Project Overview
LTER Network

SBC LTER established in April 2000

Focus on the Land-Ocean Margin
Giant Kelp Forests

- Worldwide distribution on shallow temperate reefs
- High productivity
- High species diversity
- High economic importance
Site Characteristics

- ~ 10,000 km²
- Steep coastal mountains
- Small estuaries
- Shallow rocky reefs
- Mediterranean climate
- Strong ENSO and PDO signal
- Offshore islands
- Major biogeographic boundary
Land Attributes

- Variable Watersheds
- Steep slopes
- Episodic Flows
Marine Attributes

- High topographic relief
- Complex circulation
- Variable temp/nutrient regime
- Network of no-take reserves
Major Hypotheses

**Hypothesis 1:** The production and food web dynamics of giant kelp forests are driven by variability in terrestrial, ocean and atmospheric forcing that alter the supply and character of allochthonous and autochthonous resources.

**Hypothesis 2:** The structure and function of giant kelp forests is determined by the frequency and intensity of biological, chemical and physical disturbance events that reorder space utilization and trophic interactions.
Primary Research Areas:

• The processes in terrestrial and ocean systems that drive changes in the nature and quantity of subsidies delivered to kelp forests.

• The relative importance of land and ocean inputs to primary production and food web structure in kelp forests.

• How the short and long-term dynamics of kelp forest populations, food webs, and communities respond to changing ocean, land and atmospheric climatologies.
Research Approach

Integrative measurements

Manipulative experiments

Modeling

Dynamic Isotope Model

N_{14}C

N_{15}C

Pulsed Inputs

Assimilation

Growth of Structure:
Trophic Level 2
(Consumers)

Food:
Trophic Level 1
(Producers)

Output Dynamics

Food chain dynamics

N_{14}C

N_{15}C

N_{14}C

N_{15}C

N_{14}C

N_{15}C

N_{14}C

N_{15}C
Land measurements

- Data on hydrology and water chemistry collected at 31 stream sites distributed among 10 watersheds.
- Stream and soil experiments on nutrient and carbon processing.
- Studies of land use effects on microbial diversity in streams.
Data on ocean currents, biogeochemistry, and phytoplankton biomass and production obtained from channel wide cruises, moored instruments, and satellite imagery.
Data on population dynamics of > 100 species are collected annually at 20 sites
Instructional field guide available at http://sbc.lternet.edu/research/c1.html

A Field Guide To

Common Subtidal Plants and Animals

Phylum Echinodermata

Strongylocentrotus franciscanus
red sea urchin
SFL/S
- Identification: Large urchin with sharp, long spines. Color ranges from red to dark purple to black (S. purpuratus shown in bottom left).
- Size: Test diameter to 10 cm.
- Habitat: On rocky substrate.

Asterina miniata
bat star
AML/S
- Identification: This webbed sea star varies greatly in color. Lacks pedicellariae or spines. Number of arms usually 5, but can be 4 to 9.
- Size: Diameter to 30 cm.
- Habitat: On rocky and sandy substrates.

Dermasterias imbricata
leather star
DL/S
- Identification: This sea star feels smooth and almost leather-like.
- Size: Diameter to 25 cm.
- Habitat: On rocky substrate, occasionally on sand.
Giant kelp, *Macrocystis pyrifera*

- World’s largest alga
- Fast growing
- Short lifespan
Sources of Disturbance

- Waves
- Nutrient stress
- Grazing
High interannual variability in kelp standing crop

Frond density (no. / 20 m$^2$)

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Measuring Net Primary Production in Giant Kelp

Estimated monthly from data collected in permanently marked areas (~200 m²) of three kelp beds

\[ \text{NPP} = \text{Change in Standing Crop} + \text{Losses} \]

\( \text{Change in Standing Crop} \)

(Growth – losses)

Standing crop of kelp in meters
measured by divers in permanent transects

Standing crop of dry kelp in kilograms
estimated from length vs. mass relationship

Loss of fronds
estimated from tagged fronds

Loss of plants
estimated from change in plant density in fixed transects
Variation Among Biomes in Net Primary Production

Adapted from Knapp and Smith 2001

NPP (g dry mass m$^{-2}$ y$^{-1}$)

**Estimated from 3 years of data on frond density**

* 2002-2003