP04_Rrs_006	17-Aug-16 20:22	28.453	-87.423
B175	DP04_Rrs_007	18-Aug-16 21:00	28.933	-87.449

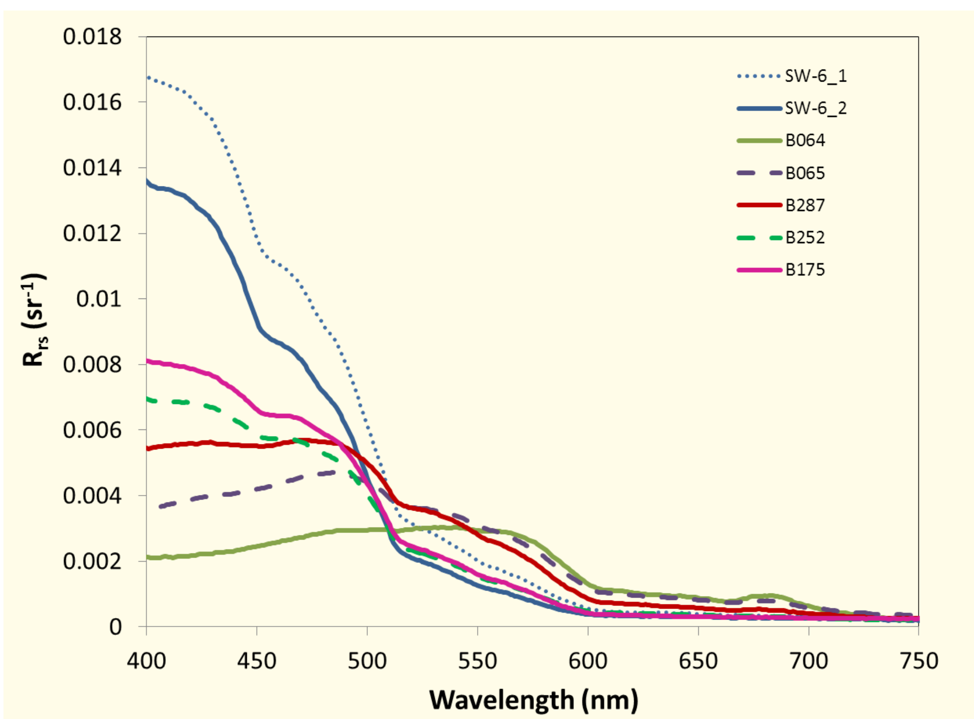


Figure 32. Remote sensing reflectance (Rrs(λ)) estimates from seven measurements on the R/V *Point Sur* between 06 Aug. and 18 Aug. 2016.

5.10.4 Glider Data

The University of South Florida Slocum Electric 1000m Glider (Figure 33) was utilized to characterize the upper 400m of the water column. This glider is equipped with a Seabird SBE41CP CTD, two WETLabs fluorometers, two Satlantic radiometers, and an Aanderraa dissolved oxygen sensor. The fluorometers are equipped to sample for chlorophyll, CDOM, backscatter at 660 and 880nm, and turbidity. The radiance and irradiance sensors sample at four wavelengths, ~412, 443, 556, and 683nm. All sensors sample at ¼Hz. Since the gliders transit vertically at ~0.1m/s, this results in a vertical sample resolution of ~0.4m. All science and flight data is recorded on board. At the surfacing the glider sent back a subset of the data collected.

The glider was deployed from the R/V *Point Sur* on August 11, 2016, near station SE-2 and recovered on August 17, 2016 near station B252, covering >200km of distance. The glider profiles were limited to 200m while its operations were being verified, but it then profiled to 400m until 13 August. Most of the depth profiles were increased to 600 to 800 m for the remainder of the deployment and the glider made several vertical profiles between the times when it surfaced for operational communications. During the deployment, data transmitted to shore during the surface intervals was sent to the IOOS National Glider DAC and to the Naval Research Laboratory with the assistance of the Gulf of Mexico Coastal Ocean Observing System (GCOOS). After retrieving the complete glider data ashore, it was uploaded to a NOAA National Centers for Environmental Information (NCEI) data archive and portal. Several examples of the measurements collected by the glider a shown in Figure 34-Figure 36.

Figure 33. Glider "Murphy" after deployment and before its mission was programmed.

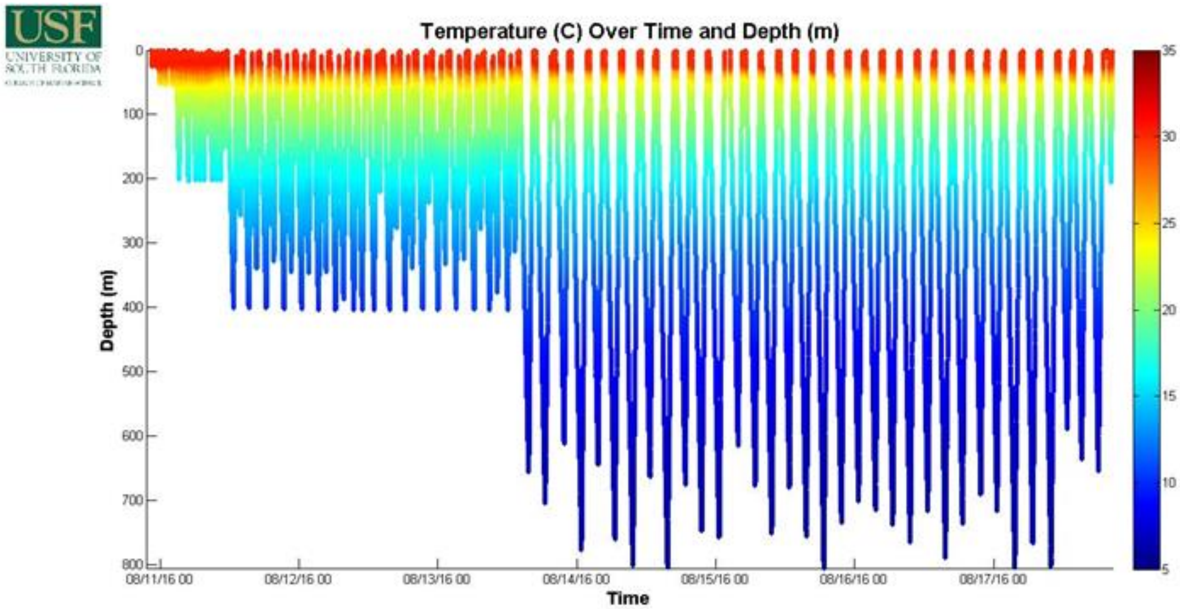


Figure 34. Temperature over time and depth collected by the glider.

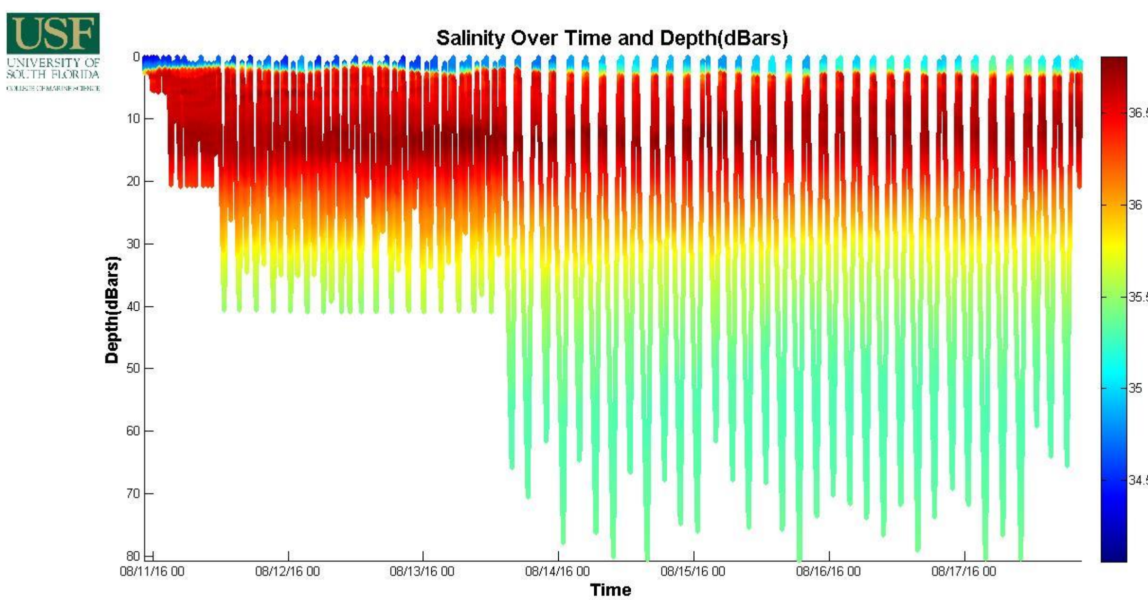


Figure 35. Salinity over time and depth collected by the glider.

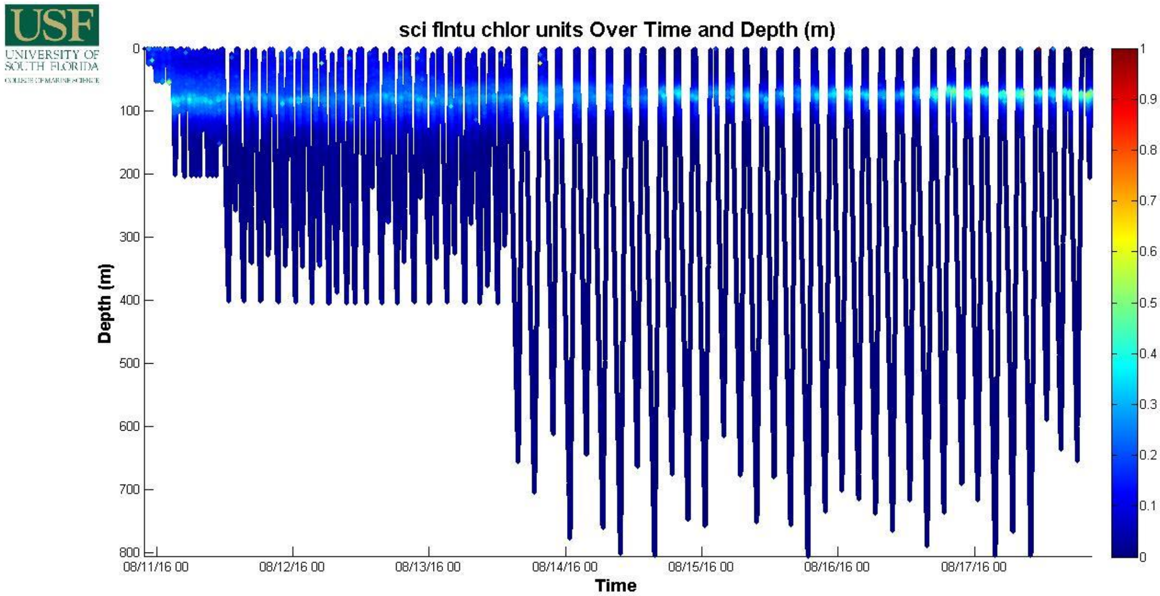


Figure 36. Chlorophyll concentrations over time and depth collected by the glider.

6 Outreach Activities

Dr. Danté Fenolio, Lead of DEEPEND's imaging program, continued gathering content for education and outreach. All of the images in this report were generated by this project, as was video of live animals and MOC-10 sampling methods. Figure 37 shows a sample of Dante's photography; he photographed an adult female anglerfish, *Linophryne* sp., with a male attached. Figure 38 demonstrates how Danté photographs the organisms aboard the R/V *Point Sur*.

The public outreach component continued focusing on the Kids blog with "*Squirt*" (Figure 39). *Squirt* continues guiding the kids through the DEEPEND adventures and informs kids about the exciting adventures at sea. Activities at sea were explained an age-appropriate level. Additionally, the DEEPEND Teacher-At-Sea Program for secondary teachers allowed Christopher Valdes to participate in the DP04 Cruise. He efficiently updated the adult blog each day on the DEEPEND website. He was able to inform DEEPEND's followers about his hands-on experience on the two-week DEEPEND cruise. He posted numerous pictures to the blog that highlighted "life at sea" in addition to the unique organisms in the deep sea. Blogs were tied to the daily shiptracker, which was updated daily on the DEEPEND home page. Facebook, Twitter, and Instagram accounts were linked to the DEEPEND website. Styrofoam cups were also attached to deep CTD deployments and shrunk for students who will be participating 'virtually' on the August DEEPEND cruise through the Creep into the Deep Program (Figure 40).

Outreach efforts included all levels of students as well as the public during the first three DEEPEND cruises. After the cruise, in February, 2017, in St. Petersburg, Florida, twenty grade 6-12 teachers will be participating in a one-day workshop learning about DEEPEND projects (DP03 and DP04 cruises), science content and ways to incorporate our program into their classroom activities. They will bring teaching activities and graphics back to classrooms to use. Moreover, new Postcards from the Deep have been added to the E/O page on the DEEPEND site for students in grade K-5 to view and share. Also, new scientist trading cards and mini-posters have been made for students as well.

Figure 37. An adult female *Linophryne* sp. with male attached. Photo: Danté Fenolio/DEEPEND 2016.

Figure 38 – Dr. Danté Fenolio preparing to photograph a cephalopod specimen during the DEEPEND cruise DP04 for the imaging program.

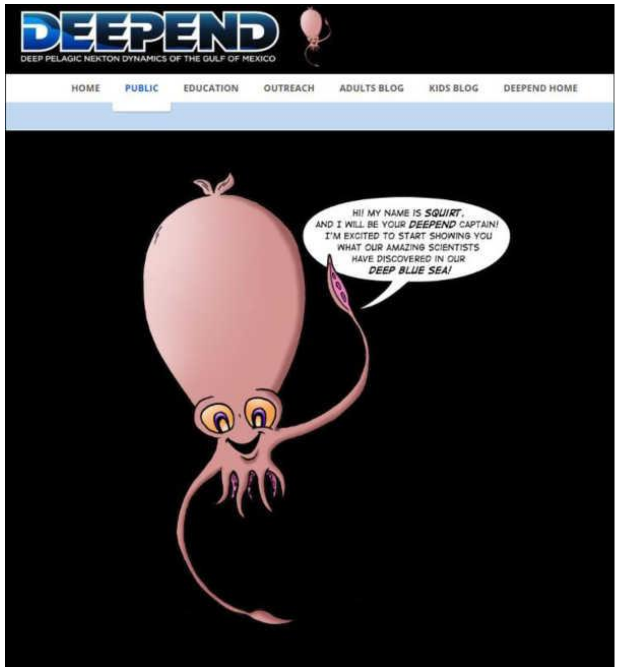


Figure 39 - "Squirt"- cartoon and animated character within the Kids Blog to explain the DEEPEND science to kids.

Figure 40 - Education team shrinking cups on CTD for students who will be participating 'virtually' on the August DEEPEND cruise through the Creep into the Deep Program.