Trophic Structure Biomass of Kelp Forest Fishes In and Adjacent to Four Marine Protected Areas in Channel Islands National Park

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Overview

Trophic biomass pyramids give insight into the structure, energy flow, and health of an ecological community. Recent studies have shown that the majority of biomass in pristine marine fish communities is held in large-bodied predators, portraying an inverted or top-heavy pyramid. Our objective is to provide trophic level biomass estimates of kelp forest fish communities inside and outside of Marine Protected Areas (MPAs) within the Channel Islands National Park as a proxy of community health. From 2007-2015, fish size and abundance data were collected annually at 24 sites across the Park islands, with 12 sites located inside and 12 outside of four targeted MPAs. Our results show that recently (2013-2015) both piscivores and carnivores make up a large portion of the fish community with higher biomass inside MPAs. Inversely, at islands where fishing pressure is greater, small bodied planktivores have higher biomass outside of MPAs. Overall, since 2007 total fish biomass has increased both inside and outside MPAs. Continued long term monitoring can further our understanding of how kelp forests respond to protection and elucidate the resilience and health of the reefs off the Channel Islands.

Introduction

Background

- Fishing directly and indirectly alters structure and function of many marine ecosystems (Dayton et al. 2003).
- Many species targeted in fisheries are large higher trophic level fishes (Myers and Worm 2003).
- Marine Protected Areas (MPAs) serve as the best available means to test the ecosystem effects of fishing and have been shown to increase the abundance of many targeted populations (Tegner and Dayton 2000, Hamilton et al. 2010).

Objective

- Provide trophic level biomass estimates of kelp forest fishes inside and outside of Marine Protected Areas (MPAs) within the Channel Islands National Park as a proxy for community health after 13 years of protection.
- **Trophic Groupings of Fish Assemblage** (Allen et al. 2006, Hamilton et al. 2010)

Example species per trophic group

1) Herbivore
2) Planktivore
3) Carnivore
4) Piscivore

*Illustrations by Larry G. Allen

Methods

Study sites

- 12 sites inside and 12 outside of four MPAs located off Santa Barbara, Anacapa, Santa Cruz, and Santa Rosa Island.
- Sites sampled annually from 2007-2015.
- Sites inside and adjacent to MPAs have been shown to have similar habitat characteristics and depth (Hamilton et al. 2010).

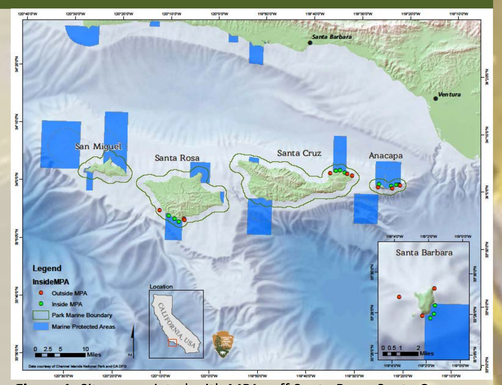
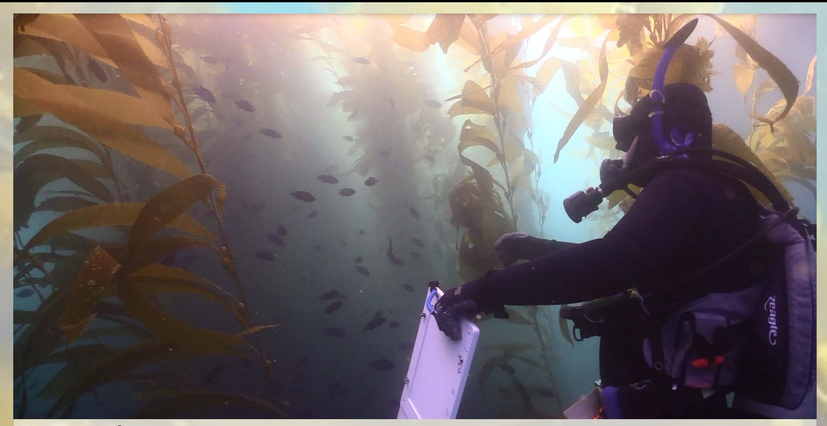


Figure 1. Sites associated with MPAs off Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands.



Protocol

- 100 m transect tape is laid onto a permanent lead line at each site.
- Minimum of 4 trained divers count all fish observed within 10 m on each side of transect line (2000 m^2).
- Divers survey site within a 30 minute time frame and cover the 2000 m^2.
- Size is estimated to the nearest cm for each fish.
- Length → Biomass (g/2000 m^2) using published growth curves for species.
- Kelp forest species grouped by published trophic affinity for analyses.

Results

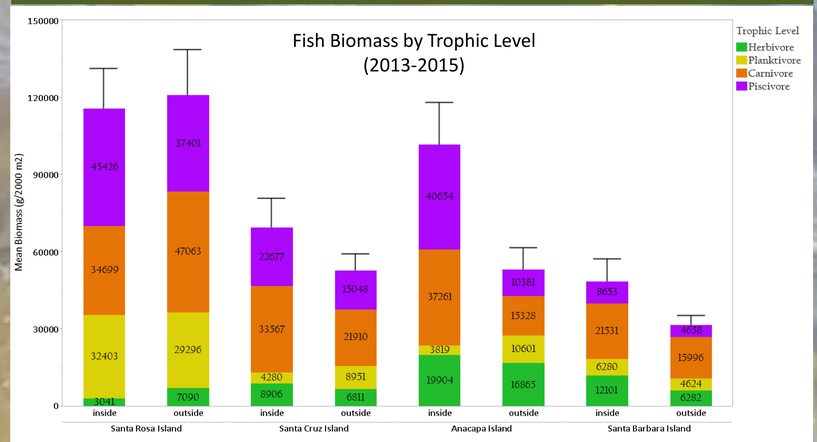


Figure 2. Differences in mean fish biomass (g/2000 m^2) inside and outside MPAs off Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands from 2013-2015. Colors represent fish trophic levels: Herbivore (green), Planktivore (yellow), Carnivore (orange), and Piscivore (purple).

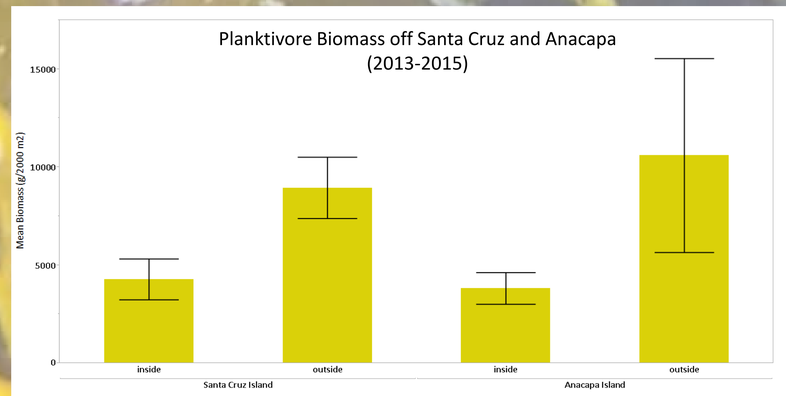


Figure 3. Differences in mean planktivore biomass (g/2000 m^2) inside and outside MPAs off Santa Cruz and Anacapa islands from 2013-2015.

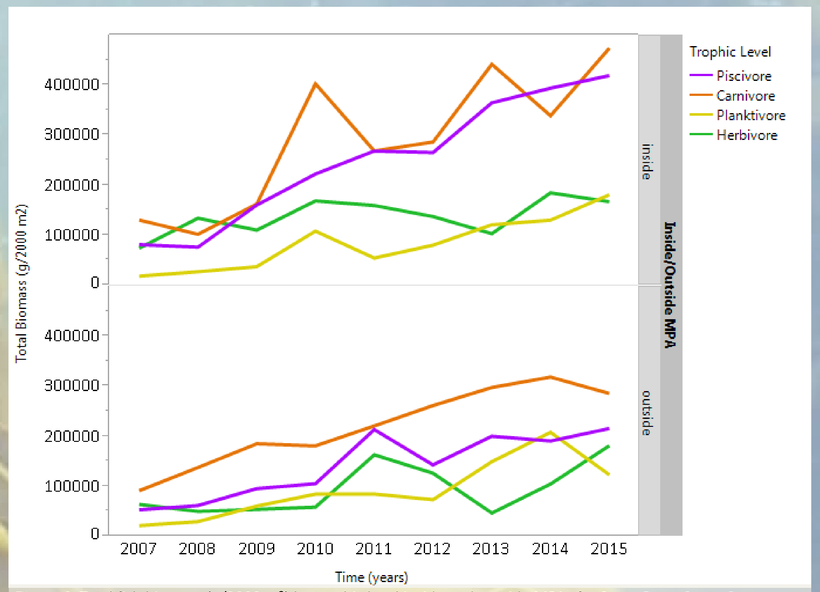


Figure 4. Total fish biomass (g/2000 m^2) by trophic level inside and outside MPAs for Santa Rosa, Santa Cruz, Anacapa, and Santa Barbara Islands from 2007-2015

Discussion

Similar to the results of Hamilton et al. (2010), Piscivore ($F_{4,70}$=17.2, P<0.01) and Carnivore ($F_{4,70}$=5.7, P<0.05) biomass is higher inside MPAs, and likely a result due to many species being targeted in commercial and recreational fisheries.

Recently, Planktivore ($F_{2,36}$=5.8, P=0.02) biomass is higher **outside** of MPAs off Santa Cruz and Anacapa Islands where mean SST is warmer and fishing pressure is higher. This result could be explained by a release in predation pressure due to fewer piscivores outside MPAs, and could provide support of top-down control within the kelp forest fish community.

The large amount of higher trophic level (Piscivore/Carnivore) biomass inside MPAs portray a top-heavy biomass pyramid indicative of healthy reef ecosystems (DeMartini et al. 2008).

Overall, total fish biomass from 2007-2015 has increased in both MPAs and the adjacent sites outside the reserves.

Future Directions

Further monitoring is necessary to document if the fish biomass in the Channel Islands reserve network and adjacent sites continue to increase and how this may affect the kelp forest community structure in the years to come.

References

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