

Site Summaries

RATIONALE

The purpose of this section is to provide a more comprehensive survey of TCRMP site characteristics than can be achieved in the overall data compilations. Each TCRMP monitoring site is unique and has had distinct responses to local and global stressors. Given the increase in sites included under this program and the inclusion of more information at each site, such as physical data, this section is designed to provide a summary that highlights each site's individual characteristics and serves as a quick reference guide for managers, policy makers, and academics. The duration of surveys at most sites also now provides sufficient data from which to draw conclusions about longer term site dynamics and the processes that might be contributing to recent trajectories of health, development, and degradation.

SITE SUMMARY ELEMENTS

TCRMP site information is presented in a few pages that provide a brief description of the setting and the potential susceptibility to local and global stressors and disturbances. Subsections include a description of (1) the physical environment, (2) the benthic community and (3) the fish community. The benthic data and coral health are updated in each annual report, whereas the fish summaries and physical data are updated periodically.

Benthic community structure is presented as the mean ($\pm$ SE) cover of coral, macroalgae, cyanobacteria, and epilithic algae. Epilithic algal communities are diminutive turf and filamentous algae that cover hardbottom surfaces, whilst macroalgae have identifiable thallus differentiation and structure. Any open hardbottom space is assumed to host an epilithic algal community even if algae cannot be resolved in video images. The loss of coral cover due to the 2005 bleaching event was calculated as the relative change in coral cover from 2005 to 2007, unless otherwise noted for sites not sampled in these years. In addition, the percent recovery from the 2005 bleaching event was calculated as the amount of coral cover regained by 2011 $(\text{Cover}_{2011} - \text{Cover}_{2007}) / (\text{Cover}_{2005} - \text{Cover}_{2007})$. Change calculations must be treated with caution for sites where transects were not made permanent until after the 2005 bleaching event or where percent cover is low, since the

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conditions introduce an unknown amount of error. Trends are shown for all available years of monitoring

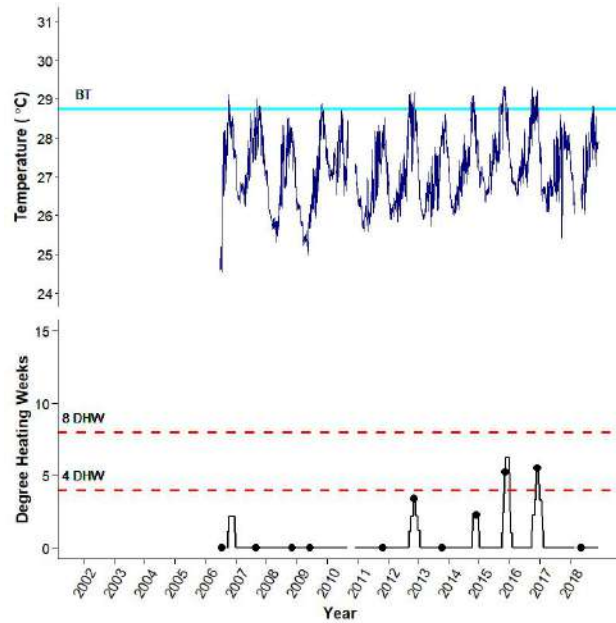
Benthic community pie charts were constructed from all years of data. The sessile epibenthic animal community includes *Agaricia* spp., *Colpophyllia natans*, *Pseudodiploria strigosa*, *Orbicella annularis*, *Orbicella* spp. (*O. faveolata*, *O. franksi*, + unidentified *Orbicella* spp.), *Montastraea cavernosa*, *Porites astreoides*, branching *Porites* species, *Siderastrea siderea*, other corals, sponges, and gorgonians. The algae/non-living substrata category includes cyanobacteria, epilithic algae ("DCA"), *Lobophora variegata*, *Dictyota* spp., *Halimeda* spp. crustose coralline algae, and sand/sediment. These figures not are updated every annual report, since relative composition tends to change slowly. Figures are changed every five years or after a major disturbance, such as a coral bleaching event.

Coral Health is presented as the mean ($\pm$ SE) of coral bleaching prevalence (proportion of population affected) and extent (proportion of colony affected), disease prevalence, and partial mortality prevalence.

PHYSICAL CHARACTERISTICS

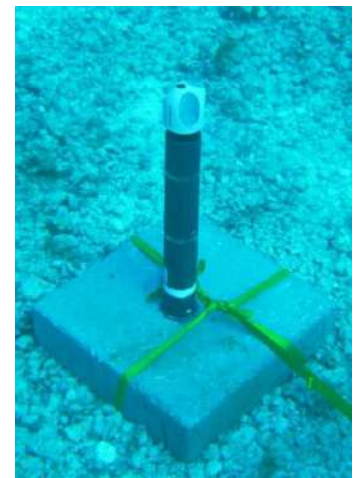
Temperature. Benthic temperatures were recorded at each site with a calibration checked HoboTemp™ thermistor data logger (Onset Computer Corporation, Bourne, Massachusetts). After 2011 sensors were only deployed if recorded temperatures did not deviate more than 0.2°C from actual, recorded in an ice bath for at least 2 hours. Thermistors were affixed within transects and set to record at intervals of 15 minutes. Records are presented as daily averages across months, February 29th excluded. Data for 2005 was taken from current profilers or federal data sources when available. See Temperature Figure Guide (following page) for interpretation of temperature data. Degree heating weeks was calculated based on the NOAA methodology (NOAA 2006) and using site-specific bleaching thresholds. As a rough estimate, 4 DHW is associated with the onset of widespread bleaching, and 8 DHW is associate with the onset of mass bleaching and the start of coral mortality.

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Temperature Figure Guide. Temperatures in degrees Celsius and degree heating weeks. BT = Bleaching Threshold, calculated empirically or taken from linear relationship shown in Smith et al. (2016a). MMM = BT – 1°C, EMMM = Empirical MMM derived from non-bleaching years over period of observation. DHW = Degree Heating Week (NOAA 2006). Black dot on DHW line indicates the date of annual sampling to put the bleaching observations in context. Example taken from the Hind Bank Monitoring site.

Currents. Water currents were recorded at a subset of sites and times with Nortek Aquadopp™ Acoustic Doppler Current Profilers (ADCPs). Profilers were set in bases on the seafloor and set to record current speed and direction within predefined depth bins above the substrate. The bin closest to the substrate and closest to the coral reef was selected for display. Compass rose figures were developed that show the frequency of current in magnetic directions 0, 22.5, 45, 67.5, 90, 112.5, 135, 157.5, 180, 202.5, 225, 247.5, 270, 292.5, 315, 337.5, 360°. Within



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each direction the frequency of current speed within bins of 0.1 m s^{-1} were plotted. For Flat Cay, current data was retrieved with an Aandaraa 2-D current meter that measured current speed and direction directly over the sensor head.

Chlorophyll and Turbidity. Continuous fluorometric measurements of chlorophyll and turbidity were conducted at some sites for short periods (Black Point, Grammanik, Magens Bay). Wetlabs ECOFLNT fluorometers with antifouling bio-wipers were deployed and set to record for one minute at hourly intervals. Water column chlorophyll measurements detect phytoplankton abundance. Fluorometric measurements of chlorophyll are proxies for true chlorophyll concentrations. Direct chlorophyll measurements to calibrate fluorometric measurements have not been conducted at the monitoring sites.

St. Croix

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BUCK ISLAND, ST. CROIX

Description. The Buck Island, St. Croix site is a seaward extension of the southeast Buck Island barrier reef complex in water depth of 15 m. The reef is a low framework surrounded by a sand plain to the west and a rolling reef/hardbottom to the east. The Buck Island, St. Croix site is largely composed of large living and dead *O. annularis* heads surrounded by sand. The site has been monitored since 2001, with three permanent benthic transects installed in 2001, and three additional transects installed in 2003.

Outstanding Feature. The Buck Island, St. Croix site is within the expanded (2001) Buck Island Reef National Monument. The reef fish populations may show recovery due to the restriction of fishing.

Threats. Due to its protected area status and remoteness from land-based pollution Buck Island, St. Croix is primarily threatened by changing climate as its populations of *O. annularis* were shown to be susceptible during the 2005 bleaching event.

Figure 29. (top) The Buck Island, St. Croix position in the Buck Island Reef National Monument. (right) A representative photo.



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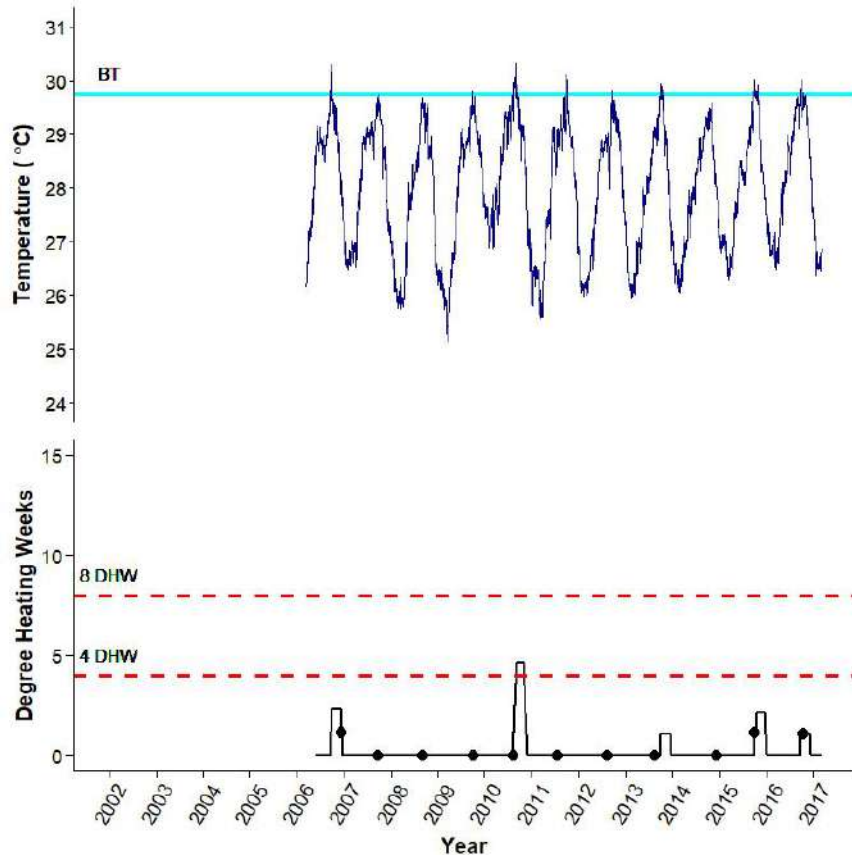


Figure 30. Buck Island, St. Croix benthic temperatures (14 m depth). Data provided by the National Park Service (site BUIS_SFR).

Physical Characteristics

Current. Currents have not been recorded at the Buck Island, St. Croix monitoring site. Unidirectional currents have always been light during monitoring. Oscillatory currents occasionally impact the site when swell is from the east.

Temperature. Temperatures at the Buck Island, St. Croix monitoring sites can get very warm and surpassed the bleaching threshold at or above 4 Degree Heating Weeks in 2005 (data from NOAA Coral Reef Watch, not shown) and 2010.

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Benthic Community. The Buck Island, St. Croix hard coral community is dominated by the boulder star coral *Orbicella annularis*; however, the most abundant sessile epibenthic animals are gorgonians. Epilithic algae dominate the algal community, with a low cover of macroalgae relative to other sites. There is a high proportion of sand.

This coral community lost 65.5% of its coral cover in the 2005 bleaching event and had only regained 6% of coral cover by 2011. Filamentous cyanobacteria showed very large increases in cover after the 2005 bleaching event.

Coral Health. Buck Island, St. Croix corals were likely severely affected during the 2005 bleaching event; however, bleaching health surveys were not completed until Jan. 13, 2006 when recovery had already commenced. The prevalence of coral diseases was high on *O. annularis*, with frequent incidence of yellow band disease and white disease following the 2005 bleaching event. Old partial mortality was very prevalent after the 2005 coral bleaching event and then decreased, becoming stable over time in 2011. However, since 2015 coral cover has declined again for unknown reasons, but possibly related to diseases on *Orbicella* spp.

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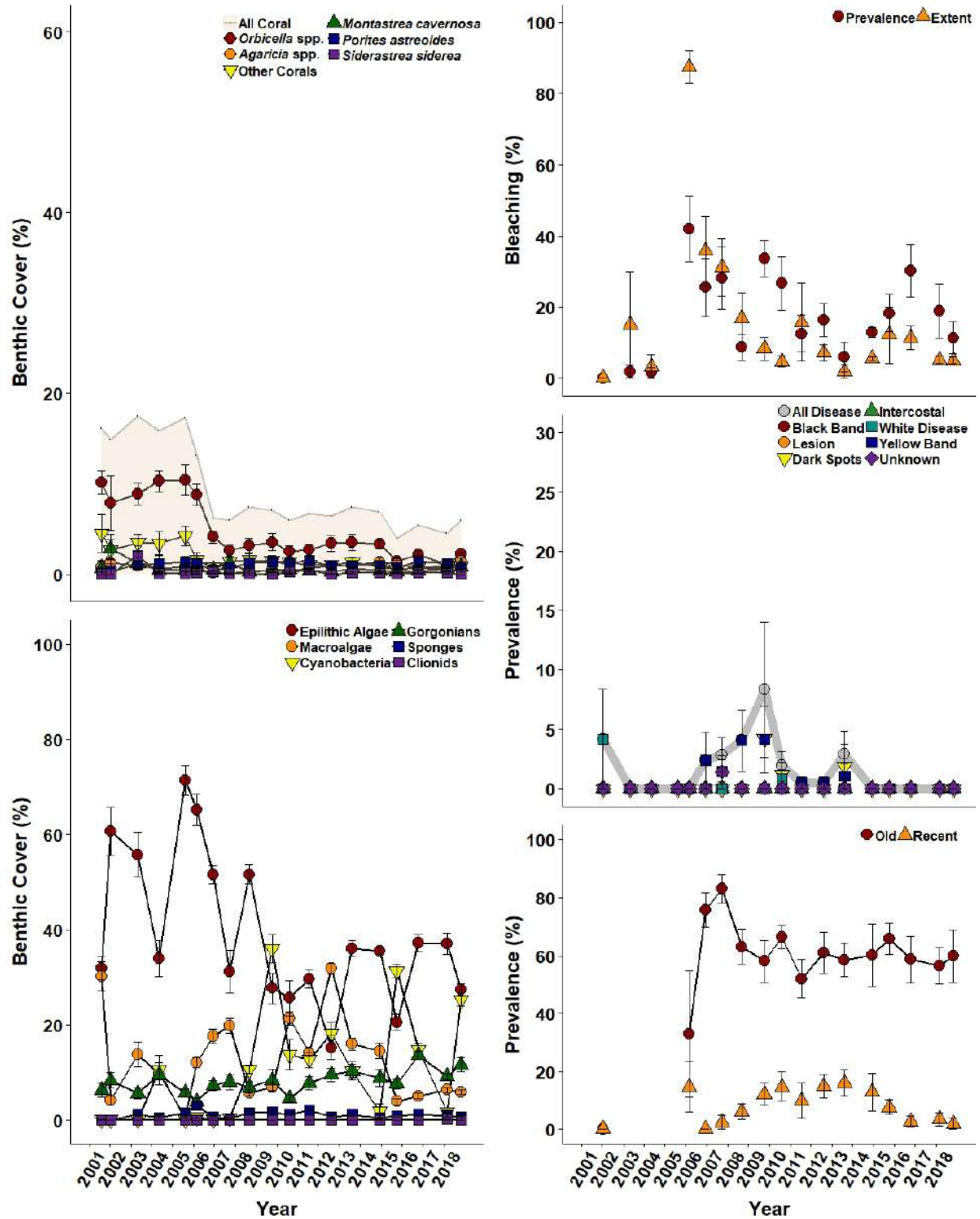


Figure 31. Buck Island, St. Croix benthic cover and coral health through time (mean $\pm$ SE).

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Fish Community. Buck Island is a low patchy reef community surrounded by and interspersed with sand. The fish community is highly dominated in biomass by herbivores, with large grazing schools of blue tang and an abundance of adult stoplight parrotfish. Close to the monitoring site are “the Haystacks”, large *Acropora palmata* skeletal remains that provide ample grazing area for large parrotfish. The Buck Island site is within the Buck Island Coral Reef National Monument and the fish inhabitants are theoretically protected from all fishing. Invertivore fishes at Buck Island also contribute a relatively high biomass to the community composition. Grunts (tomtate, French, Spanish, white, and bluestripe) and yellowhead wrasses dominate the guild, although the group is very diverse, utilizing the variety of resources available at the site. Conversely, piscivores are uncommon; the only serranids observed during TCRMP monitoring include small red hind, graysby, small basslets and hamlets. Snapper are limited to rare schoolmaster and mahogany snapper, although a subadult dog snapper was recorded at Buck Island in 2018. Other than this fish, no recovery has been noted for the fish populations on the site.

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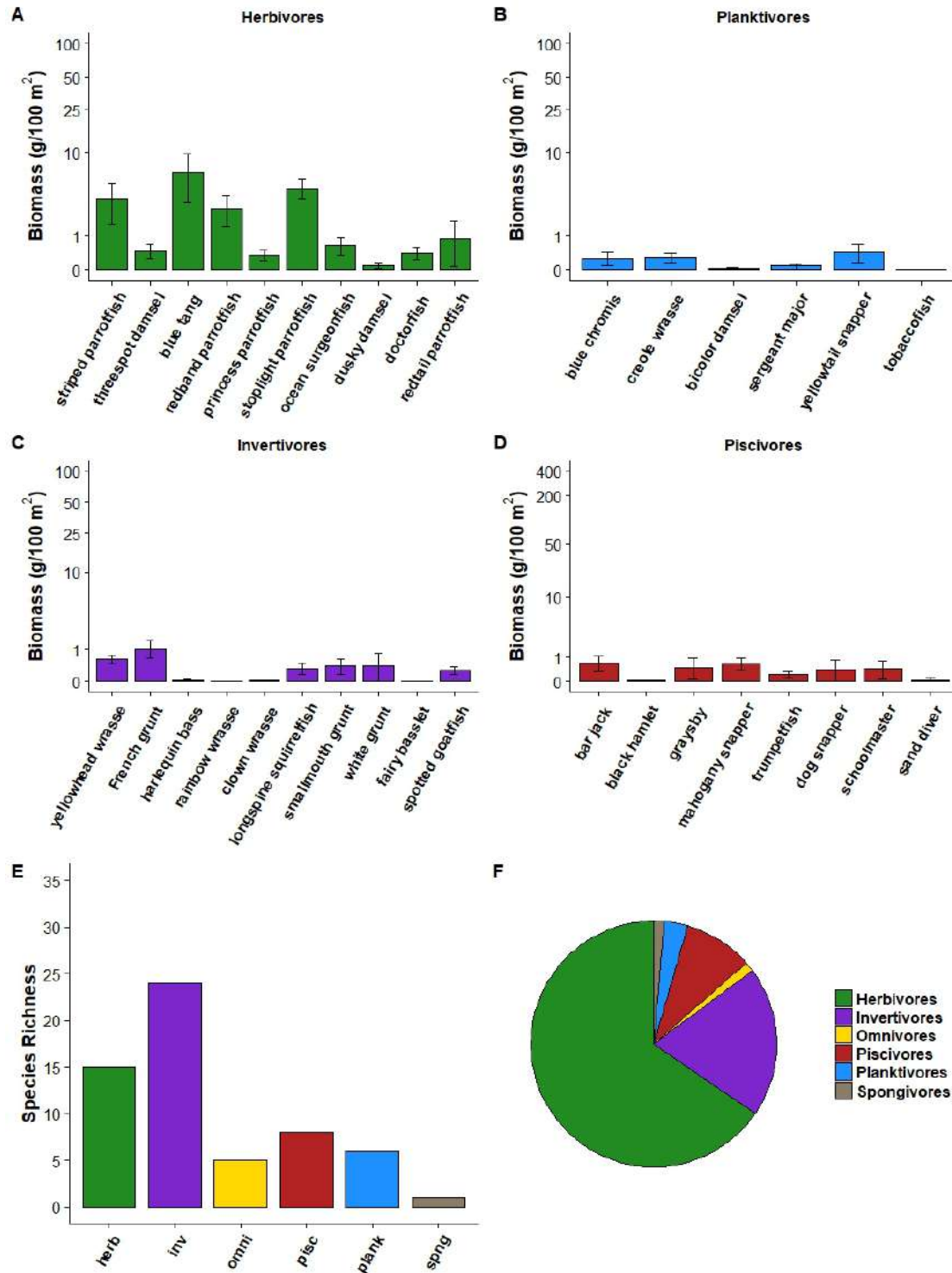


Figure 32. The Buck Island, St. Croix fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

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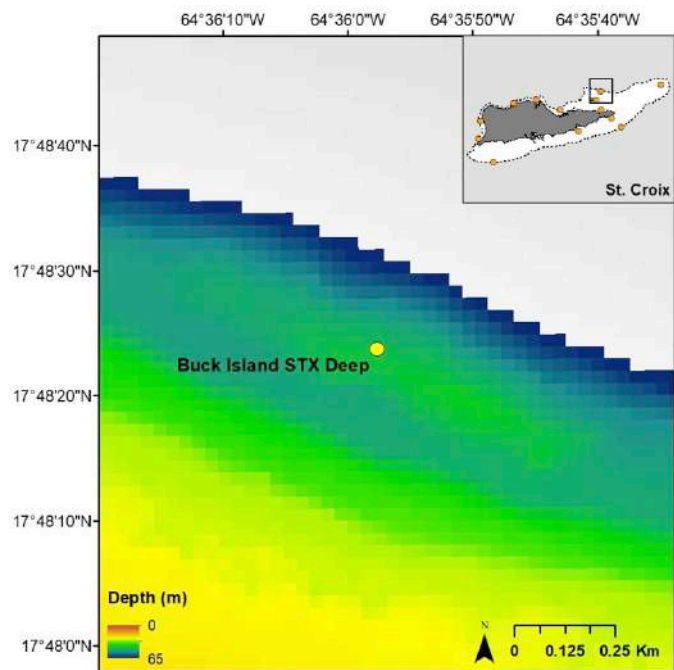
BUCK ISLAND DEEP, ST. CROIX

Description. The Buck Island Deep, St. Croix site is an upper mesophotic bank reef northeast of Buck Island in water depth of 33 m. The reef is a low slope bank system similar in form to the mesophotic reefs systems south of St. Thomas. The Buck Island Deep reef site is dominated by plating growth forms of the *O. annularis* species complex. The site was first described in an exploratory mission following the 2016 TCRMP sampling. Six benthic transects were installed in collaboration with NPS in April 2017 and have been monitored since.

Outstanding Feature. The Buck Island Deep, St. Croix site is an exceptionally healthy mesophotic orbicellid bank system on the island of St. Croix. The coral cover is double that of the next highest cover site in the TCRMP St. Croix monitoring program and large corals are largely intact with, high levels of coral-coral competition.

Threats. Due to its protected area status and remoteness from land-based pollution Buck Island Deep is largely threatened by climate change and disease.

Figure 33. (top) The Buck Island Deep, St. Croix position in the Buck Island Reef National Monument. (right) A representative photo.



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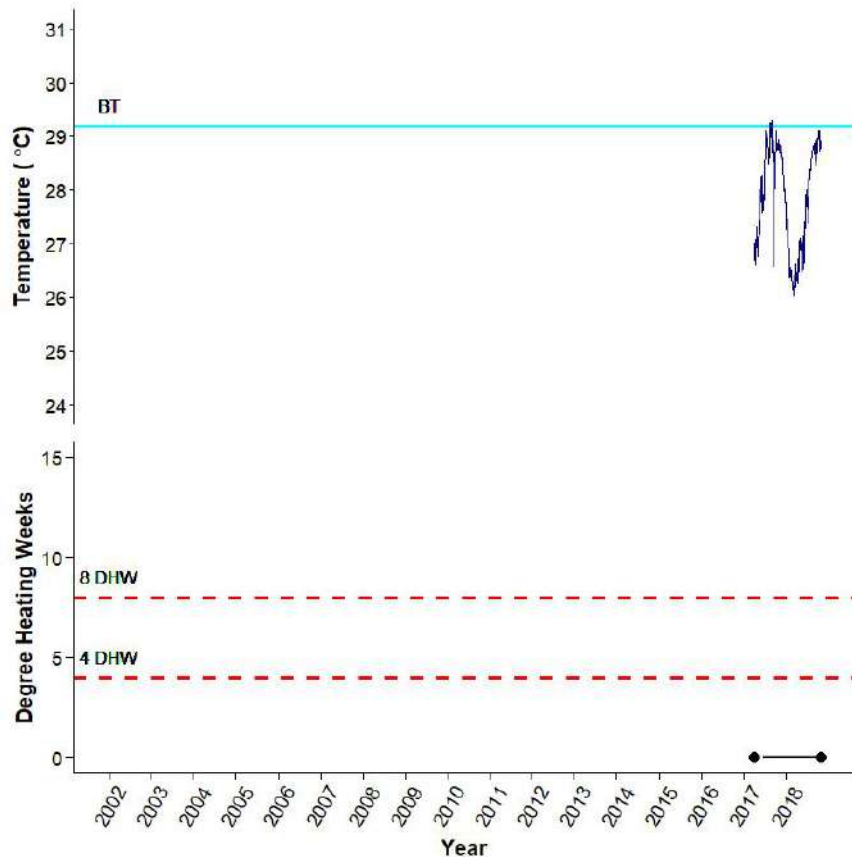


Figure 34. Buck Island Deep, St. Croix benthic temperatures (33 m depth).

Physical Characteristics

Current. Currents have not been recorded at the Buck Island Deep monitoring site.

Unidirectional currents have always been light during monitoring. Oscillatory currents are not expected at this depth except during very strong storms.

Temperature. Temperatures at the Buck Island Deep, St. Croix monitoring sites have remained relatively cool and not surpassed the bleaching threshold during the current two years of monitoring.

SITE SUMMARIES

Benthic Community. Coral cover at the Buck Island Deep, St. Croix location was 33% in 2017, which is exceptionally high for St. Croix. However, the site lost about 27% of its relative cover in between the 2017 and 2018 monitoring, possibly due to an outbreak of white disease. The coral community is dominated by the boulder star coral *Orbicella franksi*. Epilithic algae and other macroalgae have shown an inverse relationship during the two years of available monitoring data, and collectively account for the majority of living benthic cover. Sponge cover is high relative to other mesophotic bank locations, but below average for other types of mesophotic locations in St. Croix. Gorgonian cover is the highest of any other mesophotic monitoring site in the TCRMP.

Coral Health. The Buck Island Deep, St. Croix location had the highest disease prevalence of any mesophotic location in the TCRMP during the two years of monitoring. Disease prevalence was driven by both dark spot disease and white disease (possibly a type of white plague). However, old and recent mortality and bleaching prevalence was average at this site compared to other mesophotic locations.

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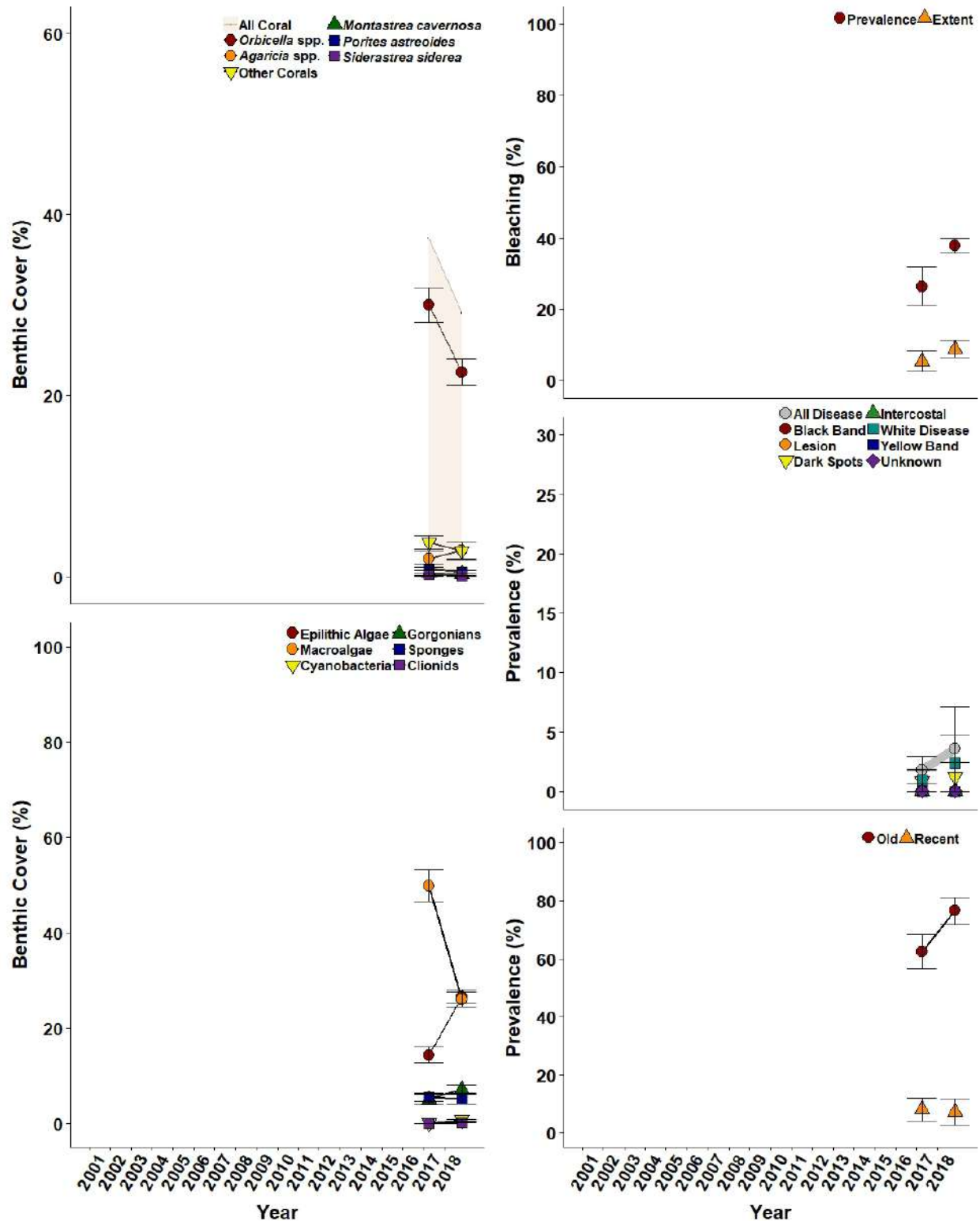


Figure 35. Buck Island Deep, St. Croix benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. Buck Island Deep has a rich upper mesophotic reef community that is largely dominated in biomass by herbivores, primarily princess and stoplight parrotfishes. The planktivore guild is relatively high in biomass, but limited to a few species: creole wrasse, blue chromis and black durgon. Benthic invertivore feeders are diverse and include significant numbers of adult red hind. Adult schoolmaster were also recorded at large sizes on the Buck Island Deep site, and in the first year of sampling, 2018, dog snapper, a rare fish on the St. Croix shelf, were observed in transects. Large serranids were not observed, however, since the site is now protected from all fishing, it is hoped that larger groupers will return to the deepwater community.

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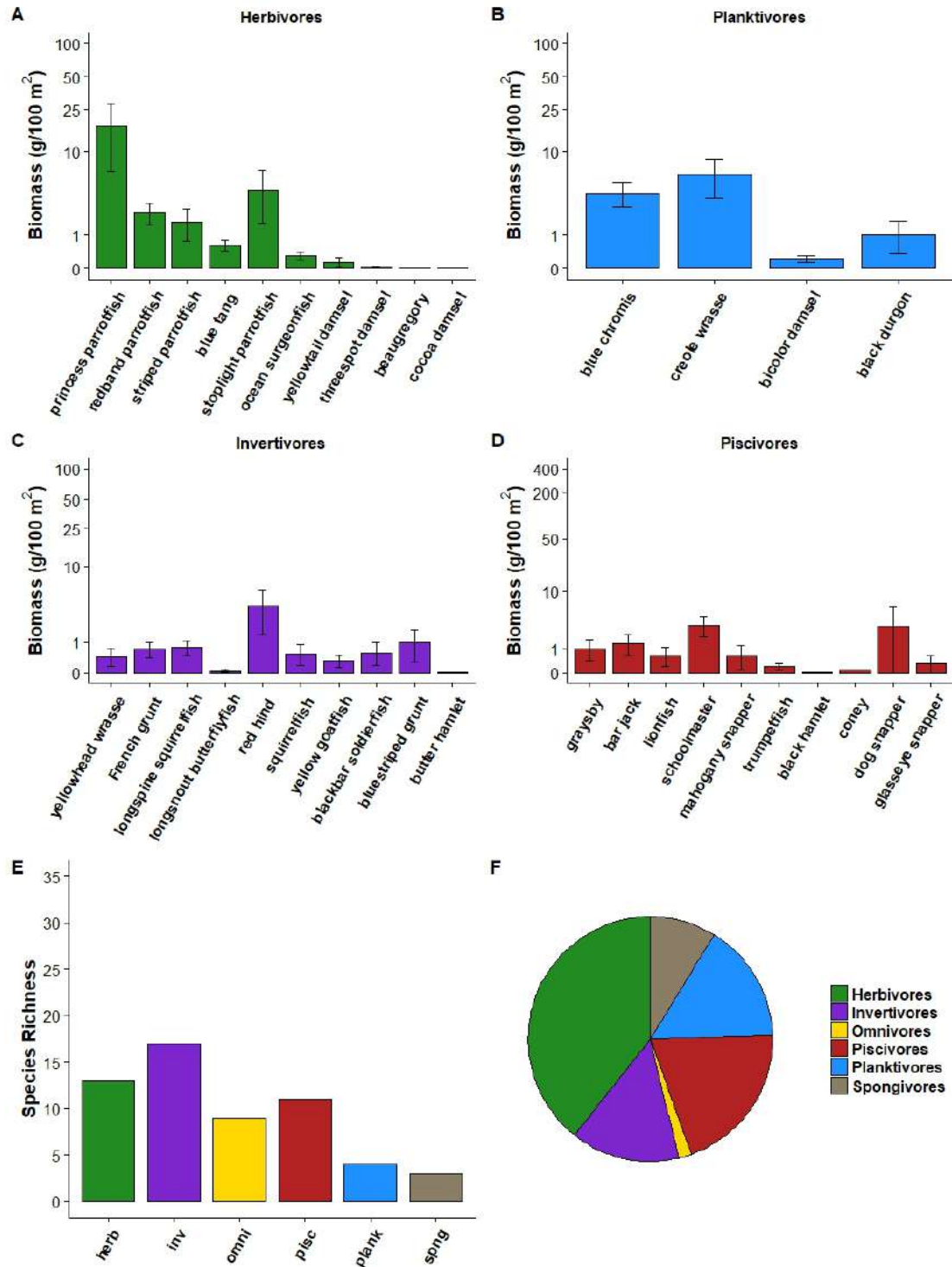


Figure 36. The Buck Island Deep, St. Croix fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

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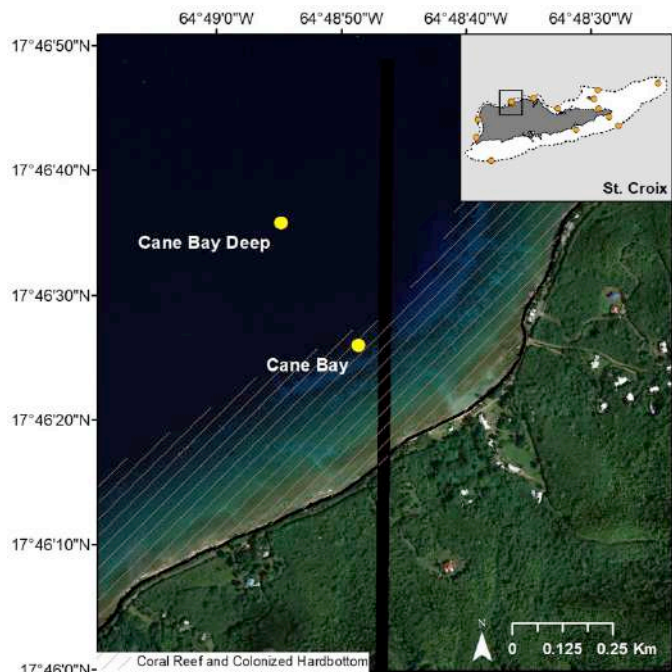
CANE BAY

Description. The Cane Bay monitoring site is a nearshore/shelf edge fringing reef on the northwest coast of St. Croix. Transects follow the trend of the leeward spur and groove formations. Cane Bay has been monitored since 2001.

Outstanding Feature. Cane Bay is one of the most well developed nearshore reefs on St. Croix. It is also one of the most heavily visited dive sites by both tourists and residents in the Virgin Islands due to its proximity to the wall, considered by some to be the most precipitous submarine drop off in the world. The reef has been under scientific investigation since the 1970's.

Threats. Although the Cane Bay reef is a singular treasure for the Virgin Islands, it is threatened by pollution, fishing, climate change, and recreational overuse. The watershed above Cane Bay has been planned for residential development with potential for the influx of terrestrial sediment. The reef is also fished commercially, and teams of spearfishers on SCUBA have been observed. This reef also lost half its coral cover in the 2005 bleaching event, suggesting it is vulnerable to warming ocean temperatures.

Figure 37. (top) Cane Bay location. (right) A representative photo of the reef.



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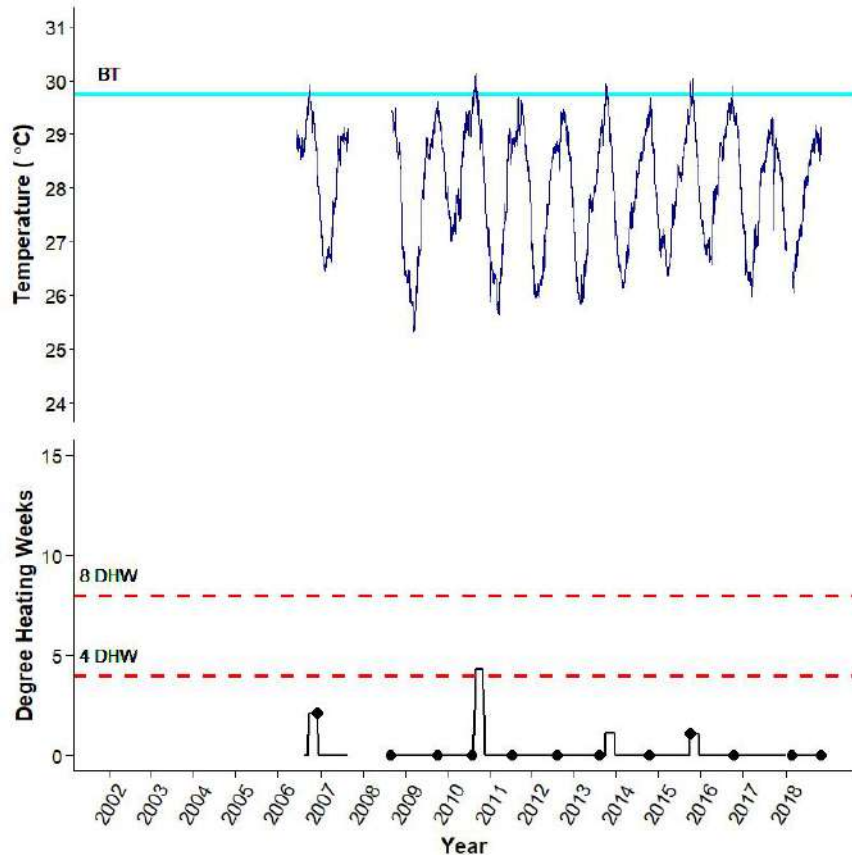


Figure 38. Cane Bay benthic temperatures (8 m depth)

Physical Characteristics

Current. Cane Bay currents have not been directly measured by the TCRMP. However, this site typically has moderate unidirectional currents with the occasional exposure to strong north swell. The current at the site may be part of an eddy formed by the dominant westward flowing current wrapping around the eastern point. Its downstream location from the entire north coast of St Croix may also make this site a recruitment sink for larvae, potentially adding to the diversity.

Temperature. Cane Bay is a relatively open and clear environment, and the temperatures tend to stay cooler, but the propensity for bleaching may be increased by the high light transmission.

SITE SUMMARIES

Benthic Community. Cane Bay supports a very diverse coral community, with dominance by *Orbicella* spp. Open substrates were mostly epilithic algal community; however, epilithic algae cover has declined since the 2005 bleaching event with increases in the cover of macroalgae and filamentous cyanobacteria. This indicates that the resident herbivore community was not able to effectively graze substrates opened by coral mortality. This coral community lost 46.8% of coral cover in the 2005 bleaching event and lost 6% more as of 2011. However, more recently coral cover has shown an increasing trend, led by recovery of the orbicellid community.

Coral Health. Cane Bay corals were severely affected during the 2005 bleaching event with nearly all colonies bleached over 80% of the colony surface. The prevalence of bleaching was also high in 2010, yet at a low extent. The prevalence of coral diseases was low before 2005, but outbreaks of white, yellow band, and dark spots disease have occurred more recently, another indication of declining health at this reef. Old and recent partial mortality became very prevalent after the 2005 coral bleaching event and have remained nearly steady or increased since.

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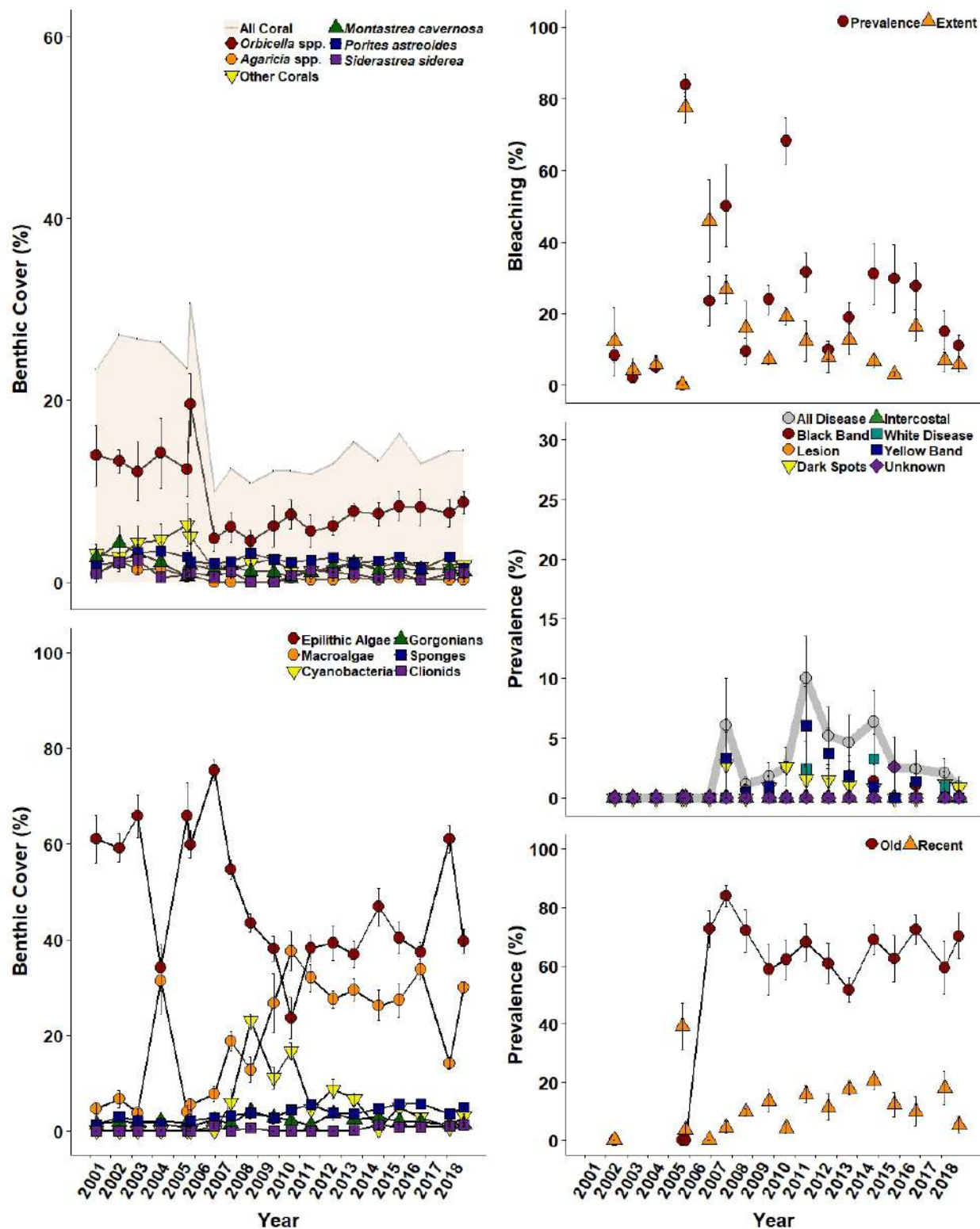


Figure 39. Cane Bay benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. Cane Bay has a high diversity, abundance, and biomass of fish, reflecting the benthic diversity and high structural complexity of the reef. The trophic guilds are evenly split, illustrating the resources available. Herbivores are dominated both in abundance and biomass by the common Caribbean parrotfishes, which occur at the site as both juveniles and adults. Planktivores include both huge numbers of small chromis, and adult black surgeon, yellowtail snapper and black jacks, indicative of a shelf edge site. The piscivore guild is dominated both in abundance and biomass by schoolmaster and mahogany snapper, followed by coney and graysby. Large grouper and snapper are rare at the Cane Bay reef; however, a tiger grouper and Nassau grouper (~30 cm total length each) were sited at the shelf break in 2018. The site is not protected from fishing, and spearfishing is popular along this northern wall of St. Croix. Nonetheless the site has a high diversity of fish, and holds some of the deeper water species (sunshinefish, longsnout butterflyfish, and cherubfish) due to the site's close proximity to the northern wall drop.

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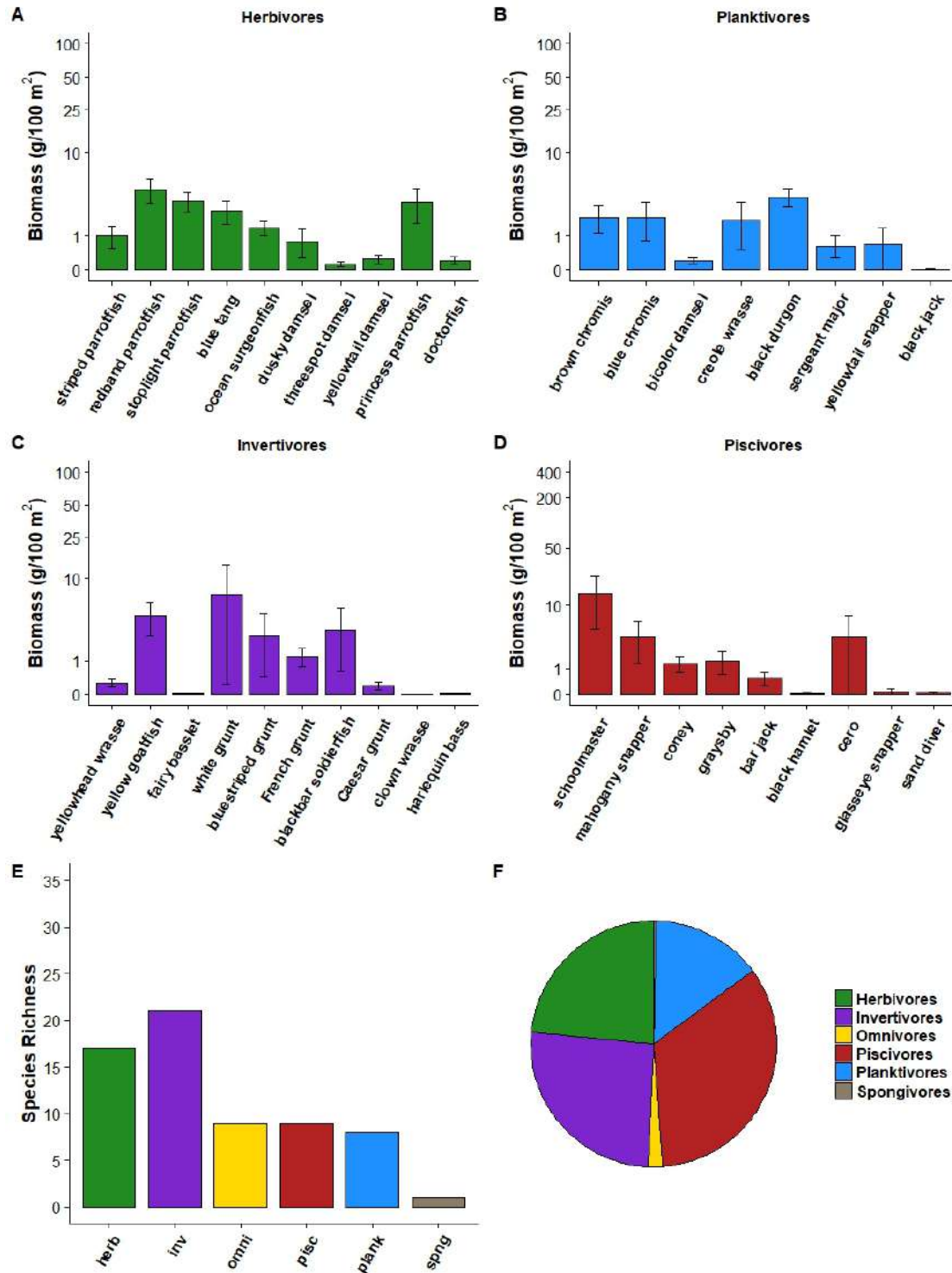


Figure 40. The Cane Bay fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

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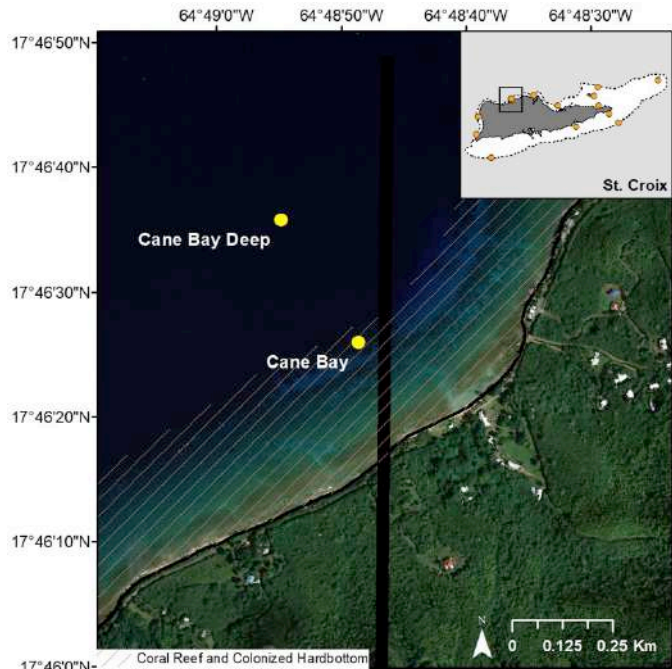
CANE BAY DEEP

Description. The Cane Bay Deep monitoring site is a mesophotic wall coral reef environment just downslope from the Cane Bay site. The reef is composed of deep spurs of coral interspersed with sediment. Cane Bay Deep was first surveyed during the 2005 coral bleaching event, but a permanent monitoring site was not established until 2009.

Outstanding Feature. Cane Bay Deep is one of the most impressive wall environments in the Caribbean and is the crown jewel for St. Croix dive tourism and biodiversity.

Threats. Although Cane Bay is economically important via dive tourism, it is under no special protection. Cane Bay Deep is threatened by sediment, fishing, climate change, and recreational overuse. Sediment cascades down from the shallow reef. Fishing occurs even at the deep reef evidenced by the presence of lost gear (monofilament and trap lines).

Figure 41. (top) Cane Bay Deep location. (right) A representative photo of the reef.



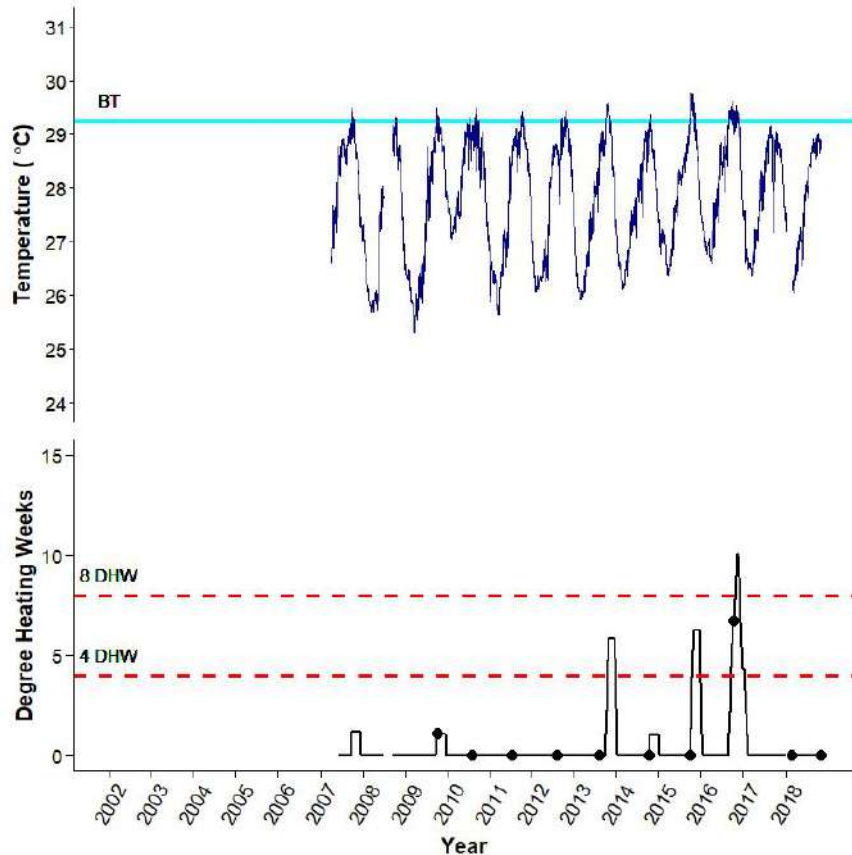


Figure 42. Cane Bay Deep temperature (39 m depth).

Physical Characteristics

Current. Cane Bay Deep is a calm wall environment that is buffered from water motion. However, it does receive sediment cascades from particles resuspended from the upper reef terrace. These flows are directed in the depressions between spurs.

Temperature. Cane Bay Deep temperatures are buffered in the warmest months by the presence of the thermocline. However, internal tide activity at this site is not as strong as in deep (~40 m) sites on the south shelf of St. Thomas, leading to less diurnal variability in temperatures. This may make the mesophotic wall environments more susceptible to bleaching than other mesophotic sites on the southern Puerto Rican shelf. There is currently no site-specific DHW for this site due to limited observations over coral bleaching events, and it is currently based on the Smith et al. (2016a) model. Observations for thermal stress and bleaching in 2016 suggest the bleaching threshold may be too low, as bleaching was weaker than expected based on peak DHW (~10).

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Benthic Community. Cane Bay Deep is a mesophotic plating coral community dominated by lettuce corals (*Agaricia* spp.), sponges, gorgonians, and black coral. Coral cover declined after 2017, a possible effect of Hurricane Maria. The algal community is mostly epilithic algae, but there are also quantities of *Dictyota* spp. and *Lobophora variegata*. A high proportion of the substrate is soft sediment that flows from the upper shelf to deposit in grooves.

Coral Health. Surprisingly for a dim and cooler mesophotic reef, Cane Bay Deep corals bleached heavily in the 2005 coral bleaching event by both prevalence and extent. Low-extent coral bleaching is very prevalent even in years without thermal stress, a likely result of sediment deposition. Unknown diseases and dark spots diseases are prevalent in some years. Old partial mortality increased after 2005, and remained high and steady from 2009-2011.

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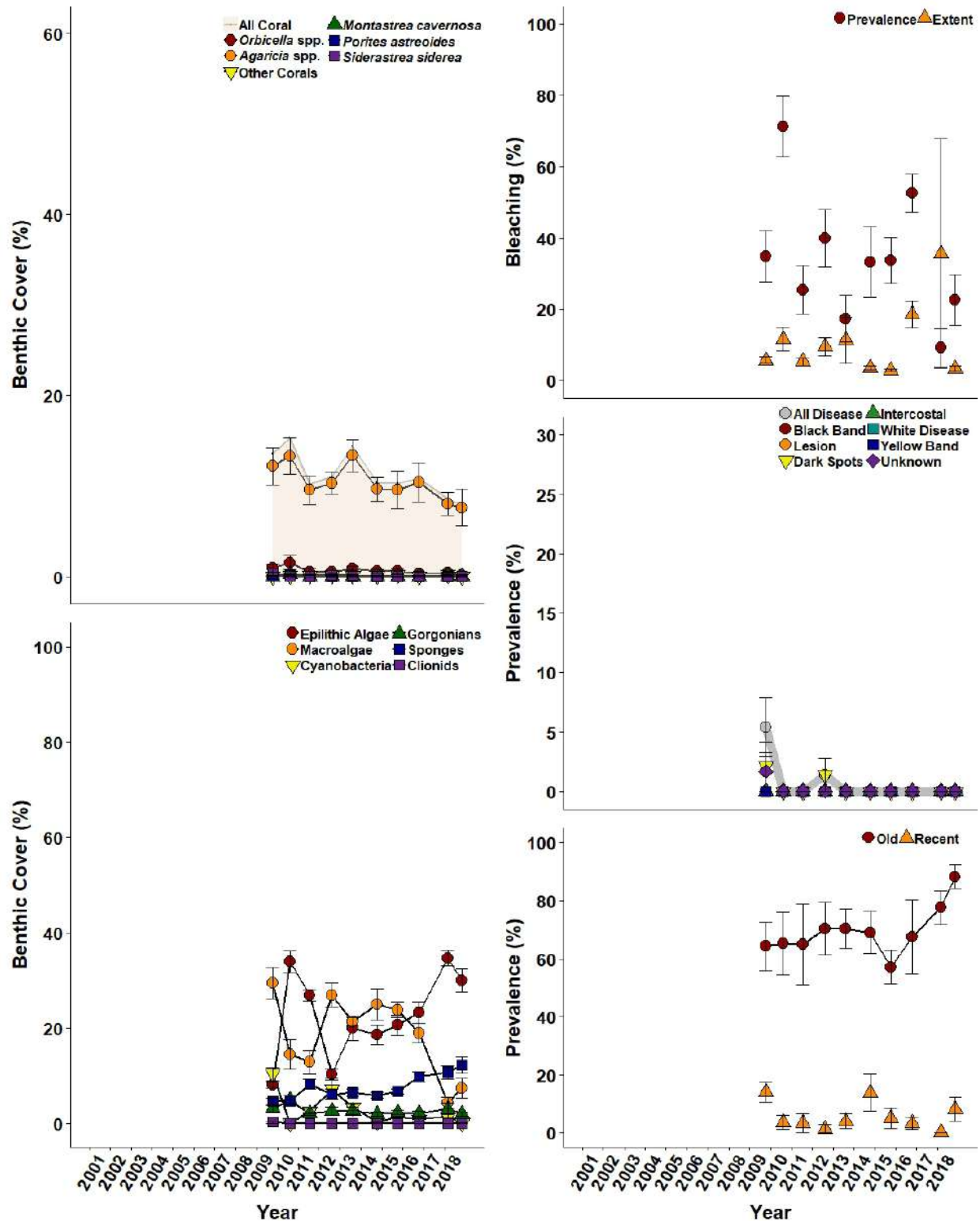


Figure 43. Cane Bay Deep benthic cover and coral health through time (mean $\pm$ SE).

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Fish Community. Cane Bay Deep is characterized by a very low fish biomass compared to both other mesophotic sites across the TCRMP, and shallow and midshelf sites of St. Croix. The site is dominated by planktivores: creole wrasse, blue chromis black durgelon and yellowtail snapper. This planktivorous community is depauperate compared to that of Salt River Deep however. The herbivore guild contributes little to the community composition, and is composed primarily of striped, princess, and redband parrotfish. Large stoplight parrotfish are recorded very occasionally. There is also very low biomass in the invertivore guild, which is made up primarily French and bluestriped grunts, goatfish and wrasse. Caribbean reef sharks cruise the wall, looking for a free lionfish handout that has become common from local divers. They have become quite bold as a consequence of this generosity however lionfish are now absent from the site. The Caribbean reef shark contributes highly to the piscivore trophic guild and is joined by other pelagics: the almaco jack, horseeye jack, barracuda and bar jack. Benthic piscivores are limited to graysby and small mahogany and schoolmaster snapper. The St. Croix northern wall is heavily fished by both commercial and sport spearfishermen, so large snappers and groupers are rare. Small deepwater reef species such as the bantum bass, fairly basslet, cherubfish, and sunshine fish are recorded at the site.

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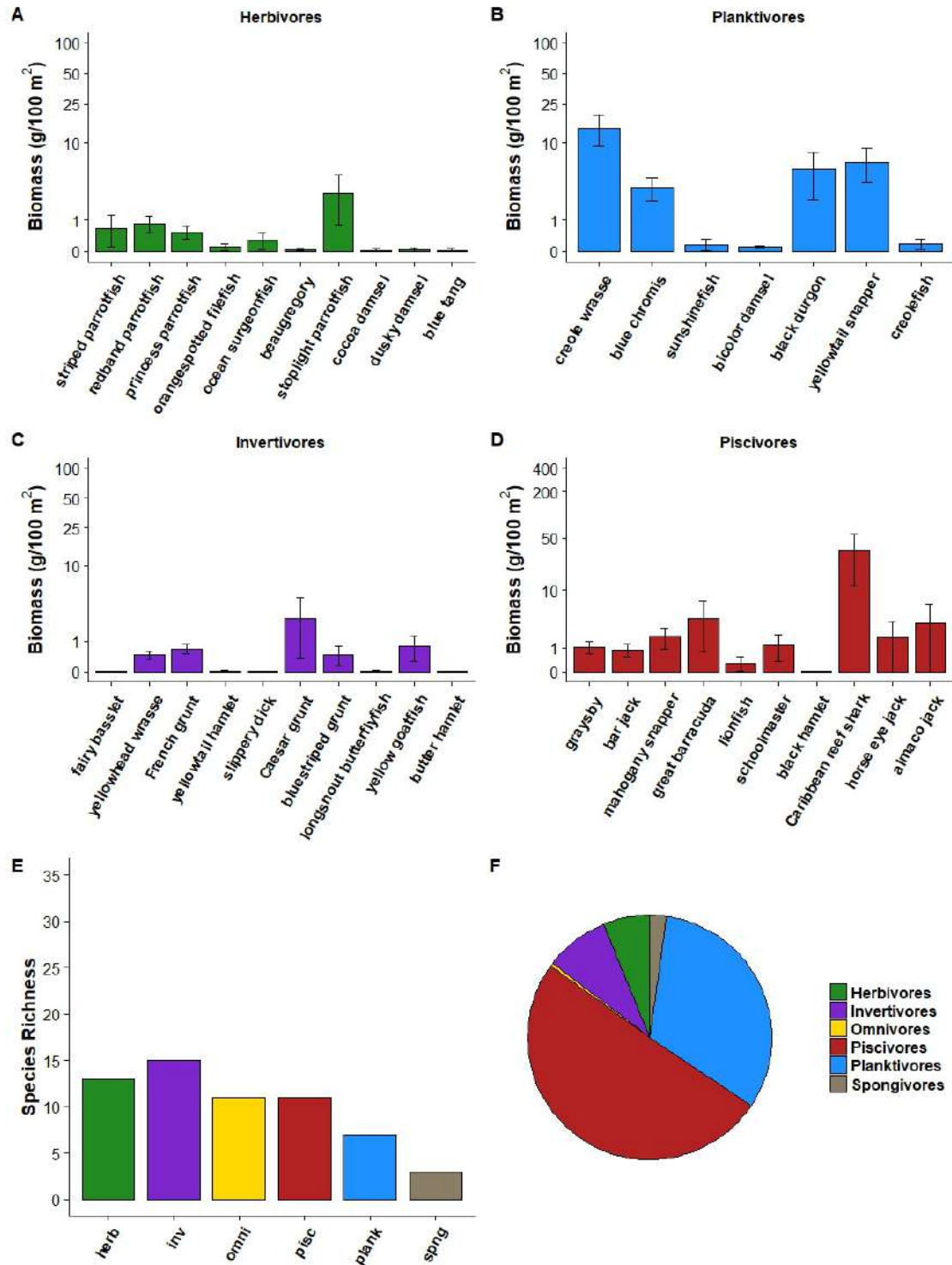


Figure 44. The Cane Bay Deep fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

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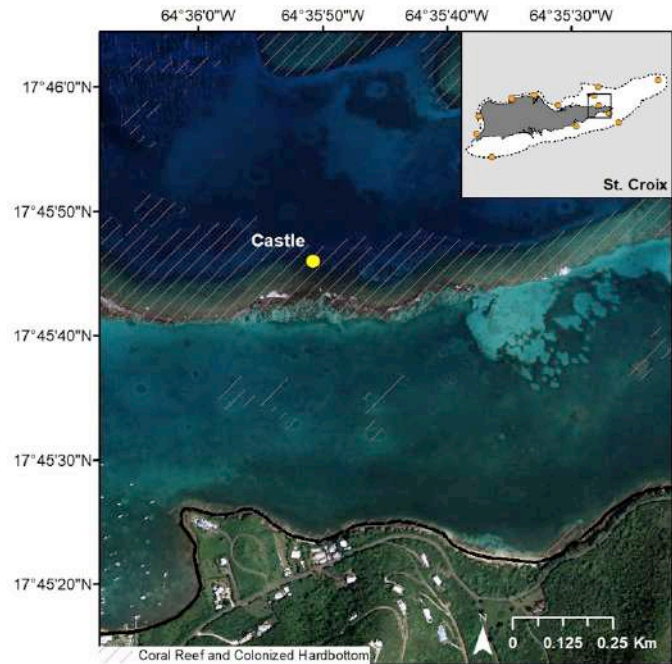
CASTLE

Description. Castle (aka. West Indies Lab) is part of the seaward northeastern St. Croix barrier reef complex outside Teague Bay. The reef starts at sea level as a relict elkhorn coral reef and is dominated by boulder star corals along the seaward edge. The area around the Castle site was monitored initially in 2003, but permanent transect were not installed until 2008.

Outstanding Feature. Castle is part of the once luxurious living elkhorn coral barrier reef that protects the northeastern St. Croix shoreline. It was a research area of the former West Indies Laboratory of Farleigh Dickenson University, which was a seminal area for global coral reef research from the 1970's and 1980's.

Threats. The barrier reef outside Teague Bay is inside the St. Croix East End Marine Park, but is in the open fishing zone. There is relatively low potential for land-based sources of pollution due to the sites midshelf location in front of a lightly populated area. Clear water and warm temperatures make this an area of potential concern during bleaching events.

Figure 45. (top) Castle location. (right) A representative photo of the reef.



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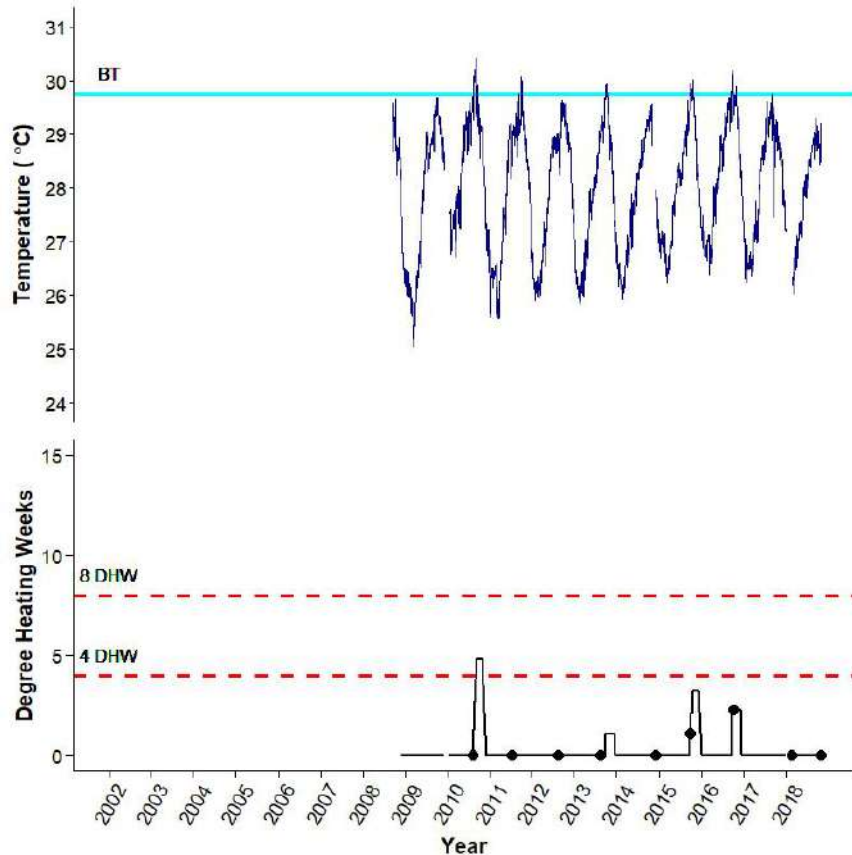


Figure 46. Castle benthic temperatures (9 m depth).

Physical Characteristics

Current. Little is known about the current at the Castle site. It is under the influence of wave-driven oscillatory flow in the shallows, but strong directional currents have not been experienced during monitoring activities.

Temperature. Castle has the potential to develop very warm temperatures and spent nearly a month above the bleaching threshold in 2010.

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Benthic Community. The Castle site is unusual for its dominance of branching *Porites* corals along the slope and concentrations of *Orbicella* spp. corals at the outer fringe adjacent to sand. The algal community is dominated by epilithic algae, with lesser abundance of *Dictyota* spp.. Macroalgae and filamentous cyanobacteria are also common. The impacts of the 2005 bleaching event are not known since monitoring in 2003 was not necessarily in exactly the same spot as the location of permanent transects established in 2008.

Coral Health. Bleaching is mild at the site. Corals were assessed prior to but not during the 2010 coral bleaching event. Old partial mortality is high in prevalence and steady. Recent partial mortality is particularly high at the site, and this may be a consequence of numerous damselfish (*Stegastes* spp.) and predatory snails (*Coralliophila* spp.) on large *Orbicella* spp. colonies.

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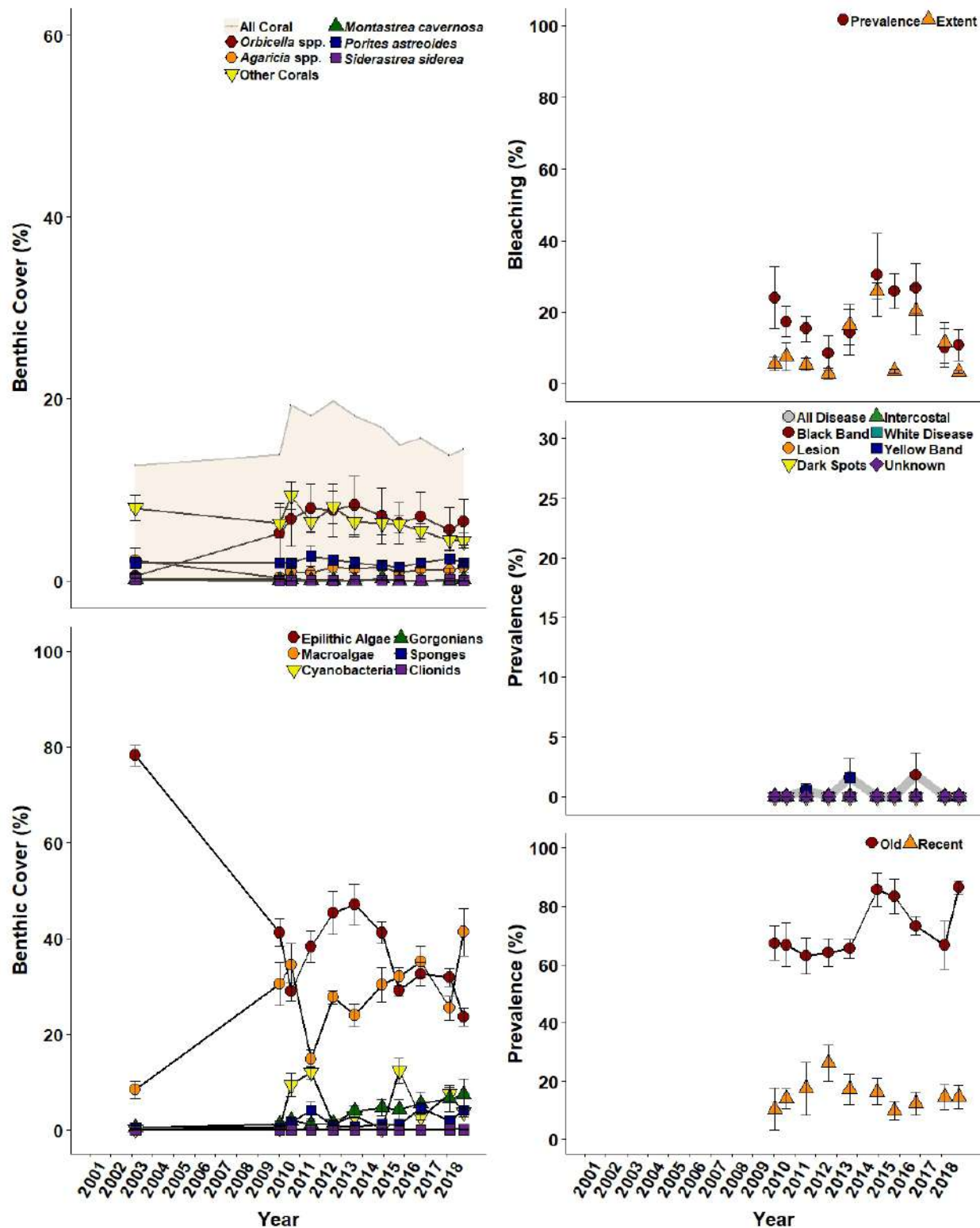


Figure 47. Castle benthic cover and coral health through time (mean $\pm$ SE).

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Fish Community. The Castle fish community is typically lower in overall abundance and biomass than most of the St. Croix offshore sites. It is dominated by herbivores in biomass, driven by schools of subadult striped parrotfish and mixed acanthurids. Invertivores are diverse and fairly high in biomass; the group is dominated by wrasses, French grunts and spotted goatfishes. Piscivores and planktivores contribute less to community structure and are limited to a few species. Juvenile yellowtail snapper and blue chromis contribute most to the invertivore biomass and bar jacks and yellow jacks contribute most to the piscivore guild. No serranids other than graysby, hamlets and tiny basslets have been recorded at Castle. Lionfish have been observed there commonly over the past five years.

SITE SUMMARIES

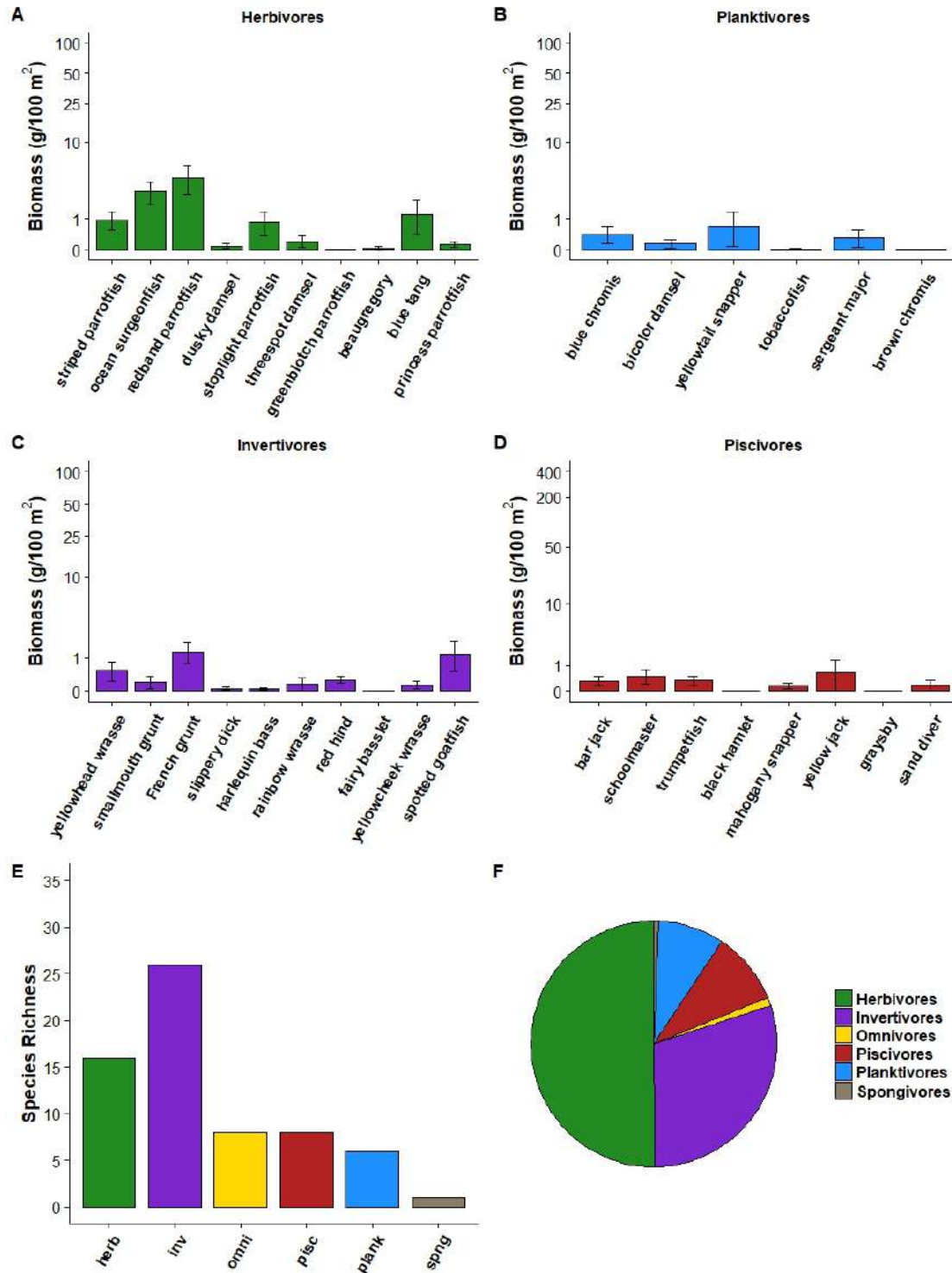


Figure 48. The Castle fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

EAGLE RAY

Description. The Eagle Ray site is a shallow seaward barrier reef located at west dive buoy 1 outside the main Christiansted access channel. The monitoring site is colonized hardbottom to coral reef, with more extensive development of reef at the seaward edge. Eagle Ray has been monitored since 2001.

Outstanding Feature. Eagle Ray is one of the most visited dive sites due to its proximity to Christiansted.

Threats. Proximity to Christiansted increases the potential for land-based sources of pollution, such as sewage, run-off, and marine debris. The site is frequented by small fishing craft that venture just out of port, likely increasing the fishing pressure.

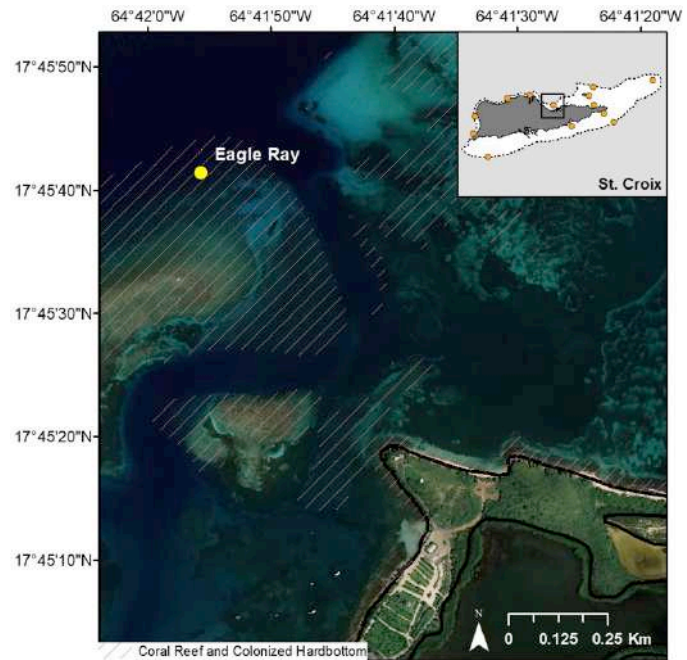


Figure 49. (top)
Eagle Ray location.
(right) A
representative photo
of the reef.



SITE SUMMARIES

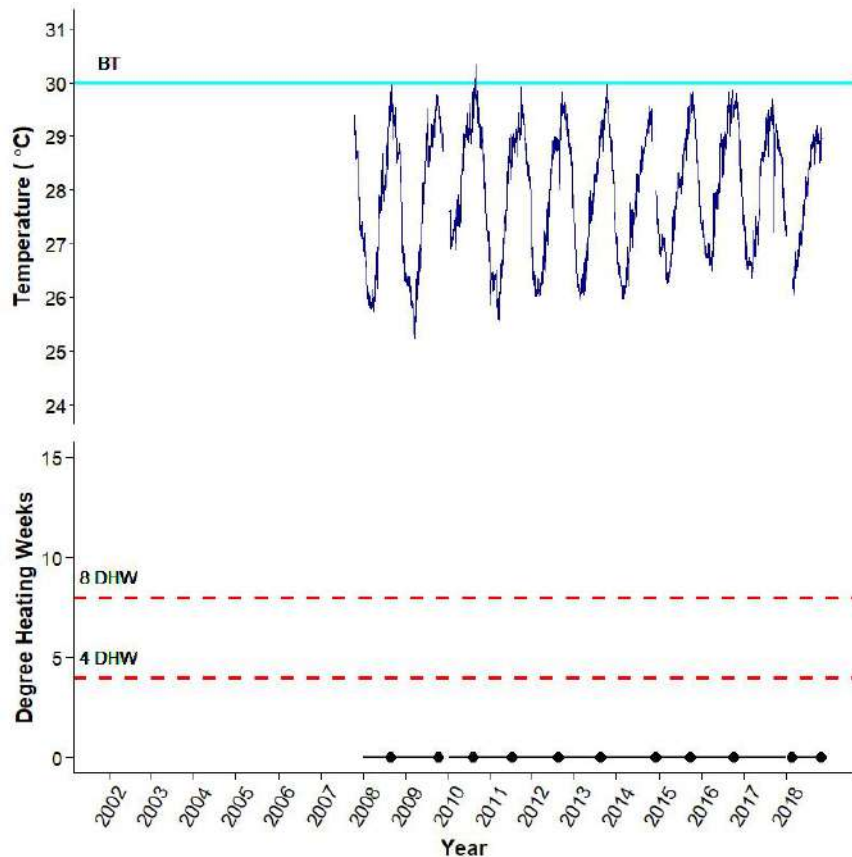


Figure 50. Eagle Ray benthic temperature at 9 m depth

Physical Characteristics

Current. Currents have not been measured at Eagle Ray; however, strong unidirectional currents seem rare. There are increased oscillatory currents near the shallow portion of the site.

Temperature. Eagle Ray is shallow but near deep water on two sides, which may potentially help to reduce the temperature relative to sites in more enclosed environments. The site has no empirically established bleaching threshold.

SITE SUMMARIES

Benthic Community. Eagle Ray supports a diverse community of small coral colonies, but sponges and gorgonians compose half the sessile epibenthic animal community. Coral cover has been low (less than 10%) throughout the monitoring period. Coral cover decreased only slightly with the 2005 coral bleaching event, 11.7%, but cover has come back and actually increased above pre-bleaching values. The limited response may be partly due to the high relative abundance of more thermally resistant coral species. The site was dominated with epilithic algae; however, this has declined after the 2005 bleaching event with a concomitant increase in macroalgae and filamentous cyanobacteria.

Coral Health. Eagle Ray corals were severely affected during the 2005 bleaching event with nearly all colonies bleached over about 80% of the colony surface. Low-level bleaching is also common in years without thermal stress. The site was monitored in 2010 prior to the thermal stress event and bleaching is underestimated for that year. Diseases are a common feature of the site, with black band, yellow band, and dark spots disease having outbreaks in certain years. Lesions were also common during the 2005 coral bleaching event. Old partial mortality became very prevalent after the 2005 coral bleaching event and subsided in the following years.

SITE SUMMARIES

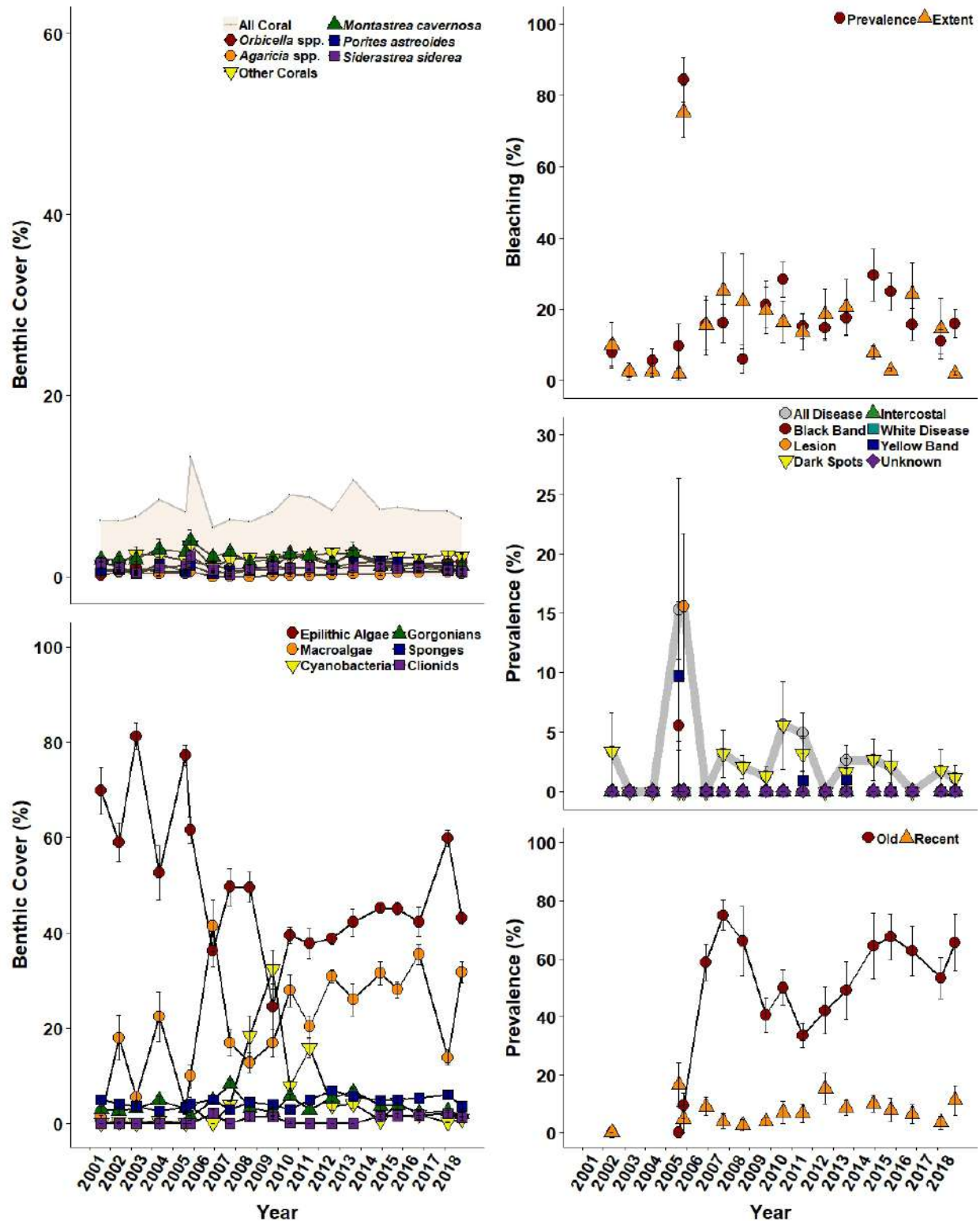


Figure 51. Eagle Ray benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES

Fish Community. Eagle Ray is a diverse and rich site; surprising considering the fishing and diving pressure it receives as well as the land source pollution due to the site's proximity to Christiansted Harbor. It is dominated by herbivores and invertivores, with a strong component of parrotfish, acanthurids and herbaceous damselfishes. Invertivores are led in both abundance and biomass by the nocturnal benthic feeder, the blackbar soldierfish. Proximity to open deep water is evidenced by the occurrence of high numbers of planktivorous creole wrasse, and black durgon and piscivorous large jacks and great barracuda. Yellowtail snapper are large and plentiful, probably due to the divers that frequent the site with fish food. Graysby, coney, schoolmaster and mahogany snapper comprise the benthic piscivore guild. No large serranids or lutjanids are ever observed on Eagle Ray. However Caribbean reef sharks are recorded at the site and overall the fish community remains high in overall biomass and species richness.

SITE SUMMARIES

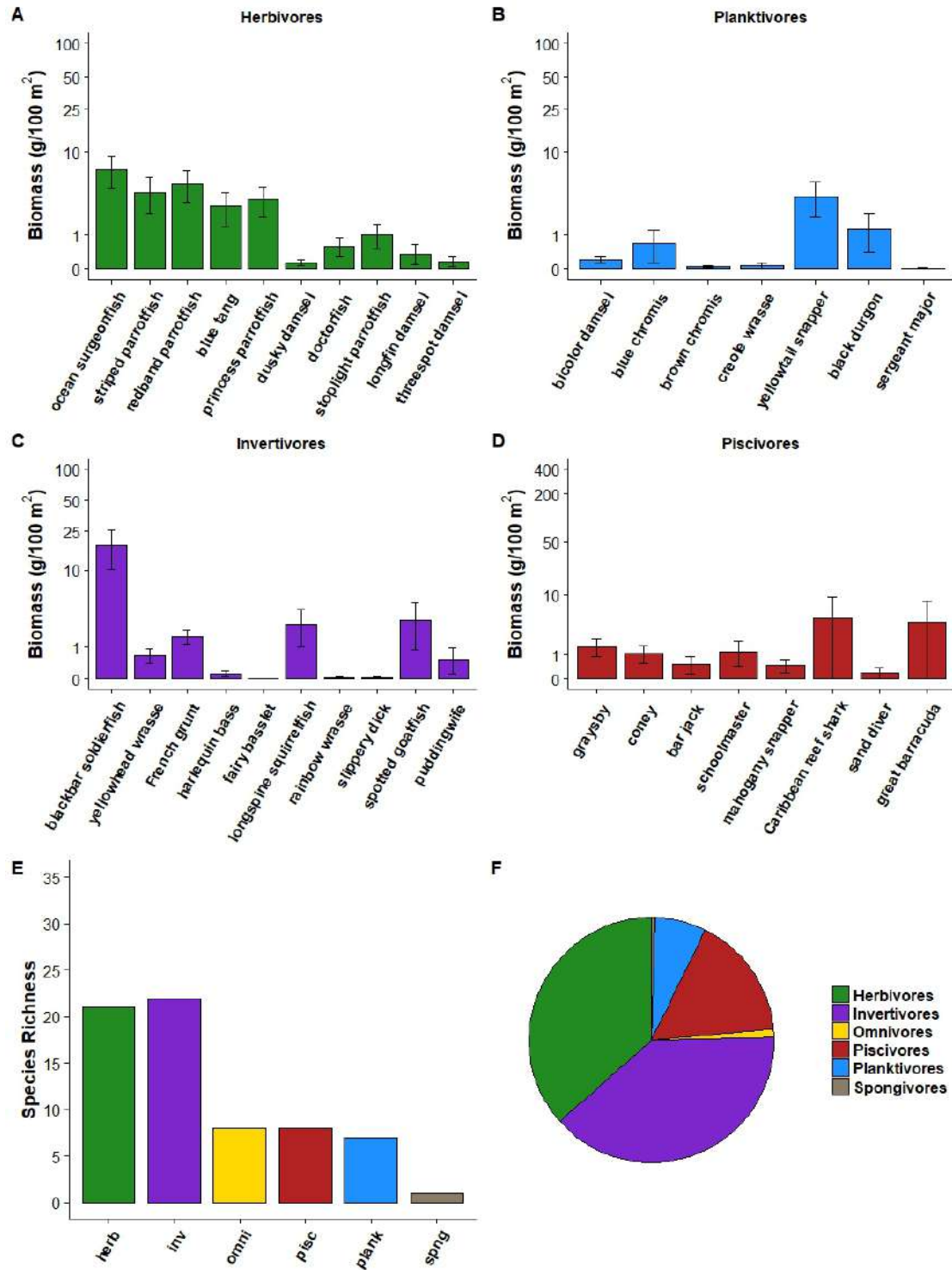


Figure 52. The Eagle Ray fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

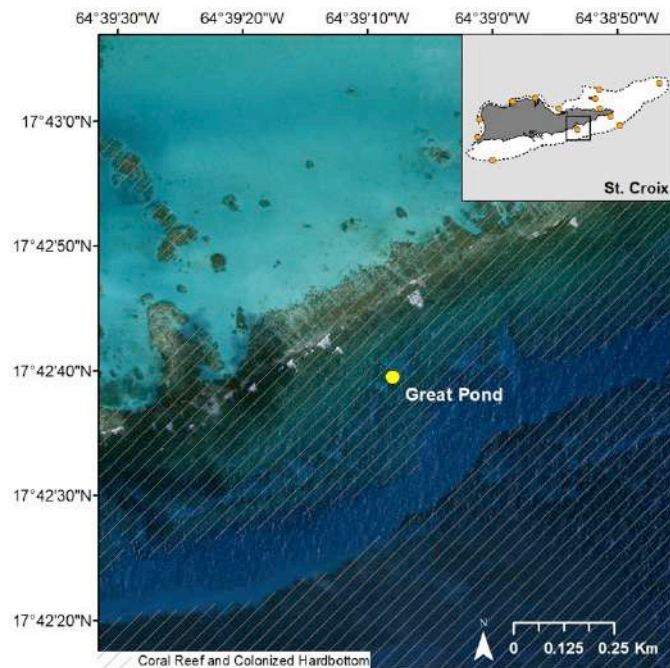
GREAT POND

Description. The Great Pond monitoring site is a wave-washed shallow barrier reef that was formerly an elkhorn coral reef in depths of 5-7 m. The reef is part of the barrier reef front surrounded by patch reefs and sand. Great Pond has been monitored since 2003.

Outstanding Feature. Great Pond hosts the largest population of the black spiny urchin *Diadema antillarum* of any TCRMP monitoring site, likely because of its shallow depth. It also hosts an abundance of large-bodied stoplight (*Sparisoma virde*) and yellowfin parrotfish (*Sparisoma rubripinne*) that likely spawn near the site.

Threats. The Great Pond monitoring site is located in the St. Croix East End Marine Park but outside the no-take fishery zone. If park rules are enforced, this site could see a return of fisheries species by spillover from adjacent protected areas. Because of high turbulence and low watershed development, sediment is not considered a problem; however, large industrial sites operate within 3-10 km westward and could contribute to pollution.

Figure 53. (top) Great Pond location. (right) A representative photo of the reef.



SITE SUMMARIES

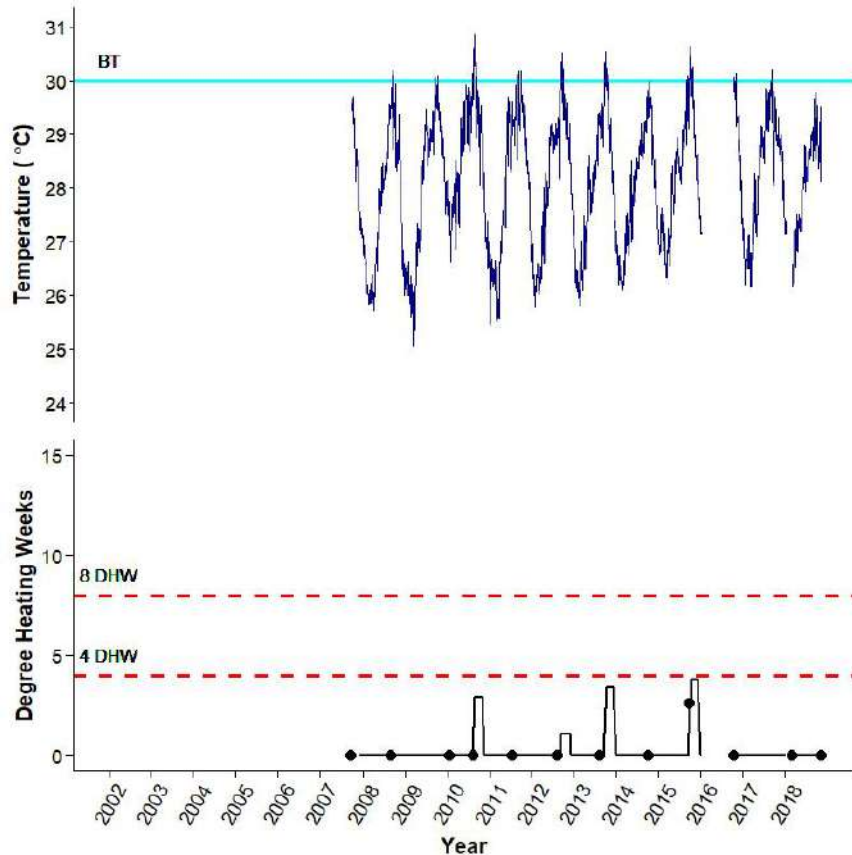


Figure 54. Great Pond benthic temperature (5 m depth).

Physical Characteristics

Current. Great Pond currents have not been measured directly. Wave-generated oscillatory currents dominate and this is the most regularly swell-influenced site in the TCRMP making work conditions difficult on all but the calmest day. Strong unidirectional currents have not been experienced.

Temperature. Great Pond typically experiences very high temperatures in August to October, with temperatures peaking at nearly 31°C in 2010.

SITE SUMMARIES

Benthic Community. The Great Pond site is unusually dominated with the mustard hill coral (*Porites astreoides*) and *Pseudodiploria strigosa*. It is also the only site with a relatively high abundance of *Pseudodiploria clivosa*. The site lost 55.9% of its coral cover in the 2005 bleaching event, but has regained about half as of 2011. Macroalgal blooms occur occasionally (2007 and 2011), but the site is dominated by epilithic algae.

Coral Health. Great Pond corals were moderately affected during the 2005 coral bleaching event, which may be a reflection of the high composition of resistant coral species and the regular exposure to high temperatures. The site was not monitored during the height of the 2010 coral bleaching event. Patchy, low-level bleaching is common in some years. Diseases have been almost non-existent at the monitoring site. Partial mortality is variable and has not shown consistent trends over years.

SITE SUMMARIES

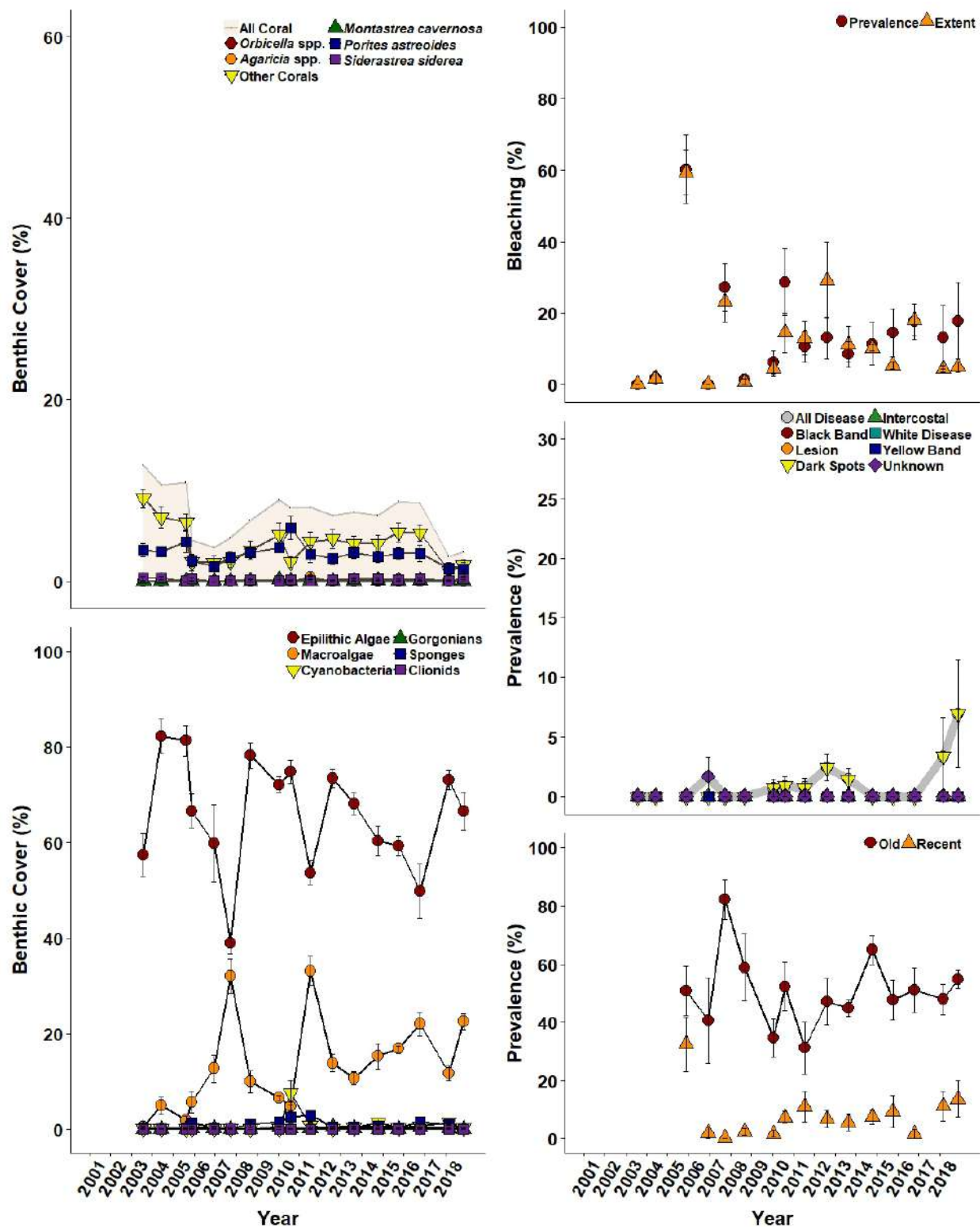


Figure 55. Great Pond benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES

Fish Community. The Great Pond fish community is highly dominated by herbivores. The primary herbivores at the site are the ocean surgeonfish and blue tang, which swim in foraging schools feeding on algae covering the relict elkhorn coral. Also present are the stoplight, yellowtail and queen parrotfish, which can also be seen foraging in large groups on old elkhorn skeletal remains. Quite possibly these fish are spawning in the late afternoon and evening hours at or near the site. Between the old relic *Acropora* stands the fish biomass is low and is primarily made up of yellow goatfish, wrasses, and schools of juvenile parrotfish. Piscivores at Great Pond are limited almost entirely to mahogany snapper and bar jacks, with the occasional mackerel or schoolmaster snapper. Benthic invertivores are dominated in biomass and abundance by wrasses. Wrasse diversity is high and includes the slippery dick, clown wrasse, yellowhead and bluehead wrasse, rainbow wrasse, puddingwife, and Spanish hogfish.

SITE SUMMARIES

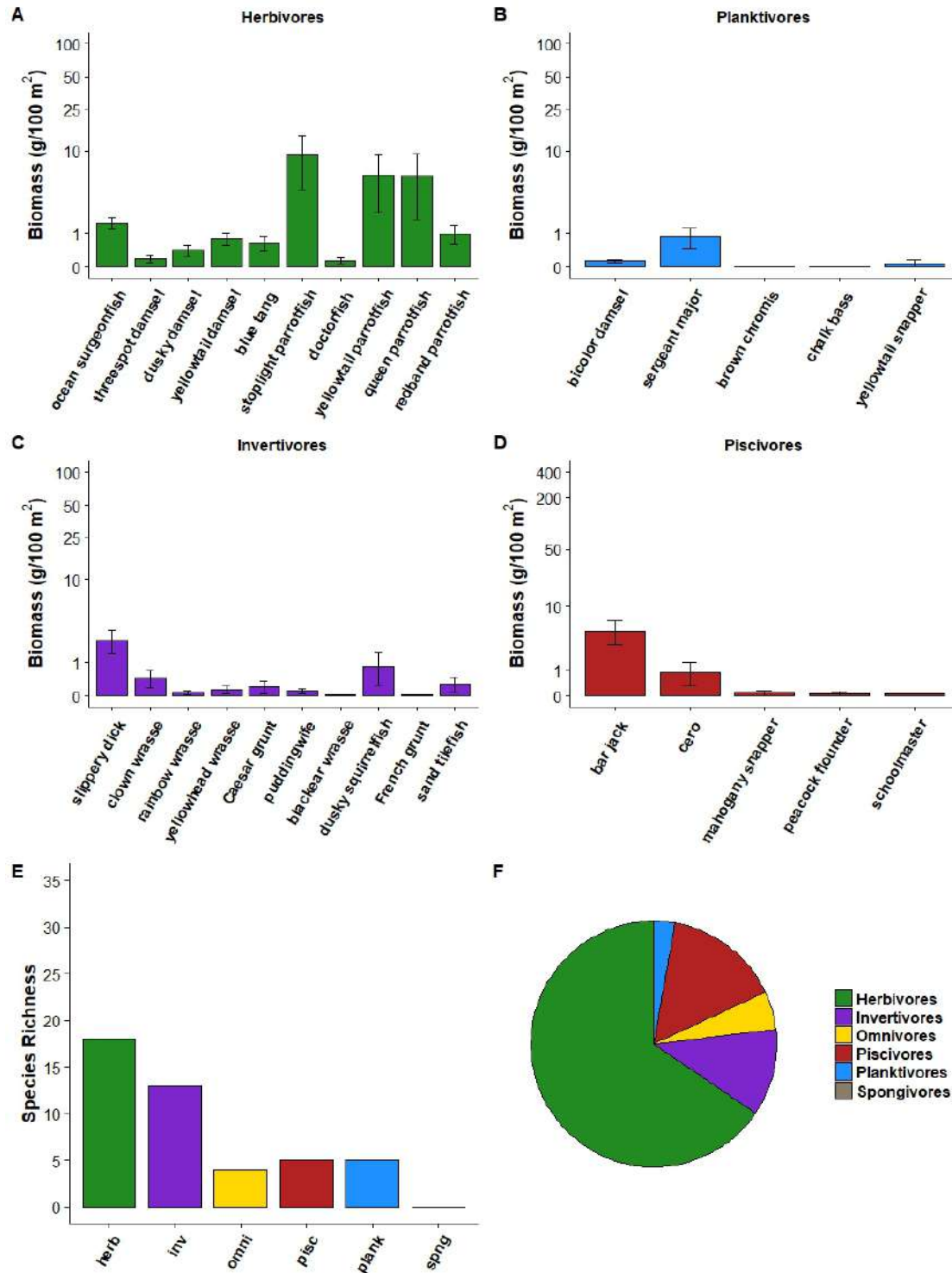


Figure 56. The Great Pond fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

JACKS BAY

Description. The Jacks Bay monitoring site (aka Jacks/Isaacs Bay) is part of fringing reef, colonized hardbottom on the southeast point of St. Croix in water depths of 13-16 m. The monitoring site is just inward from the shelf break and seaward reef slope, which terminates in a sand plain at about 20 m depth. Jacks Bay is largely a carbonate hardbottom with scattered hard coral, although there are some large coral heads seaward of the transects. Permanent transects were installed at Jacks Bay in 2001.

Outstanding Feature. Jacks Bay hosts a unique fish community with high abundance of small wrasses and the occasional occurrence of red hind (*Epinephelus guttatus*).

Threats. Jacks Bay is within the St. Croix East End Marine Park but lies just outside the restricted fisheries area and is open to fishing. High turbulence and no watershed development mean there is low threat of land-based sources of pollution at this nearshore site.

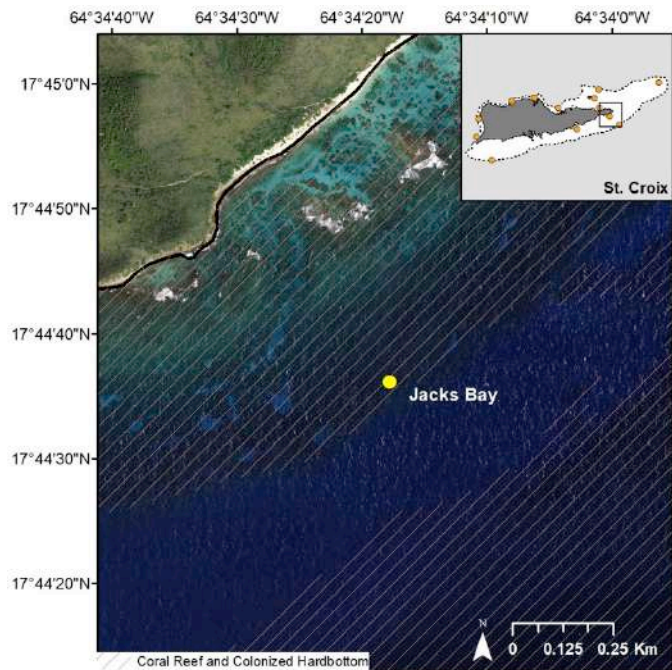


Figure 57. (top) Jacks Bay location. (right) A representative photo of the reef.



SITE SUMMARIES

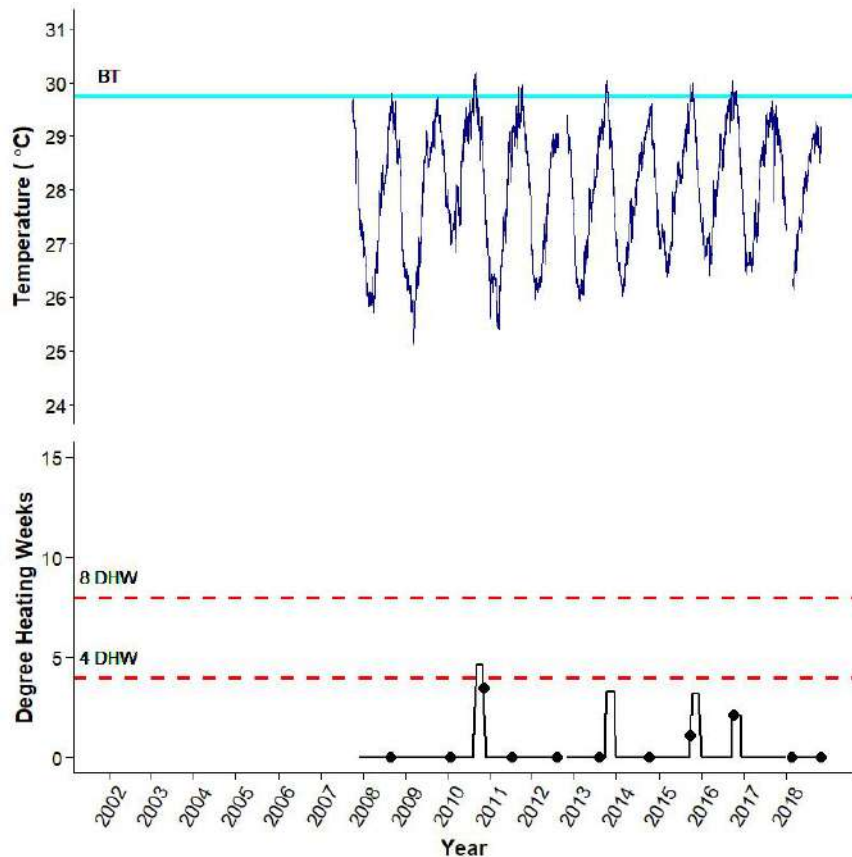


Figure 58. Jacks Bay benthic temperature at 12 m depth

Physical Characteristics

Current. Jacks Bay currents have not been measured directly. There are weak unidirectional currents, but there is a propensity for strong wave-generated oscillatory currents due the open coast southeast exposure.

Temperature. Jacks Bay can experience high temperatures during August to October.

SITE SUMMARIES

Benthic Community. The Jacks Bay site has low coral cover (<10%) and is the only TCRMP site dominated by the great star coral *Montastraea cavernosa*. Jacks Bay lost 44.7% of its coral cover in the 2005 coral bleaching event, but had regained about 32% of the loss by 2011. Over half of the sessile epibenthic community is composed of gorgonians and sponges and the site might be considered more a colonized hardbottom than true coral reef. The algal community is composed of high proportions each of epilithic algae, macroalgae, and filamentous cyanobacteria. The site also shows a high degree of sand intermixed with filamentous algae, an important deterrent for coral larval settlement (Bellwood and Fulton 2008). This site is often colonized by fleshy upright brown algae, such as *Turbinaria turbinata* and *Sargassum hystrix* (species unconfirmed). Very large beach wrack of these brown algae can often accumulate on the windward beaches behind the site.

Coral Health. The Jacks Bay site was strongly affected during the 2005 bleaching event and was moderately affected during the 2010 bleaching event. Disease prevalence was low and only dark spots disease was present. Recent partial mortality was high during the 2005 bleaching event, likely reflecting the fact that surveys were conducted in November 2005 when mortality had begun. Old partial mortality increased greatly after the 2005 bleaching and then declined to stable levels in 2009-2011.

SITE SUMMARIES

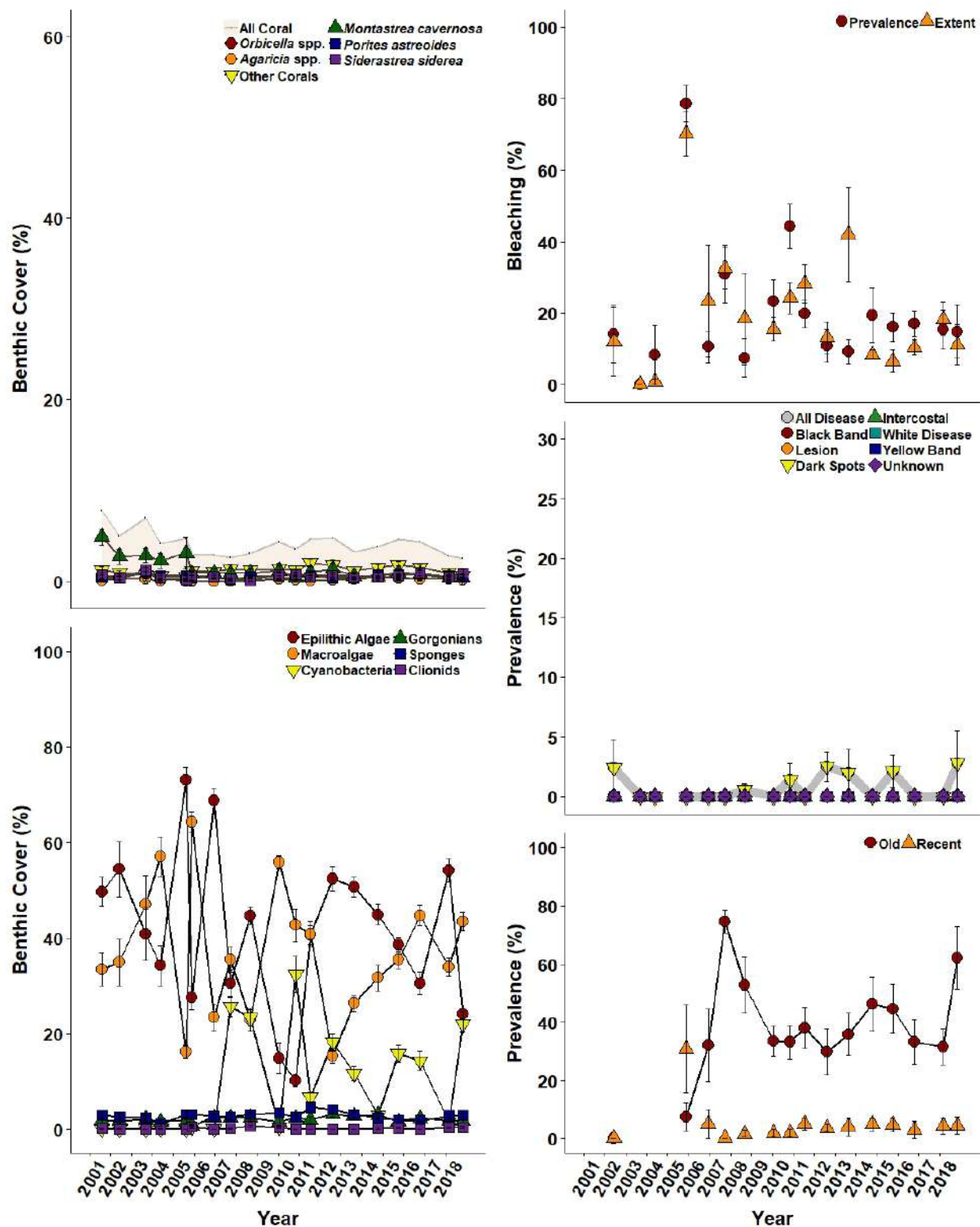


Figure 59. Jacks Bay benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. The Jacks Bay fish community is characterized by very low fish biomass and abundance but relatively high diversity. Total fish biomass is disproportionately made up of small herbivores. The site is primarily hard bottom, adjacent to more developed coral reef on the seaward edge, over which some larger fishes are observed. The hardbottom community is highly dominated numerically by blue chromis, yellowhead wrasse, and bicolor damselfish. Juvenile wrasse and parrotfish swim and hover in mixed schools among the rubble and gorgonians. Slippery dicks, clown wrasse, rainbow wrasse, and blackear wrasse are common. Piscivores are always rare and are usually limited to small coney, graysby, schoolmaster, mahogany snapper and a few jacks. Medium to larger sized benthic species are very rare overall, and when observed at Jacks Bay they are generally seen in the juvenile life history stage.

SITE SUMMARIES

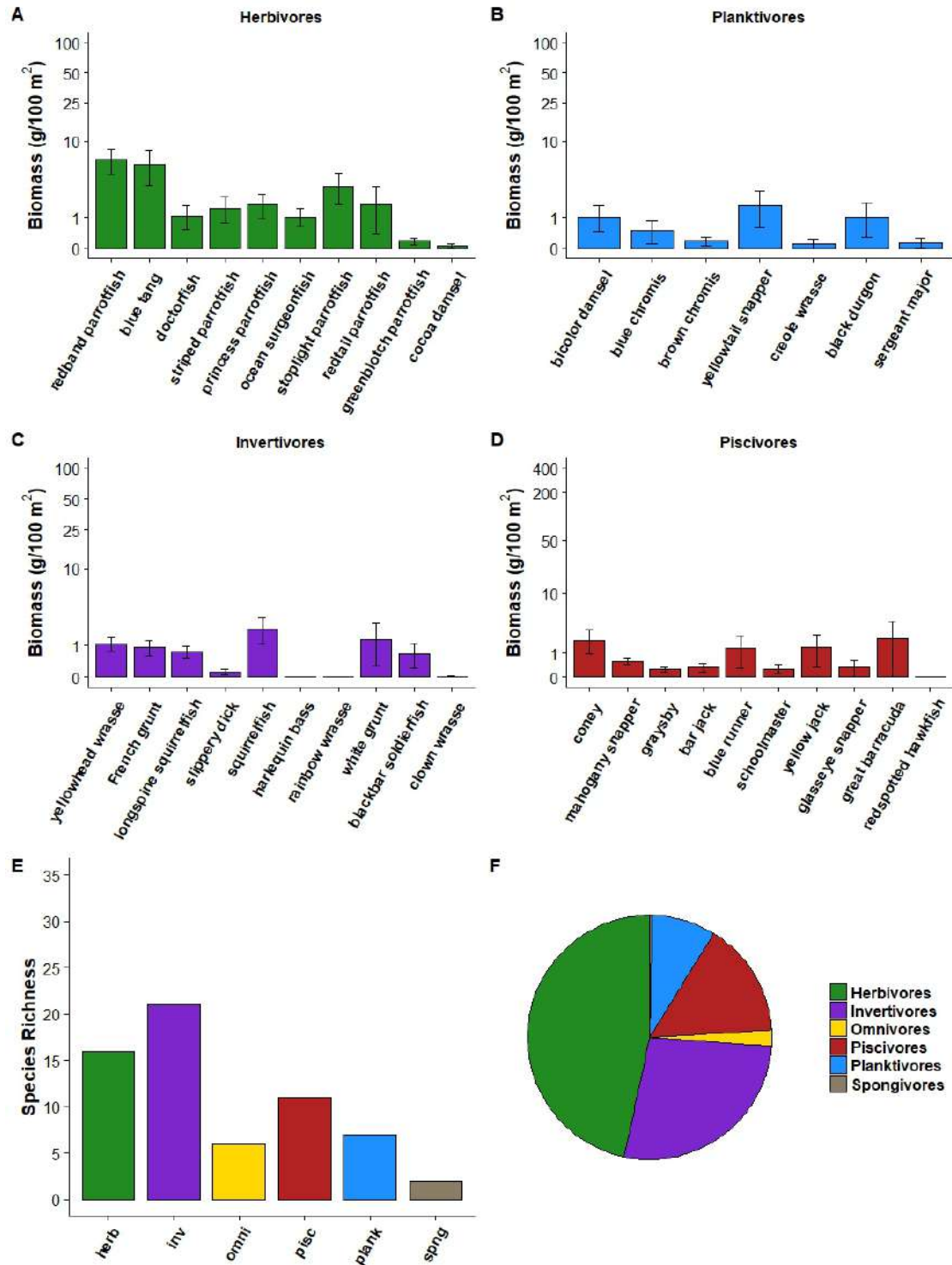


Figure 60. The Jacks Bay fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

KINGS CORNER

Description. The Kings Corner monitoring site is a part of a patchy reef complex along the steeply sloping west coast of St. Croix in depths of 15-25 m. The reef contains a high diversity of corals and sponges on mounds surrounded by sand. Kings Corner has been monitored since 2006, with permanent transects installed in 2007.

Outstanding Feature. Kings Corner is a commercially important recreational dive site. The site supports a high diversity and density of fishes. It is also a very aesthetically pleasing site with high topographic relief.

Threats. Kings Corner is open to fishing and is easily accessible as part of the calm lee of western St. Croix near Frederiksted. Derelict fishing lines, fish traps, fish weights, and other marine debris are in evidence in and around the site. Large plumes of sediment that wrap around Sandy Point from the south coast of St. Croix also periodically affect the site. Plumes can drop visibility to near zero and lead to high incidence of sediment on coral and spotty bleaching.

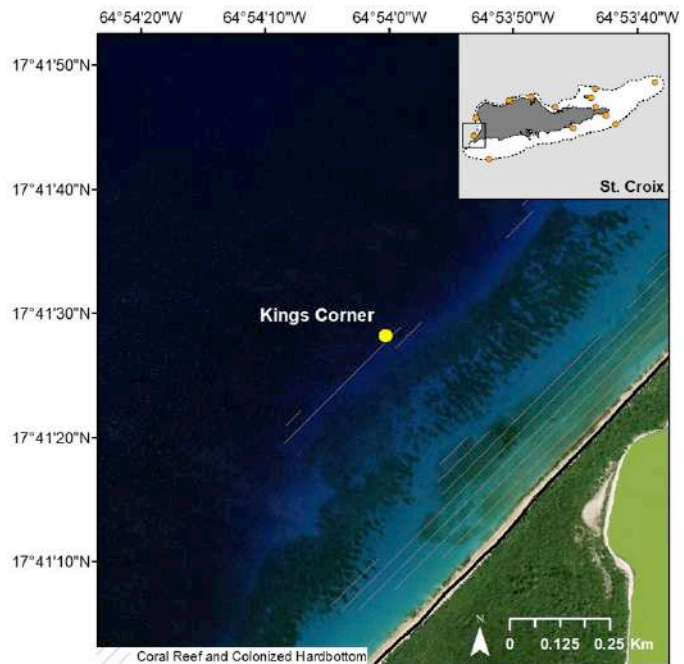
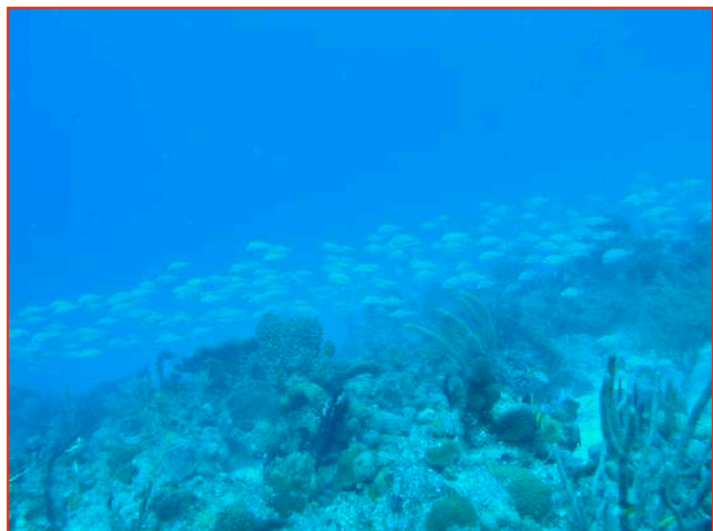


Figure 61. Kings Corner. (top) Location. (right) A representative photo of the reef with a school of lane snapper (*Lutjanus synagris*).



SITE SUMMARIES

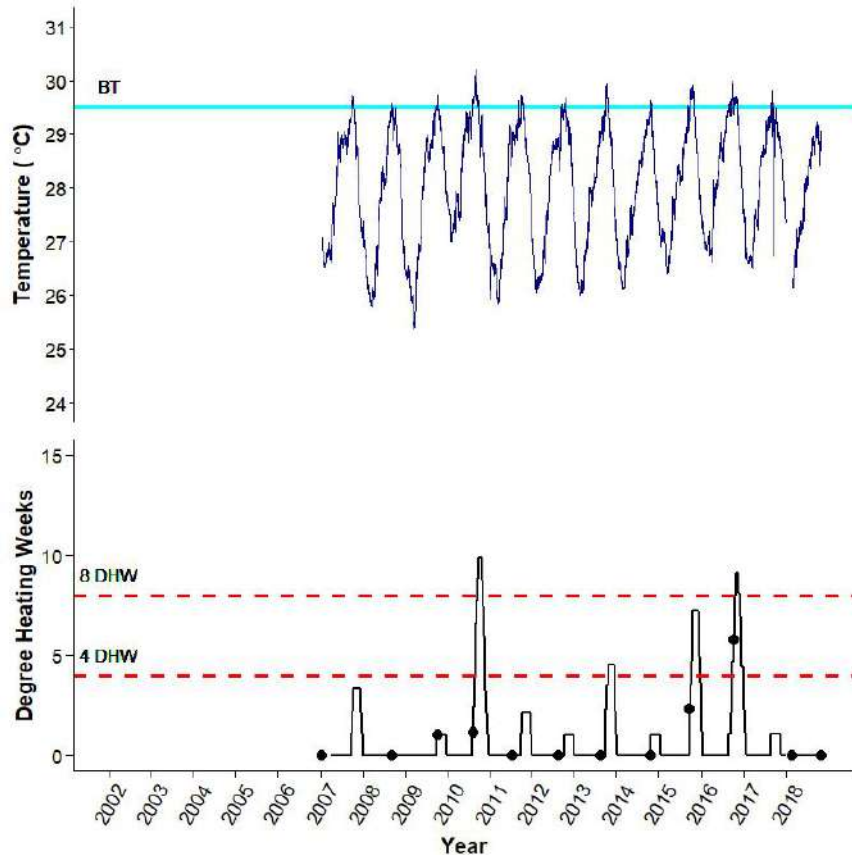


Figure 62. Kings Corner benthic temperature (17 m depth)

Physical Characteristics

Current. Kings Corner currents have not been measured directly. The site is protected from wave action, but can experience strong unidirectional currents at times, particularly at shallower depths.

Temperature. Kings Corner has moderately high temperatures. This site has no empirically established bleaching threshold.

SITE SUMMARIES

Benthic Community. The Kings Corner site supports a diverse community of hard corals dominated by *Orbicella* spp. The site also has a very abundant population of sponges. This site was not monitored until after the 2005 bleaching event, so the impacts on coral cover are not known. An outbreak of white disease in 2012 temporarily reduced coral cover. Epilithic algae dominate the algal community at Kings Corner, with very low abundance of macroalgae and filamentous cyanobacteria. Sand is prominently interspersed among the coral banks.

Coral Health. Non-thermal bleaching with moderate prevalence but low extent on colonies is a common feature at this site, likely as the result of chronic sedimentation. The prevalence of coral diseases has been low with dark spots disease predominating. Old partial mortality has been very high at this site and may be an indication of impacts from the 2005 coral bleaching event. Old partial mortality has increased lately.

SITE SUMMARIES

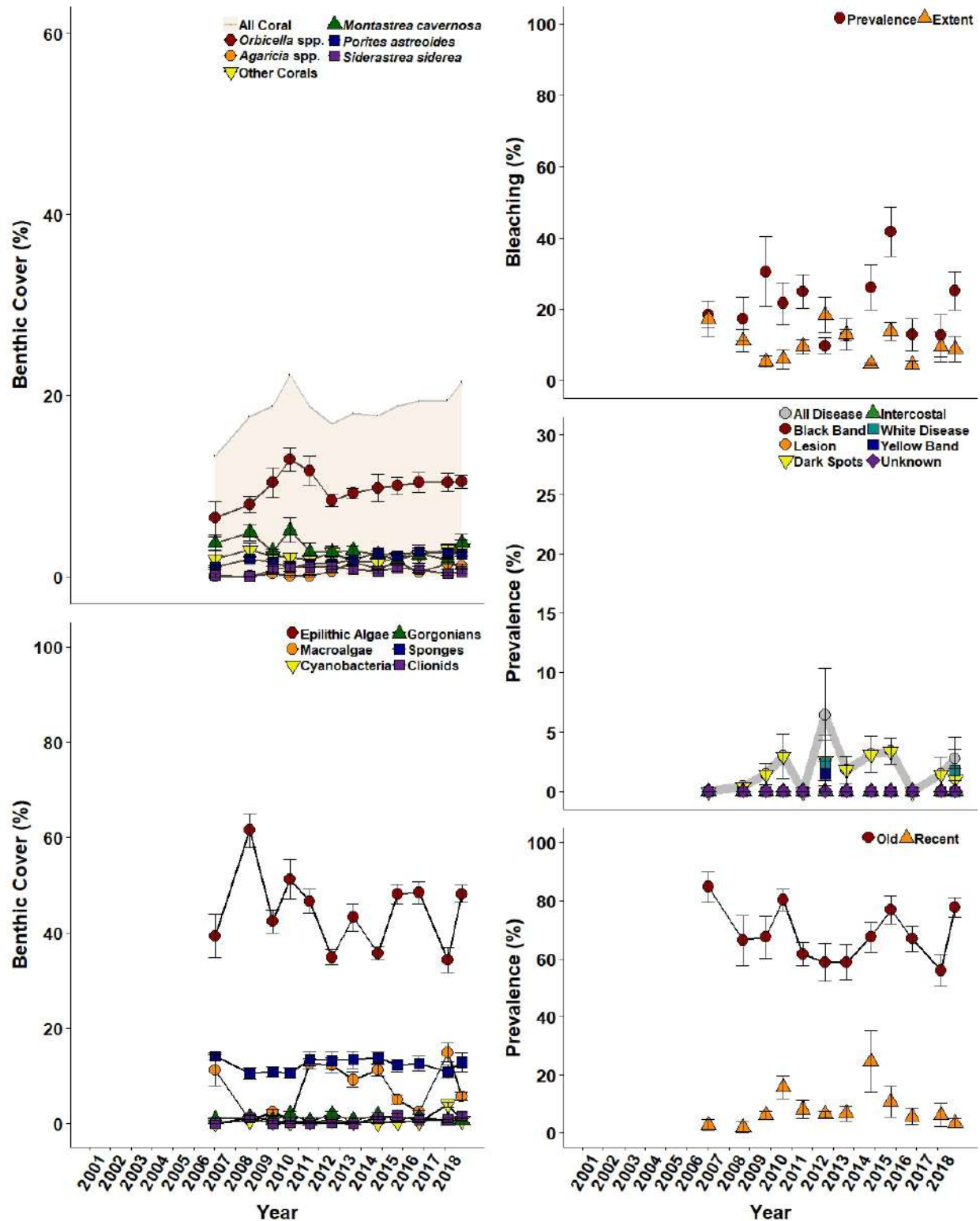


Figure 63. Kings Corner benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. Kings Corner represents the most diverse fish community with the highest fish biomass in the TCRMP monitoring program on St. Croix, with a huge variety of resources available for foraging and habitat. The site is dominated by invertivores, where overall biomass is influenced highly by the large numbers of the nocturnal feeding blackbar soldierfish, a zooplanktivore, and the tomtate, a more opportunistic benthic feeder of invertebrates, zooplankton and benthic algae. Other common planktonic feeders at Kings Corner include the boga, black surgeon, and creole wrasse. Common benthic herbivores include the blue tang and ocean surgeonfish as well as the common Caribbean parrotfishes (stoplight, princess, redband, redfin, queen, and striped). A variety of grunts are common on the site as well as angelfishes and huge moray eels. Mutton snapper are occasional. Piscivores as a group are relatively low in biomass, and are represented by jacks (pelagic), glass-eye snapper and bigeye (nocturnal feeders), and graysby, coney, lionfish, and small snappers (diurnal bottom feeders). No large snappers or groupers have been observed on the site. It is not protected from any fishing pressure.

SITE SUMMARIES

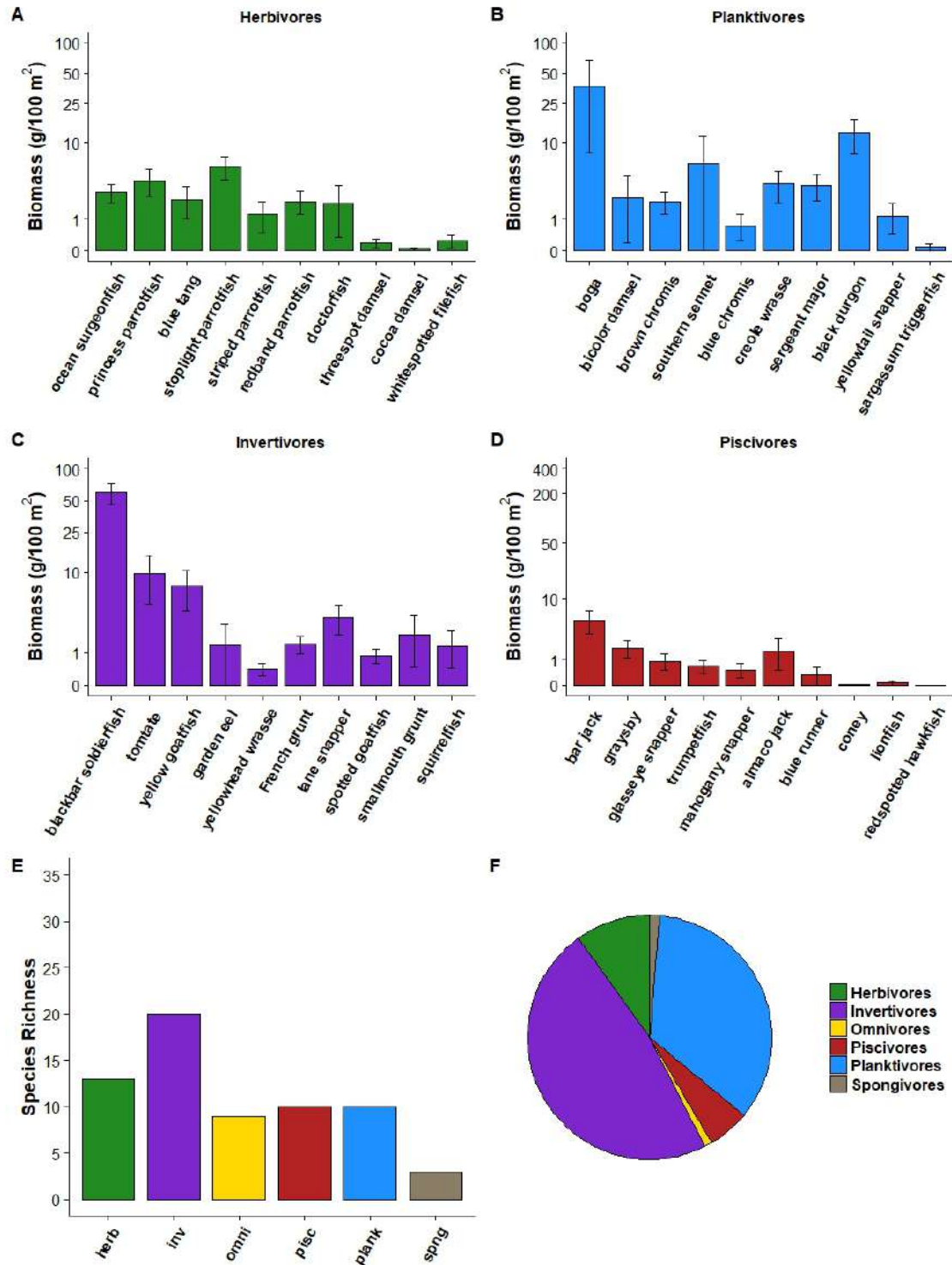


Figure 64. The Kings Corner fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

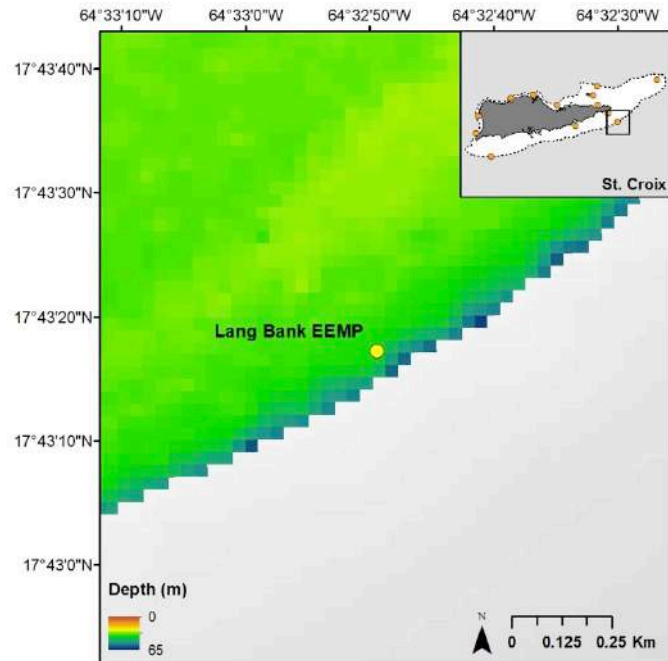
LANG BANK EAST END MARINE PARK

Description. The Lang Bank EEMP site is a shelf edge mesophotic coral reef located at a depth of 27 – 30 m. The monitoring site sits just above a steep shelf break and is composed of rolling coral knolls dominated by boulder star corals (*Orbicella* spp.). This site was established in 2009.

Outstanding Feature. The Lang Bank EEMP site appears to be a well-developed mesophotic boulder star coral reef on St. Croix, which may be relatively rare compared to St. Thomas. Large populations of fishes and spiny lobsters are often encountered.

Threats. The Lang Bank EEMP is in the outer park area and is open to fishing year-round. Its offshore location protects it from land-based sources of pollution.

Figure 65. Lang Bank EEMP. (top) Location. (right) A representative photo of the reef.



SITE SUMMARIES

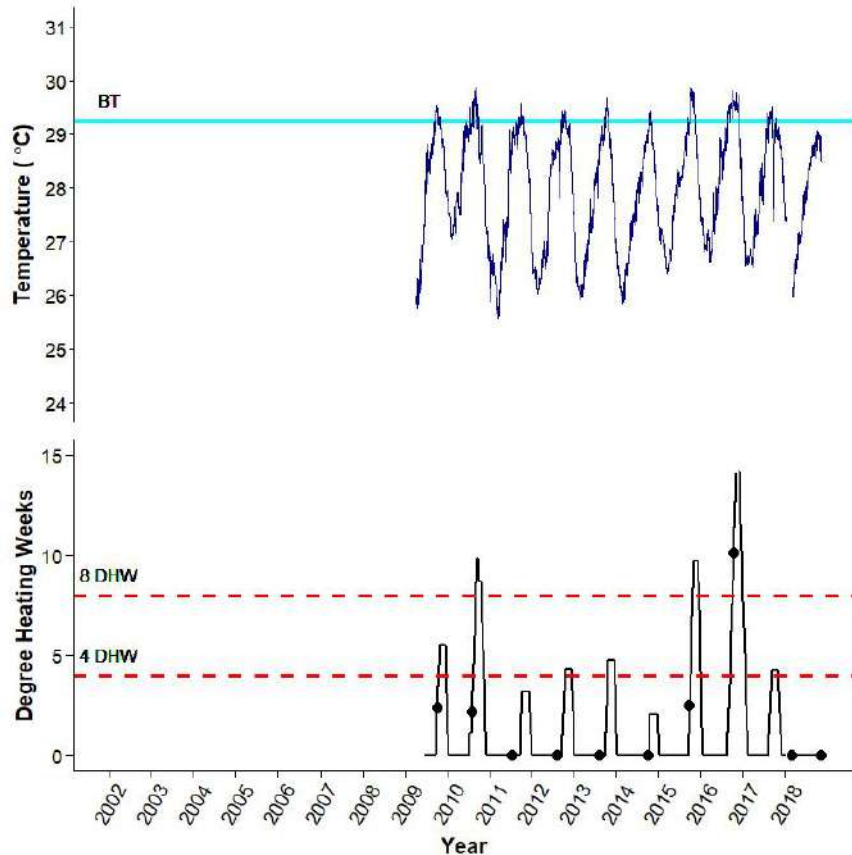


Figure 66. Lang Bank EEMP benthic temperature (28 m depth).

Physical Characteristics

Current. Direct current measurements have not been taken at Lang Bank EEMP. The depth buffers the site from wave-driven oscillatory currents. Only weak unidirectional benthic currents have been experienced at the site during monitoring; however, midwater and surface currents can be moderate to strong ($>10\text{cm s}^{-1}$).

Temperature. Lang Bank EEMP has temperature that is reduced relative to shallow water sites. However, the bleaching threshold has not been established and here is based on a relationship between depth. The modeled bleaching threshold is likely too low given that there was an estimate 9 DHW in 2016, yet bleaching was not elevated.

SITE SUMMARIES

Benthic Community. Lang Bank EEMP supports many coral species but is dominated by *Orbicella* spp.. Sponges are also quite prominent and make up a quarter of the sessile epibenthic animal community. Epilithic algae, *Lobophora variegata*, and filamentous cyanobacteria near equally represent the algal community. The prominence of filamentous cyanobacteria is quite striking and has reached almost 40% of the substrate in some years.

Coral Health. Background, non-thermal bleaching prevalence is quite high at Lang Bank EEMP. White disease showed an outbreak in 2011. Lang Bank EEMP was not initially monitored until well after the 2005 coral bleaching event; however, a high prevalence of old partial mortality suggests that corals were impacted. Many of the large faviids show lesion patterns that are consistent with the large lunate dead areas caused by white diseases following bleaching in 2005.

SITE SUMMARIES

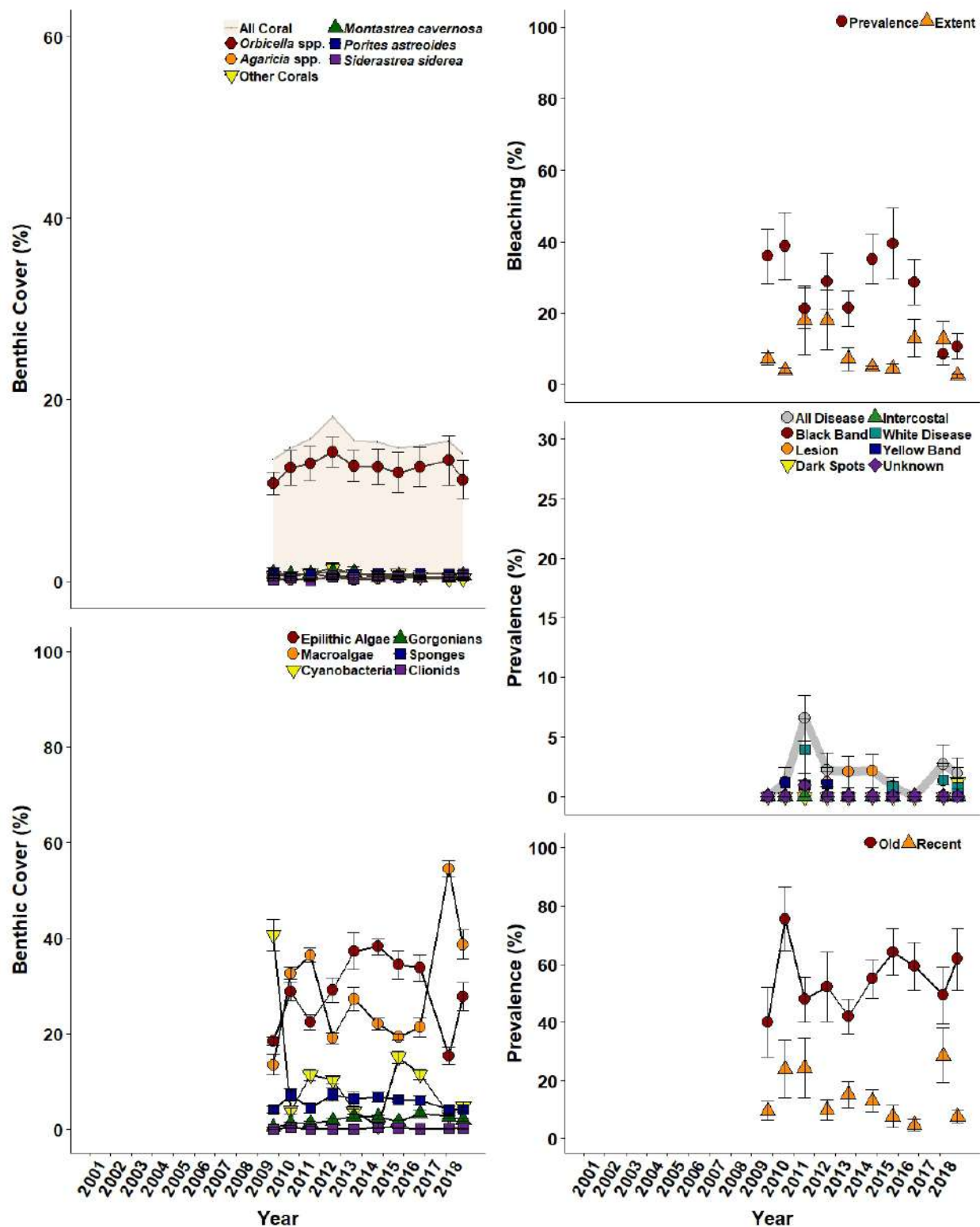


Figure 67. Lang Bank EEMP benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. The Lang Bank East End Marine Park site represents a mesophotic reef community that is characterized by a high biomass of planktonic feeders and a low biomass of herbivores. The high overall biomass of planktivores is influenced by the ocean triggerfish and black durgon, while numerically blue chromis and creole wrasse are dominant. Benthic herbivores are dominated both numerically and in biomass by the ocean surgeonfish, redband parrotfish, and stoplight parrotfish. Benthic invertivores at the site are diverse and include nocturnally feeding blackbar soldierfish and squirrelfish, as well as several species of grunt (French, tomtate, white, bluestriped, Caesar, and smallmouth), red hind and several wrasse species. Piscivores are generally dominated in biomass by jacks, barracuda and Caribbean reef sharks, however, coney, graysby, schoolmaster and mahogany snapper contribute as benthic piscivores. There have been no large snappers or groupers recorded there. The Lang Bank East End Marine Park is now protected from fishing, so there is hope that large snappers and groupers will return to this rich mesophotic community.

SITE SUMMARIES

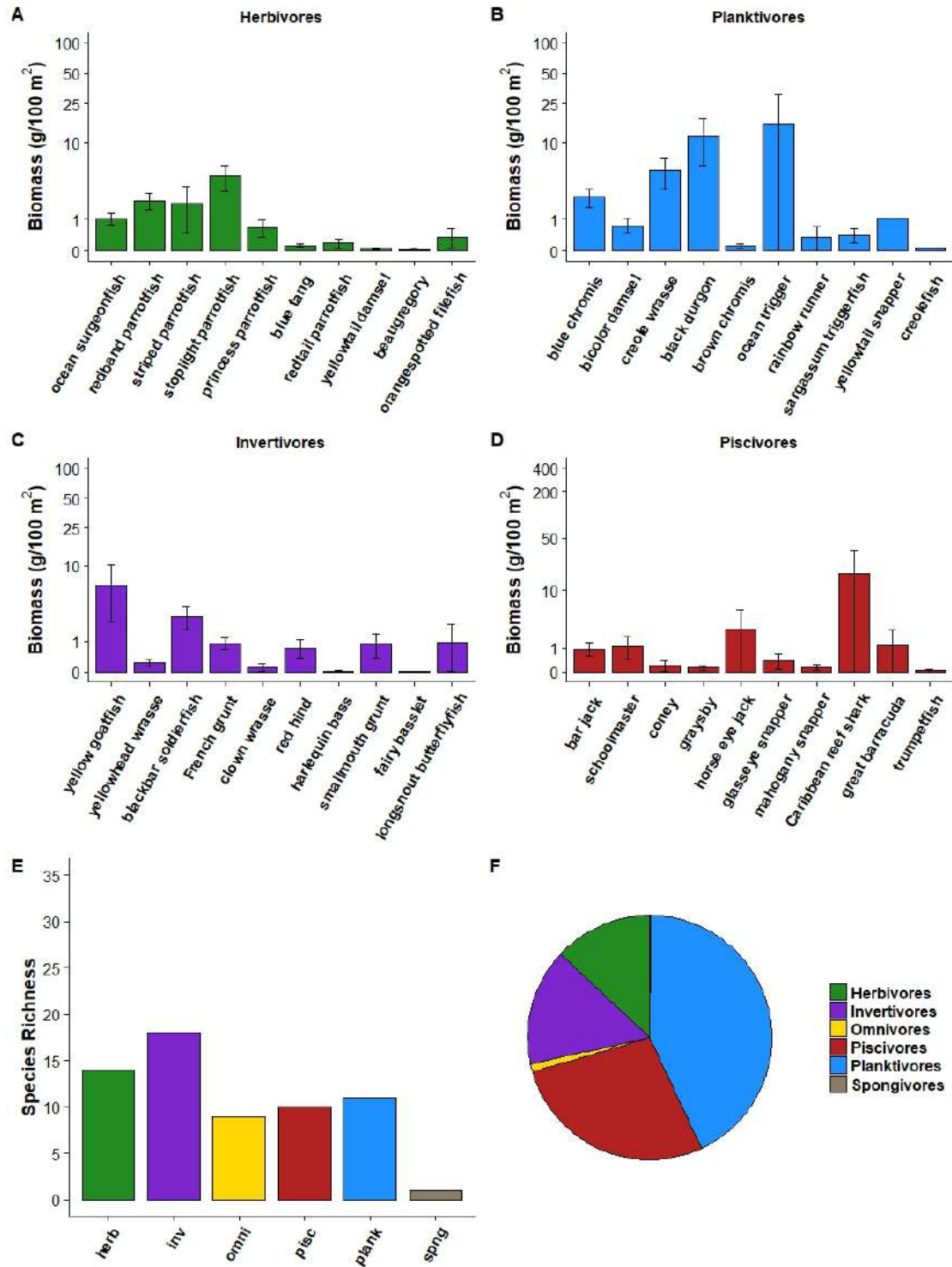
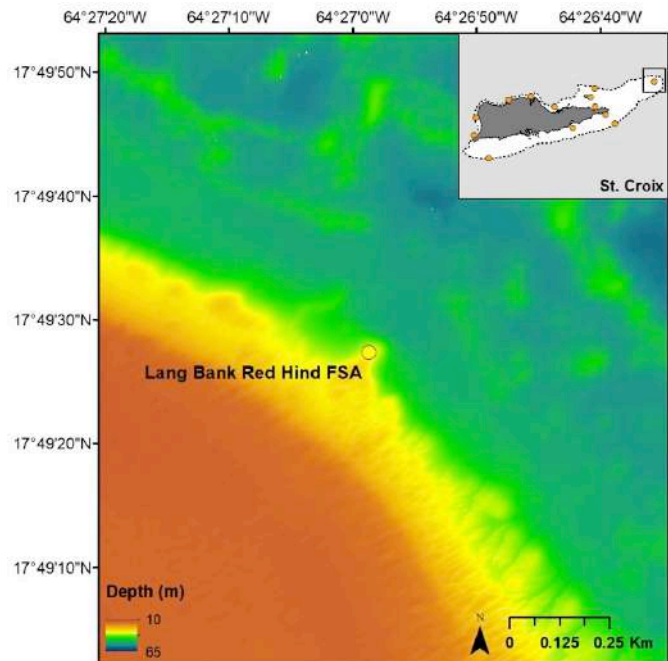


Figure 68. The Lang Bank EEMP fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

LANG BANK RED HIND FISH SPAWNING AGGREGATION

Description. The Lang Bank Red Hind Fish Spawning Aggregation (Lang Hind) monitoring site is a mesophotic reef of antecedent spur and groove structure at a depth of 30 – 35 m. The site is perched on the southeast side of the spur, which is a large finger that rises to 24 m to the west and drops on all other sides to a rhodolith/sand plain at about 50 m. Lang Hind was initially monitored in 2001 at a site on the shallower (24 m) portion of the bank to the west. Monitoring in 2004-2007 occurred along random transects in a deeper portion of the reef (~33 m depth) and benthic transects were made permanent in this area in 2009



Outstanding Feature. Lang Hind supports an annual fish spawning aggregation of the red hind (*Epinephelus guttatus*). This site also possesses high water clarity.

Threats. The Lang Hind site is removed from land-based stressors. Fishing of the red hind aggregation was common prior to closure of the area to fishing in 1993. However, the aggregation is near the closure boundary.

Figure 69. Lang Bank Red Hind FSA. (top) Location. (right) A representative photo of the reef



SITE SUMMARIES

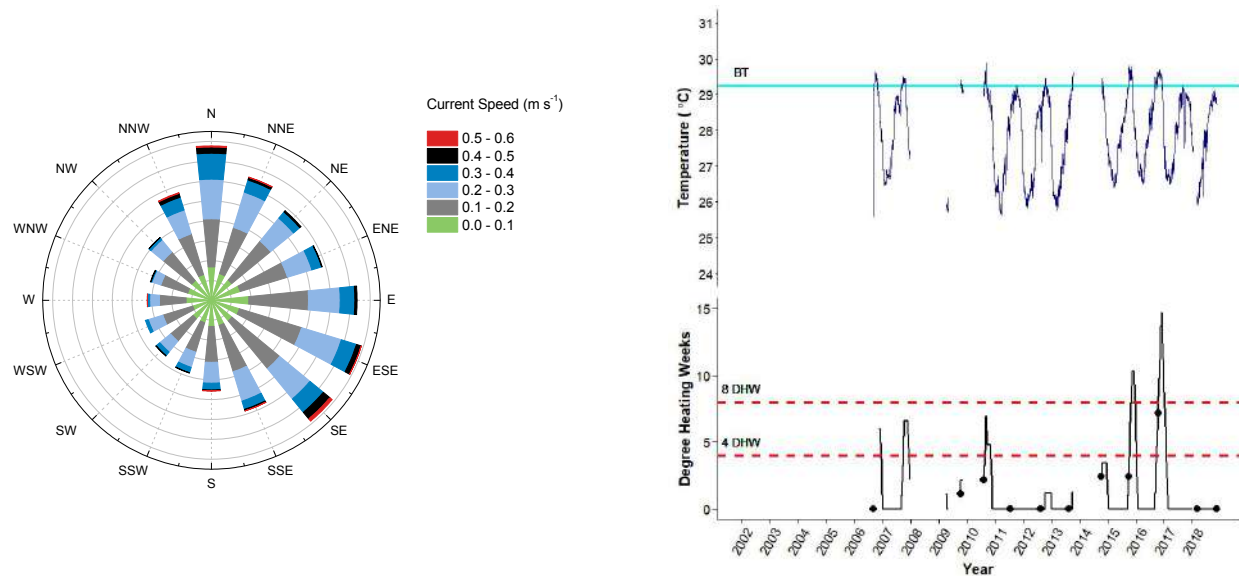


Figure 70. Lang Bank Hind current speed (left) and benthic temperature (right; 33 m depth).

Physical Characteristics

Current. Lang Hind had benthic currents recorded with ADCP every 30 minutes from 11/20/05 to 8/20/06, and 12/11/06 to 3/10/07. Bottom currents most typically alternate between north and southeast and can attain strong speeds periodically exceeding 0.4 m s^{-1} .

Temperature. Lang Hind has temperatures that are reduced due to the depth and proximity of the warm season thermocline. However, temperatures are not as cool or variable as sites on the southern Puerto Rican shelf, indicating that this site may be more susceptible to warming ocean temperatures. There is no empirically established bleaching threshold and the one displayed is based on a depth – bleaching threshold model (Smith et al. 2016a). The site-specific bleaching threshold is likely higher than the model because there was low-level bleaching when the site was monitored in 2016, but a predicted 8 DHW, the predicted point of mass coral bleaching (NOAA 2006).

SITE SUMMARIES

Benthic Community. Lang Hind has a diverse sessile epibenthic community dominated by hard corals, predominantly *Orbicella* spp., gorgonians, and sponges. Coral cover actually increased by 110% between the coral bleaching event and re-monitoring in 2006, but this may reflect the fact that transects were laid in random, rather than permanent, locations prior to 2009. The algal community is largely open epilithic algal communities, but also contains large proportions of *Lobophora variegata* and filamentous cyanobacteria. The algal community shows high inter-annual variability.

Coral Health. Lang Hind FSA was heavily affected during the 2005 coral bleaching event, with a very high prevalence of corals that were 100% bleached over the colony surface. Non-thermal bleaching with moderate prevalence and low extent on colonies also occurred in later years. The site was heavily affected with white diseases after the coral bleaching event and has had high disease prevalence in all years of monitoring. Old partial mortality jumped after the 2005 bleaching event and was variable in later years. Recent partial mortality is unusually high at Lang Hind, largely as the result of fish bites and predation by the corallivorous snail *Coralliophila* spp.

SITE SUMMARIES

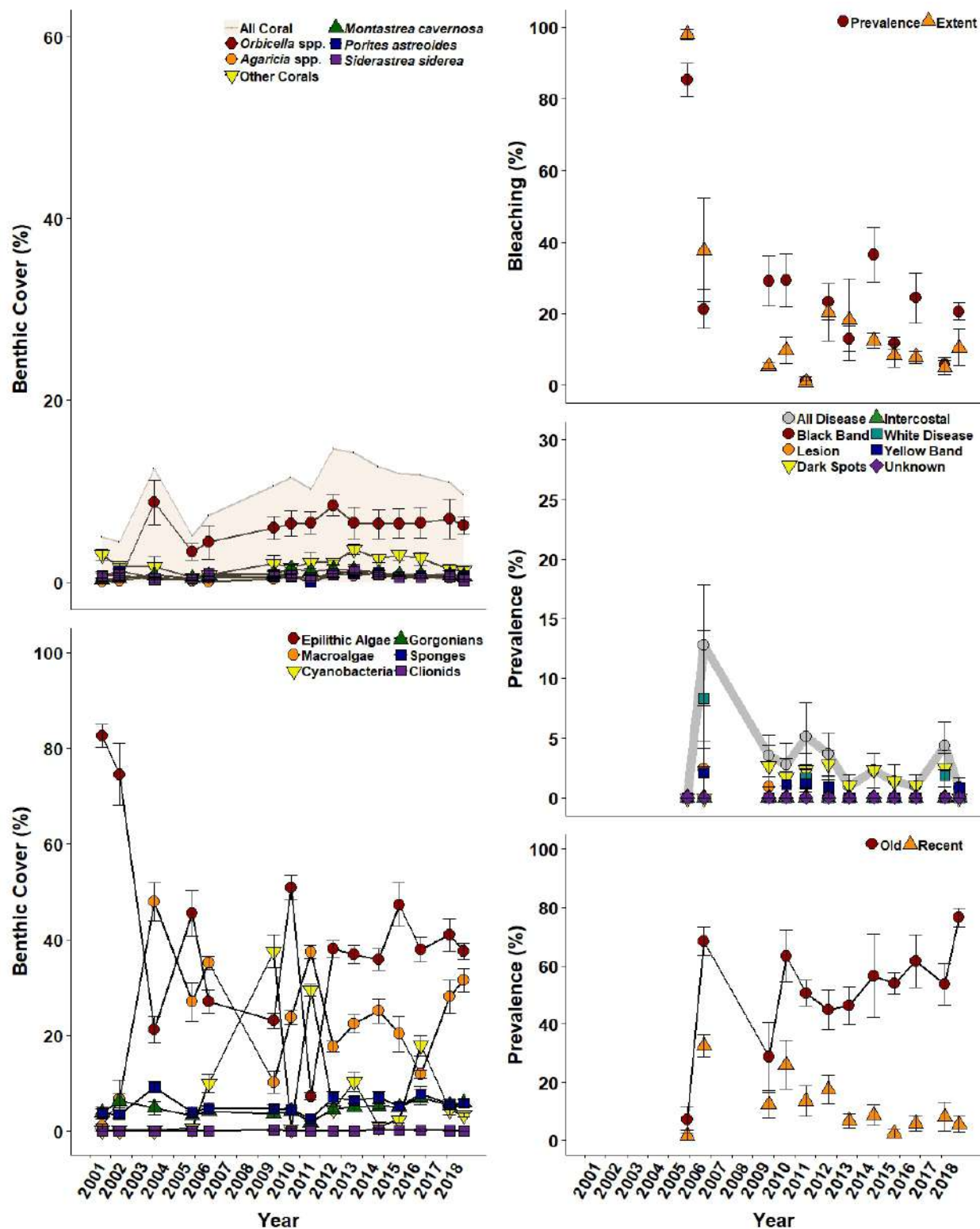


Figure 71. Lang Bank Red HindFSA benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. The fish community at Lang Bank FSA is representative of a St. Croix mesophotic reef system. High water column planktonic feeders are abundant and include the black durgelon, creole wrasse, black jack, and creolefish. Bicolor damselfish are numerous while herbivorous damselfishes are uncommon. Benthic herbivores are relatively low in diversity, abundance and biomass compared to nearshore sites. Invertivores are diverse and include many planktivores as well as benthic feeders, utilizing the varied resources of the bank. Four species of angelfish were observed on transects reflecting the high sponge cover. Lang Bank FSA supports a red hind spawning site, active during December through February each year, and red hind are occasionally seen on both roving dives and transects. One Nassau grouper was observed on the bank in 2011, a first observation across all St. Croix monitoring sites. There is reportedly a historic Nassau grouper spawning site near the Lang Hind monitoring site, and with the bank now closed to trap fishing there is hope of some re-establishment of the species on St. Croix. In 2018 a yellowfin grouper was reported on Lang Bank FSA. This is also a new TCRMP St. Croix record. The mahogany snapper dominates in abundance the piscivorous fish community on Lang Bank FSA. Other important piscivores include the great barracuda, coney, graysby and Caribbean reef shark.

SITE SUMMARIES

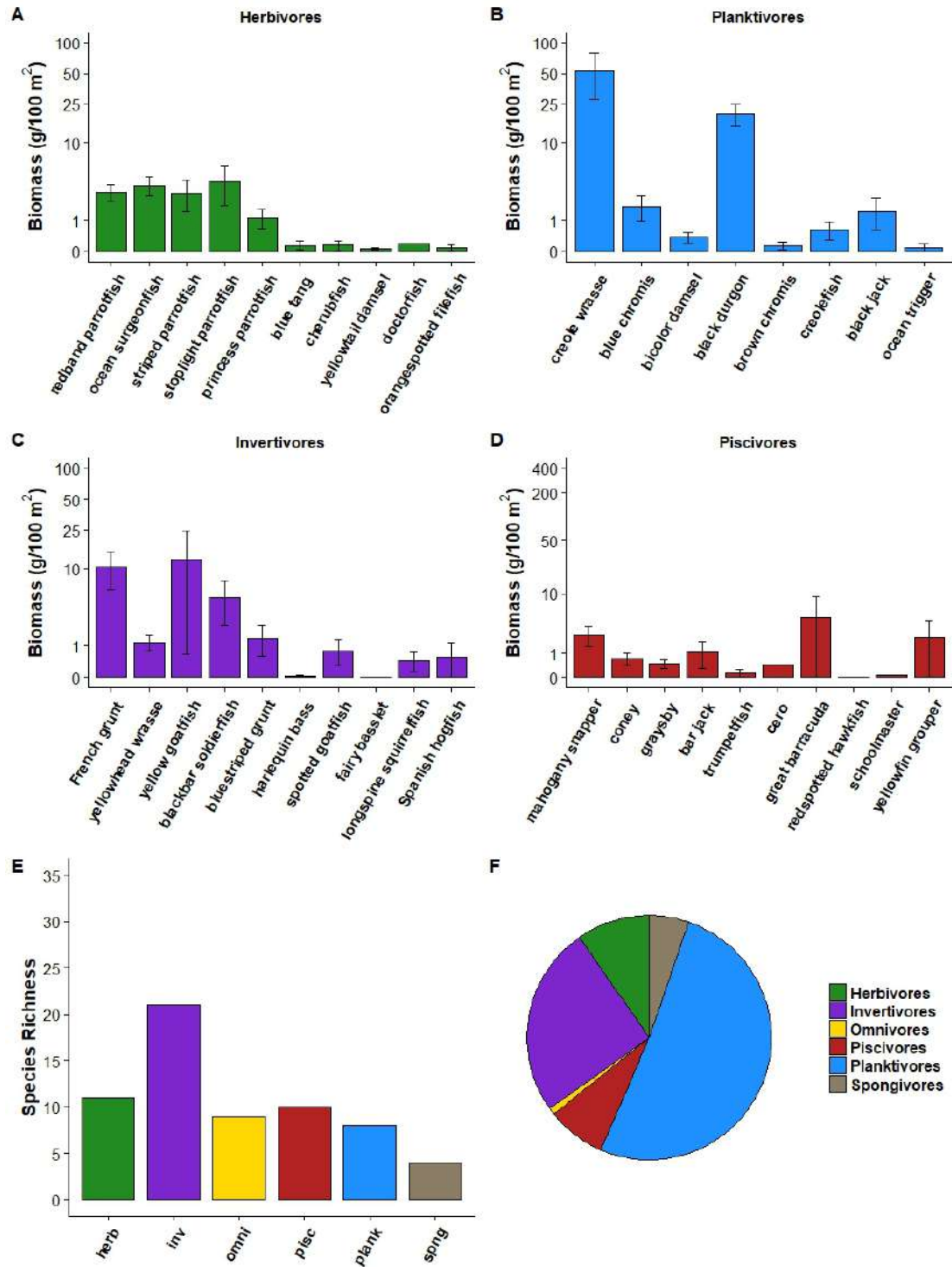


Figure 72. The Lang Bank Red Hind FSA fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES

MUTTON SNAPPER

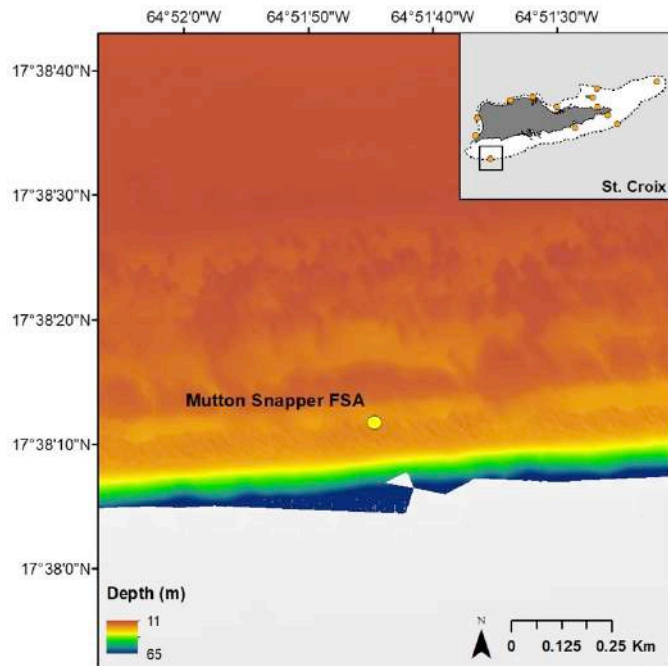
Description. The Mutton Snapper site is located on the landward side of a shelf edge spur and groove reef on the southwest shelf of St Croix in depths of 22-24 m. The reef was dominated by boulder star coral (primarily *Orbicella franksi*) until a mass coral die-off following the 2005 bleaching event. Mutton Snapper has been monitored since 2003.

Outstanding Feature. The Mutton

Snapper site was located in conjunction with the possible proximity of a mutton snapper (*Lutjanus analis*) spawning aggregation. It is seasonally closed to fishing. The site was devastated by the 2005 coral bleaching event, with an 87% drop in coral cover and a concomitant increase in algae.

Threats. The Mutton Snapper site is threatened by fishing pressure as evidenced by the abundance of fishing line and fishing trap debris. This site is offshore and less likely threatened by land-based stressors. The clear waters and warm temperatures make this site vulnerable to long-term seawater warming.

Figure 73. Mutton Snapper. (top) Location. (right) A representative photo of the reef taken in 2014.



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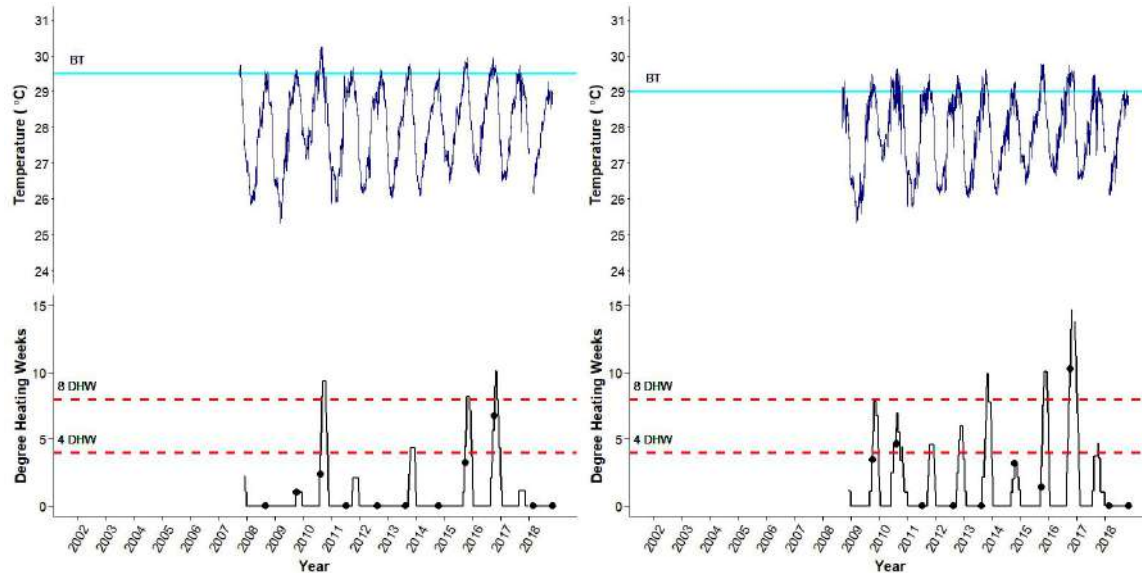


Figure 74. Mutton Snapper benthic temperature record at 24 m (left) and 40 m depth (right).

Physical Characteristics.

Current. Current records have not been taken at Mutton Snapper. There seems to be little wave-driven oscillatory flow. There are often strong unidirectional currents in a westward direction that penetrate to nearly the bottom.

Temperature. Benthic temperatures at the Mutton Snapper site (23 m) showed warming above the regional bleaching threshold during 2010 and 2016. However, this may be an overestimation of the heat stress (bleaching threshold set to low) since an empirical bleaching threshold has not yet been established for this site. There was no noticeable change in bleaching in 2016 when 10 DHW was predicted based on the model in (Smith et al. 2016a). A DHW value of 10 would predict mass bleaching and mortality.

SITE SUMMARIES

Benthic Community. The Mutton Snapper site's sessile epibenthic animal community is dominated the boulder star coral (*Orbicella* spp.), with sub-dominance of sponges. This site lost an extreme amount of coral cover (87.0%) in the 2005 coral bleaching event and has not regained any cover (-2.3%) as of 2011. *Lobophora variegata*, epilithic algae, and filamentous cyanobacteria dominate the algal community. Apparent is the rise in the abundance of macroalgae and filamentous cyanobacteria after 2005. Filamentous cyanobacteria reached extreme cover values (57.7%) in 2009. Current levels of herbivory no longer appear to be able to control algal abundance.

Coral Health. Mutton Snapper bleached heavily in the 2005, with 100% of corals bleaching over 90% of the colony surface. Bleaching prevalence has remained high for most years since 2005, but at low colony extent, indicating continued impairment of corals. White disease has been at consistently high values through many years of monitoring. Old partial mortality increased after 2005, and then subsided as whole colonies were lost from the system. Impairment of this site is puzzling as stressors besides fishing appear to be low. Clear water and low genetic diversity of corals may increase susceptibility to environmental stress and white disease.

SITE SUMMARIES

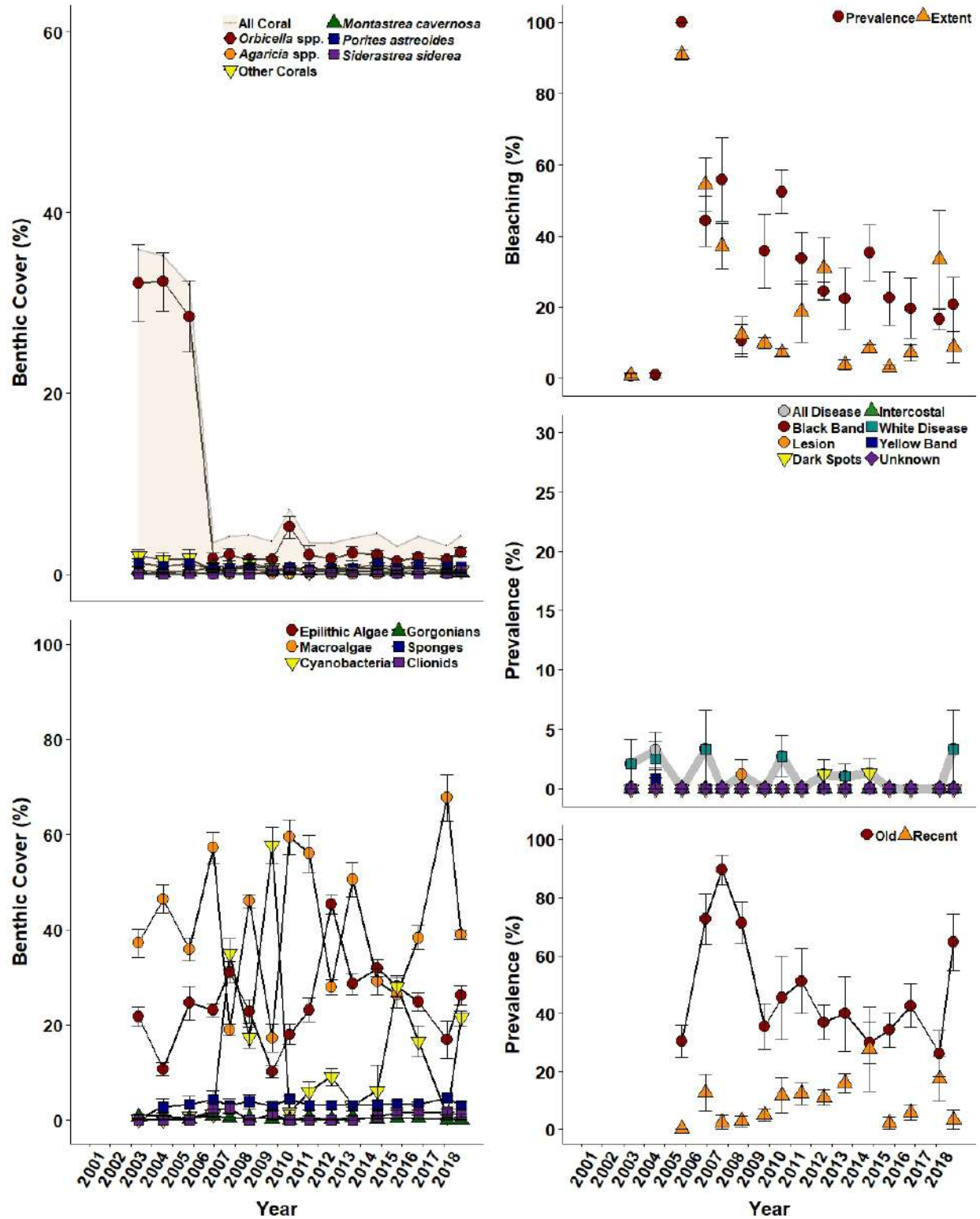


Figure 75. Mutton Snapper benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES

Fish Community. The Mutton Snapper site is an offshore, shelf edge site with a diverse and rich fish community. Mutton Snapper is reportedly in an area that mutton snapper spawn, however this species has been rare in surveys conducted at the site over the past 8 years. The Mutton Snapper site has an equally divided community composition between herbivores, invertivores and piscivores. Planktivores are relatively low in biomass but are dominated by black surgeon and yellowtail snapper. The herbivore trophic guild is numerically led by the very prolific threespot damselfish, but the biomass is primarily contributed by redband, striped and princess parrotfish. The majority of these fish encountered are in the juvenile and sub-adult phase. The invertivore group is diverse, and indicative of the variety of resources available on the reef. Blackbar soldierfish contribute most highly to invertivore abundance and biomass. Piscivores are not common on Mutton Snapper and in general the biomass of this group is made up of jacks, barracuda and mackerel. Piscivorous serranids and lutjanids are usually limited to the graysby and mahogany snapper, however in 2018 a cubera snapper was recorded. Red lionfish are observed regularly on Mutton Snapper, probably because the reef is offshore and does not receive the recreational diving and hunting pressure of nearshore sites.

SITE SUMMARIES

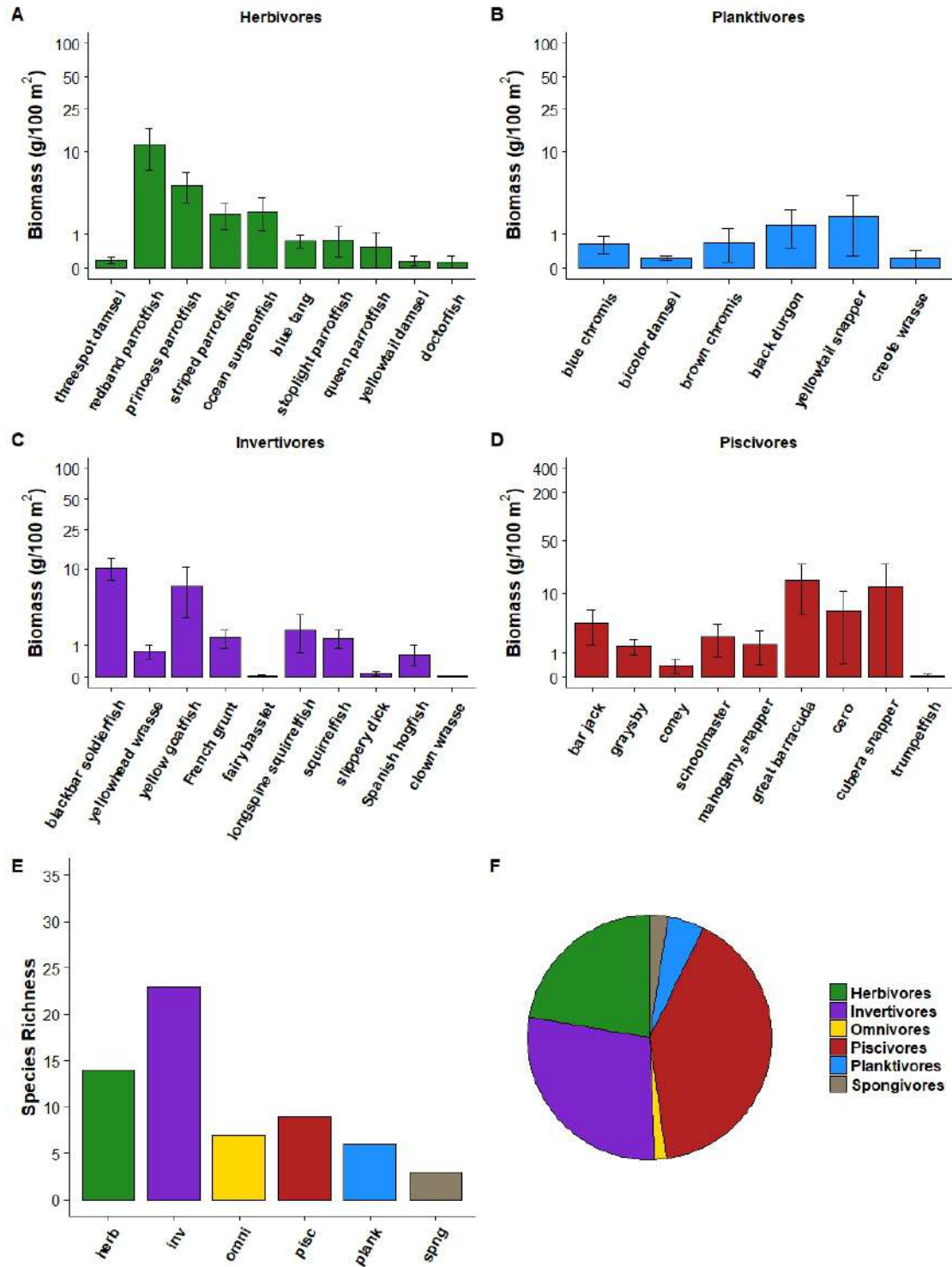


Figure 76. The Mutton Snapper fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.