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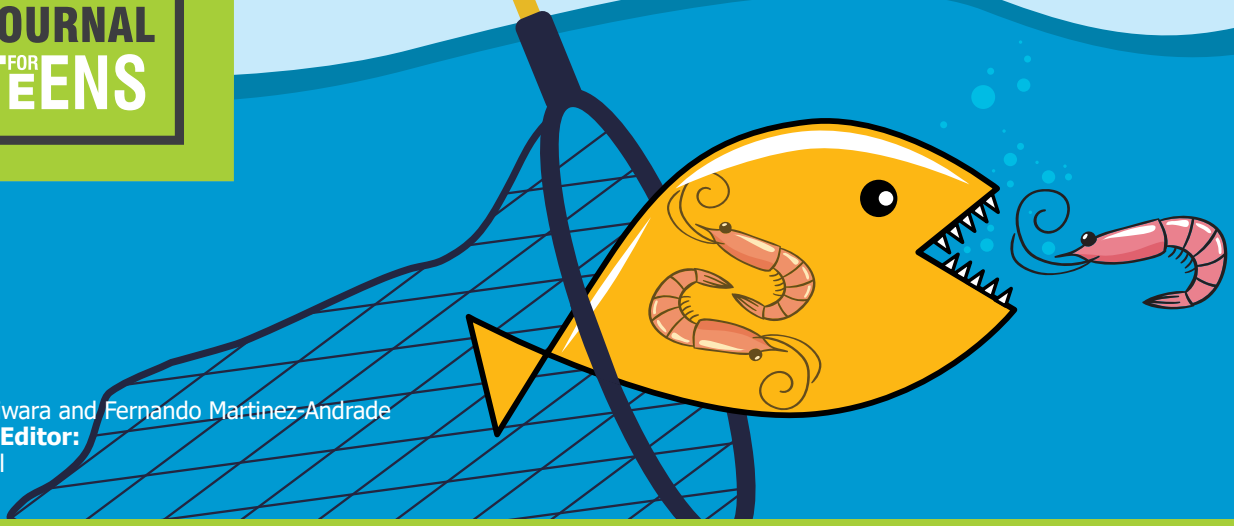
Who's eating all the shrimp?



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Abstract

Whether in prawn cocktail, shrimp gumbo, or grilled on the barbeque, you've probably eaten shrimp lots of times. It's the most common seafood in the US. An American eats on average 4 pounds of it every year!

While we know that shrimp is a popular seafood, we wanted to find out how important it was in supporting other valuable fish species in the Gulf of Mexico.

We studied the relationship between the abundance of shrimp and the fish that eat them, and found that there was a statistical link between the two. Although we cannot conclude that this is entirely due to the abundance of shrimp, we believe that our research shows that shrimp are a really important prey for these fish species.

Introduction

Shrimp fishing is big business in the Gulf of Mexico! In fact, it's the most valuable fishery in the entire Gulf region, contributing a whopping 65% of all US shrimp (Fig. 1). But that's not the only reason why shrimp are valuable…

Recent studies have shown that shrimp might be a very important prey for larger fish. We call this type of species *forage species*, which means that if their population falls, it will have a negative impact on the populations of the fish that eat them (their predators).

Three of the major predators of young *(juvenile)* shrimp in the Gulf of Mexico are southern flounder, spotted seatrout and red drum. These fish are really important for recreational and/or commercial fisheries.

The potential decrease in shrimp abundance is a big ecological concern because of its role as prey supporting many valuable predators, such as these fish species.

In this study, we wanted to find out how important shrimp were as a forage species for these fish.

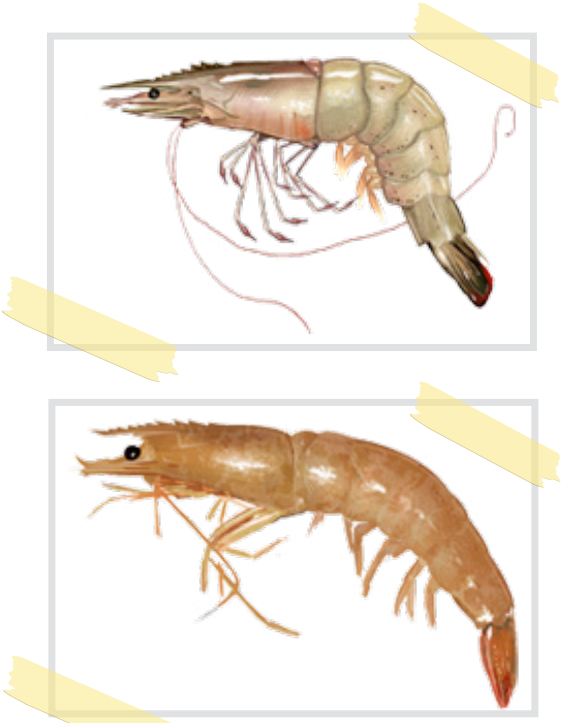

Figure 1:
White and brown shrimp. Most shrimp are grey or transparent while alive but they turn pink when we cook them.

Methods

From 1986 to 2014 the Texas Parks and Wildlife Department (TPWD) used different types of nets to collect samples of white shrimp and brown shrimp, and three fish species: southern flounder, spotted seatrout and red drum (Fig. 2). Juveniles and young adults of these fish prey upon shrimp, so these were the stages included in our statistical analysis.

While sampling took place monthly for shrimp, we found more brown shrimp in May and more white shrimp in August and November than during any other months. We used shrimp data from these months in the analysis and matched these data to the closest spring and fall catch data available for the fish.

We converted these data into an indicator known as *catch-per-unit effort* (CPUE), which in this case is the number of individuals of each species caught per hour within the nets used for sampling. It shows the relative abundance of each species in a particular place and time.

We investigated the statistical relationship between the CPUE of shrimp as prey and fish as predators over the time of the studies. We call these data a 'time series'. We ran two types of statistical analysis on these time series to look for relationships between the abundance of shrimp and the abundance of fish.

The two statistical analyses we used were Partial Least Squares Regression (PLSR) and co-integration analysis. PLSR is good for finding links between two variables (shrimp and fish) in year-to-year fluctuation, while co-integration analysis is good for slowly changing (increasing or decreasing) time series, which are called "non-stationary time series." Most of our CPUE time series were non-stationary.

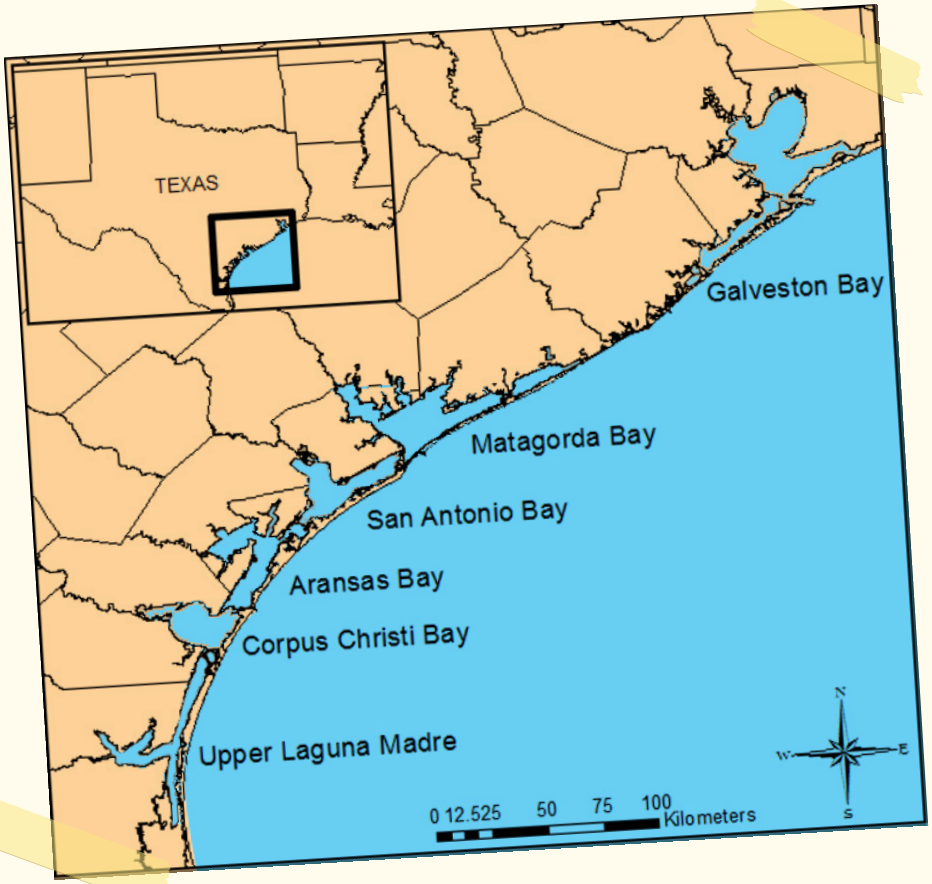

Figure 2: Scientists collected data from 6 bays along the coast of Texas, between 1986 and 2014.

Results

Our PLSR analysis found 8 significant relationships between shrimp and fish time series out of a total of 36 comparisons.

Our co-integration analysis showed significant associations between 31 out of 70 shrimp and fish time series pairings.

Using co-integration analysis we also found that white shrimp in August and brown shrimp in May were strongly linked with fish CPUEs in bays on the southern coast of Texas (Fig. 3). White shrimp in November were more strongly linked with fish CPUEs in bays located to the north.

All three fish species appeared to be affected by shrimp abundance in all of the regions that we studied.

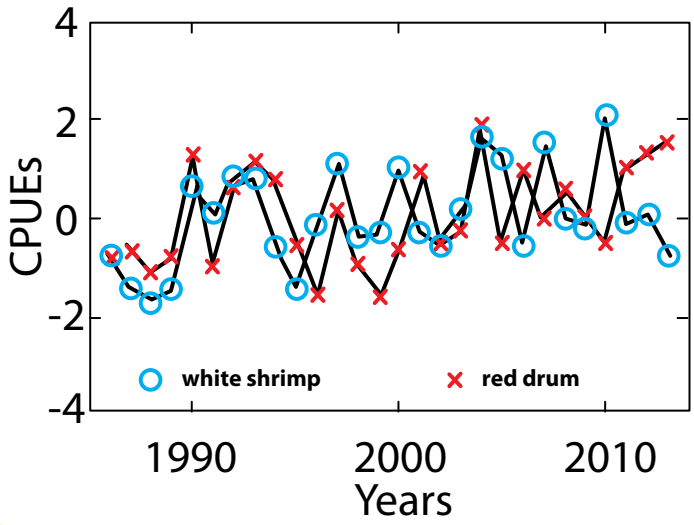

Figure 3:
Upper Laguna Madre in the Gulf of Mexico: Relationship between White shrimp CPUEs in August and red drum CPUEs in November.
(CPUE stands for *catch-per-unit effort* which in this case is the number of individuals of each species caught per hour within the nets used for sampling. In this graph, CPUE-s are scaled, that's why some values are negative!)

Discussion

We predicted that if our two shrimp species were vital for the fish in our study, there would be a statistical association between the changes in abundance of prey and predator.

Our PLSR analysis wasn't conclusive because we found associations between shrimp and fish CPUEs in only 22% of cases. These associations could have just been because of statistical error.

However, our co-integration analysis showed significant associations in 52% of cases. It also revealed clear patterns between the seasons and different locations.

Different shrimp species are important at different times of the year and in different parts of the Gulf of Mexico. Observed patterns in their abundance over the latitude (the distance from the equator) might be because of changes in temperature or salinity – both of which have an effect on shrimp populations. We would need to do further studies to better understand these effects.

Fishing for all of the species in this study has had a big impact on their populations, and affected their roles as prey or predators. There have been lots of improvements in fishery management practices to stop overfishing. It is possible that these actions could be covering up, or adding to, the statistical associations that we saw.

The importance of any fishery stock is normally worked out by its market value when caught. Our research shows that the ecological importance of shrimp has been underestimated. The shrimp are not just valuable as a fishing stock, but they are also important as a forage species for three of the most valuable fishes in the Gulf of Mexico.

Conclusion

Using statistical analyses we found that there was a significant relationship between shrimp abundance and the presence of these three fish species in the Gulf of Mexico.

We also found that naturally-occurring changes in shrimp abundance from year to year complicate this relationship and additional studies are needed. However, it's clear that shrimp fisheries need to be regulated in order to keep them sustainable. If not, it could have a negative effect on these three valuable fish species.

Glossary of Key Terms

Commercial fisheries – The people and companies who catch fish to sell them.

Habitat – The place, or type of place, where an animal lives and hangs out.

Predator – An animal that's above another in the food web. In our study, the predators were the southern flounder, spotted seatrout and red drum.

Prey – An animal that's below another in the food web. In our study, the prey were the white and brown shrimp.

Recreational fishing – People who catch fish for fun and/or for their own food.

Salinity – The salt content of the sea. High salinity means there's a lot of salt, low salinity means that there is not as much.

Significant – A result that is likely not due to chance, but rather due to a real process. Scientists often define a result as "significant" if it would happen by chance less than 5% of the time.

Check your understanding

1. One of the changes in management practices was to reduce the sale of new shrimp fishing licenses and a buyback program for old licenses. Over 65% of shrimp fishing licenses were bought back and retired. What effect do you think this would have had on the shrimp population?

2. Most young shrimp start their lives in marshes and coastal wetlands. Our findings show the importance of protecting ecological integrity of such habitats in order to increase the amount of shrimp reaching adulthood and helping the valuable fish species they support. What management strategies would you suggest to protect these habitats?

3. Scientists have proven that temperature affects the survival and growth of shrimp in the Gulf of Mexico. Why do you think this is?

4. Why is statistical analysis alone not sufficient to prove a relationship between the abundances of shrimp and fish? What other data can help prove a relationship?

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