The Change in Total Abundance of Coral Reef Fish Since 2012

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Abstract

Coral reefs are home to a diverse range of species that have been studied around the world to determine the effect of coral bleaching on the abundance of fish. We examined whether the total abundance of fish would increase or decrease throughout time due to the disappearance of coral reefs. We separated our data into three sites off the coast of Utila, Honduras where we recorded the data by collecting 50m transects by SCUBA divers using a stereo-video system, or SVS. We load these videos into a software called Event Measure, which allows us to count and identify all fish within 2.5m and 5m above the surface of the reef.

Transects are laid at 5m and 15m, 6 at each depth, and this is repeated across all three sites. This data revealed that the total abundance of fish was increasing from 2012 to 2019 instead of decreasing as scientists predicted. This study provides evidence that conservation efforts are working and lays groundwork for the reestablishment of coral reef fish in human aquariums.

Introduction

Coral reefs, the tropical forest of the ocean, are some of the most beautiful and vibrant places on Earth and are visited from time to time on very expensive vacations, and rightfully so! These ecosystems are home to the most diverse abundance of fish species, as well as other types of organisms. Coral reefs include different types of coral that get their color from microscopic algae called Zooxanthellae which share a symbiotic relationship that provides 80% of the reef's energy. The other 20% is achieved from heterotrophy where the coral stuns and preys on an organism. You might find coral reefs interesting, but they are slowly disappearing from the earth due to many threats they face in the modern day. Despite substantial international conservation efforts, diversity and abundance continue to decline within many of the world's ecosystems (Cinner et al 2016).

Corals reefs contain a diverse amount of fish species that are intertwined in a complicated food web and one change in the web can offset the entire ecosystem. This was seen in 2000, where Lionfish were a common sight off the coast of North Carolina, where their abundance soon rivaled that of the commonest native grouper species (Cote and Smith 2018). Invasive species like the Lionfish are killing the diversity of coral reefs as well as potentially killing off any fish that eat algae like the parrotfish or angel queenfish. This is bad for coral reefs because they need access to the sun for their microscopic algae to give them

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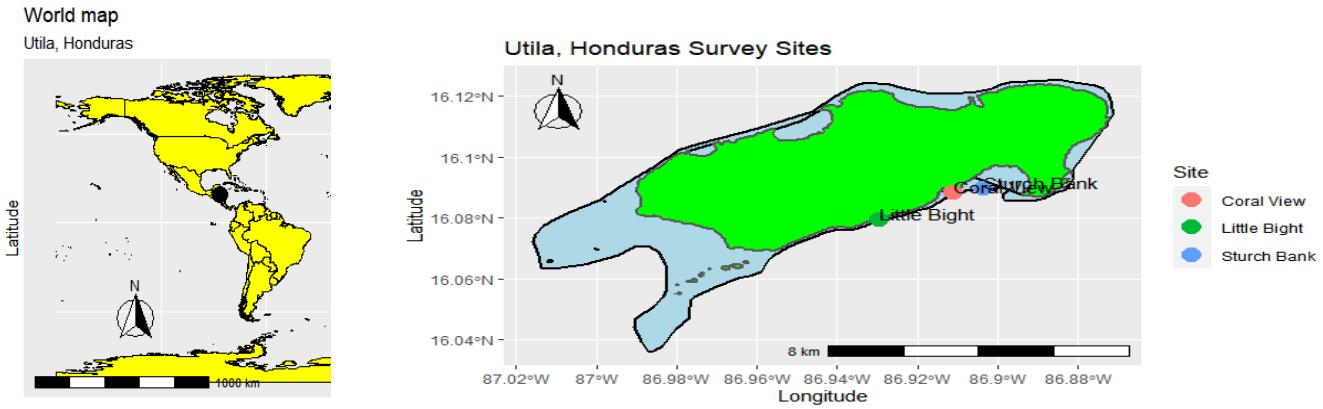
energy through photosynthesis. Cote and Smith (2018) also highlight that in some places, rates of prey consumption by lionfish far exceed prey production rates and the majority of native fish biomass is being converted to lionfish biomass.

Coral reefs are threatened today by a multitude of problems that are caused by humans. In response to multiple stressors, coral reef health has declined in recent decades, with reefs exhibiting reduced living coral and structural complexity, and a concomitant rise in the dominance of algal resources (Rogers et al 2018). A rise in greenhouse gasses is increasing the level of SST and melting the ice caps, which in return releases methane. An increase in the levels of carbon dioxide increases the level of ocean acidification and causes carbonate to be removed from the ocean which coral needs to form its shell. Overfishing has caused over 70% of the world's fisheries to be depleted and most fish species will never recover. More significant losses of refuges associated with the erosion of structural complexity correspond to fisheries productivity losses of at least 35% compared to healthy reefs (Rogers et al 2018). All of these threats are examples of how Coral Reefs are being negatively impacted and as a result, are bleaching.

With coral bleaching increasing, we need to pay close attention to the species living in coral reefs and how their abundance changes over time. Losing a species in a coral reef could be detrimental to the survival of the reef as well as the future of humankind and the Earth. Future research could identify how a coral reef fish can cure cancer, but how could that happen if the fish goes extinct due to human created threats? This study aims to investigate the change in total fish abundance since 2012 and by comparing total fish abundance we will find out how fish species are affected by the disappearance of coral reefs. Patterns expected to be seen in the data are increases in the populations of fish due to an increase in conservation efforts.

Methods



Data was collected in Utila, Honduras, which is located in central America (as seen on the left). The survey data was conducted in three sites off the southeastern coast of Utila called Coral View, Little Blight, and Sturch Bank (as seen on the right). The data was collected along 50m transects by SCUBA divers using a stereo-video system, or SVS. This system contains two cameras, allowing divers to collect two videos per transect. They load these videos into a software called Event Measure, which allows them to count and identify all fish within 2.5m and 5m above the surface of the reef. The transects were laid out at 5m

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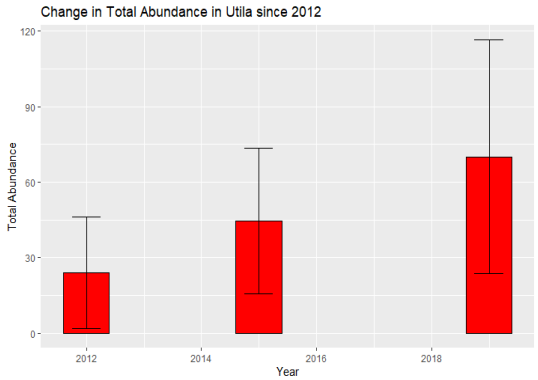
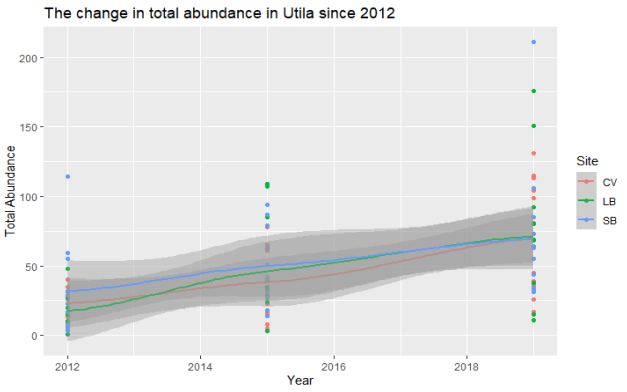
and 15m respectively, 6 at each depth, which is then repeated across all three sites. This data was collected once each in the years 2012, 2015, and 2019.

Results





The results of the study, shown above by a bar graph and a point graph, show that the Total Abundance of fish since 2012, continues to grow despite coral bleaching. The bar graph shows the mean abundance of fish including every site present in the data set. The point graph shows the total abundance of fish at every site recorded each year. The eros bars represent standard deviation. The results of the study are also shown in statistical data.

Paired t-test

data: fish$TotalAbundance and fish$Year
t = -547.52, df = 107, p-value < 2.2e-16
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
-1976.213 -1961.954
sample estimates:
mean of the differences
-1969.083

Anova test

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Year	1	38341	38341	33.34	7.8e-08 ***
Residuals	106	121907	1150		

Signif. codes: 0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

The Anova test resulted in an F value of 33.34, a df value of 106, and a p value of 0.0000000078, which is extremely significant because it is certain that there is a difference in data between each year and no room for random chance. The paired t-test resulted in a t value of -547.52, a df value of 107, and a p value of 0.00000000000000000022 which supports the results made in the Aova test because a p value less than 0.05 shows a significant probability that the data is real.

Discussion/Conclusion

The findings of the study shows an increase in Total Abundance between 2012 and 2019, proving my hypothesis correct and conservation attempts are working. Possible trends to support this result are conservation attempts by scientists to prevent the disappearance of

coral reefs. Previous studies have found bright spots in many places in the world where coral reefs are thriving despite the bleaching outbreak. ¨Seeking out and learning from bright spots is a novel approach to conservation that may offer insights into confronting the complex governance problems facing coupled human–natural systems such as coral reefs¨ (Ciner et al 2016). A possible reason for this theory is ¨we found that bright spots were associated with having high levels of dependence on fishing. This seems kind of counterintuitive, but decades of research into common property institutions found that where people's livelihoods depend on resources, they're willing to develop and invest in creative solutions to environmental problems. We also found strong local traditions with the sea and high levels of participation in management by the local communities.¨ (Ciner et al 2016). These findings can be useful in identifying why bright spots are doing so well and studies can be conducted for future use in conservation attempts. Some survey limitations from this data can be the array of fish found in Utila, and Utila not being an accurate representation of the rest of the world. Another limitation is the narrow amount of years recorded for this data and the gaps presented between the years 2012, 2015, and 2019.

References

Ciner et al (2016) Bright Spots among the World's Coral Reefs. LETTER doi:10.1038/nature18607

Cote, Smith (2018) The lionfish Pterois sp. invasion: Has the worst-case scenario come to pass? Journal of Fish Biology, 92, 660-689. doi:10.1111/jfb.13544

Rogers et al (2018) Fisheries productivity under progressive coral reef degradation. Journal of Applied Ecology. DOI: 10.1111/1365-2664.13051