



## How Fisheries Can Test Management Rule Changes Before Enacting Them

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In the United States in 2021, it would be difficult to find a food item, available at a major retailer, that has not been thoroughly tested before it reached consumers. U.S. law requires testing to ensure products meet minimum food safety standards and will not endanger consumers. Further, companies often have quality assurance departments that require products meet company standards (which often go beyond the minimum legal requirements) to ensure consumer satisfaction.

Although there are strict testing requirements that ensure food is safe for consumers, there are few regulations – or other incentives – that help business and government leaders test and improve the systems that produce food. While this may not pose an immediate risk to the public's health, the failure to test these systems poses a real and growing risk for the economy.

One reason these system changes are not being tested is that, until recently, the technology needed to test changes in complex systems has not been widely available. Research I have done with colleagues helps address this technological gap. We have created a simulation tool that will help fisheries determine how different rule changes will affect the complex ecosystems that house their fisheries. These tools and future fishery management rule changes will be especially important for one of the most valuable fisheries in the country, The Gulf of Maine American lobster fishery. Currently, The Gulf of Maine fishery is in danger because of rapidly changing environmental factors. To address these complex problems, fishery owners and managers, researchers, policymakers, and others concerned about Maine's coastal economies and the future availability of lobster should work to increase awareness about and use of these simulation tools.

### THE IMPORTANCE OF THE AMERICAN LOBSTER

The American lobster supports the Gulf of Maine American lobster fishery, one of the most culturally and economically valuable fisheries in the United States. In recent years, the lobster catch in the Gulf of Maine has increased dramatically, reaching historic highs. In 2019 alone, the fishery brought in more than 486 million USD. However, the future of the Maine lobster fishery is uncertain.

Water temperatures are increasing faster in the Gulf of Maine than anywhere else on Earth, which has a large impact on lobster biology. These environmental changes should be accompanied by fishery rule changes and tests of those rules (i.e. protection of egg-bearing lobsters, minimum size a lobster can be kept). Testing rules is necessary because fishery managers need to know how rule changes and environmental factors impact the fishery's catches.

The importance of the lobster fishery and the uncertainty of the fishery's future calls for an evaluation of management rules. Other fisheries – the Western Baltic herring, the Mediterranean swordfish, the Atlantic tunas to name a few – have all tested management rules with simulation tools, however, until recently there were no simulation tools available for the lobster fishery.

### SIMULATION TOOLS AND RULE CHANGES

Simulation tools are important for helping fishery managers and workers understand the how rule changes in fishery management can affect individual lobsters, fishery practices, and related environmental factors. In addition, simulation tools can help create a framework for testing these fishery management rules.

Scientists from the University of Maine have developed a tool to test rules in the fishery before they are enacted. Both the American lobster fishery and the American lobsters' biology are complex, which makes it difficult to simulate with traditional simulation tools. Usually, simulation tools are not capable of accounting for differences among individual fish as they move through different fishery processes.

To make it possible to test the fisheries complex rules, we developed a simulator that tracks the life history of individual lobsters as they encounter different fishery processes. We modified a simulator to replicate an actual lobster fishery, where each individual lobster has a different probability of going through various natural and human designed processes including growth, being caught, being designated for protection, and death. This is important because:

- Growth varies between individual lobsters and is not gradual, the simulator can account for this. For example, lobsters grow by molting, which means they grow suddenly after they shed their exterior carapace.
- Conservation measures themselves are complex and the simulator allows us to account for this factor as well. There are several conservation measures in the fishery, and they protect lobsters of different sexes and sizes.
- The simulator can test management rules under changing environmental conditions. Water temperatures in the Gulf of Maine are warming rapidly, and this has effects on lobster growth and productivity.

This simulation tool can now closely replicate the historical Gulf of Maine lobster fishery and is ready to test rules that could be implemented in the future. The nuance of this tool allows the fishery managers to ask the question: *What if* the fishery was managed differently?

Currently, the lobster fishery has rules about the minimum and maximum sizes of lobsters that can be caught and kept, about the protection of egg-bearing lobsters, about trap limits, and about limited entry into the fishery. However, the fishery is experiencing rapid changes, and this tool can help fishery managers identify rules that will proactively keep the lobster catch abundant in the face of rapid ecological change. Management rules can control the fishery catch, such as the size of fish that can be caught, the number of lobsters that can be caught, and where they can be caught.

Fishery failures, such as the collapse of northern cod, have been common in history. As a result, there has been a push for better management practices. Simulation tools, like the one we created, can help fishery managers develop more sustainable practices by helping them test rules before they implement them. These tools are relatively new to fisheries management, but using them can help ensure that fisheries become more adaptive and that there are plenty of lobster for generations to come.

**Read more in Mackenzie Mazur, Bai Li, Jui-Han Chang, and Yong Chen in "Using an Individual-Based Model to Stimulate the Gulf of Maine American Lobster (*Homarus americanus*) Fishery and Evaluate the Robustness of Current Management Regulations,." (December 2018 Canadian Journal of Fisheries and Aquatic Sciences, 76 (9))**