# DATA REPORT

# 2012

# ST. CROIX, USVI

**Prepared by NCCOS in Partnership with**

**NMFS/SEFSC and NPS Buck Island Reef National Monument and Southeast Inventory and Monitoring, University of Virgin Islands, University of Miami, The Nature Conservancy, and USVI DPNR**

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# I. Mission Purpose and Background

A collaborative research effort between the NOAA's National Centers for Coastal Ocean Science (NCCOS), Center for Coastal Monitoring and Assessment's (CCMA) Biogeography Branch (BB) and the National Park Service South Florida and Caribbean Network (NPS-SFCN) has been inventorying and assessing reef fish populations in reef and reef-associated habitats in the northeast region of St. Croix from 2001-2011. The diver-based fish and benthic community survey methods were developed at the scale of the NPS MPAs (Buck Island in St. Croix and Coral Reef National Monument and National Park in St. John) and adjacent non-protected habitats. The methods were developed with the desire to expand to greater spatial scales, e.g., all of St. Croix or all of St. Thomas and St. John. Region-wide population metric estimates are required to effectively manage reef fisheries but are also imperative for spatial management and understanding ecosystem-level processes, such as measuring MPA efficacy. To date, very little information exists outside the northeast portion of St. Croix and this effort was designed to establish a baseline characterization for the whole island of St. Croix. This effort was also a logistical, as well as statistical primer, for the implementation of the National Coral Reef Monitoring Program (NCRMP) that will start in 2016. This program will implement standardized fish and benthic community survey across the USVI, Puerto Rico, Florida Keys and Flower Garden Banks National Marine Sanctuary (and a similar structure in the US Pacific) and serve as a broad scale monitoring tool for the foreseeable future.

In May 2012, NOAA and NPS led a multiagency mission to conduct a comprehensive assessment of fish and benthic communities at depths between 1-100 feet (0.5-30 m) around the island of St. Croix. The mission included over 35 participants from NOAA-NCCOS, NOAA's Southeast Fisheries Science Center (SEFSC), the National Park Service (NPS, South Florida/Caribbean Network - Miami, St. John, and St. Croix), U.S. Virgin Islands Department of Planning and Natural Resources (DPNR), The Nature Conservancy (TNC), the University of the Virgin Islands (UVI, St. Thomas campus and St. Croix campus), and the University of Miami.

The survey design implements a stratified random approach built around metrics from pre-existing data from the northeast region and extrapolated to the whole island. Stratification comprises five hardbottom benthic habitats, two depth zones (less than and greater than 9.1m (30ft), and region (Table 1). There are seven regional strata including three marine protected areas (MPAs)-Buck Island Reef National Monument (BUIS) managed by the NPS; St. Croix East End Marine Park (STXEEMP) managed by the USVI DPNR; and, the Salt River Bay National Historic Park and Ecological Preserve (SARI) co-managed by NPS and USVI DNR (Figure 1). NOAA developed benthic habitat maps in 2001 where soft and hard bottom habitats were delineated from nearshore to depths near 30m (~100 ft) (http://ccma.nos.noaa.gov/ecosystems/coralreef/usvi_pr_mapping.aspx).

**Table 1. Survey strata.**

| Regions | Management areas | Depth | Hard bottom types |
|---|---|---|---|
| North | Buck Island Reef National Monument | Shallow | Pavement |
| South | Salt River Ecological Reserve | Deep | Patch reef |
| East | East End Marine Park | | Linear reef |
| West | | | Bedrock |
| | | | Scattered coral and rock in sand |

Previous fish and benthic community surveys in northeast St. Croix were conducted on hard and soft bottom habitat types whereas this survey focused on hard bottom habitats that included linear reef, patch reef, colonized pavement, scattered coral and rock in sand, and bedrock (Figure 1).

Overall 250 sites were allocated as primary targets and an additional 100 alternates, for the island wide survey. The survey objectives were to survey all 250 sites and to include additional sites if time and weather permitted.

## II. Survey Methods

*Site*

Site allocation (N=250) was to be distributed amongst the 70 survey strata as defined in Table 1. Figure 2 displays the spatial distribution of the primary survey sites. At each site data on fish and benthic communities were to be collected via the methods described in this section.

*Fish surveys*

All fish were identified to species, counted and measured in 5 cm (fork length) size bins along a 100 $m^2$ (25x4m) belt transect. Fishes greater than 35 cm (fork length) were not binned but measured to the nearest full cm. More detailed information can be found here: (http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html).

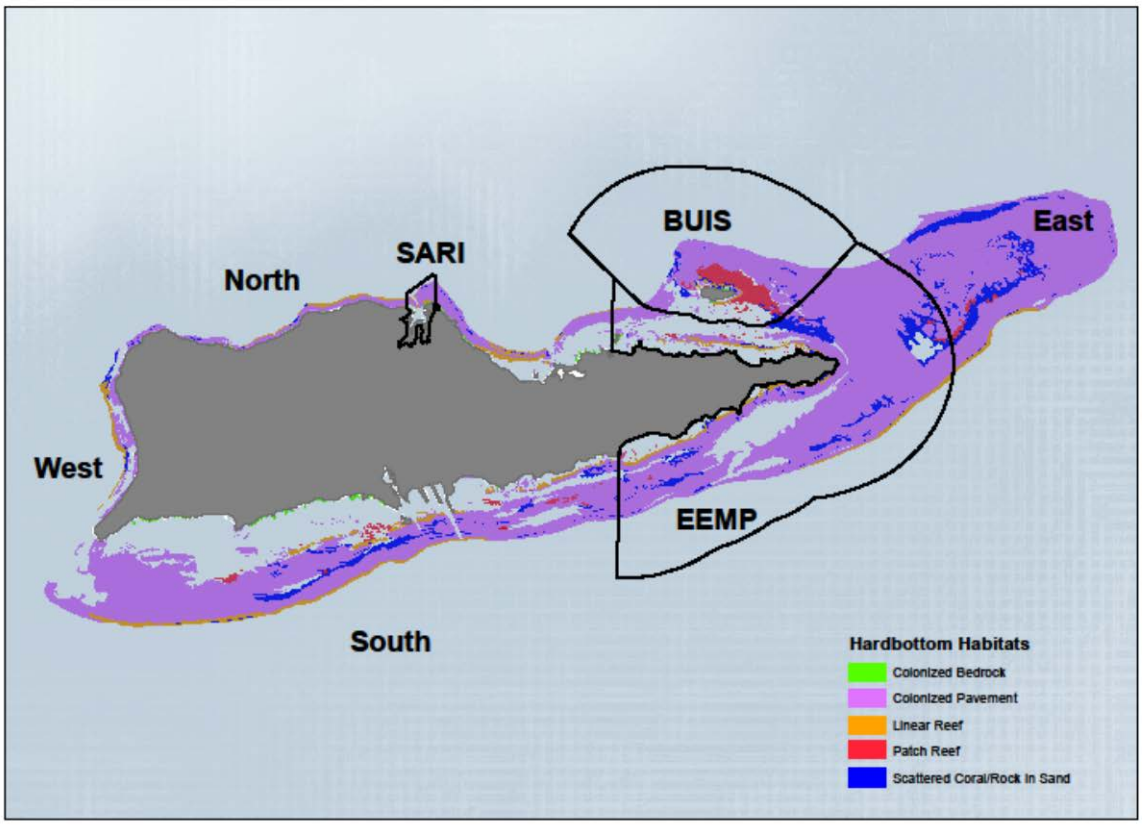



Figure 1. Hardbottom benthic habitats and regional strata for St. Croix. BUIS=Buck Island Reef National Monument; EEMP=St. Croix East End Marine Park; and, SARI=Salt River Bay National Historic Park and Ecological Preserve.

*Benthic surveys*

Benthic surveys were collected along the same transect as the fish survey. Percent cover of benthic organisms were estimated at five random locations along the transect using a 1 $m^2$ qaudrat. Percent cover of scleractinian corals were estimated by species, while other taxa were estimated in broader groups: filamentous algae, macroalgae, turf algae, crustose coralline algae, upright sponges, encrusting sponges, upright gorgonians, encrusting gorgonians, hydrocorals, tunicates, anemones, and zooanthids. Detailed information can be found here: (http://ccma.nos.noaa.gov/ecosystems/coralreef/reef_fish/protocols.html).

Other data collected included the counting of conch, lobster and *Diadema* in each transect. Also the presence/absence of *Acropora cervicornis* and *A. palmata* on the transect or at the site level were recorded. Marine debris was also noted if observed within the transect area.

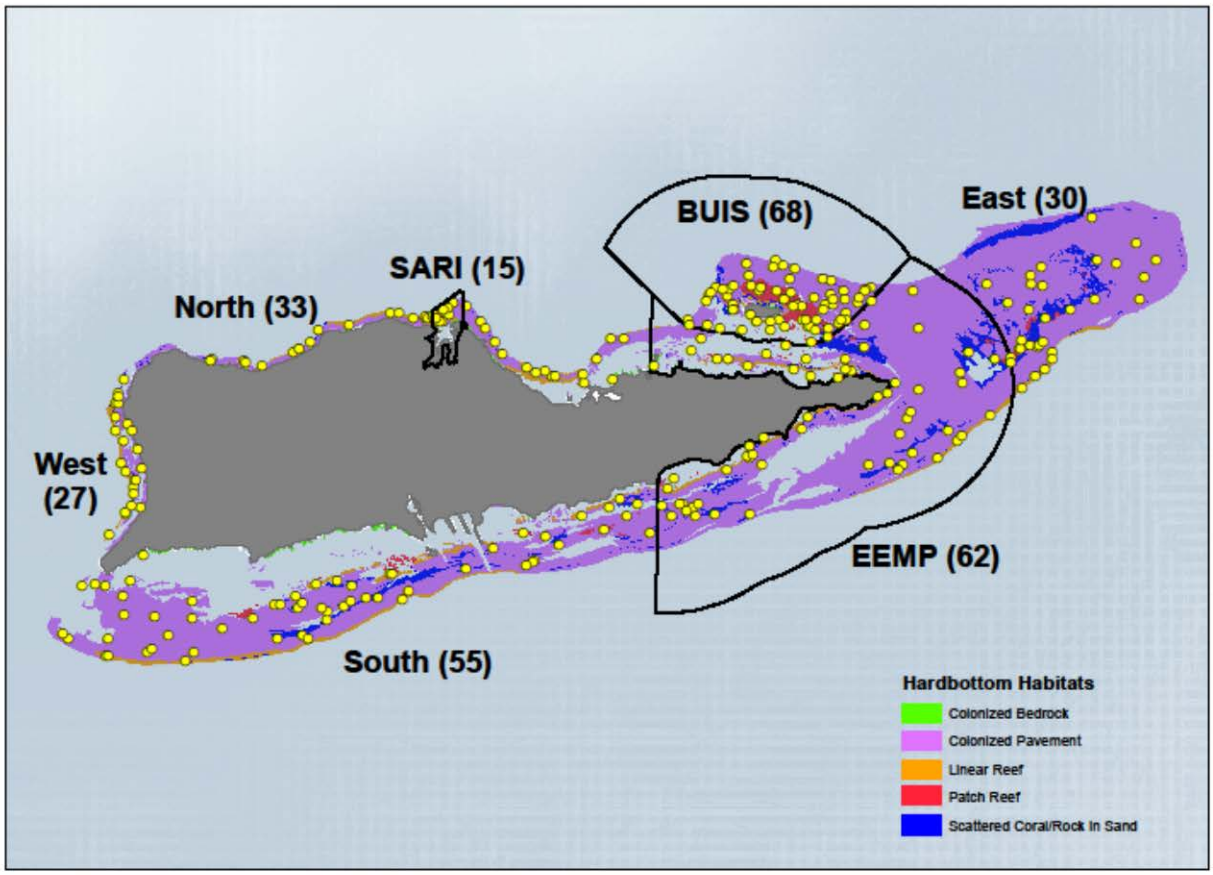



Figure 2. Spatial distribution of fish and benthic surveys.

## IV. Data analysis

*All data*

Surveys conducted on the last data (May 18) were not included in the analysis as they were not part of the original random selection. Means and standard error (SE) were calculated for community metrics (Table 1) and select species density/biomass using the survey package in R. Sample weights (W) for each stratum (h) were calculated for each survey as $W_h = N/N_h$, where N is the total number of grid cells in each stratum. Summary statistics were calculated for the overall study area, by habitat-zone, and by habitat-depth. The original mapped habitat was used (i.e., no post-stratification based on diver observation). Data were also plotted in ArcGIS for visual display.

# V. Fish Results

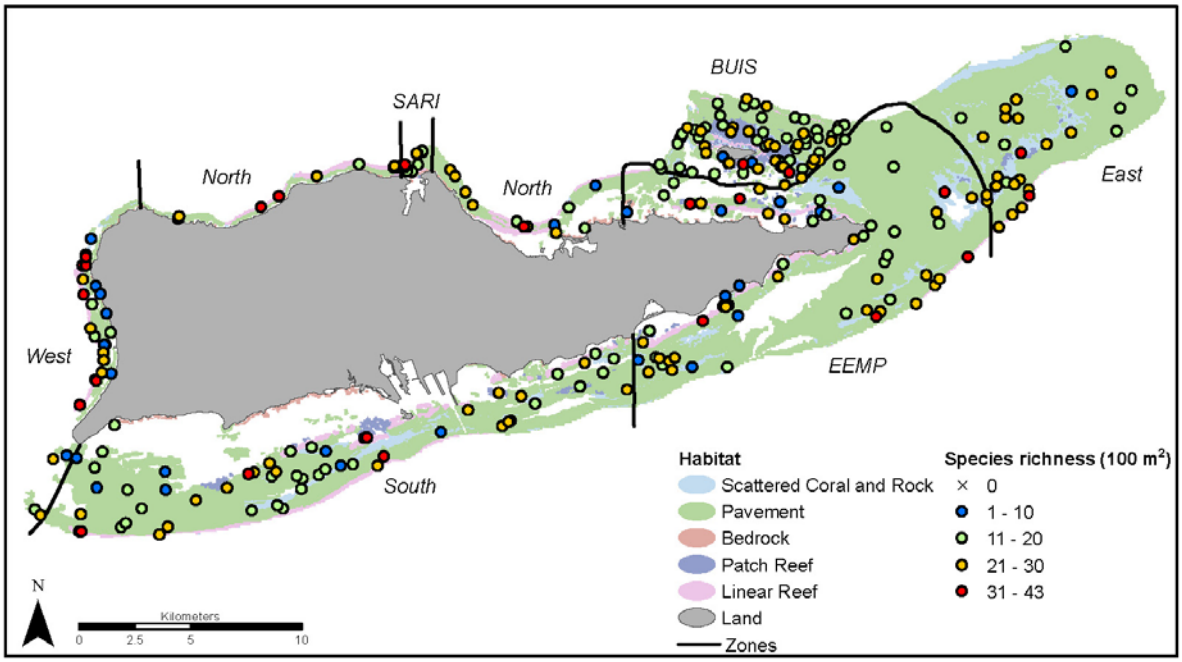
Table 2 displays the island-wide values for select metrics for all strata combined. The preceding pages will display these metrics according to various combinations of strata.

**Table 2. Overall mean and SE for select community metrics.**

| Metric | Mean (SE) |
|---|---|
| Species richness | 19.95 (0.52) |
| Total biomass | 8531.87 (1383.53) |
| Total density | 198.54 (8.56) |
| Herbivore density | 84.08 (3.82) |
| Invertivore density | 88.55 (3.95) |
| Piscivore density | 4.27 (1.27) |
| Planktivore density | 21.63 (3.05) |
| Herbivore biomass | 2867.93 (387.94) |
| Invertivore biomass | 4928.54 (1325.58) |
| Piscivore biomass | 555.1 (125.31) |
| Planktivore biomass | 180.3 (50.21) |
| Grouper density | 2.67 (0.23) |
| Snapper density | 0.71 (0.22) |
| Parrotfish density | 17.97 (1.27) |
| Grouper biomass | 245.43 (29.27) |
| Snapper biomass | 131.03 (37.9) |
| Parrotfish biomass | 1157 (149.38) |

*Species richness*

Observed species richness ranged from 0-43 species/ 100 $m^2$ (Figure 3a). Region-wide, mean species richness was highest in the East region (21.7 ± 0.9) and lowest in SARI (17.2 ± 1.5) (Table 1). In most regions, mean richness was greater on the more complex habitats (patch reef and linear reef) (Figure 3b). Mean richness was generally similar across depth strata, although slightly higher on deep linear reefs compared to shallow (Figure 3c).



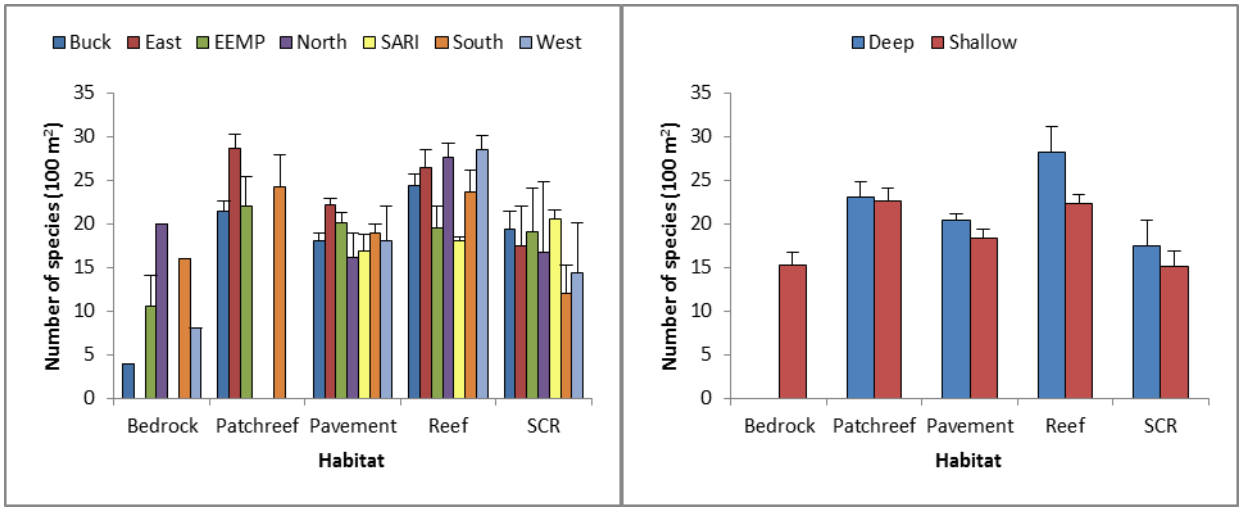
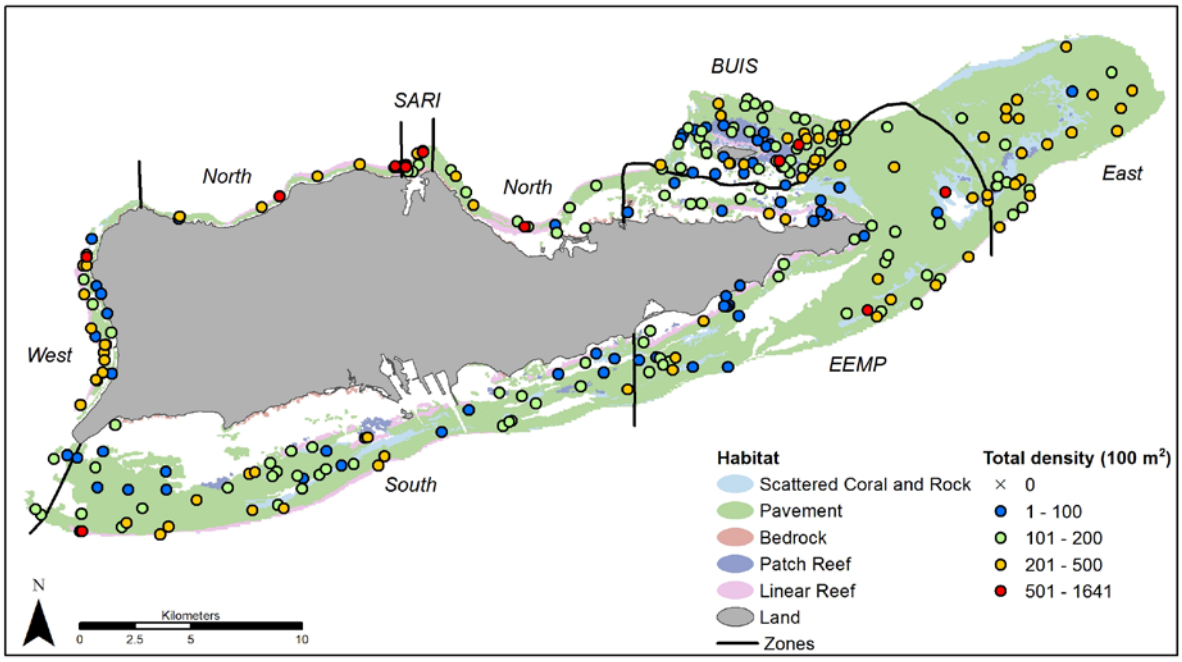




Figure 3. a) Observed species richness, b) mean (± SE) richness by zone and habitat, and c) mean (± SE) richness by depth and habitat.

*Total fish density*

Total fish density ranged from 0-1,641 individuals/ 100 $m^2$ (Figure 4a). Sites with the highest observed density were frequently characterized by large abundances of damselfish (Family Pomacentridae) and wrasses (Family Labridae). Overall, mean density was highest in the SARI and East strata and lowest in the South strata, however there was considerable variability among some region-habitat combinations (e.g., SARI pavement, North reef) (Figure 4b). Mean densities were higher in the deep strata with the exception of patch reef (Figure 4c).



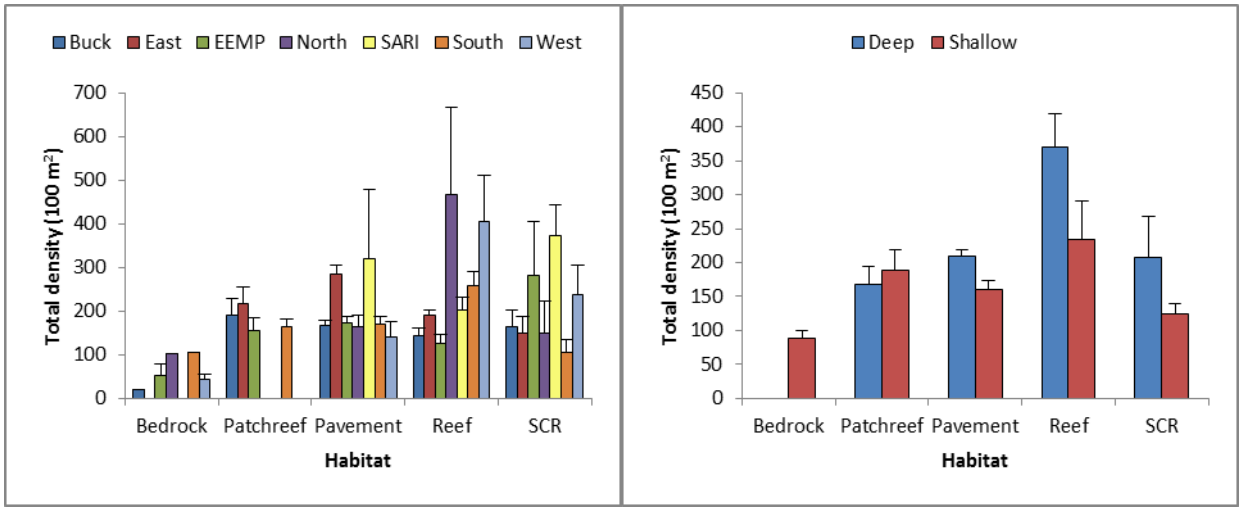




Figure 4. a) Observed total fish density, b) mean (± SE) total density by zone and habitat, and c) mean (± SE) total density by depth and habitat.

*Total fish biomass*

Observed total fish biomass ranged from 0-247,598.5 g/100m$^2$ (Figure5a). The occasional presence of large predators contributed to large variability in some strata. For example, the two sites with the highest observed biomass were characterized by the presence of a nurse shark (*Ginglymostoma cirratum*) and Southern stingray (*Dasyatis americana*), respectively. Mean biomass was similar across depths with the exception of linear reef, where mean biomass for deep reef was nearly three times that observed on shallow reef (Figure 5c).

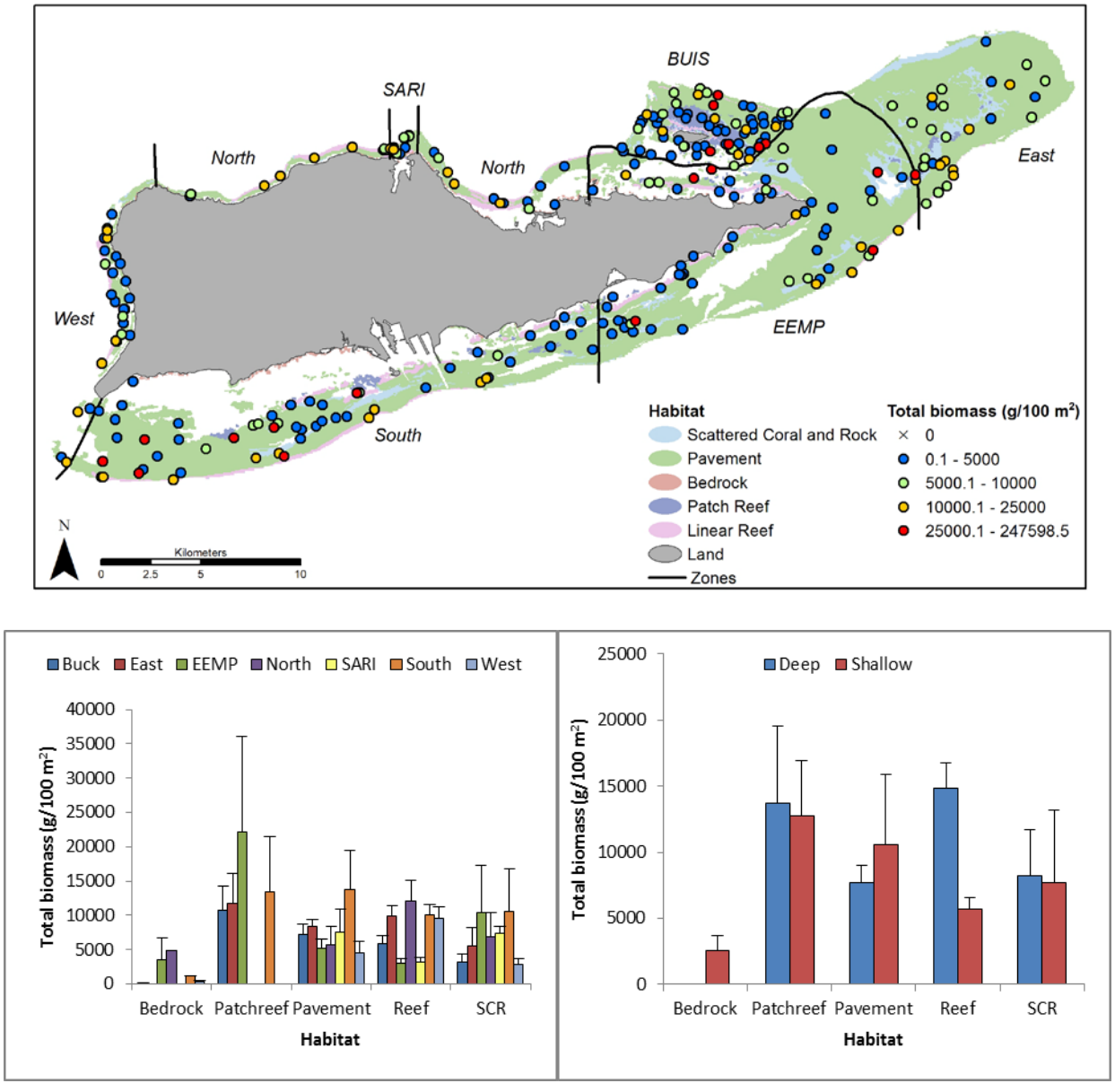
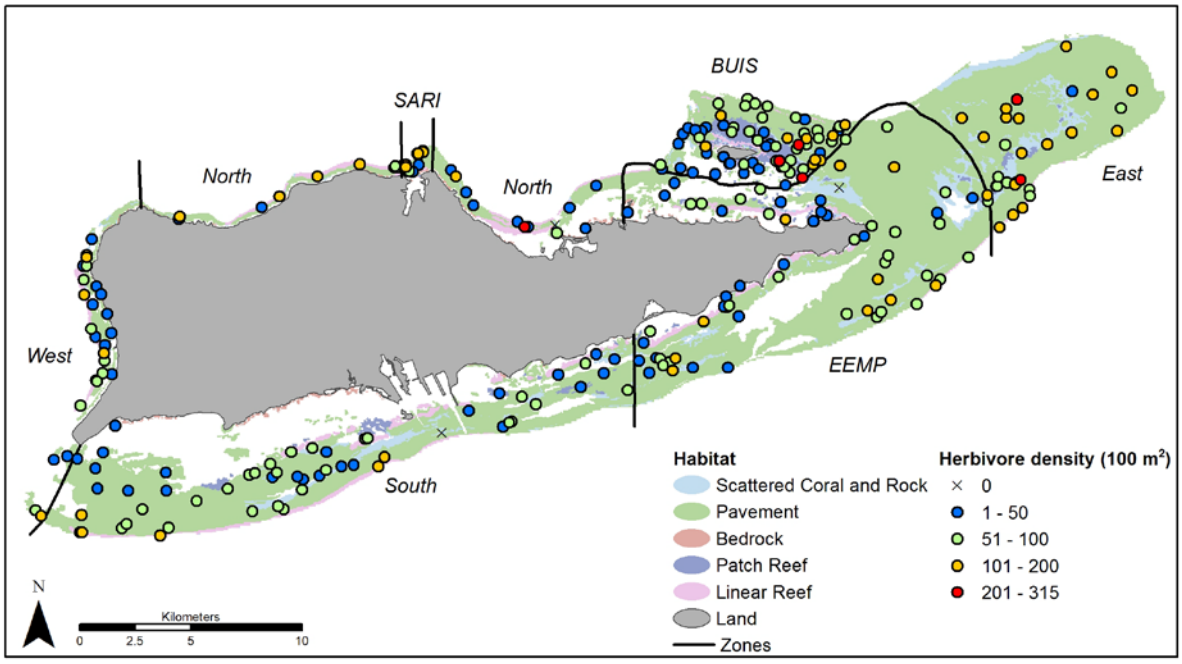



Figure 5. a) Observed total fish biomass, b) mean (± SE) total biomass by zone and habitat, and c) mean (± SE) total biomass by depth and habitat.

*Herbivores*

Total herbivore (e.g., parrotfish, damselfish) density ranged from 0-315 individuals /100m$^2$ (Figure 6a). Five of the top ten sites in herbivore density were located in the East region. This region was also characterized by the highest mean density and biomass of herbivores (Table 3). With the exception of patch reefs, densities tended to be higher in the deeper strata (Figure 6c).



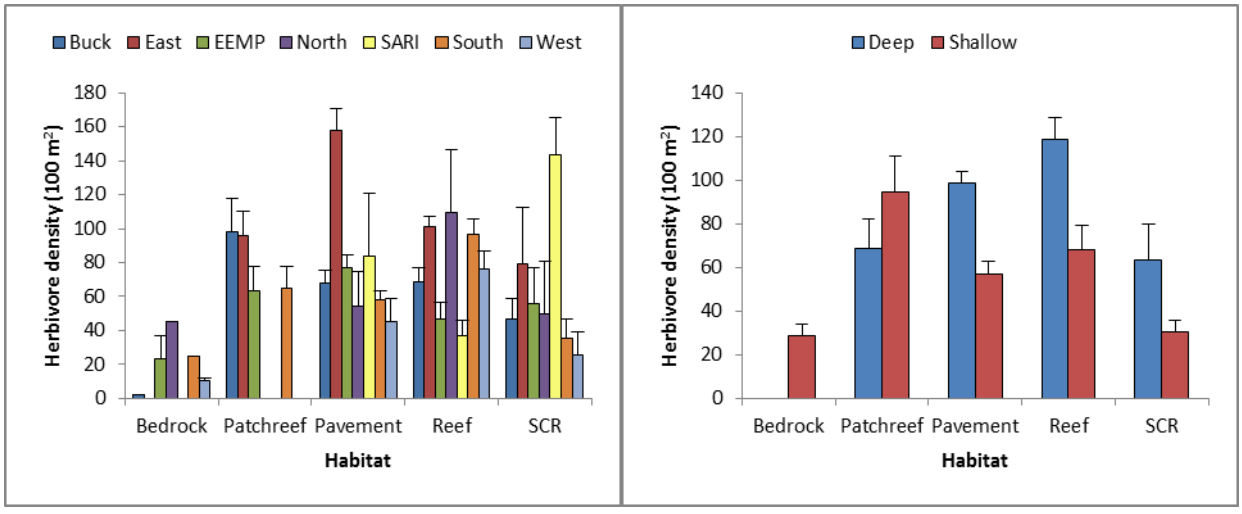




Figure6. a) Observed herbivore density, b) mean (± SE) herbivore density by zone and habitat, and c) mean (± SE) herbivore density by depth and habitat.

Herbivore biomass followed similar spatial patterns to that of density (Figure 7a). Biomass by habitat type (Figure 7b) and depth strata (7c) were also similar.

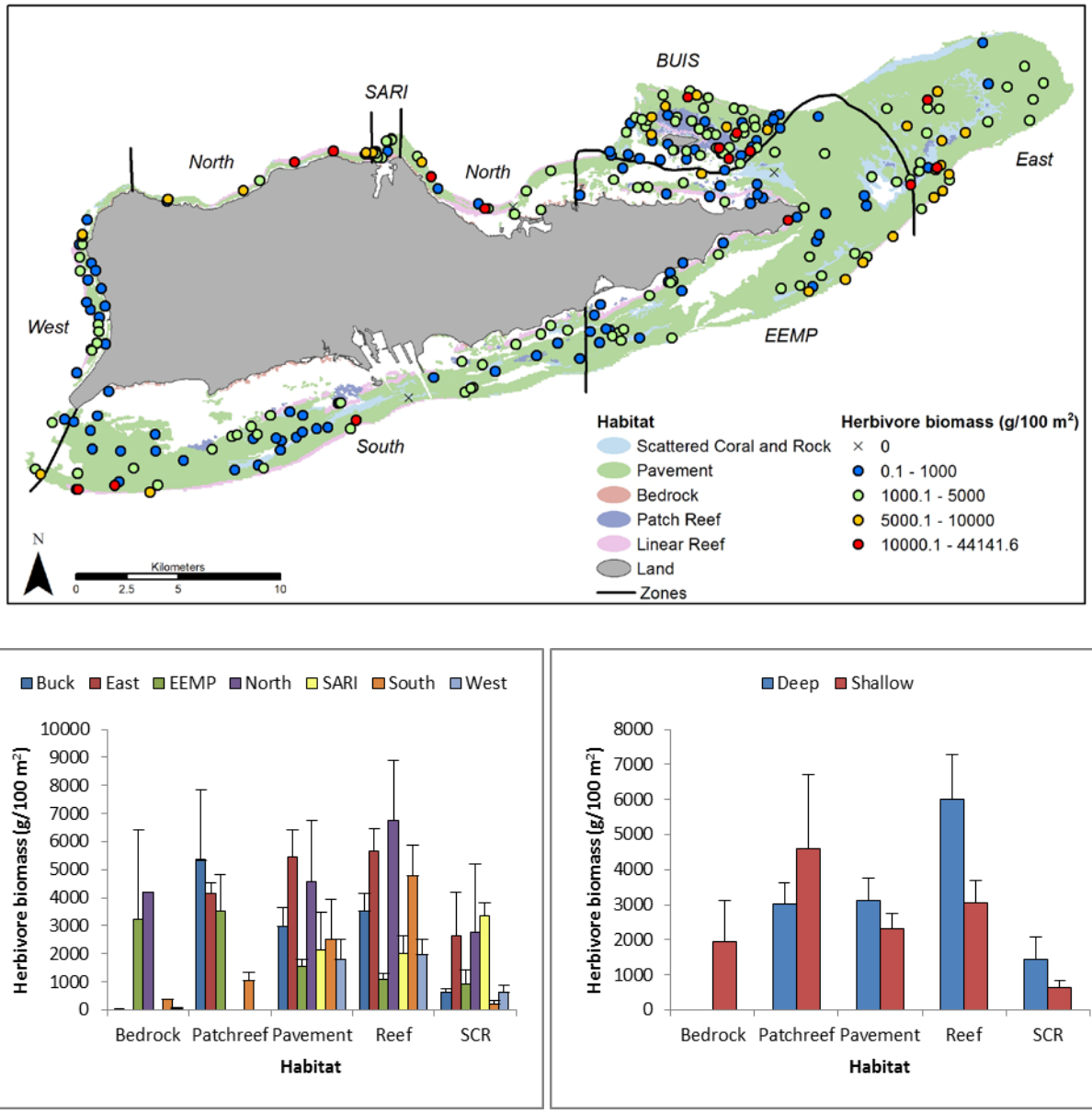
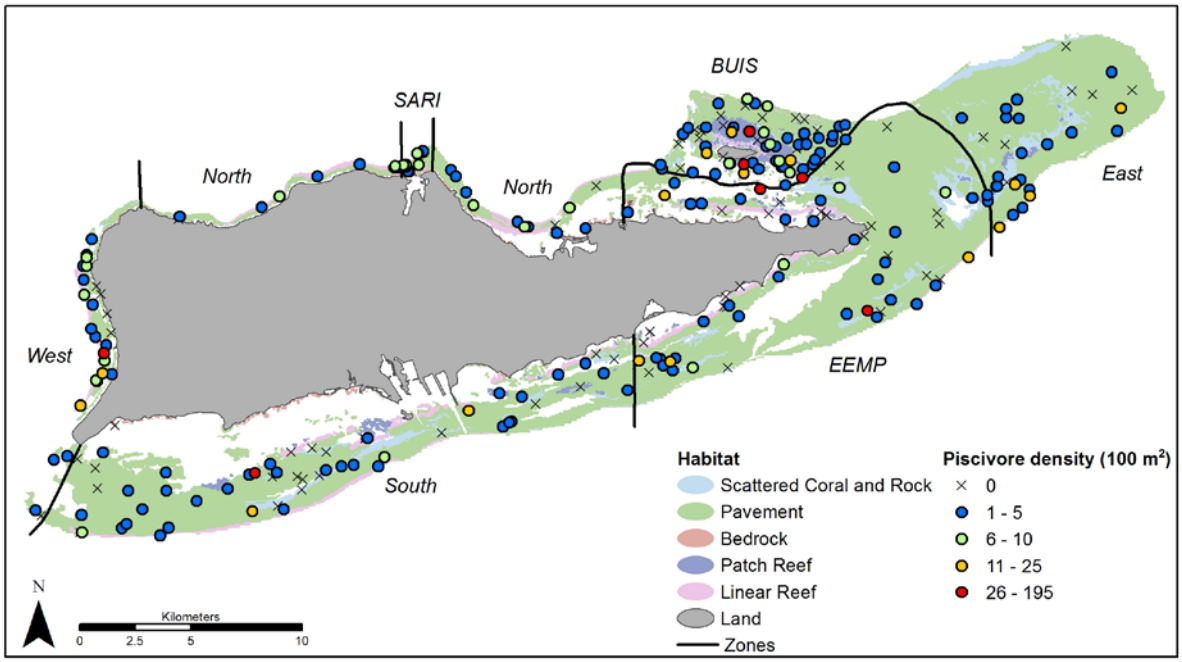



Figure 7. a) Observed herbivore biomass, b) mean (± SE) herbivore biomass by zone and hab

itat, and c) mean (± SE) herbivore biomass by depth and habitat.

*Piscivores*

Piscovre (e.g., snapper, grouper) density ranged from 0-195 individuals /100 $m^2$ (Figure 8a). The site with the highest observed piscivore density, which was primarily comprised of a school ofsmall flat needlefish (*Ablennes hians*), was located on deep scattered coral and rock habitat in the EEMP. In all other strata, mean density did not exceed 10 individuals per 100$m^2$ (Figure 8b, 8c).



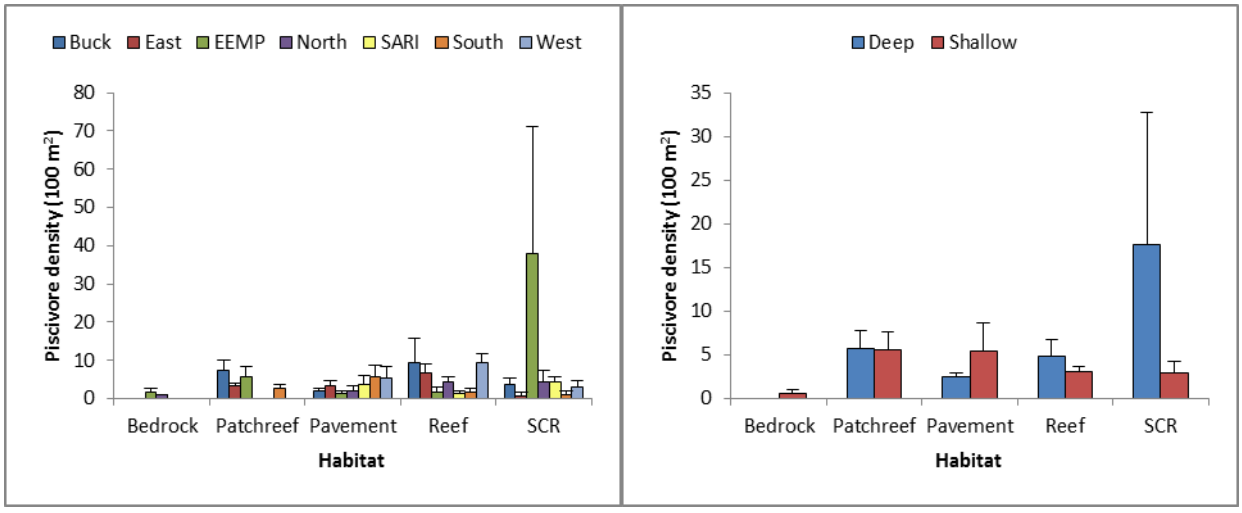




Figure8. a) Observed piscivore density, b) mean (± SE) piscivore density by zone and habitat, and c) mean (± SE) piscivore density by depth and habitat.

The site with the largest piscivore biomass, located in deep pavement habitat in BUIS (Figure 9a), was characterized by the presence of several large great barracuda. Biomass was similar across most habitat types (Figure 9b) but was generally greater on deeper habitats (>13 m; Figure 9c).

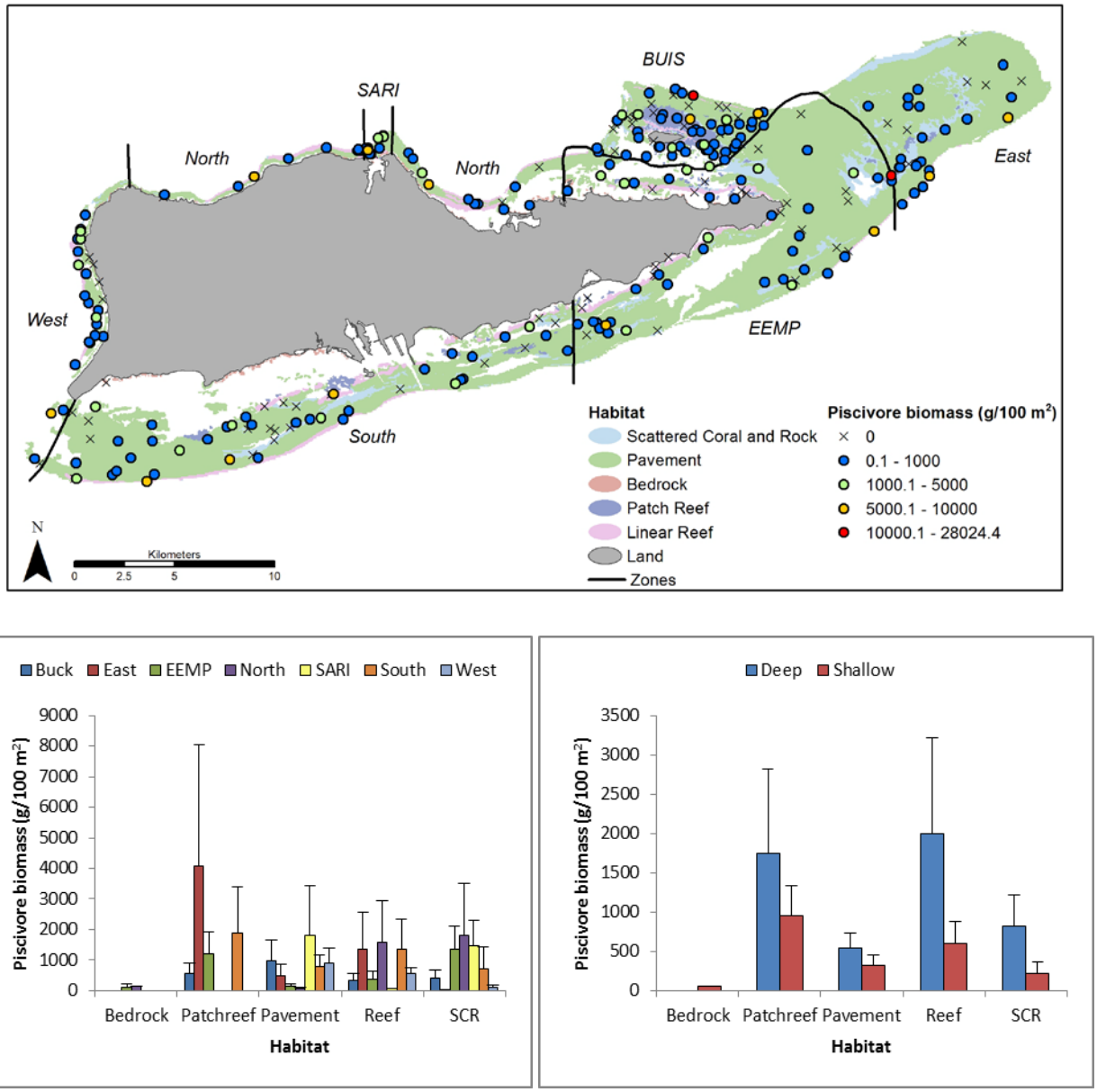
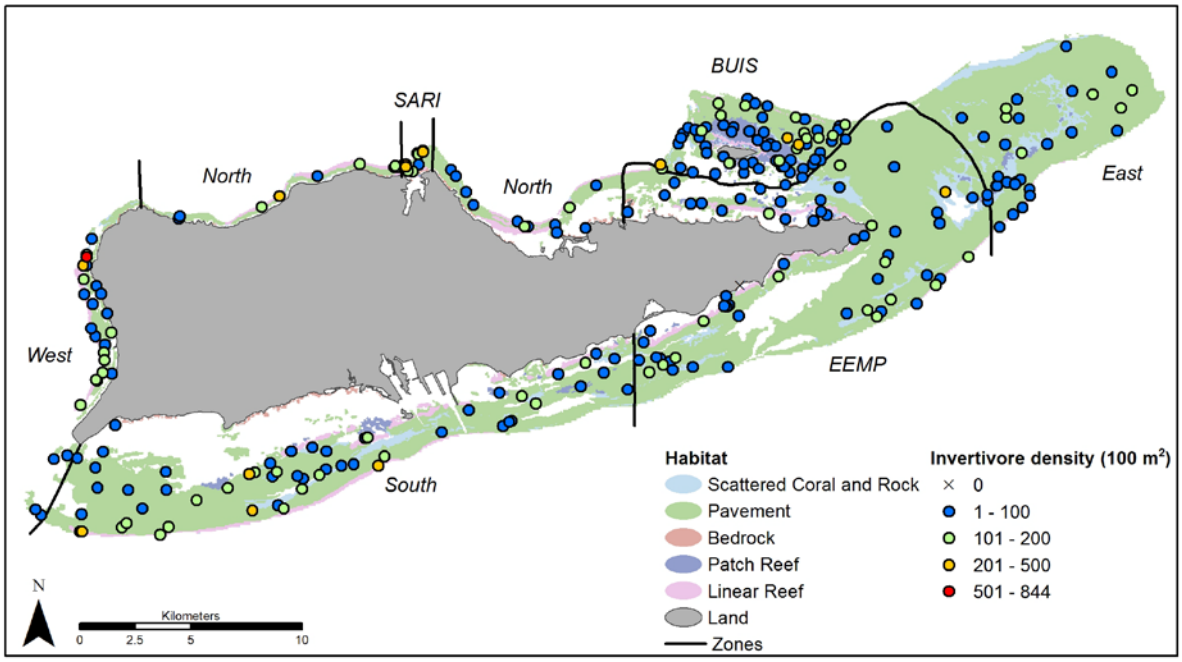



Figure 9. a) Observed piscivore biomass, b) mean (± SE) piscivore biomass by zone and habitat, and c) mean (± SE) piscivore biomass by depth and habitat.

*Invertivores*

Invertivore (e.g., grunts, butterflyfishes) density ranged from 0-844 individuals per 100 $m^2$ (Figure 10a), while biomass ranged from 0.1-247,186 g per 100 $m^2$. Fish density and biomass within this trophic group were similar across all regions, habitats (Figures 10b and 11b) and depths (Figures 10c and 11c). Invertivore biomass tended to be higher on south shore pavement and scattered coral and rock habitats (Figures 11a, b).



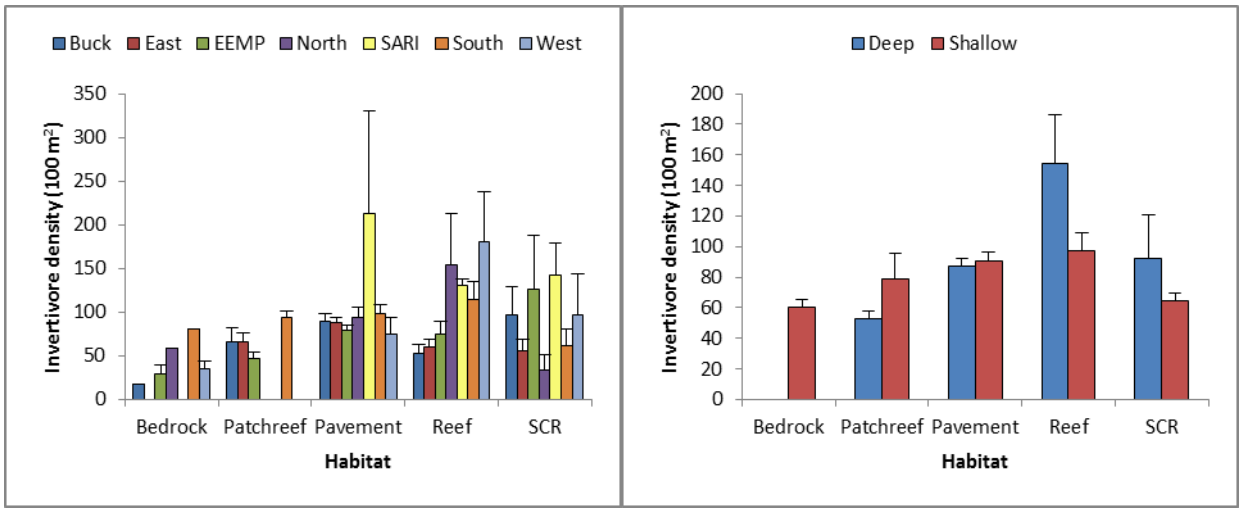
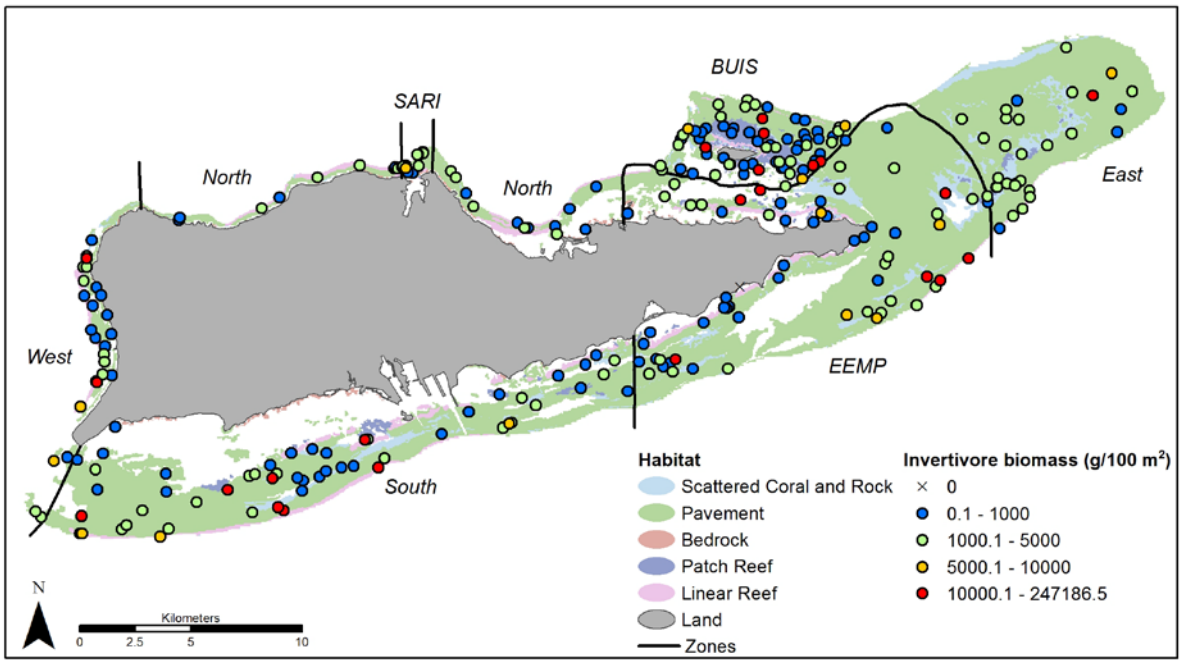
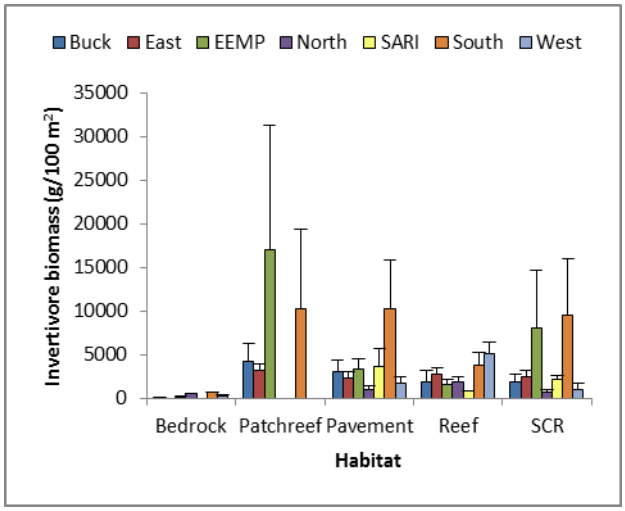




Figure 10. a) Observed invertivore density, b) mean (± SE) invertivore density by zone and habitat, and c) mean (± SE) invertivore density by depth and habitat.



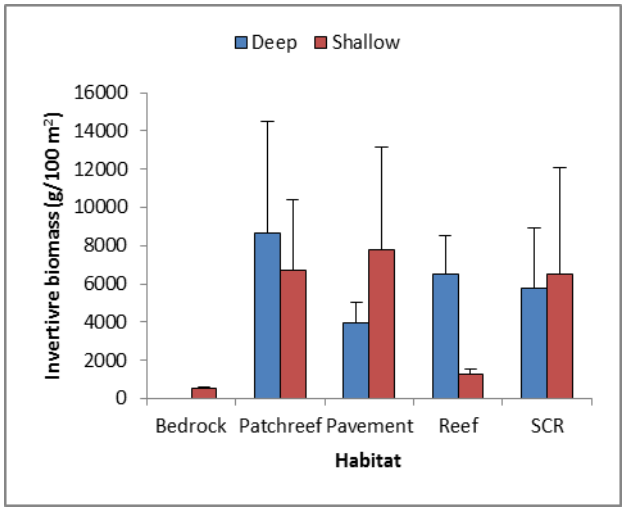




Figure11. a) Observed invertivore biomass, b) mean (± SE) invertivore biomass by zone and habitat, and c) mean (± SE) invertivore biomass by depth and habitat.

*Planktivores*

Planktivore (e.g., herring) densities were typically observed in densities ≤100 individuals /100 $m^2$, but were occasionally present in large numbers, up to 983 individuals / 100 $m^2$ (Figure 12a). Sites with highest observed density and biomass of planktivores were most frequently located in the North and West regions, but there was also a high degree of variability in these regions (Figures 12a and 13a).

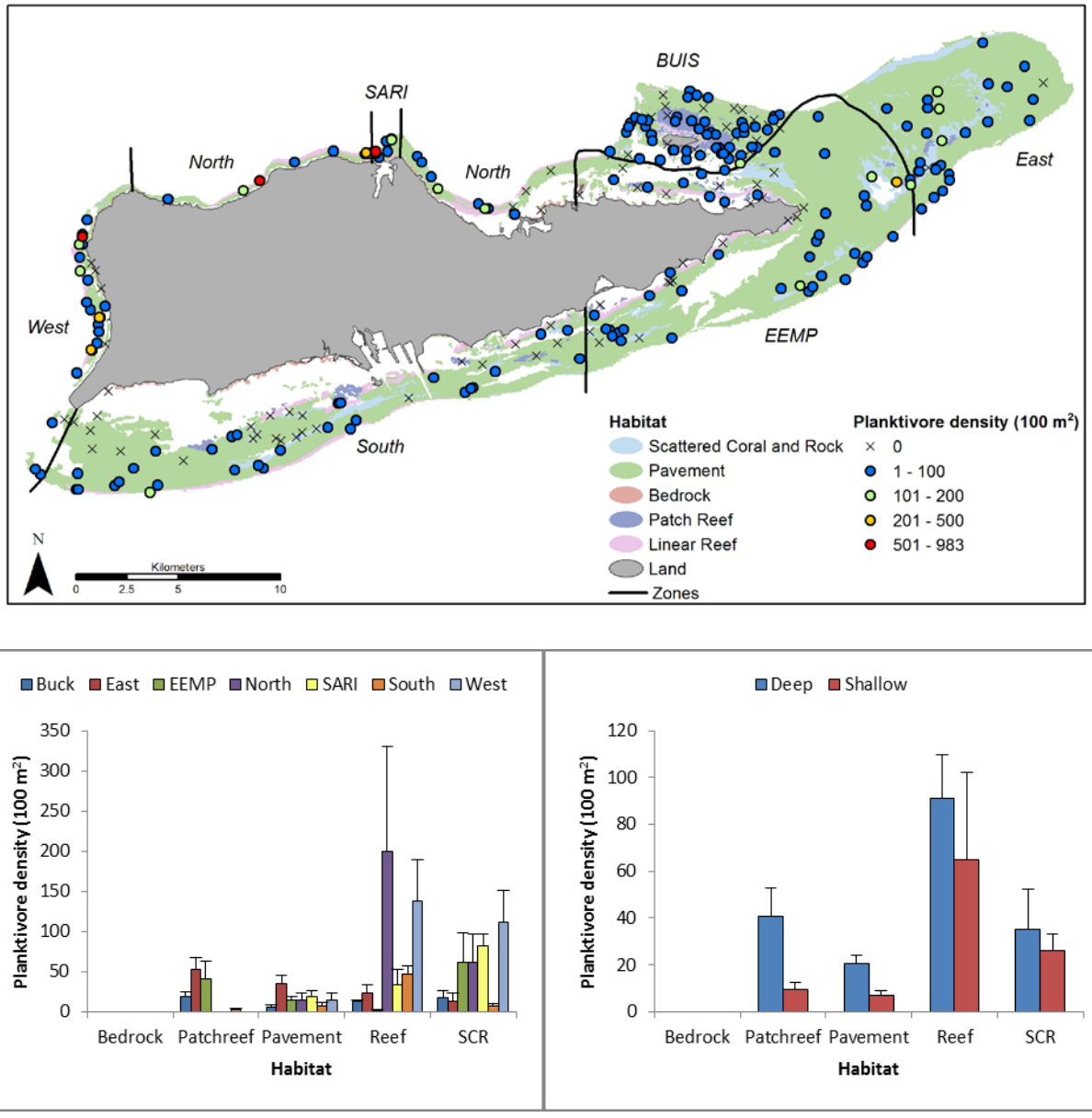



Figure 12. a) Observed planktivore density, b) mean (± SE) planktivore density by zone and habitat, and c) mean (± SE) planktivore density by depth and habitat.

Density and biomass were greater on linear reef and scattered coral and rock habitats (Figures 12b and 13b). Density was generally higher on deeper habitats (12c) while biomass was greater on shallow habitats (13c).

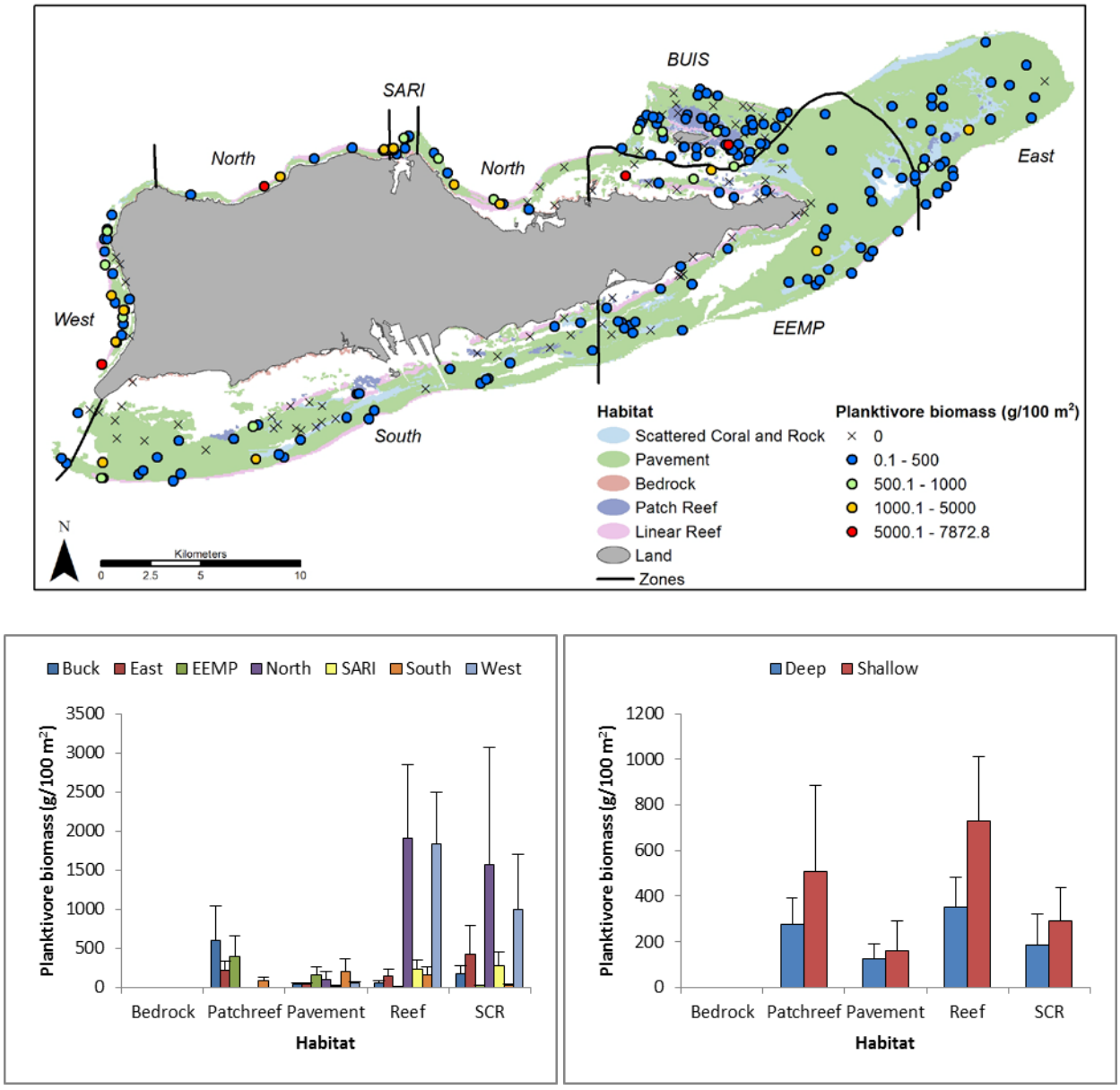



Figure 13. a) Observed planktivore biomass, b) mean (± SE) planktivore biomass by zone and habitat, and c) mean (± SE) planktivore biomass by depth and habitat.

*Groupers*

Groupers (*Mycteroperca*, *Epinephelus*, and *Cephalopholis* sp.) were present in approximately two-thirds of survey transects, occurring in densities up to 18 individuals /100m$^2$ (Figure 14a).Both mean grouper density and biomass were highest in the East region (Figures 14b and 15b), while SARI ranked last (Table 3). Density and biomass also tended to be higher in deeper strata in comparison to shallow (Figures 14c and 15c). One yellowfin grouper (*Mycteroperca venenosa*) was observed on a patch reef in the East region; all other observed individuals belonged to the *Epinephelus* or *Cephalopholis* genus.

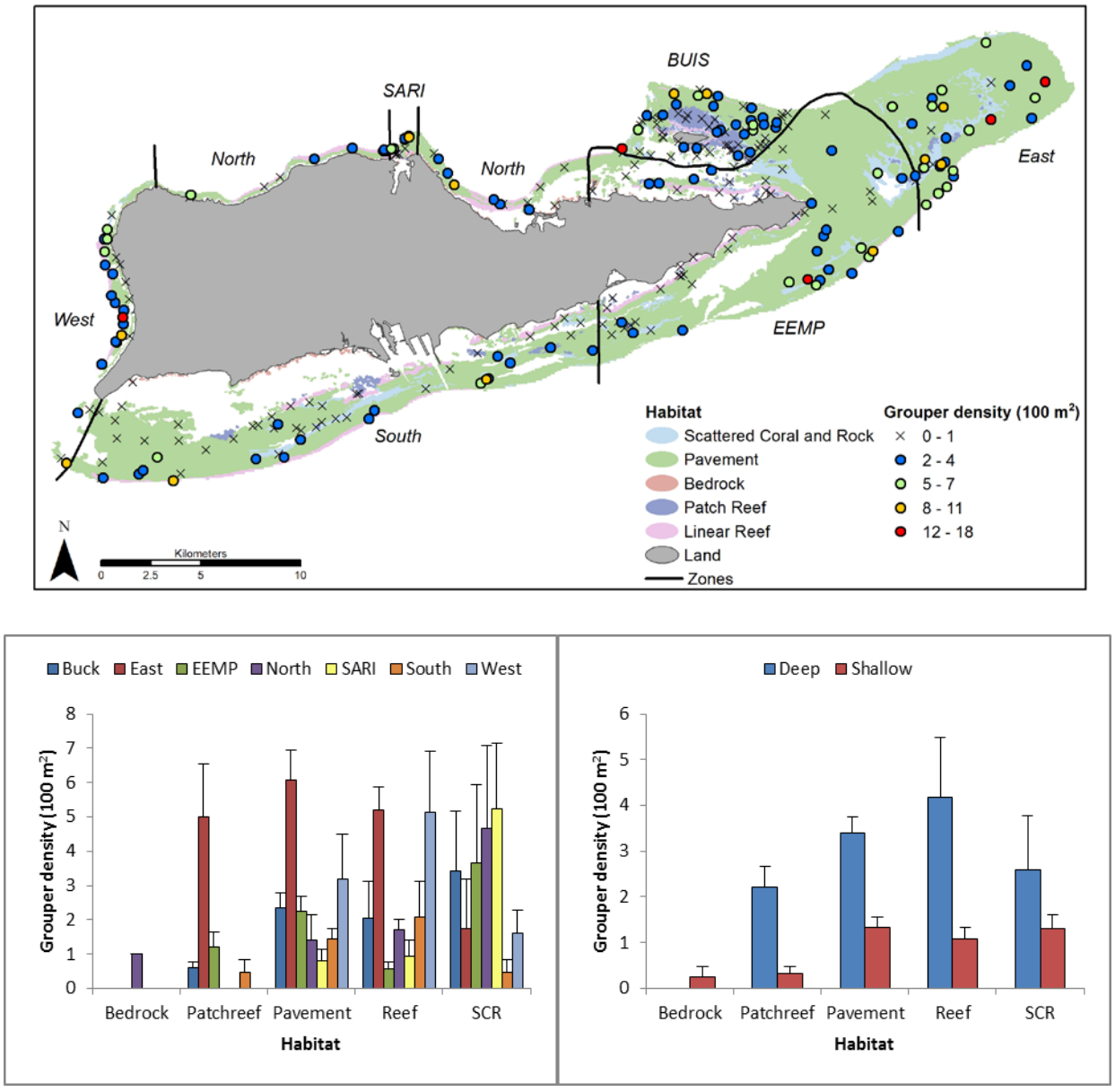
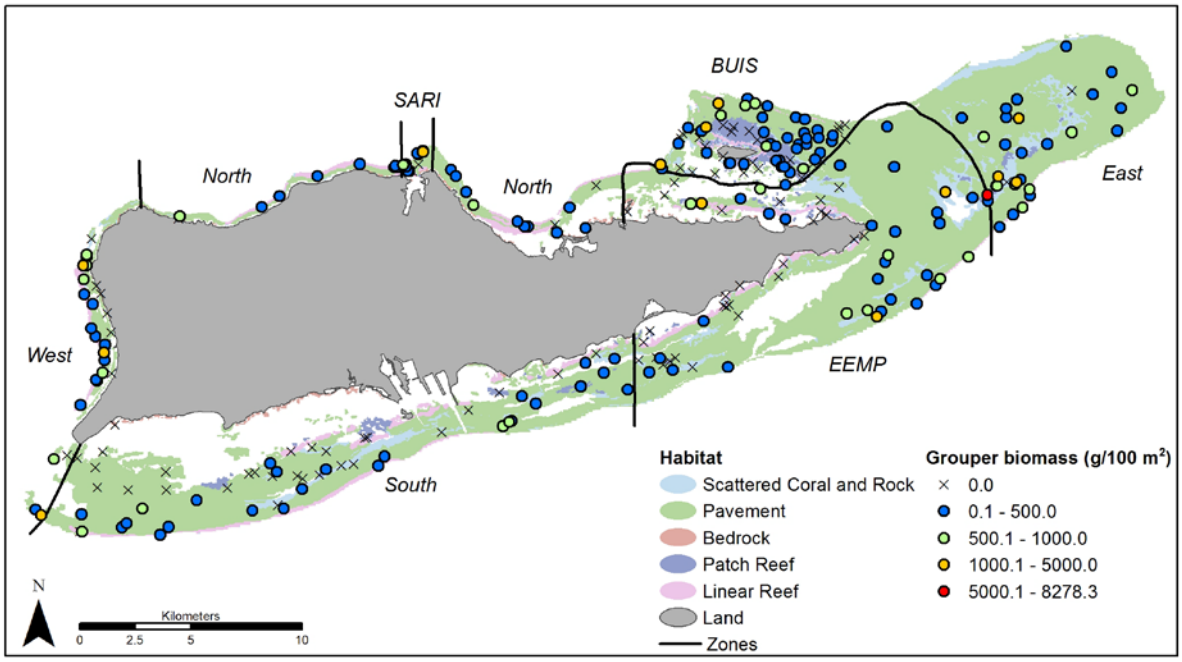
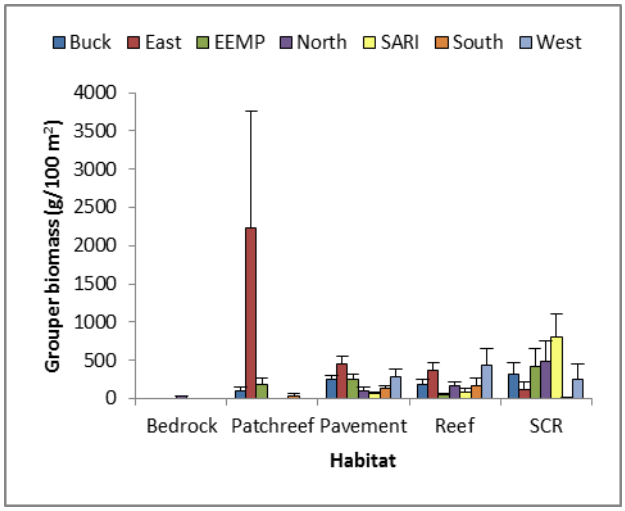



Figure 14. a) Observed grouper density, b) mean (± SE) grouper density by zone and habitat, and c) mean (± SE) grouper density by depth and habitat.



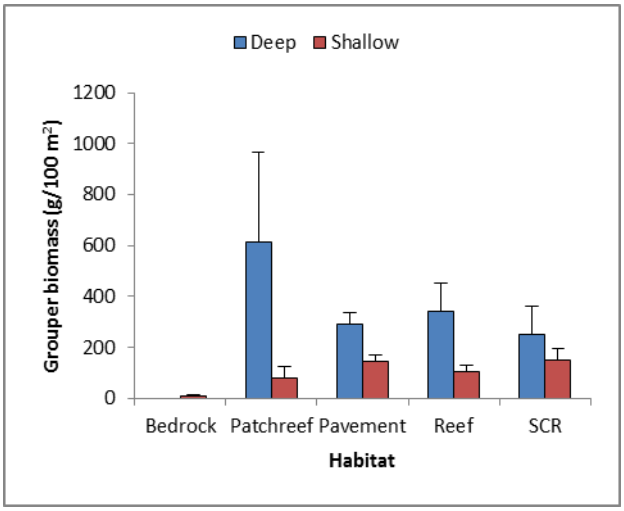
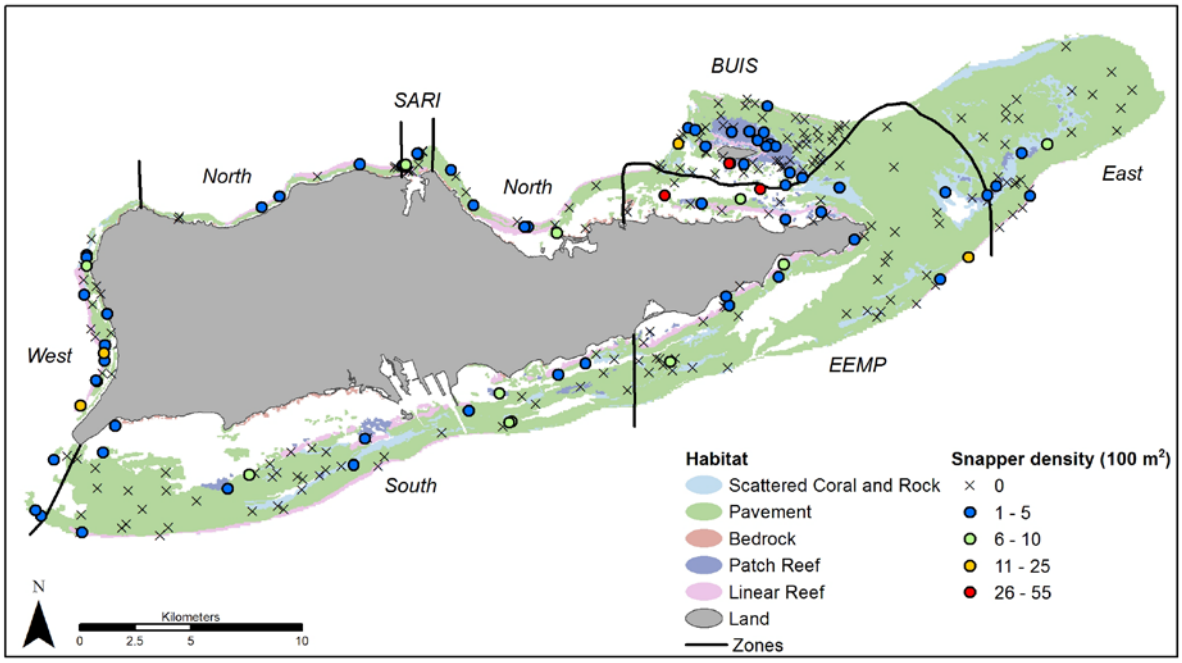




Figure 15. a) Observed grouper biomass, b) mean (± SE) grouper biomass by zone and habitat, and c) mean (± SE) grouper biomass by depth and habitat.

*Snappers*

Snappers occurred in 29% of survey transects across St. Croix and were generally observed in low densities. Densities of ≥10 individuals/ 100 $m^2$ occurred at only eight sites. The three sites with the highest observed densities were located between NE St. Croix and Buck Island (Figure 16a). Several species (muitton, gray, mahoghany) were present at the site with the highest observed biomass, which was located on shallow reef habitat in the West region (Figure Xa). No clear patterns were observed for snapper biomass and density on habitat types (Figures 16b and 17b) and depth (Figures 16c and 17c).



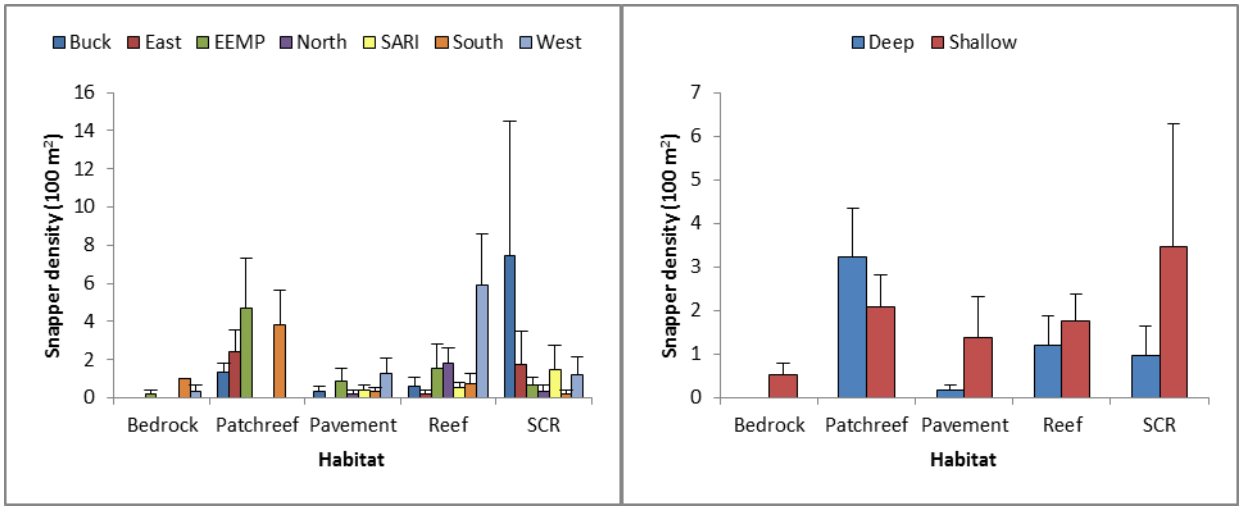




Figure 16. a) Observed snapper density, b) mean (± SE) snapper density by zone and habitat, and c) mean (± SE) snapper density by depth and habitat.

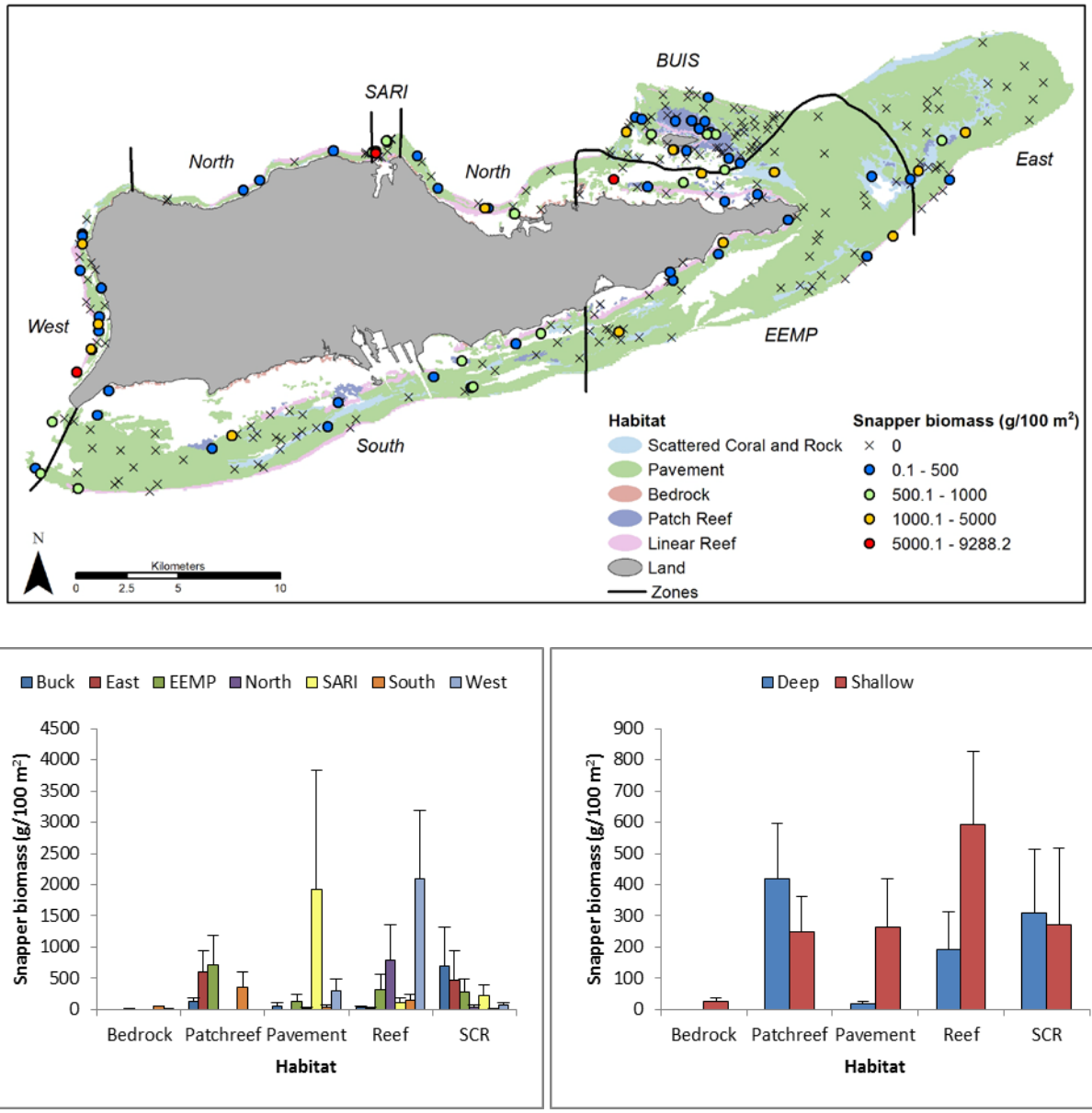
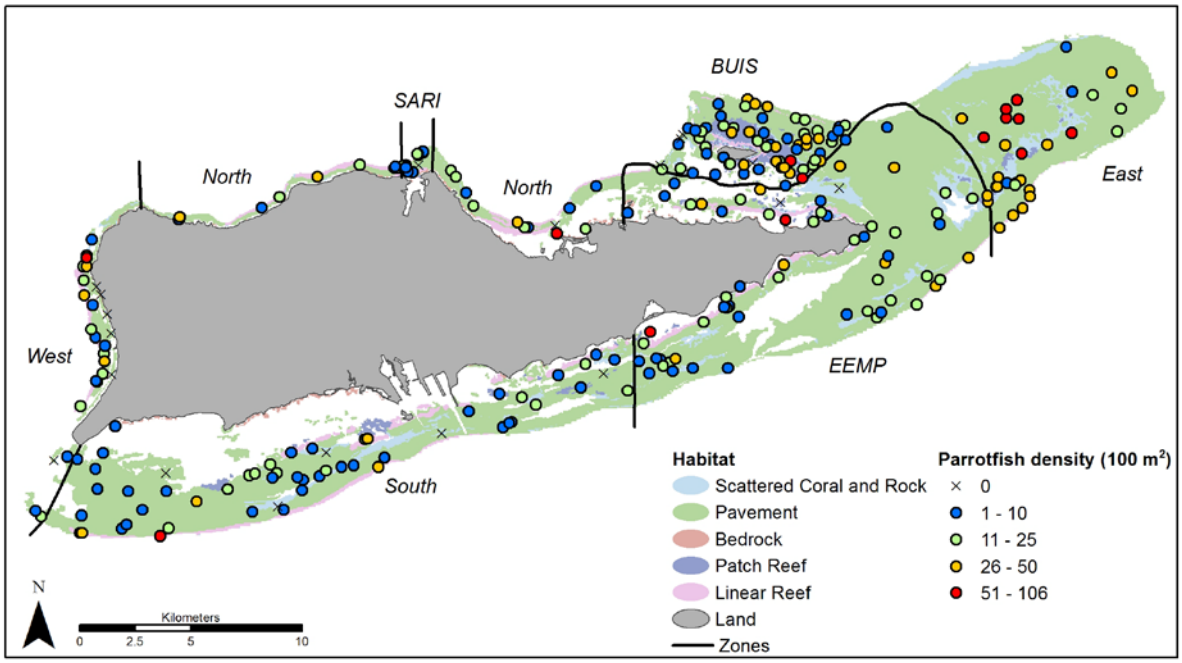



Figure 17. a) Observed snapper biomass, b) mean (± SE) snapper biomass by zone and habitat, and c) mean (± SE) snapper biomass by depth and habitat.

*Parrotfish*

Parrotfish density ranged from 0-106 inividuals /100 $m^2$ (Figure 18a). Both mean parrotfish density and biomass were highest in the East region, followed by BUIS and the North regions, respectively. Densities were similar among depth strata on patch reefs (Figure 18c), but tended to be higher in deep pavement and reef strata compared to shallow (Figure 18b). Higher parrotfish biomass was more frequently accociated with deeper strata across all habitats (Figures 19 b and c) and predominantly in the East.



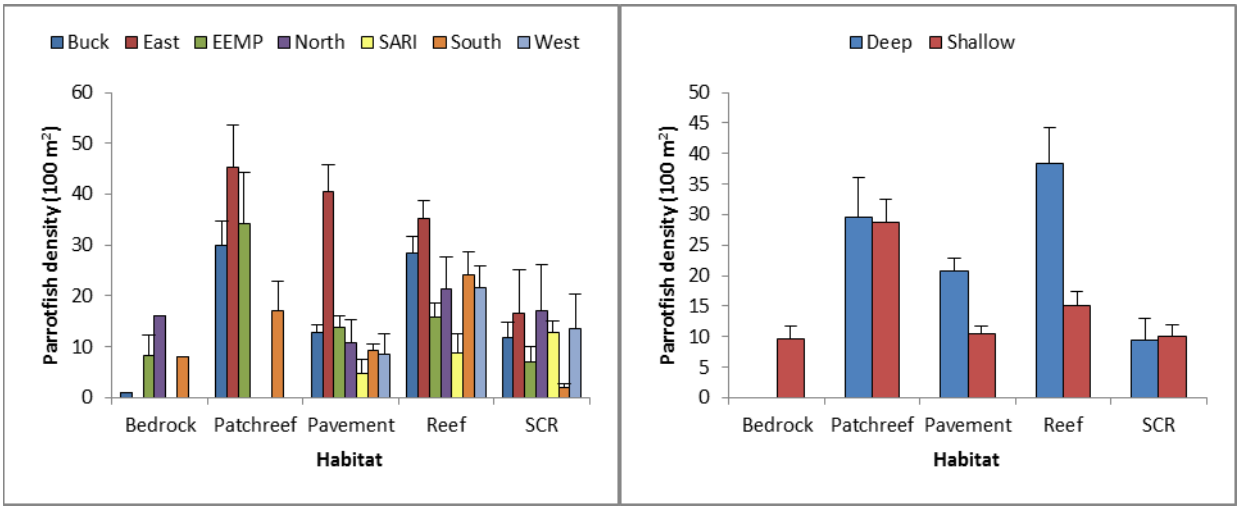




Figure 18. a) Observed parrotfish density, b) mean (± SE) parrotfish density by zone and habitat, and c) mean (± SE) parrotfish density by depth and habitat.

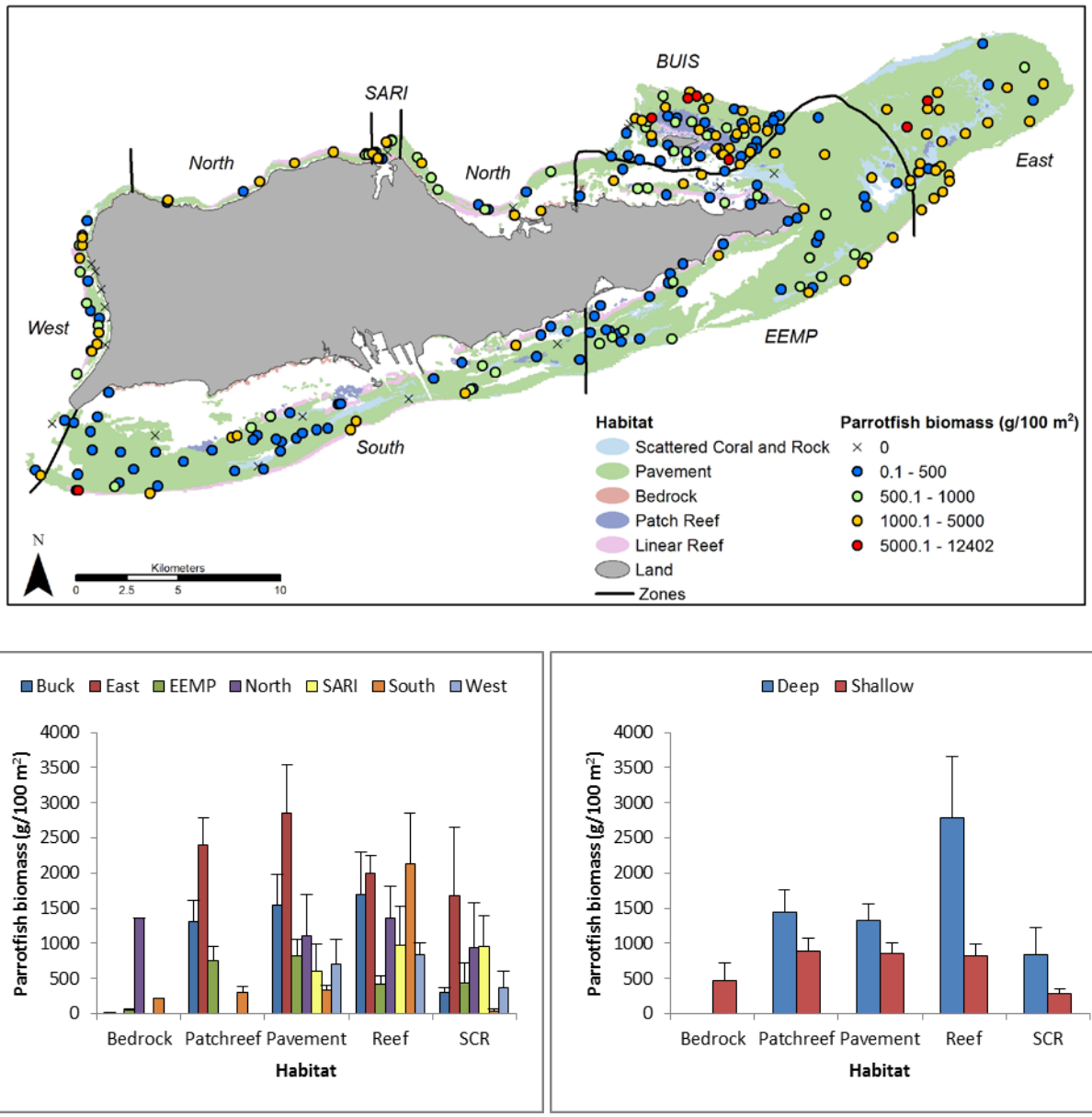



Figure 19. a) Observed parrotfish biomass, b) mean (± SE) parrotfish biomass by zone and habitat, and c) mean (± SE) parrotfish biomass by depth and habitat.

Table 3. Rank of regions by the mean value of select community metrics. 1=highest, 7=lowest.

| Metric | Zone | | | | | | |
|---|---|---|---|---|---|---|---|
| | Buck | East | EEMP | North | SARI | South | West |
| Species richness | 5 | **1** | 2 | 4 | 7 | 6 | 3 |
| Total density | 6 | 2 | 5 | 3 | **1** | 7 | 4 |
| Total biomass | 3 | 2 | 6 | 4 | 5 | **1** | 7 |
| Piscivore density | 4 | 6 | 3 | 7 | 5 | 2 | **1** |
| Piscivore biomass | 3 | 6 | 7 | 5 | **1** | 2 | 4 |
| Herbivore density | 3 | **1** | 4 | 5 | 2 | 6 | 7 |
| Herbivore biomass | 3 | **1** | 7 | 2 | 5 | 4 | 6 |
| Invertivore density | 6 | 5 | 7 | 2 | **1** | 4 | 3 |
| Invertivore biomass | 3 | 5 | 2 | 7 | 4 | **1** | 6 |
| Planktivore density | 6 | 3 | 5 | **1** | 4 | 7 | 2 |
| Planktivore biomass | 4 | 6 | 5 | 1 | 7 | 3 | 2 |
| Grouper density | 4 | **1** | 3 | 5 | 7 | 6 | 2 |
| Grouper biomass | 4 | **1** | 3 | 6 | 7 | 5 | 2 |
| Parrotfish density | 2 | **1** | 4 | 3 | 7 | 6 | 5 |
| Parrotfish biomass | 2 | **1** | 4 | 3 | 5 | 7 | 6 |
| Snapper density | 2 | 7 | 3 | 4 | 6 | 5 | **1** |
| Snapper biomass | 5 | 6 | 4 | 3 | **1** | 7 | 2 |
| **Mean** | 3.82 | 3.23 | 4.76 | 3.82 | 4.4 | 4.64 | 3.70 |

*Lionfish*

The invasive Red lionfish, *Pterois volitans*, was observed at 8% of the survey sites (n=23). Overall there were 38 individuals observed on transects ranging in size from 7-33 mm (FL). Most lionfish observations occurred at sites greater than 10 m. Lionfish sightings occurred in all regions around the island with no apparent spatial patterns. Approximately half of the lionfish abundance occurred within MPAs.

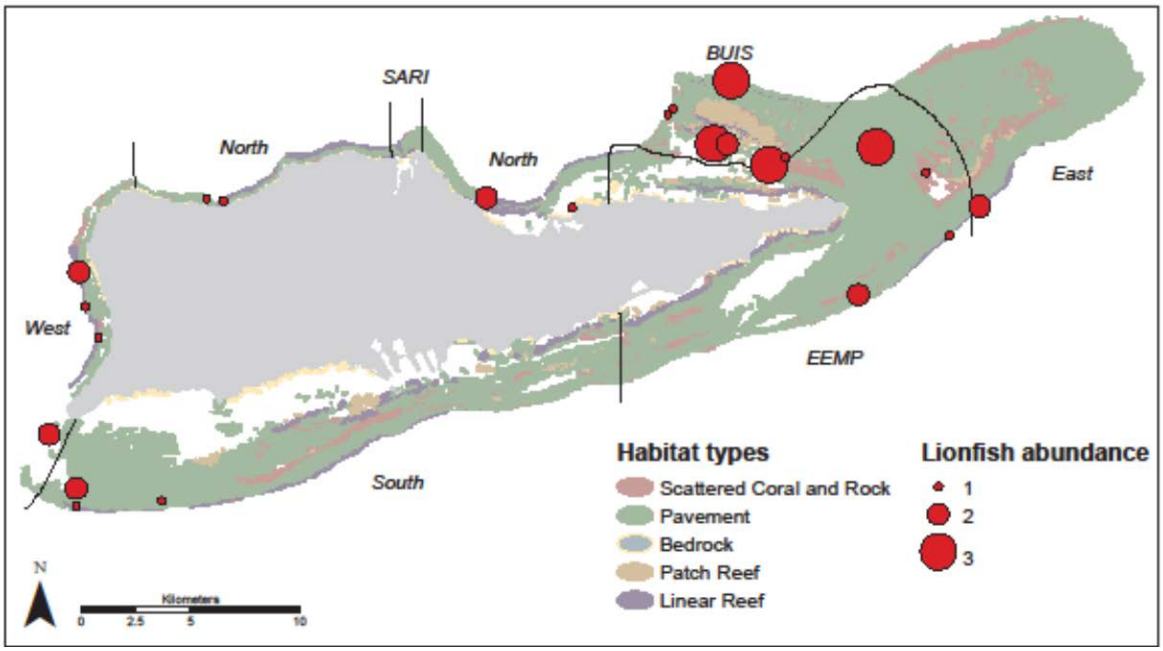



**Figure 20.** Spatial distribution of lionfish sightings and numbers of individuals observed.

**Benthic Results**

Table 4 displays the island-wide values for benthic metrics for all strata combined. The preceding pages will display these metrics according combinations of region, habitat type and depth strata.

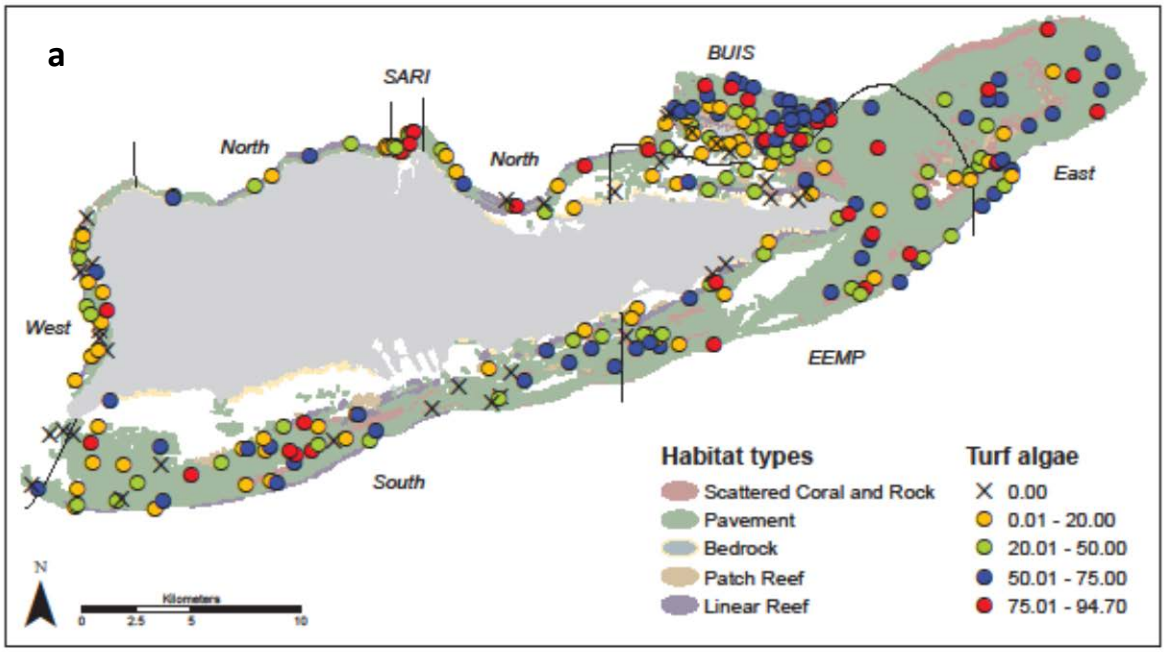
**Table 4.** Overall mean and SE for select benthic community metrics.

| Benthic group | **Mean** | **SE** |
|---|---|---|
| turf algae | 46.55 | 2.46 |
| bare | 27.54 | 2.51 |
| macroalgae | 15.64 | 1.73 |
| total coral cover | 3.41 | 0.25 |
| total sponge | 2.43 | 0.18 |
| crustose coralline algae | 1.14 | 0.13 |
| cyano | 0.97 | 0.20 |
| gorgonians | 0.96 | 0.15 |
| seagrasses | 0.94 | 0.30 |
| hydrocorals | 0.21 | 0.03 |
| tunicates | 0.08 | 0.04 |
| zoanthids | 0.07 | 0.02 |
| rhodoliths | 0.03 | 0.02 |
| anemones | >0.01 | >0.01 |
| hydroids | >0.01 | >0.01 |

Turf algae was overwhelmingly the most abundant benthic group in terms of percent cover, followed by macroalgae, coral, sponge, and crustose coralline algae (CCA). Approximately 27% of sites were comprised of bare substate. Other benthic groups comprised less than 1% of the benthic biota.

*Turf algae*

Turf algae was present on 87% of surveys and percent cover was greater than 20% on the majority of surveys. No obvious spatial patterns were observed (Figure 21a) and no distinct patterns were observed between depth strata (Figure 21b) and most habitat types (Figure 21c). In general, turf algae was less abundant on bedrock habitats.



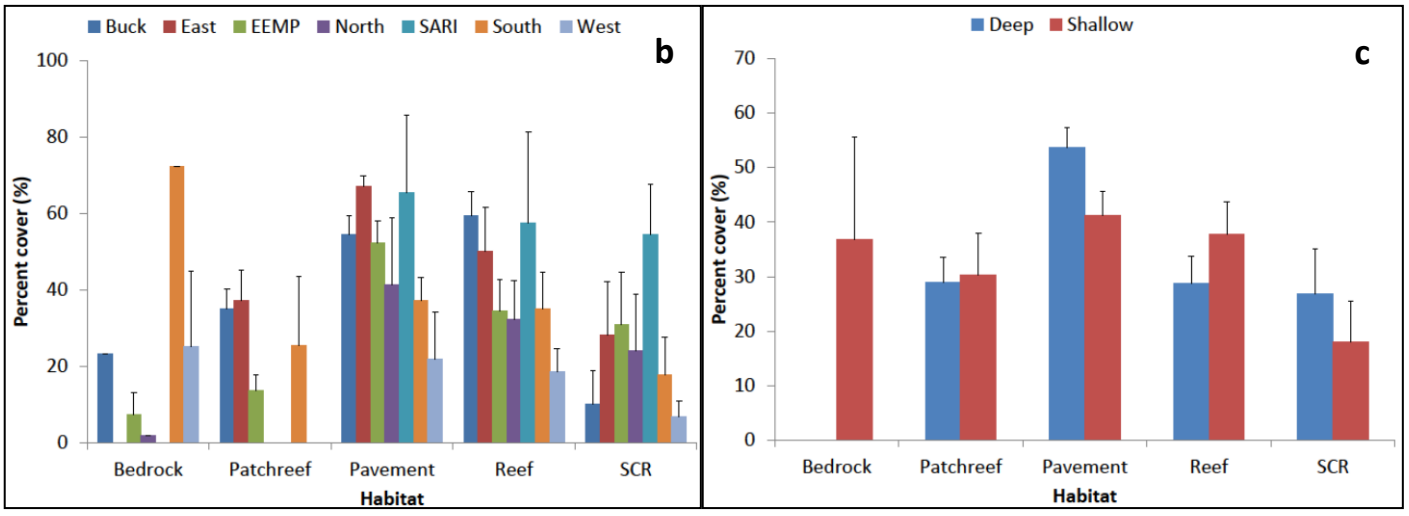




Figure 21. Percent cover of turf algae: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

*Macroalgae*

Macroalgae was present on 95% of surveys. No spatial patterns were evident (Figure 22a) while macroalgae was less abundant on most scattered coral and rock habitats (Figure 22b). No distinct patterns were observed by depth zone (Figure 22c).

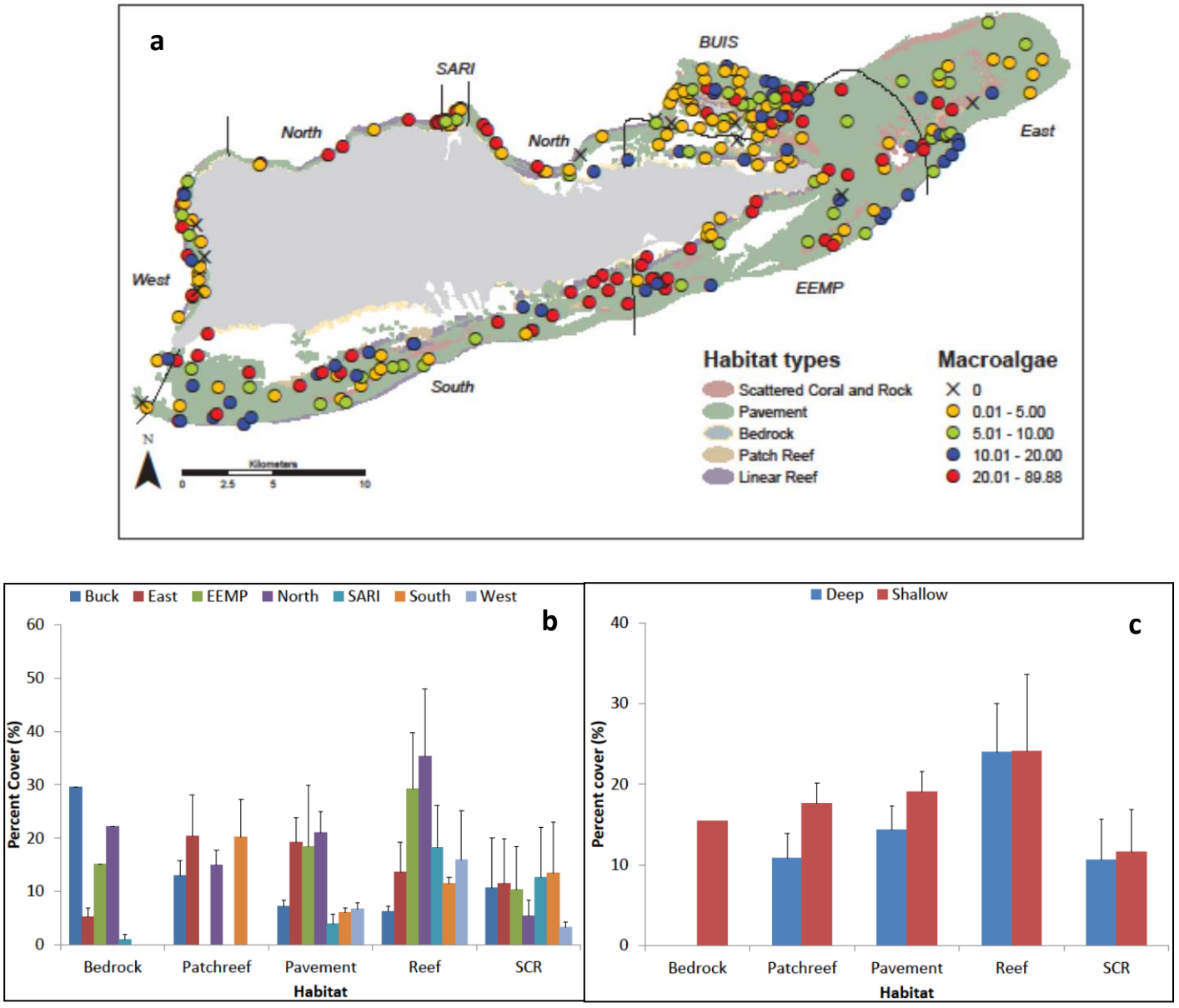
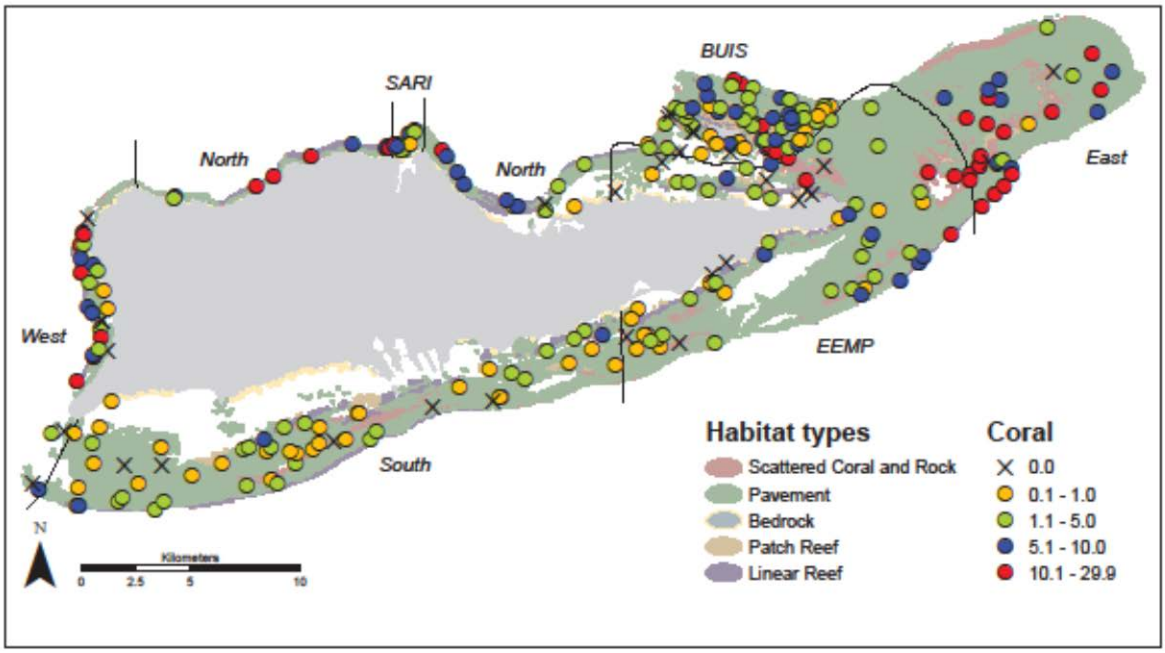
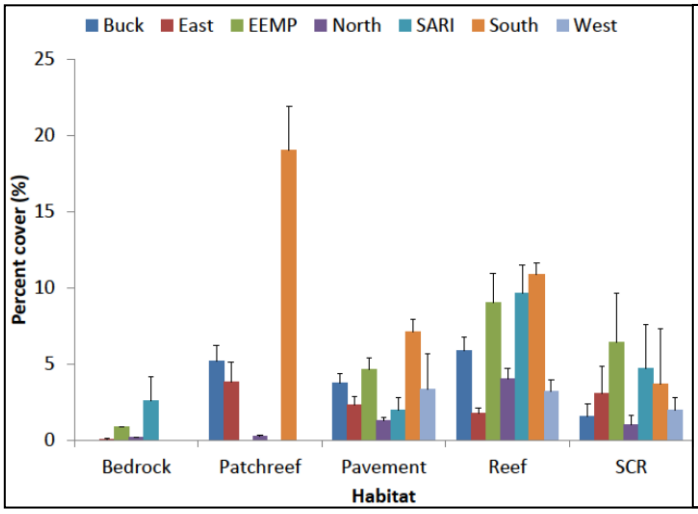



Figure 22. Percent cover of macroalgae: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

Coral

Scleractinian corals were observed on 88% of surveys. Most sites with cover greater than 5% were found in the northeast portion of the study area (Figure 23a). Southshore patchreef, pavement and linear reefs yielded highest coral cover compared to other regions (Figure 23b). In general, habitats deeper than 13 m had higher coral cover than that observed in shallow habitats (Figure 23c).



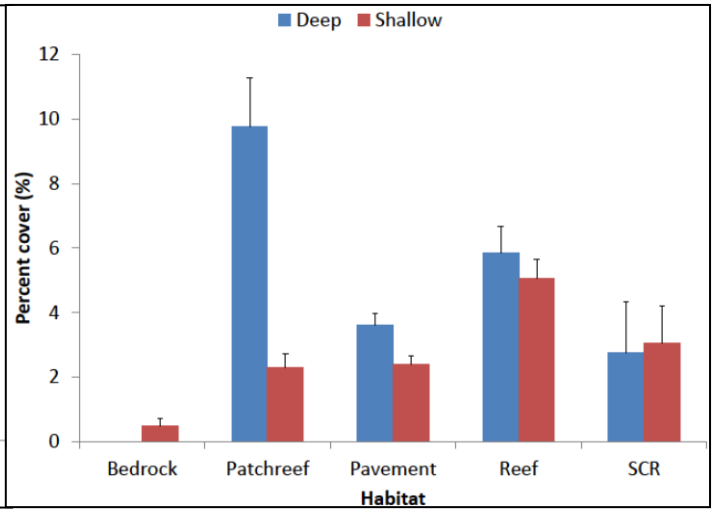
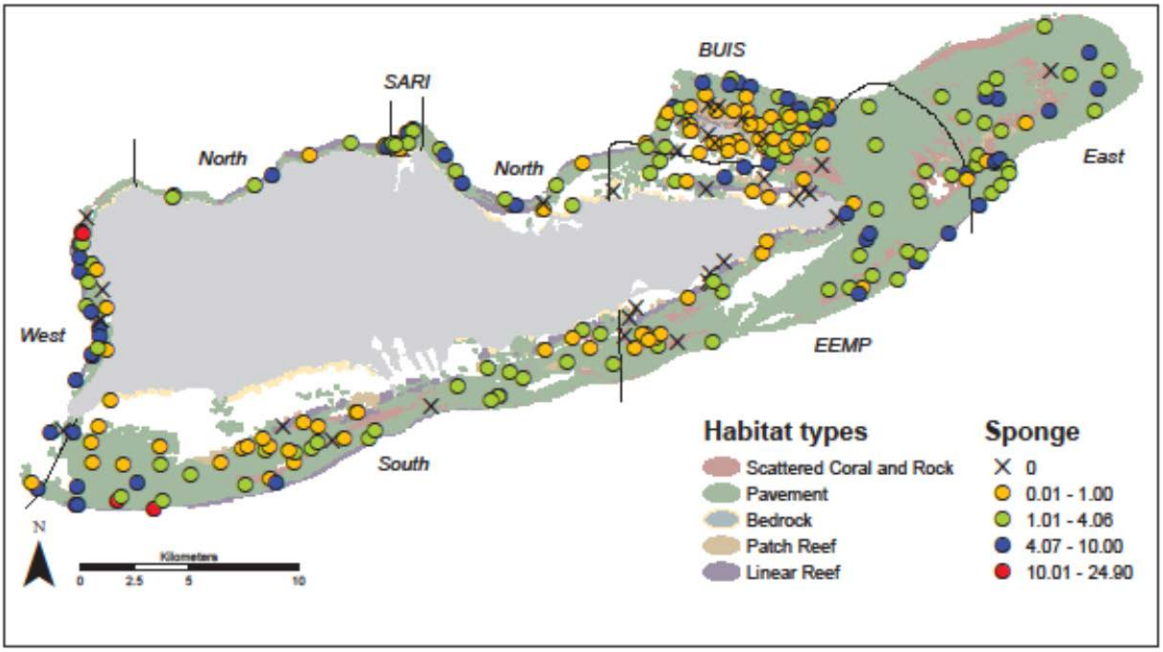




Figure 23. Percent cover of coral: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

*Sponge*

Sponges (both upright and encrusting types) were present on 86% of surveys. Few sites had cover greater than 4% and the majority of those were found in deeper habitats. No spatial patters of sponge cover were observed around the island (Figure 24a). Sponge cover was greater on linear reef and pavement while bedrock had the least amount of sponge (Figure 24b). In general, sponge cover was greater in deeper (>13m) habitats (Figure 24c).



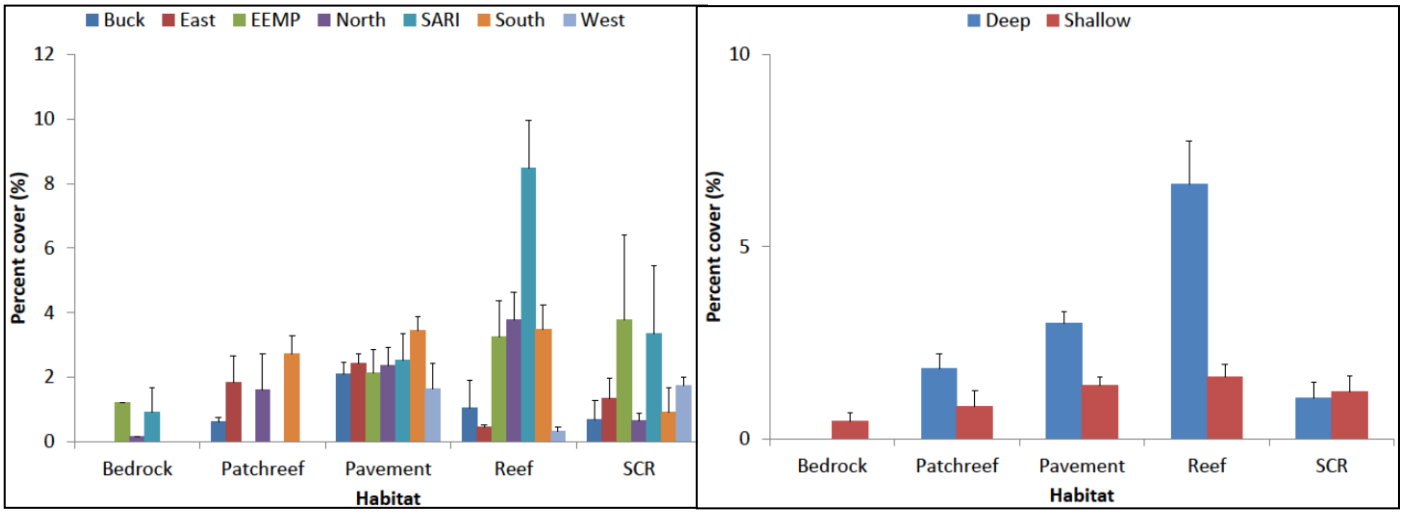




Figure 24. Percent cover of sponge: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

*Crustose coralline algae*

CCA was observed on 69% of surveys. Most observations occurred on the eastern portion of the island (Figure 25a). CCA cover was generally low among all habitat types (Figure 25b) and depth zones (Figure 25c). Patch reefs appeared to be the most abundant on patchreefs.

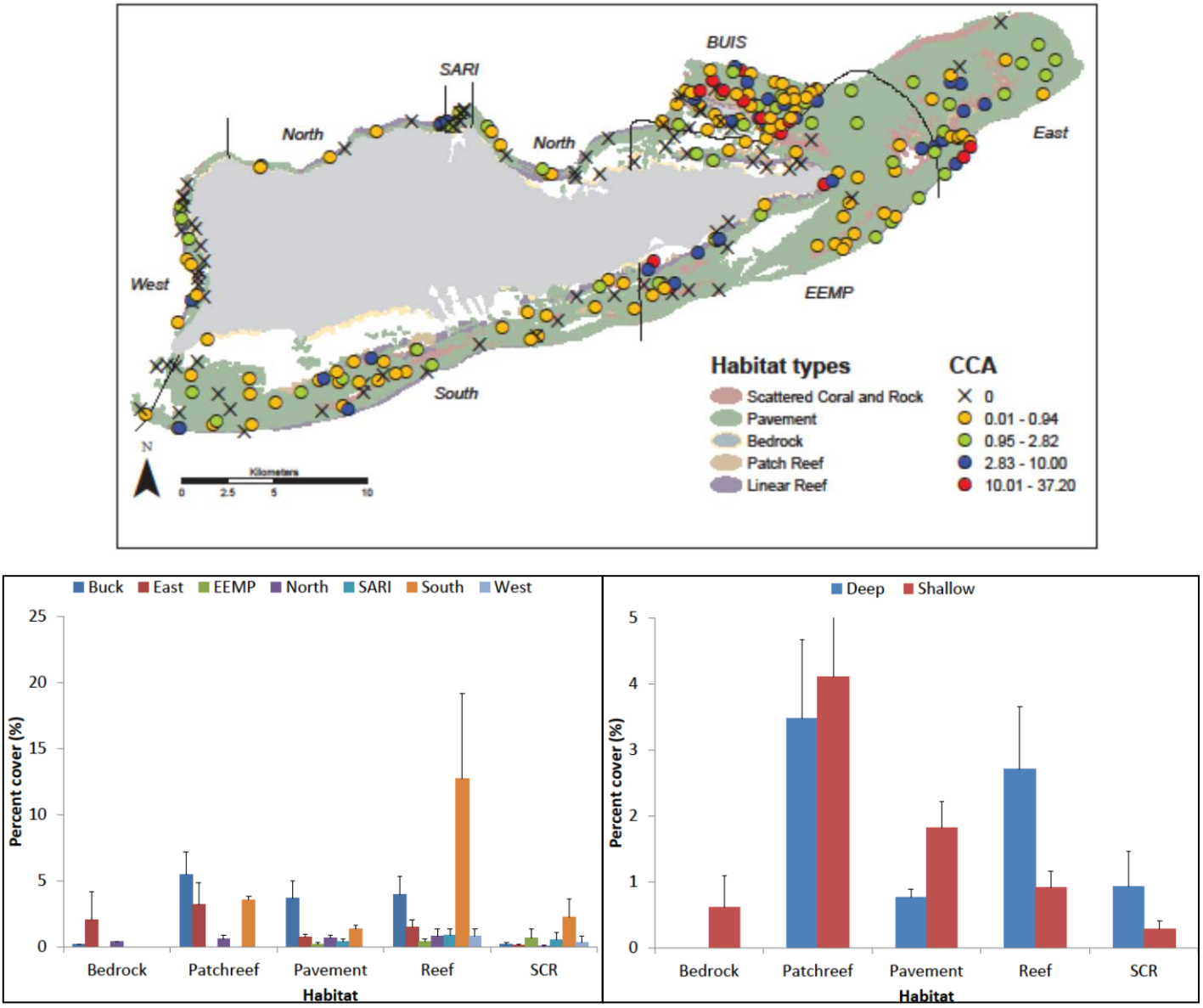
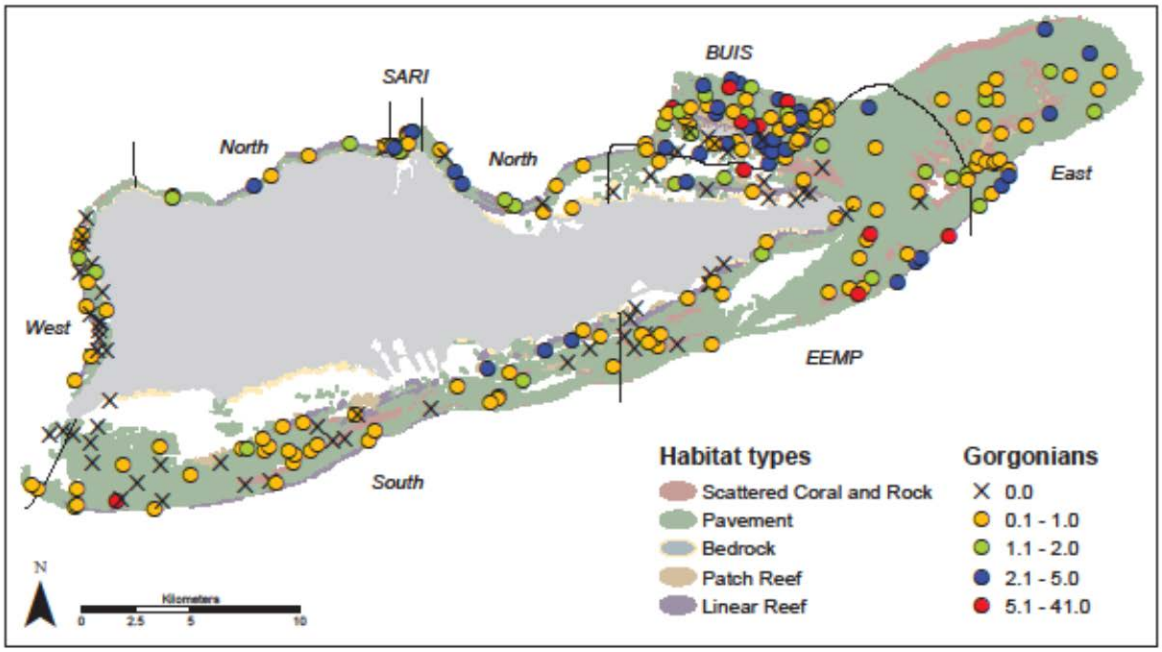



Figure 25. Percent cover of crustose coralline algae: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

*Gorgonians*

Gorgonians were observed on 75% of surveys. Gorgonians were uncommon on the west coast and most common on the south and northeast regions of the island (Figure 26a). Gorgonians were rarely encountered on bedrock and no distinct patterns of associations with any particular habitat type (Figure 26b). Gorgonian cover was typically greater on deeper habitats (>13m; Figure 26c).



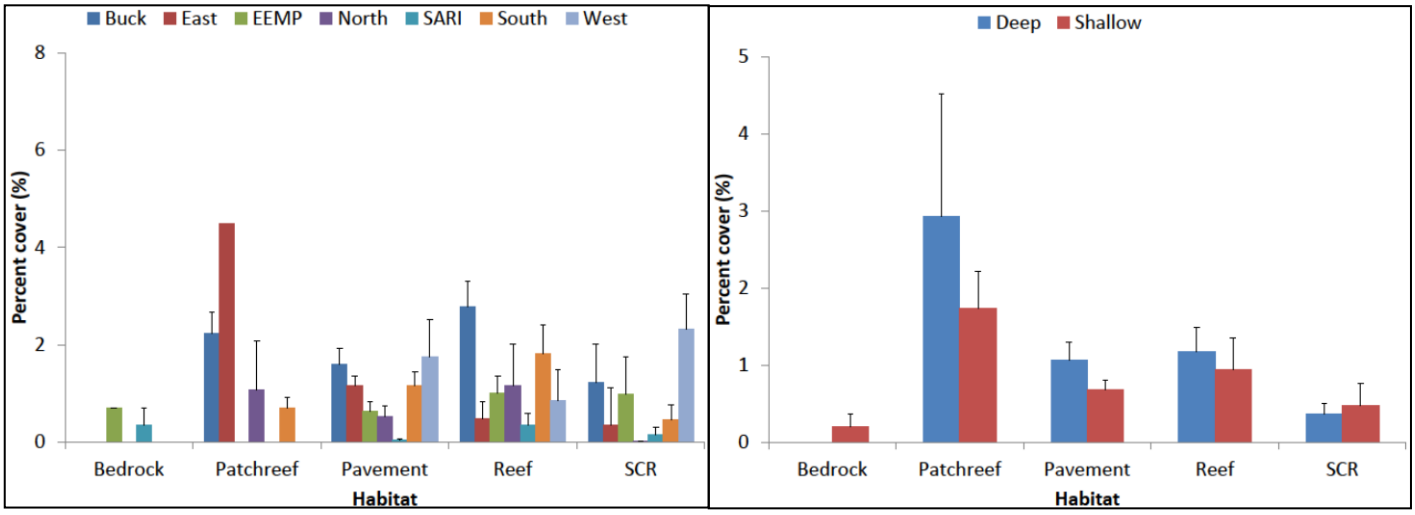




Figure 26. Percent cover of gorgonians: a) by survey site, b) mean (± SE) values by zone and habitat, and c) mean (± SE) values by depth and habitat.

**Table 3.** Rank of regions by the mean value of select community metrics. 1=highest, 7=lowest.

| Metric | Zone | | | | | | |
|---|---|---|---|---|---|---|---|
| | Buck | East | EEMP | North | SARI | South | West |
| Turf algae | 2 | 1 | 4 | 6 | 3 | 5 | 7 |
| Macroalgae | 7 | 6 | 3 | 1 | 4 | 2 | 5 |
| Coral | 5 | 1 | 6 | 2 | 4 | 7 | 3 |
| Sponge | 7 | 2 | 6 | 3 | 5 | 4 | 1 |
| CCA | 2 | 1 | 3 | 6 | 4 | 5 | 7 |
| Gorgonians | 1 | 4 | 2 | 5 | 3 | 6 | 7 |
| Mean | 3.42 | 2.50 | 4.00 | 3.83 | 3.83 | 4.83 | 5.00 |

*Acropora* sightings

Colonies of *Acropora cervicornis* and *A. palmata* were observed predominantly on the northeast of St. Croix. Sightings were uncommon on the south and western regions. *A.palmata* was observed at 33 sites (11% of total surveys) and *A. cervicornis* was sighted on 12 sites (4% of total surveys). Two sites had both species present. Most observations were recorded on shallow habitats on the northshore, specifically within BUIS (Figure 27). Nearly 60% of sightings were located in marine protected areas.

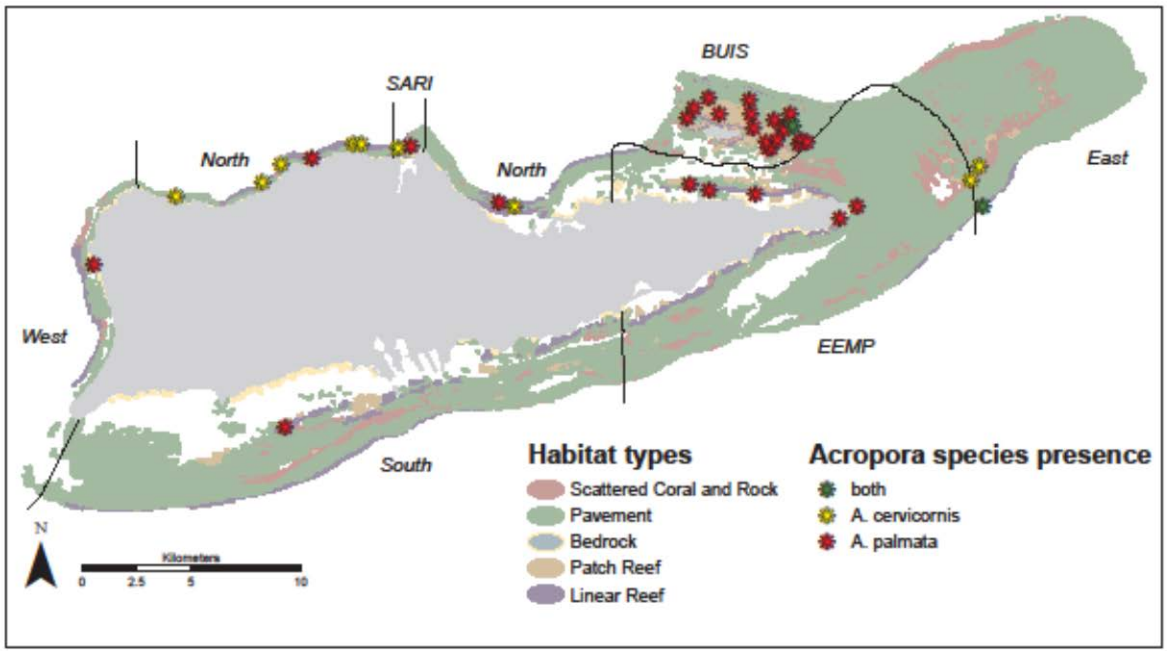



Figure 27. Spatial distribution of *Acropora cervicornis* and *A. palmata*.

Spiny sea urchin (*Diadema antillarum*)

Sea urchins were observed in all regions (21 sites) except for the East region. Densities ranged from 1 to 130 individuals/100 $m^2$. Figure 28 displays the spatial distribution of sightings; most were recorded in the southwest and west regions.

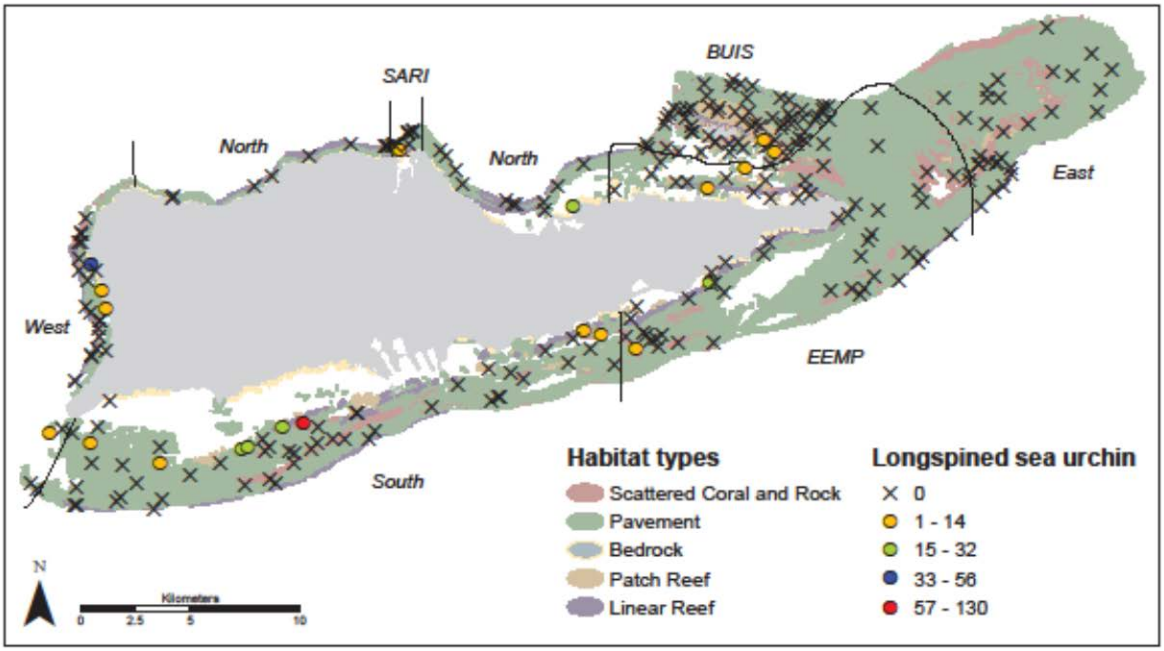



Figure 28. Spatial distribution of longspined sea urchin*, Diadema antillarum*.

Queen conch – *Strombus gigas*

Queen conch were present on 38 survey sites (13.8%). Most conch were observed in the northeast, east and southeast regions of the island (Figure 29). Conch were present on both depth strata and all habitat strata, except linear reef.

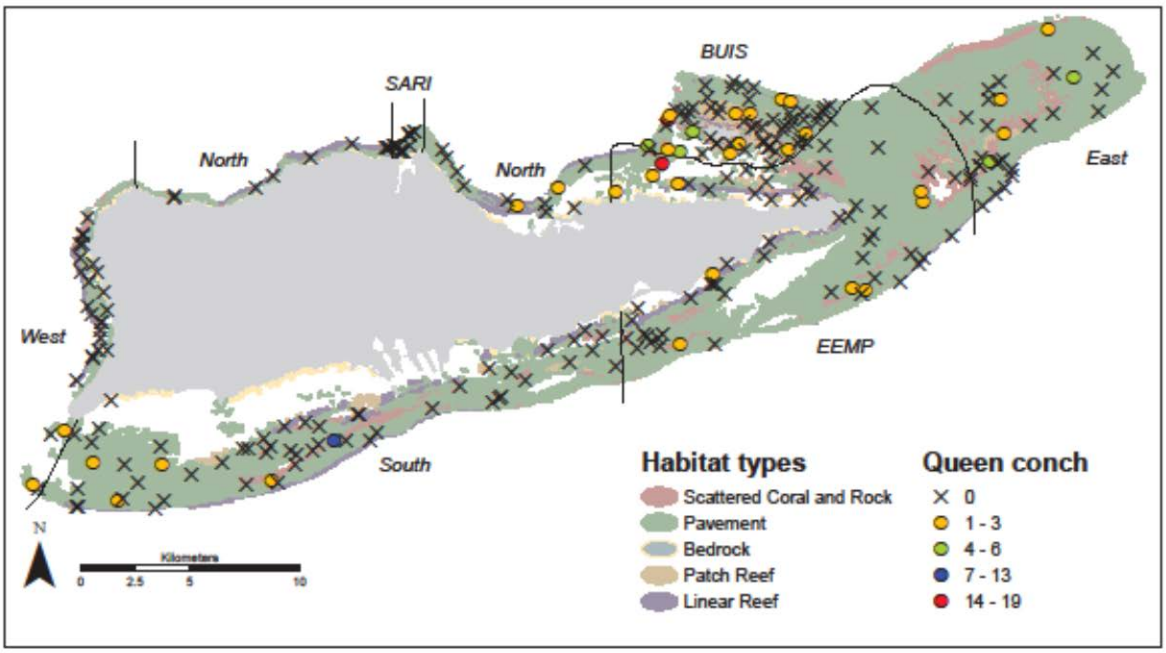
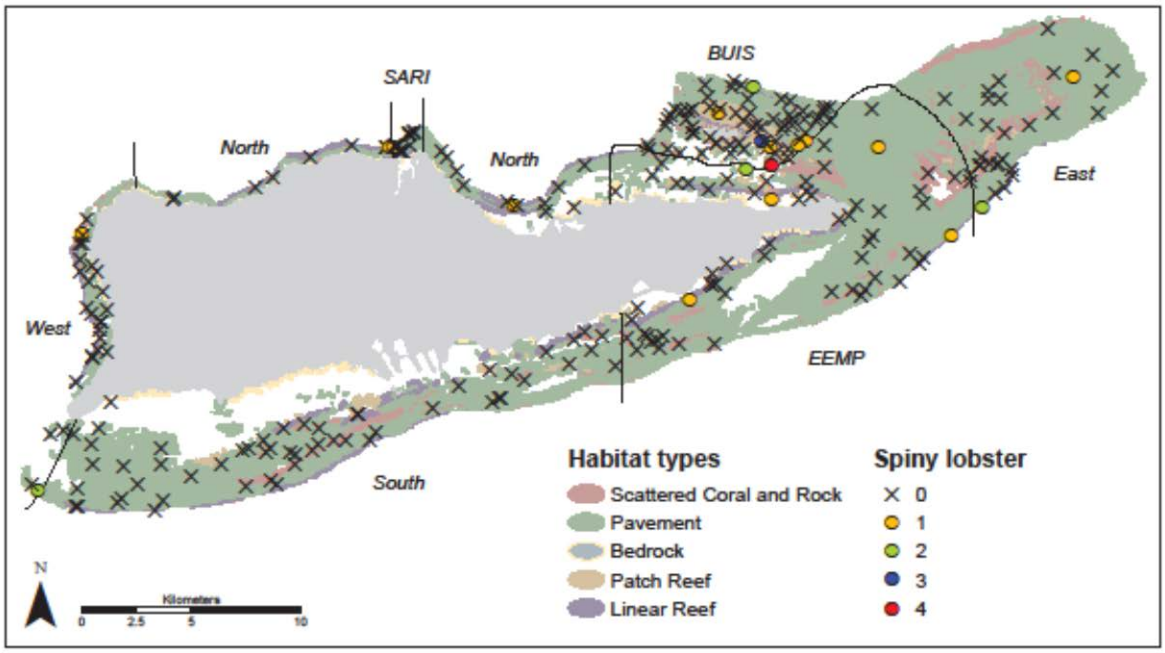



Figure 29. Spatial distribution of queen conch*, Strombus gigas*.

Spiny lobster – *Panulirus argus*

Spiny lobster were only observed on 19 surveys (6.8%). Where lobster were found, they on linear and patch reefs across all depths surveyed. Most observations were in the northeast and east regions (Figure 30).



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