EVALUATING ADAPTIVE MANAGEMENT STRATEGIES FOR CLIMATE-RESILIENT FISHERIES

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BACKGROUND

Global fisheries are an important food source, providing 15% of the average per capita animal protein intake for more than 2.9 billion people.

Fisheries provide economic value, employing 43.5 million people in primary fish production and yielding exports valued at $85.9 billion.

Despite their social and economic significance, over 33% of global fisheries are currently classified as overfished. In reality, it is likely that number is much larger due to a lack of available data.

Climate change is now altering marine ecosystems by driving range and productivity shifts, increasing physiological stress, and altering food and habitat availability, all of which may result in changes to maximum sustained yield (MSY). These changes could come gradually or abruptly in the form of climate driven shocks to the ecosystem.

AS A RESULT, GLOBAL FISHERIES STAND TO LOSE UP TO 50% OF GROSS REVENUES IN THE FACE OF SEVERE CLIMATE CHANGE AND CONTINUED OVERFISHING.

To assist data-limited fisheries, EDF created the Framework for Integrated Stock and Habitat Evaluation (FISHE). FISHE is an 11-step framework designed to help fisheries managers evaluate management options with minimal inputs.

Each step contains multiple different tools and resources, allowing for FISHE to be adapted for any type of stock in any geographic location. However, the framework ultimately helps managers address three main questions:

What is the state of your resource? ▶ What is your response? ▶ How often will you repeat this?

The FISHE Framework

PROBLEM

While FISHE was designed to capture the dynamic nature of fisheries, it was not specifically designed to address the expected environmental changes stemming from global climate change. As climate change has already started to impact fish stocks worldwide, it is imperative that FISHE is robust to climate-induced variations.

OBJECTIVES

1. **DETERMINE** IF FISHE WILL CONTINUE TO PERFORM AS EXPECTED UNDER VARIOUS CLIMATE CHANGE SCENARIOS
2. IF NOT, **IDENTIFY** WHY, AND **RECOMMEND** WHAT REVISIONS COULD SIGNIFICANTLY IMPROVE ITS PERFORMANCE

APPROACH

Our team developed a model to test different management actions on fishery outcomes. The model included three components: a biological component to track the growth of the fish stock over time, a climate component to incorporate the effects of climate change on the fish stock, and a management component to simulate FISHE management actions.

MODEL INPUTS

BIOLOGICAL	+	CLIMATE	+	MANAGEMENT
Fish population dynamics model		Climate change effects		FISHE management actions

MODEL OUTPUT

200,000+ simulations of fish stocks over 100 year periods

WITH THIS MODEL, OUR TEAM ASSESSED THE ABILITY OF THREE PRIMARY MANAGEMENT ACTIONS TO MITIGATE THE EFFECTS OF CLIMATE CHANGE, EACH ASSOCIATED WITH A MAIN MANAGEMENT QUESTIONS ADDRESSED BY FISHE.

THE QUESTIONS:

What is the state of your resource? ▶ What is your response? ▶ How often will you repeat this?

OUR TESTS:

1: Sampling Accuracy

"What is the state of your resource" refers to how many fish are in the water. It's impossible to know exactly, but managers can make an estimate. One action to improve outcomes is to invest resources to make better estimates, as you can imagine the closer your estimate is to the actual number of fish, the better your outcome will be. We tested and compared three levels of sampling accuracy - 50%, 30%, and 10% sampling error.

2: Reductions in Fishing Pressure

Our second question, what is your response, refers to what actions you will take if you learn that your fishery isn't meeting its goals. One common action available to a fishery manager in response to poor fishery status is to reduce the amount of fishing that is allowed. We tested and compared a range of reductions in fishing pressure, from 5% to 50% reductions.

3. Assessment Frequency

Finally, how often will you repeat this, refers to how frequently you go through this process and update the state of your resource and your response. Repeating this process more often, means a fishery manager is more likely to correct a past poor decision with a better one. We tested and compared assessment frequencies of every 20, 15, 10, 5, and 1 years.

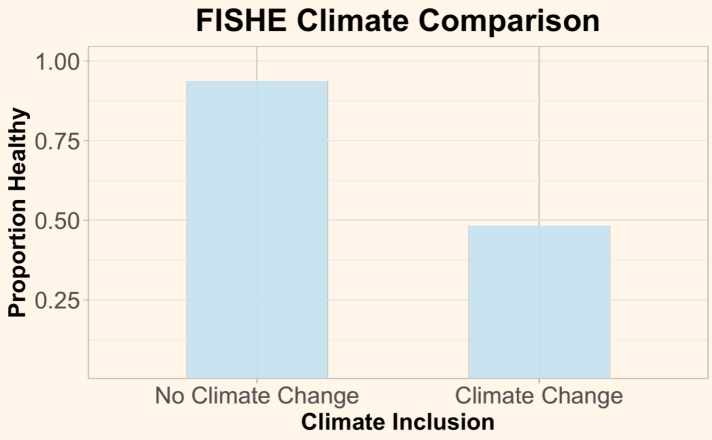
4: Climate Change Anticipation

This test simulated fisheries managers that took climate change into account when making management decisions by assuming the growth of the fish stock would change in some way to due to climate effects. In this test, managers were perfect in their climate response.

FINDINGS

OBJECTIVE 1:

FISHE climate comparison. Fishery biomass was tracked over a 100-year time period without climate change and with climate change. We assume a 10-year assessment interval and good sampling accuracy (10% error margin). When a fishery is estimated to be experiencing too much fishing pressure, it is reduced by 15% until the next assessment. The y-axis refers to the proportion of healthy fisheries at the end of the time period out of all the simulations.

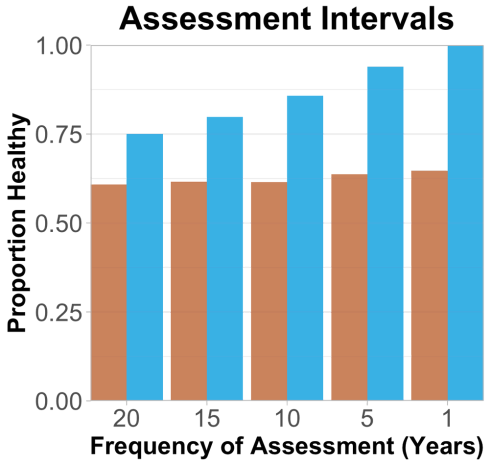


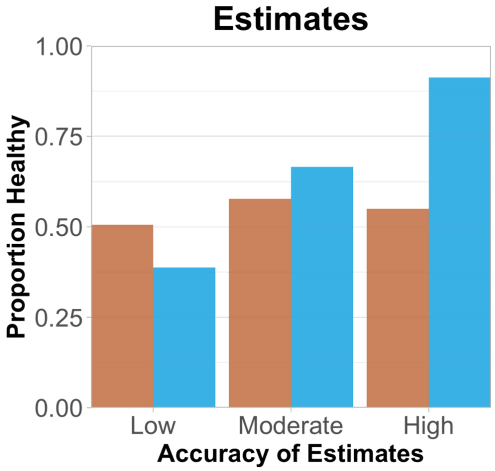
Our findings showed that FISHE will not perform as expected under various climate change scenarios. In our model without climate change, 90% of fish stocks managed using FISHE were healthy after 100 years. In our model with climate change, less than 50% of fish stocks managed using FISHE were healthy after 100 years.

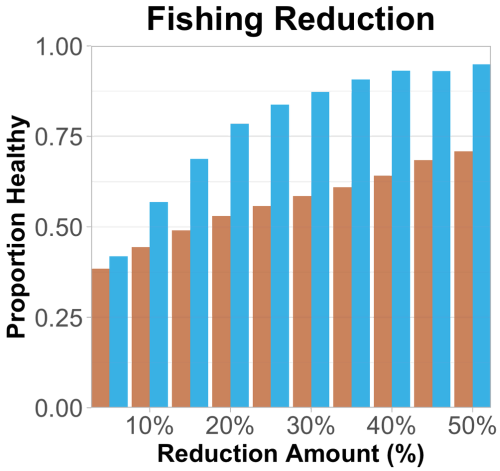
AS LIVELIHOODS AND FOOD SECURITY DEPEND ON HEALTHY FISHERIES, IT IS IMPERATIVE THAT FISHE CONTINUES TO OFFER SOUND SCIENTIFIC GUIDANCE IN THE FACE OF CLIMATE CHANGE

OBJECTIVE 2:

Traditional management actions (improving sampling accuracy, increasing assessment frequency, and further reducing fishing pressure), do not have the same efficacy under climate change as when environmental, and therefore growth conditions stay consistent. We compared the outcomes for different management outcomes from when climate change was anticipated and when it was not. Our results indicate that regardless of the management action, anticipating the effects of climate change on your fishery improves outcomes. In the figures, no climate change anticipation corresponds to a fishery where growth is considered consistent, and ideal climate change anticipation corresponds to a fishery where changes in growth are taken into account with perfect accuracy.







Climate Change Anticipation

None

Ideal

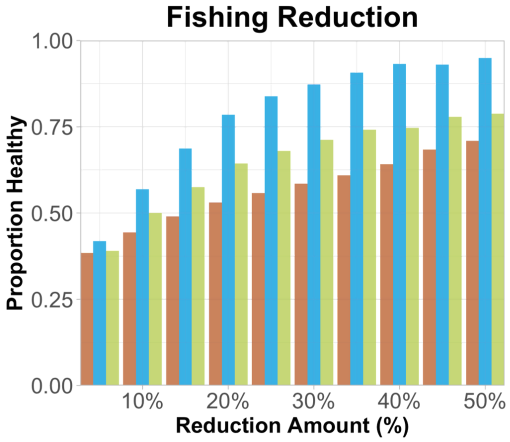
However, understanding how fish are responding to climate change is challenging in any real-world scenario, especially data-limited ones. Can FISHE be adapted to capture the benefits from anticipating climate change?

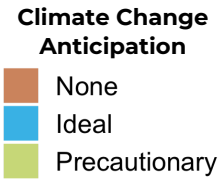
RECOMMENDATIONS

What is the state of your resource? → **How is climate change affecting your resource?** → What is your response? → How often will you repeat this?

A REGIONAL PROXY FOR CLIMATE CHANGE ANTICIPATION

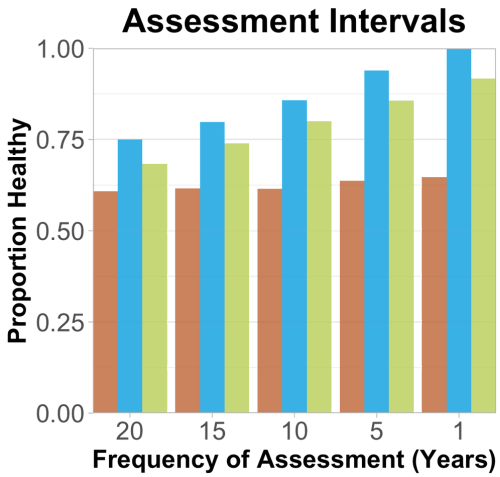
We recommend that EDF incorporate an additional management question into FISHE: How is climate change affecting your resource? Different geographies will experience different levels of climate effects. As a result, the severity of those effects will vary for any given region. Taking a precautionary approach, fisheries managers can institute a climate change anticipation "proxy" - an assumed change in the growth of the fish stock - that is scaled to the expected severity of climate change in their region.





These graphs illustrate that assuming a certain level of change in growth can yield better outcomes in the face of climate change than when no precautionary actions are taken.

By incorporating a new step into FISHE, managers are encouraged to consider the context-specific impacts of climate change. This knowledge can then be taken into account as unique precautionary management strategies are developed.



CONCLUSION

Climate change is affecting how fast fish grow and where they can be found, but how quickly and severely these impacts are occurring is uncertain and varies across species and regions. Our project provides EDF with evidence that precautionary management can improve outcomes despite the uncertainties of climate change and provides a framework for testing strategies that improve outcomes and promote more climate resilient fisheries.

THANK YOU

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