

Where are the *Diadema* in the Florida Keys?

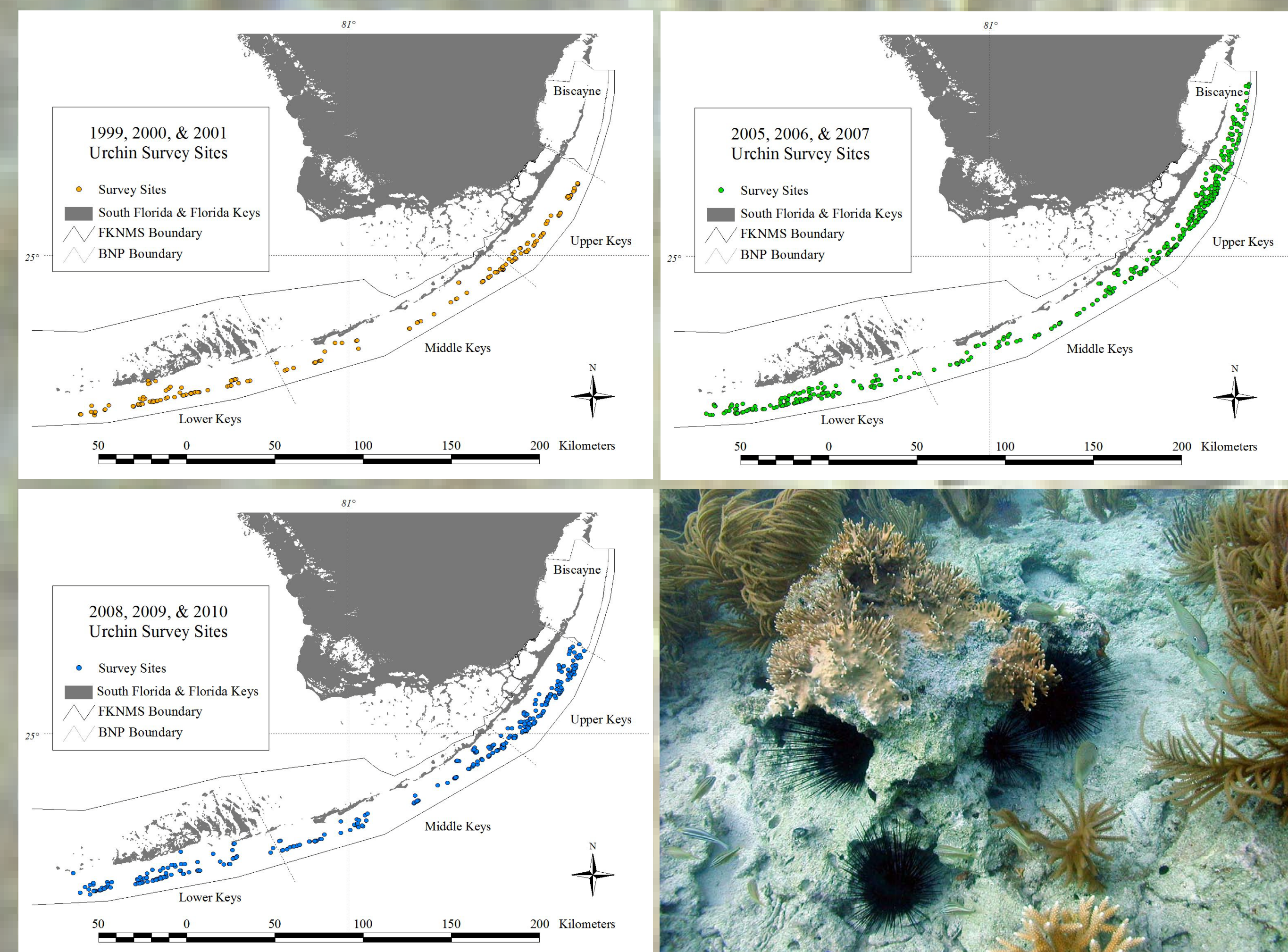


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Background

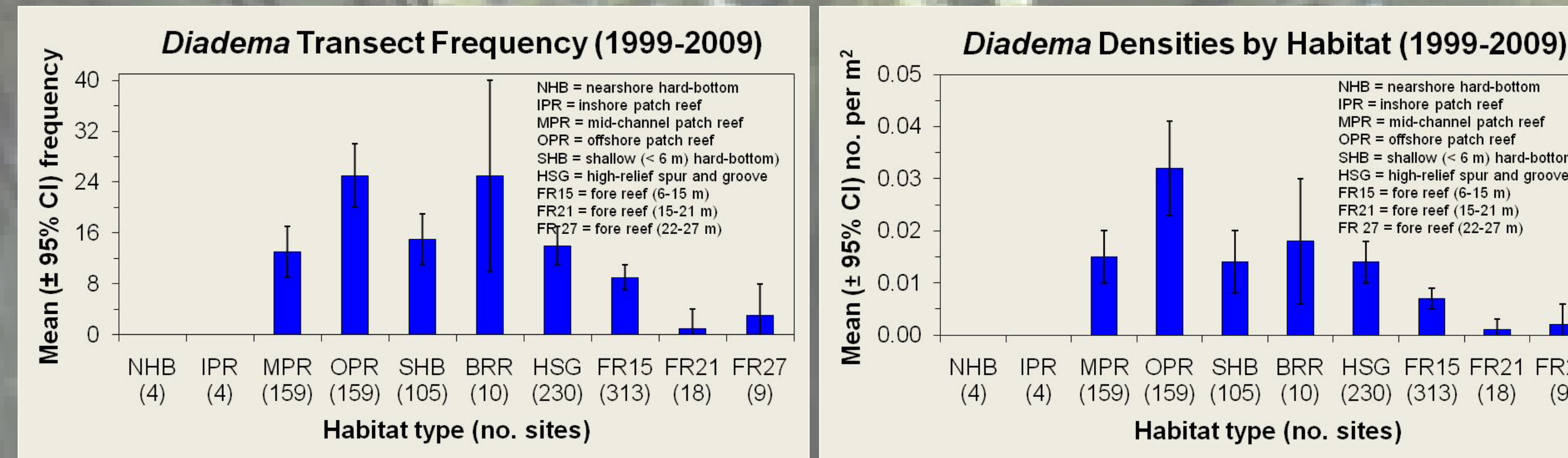
The 1983-84 mortality of the once-ubiquitous echinoid *Diadema antillarum* is one of several factors that caused Florida Keys coral reef change. Pre-mortality surveys are limited, but suggest that densities were similar to Caribbean reefs, with shallow fore-reef densities as high as 4+ individuals per m². By 1990, the population was apparently recovering, with densities approaching 1/10 of pre-1983 levels (0.5-0.6 individuals per m²), with a size structure dominated by larger (> 5 cm) individuals. Unfortunately, the population suffered a second mass mortality beginning in April 1991, reducing the population to 1/100th of its pre-1983 level.



Sampling locations for urchins in the Florida Keys during 1999-2010. Visual surveys using belt transects were used to quantify the frequency of occurrence, abundance, and test diameter of all species, including *Diadema antillarum*.

Study Objectives

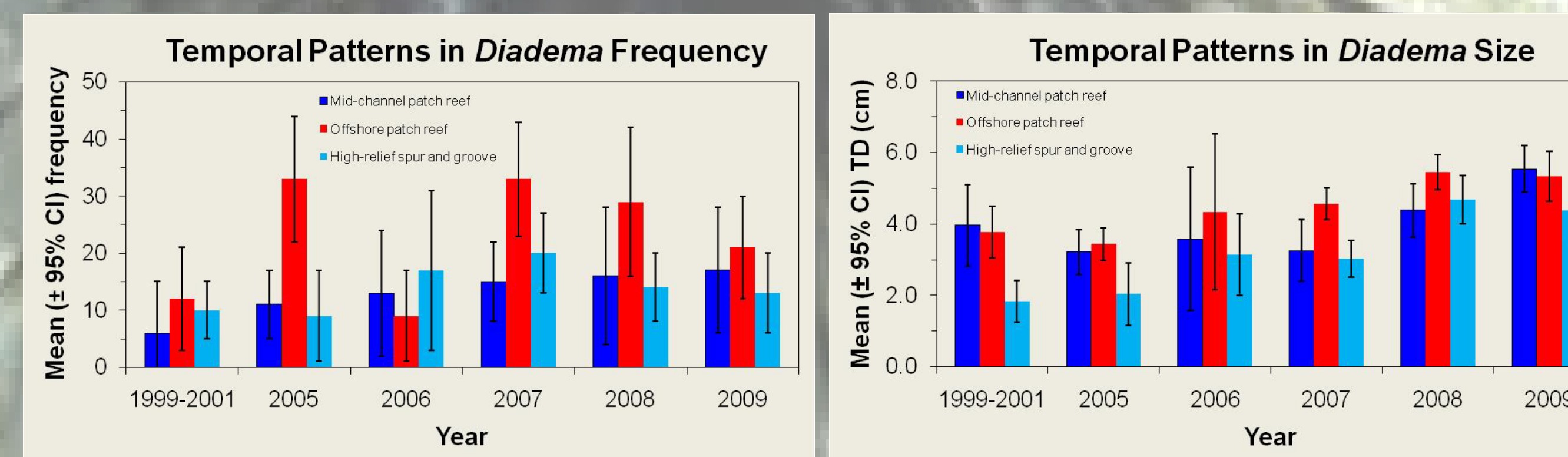
- Monitor changes in habitat distribution, density, and size of *Diadema antillarum* and other urchins in multiple habitats throughout the Florida Keys, including areas within and adjacent to no-fishing zones.
- Monitor changes in benthic community structure as they relate to potential population recovery



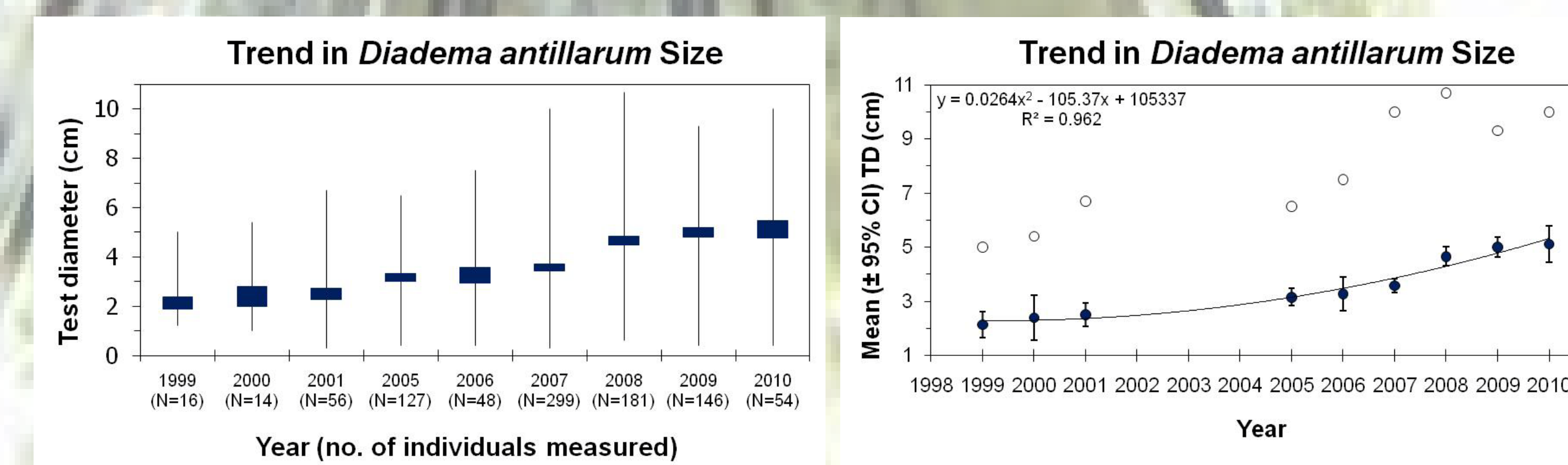
Spatial patterns among cross-shelf habitat types in the transect frequency of occurrence and mean density of *Diadema antillarum* in the Florida Keys during 1999-2009.

Methods

A two-stage stratified random sampling design is used that partitions the Florida Keys sampling domain by cross-shelf habitat type, depth, along-shelf position, and management zone. Four replicate belt transects (15-m x 1-m) are surveyed per site for all urchin species. Surveys yield data on the transect frequency of occurrence, density (no. per m²), and size (test diameter). Excluding the Tortugas region, a total of 1,173 sites were surveyed during 1999-2010 from Fowey Rocks to east of the Marquesas Keys.



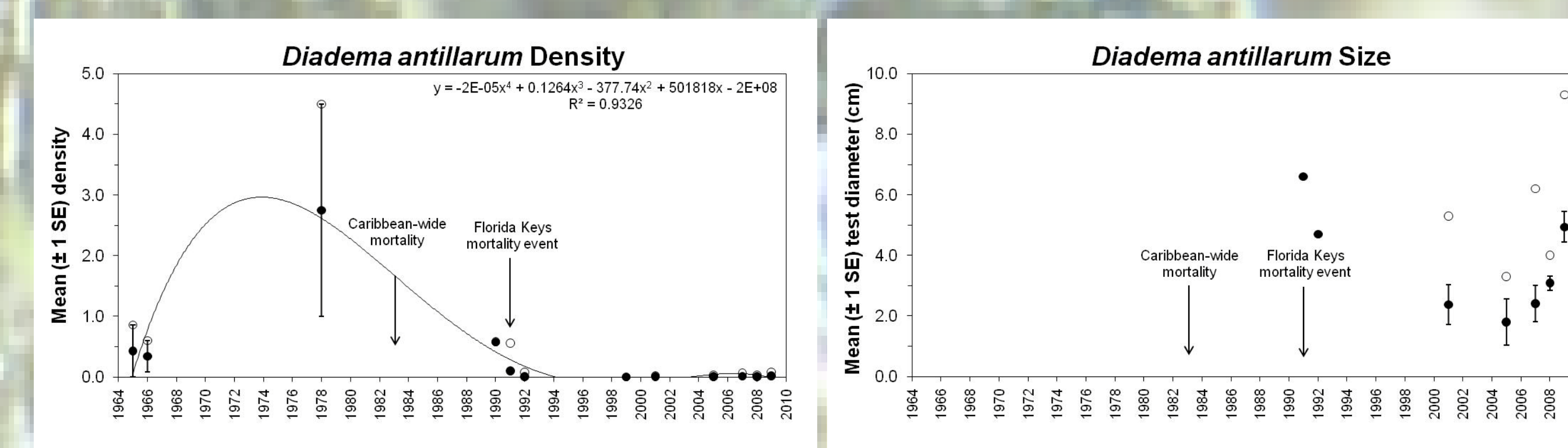
Temporal changes in transect frequency of occurrence and mean density of *Diadema antillarum* in the Florida Keys for mid-channel and offshore patch reefs and shallow spur and groove reefs from 1999-2009.



Trend in *Diadema antillarum* size in the Florida Keys during 1999-2010. Left graph: middle of box = mean test diameter, top and bottom of box = ± 1 SE, and vertical lines are minimum and maximum sizes. Right graph: mean and 95% CI of mean size (filled circles), along with maximum sizes measured in all habitats for a particular year

Results

More than a decade of urchin surveys indicate that the *Diadema antillarum* population is recovering, albeit slowly relative to pre-1983 levels. Offshore patch reefs tend to yield the greatest densities and sizes, while back-reef rubble zones are dominated by recently settled recruits. The most notable change in the population is the increase in the mean test diameter and maximum size during the past 11 years, perhaps indicative of greater survivorship in many coral reef habitats.



Historical vs. recent patterns of *Diadema antillarum* density (left) and size (right) in the Florida Keys for shallow (< 6 m) spur and groove reefs. Filled circles = mean values, open circles = maximum values. Pre-1999 data based upon surveys by Bauer (1980) and Forcucci (1994). Although the average and maximum size of the population has recovered, densities have not.

Conclusions

- Diadema antillarum* is slow recovering in the Florida Keys, especially on offshore patch reefs.
- Densities still remain well below pre-1991 and especially pre-1983 levels.
- Recovery of densities to pre-1983 levels could take decades, if not longer, based upon current patterns.
- Herbivorous fishes are probably critical for maintaining low algal standing crop on many reefs.

Acknowledgments

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