Current and Future Distributions of Atlantic Cobia

Fish movements and distributions are determined by several factors, many dynamic in nature, like temperature. Understanding the relationships between factors such as temperature and fish distribution can aid us in predicting where species may be in the future. In turn, predictive relationships may allow fisheries agencies to manage more dynamically in space and time. Understanding current and future distributions could assist management in defining stock structure, assigning quota allocations, designating closed areas, reducing bycatch, and proactively adapting to climate change.

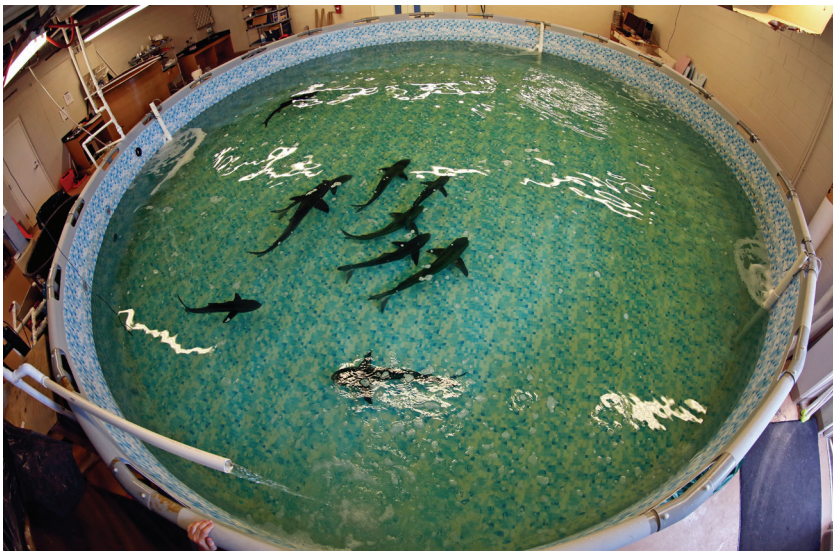

Figure 1. Working with recreational anglers, cobia were caught and brought to the VIMS laboratory, where a series of manipulative experiments were conducted to identify the warmest water and lowest oxygen concentration Atlantic cobia could tolerate. Photo (c) Aileen Devlin, Virginia Sea Grant

The first step is establishing the relationship between fish and their environment. This can be done using several research methods, such as tagging, physiological experiments, and habitat modeling. Fish tagging can determine the locations and environments fish prefer in the wild. Physiological experiments in the laboratory can be used to understand why a fish may prefer or avoid a specific environment, as well as test how a species may respond to new environmental conditions (i.e., identify the species' tolerance). Habitat modeling that incorporates physiology and/or tagging results can be used to statistically examine relationships and predict species distributions over specific time periods and areas. Combining these techniques provides a powerful approach to understanding how the environment affects fish in order to estimate their distributions today and tomorrow.

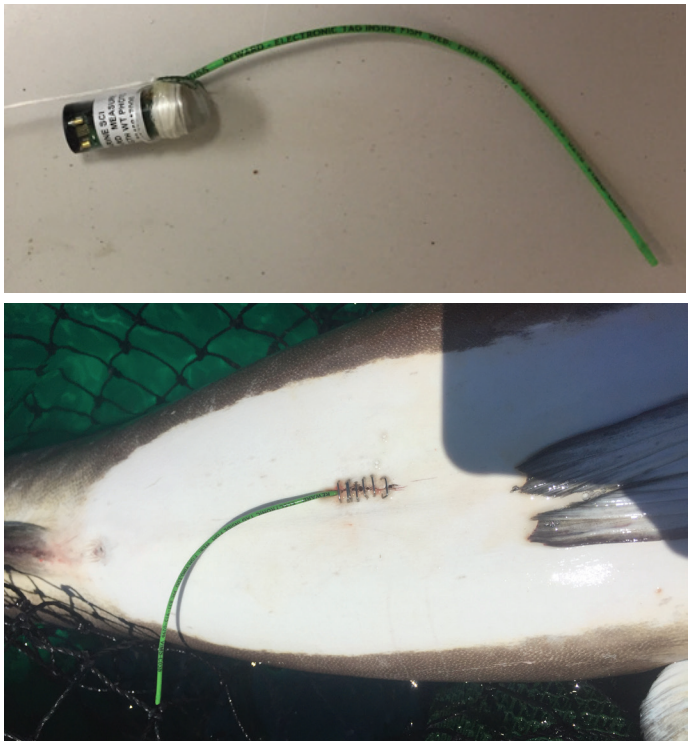

Figure 2. Internal archival tag before (top image) and after (bottom image) being surgically implanted into Atlantic cobia.Photos (c) Dan Crear

Cobia are energetically pursued by recreational anglers and support fisheries in the South and Mid-Atlantic. Atlantic cobia migrate to inshore waters to spawn and feed in Chesapeake Bay as well as other bays and estuaries in North and South Carolina during the warmer months of the year, when they are targeted by recreational anglers. The migratory nature of Atlantic cobia make them particularly sensitive to changing ocean conditions because migrations are often cued by temperature. For example, warming conditions could change the timing of migration, as well as the general distribution of Atlantic cobia, particularly as marine heatwaves become more common and the ocean in general warms.

From 2016-2019 researchers from the Virginia Institute of Marine Science (VIMS) at the College of William and Mary set out to define relationships between environmental factors and Atlantic cobia distributions, and project where they may be in the future. Working with recreational anglers, Atlantic cobia were caught and brought to the VIMS laboratory, where a series of manipulative experiments were conducted to identify the warmest water and lowest oxygen concentration Atlantic cobia could tolerate (Figure 1). The experiments also identified how intense exercise and stress conditions (e.g., catch and release fishing) affect cobia survival. In addition, over 50 cobia, primarily caught in Chesapeake Bay by recreational anglers, were fitted with a series of tags. They included acoustic tags to determine movement patterns of fish, and internal archival tags and popoff satellite archival tags (PSATs) to identify habitats the fish are using (Figure 2). Researchers then used tagging and lab experiment data to generate habitat models

for estimating the current and future distributions of Atlantic cobia along the U.S. shelf and inside Chesapeake Bay, and estimate how migrations may change as waters warm.

From the lab experiments, it appears Atlantic cobia can withstand temperatures as warm as 90°F and low oxygen concentrations, broad tolerance ranges for a migratory coastal pelagic species. It is important to note, however, that when exercised to exhaustion and then exposed to warmer temperatures (>82°F), 20% of the Atlantic cobia died. If temperatures increase in bays and estuaries, rates of post-release mortality are likely to increase.

Using the tagging data and habitat modeling results, researchers found large differences in the distribution of suitable cobia habitat along the U.S. shelf among different years and time periods. For example, during an average year in September, it was estimated that 8% of Atlantic cobia's suitable habitat over the U.S. shelf occurred in waters off of New Jersey. However, during a warm year (e.g., 2012), 27% of cobia's suitable habitat was estimated to occur in waters off of New Jersey. This highlights the interannual variability in Atlantic cobia distributions as a result of temperature changes. When projecting into the future, it appears that during summer months the percentage of suitable cobia habitat will increase in waters north of Virginia and decrease in waters south of Virginia. Researchers predict in summers 40 years from now, waters off of New Jersey will have the most suitable cobia habitat of any state along the East Coast. Suitable habitat is not estimated to decline in Chesapeake Bay until the end of the century.

Finally, when projecting Atlantic cobia migrations into the future, researchers suggest Atlantic cobia will migrate into Chesapeake Bay earlier in the year and leave later as a result of warming waters. By mid-century, Atlantic cobia could extend their amount of time spent in the Bay by over 30 days.

The new research suggests Atlantic cobia's broad environmental tolerances will provide resiliency to climate change in the near future. However, because they respond closely to temperature changes and thresholds, Atlantic cobia distribution along the East Coast will likely change on an annual basis. This makes Atlantic cobia a suitable species for using a more dynamic approach to fisheries management. For example, if scientists can provide estimates of Atlantic cobia distribution six months in advance of the fishing season, managers could set quota allocations among states that reflect the predicted distributions.

Researchers at VIMS would like to thank the many fishermen who contributed to collecting and tagging Atlantic cobia. Without them the study would not have been possible.
For more information on the Atlantic cobia research study, please contact Dr. Dan Crear at dcrear8@gmail.com. Dr. Crear completed the study as part of his Ph.D. work at the Virginia Institute of Marine Science, College of William and Mary.

For scientific journal publications describing additional study results, please visit:
https://royalsocietypublishing.org/doi/full/10.1098/rsos.200049
https://onlinelibrary.wiley.com/doi/full/10.1111/ddi.13079
https://www.frontiersin.org/articles/10.3389/fmars.2020.579135/full

Two science communication products were also developed by Dr. Crear. An interactive StoryMap at https://arcg.is/1Gem8X provides images, videos, and further descriptions of the cobia study. The infographic (on page 10) was created to understand the impacts of climate change on fish and fisheries. The Commission thanks Dr. Crear for contributing this article.

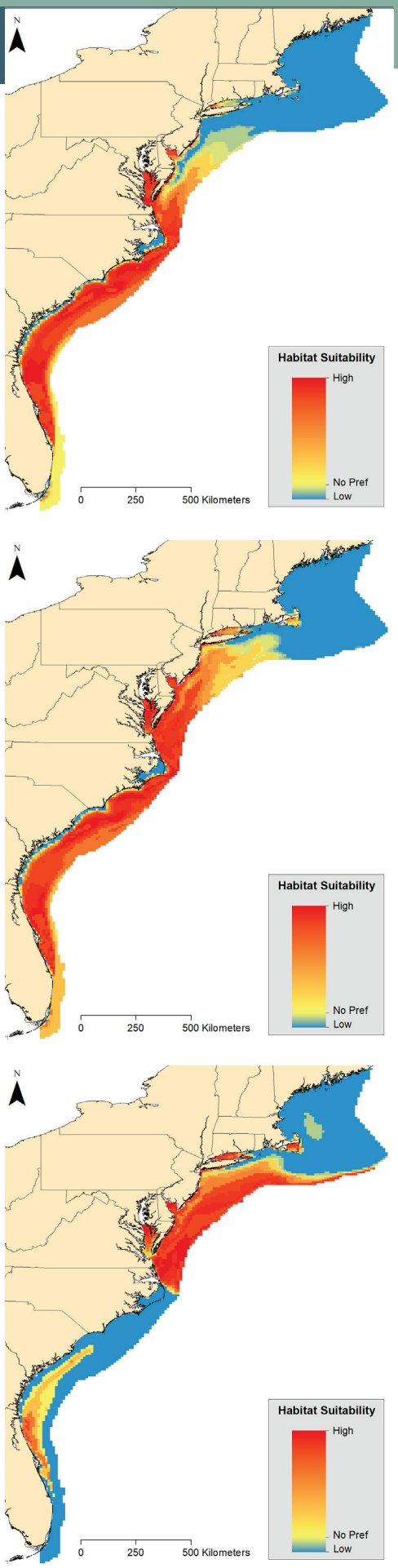

Figure 3 (to the right). Atlantic cobia suitable habitat projections along the U.S. shelf for July during an average year (top image), warm year (middle image), and 60-80 years in the future (bottom image). No pref on the legend represents a value of 1 meaning no difference than random. Above No pref represents habitat that is suitable whereas below indicates unsuitable habitat.