APPENDIX 9
CBCC Coral Bay Biodiversity Comments

CORAL BAY COMMUNITY COUNCIL

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Memorandum

To: *Sharon Coldren, CBCC President*

From: *Patricia Reed, CBCC Environmental Projects Manager*

Date: *January 30, 2015*

Subject: *Coral Bay Biodiversity*

Several recent reports have documented long term monitoring conducted around St. John for various projects. The findings of these reports speak to the diversity of habitats, corals, and fish within Coral Bay. The findings of several reports also document the effectiveness of Coral Bay's Virgin Islands Coral Reef National Monument (VI CRNM) Marine Protected Area (MPA) (a no-fishing, no anchoring area) on preserving marine diversity. (All VI National Park waters occur principally outside Coral Bay so the effectiveness of this MPA is not discussed here.) This memo aggregates relevant excerpts of these reports to highlight the biodiversity in Coral Bay and the highly diverse benthic habitat, including essential fish habitat, occurring both within the Virgin Islands Coral Reef National Monument and in other portions of Coral Bay. Given the finding of these reports, the entire bay needs to be protected from stressors such as overfishing, pollution from development, greatly increased recreational vessel use and transit caused by a large marina and port of entry, and other forms of human use. Also, resource managers should encourage low impact human uses in this highly sensitive area to ensure protection of the bay's significant biodiversity.

Even with all the research that has been completed to date, more is required to determine how important the less studied embayments, such as Coral Harbor, are as breeding, nursery, and juvenile habitats and what other aquatic functions these areas serve. For instance, Coral Harbor and all of Coral Bay are wide open to the ocean currents from the southeast. These currents typically transport various pelagic larvae, which could assist in promoting genetic diversity. The part these currents play in Coral Bay's rich marine habitat and the importance of the Coral Harbor mangrove, sea grass and coral reef habitats needs to be evaluated prior to allowing more intense development to occur. The unique biodiversity that is anecdotally reported, or mentioned in passing in various studies need to be documented to ensure that habitat and species loss will not occur. It is possible based on the following research conclusions that all of Coral Bay is an exceptional and resilient habitat in the face of climate change.

Figures associated with some of the reports are appended to the end of this memo.

1. ***A Baseline Assessment of Coral and Fish Bays (St. John, USVI) in Support of ARRA Watershed Restoration Activities: Chapter 2: A Synthesis of Ten Years of Biogeographic Data*** **(Menza et al. 2014)**

   "Over the course of ten years 30 distinct species of coral and 194 species of fish were observed in Coral Bay.... As is common in most coral reefs in the USVI, algae cover was one of the most abundant taxonomic components of the benthic communities in both bays and live coral cover was generally low. Plots of indicators over time and maps of indicators across space showed variation among fishes, corals and habitats across a range of spatial and temporal scales. Although many reefs in both bays were dominated by algae, pockets of coral refuges with very high coral cover were identified in Coral Bay.... These observed patterns in the spatial occurrence and abundance of algae, live coral, and reef fishes were similar with and reflected the broader-scale spatial patterns observed by Friedlander et al. (2012) around the island of St. John."

   "Estimates of algae and coral were quite variable in time ... and in space ... across Coral Bay. Among individual survey sites, estimates of live coral and algae cover varied from 0% to 90% and 1% to 90%, respectively. Together, comprehensive and rapid habitat assessments identified 148 sites where live coral cover was greater than 20% and 15 sites greater than 50% (N=544). Sites with relatively high coral cover may indicate refuge areas where stressors are low or where demographic processes have resulted in resilient populations. The reefs in the northeast of Coral Bay, specifically in Round Bay and south of Turner Point, tended to possess sites with the highest coral cover compared to other reefs in Coral Bay ...."

   "Interestingly, Friedlander et al. (2012) found that parts of Coral Bay were among the areas with highest coral richness, coral cover, and structural complexity in St. John. In addition, these areas of high coral cover and richness in Coral Bay also correlated with hotspots of several fish assemblage metrics such as richness, numerical abundance, biomass, and diversity (Friedlander et al. 2012). Furthermore, the broader scale analyses by Friedlander et al. (2012) suggest that Coral Bay may be an important juvenile habitat for commercially important fisheries species such as Yellowtail Snapper, Schoolmaster Snapper, and several species of parrotfishes. These ecosystem attributes along with the nursery function of the Coral Bay area highlights the importance and need to mitigate known stressors through watershed improvements."

2. ***Life on the edge: corals in mangroves and climate change* (Rogers and Herlan 2012)**

"Within the last few years, a high abundance and diversity of scleractinian corals have been observed on and near the prop roots of red mangrove (*Rhizophora mangle*) trees in Hurricane Hole, within Virgin Islands Coral Reef National Monument, a marine protected area off St. John, US Virgin Islands (Rogers 2009). To date, no published papers have been found that indicate such a high number of coral species in any other Caribbean mangrove ecosystems. Hurricane Hole consists of four bays with mangrove-fringed shorelines and no major sources of freshwater. It is not clear why the coral communities in these bays are so diverse or why the individual bays differ so much from each other with respect to coral abundance and diversity. Borck Creek has few corals except at the mouth of the bay, Princess Bay has an intermediate abundance and diversity, and Otter Creek and Water Creek have the highest number of species and individuals. Differences in water circulation and/or seawater chemistry may be driving variations in coral abundance and diversity, with Otter and Water having greater water exchange creating physical and chemical conditions more similar to those on a coral reef than in a mangrove environment."

"To our knowledge, no other Caribbean mangrove ecosystems have as many coral species as those in Hurricane Hole. Some major review papers on prop root communities in Caribbean mangroves do not even mention corals (e.g., Kathiresan and Bingham 2001, Nagelkerken et al. 2008)."

"Chemical and physical parameters likely play a role in the distribution of corals and their response to bleaching in the fringing mangrove habitats of Hurricane Hole. Although further research is needed, many corals shaded by mangroves did not bleach. Scientists with whom we are collaborating made diurnal measurements of Photosynthetically Available Radiation (PAR) and carbonate system parameters (including pH) at selected sites of similar water depth in Princess, Otter and Water 1) where corals are growing on mangrove prop roots, 2) near mangroves without associated corals, and 3) at sites where corals are growing on rocky outcrops with no shading from mangroves. A preliminary analysis of the data indicates that PAR is considerably lower at mangrove coral sites than at rocky outcrop sites where corals are not shaded; and pH is consistently lower at mangrove sites with no corals than at mangrove and rocky outcrops sites where corals are growing (K. Yates, USGS, unpublished data)."

"Further research on coral genotypes and on water circulation is needed to determine how the Hurricane Hole mangrove areas are linked or connected to the coral reefs within and outside the national monument and park and whether they are functioning as a source or a sink (or both) with regard to coral larvae. It is possible that the Hurricane Hole coral communities have the potential to provide larvae of some of the coral species, including major reef-building species, to reefs which have declined dramatically since 2005."

3. ***Coral reef ecosystems of St. John, U.S. Virgin Islands: Spatial and temporal patterns in fish and benthic communities (2001- 2009)* (Friedlander et al. 2013.)**

"Based on full-scale benthic surveys, the highest generic stony (Scleractinian) coral richness and cover occurred at the mouth of Coral Bay, St. John, along the north shore between Haulover and Newfound Bays, and along the south shore between Lameshur and Salt Pond Bays. Fish species richness and diversity were also highest where coral was most diverse and most abundant."

"In Coral Bay, live coral cover averaged 7.90 % ± 2.31 SE within the VICR and 7.5% ± 1.96 SE in adjacent areas outside. An interpolated surface of live coral cover indicated that areas with higher live coral cover were more extensive in several of the southeastern locations of St. John, particularly in Coral Bay."

"At 13.3 km2, Coral Bay represents the largest land surface area draining into an individual bay on St. John.... Coral Bay encompasses over 16 km of shoreline, including some of St. John's largest salt ponds, extensive mangrove habitat, sea grass beds and fringing reefs. The bay includes portions of the VICR and supports protected *Acropora* corals and sea turtle nesting areas."

"Several of the small mangrove-lined bays within the Coral Bay portion of VICR support diverse coral communities. In St. John, mangrove habitats are the most extensive, best developed, and least disturbed within the large embayment in Coral Bay, known as Hurricane Hole.... Mangroves in that area function as a nursery habitat for juvenile fish, spiny lobsters, and queen conch (*Strombus gigas*); in fact, Hurricane Hole was included in the VICR, partly to protect the mangroves there (U.S. Presidential Proclamation 7399, 2001). As many as 28 species of scleractinian coral have been identified from initial surveys in 2008 (Rogers, 2009). Furthermore, many of the coral colonies within Hurricane Hole mangroves generally appear healthier than those on coral reefs around St. John (Rogers, 2011). U.S. Geological Survey (USGS) and NPS scientists are monitoring and studying these colonies as case-study examples of resilience because they survived the mass bleaching event in 2005 and 2006."

"Examination of an interpolated surface of live coral cover indicated that areas with higher live coral cover were more extensive within Coral Bay and along the northeastern portion of St. John from Haulover Bay to Newfound Bay (Figure 3.17a). These areas also had the highest number of coral genera with additional areas off of Leduck Island (also known and referred to as LeDuc) and Eagle Shoal to the southeast and Johnston Reef in the northwest also having higher numbers of coral genera (Figure 3.17b). Most of the locations that demonstrated greater numbers of coral genera and higher percent coral cover, were also the most topographically complex as reflected in the high indices of rugosity in these areas (Figure 3.17c). A number of the areas with high coral cover and generic richness were outside VIIS, particularly around the eastern portion of the island."

"Interpolations of cover for the six most abundant coral species showed patchy and uneven distributions (Figures 3.18 and 3.19). *Montastraea annularis* complex was more common in Coral Bay, along the northeast near Newfound Bay, and at scattered locations along the southeast shore from White Cliffs to Booby Rock (Figure 3.18a). Cover of *Porites astreoides* was higher in a few locations in Coral Bay including Johnson's Bay, in Haulover Bay, and at a few locations along the northwest shore including Hawksnest Bay, Johnson's Reef, and Cinnamon Bay (Figure 3.18b). *Siderastrea siderea* had higher cover off Leduck Island, off Whistling Cay, and scattered locations along the southshore (Figure 3.18c). *Montastraea cavernosa* demonstrated fairly patch distribution and overall low percent cover inside and outside VIIS, with a few distinct areas of high percent cover off the eastern end of St. John and off Mary's Point (Figure 3.19a). *Siderastrea radians* had areas of higher cover between Cabritte Horn Point and Ram Head (Figure 3.19b). Cover of *Porites porites* showed higher concentrations around Durloe Cays and Johnson's Reef in the northwest, in Round Bay inside Coral Bay, and between Haulover and Newfound Bay to the northeast (Figure 3.19c)."

"Additional areas of high macroalgae cover were observed in Coral Bay and along the eastern shore near John's Folly Bay. Algal turf was broadly distributed around St. John, both within and outside VIIS, with most of the algal turf on the south and east shores occurring in shallow, nearshore locations."

"Seagrasses were common on the softbottom habitats in the study area (Figure 3.21). Seagrass cover was most extensive close to shore within intermediate to high percent cover within Coral, Lameshur, Reef, and Rendezvous Bays (Figure 3.21a). Large continuous areas of seagrass are present nearshore, adjacent to mangroves in the Coral Bay and inside the fringing reefs. In this zone, seagrass was predominantly *T. testudinum* that was abundant to depths of approximately 16 m (Figure 3.21b). *T. testudinum* cover was highly variable, ranged from 0.02 to 78.6%, and occurred primarily in Coral Bay where several sites had greater than 30% cover and Rendezvous Bay which also had some sites with greater than 30% cover (Figure 3.21b)."

"In the Coral Bay area, turf algae comprised the dominant biotic cover on hardbottom (34.5% ± 17.6%), followed by macroalgae (19.4% ± 11.8%), coral (7.7% ± 7.7%), gorgonians (4.0% ± 3.6%), and others (4.7% ± 3.4%; Figure 3.26). There were no differences in cover between management strata among these key benthic components (all p>0.05, Figure 3.27). Live coral cover was highest along Johnson Bay and inside Round Bay (Figure 3.28). Coral generic richness was also high along Johnson Bay, as well as off Turner Point and Long Point. Macroalgae was highest around the inner portions of Coral Bay and Hurricane Hole. Although the composition of benthic substrates varied spatially within and among habitat types in St. John, some general spatial patterns in occurrence and cover of benthic organisms were observed. Most coral reefs and hardbottom substrates in St. John including the VIIS and VICR appear to be dominated by some form of algae, with occasional patches of hard corals, gorgonians, sponges, and other encrusting invertebrates. For example, turf algae was the most extensively occurring benthic organism group within all hardbottom habitat types, followed by macroalgae (Figure 3.29). Another general pattern was the low average cover of live scleractinian coral (~5%) on coral reef and hardbottom areas. Such low coral cover is now typical of most reefs in the USVI and other parts of the Caribbean and has resulted from the synergy of natural and anthropogenic factors operating over the several decades (Gardener et al. 2003; Jeffrey et al., 2005; Rogers et al., 2008; Rothenberger et al., 2008)."

"Interpolations of this study's synoptic estimates of live coral cover, which were summed across species, revealed a few hotspots of relatively high coral cover in southeastern St. John, particularly in Coral Bay (see Figure 3.17a). These hotspots may be refuge areas where demographic processes have resulted in coral populations that are resilient to multiple synergistic stressors (Pittman et al., 2010). If so, corals at these locations are more likely to persist longer in the future than corals at other locations. Additionally, the locations of such hotspots corresponded with areas of relatively high numbers of coral genera and high rugosity (Figure 3.17b,c). Protection of these hotspots may benefit ecosystem conservation, but several of these hotspots occur in areas outside of the VIIS."

"Several studies have shown that softbottom habitats are ecologically important components of coral reef ecosystems. For example, reef fishes are known to migrate from reef and hardbottom areas, forage on adjacent non coral reef habitats (sand, seagrasses, and algal plains), and they represent a trophic pathway of energy transfer among habitats (McFarland et al., 1979, Meyer et al., 1983). Furthermore, several landscape analyses have correlated various seagrass metrics with increased probability of juvenile grunt occurrence on reef and hardbottom areas in St. Croix (Kendall et al., 2003), higher sighting frequencies of groupers on hardbottom habitats in the Florida Keys (Jeffrey, 2004), and increased fish abundance and species richness in mangrove communities in Puerto Rico (Pittman et al., 2007; Pittman et al., 2010). Several other studies have demonstrated that both vegetated and non-vegetated softbottom areas are known to provide habitat and food for several coral reef fishery species, endangered and threatened species, and many other marine organisms (Parrish, 1989; Nagelkerken et al., 2000; Dahlgren and Marr, 2004; Adams et al., 2006)."

"Fish species richness and diversity were highest along the east shore, within Coral Bay and along the north shore between Mary's Point and the Durloes (Figure 4.6a,c). The largest continuous area of high fish species richness and high fish diversity occurred within Coral Bay (Figure 4.6a,c)."

"Overall, fish assemblage characteristics within Coral Bay were similar inside and outside the VICR (Table 4.11.). Fish biomass was 27% higher inside the monument compared with outside and significantly different (p = 0.05). All other metrics were indistinguishable. Fish species richness within Coral Bay was highest along Johnson's Reef and Round Bay (Figure 4.81). Higher biomass was observed near Turner Point while higher diversity was centered around Johnson's Reef, Turner Point and Long Point."

"Our study highlights the local significance of Coral Bay for species of the snapper family (Lutjanidae). It is likely that the combination of mangroves, seagrasses and structurally complex coral reefs works synergistically to provide the resources required by snapper (Pittman et al. 2007). These areas have high conservation value and should be managed accordingly."

"Many species associated with coral reef ecosystems utilize multiple habitat types, often with very different biophysical structure (seagrasses, mangroves, coral reefs, etc.) and species composition."

"Although direct evidence of habitat connectivity cannot be explicitly inferred from our underwater surveys, the current work does demonstrate that many fish species use multiple habitat types. Some key species exhibited spatial segregation between distribution patterns of juveniles and adults, while for other species juveniles and adults co-occurred at the same sites, habitat types and zones. Snappers, grunts, and parrotfishes showed the greatest segregation of adult and juvenile habitat and highlight the importance of linking habitats. Species that have evolved to use all habitat types (seascape generalists) were also the most abundant species across the region. These seascape relationships require further study and need to be evaluated relative to the implications for resource management."

"Coral Bay appeared to be an important juvenile habitat particularly for several commercially important fisheries species such as Yellowtail Snapper, Schoolmaster Snapper, and several species of parrotfishes (Figure 4.87). Current efforts to reduce sediment loads within the watershed have the potential to improve coastal ecosystem condition in Coral Bay. The importance of Coral Bay as a nursery habitat for many resource species highlights the need to conserve this area and develop appropriate management strategies to improve ecosystem health."

4. Coral Bay Community Council Cooperative Shark Study (DeAngelis 2008)

Bryan DeAngelis (formerly with NOAA) began a study in 2004 to investigate the species diversity and habitat use of shark and other elasmobranch species around St. Thomas and St. John. This work resulted in "Bryan and co-investigator Dr. Gregory Skomal of the Massachusetts Division of Marine Fisheries ... collecting data on the species diversity and relative abundance of sharks in Coral Bay, as well as determining the extent that Coral Harbor is used as a shark nursery (DeAngelis 2008)."

Results indicate that blacktip and lemon sharks partition the habitat.

> "... both species prefer to remain against the coastline in relatively shallow water (less than 3 m [10 ft.]), but blacktips tend to use a wider range of Coral Harbor. Alternatively, lemon sharks appear to strictly prefer the north corner of the Coral Harbor coast, as well as the shallow mangrove flat of Lagoon Point. Both areas of high lemon shark densities are characterized by very shallow water and often dense seagrass. While we found some overlap of areas used by both species ... , no blacktip sharks have been recorded in Lagoon Point. This pattern of habitat use by depth and bottom type, and apparent habitat partitioning by the two kinds of shark mimics what [has been] found in Fish Bay, another well studied, highly productive shark nursery for these two species on St. John (DeAngelis 2008)"

5. ***Outline for a Coral Bay "Area of Particular Concern" Marine Inventory Coral Bay, St. John, U.S. Virgin Islands Phase 1: Inner Coral Harbor (Myers 2006)***

Surveys were conducted by CBCC in Coral Harbor to record fish, coral, and other marine species. These surveys were conducted in September and October 2004 along the eastern shore of Coral Harbor and Penn Point and resurveyed on July 30-31, 2005, July 2012, and July 2014. The list of fish, corals, and other marine species from the 2004 and 2005 surveys can be found in the marine inventory document referenced above. The 2012 and 2014 surveys are still being compiled.

The 2004-2005 surveys of Coral Harbor resulted in observations of 31 stony and gorgonian coral species, 59 fish species, 38 other marine species, and 16 marine plant species.

References

Charles Menza*, Lisa Wedding, Randy Clark, Chris Caldow and Mark Monaco National Oceanographic and Atmospheric Administration National Ocean Service National Centers for Coastal Ocean Science Center for Coastal Monitoring and Assessment. 2014. *Chapter 2: A Synthesis of Ten Years of Biogeographic Data.* In: Whitall, D., C. Menza, and R. Hill. 2014. A Baseline Assessment of Coral and Fish Bays (St. John, USVI) in Support of ARRA Watershed Restoration Activities. NOAA Technical Memorandum NOS NCCOS 178. Silver Spring, MD. 74 pp.

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Friedlander, A.M., C.F.G. Jeffrey, S.D. Hile, S.J. Pittman, M.E. Monaco and C. Caldow (eds.). 2013. *Coral reef ecosystems of St. John, U.S. Virgin Islands: Spatial and temporal patterns in fish and benthic communities (2001- 2009).* NOAA Technical Memorandum 152. Silver Spring, MD. 150 pp.

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Figures

CCMA-BB approaches the assessment of management and conservation strategies such as marine protected areas (MPAs), boundary delineation, and defining species habitat utilization patterns via three integrated activities: 1) map the distribution and characteristics (quality) of benthic habitats; 2) inventory and map the distribution of macro-invertebrates and fishes; and 3) define species habitat relationships in space and time. These three components are integrated using a suite of analytical techniques and GIS tools to quantitatively define species habitat utilization patterns within and outside MPAs. This approach results in hypothesis-driven studies that address many aspects of evaluating MPA delineation, use, function, and effectiveness in protecting marine resources.

CCMA-BB has developed digital benthic habitat maps for the U.S. Caribbean, Florida and the U.S. Pacific Islands to support the National Coral Reef Ecosystem Monitoring Program, as directed by the U.S. Coral Reef Task Force (Monaco et al., 2012). These key maps products are being used widely to design many ecological studies that assess marine animal populations (Friedlander et al., 2007), species richness and diversity (Pittman et al., 2007), effects of pollutants on reefs (Pait et al., 2009), overall coral reef ecosystem condition (Whitall et al., 2011), and the efficacy of reef restoration efforts (Zitello et al., 2008; Whitall et al. 2011). CCMA-BB's integrated mapping and monitoring approach for assessing coral reef ecosystems and reef fish habitat utilization patterns are designed to aid resource managers in making informed decisions about conserving living marine resources. For example, this integrated mapping and monitoring approach is being used to support the designation of essential fish habitat (EFH) areas, delineation and modification of MPA boundaries, and the evaluation of the effectiveness of MPAs. Furthermore, the benthic habitat maps have been combined with surface rugosity information and bathymetry to predict the spatial patterns of fish richness around St. John yielding an overall map accuracy of 70.5 % and 86.5 % for the high (15-25) fish species richness class (Pittman et al., 2007; Figure 2.7). Information from these recently developed fine-scaled benthic habitat maps (2009) and newly available Light Detection and Ranging mapping technology (LiDAR; 2011/2012) will help improve analyses of current and future natural resources datasets, which ultimately would lead to even more robust predictive models and evaluations of management-induced changes in reef ecosystems.

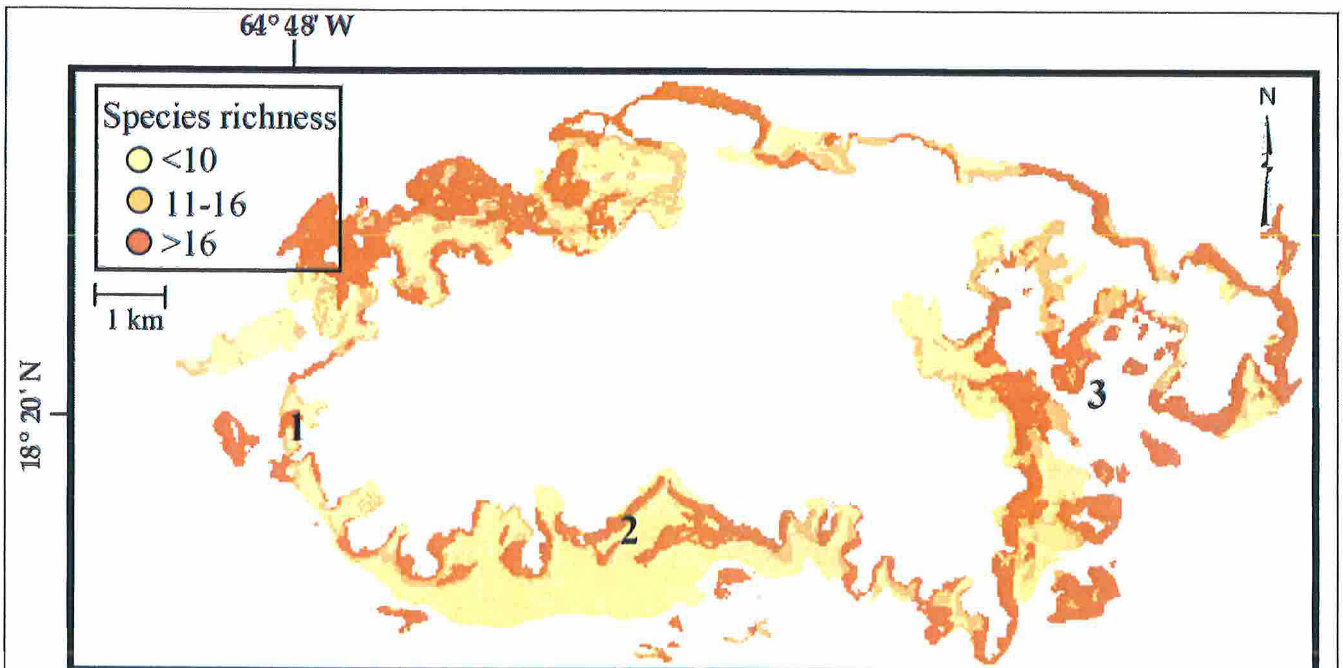

Figure 2.7. Predictive map of fish species richness (high, medium, low) around St. John based on a regression tree model of the relationship between the number of fish at 423 stratified random survey sites and the surrounding benthic structure (benthic habitat and associated rugosity combined with bathymetric variability): 1) Cruz Bay, 2) Reef Bay, and 3) Coral Bay are marked. Source: Pittman et al. (2007).

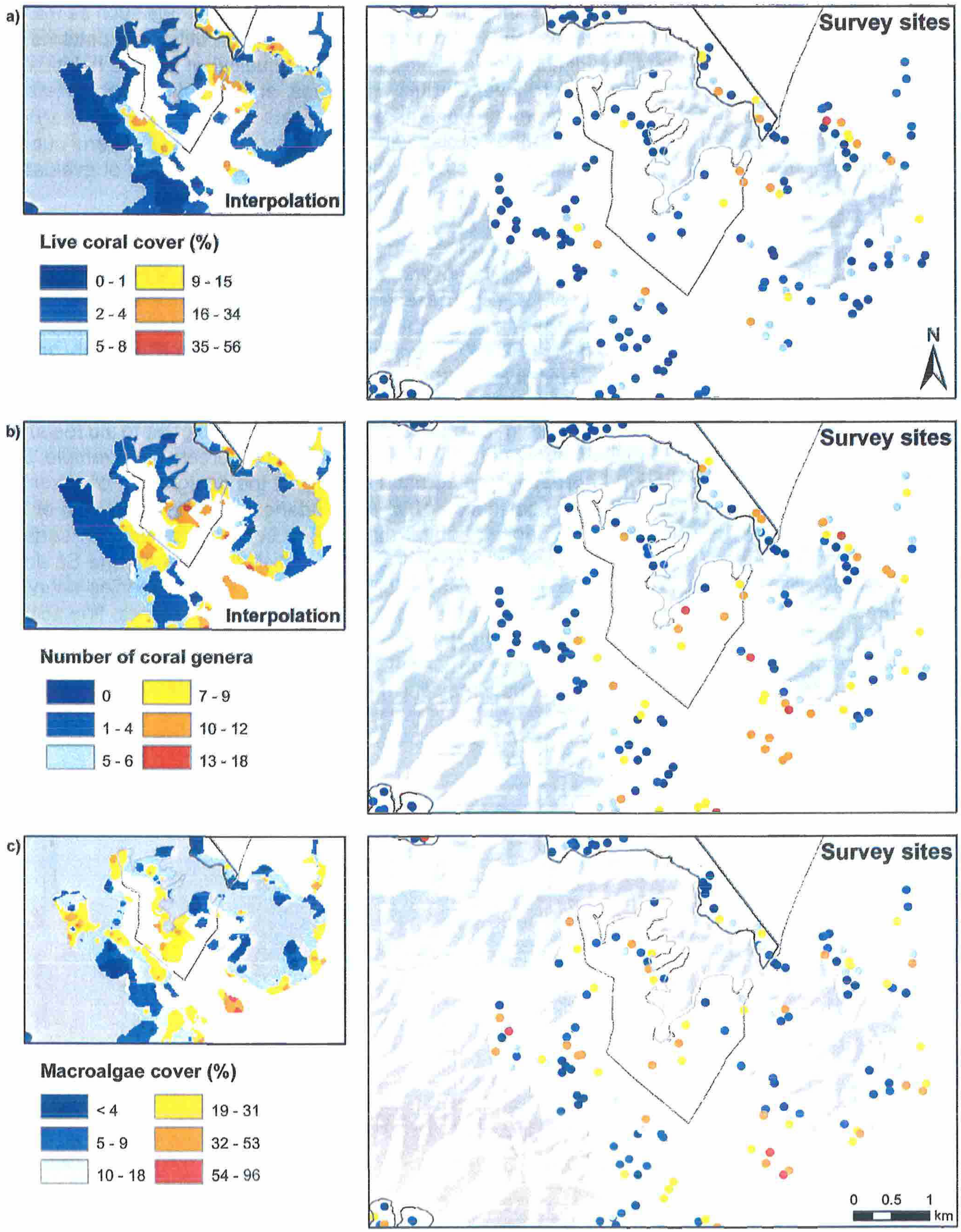

Figure 3.28. Spatial distributions of key benthic components at all quantitative benthic survey sites within Coral Bay between 2001 and 2009. (a) Percentage live coral cover; (b) number of coral species/groups; and (c) macroalgae cover. Source: K. Stamoulis (University of Hawaii).

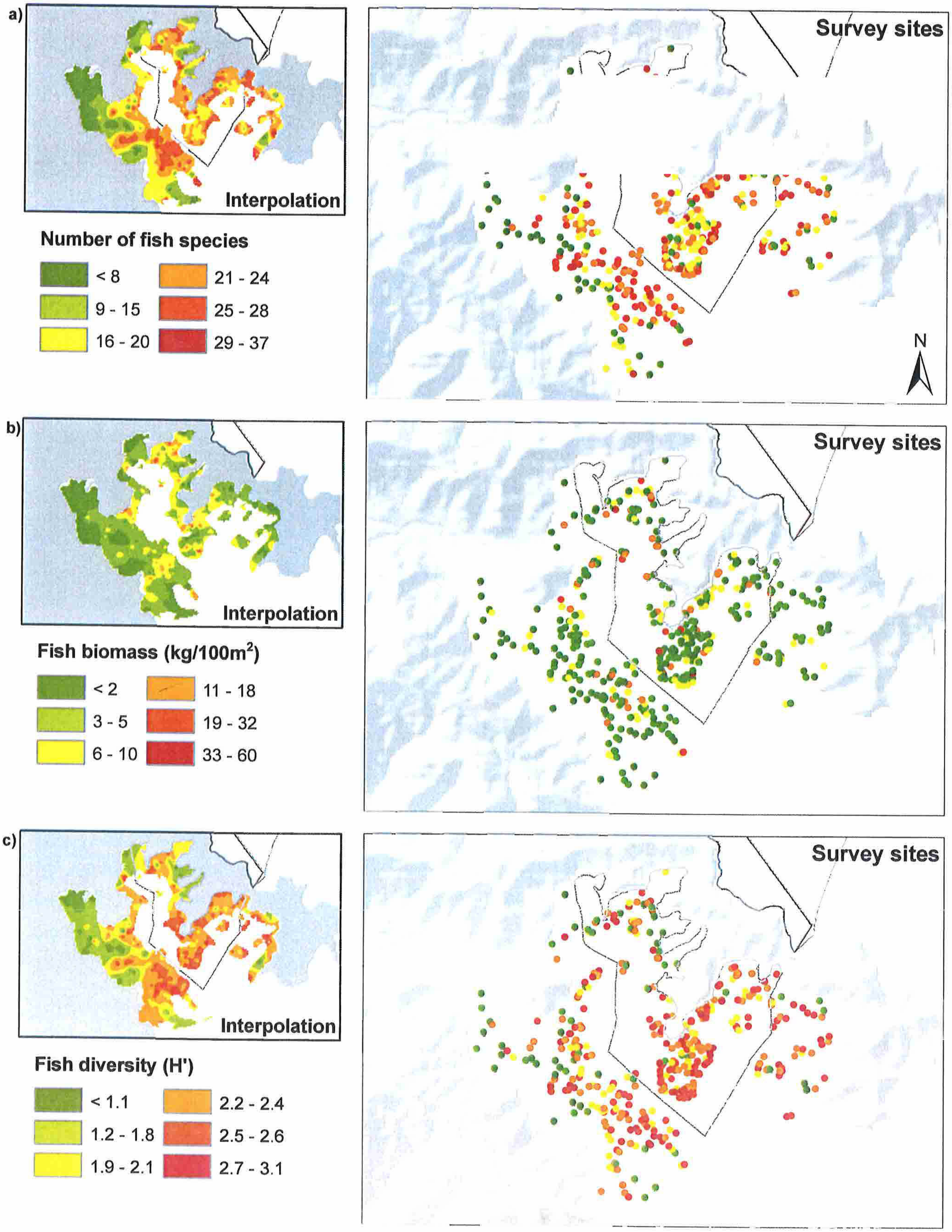

Figure 4.82. Spatial distribution of fish assemblage characteristics within Coral Bay between 2001 and 2009. (a) abundance; (b) biomass; and (c) diversity. Source: K. Stamoulis (University of Hawaii).