

## Sea Urchin Size Structure

**Overview:** One potential manifestation of climate change is an increase in the frequency of severe storms. Such changes are likely to have profound effects on giant kelp forest ecosystems because storms are a major source of disturbance that removes kelp and other biota. An increase in the frequency of severe storms would likely result in large losses of giant kelp every winter. Giant kelp is the foundation species of the ecosystem and our long-term monitoring shows that the dynamics of the benthic community of understory algae and sessile invertebrates are directly linked to the dynamics of giant kelp (Arkema et al. 2009. *Ecology* 90: 3126–3137).

**Experimental design:** We initiated a long-term experiment (LTE) at four kelp forest sites (Arroyo Quemado, Naples, Mohawk, and Carpinteria) in 2008 to investigate the ecological consequences of regular kelp loss during winter to the structure and function of kelp forest communities in the Santa Barbara Channel (a fifth site, Isla Vista, was added in 2011). Paired 40 m x 40 m plots were established at each site and giant kelp is removed once per year in winter from one of the plots in each pair to simulate the effects of increased frequency of storm disturbance on giant kelp. The other plot in each pair is subjected to only natural disturbance and serves as a control for the experimental removal of kelp. Changes in the structure (e.g. species abundance, diversity) and function (e.g. primary production of understory algae, detrital accumulation) of the benthic community are being followed over time with seasonal monitoring in permanent 40 m x 2 m transects centered within each plot. To evaluate the effects of the constant removal of giant kelp on the benthic community we established a second 40 m x 2 m transect in the kelp removal plots at each site within which giant kelp is continually removed throughout the year. Transects are oriented parallel to shore in an eastward direction and are marked with six bolts placed at distances of 0, 8, 16, 24, 32, and 40 meters. Before each survey divers swim a fiberglass meter tape along the transect and clip it to each permanent bolt before pulling it taut. All transects were sampled every six weeks (twice per season) from 2008 through 2012 and have been sampled once per season since then. Seasonal sampling is conducted midmonth in February, May, August, and November. Giant kelp is removed from the experimental plots immediately after the first survey of each year is completed.

**Methods:** Data on the size structure of red *Strongylocentrotus franciscanus* and purple *Strongylocentrotus purpuratus* sea urchins are collected along each 40 m transect. Size is recorded as test diameter measured to the nearest 5 mm using plastic calipers. At least 50 individuals of each species are measured along each transect. If a sample size of 50 cannot be obtained within the 40 m x 2 m area defined by the transect, then sea urchins occurring within 2 m of either side of the transect are measured.