Date:

Ocean warming alters the distributional range, migratory timing, and spatial protections of an apex predator, the tiger shark (Galeocerdo cuvier)

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Abstract

Given climate change threats to ecosystems, it is critical to understand the responses of species to warming. This is especially important in the case of apex predators since they exhibit relatively high extinction risk, and changes to their distribution could impact predator–prey interactions that can initiate trophic cascades. Here we used a combined analysis of animal tracking, remotely sensed environmental data, habitat modeling, and capture data to evaluate the effects of climate variability and change on the distributional range and migratory phenology of an ectothermic apex predator, the tiger shark (*Galeocerdo cuvier*). Tiger sharks satellite tracked in the western North Atlantic between 2010 and 2019 revealed significant annual variability in the geographic extent and timing of their migrations to northern latitudes from ocean warming. Specifically, tiger shark migrations have extended farther poleward and arrival times to northern latitudes have occurred earlier in the year during periods with anomalously high sea-surface temperatures. A complementary analysis of nearly 40 years of tiger shark captures in the region revealed decadal-scale changes in the distribution and timing of shark captures in parallel with long-term ocean warming. Specifically, areas of highest catch densities have progressively increased poleward and catches have occurred earlier in the year off the North American shelf. During periods of anomalously high sea-surface temperatures, movements of tracked sharks shifted beyond spatial management zones that had been affording them protection from commercial fishing and bycatch. Taken together, these study results have implications for fisheries management, human–wildlife conflict, and ecosystem functioning.

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Credit: Jillian Morris

How might the results vary among different shark species?

Summary

In order to address global climate change, we need to understand its effects to the fullest. Top ocean predators, like tiger sharks, are at a high risk for extinction, so the effects of climate change are especially important to understand. They have a top down control of marine food webs and changes to their populations can cause changes to trophic levels underneath them. The team of scientists conducting this study wanted to know how changes in climate can affect where tiger sharks live and migrate to. In order to do this, they used multiple methods- tracking sharks via tagging, collecting environmental data, like temperature, habitat modeling, and analyzing fishing capture data from nearly 40 years. Through the collection and analysis of this data, they found that tiger sharks prefer water temperatures between 26-28 degrees Celsius, fitting for their role as apex predators in tropical and subtropical waters. Shark tracking data from over 9 years showed that there was variation in how these tiger shark use different habitats and spaces and where they migrated. They determined that it can be linked to warming ocean waters. Tiger sharks migrate earlier and farther north when the waters warmed to the temperature range they prefer.

This study determined that climate change and warming oceans can lead to changes in tiger shark distribution and range, which can in turn lead to an increase in human-shark interactions. Sharks can also migrate outside of the management zones and the protected areas. In order to be successful in proper management, there needs to be changing policy for the changing environmental conditions.

This study was conducted in the western North Atlantic Ocean. How might the results vary in other parts of the world?

Why did the scientists use different forms of data analyses to come to the conclusion instead of one?

What are some policy changes that the scientists may advise as a result of this study?

Did you know? Pop-off archival satellite tags (used for tracking in this study) records the temperature and depth of the water the shark is in.

Glossary of Key Terms

Climate Change- the long-term shifts in temperatures and weather patterns. These shifts may be natural, but since the 1800s, human activities have been the main driver of climate change, primarily due to the burning of fossil fuels (like coal, oil, and gas).

Trophic Cascade- an ecological phenomenon triggered by the addition or removal of top predators and involving reciprocal changes in the relative populations of predator and prey through a food chain.

Fisheries Management- management used to produce sustainable biological, environmental and socioeconomic benefits from renewable aquatic resources.

Distributional Range- the geographical area or habitat where the species live.