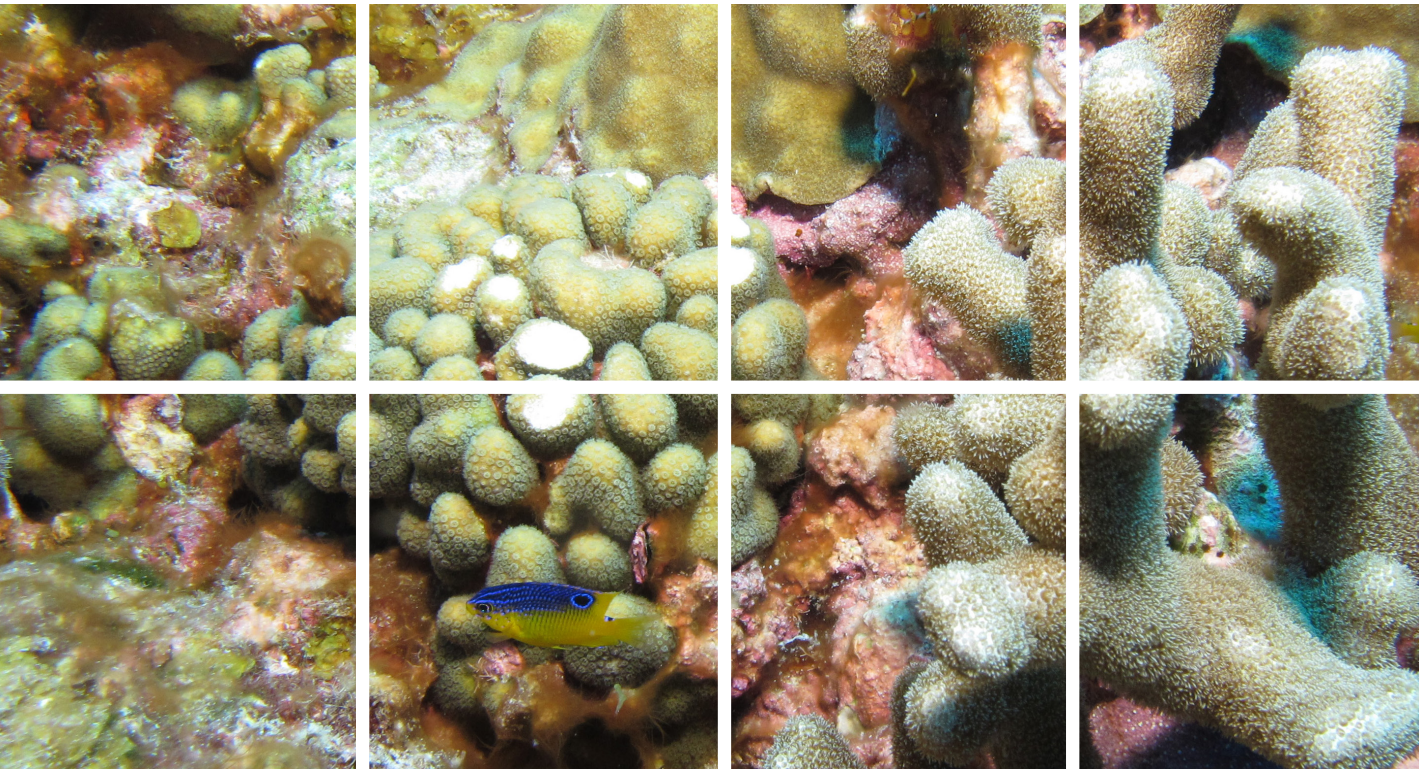
NATIONAL CORAL REEF MONITORING PROGRAM

Biological Monitoring Atlantic/Caribbean

Flower Garden Banks National Marine Sanctuary



2013

Mission Data Report

February 2016

NOAA NOS
National Centers for Coastal Ocean Science

Citation

Clark, R., S. Viehman, L. Bauer, C.A. Buckel, K. Egan, and J. Vander Pluym. 2016. National Coral Reef Monitoring Program, Biological Monitoring Atlantic/Caribbean: Flower Garden Banks National Marine Sanctuary 2013 Mission Data Report. NOAA National Ocean Service, National Centers for Coastal Ocean Science. 64 pp.

Cover photo was taken by G.P. Schmahl (NOAA NOS/ONMS/FGBNMS). Back cover photo was taken by NOAA NOS/NCCOS/CCMA.

National Coral Reef Monitoring Program
Biological Monitoring, Atlantic/Caribbean
Flower Garden Banks National Marine Sanctuary
2013 Mission Data Report

Randy Clark
Shay Viehman
Laurie Bauer
Christine A. Buckel
Katharine Egan
Jenny Vander Pluym

NOAA National Ocean Service
National Centers for Coastal Ocean Science (NCCOS)
1305 East West Highway, N/SCI-1
Silver Spring, MD 20910

and

101 Pivers Island Rd
Beaufort, NC 28516

April 2016

United States Department of Commerce	National Oceanic and Atmospheric Administration	National Ocean Service
Penny Pritzker Secretary	Kathryn Sullivan Administrator	Russell Callender Acting Assistant Administrator

Acknowledgments

Thanks to all who contributed to the National Coral Reef Monitoring Program 2013 FGBNMS Ecological field mission. We thank the following agencies and offices for support: Flower Garden Banks National Marine Sanctuary and Texas A&M University at Galveston.

We thank the following divers for their assistance with data collection and/or logistical support:

Jeremiah Blondeau
Randy Clark
Ryan Eckert
Kimberly Edwards
John Embesi
Emma Hickerson
Michelle Johnston
Marissa Nuttall
G.P. Schmahl
Matthew Stout

This project was funded by the NOAA Coral Reef Conservation Program. Government contract labor was provided by CSS-Dynamac of Fairfax, Virginia under NOAA contract number DG133C11CO0019 and JHT, Inc. of Orlando, Florida.

Significant Contributors

The following persons contributed significantly to the development of protocols, sample allocation, field logistics, and data management and support.

Kimberly Edwards
Sarah Hile
Tom McGrath
Charles Menza
Kimberly Roberson
Laughlin Siceloff

Table of Contents

Photo courtesy of Michelle Johnston (NOAA ONMS/FGBNMS)

INTRODUCTION

Background

The National Coral Reef Monitoring Program (NCRMP) is a strategic plan developed by NOAA's Coral Reef Conservation Program (CRCP) to monitor all U.S. coral reef ecosystems with standardized methodologies (http://www.coris.noaa.gov/monitoring/). The monitoring goal is to generate large-scale regional status and trend information for a broad-scale perspective to local jurisdictional or other survey programs. The program includes data collection for fish, corals, socio-economics and climate and is implemented in the Pacific and Atlantic basins.

In the Atlantic/Caribbean region, NCRMP biological field data is collected biennially at each location and targets hardbottom habitats to depths of 30 m (Figure 1). NCRMP fish monitoring protocols were modified from existing protocols in the U.S. Virgin Islands (USVI), Puerto Rico (Pittman et al. 2008, 2010; Friedlander et al., 2013) and the Flower Garden Banks (FGB; Caldow et al., 2009; Clark et al., 2014). New benthic protocols were implemented in the 2013 NCRMP field mission for benthic cover and coral demographics (Available online at http://coastalscience.noaa.gov/projects/detail?key=180).

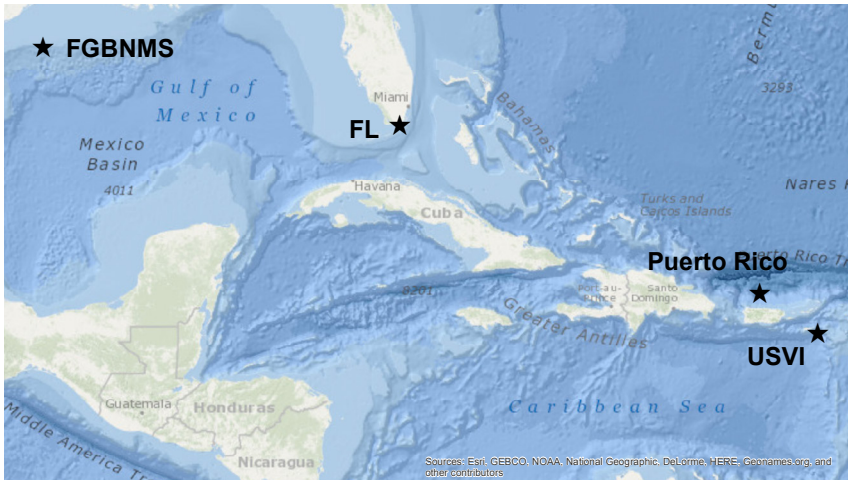


Figure 1. Coral reef areas surveyed by NOAA and partners for the Atlantic/Caribbean National Coral Reef Monitoring Program (NCRMP): U.S. Virgin Islands, Puerto Rico, Florida and Flower Garden Banks National Marine Sanctuary.

The primary monitoring objectives include:

- Develop consistent survey designs, field protocols and training tools
- Survey fish and coral communities to track status and trends
- Collect water samples for NCRMP Climate team
- Provide status and trend information to local resource managers
- Disseminate data to the public
- Provide data summaries annually

This report addresses a subset of the Atlantic/Caribbean domain and provides summary statistics for reef fish and benthic data collected in during 2013 surveys in Flower Garden Banks National Marine Sanctuary (FGBNMS). All data used in this report are available upon request.

Accomplishments and highlights of the 2013 FGBNMS Mission

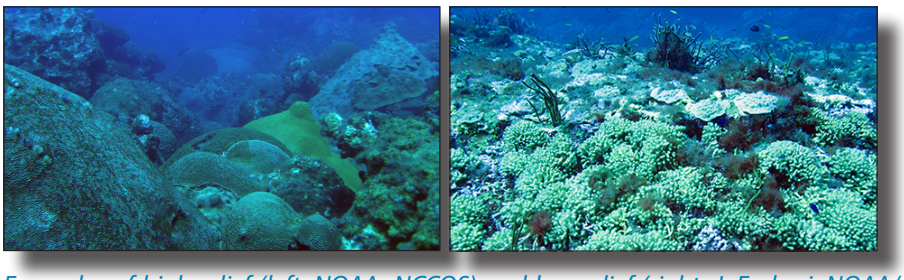
- Trained 7 divers from 2 agencies
  NOAA
  Texas A&M University

- 69 fish and Line point-intercept (LPI) surveys; 34 coral demographic surveys
- 24 water collections for NCRMP Climate team
- Fully functional transportable data entry system

METHODS

Sampling domain and design

The sampling domain included hardbottom habitats at depths less than 30 m (Table 1). All surveys were located within the boundaries of FGBNMS and stratified by habitat type (low relief, high relief) and biotope (East Bank, West Bank). Low-relief habitat is characterized by a relatively low variance in slope and dominance of *Madracis auretenra* coral and rubble, while high relief habitat is characterized by a relatively larger variance in slope and presence of boulder and plate corals (Caldow et al., 2009). Maps of strata were created using the most recent and best available habitat maps and bathymetry (Clark et al., 2014).



Examples of high-relief (left; NOAA NCCOS) and low-relief (right; J. Embesi, NOAA/OCNM/FGBNMS) habitat types.

Table 1. Sampling terms and definitions.

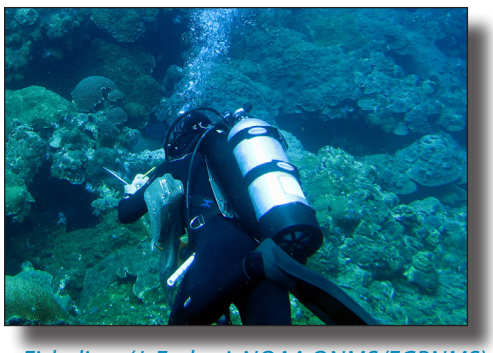
Term	Definition
Region	Gulf of Mexico (GOM)
Strata	Habitat type (high and low relief coral reef) Biotope (East and West Banks) Administrative area (FGBNMS)
Reporting Unit	A collection of sample sites, typically a region and in some cases a management unit
Sample site data	The average values of estimated observed quantities from fish and benthic surveys conducted at each site. Typically derived from a pair of simultaneous surveys (Fish/LPI and coral demographic). Sites are tied to geographic coordinates.

Site selection

Prior to each regional survey, sample site locations were randomly selected from the comprehensive site list within the sampling domain. Sites were allocated based on habitat proportion. Overall, 75 primary sites were generated based on the maximum daily number of dives possible for a five day mission. Three to five alternates were generated for each stratum. Where divers identified a site as unsuitable (e.g., no hardbottom habitat or exceeded maximum survey depth) or inaccessible (e.g., due to inclement weather conditions) the dive was terminated and an alternate site was picked from the randomized list, ideally to meet the same strata requirements. In some cases, these changes resulted in incomplete spatial coverage of targeted strata.

Fish surveys

Fish surveys were conducted along 25x4 m transects (100 m^2) using a fixed survey duration (15 minutes) independent of habitat type or complexity (NOAA, 2013a). Divers quantified fish that were observed in the water column and on the substrate, including under ledges and in holes. The number of individuals per species was recorded in 5 cm size class increments up to 35 cm using visual estimation of fork length. In addition, an estimate of actual fork length was recorded for certain managed species of all sizes. These species included all grouper and snapper species, as well as the hogfish (*Lachnolaimus maximus)*. If an individual could not be identified to species, it was identified to the finest extent possible (i.e., genus or family). Individuals greater than 35 cm were recorded as an estimate of the actual fork length to the nearest centimeter.

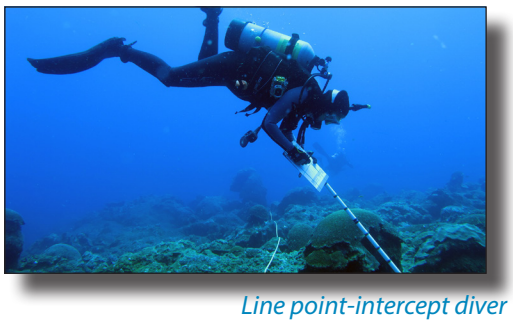


Fish diver (J. Embesi, NOAA ONMS/FGBNMS)

Benthic surveys

Linear point-intercept (LPI) surveys

Benthic composition was surveyed using linear point-intercept (LPI) surveys, in which divers estimated cover of biotic and abiotic benthic habitat (NOAA, 2013b). Using this method, benthic organisms were identified at every 20 cm for 20 m (N=100) along the transect tape laid out by the fish diver. Cover for each category was determined by the frequency of occurrence divided by total observations. Each sample point was identified to predetermined major functional categories or to species for corals and select algae.



Line point-intercept diver (J. Embesi, NOAA ONMS/FGBNMS)

Coral demographic surveys

Coral abundance, density, size, and condition were surveyed on non-juvenile (>4 cm) scleractinian coral species (NOAA, 2013c). This survey was conducted at approximately half of the fish survey sites. The coral demographic survey was conducted concurrently with the fish survey along the first 10x1 m of the transect area.

Coral demographic diver (J. Embesi, NOAA ONMS/FGBNMS)

Each coral colony with diameter greater than or equal to 4 cm was identified to species and three dimensions were measured (cm): maximum diameter (diameter of widest skeletal unit), perpendicular diameter (length perpendicular to maximum diameter), and height (measured from based of skeletal unit). For colonies less than 4 cm, presence was recorded to estimate species richness. If an individual could not be identified to species, it was identified to the extent possible (i.e., genus or family). Coral condition measurements included old mortality, recent mortality and bleaching. Old mortality and recent mortality were recorded as a percentage of dead skeletal cover. Coral bleaching was categorized as total, partial or none. Coral disease was not recorded in 2013 but was included in subsequent years.

Invertebrate key species surveys

At each fish/LPI survey site, divers surveyed for select macroinvertebrates including lobsters (*Panulirus argus*), queen conch (*Lobatus gigas*), long-spined sea urchins (*Diadema antillarum*) and species of corals under consideration for listing under the Endangered Species Act at the time of the surveys (Table 2; NOAA, 2013b; http://www.nmfs.noaa.gov/pr/species/invertebrates/corals.htm). Macroinvertebrate abundance and presence/absence of ESA listed corals was conducted in a 25x2 m survey area, along the same transect as the fish survey. (Table 2).

*Table 2. Coral species under consideration in 2013 for listing under the Endangered Species Act. Presence or absence of these species was identified as part of the LPI surveys (25x2 m). + indicates species listed as Threatened in 2006. * indicates species listed as Threatened in 2014.*

*Acropora palmata+**	*Mycetophyllia ferox**
*Acropora cervicornis+**	*Orbicella annularis**
Agaricia lamarcki	*Orbicella franksi**
*Dendrogyra cylindrus**	*Orbicella faveolata**
Dichocoenia stokesii	

Topographic complexity surveys

Topographic complexity surveys were conducted by the fish diver after the fish census was completed (NOAA, 2013d). Minimum and maximum depth, and maximum vertical relief within the 25x4 m transect, were recorded, along with an estimate of surface area topography as a relative proportion of different relief categories. In this methodology, the 100 m^2 transect was divided into 24 smaller 2x2 sampling units (12 on each side of the transect), and each sampling unit was scored for maximum vertical relief using one of the following six categories: <0.2 m, 0.2-<0.5 m, 0.5-<1.0 m, 1.0-<1.5 m, 1.5-<2 m and >2 m.

METHODS

Data entry and storage

Data were entered into an offline database application. Upon mission completion, all data were migrated to a web-accessed database on a server.

Data quality control

Data quality control was implemented at three main stages:

1. Ongoing routine training of observers (initial detailed training, annual refresher training).
2. Data check following data collection, where divers trade datasheets immediately upon returning to boat after dive, to ensure all data were collected accurately and required information is complete.
3. Independent reviewers compared datasheets with database entries.

Data handling

The site is the base sample unit for this study, and data estimates (e.g., biomass, density and percent cover) were calculated by taking the total number per survey area. Note coral density is presented as corals/m^2.

Calculations of fish biomass per site

Biomass was calculated using published length-weight relationships based on the allometric scaling law,

$$W = aL^b$$

where L is length in centimeters and W is weight in grams, *a* is a condition factor related to body form, and *b* is the scaling exponent indicating either isometric or allometric growth. The midpoint of each size class was used for *L* values up to 35 cm, and the actual length was used for fish >35 cm. For fish in the 0-5 cm size class, 3 cm was used as the mid-point because we do not typically observe fish <1 cm. Values for *a* and *b* by species were obtained from FishBase (Froese and Pauly, 2008). Biomass for species with no published length-weight relationships was calculated using terms for the closest congener with the most similar morphology.

Trophic groups surveyed included piscivores, herbivores, invertivores and zooplanktivores and were defined for each species based on diet information from Randall (1967). It is important to note that these groups are not mutually exclusive because many fish species can be classified into two or more of these groups based on diet. In those circumstances the trophic group was assigned based on the dominant diet component.

Calculations of coral colony mean size

Estimates of coral colony mean size were obtained by calculating the mean of three dimensions measured in the field: longest diameter, perpendicular diameter and height. Note that this is not tailored to species morphology, and as such likely underestimates area of some species (e.g., branching Acroporids). Estimates of mortality were not subtracted from coral area.

Calculation of region-scale estimates from the stratified sampling design

The stratified-random survey design was used to produce estimates of the survey populations. Weighted means, standard errors (SE) and coefficients of variance (CV) for a suite of fish and benthic metrics were calculated using the "survey" package in R statistical software (Lumley, 2013). Summary statistics were generated at both the overall region level as well as for specific domains (i.e., habitat type, biotope).

This section summarizes fish and benthic community data collected in NCRMP 2013 FGBNMS surveys of coral reef habitats (Table 3). All surveys were conducted within the sanctuary boundary between depths of 18-30 m. The sanctuary encompasses two salt domes (East and West Bank) that span depths of 18-150 m. Due to the distance of the Sanctuary from the coastline (approximately180 km south of Galveston, Texas), FGBNMS marine communities have a buffer from land-based human impacts. Hook and line fishing is allowed and does occur within the Sanctuary boundaries.

Table 3. List of strata and surveys by region for FGBNMS 2013 sampling period. Sample weights for each survey type were calculated as the number of cells per strata/number of sites by survey type.

Region	Strata			# cells/ strata	# Sites by survey type		
	Biotope	Habitat Type	Adminstrative area		Fish	LPI	Demo
GOM	East Bank	High Relief	FGBNMS	213	34	34	17
GOM	East Bank	Low Relief	FGBNMS	21	5	5	2
GOM	West Bank	High Relief	FGBNMS	122	27	27	15
GOM	West Bank	Low Relief	FGBNMS	4	3	3	0
FGBNMS total survey number by survey type					**69**	**69**	**34**

Effort summary

Surveys were conducted in 5 days from September 2-6, 2013. A total of 69 surveys were completed, including 69 fish sites, 69 LPI sites and 34 coral demographic sites (Figure 3; Appendix 2).

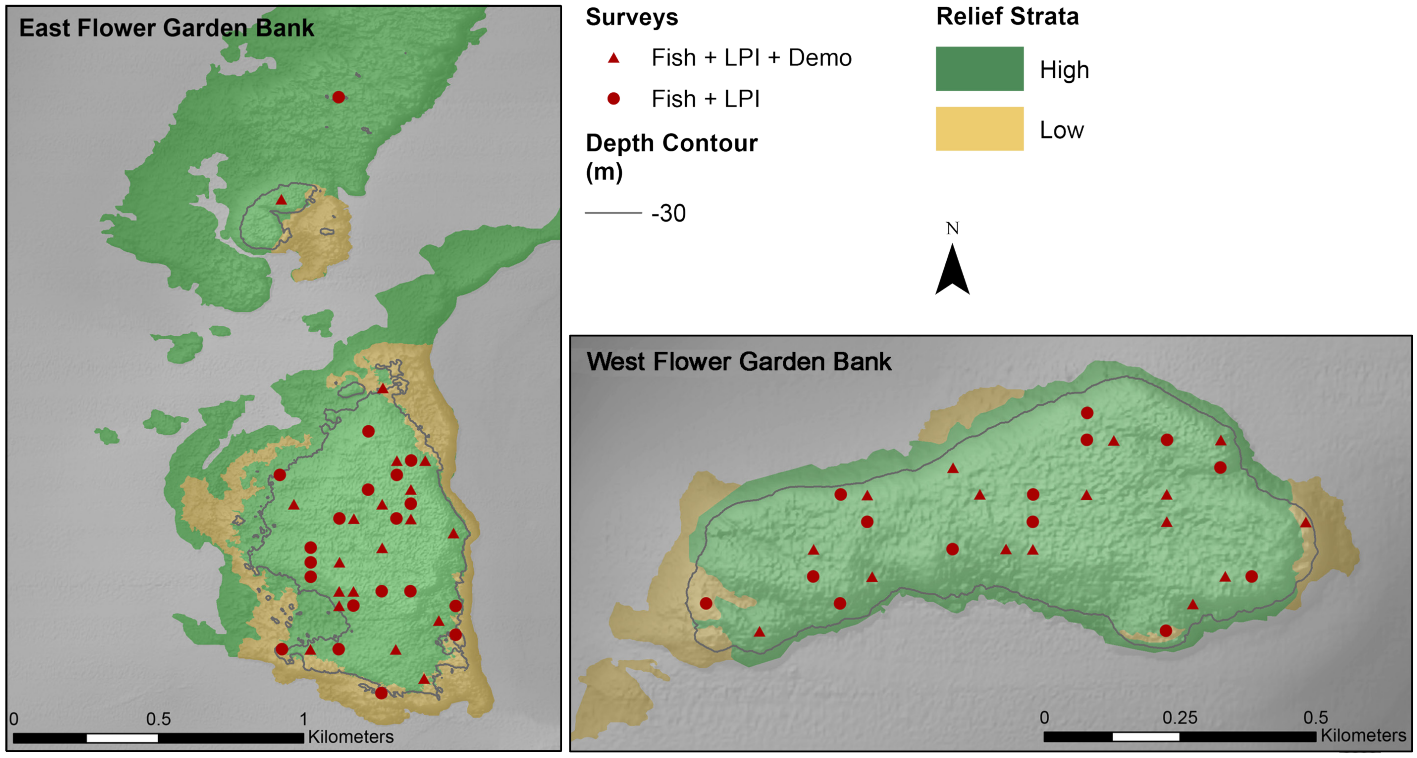


Figure 2. NCRMP 2013 FGBNMS survey sites for fish, benthic habitat (LPI), and coral demographics

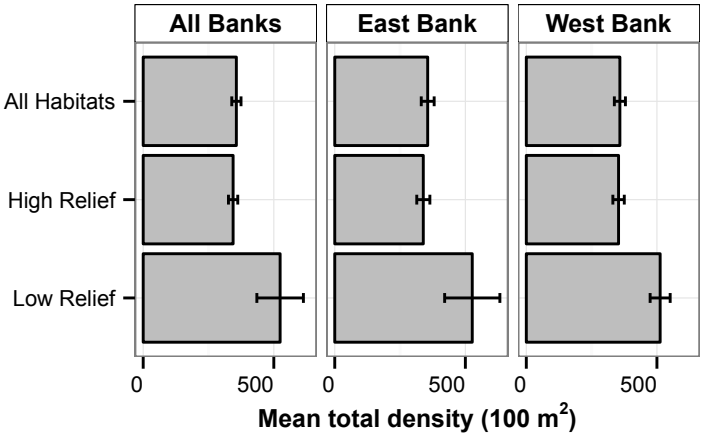
RESULTS

Fish

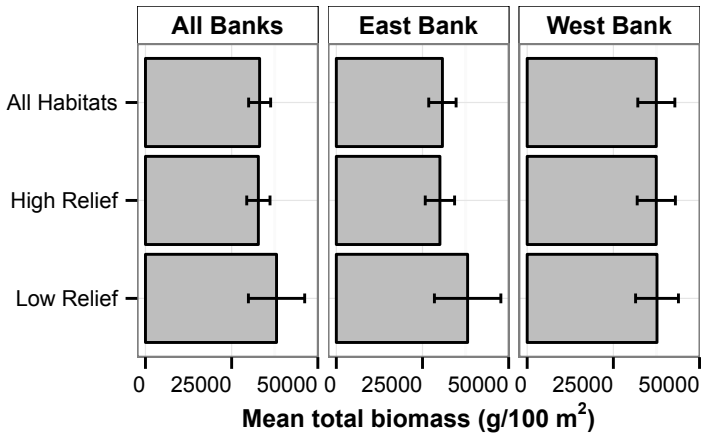
In the NCRMP FGBNMS 2013 survey sampling period, 69 fish surveys were completed.

Fish metrics

(a) Total fish density



(b) Total fish biomass



(c) Species richness

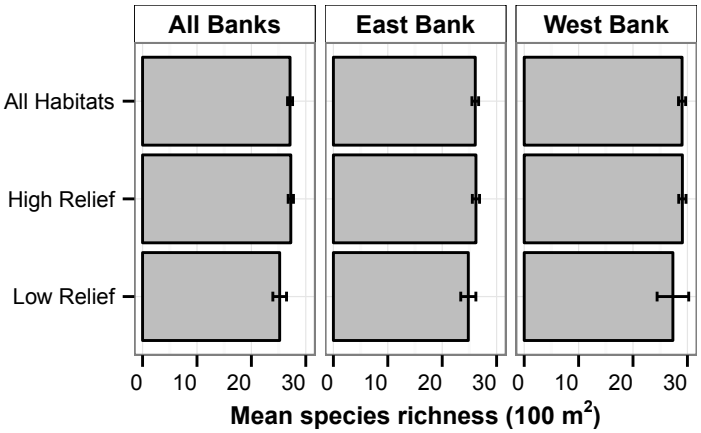


Figure 3. NCRMP 2013 FGBNMS (a) total fish density (#/100 m²), (b) total fish biomass (g/100 m²), and (c) species richness (species #/100 m²), shown by biotope (columns) and habitat type (rows). Weighted means with standard error bars.

Photos of Caranx lugubris *and hybrid angelfish at FGBNMS 2013 (NOAA NCCOS).*

Total fish density

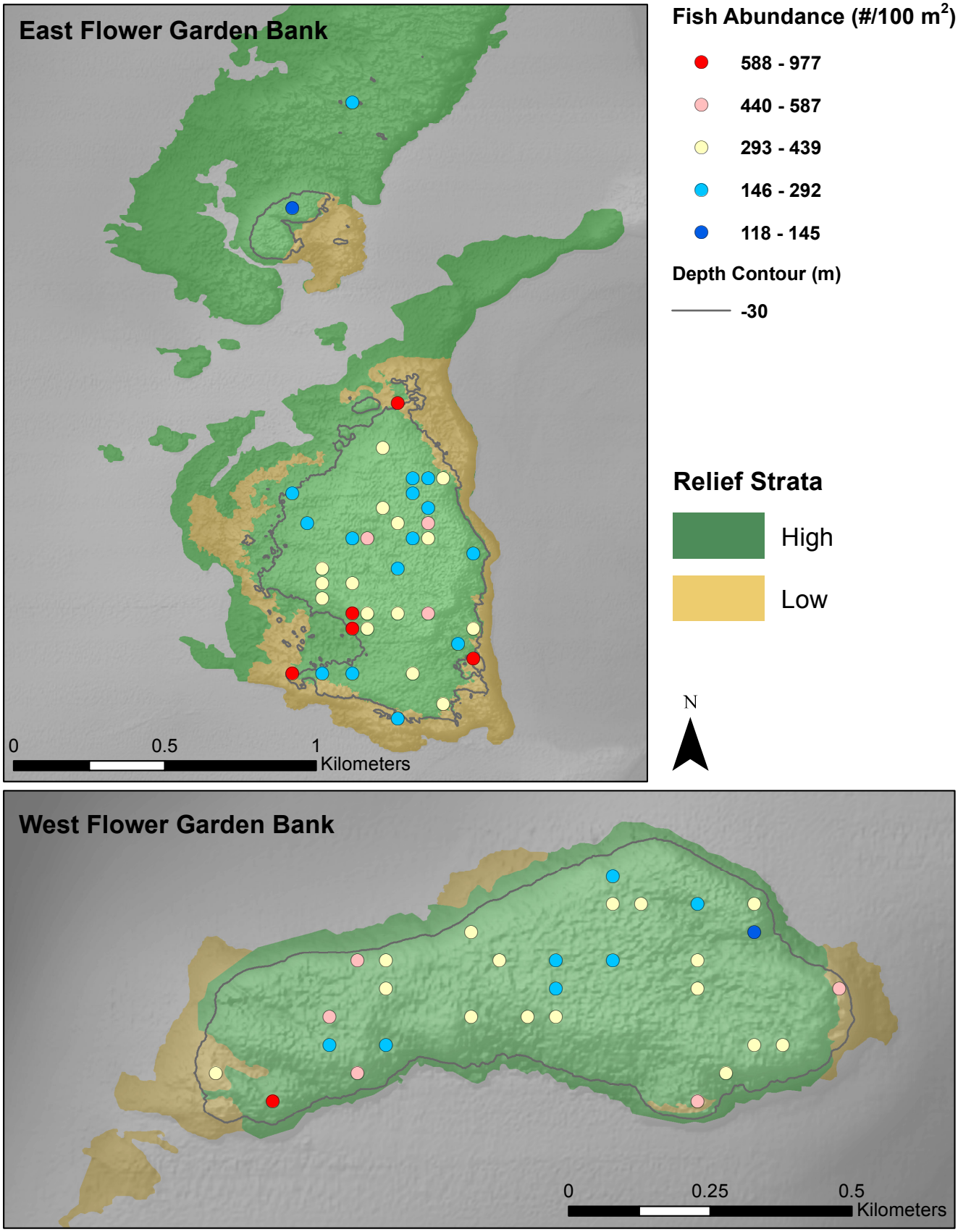


Figure 4. NCRMP 2013 FGBNMS observed total fish density (#/100 m²), shown by standard deviation categories (>1.5, 0.50 – 1.5, -0.50 – 0.50, -1.5 – -0.5, <-1.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.

RESULTS

Total fish biomass

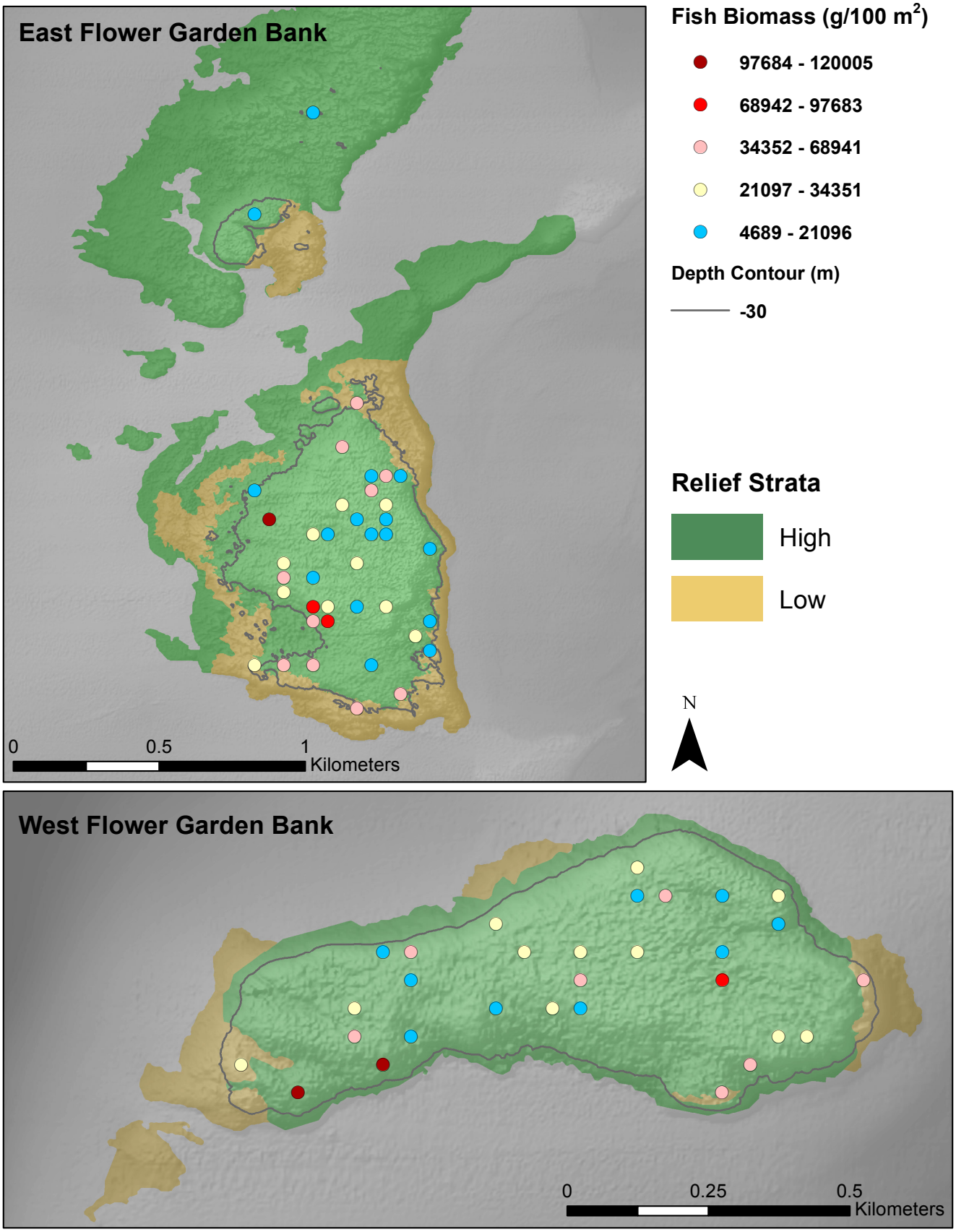


Figure 5. NCRMP 2013 FGBNMS observed total fish biomass (g/100 m²), shown by standard deviation categories (>2.5, 1.5 – 2.5, 0.5 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.

Species richness

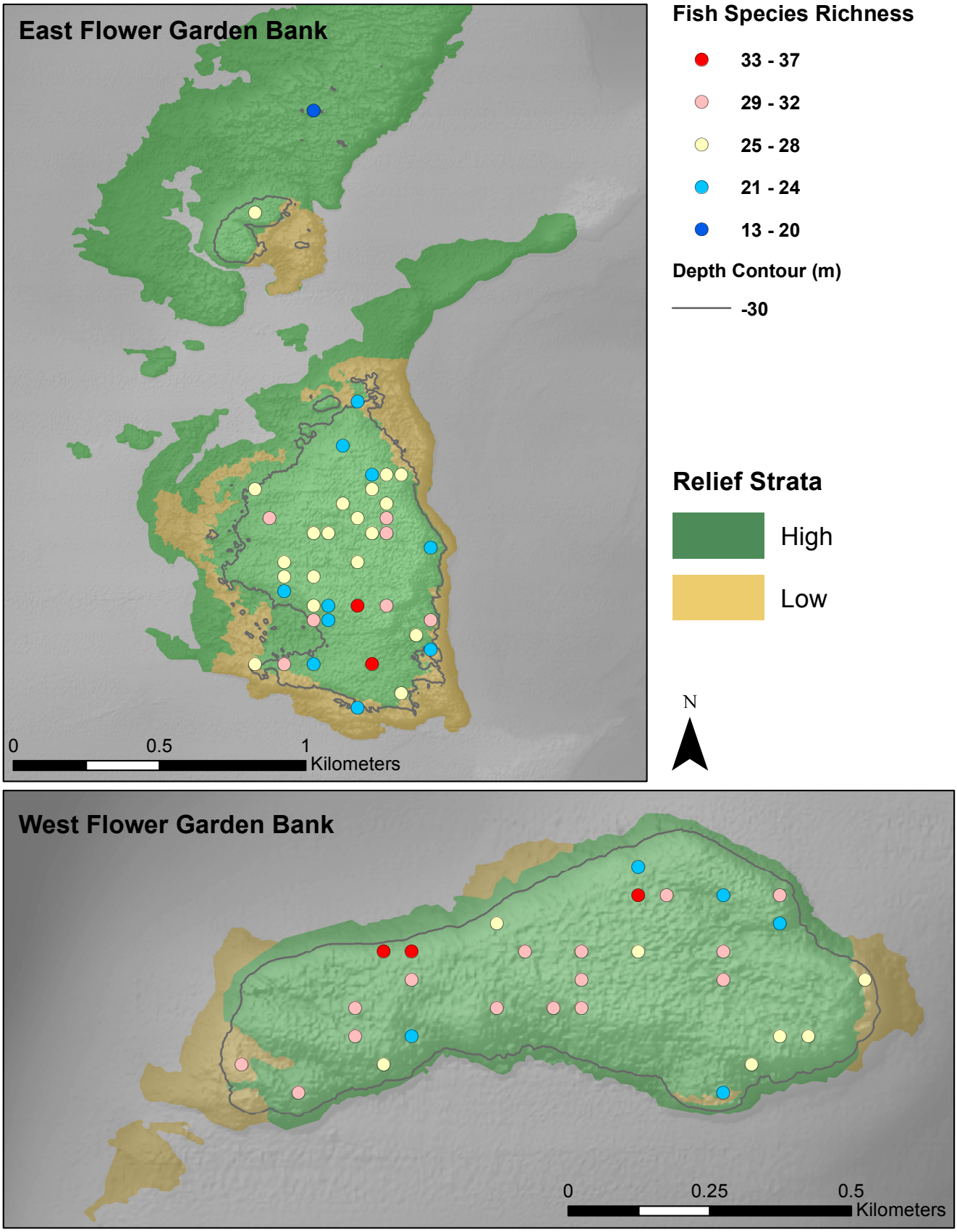


Figure 6. NCRMP 2013 FGBNMS observed fish species richness (species #/100 m^2), shown by standard deviation categories (>1.5, 0.5 – 1.5, 0.50 – -0.5, -0.50 – -1.50, <-1.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.

RESULTS

Overall

Table 4. Top ten fish species by observed mean density (left), mean biomass (center), and frequency of occurrence (right). Species are sorted in descending order.

Rank	Density	Biomass	Occurrence (%)
1	*Chromis multilineata*	*Paranthias furcifer*	*Thalassoma bifasciatum*
2	*Thalassoma bifasciatum*	*Kyphosus sectator*	*Canthigaster rostrata*
3	*Paranthias furcifer*	*Caranx latus*	*Bodianus rufus*
4	*Clepticus parrae*	*Clepticus parrae*	*Stegastes partitus*
5	*Stegastes partitus*	*Sphyraena barracuda*	*Stegastes planifrons*
6	*Stegastes planifrons*	*Lutjanus jocu*	*Chromis multilineata*
7	*Chromis cyanea*	*Sparisoma viride*	*Paranthias furcifer*
8	*Chromis insolata*	*Mycteroperca tigris*	*Acanthurus coeruleus*
9	*Kyphosus sectator*	*Chromis multilineata*	*Sparisoma aurofrenatum*
10	*Canthigaster rostrata*	*Scarus vetula*	*Chromis cyanea*

Density and spatial distribution of key fish families

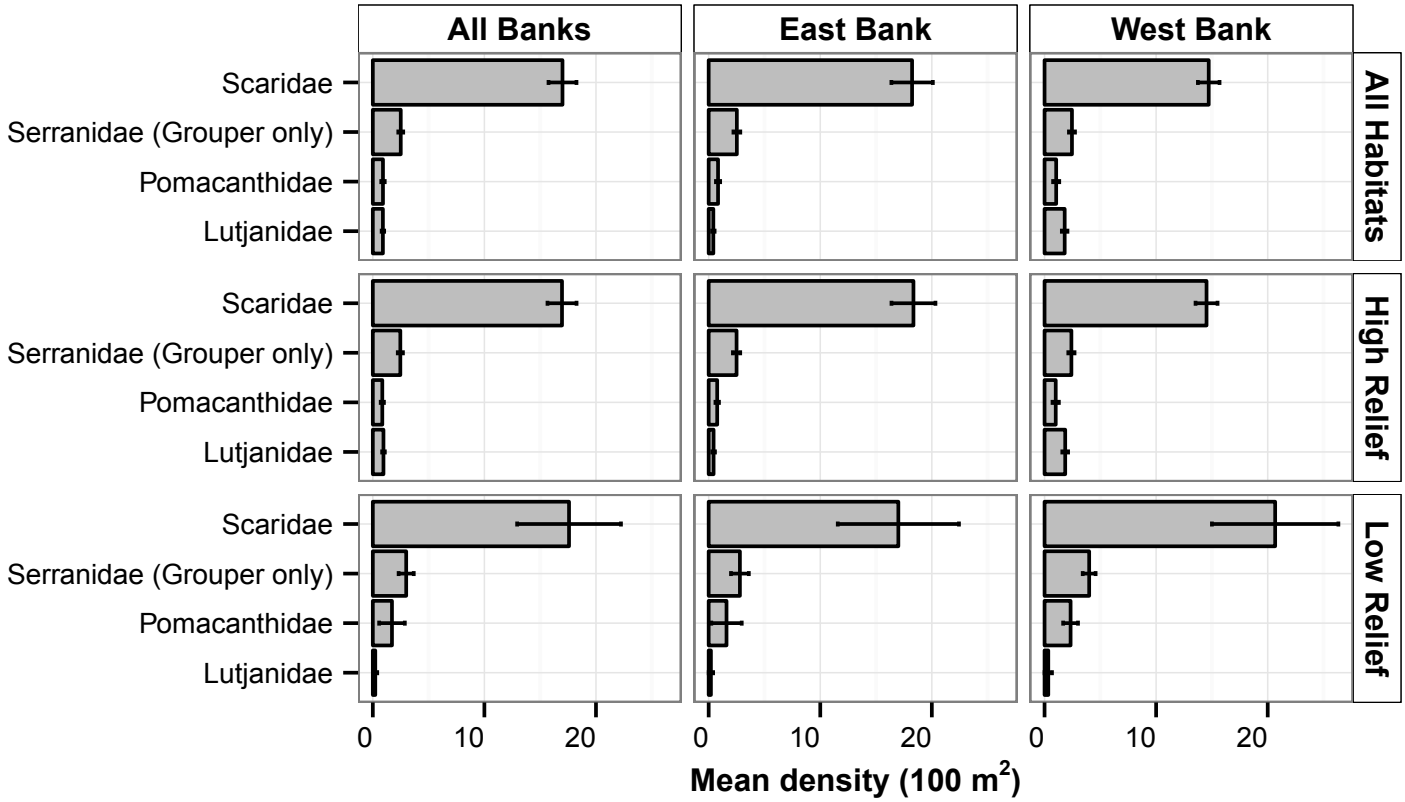


Figure 7. NCRMP 2013 FGBNMS mean density (#/100 m^2) of key fish families: Scaridae (all parrotfish), Lutjanidae (all snappers), Serranidae (groupers only), and Pomacanthidae (angelfish) shown by biotope (columns) and habitat type (rows). Weighted means with standard error bars.

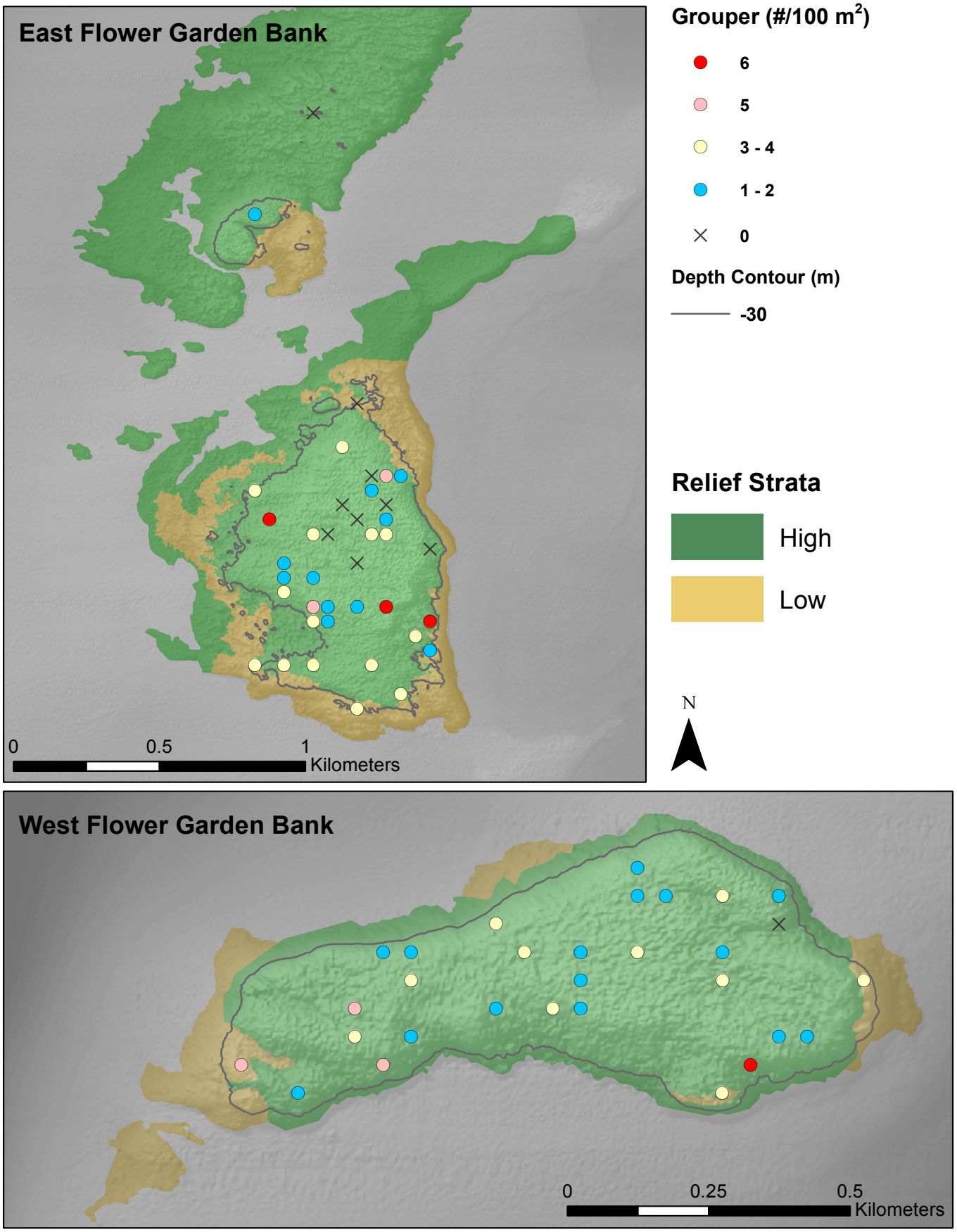


Figure 8. NCRMP 2013 FGBNMS observed density (#/100 m^2) of Serranidae (grouper only) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, <-0.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.

RESULTS

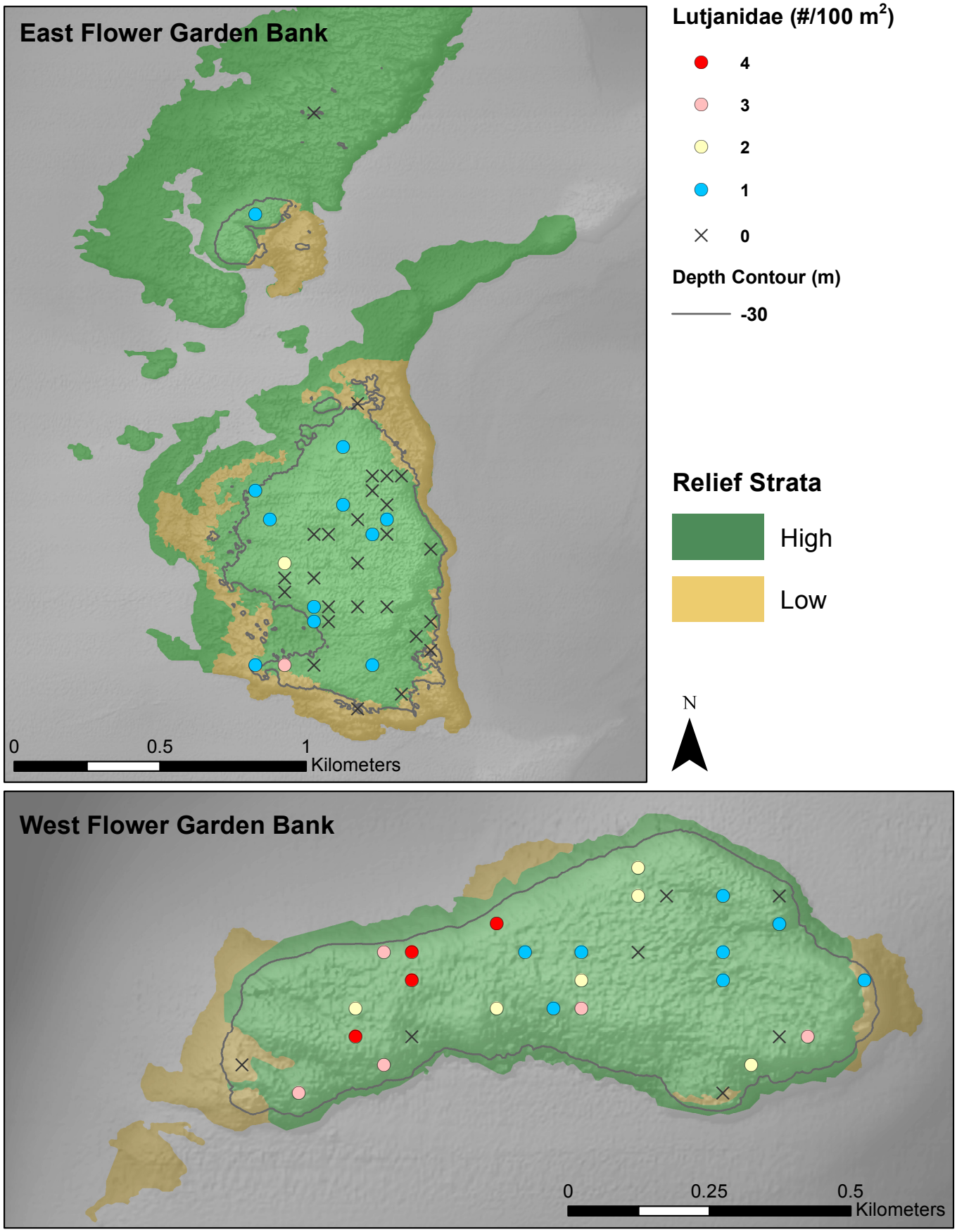


Figure 9. NCRMP 2013 FGBNMS observed density (#/100 m²) of Lutjanidae (all snappers) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.

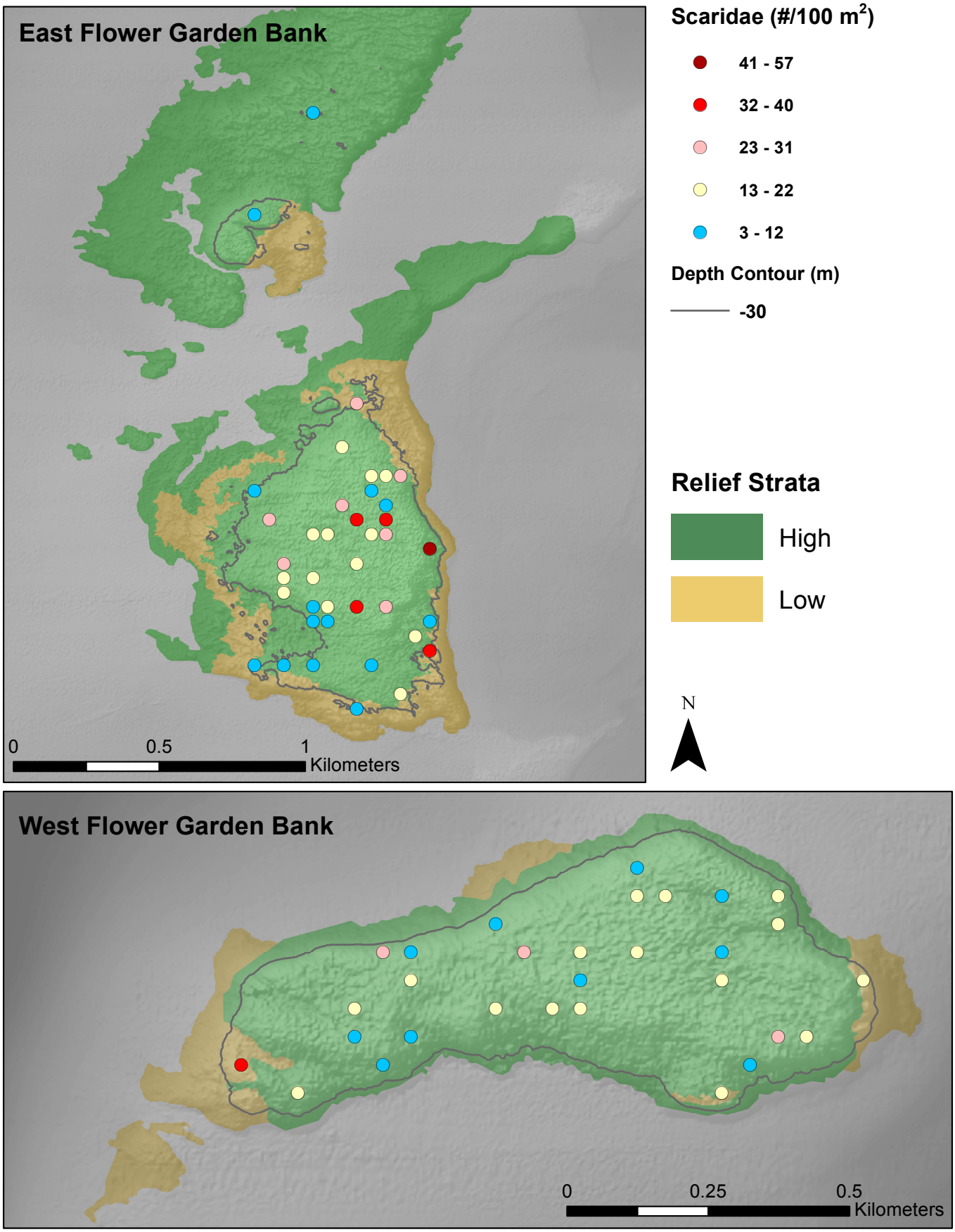


Figure 10. NCRMP 2013 FGBNMS observed density (#/100 m²) of Scaridae (all parrotfish) shown by standard deviation categories (>2.5, 1.5 – 2.5, 0.5 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.

RESULTS

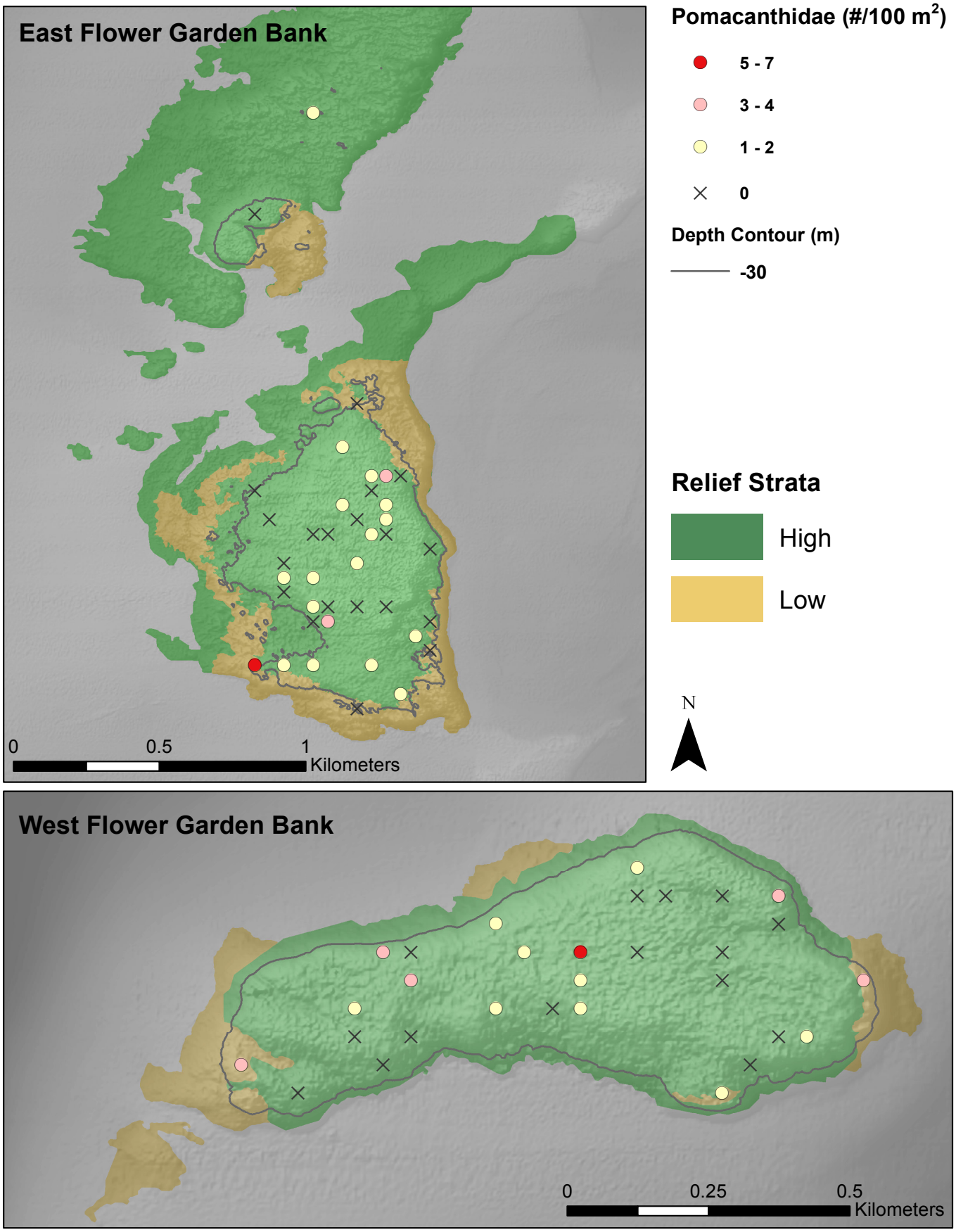


Figure 11. NCRMP 2013 FGBNMS observed density (#/100 m²) of Pomacanthidae (all angelfish) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.

Density and spatial distribution of key fish species

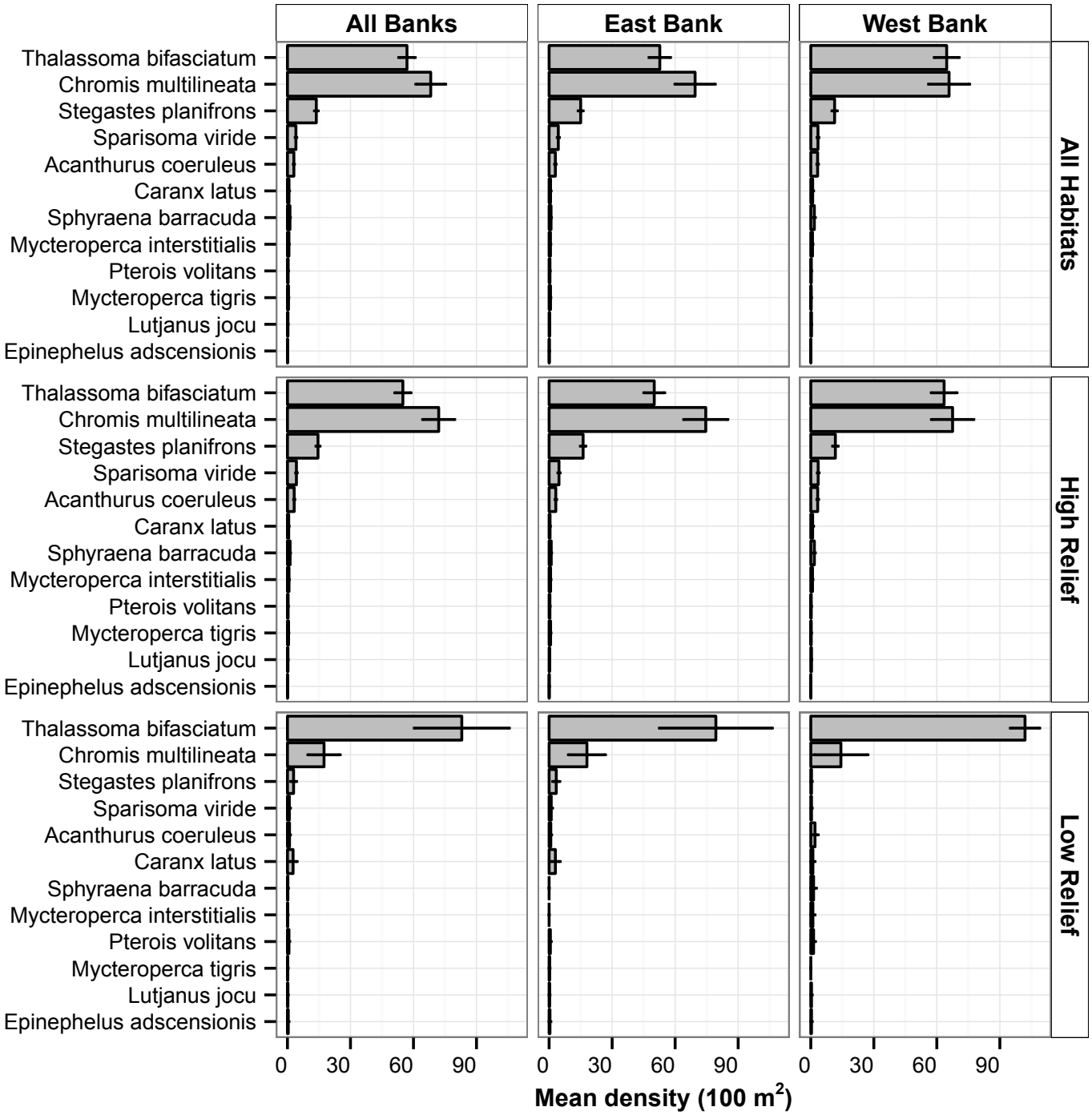
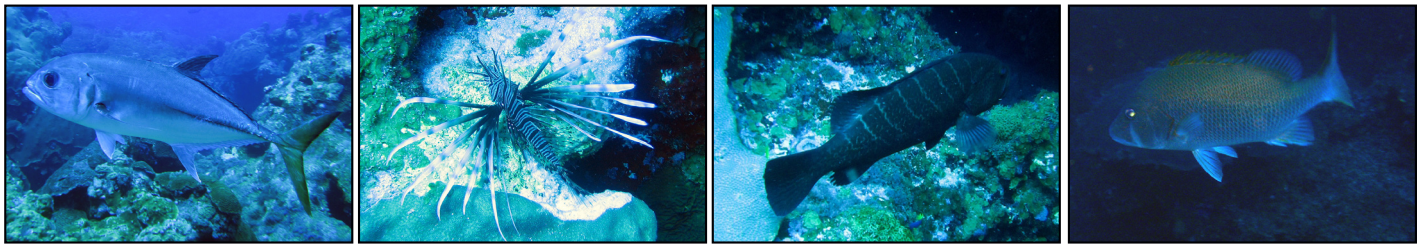


Figure 12. NCRMP 2013 FGBNMS density (#/100 m²) of key fish species, shown by biotope (columns) and habitat type (rows). Weighted means with standard error bars.



Photos of Caranx latus, Pterois volitans, Mycteroperca tigris *and* Lutjanus jocu *at FGNMS 2013 (NOAA NCCOS).*

RESULTS

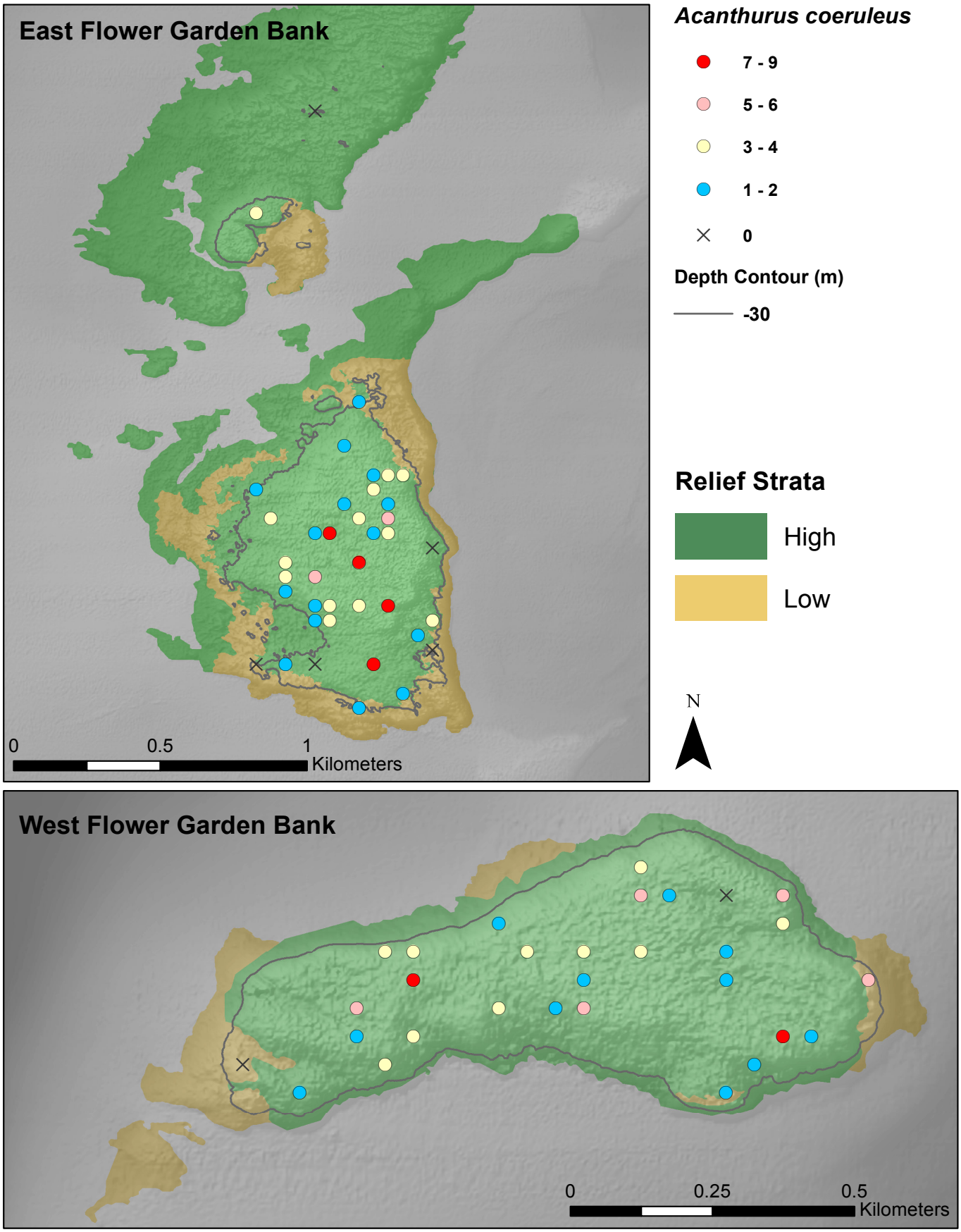


Figure 13. NCRMP 2013 FGBNMS observed density (#/100 m²) of Acanthurus coeruleus *(blue tang) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

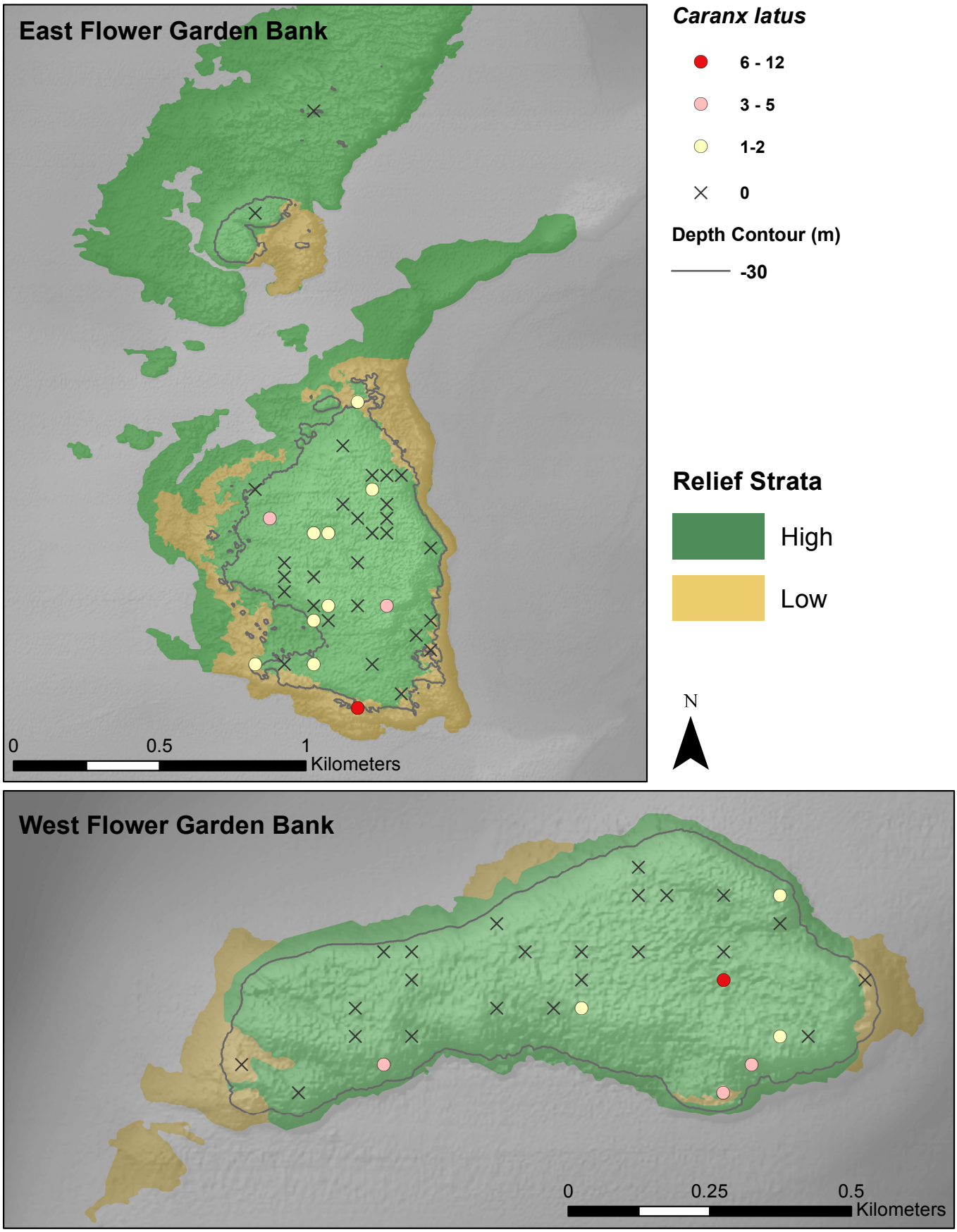


Figure 14. NCRMP 2013 FGBNMS observed density (#/100 m²) of Caranx latus *(horse-eye jack) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

RESULTS

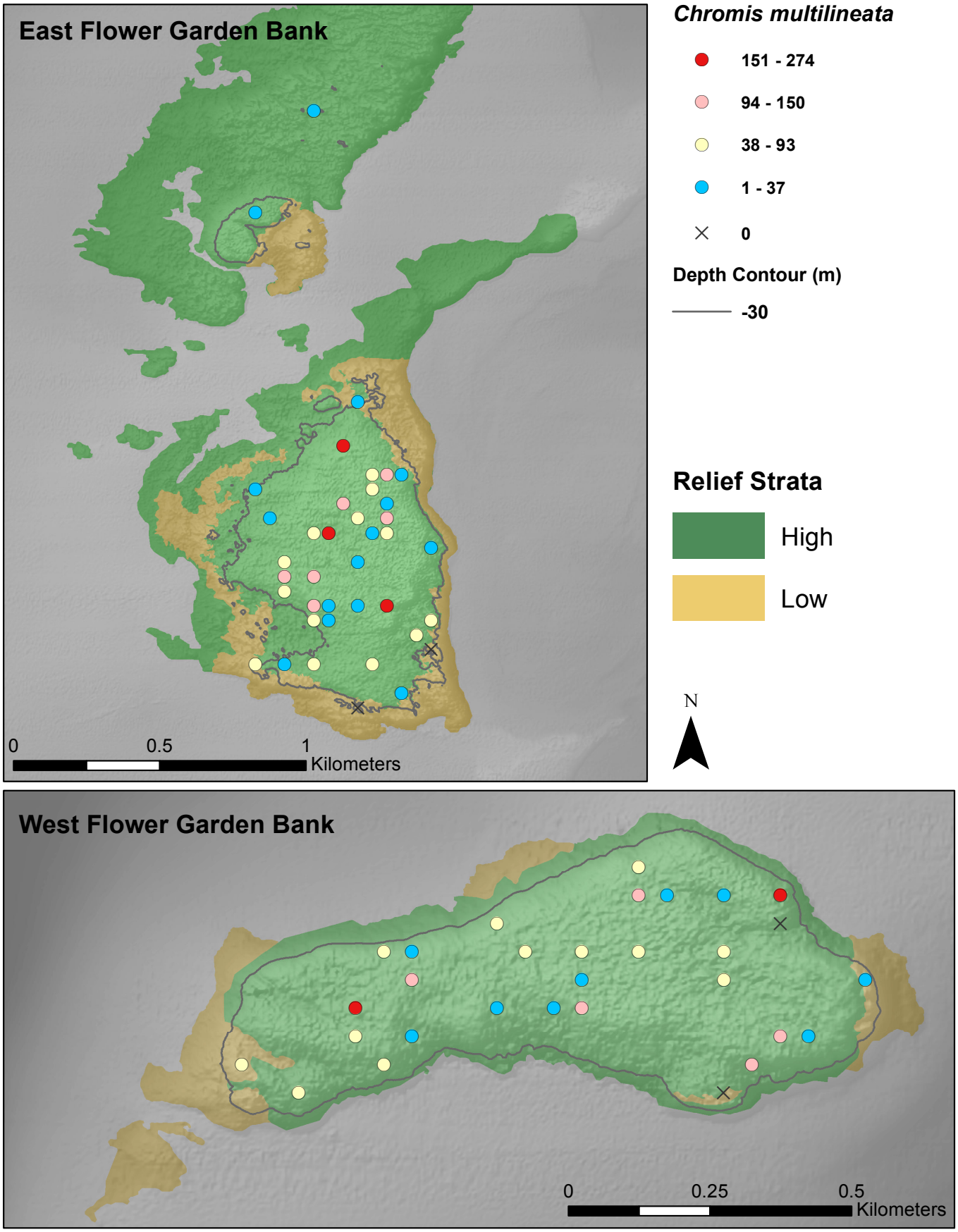


Figure 15. NCRMP 2013 FGBNMS observed density (#/100 m²) of Chromis multilineata *(brown chromis) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

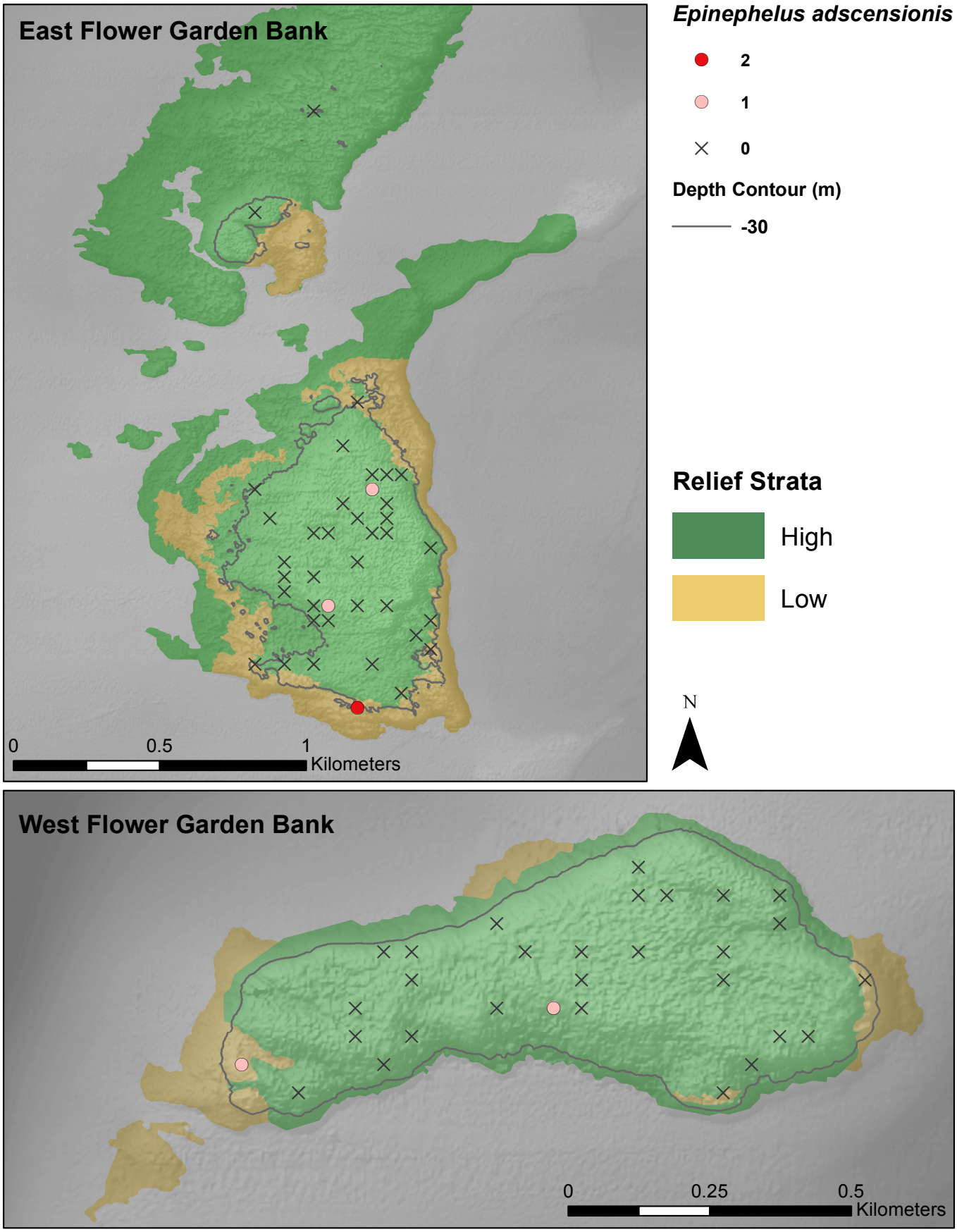


Figure16. NCRMP 2013 FGBNMS observed density (#/100 m²) of Epinephelus adscensionis *(rock hind). Observed values are shown in place of standard deviation because the species was encountered in low numbers at few locations.*

RESULTS

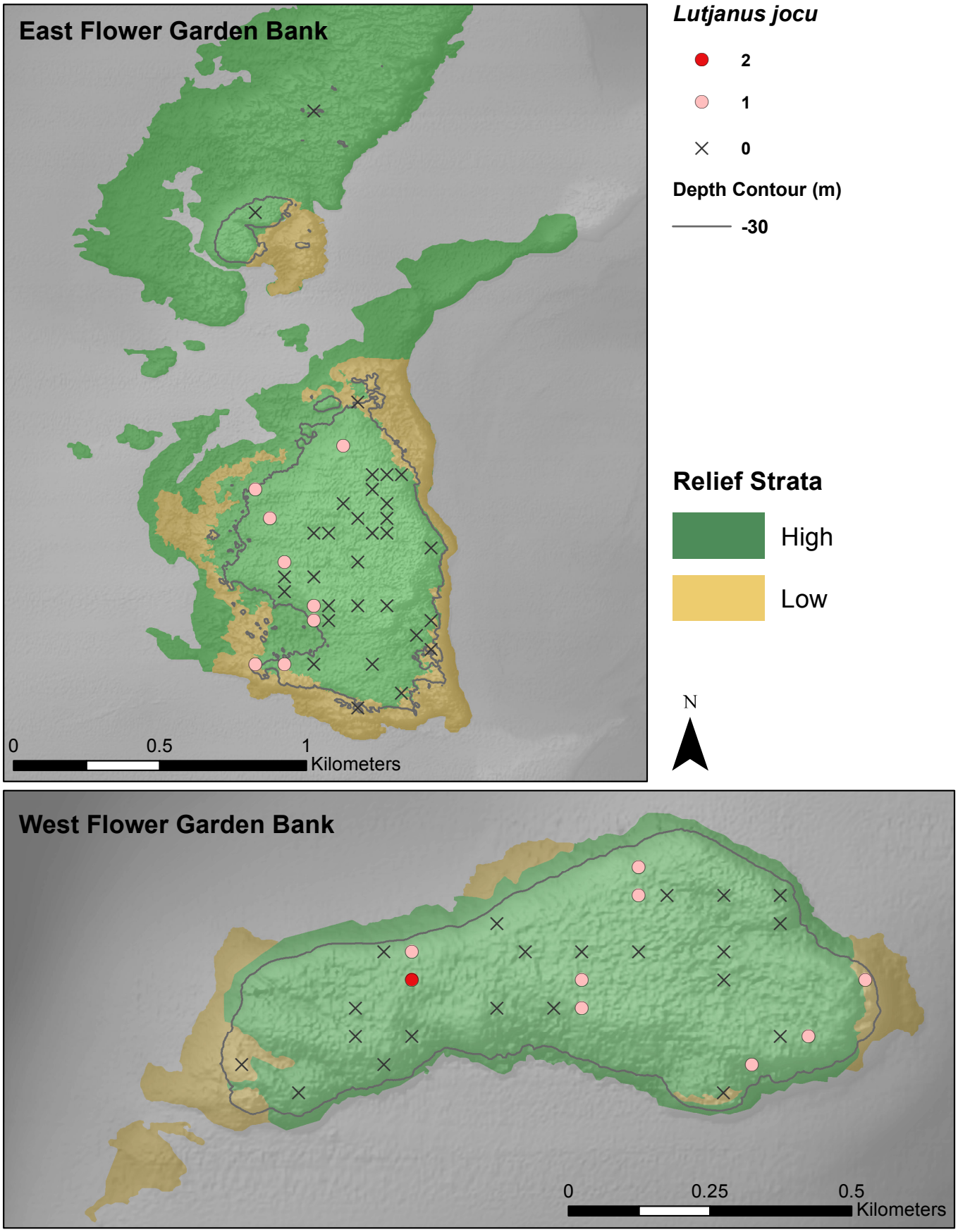


Figure 17. NCRMP 2013 FGBNMS observed density (#/100 m²) of Lutjanus jocu *(dog snapper). Observed values are shown in place of standard deviation because the species was encountered in low numbers at few locations.*

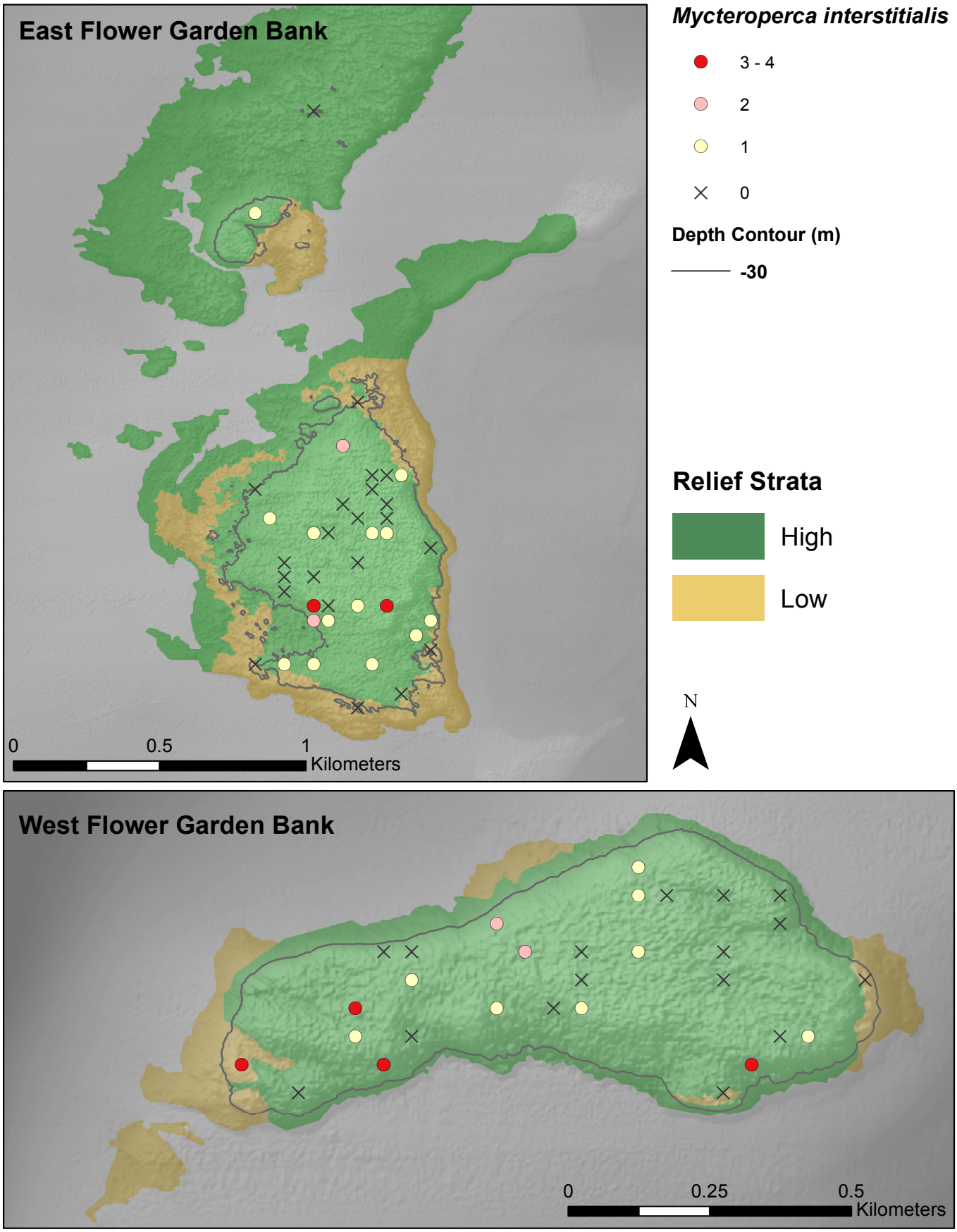


Figure18. NCRMP 2013 FGBNMS observed density (#/100 m^2) of Mycteroperca interstitialis *(yellowmouth grouper) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

RESULTS

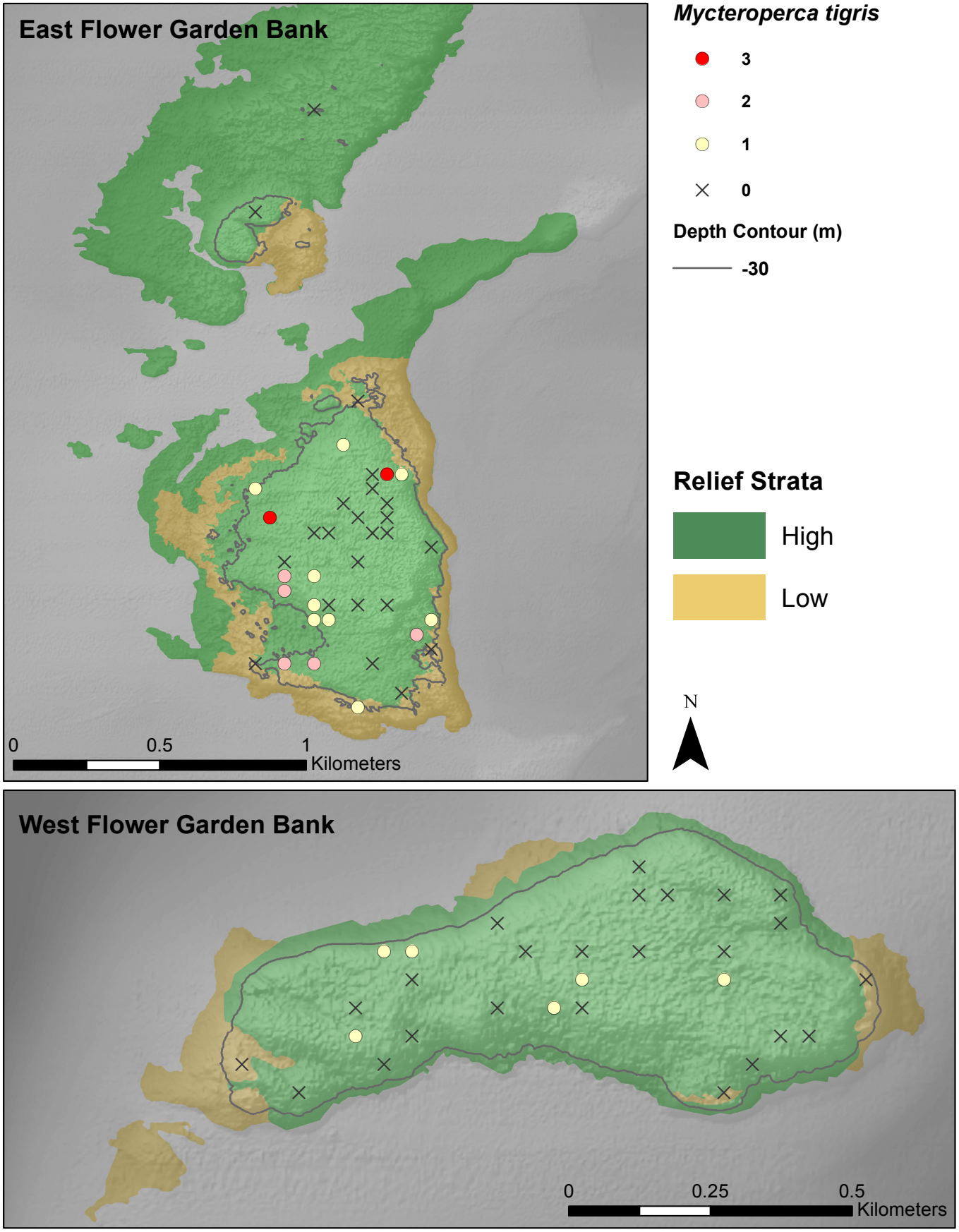


Figure 19. NCRMP 2013 FGBNMS observed density (#/100 m²) of Mycteroperca tigris *(tiger grouper) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

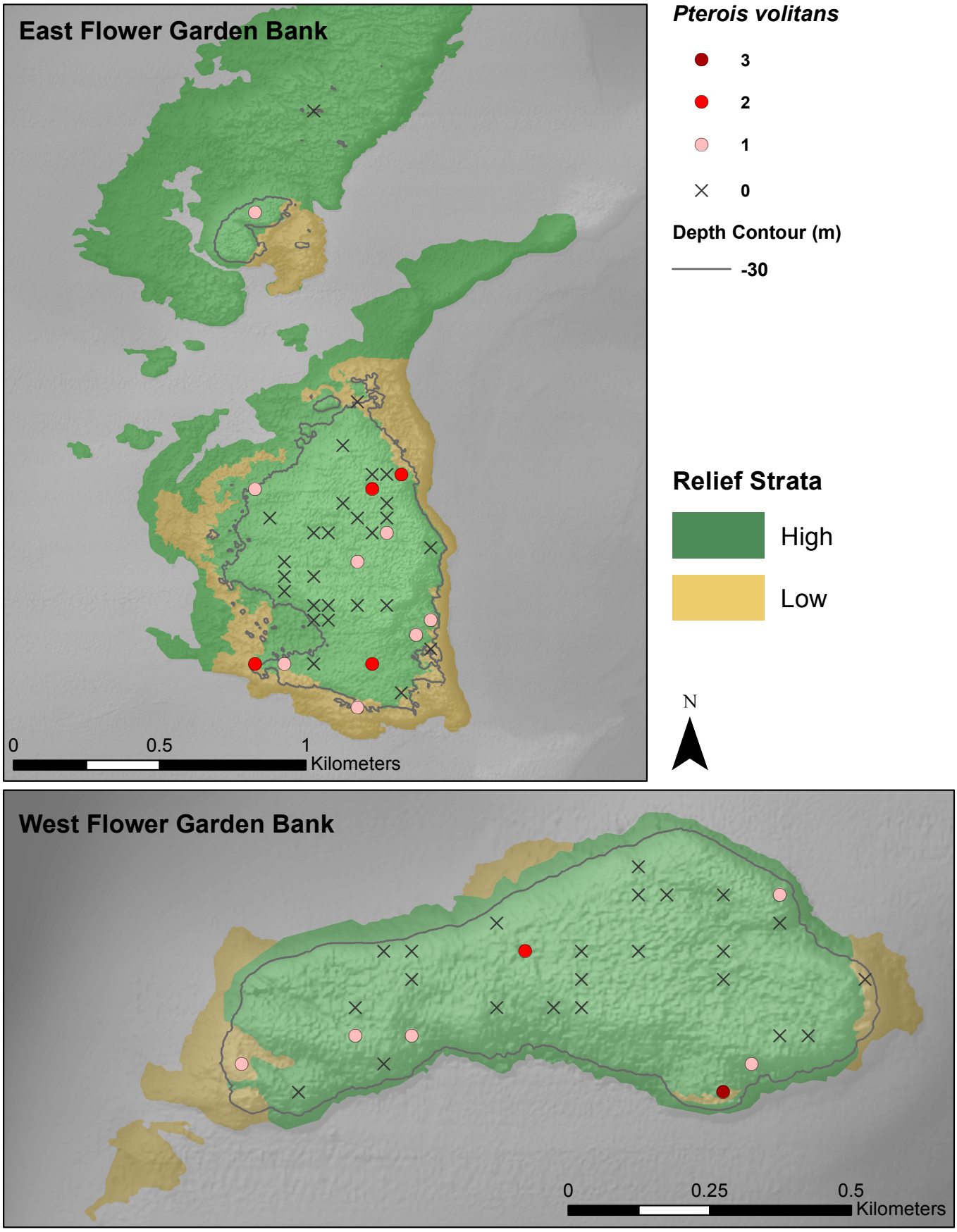


Figure 20. NCRMP 2013 FGBNMS observed density (#/100 m²) of Pterois volitans *(red lionfish). Observed values are shown in place of standard deviation because the species was encountered in low numbers at few locations.*

RESULTS

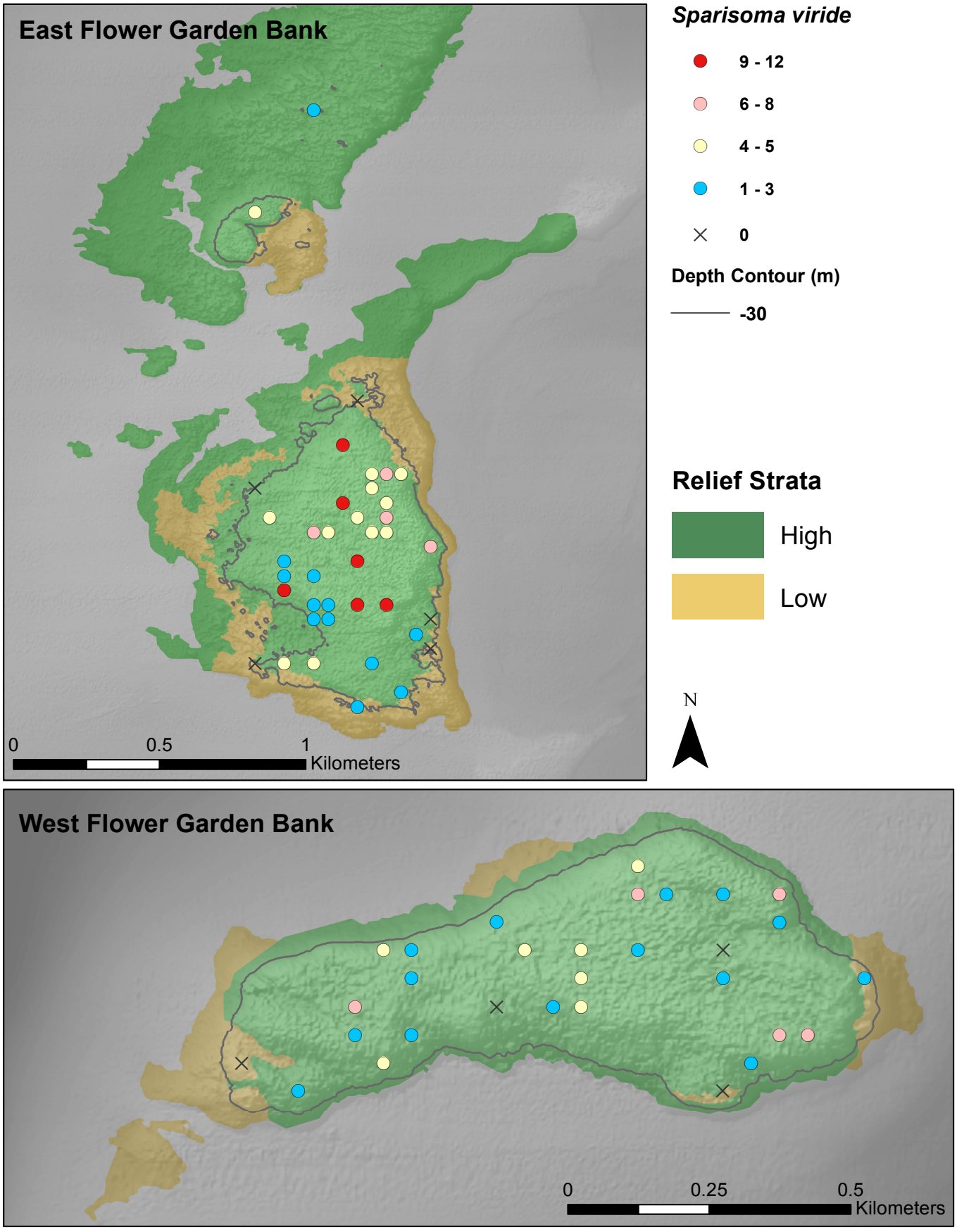


Figure 21. NCRMP 2013 FGBNMS observed density (#/100 m²) of Sparisoma viride *(stoplight parrotfish) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, < -0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

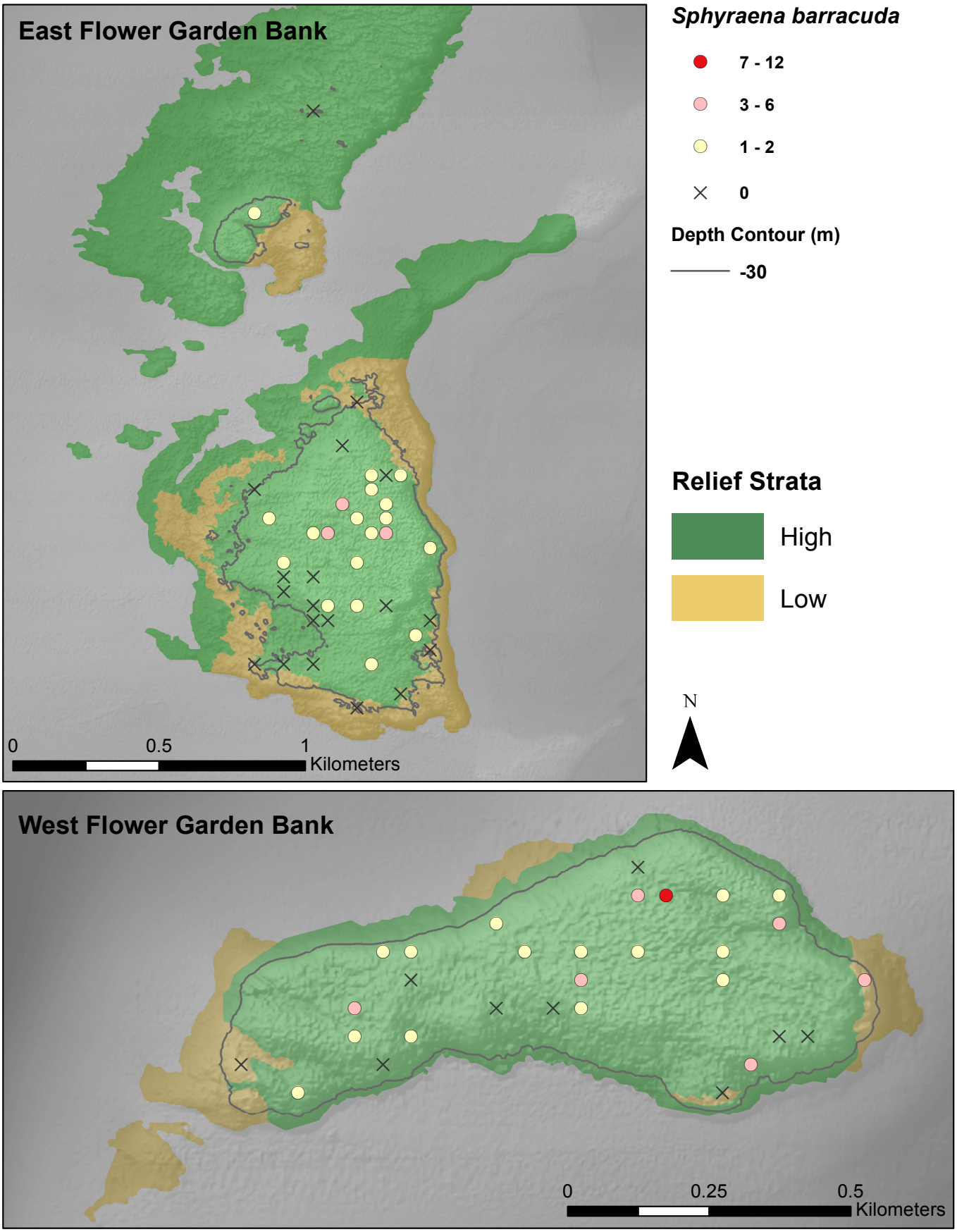


Figure 22. NCRMP 2013 FGBNMS observed density (#/100 m²) of Sphyraena barracuda *(barracuda) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

RESULTS

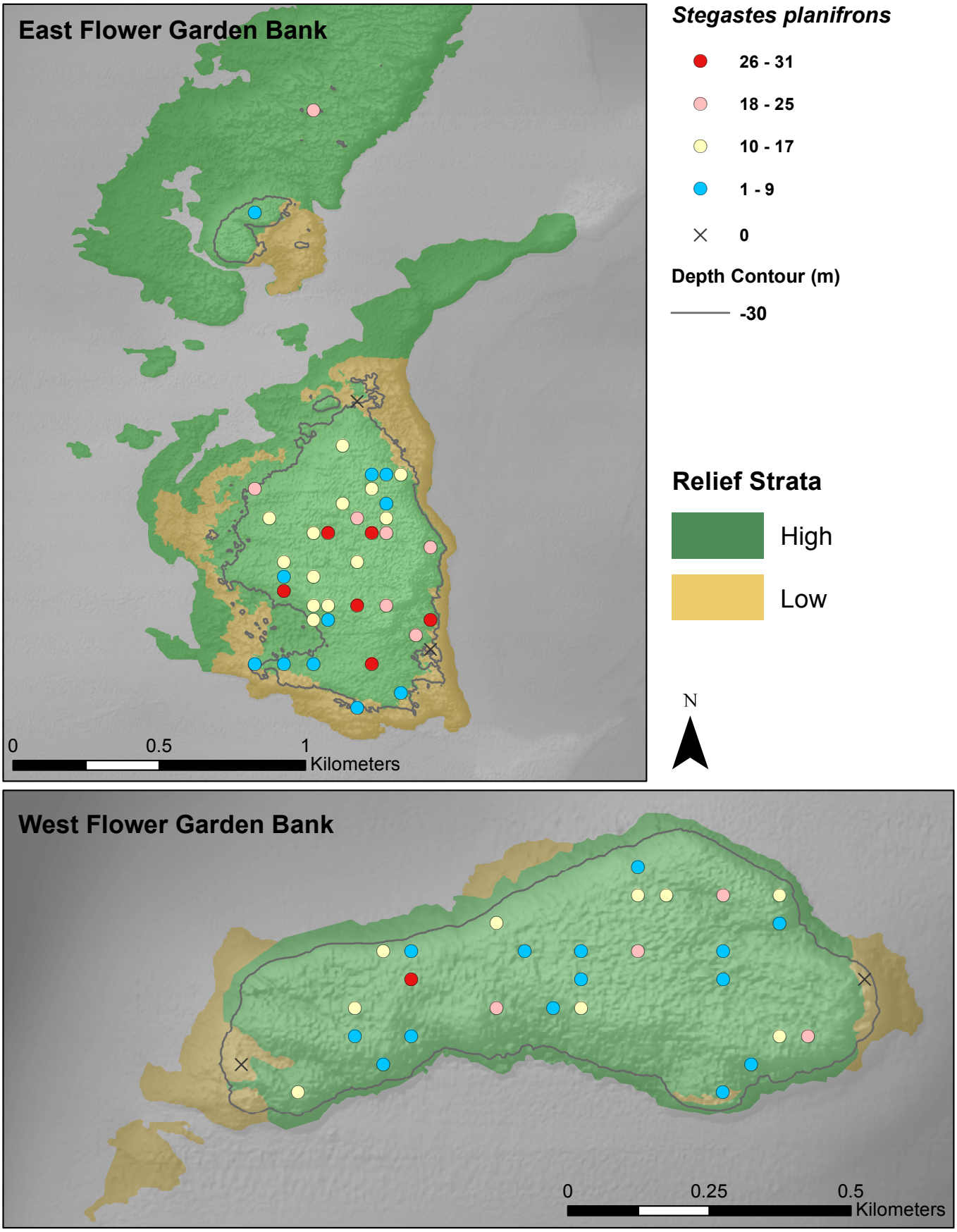


Figure 23. NCRMP 2013 FGBNMS observed density (#/100 m²) of Stegastes planifrons *(threespot damselfish) shown by standard deviation categories (>1.5, 0.5 – 1.5, -0.50 – 0.50, < -0.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

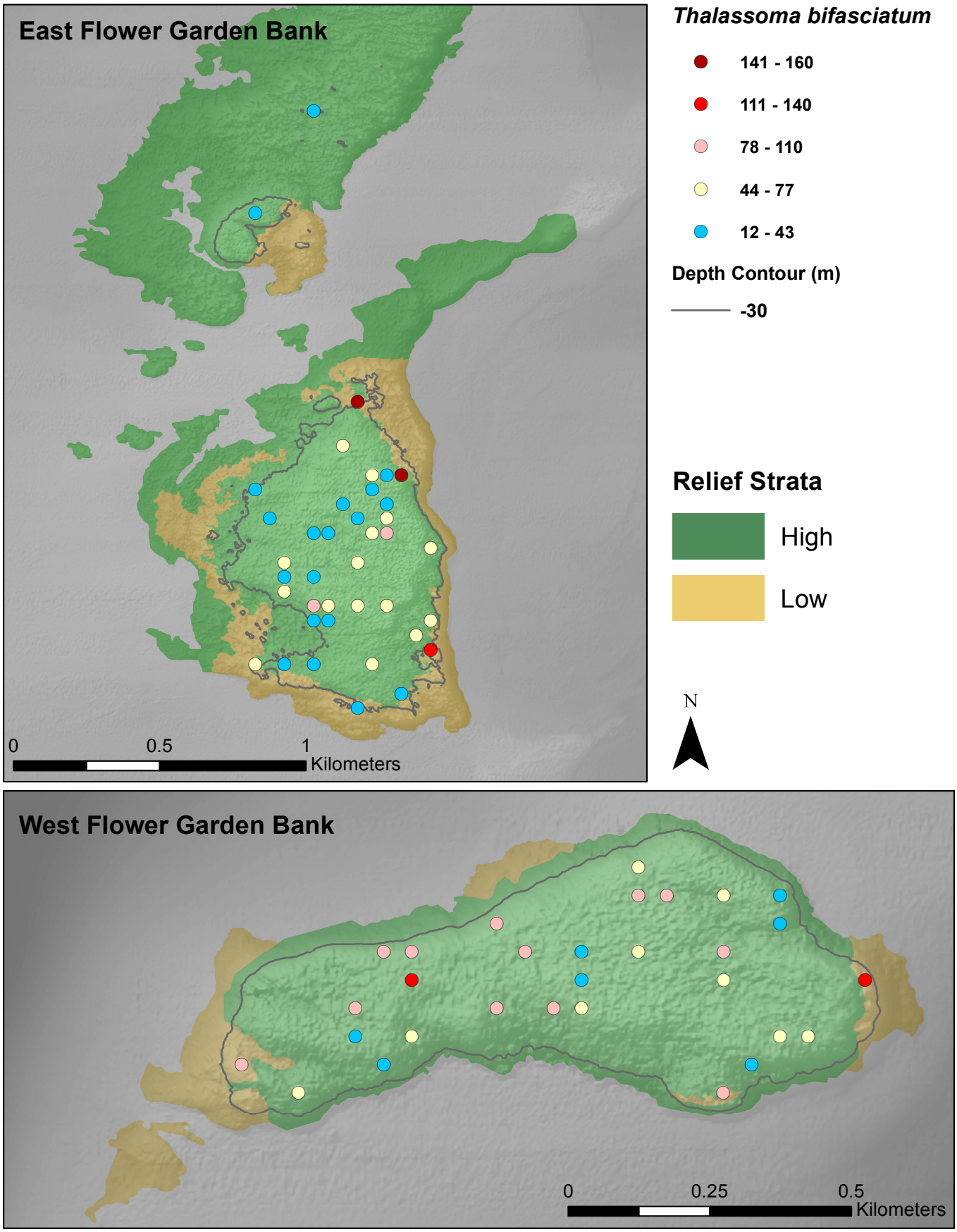


Figure 24. NCRMP 2013 FGBNMS observed density (#/100 m²) of Thalassoma bifasciatum *(bluehead wrasse) shown by standard deviation categories (>2.5, 1.5 – 2.5, 0.5 – 1.5, -0.50 – 0.50, < -0.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.*

RESULTS

Benthic habitats

In NCRMP FGBNMS 2013 sampling, 69 sites were surveyed for benthic cover (LPI) and key species, and 34 sites were surveyed for coral demographics.

Cover of benthic habitat categories

Cover data (from LPI surveys) were grouped into the following general categories: algae, hard corals, bare substrate (hard), bare substrate (soft), bare substrate (rubble), hydrocorals, sponges, and cyanobacteria.

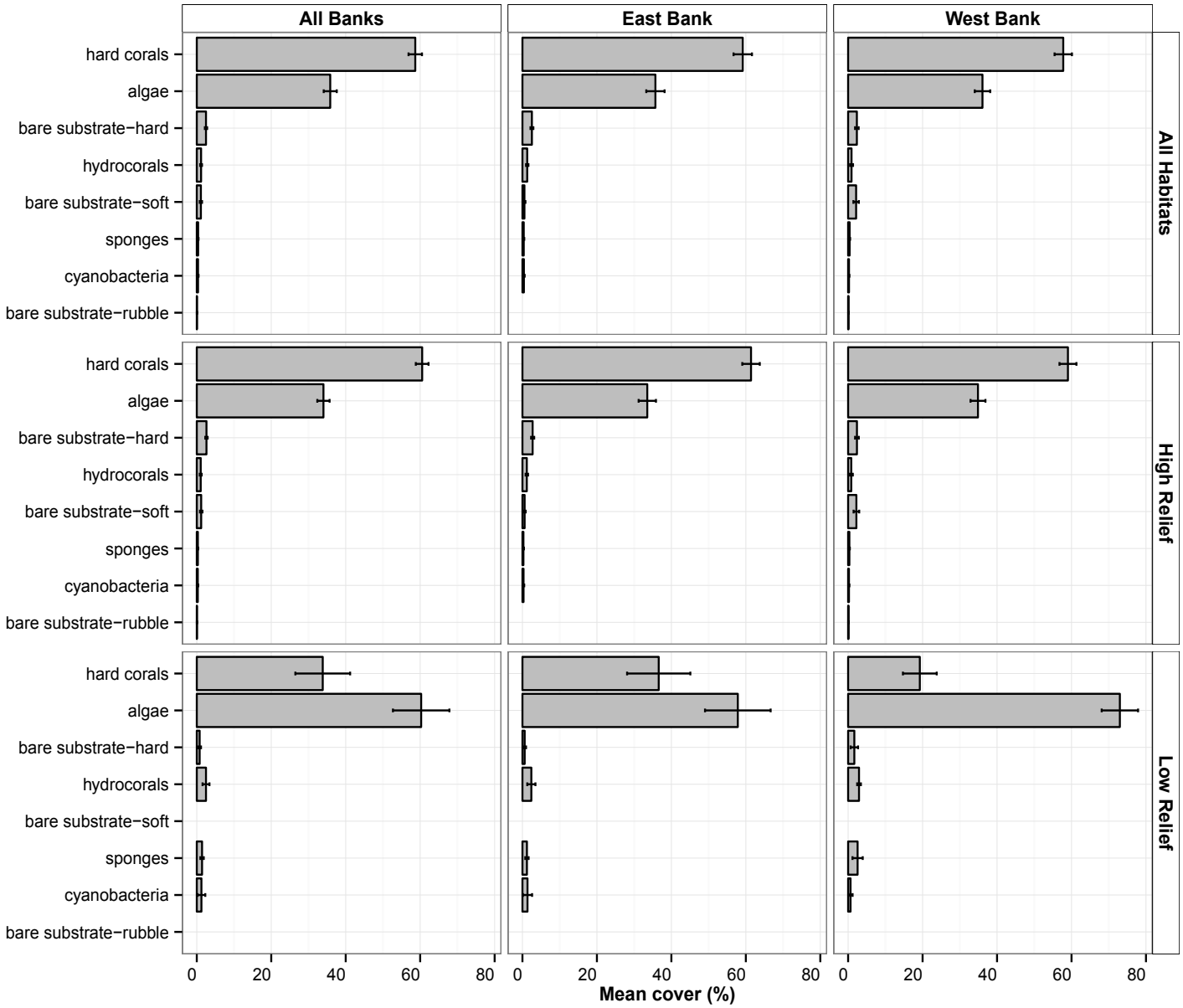


Figure 25. NCRMP 2013 FGBNMS general benthic habitat cover (%) by biotope (columns) and habitat type (rows). Weighted means with standard error bars.

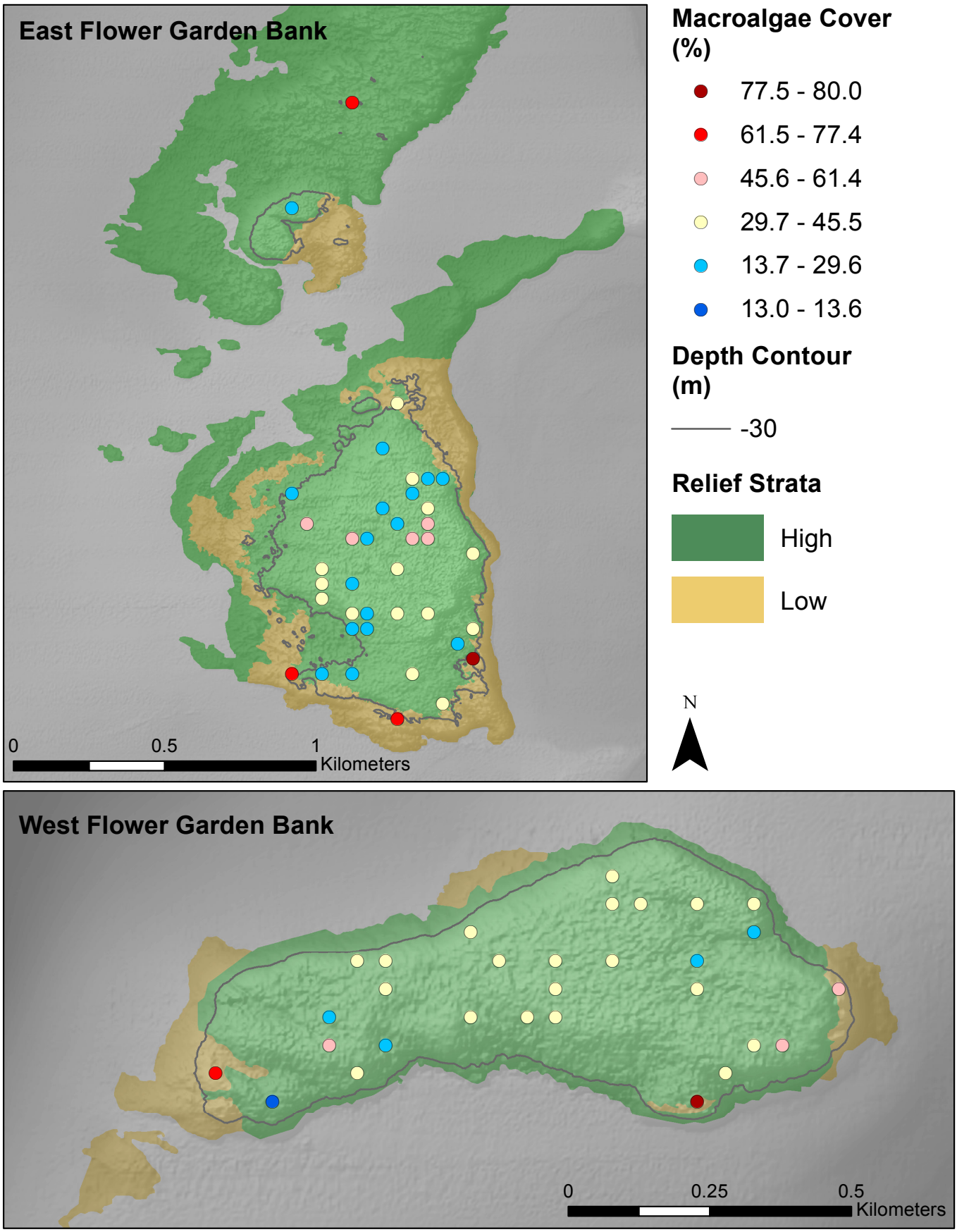


Figure 26. NCRMP 2013 FGBNMS observed macroalgal cover (%), shown by standard deviation categories (>2.5, 1.5 – 2.5, 0.5 – 1.5, -0.50 – 0.50, -0.50 – -1.5, <-1.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.

RESULTS

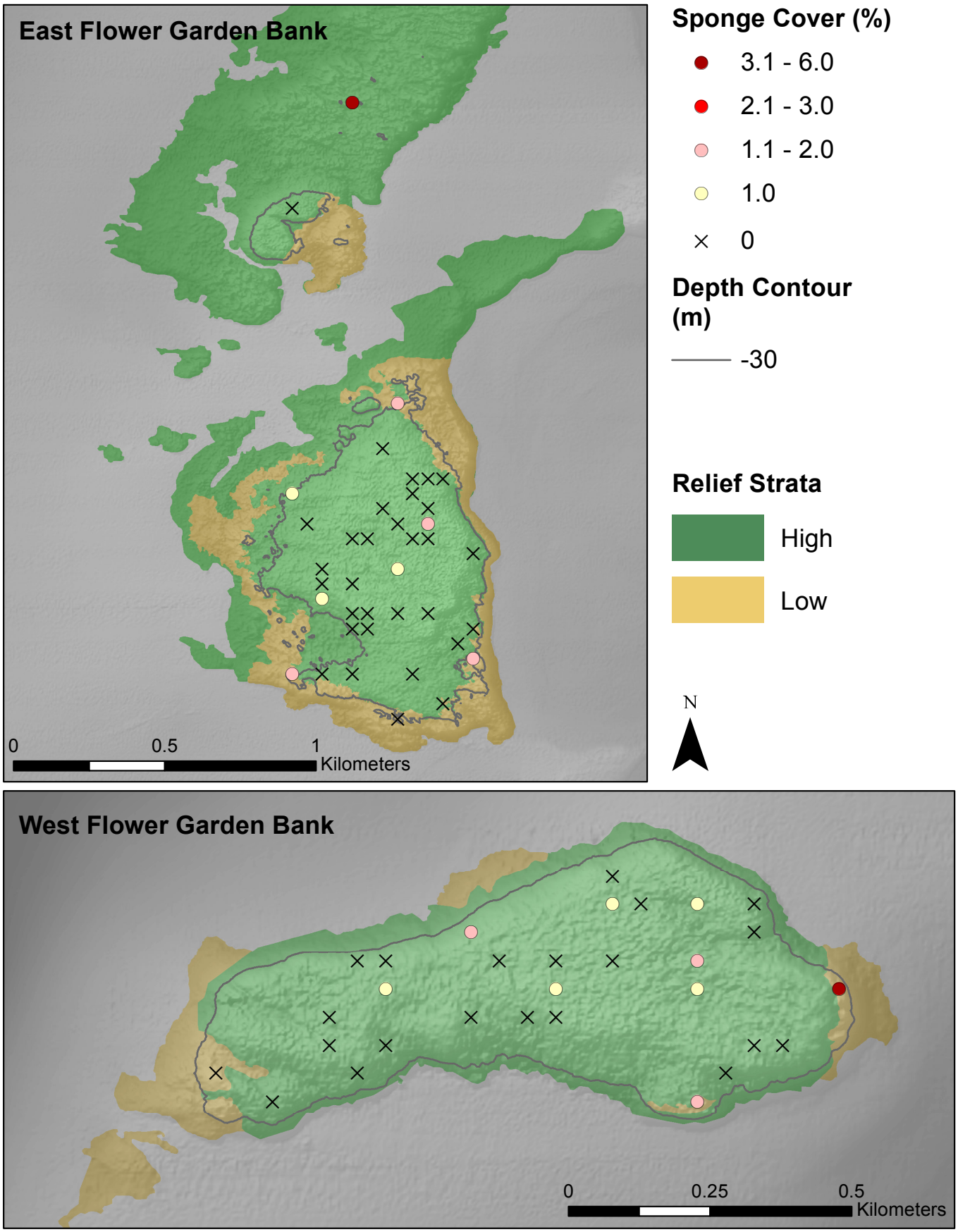
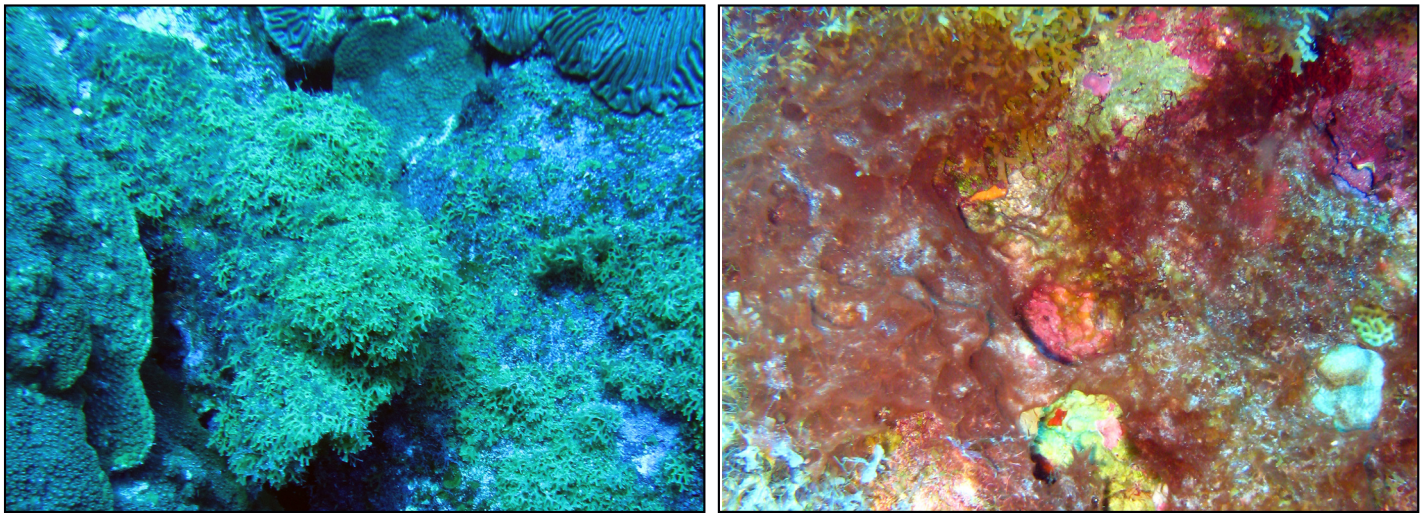


Figure 27. NCRMP 2013 FGBNMS observed sponge cover (%), shown by standard deviation categories (>2.5, 1.5 – 2.5, 0.5 – 1.5, <0.50). Yellow circles symbolize the mean +/- 0.5 standard deviation.



Photos of Dictyota *algae and filamentous/cyanobacteria at FGNMS 2013 (NOAA NCCOS).*

Coral cover

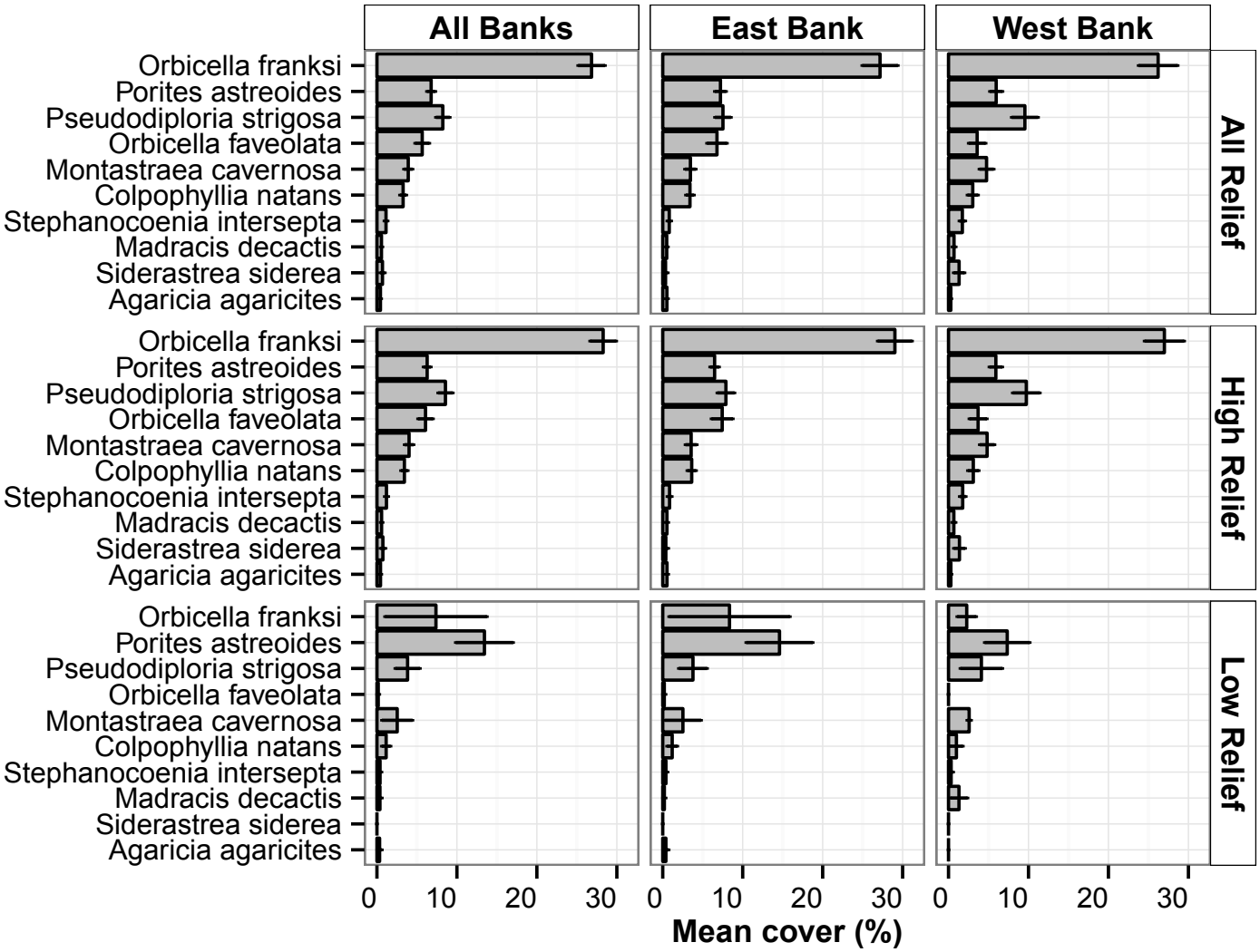


Figure 28. NCRMP 2013 FGBNMS coral species with the highest cover (%) shown by biotope (columns) and habitat type (rows). Weighted means with standard error bars.

RESULTS

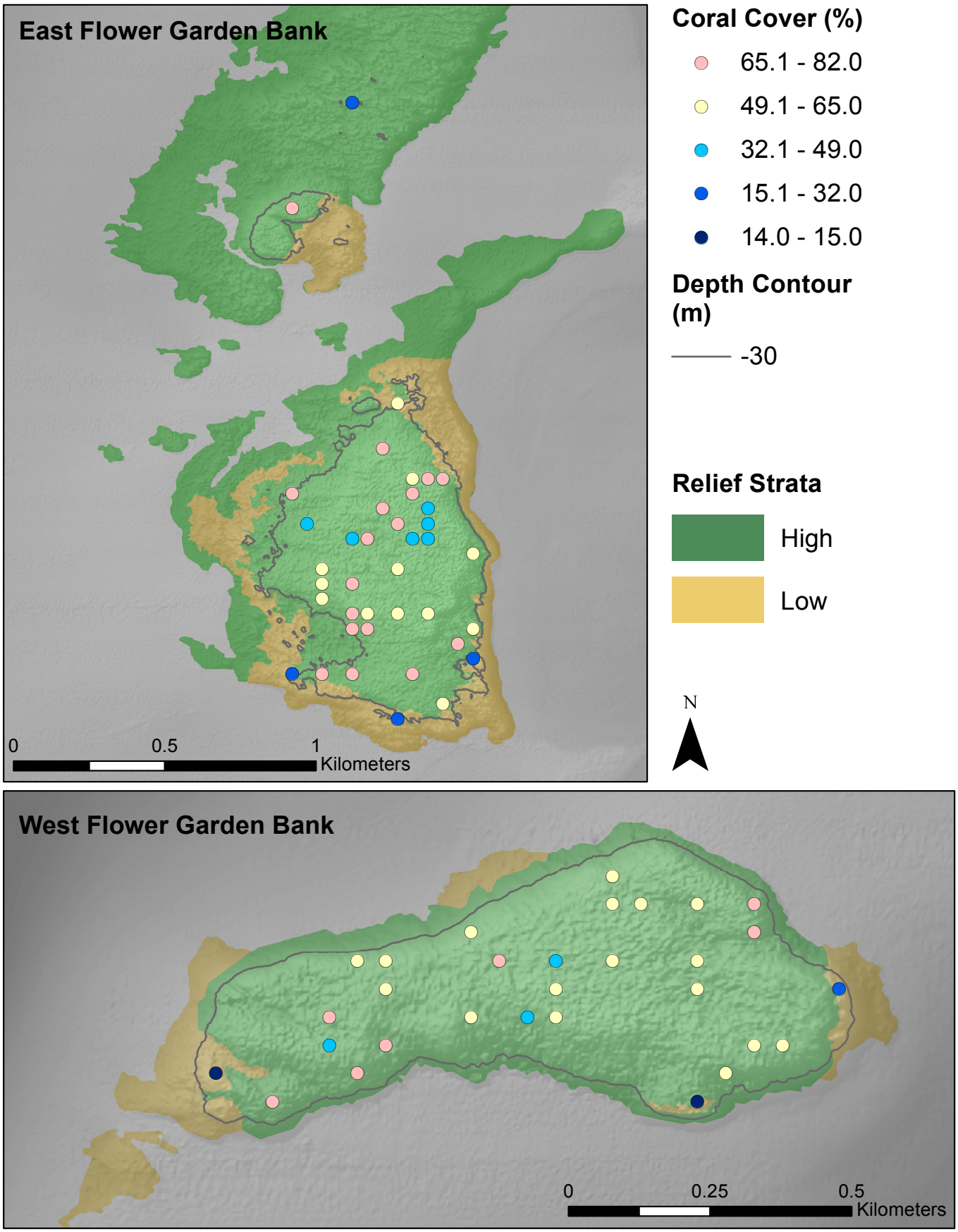


Figure 29. NCRMP 2013 FGBNMS observed total coral cover (%), shown by standard deviation categories (>0.50, -0.50 – 0.50, -1.5 – -0.50, -2.5 – -1.5, <-2.5). Yellow circles symbolize the mean +/-0.5 standard deviation.

Coral species richness

Table 5. NCRMP 2013 FGBNMS coral species richness (number of coral species) for the region by biotope and habitat type for line point intercept, demographic surveys, and overall.

Survey Method	No. of surveys	East Bank	West Bank	High Relief	Low Relief
Line Point Intercept	17	16	14	17	12
Demographic	23	19	19	22	11
All methods combined	25	22	20	25	16

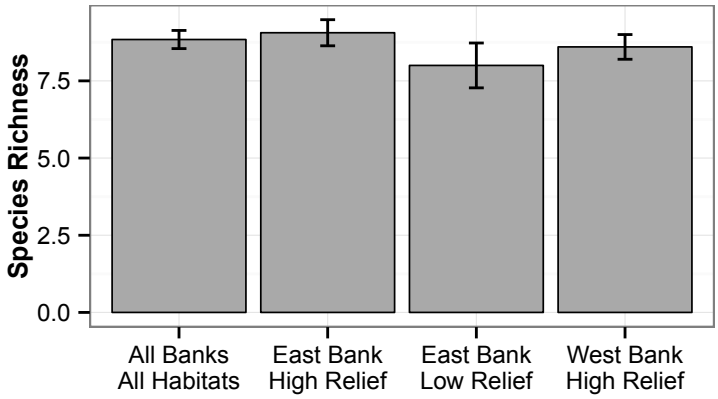
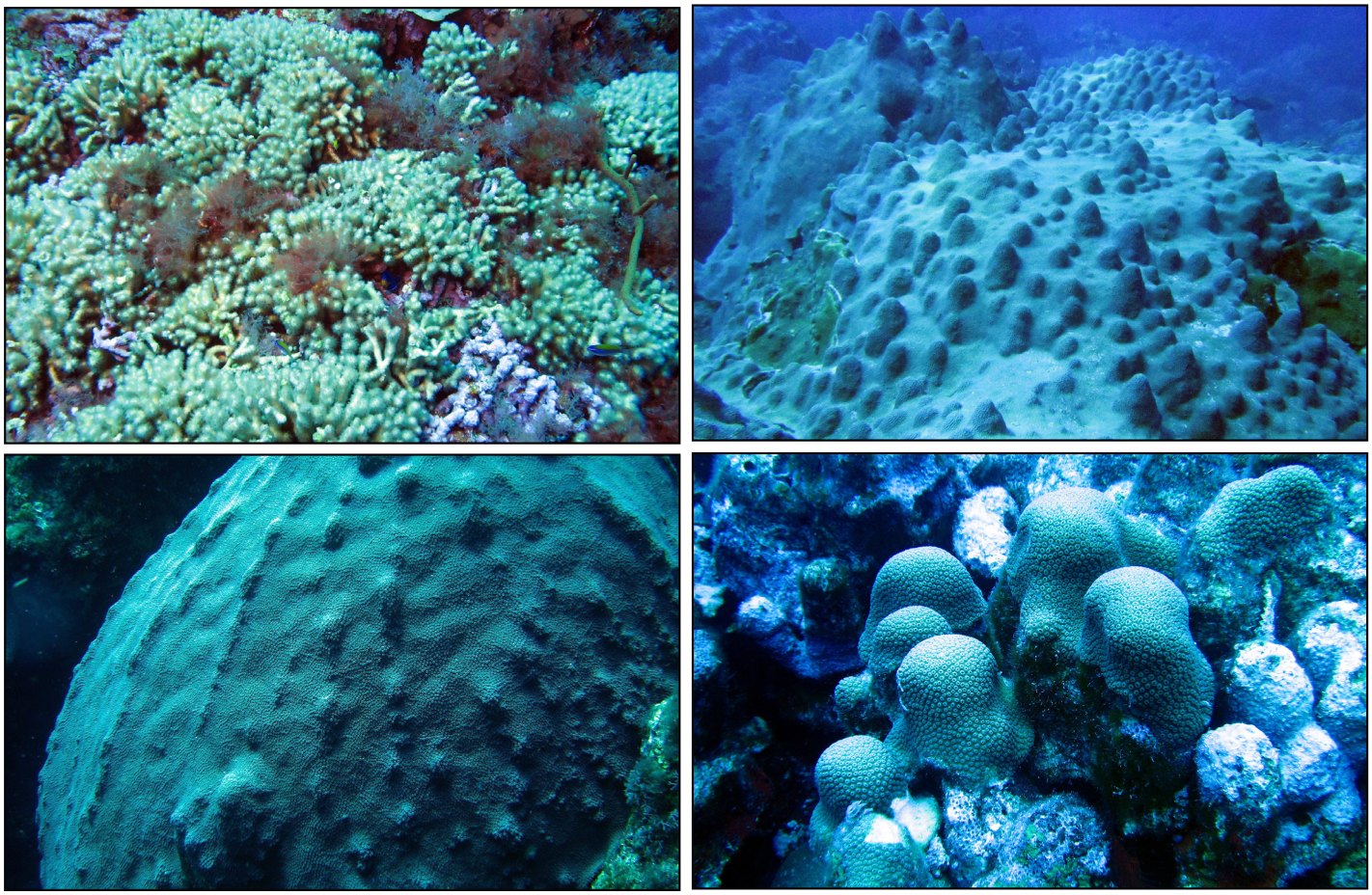


Figure 30. Species richness of corals for each biotope and habitat strata in NCRMP 2013 FGBNMS sampling effort. Weighted means with standard error bars.



Photos of observed coral species (L-R): Madracis auretenra *(J. Embesi, NOAA ONMS/FGBNMS) and* Orbicella franski, Orbicella faveolata, *and* Orbicella annularis *(NOAA NCCOS) at FGBNMS 2013.*

RESULTS

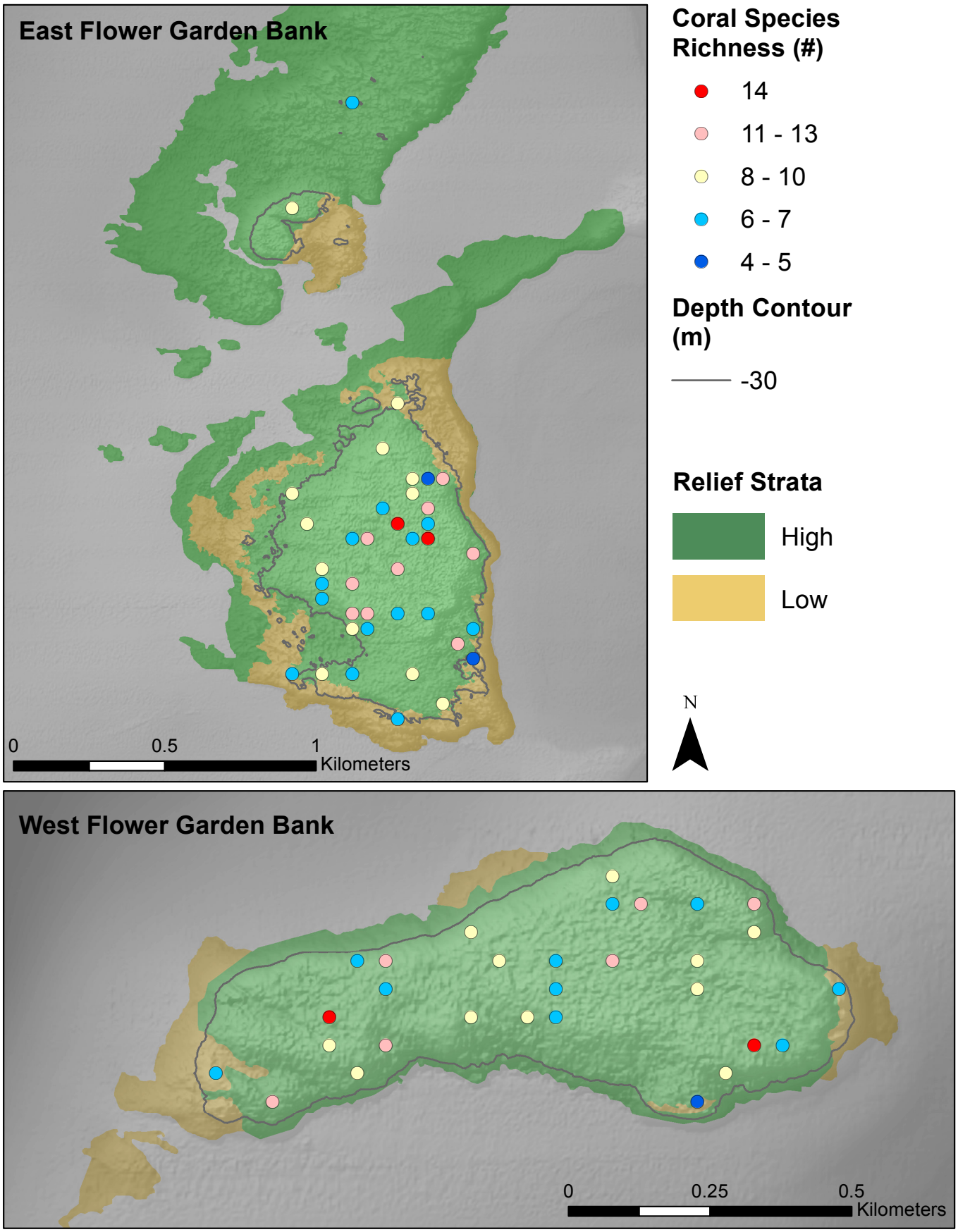


Figure 31. NCRMP 2013 FGBNMS observed coral species richness (# species/site), shown by standard deviation categories (>1.5, 0.50 – 1.5, -0.50 – 0.50, -1.5 – -0.50, <-1.5). Yellow circles symbolize the mean +/- 0.5 standard deviation.

Coral density

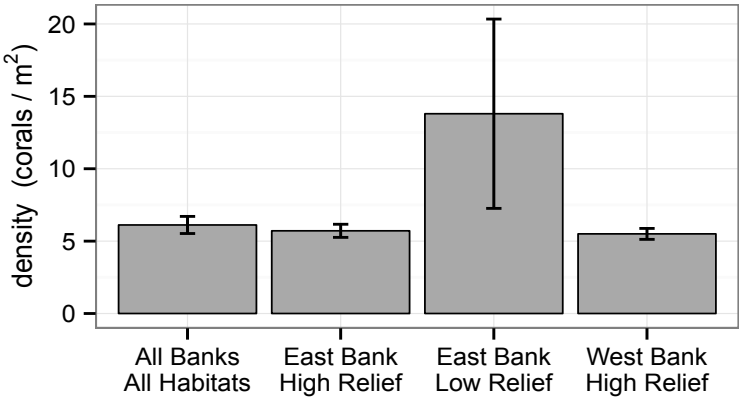


Figure 32. Overall coral density (corals/m2) shown by biotope and habitat type in NCRMP 2013 FGBNMS sampling effort. Weighted means with standard error bars.

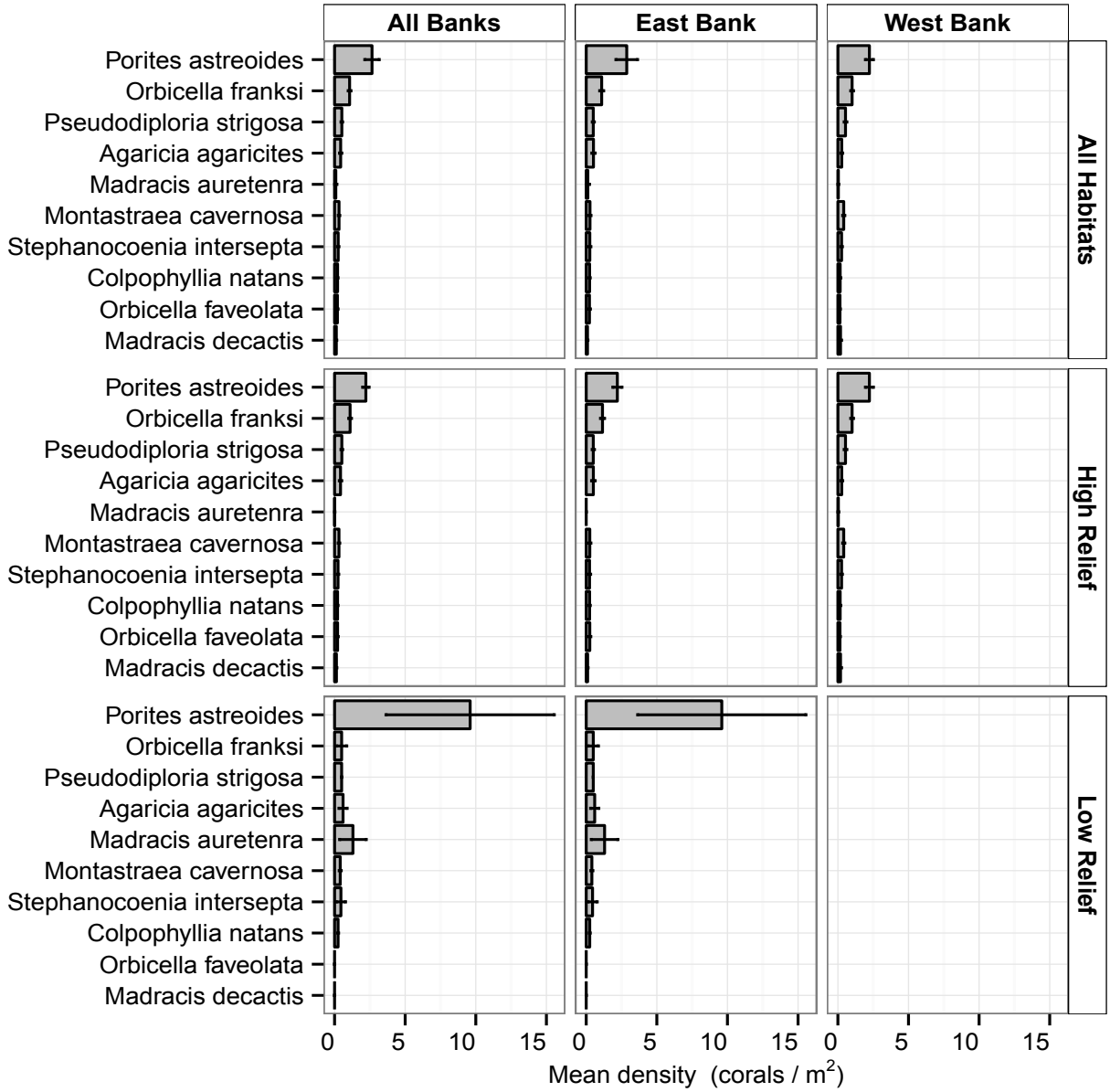


Figure 33. Mean species level density (corals / m²) of most abundant corals shown by biotope (columns) and habitat type (rows) in NCRMP 2013 FGBNMS sampling effort. Weighted means with standard error bars.

RESULTS

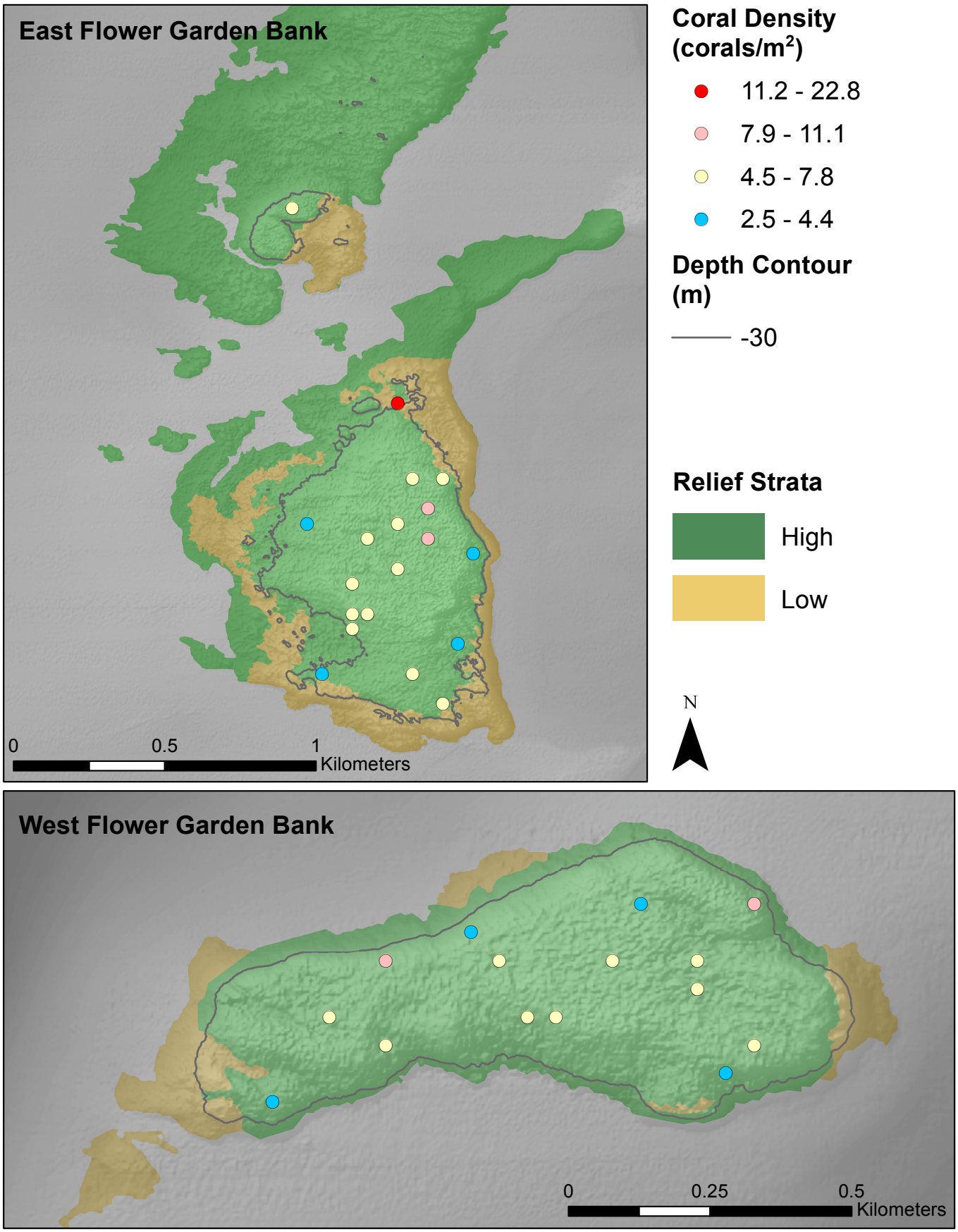


Figure 34. NCRMP 2013 FGBNMS observed coral colony density (coral/m²), shown by standard deviation categories (>1.5, 0.50 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize the mean +/-0.5 standard deviation.

Coral size estimations

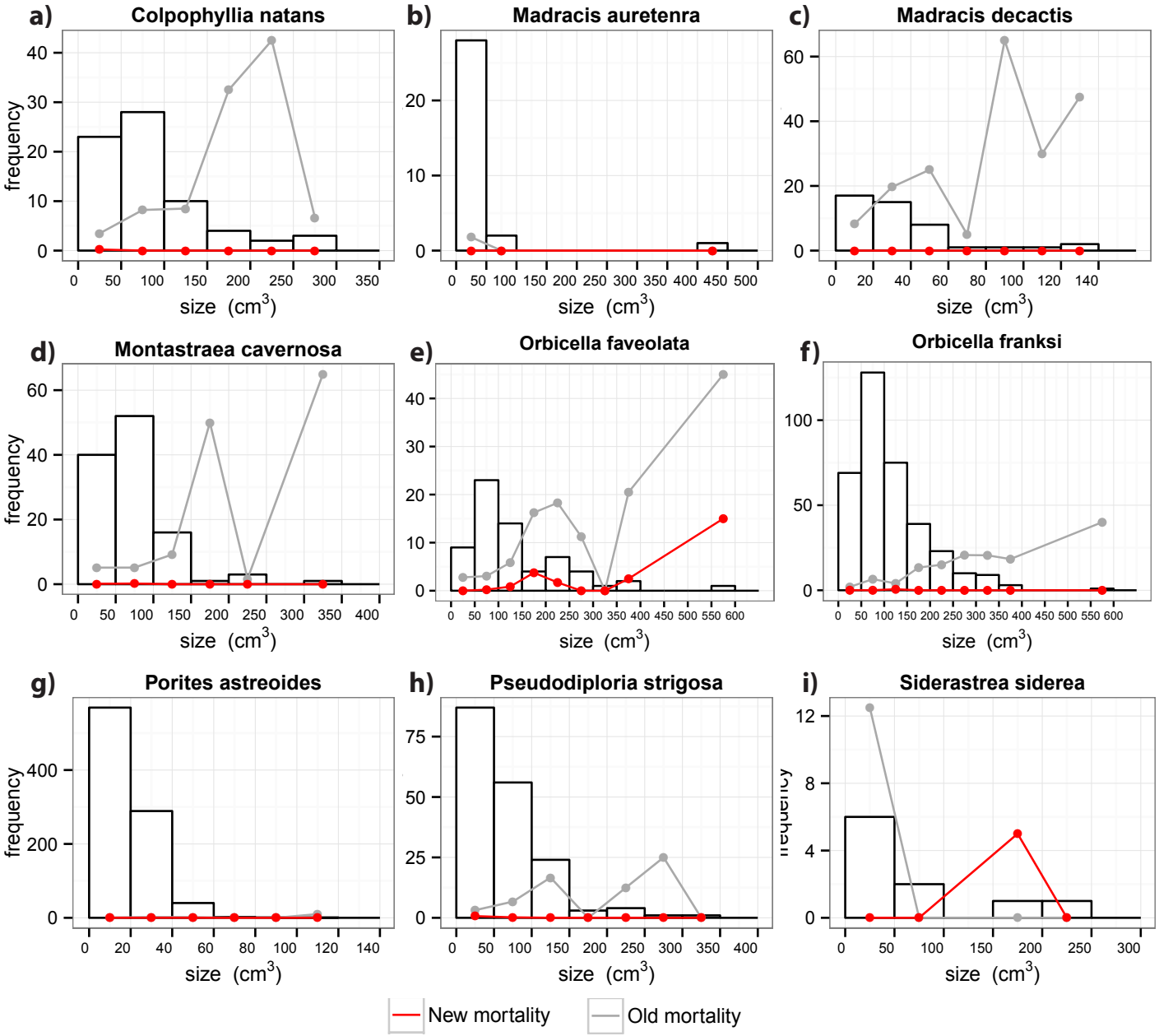


Figure 35. NCRMP 2013 FGBNMS size distribution and frequency of new and old mortality of nine of the most abundant coral species: a) Colpophyllia natans, *b)* Madracis auretenra, *c)* Madracis decactis, *d)* Montastraea cavernosa, *e)* Orbicella faveolata, *f)* Orbicella franksi, *g)* Porites astreoides, *h)* Pseudodiploria strigosa, *and i)* Siderastrea siderea.

RESULTS

Coral condition

Coral mortality

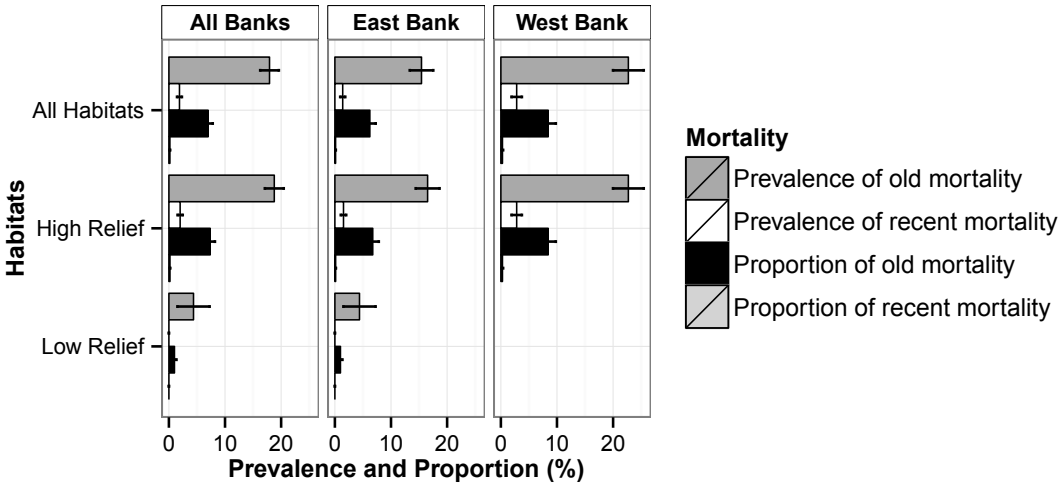


Figure 36. NCRMP 2013 FGBNMS overall mean mortality prevalence and proportion (%) of corals within biotope (columns) and habitat type (rows). Weighted means with standard error bars.

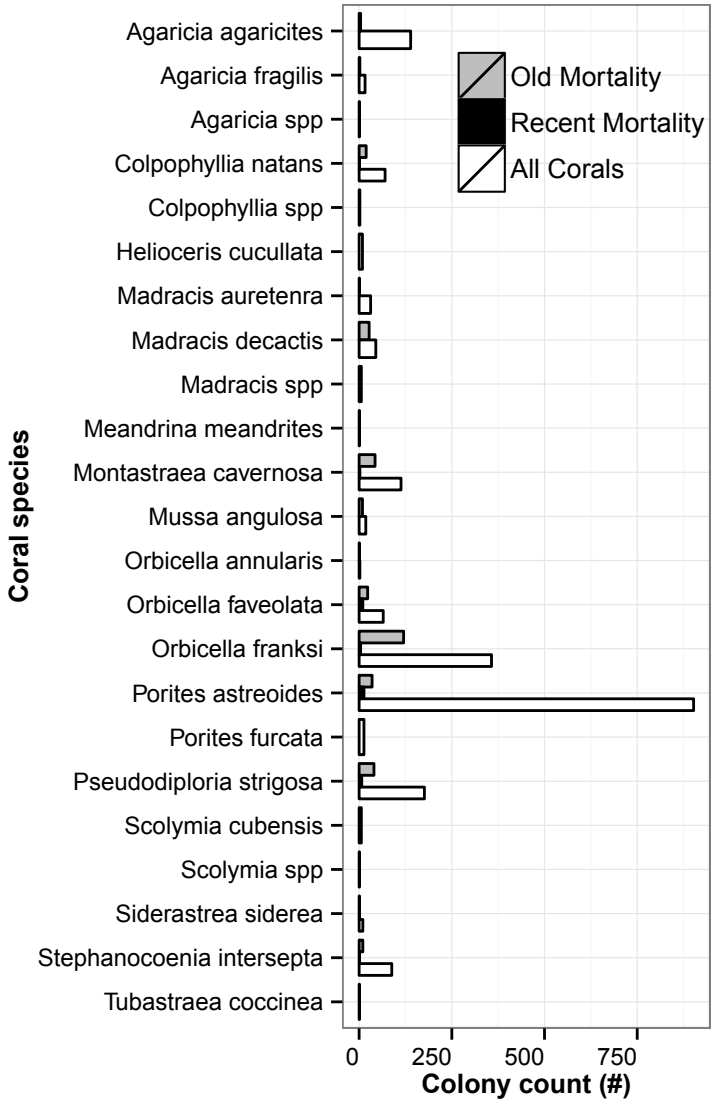


Figure 37. NCRMP 2013 FGBNMS prevalence of mortality as counts of colonies with old mortality (gray), recent mortality (black), and the total number of colonies counted for each coral species in demographic surveys (white).

Coral bleaching

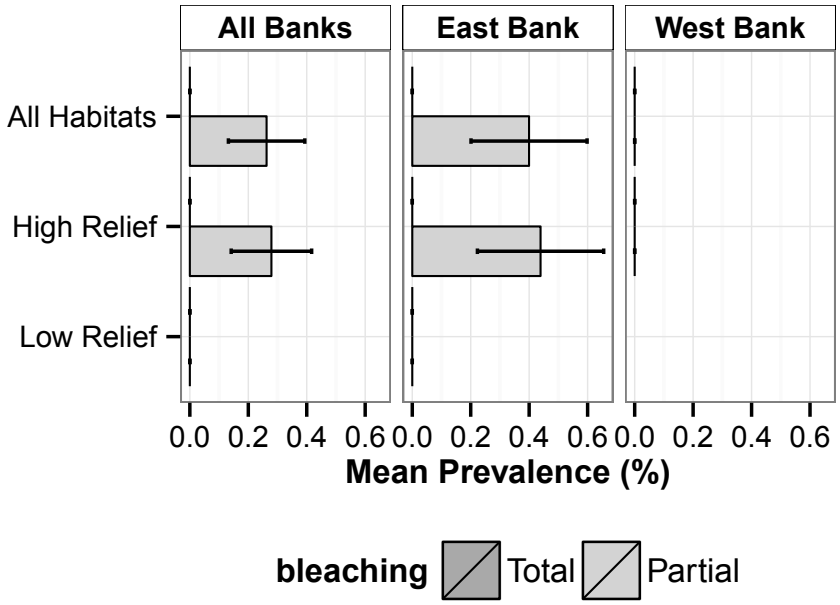


Figure 38. NCRMP 2013 FGBNMS bleaching prevalence by biotope (columns) and habitat type (rows). Weighted means and standard error bars.

Threatened coral species

Acropora cervicornis, *Acropora palmata*, *Dendrogyra cylindrus* and *Mycetophyllia ferox* were not observed in the NCRMP 2013 FGBNMS surveys.

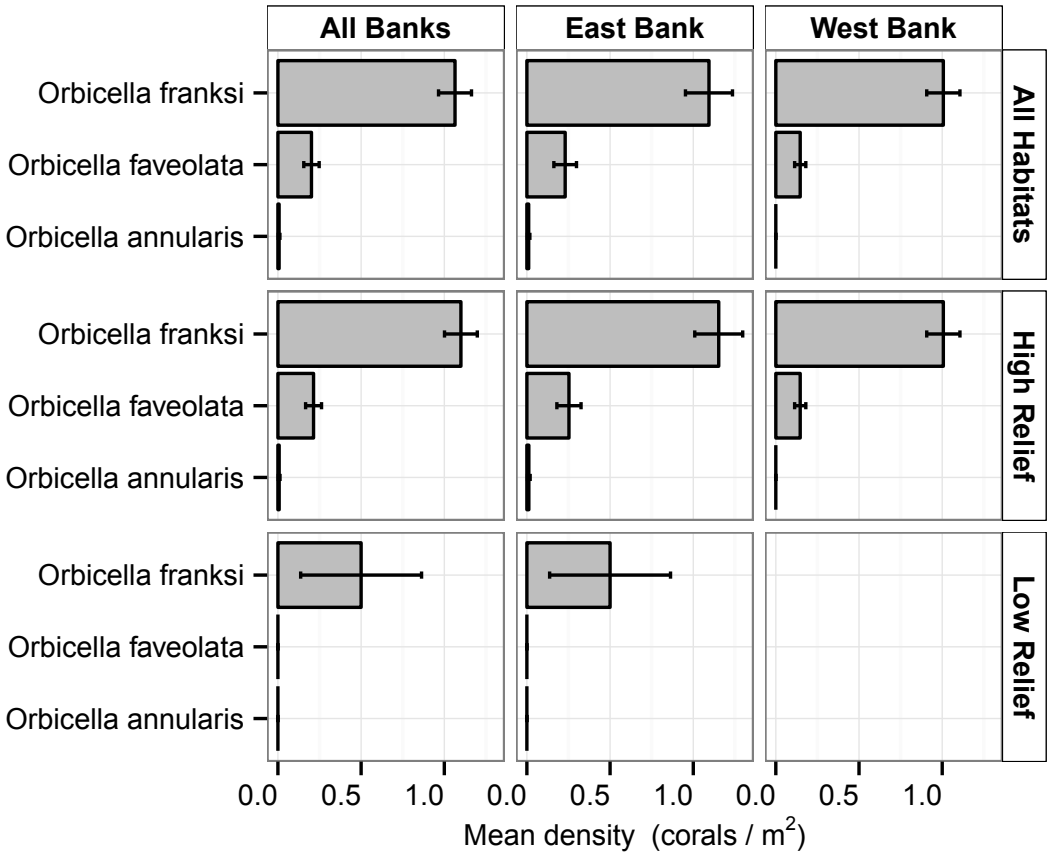


Figure 39. Mean species level density (corals/m²) of Endangered Species Act (ESA)-listed corals in NCRMP 2013 FGBNMS sampling, shown by biotope (columns) and habitat type (rows). Weighted means with standard error bars.

RESULTS

Orbicella annularis

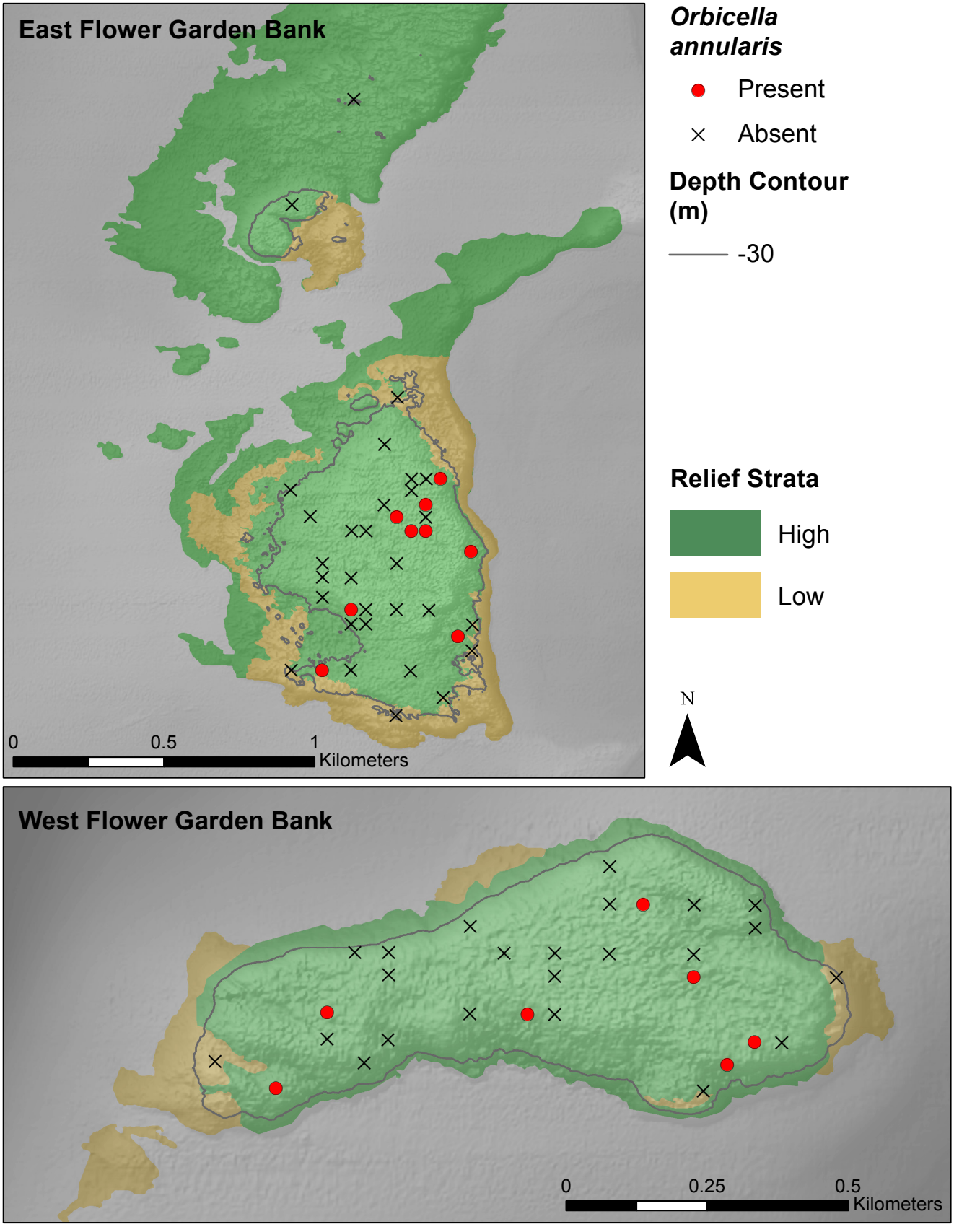


Figure 40. NCRMP 2013 FGBNMS observations of Orbicella annularis. *Presence/Absence are shown in place of standard deviation because the species was encountered in low numbers at few locations.*

Orbicella faveolata

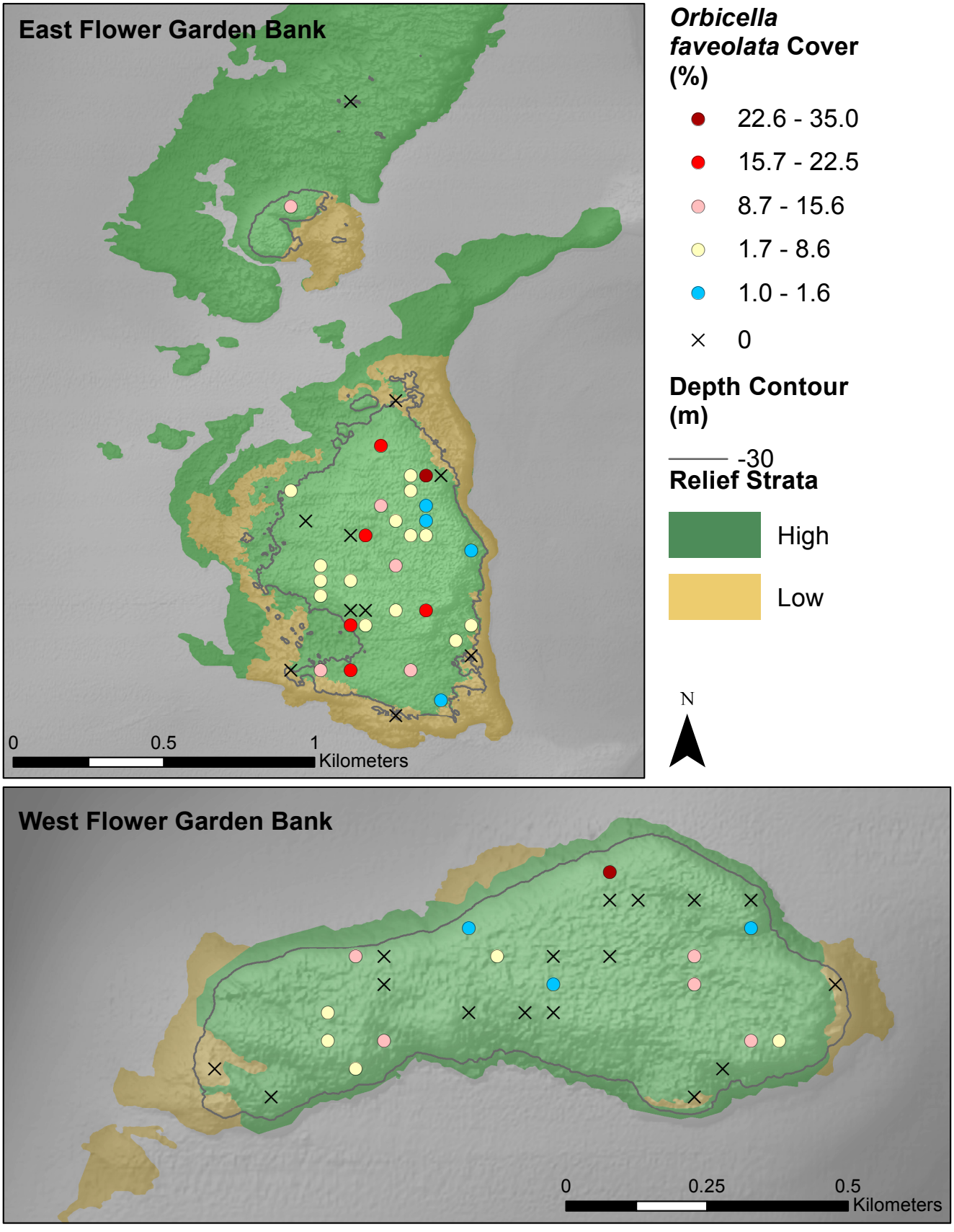


Figure 41. NCRMP 2013 FGBNMS observed Orbicella faveolata *cover (%), shown by standard deviations (>2.5, 1.5 – 2.5, 0.50 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize mean +/- 0.5 SD.*

RESULTS

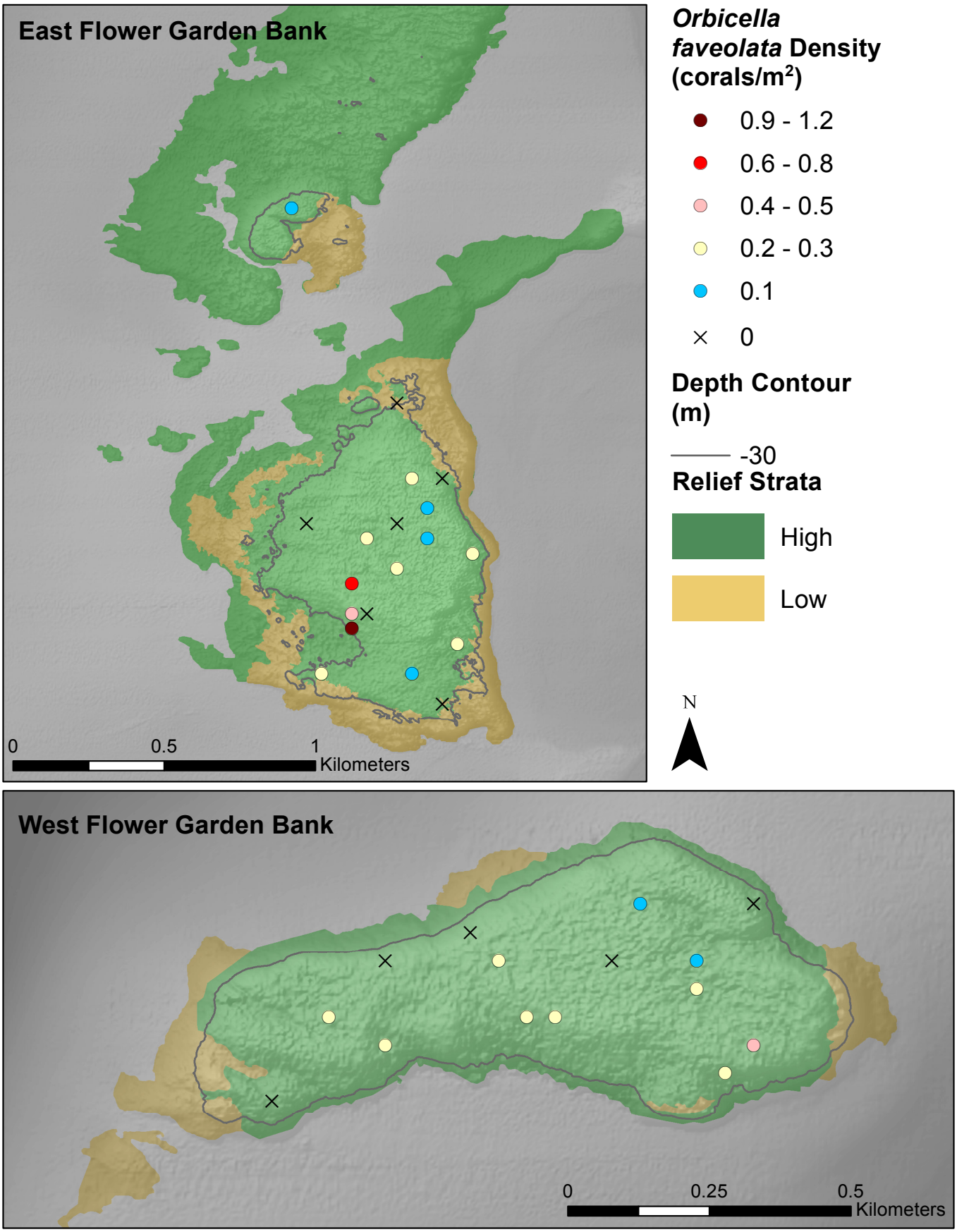


Figure 42. NCRMP 2013 FGBNMS observed Orbicella faveolata *density (corals/m²), shown by standard deviations (>2.5, 1.5 – 2.5, 0.50 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize mean +/- 0.5 SD.*

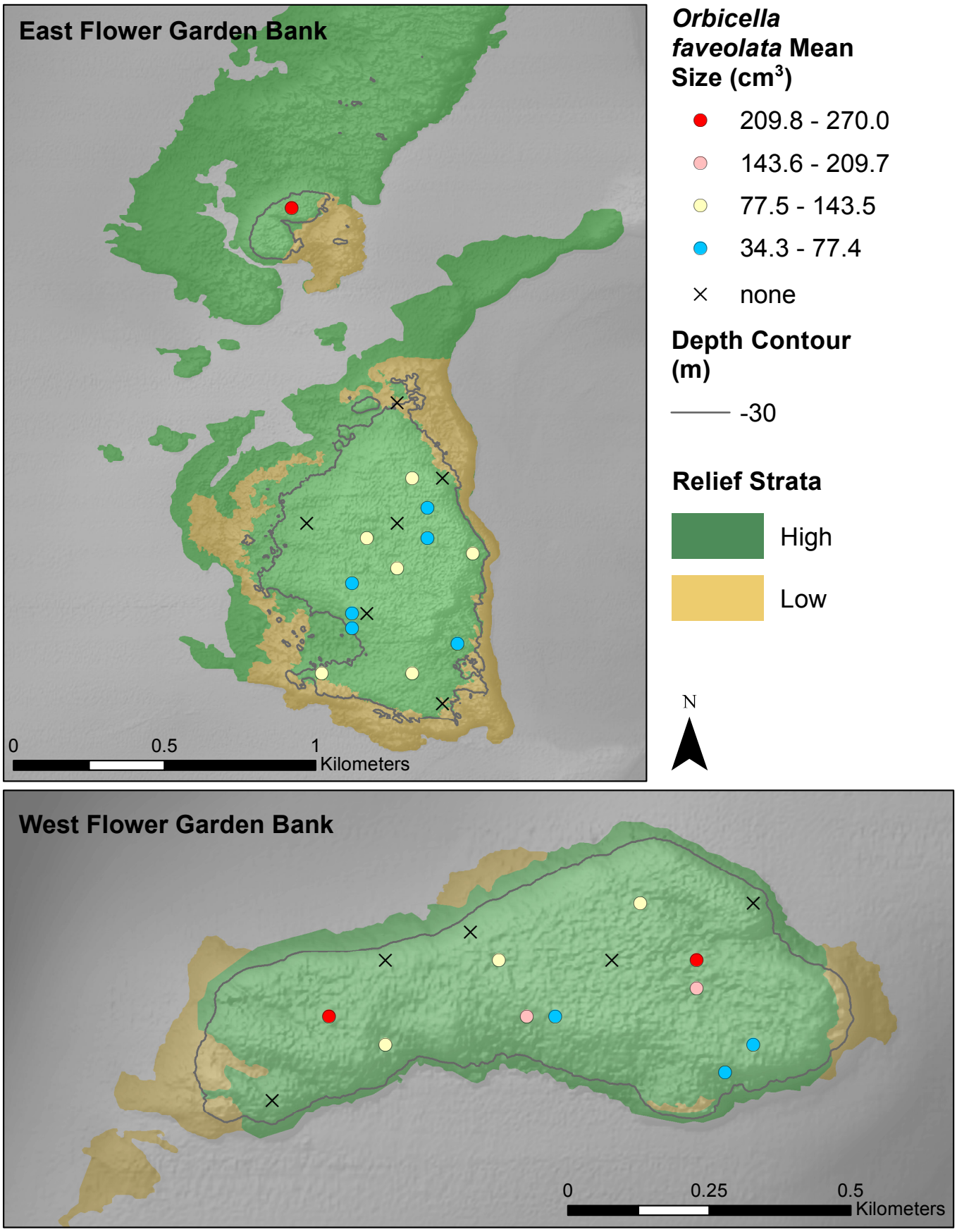


Figure 43. NCRMP 2013 FGBNMS calculated Orbicella faveolata *mean size distribution (cm³), shown by standard deviations (>1.5, 0.50 – 1.5, -0.50 – 0.50, <-0.50). Yellow circles symbolize mean +/- 0.5 SD.*

RESULTS

Orbicella franksi

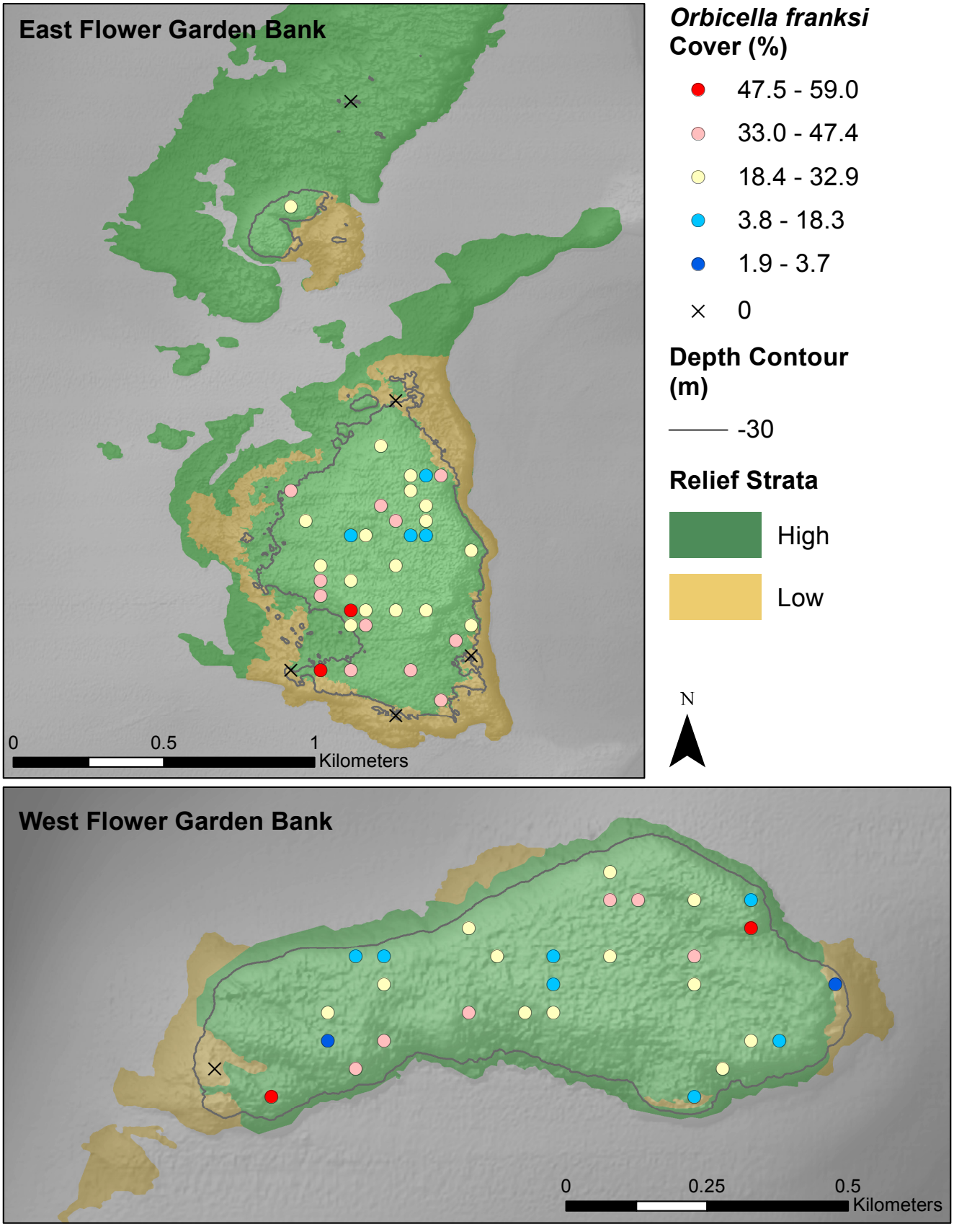


Figure 44. NCRMP 2013 FGBNMS observed Orbicella franksi *cover (%), shown by standard deviations (>1.5, 0.50 – 1.5, -0.50 – 0.50, -1.5 – -0.50, <-0.50). Yellow circles symbolize mean +/- 0.5 SD.*

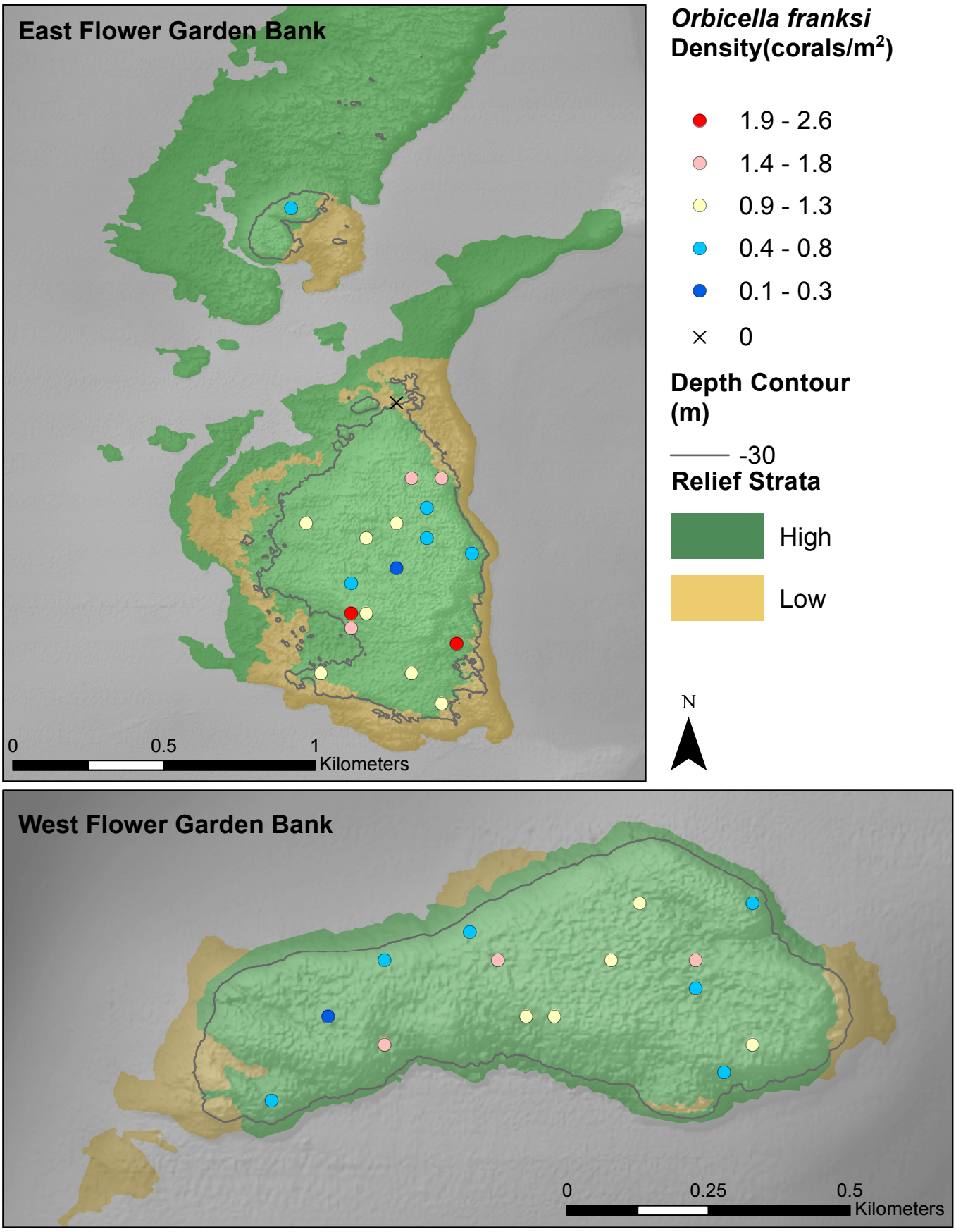


Figure 45. NCRMP 2013 FGBNMS observed Orbicella franksi *density (corals/m²), shown by standard deviations (>1.5, 0.50 – 1.5, -0.50 – 0.50, -1.5 – -0.50, <-1.5). Yellow circles symbolize mean +/- 0.5 SD.*

RESULTS

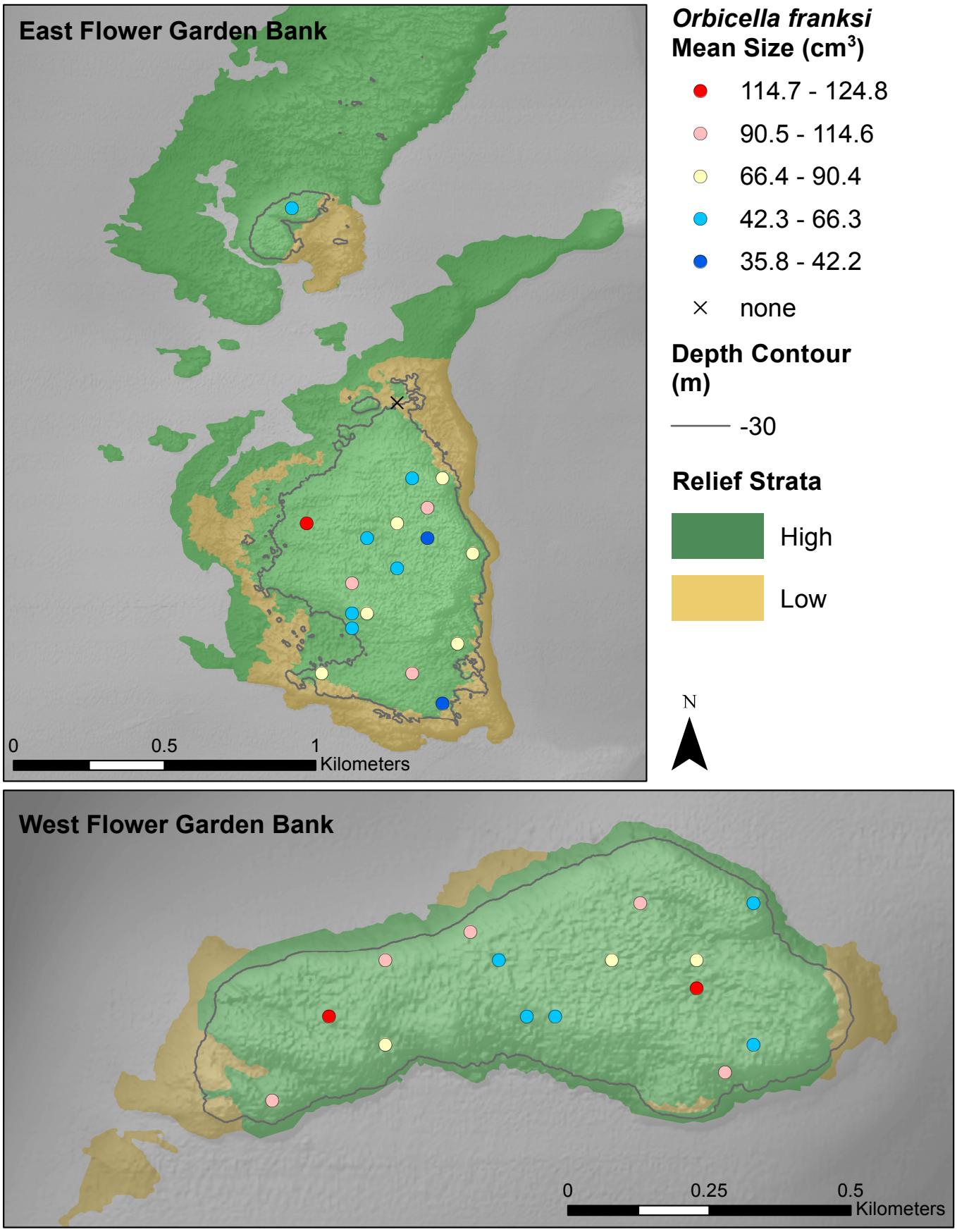


Figure 46. NCRMP 2013 FGBNMS calculated Orbicella franksi *mean size distribution (cm³), shown by standard deviations (>1.5, 0.50 – 1.5, -0.50 – 0.50, -1.5 – -0.50, <-1.5). Yellow circles symbolize mean +/- 0.5 SD.*

Key species of mobile macroinvertebrates

Lobatus gigas (queen conch) and *Panulirus argus* (Caribbean spiny lobster) were not observed in the NCRMP 2013 FGBNMS surveys.

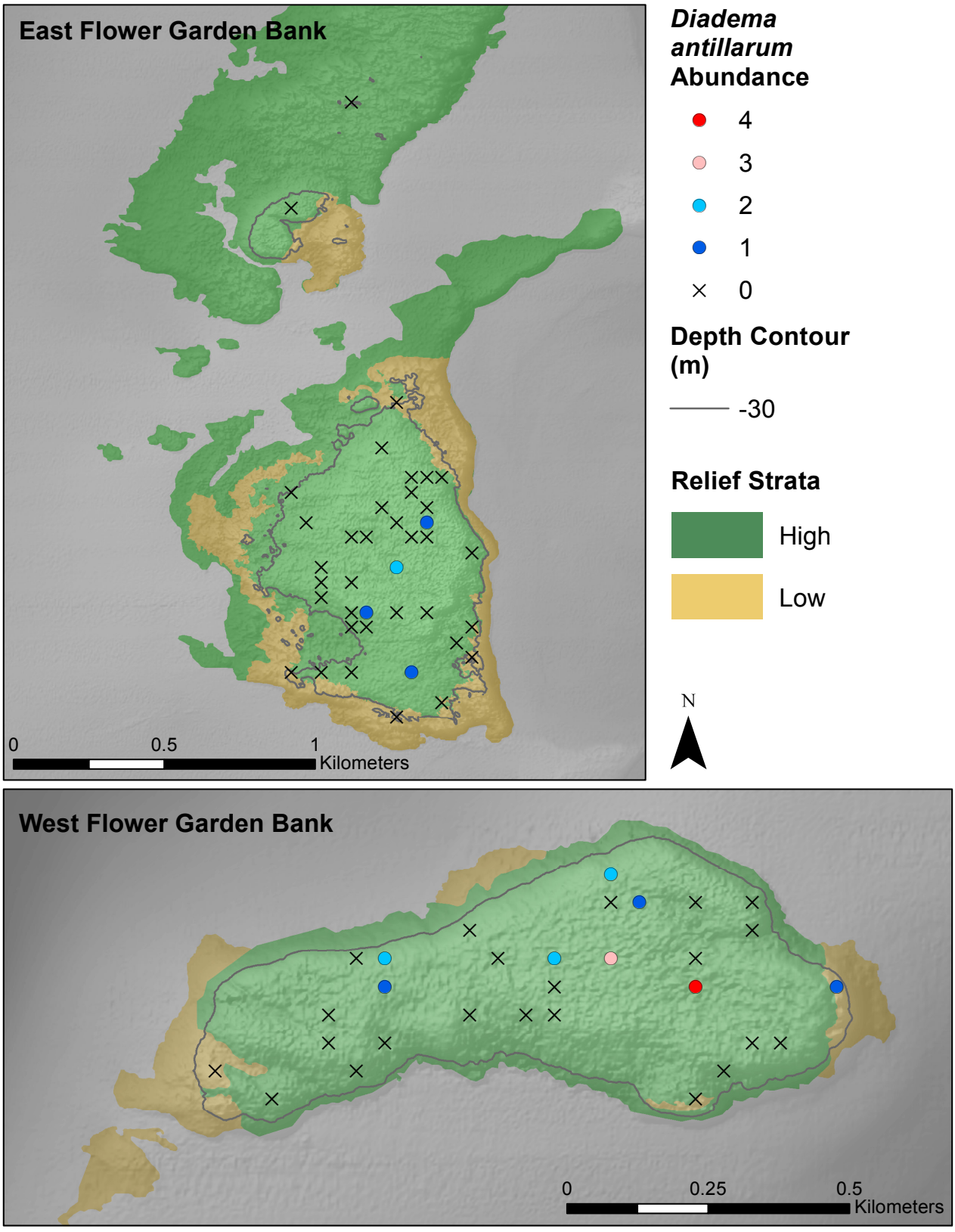


Figure 47. NCRMP 2013 FGBNMS observed Diadema antillarum *abundance (per site). Because the species was encountered at such low numbers in very few locations, observed site values are shown rather than ranges of standard deviation.*

REFERENCES

Caldow, C., R. Clark, K. Edwards, S.D. Hile, C. Menza, E. Hickerson, and G.P. Schmahl. 2009. Biogeographic characterization of fish communities and associated benthic habitats within the Flower Garden Banks National Marine Sanctuary: Sampling design and implementation of SCUBA surveys on the coral caps. NOAA Technical Memorandum NOS NCCOS 81. Silver Spring, MD. 134 pp.

Clark, R., J.C. Taylor, C.A. Buckel, and L.M. Kracker. 2014. Fish and benthic communities of the Flower Garden Banks National Marine Sanctuary: Science to support sanctuary management. NOAA Technical Memorandum NOS NCCOS 179. Silver Spring, MD. 317 pp.

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. Online: http://www2.coastalscience.noaa.gov/publications/detail.aspx?resource=ZkLaj6QXfndslVpEEeSU9rVY/Opd2Lp8O2PS2+g0cwE=

Froese, R. and D. Pauly (eds.). 2008. FishBase. World Wide Web electronic publication. Online: http://www.fishbase.org version (04/2015). (Accessed 17 December 2015)

García-Cagide, A., R. Claro and B.V. Koshelev. 1994. Reproducción. pp. 187-262. In: R. Claro (ed.) Ecología de los peces marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo (CIQRO) México. 525 pp.

Gardner, P.G., T.K. Frazer, C.A. Jacoby, and R.P.E. Yanong. 2015. Reproductive biology of invasive lionfish (*Pterois* spp.). Frontiers in Marine Science 2(7).

Lumley, T. (2014) "survey: analysis of complex survey samples". R package version 3.30.

Lumley, T. (2004) Analysis of complex survey samples. Journal of Statistical Software 9(1): 1-19

Morris, J.A. (2009). The Biology and Ecology of the Invasive Indo-Pacific lionfish. Dissertation, North Carolina State University, Raleigh.

Pittman, S.J., S.D. Hile, C.F.G. Jeffrey, C. Caldow, M.S. Kendall, M.E. Monaco and Z. Hillis-Starr. 2008. Fish assemblages and benthic habitats of Buck Island Reef National Monument (St. Croix, U.S. Virgin Islands) and the surrounding seascape: A characterization of spatial and temporal patterns. NOAA Technical Memorandum NOS NCCOS 71. Silver Spring, MD. 96 pp.

Pittman, S.J., S.D. Hile, C.F.G. Jeffrey, R. Clark, K. Woody, B.D. Herlach, C. Caldow, M.E. Monaco and R. Appeldoorn. 2010. Coral reef ecosystems of Reserva Natural La Parguera (Puerto Rico): Spatial and temporal patterns in fish and benthic communities (2001-2007). NOAA Technical Memorandum NOS NCCOS 107. Silver Spring, MD. 202 pp.

R Core Team (2013). R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. Online: http://www.R-project.org/ (Accessed 17 December 2015)

Randall, J.E. 1967. Food habits of reef fishes of the West Indies. Studies in Tropical Oceanography (Miami) 5: 665-847.

APPENDICES

Appendix 1: Site Allocation Tables by Biotope and Administration Strata

Fish/LPI	High Relief		Low Relief	
	Total Available	Priority (Needed)	Total Available	Priority (Needed)
East Bank	213	33	221	27
West Bank	21	6	4	3

Coral Demographics	High Relief		Low Relief	
	Total Available	Priority (Needed)	Total Available	Priority (Needed)
East Bank	213	17	221	14
West Bank	21	3	4	3

APPENDICES

Appendix 2. NCRMP USVI 2013 Field Mission Sample Sites

Site	Latitude	Longitude	Depth (ft)	Bank	Relief	Depth	Fish	LPI	Demo	Additional Samples
EH1	27.9098	-93.5992	66	East	High	Deep	X	X	X	
EH14	27.91071	-93.5987	66	East	High	Deep	X	X		
EH15	27.90528	-93.6007	92	East	High	Deep	X	X		Water
EH17	27.91206	-93.5997	72	East	High	Deep	X	X		
EH18	27.90981	-93.5982	69	East	High	Deep	X	X		
EH19	27.90709	-93.6002	66	East	High	Deep	X	X	X	Water
EH23	27.91025	-93.5997	62	East	High	Deep	X	X		
EH28	27.91926	-93.6028	89	East	High	Deep	X	X	X	Water
EH3	27.9071	-93.5982	66	East	High	Deep	X	X		
EH30	27.90935	-93.5987	69	East	High	Deep	X	X		
EH37	27.90664	-93.6007	92	East	High	Deep	X	X	X	
EH38	27.90891	-93.5967	85	East	High	Deep	X	X	X	Water
EH39	27.91116	-93.5987	66	East	High	Deep	X	X	X	
EH4	27.90753	-93.6017	82	East	High	Deep	X	X		
EH41	27.90798	-93.6017	72	East	High	Deep	X	X		
EH46	27.9062	-93.5972	92	East	High	Deep	X	X	X	
EH47	27.90709	-93.6007	79	East	High	Deep	X	X	X	
EH48	27.90665	-93.5966	85	East	High	Deep	X	X		Water, Algae
EH50	27.90529	-93.5987	82	East	High	Deep	X	X	X	
EH51	27.90845	-93.5992	69	East	High	Deep	X	X	X	
EH54	27.90979	-93.6023	82	East	High	Deep	X	X	X	
EH55	27.90528	-93.6017	95	East	High	Deep	X	X	X	
EH58	27.91116	-93.5977	75	East	High	Deep	X	X	X	Water
EH60	27.90664	-93.6002	79	East	High	Deep	X	X		
EH62	27.90844	-93.6017	75	East	High	Deep	X	X		
EH64	27.90935	-93.5982	62	East	High	Deep	X	X	X	Water
EH65	27.91069	-93.6028	98	East	High	Deep	X	X		water
EH67	27.91026	-93.5982	66	East	High	Deep	X	X	X	Algae
EH68	27.90799	-93.6007	69	East	High	Deep	X	X	X	
EH7	27.91116	-93.5982	59	East	High	Deep	X	X		
EH71	27.90709	-93.5992	66	East	High	Deep	X	X		
EH74	27.92243	-93.6008	95	East	High	Deep	X	X		Water
EH75	27.90934	-93.6007	72	East	High	Deep	X	X		
EH89	27.90935	-93.6002	69	East	High	Deep	X	X	X	
EL10	27.90393	-93.5992	95	East	Low	Deep	X	X		Water
EL42	27.91341	-93.5992	95	East	Low	Deep	X	X	X	
EL44	27.90527	-93.6027	92	East	Low	Deep	X	X		Algae
EL59	27.90575	-93.5966	98	East	Low	Deep	X	X		Water
EL72	27.90439	-93.5977	92	East	Low	Deep	X	X	X	
WH12	27.87346	-93.8199	92	West	High	Deep	X	X	X	Water, Algae
WH13	27.87575	-93.8144	82	West	High	Deep	X	X		Water
WH16	27.8739	-93.821	79	West	High	Deep	X	X	X	
WH2	27.87254	-93.822	95	West	High	Deep	X	X	X	
WH22	27.87527	-93.8184	79	West	High	Deep	X	X	X	Water
WH26	27.87481	-93.82	79	West	High	Deep	X	X	X	Water
WH27	27.8735	-93.8128	75	West	High	Deep	X	X		
WH32	27.87574	-93.8159	72	West	High	Deep	X	X		Algae
WH33	27.87304	-93.8139	98	West	High	Deep	X	X	X	Water

Site	Latitude	Longitude	Depth (ft)	Bank	Relief	Depth	Fish	LPI	Demo	Additional Samples
WH35	27.8753	-93.8134	89	West	High	Deep	X	X		
WH36	27.87574	-93.8154	72	West	High	Deep	X	X	X	
WH40	27.87393	-93.8169	72	West	High	Deep	X	X	X	
WH43	27.87483	-93.8169	69	West	High	Deep	X	X		
WH45	27.87438	-93.8169	72	West	High	Deep	X	X		
WH49	27.87619	-93.8159	79	West	High	Deep	X	X		
WH5	27.87436	-93.82	82	West	High	Deep	X	X		
WH52	27.87484	-93.8159	69	West	High	Deep	X	X	X	Water
WH53	27.87481	-93.8205	85	West	High	Deep	X	X		Algae
WH56	27.8744	-93.8144	79	West	High	Deep	X	X	X	
WH57	27.87393	-93.8174	82	West	High	Deep	X	X	X	
WH6	27.87392	-93.8184	82	West	High	Deep	X	X		
WH61	27.87483	-93.8179	75	West	High	Deep	X	X	X	
WH63	27.87485	-93.8144	72	West	High	Deep	X	X	X	
WH69	27.87345	-93.821	79	West	High	Deep	X	X		
WH70	27.8735	-93.8133	75	West	High	Deep	X	X	X	
WH8	27.87301	-93.8205	98	West	High	Deep	X	X		
WH9	27.87576	-93.8134	92	West	High	Deep	X	X	X	
WL11	27.87299	-93.823	89	West	Low	Deep	X	X		Water, Algae
WL29	27.87259	-93.8144	98	West	Low	Deep	X	X		
WL31	27.87441	-93.8118	98	West	Low	Deep	X	X	X	
Total (69)				**East (39) West (30)**	**High (61) Low (8)**		**(69)**	**(69)**	**(34)**	

APPENDICES

Appendix 3. Fish Survey Supplemental Information

Appendix 3A. Fish species summary

For all fish species observed in NCRMP FGBNMS 2013 surveys, weighted means, standard errors and coefficient of variance (%) for fish density (#/100 m^2), biomass (g/100 m^2), and frequency of occurrence (%).

Species	Mean density (#/100 m^2)	SE density (#/100 m^2)	CV density (%)	Mean biomass (g/100 m^2)	SE biomass (g/100 m^2)	CV biomass (%)	Occurrence (%)
Abudefduf saxatilis	0.09	0.05	61.69	3.37	2.06	61.19	4.25
Acanthostracion polygonius	0.01	0.01	100	14.39	14.39	100	1.26
Acanthurus bahianus	0.48	0.16	33.88	154.45	60.49	39.16	15.86
Acanthurus chirurgus	0.82	0.15	18.51	52.39	11.66	22.26	42.78
Acanthurus coeruleus	3.07	0.27	8.77	426.69	59.36	13.91	90.82
Amblycirrhitus pinos	0.24	0.06	25.97	0.34	0.11	33.26	20.88
Anisotremus virginicus	0.03	0.02	69.34	2.16	1.68	77.73	2.51
Bodianus pulchellus	0.09	0.03	37.86	2.09	0.90	43.14	6.07
Bodianus rufus	5.63	0.42	7.43	202.51	28.69	14.17	98.26
Calamus species	0.00	0.00	100	3.56	3.56	100	0.37
Cantherhines macrocerus	0.04	0.03	71.46	11.49	8.18	71.21	2.91
Cantherhines pullus	0.17	0.05	30.94	9.33	3.01	32.33	14.11
Canthidermis sufflamen	0.88	0.34	38.86	749.91	245.75	32.77	20.59
Canthigaster rostrata	10.03	0.64	6.39	30.64	2.23	7.27	100
Carangoides bartholomaei	0.03	0.03	100	134.36	134.36	100	1.26
Carangoides ruber	1.23	0.39	31.78	46.79	18.97	40.54	27.07
Caranx latus	0.75	0.22	29.39	2867.43	949.12	33.10	25.32
Caranx lugubris	0.02	0.01	72.47	15.54	11.35	73.03	1.54
Centropyge argi	0.02	0.01	80.54	0.01	0.01	80.54	1.63
Cephalopholis cruentata	0.99	0.12	11.93	139.81	25.96	18.57	60.55
Cephalopholis fulva	0.03	0.02	79.67	7.10	6.39	90.05	1.54
Chaetodon ocellatus	0.49	0.11	23.10	38.74	9.76	25.19	23.85
Chaetodon sedentarius	2.38	0.19	8.20	58.08	8.10	13.94	86.00
Chaetodon striatus	0.07	0.05	69.63	4.30	2.99	69.63	3.48
Chromis cyanea	13.71	1.43	10.42	33.56	5.57	16.61	90.25
Chromis enchrysurus	0.15	0.15	100	0.10	0.10	100	1.26
Chromis insolata	11.77	1.98	16.82	19.63	4.83	24.62	77.86
Chromis multilineata	68.22	7.10	10.41	878.54	96.51	10.99	96.04
Chromis scotti	2.80	0.57	20.40	2.19	0.50	22.92	48.32
Clepticus parrae	40.13	5.25	13.08	1907.36	415.15	21.77	83.66
Coryphopterus eidolon	0.03	0.03	100	0.02	0.02	100	1.26
Coryphopterus personatus/ hyalinus	0.02	0.02	100	0.01	0.01	100	1.74
Coryphopterus species	0.03	0.03	100	0.02	0.02	100	1.74
Diodon holocanthus	0.05	0.03	50.28	4.19	2.23	53.25	5.42

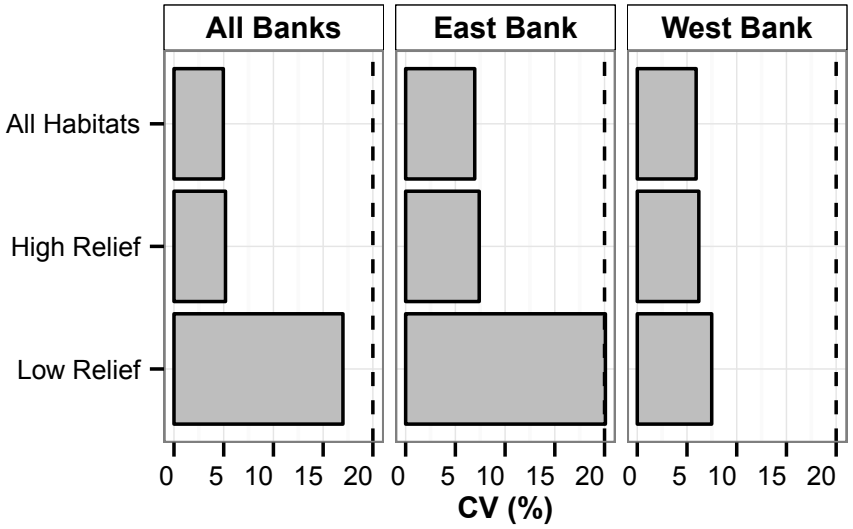
Species	Mean density (#/100 m²)	SE density (#/100 m²)	CV density (%)	Mean biomass (g/100 m²)	SE biomass (g/100 m²)	CV biomass (%)	Occurrence (%)
Diodon hystrix	0.03	0.02	71.63	10.77	7.72	71.63	3.00
Elacatinus oceanops	2.31	0.25	11.06	0.58	0.06	11.09	76.70
Emmelichthyops atlanticus	0.62	0.31	51.07	0.35	0.18	51.07	6.67
Epinephelus adscensionis	0.07	0.04	48.53	58.60	30.86	52.67	6.27
Epinephelus guttatus	0.08	0.04	43.28	137.74	77.61	56.34	8.13
Equetus punctatus	0.03	0.03	100	1.66	1.66	100	1.26
Euthynnus alletteratus	0.03	0.03	100	64.79	64.79	100	1.74
Gnatholepis thompsoni	1.12	0.20	17.91	0.25	0.04	17.91	44.24
Gymnothorax moringa	0.02	0.02	100	1.04	1.04	100	1.74
Halichoeres bivittatus	0.05	0.04	79.93	1.05	0.80	76.32	2.42
Halichoeres garnoti	0.71	0.15	21.50	6.08	1.96	32.27	34.19
Halichoeres maculipinna	3.27	0.97	29.63	8.98	2.45	27.30	35.74
Halichoeres radiates	0.09	0.04	45.13	2.64	1.32	50.01	7.25
Holacanthus bermudensis	0.03	0.02	69.63	10.48	8.49	80.95	3.48
Holacanthus ciliaris	0.15	0.06	43.64	100.69	49.49	49.15	10.15
Holacanthus tricolor	0.34	0.08	22.16	49.04	14.10	28.75	26.55
Holocanthus species	0.01	0.01	100	6.32	6.32	100	1.26
Holocentrus adscensionis	0.01	0.01	100	1.40	1.40	100	1.26
Holocentrus rufus	0.14	0.05	35.38	13.39	5.36	40.01	11.87
Inermia vittata	0.08	0.05	59.55	0.03	0.02	59.55	4.25
Kyphosus spectator	11.43	2.26	19.80	6230.72	1223.69	19.64	60.19
Lactophrys bicaudalis	0.02	0.02	100	10.64	10.64	100	1.74
Lactophrys triqueter	0.53	0.10	19.42	42.72	12.03	28.17	34.89
Liopropoma rubre	0.01	0.01	100	0.00	0.00	100	1.26
Lutjanus griseus	0.64	0.09	14.37	436.56	74.98	17.18	38.05
Lutjanus jocu	0.25	0.06	22.59	1622.17	568.42	35.04	23.76
Melichthys niger	1.41	0.22	15.66	736.53	141.23	19.17	56.51
Microspathodon chrysurus	0.30	0.08	27.62	19.43	6.51	33.53	21.45
Mulloidichthys martinicus	0.39	0.20	51.91	64.51	27.47	42.57	13.24
Mycteroperca bonaci	0.07	0.03	50.97	31.31	16.96	54.17	5.51
Mycteroperca interstitialis	0.70	0.12	17.05	585.10	140.26	23.97	46.27
Mycteroperca tigris	0.50	0.10	19.78	973.09	376.97	38.74	34.80
Mycteroperca venenosa	0.05	0.02	46.77	23.94	16.47	68.82	3.50
Ocyurus chrysurus	0.02	0.02	100	2.16	2.16	100	1.74
Ophioblennius macclurei	0.09	0.04	44.75	0.13	0.10	78.13	7.73
Opistognathus species	0.03	0.03	100	0.23	0.23	100	1.26
Paranthias furcifer	55.56	10.18	18.32	8736.65	1585.51	18.15	95.75
Pomacanthus paru	0.35	0.09	24.80	616.86	191.55	31.05	23.84
Pomacanthus species	0.01	0.01	100	12.36	12.36	100	1.17

APPENDICES

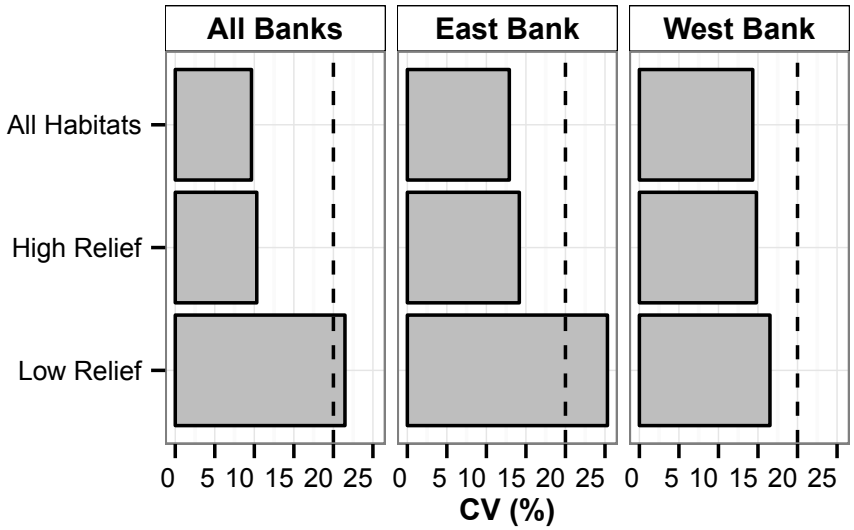
Species	Mean density (#/100 m²)	SE density (#/100 m²)	CV density (%)	Mean biomass (g/100 m²)	SE biomass (g/100 m²)	CV biomass (%)	Occurrence (%)
Prognathodes aculeatus	0.59	0.15	25.36	7.60	1.93	25.36	32.89
Pseudupeneus maculatus	0.01	0.01	100	0.47	0.47	100	1.17
Pterois volitans	0.35	0.08	22.24	92.60	26.71	28.84	26.75
Sargocentron coruscum	0.07	0.05	78.33	96.33	94.45	98.05	3.48
Scarus iseri	1.04	0.22	20.79	3.36	0.95	28.40	37.00
Scarus taeniopterus	0.80	0.17	20.77	50.44	14.29	28.33	31.38
Scarus vetula	3.97	0.69	17.44	783.61	100.04	12.77	86.98
Sparisoma atomarium	1.43	0.33	23.03	2.56	0.70	27.51	42.60
Sparisoma aurofrenatum	5.68	0.62	11.00	408.49	86.16	21.09	90.53
Sparisoma radians	0.03	0.03	100	0.01	0.01	100	1.74
Sparisoma viride	4.04	0.35	8.70	1138.87	181.52	15.94	89.77
Sphoeroides spengleri	0.01	0.01	100	0.01	0.01	100	1.26
Sphyraena barracuda	1.18	0.19	16.08	1893.79	436.62	23.06	60.28
Stegastes adustus	0.46	0.14	30.74	1.78	0.77	43.34	21.74
Stegastes leucostictus	0.05	0.04	73.63	0.04	0.03	73.70	3.48
Stegastes partitus	18.38	2.46	13.40	38.71	4.45	11.50	97.49
Stegastes planifrons	13.74	0.89	6.45	100.28	8.15	8.13	96.93
Stegastes variabilis	1.88	0.30	15.81	3.46	0.68	19.59	64.17
Thalassoma bifasciatum	56.90	3.92	6.89	53.63	5.80	10.82	100

Appendix 3B. Fish coefficient of variance

Total fish density



Total fish biomass



Total fish richness

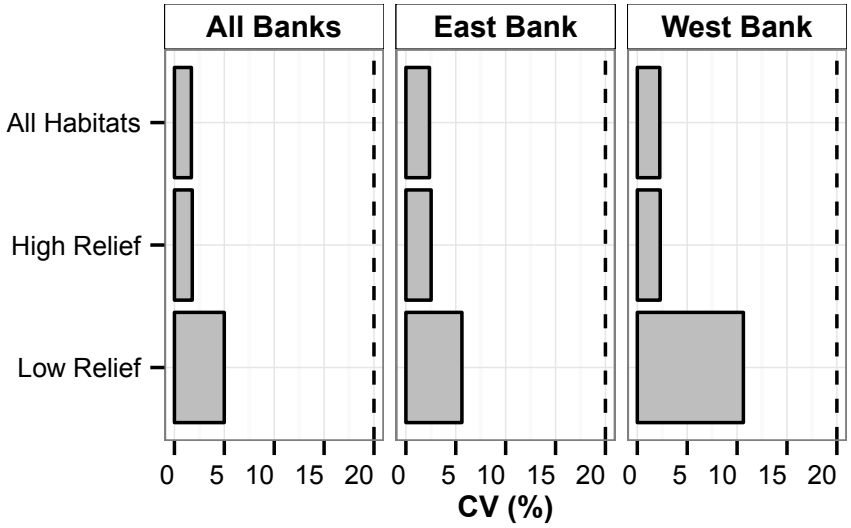


Figure 3B-1. Coefficient of variance (CV) for: total fish density (#/100 m^2; top), total fish biomass (g/100m^2; middle), and species richness (# species/100 m^2; bottom), shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

APPENDICES

Density of key families

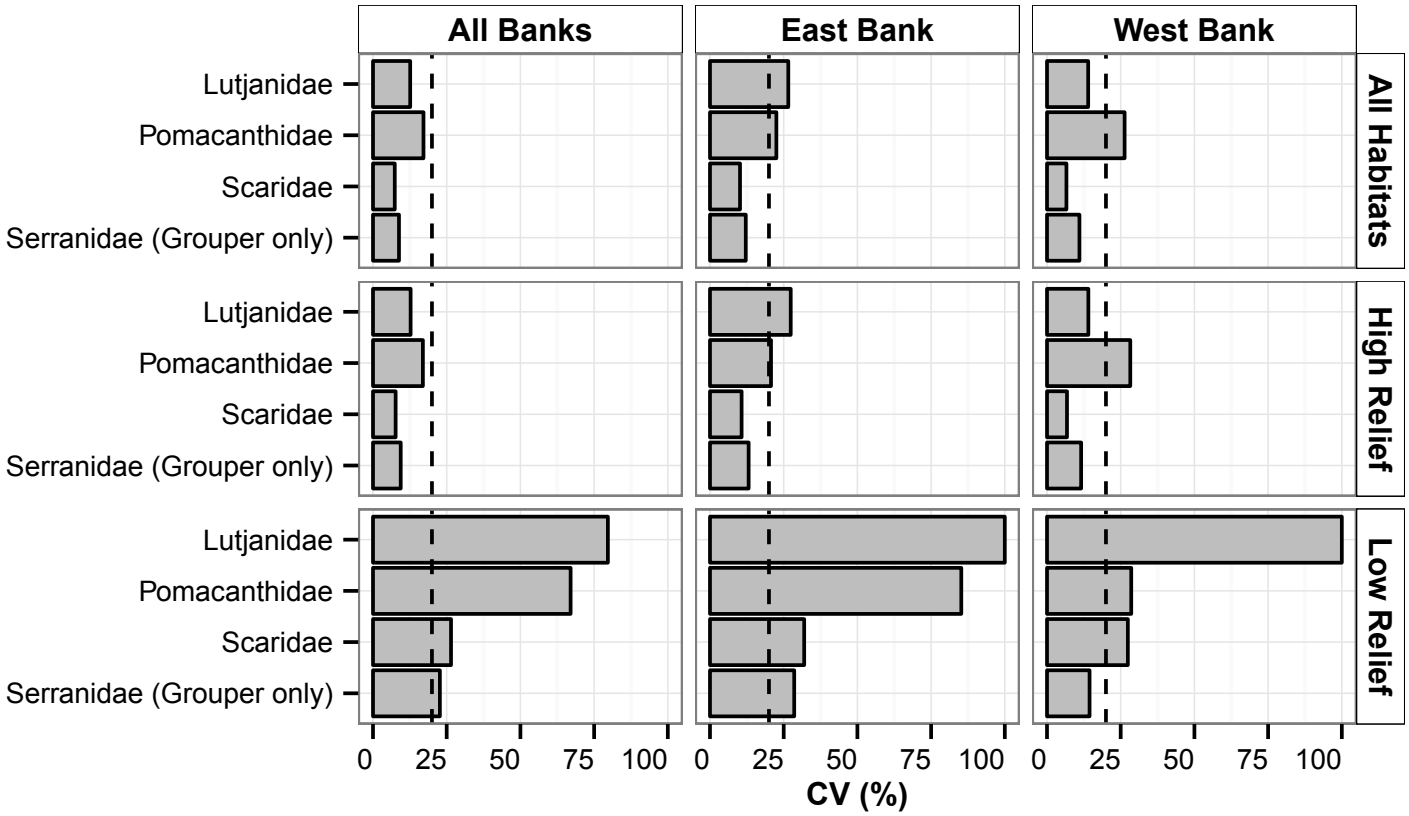


Figure 3B-2. Coefficient of variance (CV) for density (#/100 m^2) of key fish families, shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV..

Density of key fish species

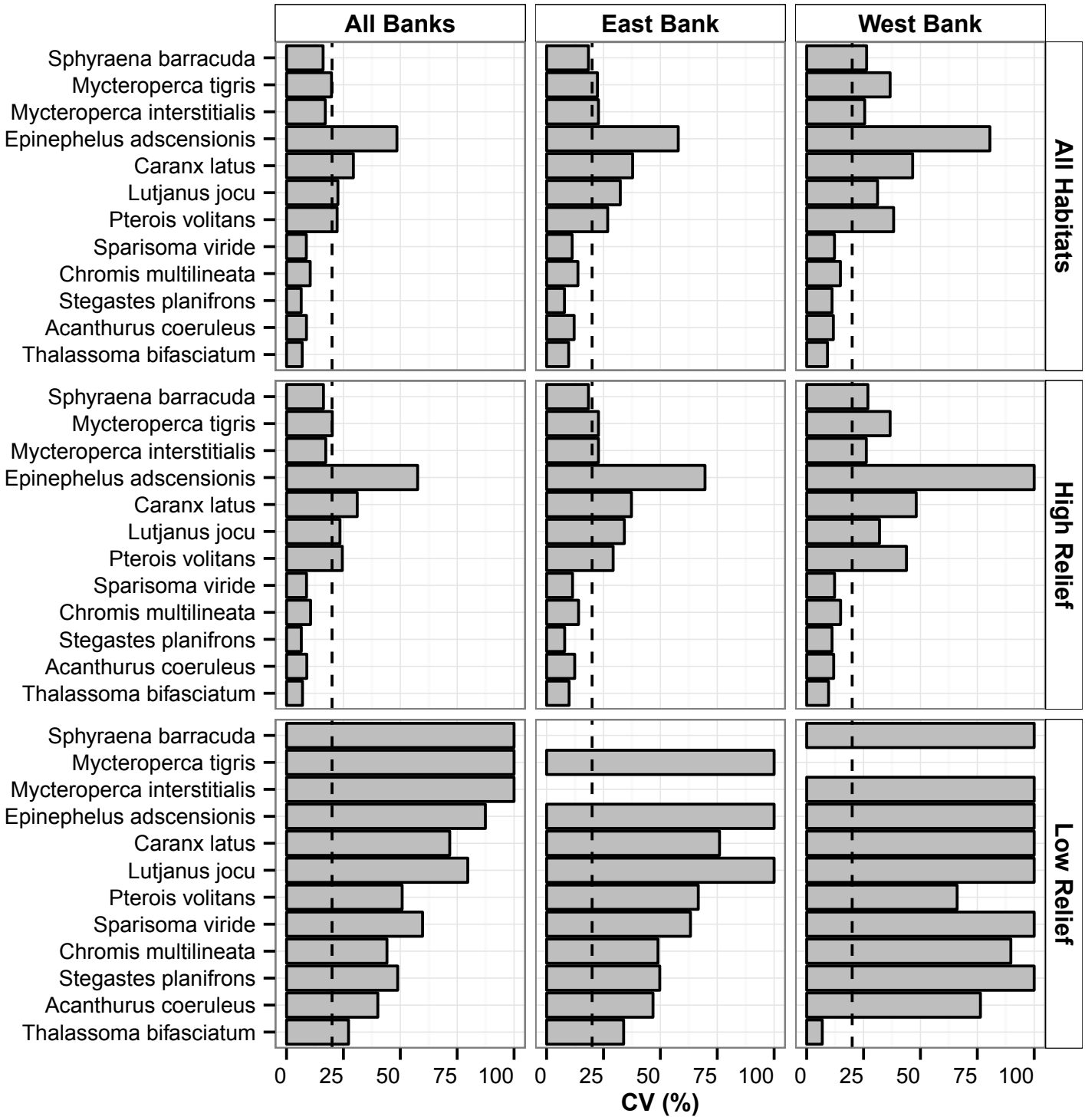


Figure 3B-3. Coefficient of variance (CV) for density (#/100 m^2) of key fish species, shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

APPENDICES

Appendix 4. Benthic Surveys Supplemental Information

Appendix 4A. Benthic species summary

For all coral species observed in the NCRMP 2013 FGBNMS surveys, weighted means, standard error, and coefficient of variance (%) for coral cover (%) from LPI surveys and coral density (corals /m2) from demographic surveys. Additionally, number of colonies counted (demographic surveys) and frequency of occurrence (%) are included. * indicates ESA species.

Species	Mean Cover (%)	SE Cover (%)	CV cover (%)	Mean Density (corals/ 100 m²)	SE Density (corals/ 100 m²)	CV Density (%)	Number of Colonies	Occurrence (%)
Agaricia agaricites	0.44	0.11	24.32	0.43	0.08	19.05	139	60.87
Agaricia fragilis	0.09	0.05	50.95	0.05	0.02	34.82	16	18.84
Agaricia lamarcki	-	-	-	-	-	-	-	1.45
Agaricia spp	-	-	-	<0.01	<0.01	100.00	1	1.45
Colpophyllia natans	3.27	0.41	12.63	0.21	0.03	15.09	70	81.16
Colpophyllia spp	-	-	-	0.01	0.01	100.54	2	1.45
Helioceris cucullata	-	-	-	0.03	0.01	37.24	9	8.70
Madracis auretenra	0.44	0.24	55.98	0.09	0.08	88.53	31	8.70
Madracis decactis	0.57	0.13	23.66	0.12	0.03	25.57	45	49.28
Madracis spp	0.01	0.01	99.93	0.01	0.01	53.46	6	7.25
Meandrina meandrites	-	-	-	<0.01	<0.01	100.00	1	1.45
Montastraea cavernosa	3.91	0.55	14.02	0.32	0.05	17.12	113	82.61
Mussa angulosa	-	-	-	0.06	0.02	33.16	18	21.74
*Orbicella annularis**	0.29	0.14	49.20	0.01	0.00	68.63	2	28.99
*Orbicella faveolata**	5.66	0.91	15.98	0.20	0.05	22.90	65	92.75
*Orbicella franksi**	26.84	1.69	6.30	1.06	0.10	9.30	357	95.65
Orbicella spp*	0.05	0.03	57.44	-	-	-	-	4.35
Porites astreoides	6.78	0.54	8.02	2.65	0.51	19.32	901	100.00
Porites furcata	0.02	0.02	99.94	0.03	0.02	55.83	13	8.70
Pseudodiploria strigosa	8.24	0.88	10.66	0.51	0.06	11.39	176	92.75
Scolymia cubensis	-	-	-	0.02	0.01	44.08	6	13.04
Scolymia spp	-	-	-	<0.01	<0.01	100.00	1	2.90
Siderastrea radians	0.06	0.04	71.31	-	-	-	-	2.90
Siderastrea siderea	0.69	0.31	45.03	0.03	0.01	44.63	10	20.29
Stephanocoenia intersepta	1.14	0.22	19.13	0.26	0.05	21.18	88	47.83
Tubastraea coccinea	-	-	-	<0.01	<0.01	99.94	1	1.45

Appendix 4B. Benthic coefficient of variance

Cover of benthic habitat categories

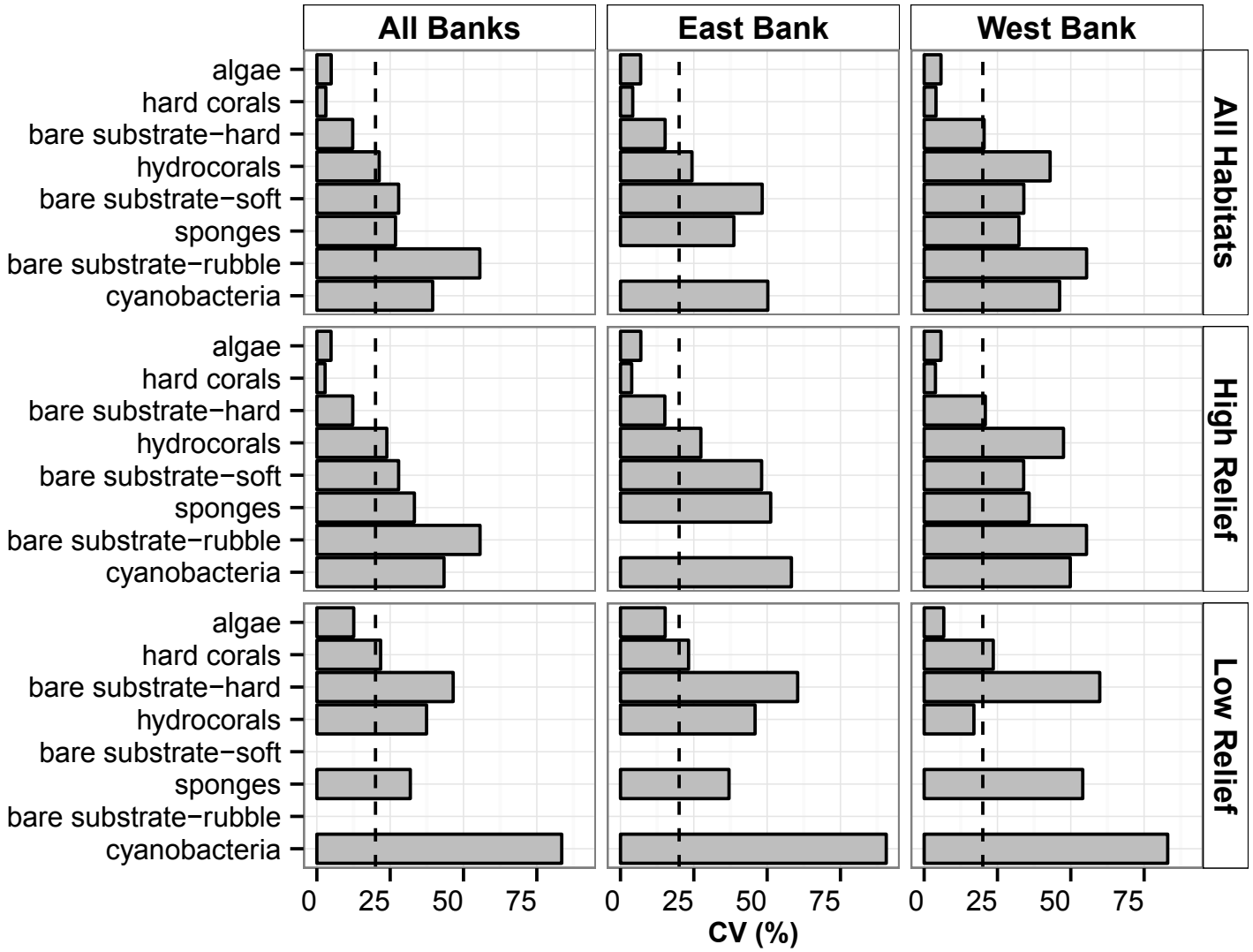


Figure 4B-1. Coefficient of variance (CV) for percent cover of benthic habitat categories, shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

APPENDICES

Coral cover

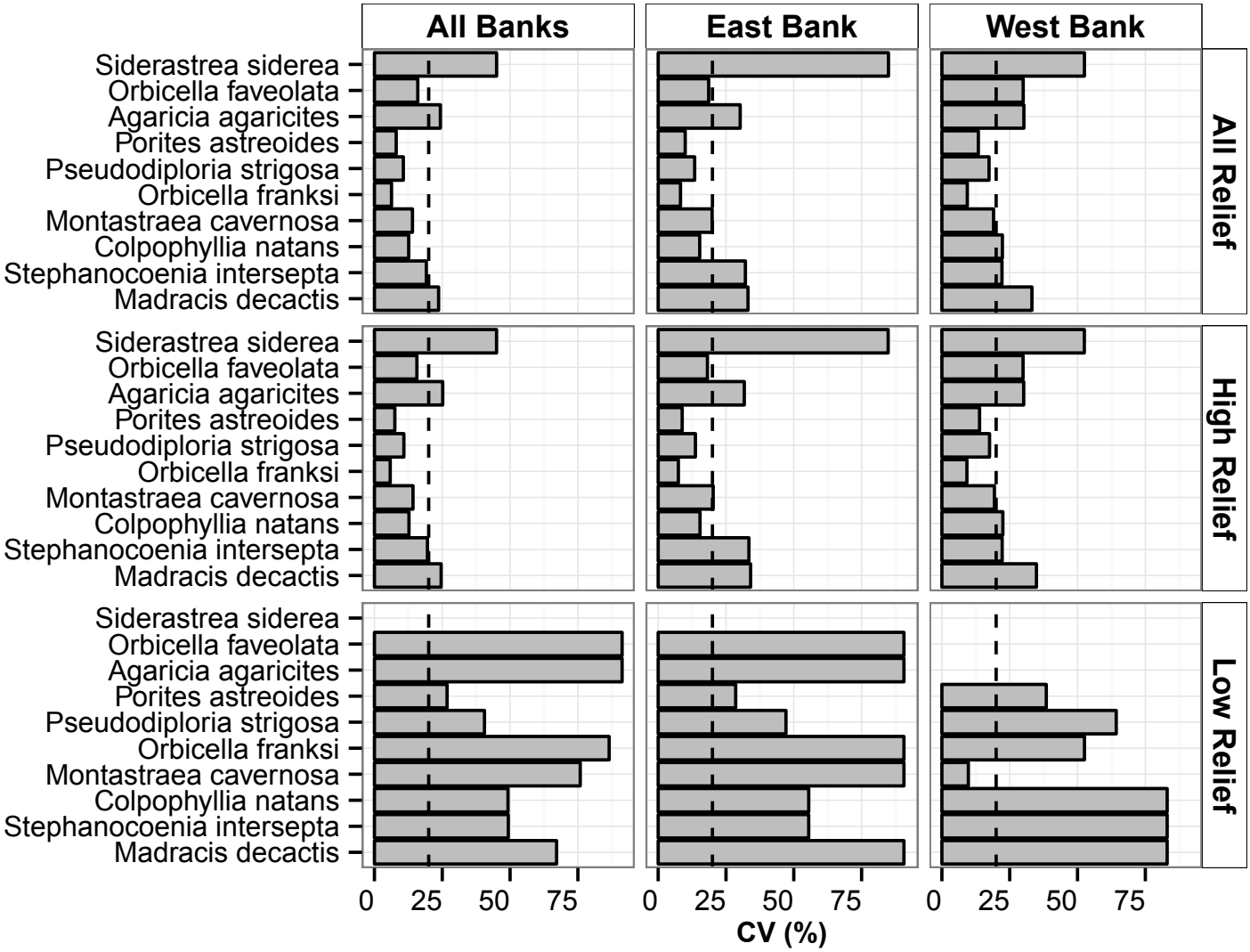


Figure 4B-2. Coefficient of variance (CV) for select coral species, shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

Coral density

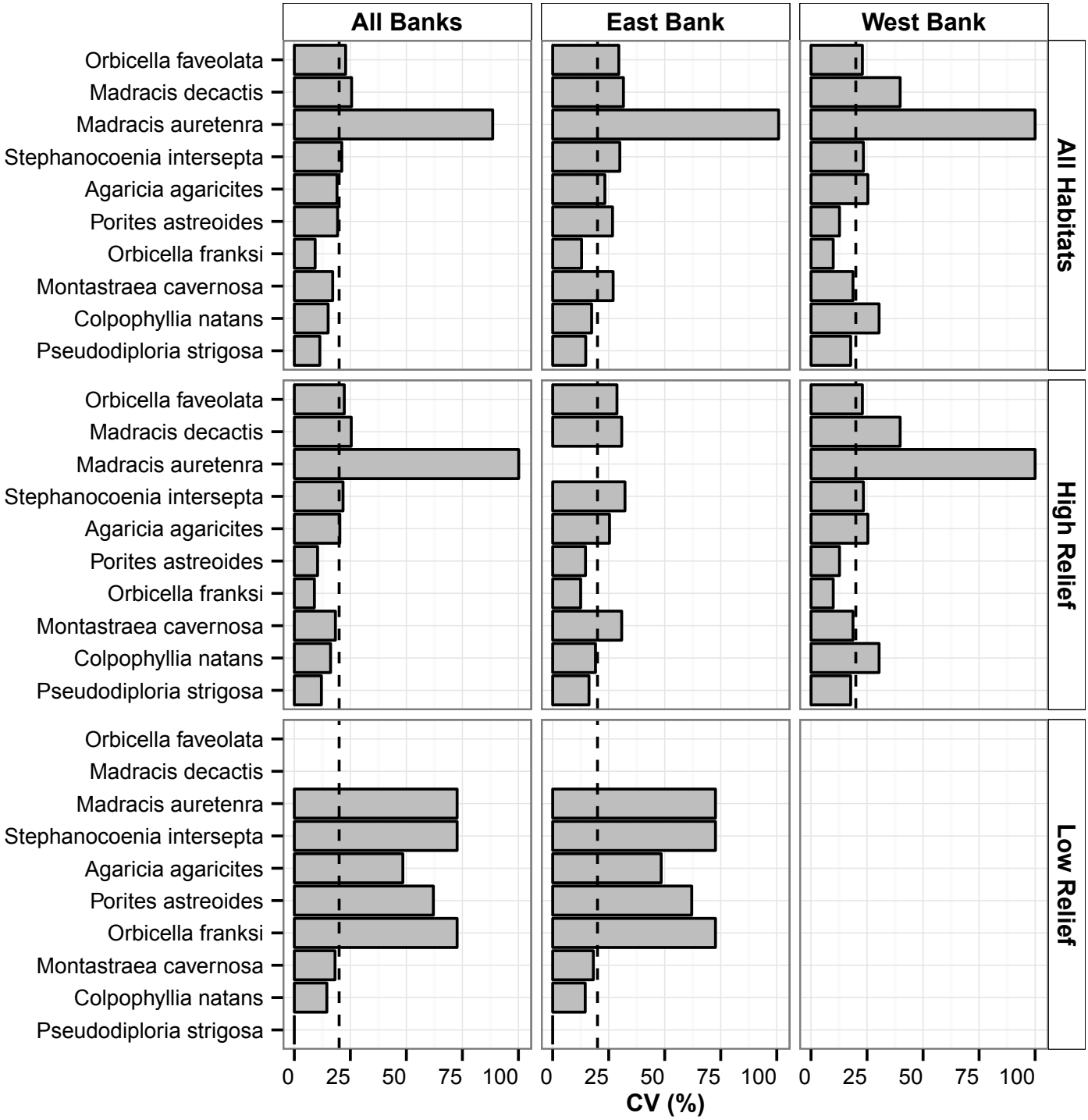


Figure 4B-3. Coefficient of variance (CV) for density (per m²) of the most abundant coral species, shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

APPENDICES

Threatened coral species

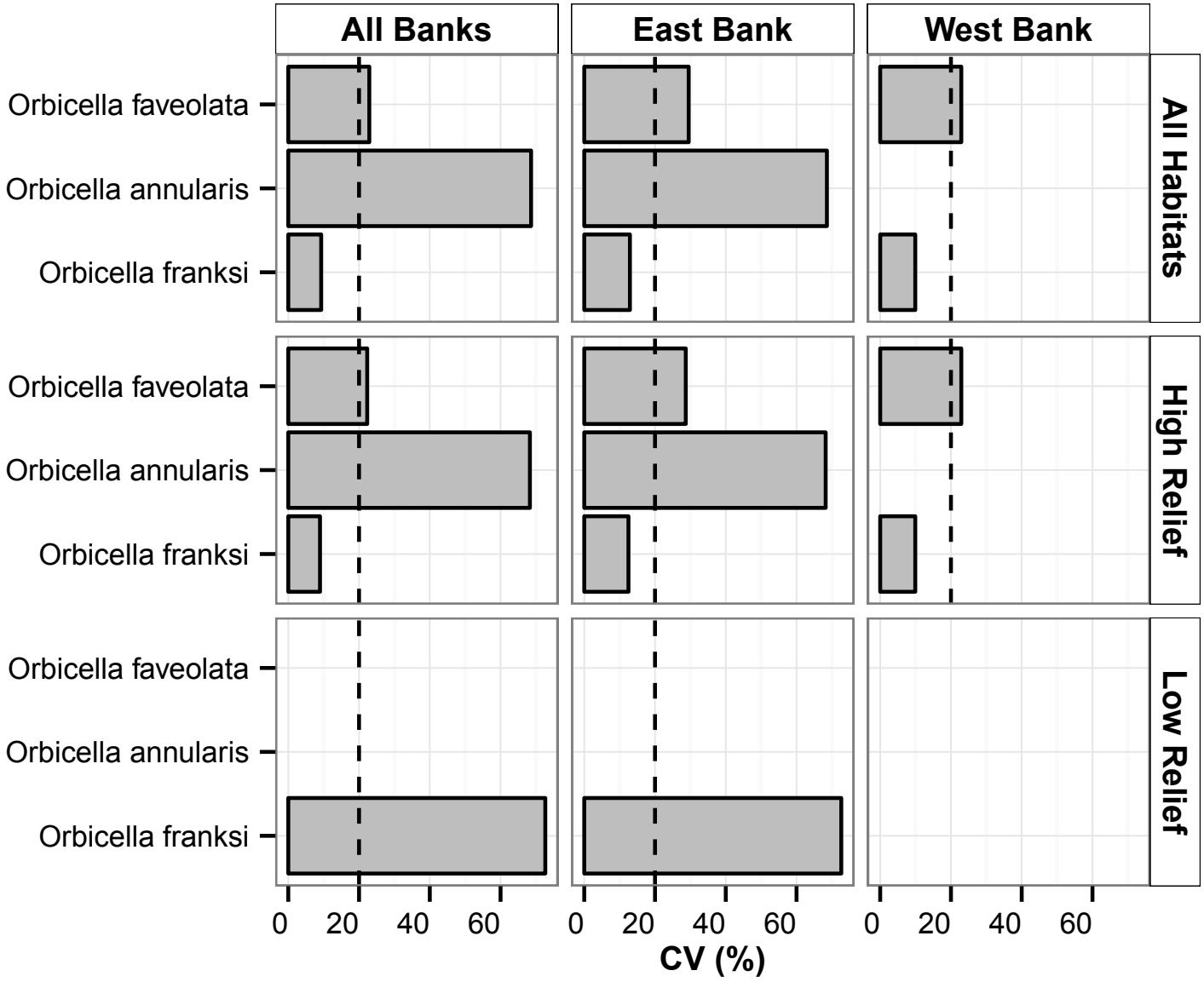
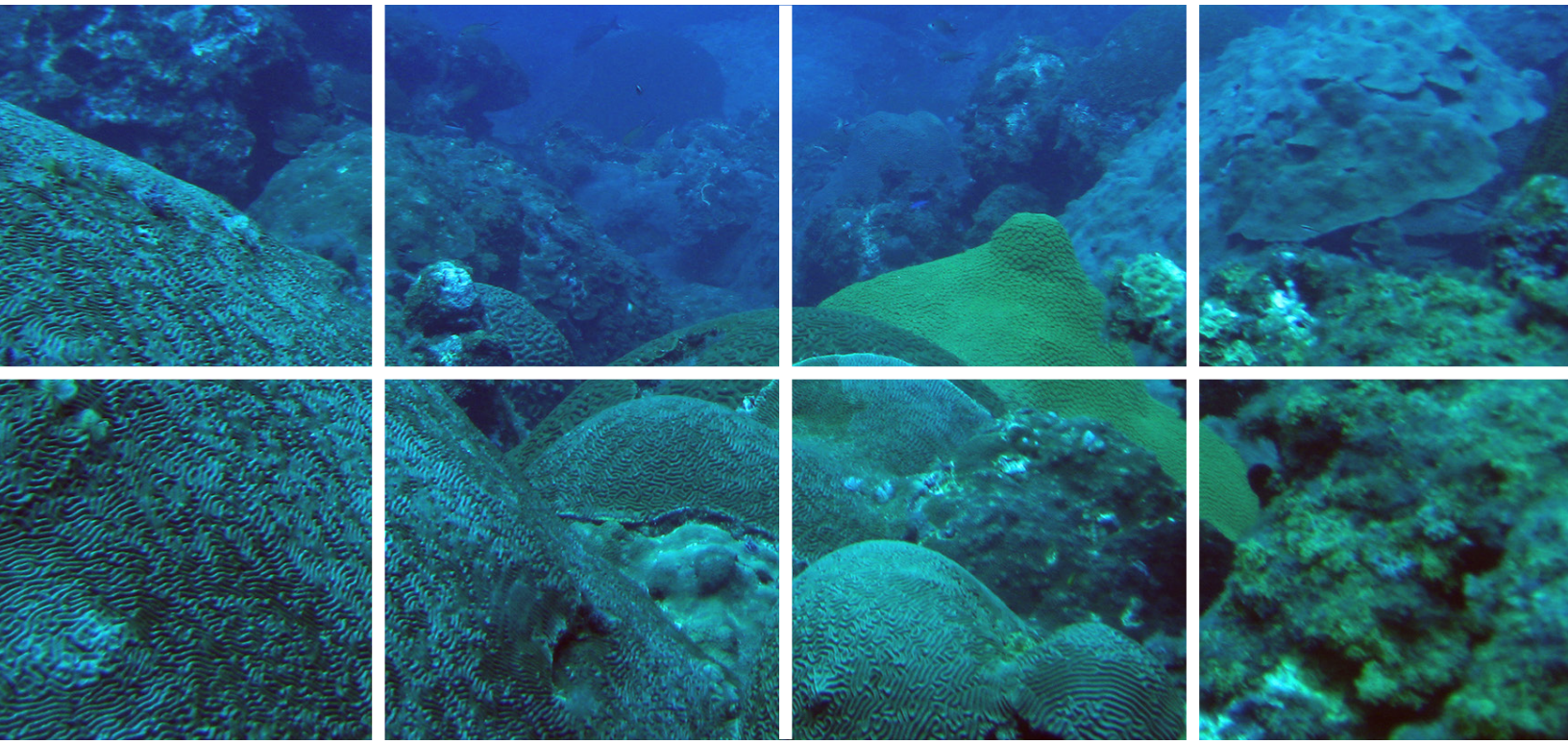


Figure 4B-4. Coefficient of variance (CV) for ESA coral species density (per m^2), shown by biotope (columns) and habitat type (rows). Dashed vertical line indicates 20% CV.

Blank Page



U.S. Department of Commerce

Penny Pritzker, *Secretary*

National Oceanic and Atmospheric Administration

Kathryn Sullivan, *Administrator*

National Ocean Service

Russell Callender, *Acting Assistant Administrator*

The mission of the National Centers for Coastal Ocean Science is to provide managers with scientific information and tools needed to balance society's envorinmental, social and economic goals. For more information, visit: http://www.coastalscoence.noaa.gov/.