Southeast Fisheries Science Center

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USVI Larval Reef Fish Supply Study: 2007-08 Report

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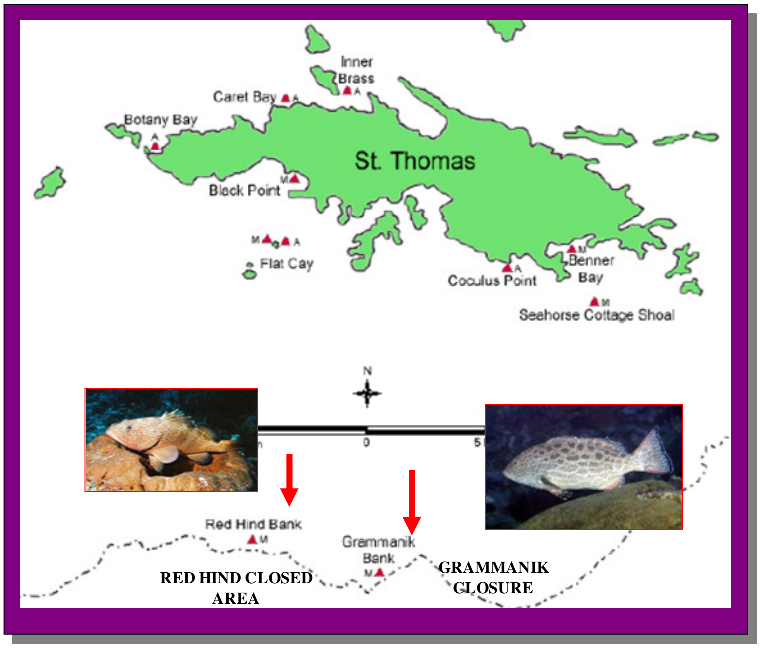
The U.S. Virgin Islands (USVI), comprised of St. Thomas, St. John, and St. Croix, are located on a geological shelf surrounded by an extensive Caribbean tropical marine ecosystem. This ecosystem contains a mosaic of critical habitats that support productive local fisheries. Nearshore "nursery habitats" such as sea grasses, mangroves, and associated coral reefs, provide vital foraging, predator refuge, and spawning habitat for over 400 species of fish found in the Virgin Islands.



Red Hind and Grammanik Banks, located 14 km south of St. Thomas, provide habitat for multi-species spawning aggregation sites and a healthy, deep coral reef system (35-40 m) for economically important coral reef fish including red hind, yellow fin grouper, Nassau grouper, tiger grouper, and dog snapper. Fishing pressure at these suspected sources of larval recruits prompted the Caribbean Fisheries Management Council to close the Grammanik Bank seasonally from February through April, and designate Red Hind Bank a permanently closed Marine Conservation District (MCD). Banks contiguous with these protected areas provide similar habitats and contain reported spawning aggregation sites. Unfortunately, neither the biological nor the physical processes which drive production on the banks, nor the larval transport pathways connecting the banks, the protected areas, nor the flows across the banks, have been quantified. Absent such knowledge, management decisions (including the designation of MCD and/or seasonal closures) are based on historical knowledge and best professional judgment, rather than quantifiable, scientific information.

To address this data gap, National Oceanic and Atmospheric Administration (NOAA) scientists from the Southeast Fisheries Science Center (SEFSC) and the Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Florida, working with scientists from the University of the Virgin Islands (UVI) and the Virgin Islands Department of Planning and Natural Resources, Division of Fish and Wildlife (VIDPNR), designed and executed a three-year interdisciplinary pilot research project consisting of two major components: research cruises and inshore studies. Funding for this research was provided by NOAA's Coral Reef Conservation Program (CRCP).

Research Cruises

The first component consisted of research cruises using the NOAA Ship *Nancy Foster* to conduct biological and physical oceanographic surveys of the USVI bank ecosystems and surrounding regional waters. A total of three research cruises were conducted from 2007 to 2009 (See 2009 cruise report attached). These cruises focused on reef fish larvae in association with an oceanographic (biological, physical and chemical) survey of the bank system, coral reef environs and inshore waters of the USVI. The cruise track from the first cruise, conducted March 28 through April 9, 2007, is shown in Figure1. Station locations for the 48 stations taken in this portion of the cruise, in addition to the locations where seven satellite-tracked surface drifters were deployed, are marked on the figure (an additional set of stations were collected farther to the west, west and south of Puerto Rico, not shown). As shown in Figure 1, detailed surveying was conducted south of the USVI and British Virgin Islands (BVI); a section was done across Anegada Passage, and less spatially intensive sampling was conducted in the upstream region of the Leeward Islands and along the northern edge of Saba Bank.

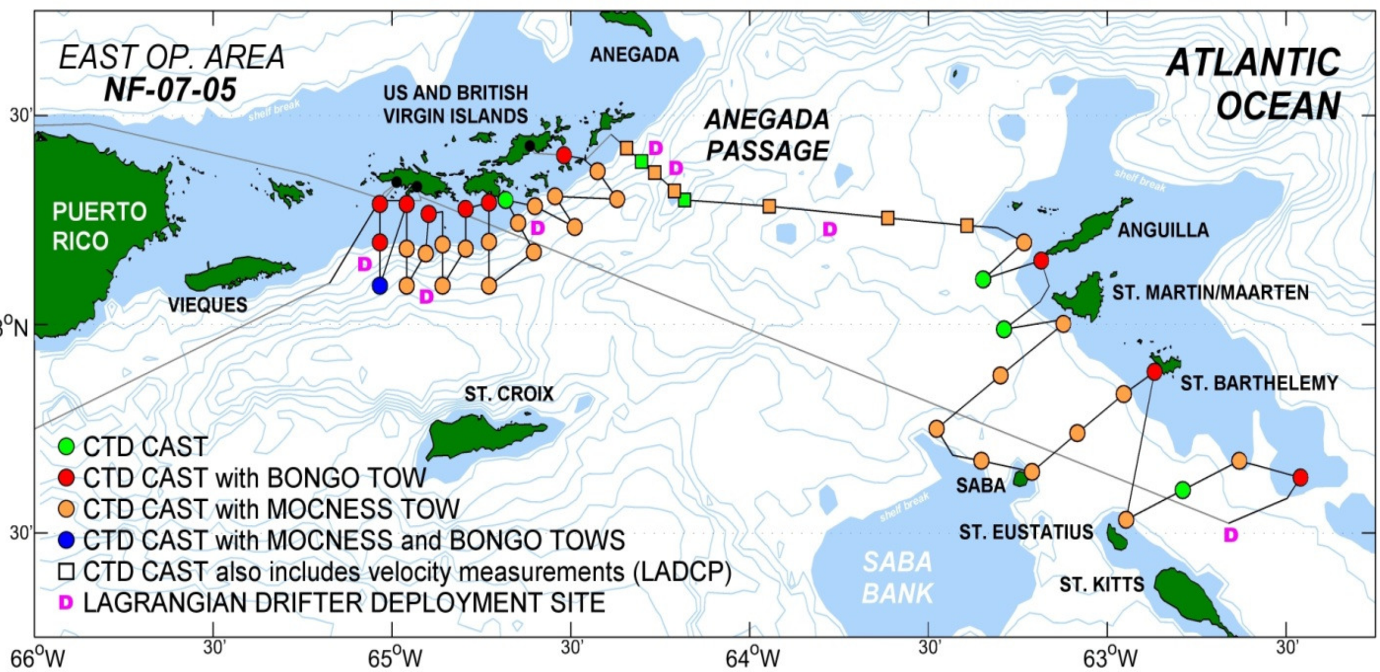


Figure 1. Cruise track, station locations and drifter deployment sites for Year 1, March 28 – April 9, 2007.

The cruise track from the second cruise, conducted March 11 through March 24, 2008, is shown in Figure 2 Station locations from the 76 CTD casts, 6 surface drifter deployments, and biological sampling are shown. As can be seen in Figure 2, the sampling protocol in 2008 was similar to that of 2007, with the addition of sampling to the north of the U. S. and British Virgin Islands and Anegada Island, and a transit across Saba Bank to the southeast.

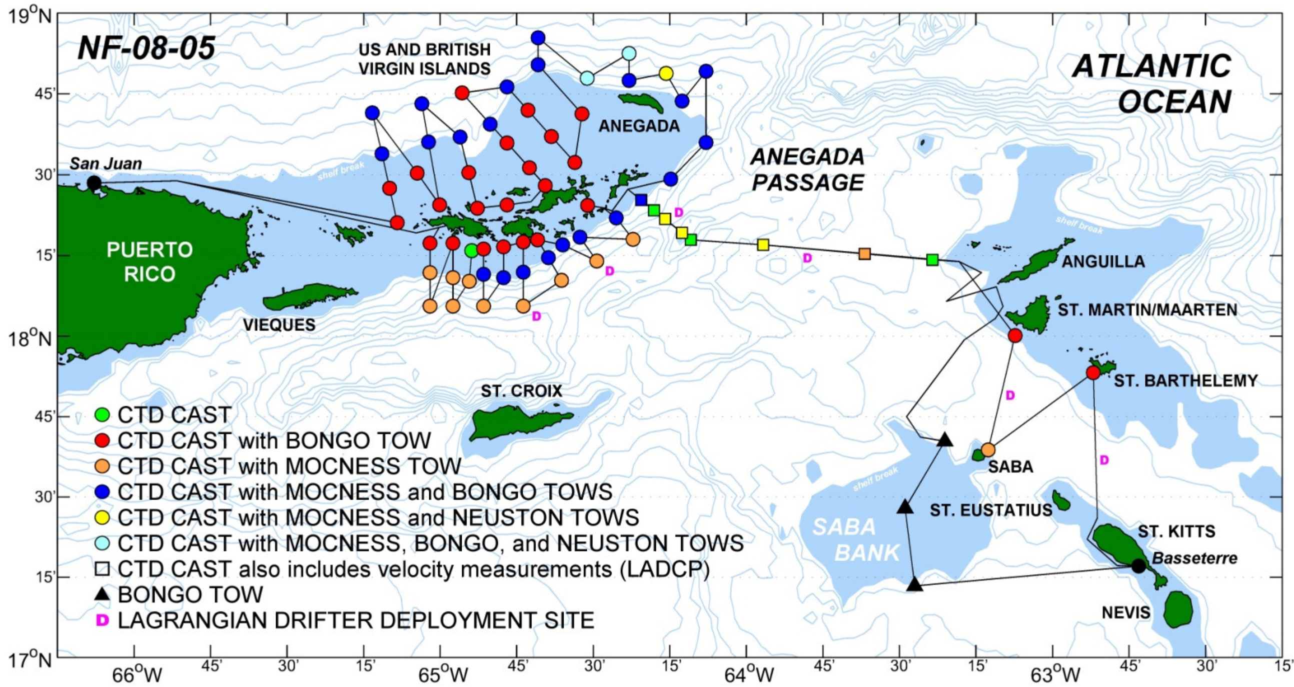


Figure 2. Cruise track, station locations and drifter deployment sites for Year 2, March 11-24, 2008.

In order to understand larval dispersion and transport it is necessary to develop regional larval transport models and integrate mesoscale physical oceanographic observations. This was accomplished by shipboard measurements combined with real-time satellite imagery and satellite-tracked surface drifters. This allows biological sampling to be adapted to physical oceanographic conditions at appropriate time scales. As this study expands, future surveys will include sampling around the islands of St. Croix, Vieques, and Culebra.

Inshore Study

The second component of this research was shore-based collections of post settlement fishes in nursery habitats such as mangroves, sea grasses, and patch reefs, using small boat operations. Shore-based sampling was conducted once per year in years 2007 and 2008 to investigate the connectivity between coastal nursery habitats and adult habitats offshore.

The project is focused on critical reef fish species that are heavily fished throughout the study region and directed at answering one broad question: How are unprotected USVI banks, fisheries managed areas such as the Red Hind Bank Marine Conservation District, seasonally closed areas such as the Grammanik Bank, and inshore areas ecologically linked via reef fish larval dispersal, transport, and life-history patterns? To begin answering this question, we surveyed water properties, currents, and dispersal and transport of settlement-stage fish larvae around the USVI and neighboring regions. We also surveyed near shore habitats for newly settled larval recruits. These surveys will yield an understanding of regional spatial variation in the supply of settlement-stage fishes and the relative importance of Grammanik Bank and other areas as sources of juvenile fishes recruiting to the waters of the USVI. This project will provide fisheries independent data and valuable tools for resource management, and will assist in developing an integrated ecosystem-scale assessment of coral reef-based fisheries.

Physical Oceanographic Processes

The upper level currents of the Caribbean Sea form the southwestern limb of the North Atlantic Subtropical Gyre, flowing primarily to the west-northwest as part of the geostrophic western boundary current system, with a superimposed northward surface component due to the non-geostrophic Ekman forcing of the easterly trade winds. On average, these currents (Figure 3) are organized into a broad, weak Antilles Current which runs to the northwest along the northern side of the Virgin Islands, Puerto Rico, Hispaniola, and the Bahamas, and a stronger Caribbean Current which enters the Caribbean Sea through the Windward Islands, flowing westward and then northward at the Yucatan coastline to form the Yucatan Current, which in turn becomes the Loop Current in the Gulf of Mexico and finally the Florida Current/Gulf Stream as it exits the Gulf of Mexico through the Florida Straits. Several quasi-permanent gyres are found along the path of the Caribbean Current, mostly obviously in Figure 3 in the area just northwest of Panama near 80 W, known as the Panama-Colombia Gyre.

Thus, the average regional currents surrounding the study area for the USVI Larval Distribution and Supply Study generally describe a splitting of the westward flow around the Virgin Islands and Puerto Rico, with the portion to the north taking the shorter Antilles Current route towards the northern Bahamas, and the portion to the south joining the Caribbean Current. Ultimately both branches of the average currents join up as the Gulf Stream north of the Bahamas (Figure 3).

However, these average current maps do not describe the synoptic situation, i.e. the currents that may be found at any particular time. On the contrary, this region of the northeast Caribbean Sea is dominated by smaller-scale eddies and gyres as illustrated by the synoptic run of the Naval Research Laboratory (NRL) Global Numerical Layered Ocean Model shown in Figure 4. This typical example of surface current speed and direction shows that, while in the western portion of the Caribbean the currents are indeed organized into fairly strong and continuous flows associated with the Caribbean-Yucatan-Loop Current system, the situation in the eastern Caribbean is not as clear and the flow appears to be dominated by eddy variability. In other words, while on average the currents appear relatively simple as in Figure 3, in reality if one were to sample at a particular time the situation would be significantly more complex as shown in Figure 4.

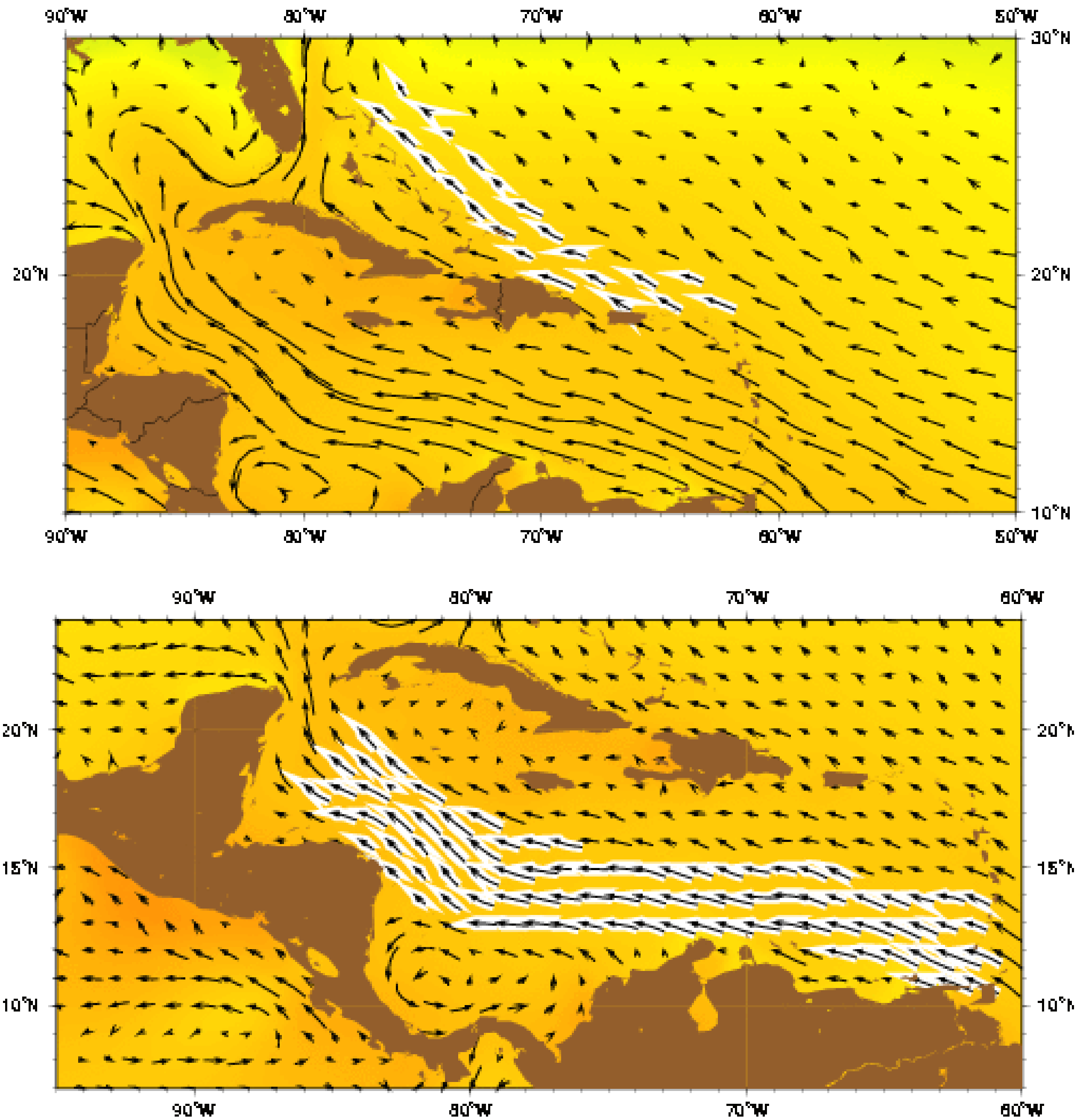


Figure 3. Average ocean surface currents from historical ship drift analysis from the US Coast Guard's Mariano Global Surface Velocity Analysis. The lower panel highlights the Antilles Current, and the upper panel highlights the Caribbean Current. (for more information see http://oceancurrents.rsmas.miami.edu/data.html).

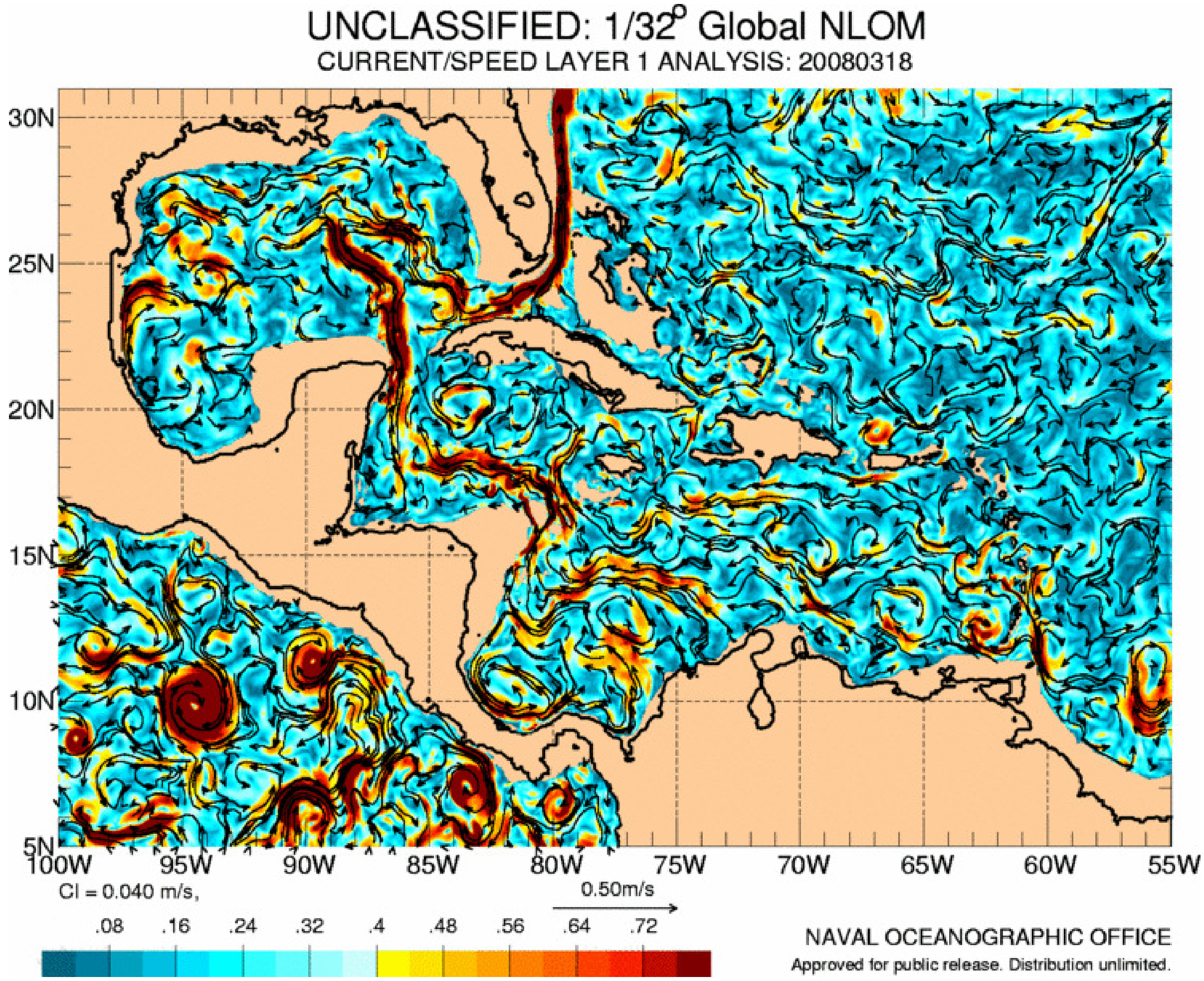


Figure 4. Naval Research Laboratory (NRL) Global Numerical Layered Ocean Model (1/32 degree) result depicting surface current direction and speed for March 18 2008.

Fisheries Oceanography Surveys (2007, 2008)

The first large-scale fisheries oceanography research cruise was conducted between March 28 and April 9, 2007 aboard the NOAA Ship *Nancy Foster*. The research conducted was aimed at answering the following three questions: 1) How do the abundance and composition of ichthyoplankton around Grammanik Bank and other similar banks change with space and time? 2) How much of this variation in abundance and composition can be explained by the oceanographic setting? 3) How do the oceanography and ichthyoplankton assemblages interface with the boundary areas of seasonally or permanently closed fisheries management areas? We sampled settlement-stage larvae in conjunction with an oceanographic (biological, physical and chemical) survey of the bank system, coral reef environs, and inshore waters of the USVI, with emphasis on these managed areas. Surveys included bongo and one meter multiple open and closing net environmental sampling system (MOCNESS) trawl tows, as well as CTD02/LADCP casts profiling temperature, salinity, dissolved oxygen, chlorophyll, and water velocity. Continuous surface measurements of temperature, salinity, chlorophyll, and water velocity were collected via the ship's flow-through system and hull-mounted ADCP. Finally, satellite-tracked surface drifters were deployed to assess regional ocean circulation.

Areas of operation included an eastern region and a western region. In 2007, sampling began in the western region in the Mona Passage and concluded in the Leeward Islands east of St. Eustatius. A total of 55 stations were sampled during the cruise, with 23 of them focused on the USVI and BVI. Stations directed at the Virgin Islands were designed along transects that allowed for sampling nearshore, along the shelf edge, and offshore. Depending on the location along the sampling transects, various biological and/or physical oceanographic sampling methods were used (see cruise tracks, Figures 1 and 2). NOTE: biological tows were not conducted in the western region during 2007. This report consists of all biological results from year 2007 and a snapshot of preliminary data for year 2008.

Ichthyoplankton Sampling

Ichthyoplankton sampling consists of collection of the larvae of fish found mainly in the upper 200 meters of the water column, also called the near-surface waters. Most fish larvae have almost no swimming ability initially. However, by half way through their development they are active swimmers. Ichthyoplankton data are key contributions to stock assessments and can provide fishery-independent time series information for many fish species. Additionally, comprehensive datasets are used to study the distribution and abundance changes of many fish species in relation to climate and ecosystem changes for the region, and to gain insight into the relationship between early life history processes and subsequent recruitment success. At the species level, monitoring their population trends by monitoring their larvae can provide an indication of a healthy or stressed ecosystem. The two widely used methods for collection of ichthyoplankton include plankton tows using various net systems, or collecting water pumped through the vessel. Samples for this research endeavor were collecting through plankton tows using MOCNESS and Bongo nets.

MOCNESS- Ichthyoplankton sampling was conducted as follows: net 1 (0-125m), net 2 (125-75m), net 3 (74-50m), net 4 (49-25m), net 5 (24-0m). Volume filtered was 500 m^3. Maximum depth for sampling (125m) was determined by the chlorophyll maximum measurements from physical oceanographic data. Sample collections were preserved with reagent grade 90% ethanol for transport to the laboratory. Ichthyoplankton samples were sorted for larval fishes and lobster. Fishes were identified to family taxonomic levels.

Bongo- Ichthyoplankton sampling was also conducted with bongo nets submerged approximately 5m below surface at a 45 degree wire angle from winch operations off the side of the vessel. Nets were towed for 10 minutes at approximately 2 knots. A flow meter attached to the apparatus measured water volume filtered in m^3. Sample collections were preserved with reagent grade 90% alcohol for transport to the laboratory. Ichthyoplankton samples were sorted for removal of larval fishes and lobsters. Fishes were identified to family taxonomical levels.

Biological Sampling Results

We collected a total of 128 MOCNESS samples and 22 Bongo samples from the Nancy Foster 2007 research cruise. The fish total for the entire cruise was 36,214 from the MOCNESS and 3,252 from the Bongo net. Lobster totals were 1,646 from the MOCNESS and 149 from the Bongo net. Larval identifications have been completed for the U.S. and British Virgin Islands portion of the cruise to date.

Within the U.S. and British Virgins Island stations, 99 families were identified from 16,769 fish. Sixty-two samples (8 Bongo and 54 MOCNESS samples) were collected from this area. Samples from 2 stations, 23 and 30, were not sorted due to MOCNESS failure. Approximately 9% (1,558 larvae) of fish collections were not identifiable due to early stage at development or damage in sample. Of those identified, 89.7% of the samples were represented by 15 principle families: Gobiidae, Labridae, Myctophidae, Apogonidae, Scaridae, Gonostomatidae, Serranidae, Phosichthyidae, Paralepididae, Callionymidae, Labrisomidae, Balistidae, Clupeidae, Bothidae, and Carangidae (Appendix, Table 3). Among nets sampling at different depths, total collections from net 4 of the MOCNESS sampling at a depth range of 50-25m were most diverse, with 76 families. Net 3 (75-50m) had 71 families, net 5 (25-0m) 66 families, net 2 (100-75m) 44 families, and the Bongo net had 50 families.

Serranidae (groupers) were abundant across the VI shelf in 2007 as shown in Figure 5, but only from the subfamily serraninae (a non-commercially important species). The distribution was significantly different in 2008, when serranids were concentrated south of St. John as well as along the shelf. Samples from 2008 will be completed by August 2009.

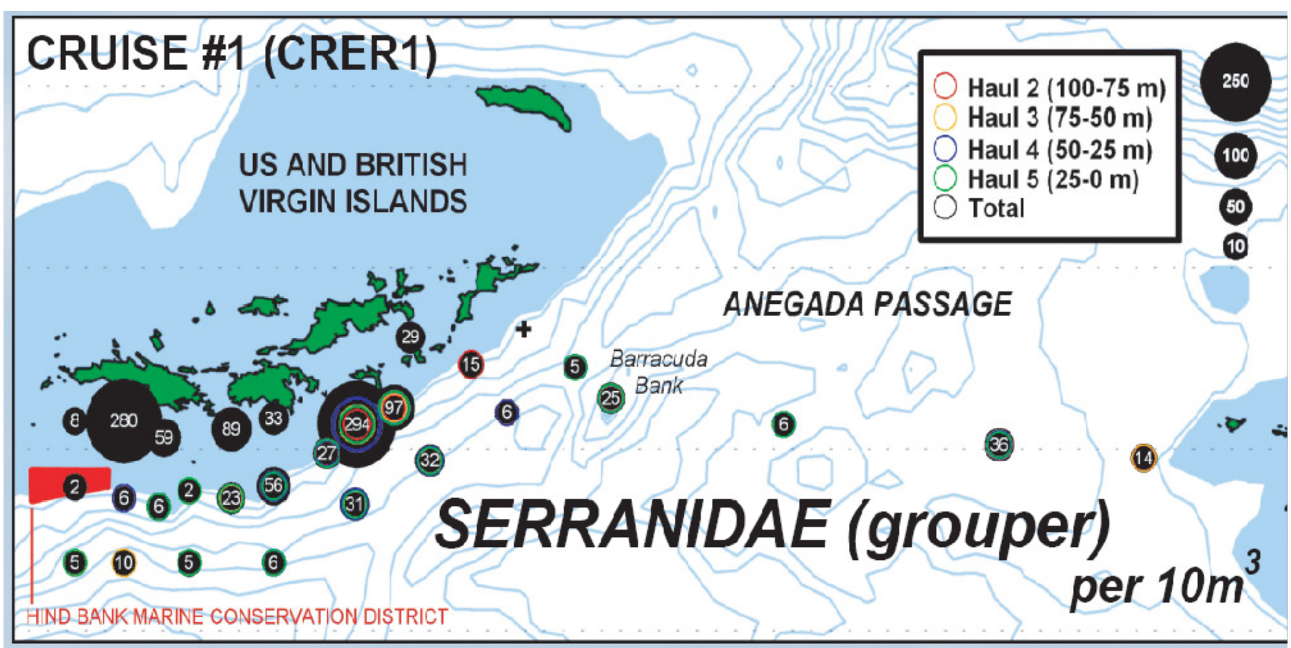


Figure. 5: Family Serranidae abundance per 10 m^3 volume of ocean water.

Snappers (Lutjanidae) were not as abundant as other species, but the lower relative abundance is probably a reflection of a later spawning period. However, they were the 6th most abundant family with the highest abundance (0.15 fish per $10m^3$) in Bongo collections compared to the MOCNESS. Highest average density was also in night Bongo samples. Lutjanids were found mostly in the upper 50m of the water column. During the day, they were absent in nets collected below 50m, and they were sparse at night. The average density of only 0.006 per $10m^3$ was collected at night in water column below 50m (Figure 6).

Initial analysis of the samples indicates that there was a higher abundance and diversity at the familial level at night (6PM ~ 6AM) than during the day (6AM ~ 6PM). 92 families with an average of 194.4 fish under $10m^2$ were identified from nighttime samples (n=37), and 76 families with average density of 76.489 fish under $10m^2$ from day samples (n= 25).
Myctophidae, Gobiidae, Gonostomatidae, Apogonidae, and Scaridae were the most abundant families from day time samples accounting for 61% of the larvae collected. The most abundant samples collected at night were Gobiidae, Labridae, Myctophidae, Apogonidae, and Scaridae accounting for 75% of the larvae collected.

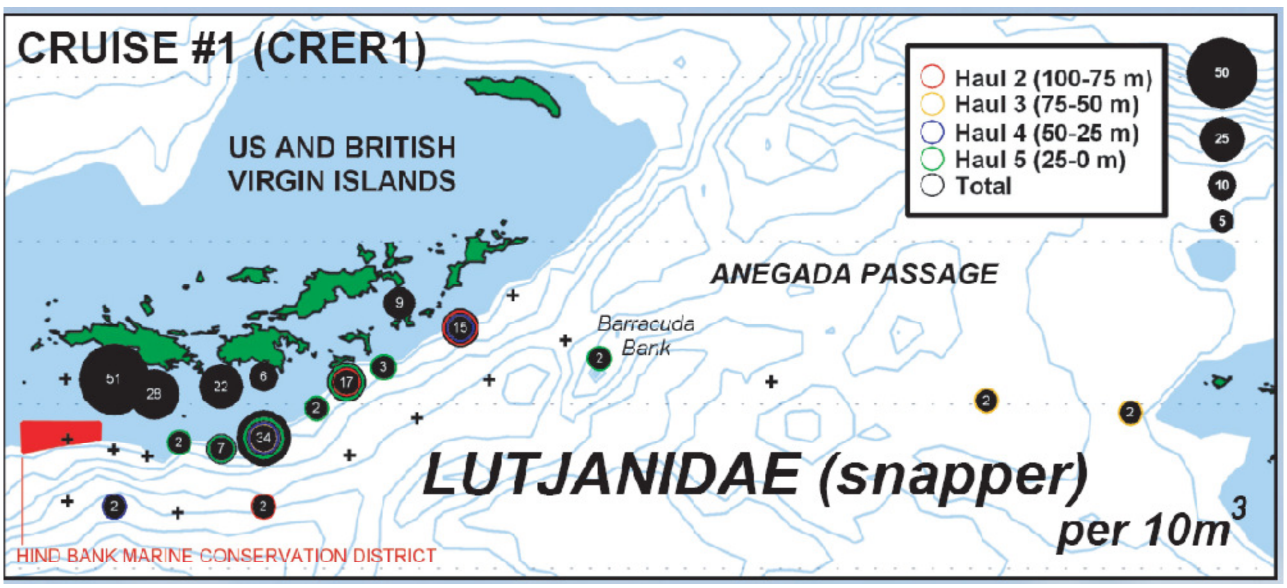


Figure. 6: Family Lutjanidae abundance per 10 m^3 volume of ocean water.

Comparative Cruise Results (2007, 2008)

The preliminary results from the physical oceanography component of this interdisciplinary project suggest that there is intriguing variability in surface properties, such as surface salinity, chlorophyll, and ocean surface currents, which is relevant to the coral reef fish and the entire. Virgin Islands marine ecosystem. These properties vary in response to wind and hydrological forcing, as well as advection from outside of the study area.

Surface Salinity

Figure 7 shows the surface salinity results obtained using the continuous flow-through seawater and TSG-Chl system. During the first cruise in 2007, the surface salinity field was shown to exhibit a range from the lowest observed values (<35.9 psu, or "practical salinity units") which were seen off the southeast side of Puerto Rico probably in response to freshwater runoff from the local rivers and streams, to the highest observed values (>36.4 psu) which were found in the Leeward Islands and Saba Bank vicinity, reflecting more Atlantic Ocean values due to the direct connection with the Atlantic through the Leeward Islands passages. The total range of observed surface salinity during this first cruise was therefore approximately 0.5 psu over the study area.

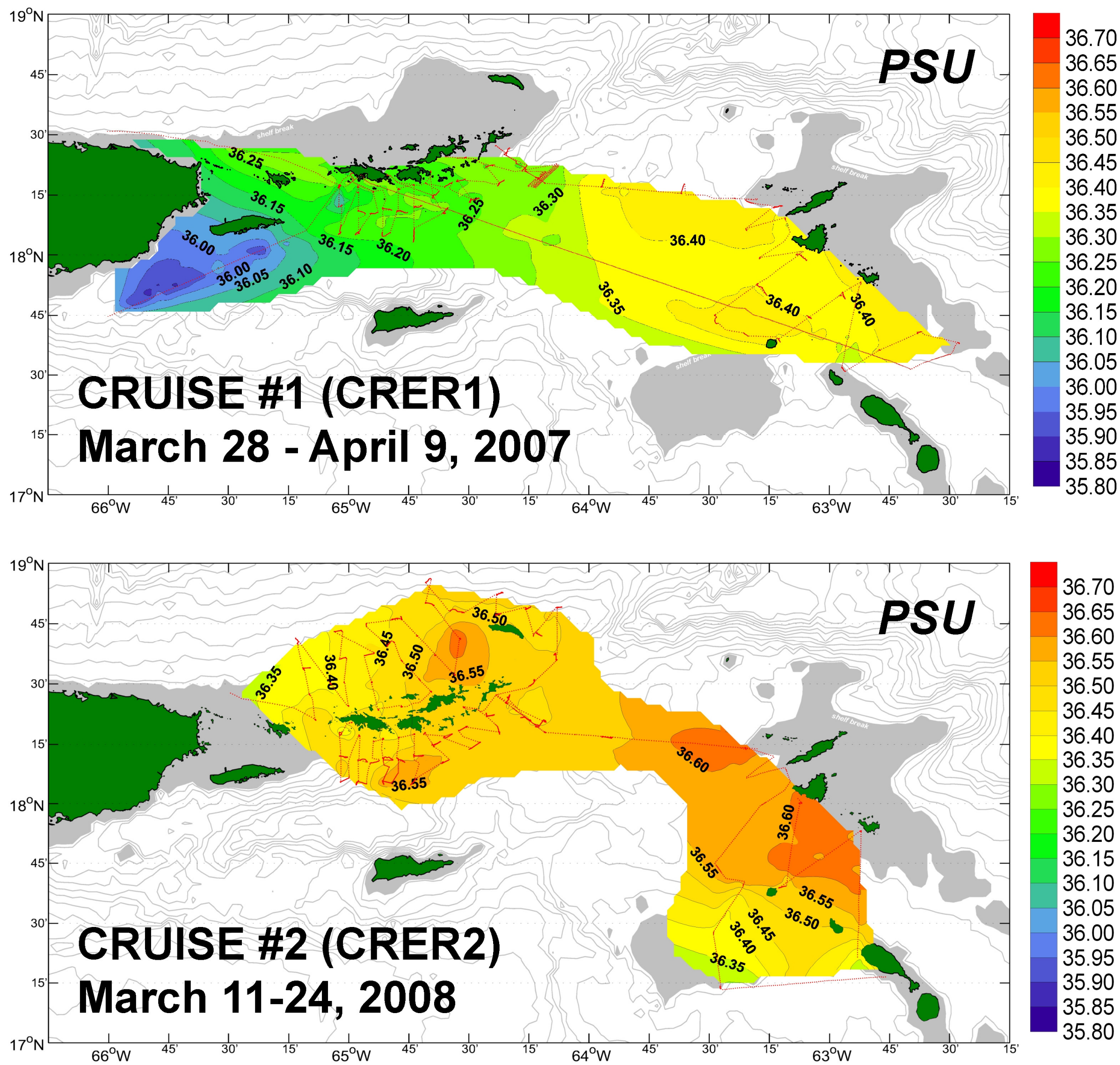


Figure 7. Sea surface salinity in practical salinity units (psu) for 2007 and 2008 cruises from flow-through seawater system and thermosalinograph (TSG) instrumentation.

In contrast, the surface salinity from the second cruise conducted in 2008 shows that, although the regional sampling regime was a bit different particularly at the western side of the area, the surface salinity was noticeably higher overall, with low values of 36.4 psu found in a small area at the extreme northwest of the cruise track, and also over the southern portion of Saba Bank. Note that these "low" areas are closer to the "high" values found during 2007 in the same region. During this second cruise the highest surface salinities (>36.6 psu) were observed inshore of the Leeward Islands and in a small area to the west of Anegada Island, north of the British Virgin Islands. Such year-to-year variability may impact economically important larval fish distributions and recruitment regionally, which, in turn, may affect fisheries productivity. As a longer time series dataset is built up in the region, the magnitude and causes of such inter-annual variability will be better understood.

Surface Chlorophyll

Figure 8 shows similar maps as were shown in Figure 7 for surface salinity, but for the surface chlorophyll (in mg/m^3) for the 2007 and 2008 cruises. During the first cruise, the surface chlorophyll values were fairly uniformly low, with the lowest values near zero in Anegada Passage and north of Saba Bank, reflecting a greater proportion of oligotrophic (low productivity) Atlantic waters. The highest values found during this cruise were located in the immediate vicinity of the south side of the U. S. and British Virgin Islands, where the chlorophyll values exceeded 0.125 mg/m^3, for a total cruise range of 0.125 mg/m^3.

The situation during 2008 was different, with noticeably higher values (up to nearly .400 mg/m^3) to the north of the U. S. and British Virgin Islands extending quite far offshore to the north over the banks to the west of Anegada Island. It must be noted that the 2007 cruise did not sample in these waters to the north of the Virgin Islands, and so a direct comparison is not included. The higher chlorophyll values to the north are likely due to the rougher conditions that were found on the unsheltered side of the islands, which would stir up chlorophyll and nutrients from the sediments. In fact, there was a very large swell event that occurred in this area during the cruise that was noteworthy to local residents and press. This will be explored in more detail in future work. The waters just to the south of the U.S. Virgin Islands along the shoreline show similar values (0.2 mg/m^3) during both years. There is also, in 2008, a small area of elevated chlorophyll values (0.175 mg/m^3) just to the northwest of St. Kitts at the southeast corner of the study area. The total range of observed chlorophyll values observed in 2008 was approximately 0.4 mg/m^3.

Satellite Imagery

The images shown in Figure 9 are ocean chlorophyll fluorescence from the NASA Earth Science satellite mission “Moderate Resolution Imaging Spectroradiometer” (MODIS-Aqua). MODIS is a 36-band spectroradiometer measuring visible and infrared radiation and providing data that can be used to derive products ranging from vegetation, land surface cover, and ocean chlorophyll fluorescence to cloud and aerosol properties, fire occurrence, snow cover on the land, and sea ice cover on the oceans. The first MODIS instrument was launched on board the Terra satellite in December 1999, and the second was launched on Aqua in May 2002.

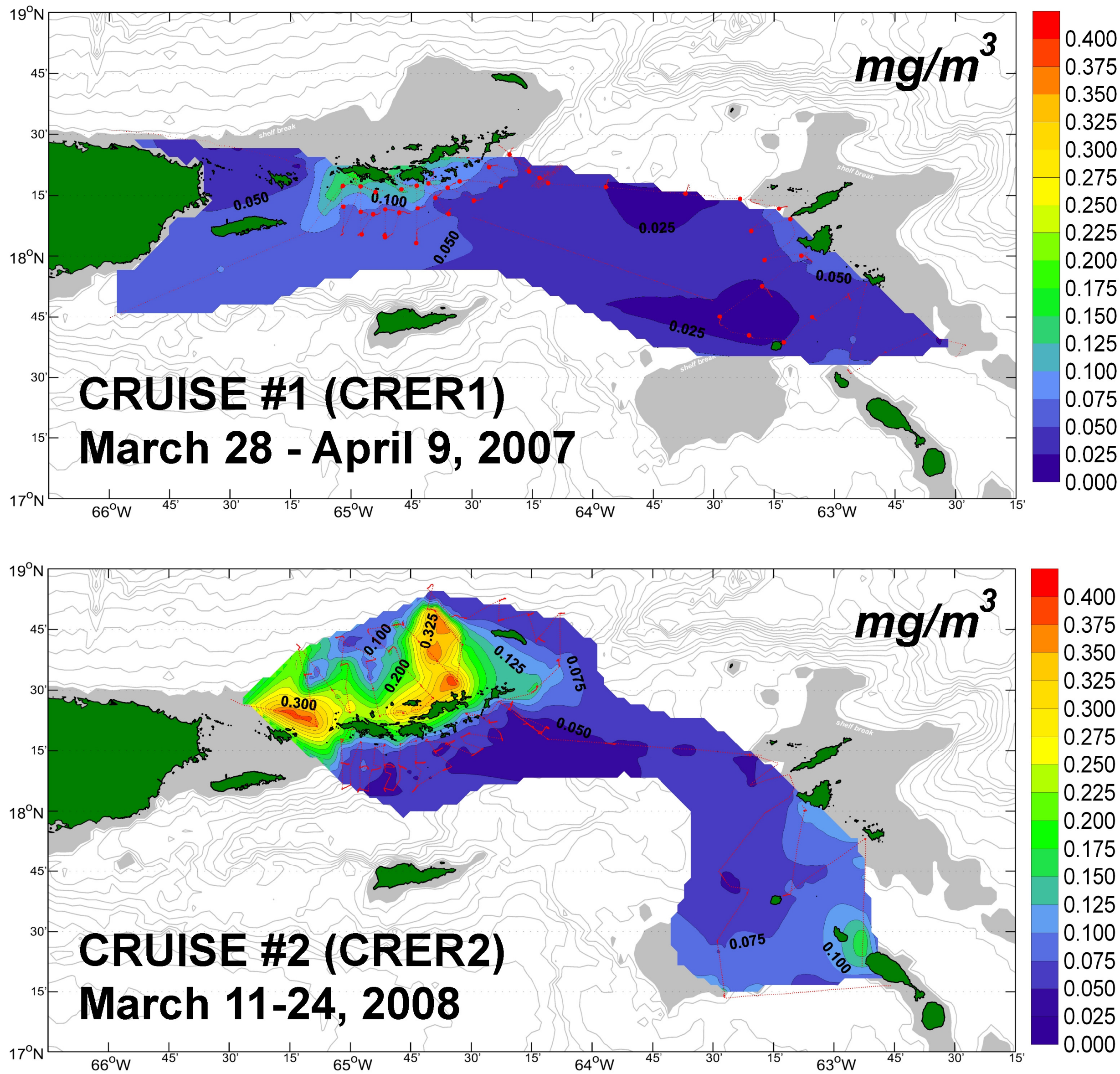


Figure 8. Sea surface chlorophyll in mg/m3 for 2007 and 2008 cruises from flow-through seawater system and fluorometer instrumentation.

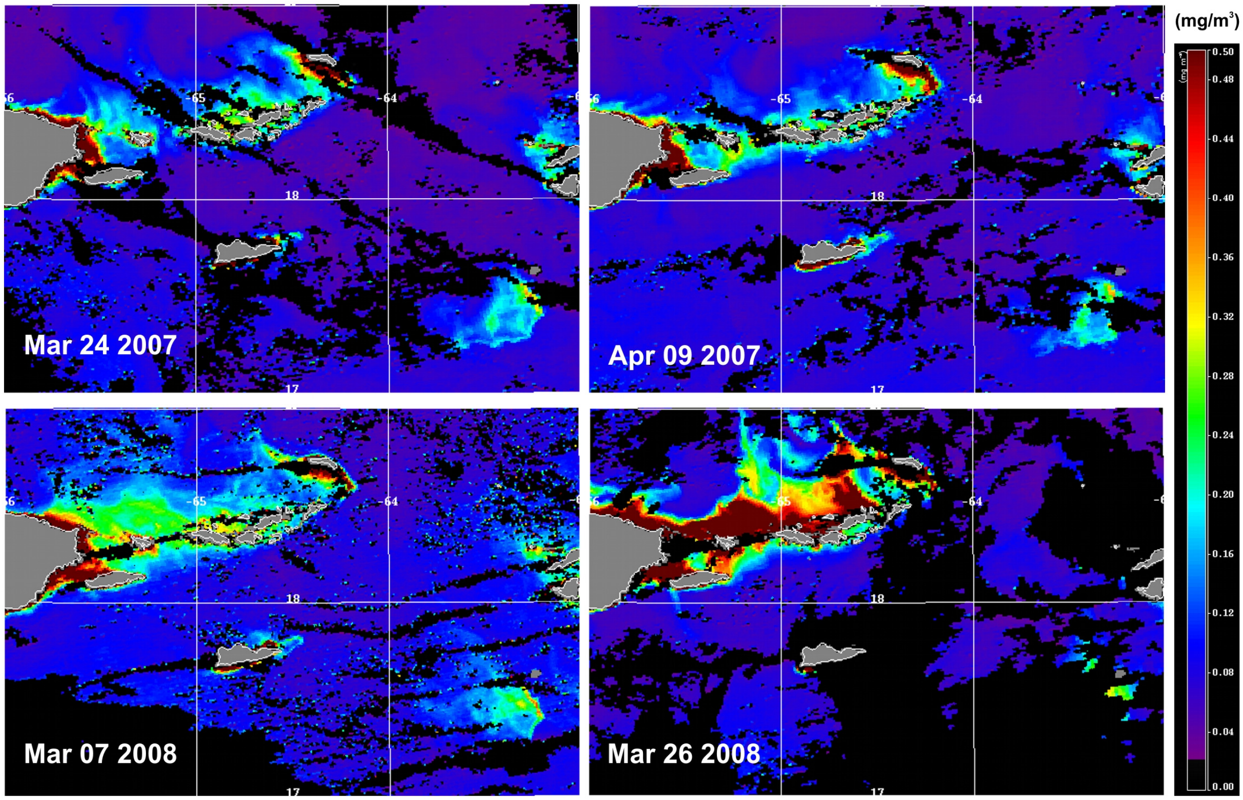


Figure 9. Ocean color fluorescence from the NASA Earth Science satellite mission MODIS-Aqua. The upper panel shows images from the beginning and end of the 2007 cruise. The lower panel shows images from the beginning and end of the 2008 cruise.

Figure 9 shows these ocean color images calibrated to yield surface chlorophyll values in mg/m^3, for selected relatively cloudless days near the beginning and end of each of the two cruises. As expected, these images show a marked similarity to the cruise-derived chlorophyll data. For example, the satellite imagery confirms that the overall values were lower in 2007 in the region of Puerto Rico and the U. S. and British Virgin Islands than they were in 2008. Due to incomplete sampling near Puerto Rico (no sampling inshore and around the southeast side of the island), a coastal high chlorophyll maximum that was present in the satellite imagery was not observed in the cruise data.

Similarly, the satellite imagery for both 2007 and 2008 shows relatively high chlorophyll areas to the south of Anegada Island and over Saba Bank, and in a narrow region just south of St. Croix. These higher areas may be present every year, and retrospective analyses of a longer time series of satellite images will help to establish the degree and range of variability of these oceanographic features that are indicative of productivity. It is possible that some fish species, such as economically important larval parrotfish, may be concentrated along the edges of these chlorophyll fronts. Future data collections will help to elucidate the biological significance of such oceanographic patterns in the region.

Surface Drifter Trajectories

Surface drifter trajectories for the 2007 deployments are shown in Figure 10. (For more information see AOML's Global Drifter Center -- http://www.aoml.noaa.gov/phod/dac/gdp.html). The overall visual pattern of these trajectories confirms the statements made above about the prevalence of eddies in the study area. Most of the drifters showed looping, eddy-influenced paths, and with the exception of the drifter that went on a long counterclockwise circling motion near Saba Bank, the others all eventually exited the Caribbean to the north. Interestingly, at least two of the drifters went through Virgin Islands Pass, just west of St. Thomas, and spent some time in the banks to the north of the USVI before continuing to the north and out of the region. This feature will require further study as it may be significant to larval fish distributions throughout the region.

Figure 11 shows a larger-scale map of the same drifters, deployed in 2007. As shown, although none of these particular drifters went far enough south to be caught up in the Caribbean Current and eventually the Loop Current/Florida Current system, several of them escaped the eddy-dominated waters of the northeastern Caribbean to the north and traveled northeast in the surface manifestation of the Antilles Current (see Figure 2). Two of these three drifters eventually grounded in the Bahamas, while the other drifter retro-flected and drifted back into the eddy dominated region of the subtropical Atlantic.

Finally, Figure 12 shows the surface drifter trajectories from the 2008 deployments. Most of these drifters showed westward paths south of the Virgin Islands, with one escaping the Caribbean east of Puerto Rico and two others getting all the way to 69^o W before re-curving and, in one case, exiting the Caribbean through Mona Passage (between the Dominican Republic and the west shore of Puerto Rico). Other drifters which were deployed between Saba Bank and the Leeward Islands traveled northwest, and one appears to have grounded at Anegada Island. The ultimate destinations of the drifters from 2008 (not shown) will provide additional information about the larger-scale physical and biological connectivity of the study area with more distant regions of the North Atlantic.

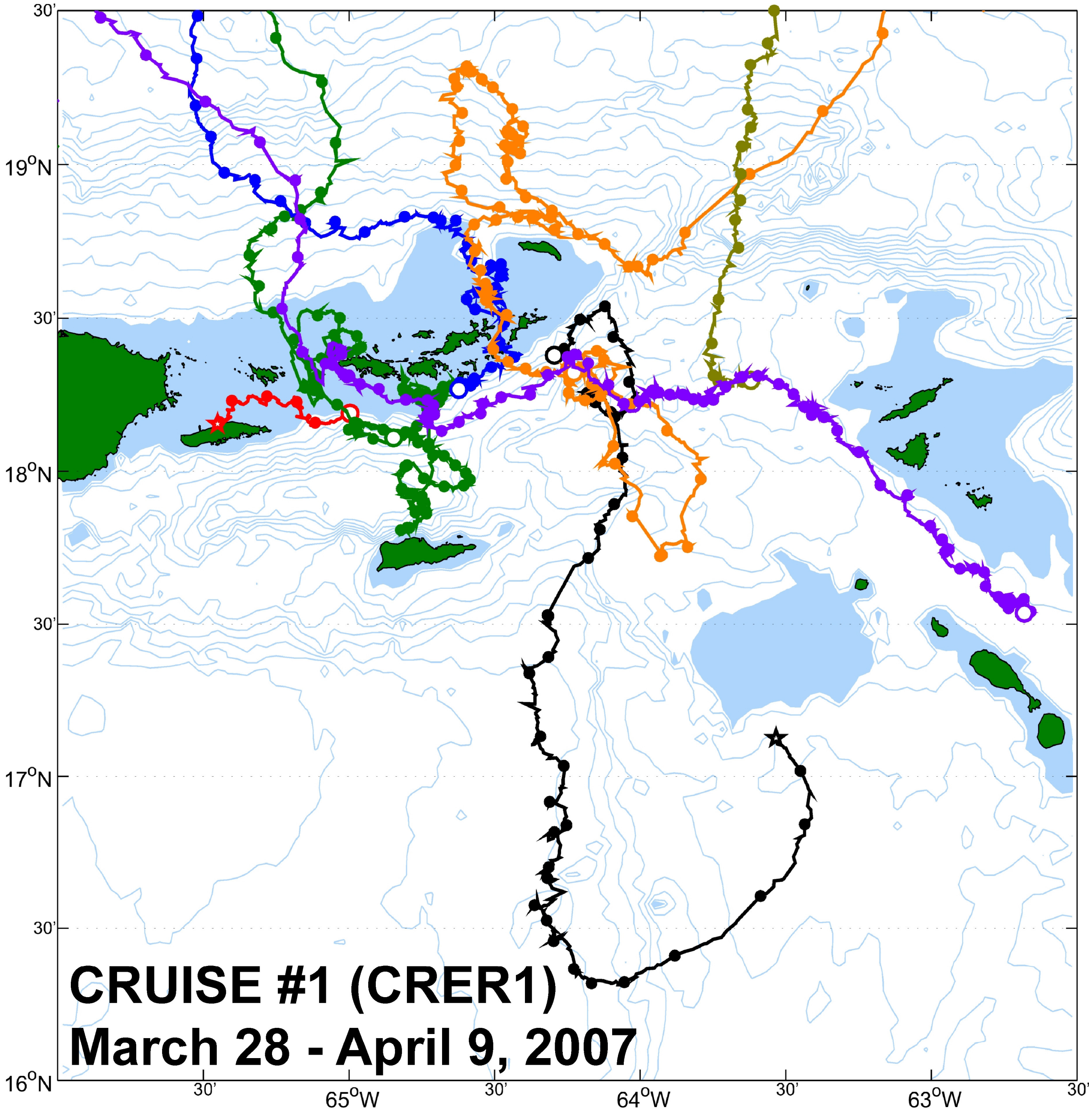


Figure 10. Satellite-tracked surface drifter trajectories from the 2007 deployments. Circles show 24-hour positions.

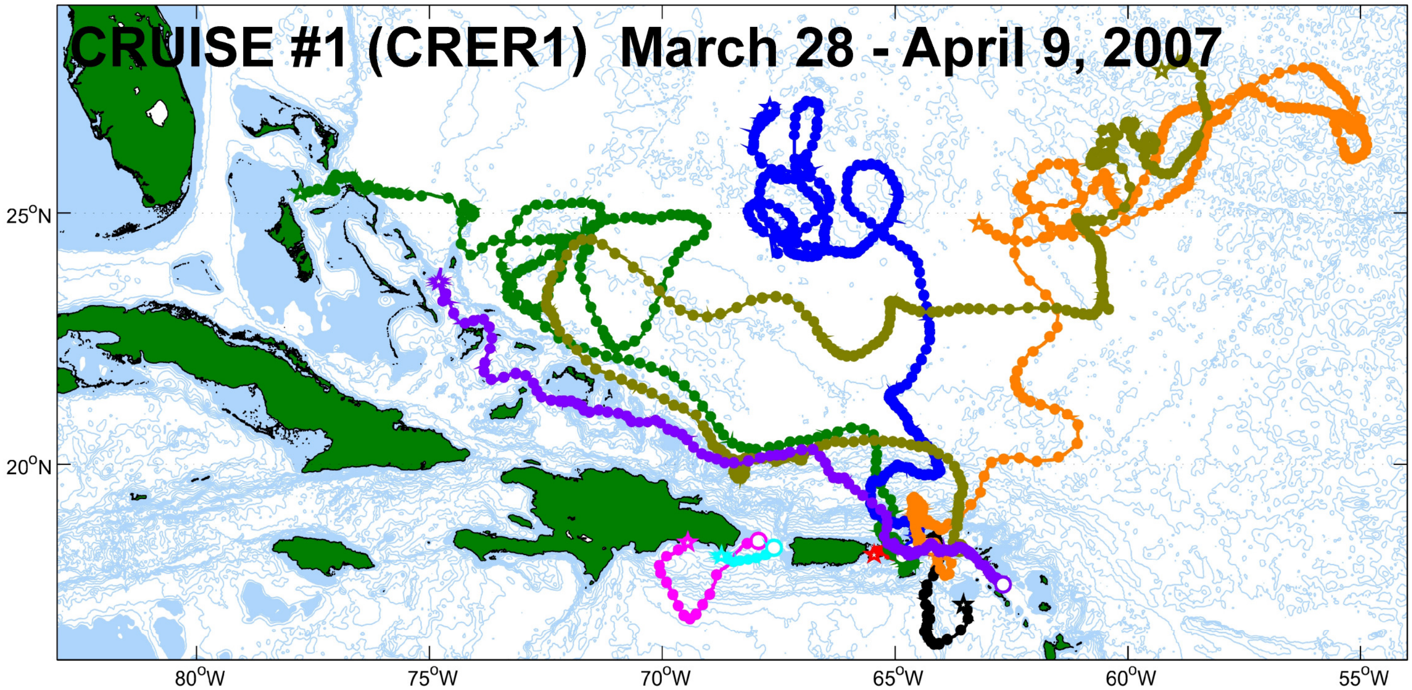


Figure 11. Satellite-tracked surface drifter trajectories from the 2007 deployments, larger-scale view. Circles show 24-hour positions.

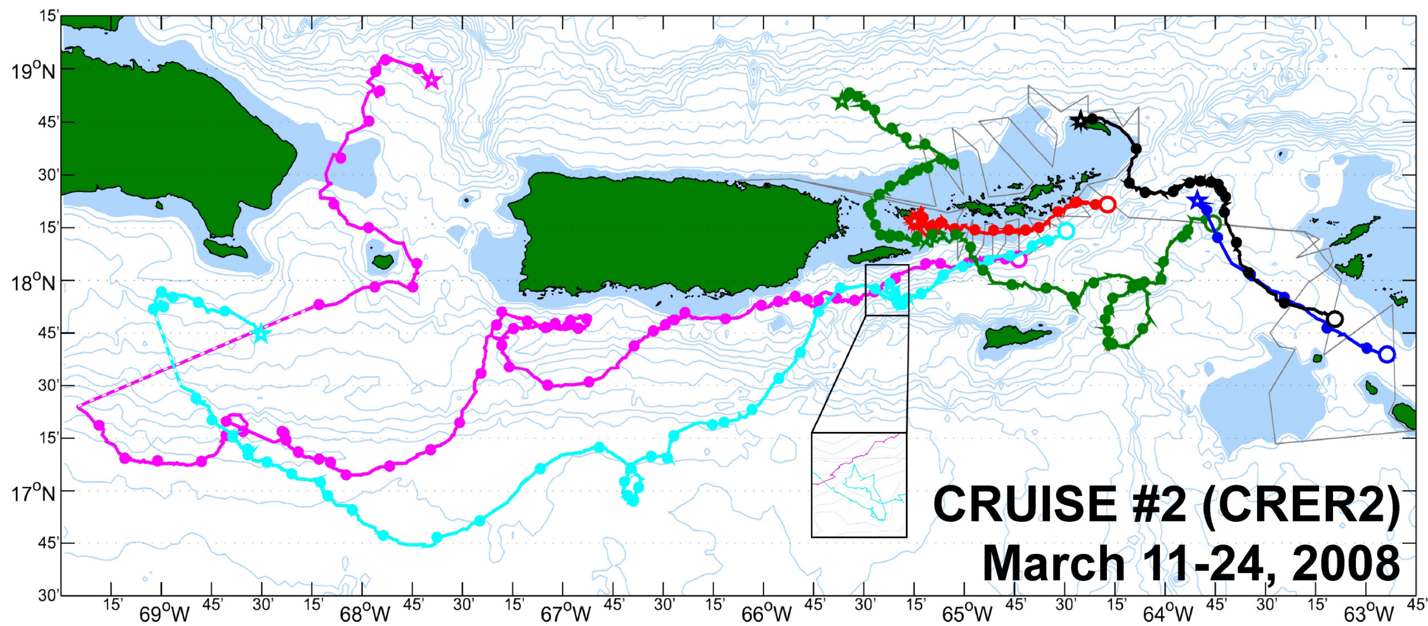


Figure 12. Satellite-tracked surface drifter trajectories from the 2008 deployments. Circles show 24-hour positions.

Inshore biological Surveys

Shore based surveys took place April 13 - 24, 2007, with a focus on sampling the southwestern side of the island of St. Thomas. Surveys were designed to test the following questions: 1) What is the level of recruitment of larval fishes to sea grasses near shore? and 2) What is the significance of Grammanik Bank and alternative areas as sources of larvae to inshore habitats and fishing grounds? Newly recruited larvae were sampled using light traps during small boat operations. Post settlement larvae were sampled using a beach seine along the shore.

The areas of operation were Brewer's Bay and Perseverance Bay on the southwest shores of St. Thomas and north of Grammanik Bank. Perseverance Bay is located west of Brewer's Bay, separated only by Black Point (Figure 13). Two light traps were deployed in Brewer's Bay and two in Perseverance Bay. Beach seining was conducted only in Brewer's Bay. The bottom type at Brewer's Bay was patchy sea grass and sand, while the bottom at Perseverance Bay was patch reefs and coral rubble.

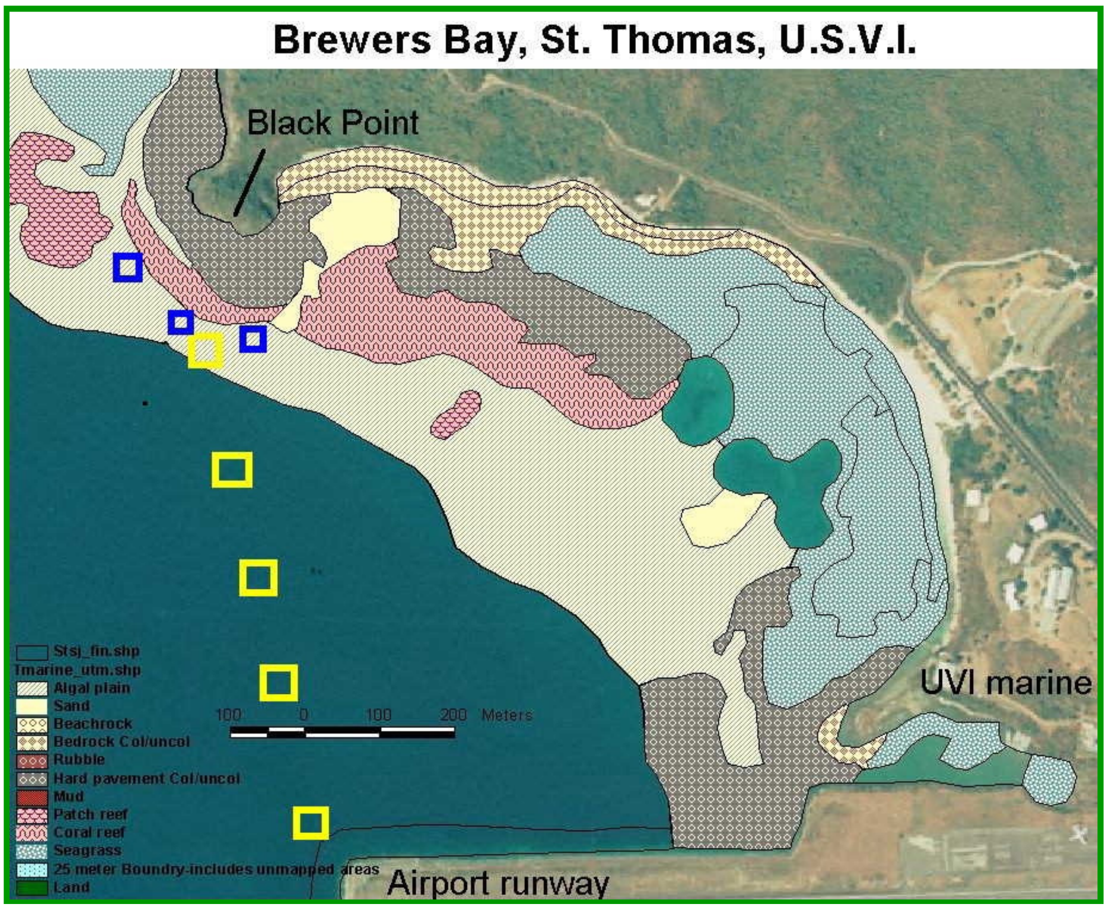


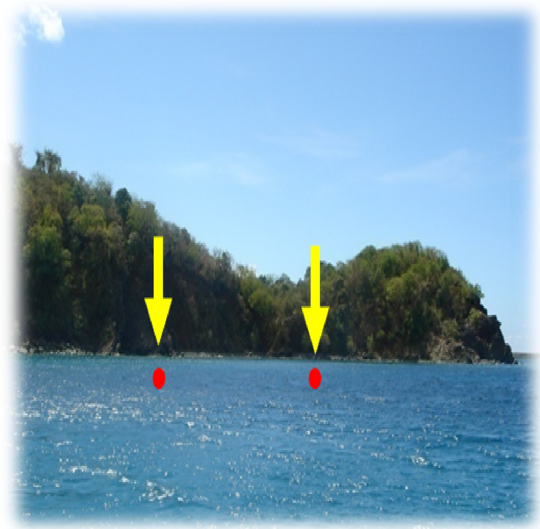
Figure 13: Brewer's Bay sampling area. Perseverance Bay is immediately west of Black Point.

Light trap sampling- All traps were sampled every day in the morning for a total of eight days. Sampling was conducted around the new moon, allowing for sampling four days before the new moon date and three days after. Two different types of lights were used in light traps to compare larval preference between different light wavelengths. Regular lights and ultraviolet lights were used. One of each type of light trap was deployed in both Brewer's Bay and Perseverance Bay. Lights on all traps were timed to illuminate at 8 pm and cease illumination at 5:30 am every day. The average water depth of the trap locations was 15 ft. Using small boat operations, light traps were sampled for newly recruited fishes, the instrument batteries were changed, and the timers were checked for accurate operation. Samples were fixed in 90% ethanol and transported to the laboratory in Miami. Samples were sorted and identified for family level and beyond when possible. (Table 1)

Year	Lat.	Long.	Station #	Bottom Type	Station Location
2007	18.3475	64.9875	BB STA 1	Rocky reef rubble, protected	Perseverance Bay
2007	18.3404	64.9874	BB STA 2	rocky reef rubble, protected	Perseverance Bay
2007	18.3475	64.9875	BB STA 4	rocky reef rubble, protected	Brewer's Bay
2007	18.3065	64.8805	BB STA 5	rocky reef rubble, protected	Brewer's Bay

Table 1. Stations location for inshore light trap sampling

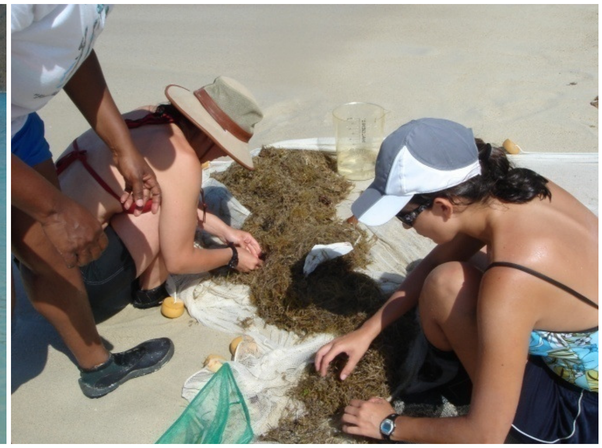
Light trap



Light traps deployed in Perseverance Bay

Beach Seining- Beach seining was conducted once every three days during the 13-day sampling period. The beach seine was a non-monofilament 25 ft purse seine (25' x 5 ' with 1/8" mesh size). Three tows were conducted along sea grass patches during every seine sampling. Sample collections were preserved with reagent grade 90% alcohol for transport to the laboratory. The latitude/longitude of the center of Brewer's Bay beach is N 18.343317, W 64.977406. Beach seining was conducted immediately east or west of this position.

Beach seining in Brewer's Bay



Collecting samples from beach seine in Brewer's Bay

Channel Net: A channel net was deployed between both Perseverance Bay and Brewer's Bay, just in front of Black Point at latitude/longitude 18.3448 North, 064.9854 West. Both channel net and light trap samples were collected daily.

Results

Inshore sampling of Brewer's Bay and Perseverance Bay in St. Thomas, using light traps, yielded numerous larval coral reef fishes such as grouper, parrot fish, and surgeon fish. Specifically, twenty-five families were represented in the light trap samples (Figures 14, 15). Factors such as moon phase, type of light used in light trap, and habitat type showed no significant difference when compared. Genetic (DNA) analysis identified the bonefish (Albulidae) catches as two distinct species, *A. vulpes* and *A. garcia*. Comparison to Albulidae caught in the Mexican Caribbean reveals that *A. Garcia* seems to be distributed specifically in the Eastern Caribbean whereas *A. vulpes* is distributed in both in the Eastern and Mexican Caribbean.

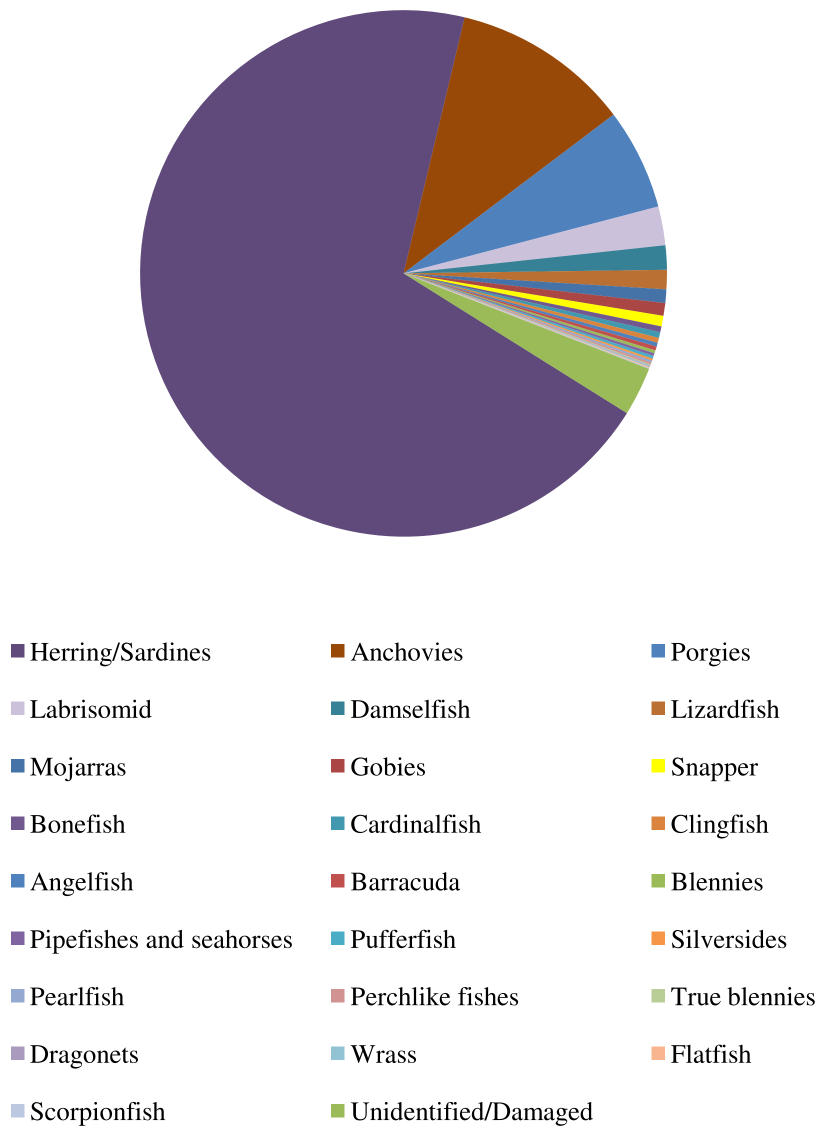


Figure 14. Abundance and composition of larval collections in Brewer's Bay and Perseverance Bay light trap sampling 2007 in order of abundance (left to right).

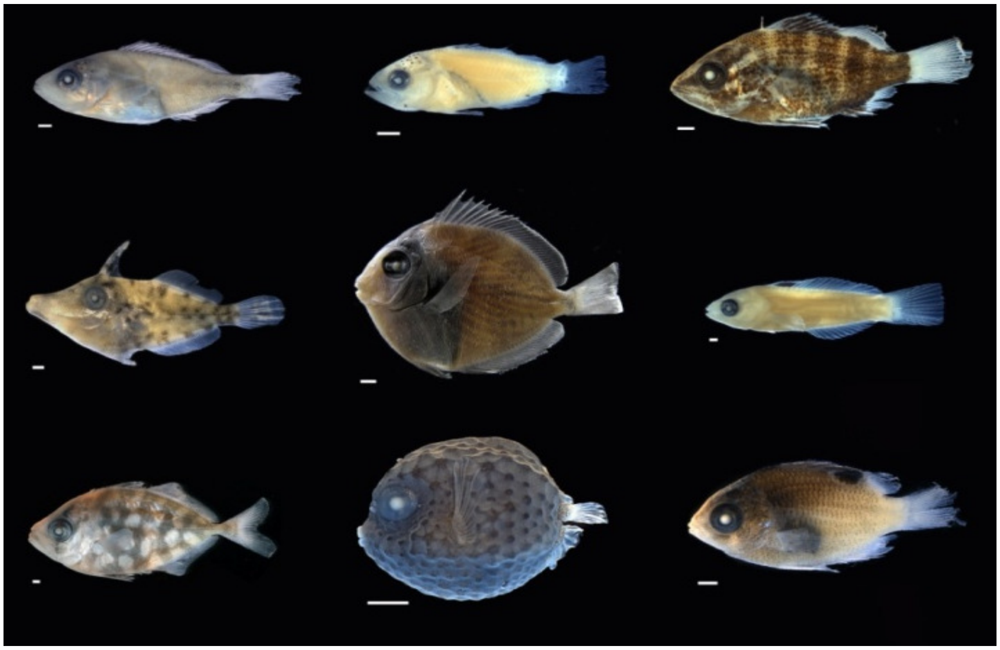


Figure 15. Economically important coral reef fishes collected with light traps in 2007 samples. Line represents 1 mm (snapper, grouper, snapper, file fish, surgeon fish, wrasse, jack, porcupine fish, damselfish).

Seining of Brewer's Bay yielded 163 yellowtail snapper among other local species in the sea grass patches. (Figure 16) (Table 2)

Figure 16. Larval yellowtail snapper collecting during seining at Brewer's Bay (16mm SL).

Table 2. Abundance and composition of beach seining collections.

# tows	**Date**	**Station**	**Gear**	**# Fish**	**Notes**
3 tows	15-Apr-07	BB	Seine	9	*L. synagris*
	15-Apr-07	BB	Seine	18	unidentified
	15-Apr-07	BB (1/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (2/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (3/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (4/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (5/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (6/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (7/8)	Seine	15	*L. chrysurus*
	15-Apr-07	BB (8/8)	Seine	10	*L. chrysurus*
3 tows	17-Apr-07	BB	Seine	23	*L. albula* sent to Canada via ECOSUR
	17-Apr-07	BB	Seine	15	unidentified
	17-Apr-07	BB	Seine	1	*L. synagris*
	17-Apr-07	BB	Seine	2	(lobster & fish)
	17-Apr-07	BB (1/2)	Seine	10	*L. chrysurus* -- all sent to Canada via ECOSUR
	17-Apr-07	BB (2/2)	Seine	16	*L. chrysurus*
3 tows	19-Apr-07	BB	Seine	15	*L. chrysurus*
	19-Apr-07	BB	Seine	7	*L. chrysurus*
	19-Apr-07	BB	Seine	1	Sphyraenidae
	19-Apr-07	BB	Seine	5	*L. synagris*
	19-Apr-07	BB	Seine	14	Atherinidae - a
	19-Apr-07	BB	Seine	8	Atherinidae - b
	19-Apr-07	BB	Seine	7	Atherinidae - c
	19-Apr-07	BB	Seine	1	unidentified

Channel Net: There was not sufficient current flowing around Black Point; therefore, the channel net did not collect any larval fish samples.

Conclusion

More study and additional future cruises are needed to fully understand and document the mean and varying oceanographic and biological conditions of the region, and the relative influence of local vs. remote forcing and connectivity with the rest of the Caribbean Sea and the Atlantic Ocean. The concept of collecting simultaneous biological and physical oceanographic observations and thus having the ability to combine the results to better understand the interaction of the biota with its changeable environment is extremely useful in optimizing resource management of these valuable coastal waters and local fisheries.

This project will continue to provide ecosystem-scale fisheries independent data for stock assessments. The main focus of this project is economically valuable fish species that are heavily exploited throughout the study region. Given ongoing results from multiyear surveys, the research project will provide the CFMC with enhanced tools for effective resources management and for the development of increasingly sustainable fisheries. Additionally, the synthesis of larval fish transport and physical oceanographic data will help to assess the effectiveness and potentially optimize the benefits of fisheries managed areas, including Marine Conservation Districts such as Red Hind Bank. Products and services from this project will lead to the ecological characterization of the offshore bank system, which is one of the primary fishing grounds for the USVI and Puerto Rico. Ultimately, this project will assist managers, such as the Caribbean Fisheries Management Council, to develop an integrated ecosystem assessment of coral reef-based fisheries.

APPENDIX

I. *Stations and type of collection gear*

II. *Displacement volumes and abundance of fish/lobster larvae by station.*

III. *Abundance and composition of fishes in ichthyoplankton samples*

IV. *Composition and percent abundance (top 80%) of fishes in total collections per gear and depth*

Appendix 1: Stations and type of collection gear

Sta #	**Type Code**	**Station Name**	**Casts**	**Depth (m)**	**LAT DEG**	**LAT MIN**	**LON DEG**	**LON MIN**	**DECIMAL LAT**	**DECIMAL LON**
WP	001	Mayaguez			18	12.00	067	09.50	18.2000	-067.1583
WP	002	WP			18	13.20	067	12.00	18.2200	-067.2000
WP	002	WP			18	11.40	067	20.30	18.1900	-067.3383
WP	002	WP			18	33.40	068	14.20	18.5567	-068.2367
001	007	MO-0	CTD. LADCP	170	18	30.60	068	07.40	18.5100	-068.1233
002	007	MO-1	CTD, LADCP	400	18	25.90	067	55.80	18.4317	-067.9300
003	007	MO-2	CTD, LADCP	580	18	23.20	067	49.70	18.3867	-067.8283
004	007	MO-3	CTD, LADCP	530	18	20.50	067	42.50	18.3417	-067.7083
005	007	MO-4	CTD, LADCP	560	18	17.70	067	35.80	18.2950	-067.5967
006	007	MO-5	CTD, LADCP	380	18	14.50	067	27.50	18.2417	-067.4583
WP	002	WP			18	11.40	067	20.30	18.1900	-067.3383
WP	002	WP			18	06.30	067	27.20	18.1050	-067.4533
WP	002	WP			17	50.70	067	19.80	17.8450	-067.3300
007	003	CATS	CTD	3650	17	30.00	067	00.00	17.5000	-067.0000
WP	002	WP (Cable Repair)		4900	17	21.50	066	55.40	17.3583	-066.9233
WP	002	WP			18	06.00	065	10.40	18.1000	-065.1733
WP	002	WP			18	18.90	065	01.30	18.3150	-065.0217
WP	001	Brewers Bay			18	20.50	064	58.90	18.3417	-064.9817
008	004	VI-01	CTD, BONGO	27	18	17.30	065	02.00	18.2883	-065.0333
009	004	VI-02	CTD, BONGO	(shelf break) 300	18	11.80	065	02.00	18.1967	-065.0333
010	006	VI-03	CTD, BONGO, MOC	2130	18	05.60	065	02.00	18.0933	-065.0333
011	004	VI-04	CTD, BONGO	26	18	17.30	064	57.50	18.2883	-064.9583
012	005	VI-05	CTD, MOC	(shelf break) 300	18	10.90	064	57.50	18.1817	-064.9583
013	005	VI-06	CTD, MOC	2900	18	05.60	064	57.50	18.0933	-064.9583
014	005	VI-07	CTD, MOC	(shelf break) 300	18	10.20	064	54.30	18.1700	-064.9050
015	004	VI-08	CTD, BONGO	32	18	15.90	064	53.80	18.2650	-064.8967
WP	002	VI-09		23	18	16.20	064	51.50	18.2700	-064.8583

Sta #	Type Code	Station Name	Casts	Depth (m)	LAT DEG	LAT MIN	LON DEG	LON MIN	DECIMAL LAT	DECIMAL LON
016	005	VI-10	CTD, MOC	(shelf break) 300	18	11.50	064	51.50	18.1917	-064.8583
017	005	VI-11	CTD, MOC	2500	18	05.60	064	51.50	18.0933	-064.8583
018	005	VI-12	CTD, MOC	(shelf break) 300	18	10.90	064	47.60	18.1817	-064.7933
019	004	VI-13	CTD, BONGO	35	18	16.60	064	47.60	18.2767	-064.7933
020	004	VI-14	CTD, BONGO	30	18	17.50	064	43.70	18.2917	-064.7283
021	005	VI-15	CTD, MOC	(shelf break) 300	18	11.90	064	43.70	18.1983	-064.7283
022	005	VI-16	CTD, MOC	2600	18	05.60	064	43.70	18.0933	-064.7283
023	005	VI-17	CTD, MOC	1800	18	10.40	064	36.20	18.1733	-064.6033
024	005	VI-18	CTD, MOC	(shelf break) 300	18	14.60	064	38.80	18.2433	-064.6467
025	003	VI-19	CTD	34	18	17.90	064	40.90	18.2983	-064.6817
026	005	VI-20	CTD, MOC	(shelf break) 300	18	17.00	064	36.00	18.2833	-064.6000
027	005	VI-21	CTD, MOC	1940	18	14.00	064	29.30	18.2333	-064.4883
028	005	VI-22	CTD, MOC	(shelf break) 300	18	18.40	064	32.60	18.3067	-064.5433
029	005	VI-23	CTD, MOC	2110	18	18.00	064	22.20	18.3000	-064.3700
030	005	VI-24	CTD, MOC	(shelf break) 300	18	22.00	064	25.50	18.3667	-064.4250
WP	002	WP			18	23.80	064	27.90	18.3967	-064.4650
031	004	VI-25	CTD, BONGO	25	18	24.30	064	31.10	18.4050	-064.5183
WP	002	WP			18	24.60	064	36.00	18.4100	-064.6000
WP	001	Road Town			18	25.30	064	36.70	18.4217	-064.6117
WP	002	WP			18	24.60	064	36.00	18.4100	-064.6000
WP	002	WP			18	24.30	064	31.10	18.4050	-064.5183
WP	002	WP			18	23.80	064	27.90	18.3967	-064.4650
WP	002	WP			18	23.60	064	27.50	18.3933	-064.4583
WP	002	WP			18	27.30	064	23.20	18.4550	-064.3867
032	008	AN-1	CTD, LADCP, MOC	480	18	25.30	064	20.60	18.4217	-064.3433

Sta #	Type Code	Station Name	Casts	Depth (m)	LAT DEG	LAT MIN	LON DEG	LON MIN	DECIMAL LAT	DECIMAL LON
033	007	AN-2	CTD, LADCP	1110	18	23.40	064	18.10	18.3900	-064.3017
034	008	AN-3	CTD, LADCP, MOC	1810	18	21.80	064	15.90	18.3633	-064.2650
035	008	AN-4	CTD, LADCP, MOC	(STEEP shelf break) 500	18	19.20	064	12.60	18.3200	-064.2100
036	007	AN-5	CTD, LADCP	1200	18	17.90	064	10.90	18.2983	-064.1817
037	008	AN-6	CTD, LADCP, MOC	1330	18	17.00	063	56.70	18.2833	-063.9450
038	008	AN-7	CTD, LADCP, MOC	1110	18	15.30	063	36.80	18.2550	-063.6133
039	008	AN-8	CTD, LADCP, MOC *	600	18	14.20	063	23.50	18.2367	-063.3917
WP	002	WP			18	13.90	063	18.30	18.2317	-063.3050
040	005	LI-01	CTD, MOC	(shelf break) 300	18	11.80	063	13.90	18.1967	-063.2317
041	003	LI-02	CTD	600	18	06.50	063	20.80	18.1083	-063.3467
WP	002	LI-03		(shelf break) 300	18	08.20	063	14.70	18.1367	-063.2450
042	004	LI-04	CTD, BONGO	24	18	09.20	063	11.00	18.1533	-063.1833
WP	002	WP			18	05.50	063	09.70	18.0917	-063.1617
WP	002	LI-05		60	18	03.30	063	11.20	18.0550	-063.1867
043	003	LI-06	CTD	1050	17	59.30	063	17.30	17.9883	-063.2883
WP	002	WP			18	00.90	063	06.10	18.0150	-063.1017
044	005	LI-07	CTD, MOC	(shelf break) 300	18	00.10	063	07.30	18.0017	-063.1217
045	005	LI-08	CTD, MOC	1090	17	52.70	063	17.90	17.8783	-063.2983
046	005	LI-09	CTD, MOC	(shelf break) 300	17	45.00	063	28.60	17.7500	-063.4767
WP	002	LI-10		80	17	41.20	063	25.90	17.6867	-063.4317
047	005	LI-11	CTD, MOC	(shelf break) 300	17	40.40	063	21.10	17.6733	-063.3517
048	005	LI-12	CTD, MOC	(shelf break) 300	17	38.80	063	12.60	17.6467	-063.2100
049	005	LI-13	CTD, MOC	770	17	44.40	063	05.00	17.7400	-063.0833

Sta #	Type Code	Station Name	Casts	Depth (m)	LAT DEG	LAT MIN	LON DEG	LON MIN	DECIMAL LAT	DECIMAL LON
050	005	LI-14	CTD, MOC	(shelf break) 300	17	50.00	062	57.20	17.8333	-062.9533
051	004	LI-15	CTD, BONGO	30	17	53.20	062	52.00	17.8867	-062.8667
052	005	LI-16	CTD, MOC	(shelf break) 300	17	31.90	062	56.80	17.5317	-062.9467
053	003	LI-17	CTD	600	17	36.20	062	47.30	17.6033	-062.7883
054	005	LI-18	CTD, MOC	(shelf break) 300	17	40.40	062	37.80	17.6733	-062.6300
055	004	LI-19	CTD, BONGO	45	17	38.00	062	27.50	17.6333	-062.4583
WP	002	WP			17	35.00	062	29.80	17.5833	-062.4967
WP	002	WP			17	31.40	062	39.60	17.5233	-062.6600
WP	002	WP			18	18.40	064	55.30	18.3067	-064.9217
WP	001	Charlotte Amalie			18	20.00	064	55.80	18.3333	-064.9300
WP	002	WP			18	17.80	064	55.10	18.2967	-064.9183
WP	002	WP			18	17.80	065	00.80	18.2967	-065.0133
WP	002	WP			18	21.50	065	14.10	18.3583	-065.2350
WP	002	WP			18	28.80	065	50.60	18.4800	-065.8433
WP	001	San Juan			18	28.00	066	04.90	18.4667	-066.0817

***NOTE: AN-8 MOCNESS was conducted at 18 14.0 N 63 20.8 W**

Type Codes:

Port call	001
Waypoint	002
Ctd	003
Ctd, bongo	004
Ctd, mocness	005
Ctd, mocness, bongo	006
Ctd/ladcp	007
Ctd/ladcp, mocness	008

Appendix 2: Displacement volumes and abundance of fish/lobster larvae by station.

MOCNESS Plankton collecting nets						
Sta. #	**Net #**	**Weight (g)**	**Displ. Vol (mL)**	**Mesh (µm)**	**Fish larvae n =**	**Lobster larvae**
10	1	18	22.5	335	178	0
10	2	12	10	335	44	0
10	3	18	21	335	335	0
10	4	8	10	335	98	0
10	5	26	35	335	85	15
12	1	16	17.5	335	257	0
12	2	14	17.5	335	93	0
12	3	16	20	335	140	0
12	4	14	15	335	53	0
12	5	10	10	335	43	0
13	1	22	25	335	n/a	n/a
13	2	10	15	335	129	0
13	3	20	22.5	335	243	1
13	4	16	20	335	148	7
13	5	14	20	335	135	6
14	1	12	15	335	n/a	n/a
14	2	4	5	335	42	0
14	3	8	10	335	193	1
14	4	14	10	335	294	8
14	5	12	13	335	169	0

Sta. #	Net #	Weight (g)	Displ. Vol (mL)	Mesh (µm)	Fish larvae n =	Lobster larvae
16	1	10	13	335	n/a	n/a
16	2	8	9	335	25	0
16	3	6	7	335	208	17
16	4	6	7.5	335	112	0
16	5	10	11	335	46	0
17	1	12	15	335	n/a	n/a
17	2	8	7.5	335	21	0
17	3	14	17.5	335	146	0
17	4	16	20	335	237	5
17	5	8	10	335	37	5
18	1	8	10	335	n/a	n/a
18	2	4	10	335	107	0
18	3	8	10	335	318	0
18	4	10	12.5	335	331	4
18	5	16	20	335	177	0
21	1	26	35	335	n/a	n/a
21	2	4	7.5	335	534	6
21	3	12	15	335	495	0
21	4	14	17	335	875	19
21	5	14	20	335	532	22
22	1	20	25	335	n/a	n/a
22	2	8	10	335	115	7
22	3	14	17.5	335	122	0
22	4	10	12.5	335	195	3

Sta. #	**Net #**	**Weight (g)**	**Displ. Vol (mL)**	**Mesh (µm)**	**Fish larvae n =**	**Lobster larvae**
22	5	10	12.5	335	181	3
23	1	2	.1	335	n/a	n/a
23	2	2	.1	335	0	0
23	3	2	1	335	26	0
23	4	42	56	335	922	12
23	5	8	6	335	44	0
24	1	8	9	335	385	n/a
24	2	4	10	335	88	0
24	3	12	12	335	71	0
24	4	16	20	335	106	1
24	5	14	20	335	204	0
26	2	14	20	335	1273	25
26	3	38	44	335	3425	23
26	4	32	40	335	2510	16
26	5	34	41	335	1152	0
27	1	22	35	335	n/a	n/a
27	2	4	7.5	335	51	0
27	3	23	28	335	198	0
27	4	24	32.5	335	172	0
27	5	24	32.5	335	182	0
28	1	34	42.5	335	n/a	n/a
28	2	6	6	335	82	1
28	3	52	65	335	602	14
28	4	40	48	335	458	123

Sta. #	**Net #**	**Weight (g)**	**Displ. Vol (mL)**	**Mesh (µm)**	**Fish larvae n =**	**Lobster larvae**
28	4	48	55	335	458	123
28	5	28	35	335	395	31
29	1	12	15	335	n/a	n/a
29	2	6	10	335	114	0
29	3	12	15	335	198	0
29	4	14	17.5	335	217	7
29	5	12	12.5	335	131	n/a
30	1	16	20	335	n/a	n/a
30	2	28	35.5	335	359	185
30	4	6	10	335	37	12
30	5	10	12.5	335	15	8
32	1	28	35	335	n/a	n/a
32	2	0	0	335	83	0
32	3	26	31	335	1102	0
32	4	22	30	335	846	392
32	5	18	25	335	473	103
34	2	n/a	n/a	335	68	2
34	3	20	25	335	535	0
34	4	22	26	335	268	12
34	5	18	21	335	154	0
35	1	14	20	335	n/a	n/a
35	2	0	0	335	34	0
35	3	8	11	335	518	2

Sta. #	Net #	Weight (g)	Displ. Vol (mL)	Mesh (µm)	Fish larvae n =	Lobster larvae
35	4	14	17	335	630	16
35	5	12	15	335	359	16
37	1	14	18	335		
37	2	n/a	n/a	335	14	n/a
37	3	8	11	335	69	25
37	4	18	27	335	170	62
37	5	12	20	335	135	3
38	1	10	12.5	335		
38	2	n/a	n/a	335	32	0
38	3	12	17	335	202	0
38	4	14	17.5	335	454	15
38	5	16	21	335	209	13
39	1	20	25	335		
39	2	n/a	n/a	335	434	0
39	3	10	15	335	702	7
39	4	16	20	335	462	6
39	5	20	25	335	265	26
40	1	100	125	335	n/a	n/a
44	1	88	112.5	335	n/a	n/a
44	2	10	15	335	202	8
44	3	28	37.5	335	611	17
44	4	56	70	335	48	33
44	5	64	82	335	1029	124
45	1	24	30	335	n/a	n/a

Sta. #	**Net #**	**Weight (g)**	**Displ. Vol (mL)**	**Mesh (µm)**	**Fish larvae n =**	**Lobster larvae**
45	2	10	12	335	120	1
45	3	14	20	335	529	4
45	4	22	30	335	787	16
45	5	18	22	335	280	1
46	1	18	20	335	n/a	n/a
46	2	n/a	n/a	335	14	0
46	3	8	10	335	99	1
46	4	14	20	335	188	13
46	5	32	39	335	257	39
47	1	32	41	335	351	39
48	1	60	75	335	555	6
49	1	50	70	335	830	16
50	1	60	75	335	1201	5
52	1	52	65	335	558	14
54	1	30	35	335	529	22
				Total	**36,214**	**1,646**

Bongo Nets						
Sta. #	**Net #**	**Weight (g)**	**Displ. Vol (mL)**	**Mesh (µm)**	**Fish larvae n =**	**Lobster larvae**
8	R	8	10	500	48	0
9	R	4	5	500	39	4
10	R	12	20	500	117	12
11	R	12	10	500	611	6
15	R	30	37	500	311	13
19	R	22	28	500	885	0
20	R	16	22.5	500	633	28
31	R	6	6	500	79	12
42	R	26	33	500	371	6
51	R	56	70	500	126	68
55	R	n/a	n/a	500	32	0
				Total	**3,252**	**149**

***NOTE: n/a- insufficient sample to conduct biomass measurements**

Appendix 3: Abundance and composition of fishes in ichthyoplankton samples

Taxonomic Family (n=99)	**Total Abundance**	**% Abundance per total collection**
Gobiidae	3999	23.85%
Labridae	2712	16.17%
Myctophidae	1902	11.34%
Apogonidae	1143	6.82%
Scaridae	1008	6.01%
Gonostomatidae	872	5.20%
Serranidae	475	2.83%
Phosichthyidae	276	1.65%
Paralepididae	263	1.57%
Labrisomidae	222	1.32%
Callionymidae	199	1.19%
Balistidae	194	1.16%
Clupeidae	159	0.95%
Bothidae	150	0.89%
Carangidae	103	0.61%
Lutjanidae	89	0.53%
Opistognathidae	87	0.52%
Acanthuridae	84	0.50%
Paralichthyidae	80	0.48%
Pomacentridae	77	0.46%
Bregmacerotidae	71	0.42%
Notosudidae	70	0.42%
Taxonomic Family	**Total**	**% Abundance per total**

	Abundance	collection
Symphysanodontidae	59	0.35%
Haemulidae	54	0.32%
Syngnathidae	54	0.32%
Tetraodontidae	52	0.31%
Synodontidae	44	0.26%
Engraulidae	38	0.23%
Microdesmidae	38	0.23%
Ptereleotridae	38	0.23%
Ophidiidae	35	0.21%
Blenniidae	35	0.21%
Chaenopsidae	31	0.18%
Acropomatidae	31	0.18%
Scombridae	27	0.16%
Sphyraenidae	24	0.14%
Sparidae	23	0.14%
Ophichthidae	22	0.13%
Mugilidae	21	0.13%
Priacanthidae	20	0.12%
Evermannellidae	20	0.12%
Antennariidae	19	0.11%
Pomacanthidae	17	0.10%
Atherinidae	16	0.10%
Moringuidae	16	0.10%

Taxonomic Family	Total Abundance	% Abundance per total collection
Blenniidae	15	0.09%
Oneiroidae	12	0.07%
Gobiesocidae	11	0.07%
Gempylidae	10	0.06%
Melamphaidae	10	0.06%
Diodontidae	10	0.06%
Congridae	10	0.06%
Melanostomiidae	9	0.05%
Scorpaenidae	9	0.05%
Eleotridae	9	0.05%
Muraenidae	8	0.05%
Bythitidae	6	0.04%
Nettasomatidae	6	0.04%
Polyprionidae	6	0.04%
Coryphaenidae	6	0.04%
Xenocongridae	5	0.03%
Scopelarchidae	5	0.03%
Bramidae	5	0.03%
Ostraciidae	5	0.03%
Scombrolabracidae	5	0.03%
Chaetodontidae	5	0.03%
Alubulidae	4	0.02%
Holocentridae	4	0.02%

Taxonomic Family	Total Abundance	% Abundance per total collection
Centropomidae	4	0.02%
Malacanthidae	4	0.02%
Nomeidae	4	0.02%
Preleptocephalus	4	0.02%
Cynoglossidae	3	0.02%
Chiasmodontidae	3	0.02%
Leptocephalus	3	0.02%
Howellidae	3	0.02%
Exocoetidae	3	0.02%
Fistulariidae	3	0.02%
Gerreidae	2	0.01%
Nemichthyidae	2	0.01%
Monacanthidae	2	0.01%
Ariommatidae	2	0.01%
Ogocephalidae	2	0.01%
Grammatidae	2	0.01%
Congridae	2	0.01%
Neoscopelidae	2	0.01%
Echeneidae	2	0.01%
polymixiidae	1	0.01%
Trachiuridae	1	0.01%
Astronesthidae	1	0.01%
Cirrhitidae	1	0.01%

Taxonomic Family	**Total Abundance**	**% Abundance per total collection**
Serrivomeridae	1	0.01%
Stomiidae	1	0.01%
Istiophoridae	1	0.01%
Derichthyidae	1	0.01%
Emmelichthyidae	1	0.01%
Sternoptychidae	1	0.01%
Serrivomeridae	1	0.01%
Tetragonuridae	1	0.01%
Anguillidae	1	0.01%
Belonidae	1	0.01%
Hemiramphidae	1	0.01%
Chlopsidae	0	0.00%
Clupeidae	0	0.00%
Gonostomatidae	0	0.00%
Chloropthalmidae	0	0.00%
Ipnopidae	0	0.00%
Carapidae	0	0.00%
Epigonidae	0	0.00%
Triptrygiidae	0	0.00%
yolk-sac larvae	9	0.05%
Damaged	1,013	6.04%
UNID	536	3.20%
Grand Total	**16,769**	**100.00%**

Appendix 4: Composition and percent abundance (top 80%) of fishes in total collections per gear and depth

Taxonomic Family	Bongo	MOCNESS			
	0-5 m	0-25 m	25-50 m	50-75 m	75-100 m
Apogonidae	15.84%	12.41%	4.25%	7.11%	7.11%
Balistidae	1.68%	1.65%	1.39%	1.18%	1.18%
Bothidae	n/a	1.33%	1.12%	0.81%	0.81%
Clupeidae	3.08%	1.41%		1.06%	1.06%
Callionymidae	n/a	1.59%	n/a	1.19%	1.19%
Carangidae	n/a	1.17%	n/a	n/a	n/a
Engraulidae	1.46%	n/a	n/a	n/a	n/a
Gobiidae	36.99%	24.45%	23.00%	24.65%	24.65%
Gonostomatidae	n/a	3.32%	4.69%	4.98%	4.98%
Haemulidae	1.40%	n/a	n/a	n/a	n/a
Labridae	1.26%	11.54%	27.96%	15.39%	15.39%
Labrisomidae	4.91%	1.53%	n/a	1.34%	1.34%
Lutjanidae	1.85%	n/a	n/a	n/a	n/a
Myctophidae	n/a	9.09%	9.66%	10.85%	10.85%
Opistognathidae	1.73%	n/a	n/a	n/a	n/a
Paralepididae	n/a	n/a	n/a	1.49%	1.49%
Phosichthyidae	n/a	n/a	n/a	1.61%	1.61%
Pomacentridae	1.04%	n/a	n/a	n/a	n/a
Scaridae	1.26%	8.36%	6.23%	5.71%	5.71%
Serranidae	7.70%	2.55%	2.31%	3.05%	3.05%
Top 80%	80.20%	80.40%	80.61%	80.42%	80.42%