Title
Vertical Flow Dynamics in Kelp Forests: Implications for Nutrient Uptake, Condition and Survival

Author
Edwards, Matthew S.

Publication Date
2008-08-08

California Sea Grant
Final Project Progress Report

Vertical Flow Dynamics in Kelp Forests:
Implications for Nutrient Uptake, Condition and Survival
07/01/2006–08/01/2008

Matthew S. Edwards
San Diego State University
Department of Biology
edwards@sciences.sdsu.edu

Project Hypotheses

- The influence of ocean waves on giant kelp fronds results in the vertical transport of water along the thallus
- Morphological traits of giant kelp result in vertical transport being greater than in the absence of giant kelp
- Vertical flow along giant kelp thalli is persistent, but flow rate is correlated with vertical orbital displacements of the incident ocean waves

Project Goals and Objectives

1. To assess the potential for locally-induced vertical flow along giant kelp thalli, from the benthos towards the surface canopy, in a southern California kelp forest.
2. To assess whether vertical flow is the result of special morphological characteristics of giant kelp, the presence of vertical structure in the water column, or simply due to passive diffusion that would also occur in the absence of structure.
3. To assess whether vertical flow is persistent or episodic, and quantify the relationship between flow rates and incident wave activity.
4. To determine whether vertical flow transports cold nutrient-rich water from below the thermocline towards the surface canopy.
5. To assess whether vertical flow of nutrient-rich water results in increased Nitrogen uptake by giant kelp and thus increased growth and thallus condition.

Briefly describe project methodology

Vertical flow along giant kelp thalli will be assessed in situ using Fluorocein dye and a series of digital video and fluorometry methods. Flow will be compared among natural giant kelp thalli, vertical structure, and in the absence of structure, and flow rates (determined from video analysis of the dye movement) will be correlated incident wave activity as measured by ADCPs. The effects of vertical flow on the temperature/nutrient regime around giant kelp will be evaluated

using thermographs and a combination of water and tissue nutrient analyses. We will carefully monitor thermocline oscillations and evaluate how they interact with vertical flow to increase nutrient near the surface canopies using synchronized thermographs and a series of nutrient analyses.

Describe progress and accomplishments toward meeting goals and objectives

To date we have completed teo years of field work examining vertical flow along kelp thalli. So far, we have characterized internal wave dynamics at three locations within and near the Point Loma kelp forest. We have characterized differences in water temperature along kelp thalli and away from kelp thalli at meter intervals (we have repeated this experiment 5 times). We have found that water temperature is consistently cooler within the kelp fronds than is is in adjacent waters, but hat these differences are most pronounced in regions of the water column above the thermocline.

Project modifications

We have begun examining total inorganic carbon (TIC) in the waters above the thermocline and below it to examine photosynthesis/respiration of the dominant kelp organisms.

Impacts of project

We are still in the process of compiling and analyzing all the data.

Economic benefits generated by discovery, exploration and development of new,
sustainable coastal, ocean and aquatic resources (i.e., aquaculture, marine natural products, foods, pharmaceuticals). We are working on ways to enhance alginate production in the dominant kelps (project still underway).

Issue-based forecast capabilities to predict the impacts of a single ecosystem stressor, developed and used for management (i.e., climate change, extreme natural events, pollution, invasive species, and land resource use).

This project will have major implications for climate change and ENSO impacts on kelp forests. As yet, we are still compiling and analyzing the data.

Publications

Workshops and presentations

This work is scheduled to be presented at the 2008 annual meeting of the Western Society of Naturalists in Vancouver, B.C. We expect 500 attendees (academics and graduate students).

International implications

We have been working with Dr. Kwang Young Kim from Chonnam National University in South Korea to examine carbon uptake/production in the waters above and below the thermocline.