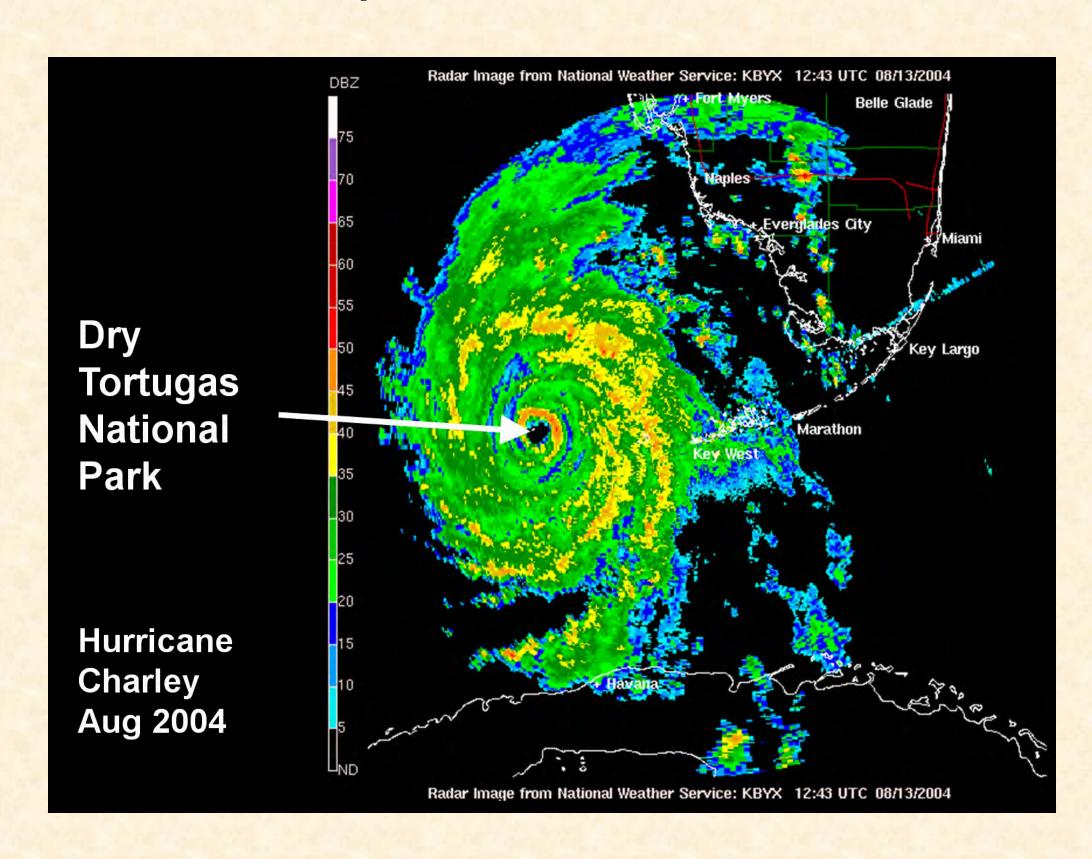
Hurricane Effects on Dry Tortugas National Park Coral Reefs and Seagrass Meadows

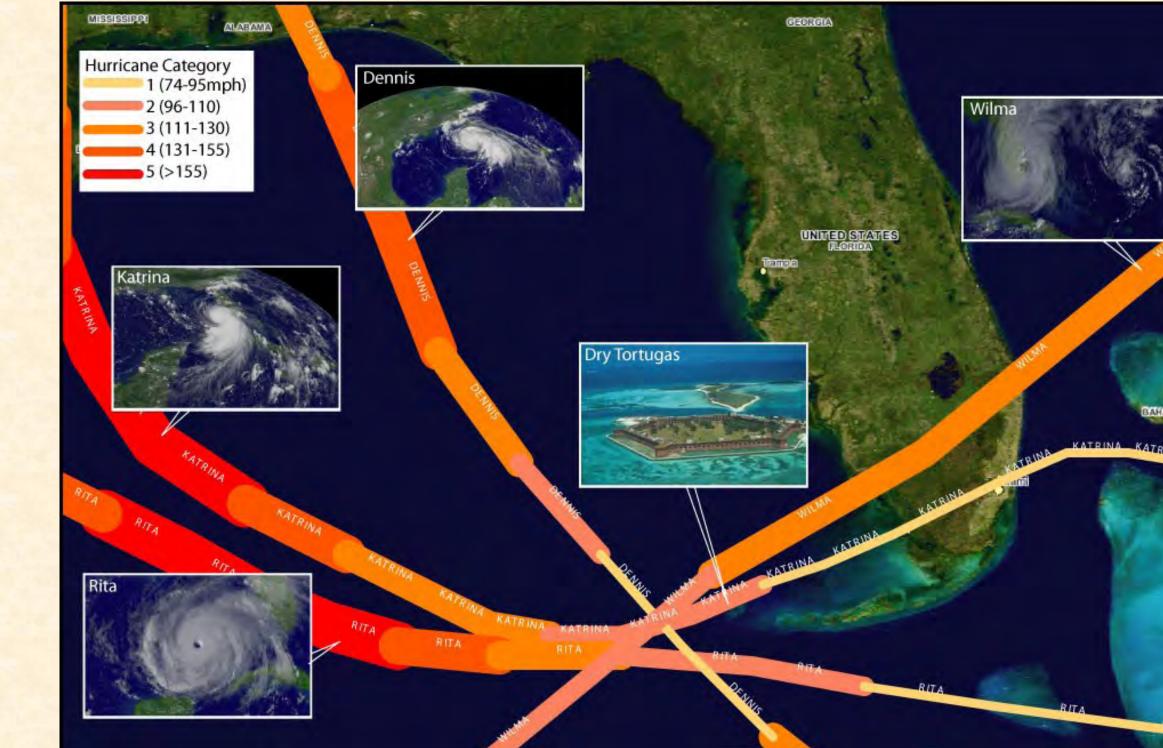
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Introduction and Project Objective

Five hurricanes and a tropical storm affected Dry Tortugas National Park (DTNP) during the 14 month period from August 2004 to October 2005. This is an unprecedented event in the 130 year history of Tortugas science. Our objective is to assess the effects of, and any recovery from, these natural disturbances on DTNP coral reefs and seagrass meadows. DTNP stony coral abundance already had been declining due to disease for at least a decade before the hurricanes. Seagrass beds are the most abundant epibenthic biotic community in DTNP, covering more than 25% of the park.





Paths and categories of four hurricanes that passed within 160 km of Dry Tortugas National Park in 2005.

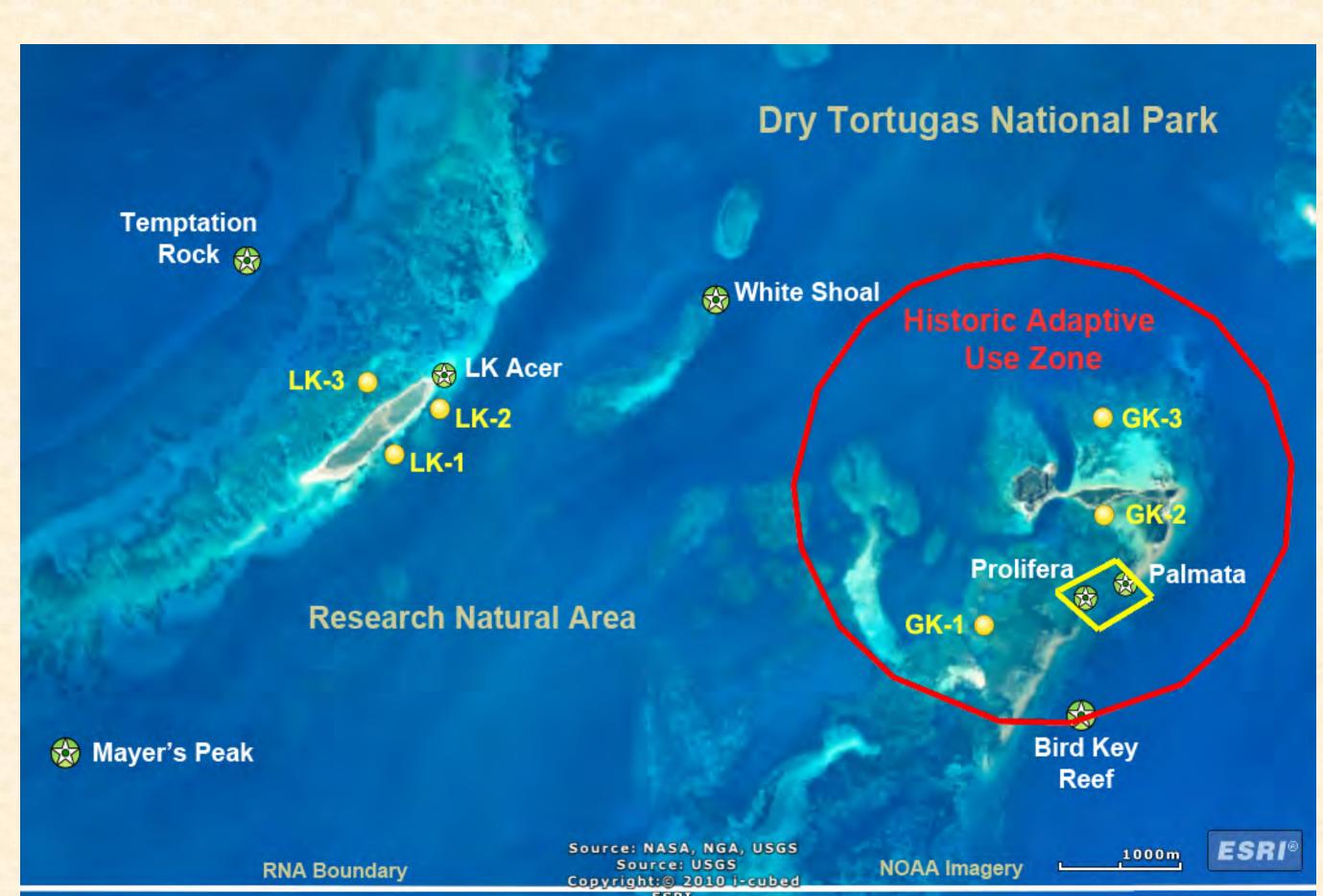
Methods

Coral Reef Benthic Communities:

We used the seven park coral reef monitoring sites that employ Florida Fish and Wildlife Research Institute Coral Reef Evaluation and Monitoring Program (CREMP) methods to evaluate the effects of the 2004-05 storms. These sites are representative of most of the common and rare DTNP reef types. The live percent cover of stony corals and other reef benthic biotic and functional groups was determined using CREMP videographic techniques. The CREMP stations (replicates) at each site are fixed. Thus, a repeated measures ANOVA (≥3 years) or paired t-test on arcsine transformed percent cover data was performed to assess statistical differences among years.

Seagrass Communities:

Pre (2003) and post (2007) hurricane satellite imagery, with ground truthing, was used to assess seagrass loss on a large spatial scale. Seagrass and benthic macroalgal percent cover were measured annually in haphazardly located 0.25m² quadrats (N=20/site) at monitoring sites to ascertain hurricane effects on a smaller scale. Echinoids (sea biscuits and sea urchins) in grass beds were counted in haphazardly located 1m² quadrats. The nonparametric Kruskal Wallis or Mann-Whitney U tests were conducted to assess statistical differences among years.



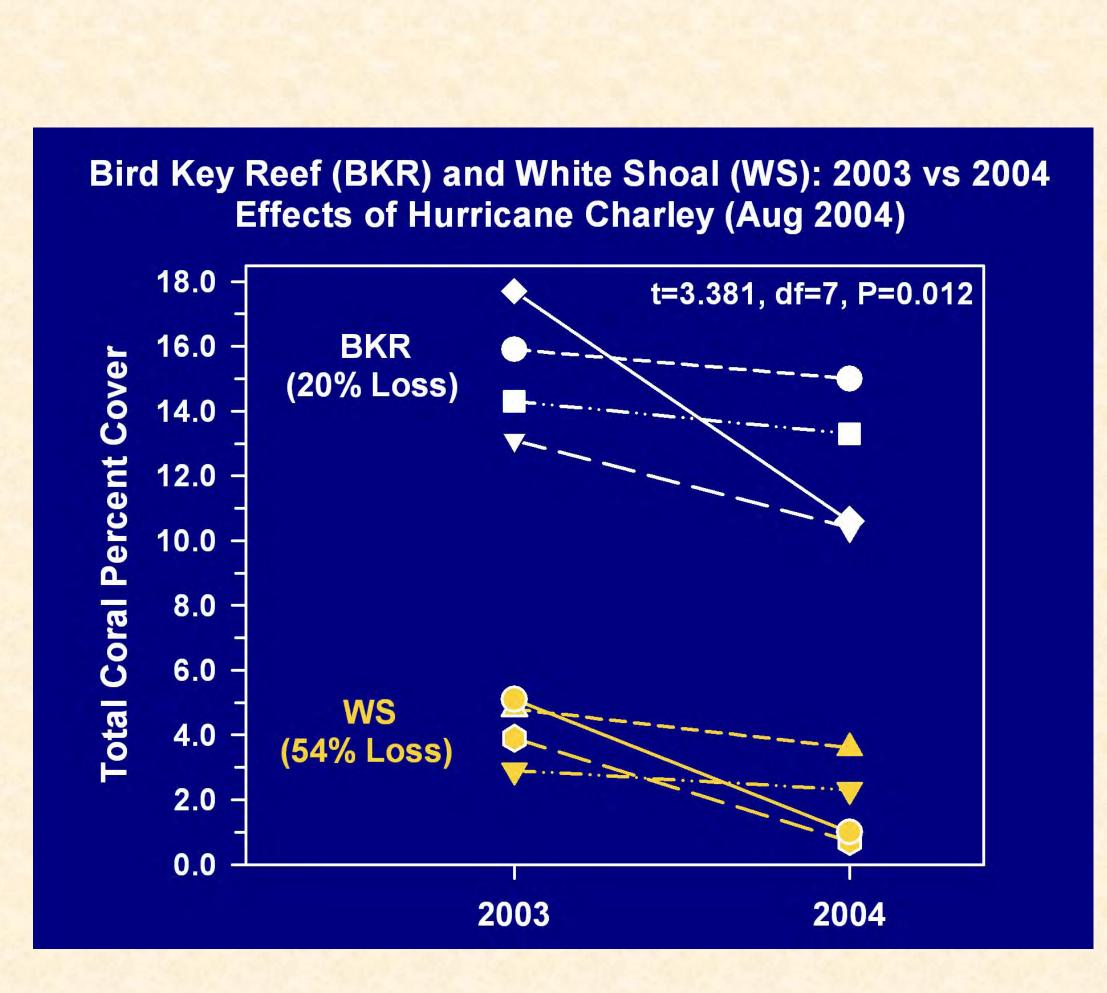
Circled stars show coral reef benthic communities assessment sites.

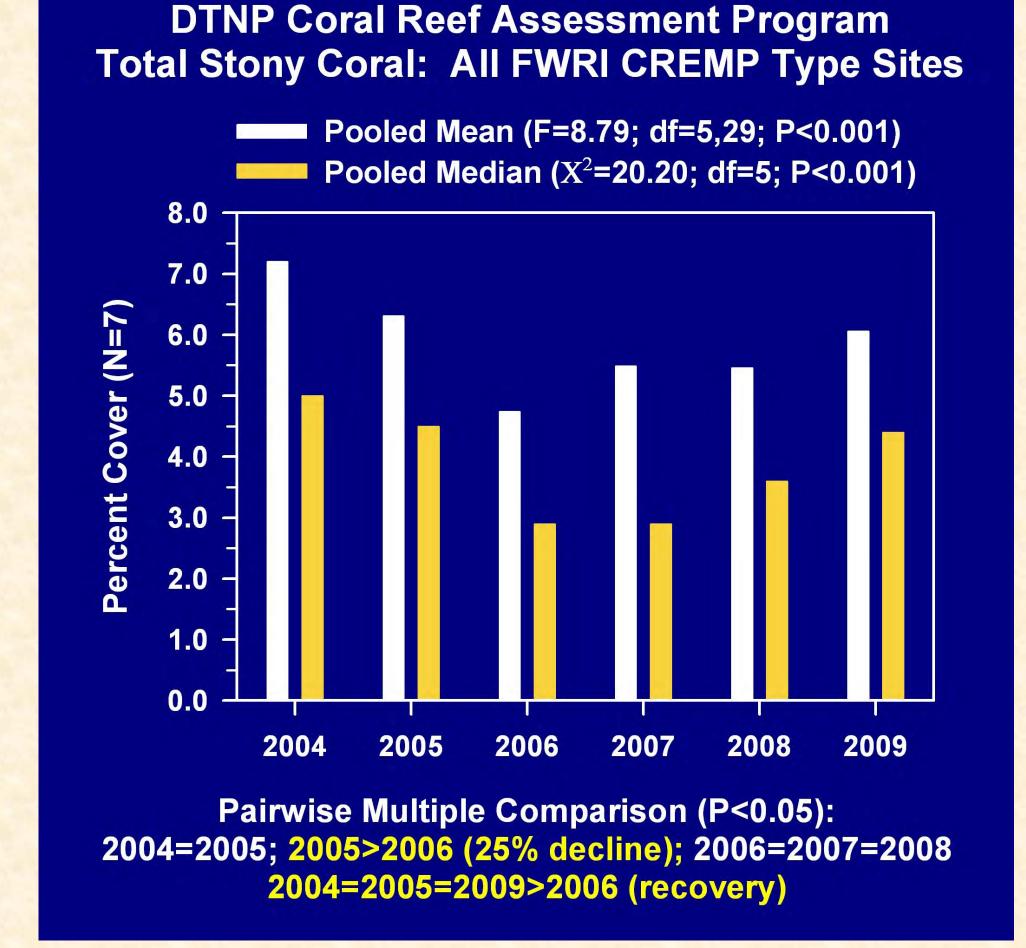
Yellow spheres indicate seagrass communities assessment sites.

Results

Coral Reef Benthic Communities:

Only two reef sites, Bird Key Reef and White Shoal, were being monitored annually before Hurricane Charley struck DTNP in August 2004. Total stony coral percent cover decreased 20% on Bird Key Reef and 54% on White Shoal from July 2003 to September 2004, after Charley (p=0.012). Statistical analyses of stony coral cover data collected at seven monitoring sites from 2004 to 2009 revealed significant differences among years (p<0.001). Stony coral declined 25% from 2005 to 2006. However, stony coral cover in 2009 was statistically greater than in 2006 and not significantly different than in 2004 or 2005, indicating statistical recovery from 2005 hurricane impacts. These conclusions apply to only these seven sites and should not be extrapolated park-wide. Octocoral percent cover also decreased significantly (p<0.05) from 2005 to 2006 at Mayer's Peak and Temptation Rock, the sites with the highest octocoral abundance.







Loggerhead Key Acropora cervicornis patch reef about one year prior to Hurricane Charley.

[Photo by Dana Williams, NOAA]

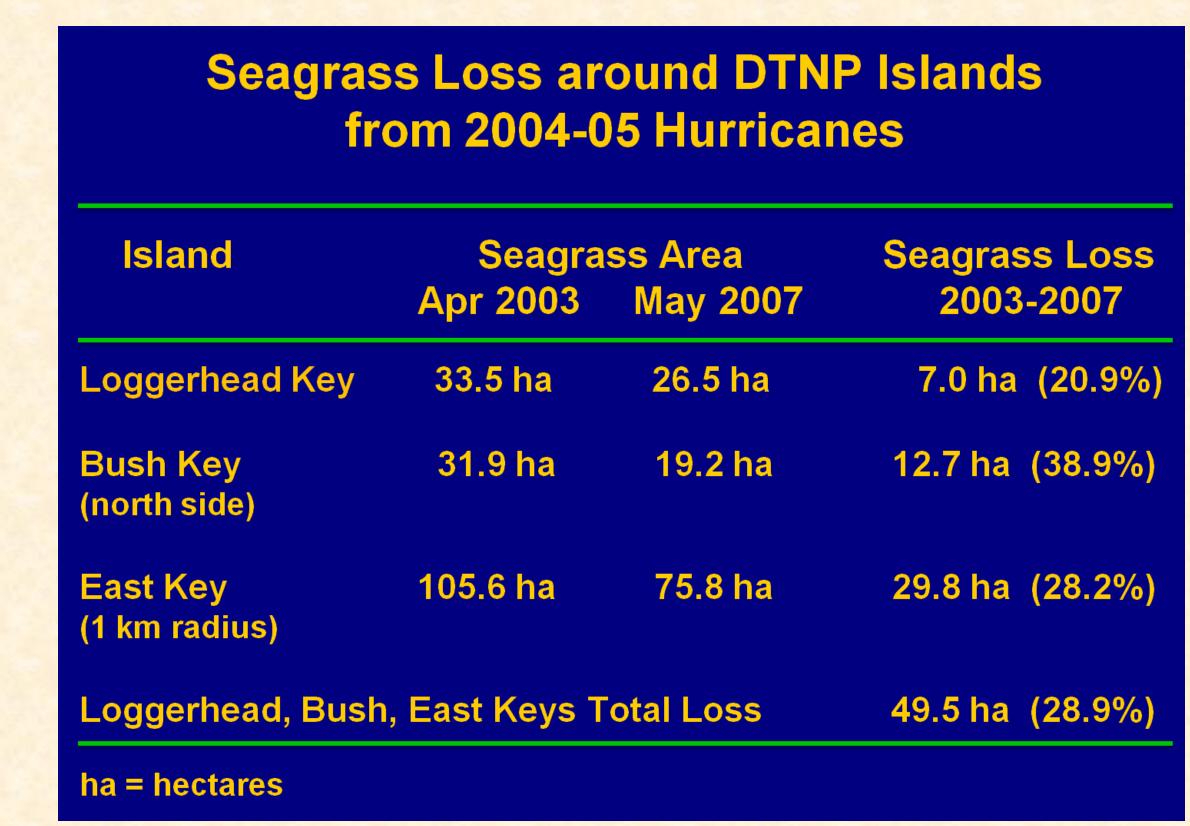


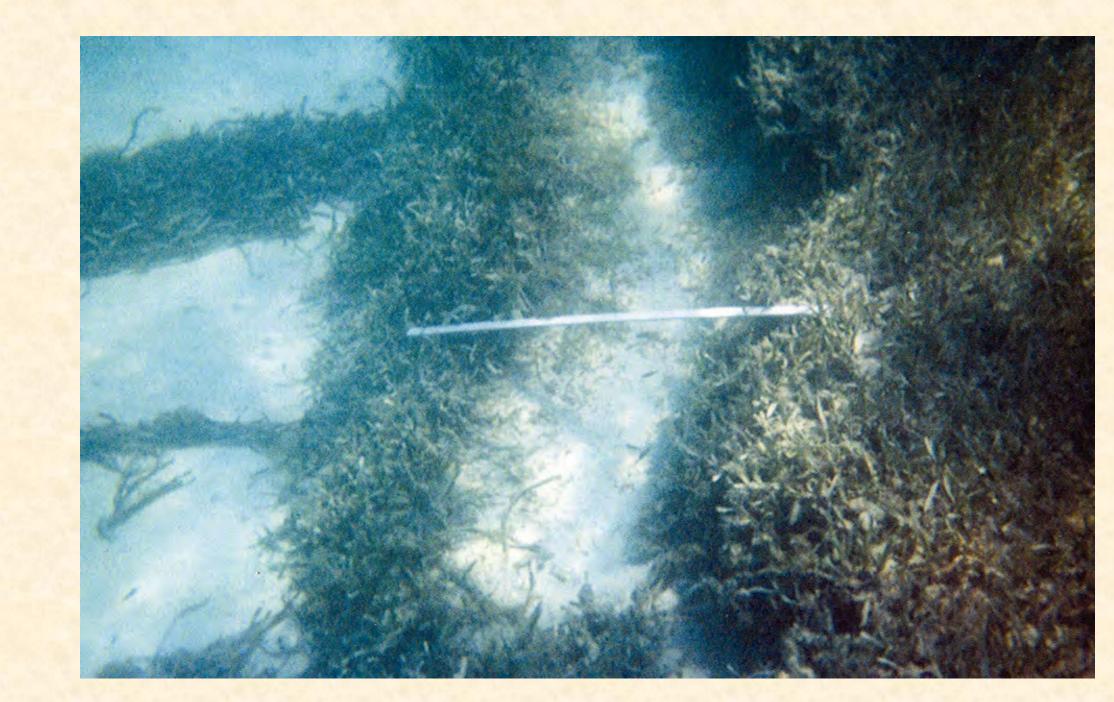
Loggerhead Key *Acropora cervicornis* patch reef about one year after Hurricane Charley (24 Jul 05).

Results

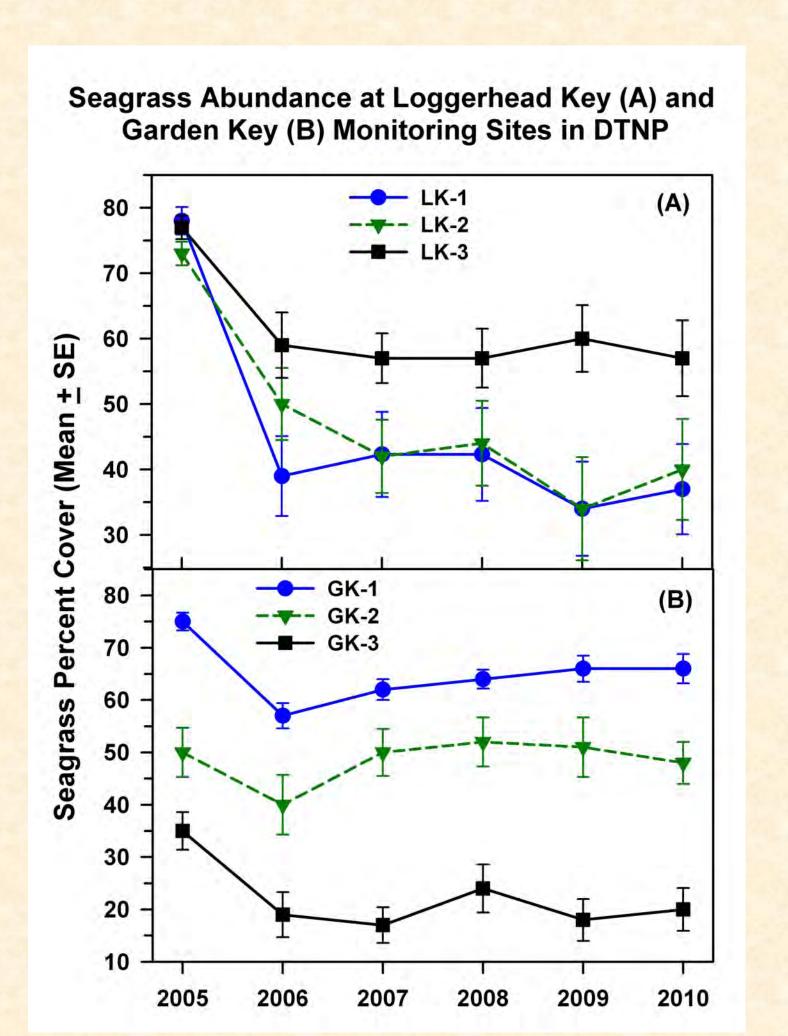
Seagrass Communities:

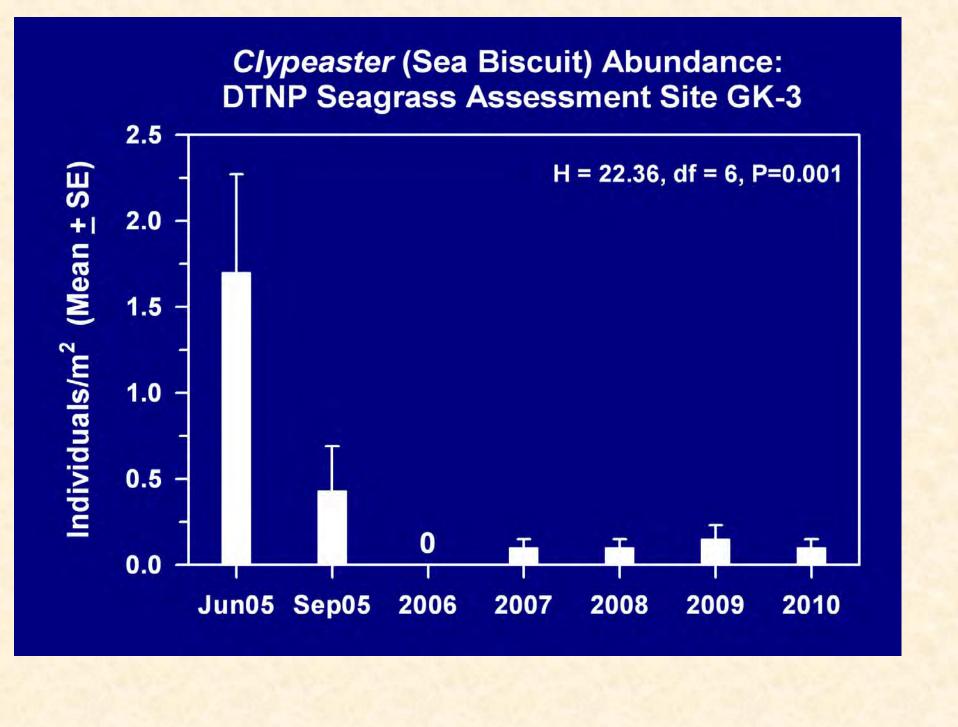
About 50 hectares (29%) of seagrass meadows were destroyed from April 2003 to May 2007 just around Loggerhead, Bush, and East Keys. This loss is greater than the total area of all the Tortugas islands (40 hectares). Seagrass and total macrophyte percent cover decreased significantly (p<0.05) at shallow (\leq 3m) seagrass monitoring sites from June 2005 through September 2005; three hurricanes affected DTNP during this period. Seagrass cover was significantly lower in July 2006 than June 2005 at all sites except GK-2. Density of the sea biscuit *Clypeaster* declined significantly (p<0.001) after the 2005 hurricanes. There was little or no effect of these storms on seagrass beds deeper than 10m. Seagrass is recovering at more protected sites (e.g., GK-1, GK-2), based on percent cover data. However, additional seagrass loss from Hurricane Ike in September 2008 occurred at more exposed sites (LK-1, LK-2, GK-3). On a larger spatial scale, shallow meadows continue to erode due to winter storms undercutting grass beds in blowouts caused by the hurricanes. This has resulted in a bimodal distribution of percent cover data at sites with substantial seagrass loss (e.g., LK-1, LK-2): 50-90% in the intact bed and <20% (mostly 0%) where the original monitoring bed has eroded away.





Hurricane and subsequent winter storm damage/ erosion of a DTNP seagrass meadow; white pole=1m.





Conclusions:

- Five hurricanes and a tropical storm affected DTNP in a 14 month period from August 2004 to October 2005, an unprecedented event in the 130 year history of Tortugas science.
- These storms had substantial negative effects on DTNP coral reefs and shallow (≤ 3m) seagrass meadows throughout the park.
- Significant stony coral loss occurred after Hurricane Charley (2004) at the only two sites being monitored annually before Charley: White Shoal 54% decrease; Bird Key Reef 20% decline.
- Total stony coral percent cover at seven monitoring sites decreased 25% from 2005 to 2006, following the four 2005 hurricanes.
- By 2009, stony coral percent cover at the seven sites was not significantly different from pre 2005 hurricane levels, indicating statistical recovery from 2005 hurricane impacts. These conclusions apply to only these seven sites and should not be extrapolated park-wide.
- 50 hectares (29%) of seagrass meadows were lost from April 2003 (pre-hurricanes) to May 2007 (post-hurricanes) just around Loggerhead, Bush, and East Keys.
- More sheltered seagrass beds are recovering; but more exposed meadows continue to erode due to wave action from winter storms undercutting beds in blowouts caused by the hurricanes.