

The United States Virgin Islands

TERRITORIAL CORAL REEF MONITORING PROGRAM



ANNUAL REPORT

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Smith TB, Kadison E, Henderson L, Gyory J, Brandt ME, Kammann M,
Wright V, Nemeth RS, Rothenberger P

A collaboration between:

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MISSION STATEMENT

Mission



OUR VISION

To provide critical information on the status and threats to all Virgin Islands coral reef ecosystems in order to increase management effectiveness and improve basic and applied coral reef research

OBJECTIVES

- Monitor the **status and trajectories** of coral reefs across a majority of habitats and threats, including land-based sources of pollution & thermal stress
- Link changes in coral reef health with specific stressors, indicating specific **management interventions** most effective for preserving reefs
- Integrate assessments of understudied **mesophotic coral reef ecosystems** and **threatened species** in the USVI
- Provide data, outputs, and advice to stakeholders and create a **nexus of information** for reef research

EXECUTIVE SUMMARY

Executive Summary

Coral reefs in the Caribbean are facing a dramatic decline and are at a crossroads. Management decisions made today will affect the goods and services that reefs provide for decades to come. The government of the United States Virgin Islands (USVI), in coordination with the NOAA Coral Reef Conservation Program and the University of the Virgin Islands, implemented the **Territorial Coral Reef Monitoring Program (TCRMP)**. The TCRMP has established baseline conditions and temporal trends of coral reefs and fish populations and has identified threats that will influence the future reef health and development.

A major focus of the TCRMP is to provide information that can lead to more effective management strategies that balance the immediate needs of the Virgin Island's population with preservation and sustainability of coral reefs and the renewable goods and services they provide.

The intent of this report is to distill monitoring data into actionable information that can guide management decisions and inform the public and policy-makers about areas that need further effort. This executive summary presents information on threats to USVI reefs that require management intervention/action as well as positive signs that can inform our understanding of sustainability.

CORAL REEFS OF THE VIRGIN ISLANDS: MANAGEMENT ACTIONS NEEDED

The TCRMP data has identified threats to USVI coral reef ecosystems that need increased management attention if reef corals are to persist in a condition that is equal to or better than current conditions.

Coral Reef Bleaching. High thermal stress caused by climate change is currently the greatest threat to USVI coral reef ecosystems. The 2005 coral bleaching event caused the

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largest loss of coral in the documented history of the USVI, with a 50% decline in coral cover in shallow waters less than 25m/85' deep. This event surpassed all known modern impacts from physical damage (storms and anchoring), ecosystem changes (fishing and disease), and pollution (terrestrial sediments and toxins). These events are predicted to increase with a warming planet, troubling news for the USVI.

While local management actions cannot remove impacts to reefs from global warming, reefs that are otherwise less stressed by land-based sources of pollution, fishing, and/or physical damage are known to recover more quickly from bleaching. Hence, local management actions that promote seascape-wide coral reef health offer the best strategy for sustainable reefs. We can also identify areas that are naturally more resistant to thermal stress and offer these areas further protection, since they offer insurance against the worst possible future outcomes for USVI reefs.

Figure 1. Partially bleached and recovering colony of *Siderastrea siderea* at Flat Cay, St. Thomas (Nov. 12, 2005).



EXECUTIVE SUMMARY

Overfishing. There are clear indications that reefs of the USVI are suffering the effects of overexploitation of reef resources, although there are also positive signs. The entire district of St. Croix has an extremely low abundance of commercially important grouper species, including the threatened Nassau grouper. In St. John and St. Thomas, many common species have completely or nearly disappeared from nearshore waters in the last 30 years. For example, a study conducted by Rogers et al. (1982) on the southwest coast of St. Thomas during the airport runway expansion (1979-1981) found a variety of species that are no longer encountered or are rare, including the black, Nassau, tiger, and yellowfin groupers, as well as the federally protected parrotfish species blue, midnight, and rainbow. A study by Randall (1963) also found high relative abundances of groupers and threatened parrotfish on the south coast of St. John. Rebuilding these fish stocks will require comprehensive life-history information for target species, a willingness to find strategies to rebuild stocks, and partnerships between commercial and recreational fishers, community stakeholders and managers.

Land-Based Source of Pollution. The steep hillsides of the USVI are natural conduits for run-off during heavy rain events and in many instances there is little interception of materials before they reach the sea and impact coral reefs. When tropical soils are naturally disturbed or altered through human actions, they can erode and release fine-grained silt and clay particles. In the USVI, these fine-grained particles are quickly transported to coral reefs where they can block sunlight, directly smother corals, or increase the growth of organisms that compete with corals for space. There is evidence from the TCRMP that terrestrial sediments are having large negative impacts on nearshore coral reefs by increasing mortality of ecologically important corals.

CORAL REEFS OF THE VIRGIN ISLANDS: POSITIVE SIGNS

Despite the incredible declines in reef health witnessed since the inception of the TCRMP in 2001, there are many positive signs for the USVI that should be highlighted. These

EXECUTIVE SUMMARY

successes offer lessons that can be applied to troubled reefs and may indicate refuge areas where we might “double-down” on current management strategies.

Reef Refuges. The USVI is blessed, perhaps uniquely for the Caribbean, with extensive areas of deep bank and slope reefs that may be buffered from the direct impacts of climate change and local pressures. The mesophotic (pronounced: me-zo-photik; meaning; “middle-light”) reefs of the USVI are the best developed in the Caribbean from what is currently known. Mesophotic Coral Ecosystem (MCE) bank reefs with high populations of star corals (*Orbicella* spp.), which have recently been proposed for listing as endangered on the United States Endangered Species List (NOAA 2012), form extensive tracts on the south shelf of St. John and St. Thomas, from the British Virgin Islands to Vieques, Puerto Rico. Well-formed, but patchier mesophotic boulder coral reefs also form on the Lang Bank, St. Croix and the northern Puerto Rican Shelf. During the 2005 bleaching event, where shallow water reefs lost 50% of coral cover, MCE studied by the TCRMP hardly bleached and lost a more modest 20% coral cover. Thus, there is hope that these reefs will serve as refuges for corals during a time of increasing ocean temperatures.

In federal waters some of these areas are wholly or partly protected from fishing of ecologically important species that help maintain reef health. These include the Red Hind Marine Conservation District (est. 1999), the Grammanik Bank Seasonally Closed Area (est. 2005), and the Lang Bank Red Hind Seasonally Closed Area (est. 1993). However, extensively developed mesophotic reef in unprotected territorial waters also exist near the island of French Cap and Sail Rock, St. Thomas District. It is important that these areas are identified, their threats assessed, and they are incorporated into the territorial and federal management planning process.

Rebounding Fisheries Species. There are positive signs of recovery for certain fish species in some areas. At the Grammanik Bank grouper spawning aggregation site there have

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been increasing numbers of Nassau grouper present for annual spawning (Kadison et al. 2010; Jackson et al. 2014) and a red hind aggregation in the Red Hind Marine Conservation District (MCD) has dramatically rebounded (Nemeth 2005). Red hind caught in the fishery on the south side of St. Thomas are more numerous and larger (D. Olsen, pers. comm.). It is also the impression of the authors that stocks of grouper and snapper are increasing in the MCD, although TCRMP measurements are confounded to some degree by the rotating array of aggregating fishes. Other territorial and federal closed areas in St. Croix, St. John, and St. Thomas are more recently established and may not show effects for several years. In 2011 the TCRMP recorded the first ever sightings of two Nassau grouper in St. Croix, a positive sign. However, no Nassau grouper were observed in 2012 and 2013. For species that are completely protected from fishing (Nassau grouper and blue, midnight, and rainbow parrotfish), educational campaigns for recreational and commercial fisherman are critical, as awareness of regulations appears to be lacking (Authors, unpub. obs.).

Land-based source of pollution. While development of steep island slopes has continued despite current regulations intended to prevent sediments from entering nearshore waters, research has identified key targets for restoration and some effective habitat restoration best-management practices. Results from TCRMP research suggest that there are certain levels of silt-laden terrestrial run-off that are damaging to corals, providing a target for reductions of sediment in the marine environment. Unpaved road segments have been implicated as the worst culprits in the production of sediment-laden run-off (Ramos-Scharrón and MacDonald 2007a) and this provides a clear target for where management can be most effectively applied. Restoration of watersheds has shown that implementation of best-management practices and control structures can be effective in reducing sedimentation. For example, the American Recovery and Reinvestment Act project “USVI Coastal Habitat Restoration Through Watershed Stabilization” showed

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promising results (Virgin Islands Resource Conservation and Development Council; P.I. M. Taylor).

This report presents results of the 13th year of monitoring on reefs surrounding St. Croix, St. John, and St. Thomas (years 2001-2013). Monitoring sites were distributed across the insular platform in depths from 5 to 63 m (16 – 220') in an effort to capture the diversity of reef types present in the Virgin Islands. Long-term data is presented from 33 sites.

While not exhaustive, the TCRMP is generally representative of the geographic areas and variety of reef types in the USVI. Digital video and diver surveys were used to quantify benthic cover and coral health at 14 permanent sites surrounding the island of St. Croix and 19 permanent sites on the Puerto Rican Shelf surrounding the island of St. John and St. Thomas. In addition, at 32 of these sites sea urchin density and fish community structure were evaluated. This report presents data from a major expansion of coral reef monitoring sites.

Research Highlights

LIONFISH INVASION IN THE USVI

Invasion of the Indo-Pacific Red Lionfish (*Pterois volitans*):

The first Indo-Pacific lionfish (Fig. 2) reported in USVI waters was found in 2009 on the west end of St. Croix under the Frederiksted pier. The invasive species had been rapidly spreading throughout the Caribbean from the believed introduction point of Florida, and was already common in the Bahamas, Jamaica and Hispanola. Several more of the fish were seen over the next few weeks; however, it was not until early 2010 that the first lionfish was reported in St. Thomas. By early 2011 divers and fishermen from around the territory were finding lionfish commonly, and although a concerted effort was made to eradicate the fish, reports escalated. Today the invader is quite prevalent throughout the territory and Caribbean region. It is estimated around 30,000 lionfish were taken by St. Thomas fishermen in traps in 2011 (Olsen, unpub. data), and fishermen say lionfish numbers are now higher than ever (Berry, commercial fisherman, pers. com.).

Figure 2. An Indo-Pacific red lionfish (*Pterois volitans*) hovers over a reef in the USVI.



RESEARCH HIGHLIGHT

The lionfish invasion is particularly important because of the ability of lionfish to consume large quantities of native reef fish. Lionfish are gape-limited stalking predators capable of consuming prey that are almost half their total length, yet lionfish are themselves largely protected from predation by venomous fin spines (Morris and Whitfield 2009). Lionfish have rapidly spread over more than 4,000,000 km² of marine habitat across the Western Atlantic, Caribbean and Gulf of Mexico, and are now undergoing exponential increases in abundance at many locations (Betancur-R et al. 2011; Foundation 2012). Invasive lionfish occupy a range of habitat types and depths, where they consume an array native fishes and crustaceans at very high rates (Schofield 2009; Green et al. 2011). There is growing concern that predation by lionfish will nullify efforts to protect vulnerable fish populations from anthropogenic threats in the region.

In the TCRMP, lionfish were first observed on roving dives at only two sites in 2010, Lang Bank and Kings Corner, both located off St. Croix. By 2011, seven sites out of 32 held lionfish, including four sites off St. Thomas. Fish were recorded in transects as well as roving dive surveys (Fig. 3). One year later lionfish were recorded on transects at over 50% of monitoring sites. On roving dives, they were observed on 20 out of 32 sites (data not shown). In the most recent 2013 fish transect surveys, lionfish abundance has increased from previous years at St. Thomas/St. John sites, but a slight decrease was seen at St. Croix sites. However; on both island shelves the total number of sites they were present on was less in 2013 (Fig 3). A total of 58 lionfish were observed on transects off St. Thomas/St. John in 2013, and 9 on transects conducted off St. Croix. As in the previous year, the mesophotic sites off St. Thomas had the highest abundances of lionfish. This includes the deep (64m) Ginsburgs Fringe site, where large and small lionfish were very abundant around the permanent transects, but were not quantified. Lionfish were observed during roving dives on seven out of 14 sites off St. Croix, and eight out of 18 on St Thomas. On roving dives as well as transects, more lionfish were seen on St. Thomas/St. John sites than on St. Croix sites. Lionfish across the territory

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ranged in size from 6 to 40 cm TL but the majority (~50%) of fish were between 20 and 30 cm TL. Twelve lionfish (18%) were recorded over 30 cm TL in 2013.

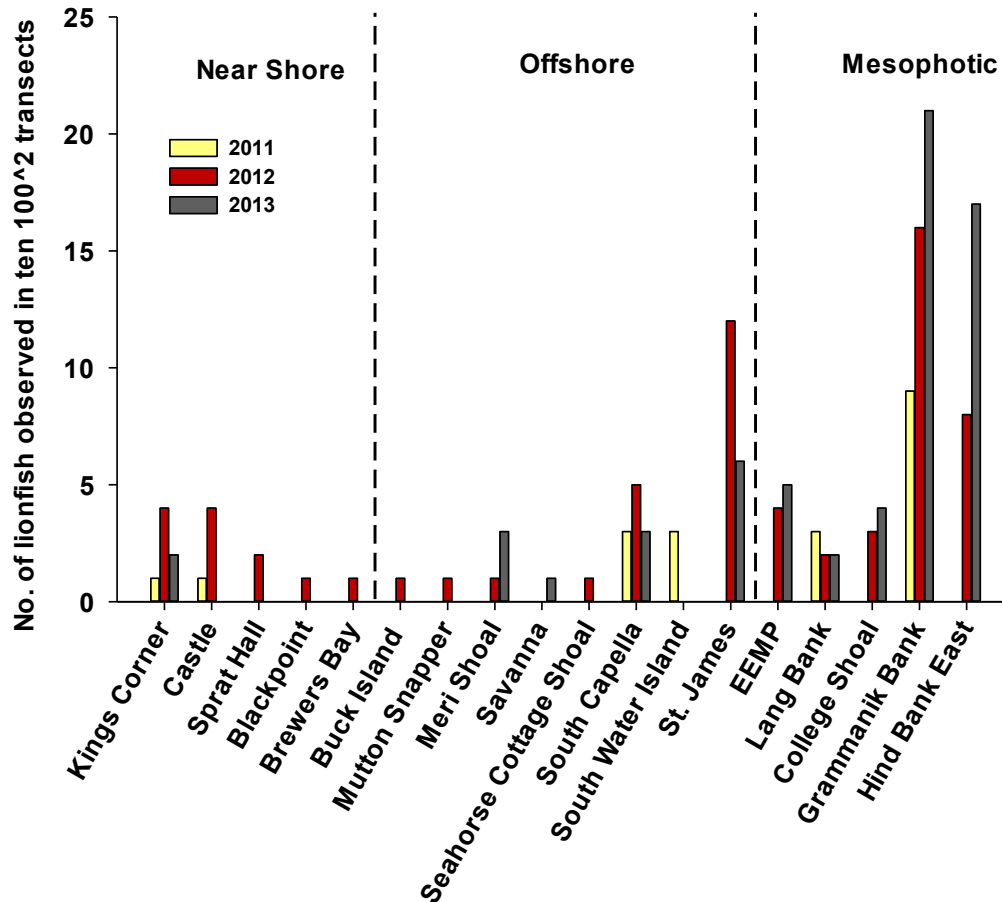


Figure 3. The abundance of red lionfish on TCRMP transects from time they first appeared in transects in 2011 to 2013.

RESEARCH HIGHLIGHT

Little data has been collected and analyzed regarding preferential habitat for lionfish in the western Atlantic; however, based on the TCRMP data and many other dives conducted across the USVI shelves by the authors, it appears that the species utilizes a variety of habitats, congregating around any available structure. They are common on hard bottom areas (generally associated with the largest rock /coral around) as well as coral reefs, and are found to be particularly abundant on submerged man-made structures. They may be somewhat limited from turbulent or high current environments by their large fins. It is unknown if their high densities on mesophotic reefs represent a preference for deepwater habitats, or a reduction in fishing pressure. The Grammanik Bank and Red Hind Bank are marine reserves where bottom fishing is prohibited and large snappers, groupers and sharks are observed regularly. Predation by large piscivores does not appear to control the recruitment or growth of lionfish in and around these sites.

A project conducted by the U.S. Food and Drug Administration, the University of the Virgin Islands and collaborators was the first to document the presence of toxins responsible for Ciguatera Fish Poisoning in the flesh of lionfish harvested from USVI waters (Robertson et al. 2013). This indicates a potential human health threat from the consumption of lionfish that needs to be addressed in any management plan that considers harvesting lionfish for food. The research suggests that lionfish toxicity rates above FDA guidelines (0.1 µg/kg C-CTX-1 equivalents) were roughly 12%. The rates of toxicity are comparable to the schoolmaster snapper (*Lutjanus apodus*), a fish that is eaten in the USVI, with precautions taken on area caught. Typically the south side of St. Thomas-St. John is considered more toxic than the north bank of the Puerto Rican Shelf and St. Croix. Consequently, many species, including schoolmaster snapper, are avoided there. Similar precautions could be applied to lionfish. A market has developed for lionfish in the USVI and no poisonings have been reported of which we are aware. This

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suggests that typical prophylactic procedures of commercial and recreational fishermen are working to limit the risk of Ciguatera Fish Poisoning for lionfish consumption.

Normally the TCRMP would provide management recommendations for the lionfish, but in this case defer to the recently published USVI Lionfish Management Plan for recommendations. The information here is presented as a documentation of the invasion and current progress towards management in the territory.

INTRODUCTION

Introduction

The U.S. Virgin Islands consists of three large islands, St. Thomas, St. John and St. Croix, and numerous smaller islands surrounded by a diverse, tropical marine environment that includes coral reefs, seagrass beds, and mangrove forests (Fig. 4). The islands of St. Thomas and St John lie on the Puerto Rican Shelf, an extensive shallow water platform that connects them to Puerto Rico to the west and the British Virgin Islands to the east. Sixty-five kilometers to the south of St. Thomas and St. John and separated by the Anegada Passage and the Virgin Islands Trough (over 3,000 m deep), St. Croix lies on an isolated platform. This forms an effective barrier to the migration of coral reef fishes and invertebrates. The coral reefs of the Virgin Islands represent a wide range of characteristic coral reef habitats of the Caribbean, including patch reefs, fringing reefs, barrier reefs, shelf reefs, and extensive bank and slope mesophotic coral reef ecosystems.

Tourism drives the economy of the Virgin Islands, famous for white sand beaches that give way to clean, clear marine waters. The Virgin Islands are ideal for sailing because of the persistent trade winds and the numerous bays that provide protected anchorages. The diverse marine life of the coral reefs and other habitats attracts thousands of skin and scuba divers each year. Sportfishing on charter boats and private vessels also makes an important contribution to the economy.

In addition to their tourist appeal, the coral reefs and other habitats in the Virgin Islands are essential to the lives of hundreds of thousands of species including economically important queen conch, whelk, spiny lobster, snapper and grouper. Over three hundred full-time or part-time commercial fishermen fish in territorial and federal waters surrounding all three islands (Tobias 1997). Recreational and artisanal fishing is a frequent activity and is likely to have a significant impact on nearshore fish populations, but there exists very limited data on species composition and spatial distribution of annual catches (Authors, personal observation). In tough economic times and after

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natural disasters, fishing is an important means of supplemental income or extra protein for many people.

Over the last few decades, major hurricanes, coral disease outbreaks and mass coral reef bleaching have caused extensive coral mortality to the coral reefs surrounding the Virgin Islands (Gladfelter 1982; Edmunds and Witman 1991; Rogers et al. 1991; Rothenberger et al. 2008; Woody et al. 2008; Miller et al. 2009). Recovery from these natural disturbances is hindered by a multitude of human impacts that affect coral reefs, such as overfishing of ecologically important species, physical damage to reef structure, and pollution (Hatcher 1984; Pastorok and Bilyard 1985; Rogers and Garrison 2001; Mumby 2006; Mumby et al. 2006; Mumby and Harborne 2010). Moreover, rapid development of steep island slopes has dramatically increased soil erosion and sedimentation into nearshore waters (Brooks et al. 2007; Gray et al. 2008; Smith et al. 2008), particularly below unpaved road surfaces (Anderson and Macdonald 1998; Ramos-Scharrón and MacDonald 2007b). Chronic sedimentation affects the abundance and diversity of corals and other reef organisms, increases coral stress and susceptibility to diseases and bleaching, and reduces the ability of corals and other reef organisms to recover and regenerate after natural disturbances such as hurricanes (Acevedo and Morelock 1988; Rogers 1990; Nemeth and Sladeck Nowlis 2001; Fabricius 2005). The first sightings of the invasive Indo-Pacific lionfish (*Pterois volitans*) occurred in the US Virgin Islands in 2009. This predator has the ability to dramatically alter coral reef fish community structure (Cote and Maljkovic 2010) and these alterations may have additional, indirect impacts on benthic communities (Albins and Hixon 2011).

High thermal stress and coral bleaching events affected the northeastern Caribbean in 2005 and 2010, but these events had contrasting signatures in the United States Virgin Islands. These events and the species-specific responses of Caribbean corals are summarized in Smith et al. (2013). The year 2005 was the most severe high sea surface

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temperature (SST) event on record for the northeastern Caribbean (Eakin et al. 2010). In the Virgin Islands a peak of 10.25 Degree Heating Weeks (DHW) was registered from satellite SST records (NOAA 2012) and a period of approximately 59 days above the local bleaching threshold of 29.5°C (Aug. 20 – Oct. 18); a level of thermal stress accumulation associated with severe coral bleaching and some mortality. The warm season of 2010 started as warm or warmer than 2005, with the bleaching threshold surpassed for 21 days between August 12 and September 2. In a clear example of ameliorative storm cooling (Manzello et al. 2007), the passing of the storm center of Hurricane Earl on August 30th, approximately 100 km to the northeast of the St. Thomas-St. John, caused a rapid decline in SST's below the bleaching threshold to 29.3°C, and then from October 5 - 8, the passage of Hurricane Otto caused windy and cloudy weather that further reduced SST below 29.1°C. Total DHW accumulated in 2010 began to decrease after the beginning of October, when it had reached 5.1 DHW, a level associated with some bleaching and limited mortality.

Most research around the Virgin Islands has focused on fringing reefs (5 – 30 m depth) located along the shoreline of the three main islands, St. Thomas, St. John, and St. Croix. In contrast, very little information exists for offshore and deeper reef systems, which can be quite extensive. Surrounding St. Thomas and St. John, these other reef systems include mid-shelf reefs (5 – 30 m depth) located 2 to 10 km from the shore of the main islands and mesophotic reefs (>30 m depth) located from 0.5 to 15 km offshore along the edge of the insular platform (Armstrong et al. 2002; Herzlieb et al. 2005; Armstrong et al. 2006; Armstrong 2007; Menza et al. 2007; Menza et al. 2008; Nemeth et al. 2008; Smith et al. 2010b). Distance from shore may be a factor in the historical degeneration of coral reef systems in the Virgin Islands (Herzlieb et al. 2005; Calnan et al. 2008; Smith et al. 2008). A systematic approach to investigating these cross-shelf coral reef systems allows us to evaluate the variable impacts and synergistic effects of natural impacts and human-induced stress that influence the decline or recovery of Caribbean coral reef systems.

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The first two years of this project (2001 and 2002) concentrated on the fringing reefs surrounding St. Croix. In 2003, monitoring continued at St. Croix reefs and began at reef systems distributed across the insular platform surrounding St. Thomas. In 2004, 2005 and 2006 monitoring continued at reefs surrounding both islands, with additional reefs surrounding St. Thomas added in 2004, 2005, and 2011. Mesophotic coral reef monitoring sites were added to St. Croix during the 2008 and 2009 monitoring, as well as an additional monitoring site in the St. Croix East End Marine Park. In 2011, the TCRMP also expanded to include sites established under separate funding that will be continued in the core TCRMP monitoring activities funded by USVI DPNR and NOAA CRCP.

OBJECTIVES FOR MONITORING CORAL REEFS

Effective management is necessary to maintain the resources in the territorial and federal waters of the Virgin Islands in an ecologically and economically sustainable manner. Monitoring programs are essential for successful management because they provide managers with fundamental information with which to make and reinforce decisions. Standards for resource protection can be measured by comparison to baseline data established by monitoring. Monitoring also provides the means to assess the status and trends of ecological resources, allowing managers to determine the effectiveness of current management and to develop effective management plans for the future. The Territorial Coral Reef Monitoring Program monitors the condition of coral reefs throughout the U.S. Virgin Islands and provides key information to better manage these ecosystems. This report presents monitoring results from 2001-2013 in St. Croix and from 2003-2013 in St. Thomas. For both islands, temporal changes from year to year in the conditions of the reef communities are assessed.

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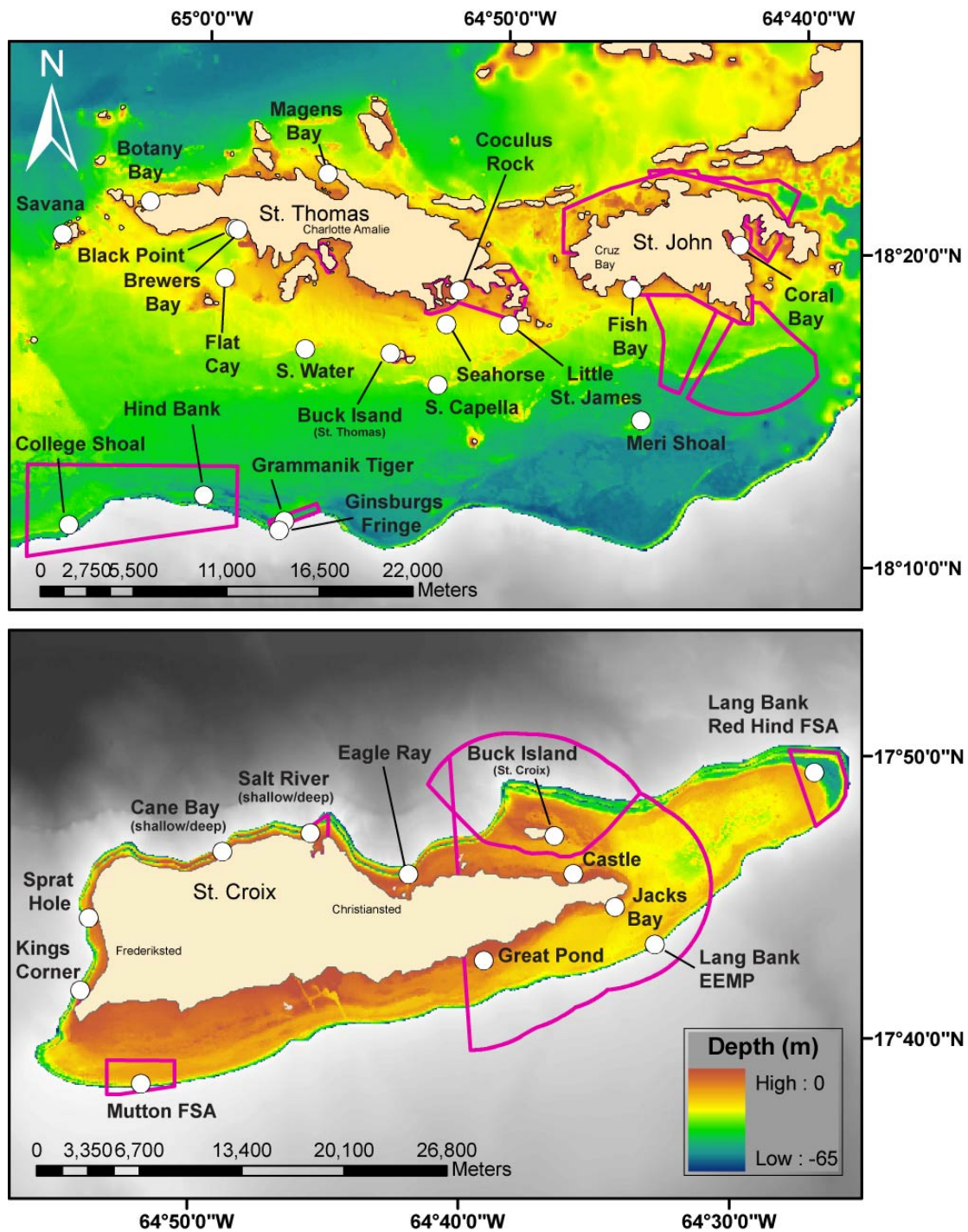


Figure 4. Locations of Territorial Coral Reef Monitoring Sites in the US Virgin Islands, 2008-2010. Boundaries indicate federal and territorial marine protected areas.