

Percent Cover of Algae, Invertebrates and Bottom Substrate

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: Uniform Point Contact (UPC) sampling is done to determine the percentage cover of algae and sessile invertebrates and different types of bottom substrate. UPC data are collected at 80 points uniformly positioned within a 1 m wide area centered along each 40 m transect (Figure 1). A diver records all organisms intersecting an imaginary vertical line passing through each point and species percent cover is determined as the fraction of points a species intercepts x 100. A species is only recorded once at a given point even if it intersects the imaginary line multiple times. Using this technique the percent cover of all species combined on a transect can exceed 100%, but the percent cover of any individual species cannot. Species are recorded from top-down as they are encountered and are entered from left to right on the datasheet in such a way that primary space holders occupy the left side of the “SP_CODE” column. Species growing attached to other organisms are not counted, except those species growing on the ornate tube worm (*Diopatra ornata*). Additionally, the substrate type under each point is recorded and if the substrate is sand, then the depth of the sand is measured to the nearest cm. Mobile organisms occurring at a sampling point are not counted and are moved so that the species and substrate beneath them can be recorded. Only the holdfast is recorded to estimate the percent cover of the kelps *Macrocystis pyrifera*, *Pterygophora californica*, *Eisenia arborea* and *Laminaria farlowii*; the blades and stipes of these species, which extend into the water column, are ignored if they intersected a sampling point. Unlike the sampling of algal and invertebrate density done in fixed quadrats and swaths, the number of taxa sampled by UPC is not fixed; instead all sessile species encountered are recorded. Species that are difficult to identify underwater are lumped into broader taxonomic categories (e.g., crustose coralline algae) to facilitate sampling.

Figure 1. Diagram of Uniform Point Contact Sampling showing 80 points sampled.

