# Comparing fish populations at sites dominated by native and invasive algae species in the Southern California Bight

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## I. Introduction

Over 480 fish species live in rocky reefs and kelp forests in the Southern California Bight (SCB).[1] Giant kelp (*Macrocystis pyrifera*) is a macroalgae native to the Southern California Bight (SCB) that creates useful habitat for fish recruitment as it forms a large canopy underwater when it entangles with itself (**Figure 1**). *Sargassum horneri* (**Figure 2**) is an invasive macroalgal species originally from Japan and Korea that was first found in the SCB in 2003. *Sargassum* may directly compete with and displace the native *Macrocystis*. *Sargassum* is not as tall as *Macrocystis* and it forms more of a bush-like structure, which offers less protection to fish species during recruitment. Unlike giant kelp, *Sargassum* is also not a primary food source of fish native to the SCB as the tissues contain polyphenols that are unpalatable. This invasive species may affect many species supported by these kelp forests and may have long lasting effects on the ecosystem.[2]

Using subtidal survey data of rocky reefs in the SCB, I aimed to determine if fish communities differed significantly in sites dominated by *Macrocystis pyrifera* versus those dominated by *Sargassum horneri*. This information would give researchers insight on if these fish communities are negatively impacted by the presence of the macroalgae, requiring projects to be put in place for its management or removal.

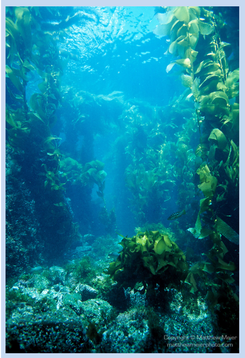

**Figure 1** - *Macrocystis pyrifera*

**Figure 2** - *Sargassum horneri*

## II. Methods

The Vantuna Research Group (VRG) surveyed over 100 shallow rocky reefs (5-10 m depth) in the SCB (**Figure 3**) from 2011 to 2019. During surveys, divers swam 30 m transects while identifying and counting each fish encountered on 1 m on either side of the transect. Divers also counted macroalgae (including *Macrocystis* and *Sargassum*) in the same survey area. Fish and macroalgae densities were then estimated by dividing the number of each species by the total area sampled (60 $m^2$ for each transect). Sites were removed from the analysis where neither alga was present, or where *Macrocystis* density was < $1/m^2$, or where *Sargassum* density was < $0.5/m^2$. Sites were then classified as either *Macrocystis* (n=32) or *Sargassum* (n=33) dominated depending on which density was higher (**Figure 4**).

Using the R statistical programming language, I constructed a Bray-Curtis similarity matrix using the square root-transformed species-specific densities by site and the Bray-Curtis similarity coefficient. Two-dimensional, non-metric multidimensional scaling (nMDS) was used to visualize and examine fish communities among *Macrocystis* and *Sargassum* dominated reefs. Differences in community composition were determined using PERMANOVA, and SIMPER analysis determined which species had greatest impact on dissimilarity between those reefs.

Blacksmith (*Chromis punctipinnis*)

Bluebanded Goby (*Lythrypnus dalli*)

Rock Wrasse (*Halichoeres semicinctus*)

Señorita (*Oxyjulis californica*)

Opaleye (*Girella nigricans*)

## III. Results

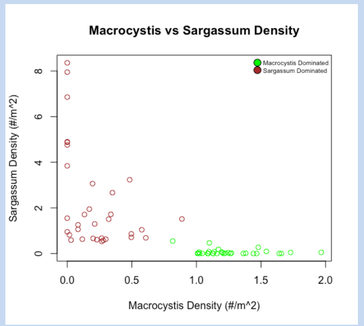


**Figure 4** – *Macrocystis pyrifera* density versus *Sargassum horneri* density by site, colored by macroalgae dominance classification.

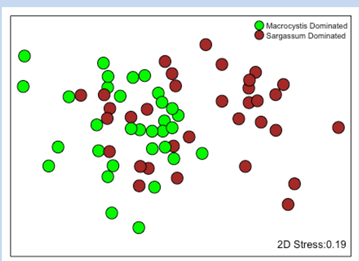


**Figure 5** – Two-dimensional nMDS plot of fish community structure. Each dot represents a site, color represents sites dominated by *Macrocystis pyrifera* or *Sargassum horneri*.

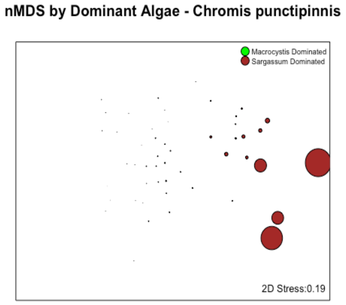


**Figure 6** – Two-dimensional nMDS plot of fish community structure colored by dominant algae. Each point represents a site and the point size is scaled to Blacksmith (*Chromis punctipinnis*) density at that site.

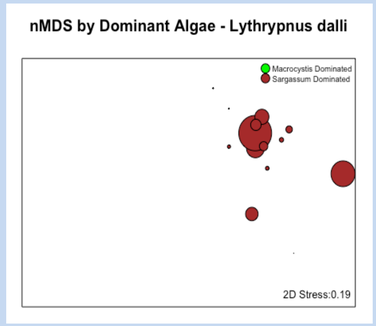


**Figure 7** – Two-dimensional nMDS plot of fish community structure colored by dominant algae. Each point represents a site and the point size is scaled to Bluebanded Goby (*Lythrypnus dalli*) density at that site.

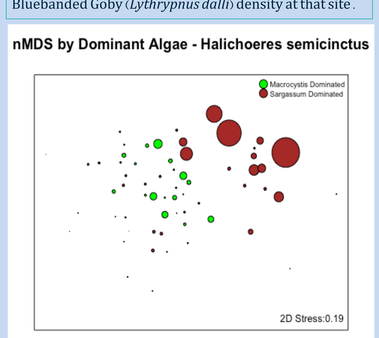


**Figure 8** – Two-dimensional nMDS plot of fish community structure colored by dominant algae. Each point represents a site and the point size is scaled to Rock Wrasse (*Halichoeres semicinctus*) density at that site.

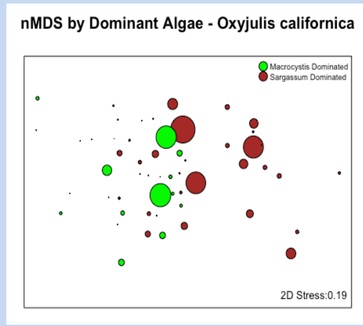


**Figure 9** – Two-dimensional nMDS plot of fish community structure colored by dominant algae. Each point represents a site and the point size is scaled to Señorita (*Oxyjulis californica*) density at that site.

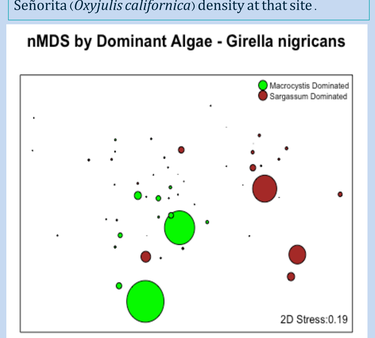


**Figure 10** – Two-dimensional nMDS plot of fish community structure colored by dominant algae. Each point represents a site and the point size is scaled to Opaleye (*Girella nigricans*) density at that site.

PERMANOVA analysis determined that each dominant algae had significantly different fish communities ($R^2 = 0.123$, $p < 0.001$) as seen in **Figure 5**. SIMPER analysis determined that just five fish species (pictured above) contributed more than 50% of the dissimilarity in fish communities between sites dominated by *Macrocystis* versus *Sargassum*.

To show the strength of influence of each fish species on the overall fish communities for *Macrocystis* and *Sargassum* dominated reefs, **Figures 6-10** show the sites at the same point in two-dimensional space, still separated by dominant algae type, but the points are scaled by density of the labeled fish species. In this study, a few species show clear preference for *Sargassum* dominated sites versus *Macrocystis* dominated sites.

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**Figure 3** – Map of the Southern California Bight and subtidal survey sites (white dots). The SCB ranges from Point Conception, California to the U.S./Mexico border.

## IV. Conclusions

- Fish communities differ significantly between *Macrocystis* and *Sargassum* dominated sites (**Figure 5**)
- Just five species are responsible for more than 50% of the dissimilarity between *Macrocystis* and *Sargassum* dominated fish communities
- Blacksmith, Bluebanded Gobies, and Rock Wrasse occur far more frequently in many *Sargassum* dominated rocky reef sites compared to *Macrocystis* dominated rocky reef sites (**Figures 6-8**)
- Senorita occur slightly more frequently in a few *Sargassum* dominated rocky reef sites compared to *Macrocystis* dominated rocky reef sites (**Figure 9**)
- Opaleye occur slightly more frequently in a few *Macrocystis* dominated rocky reef sites compared to *Sargassum* dominated rocky reef sites (**Figure 9**)
- While there are decreases in species across each community, we cannot say that *Sargassum* domination or *Macrocystis* domination in areas caused a decrease in commercially or recreationally important species
- Originally, I predicted that fish communities would be denser at *Macrocystis* dominated sites than *Sargassum* dominated, but this was not the case.

**References**

[1]Dailey, M. D., Reish, Donald J., and J. W. Anderson. 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkley, CA.

[2]Hood, D. W., M. D. Dailey, Reish, Donald J., and J. W. Anderson. 1993. Ecology of the Southern California Bight: A Synthesis and Interpretation. University of California Press, Berkley, CA.