Elevated Temperature and UV Light Affect Condition of Reef-Building Corals

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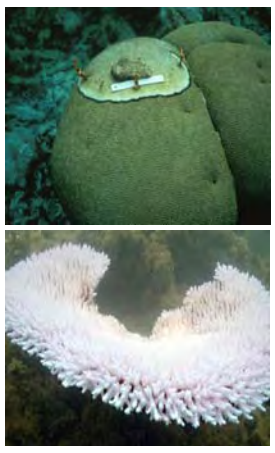
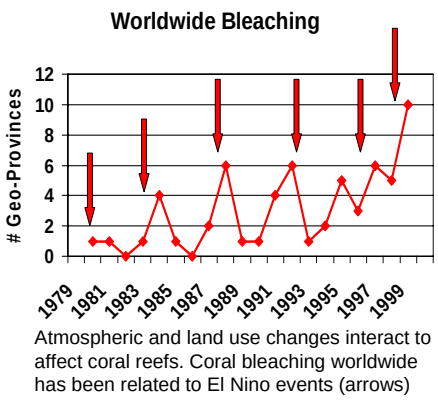
Corals Decline Worldwide

Multiple stressors from global atmospheric and land use changes create adverse conditions for corals and coral reef communities. Florida Keys corals suffer from bleaching and several emerging diseases.



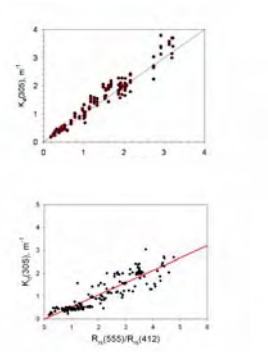


Atmospheric and land use changes interact to affect coral reefs. Coral bleaching worldwide has been related to El Nino events (arrows)

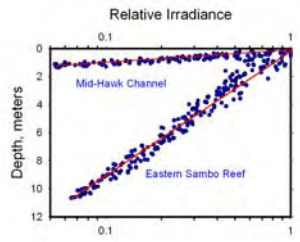
Coral reefs in Florida Keys have experienced unprecedented disease and bleaching. Top, black band disease of a brain coral. Bottom, disruption of symbiosis causes loss of symbiotic algae and a 'bleached' appearance.

Exposure Assessment

Solar radiation reaching the coral reefs is influenced by season, time of day, wind, depth and water composition. Attenuation of UV light is largely controlled by organic carbon in the water column. Seagrasses and mangroves are a major source of this colored organic carbon.



Attenuation of UV light (below) varies dramatically at two Florida Keys locations, Mid-Hawk Channel and Eastern Sambo Reef.



UV attenuation (Kd 305 nm) and absorption coefficients for colored organic matter in the Florida Keys show a 1:1 correspondence (top left). These data are the first conclusive evidence that UV penetration through water is controlled by colored organic carbon. A linear association between UV attenuation and visible reflectance (412 nm) measured in the Florida Keys (bottom left) demonstrates a potential to estimate UV exposure from remotely-sensed ocean color.

Collaborators

U.S. EPA Region 4 and Office of Water
U.S. Global Change Program
NOAA Florida Keys National Marine Sanctuary
NOAA National Ocean Service, NOAA AOML
Dry Tortugas National Park Service
The Nature Conservancy
World Wildlife Fund
Mote Marine Laboratory
University of Georgia
University of Miami

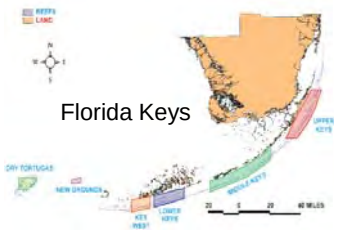
Effects Assessment

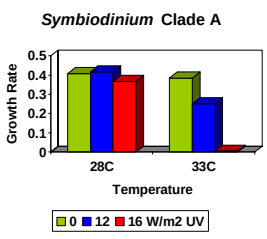
Probability-based transects in the Florida Keys are surveyed for prevalence of coral disease, bleaching and coral condition indicators:

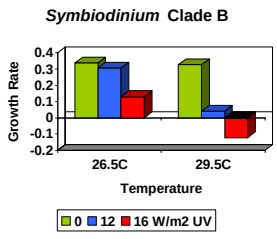
- species richness/ diversity
- colony survival
- live coral surface area
- 3-D coral relief

These provide assessments of

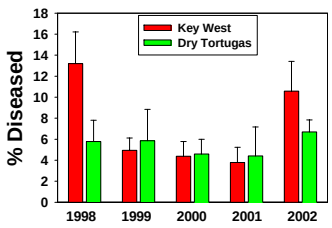
- habitat value
- health and growth
- sustainability





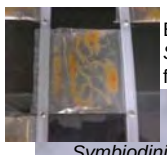


Laboratory experiments with coral fragments and isolated algal symbionts (*Symbiodinium* sp.) have clearly demonstrated adverse interactions of temperature and UV radiation. Above, the temperature tolerance of two symbiotic algae is decreased in the presence of UV.

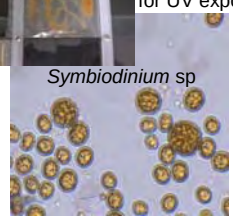


Coral diseases were greatest in Key West after the 1997/98 bleaching event, and increased again in 2002.

Coral fragments of various species in laboratory culture



Bag culture of *Symbiodinium* for UV exposure



Coral surface area is critical to the sustainability of the coral reef community. Scales and billiard balls provide references for generation of 3-D models to determine surface area of live and dead coral.

Adaptive Management

Reefs areas that are most resilient to coral bleaching are likely to have one or more of the following characteristics:

- cool water due to upwelling
- rapid currents that flush toxins
- shading of UV by cliffs/shelves
- turbid waters that screen UV
- communities that have adapted or acclimated to past fluctuations in temperature/UV
- conditions that are conducive to coral recolonization

Information from exposure and effects research supports identification of reef areas that are most resistant to temperature-induced bleaching and most able to recover after bleaching has occurred. These resilient reefs can be given high priority for inclusion in marine protected areas (MPAs) that protect reefs from direct anthropogenic impacts by regulating different forms of human activity.

Rapid currents flush toxins associated with coral bleaching