Large scale community responses to El Niños in Galapagos subtidal ecosystems.

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Background

A fundamental unknown required to predict how climate change will impact ecosystems is whether or not the community responds to the physical disturbance in a linear (ie all negative or positive responses) or non-linear (leveling off) fashion where thresholds come into play.

As recurrent, large scale shifts in oceanographic climate, El Niño 's (ENSO's) represent a good proxy for studying some aspects of future climate change in the ocean. For example, El Niño events are forecasted to increase in severity in a warming climate. Most studies of El Niño impacts on marine systems to date have described linear losses of biomass, abundance or diversity. By monitoring ocean temperature and benthic communities at 12 sites spanning a large region of the central Galapagos since 1999-2002, we have discovered non-linear changes where corals were bleached and /or killed (negative response) and barnacle populations dramatically increased (positive response) during the 2006- 2008 ENSO. Our experimental work has shown that increased abundance of barnacles will have a positive (bottom up) effect on subtidal food webs in the Galapagos Marine Reserve because whelks (*Hexaplex princeps*) and fish feed on them. Remarkably, the same effects re-occurred during the 2010-2011 ENSO. We are currently analyzing these data.

Consequently, the specific results described below are for the 2006- 2008 ENSO.

Research objectives and questions

- How do El Niño (warm period) and La Niña (cold period) events affect benthic communities and food webs?
- How resilient are coral and coral associated communities to ENSO disturbance?
- Are there cumulative impacts of multiple ENSO events?

How we're doing it

We began to measure changes in communities of epifaunal invertebrates and their predators in subtidal rock wall habitats at 2 sites in the central Galapagos in 1999, and expanded monitoring to 10 more sites in 2002. Since then, we have re-visited the sites twice a year to photograph quadrats along transects placed at fixed locations on the walls at two depths per site: 6m and 12-15 m. We have photographed the areas with a quadrapod (i.e. 4 legged camera framer, see video), which allows us to capture a standardized area.

Separate band transects are surveyed for densities of mobile consumers, such as sea urchins, predatory gastropods and sea stars. During the later half of the project, we also began surveying walls, adjacent slopes and horizontal ledges for the frequency and extent of coral bleaching. In relation to the consumer diversity project (A1 above) , we have deployed GoPro cameras on the transects to characterize the species richness of fish assemblages when divers are not present. Physical data are also collected at each site. These measurements include characterizing the structure of the water column with a CTD and measuring temperature continuously with Tidbit Temperature Loggers (Onset Computer Corporation).

The major changes (corals bleached and /or killed, large increases in barnacle recruitment and abundance) were likely triggered by unusually cold water during each \ La Niña phase. For instance, anomalously cold episodes (as low as 13.00 C; 6, 15 m depth) were common by May – June 2007 when average temperatures were 0.6 – 2.4 00 C lower than long term averages at some sites. Extensive coral bleaching occurred between June 2007 and January 2008 surveys, and again in January 2011. Coral bleaching and resilience was taxon specific, with the most damage incurred by Pocilloporid finger corals where all colonies encountered were at least partially bleached and over half were dead. Mounding corals (Porites, Pavona) sustained less bleaching and the majority of colonies had recovered by January 2009. La Niña impacts on the subtidal ecosystem were apparently asymmetric since significant increases in the percent cover of barnacles (Megabalanus) occurred via recruitment and growth at all 12 sites during the period when corals were stressed. La Niña associated increases in barnacle abundance will likely have a bottom up effect on the rocky subtidal food web as such effects on predatory whelk populations were demonstrated over a 3 yr period leading up to the first ENSO. Effects on the broader food web, including fish are being evaluated. In contrast to corals and barnacles, densities of a key grazer and omnivore, the pencil urchin, *Eucidaris galapagensis,* remained stable during and after the 2006-2007 ENSO.

Overall, the results suggest that climate oscillations may have simultaneously negative and positive effects on different components of the same large-scale ecosystem, underscoring the importance of long- term field observations to probe the impacts of climate change in the ocean.

http://eco.confex.com/eco/2010/techprogram/S5573.HTM (Link to Symposium on ESA 2010 Annual meeting archive)