Trend in Coral "Hot Spots" in the Florida Keys: Implications for Ecosystem Restoration

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Introduction

Florida's coral reefs were once the 3rd largest in the world but have declined by as much as 90% since the late 1970s due to the combination of increasing water temperatures and diseases including White Band Disease.[1] Researchers have planted new corals to help support Florida's reefs but the July 2023 heat wave, which was the hottest on record in the region, caused a massive coral bleaching event that threatened reef restoration efforts. Researchers are concerned that coral reefs could be reaching a "tipping point" from which they would be unlikely to recover.[2]

Coral Bleaching

Coral bleaching occurs when corals are exposed to prolonged, extreme heat and expel symbiotic algae, exposing their white skeleton (Figure 1). Without the nutrients provided by the zooxanthellae, the corals become susceptible to starvation and disease.[3] Over time, coral reefs may recover from a bleaching event, but the increased frequency, intensity, and duration of marine heatwaves limit the ability of corals to recover.

The purpose of this study was to analyze the increase in Hot Spots in the Florida Keys Regional area and to communicate the plausible increase in coral bleaching events in relation to increases in ocean temperature

Figure 1. Photo showing side-by-side of elkhorn coral in the Florida Keys in August 2022 vs August 2023. (Image source: CNN Photo by Liv Williamson)

Coral Bleaching Heat Stress "HotSpot"

NOAA's Coral Reef Watch Coral Bleaching **HotSpot (HS)** product is a measure of "instantaneous heat stress" experienced by coral.[4] HS values greater than 1˚C. Daily HS data from the NOAA Coral Reef Watch daily Florida Keys 5km Regional Virtual Station (24.7500N, 81.6250W) for 1985 to 2024 were used here to determine if the frequency of bleaching conditions within the Florida Keys Reef have changed over time. A Virtual Station is like having a temperature sensor in the water next to a coral reef, but data are completely based on satellite **remote** sensing measurements.

Map of the Florida 5 km Regional Virtual Station
Polygon Middle Longitude: -81.6250
Polygon Middle Latitude: 24.7500

Results & Discussion

Given the seasonality in SSTs, daily HS values were averaged annually to determine if there was a change in HS intensity over the period of record (1985-2024). The trend in average annual HS was determined using the non-parametric Sen's slope and tested for significance using Mann-Kendall text for *p*-value < 0.05.

Results indicate that there was a significant increase in the intensity of HS within the Florida Keys over the 40 years (Figure 1). Given the extreme nature of the 2023 heat wave, the trend was calculated for 1985 to 2022, which resulted in a similar, significant increase. Additionally, the average annual HS value exceeded 1˚C 18 times since 1985, 17 of which occurred since 2005.

The results show that coral reefs are going to continue being in danger. They need the oceans to slow in warming and for more resilient species to be planted in dying reefs. A recommended future calculation is the tipping point from which the reef in the Florida Keys are no longer viable. Without the reefs, shorelines will suffer from storm wave damage, local ecosystems will suffer, and biodiversity will be lost. Restoration efforts include planting coral after bleaching events. However, these coral also have a high mortality rate, <22% of staghorn and <5% of elkhorn planted coral survived the 2023 heat wave. A NOAA post-heatwave survey found many healthy and thriving wild and out planted boulder, massive, and brain corals. [5]

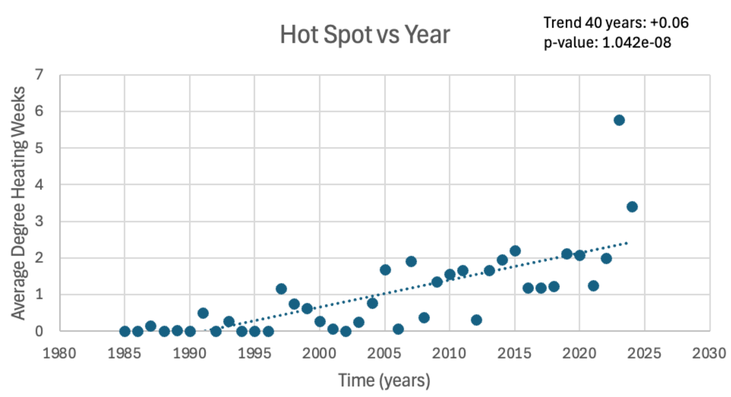

Figure 1. Average number of HotSpot days per year from 1985-2024 for Virtual Regional Florida Keys NOAA station, with a slope of 0.06 and a p-value of 1.042e-08 and a 95% confidence interval

References

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