

Reef Fish Density

Overview: These data are part of a larger collection of datasets associated with a long-term experiment designed to examine trajectories of change in the structure and ecological function of kelp forest communities in response to changes in the frequency and severity of disturbance to giant kelp. The experiment was motivated by previous findings demonstrating the important foundational role of giant kelp in structuring subtidal reefs and its high susceptibility to being removed by winter wave disturbance, which has been predicted to increase in frequency and severity due to ongoing anthropogenic climate change. The disturbance manipulations in this experiment included: (1) removing giant kelp from permanent plots once annually in winter to simulate increases in the frequency and severity of winter wave disturbance, and (2) removing giant kelp 1-2 times per season in permanent plots to examine the ecological consequences of the continuous loss of giant kelp from this system. The experiment was replicated at five reef sites in the Santa Barbara Channel and data for a variety of biological and physical variables associated with the experiment were collected from 2008-2023.

Study Sites: Time series data of reef biota (i.e., algae, invertebrates and fish), detrital accumulation, substrate type and topography, and surface and seafloor irradiance were collected at five reefs as part of a long-term experiment designed to evaluate the effects of disturbance to giant kelp (*Macrocystis pyrifera*) on the structure and productivity of the kelp forest community of algae, invertebrates and fishes. The five reefs (Arroyo Quemado 34° 28.048'N, 120° 07.031'W; Carpinteria 34° 23.474'N, 119° 32.510'W; Isla Vista 34° 23.275'N, 119° 32.792'W; Mohawk 34° 23.649'N, 119° 43.762'W; and Naples 34° 25.342'N, 119° 57.102'W) ranged in depth from 5.8 m to 8.9 m (MLLW) and were chosen to represent a range of physical and biological characteristics known to influence the structure and productivity of subtidal reef communities in the region. A ubiquitous (but not always persistent) feature on these reefs was the presence of giant kelp, which forms a dense canopy at the sea surface that alters the biomass, diversity and temporal stability of reef biota (Castorani et al. 2018, Miller et al. 2018, Lamy et al. 2020).

Beginning in 2008, giant kelp was removed once per year in winter from a 40 m x 50 m plot at three reefs (Arroyo Quemado, Carpinteria, and Naples) and a 30 m x 50 m plot at one reef (Mohawk) to simulate the effects of winter storm disturbance (referred to as “annual removal” treatment). An adjacent unmanipulated 40 m x 50 m plot at each site served as a control. Beginning in winter 2010, giant kelp was removed 1 to 2 times each season in a 10 m x 50 m area within (or in the case of Mohawk adjacent to) each of the annual removal plots to create a “continual removal” treatment. In fall 2011, a fifth site was established at Isla Vista with paired 40 m x 50 m annual removal and control plots (a 50 m x 10 m continual removal treatment was not established at this site). The reef community of algae (including giant kelp), invertebrates and fish were surveyed in annual removal and continual removal plots prior to each experimental removal of giant kelp. Thus, data collected on the date following the first kelp removal represents the first sampling period of the annual and continual removal treatments. The last experimental removals of giant kelp occurred in winter 2016 or winter 2017, depending on the site. The last sampling of reef communities under experimental conditions for annual and continual kelp removal treatments occurred ~12 months following the last kelp removal. Control, annual removal, and continuous removal plots continued to be sampled seasonally

through spring 2023 to document the recovery of the reef community in the absence of experimental kelp removal. Dates of the initiation and cessation of kelp removal in the experimental plots are provided in Table 1.

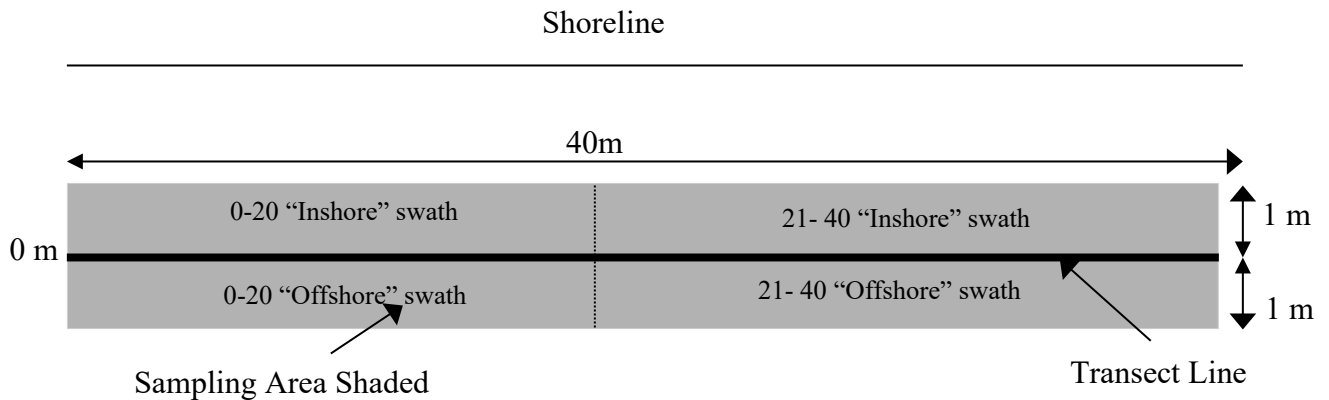
Table 1: Dates (format yyyy/mm/dd) of the first and last experimental kelp removal for the annual and continual giant kelp removal treatments at the five reef sites.

Reef	Treatment	Date of First Removal	Date of Last Removal
Arroyo Quemado	Annual	2008/01/30	2017/03/02
	Continual	2010/02/04	2017/03/02
Carpintería	Annual	2008/02/12	2017/02/15
	Continual	2010/01/29	2017/02/15
Isla Vista	Annual	2011/10/26	2016/02/18
Mohawk	Annual	2008/01/17	2017/02/13
	Continual	2010/05/05	2017/02/13
Naples	Annual	2008/01/10	2016/02/09
	Continual	2010/01/28	2016/02/09

Methods: The number, size and species identity of reef fish are recorded within a 2 m wide swath centered along each transect extending 2 m off the bottom. A diver swims the length of the 40 m transect approximately 1m above the bottom at a constant deliberate speed and records all fish passing through the sampling area. Fish size is measured as total length (TL) estimated to the nearest cm. Care is taken by the diver to not count the same individual more than once if it leaves and re-enters the sampling area. Surveys are carried out by only a select number of highly trained divers whose sampling techniques have been standardized in order to minimize observer bias. The horizontal visibility along the transect is measured and recorded for each sampling event. The number of fish taxa sampled is not fixed as all species of reef fish encountered in the sampling area are recorded. Species that are difficult to identify underwater are lumped into broader taxonomic categories (e.g., flatfish in the family Bothidae) to facilitate sampling.

Several species of small bottom-dwelling fish are difficult to accurately count and size during the reef fish survey due to their cryptic appearance and behavior. Individuals in a select group of these species are counted and sized in a separate survey done in the four contiguous 20 m x 1 m swaths that centered on the 40 m transect (Figure 1). A diver carefully searches the area within each swath taking time to look on the undersides of ledges and in crevices, and within understory vegetation for select species of small cryptic fish that are purposely not counted in the reef fish survey. Understory algae are brushed aside during the search, but no organisms or boulders are physically moved. Size is recorded as total length (TL) to the nearest cm.

Figure 1. Schematic diagram showing the position of the four 20 m x 1 m swaths relative to the 40 m transect.



Refer to the species data table for the list of species surveyed for the fish and crypticfish:
<https://portal.edirepository.org/nis/mapbrowse?scope=knb-lter-sbc&identifier=120>