# SBC-LTER Long Term Experiment Methods

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## Biomass of Macroalgae

**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::** Biomass of all macroalgal taxa is calculated at each transect for each sampling date using taxon-specific relationships generated from field estimates of abundance and laboratory measurements of biomass (http://metacat.lternet.edu/knb/metacat/knb-lter-sbc.58.4/lter). Divers using SCUBA record the abundance (percent cover or density) of all macroalgae along each 40m x 2m transect and measurements of abundance are converted to dry biomass (g $m^{-2}$). Different measures of abundance were used to calculate standing biomass of macroalgae of different sizes and morphologies. Percent cover is used to calculate the biomass of crustose forms, low lying turfs and foliose algae using the equations of Harrer et al. (2013). Density of fronds $\geq$ 1 meter in height is used to calculate the biomass of giant kelp using the equation of Reed et al. (2009). Density is coupled with measurements of individual size to estimate biomass of the understory kelps *Laminaria farlowii*, *Pterygophora californica* and *Eisenia arborea* and small individuals of the fucoid *Stephanocystis osmundacea* using the equations of Harrer et al. (2013).

*References:*


Harrer, S. L., D. C. Reed, R. J. Miller and S. J. Holbrook. 2013. Patterns and controls of the dynamics of net primary production by understory macroalgal assemblages in giant kelp forests. Journal of Phycology, 49: 248-257.

Reed, D. C., A. R. Rassweiler and K. Arkema. 2009. Density derived estimates of standing crop and net primary production in the giant kelp Macrocystis pyrifera. Marine Biology, 156: 2077-2083.