# Collaboration in Monitoring Coral Reef Ecosystems in the US Virgin Islands

## NPS South Florida/Caribbean I & M Network and US Geological Survey

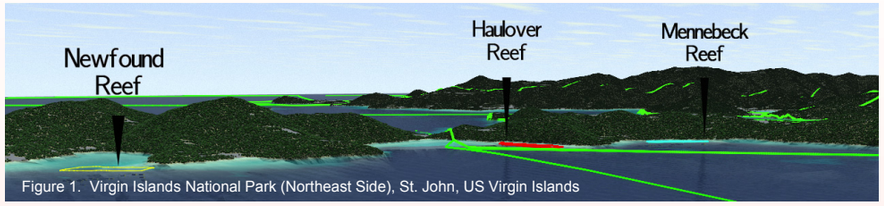

Figure 1. Virgin Islands National Park (Northeast Side), St. John, US Virgin Islands

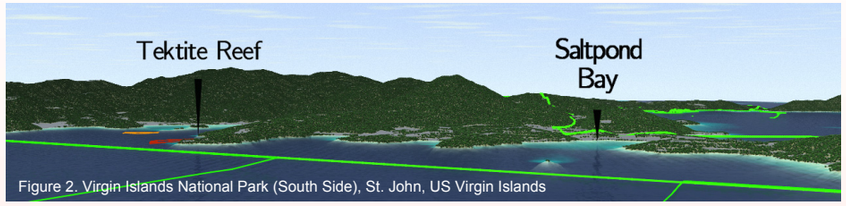

Figure 2. Virgin Islands National Park (South Side), St. John, US Virgin Islands

Figure 3. Buck Island Reef National Monument, St. Croix, US Virgin Islands

## Coral reef monitoring captures 2005 bleaching event and subsequent coral mortality

Jeff Miller[2], Rob Waara[1], Andrea Atkinson[1], Brian Witcher[1], Matt Patterson[1], Kevin Whelan[1], and Alexandra Wright[1]

### Newfound Reef

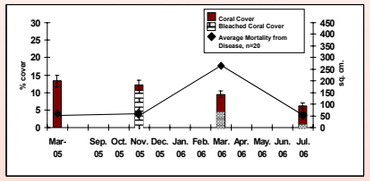

Figure 4. Coral cover, bleaching and disease at Newfound.

53% LOSS

### Haulover Reef

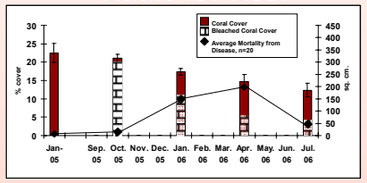

Figure 5. Coral cover, bleaching and disease at Haulover.

45% Loss

### Mennebeck Reef

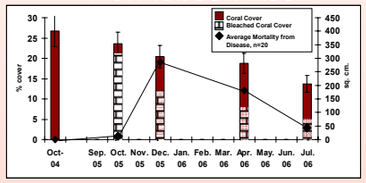

Figure 6. Coral cover, bleaching and disease at Mennebeck

49% Loss

### Tektite Reef

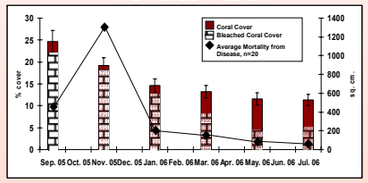

Figure 7. Coral cover, bleaching and disease at Tektite

54% LOSS

### South Fore Reef

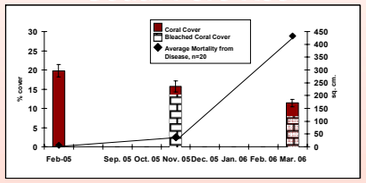

Figure 8. Coral cover, bleaching and disease at S. Fore Reef

42% Loss

The South Florida/Caribbean Inventory & Monitoring Network (SFCN) of NPS has been annually monitoring coral reef sites at Virgin Islands National Park (VIIS) since 1999 and Buck Islands Reef National Monument (BUIS) since 2000. These sites represent >30 acres of the most pristine, high coral cover, high diversity and high complexity reefs in Virgin Islands Parks. The 2005 bleaching event triggered episodic monitoring (2-6 month sample frequency) at 5 of the reef sites with major findings listed below:

- **90% of coral cover bleached**
- **Combined effect of bleaching followed by coral disease caused most mortality**
- **Two sites in VIIS have >50% loss of coral cover in less than one year (Figs. 4 & 7).**
- **47.3% loss of coral cover across all sites at both parks**
- **Although bleaching was associated with record high seawater temperatures (in 2005) at these locations mortality has continued despite normal seawater temperatures through August 2006 (Fig. 9).**

### Daily Average Reef Temperature (°C)

At Resource Depth

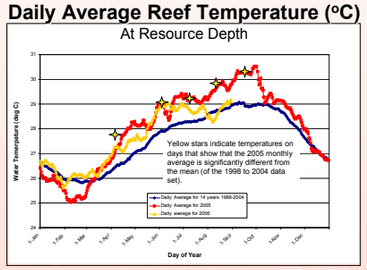

Figure 9. Daily average temperatures for 14-year average, 2005, and 2006

## Species-specific bleaching and relationships to mortality

Tony Spitzack[3]

**The bleaching response of 4153 selected coral colonies from 100 randomly selected transects at Haulover, Mennebeck, Newfound (Fig. 1) and Tektite (Fig. 2) reefs were tracked after the 2005 bleaching event. Each coral was scored with a numeric "level" corresponding to color (=zooxanthellae loss) and tracked through the 2-6 month sample interval (Fig. 10).**

**Although bleaching severity varied by species, 91.8% of corals showed some color loss (Fig. 10).**

### Coral Bleaching by Species

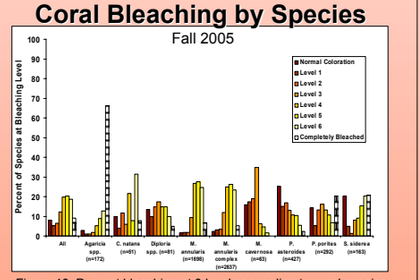

Figure 10. Percent bleaching at 8 levels according to coral species

### Coral Mortality by Species

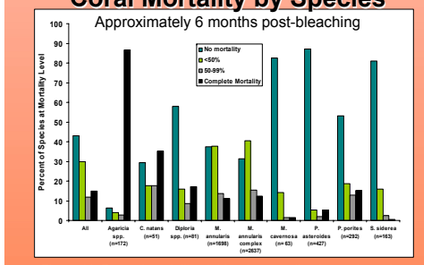

Figure 11. Percent mortality at 4 levels according to coral species

**Approximately six months after the bleaching event, 34% of surviving corals still had not recovered completely.**

**The largest and most important reef building corals, *M. annularis* complex, experienced substantial recovery at first; however high mortality due to disease followed with 68.5% of all colonies experiencing some level of mortality and 12.4% dying completely (Fig. 11).**

***Agaricia spp.* suffered the most bleaching mortality of any species (94.6%; Fig 10). Major reef building species and those species that dominate reef cover (e.g. *Montastraea, Colpophyllia, Diploria* spp.) showed relatively low total mortality (avg = 21.7%) but suffered high partial mortality (avg = 38.7%).**

**Mortality level followed bleaching (Fig. 12) with corals with greatest color loss suffering greatest mortality. Those corals that had no color loss had lowest percent mortality (Fig. 12), probably dying from disease.**

### Bleaching and Mortality

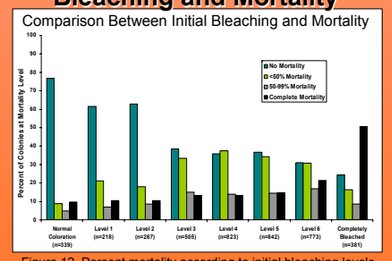

Figure 12. Percent mortality according to initial bleaching levels.

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## Elkhorn Coral Monitoring

Caroline Rogers[3], Erinn Muller[3] and Tony Spitzack[3]

Figure 13. Virgin Islands National Park (Northwest side), St. John, US Virgin Islands

### Haulover Bay

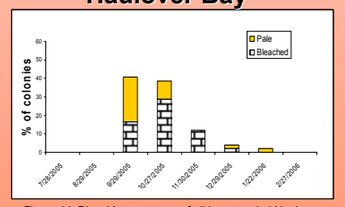

Figure 14. Bleaching response of elkhorn coral at Haulover.

**USGS monitors over 400 individual elkhorn colonies from four different reefs around the island of St. John. Two sites, Haulover Bay (Fig. 1) and Hawksnest Bay (Fig. 3) have been monitored monthly for over two years, while Saltpond Bay (Fig. 2) and Trunk Bay (Fig. 13) were monitored monthly from July, 2005 to July 2006.**

### Saltpond Bay

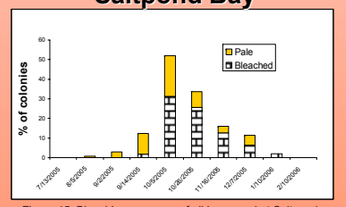

Figure 15. Bleaching response of elkhorn coral at Saltpond.

### Trunk Bay

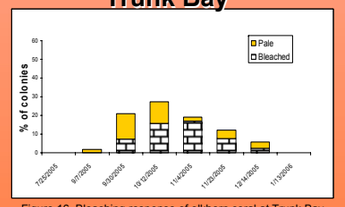

Figure 16. Bleaching response of elkhorn coral at Trunk Bay.

**All four monthly monitoring efforts encompassed the 2005 bleaching event and provided pre-bleaching baseline data of size class distribution and disease prevalence. Although coral colonies of other species have bleached in the past, bleaching of elkhorn colonies had not been observed before around St. John.**

### Hawksnest Bay

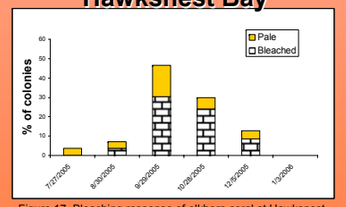

Figure 17. Bleaching response of elkhorn coral at Hawksnest.

**Elkhorn corals started to bleach in August 2005 when water temperatures (at 3 m depth) had averaged over 29°C during the previous three months (Fig. 17). 50% of all elkhorn colonies monitored showed some sign of thermal stress, with the highest percent occurring during the month of October (Figs. 14, 15, and 16).**

**Of the colonies that did show signs of bleaching, approximately 36% suffered partial mortality (Fig. 18). Complete mortality was less than 15% at Haulover, Saltpond, and Trunk Bay (Fig. 18). An outbreak of an unknown disease occurred on the eastern-most patch reef at Hawksnest Bay where the extent of bleaching at this site was the most severe. The disease outbreak caused a greater extent of mortality at this site, with only 28% of the colonies recovering without any level of mortality (Fig. 18). Disease prevalence at all other sites was within the normal range. By February 2006 all surviving elkhorn colonies appeared normal in color.**

### Elkhorn Mortality

All Sites, St. John, USVI

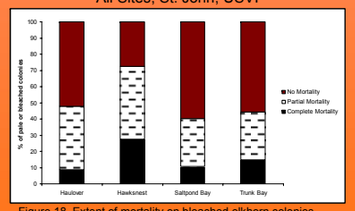

Figure 18. Extent of mortality on bleached elkhorn colonies.

## Collaborative Findings- What causes coral mortality?

Bane Schill[4], Erinn Muller[3], Caroline Rogers[3], Jeff Miller[2], and Rob Waara[1]

Figure 19. *Colpophyllia* disease mortality

The SFCN coral monitoring program captured the coral disease event that occurred between the 2005 coral bleaching event and subsequent mass die-off. The relationship between coral bleaching, coral disease, and coral mortality is poorly understood. However, some sort of correlation was observed in 2005 when corals began to recover from bleaching but then suffered mortality from disease (Fig. 19) (primarily white plague disease).

In August, 2005, USGS scientists, along with NPS personnel, sampled healthy and diseased *Montastraea annularis* along transects at Tektite Reef (Fig. 2). Samples were transferred to the lab and 16S ribosomal genes and zooxanthellae ITS-1 genes were readily amplified by Polymerase Chain Reaction (PCR) from card samples. PCR products were further analyzed to examine the diversity of bacteria and zooxanthellae colonizing the corals sampled.

PCR primers were developed to better amplify a highly variable stretch of alphaproteobacteria that past research has associated with health/disease status.

56 of the healthy colonies harbored a common, single type of alphaproteobacterium, while the remaining 8 harbored either distinctly different single types or multiple types of these microbes (Fig. 20).

All 31 of the diseased samples harbored alphaproteobacterial types that appeared to be different from the healthy samples (Fig. 20).

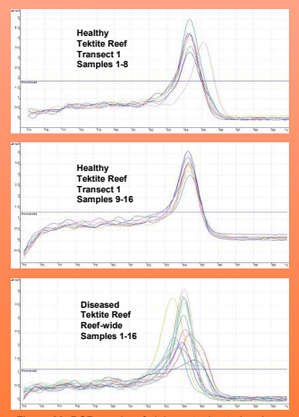

Figure 20. PCR graphs of alphaproteobacterium in healthy and diseased corals.

**This suggests that there may be an alphaproteobacterium that forms either a commensal or symbiotic relationship with *Montastrea annularis* and this relationship is disturbed in the disease process. Future research needs to address what triggers this disruption, and if coral bleaching is causing increased susceptibility to this disruption.**