# FISH LESS TO FISH MORE: OPTIMISING PROFITS THROUGH ANALYSING NON- LINEARITIES BETWEEN NO-TAKE MARINE RESERVES, FISHING EFFORT AND SUBSIDIES

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## Introduction

Over the past few decades, global fish stocks have been under severe pressure due to high fishing efforts and inefficient regulatory policies, including those involving subsidies that often encourage excessive fishing (Pauly & Zeller, 2016). The concept of peak fish around 1996 marks a significant turning point, demonstrating that traditional approaches to fisheries management are insufficient to prevent the decline of fish populations (Pauly & Zeller, 2016). The growing recognition of these issues has led to increased advocacy for Marine Protected Areas (MPAs) and the reformation of subsidy structures, aiming to reduce overfishing and promote the recovery of fish stocks (Halpern et al., 2010; Sumaila, et al., 2010).

The importance of integrating scientific research into policy-making is paramount to address these complex challenges. By developing a bio-economic model that explores the nonlinear interactions between fishing efforts, subsidies, and the establishment of MPAs, the research aims to provide a comprehensive understanding of how various management strategies can affect both the sustainability of fish stocks and the economic viability of fisheries (Branch et al., 2006). In this way, fishers are included in the process, as without their participation, recovering fish stocks would not be viable. This approach not only aligns with global sustainability goals (United Nations, 2015) but also offers practical insights for policymakers and stakeholders to make informed decisions that could lead to more resilient marine ecosystems and fishing communities.

## Methods

The study employs a dynamic bio-economic model developed using STELLA Architect software to simulate the interactions between fishing efforts, subsidies, and MPAs. This integrated approach combines ecological and economic components to evaluate fisheries management strategies.

The model simulates the life cycle of target fish species with the importance of the age structure incorporated. The model assesses the economic factors, including subsidy impacts, operational costs, and revenue from fishing activities, as well as the influence of varying fishing effort levels on the stock of the target fish species.

The model uses fisheries statistics (e.g. FIshBase), scientific studies, and historical data for parameter calibration, including growth rates, mortality, fishing catchability, and economic variables, to simulate scenarios over a 50-year timeframe. The scenarios include: no intervention, existing subsidy structures without MPAs, elimination of harmful subsidies with the implementation of MPAs covering 30% of the fishing area, combinations of reduced fishing effort, restructured subsidies, and expanded MPA coverage. The scenarios aim to identify optimal strategies that maximize fish stock sustainability, profitability for fishers, and net economic benefits to society.

## Results

**The base scenario** (No Intervention) saw a continued decline in fish stocks with increasing fishing efforts, reducing long-term profitability and fish biomass. The **subsidy-only scenario** (most current real-life scenario) saw that maintaining current subsidies without MPAs led to a slight delay in negative profits for fishers, but a slightly faster depletion in fish stocks and did not significantly improve long-term sustainability or economic outcomes. Implementing **an MPA** covering 30% of the fishing area resulted in a noticeable recovery in fish stocks and improved economic returns, even without subsidy modifications. When these scenarios were combined, the **reduction of subsidies and MPAs** maximized both fish stock recovery and economic viability. And **reducing fishing efforts** by 50% in conjunction with MPAs and restructured subsidies showed the greatest improvements in sustainability and profitability.

## Discussion

The results from the bio-economic model highlights the need for integrated management strategies in fisheries. The combined effect of MPAs and subsidy reforms shows significant promise in not only restoring fish populations but also in enhancing the economic stability of fishing communities. This multifaceted approach aligns with global sustainability goals and offers a viable solution to the ongoing challenges of overfishing and ecosystem degradation. The study highlights the importance of stakeholder involvement, particularly from the fishing communities, whose cooperation is crucial for the successful implementation and sustainability of these management measures.

## REFERENCES:


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