# Investigating the Relationship Between Sea Urchin Density and Giant Kelp Biomass

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## ABSTRACT

The relationship between sea urchin and giant kelp in the Southern California Pacific coastal regions was investigated to determine if they had a significant impact on each other and the biodiversity of the species which rely on the kelp forest habitat. Data collected from various peer reviewed papers included in this research indicated decreased kelp biomass when the urchin density was high, as well as the presence of urchin predators, sheephead and spiny lobster, at a lower concentration. These findings signify that the percent of giant kelp biomass is dependent on the amount of grazing and therefore population of sea urchin within the region which is directly regulated by the number of sheephead and spiny lobster.

## RESEARCH QUESTION

What is the relationship between sea urchin density and giant kelp biomass within the ecosystems along the Southern California Pacific coast?

## HYPOTHESIS

**Alternative**: A greater density of sea urchins will lower giant kelp biomass which causes a shift in the trophic cascade and food web along the Southern California Pacific coast.

**Null**: There is no significant impact of sea urchin density on giant kelp biomass concerning its food web along the Southern California Pacific coast.

## INTRODUCTION

**Fig. 1** Devastated Urchin Barren v. Healthy Kelp Bed

Sea urchin barrens are regions dominated by herbivorous purple sea urchins (*S. purpuratus)* on rocky reefs lacking algal vegetation (Filbee-Dexter & Scheibling, 2014); these areas are the result of kelp forests that have been devastated by the overgrazing of sea urchins and consequently the loss of aquatic organisms that rely on the source of macroalgae, in this case giant kelp (*M. pyrifera)*, as a source of nutrients and energy (Kriegisch et al., 2016).

In Southern California alone, over two hundred species of invertebrates, fish, algae, and mammals are observed within the giant kelp forest ecological systems (Graham et al., 2004). This includes urchin predators sheephead (*S. pulcher)* and spiny lobster (*P. interruptus).*

**Fig. 2** Purple sea urchin colony in a crevice habitat

## PURPOSE

The purpose of this study is to investigate the ecological correlation between sea urchin density and giant kelp biomass along the Southern California Pacific coast and its impact on the ecosystem. When the primary producer is removed, it results in an imbalance among species dependent on the health of the primary producer. This paper finds data and alternative methods to support the growth and stabilization of giant kelp to restore biodiversity within the aquatic ecosystems.

## METHODS

This study was a systematic literature review of peer-reviewed papers using databases including EBSCOhost, Plos One, PNAS, ScienceDirect, Google Scholar, and ResearchGate.
Information was collected using keywords: keystone species, kelp recovery, urchin barrens, trophic shifts, biodiversity loss, and species richness.
This method was effective for the project as it provided a deeper understanding of the relationships between giant kelp, sea urchins, sheephead, and spiny lobster in the ecosystem.

## RESULTS

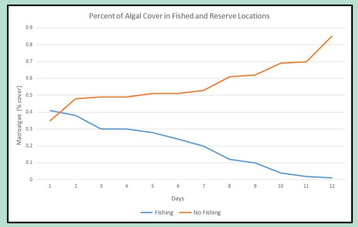


**Fig. 3** Percent of macroalgal cover in fished and reserve regions

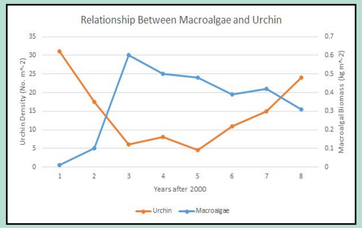


**Fig. 4** Relationship between macroalgal biomass and urchin density

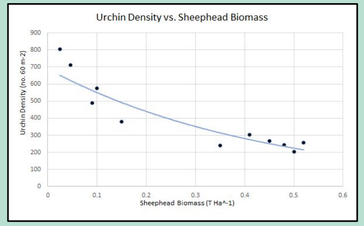


**Fig. 5** Comparison of urchin density to sheephead biomass

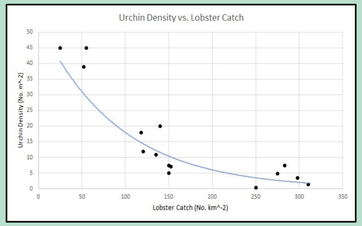


**Fig. 6** Comparison of urchin density to lobster catch/release

## DISCUSSION

The results indicated that the biomass of giant kelp that can thrive in a region is dependent upon whether it is located in a reserve or open fishing area as the natural predators can regulate urchin density.

There is a direct relationship between the biomass of giant kelp and the number of urchin predators, either spiny lobster or sheephead for as the number of predators increases, limiting the urchin population, the kelp beds increase their growth without being grazed upon at such high rates.

By managing the populations of urchin predators, the degree of overgrazing of giant kelp by sea urchin colonies can be controlled as there would be a balanced population between the three factors.

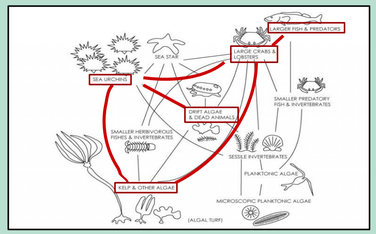


**Fig. 7** Diagram displaying species relations within the kelp food web

## CONCLUSIONS

Data collected from various peer reviewed papers provides evidence that with a higher concentration of sea urchins, biomass of kelp declines, producing urchin barrens along the Southern California coast. This reveals a direct correlation between giant kelp and sea urchins, species contributing to the biodiversity and stability of a balanced ecosystem.

## FURTHER WORK

To compare conditions of Southern California coasts to other climates, terrains, species, ocean currents, food webs, etc., further research is recommended. By comparing alternate areas, established trends in the data pooled from various peer-reviewed papers can be analyzed alongside data from similar regions around the world to determine if those patterns are observed globally.

Conservational efforts implemented in threatened regions of kelp beds such as regulation of commercial fishing and harvesting would help preserve and restore those communities back to their original health and stability, providing once again nutrients and habitat for dependent species.

**Fig. 8** Region in which the studies collected data from in California

## ACKNOWLEDGEMENTS

Special thanks to Dr. Juan Carlos Villasenor-Derbez, Dr. Matthew Edwards, and Dr. Nikki Malhotra for guidance throughout this project.

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