PR_project

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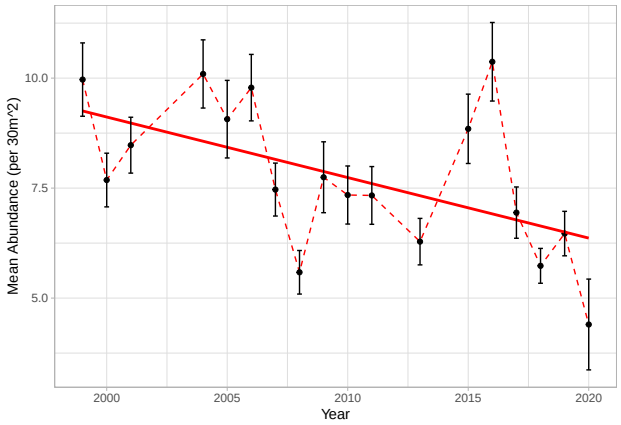
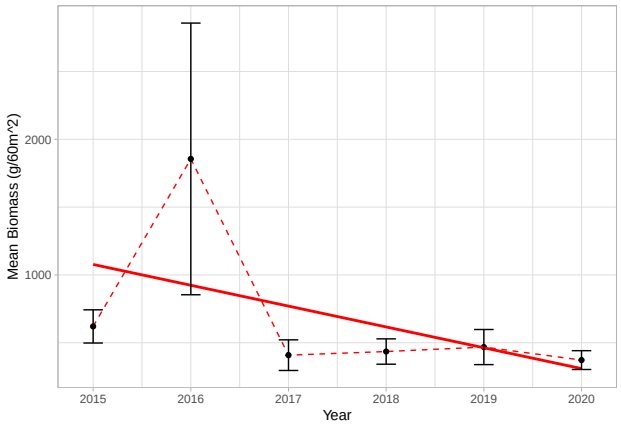
The goal of this analysis is to explore the Puerto Rico Coral Reef Monitoring Program, with a focus on the population dynamics of three main commercially important reef species: snapper, grouper, and parrotfish. This analysis aims to accomplish the following goals: (1) examine abundance and biomass patterns over time of the three fish groups, (2) investigate the impacts of biological and environmental factors, including MPA designation, benthic substrate cover, location and depth, and (3) to build a model that best fits the fish population dynamics.

Parrot Fish

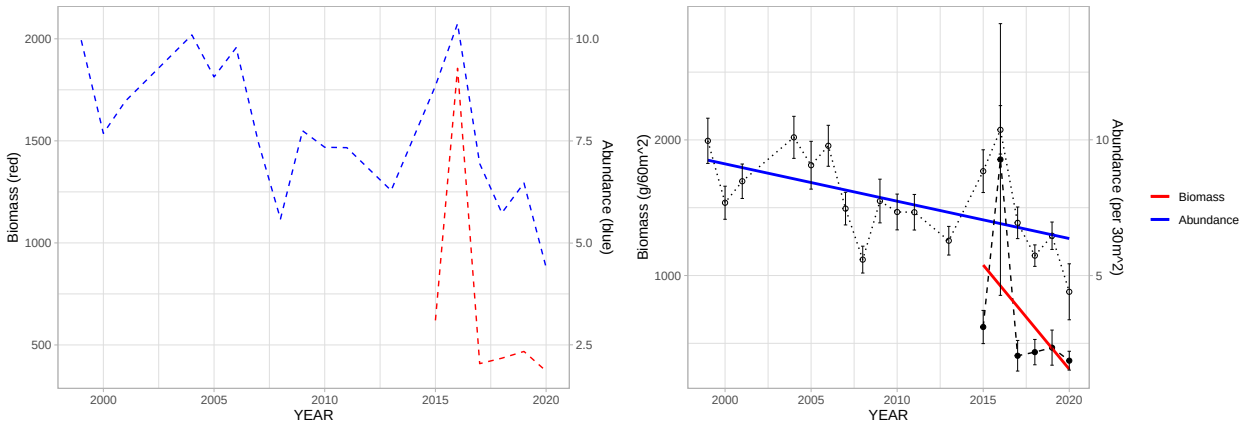
Goal: Investigate parrotfish population changes over time. These graphs use annual means and standard error for abundance (1999-2020) and biomass (2015-2020).



- Parrotfish abundance vs. year linear model: p = 7.19e-05, R^2 = 0.01096

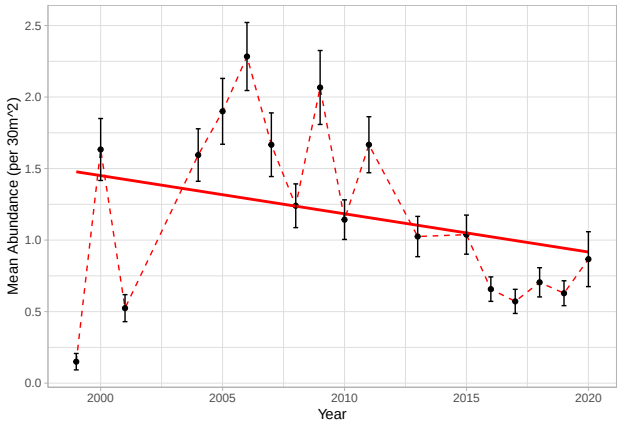


- Parrotfish biomass vs. year linear model: p = 0.2207, R^2 = 0.01681

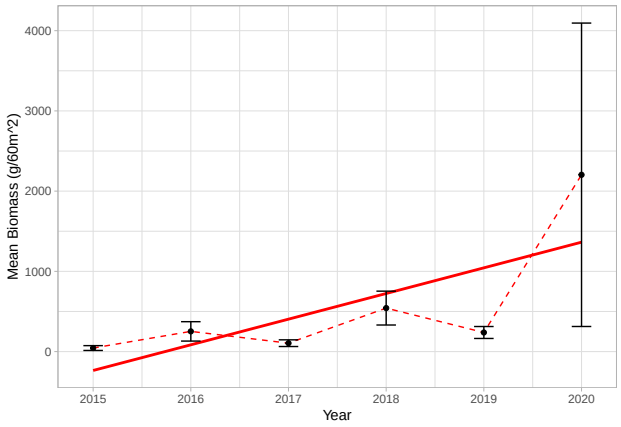


Grouper

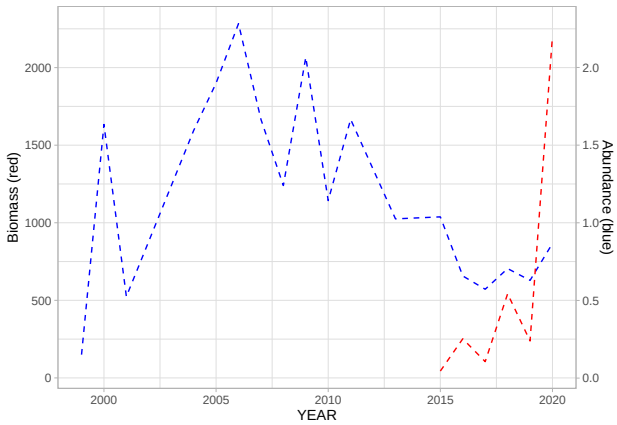
Goal: Investigate Grouper population changes over time. These graphs use annual means and standard error for abundance (1999-2020) and biomass (2015-2020).

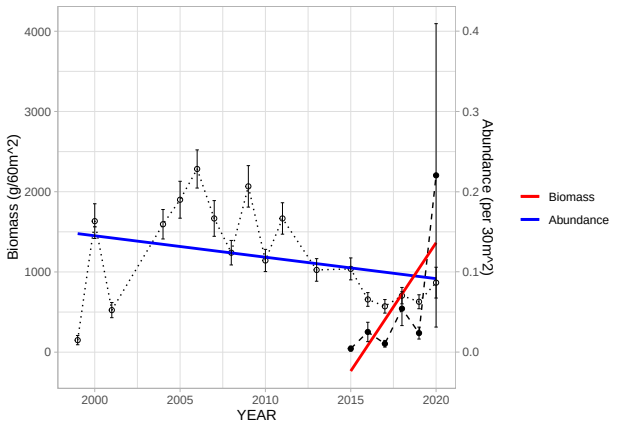


- Grouper abundance vs. year linear model: p = 4.69e-063 , R^2 = 0.01456



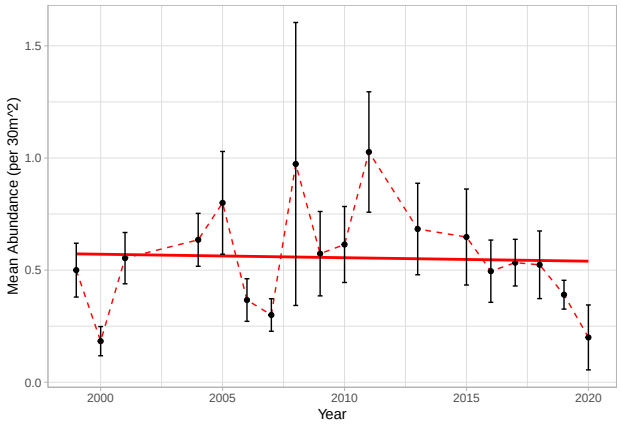
- Grouper biomass vs. year linear model: p = 0.0074364 , R^2 = 0.07776



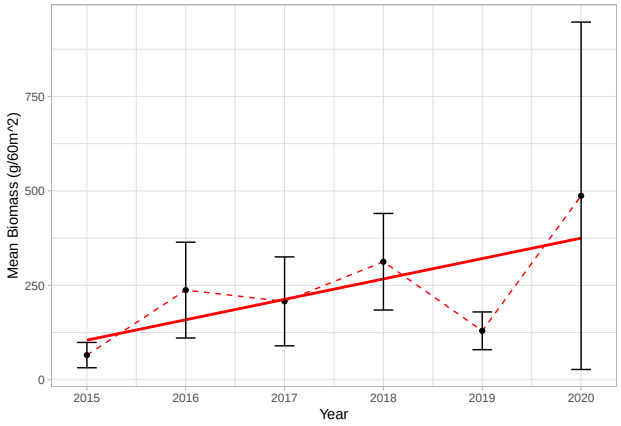


Snapper

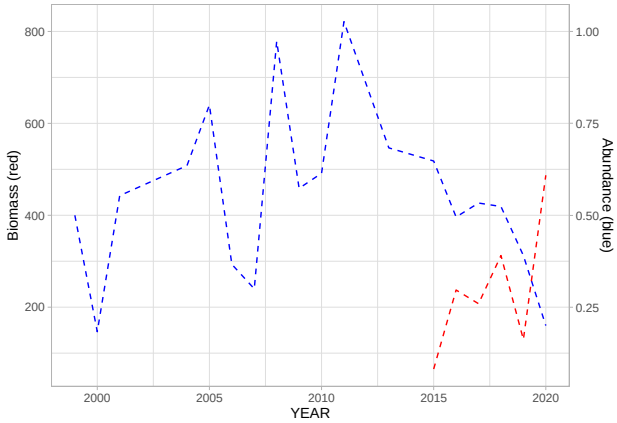
Goal: Investigate the relationship between snapper population and time. These graphs use annual means and standard error for abundance (1999-2020) and biomass (2015-2020).

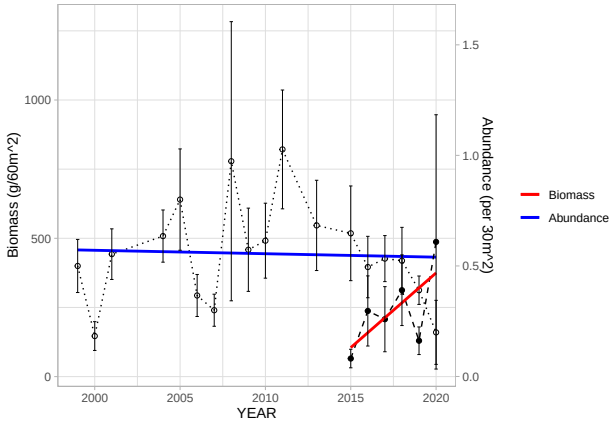


- Snapper abundance vs. year linear model: p = 0.99044, R^2 = 1.003e-07



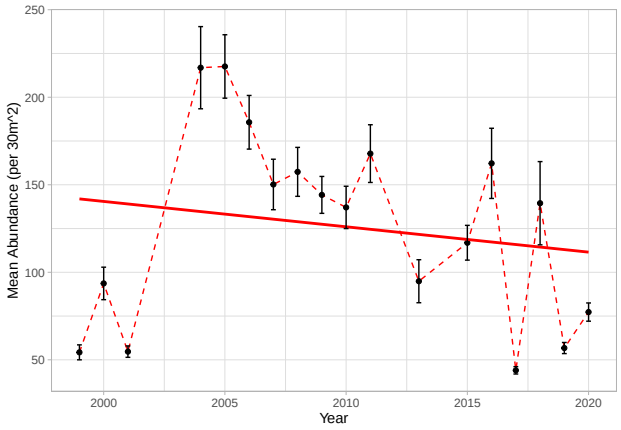
- Snapper biomass vs. year linear model: p = 0.29735, R^2 = 0.0122



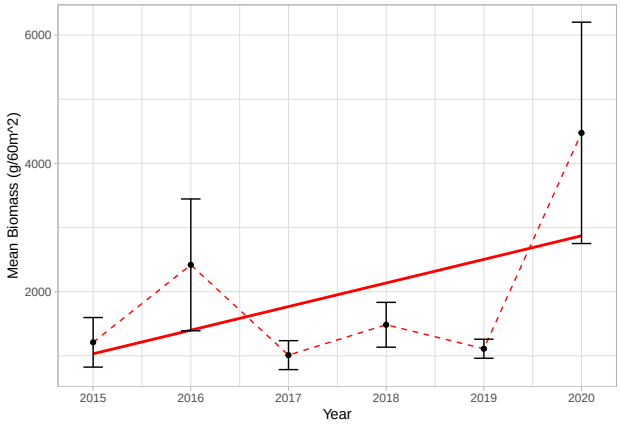


All species

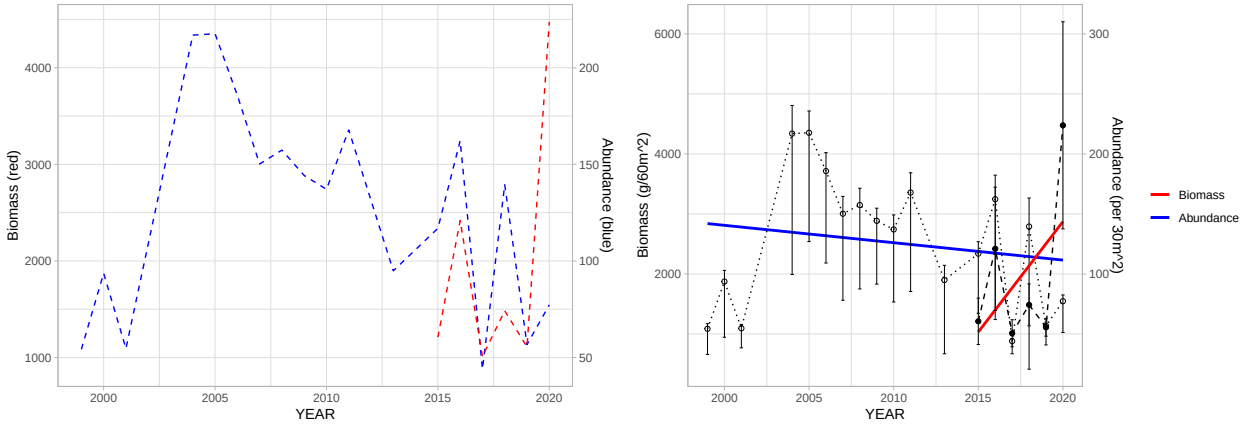
Goal: Investigate the relationships between all fish species (this includes non-commercial reef fishes) and time.



- all fish abundance vs. year linear model: p = 0.03536, R^2 = 0.003078



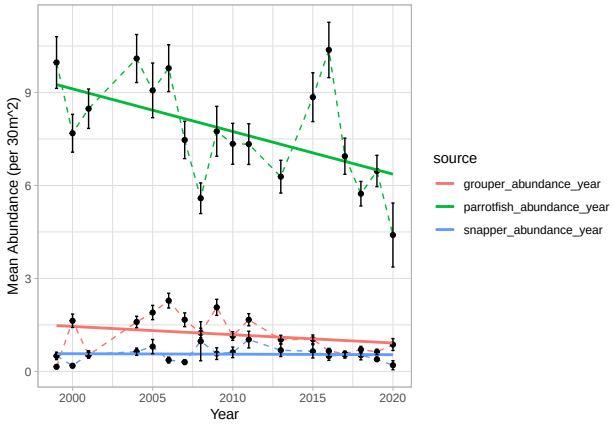
- all fish biomass vs. year linear model: p = 0.8103, R^2 = 0.0006508



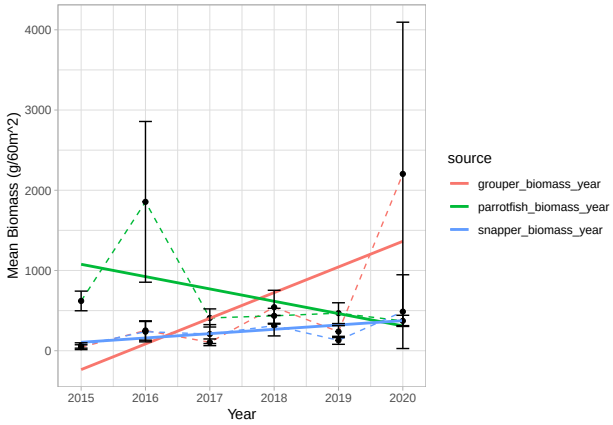
Plot three fishes together

Goal: To graph all three fish groups on one plot. The data & linear models are the same as above.

Snapper, Grouper & Parrotfish abundance on same axis:

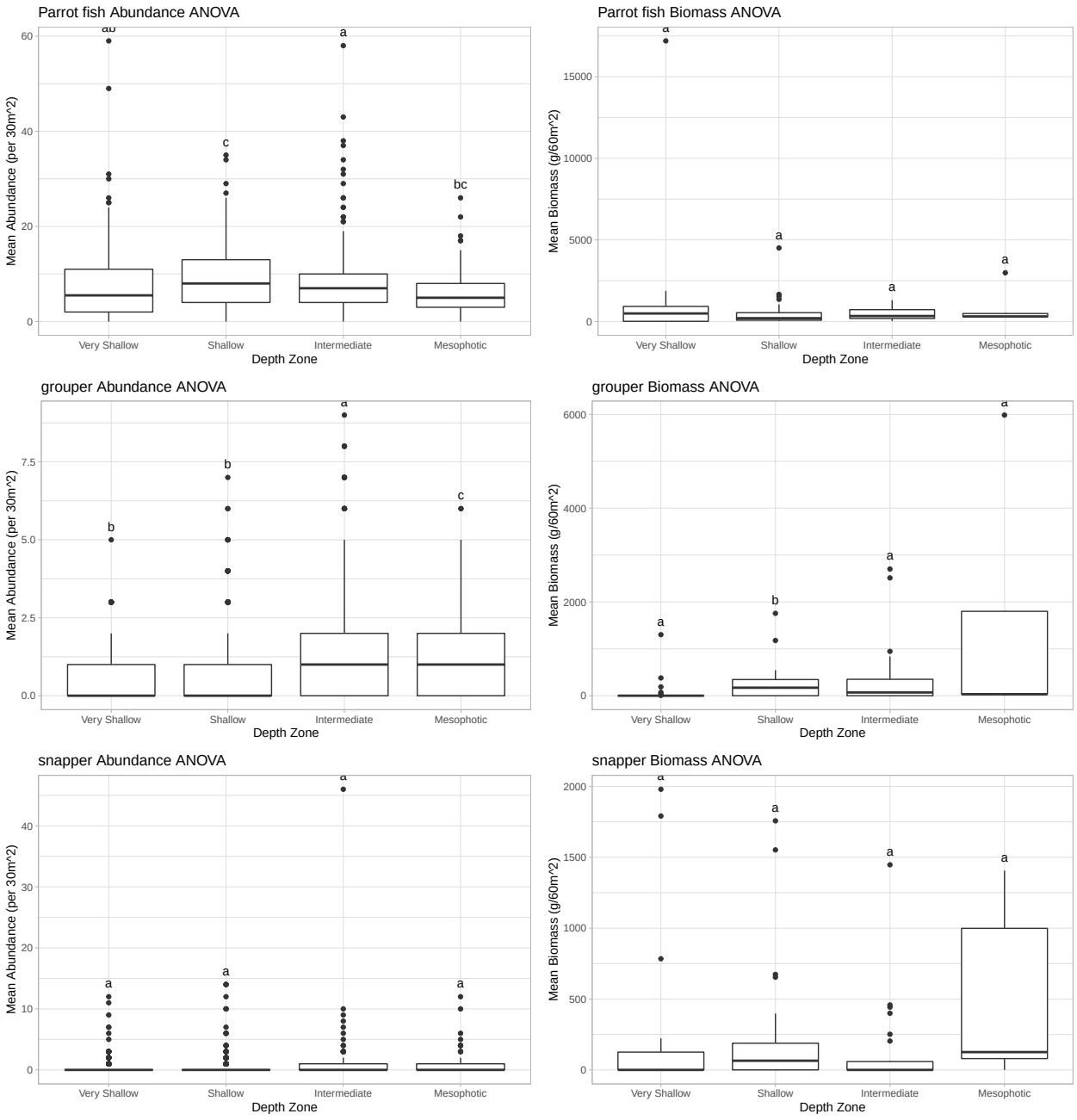


Snapper, Grouper & Parrotfish biomass on same axis:



Exploring the Effects of Depth

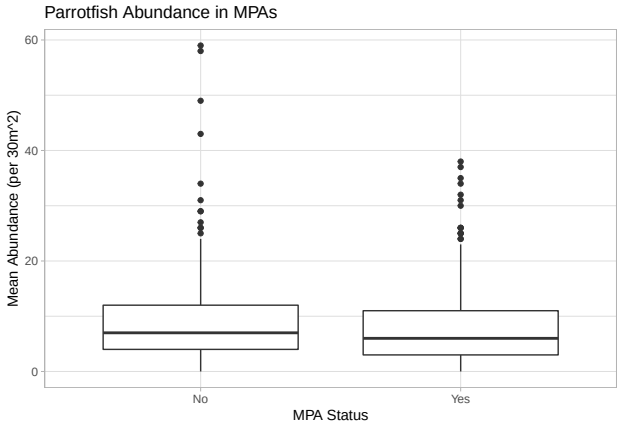
Goal: Based on the models, we know there are significant relationships between some of the population dynamics and the depth. These boxplots allow the reader to parse out the specific details of those relationships.

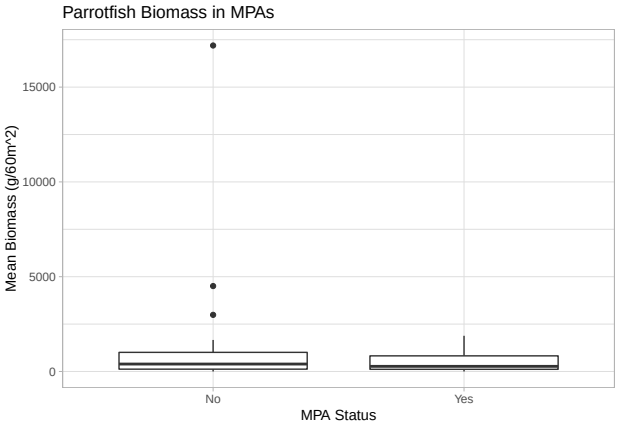


Notes: will eventually need to make sure the data is normally distributed in order for these graphs to be pretty.

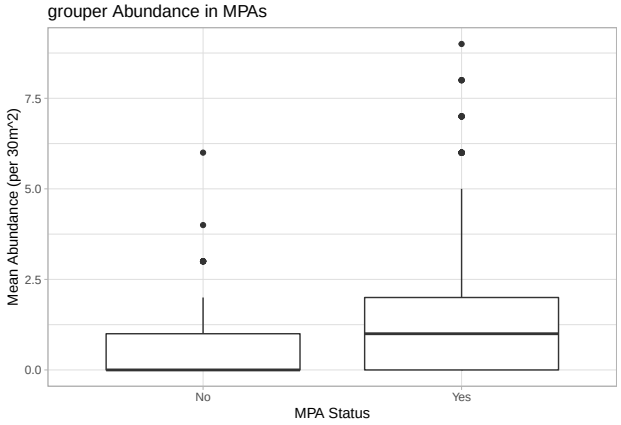
Exploring the Effects of MPAs

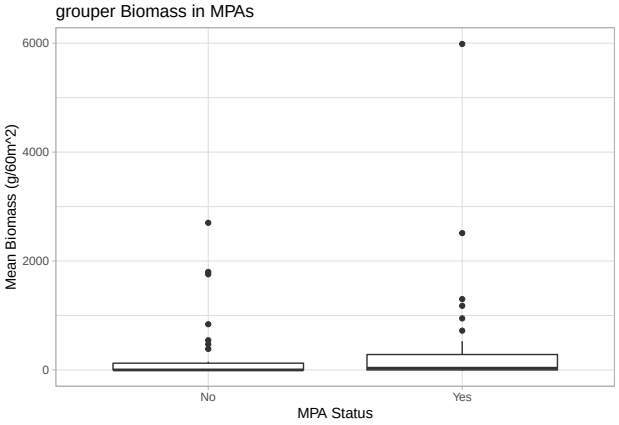
Goal: The models show that there are significant differences between MPA status for some of the fish groups. The boxplots allow the reader to see which category is higher.



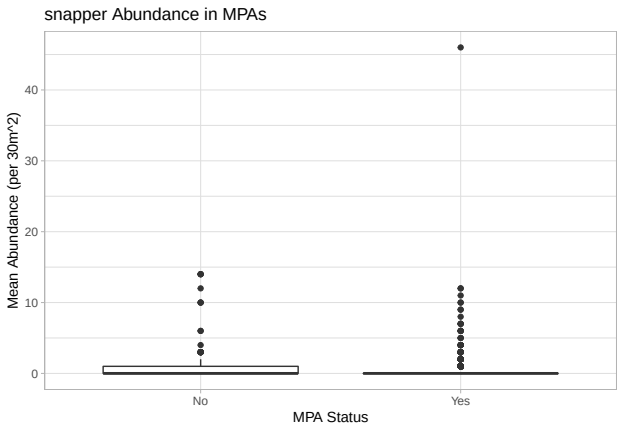


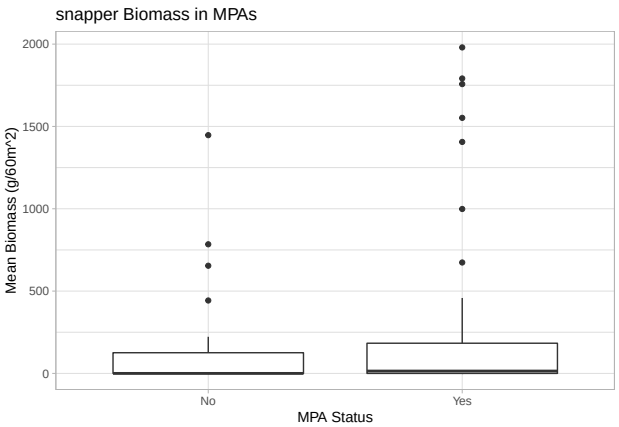
- Parrotfish abundance x MPA status ANOVA: p = 0.000394 **
- Parrotfish biomass x MPA status ANOVA: p = 0.0773





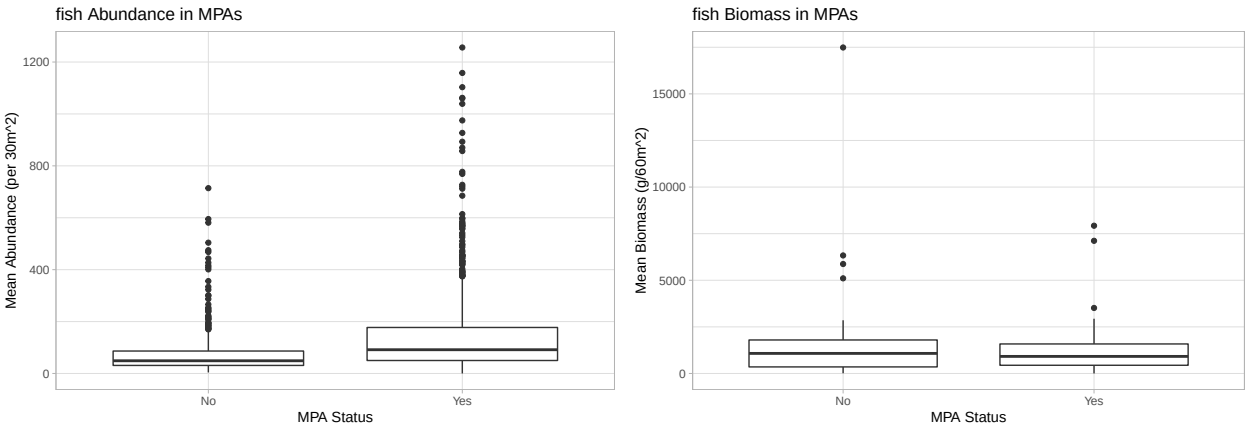
- Grouper abundance x MPA status ANOVA: p = <2e-16 ***
- Grouper biomass x MPA status ANOVA: p = 0.917





- Snapper abundance x MPA status ANOVA: p = 0.331

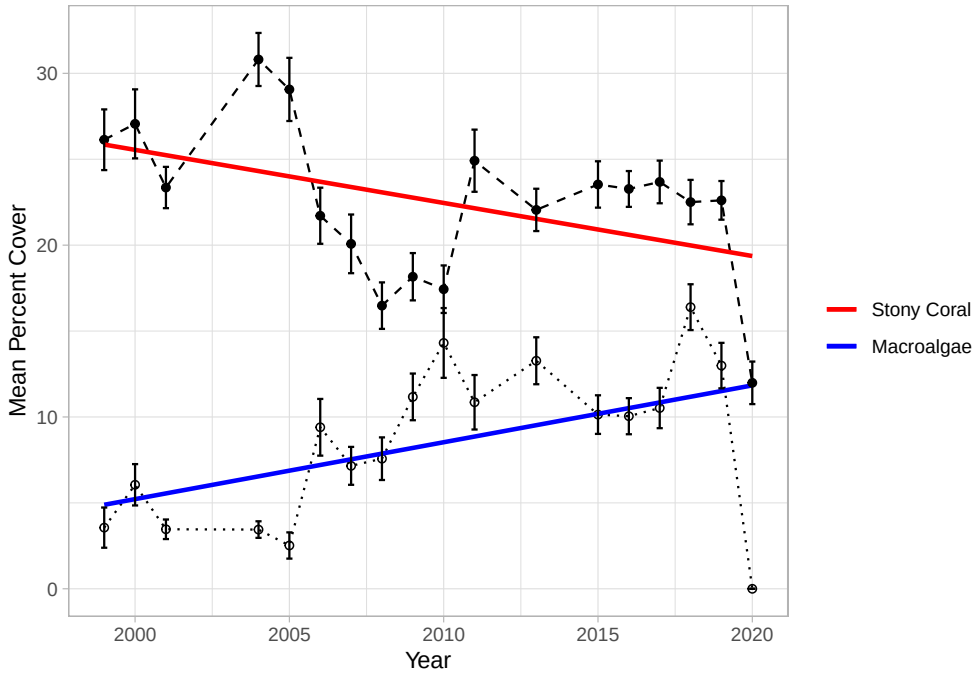
- Snapper biomass x MPA status ANOVA: p = 0.383



- All Fish abundance x MPA status ANOVA: p = 2.07e-15 ***
- All Fish biomass x MPA status ANOVA: p = 0.214

Benthic Substrate

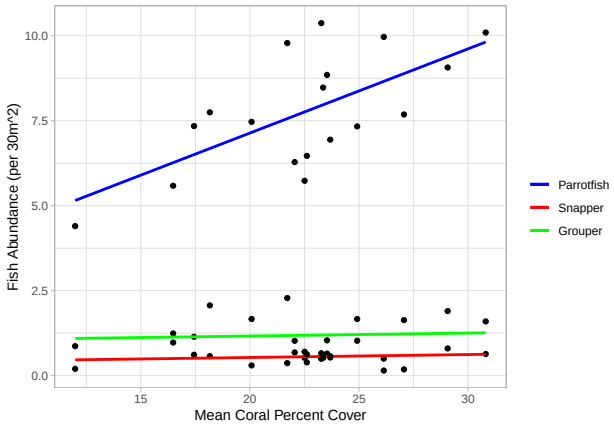
Goal: investigate changes in benthic percent cover of macroalgae and stony coral over time.



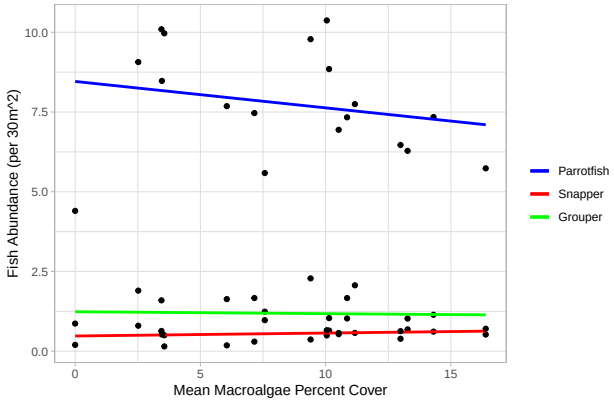
- Stony Coral vs. Year (red): p = 0.05949, R^2 = 0.2046
- Macroalgae vs. Year (blue): p = 0.04158, R^2 = 0.2348 **

Benthic Substrate & Fish Abundance

Goal: Compare the abundance of the three fishes with the percent cover of corals and algaes.



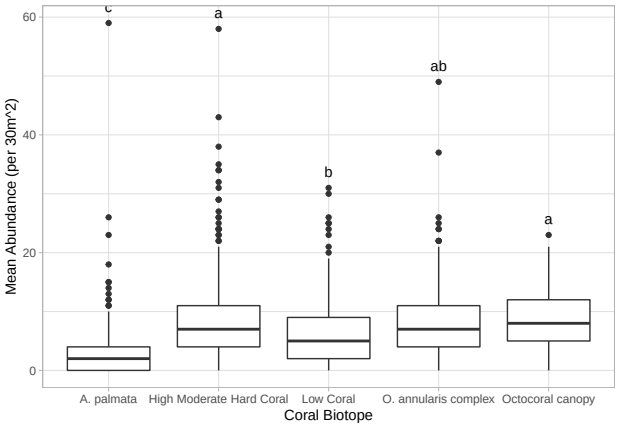
- Parrotfish vs. Coral linear model (blue): p = 0.002844, R^2 = 0.4363 **
- Grouper vs. Coral linear model (green): p = 0.7956, R^2 = 0.004319
- Snapper vs. Coral linear model (red): p = 0.4935, R^2 = 0.02979

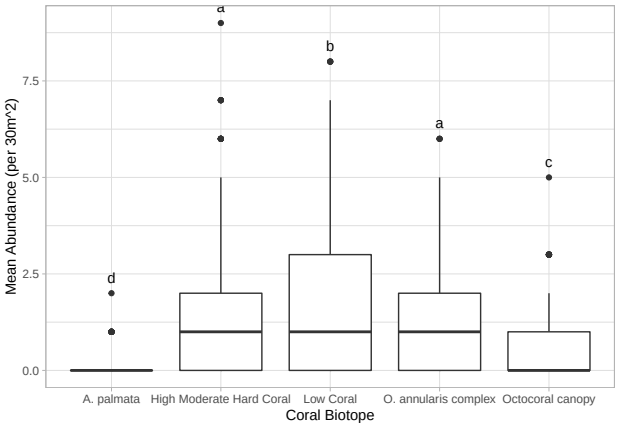


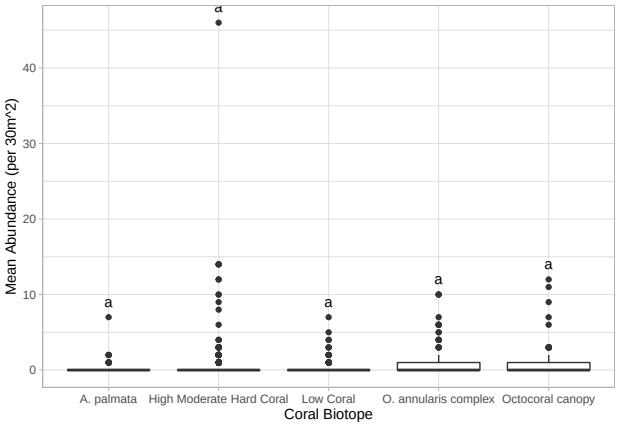
- Parrotfish vs. Algae linear model (blue): p = 0.3785, R^2 = 0.04878
- Grouper vs. Algae linear model (green): p = 0.8588, R^2 = 0.00204
- Snapper vs. Algae linear model (red): p = 0.4648, R^2 = 0.03386

Benthic Biotope ANOVAS

Goal: Use ANOVAs to parse out the details of the relationships between the fish group's abundances and the coral biotope classifications







Tables of Linear Model Outputs

Goal: Create tables for the linear model outputs based on all of the individual linear model, the full linear model with all five variables, and any other models that may have high predictability (included here are the models of just variables that were independently significant).

Parrotfish Abundance Model Inputs	p-value	Adjusted R^2
Depth Zone	8.88×10^{-7} *	0.0214
Year	7.19×10^{-5} *	0.011
MPA Status	3.94×10^{-4} *	0.00878
Location	3.15×10^{-35} *	0.137
Coral Biotope	1.04×10^{-11} *	0.0395
Depth + Year + MPA + Location + Biotope	4.11×10^{-46} *	0.17

Parrotfish Biomass Model Inputs	p-value	Adjusted R^2
Depth Zone	0.57	0.0227
Year	0.221	0.011
MPA Status	0.0773	0.0347
Location	0.834	0.113
Coral Biotope	0.953	0.00781
Depth + Year + MPA + Location + Biotope	0.642	-0.0369

Grouper Abundance Model Inputs	p-value	Adjusted R^2
Depth Zone	1.84×10^{-38} *	0.117
Year	4.69×10^{-6} *	0.0146
MPA Status	1.86×10^{-22} *	0.0645
Location	1.59×10^{-125} *	0.364
Coral Biotope	1.87×10^{-18} *	0.0608
Depth + Year + MPA + Location + Biotope	8.11×10^{-146} *	0.41

Grouper Biomass Model Inputs	p-value	Adjusted R^2
Depth Zone	6.49×10^{-4} *	0.178
Year	0.00744 *	0.0778
MPA Status	0.917	1.23×10^{-4}
Location	2.87×10^{-4} *	0.399
Coral Biotope	0.58	0.0325
Depth + Year + Location	6.59×10^{-5} *	0.345
Depth + Year + MPA + Location + Biotope	9.55×10^{-5} *	0.371

Snapper Abundance Model Inputs	p-value	Adjusted R^2
Depth Zone	0.687	0.00103
Year	0.99	10^{-7}
MPA Status	0.331	6.64×10^{-4}
Location	0.00301 *	0.0259
Coral Biotope	0.0295 *	0.00753
Location + Biotope	0.00205 *	0.0164

Snapper Abundance Model Inputs	p-value	Adjusted R^2
Depth + Year + MPA + Location + Biotope	0.00305 *	0.0169

Snapper Biomass Model Inputs	p-value	Adjusted R^2
Depth Zone	0.285	0.0424
Year	0.297	0.0122
MPA Status	0.383	0.00855
Location	0.113	0.235
Coral Biotope	0.527	0.036
Depth + Year + MPA + Location + Biotope	0.291	0.0461