Impacts of kelp forest restoration on species richness and carbon sequestration

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Background

Kelp forests are highly valuable

Kelp forests are very productive marine ecosystem with high species diversity. They are located in many parts of the world, including off the coast of California. Kelp forests are a major contributor to atmospheric carbon sequestration (storage) on the North American Pacific Coast. While sequestration by kelp receive most of the attention, little work has been conducted to assess sequestration in the fauna associated with kelp forests.

Kelp forests have been destroyed

Overpopulation of *Strongylocentrotus purpuratus* (purple sea urchin) reduces kelp growth, productivity, and species diversity (urchin barrens). The rocky reefs along the southern end of the Santa Monica Bay contain 61.5 hectares of urchin barrens.

Kelp forests are being restored

Organizations are working to remove the urchins, restore kelp forests, and monitor the outcome as part of the Palos Verdes Kelp Forest Restoration Project (KFRP). Three types of areas are monitored and compared to measure restoration efforts; see Figure 2.

Figure 1. The study area Palos Verdes is located in Southern California (left). The area contains both kelp forests and urchin barrens (right).

Objectives

(1) Has fish species richness increased significantly from the pre- to the post-restoration period?

(2) How much carbon is being stored among the animal life in the pre-restoration period compared to the post-restoration period? (see Figure 3)

Methods

- **Data source:** *Palos Verdes Kelp Forest Restoration Project Annual Report: July 2013-June 2014* (The Bay Foundation)
- **Tests:** two-way ANOVA
- **Tools:** SPSS, Excel 2013, Web Plot Digitizer
- **Measures:** fish species frequency, mean density, average individual biomass

Figure 2. Photos of the three types of designation areas observed and monitored by the Palos Verdes Kelp Restoration Project. Fish species richness and animal biomass were measured for each area over time.

Results

Objective (1): Fish species richness

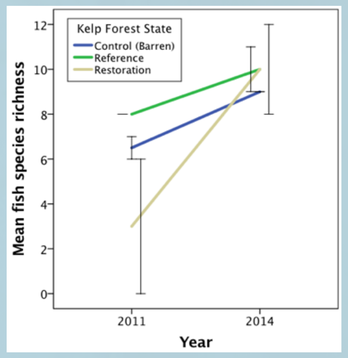


Figure 4. Fish species richness increased significantly in each designation area between pre- and post-intervention years. Fish species richness between designation areas was not significantly different.

Objective (2): Total animal biomass

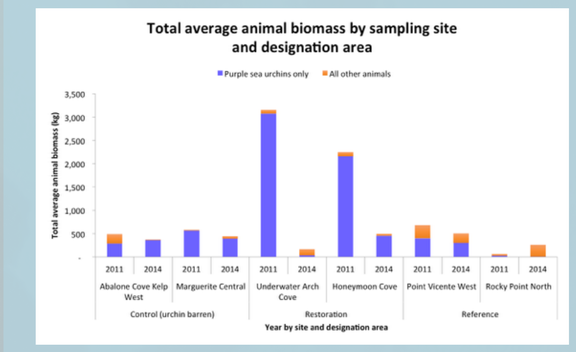


Figure 5. Total average biomass among animal life from 2011 (pre-restoration year) and 2014 (post-restoration year) were compared for each sampling site at each designation area. Animals included in these measures are listed in Figure 3. Although changes in animal biomass were observed at all sites, the only statistically significant change occurred among purple sea urchin biomass. (This is expected because removal of purple sea urchins from the restoration sites was the intervention.) As shown in the figure, the before the restoration began the kelp forest restoration sites contained vastly more purple sea urchins than even the urchin barren control area sites.

Discussion

Assumptions

- Total animal biomass estimates were based on average biomass per individual as described in literature, not from the sample population.

Limitations

- Small samples sizes of designation areas (N=2 each) resulted in high variability.
- Observation-level data were not available. Estimates are based on aggregated values.
- Since the restoration project began in 2011, the urchin barren sites in the control group have expanded. Current efforts to restore the kelp forests may not address all barrens as initially anticipated.

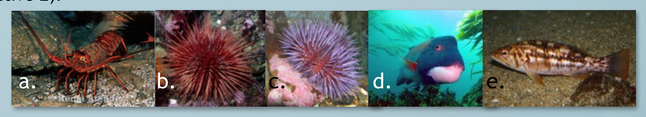
Implications

- Further data collection and analysis are needed to distinguish if increases are due to KFRP activity or other sources of variation.
- Further study will determine whether or not the KFRP's efforts have been effective and can serve as an intervention model for restoring other kelp forests.
- Inclusion of animal biomass in kelp forest biomass calculations may be a more accurate indicator of amount of carbon stored than in estimates for plant biomass alone.

Figure 6. Divers work with The Bay Foundation to monitor species density among the designation area sites.

Figure 3. Species included in animal biomass calculations (see objective 2):

a. California spiny lobster *(Panulirus interruptus)*
b. Red sea urchin *(Strongylocentrotus franciscanus)*
c. Purple sea urchin *(Strongylocentrotus purppurtus)*
d. California sheephead *(Semicossyphus pulcher)*
e. Kelp bass *(Paralabrax clathratus)*



References

- "Kelp Forest Restoration," The Bay Foundation, http://www.santamonicabay.org/learn/our-work/in-the-ocean/kelp-forest-restoration/
- *Palos Verdes Kelp Forest Restoration Project Annual Report July 2013-June 2014*, The Bay Foundation
- "*Panulirus interruptus* California spiny lobster," Animal Diversity Web, University of Michigan Museum of Zoology
- Photo credits: Tom Boyd, NOAA, Wikipedia.org

Acknowledgements

This project was supported by a grant to the STAR program from the Howard Hughes Medical Institute.

This material is based upon work supported by the National Science Foundation through the Robert Noyce Teacher Scholarship Program under Grant No. (grantee must enter NSF grant number). Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.