

Site Summaries

RATIONALE

The purpose of this section is to provide a more comprehensive survey of TCRMP site characteristics than cannot 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 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 with a brief description of the setting and the potential susceptibility to local and global stressors and disturbances. Sub-sections include a description of (1) the physical environment, (2) the benthic community and (3) the fish community.

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. The loss of coral cover due to the 2023 bleaching event was calculated as the relative change in coral cover from fall 2022 to spring of 2024. Trends are shown for all available years of monitoring.

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

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 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.

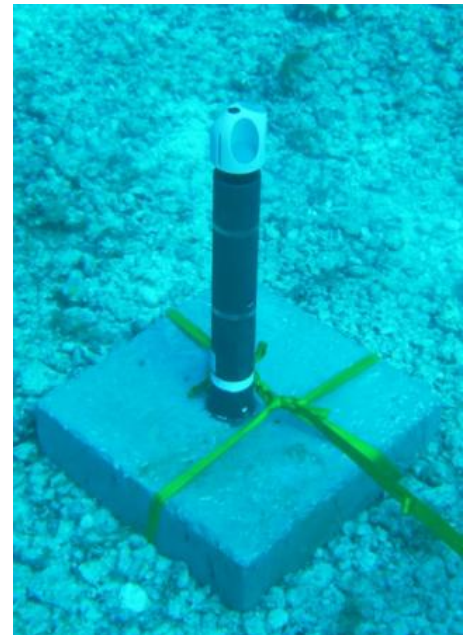
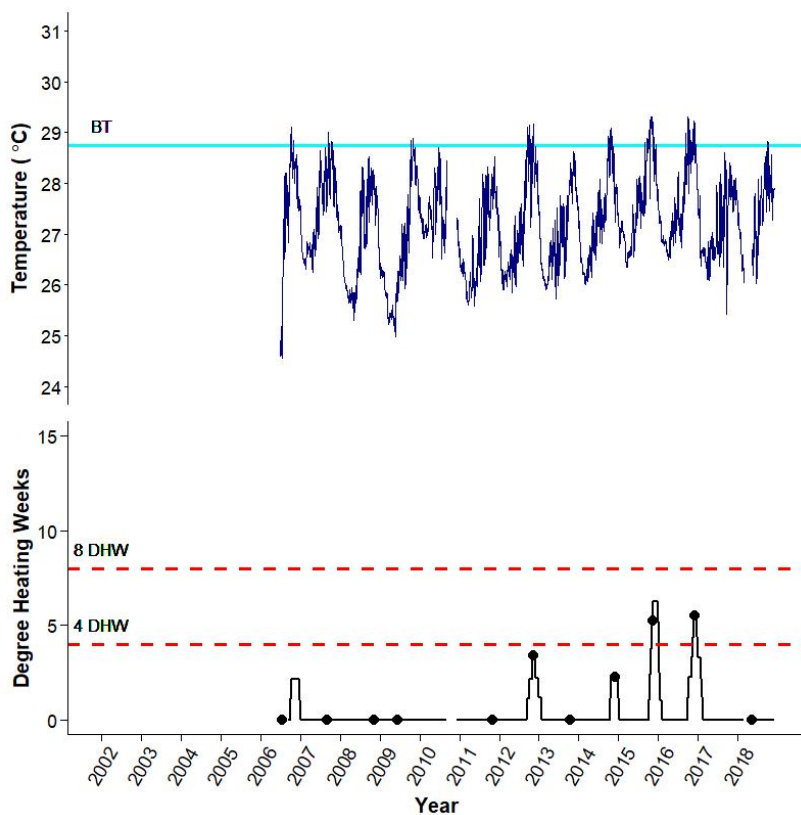


Figure 23. An Acoustic Doppler Current Profiler (ADCP) installed on the reef to measure currents.

SITE SUMMARIES

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.



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.

St. Croix

SITE SUMMARIES: BUCK ISLAND STX

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 and 2023 bleaching event.

Figure 24. (top) The Buck Island, St. Croix position in the Buck Island Reef National Monument. (right) A representative photo (photo credit: VJ. Quetel).



SITE SUMMARIES: BUCK ISLAND STX

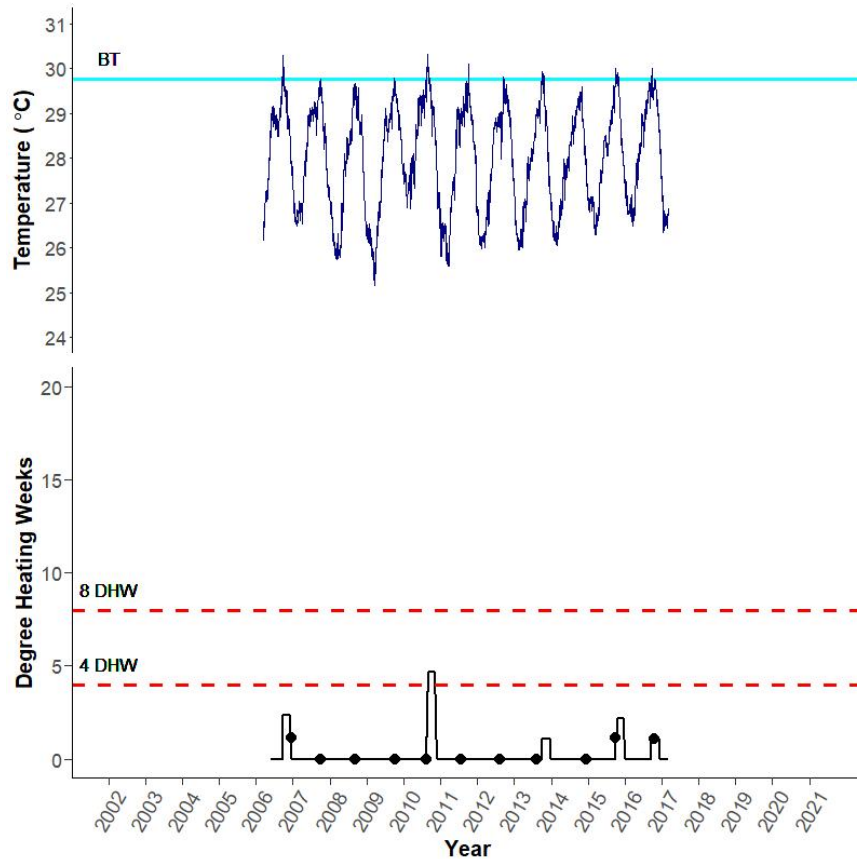


Figure 25. Buck Island, St. Croix benthic temperatures (14 m depth). Data provided by the National Park Service (site BUIS_SFR).

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.

SITE SUMMARIES: BUCK ISLAND STX

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 and filamentous cyanobacteria has been known to spike considerably every few years.

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. In comparison, this site only lost 16.9% of its relative coral cover in the 2023 bleaching event. However, coral coverage was low (4.4%) to begin.

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. Bleaching showed it highest prevalence in late 2023 with 70.5% of corals showing signs of bleaching. 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. Prevalence of disease increased in 2021 (November) with the arrival of Stony Coral Tissue Loss Disease at the Buck Island STX location.

SITE SUMMARIES: BUCK ISLAND STX

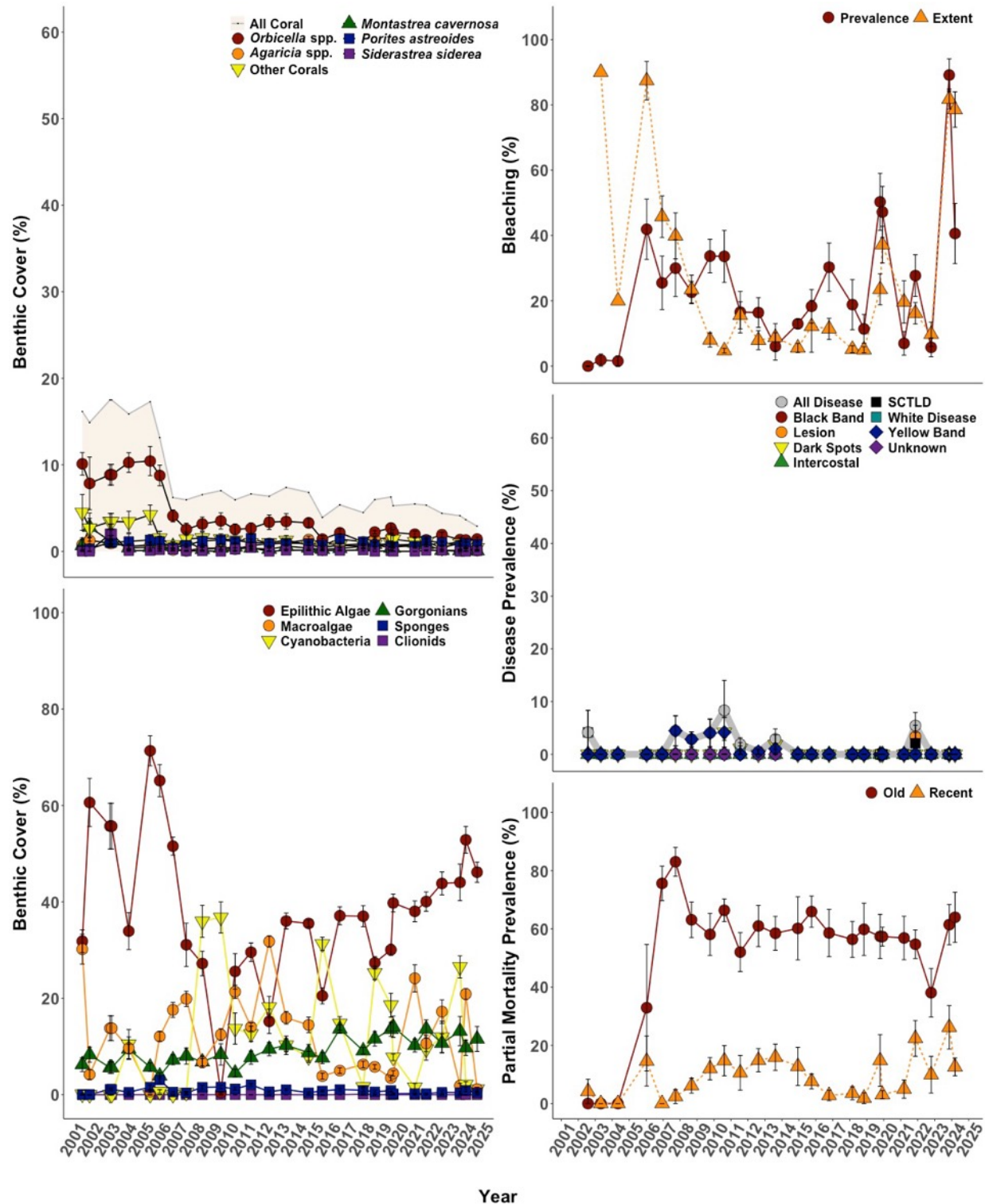


Figure 26. Buck Island, St. Croix benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: BUCK ISLAND STX

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 and invertivores, 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. Grunts (tomtate, French, Spanish, white, and bluestripe) and yellowhead wrasses dominate the invertivore guild at Buck Island, 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, coneys, 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.

SITE SUMMARIES: BUCK ISLAND STX

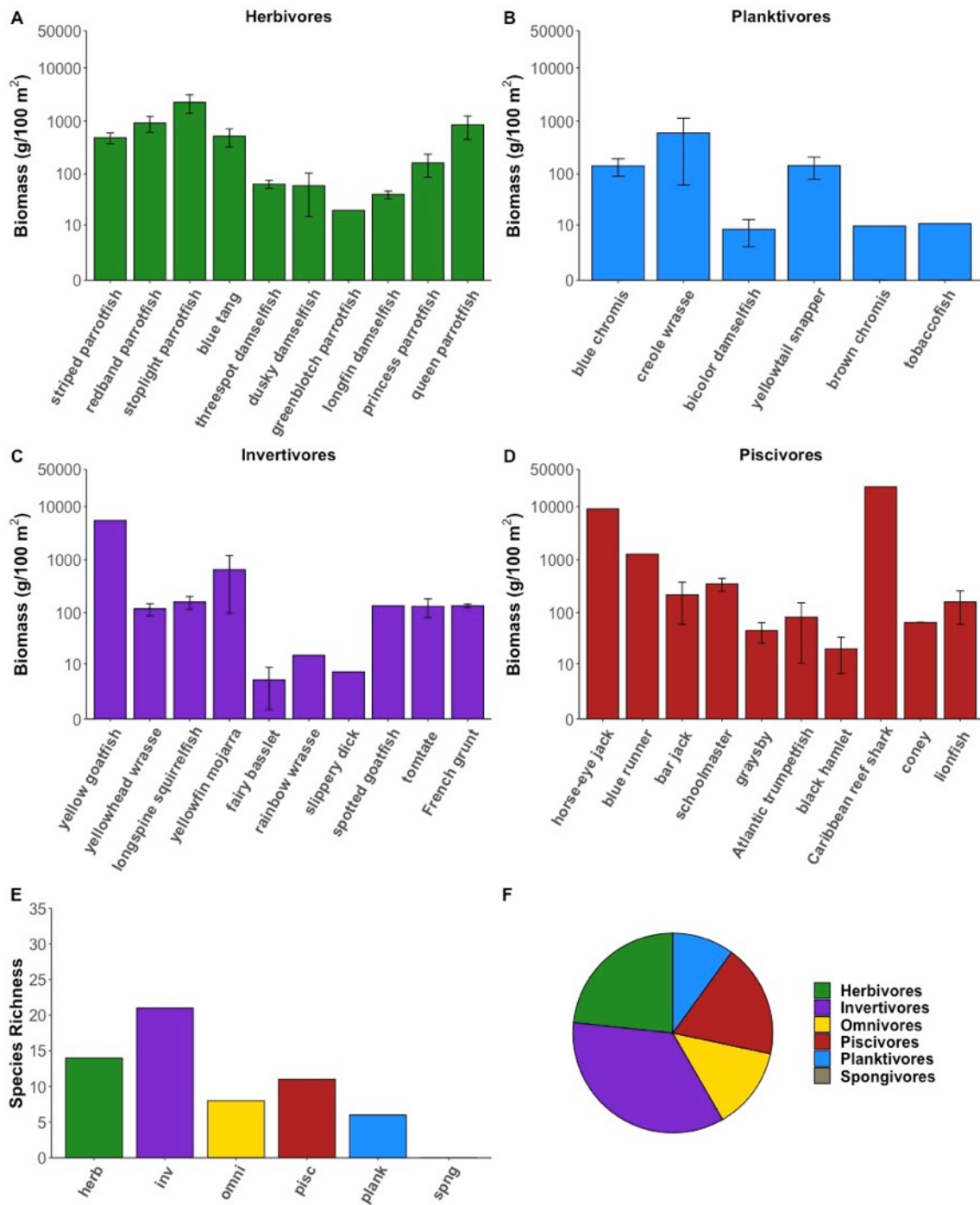
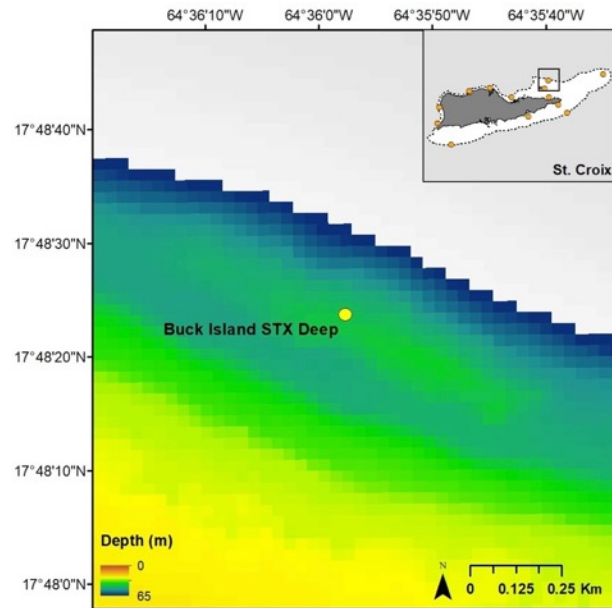


Figure 27. The 2023 Buck Island, St. Croix fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: BUCK ISLAND DEEP

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 was an exceptionally healthy mesophotic orbicellid bank system on the island of St. Croix. Recent disease outbreaks have substantially reduced coral abundance.

Threats. Due to its protected area status and remoteness from land-based pollution Buck Island Deep is largely threatened by global factors, like bleaching and disease.

Figure 28. (top) The Buck Island Deep, St. Croix position in the Buck Island Reef National Monument. (right) A representative photo (photo credit: J. Quetel).



SITE SUMMARIES: BUCK ISLAND DEEP

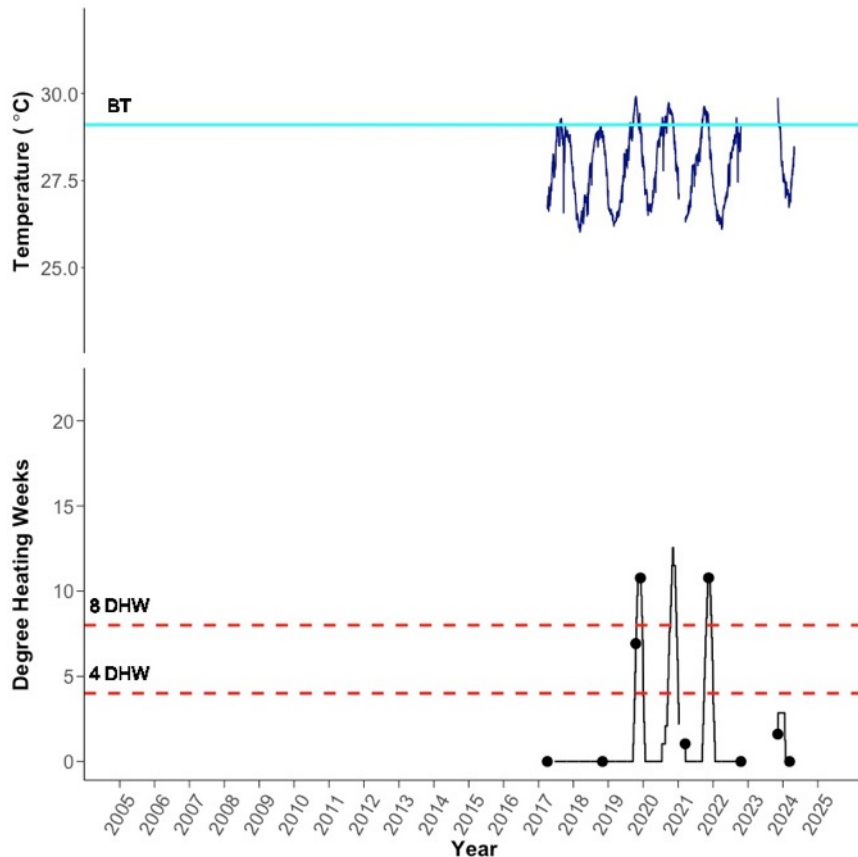


Figure 29. Buck Island Deep, St. Croix benthic temperatures (33 m depth).

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. The bleaching threshold is based on the hypothetical formula of bleaching threshold with depth for the USVI from Smith et al. 2016a and not on empirical observations. The bleaching threshold is likely too low since the current threshold shows high levels of stress in years when no bleaching occurred. More observation will help provide a validated empirical threshold in the future.

SITE SUMMARIES: BUCK ISLAND DEEP

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*. Stony Coral Tissue Loss Disease was first observed at the Buck Island STX Deep location in early 2021 and has resulted in substantial losses in coral cover since (about 50% relative cover). Epilithic algae and other macroalgae have shown an inverse relationship in 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.



Figure 30. Stony Coral Tissue Loss Disease at Buck Island STX Deep, November 2021 (photo credit. K. Cobleigh).

SITE SUMMARIES: BUCK ISLAND DEEP

Coral Health. The Buck Island Deep, St. Croix location had the highest disease prevalence of any mesophotic location in the TCRMP during the first two years of monitoring. Disease prevalence was driven by both dark spot disease and white disease (possibly a type of white plague) before 2021. Disease prevalence peaked around 20% prevalence in November 2021 due largely to the arrival of Stony Coral Tissue Loss Disease. However, old and recent mortality and bleaching prevalence was average at this site compared to other mesophotic locations. In 2019, a high prevalence of bleaching with a modest extent on corals was recorded and in 2023, prevalence and extent of bleaching reached recorded highs for this site. Moreover, at 89.1%, Buck Island STX Deep exhibited the highest prevalence of bleaching across all sites in 2023.

SITE SUMMARIES: BUCK ISLAND DEEP

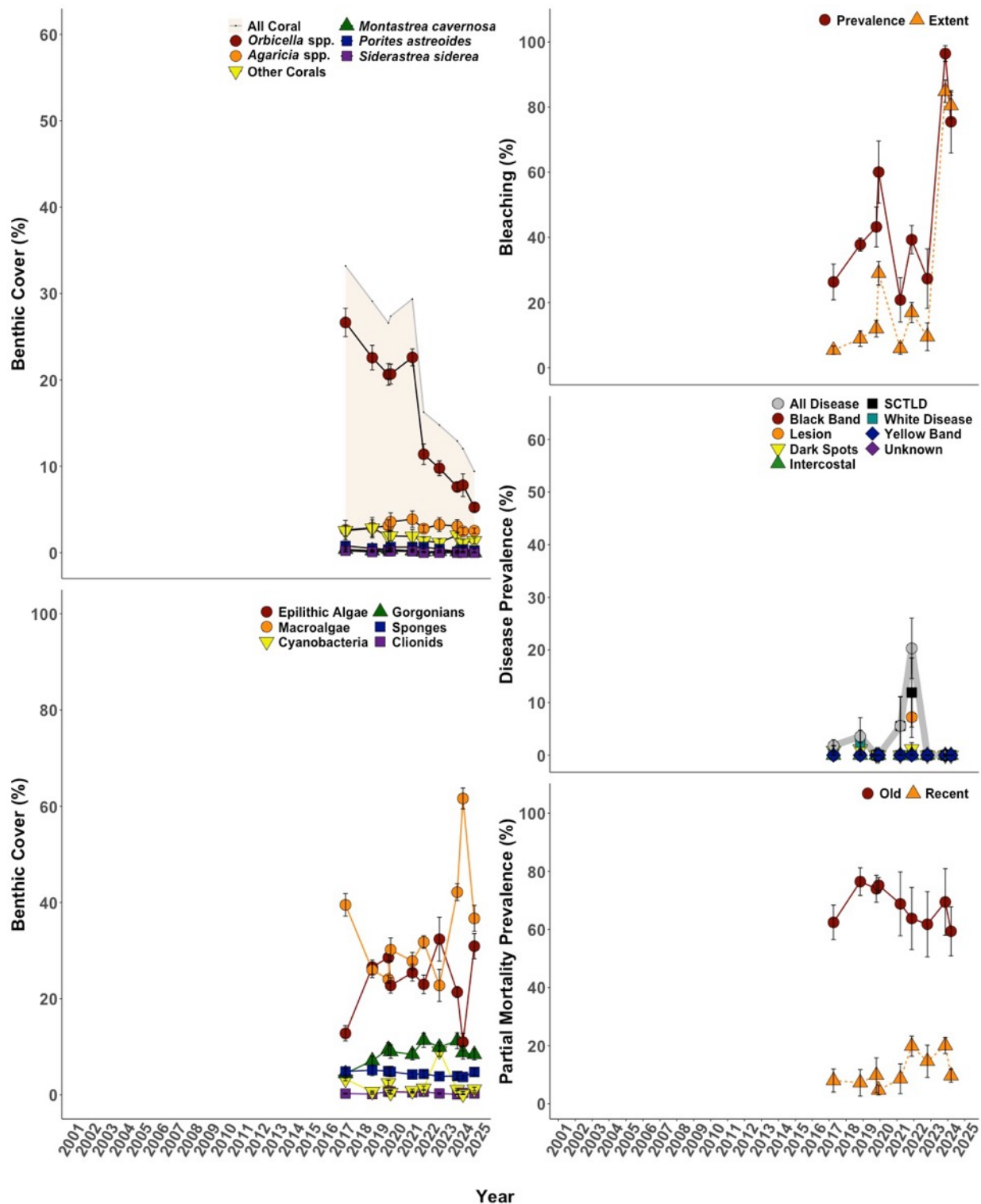


Figure 31. Buck Island Deep, St. Croix benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: BUCK ISLAND DEEP

Fish Community. Buck Island Deep has a rich upper mesophotic reef community that is largely dominated in biomass by invertivores and herbivores, primarily princess and blue tang. The planktivore guild is relatively high in biomass, but limited to a few species: creole wrasse, blue chromis and black durgon. Occasionally schools of boga are observed as well. 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 deep-water community.

SITE SUMMARIES: BUCK ISLAND DEEP

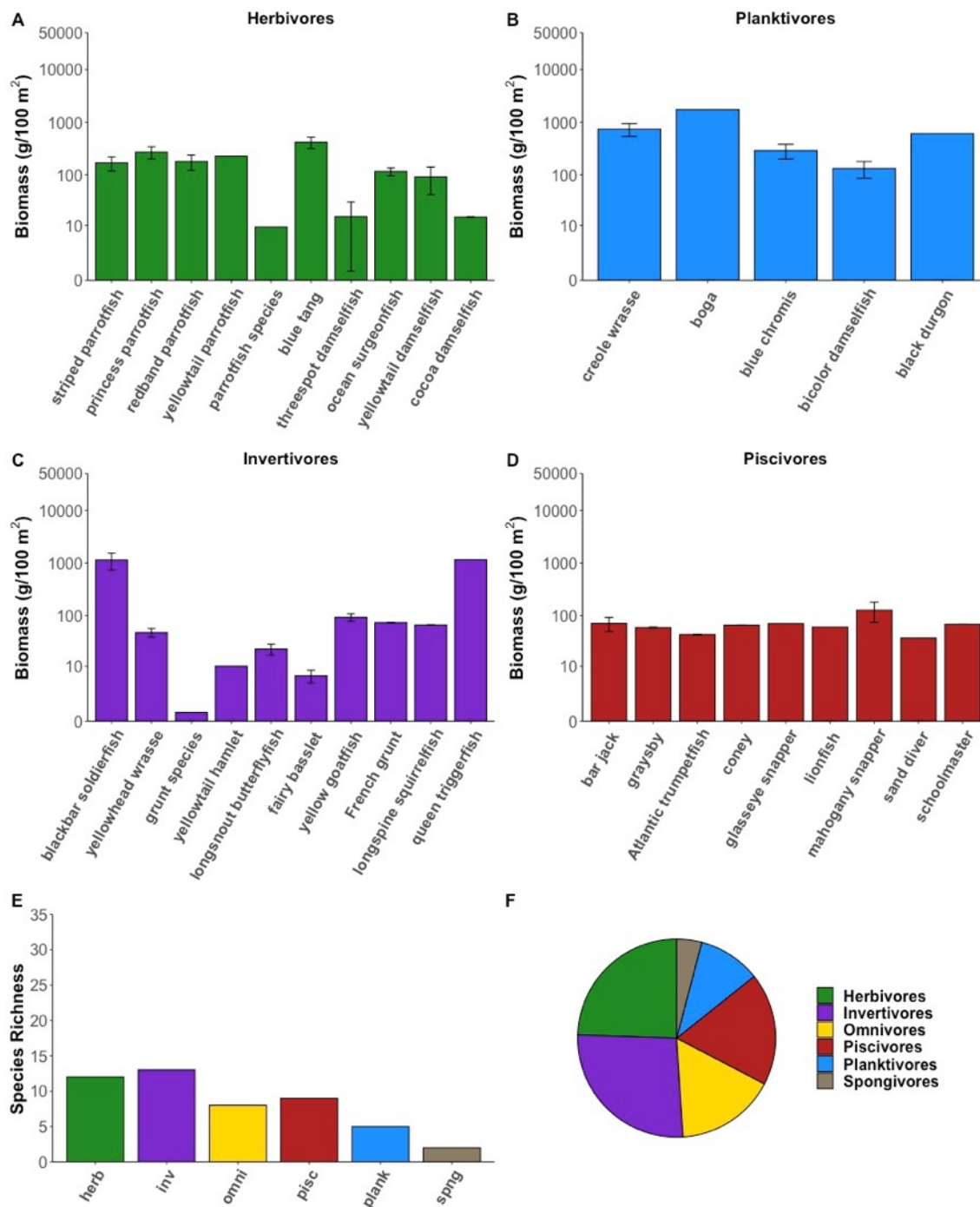


Figure 32. The 2023 Buck Island Deep, St. Croix fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: CANE BAY

CANE BAY

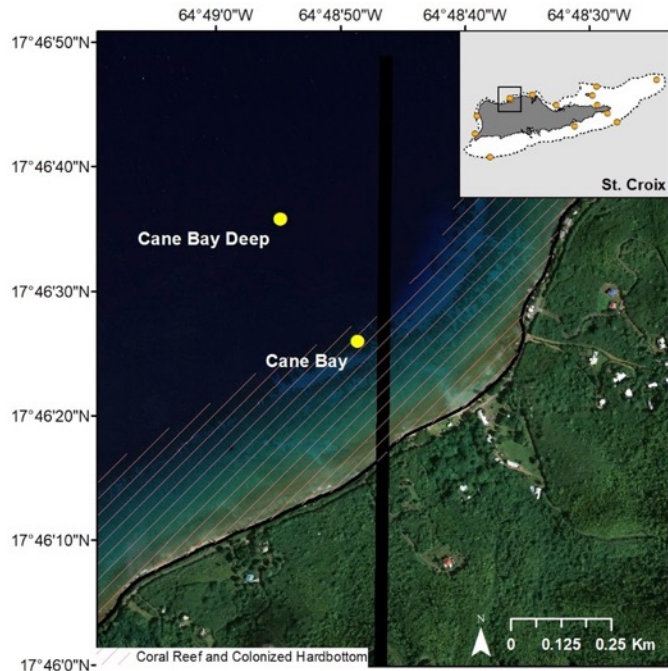
Description. The Cane Bay monitoring site is a nearshore/shelf edge fringing reef on the northwest coast of St. Croix. Transects follow the trend of the leeward spur and groove formations. Cane Bay has been monitored since 2001.

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 33. (top) Cane Bay location. (right) A representative photo of the reef (photo credit: J. Quetel).



SITE SUMMARIES: CANE BAY

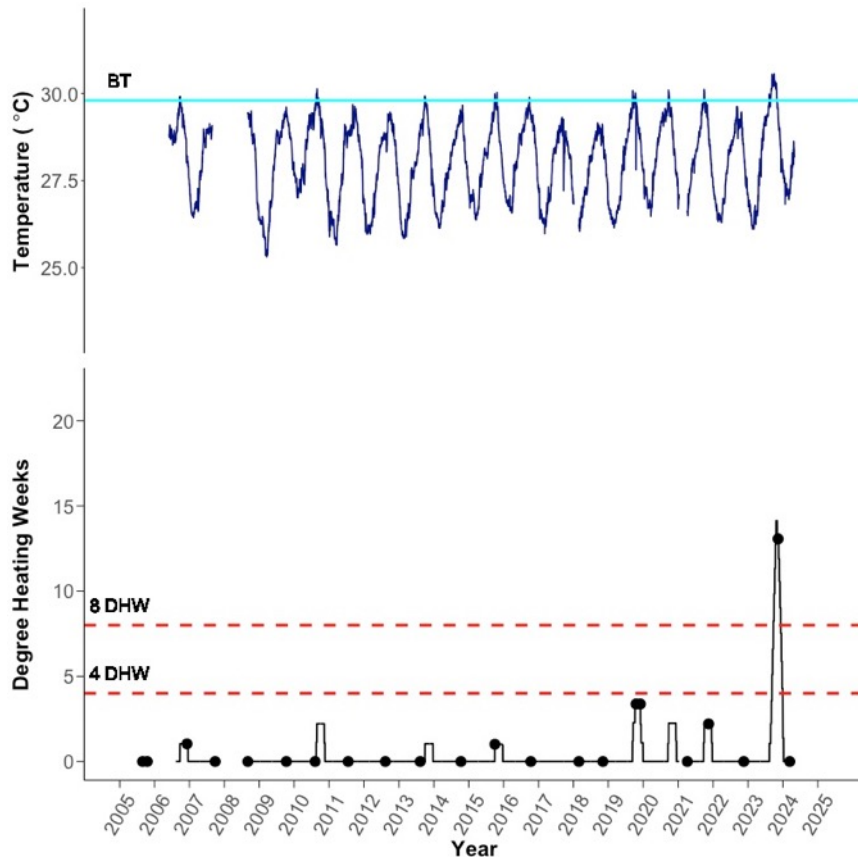


Figure 34. Cane Bay benthic temperatures (8 m depth)

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. In 2023 temperatures exceeded the bleaching threshold, peaking at 14 DHW.

SITE SUMMARIES: CANE BAY

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. Unfortunately, there were losses in coral cover (about 15% relative cover) largely driven by *Orbicella* sp. cover from 2019 to 2021 likely due to Stony Coral Tissue Loss Disease. A further reduction in relative coverage (38.7%) was observed after the 2023 bleaching event.

Coral Health. Cane Bay corals were severely affected during the 2005 and 2023 bleaching event with nearly all colonies bleached over 75% 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. Stony coral tissue loss disease was recorded in transects in the 2020 annual sampling (conducted April 2021 due to logistical restraints).

SITE SUMMARIES: CANE BAY

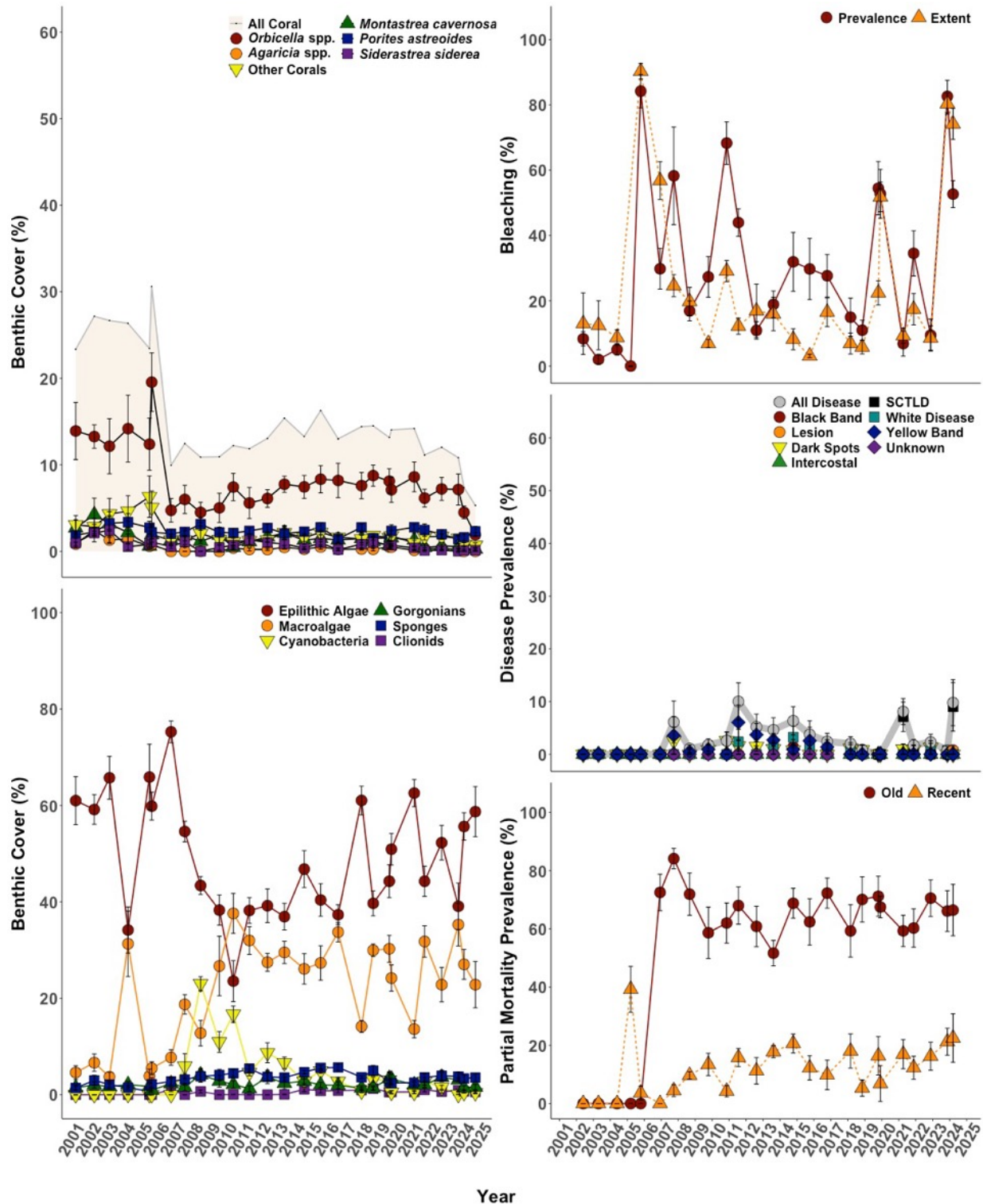


Figure 35. Cane Bay benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES: CANE BAY

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 fairly 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. There are also large numbers of damselfish. Planktivores include both huge numbers of small chromis, and adult black durgon, yellowtail snapper and bar jacks, indicative of a shelf edge site. The piscivore guild is typically 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, tiger grouper and Nassau grouper (~30 cm total length each) have been sited at the shelf break since 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.

SITE SUMMARIES: CANE BAY

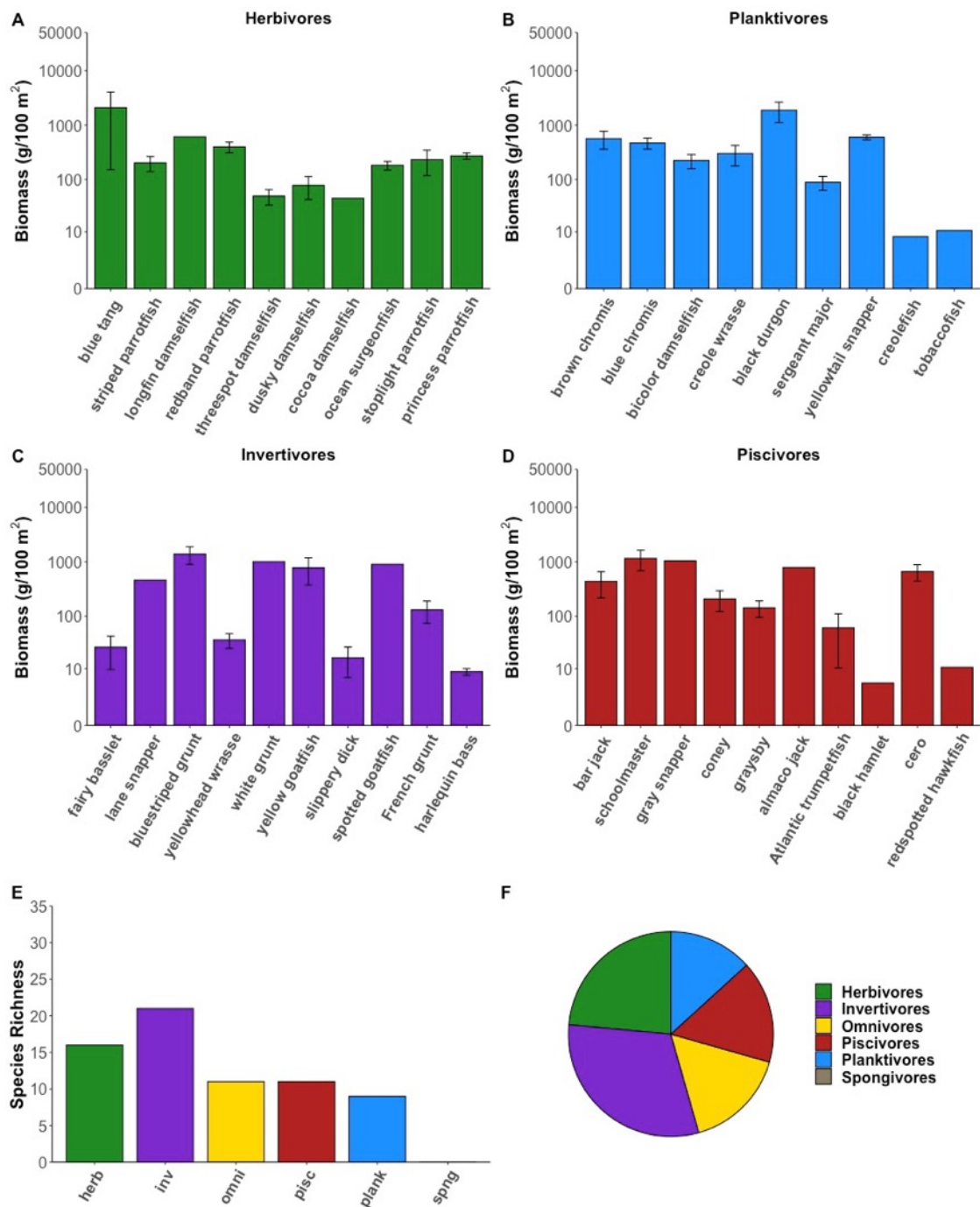


Figure 36. The 2023 Cane Bay fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: CANE BAY DEEP

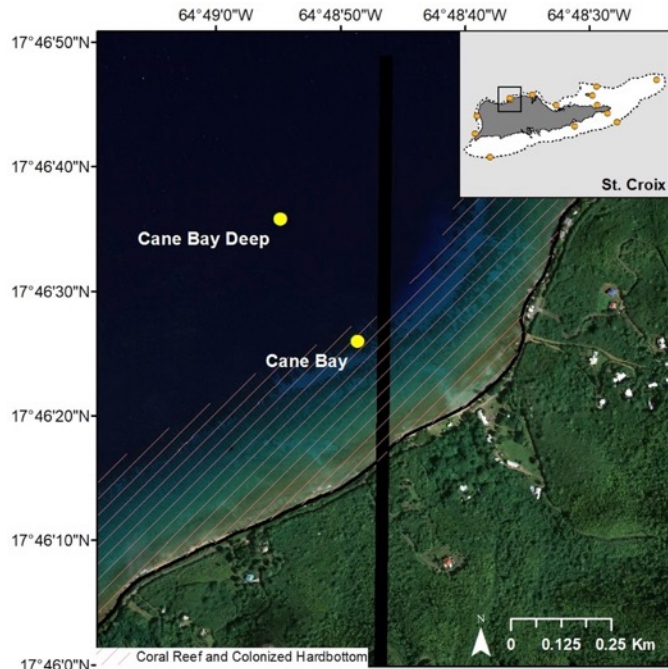
CANE BAY DEEP

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. Temperature monitoring was expanded to 67 and 100 m depths in 2018.

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 37. (top) Cane Bay Deep location. (right) A representative photo of the reef at the monitoring site (photo credit: J. Quetel).



SITE SUMMARIES: CANE BAY DEEP

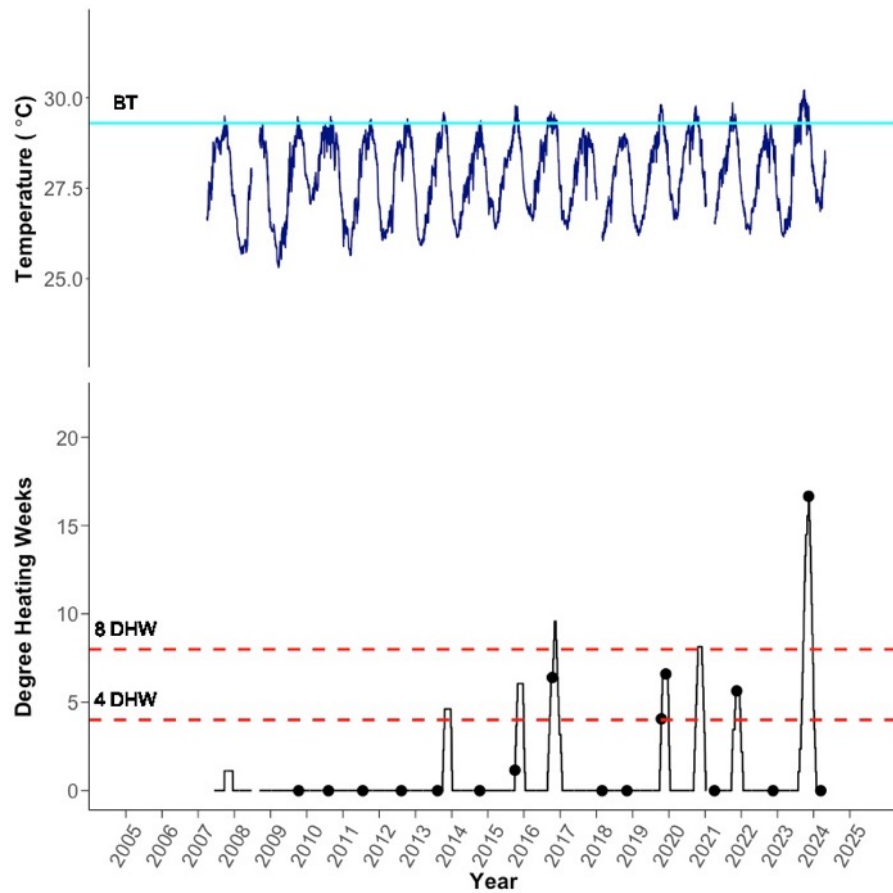
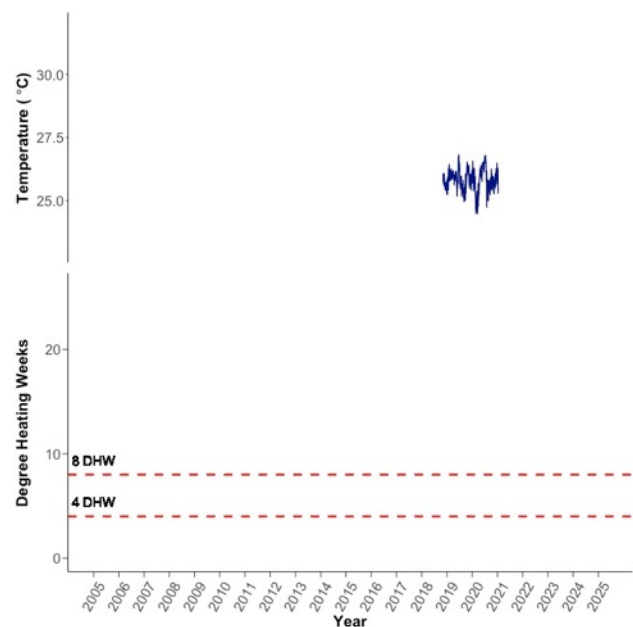
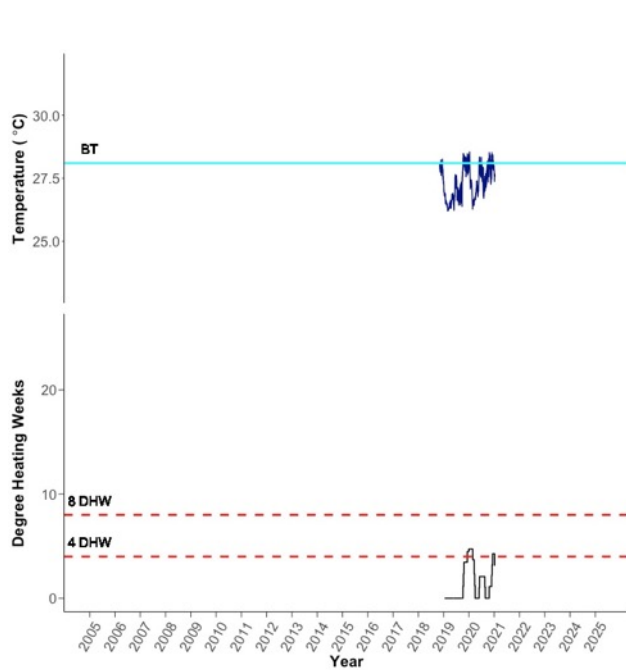


Figure 38. Cane Bay Deep temperature (Top : 39 m depth, bottom left: 67m depth, bottom right: 100 m depth).



SITE SUMMARIES: CANE BAY DEEP

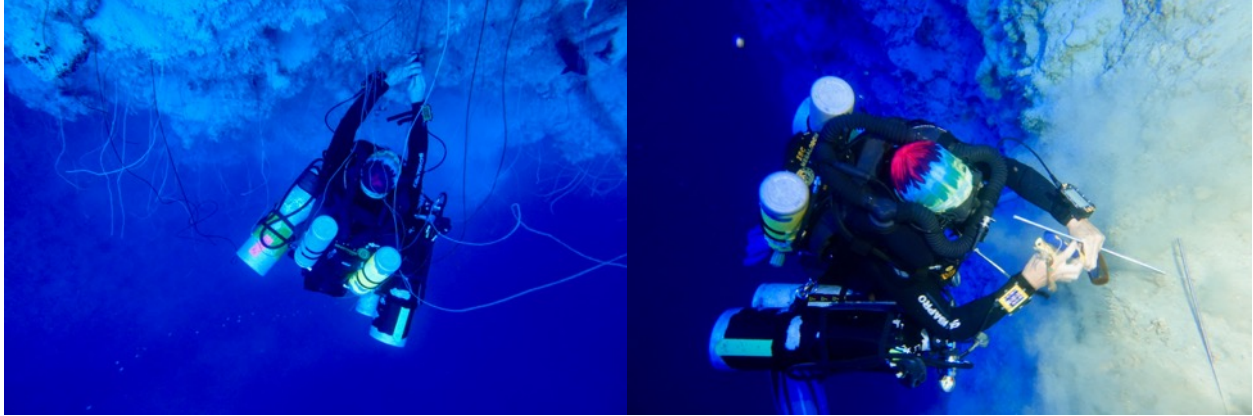


Figure 39. Installation of temperature monitoring stations at Cane Bay at 67 m (left) and 100 m (right) on the wall (credit: Viktor Brandtneris).

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. The bleaching threshold is currently based on the Smith et al. (2016a) model; however, observations of elevated bleaching in 2016 and 2019 concomitantly with elevated hypothetical degree heating weeks suggest the bleaching threshold is reasonable. Temperatures at 67 and 100 m depths were much cooler than at 40 m. In 2023, temperatures peaked at 16.7 DHW.

SITE SUMMARIES: CANE BAY DEEP

Benthic Community. Cane Bay Deep is a mesophotic plating coral community dominated by sponges, gorgonians, black coral, and living and dead lettuce corals (*Agaricia* spp.). Coral cover declined after 2017, a possible effect of Hurricane Maria and relative coral cover decreased by nearly 40% from 2020 to 2021 likely due to the arrival of Stony Coral Tissue Loss Disease. 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 based on limited observations prior to establishment of the TCRMP site (Smith et al. 2016a). This site bleached heavily again in 2019, with nearly 80% of corals bleached at a level of about 50% of the colony surface. In 2023, all corals showed signs of bleaching, with extent averaging almost 70% of the coral. 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 has remained high since and increasing slightly over the years. Recent mortality spiked in spring of 2024, likely a result of the bleaching event that occurred months previously. It is unclear if SCTLD was recorded in transects in the 2020 year sampling (April 2021), but a high abundance of lesions were present and SCTLD was present at the shallow site, so lesions may reflect SCTLD impacts.

SITE SUMMARIES: CANE BAY DEEP

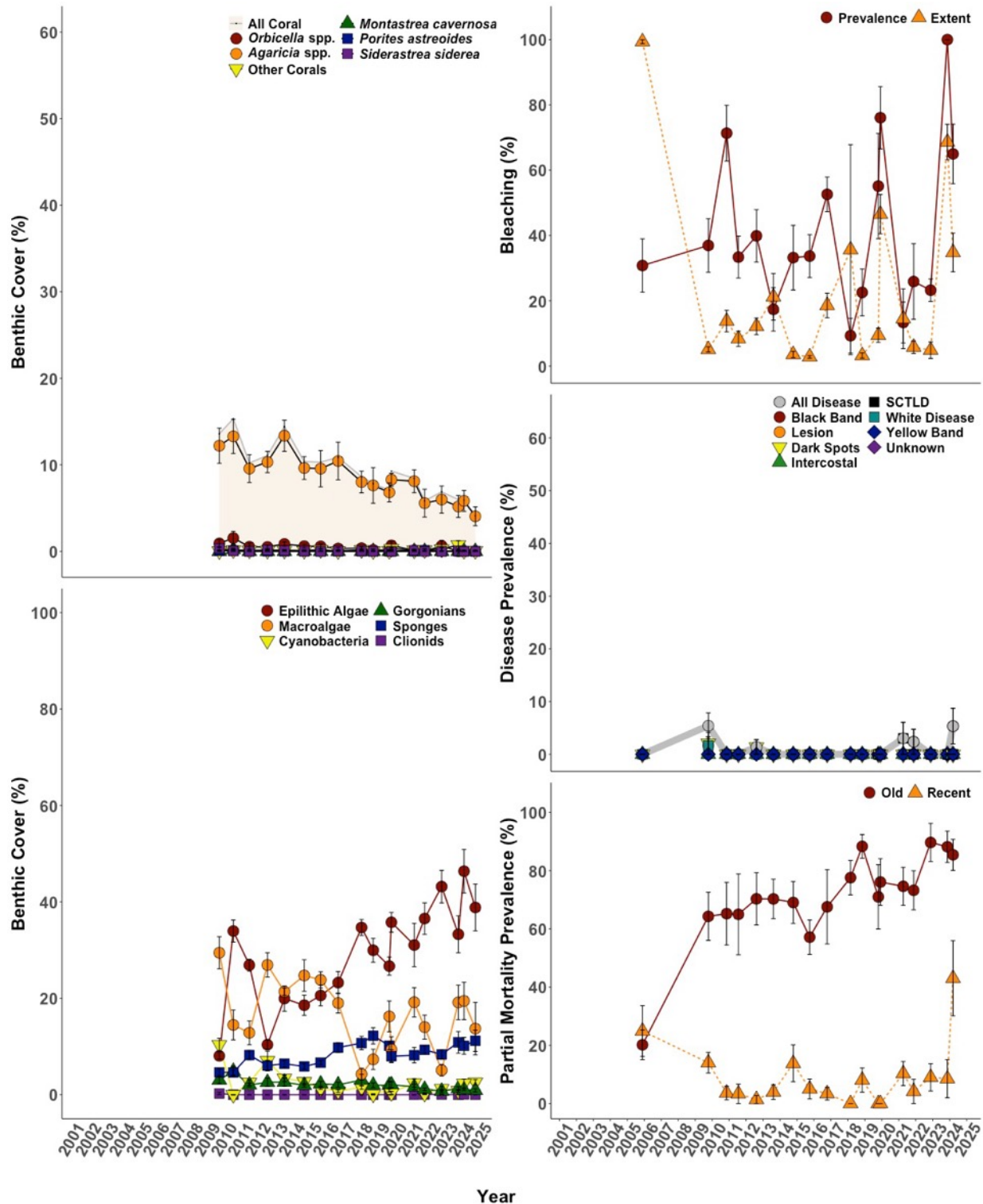


Figure 40. Cane Bay Deep benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: CANE BAY DEEP

Fish Community. Cane Bay Deep is characterized by a very low fish biomass compared to other mesophotic sites across the TCRMP, as well as shallow and midshelf sites of St. Croix. The site is typically dominated by planktivores: creole wrasse, blue chromis, black durgon and yellowtail snapper. However, in 2023, the site appeared to be dominated by invertivores, thanks to the observation of numerous margates and red hind. The herbivore guild contributes little to the community composition, and is composed primarily of parrotfish (striped, princess, redband, and stoplight). Large stoplight parrotfish are recorded very occasionally. Their invertivore guild is typically made up primarily French and bluestriped grunts, goatfish and wrasse. Caribbean reef sharks cruise the wall, looking for a free lionfish handout from local divers. They have become quite bold because of this generosity; however, lionfish are now rare at the site in recreational diving depths. The Caribbean reef shark contributes highly to the piscivore trophic guild and is joined by other pelagics: the almaco jack, horse eye 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 deep water reef species such as the bantum bass, fairy basslet, cherubfish, and sunshine fish are recorded regularly at the site. Peppermint bass are commonly observed in the 67-100 m depth range near the temperature recorders.

SITE SUMMARIES: CANE BAY DEEP

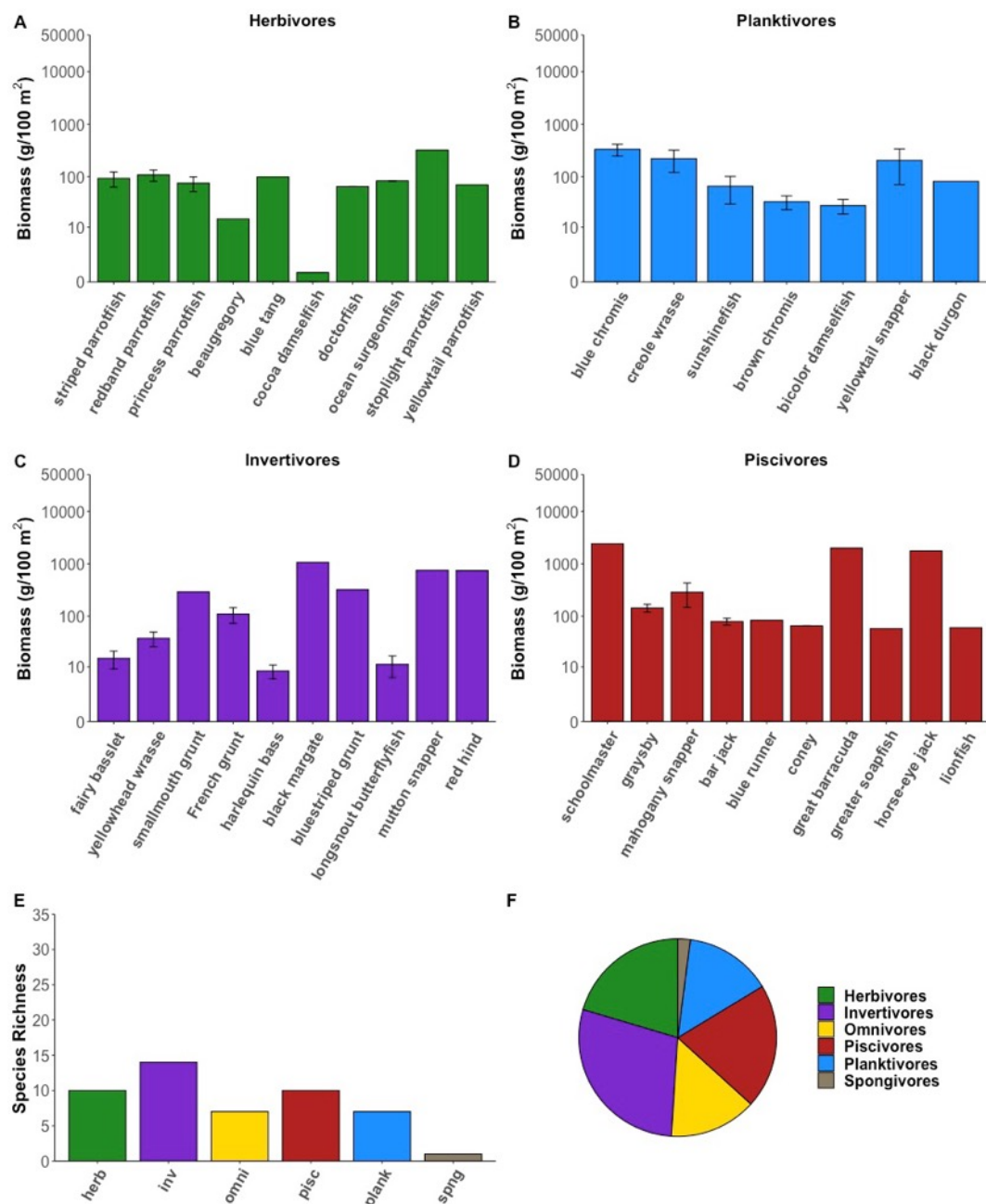
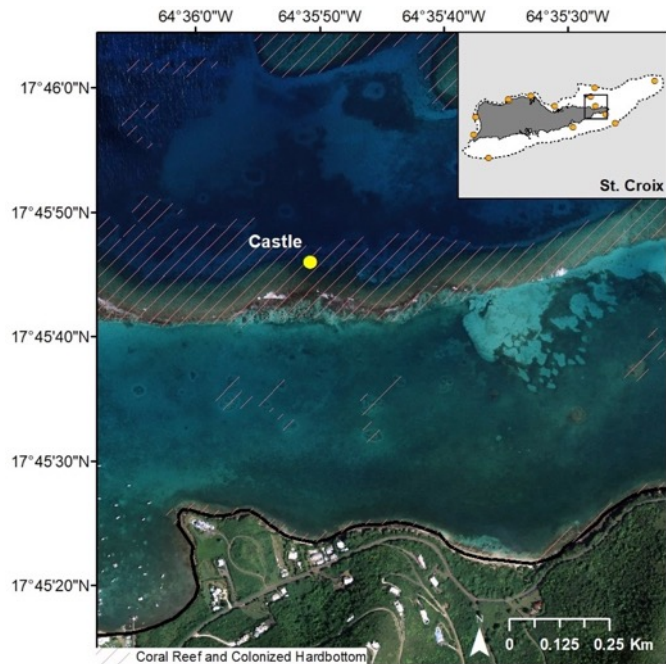


Figure 41. The 2023 Cane Bay Deep fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: CASTLE

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 42. (top) Castle location. (right) A representative photo of the reef (photo credit: L. V. Brandtneris).



SITE SUMMARIES: CASTLE

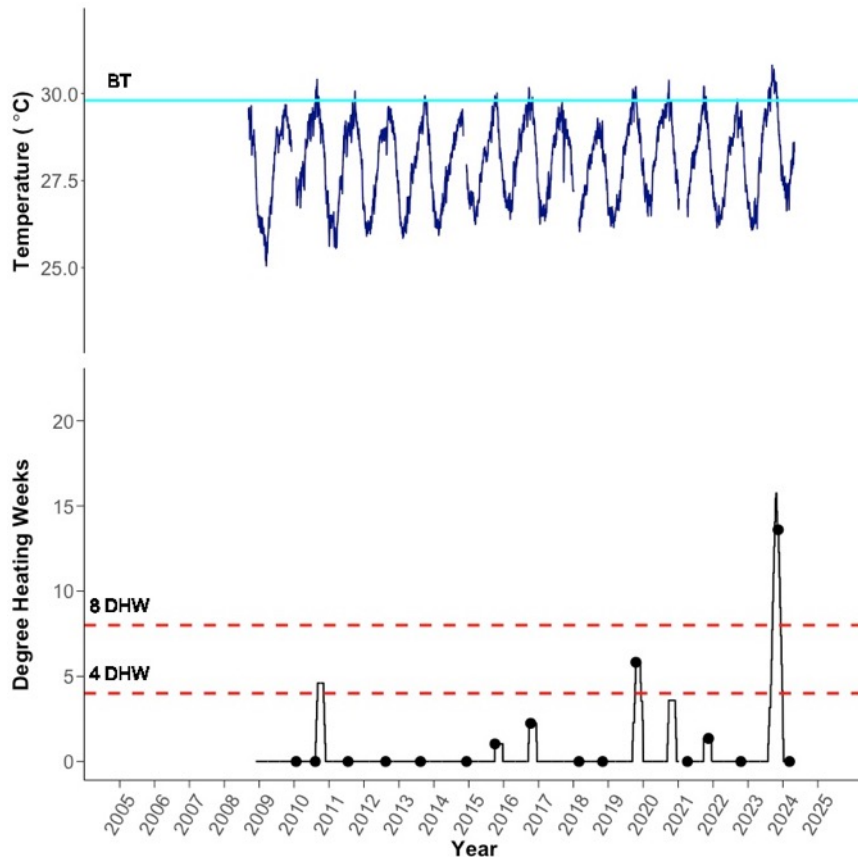


Figure 43. Castle benthic temperatures (9 m depth).

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 (4.5 DHW) and reached 6 DHW in 2019. In 2023, heat stress peaked at this site, accumulating 17.7 DHW.

SITE SUMMARIES: CASTLE

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. Following the 2023 bleaching event, relative coverage at Castle dropped 53%. Unfortunately, included in this coverage loss was large *Orbicella* spp. corals that had survived SCTLD (Fig. 50).

Coral Health. Corals were assessed prior to but not during the 2010 coral bleaching event. During the 2019 bleaching event corals were sampled near what might have been the peak of the shallow water heat stress based on the regional DHW. However, the bleaching response at that time was not that different from non-bleaching years, illustrating potential resistance at this site. In 2023 however, bleaching was highly prevalent (84.8%), as was extent of bleaching (75.7%). Old partial mortality is high in prevalence and steady, though it has been increasing in recent years. 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. Stony coral tissue loss disease was not recorded in transects in the 2020 year sampling (April 2021), but was present at the location during the 2021 annual sampling (November 2021).

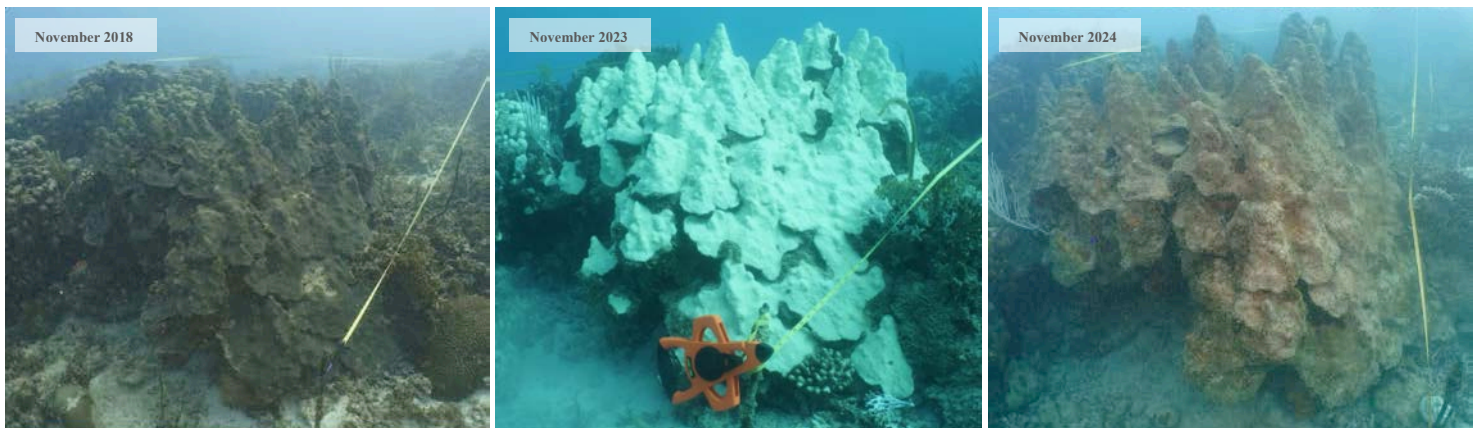


Figure 44. Time series through the 2023 bleaching event of a large *Orbicella faveolata* colony found at the beginning of one of the benthic transects at Castle (photo credit L. Henderson and B. Arrington)

SITE SUMMARIES: CASTLE

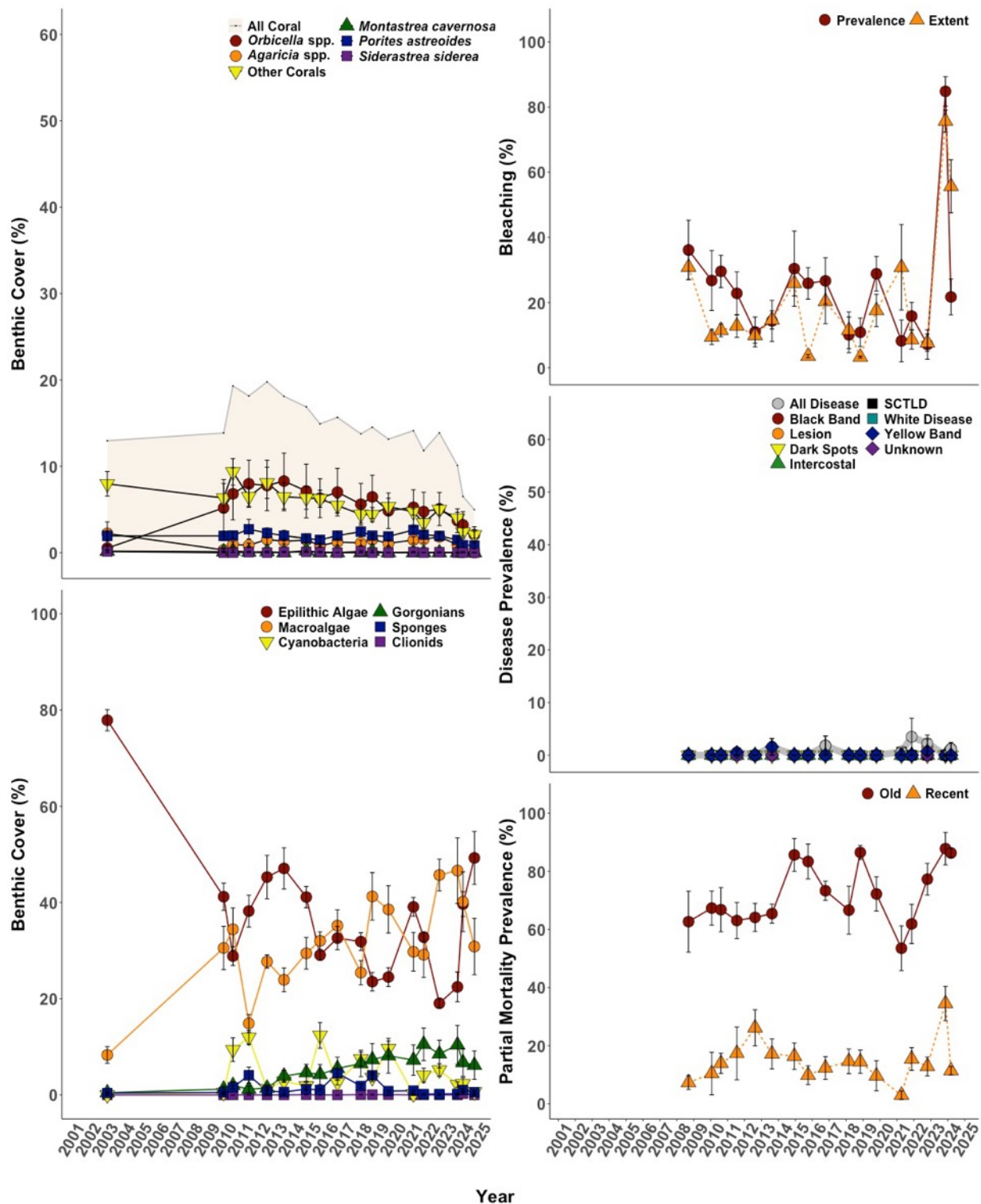


Figure 45. Castle benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: CASTLE

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, damselfish, and mixed acanthurids. Invertivores are diverse and fairly high in biomass; the group is dominated by wrasses, French grunts and squirrelfish. 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 planktivore biomass and bar jacks and yellow jacks typically contribute most to the piscivore guild. No large serranids other than the occasional gray snapper have been recorded at Castle; the family is typically dominated by coney, graysby, hamlets and tiny basslets. Lionfish have been observed commonly over the past five years, though not in 2023.

SITE SUMMARIES: CASTLE

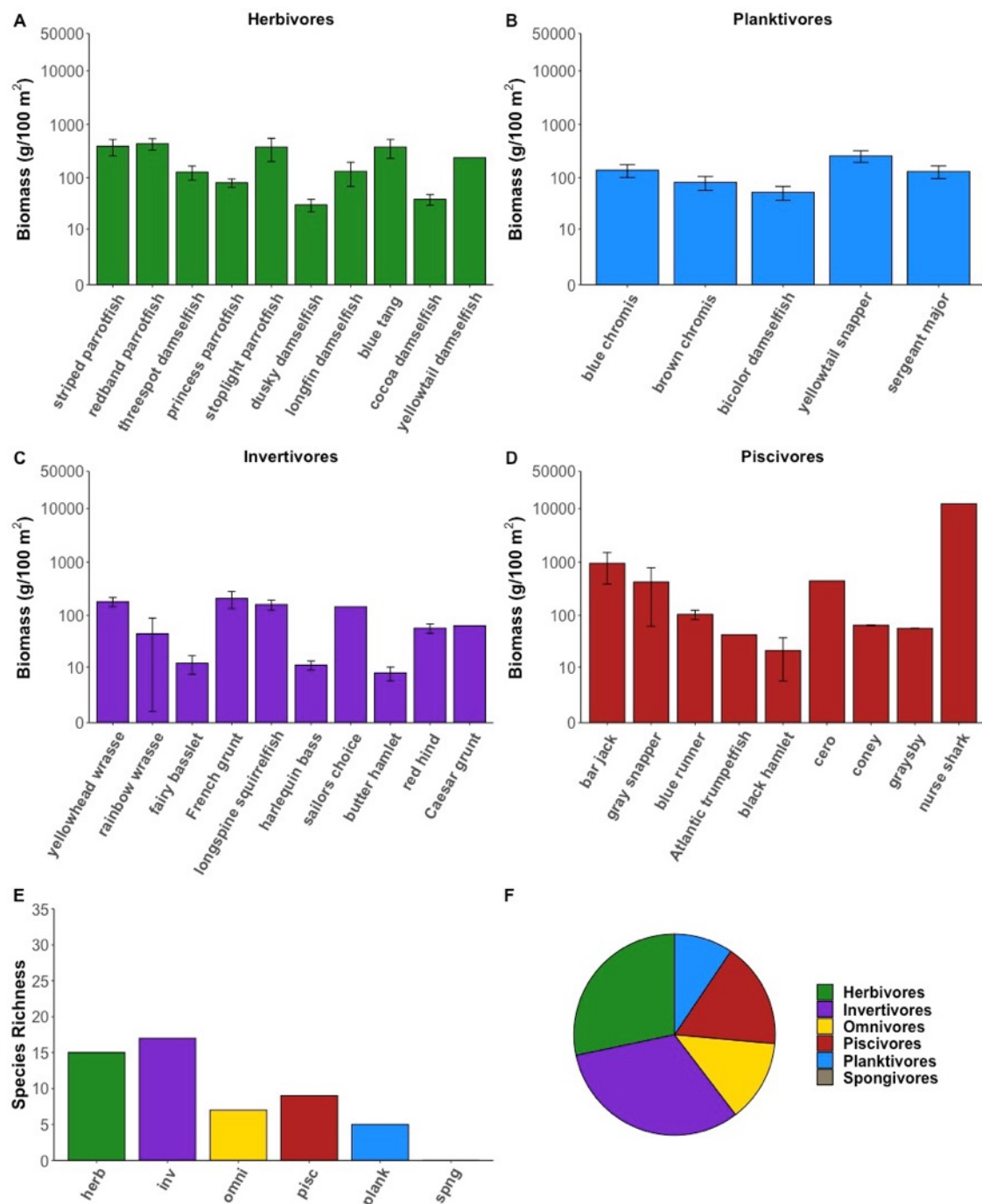


Figure 46. The 2023 Castle fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: EAGLE RAY

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.

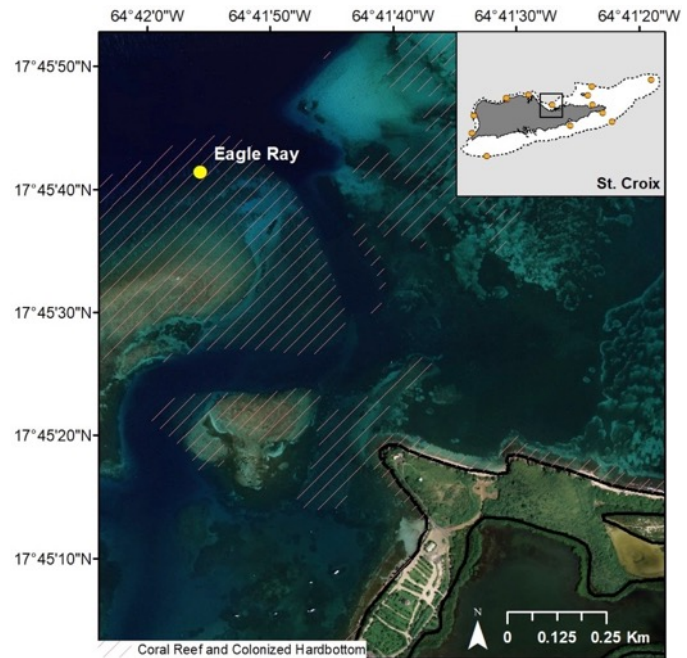


Figure 47. (top) Eagle Ray location. (right) A representative photo of the reef (photo credit: L. M. Henderson).



SITE SUMMARIES: EAGLE RAY

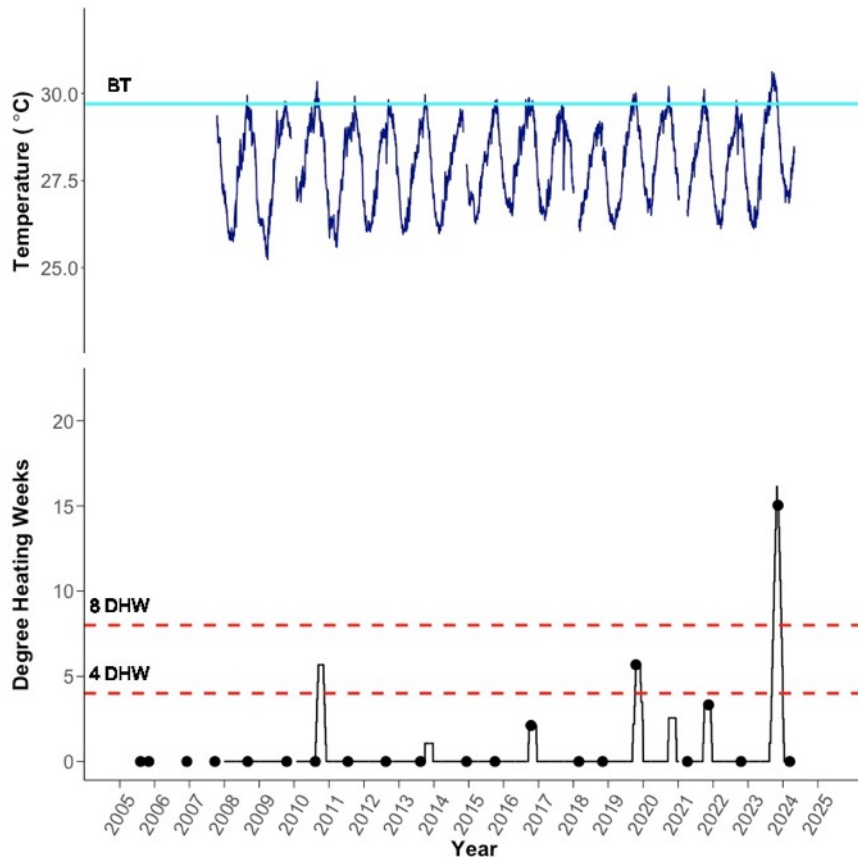


Figure 48. Eagle Ray benthic temperature at 9 m depth

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. Based on the bleaching response in 2019 an adjusted bleaching threshold of 29.70 °C was established for the site. Following that threshold, in 2023 Eagle Ray experienced substantial thermal stress in the fall, peaking at 16 DHW in late October.

SITE SUMMARIES: EAGLE RAY

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 rebounded and increased above pre-bleaching values. Following the bleaching event of 2023, coral coverage also decreased only slightly, with a 10% reduction in relative cover. The limited relative response may be partly due to the high relative abundance of more thermally resistant coral species. However, coral cover has decreased by about 52% from 2019 to 2022, likely due to Stony Coral Tissue Loss Disease. 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. In 2019, the site showed moderate prevalence and extent of bleaching. Prevalence and extent of bleaching was very high in 2023, mirroring levels that were last seen in 2005. Interestingly, though bleaching prevalence substantially subsided by the spring 2024 post-bleaching census, extent of bleaching only decreased by 20%.

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. Stony coral tissue loss disease was recorded in transects in the 2020 year sampling (April 2021).

SITE SUMMARIES: EAGLE RAY

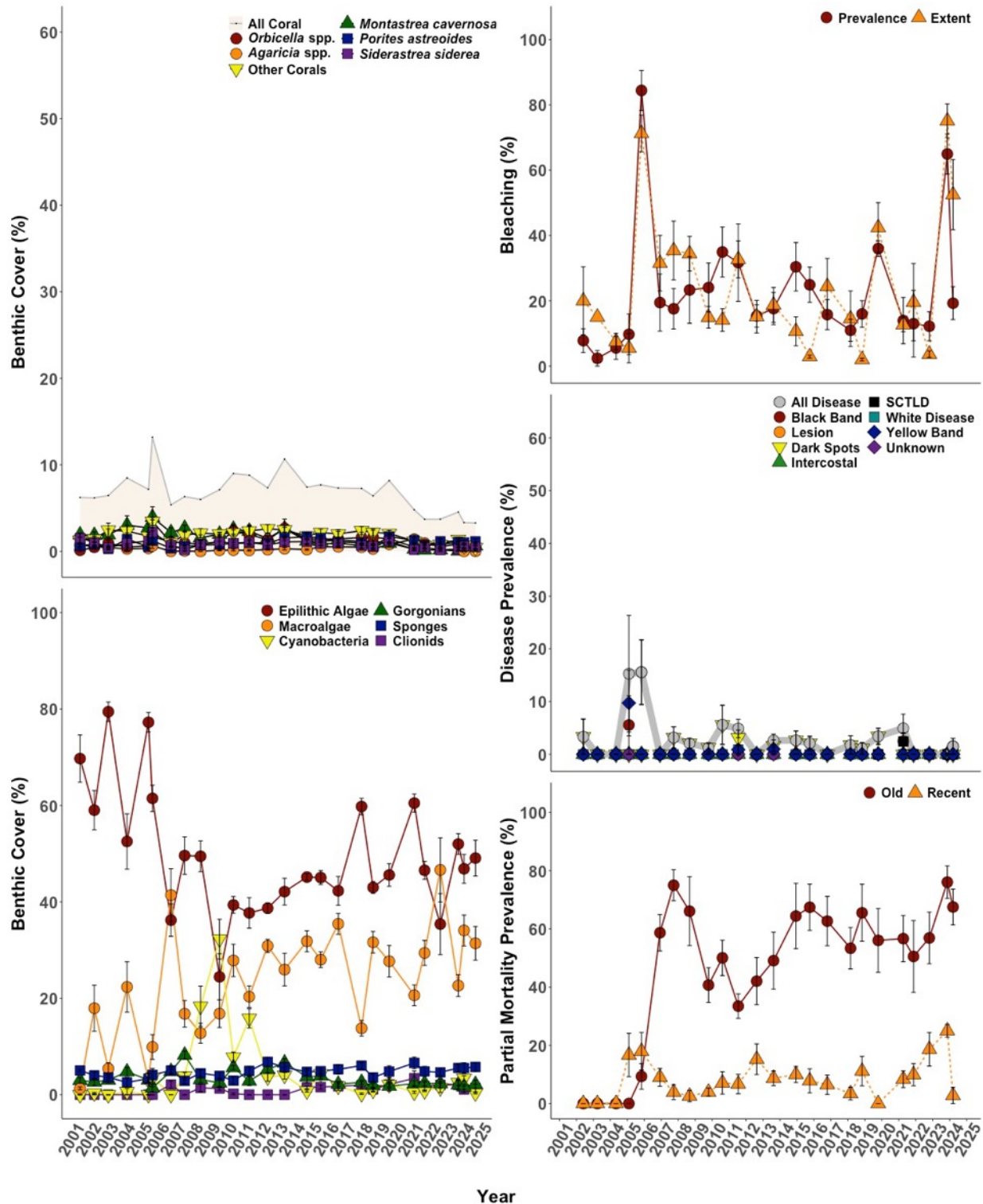


Figure 49. Eagle Ray benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: EAGLE RAY

Fish Community. Eagle Ray is a diverse and rich site; this is 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, black durgelon, piscivorous large jacks, and cero. 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 the fish community remains high in overall biomass and species richness.

SITE SUMMARIES: EAGLE RAY

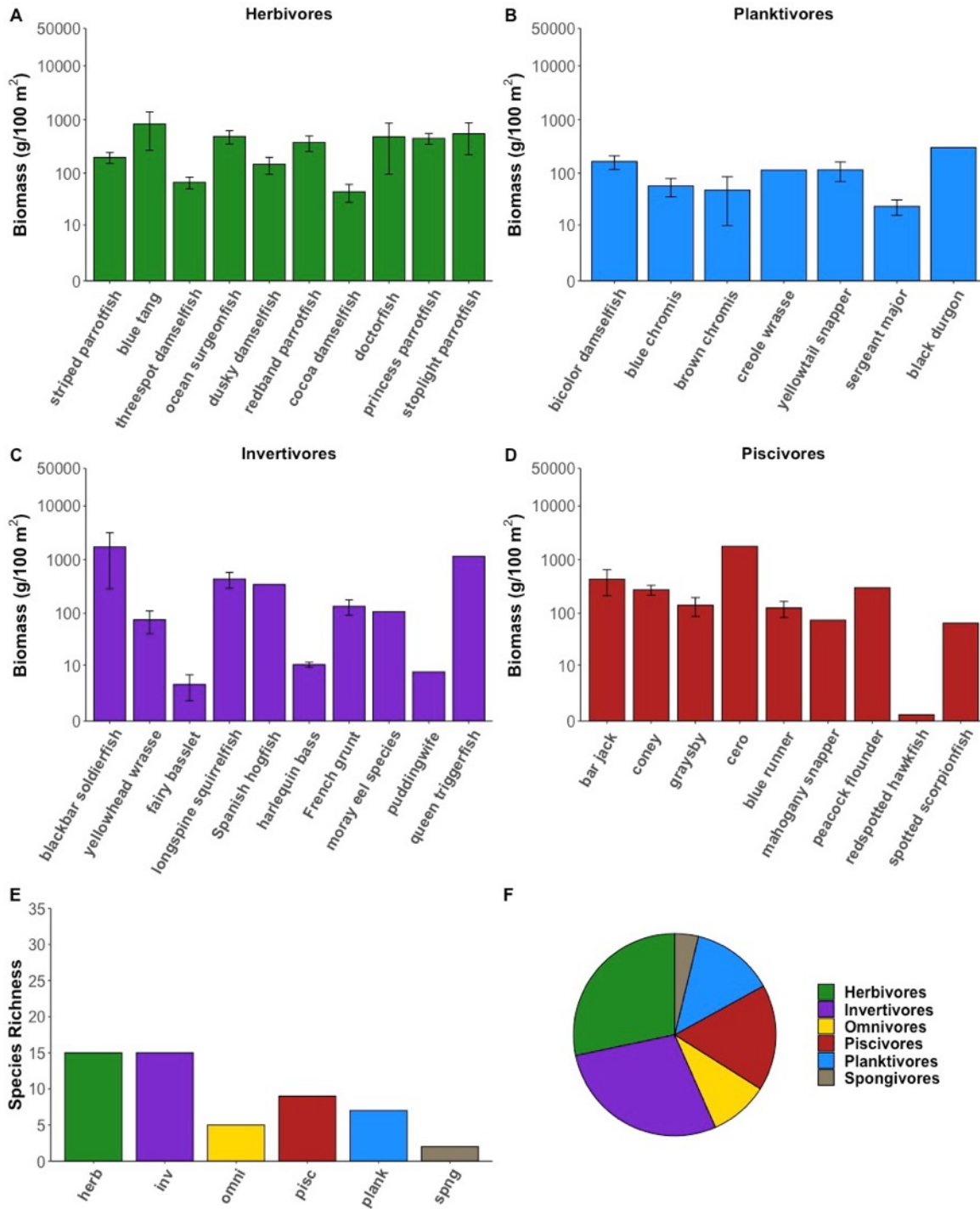


Figure 50. The 2023 Eagle Ray fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: GREAT POND

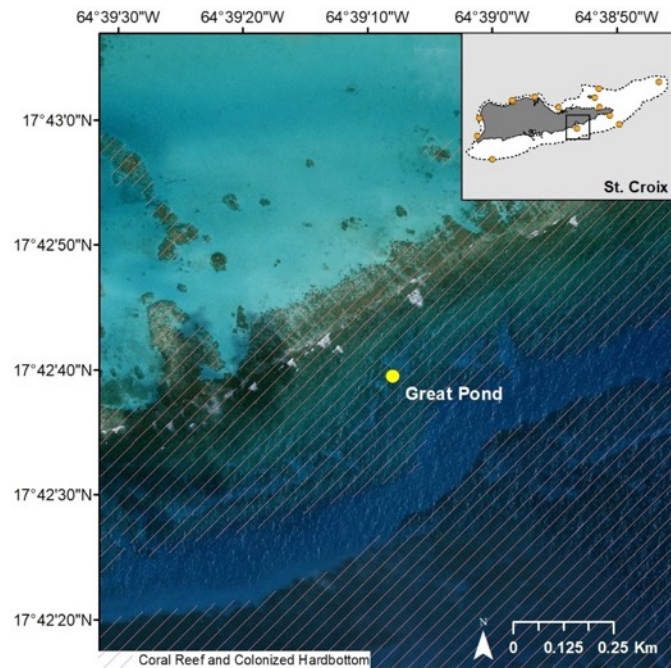
GREAT POND

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 51. (top) Great Pond location. (right) A representative photo of the reef (photo credit: L. M. Henderson).



SITE SUMMARIES: GREAT POND

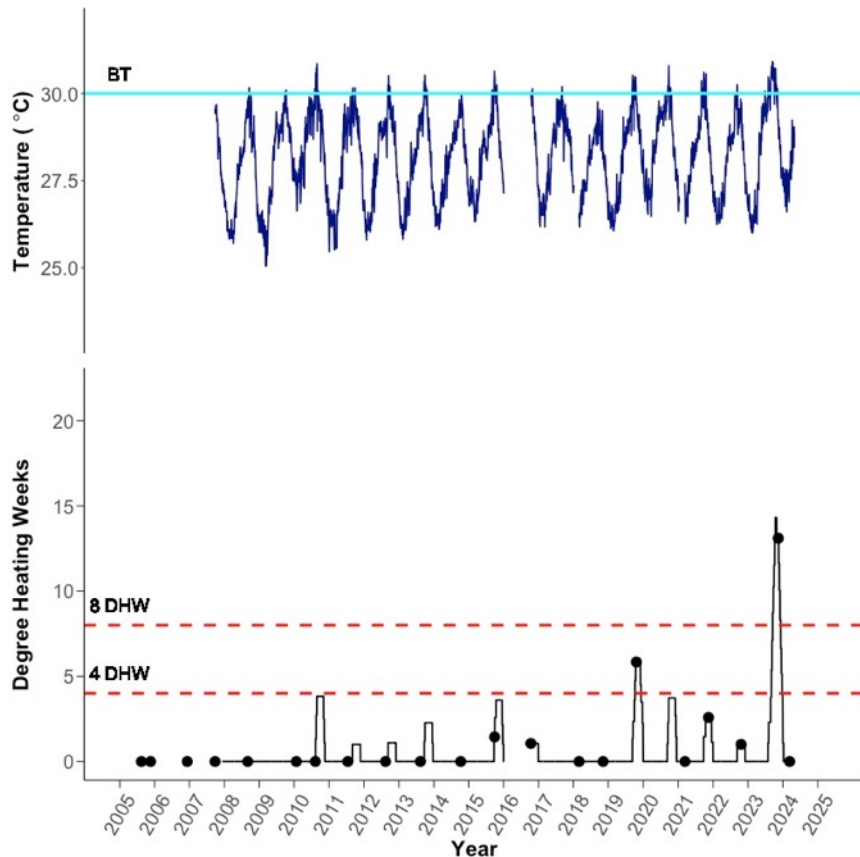


Figure 52. Great Pond benthic temperature (5 m depth).

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. Temperatures well surpassed the bleaching threshold in 2023 causing a maximum of 14 DHW.

SITE SUMMARIES: GREAT POND

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 had regained about half by 2011. Hurricanes Irma and Maria caused damage to this location in 2017, resulting in a 65% drop in relative coral cover during the 2017 annual monitoring (March 2018) but coverage has remained steady since then. Macroalgal blooms occur occasionally (2007 and 2011), but the site is dominated by epilithic algae. In the past decade or so, *Ramicrosta* has begun to increase in dominance, as reflected by the general increase in macroalgae at the site.

Coral Health. Great Pond corals were moderately affected during the 2005 coral bleaching event, which may reflect 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. In 2019 there were very few bleached colonies, but those that were affected had a high extent of bleaching on colony surfaces. Patchy, low-level bleaching is common in some years. In 2023, bleaching prevalence and extent was high, however, associated coral coverage was not affected, perhaps due to the resistant nature of these coral species, or an artifact of the very low coral coverage to begin with. Diseases have been almost non-existent at the monitoring site. Partial mortality is variable and has not shown consistent trends over years. Stony coral tissue loss disease was first recorded during the 2021 annual sampling (November 2021).

SITE SUMMARIES: GREAT POND

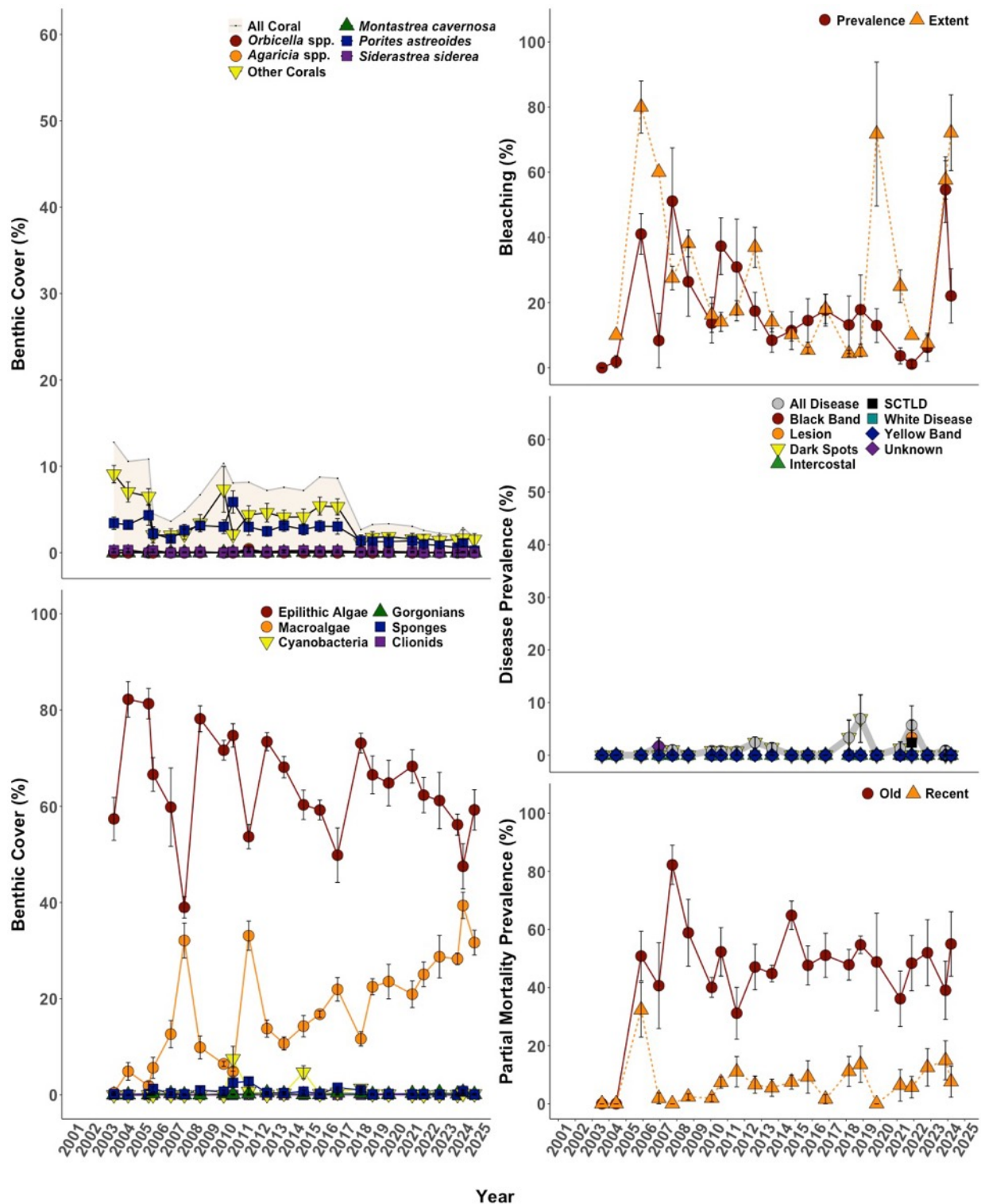


Figure 53. Great Pond benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES: GREAT POND

Fish Community. The Great Pond fish community is highly dominated by herbivores, and very low in richness of piscivores, omnivores, and planktivores. 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 typically 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 typically dominated in biomass and abundance by wrasses. Wrasse diversity is high and includes the slippery dick, clown wrasse, blackear wrasse, yellowhead and bluehead wrasse, rainbow wrasse, puddingwife, and Spanish hogfish.

SITE SUMMARIES: GREAT POND

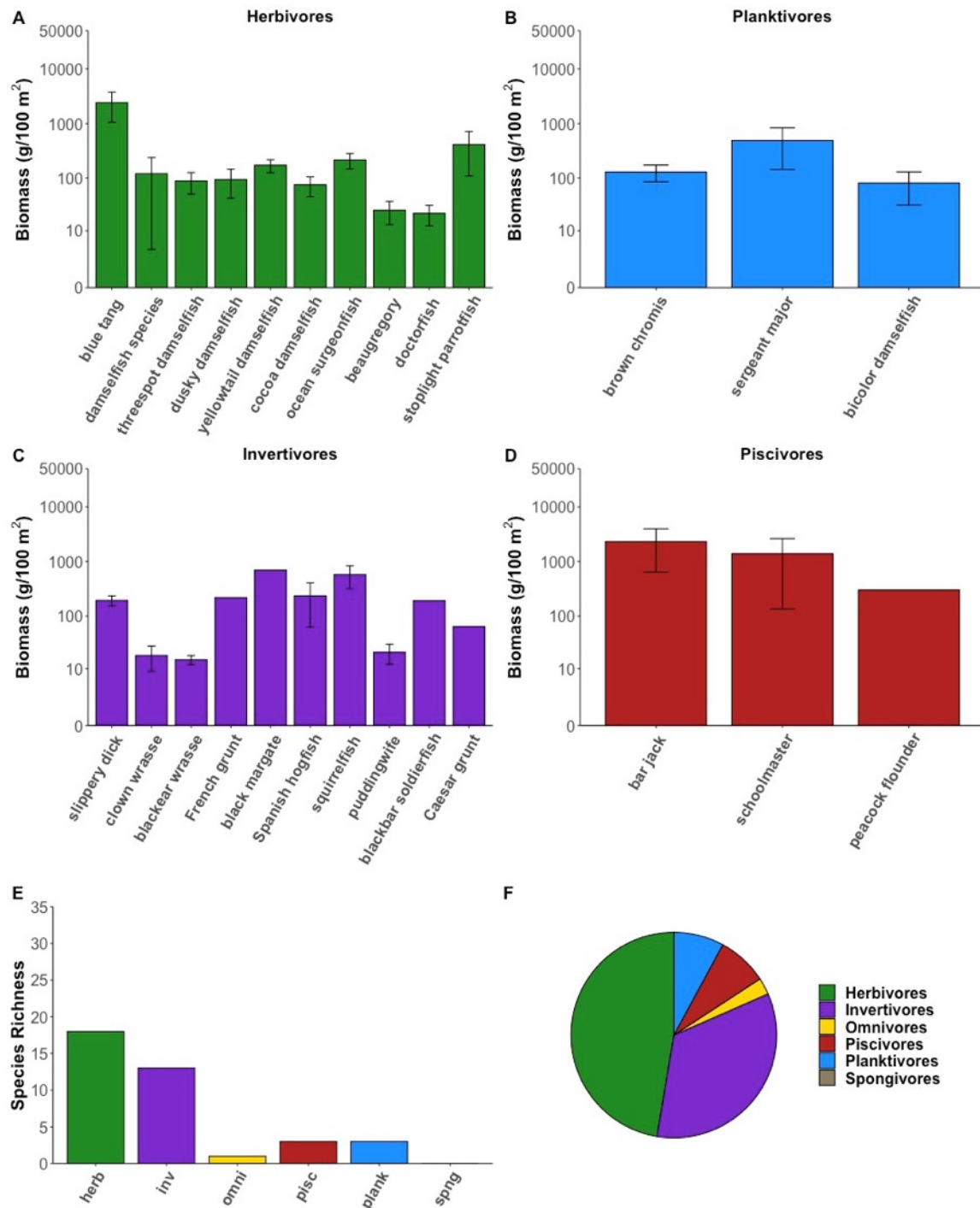


Figure 54. The 2023 Great Pond fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: JACKS BAY

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.

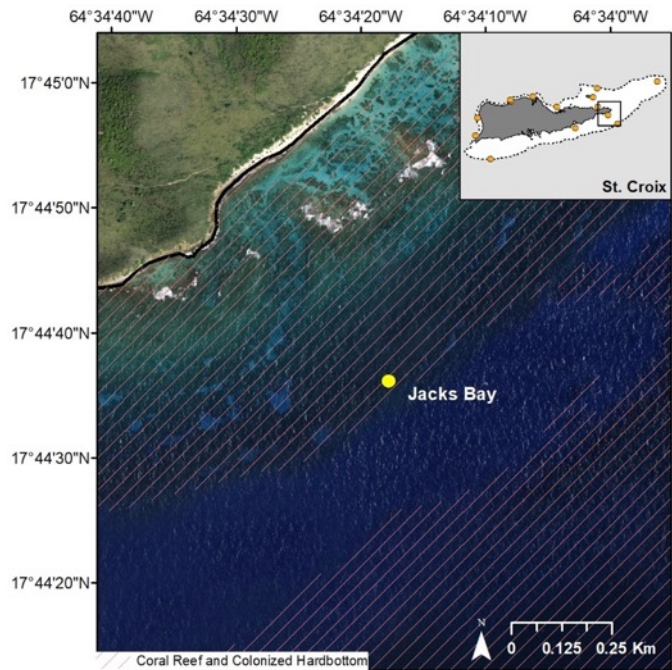


Figure 55. (top) Jacks Bay location. (right) A representative photo of the reef (photo credit: L. M. Henderson).



SITE SUMMARIES: JACKS BAY

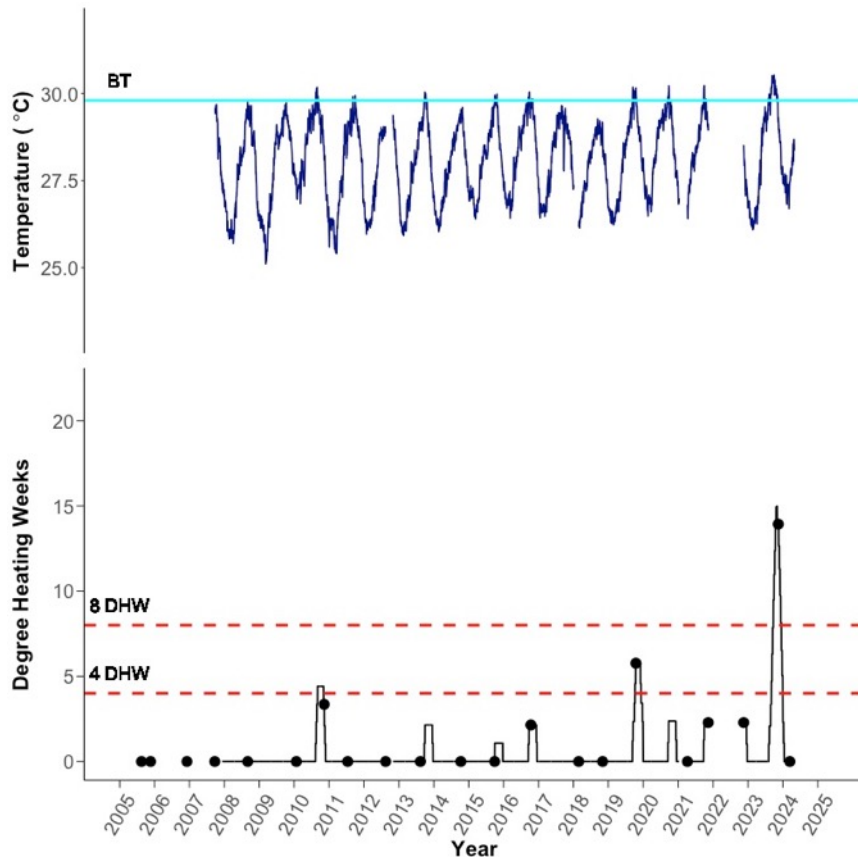


Figure 56. Jacks Bay benthic temperature at 12 m depth

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. Heat stress in 2010, 2019, and 2023 was sufficient enough to cause coral bleaching.

SITE SUMMARIES: JACKS BAY

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 and 2023 bleaching event and was moderately affected during the 2010 and 2019 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, with an increase in 2018 for unknown reasons. Stony coral tissue loss disease was first recorded in the 2021 annual sampling (November 2021).

SITE SUMMARIES: JACKS BAY

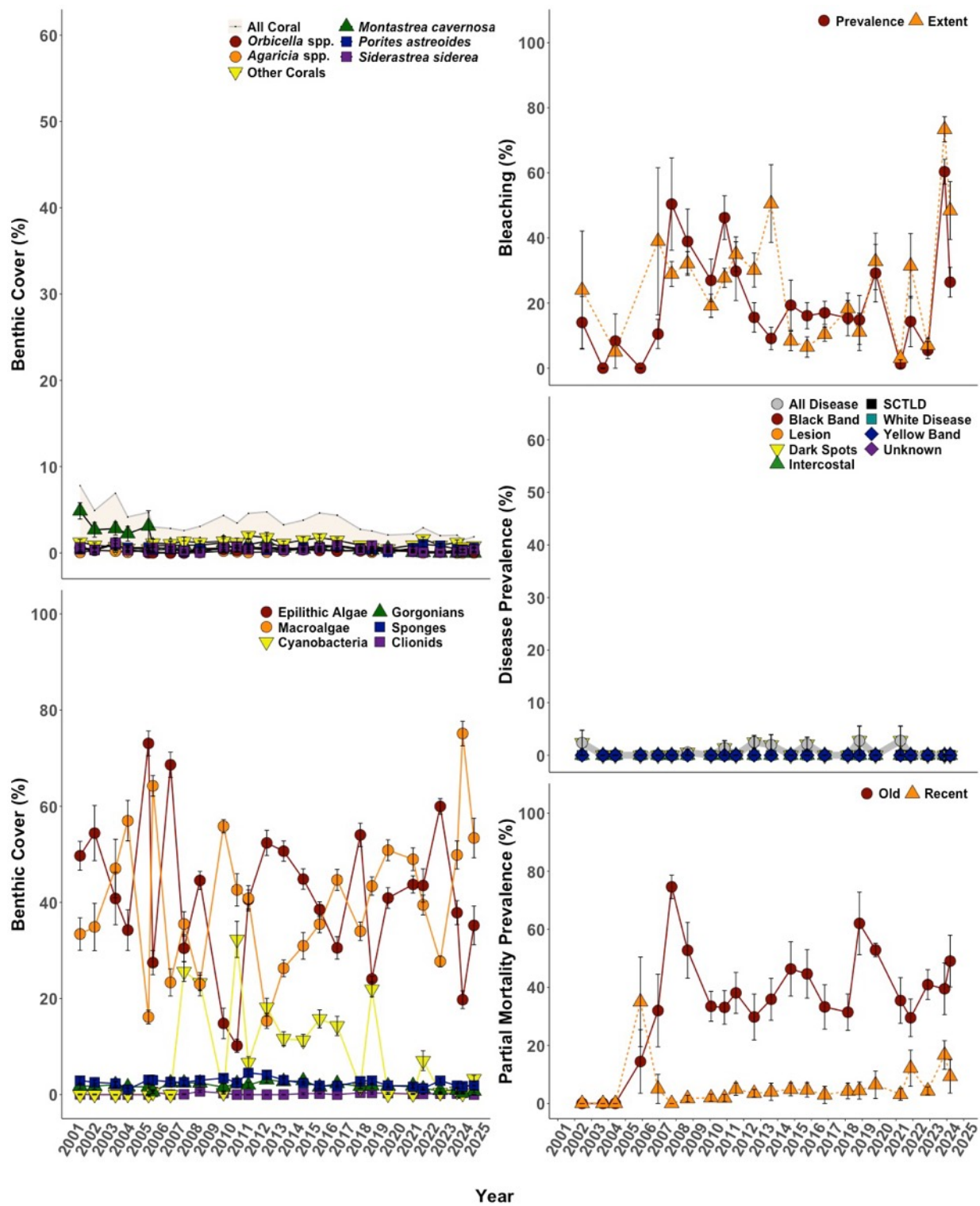


Figure 57. Jacks Bay benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: JACKS BAY

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: JACKS BAY

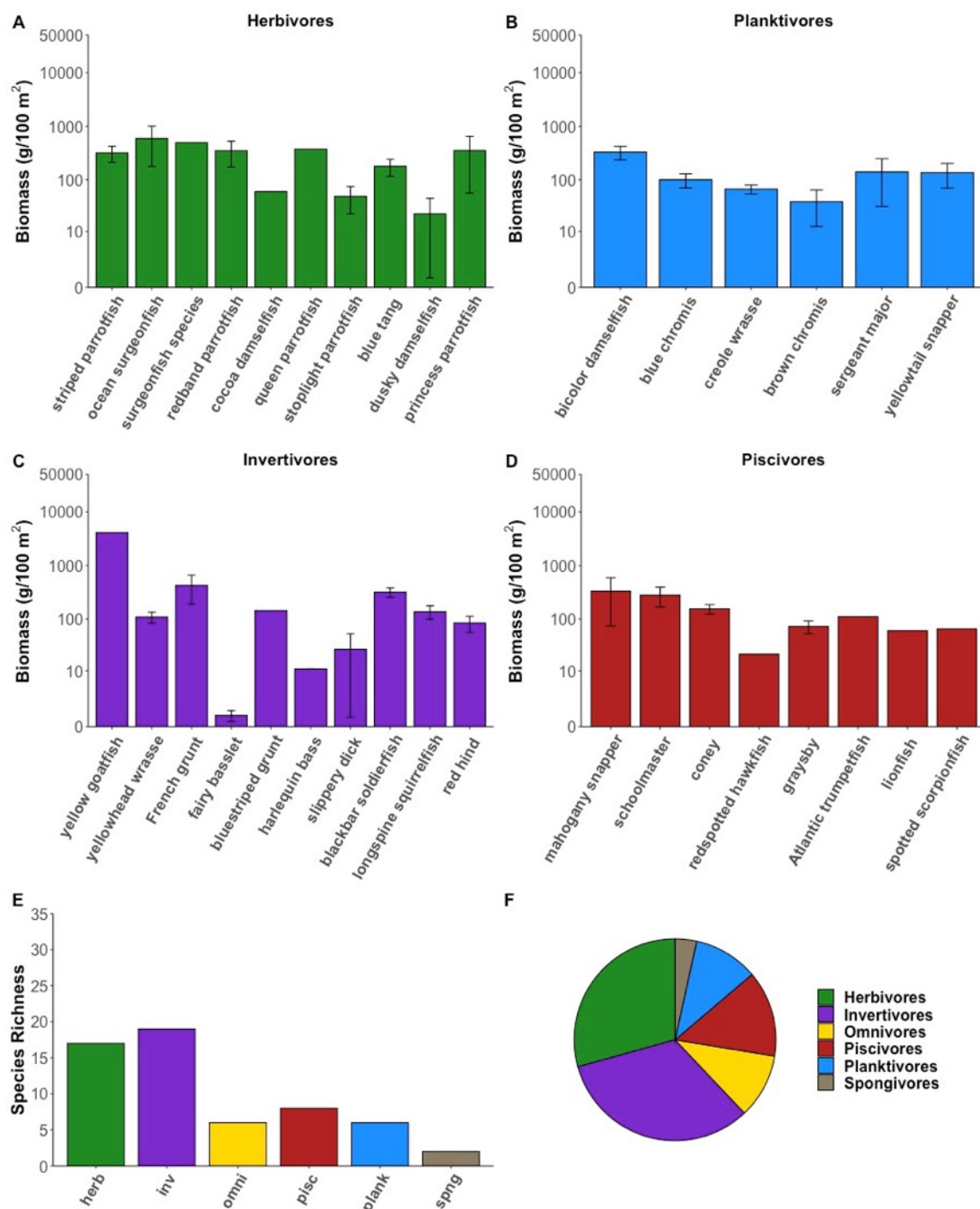


Figure 58. The 2023 Jacks Bay fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: LANG BANK EEMP

KINGS CORNER

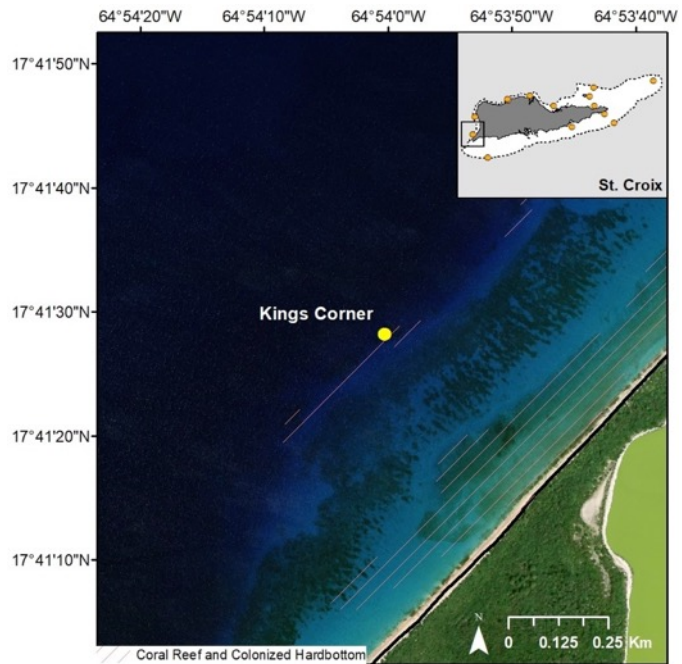
Description. The Kings Corner monitoring site is a part of a patchy reef complex along the steeply sloping west coast of St. Croix in depths of 15-25 m. The reef contains a high diversity of corals and sponges on mounds surrounded by sand. Kings Corner has been monitored since 2006, with permanent transects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

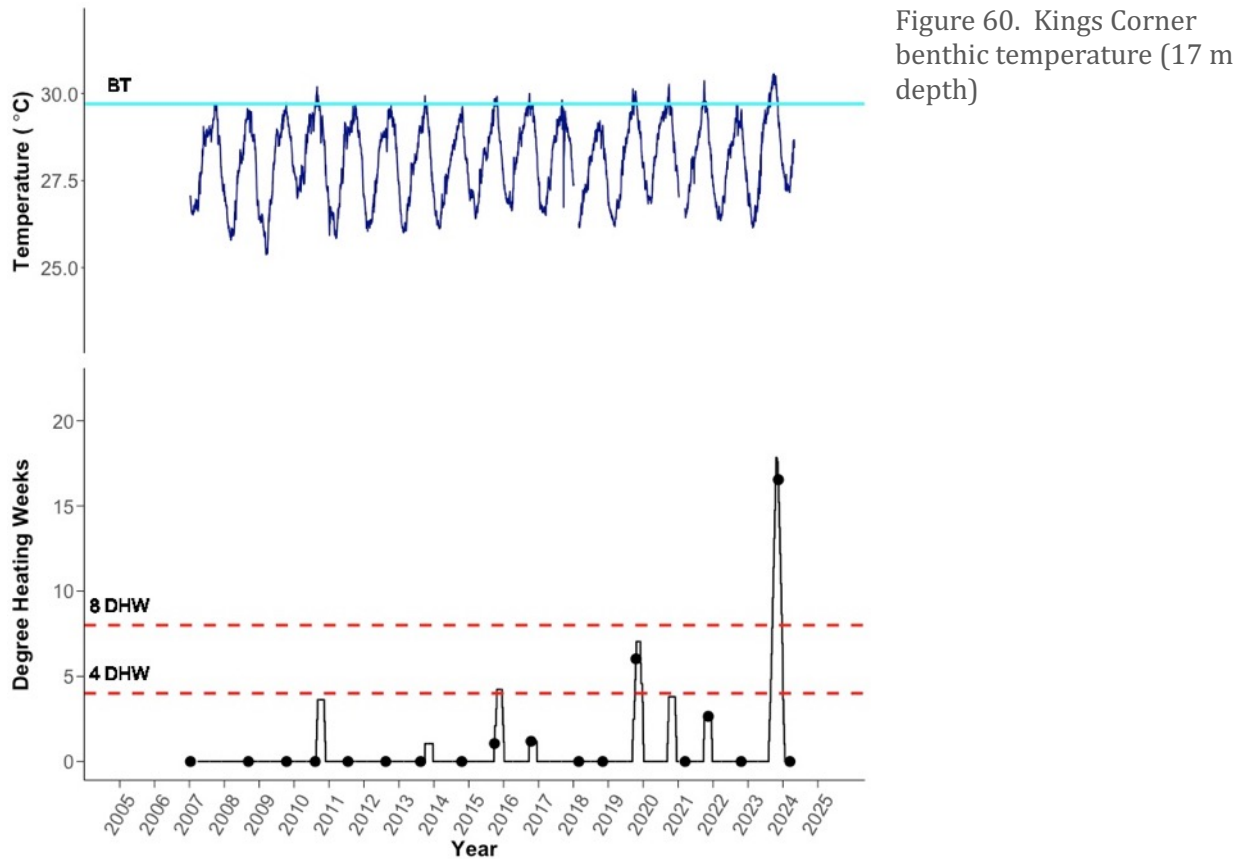
Threats. Kings Corner is open to fishing and is easily accessible as part of the calm lee of western St. Croix near Frederiksted. Derelict fishing lines, fish traps, fish weights, and other marine debris are in evidence in and around the site. Large plumes of sediment that wrap around Sandy Point from 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 59. Kings Corner. (top) Location. (right) A representative photo of the reef (photo credit: L. M. Henderson).



SITE SUMMARIES: LANG BANK EEMP



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. An adjusted bleaching threshold of 29.70 °C was established based on historical bleaching responses and 2019. Applying that threshold, high temperatures in 2023 brought 17.9 DHW.

SITE SUMMARIES: LANG BANK EEMP

Benthic Community. The Kings Corner site supports a diverse community of hard corals formally 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. Indications of increasing coral cover after 2005 suggest bleaching related mortality, but then resilience after the disturbance. An outbreak of white disease in 2012 temporarily reduced coral cover. Relative coral cover dropped precipitously by 2021 (70.0%), likely due to the arrival of Stony Coral Tissue Loss Disease and diverse coral fauna that included many susceptible species. Coral coverage at King's Corner seemed relatively unaffected by the 2023 bleaching event, with only minimal declines in coverage noted. 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. The site bleached moderately in 2019 and again in 2023. Old partial mortality has increased lately. Stony coral tissue loss disease was recorded at a high prevalence in transects in the 2020 year sampling (March 2021).

SITE SUMMARIES: LANG BANK EEMP

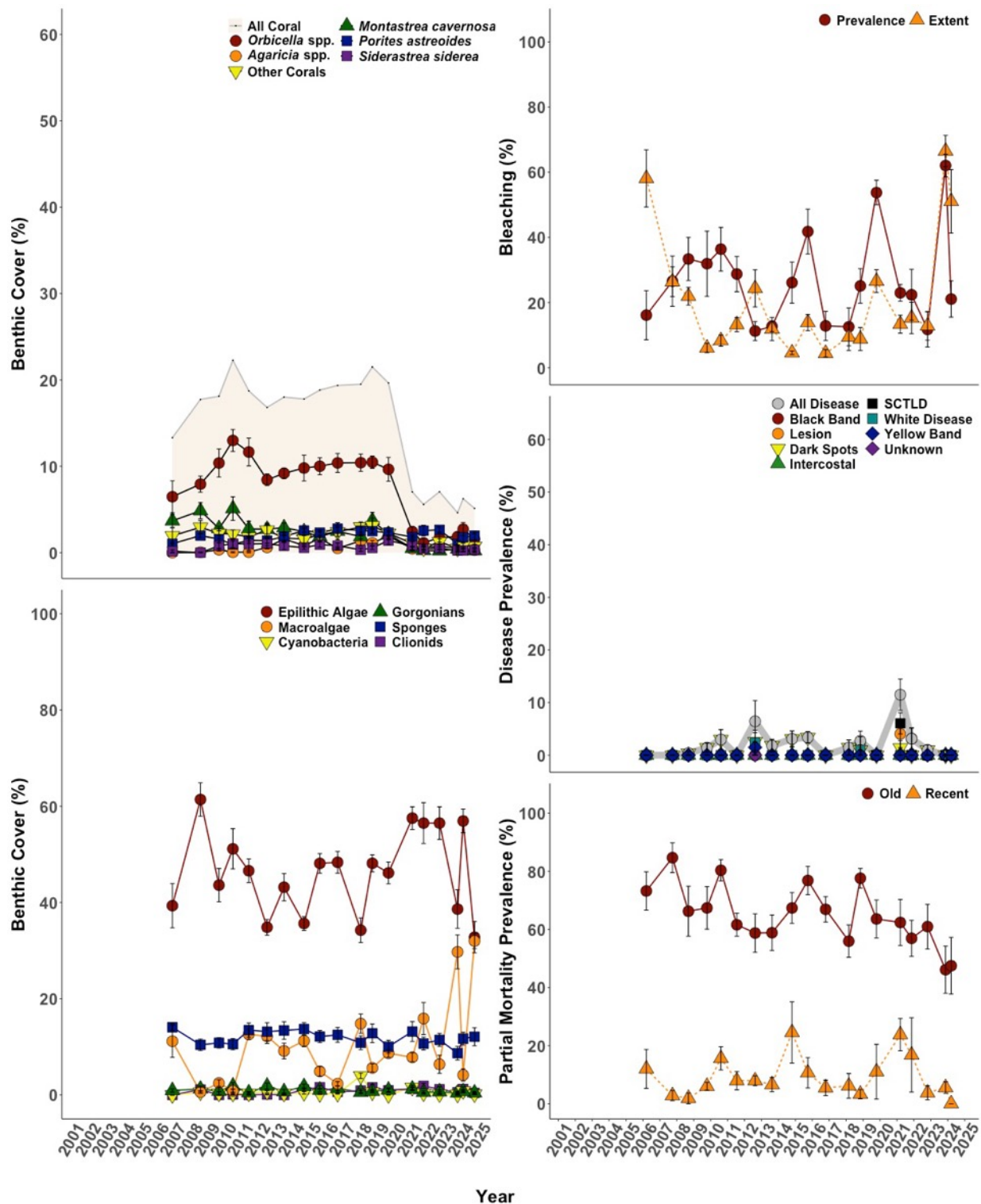


Figure 61. Kings Corner benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: LANG BANK EEMP

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, the yellow goatfish, and the tomtate, a more opportunistic benthic feeder of invertebrates, zooplankton and benthic algae. Common planktonic feeders at Kings Corner include the boga, black durgelon, Atlantic spadefish, and creole wrasse. Garden eels are ubiquitous on the sandy areas around the patchy reefs. Common benthic herbivores include the blue tang and ocean surgeonfish as well as the common Caribbean parrotfishes (stoplight, princess, redband, redbin, queen, and striped). A variety of grunts are common on the site as well as angelfishes and large green moray eels. Piscivores as a group are relatively low in biomass, and are represented by jacks (pelagic), glasseye snapper and bigeye (nocturnal feeders), and graysby, coney, lionfish, and small snappers (diurnal bottom feeders). Mutton snapper, cubera snapper, and dog snapper are occasional.

SITE SUMMARIES: LANG BANK EEMP

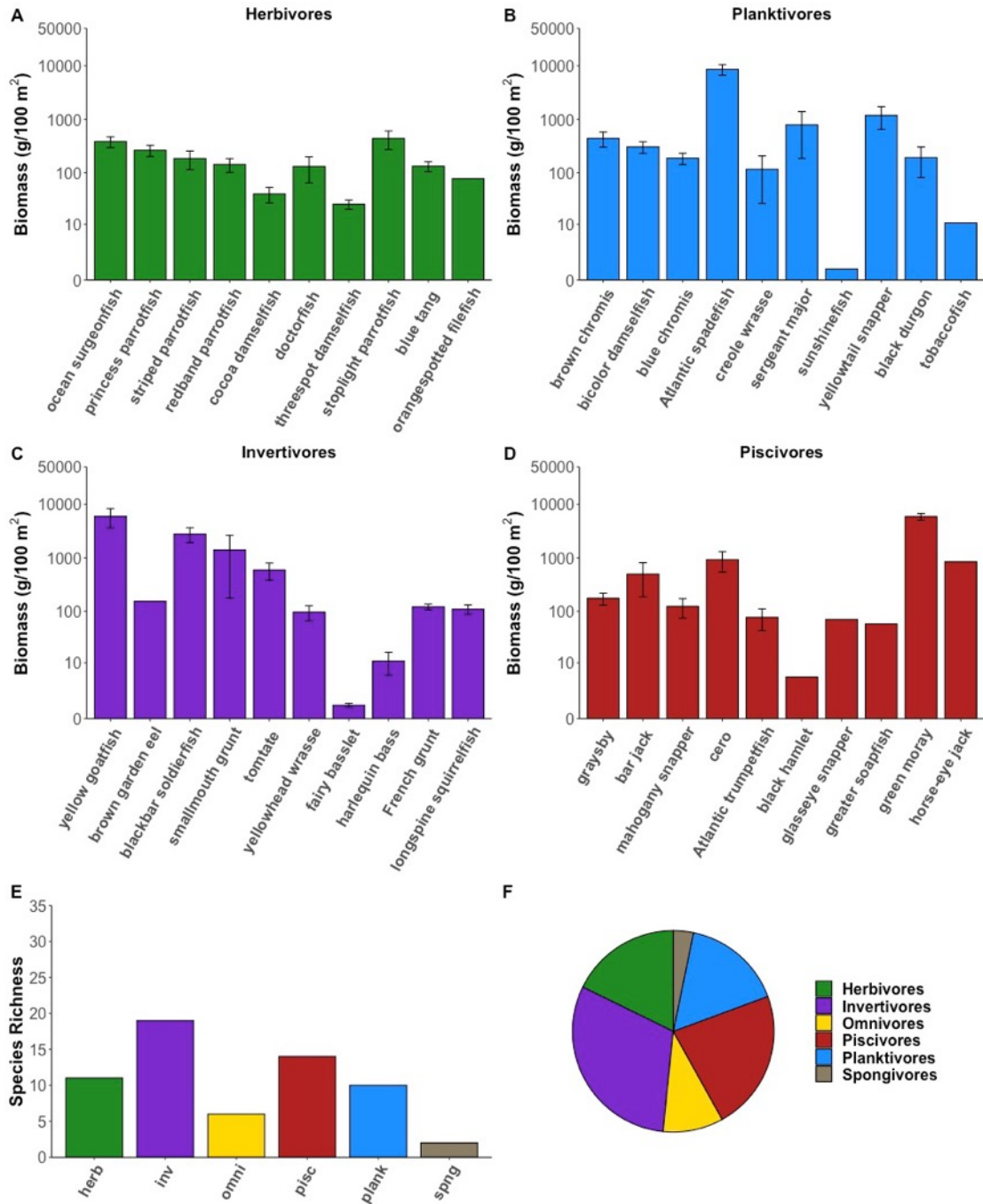


Figure 62. The 2023 Kings Corner fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: LANG BANK EEMP

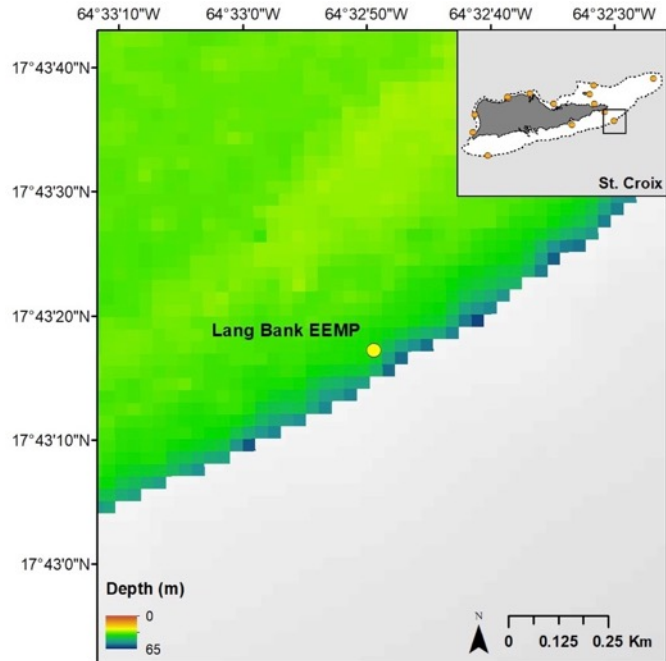
LANG BANK EAST END MARINE PARK

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



SITE SUMMARIES: LANG BANK EEMP

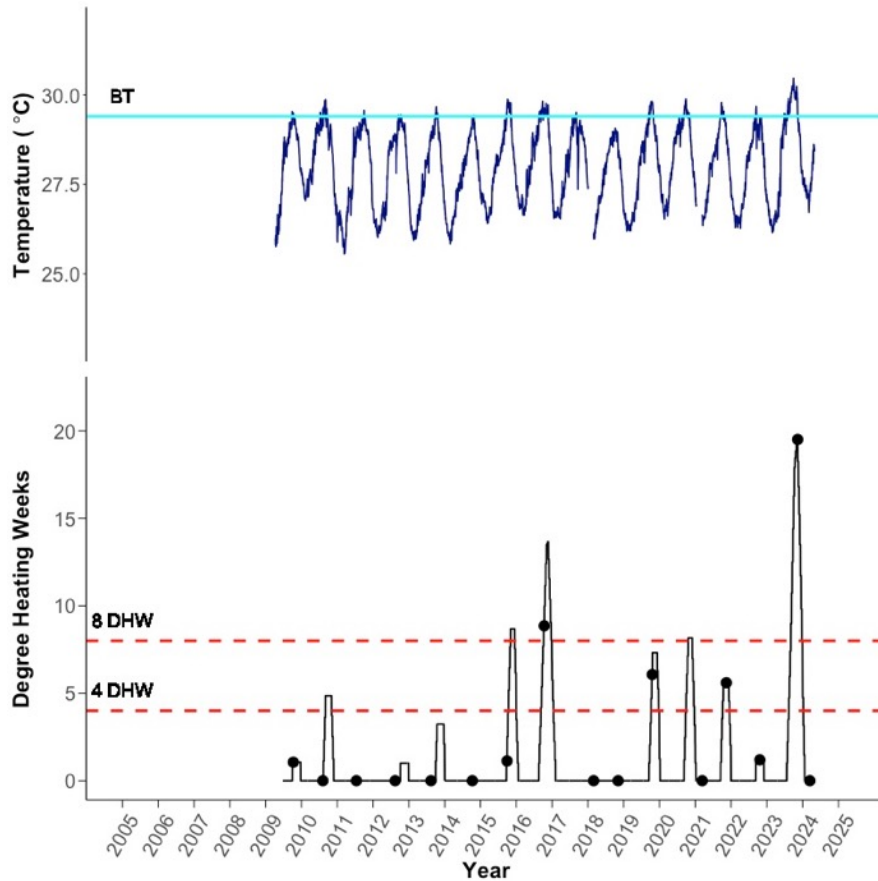
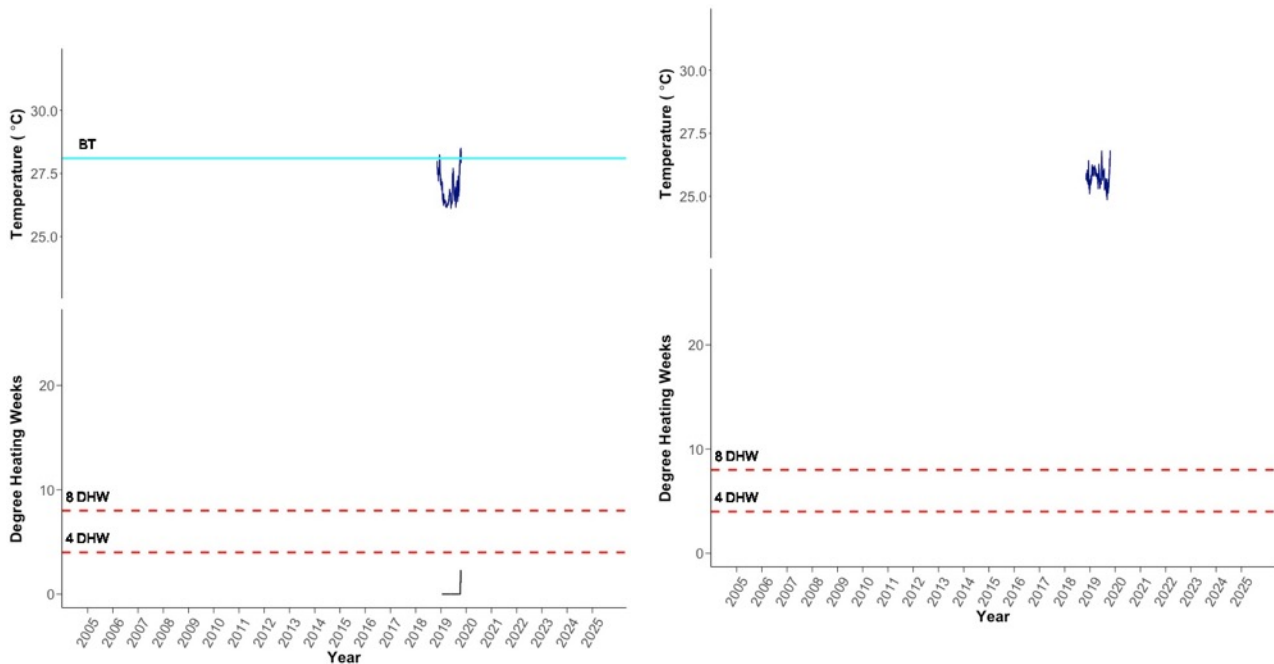


Figure 64. Lang Bank EEMP benthic temperature (Top: 28 m depth, bottom left: 67m depth, bottom right: 100 m depth).



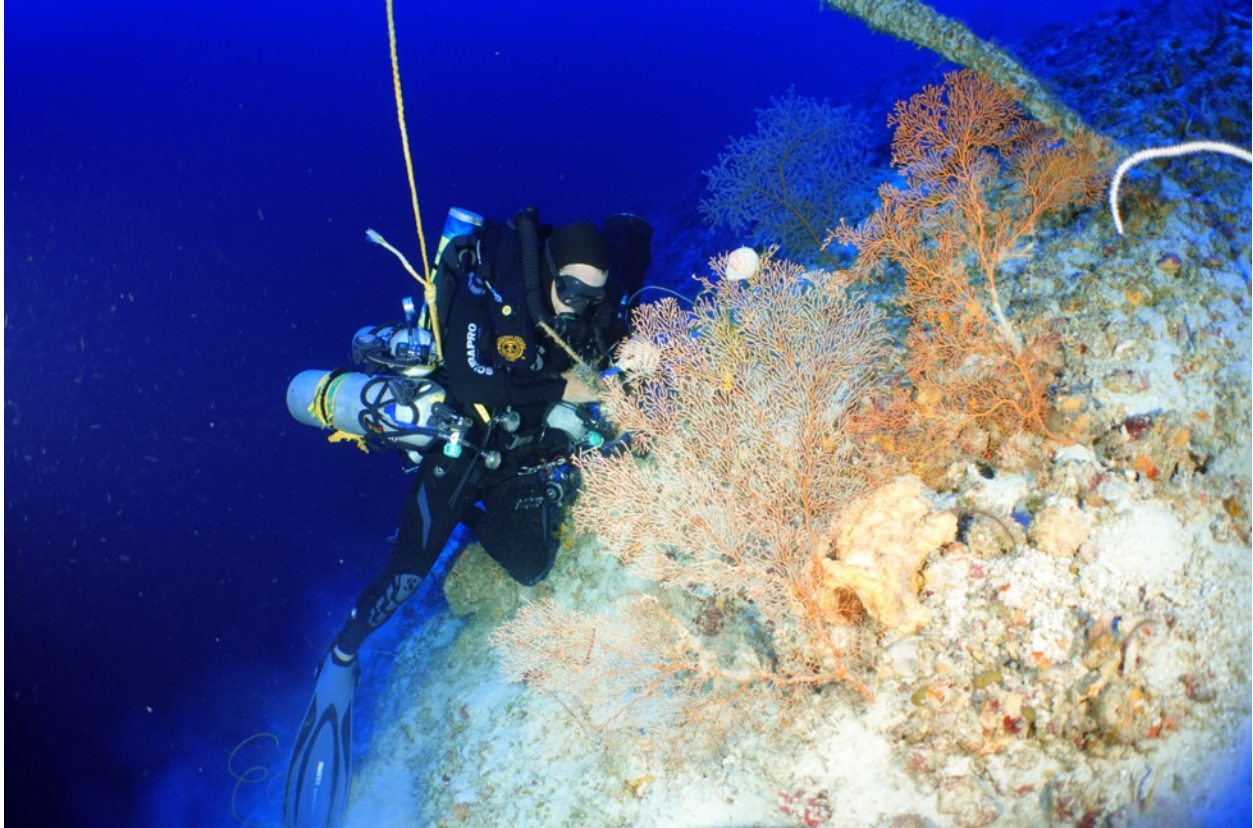


Figure 65. Changing of thermistors at Lang Bank EEMP at 100 m (credit: Viktor Brandtneris).

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 (Smith et al. 2016a). Based on the response of corals to thermal stress in 2019 an adjusted bleaching threshold of $29.63\text{ }^{\circ}\text{C}$ was established. Following that threshold, the site faced substantial thermal stress in 2023, experiencing up to 19.5 DHW.

SITE SUMMARIES: LANG BANK EEMP

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. There has been a relative decrease of nearly 50% coral cover from 2019 – 2022 likely due to Stony Coral Tissue Loss Disease. Further decline of coverage was noted after the 2023 bleaching event, in which the site lost another 36% of its relative cover.

Coral Health. Background, non-thermal bleaching prevalence is quite high at Lang Bank EEMP. White disease showed an outbreak in 2011. In 2023, corals experienced high bleaching prevalence (~60%), with colonies bleaching over about 90% of the colony surface. 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. Recent mortality appeared to spike in spring of 2024, likely due to the 2023 bleaching event.

SITE SUMMARIES: LANG BANK EEMP

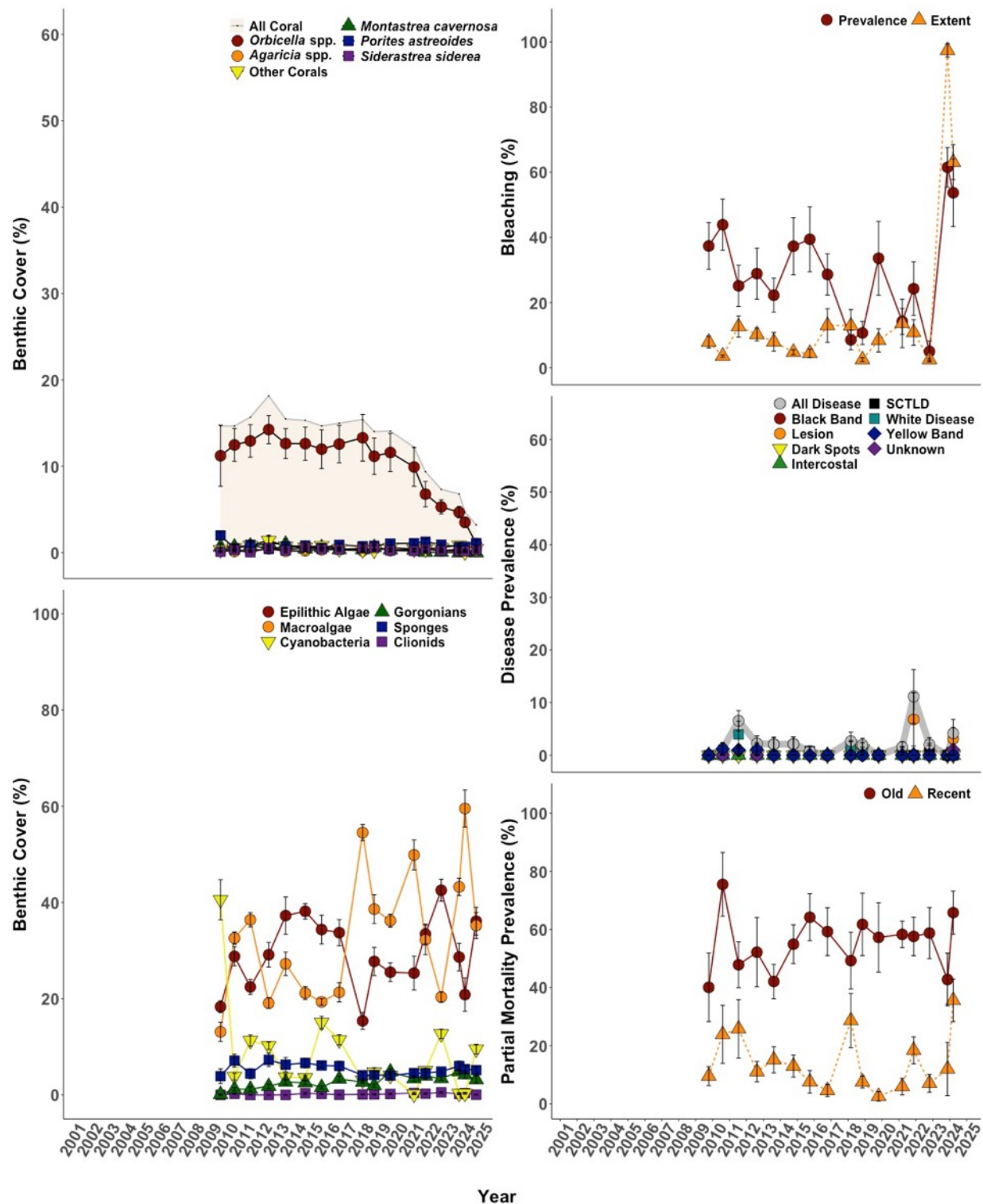


Figure 66. Lang Bank EEMP benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES: LANG BANK EEMP

Fish Community. The Lang Bank East End Marine Park site represents a mesophotic reef community that is characterized by a high biomass of planktonic and invertebrate feeders and a low biomass of herbivores. The high overall biomass of planktivores is frequently 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. At least one Nassau grouper is typically encountered during monitoring.

SITE SUMMARIES: LANG BANK EEMP

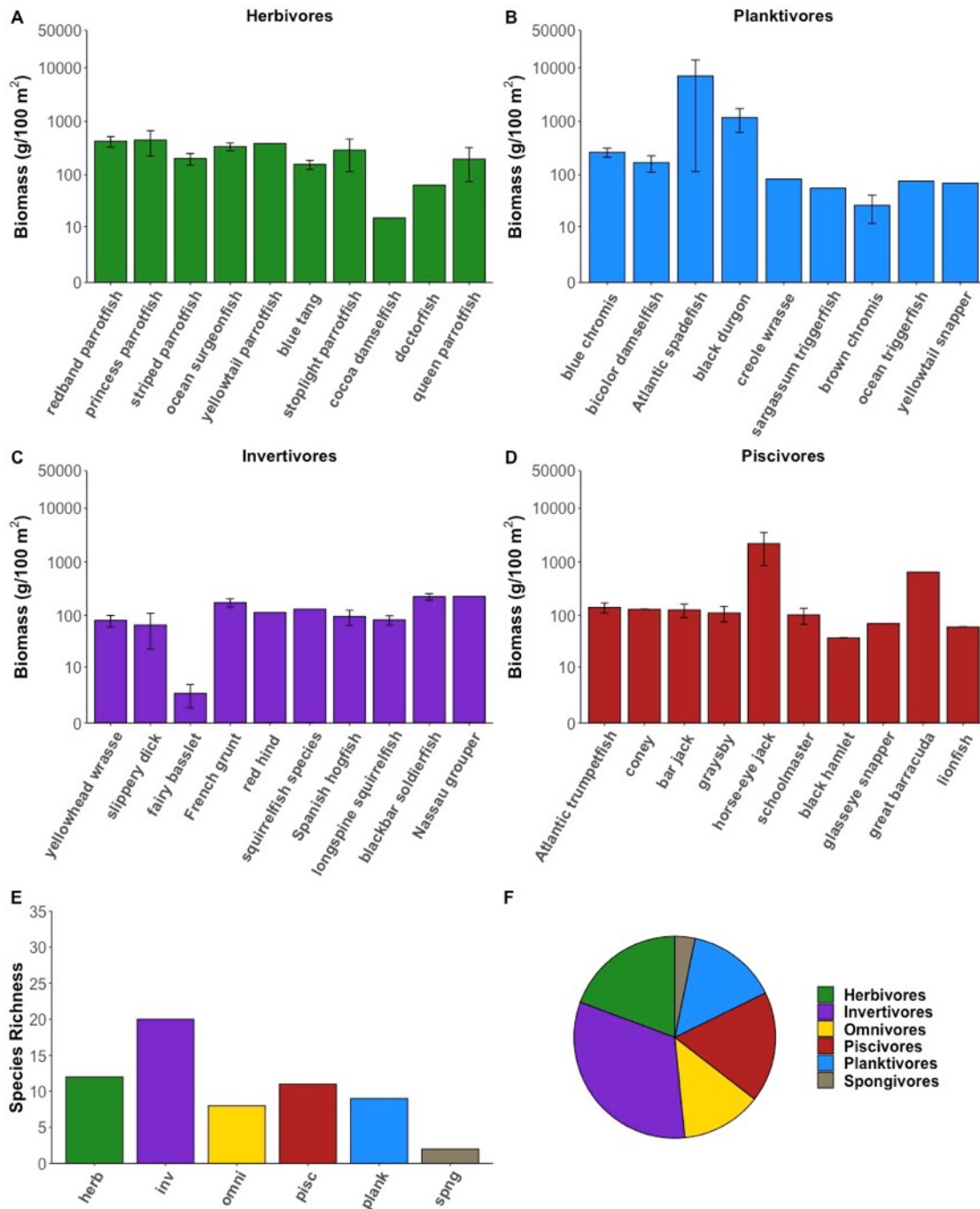


Figure 67. The 2023 Lang Bank EEMP fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: LANG BANK RED HIND

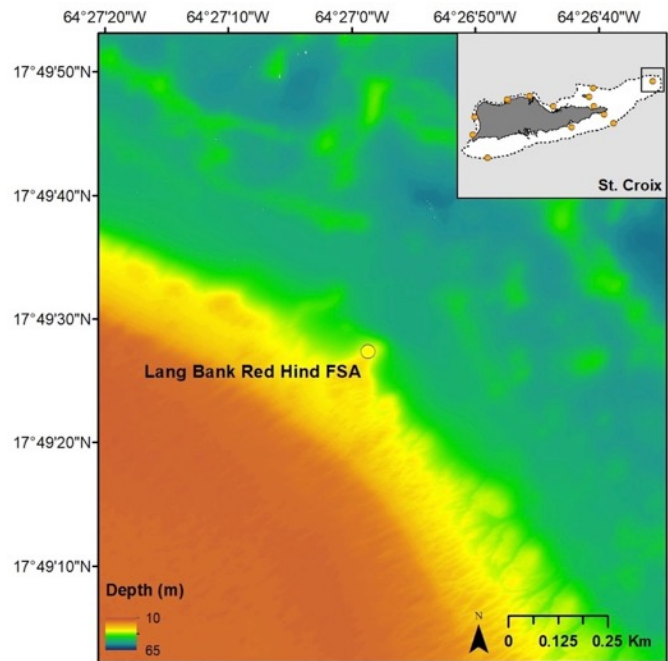
LANG BANK RED HIND FISH SPAWNING AGGREGATION

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 often 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 68. Lang Bank Red Hind FSA. (top) Location. (right) A representative photo of the reef in 2021. (photo: T. Smith)



SITE SUMMARIES: LANG BANK RED HIND

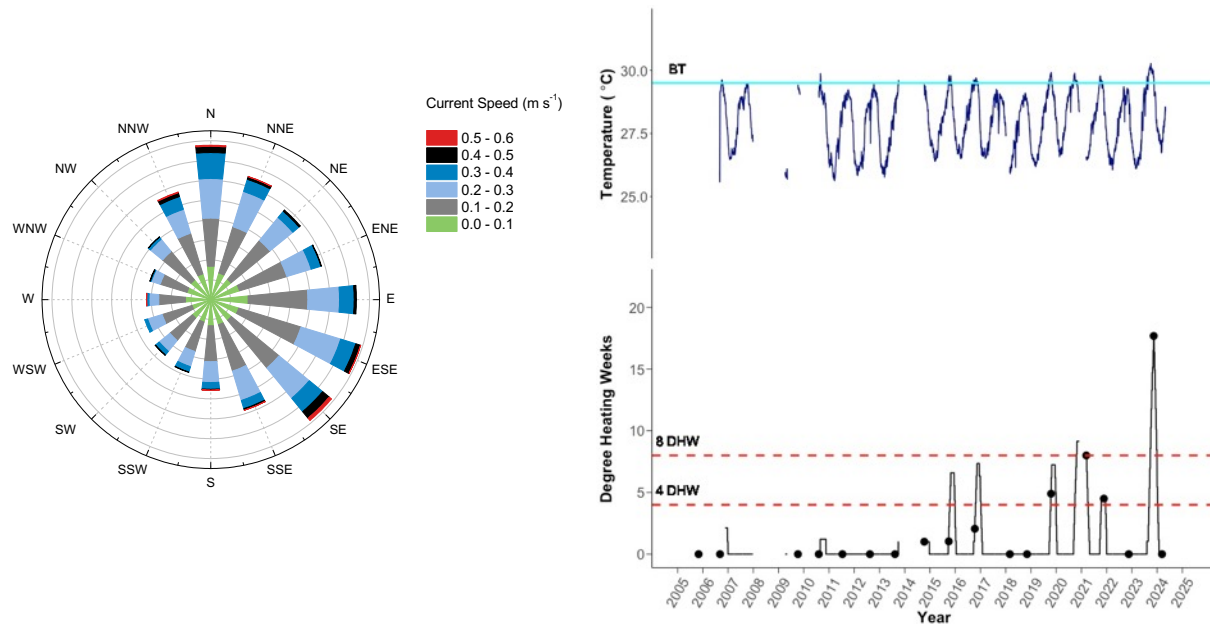


Figure 69. Lang Bank Hind current speed (left) and benthic temperature (right; 33 m depth).

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 and 2019, yet the model predicted ~8 DHW, which should have led to a mass bleaching response. Similarly, the predicted 17 DHW in 2023 led to a relatively moderately high bleaching response, instead of the extremely high (>80% bleaching prevalence) response seen at other sites with similar DHW values.

SITE SUMMARIES: LANG BANK RED HIND

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. There has been about a 44% relative drop in coral cover (2019 – 2022) since Stony Coral Tissue Loss Disease was first observed. 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. In 2023, prevalence of bleaching was high (64%), as was the associated extent of bleaching (72%). The site was heavily affected with white diseases after the 2005 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 and consistently high at Lang Hind, largely as the result of fish bites and predation by the corallivorous snail *Coralliophila* spp. Stony coral tissue loss disease was recorded in transects in the 2020 year sampling (March 2021) and caused the largest decline in coral cover since permanent transects were installed.

SITE SUMMARIES: LANG BANK RED HIND

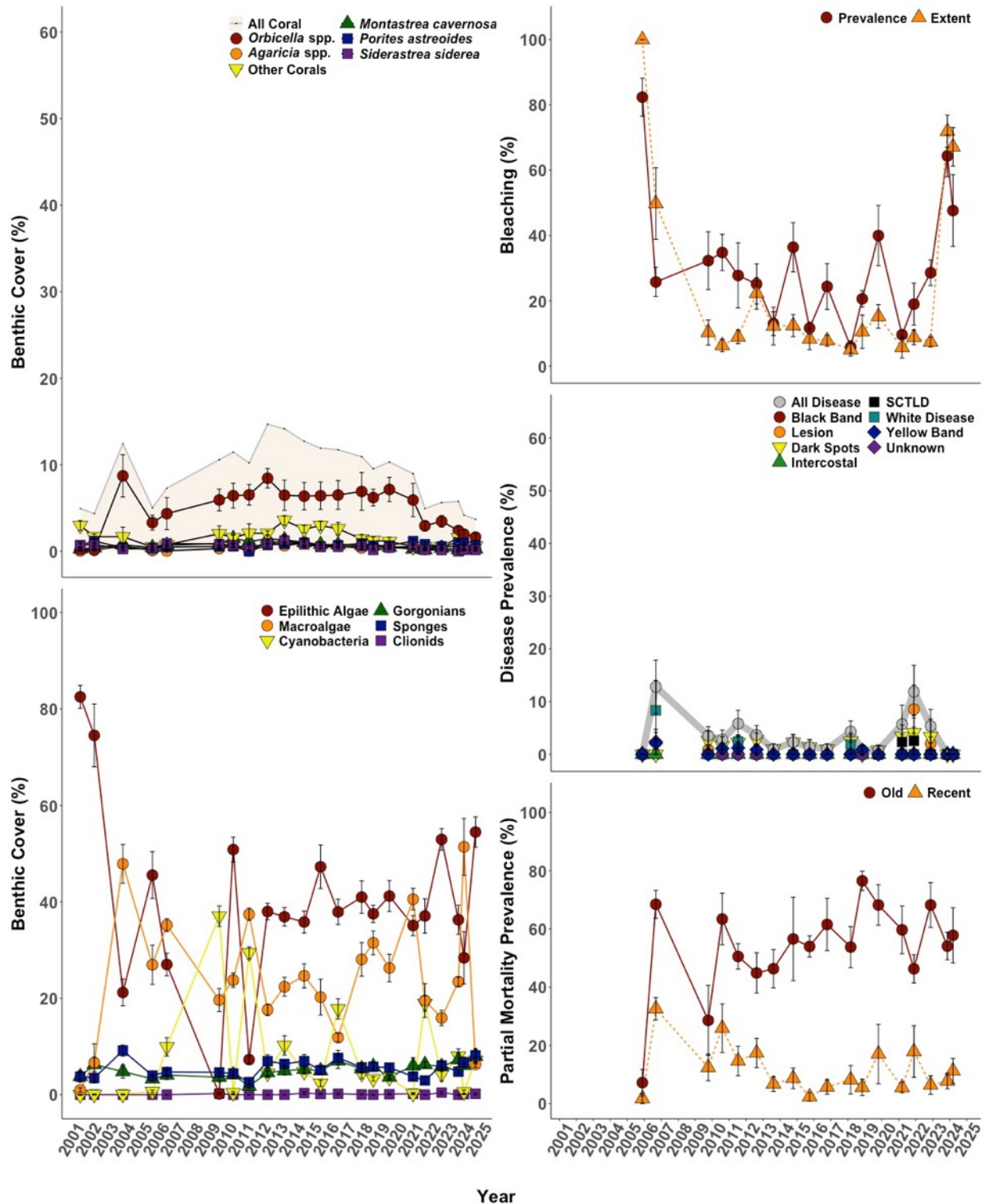


Figure 70. Lang Bank Red Hind FSA benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: LANG BANK RED HIND

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 durgeon, creole wrasse, black jack, and creolefish. Occasionally schools of rainbow runners come through as well. 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. Many different species of angelfish are typically observed on transects, reflecting the high sponge cover, though none were observed this most recent year. 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 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, marking the first time one has been observed in TCRMP transects in St. Croix. Since then, a yellowfin grouper has appeared here again in 2020 and in 2023. 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: LANG BANK RED HIND

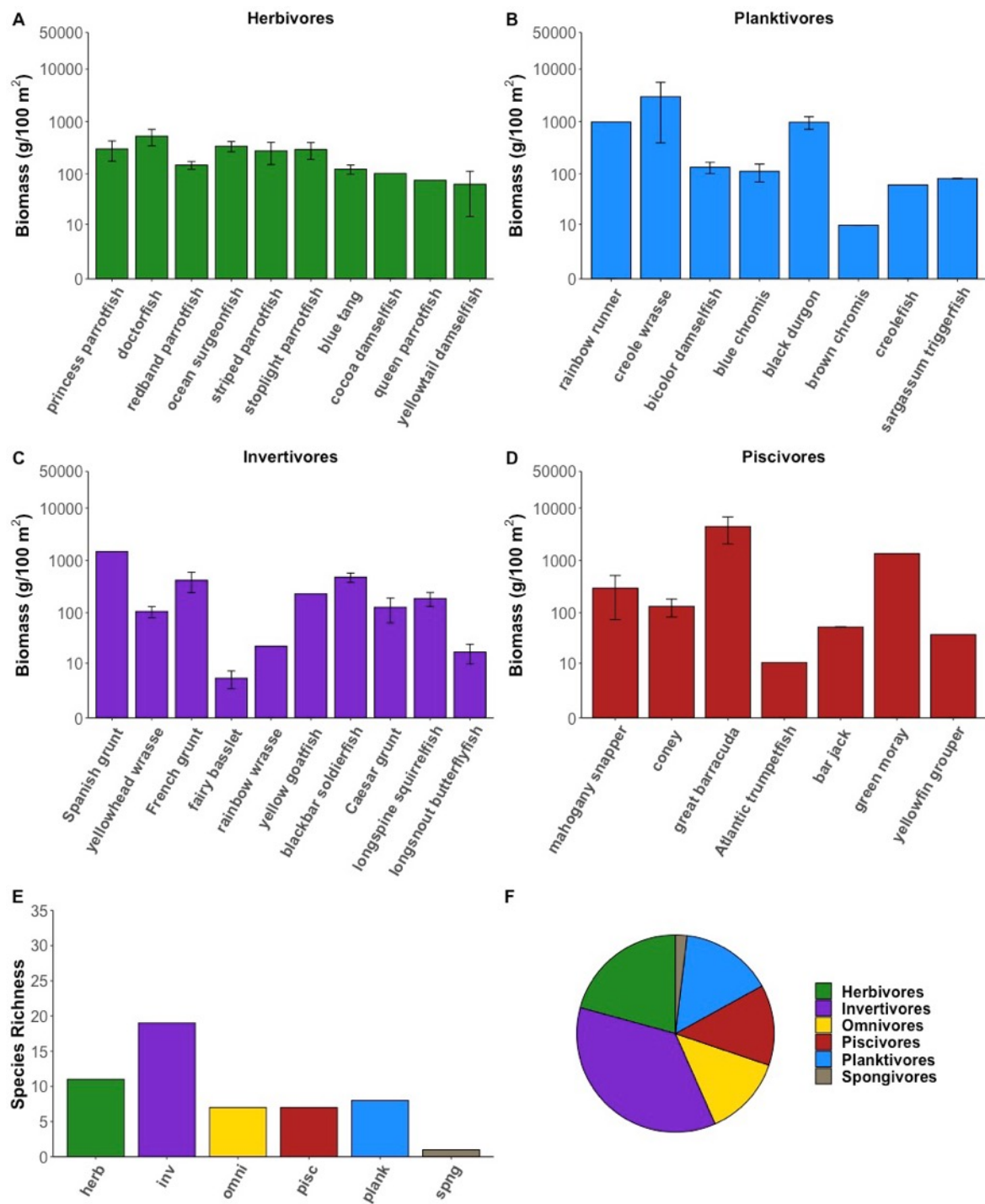
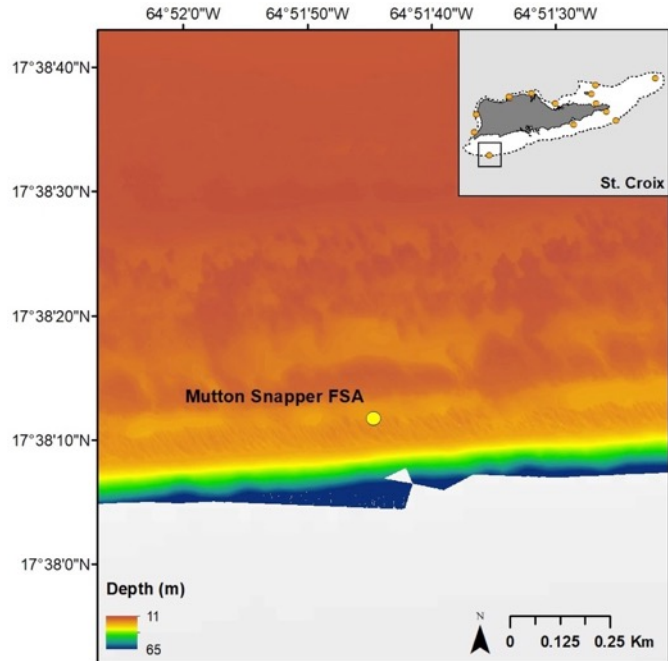


Figure 71. The 2023 Lang Bank Red Hind FSA fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: MUTTON SNAPPER

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 72. Mutton Snapper. (top) Location. (right) A representative photo of the reef taken in 2017. (photo: L. Henderson)



SITE SUMMARIES: MUTTON SNAPPER

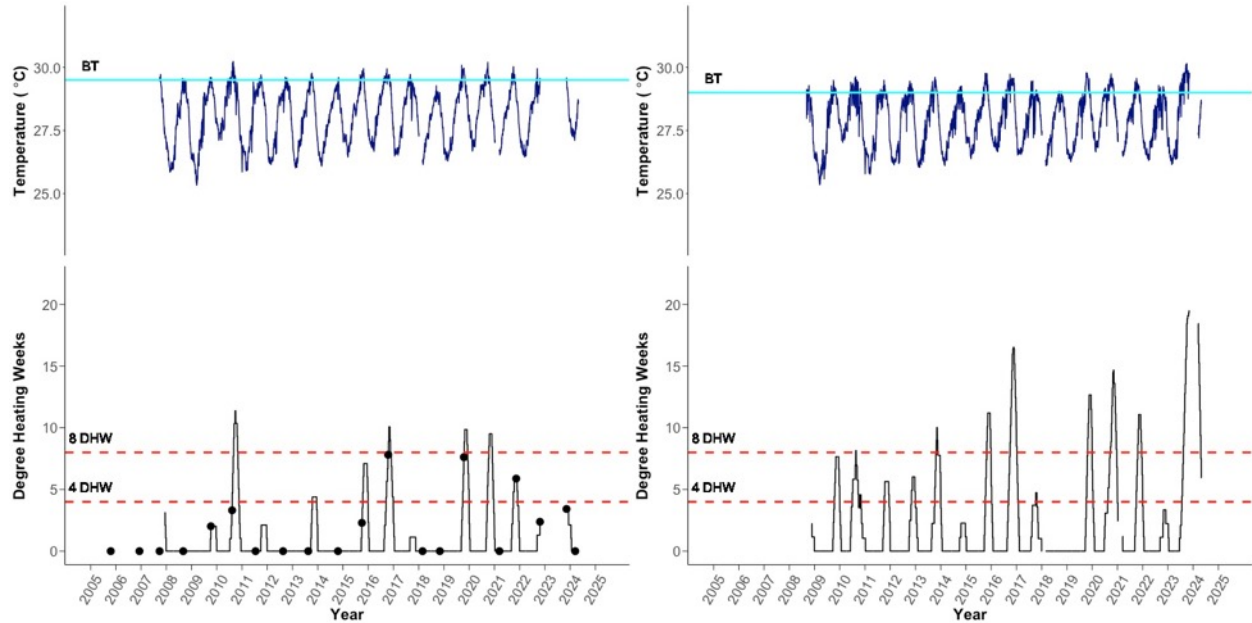


Figure 73. Mutton Snapper benthic temperature record at 24 m (left) and 40 m depth (right).

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 the bottom.

Temperature. Benthic temperatures at the Mutton Snapper site (24 m) showed warming above the regional bleaching threshold during 2010, 2016, and 2020. However, this may be an overestimation of the heat stress (bleaching threshold set to low) since empirical bleaching threshold has not yet been established for this site. Although temperature data was lost from late 2023 to early 2024, it can be inferred from high bleaching prevalence at the site and high temperatures in the 40m site that DHW likely surpassed 8 and induced moderate coral bleaching.

SITE SUMMARIES: MUTTON SNAPPER

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. Since the first observation of Stony Coral Tissue Loss Disease, there has been a 30% decrease in relative coral cover at this location (2019 – 2022). *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. There was an uptick in the percentage of corals experiencing bleaching in 2019 at a predicted 6 DHW. Interestingly, bleaching prevalence in the mass bleaching event of 2023 (45%) was lower than that observed in the moderate event in 2019 (57%). Additionally, extent of bleaching oddly peaked at 90% in the spring of 2024 when most other sites were beginning to recover.

White disease has been at consistently high values through many years of monitoring. Old partial mortality increased after 2005, and then subsided slowly through the years 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: MUTTON SNAPPER

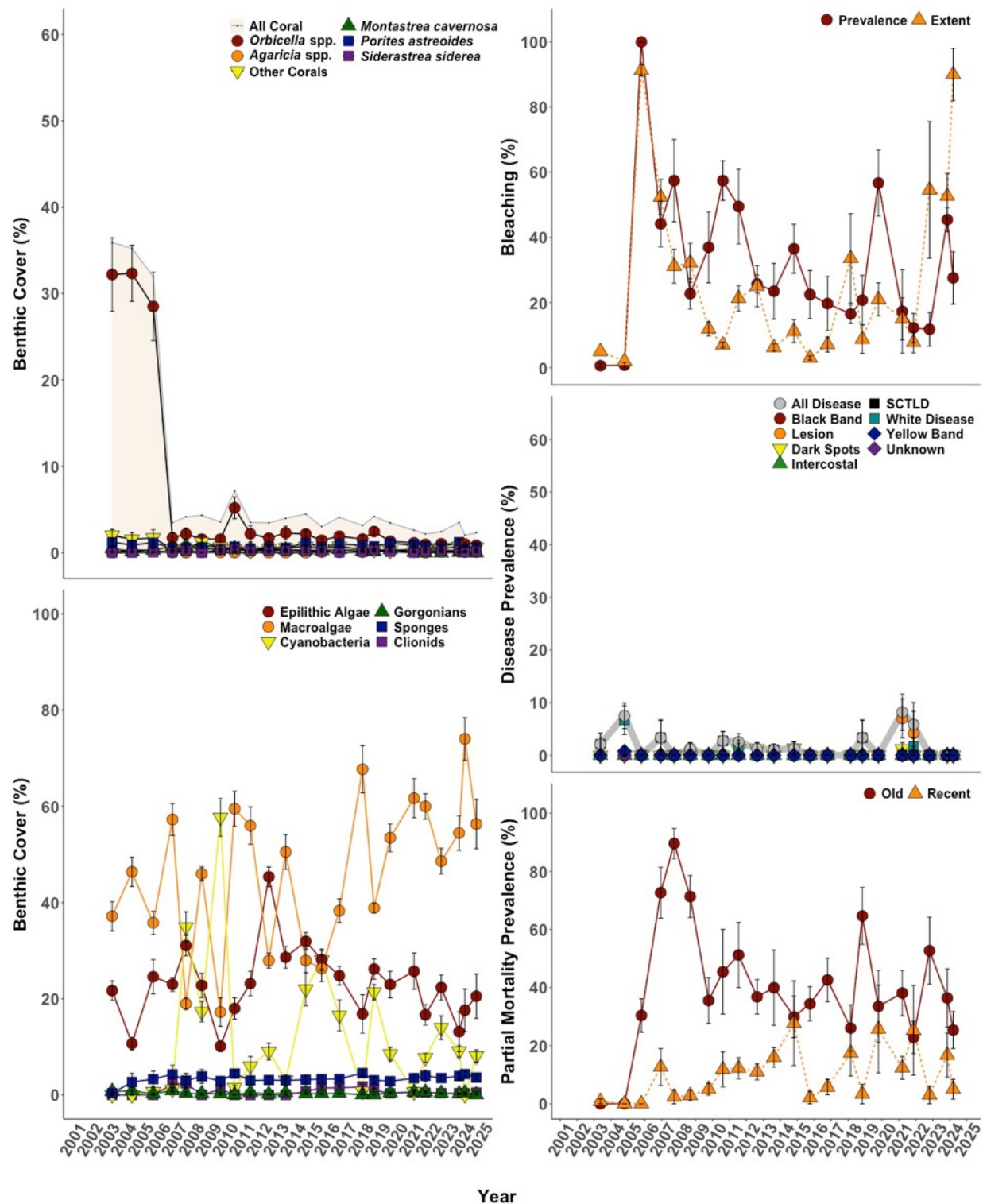


Figure 74. Mutton Snapper benthic cover and coral health through time (mean ± SE).

SITE SUMMARIES: MUTTON SNAPPER

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 twenty years; Mutton Snapper have only been observed in transects in three years (2015, 2018, and 2021). The Mutton Snapper site typically has an equally divided community composition between herbivores, invertivores and piscivores, though in 2023 it was clearly dominated by invertivores. The invertivore group is diverse, and indicative of the variety of resources available on the reef. Blackbar soldierfish and queen triggerfish contribute most highly to invertivore abundance and biomass. Planktivores are relatively low in biomass but are often dominated by black durgon 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. 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: MUTTON SNAPPER

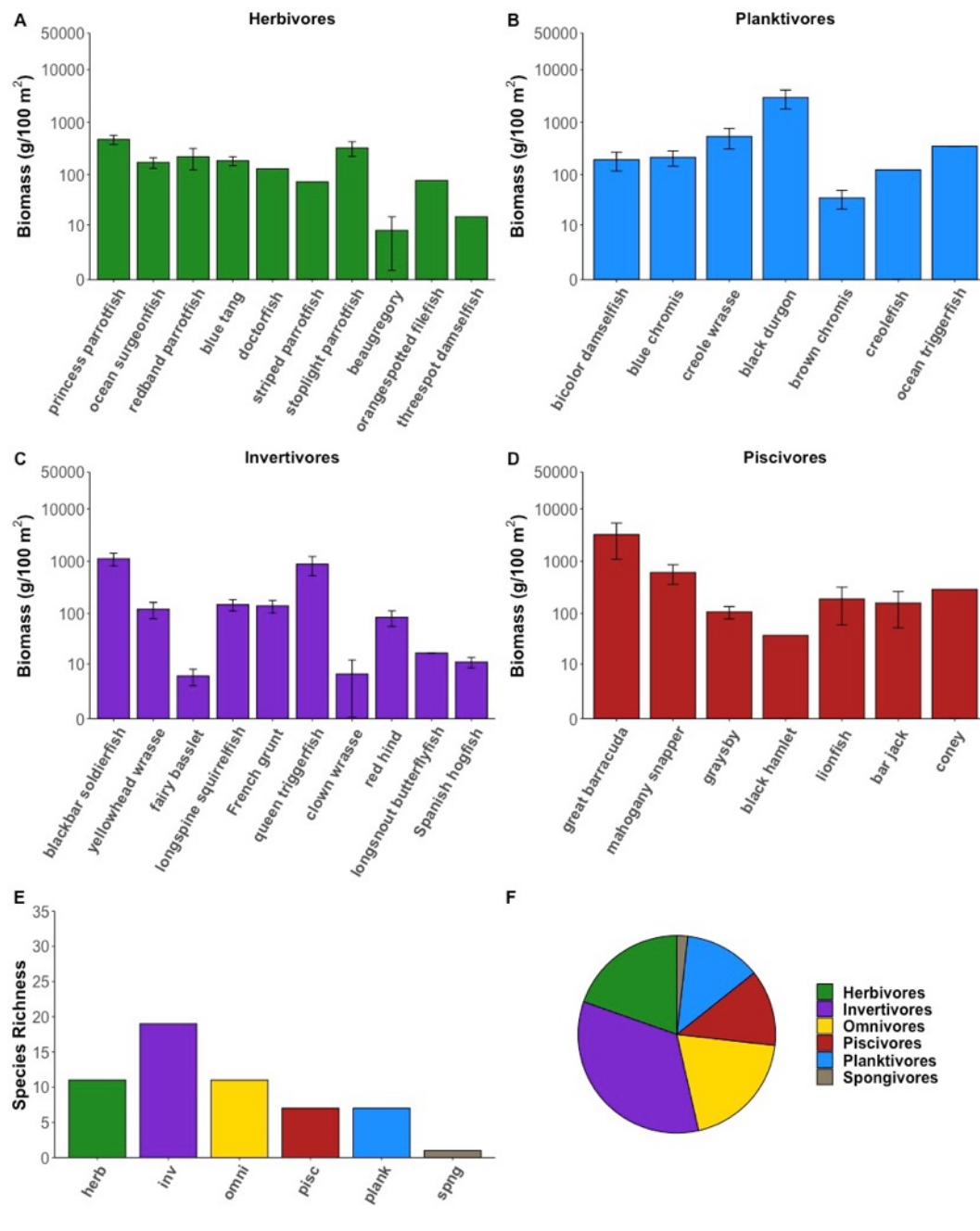


Figure 75. The 2023 Mutton Snapper fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: SALT RIVER WEST

SALT RIVER WEST

Description. Salt River West lies just atop the Salt River Canyon west wall in a depth of 9 m. The reef is a flat colonized hardbottom/coral community atop ancient carbonates. Salt River West has been monitored since 2001.

Outstanding Feature. Salt River West is a popular tourist dive site with a unique sharp drop to the wall environment. This area has been under scientific investigation since the 1970s, beginning with the installation of the Hydrolab undersea habitat run by NOAA.

Threats. Salt River West is exposed to the outflow from the Salt River Canyon and resuspension of sediment from the Salt River eastern flats. The site is now adjacent the Salt River National Historic Park and Ecological Preserve with marine waters protected in a territorial park. This protection will hopefully increase the fish populations within the reserve in the coming decades.

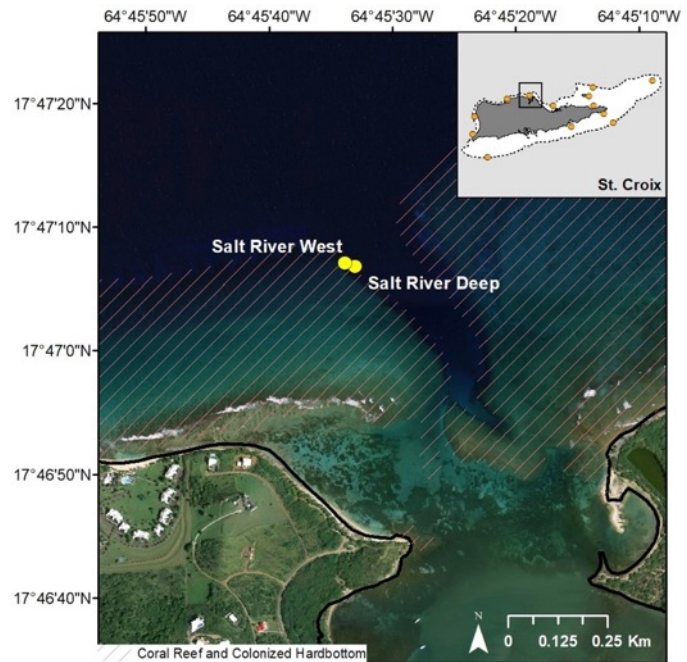


Figure 76. Salt River.
(top) Location. (right)
A representative photo
of the reef (photo
credit: L. Henderson).



SITE SUMMARIES: SALT RIVER WEST

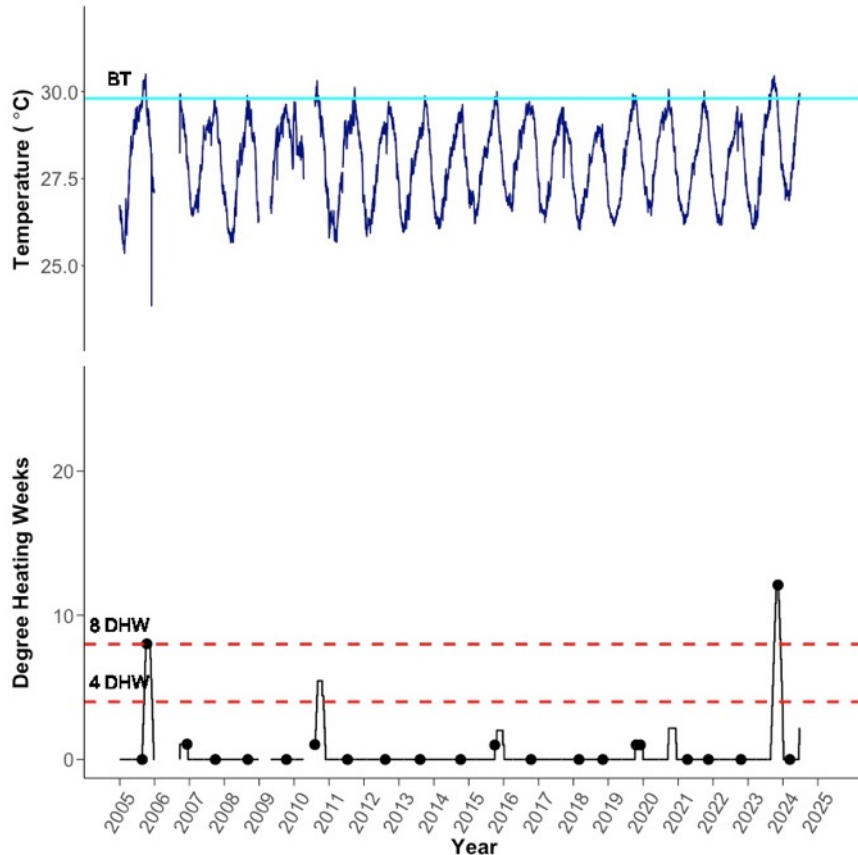


Figure 77. Salt River West surface-benthic temperature record. Data provided by the NOAA ICON monitoring network and the Atlantic Oceanographic and Meteorological Laboratory (CRCP NCRMP Project number 7430).

Physical Characteristics.

Current. Currents have not been directly measured by the TCRMP. Due to the northern exposure and shallow depth, Salt River West experiences wave-driven oscillatory flow, which can be strong. Unidirectional benthic currents are typically weak to moderate ($<15\text{cm s}^{-1}$).

Temperature. The temperature at Salt River West can be very warm and in 2005 surpassed the bleaching threshold (29.5°C) for approximately 2.5 months between August and October. This site is not monitored for temperature by TCRMP since it is a site of the physical monitoring for the National Coral Reef Monitoring Program.

SITE SUMMARIES: SALT RIVER WEST

Benthic Community. The Salt River West epibenthic sessile animal community has a diverse hard coral community of small massive corals and large proportions of sponges and gorgonians. The site lost an imperceptible amount of coral cover in the 2005 coral bleaching event (-13.6%) and had regained nearly half of that cover by 2011 (37.1%). However, there has been a 50% decrease in relative coral cover over 2019 – 2022, likely due to Stony Coral Tissue Loss Disease at this location. Further decreases in relative coverage have been noted following the 2023 bleaching event. The algal community shows extreme dominance by epilithic algae and low abundance of macroalgae and filamentous cyanobacteria. However, the abundance of macroalgae has been increasing at this site since 2009 in concurrence with a decrease in epilithic algae, suggesting a change in herbivory. In some recent years, macroalgae has become more prominent than epilithic algae.

Coral Health. Corals were severely bleached during the 2005 coral bleaching event, with over 90% of corals bleached over 80% of the colony surface. Corals were assessed just prior to the 2010 bleaching event in August but were showing increased prevalence of low colony extent bleaching by then. In 2019 bleaching was moderate whereas in 2024, bleaching was high. Diseases are typically low, with the outstanding case of dark spots disease, which attains some of the highest values seen in TCRMP sites. Of note, is the fact that disease actually decreased following severe bleaching and recovery in 2005 and 2006. Old partial mortality increased rapidly after the 2005 bleaching and then subsided somewhat by 2011, before increasing again but remaining steady. Recent partial mortality can be high and is primarily caused by fish biting, such as from parrotfish. However, extent is quite low (data not shown). Stony coral tissue loss disease was first recorded in transects in the 2020 year sampling (April 2021).

SITE SUMMARIES: SALT RIVER WEST

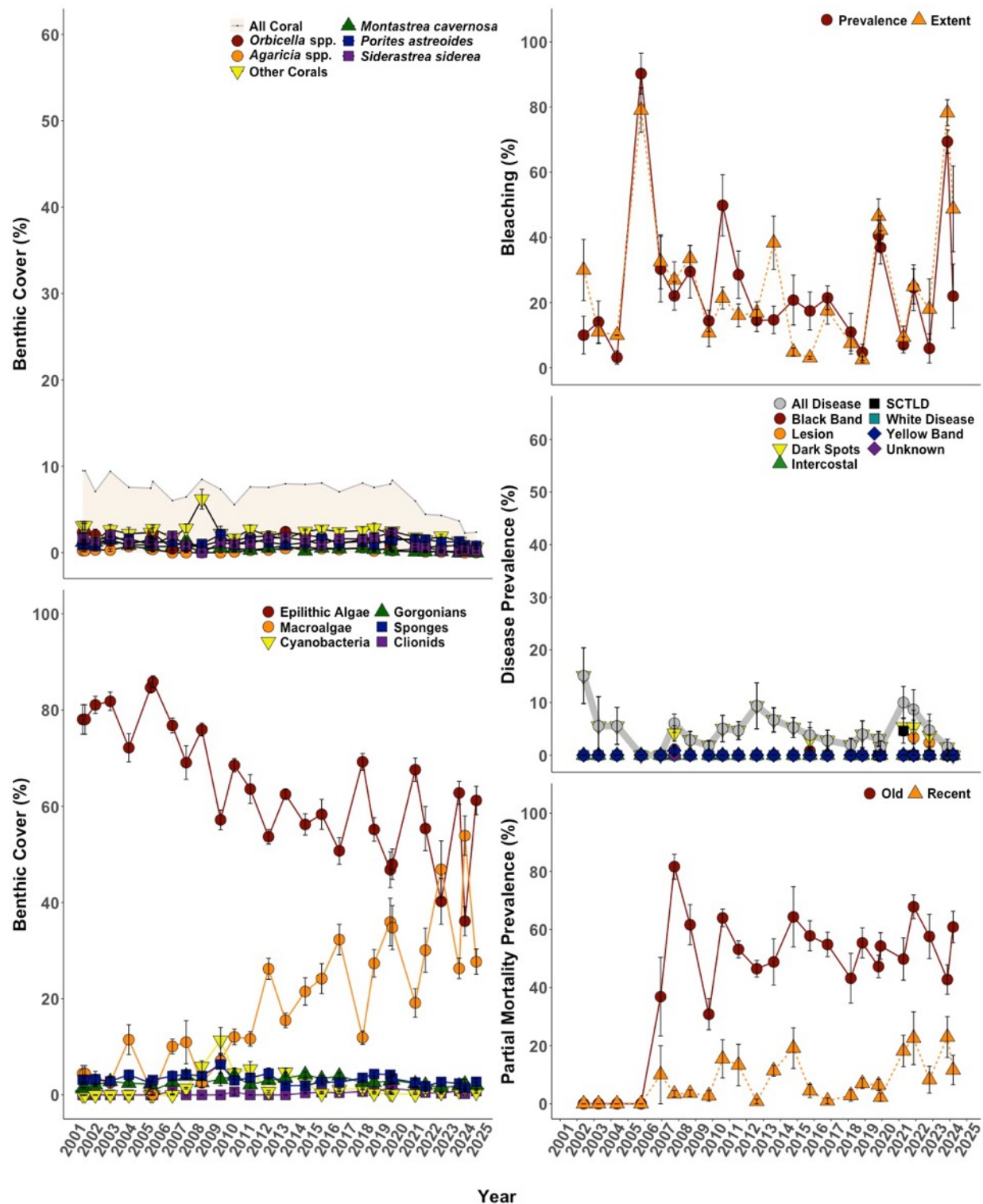


Figure 78. Salt River West benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: SALT RIVER WEST

Fish Community. Fish biomass is relatively low on the Salt River West site. More diversity and some larger fishes can be seen close to the edge of the site, near the Salt River wall; however, the top of the reef has little structure for larger fishes, with low lying coral heads, gorgonians, and sponges. In 2023 a rainbow parrotfish was spotted along the shelf edge, the second one to ever be noted in St. Croix surveys. Wrasses and damselfishes are both numerous and diverse; the most dominant species on the site is the bluehead wrasse followed closely by the bicolor damselfish. Black surgeon, an opportunistic planktivore that feeds on zooplankton, phytoplankton and algae, dominates the Salt River West site in biomass, followed by the stoplight parrotfish, ocean surgeonfish, and very numerous creole wrasse. Piscivores are nearly non-existent; they often include only graysby, coney, barracuda and schoolmaster snapper. Occasional red lionfish are seen on a Salt River West, but it is assumed they are quickly removed by recreational divers as it is a popular diving spot.

SITE SUMMARIES: SALT RIVER WEST

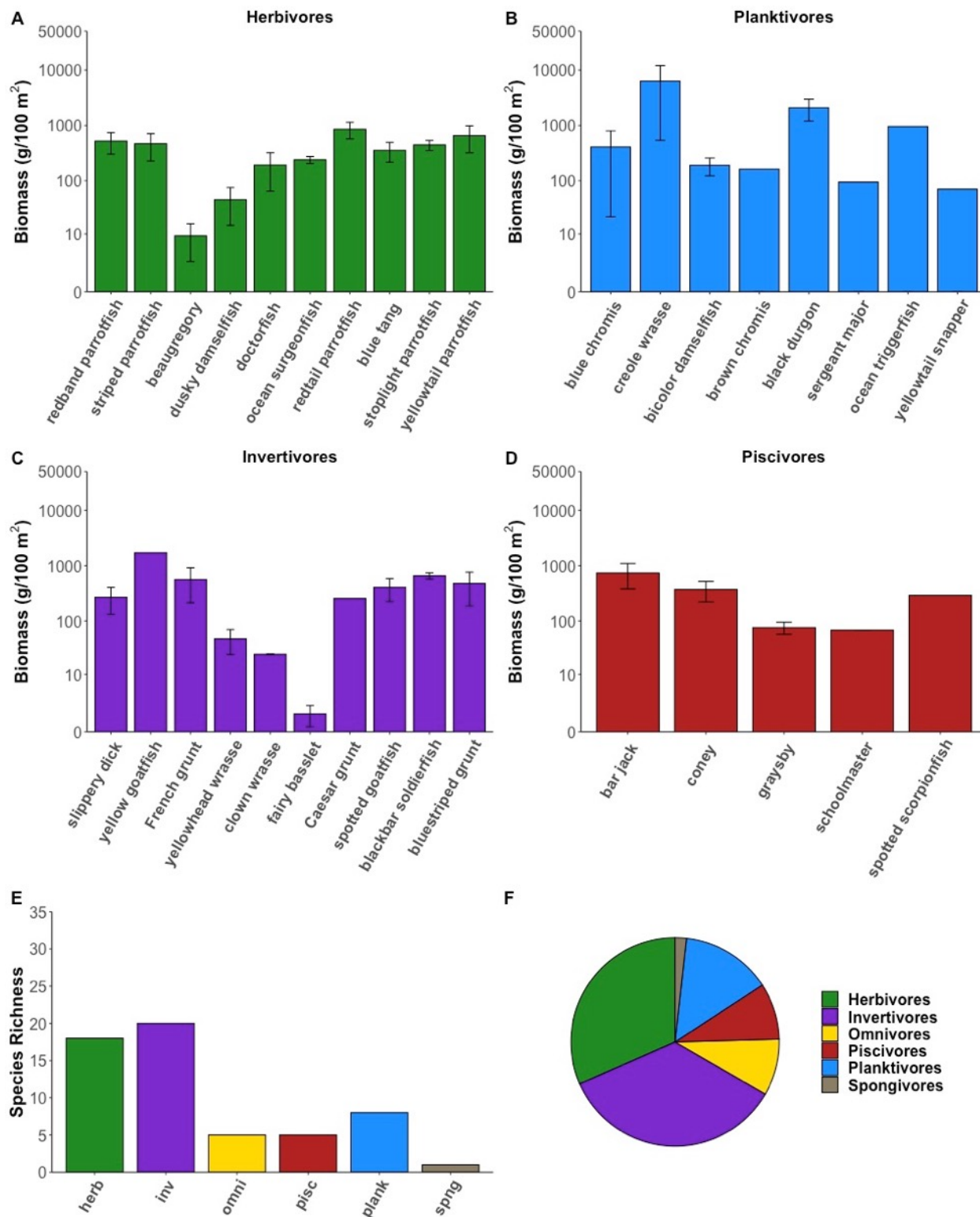
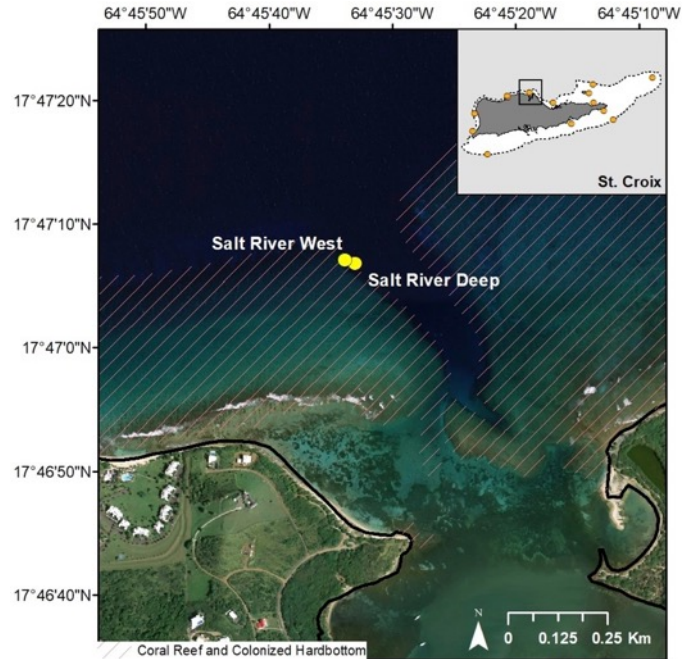


Figure 79. The 2023 Salt River West fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: SALT RIVER DEEP

SALT RIVER DEEP

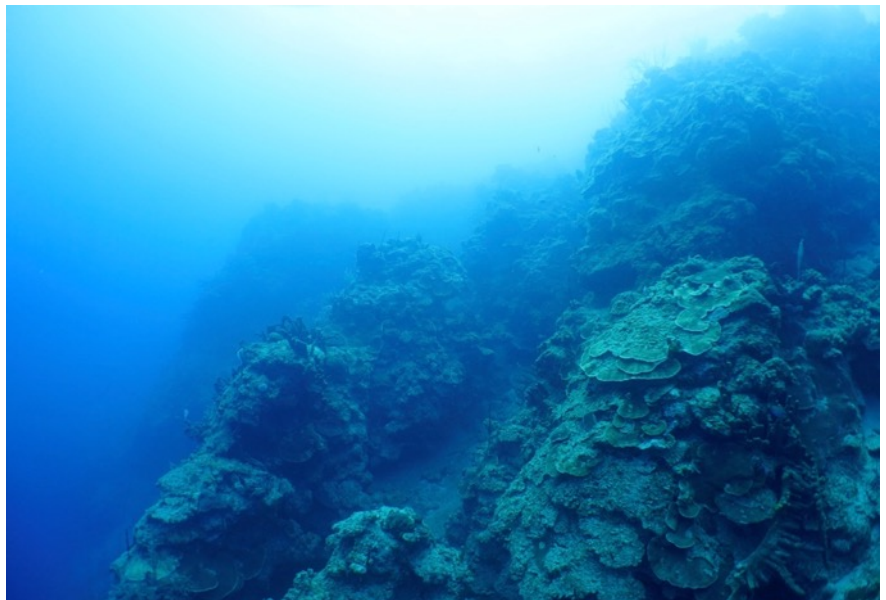
Description. The Salt River Deep site is located on the steep canyon wall just below the Salt River West monitoring site. The reef consists of vertical buttresses surrounded by extensive sand deposits. The reef is largely formed of plating coral at these deep, mesophotic depths. The initial site was deployed in 2009 with two transects at 30 m depth and 4 transects at 40 m. Due to low coral cover at 40 m transects were moved to 30m in 2010.



Outstanding Feature. Salt River Deep is a heavily visited recreational dive site. The site has been under scientific investigation since the 1970's. The underwater HYDROLAB habitat was maintained near the site from 1977 to 1985 and the Aquarius habitat from 1986 to 1989.

Threats. Salt River Deep is threatened by land-based sources of pollution due to its proximity to the Salt River Canyon outflow. The site may also be susceptible to warming temperatures.

Figure 80. Salt River Deep. (top) Location. (right) A representative photo of the reef (photo credit: L. Henderson).



SITE SUMMARIES: SALT RIVER DEEP

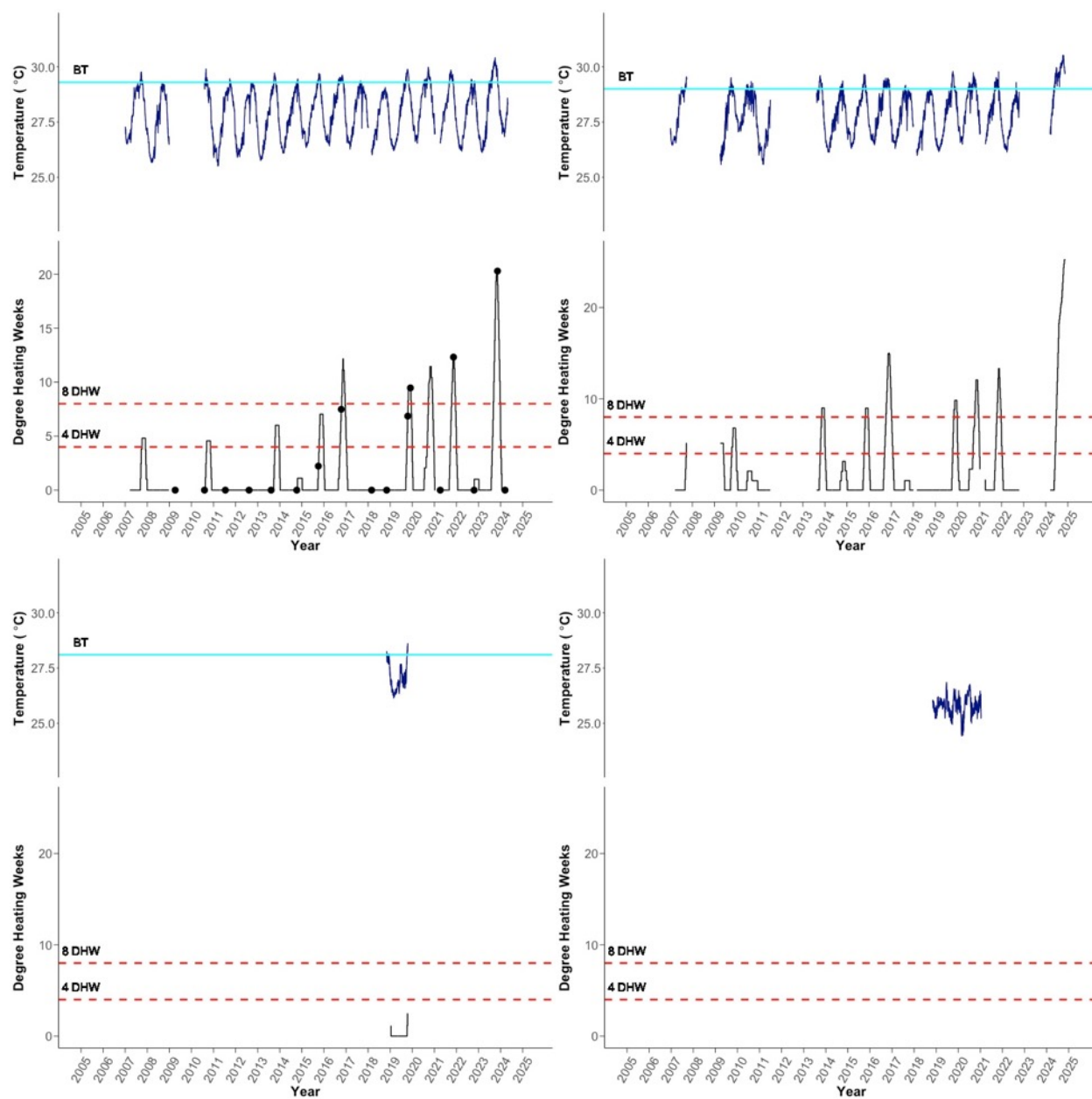


Figure 81. Salt River Deep benthic temperature (Top left: 30 m depth, top right: 41 m depth, bottom left: 67 m depth, bottom right: 100 m depth).



Figure 82. Installation of temperature monitoring stations at Salt River Deep at 100 m in the canyon (credit: Viktor Brandtneris).

Physical Characteristics.

Current. Salt River deep currents have not been measured directly by the TCRMP. Only very weak oscillatory and unidirectional currents have been experienced at the site.

Temperature. Temperatures on the wall have been measured at 30 and 41 m depths since 2017, with probes placed at 67 and 100 m in 2018. Both sites have temperatures that are much cooler than the shallow site. The 41 m site experiences even greater cooling and experiences more diel variability (not shown) and day-to-day variability due to the influence of internal waves. Despite some interaction with the thermocline, cooling is not as great as at the mesophotic reefs at similar depths on the southern Puerto Rican Shelf. The empirical bleaching threshold has not been established at this site and the modeled bleaching threshold used here (Smith et al. 2016a).

SITE SUMMARIES: SALT RIVER DEEP

Benthic Community. Hard coral community of the Salt River Deep monitoring site is dominated by plating lettuce corals (*Agaricia* spp.); however, sponges, gorgonians, and black corals dominate the overall sessile epibenthic animal community. The site was not monitored during the 2005 bleaching event, but as with the Cane Bay Deep site, severe bleaching was observed down to depths of 40m. Coverage grew or remained steady at this site from 2008 until 2019, where it declined slightly after the bleaching event and further after the introduction of Stony Coral Tissue Loss Disease. More recently, this site experienced an additional 45% reduction in coral cover following the 2023 bleaching event. The algal community is dominated by epilithic algae and unidentified diminutive macroalgae. The site is notable for the high composition of sediment, which cascades from the upper reef between spurs and buttresses. In recent years, epilithic algae has increased in dominance, likely capitalizing on the declining coral coverage.

Coral Health. Moderate to high bleaching prevalence is typically accompanied by low extent coral bleaching at the Salt River Deep site. The exception to this is the 2023 bleaching event, in which prevalence was extremely high (96.7%) and extent was also high (77%). This may reflect bleaching sensitive taxa (e.g., *Agaricia* spp.) and the influence of down-canyon sedimentation impacts. Interaction data (not shown) indicates that sediment and *Lobophora variegata* overgrowth are responsible for much of the bleaching observed in non-bleaching years (i.e., not 2010, 2019, or 2023). Old partial mortality is high on corals, which may be a reflection of numerous bleaching events, SCTLD, and the cumulative impacts from interaction with sediment and algae. Almost every coral displayed some old mortality in the spring of 2024 while a very high percentage of them (42%) experienced recent mortality as well. There was an increase in the prevalence of lesions and rapid tissue loss during the 2021 sampling period (November 2021), likely a result of the Stony Coral Tissue Loss Disease outbreak, which marked our first observation of disease at this sample site.

SITE SUMMARIES: SALT RIVER DEEP

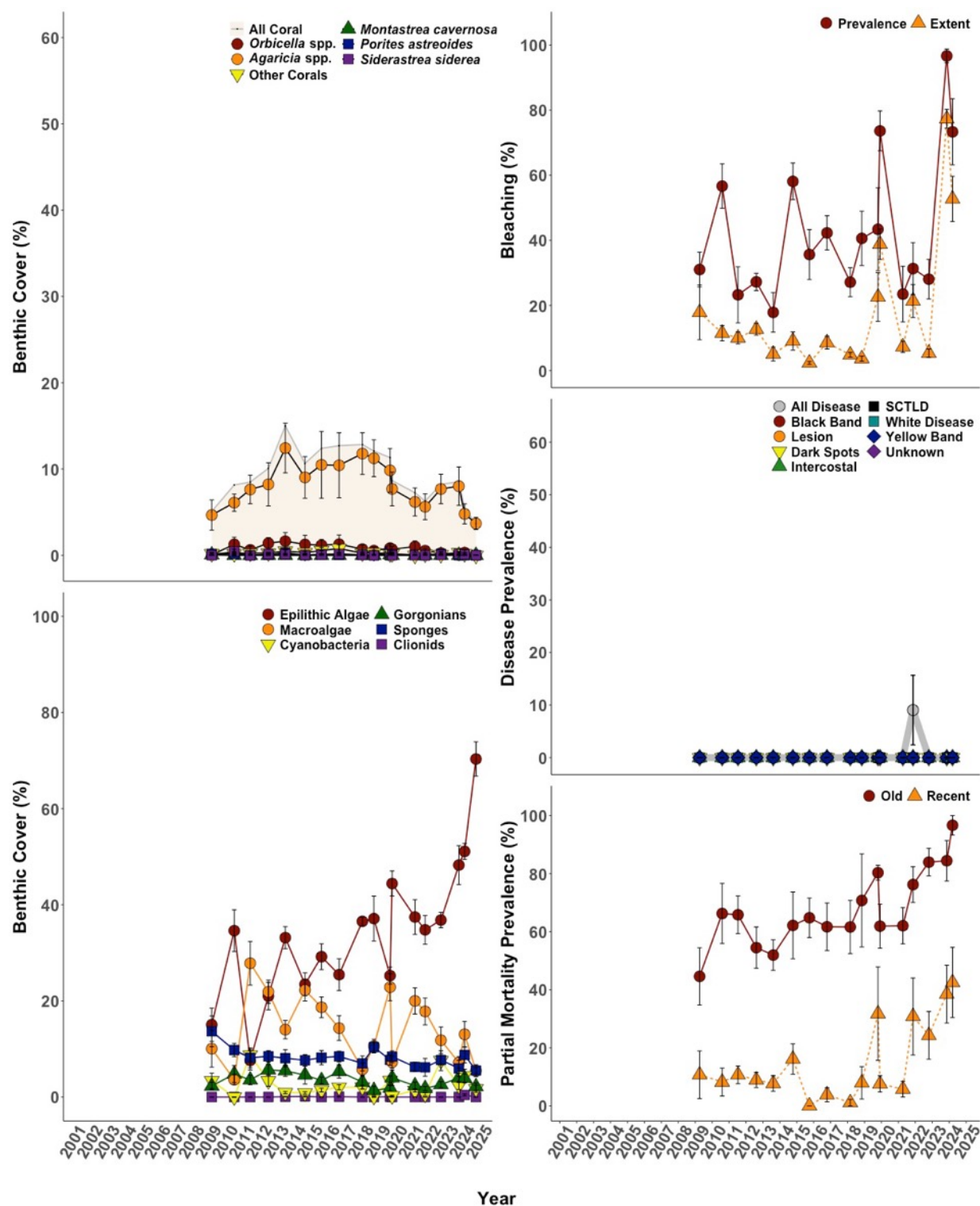


Figure 83. Salt River Deep benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: SALT RIVER DEEP

Fish Community. The relatively high turbidity and high composition of sand and silt bottom, as a consequence of river discharge, influences the fish community of Salt River Deep. The mesophotic reef wall site is characterized by a fish community of very low abundance and biomass in all trophic guilds. Planktivores are dominated numerically and in biomass by the creole wrasse. Yellowtail snapper are also frequently present. The invertivore guild is frequently led in biomass by the yellow and spotted goatfish, bottom feeders that capitalize on the silt and sediment. These fish swim in small schools along the steep wall. Schoolmaster snapper and graysby are common piscivores; however, piscivore biomass is generally very low. Characteristic deep-water fishes observed commonly on Salt Water Deep include the sunshinefish, bantum bass, fairy basslet, and longsnout butterflyfish. As on the Cane Bay Deep site, occasional cubera snapper (*Lutjanus cyanopterus*) or mutton snapper (*L. analis*) are observed during roving dives on the wall, and commonly one or two small, curious Caribbean reef sharks (*Carcharhinus perezi*) are present. Deeper in the canyon in the 50 – 70 m depth range, resting schools of black margate have been observed on every dive. In recent years a singular (or, occasionally, multiple) Nassau grouper have been observed on the wall during the divers' ascent (10-25m).

SITE SUMMARIES: SALT RIVER DEEP

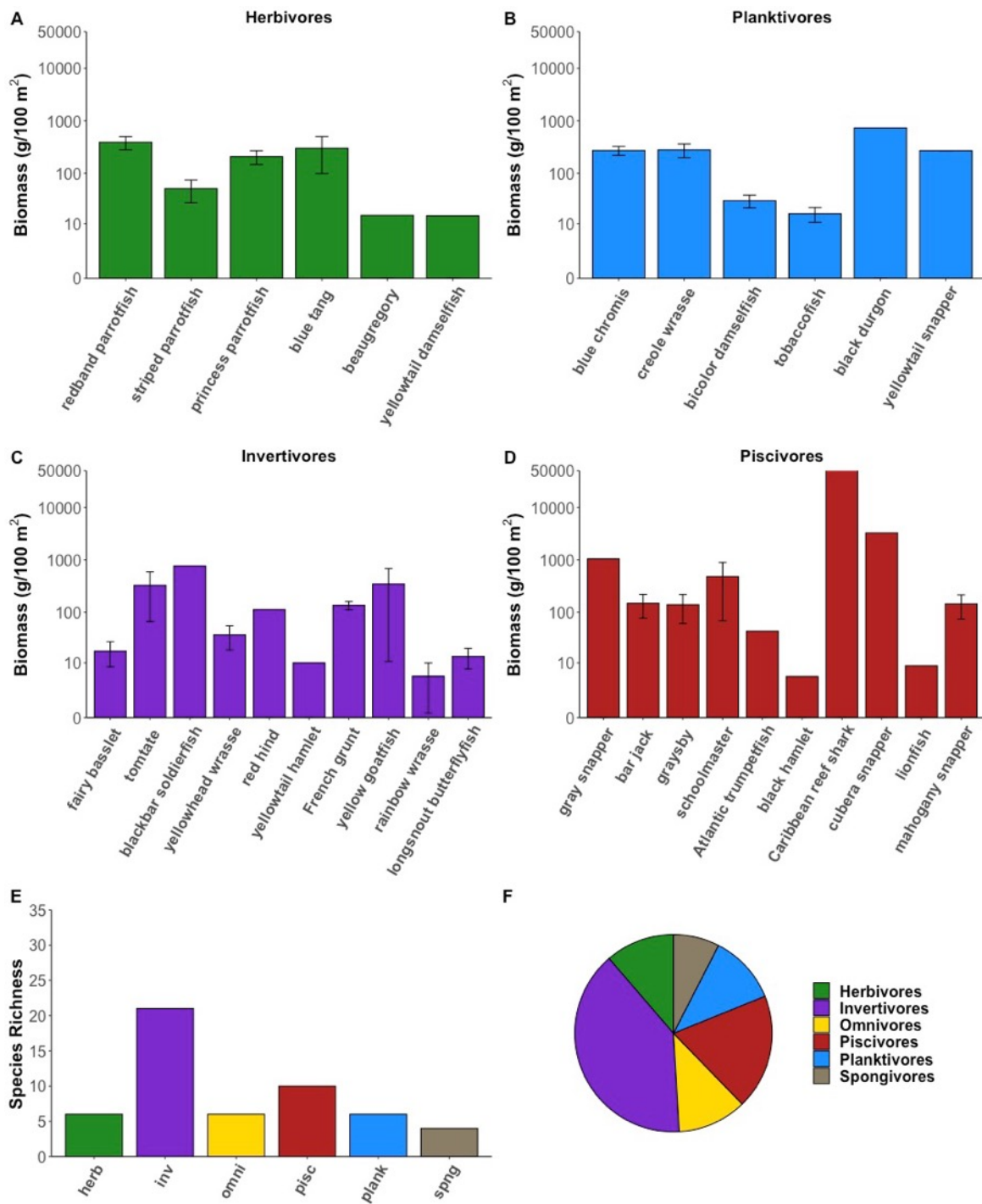


Figure 84. The 2023 Salt River Deep fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.

SITE SUMMARIES: SPRAT HOLE

SPRAT HOLE

Description. The Sprat Hole site is a nearshore/shelf-edge fringing reef in depths of 7 – 10 m. The site is a rolling boulder star coral (*Orbicella annularis*) reef. The slope to the west drops off to an attractive mixed coral community with abundant fish where it meets sand at about 25 m. Sprat Hole has been monitored since 2001.

Outstanding Feature. Sprat Hole is a heavily visited reef for snorkel and dive tours. It supports a very diverse fish community.

Threats. The Sprat Hole reef is vulnerable to land-based sources of pollution if there is increased development of the watershed. Low wave action and light currents favor settling of small particles of terrestrial sediment that injure corals. The site is also frequently fished and there is derelict fishing gear in abundance. Recreational overuse may also be a threat.

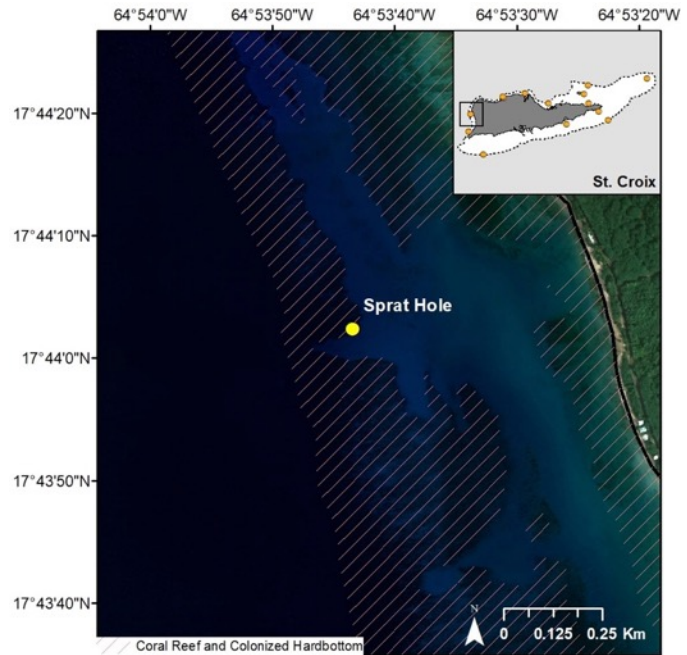


Figure 85. Sprat Hole. (top) Location. (right) A representative photo of the reef (photo credit: L. M. Henderson).



SITE SUMMARIES: SPRAT HOLE

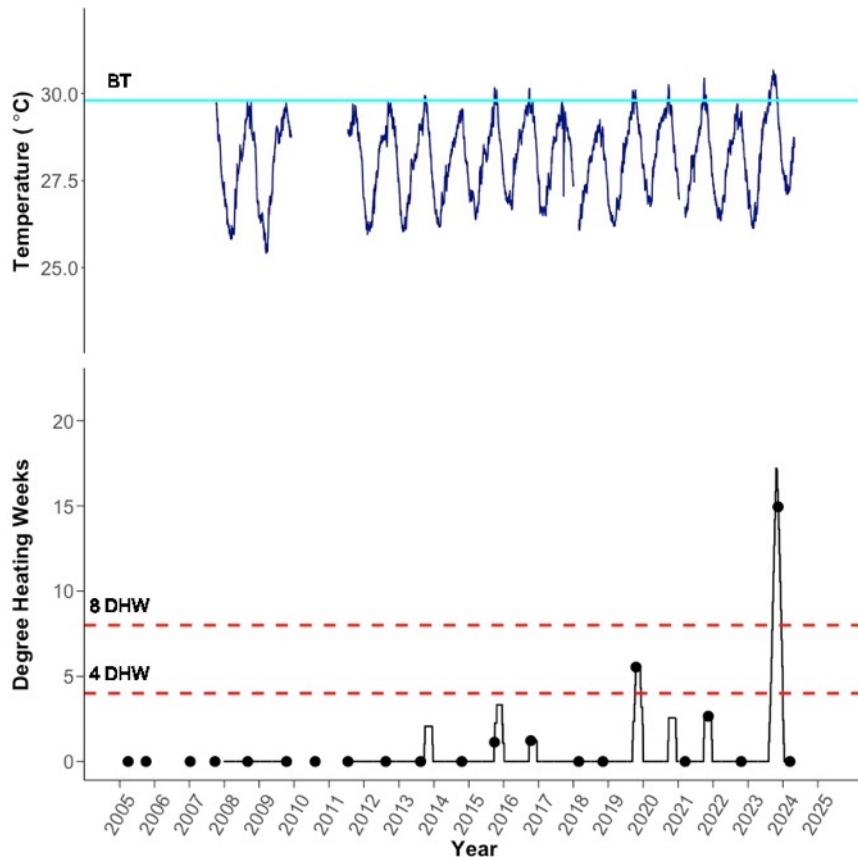


Figure 86. Sprat Hole benthic temperature (7 m depth).

Physical Characteristics.

Current. Currents have not been measured at Sprat Hole. Oscillatory currents are typically weak on the western lee of St. Croix. Unidirectional currents during monitoring have always been weak ($<10\text{cm s}^{-1}$).

Temperature. Sprat Hole temperature has not been monitored over many years due to loss of probes. This is likely due to the high exposure to recreational and commercial fishing divers. Since 2013 temperature probes of the National Coral Reef Monitoring Program have been co-located at this site. Sprat hole does not have an empirically derived bleaching threshold temperature, but observations of moderate bleaching in 2019 suggest that the current threshold of 29.8°C is reasonable. At that threshold, the site experienced a max of 17 DHW in 2023.

SITE SUMMARIES: SPRAT HOLE

Benthic Community. Sprat Hole is a fringing *Orbicella annularis* dominated reef, with a good diversity of other coral species. There was a 62.3% decline in coral cover due to the 2005 coral bleaching event, with a regain of 11.9% of cover by 2011. Although not reflected in coral cover and partial mortality, the site did suffer damage due to Hurricane Maria on September 20, 2017, as evidenced by broken and toppled lobes of *O. annularis*. Coverage following the 2005 bleaching event remained relatively steady or increasing until 2024 when it dropped 38.5% following the 2023 bleaching event. Epilithic algae used to dominate the algal community, with smaller amounts of a diverse group of macroalgae, including *Dictyota* spp. and *Halimeda* spp. In the past decade or so, however, macroalgae, particularly *Dictyota* spp. have been increasing in dominance. There has been highly variable, but increasing cover of filamentous cyanobacteria since 2005.

Coral Health. The coral community at Sprat Hole was heavily affected during the 2005 coral bleaching event, with a high prevalence of bleaching at a very high extent. Bleaching prevalence has tended to be higher since the event. There was high prevalence of low extent bleaching in 2019, and a high prevalence of high extent bleaching in 2023. Disease prevalence can be quite high, particularly for white disease. Dark spots disease has also been in high prevalence in certain years. Old partial mortality increased substantially after the 2005 bleaching event and has remained steady since. Recent partial mortality is consistently very high at Sprat Hole, due in part to the high abundance the corallivorous snail, *Coralliophila abbreviate*, and of territorial damselfish (*Stegastes* spp.) forming algal lawns on *O. annularis*. Stony coral tissue loss disease was first recorded in transects in the 2020 year sampling (March 2021).

SITE SUMMARIES: SPRAT HOLE

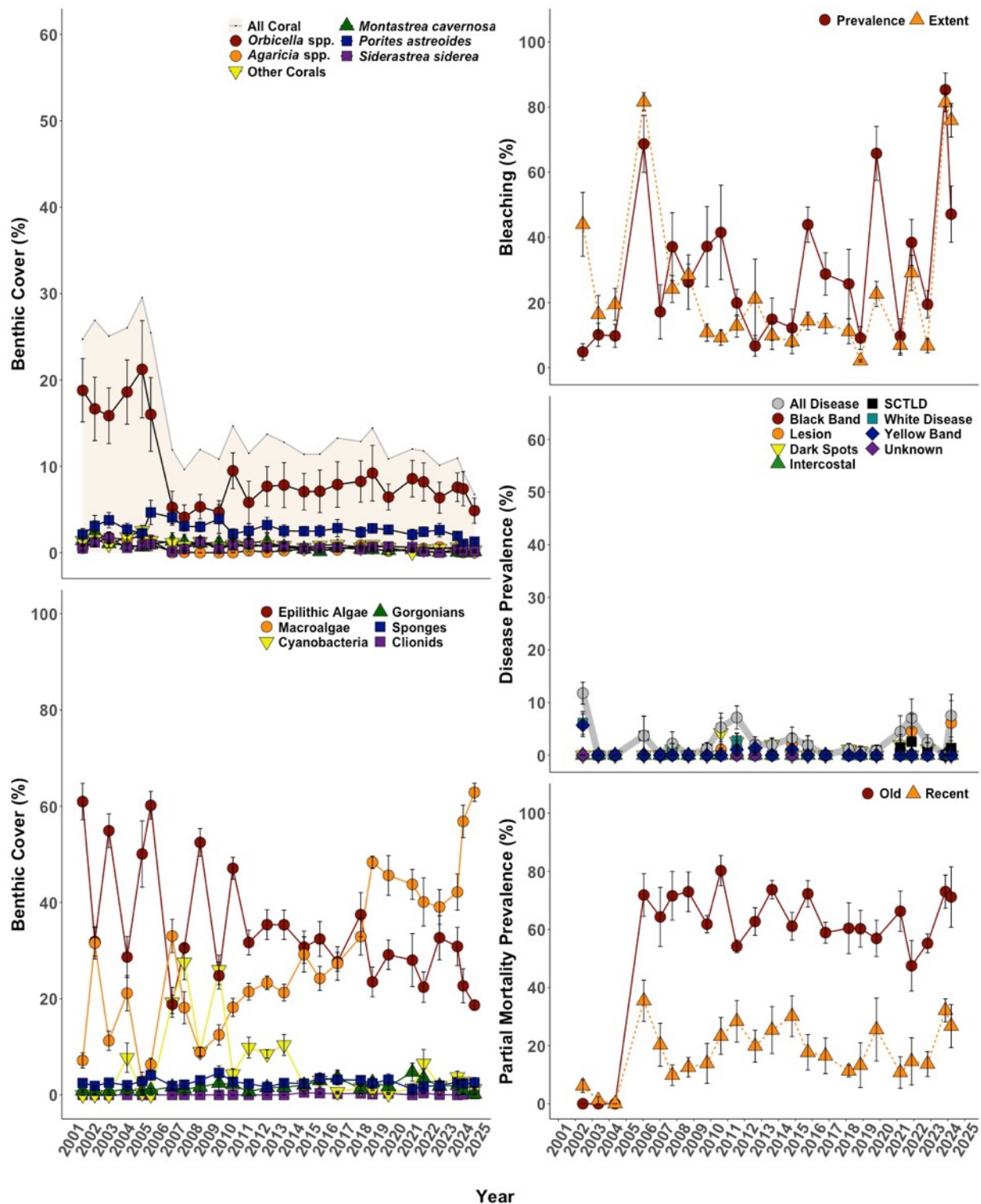


Figure 87. Sprat Hole benthic cover and coral health through time (mean $\pm$ SE).

SITE SUMMARIES: SPRAT HOLE

Fish Community. Sprat Hole exhibits typical fish community structure for a nearshore developed coral reef ecosystem receiving some amount of terrestrial runoff from the watershed. Fish biomass is moderate, and the site is dominated numerically by the creole wrasse and blue chromis, planktivorous invertivores. Benthic herbivores are common and often include all common Caribbean species of parrotfish and all three acanthurid species. Most of these fish are in a juvenile or subadult phase. Invertivores are diverse and include both planktivores and benthic feeders; mostly small fish in small numbers. Grunts, goatfish and a variety of wrasse are common. Mutton snapper have been recorded on the sight sporadically. Numerically and by biomass the graysby and schoolmaster snapper typically contribute most to the benthic piscivore group. A juvenile tiger grouper was recorded in 2013, and a yellowfin grouper was seen in 2014. The first dog snapper was also noted in 2023. Lionfish have been observed on the Sprat Hole site since 2012, but have not been seen in recent years. Bar jacks and cero mackerel, nearshore pelagic piscivores, round out the piscivore trophic guild.

SITE SUMMARIES: SPRAT HOLE

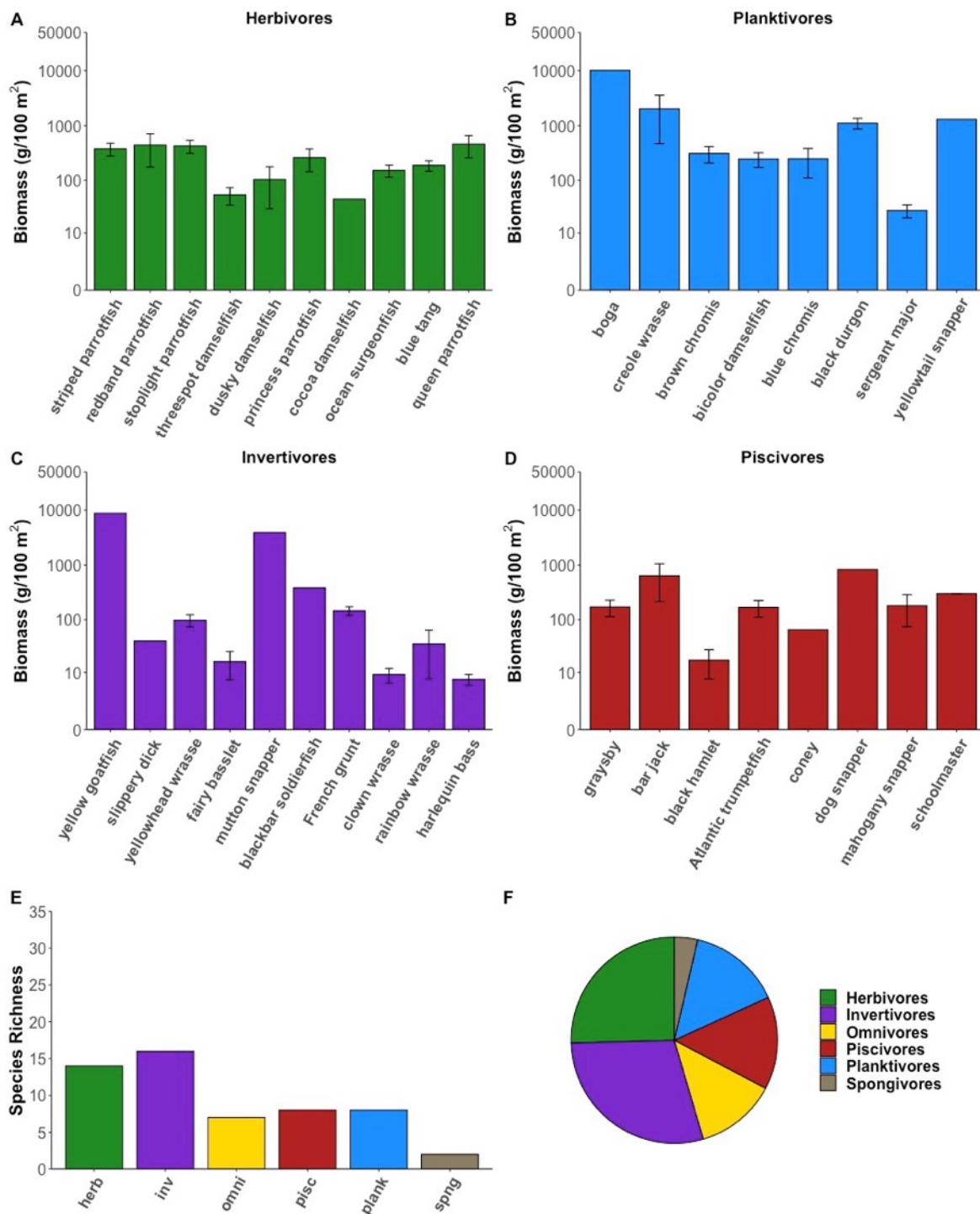


Figure 88. The Sprat Hole fish community as (A-D) average biomass per trophic group with the most common species shown in order on the x-axis, (E) species richness, and (F) relative community composition by total biomass. Note that biomass is a log scale.