Photo Credit: Mike Rigney

C282 Cruise Report: Ocean Exploration

Scientific Activities Undertaken Aboard the SSV Corwith Cramer

Woods Hole, MA – St Georges, Grenada

13th October – 20th November, 2018

Ben Harden

12 December 2018

Citation: Harden, B. E., 2018. Final Report for S.E.A. Cruise C282. Sea Education Association, Woods Hole, MA 02543, USA. www.sea.edu.

To obtain unpublished data, contact the SEA Data Archivist:

Data Archivist
Sea Education Association
PO Box 6
Woods Hole, MA 02543
E-mail: data-archives@sea.edu

Contents

Ships Company

Staff		I	Students	
Jason Quilter	Captain	I	Timo Abad	Gap Year
Ben Harden	Chief Scientist	I	Seiji Akera	Gap Year
Rebecca Johnson	Chief Mate	I	Bella Andersson	Hawaii Pacific University
Adrienne Wilber	2nd Mate	I	Paula Angel Romero	Universidad de los Andes, Columbia
Tristan Feldman	3rd Mate	I	Tomasz Dvorak	UMass Amherst
Erin Adams	1st Assistant Scientist	I	Gia Fisk	Gap Year
Steve Kielar	2nd Assistant Scientist	I	Maddie Hurtgen	Gap Year
Anna Wietelmann	3rd Assistant Scientist	I	Christina Lim	University of North Carolina at Chapel Hill
Mike Rigney	Chief Engineer	I	Jonathan Lopez de Leon	Not Currently Enrolled
Shanna Linn	Steward	I	Steven Mare	Cornell
Tyler Barron	Sailing Intern	I	Alex Puza	Gap Year
Duncan Harvey	Sailing Intern	I	Lou Ruffini	University at Albany
Emma Hayward	Sailing Intern	I	Cori Shooter	Gap Year
Ava Stasiw	Sailing Intern	I	Nino Tomas	Gap Year
Sophie Vallas	Sailing Intern	I		

1 Introduction

This report summarizes the scientific activities undertaken aboard the Sailing School Vessel (SSV) Corwith Cramer on the Sea Education Association (SEA) cruise from Woods Hole, MA to St. Georges, Grenada. This six-week cruise was the sea component of the 12-week SEA Semester program entitled Ocean Exploration (see Figure 1).

Aboard, students of this program, as with many SEA programs, were active members of the ship's crew and undertook a research project in pairs, the abstract for each is included at the end of this report.

This report begins with a cruise narrative followed by data particulars, figures and tables.

2 Cruise Narrative

Student participants boarded the SSV Corwith Cramer at 1500 on 13th October 2018. Unsettled weather ensured that we did not depart the dock that evening, but did so early the following morning of the 14th. We spent the day of the 14th at an anchorage in Tarpaulin Cove on Naushon Island to the southwest of Woods Hole to continue student-hands orientation to the ship. On the morning of the 15th October we weighed anchor and headed southeast along Vineyard sound and southwards onto the New England Shelf. We had time for one science station before a northerly gale forced us into one last anchorage in the Sakonnet River for the night of the 15th October. However, by noon on the 16th October we were heading southward into the open ocean.

The first week of the cruise was dominated by two weather systems, both delivering gale force winds to the Cramer. The first system, which contained sustained 30 knot winds, peaking on the 18th October (see Figure 3). During this time we were located to the north of the Gulf Stream in the New England Slope waters and spent much of the storm hove-to.

The second storm was stronger and longer in duration, with sustained winds of 40 knots peaking on the 21st October (Figure 3). We were hove-to for much of the first half of this storm and then ran with it to the east for the second half. During both of these storms and for some time afterwards, we were unable to do any science stations which explains the relative paucity of deployment data in this region of our cruise track (Figure 2).

We did, however, maintain our underway measurement equipment and between the gales, we crossed the Gulf Stream (Figure 5). We entered across the north wall at around 13:00 on 10-19 ships time when the temperature rose by about 4°C in an hour (Figure 4). The current was almost due eastward being far south of its mean path and about to turn north in a meander. We were clear of the strongest currents in the Stream by around 19:00 on 10-19.

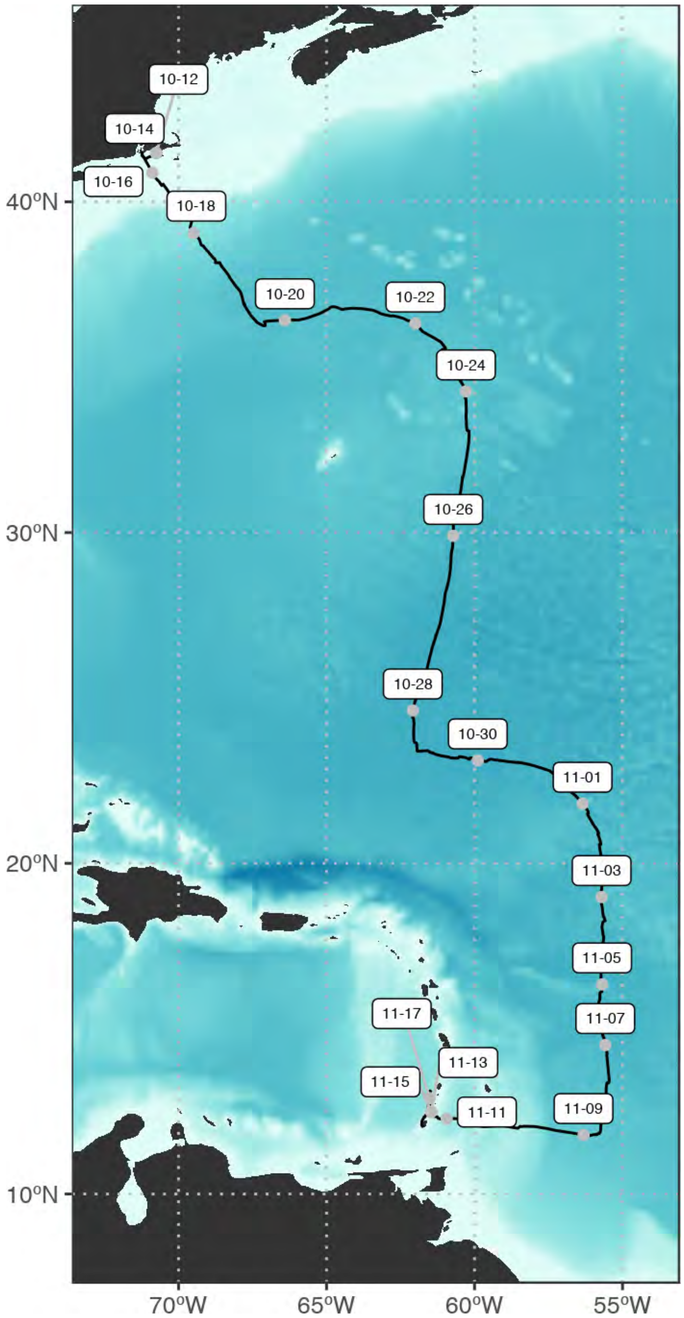

Figure 1: Map of the C282 Cruise Track. Labels indicate our locations every two days at midnight UTC in MM-DD format.

To the south of the Stream we proceeded eastwards under the strong northwesterly winds of the second gale. At 36.66°N x 65.15°W on 10:00 on 10-21 we crossed a parcel of low salinity water flanked on the west by a strong northward current and on the west by flow to the south (Figure 5). These are the typical properties of a Cold Core Eddy which had broken off from the Gulf Stream and has transporting

New England Shelf/Slope water in to the North Sargasso Sea. It was only a shame that we crossed it during a gale and hence had no chance to sample its sub-surface properties.

Following the gales we continued making eastward progress to make up for the lack of progress in that direction to date. However, we had begun to hear about a tropical disturbance far to the south of us. This increased in strength day-by-day and eventually developed into a tropical cyclone. The forecast was for the system to work its way northwest towards the southeast of Bermuda before veering off northeastwards across the Atlantic.

To avoid interacting with this storm we made quick progress to the south. Between 10/25 and 10/28 we made approximately 600 nm of southing to get south of the storm as it moved into the region we were departing. And a good job too - by 10/27 the storm had been officially upgraded to a hurricane and given the name Oscar.

Our avoidance tactics brought us south of the storm without feeling any its the wind influence. However, we covered a good distance of our cruise track in a short time and although science deployments continued through this time, their spacing was larger than is typical for this cruise track (see Figure 2).

The good news was that we experienced westerlies to the south of Oscar which allowed us to make up some of the lost ground to the east; some of our research permissions for the Caribbean islands to our south had yet to be granted so it was important that we made some ground to the east to try and remain outside of nations EEZs and hence continue sampling. We made good ground to the east and as the easterly trades began to fill in on the 1st November we made our way southwards (Figure 1).

We spent the next week of cruise heading southward along approximately 57^{o}W. Science deployments continued in earnest during mixed weather conditions. The lab's flow through system recorded some large transitions in sea surface salinity during this period as we transitioned from the salty Sargasso sea into the fresher tropics region (Figures 3, 4, and 5). On the 9th November we conducted our styrocast, deploying the free CTD to 2500 m along with styrofoam cups for shrinking.

By the afternoon of the 9th November, it was time to head westward to our port stop in Carriacou. We had not received permission to sample in the Barbadian EEZ so shortly after our turn to the west we ceased to collect scientific data and did not deploy any scientific equipment for the next two days as we made our way expediently towards Grenada. This is the reason for the lack of data in this region.

Once back in waters for which we had permission to sample, we conducted one Neuston Tow before spending the day of the 12th November sailing in the lee of Carriacou. We made anchor a Hillsborough, Carriacou at 0900 on 13th November. Students presented their research findings to the ships company that afternoon and the port stop activities commenced the following morning.

By 1200 on 17th November we had completed port stop activities and were underway again for our final 24 hours at sea. Students undertook a final mission wherein they navigated us to a location northwest of Carriacou and then back south to two locations for overnight Neuston Tows. We came alongside in

St. Georges at 0900 on 18th November. The 19th November was spent cleaning the ship and program ended on 20th November at 1000.

Sampling

Our deployment sampling was at 45 discrete locations along our cruise track.

We conducted the standard noon hydrocast (CTD on carousel) along with noon and midnight neuston tows. We collected water from the carousel for pH and chl-a analysis and less frequently for alkalinity and nitrate/phosphate. We also collected microplatic samples from a surface bucket and from the carousel at 10 and 20 m to facilitate one of the student projects.

In addition to this standard sampling, we also took evening measurements with the bathyphotometer, a device that free-falls through the top 100 m of the ocean which is used to measure bioluminescence. Concurrent with these evening deployments we also deployed our carousel to gather CTD data to compare to these casts.

During morning station we also conducted a number of dip nets of *Sargassum* clumps for a student project centered on community assemblages on this floating ecosystem.

We conducted one meter net deployment late in the cruise, mostly for fun.

Throughout we maintained our data collection from CHIRP, ADCP and our flowthrough system.

Data

The following tables and figures give a broad overview to the data collected on the cruise. They are not intended to be exhaustive nor have they been thoroughly quality controlled – many large data sets are not included and should be requested from the SEA Data Archivist if required.

Data Notes

We maintained two Event Files for the duration of this cruise (ELG #13 and #14).

ADCP lost heading data intermittently due to an issue with our gyro compass). This is only occasionally apparent in the LTA files, but plays a much bigger role in the STA and individual ensemble files.

We conducted two nutrient runs for phosphate and nitrate concentrations during the cruise. The spectrophotometer was behaving irregularly during the second nitrate run so some of the data processed in that run is now unavailable. There were no issues with either of the phosphate runs.

The pH meter used for alkalinity lost its temperature read-out half-way through the cruise. This went unnoticed for a few runs and, although was adjusted and corrected in later runs, resulted in some poor quality values which have been removed from the archived data set and that presented here.

Full descriptions of these mechanical irregularities can be found in the more detailed End of Cruise Science Report kept on file at SEA and available upon request.

Data is also available compiled in an R package from http://github.org/benharden27/C282. Use `devtools` to download directly from this source.

3 Figures

3.1 Deployment Map

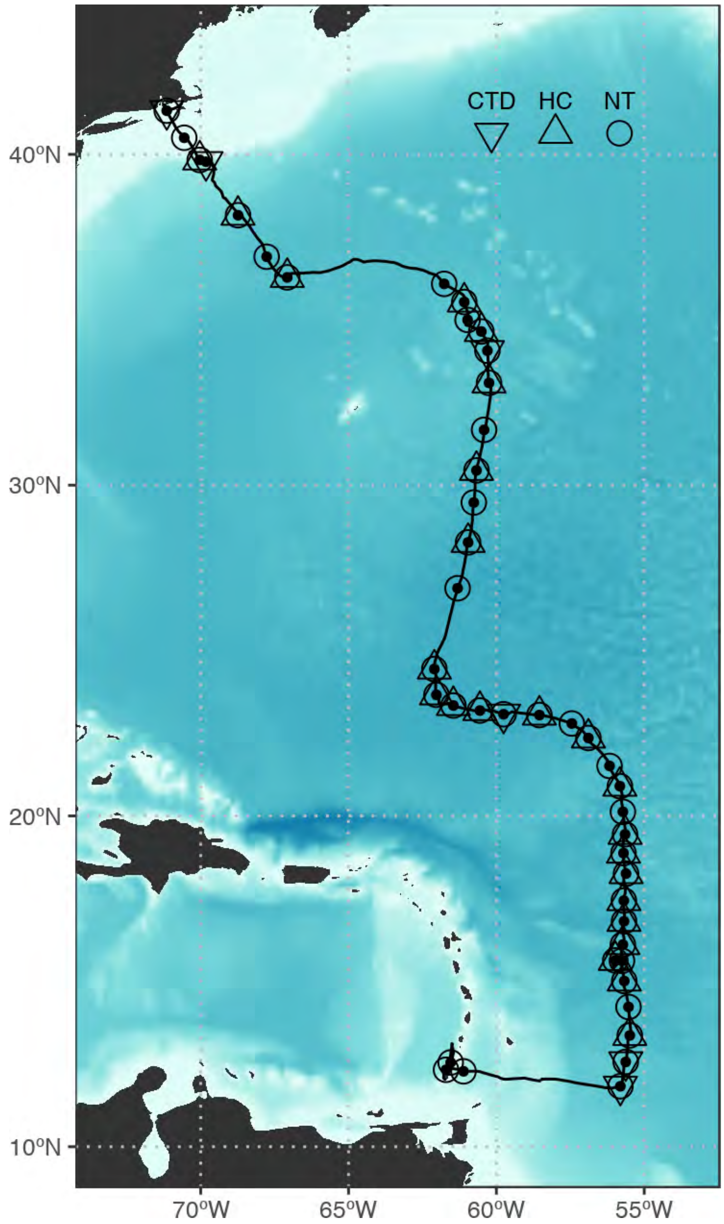

Figure 2: Deployment locations shown as small dots along the C282 cruise track. Deployments of the neuston net, hydrocast and CTD are indicated by symbols.

3.2 Flowthrough Timeseries

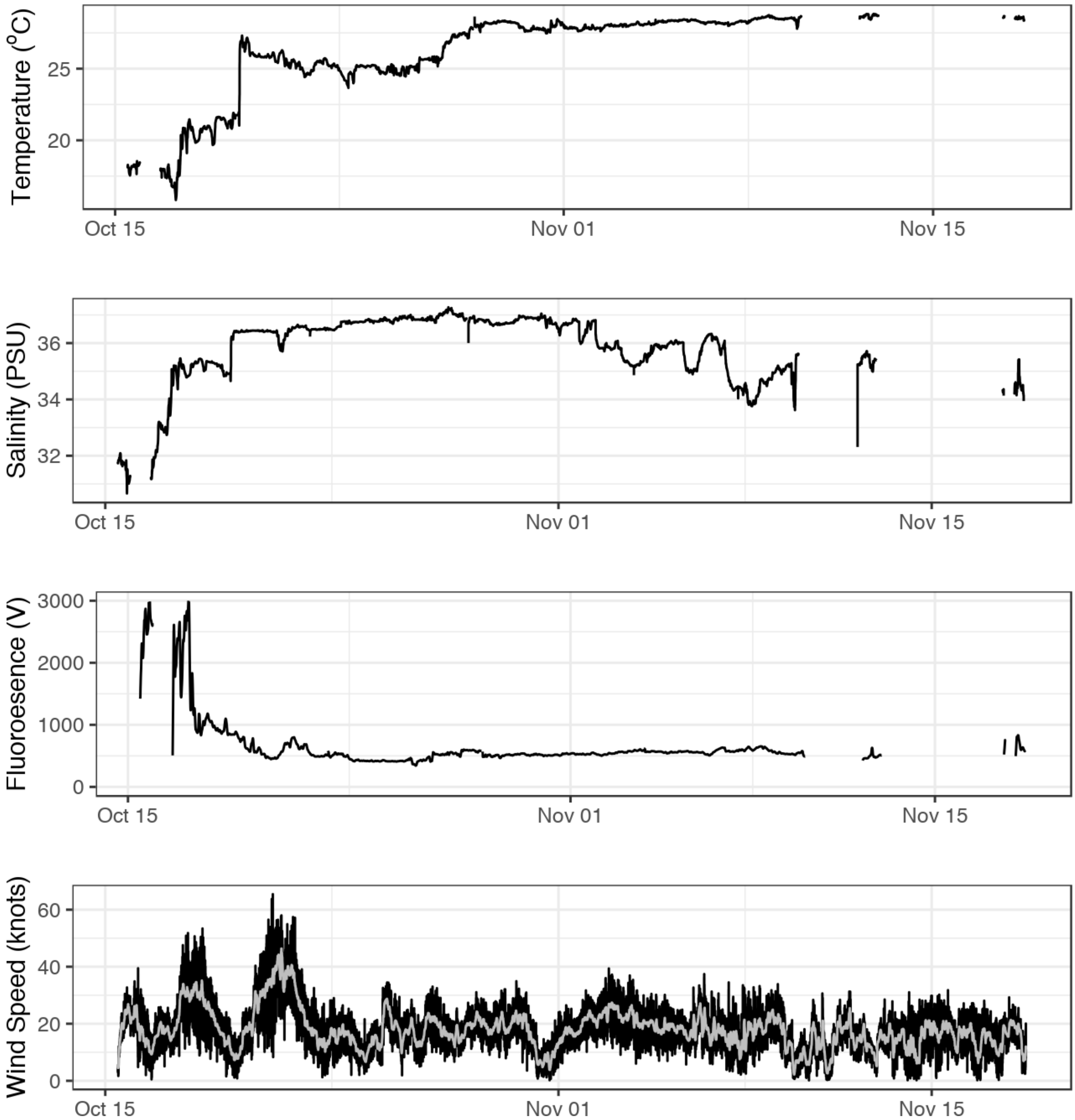

Figure 3: Continuous data recoreded along cruise track from the shipboard flowthrough system. From top: Temperature, Salinity, Fluoroescence, and Wind speed. Regions with no data are for times when the flow through was not recording data be it during a port stop or our being in teritorial waters for which we did not have permission for sampling.

3.3 Temperature and fluoroescence

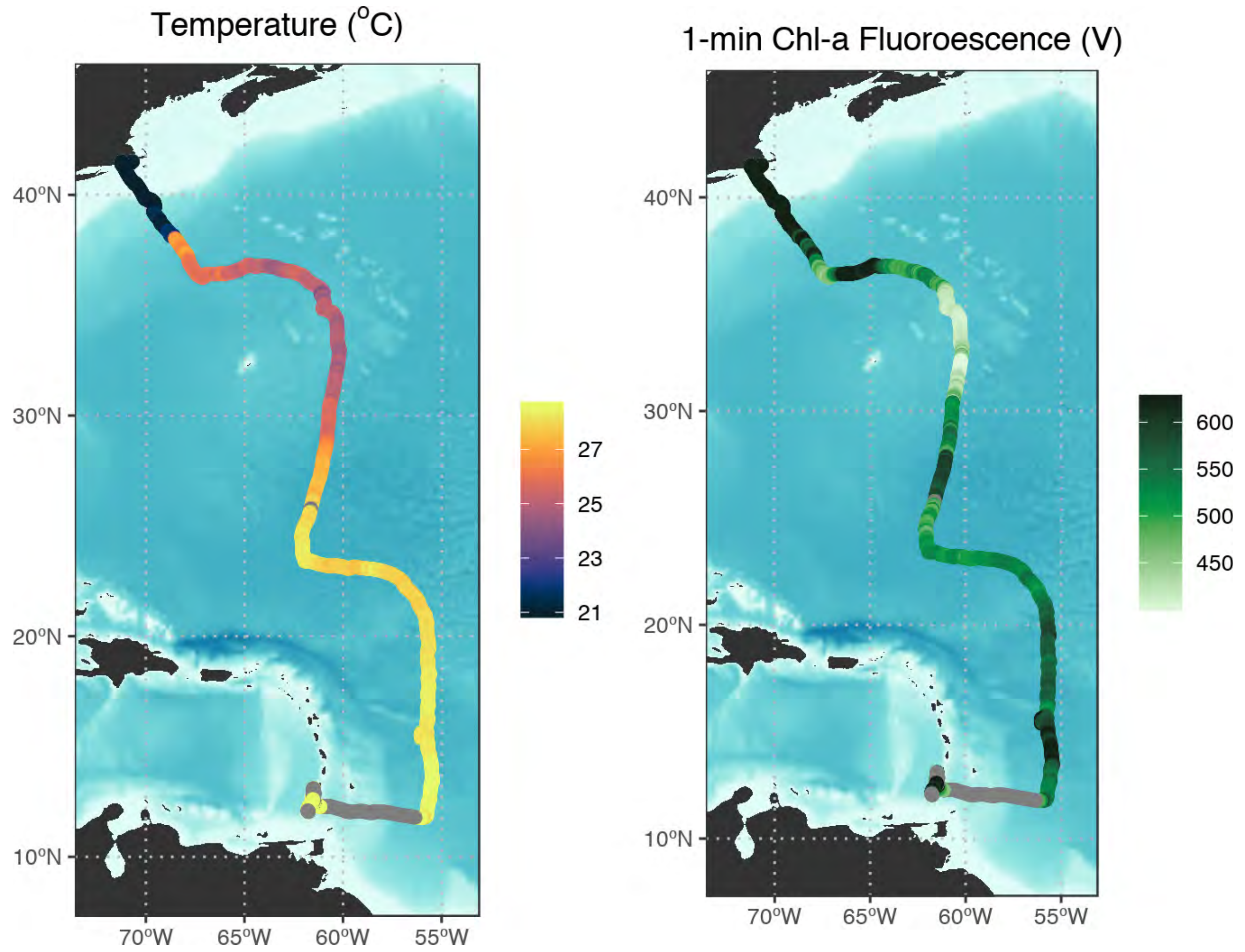

Figure 4: Mapped flow through data along the C282 cruise track. Grey regions are during instrument drop out or in EEZ regions for which we did not have permission to sample. Left: Temperature, Right: Fluoroescence

3.4 Salinity and Currents

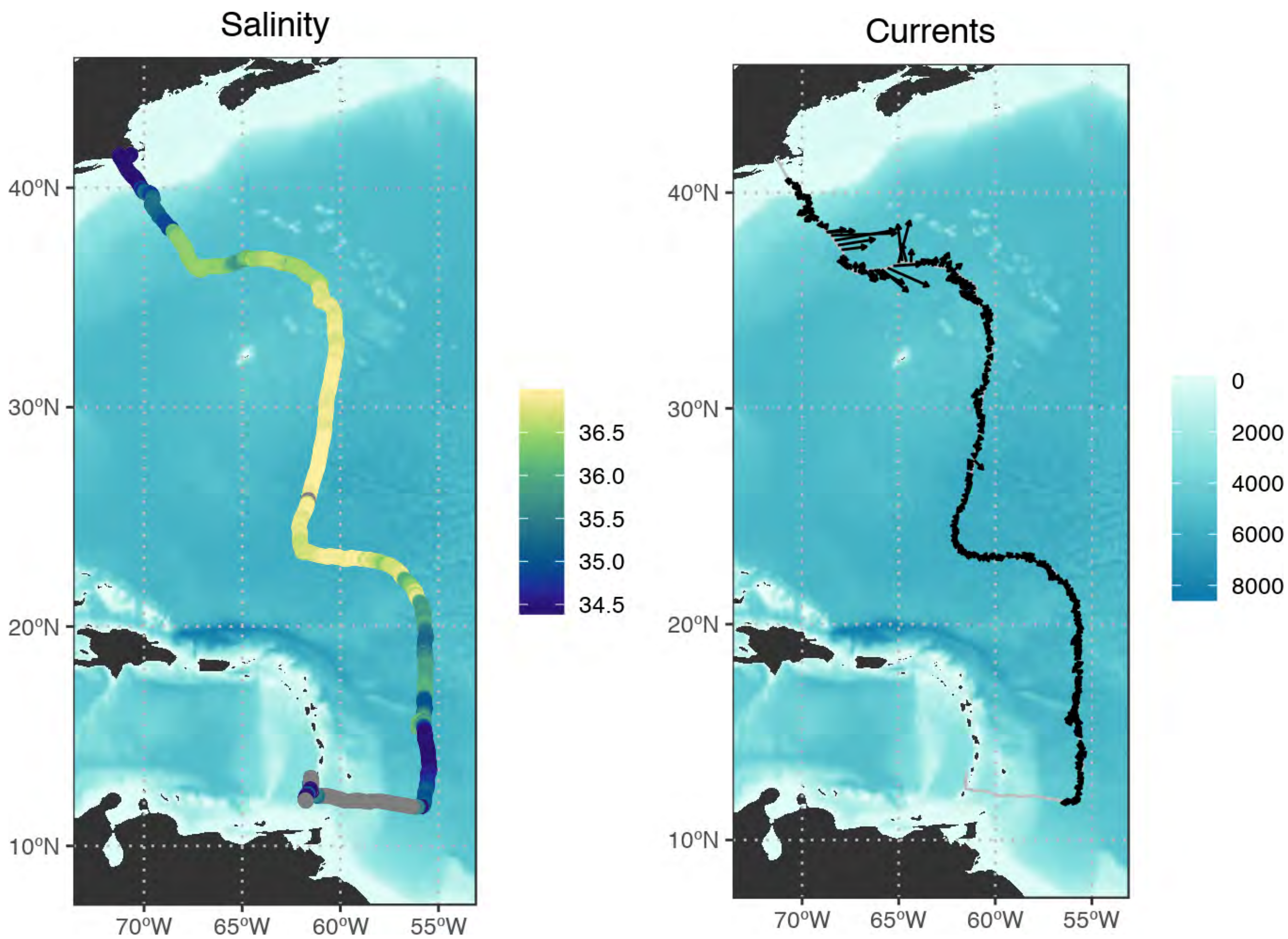

Figure 5: As Figure 4 but for salinity (left) and surface currents (right).

3.5 CTD Sections

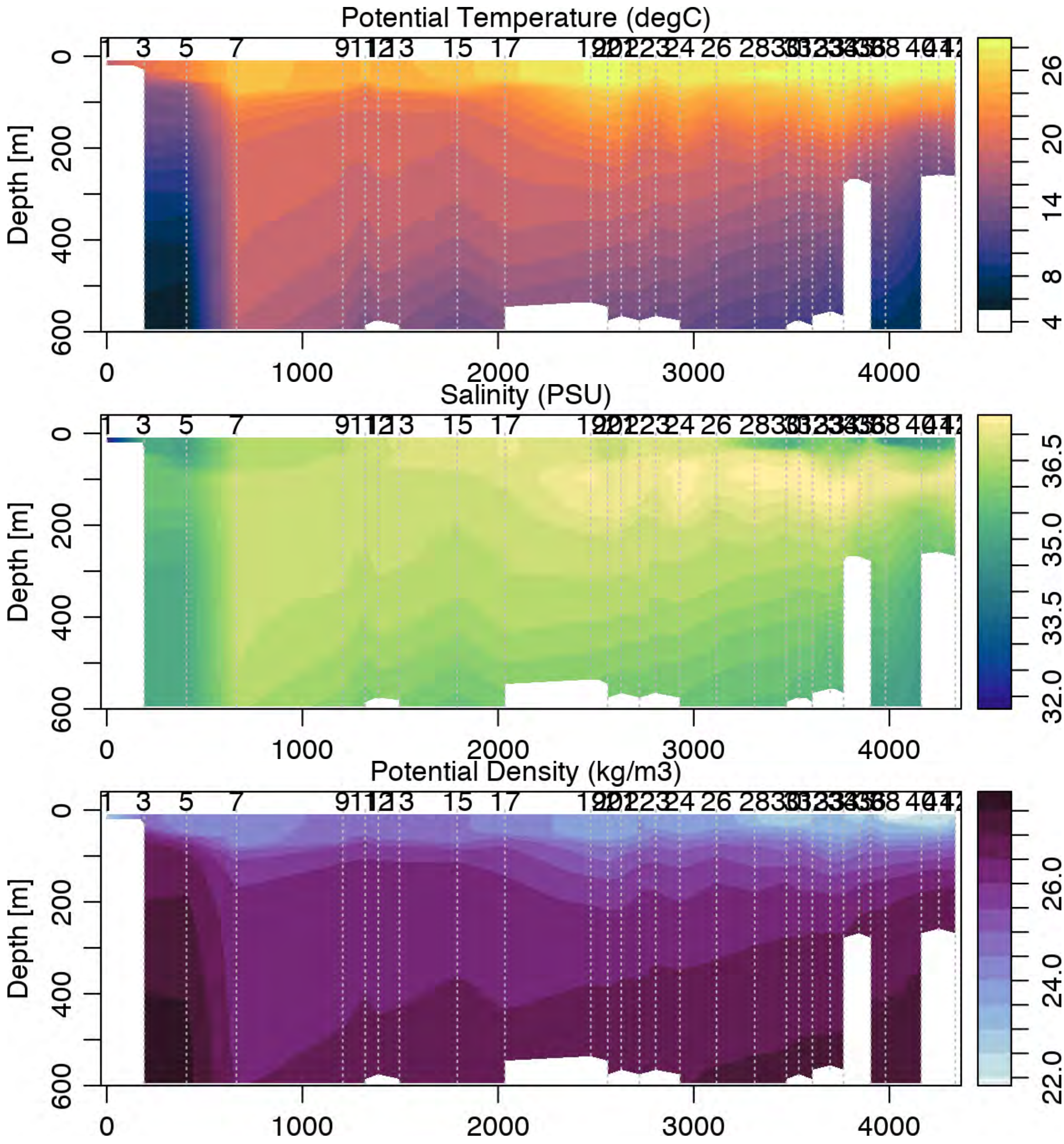

Figure 6: Sections of CTD data as a function of distance (km) along the C282 cruise track. From top: Potential Temperature, Salinity and Potential Density. Locations of sampling stations and depth of profile are indicated with vertical grey lines. Distances are as crow-flies between stations.

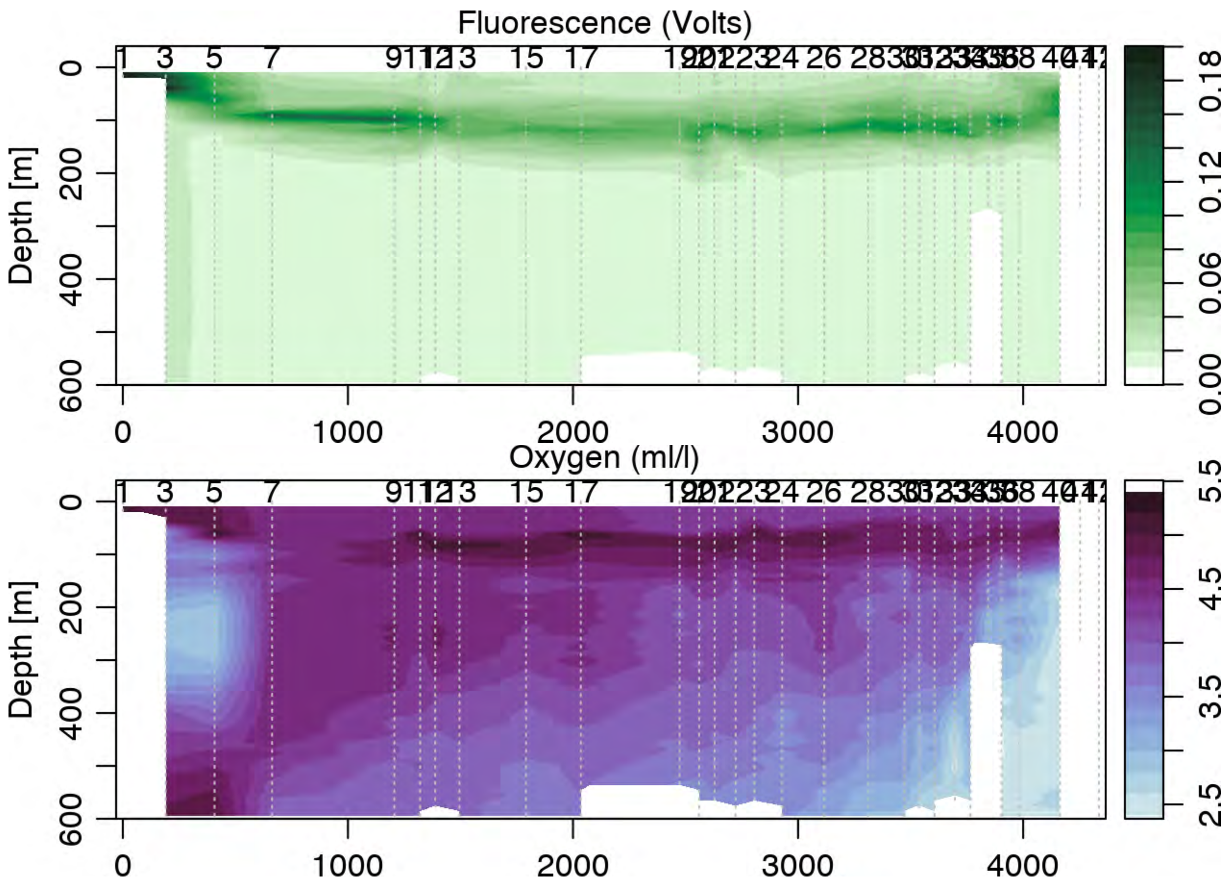

Figure 7: As Figure 6 but for Fluoroescence and oxygen concentration.

3.6 Hydrocast Bottle Sections

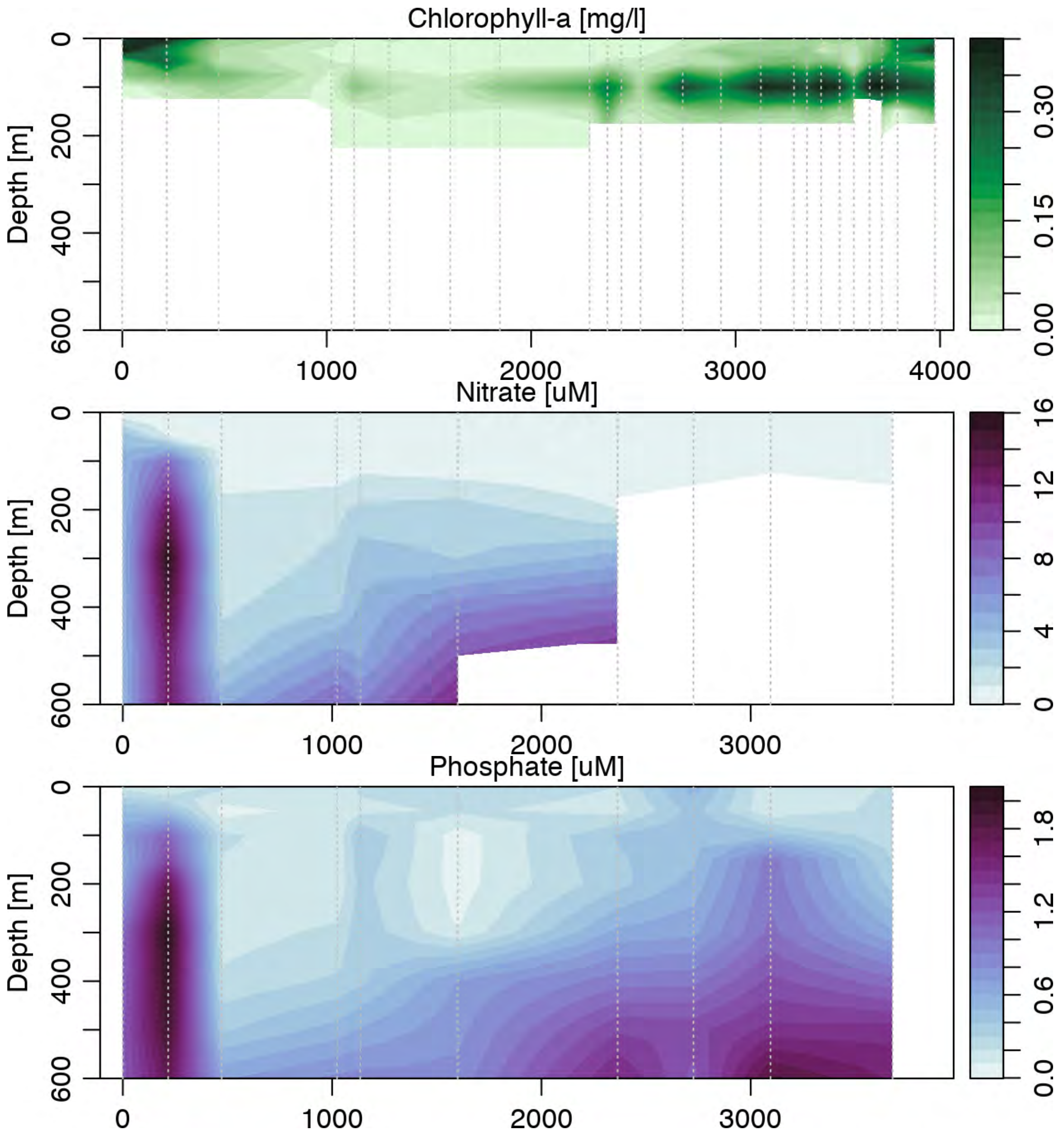

Figure 8: Sections of bottle derived concentrations from hydrocasts as a function of distance (km) along the cruise track. From top: Chlorophll-a, Nitrate, and Phosphate.

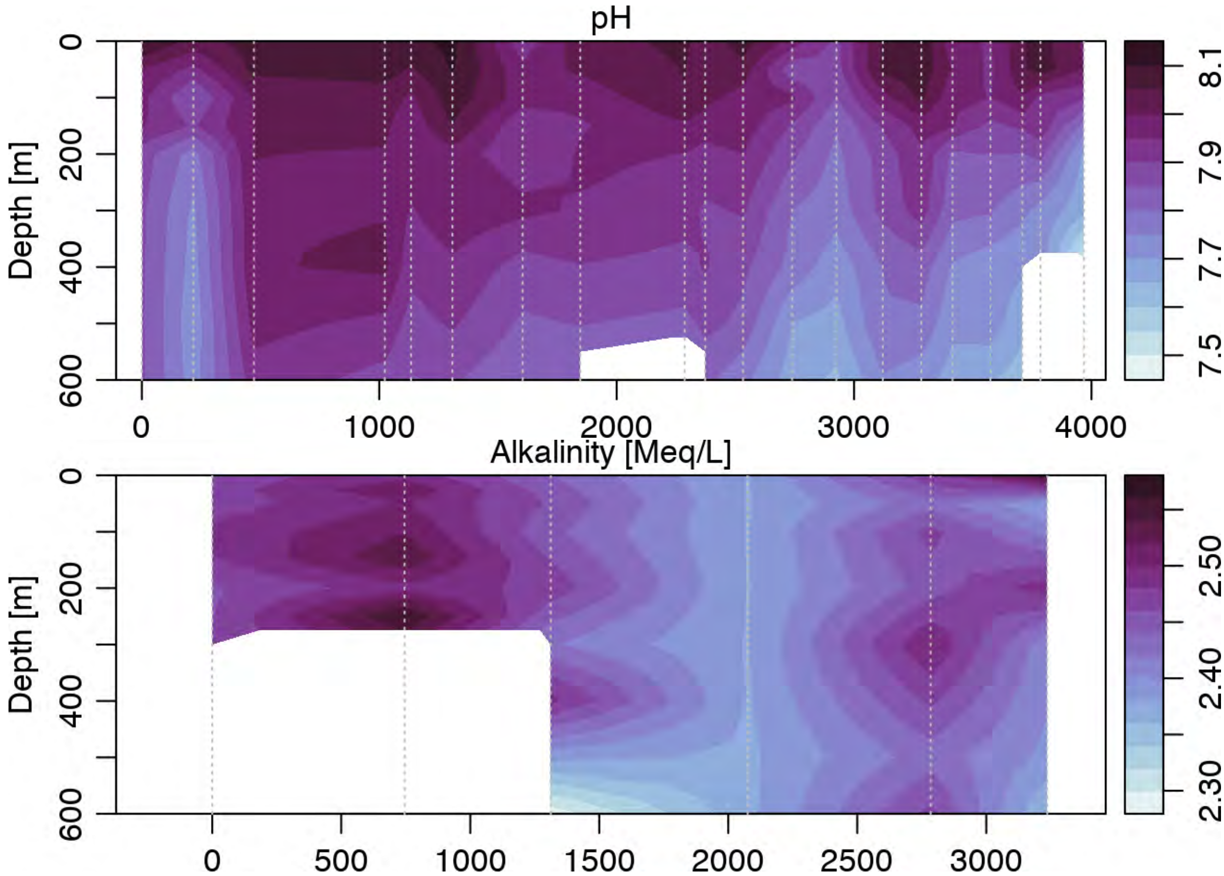

Figure 9: As Figure 8 but for pH and Alkalinity measurements from bottles.

3.7 Neuston data

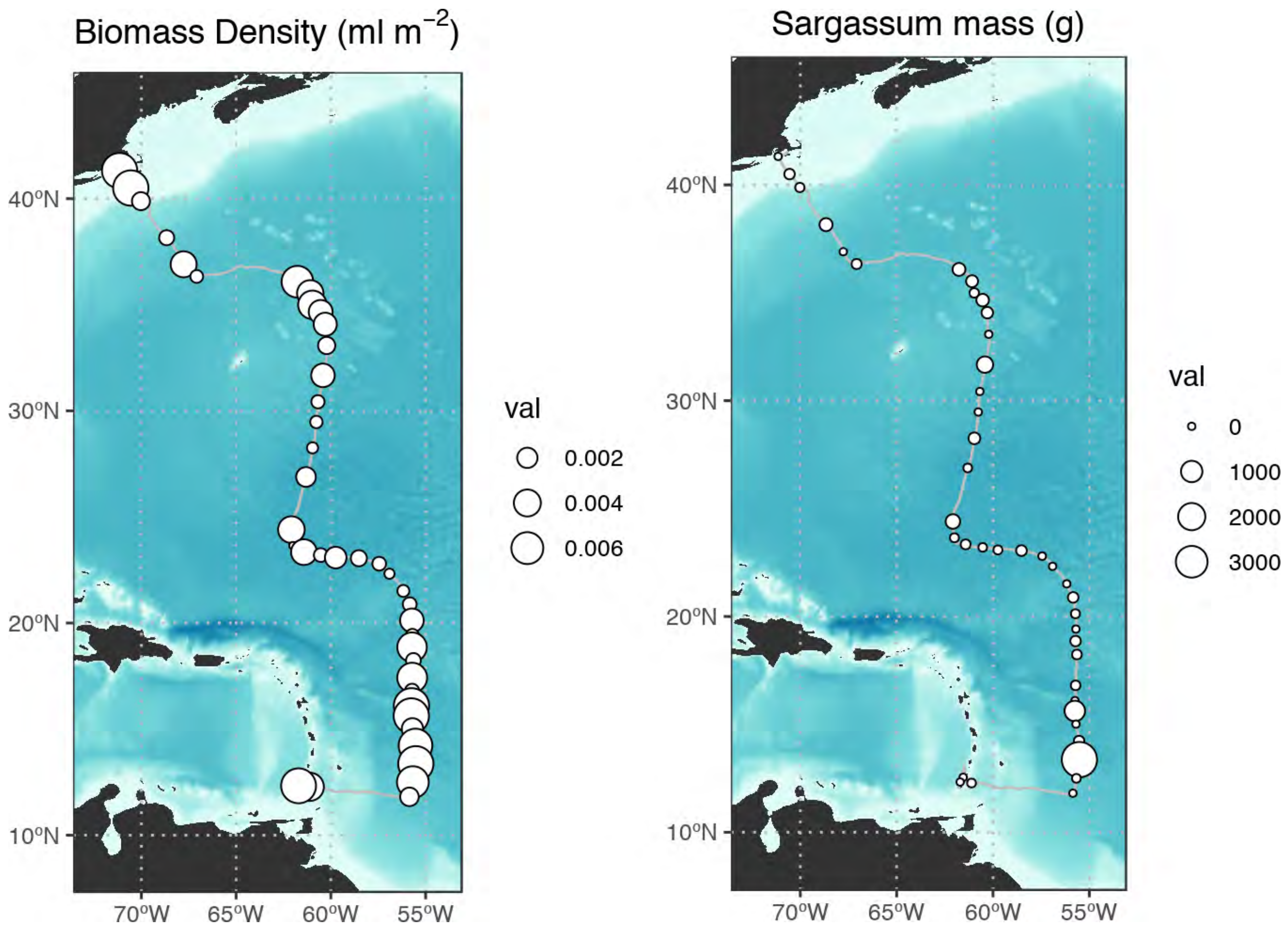

Figure 10: Map of total biovolume (top) and total sargassum biomass (bottom) collected in the Neuston Tow at each sampling station along the C282 cruise track

4 Tables

4.1 Station Summary

Table 2: Summary of the stations undertaken during C282. Abbreviations are for Hydrocast (HC), Neuston Tow (NT), Bathyphotometer (BP), Secchi Disk (SD), Meter Net (MN) and Dip Net (DN). Times are all local to the ship (UTC+4) and correspond to the starting time of the Neuston Tow.

Station	Time	Lon	Lat	CTD	HC	NT	BP	SD	MN	DN
C282-001	2018-10-15 11:42	-71.15	41.32	X		X				
C282-002	2018-10-16 23:50	-70.56	40.50			X				
C282-003	2018-10-17 10:03	-70.02	39.88		X	X				
C282-004	2018-10-18 15:30	-69.82	39.78	X						
C282-005	2018-10-19 09:50	-68.67	38.16		X	X				
C282-006	2018-10-19 23:50	-67.77	36.91			X				
C282-007	2018-10-20 09:52	-67.08	36.33		X	X				
C282-008	2018-10-22 23:21	-61.77	36.09			X				
C282-009	2018-10-23 08:57	-61.09	35.54		X	X		X		
C282-010	2018-10-23 23:34	-60.97	34.99			X				
C282-011	2018-10-24 09:24	-60.54	34.66		X	X	X			
C282-012	2018-10-24 22:50	-60.30	34.08	X		X	X			
C282-013	2018-10-25 10:02	-60.22	33.08		X	X				X
C282-014	2018-10-25 23:23	-60.42	31.67			X				
C282-015	2018-10-26 10:03	-60.68	30.43		X	X				
C282-016	2018-10-26 23:30	-60.76	29.48			X				
C282-017	2018-10-27 09:57	-60.97	28.25		X	X				X
C282-018	2018-10-27 23:23	-61.31	26.88			X				
C282-019	2018-10-28 22:12	-62.08	24.40		X	X	X			
C282-020	2018-10-29 10:12	-62.00	23.65		X	X		X		
C282-021	2018-10-29 22:05	-61.42	23.34		X	X	X			

Continued on next page

Station	Time	Lon	Lat	CTD	HC	NT	BP	SD	MN	DN
C282-022	2018-10-30 10:28	-60.53	23.20		X	X		X		
C282-023	2018-10-30 22:06	-59.74	23.08	X		X	X			
C282-024	2018-10-31 10:30	-58.52	23.05		X	X				X
C282-025	2018-10-31 23:36	-57.45	22.80			X				
C282-026	2018-11-01 10:11	-56.91	22.32		X	X				
C282-027	2018-11-01 23:33	-56.17	21.51			X				
C282-028	2018-11-02 10:05	-55.84	20.88		X	X		X		X
C282-029	2018-11-02 23:34	-55.72	20.12			X				
C282-030	2018-11-03 10:00	-55.70	19.41		X	X		X		X
C282-031	2018-11-03 22:23	-55.72	18.86		X	X	X			
C282-032	2018-11-04 09:30	-55.64	18.24		X	X		X		X
C282-033	2018-11-04 22:23	-55.71	17.42		X	X	X			
C282-034	2018-11-05 10:21	-55.71	16.81		X	X				
C282-035	2018-11-05 23:15	-55.74	16.10		X	X	X			
C282-036	2018-11-06 10:00	-55.99	15.63		X	X				
C282-037	2018-11-06 23:25	-55.75	15.62			X				
C282-038	2018-11-07 10:12	-55.69	15.01		X	X				
C282-039	2018-11-07 23:28	-55.53	14.23			X				
C282-040	2018-11-08 10:22	-55.52	13.37		X	X		X		X
C282-041	2018-11-08 22:15	-55.67	12.50	X		X	X		X	
C282-042	2018-11-09 10:05	-55.85	11.81	X		X				
C282-043	2018-11-11 23:35	-61.11	12.28			X				
C282-044	2018-11-17 23:32	-61.55	12.55			X				
C282-045	2018-11-18 02:19	-61.70	12.33			X				

Table 3: Bottle data from cruise C282 collected from the hydrocast deployments.

Station	Time (local)	Lat °N	Lon °E	Bottle	Depth [m]	NO$_3^{-1}$ [μM]	PO$_4^{-3}$ [μM]	pH	Alk	Chl-a [mg/L]	Temp [°C]	Sal
C282-003-HC	2018-10-17 10:47	39.83	-70.03	12	2	0.01	0.15	8.11		0.323	20.6	35.08
				11	11					0.270	20.7	35.15
				10	21					0.431	20.7	35.12
				9	35					0.393	20.2	35.42
				8	49	3.71	0.48	8.00		0.088	17.3	35.86
				7	75					0.097	15.0	35.81
				6	100	4.23	0.69	7.96		0.000	14.0	35.75
				5	149	4.15	0.59	7.96		0.000	13.1	35.68
				4	198	4.18	0.66	7.88			11.8	35.51
				3	299	4.23	1.06	7.86			9.2	35.21
				2	497	4.20	1.18	7.86			6.3	35.07
				1	942	4.24	1.10	7.87			4.6	34.98
C282-005-HC	2018-10-19 09:50	38.16	-68.74	12	3	0.15	0.06	8.03		0.379	21.7	34.91
				11	10					0.300	21.7	34.91
				10	19					0.200	21.7	34.91
				9	35					0.265	21.7	34.91
				8	50	0.98	0.48	7.94	2.47	0.263	16.9	35.36
				7	74					0.149	15.1	35.63
				6	99	8.05	1.11	7.85	2.49	0.045	14.3	35.80
				5	148	9.93	1.29	7.90	2.48	0.000	13.0	35.68
				4	200	12.88	1.76	7.78	2.46		11.4	35.46

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	298	15.83	2.10	7.74	2.46		9.1	35.20
				2	497	12.52	1.94	7.72	2.54		6.0	35.07
				1	847	12.32	1.21	7.75	2.66		4.5	34.99
C282-007-HC	2018-10-20 09:52	36.28	-67.07	12	3	0.00	0.22	8.07	2.47	0.087	25.7	36.44
				11	25					0.055	25.7	36.44
				10	49	0.00	0.05	8.07		0.055	25.7	36.44
				9	75					0.124	25.0	36.70
				8	100	0.71	0.22	8.00		0.076	22.8	36.83
				7	124					0.057	21.6	36.78
				6	150					0.002	21.1	36.77
				5	199	1.14	0.17	8.00			20.0	36.71
				4	297	1.28	0.15	7.99			19.4	36.68
				3	397	1.82	0.22	8.00			19.1	36.65
				2	496	2.43	0.38	7.97			18.7	36.59
				1	843	10.36	1.42	7.84			13.4	35.73
C282-009-HC	2018-10-23 10:52	35.55	-61.04	12	3	0.00	0.10	8.07	2.49	0.036	24.3	36.52
				11	10				2.53	0.018	24.3	36.52
				10	20					0.010	24.3	36.53
				9	49	0.00	0.14	8.08	2.50	0.022	24.1	36.66
				8	100	0.15	0.12	8.02		0.009	20.8	36.74
				7	149				2.54	0.013	19.4	36.65
				6	199	1.76	0.12	8.00	2.49	0.000	19.2	36.64
				5	249				2.56	0.000	19.0	36.63
				4	299	2.21	0.22	8.00	2.52		18.9	36.62

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	398	2.68	0.31	8.01			18.4	36.54
				2	497	5.42	0.53	7.94			17.1	36.35
				1	799	13.56	1.38	7.77			11.4	35.46
C282-011-HC	2018-10-24 09:36	34.65	-60.51	12	3	0.20	0.23	8.08		0.007	25.1	36.76
				11	11					0.006	25.1	36.76
				10	19					0.000	25.1	36.76
				9	49	0.10	0.16	8.04		0.015	25.0	36.76
				8	99	0.52	0.41	7.99		0.110	20.3	36.72
				7	149			7.96		0.009	19.5	36.66
				6	199	2.24	0.34	7.95		0.000	19.1	36.62
				5	248			7.96		0.000	18.8	36.60
				4	298	3.56	0.37	7.95			18.5	36.56
				3	397	4.15	0.37	7.92			17.4	36.39
				2	496	4.80	0.60	7.88			15.8	36.12
				1	974	14.93	1.72	7.72			7.2	35.15
C282-013-HC	2018-10-25 10:02	33.09	-60.25	12	3			8.11	2.73	0.027	24.9	36.83
				11	11					0.020	24.9	36.83
				10	19					0.010	24.9	36.83
				9	50			8.10		0.009	24.5	36.81
				8	99			8.08		0.045	20.6	36.75
				7	149			8.05		0.032	19.6	36.67
				6	198			7.98		0.000	19.1	36.62
				5	248			8.00		0.000	19.0	36.63
				4	298			7.98			18.8	36.60

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	398			7.94			17.9	36.47
				2	496			7.91			16.4	36.23
				1	838			7.74			9.8	35.31
C282-015-HC	2018-10-26 10:00	30.45	-60.67	12	2	0.66	0.27	7.92	2.44	0.000	25.5	36.84
				11	10					0.039	25.5	36.84
				10	19					0.005	25.5	36.83
				9	50	0.11	0.22	7.97	2.46	0.004	25.5	36.83
				8	99	0.00	0.05	7.98	2.44	0.031	20.7	36.77
				7	149			7.91		0.021	19.4	36.64
				6	198	2.57	0.06	7.91	2.47	0.000	19.0	36.61
				5	248			7.94		0.000	18.7	36.59
				4	297	2.86	0.09	7.97	2.42		18.2	36.51
				3	396	6.54	0.70	7.88	2.49		17.0	36.33
				2	497						15.1	36.03
				1	945	19.79	1.06	7.68	1.95		6.8	35.15
C282-017-HC	2018-10-27 10:08	28.27	-60.96	12	3			8.03	2.41	0.000	26.8	37.04
				11	10					0.000	26.8	37.04
				10	20					0.009	26.8	37.04
				9	49			8.01		0.000	24.1	36.92
				8	100			7.96		0.100	21.3	36.83
				7	149			7.94		0.011	19.9	36.71
				6	198			7.96		0.000	19.4	36.66
				5	248			7.95		0.000	19.0	36.62
				4	297			7.94			18.8	36.60

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	397			7.90			17.8	36.47
				2	497						16.3	36.22
				1	897			7.67			8.1	35.15
C282-019-HC	2018-10-28 22:12	24.44	-62.10	12	3			8.06	2.59	0.000	28.1	36.84
				11	11					0.002	28.1	36.84
				10	20					0.002	28.1	36.84
				9	49			8.05		0.002	28.1	36.84
				8	99			8.05		0.170	25.2	37.29
				7	150			7.99		0.035	22.9	37.16
				6	199			7.95		0.000	20.9	36.90
				5	248			7.94		0.000	19.6	36.73
				4	298			7.92			18.9	36.64
				3	398			7.89			17.3	36.43
				2	497			7.84			15.6	36.14
				1	534			7.78			14.9	36.03
C282-020-HC	2018-10-29 10:41	23.66	-62.03	12	3	0.14	0.20	8.02		0.000	28.2	36.68
				11	10					0.000	28.2	36.68
				10	20					0.000	28.2	36.68
				9	50	0.00	0.15	8.02		0.033	28.2	36.70
				8	99	0.00	0.41	8.01		0.243	25.6	37.17
				7	149			7.98			23.2	37.10
				6	199	0.97	0.36	7.93		0.051	21.3	36.90
				5	299		0.63	7.89	2.38		18.9	36.64
				4	397			7.91			17.3	36.42

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	497	11.17	1.28	7.87			15.3	36.07
				2	745		1.87	7.74	2.37		10.5	35.39
				1	878		2.47	7.72	2.40		8.2	35.10
C282-021-HC	2018-10-29 22:42	23.34	-61.45	12	3						28.1	36.71
				11	11					0.000	28.1	36.70
				10	21					0.000	28.1	36.70
				9	49					0.028	28.1	36.71
				8	100					0.187	24.9	37.15
				7	149					0.053	22.9	37.10
				6	197					0.000	21.3	36.93
				5	298						18.8	36.62
				4	397						17.2	36.39
				3	496						15.3	36.10
				2	556						14.1	35.91
				1	559						14.1	35.89
C282-022-HC	2018-10-30 10:28	23.19	-60.56	12	3			8.07		0.007	27.5	36.94
				11	11					0.013	27.5	36.94
				10	20					0.004	27.5	36.94
				9	50			8.03		0.031	27.5	37.00
				8	99			7.98		0.061	23.7	37.05
				7	149			7.98		0.039	22.1	37.04
				6	199			7.95		0.004	20.0	36.72
				5	298			7.91			18.6	36.62
				4	397			7.86			17.1	36.38

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	495			7.84			15.3	36.09
				2	745			7.66			10.2	35.33
				1	888			7.61			7.7	35.04
C282-024-HC	2018-10-31 10:35	23.05	-58.55	12	2	0.24	0.55	7.98	2.50	0.019	27.8	36.86
				11	10					0.025	27.7	36.86
				10	20					0.029	27.7	36.87
				9	50	0.20	0.44	7.86		0.046	27.8	36.96
				8	100	0.20	0.49	7.96		0.336	24.7	37.28
				7	150	0.35	0.48	7.90		0.085	22.9	37.26
				6	200			7.86		0.025	21.0	36.96
				5	300		0.67	7.80			18.4	36.58
				4	400			7.78			16.7	36.33
				3	500		1.27	7.70			14.7	36.00
				2	749		1.01	7.64			10.3	35.40
				1	952		1.16				6.9	34.98
C282-026-HC	2018-11-01 10:11	22.36	-56.89	12	3			7.89		0.016	27.5	36.84
				11	10					0.026	27.5	36.84
				10	20					0.109	27.5	36.85
				9	50			7.88		0.038	27.5	37.05
				8	99			7.85		0.232	23.3	37.12
				7	150			7.80		0.112	21.1	36.93
				6	198			7.79		0.006	19.4	36.65
				5	298			7.77			18.1	36.51
				4	398			7.72			16.2	36.24

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	496			7.68			14.0	35.89
				2	743			7.58			9.5	35.26
				1	815			7.57			8.3	35.14
C282-028-HC	2018-11-02 10:22	20.90	-55.82	12	4	0.26	0.11	8.05	2.47	0.054	28.0	35.83
				11	10					0.125	28.0	35.83
				10	20					0.069	27.9	35.87
				9	49	0.22	0.11	8.06	2.43	0.112	27.4	37.22
				8	99		0.44	7.98	2.47	0.390	24.4	37.39
				7	149	0.79	0.95	7.91		0.090	22.2	37.15
				6	199			7.87	2.45	0.002	19.8	36.82
				5	298		1.02	7.87	2.50		17.4	36.43
				4	397			7.80			15.1	36.07
				3	497		1.42	7.80	2.43		13.5	35.82
				2	745		2.41	7.67	2.52		9.0	35.21
				1	942		3.04	7.61	2.61		6.3	34.90
C282-030-HC	2018-11-03 10:35	19.45	-55.65	12	2			8.09			28.0	35.28
				11	10					0.076	28.0	35.28
				10	20					0.070	28.0	35.28
				9	49			8.08		0.118	27.9	37.11
				8	99			8.06		0.368	24.5	37.31
				7	149			7.97		0.082	21.7	37.01
				6	198			7.94		0.002	19.5	36.75
				5	299			7.92			17.2	36.41
				4	396			7.83			15.0	36.05

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	497			7.79			13.2	35.79
				2	744			7.62			7.4	34.91
				1	764			7.61			7.1	34.88
C282-031-HC	2018-11-03 22:23	18.88	-55.70	12	2			8.05	2.41	0.055	28.0	35.34
				11	10					0.102	28.0	35.33
				10	20						28.0	35.33
				9	50					0.093	27.7	37.25
				8	100					0.330	24.3	37.35
				7	148					0.108	22.1	37.12
				6	198					0.000	19.6	36.76
				5	298						16.8	36.35
				4	397						14.7	36.00
				3	497						12.7	35.71
				2	565						11.0	35.43
				1	568						10.9	35.42
C282-032-HC	2018-11-04 09:57	18.26	-55.62	12	3			7.97	2.41		28.2	35.94
				11	11					0.071	28.2	35.94
				10	20					0.002	28.2	35.95
				9	50			8.00		0.126	27.8	36.83
				8	99			7.96		0.431	25.0	37.33
				7	149			7.95		0.113	22.5	37.20
				6	198			7.84		0.002	19.4	36.72
				5	299			7.82			17.1	36.39
				4	398			7.75			14.9	36.03

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	496						12.7	35.71
				2	746						7.7	34.96
				1	875			7.59			6.0	34.78
C282-033-HC	2018-11-04 22:23	17.44	-55.69	12	3			8.04	2.45	0.064	28.3	35.98
				11	10					0.052	28.3	35.98
				10	20					0.050	28.3	36.02
				9	49					0.086	28.1	36.52
				8	99					0.377	25.9	37.13
				7	149					0.069	23.0	37.20
				6	199					0.003	20.3	36.87
				5	298						17.1	36.39
				4	396						14.3	35.92
				3	496						11.9	35.50
				2	553						11.1	35.43
				1	552						11.1	35.43
C282-034-HC	2018-11-05 10:21	16.82	-55.68	12	3			7.94	2.55		28.3	36.03
				11	10					0.061	28.3	36.03
				10	20					0.038	28.3	36.03
				9	50			7.94	2.38	0.019	28.3	36.29
				8	100			7.95	2.41	0.233	25.6	37.22
				7	149			7.89		0.090	22.8	37.25
				6	198			7.85	2.49	0.000	20.0	36.84
				5	298			7.81	2.41		16.8	36.35
				4	397			7.72			14.4	35.93

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	497			7.73	2.40		12.3	35.63
				2	695			7.59	2.32		7.8	34.96
				1	826			7.56	2.35		6.2	34.82
C282-035-HC	2018-11-05 23:50	16.11	-55.72	12	3			8.06	2.24	0.062	28.2	35.09
				11	10					0.059	28.2	35.11
				10	19					0.074	28.4	35.54
				9	29					0.113	28.3	36.18
				8	40					0.085	28.2	36.38
				7	50					0.133	27.6	36.72
				6	74					0.309	25.9	36.91
				5	100					0.417	24.7	37.18
				4	124					0.230	23.6	37.21
				3	148					0.080	21.7	37.03
				2	174						20.3	36.85
				1	198						19.0	36.68
C282-036-HC	2018-11-06 10:21	15.63	-55.98	12	2	0.23	0.21	8.05		0.118	28.2	36.31
				11	10					0.120	28.2	36.31
				10	20					0.112	28.2	36.32
				9	50	0.29	0.24	8.04		0.184	27.4	36.86
				8	99	0.68	0.23	8.00		0.432	24.3	37.21
				7	150			7.91		0.075	20.9	36.95
				6	202		0.36	7.85		0.000	18.3	36.54
				5	300	0.87	0.62	7.76			14.5	35.90
				4	399			7.71			11.8	35.48

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	500		1.46	7.66			9.8	35.17
				2	750		1.77	7.57			6.1	34.70
				1	862		1.67	7.55			5.7	34.74
C282-038-HC	2018-11-07 10:12	15.01	-55.67	12	3			8.07		0.214	28.2	34.37
				11	11					0.328	28.2	34.37
				10	20					0.227	28.4	35.01
				9	50			8.08		0.176	28.4	36.67
				8	99			7.93		0.366	24.7	37.20
				7	149			7.94		0.002	20.6	36.82
				6	198					0.000	17.6	36.40
				5	297			7.73			14.5	35.95
				4	398			7.73			12.2	35.55
				3	496						9.6	35.15
				2	695						6.5	34.73
				1	951						5.6	34.82
C282-040-HC	2018-11-08 10:22	13.37	-55.49	12	2			7.99		0.214	28.5	34.70
				11	11					0.192	28.5	34.71
				10	20					0.420	28.5	34.73
				9	50			8.00		0.114	26.9	36.38
				8	99			7.91		0.314	23.6	37.05
				7	149			7.79			19.0	36.50
				6	199			7.69		0.000	15.5	36.07
				5	300			7.67			11.9	35.45
				4	399			7.47			9.2	35.05

Continued on next page

Station	Time	Lat	Lon	Bottle	Depth	NO_3^{-1}	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E		[m]	[μM]	[μM]			[mg/L]	[°C]	
				3	499			7.46			7.7	34.77
				2	700			7.48			6.4	34.68
				1	886			7.47			5.6	34.70

Table 4: Bottle data from cruise C282 collected from surface bucket samples

Station	Time (local)	Lat °N	Lon °E	PO_4^{-3} [μM]	pH	Alk	Chl-a [mg/L]	Temp [°C]	Sal
SS-001	2018-10-17 00:09	40.51	-70.55	0.55	8.02		1.667	16.8	32.90
SS-002	2018-10-19 03:18	38.67	-69.18	0.29	8.11	2.65	0.417	21.3	35.20
SS-003	2018-10-19 10:33	38.16	-68.71					21.8	34.91
SS-004	2018-10-20 00:04	36.91	-67.78		8.12	2.40	0.354	26.1	36.41
SS-005	2018-10-20 11:45	36.33	-67.08					25.8	36.41
SS-006	2018-10-22 23:37	36.08	-61.76		8.11	2.61	0.298	25.9	36.49
SS-007	2018-10-23 11:39	35.55	-61.06					24.8	36.51
SS-008	2018-10-23 23:48	34.99	-60.98		8.00	2.53	0.082	25.2	36.78
SS-009	2018-10-24 10:10	34.65	-60.52					25.2	36.76
SS-010	2018-10-25 00:15	34.08	-60.30		8.09	2.49	0.065	24.6	36.77
SS-011	2018-10-25 10:14	33.09	-60.29					24.9	36.83
SS-012	2018-10-25 23:40	31.66	-60.41		7.69	2.30		25.0	36.94
SS-013	2018-10-26 10:45	30.43	-60.68					25.6	36.84
SS-014	2018-10-26 23:44	29.47	-60.77		8.07		0.053	25.6	36.88
SS-015	2018-10-27 10:49	28.26	-60.96					26.8	37.03
SS-016	2018-10-27 23:44	26.88	-61.31		8.06		0.039	27.4	37.02
SS-017	2018-10-28 12:12	25.49	-61.71		8.01		0.001	27.9	36.90
SS-018	2018-10-28 00:37	24.38	-62.06					28.1	36.81
SS-019	2018-10-29 10:56	23.66	-62.02					28.3	36.67
SS-020	2018-10-30 00:05	23.34	-61.42		8.05		0.001	28.2	36.70
SS-021	2018-10-30 12:19	23.21	-60.53					27.6	36.94
SS-022	2018-10-31 11:00	23.05	-58.54					27.9	36.84
SS-023	2018-10-31 23:46	22.79	-57.45				0.046	27.8	36.63
SS-024	2018-11-01 10:39	22.35	-56.90					27.6	36.82
SS-025	2018-11-02 01:13	21.42	-56.15				0.068	27.8	36.53
SS-026	2018-11-02 11:56	20.88	-55.84					28.1	35.82
SS-027	2018-11-02 23:45	20.12	-55.72			2.46	0.062	28.0	36.06
SS-028	2018-11-03 11:09	19.43	-55.66					28.0	35.29
SS-029	2018-11-04 10:19	18.25	-55.62					28.3	35.93
SS-030	2018-11-04 22:23	17.44	-55.69					28.4	35.95
SS-031	2018-11-05 11:47	16.80	-55.72					28.4	36.03

Continued on next page

Station	Time	Lat	Lon	PO_4^{-3}	pH	Alk	Chl-a	Temp	Sal
	(local)	°N	°E	[μM]			[mg/L]	[°C]	
SS-032	2018-11-06 00:02	16.11	-55.73					28.2	35.09
SS-033	2018-11-06 10:44	15.63	-55.97					28.2	36.26
SS-034	2018-11-06 23:48	15.62	-55.76		8.09	2.21	0.189	26.2	35.83
SS-035	2018-11-07 10:27	15.01	-55.68					28.2	34.34
SS-036	2018-11-07 11:39	14.22	-55.52		8.10		0.292	28.4	33.89
SS-037	2018-11-08 10:39	13.37	-55.49					28.6	34.72
SS-038	2018-11-09 00:46	12.49	-55.67		8.05	2.42	0.146	28.5	35.10
SS-039	2018-11-09 14:28	11.80	-56.00		8.09	2.47	0.211	28.4	34.73

Table 5: Neuston data from cruise C282.

Station	Time [local]	Lat [°N]	Lon [°E]	Moon Phase [% full]	Temperature [°C]	Salinity	Chl-a Fluoroesence [Volts]	Tow Area [m^2]	Zooplankton Biovolume [mL]	Zooplankton Density [μL/km^2]
C282-001-NT	2018-10-15 12:23	41.32	-71.15	38% (Risen)	18.2	31.80	2820.90	1822	147.0	80.68
C282-002-NT	2018-10-16 23:50	40.50	-70.56	57% (Set)	16.8	32.90	2737.00	1927	71.5	37.10
C282-003-NT	2018-10-17 12:16	39.88	-70.02	57% (Set)	20.3	34.86	877.90	2402	3.6	1.50
C282-005-NT	2018-10-19 11:16	38.16	-68.67	75% (Risen)	21.8	34.92	1553.80	2794	2.8	1.00
C282-006-NT	2018-10-19 23:50	36.91	-67.77	83% (Risen)	26.1	36.41	529.40	2324	8.5	3.66
C282-007-NT	2018-10-20 11:24	36.33	-67.08	83% (Set)	25.8	36.40	465.40	2726	2.0	0.73
C282-008-NT	2018-10-22 23:21	36.09	-61.77	95% (Risen)	25.2	36.49	521.34	1362	8.0	5.88
C282-009-NT	2018-10-23 12:13	35.54	-61.09	98% (Set)	24.3	36.54	413.40	1314	5.0	3.80
C282-010-NT	2018-10-23 23:34	34.99	-60.97	98% (Risen)	25.2	36.80	410.70	1533	7.0	4.57
C282-011-NT	2018-10-24 11:27	34.66	-60.54	100% (Set)	25.2	36.80	403.80	1845	5.5	2.98
C282-012-NT	2018-10-25 00:06	34.08	-60.30	99% (Set)	24.7	36.77	411.20	1809	5.0	2.76
C282-013-NT	2018-10-25 11:14	33.08	-60.22	99% (Set)	25.0	36.80	422.00	2444	3.3	1.35
C282-014-NT	2018-10-25 23:23	31.67	-60.42	99% (Risen)	25.1	36.94	411.30	2269	6.5	2.86
C282-015-NT	2018-10-26 11:19	30.43	-60.68	96% (Set)	25.6	36.83	429.60	1675	1.3	0.78
C282-016-NT	2018-10-26 23:30	29.48	-60.76	96% (Risen)	25.4	36.83	511.50	2161	1.5	0.69
C282-017-NT	2018-10-27 11:15	28.25	-60.97	91% (Set)	26.8	37.00	506.40	1684	1.0	0.59
C282-018-NT	2018-10-27 23:23	26.88	-61.31	91% (Risen)	27.4	37.03	581.50	2159	4.0	1.85
C282-019-NT	2018-10-29 00:09	24.40	-62.08	83% (Risen)	28.1	36.81	506.40	2317	9.0	3.88
C282-020-NT	2018-10-29 11:56	23.65	-62.00	74% (Set)	28.3	36.70	511.60	3233	1.5	0.46
C282-021-NT	2018-10-29 23:48	23.34	-61.42	74% (Risen)	28.2	36.70	534.60	1118	4.0	3.58
C282-022-NT	2018-10-30 12:00	23.20	-60.53	64% (Risen)	27.7	36.96	532.60	2094	1.8	0.84

Continued on next page

Station	Time [local]	Lat [°N]	Lon [°E]	Moon Phase [% full]	Temperature [°C]	Salinity	Chl-a Fluoroesence [Volts]	Tow Area [m^2]	Zooplankton Biovolume [mL]	Zooplankton Density [$\mu L/km^2$]
C282-023-NT	2018-10-30 23:34	23.08	-59.74	64% (Risen)	27.7	36.90	515.70	1679	3.9	2.32
C282-024-NT	2018-10-31 11:53	23.05	-58.52	52% (Risen)	28.0	36.90	535.50	2158	2.5	1.16
C282-025-NT	2018-10-31 23:36	22.80	-57.45	52% (Set)	27.8	36.61	534.40	1832	1.5	0.83
C282-026-NT	2018-11-01 11:29	22.32	-56.91	41% (Risen)	27.7	36.86	524.60	1874	1.0	0.53
C282-027-NT	2018-11-01 23:33	21.51	-56.17	41% (Set)	27.9	36.71	509.90	2227	1.4	0.65
C282-028-NT	2018-11-02 11:43	20.88	-55.84	30% (Risen)	28.1	35.80	536.50	1648	1.4	0.85
C282-029-NT	2018-11-02 23:34	20.12	-55.72	30% (Set)	28.0	36.04	554.00	1717	5.0	2.91
C282-030-NT	2018-11-03 12:26	19.41	-55.70	20% (Risen)	28.1	35.20	580.20	1975	1.5	0.76
C282-031-NT	2018-11-04 00:01	18.86	-55.72	12% (Set)	28.1	35.35	566.90	1306	6.5	4.98
C282-032-NT	2018-11-04 11:25	18.24	-55.64	12% (Risen)	28.3	35.95	564.00	2074	2.0	0.96
C282-033-NT	2018-11-04 23:55	17.42	-55.71	12% (Set)	28.4	36.01	570.10	1856	9.5	5.12
C282-034-NT	2018-11-05 11:39	16.81	-55.71	6% (Risen)	28.4	36.03	548.10	1715	1.5	0.87
C282-035-NT	2018-11-06 00:35	16.10	-55.74	2% (Set)	28.2	35.01	519.40	2461	19.0	7.72
C282-036-NT	2018-11-06 11:46	15.63	-55.99	2% (Risen)	28.2	36.30	606.30	2520	7.5	2.98
C282-037-NT	2018-11-06 23:25	15.62	-55.75	0% (Set)	28.2	35.81	561.22	1382	17.0	12.30
C282-038-NT	2018-11-07 11:35	15.01	-55.69	0% (Risen)	28.3	34.40	574.40	1102	2.5	2.27
C282-039-NT	2018-11-07 23:28	14.23	-55.53	0% (Set)	28.4	33.86	636.34	1909	13.0	6.81
C282-040-NT	2018-11-08 11:47	13.37	-55.52	1% (Risen)	28.6	34.67	577.90	1590	19.5	12.26
C282-041-NT	2018-11-09 00:34	12.50	-55.67	1% (Set)	28.5	35.08	528.60	2391	14.2	5.94
C282-042-NT	2018-11-09 13:41	11.81	-55.85	4% (Risen)	28.4	34.77	561.20	1240	2.0	1.61
C282-043-NT	2018-11-11 23:35	12.28	-61.11	15% (Set)				1818	8.1	4.46
C282-044-NT	2018-11-17 23:32	12.55	-61.55	68% (Risen)	28.6	803.30	34.52	2368	5.4	2.28

Continued on next page

Station	Time [local]	Lat [°N]	Lon [°E]	Moon Phase [% full]	Temperature [°C]	Salinity	Chl-a Fluoroesence [Volts]	Tow Area [m^2]	Zooplankton Biovolume [mL]	Zooplankton Density [$\mu L/km^2$]
C282-045-NT	2018-11-18 02:19	12.33	-61.70	76% (Set)	28.6	594.90	34.80	1621	12.0	7.40

Table 6: Nekton and floater information from Neuston Tows of cruise C282. Abbreviation - Phyl: Phyllosoma (Spiny lobster Larvae), Lept: Leptocephali (Eel Larvae), Halo: Halobates (Water Striders), Myct: Myctophids (Lantern Fish)

Station	Phyl [#]	Lept [#]	Halo [#]	Myct [#]	Tar [#]	Nekton > 2 cm [mL]	Gelatinous > 2cm [mL]	Plastic Density [$\#/km^2$]	Sargassum Pieces [#]	Sargassum Mass [g]
C282-001-NT	0	0	0	48	0	2.0	8.0	0	0	0
C282-002-NT	0	0	0	0	1	1.2	0.0	0	8	49
C282-003-NT	0	0	0	0	0	0.6	0.0	1249	8	17
C282-005-NT	0	0	0	0	0	0.8	0.0	4295	23	161
C282-006-NT	0	2	1	5	0	1.4	0.0	6885	0	0
C282-007-NT	0	0	0	0	0	0.2	0.0	734	31	34
C282-008-NT	0	5	0	0	0	3.6	0.4	1469	48	153
C282-009-NT	0	0	1	0	0	0.2	0.6	18261	20	106
C282-010-NT	0	3	0	0	0	3.1	1.5	13696	7	20
C282-011-NT	0	0	0	0	0	0.0	0.0	85650	21	136
C282-012-NT	0	0	0	0	0	3.5	0.0	14923	7	86
C282-013-NT	0	0	0	0	0	0.0	0.0	2046	0	0
C282-014-NT	0	9	0	3	0	6.4	0.0	26883	29	409
C282-015-NT	0	0	0	0	0	0.0	0.0	7164	0	0
C282-016-NT	0	4	0	2	0	7.0	0.0	926	0	0
C282-017-NT	0	0	0	0	0	0.0	0.0	4157	53	95

Continued on next page

Station	Phyl	Lept	Halo	Myct	Tar	Nekton > 2 cm	Gelatinous > 2cm	Plastic Density	Sargassum Pieces	Sargassum Mass
	[#]	[#]	[#]	[#]	[#]	[mL]	[mL]	[#/km^2]	[#]	[g]
C282-018-NT	0	0	2	2	0	1.2	1.0	9726	8	8
C282-019-NT	0	3	2	3	0	2.8	0.0	432	117	257
C282-020-NT	0	0	0	0	0	0.0	0.0	309	9	12
C282-021-NT	0	2	4	3	0	6.2	0.1	15200	16	29
C282-022-NT	0	0	1	0	0	0.0	0.0	1911	7	7
C282-023-NT	0	0	3	7	0	3.2	0.0	2382	4	12
C282-024-NT	0	0	0	0	0	1.5	0.0	12509	14	56
C282-025-NT	2	0	0	17	1	3.0	0.6	2729		0
C282-026-NT	0	0	0	0	0	0.0	0.0	4802	0	0
C282-027-NT	0	0	0	31	0	4.8	2.5	0	0	0
C282-028-NT	0	0	0	0	0	0.0	0.0	0	8	51
C282-029-NT	0	0	9	0	0	0.0	0.0	0	18	12
C282-030-NT	0	0	1	0	0	0.1	0.0	1519	0	0
C282-031-NT	0	0	26	7	0	13.0	0.0	0	12	49
C282-032-NT	0	0	2	0	0	0.2	0.0	1446	13	26
C282-033-NT	0	0	12	16	0	1.6	0.0	0		
C282-034-NT	0	0	2	0	0	0.0	0.0	0	6	23
C282-035-NT	1	1	2	6	0	5.2	0.8	0	0	0
C282-036-NT	0	0	3	0	0	0.0	0.0	0	77	70
C282-037-NT	0	0	8	0	0	0.0	0.0	0	325	878
C282-038-NT	0	0	1	0	0	0.0	0.0	0	0	0
C282-039-NT	0	0	6	0	0	1.3	0.2	524	37	48
C282-040-NT	0	0	0	0	0	9.0	0.0	0		3956
C282-041-NT	0	0	16	3	0	2.2	0.0	0	5	9

Continued on next page

Station	Phyl	Lept	Halo	Myct	Tar	Nekton > 2 cm	Gelatinous > 2cm	Plastic Density	Sargassum Pieces	Sargassum Mass
	[#]	[#]	[#]	[#]	[#]	[mL]	[mL]	[#/km^2]	[#]	[g]
C282-042-NT	0	0	61	0	0	0.0	0.0	806	0	0
C282-043-NT	0	13	22	0	0	16.5	1.0	0	17	9
C282-044-NT	0	0	0	0	0	0.0	0.0	1267	0	0
C282-045-NT	0	0	19	0	0	1.2	0.0		0	0

5 Student Abstracts

5.1 Ocean Acidification: A Study of pH and Alkalinity Levels From Woods Hole to Grenada

Antonino Tomas [Middlebury College] and **Maddison Hurtgen** [Hamilton College]

The increased concentration of carbon dioxide in the atmosphere has put a huge amount of strain on the natural carbon sink of the oceans, which absorbs over 30 percent of the carbon dioxide which we put into the atmosphere. This carbon dioxide reacts with the seawater, splitting apart and releasing hydrogen ions which lower the pH of the seawater. The ocean's natural buffering system absorbs this excess hydrogen by bonding it to carbonate. The availability of this carbonate determines the ocean's alkalinity, or ability to neutralize the hydrogen. The ocean can only do so much though, and with all of the carbonate bonding to hydrogen, there is a lack of calcium carbonate in the oceans which many organisms such as pteropods, corals, and shellfish require to build their shells. Additionally, the oceans have been decreasing in pH, dissolving the shells of these animals even further. In our research, we aimed to get the most recent pH and alkalinity levels throughout the water column on our cruise from Woods Hole to Grenada. We found that the most acidic areas of the ocean are the cold deep water areas, specifically the deep New England Slope water and Antarctic Intermediate Water. We also found that overall pH has been decreasing as we predicted, showing significantly lower surface values than had been recorded several years ago. Finally, our data found alkalinity to be fairly constant, both with depth and distance along our cruise track and averaging at about 2.5.

5.2 The Quantification of Bioluminescence and its Relationship to Chlorophyll Concentration in The North Atlantic Gyre

Jonathan Lopez de Leon and **Alexander Puza** [Gap Student]

bioluminescence has been observed as a naturally occurring phenomena for thousands of years. Through those many years, three prevailing explanations for its existences have been proposed: defenses, communications and mating. The objective of this research was to study the factors effecting the bioluminescence predatory response of dinoflagellate and other organisms. We hypnotized that the bioluminescent biomass would be positively correlated to the oxygen levels and the Deep Chlorophyll Maximum (DCM) in the first 100m of the water column. The areas surveyed were the North Sargasso Sea, South Sargasso Sea, Transition Zone and the Tropics. The Bathyphotometer along with the CTD with a Fluorometer and an Oxygen sensor were used to gather the data. However, Fluorometer data demonstrated a negative correlation not the predicted positive correlation and the Oxygen data was only a weak positive correlation. The findings rendered the hypothesis refuted. A better predictor of bioluminescence is the dial vertical migration of zooplankton and the potential factors effecting migratory patterns.

5.3 The Halobates micans Population in the North Atlantic Ocean in Relation to Temperature and Salinity

Timo Abad [Gap Student] and **Lou Ruffini** [University at Albany]

Halobates are the only insect genus living on open ocean and the only marine invertebrate feeding at the sea-air interface. Halobates are a substantial food source for birds and many types of fish that can break the ocean surface to catch their prey, making them notable in ocean food webs. *Halobates Micans* is the only open ocean Halobates in the North Atlantic Ocean. We collected Halobates along our cruise track from the New England Shelf down to the Tropics. We collected our samples from a neuston 333um mesh net which was deployed twice a day, at dawn and dusk, weather permitting. We determined the

nymphal stage of each specimen by measuring the *H. mican's* mid-femur under a dissection microscope. If fully matured, we determined the sex of each sample. We found a sparse scattering of adult Halobates on the New England Slope, several small collections of late Nymphal stages in the North Sargasso Sea in fresher cold waters, diverse, considerable populations of Halobates in the South Sargasso Sea and the transition zone in high salinity warm waters, and the highest population density and abundance of lower nymphal stages within the Tropics where the waters were fresher and highest in temperature.

5.4 Physical Structures and Nutrient Levels in North Atlantic Water Masses

Seiji Akera [Gap Student] and **Tomasz Dvorak** [University of Massachussets, Amherst]

The goal of this study was to investigate the properties of the water masses we would encounter from New England to the Northern Sargasso Sea – New England Shelf Water, New England Slope Water, the Gulf Stream, and eventually the Northern Sargasso Sea, with an emphasis on Gulf Stream eddies and cold-core rings – parts of the Gulf Stream that surround New England Shelf and Slope Water, then transport them deep into the Sargasso Sea. We were particularly interested in the nutrient properties of these rings, and planned to identify them using surface data and then do several hydrocast deployments to gain a section of a ring. Although we were able to identify one very clear ring on the surface, and may have also crossed another, we were unable to do hydrocast deployments transecting those rings. From this research, we gained information on what surface measurements indicate the presence of a cold-core ring. An encounter with a cold-core ring is likely to be past the Gulf Stream when traveling southward, and is characterized by warm, salty water moving counterclockwise surrounding an area of colder, slower, and fresher water. We also gained information on the nutrient properties of each water mass. Shelf and Slope waters sit on top of nutrient-rich upwellings and are generally higher in nutrients, while Gulf Stream brings low-nutrient water and forces the higher-nutrient water lower. The Northern Sargasso Sea was characterized by higher nutrient levels, but not as high as the Shelf/Slope Waters. To make future research easier, we aimed to research the relationship between nutrient levels and density levels, as well as the relationship between the nutricline and pycnocline. There is a correlation between the two when identifying different water masses. This density proxy for nutrients provides a higher resolution image of what the nutrient data looks like.

5.5 Plastics in the Sargasso Sea: Abundance and Distribution

Isabella Andersson [Hawaii Pacific University] and **Abigail Fisk** [Gap Student]

The purpose of this experiment was to determine the abundance and distribution of plastics in the Sargasso Sea and how it has change over the past ten years to better understand how the fate of pelagic plastic looks. Our hypotheses were 1) there will be a lower density of plastic near the shore and a higher density in the gyre due to fragmentation. 2) Plastic fibers will be more abundant at deeper depths between latitudes 25°N and 10°N, due to the trade winds, 3) the average plastic density will be greater than it has in the previous ten years of SEA research along this cruise track. The hypotheses were tested by towing a Neuston Net twice a day to collect larger fragments floating at the surface, and deploying Niskin bottles once a day to collect smaller fragments and fibers below the surface. We found that the density of plastic fragments floating at the surface is a lot larger in the North Atlantic Gyre than it is closer to shore. We also found that plastic fibers below the surface were not only affected by trade winds; they move as the water moves. The fibers had a high abundance closer to shore and a low abundance within the gyre. This means that plastic fragments large enough to float accumulate within the gyre, and plastic fibers too small to have a positive buoyancy will travel with the water as it converges in the gyre.

5.6 Latitudinal Changes in Zooplankton Biovolume, Community Structure and Diel Vertical Migration in the North Atlantic

Paula Angel [Universidad de los Andes, Colombia] and **Steven Maré** [Cornell University]

Zooplankton are a taxonomically diverse group of small organisms of a few centimeters of size or less that inhabit oceans and lakes, and it is known that perform a Diel Vertical Migration (DVM) moving up in the water column during night and migrating deep in the ocean. The hypothesis to explain this behavior include: predator evasion hypothesis and food quantity and quality hypothesis. The aim of this study was to characterize zooplankton vertical migration along the Sea Education Association (SEA) Ocean Exploration C282 cruise from the Woods Hole, Massachusetts, U.S. to Hillsborough, Carriacou in the Lesser Antilles by determining: 1) biovolume, 2) community assemblage, and 3) vertical migration profile by actively sampling zooplankton with a neuston net and by using an Acoustic Doppler Current Profiler (ADCP). Additionally, the chlorophyll-a fluorescence data of the surface water along the cruise track was obtained from shipboard flow-through systems as a proxy of primary productivity. It was found that the biovolume of the night samples is 3 times greater than day samples, the diversity is not significantly different but some groups of organisms are only present at night and the vertical migration can be observed in the ADCP echo amplitude data, as an increasing at night, stabilizing and decreasing pattern at day and it is observed daily mode.

5.7 Determining Population Characteristics of *Latreutes fucorum* as Mobile Macrofauna Inhabitants of Pelagic *Sargassum* Vegetation

Christina Lim [University of North Carolina at Chapel Hill] and **Cori Shooter** [Gap Student]

Sargassum is a pelagic seaweed endemic to the Sargasso Sea in the Atlantic Ocean. It is home to *Sargassum* shrimp, *Latreutes fucorum*, a keystone species important to the *Sargassum* ecosystem. Our research collected samples of *Sargassum* using a dip net to evaluate the overall health of the *L. fucorum* population by looking at certain population characteristics like fecundity and parasitism rates as well as presence of predators. Our results indicate that different species of *Sargassum* can be found in different abundances based on latitude and size of the *Sargassum* is positively correlated with the number of shrimps living on it. Currently the shrimp population is consistent with previous research, but no conclusions could be drawn about population health using fecundity or parasitism rates due to a low sample size of *L. fucorum* containing those features.