



NEW RESEARCH TO APPLY EMPIRICAL DYNAMIC MODELING TO FISHERIES MANAGEMENT

INTRODUCTION

Using mathematical models, fisheries scientists try to predict fish stock abundance over time to inform sustainable management. But, complexity and variation in ocean conditions and species interactions make this difficult. In a [previous project](#) supported by the Lenfest Ocean Program, Dr. Stephan Munch, University of California, Santa Cruz and NOAA Southwest Fisheries Science Center, cultivated empirical dynamic modeling (EDM), an alternative modeling approach that could improve the accuracy of such predictions for fisheries, and developed empirical dynamic programming (EDP), a method to generate optimal harvest policies from the EDM approach. Dr. Munch will now build on that work, collaborating with the NOAA Southeast Fisheries Science Center (SEFSC) to apply EDM and EDP to pink, white, and brown shrimp in the Gulf of Mexico, some of the most valuable commercial fisheries in the region.

WHAT IS EMPIRICAL DYNAMIC MODELING AND HOW CAN IT BE USED?

Mathematical models are critical to fisheries management. They give managers an overall picture of a fish population, helping them set catch limits and make other rules intended to sustain the ecosystem. To generate these models, fisheries scientists use peer-reviewed methods to collect, analyze, and report data in a stock assessment process. Yet, virtually every model used in fisheries management makes a fundamental assumption: that the inner workings of these populations, and the external factors that affect them, can be approximated with simple equations. While these traditional models are successful for many fisheries, the approach is particularly challenging for short-lived species with many interacting variables.

RESEARCH TEAM

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- Dr. Michelle Masi, NOAA Southeast Fisheries Science Center

Citation

Methot, R.D. 2000. Technical description of the stock synthesis assessment program. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-43, 46 p.

EDM, by contrast, starts with no equations and few assumptions, relying primarily on observational data to detect the complicated, shifting relationships that are common in nature. It essentially accounts for interactions without having to know them first and provides a means to assess how ecological factors such as oceanographic conditions, habitat, and predator-prey interactions affect fish populations, even when data on those factors are limited. EDM has been shown to be especially useful for forecasting short-lived species for which long time series of data are available. This is promising, considering these species are often the most difficult to assess with traditional methods.

Because EDM is a non-traditional forecasting approach, there is some question about how to integrate with the traditional stock assessment structure – most notably, the ability to measure the maximum sustainable yield (MSY) of a stock. In his previous work, Dr. Munch developed empirical dynamic programming (EDP), which combines EDM with dynamic programming, to generate an analogous MSY benchmark and create optimal harvest policies that implicitly account for species interactions.

RESEARCH APPROACH

In the Gulf of Mexico, short-lived (<2 years) shrimp species (pink, white, and brown) have historically been assessed using Stock Synthesis (SS, Methot, 2000), a single-species model that combines time series of catch, size composition, effort (when available), and indices of abundance. However, the shrimp assessment was recently moved into a 1 to 2-year research phase. While the primary focus is updating the assumptions and data used within the SS framework, the assessment team at the SEFSC is open to testing alternative approaches, including EDM/EDP. Given the economic value of the fishery, the short generation time of the species involved, shrimp in the Gulf of Mexico represent a singular opportunity to push EDM/EDP into the mainstream of fisheries management.

In this study, Dr. Munch will work with colleagues to apply EDM/EDP to shrimp fisheries by:

- Using EDM to update and enhance the fit of the previous stock synthesis (SS) model;
- Analyzing pink, white, and brown shrimp fisheries with both the EDM and updated SS methods to generate optimal harvest policies from each approach; and
- Conducting a management strategy evaluation (MSE) for both policies to compare the effectiveness of each after 20 years.

Environment heavily affects shrimp dynamics. As such, it is imperative to develop robust climate change policies to effectively manage shrimp populations. Using outputs from the EDM/EDP approach, researchers will develop several policies specific to scenarios under a changing environment and evaluate their success by conducting additional MSEs to approximate the optimal harvest policy for changing conditions.

ENGAGING SCIENTISTS, MANAGERS, AND STAKEHOLDERS

To ensure that assessment scientists, fisheries managers, and stakeholders are engaged throughout the project, the research team and staff at the NOAA Southeast Fisheries Science Center will meet monthly to discuss modelling updates and overcome any issues that may arise. Results will be communicated with the shrimp advisory panel, consisting of fishing industry and NGO representatives, as well as the Gulf of Mexico Fishery Management Council, the entity responsible for setting sustainable catch limits for Gulf fisheries.

This project began in December 2020 and will run up to two years.

CONTACT

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Lenfest Ocean Program was established in 2004 by the Lenfest Foundation and is managed by The Pew Charitable Trusts.

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