

# Reducing drifting Fish Aggregating Devices number and impacts through cooperation

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## Abstract

Drifting fish aggregating devices (FADs), equipped with echosounder buoys, are highly effective tools that significantly enhance tuna catchability for purse seine vessels. FADs are also responsible for various externalities, highlighting the need to develop strategies aimed at reducing FAD numbers. In this study, we explore the potential of knowledge sharing among vessels as a means to reduce FAD numbers while maintaining purse seine fleets profitability. By developing an Agent-Based Model, built upon a pelagic species behavioral model, we demonstrate that a four-fold reduction not only improves vessel profitability by cutting private costs and increasing revenue, but it also strongly decreases social costs, such as carbon emissions and FAD stranding. However, this approach also highlights trade-offs, as it leads to a slight increase in silky shark bycatch. Therefore, careful consideration will be required to balance these outcomes and guide future FAD management strategies.

**Note:** This study currently being under review, only a summary is provided.

## Introduction

The massive increase in the use of FADs since the 1980s has several potential negative externalities, which can be decomposed into three main categories. *First*, a lot of FADs are left adrift and end up stranding on coastal reefs or beaches, causing damage to coastal habitats (Escalle, Mourot, et al., 2023; Escalle, Phillips, et al., 2019; Imzilen, Lett, Chassot, and Kaplan, 2021; Imzilen, Lett, Chassot, Maufroy, et al., 2022). *Then*, FADs can also impact non-targeted pelagic species, either through ghost fishing (via the entanglement in their structure) and/or bycatch (Filmler et al., 2013; Gilman, 2011). *Finally*, FADs can impact target species, tropical tuna, either by increasing fishing efficiency - potentially leading to overfishing - or by altering their habitat through their presence at the ocean surface (Dupaix, 2023).

Although FAD impacts and their extent remain subject to debate, solutions are necessary if we aim to reduce their use. This study is based on the premise that we want to reduce the number of FADs, therefore reducing their negative externalities. Hence, we assess how the number of FADs can be reduced without impacting those using these tools, *i.e.* without impacting the economic results of purse seine fleets.

## Material and methods

We investigate vessel cooperation as a strategy to reduce the number of FADs and their environmental impacts. This cooperation is based on information sharing, specifically as we analyze the effects of sharing data from echosounder buoys associated to FADs. Developing an Agent-Based Model of a purse seine fleet, built upon a behavioral model of tuna around FADs, we design multiple scenarios, with varying FAD densities and information sharing. These simulations allow to evaluate the effects of information sharing on purse seine fleets' profitability and on generated externalities (FAD stranding, shark by-catch and carbon emission).

## Results and Discussion

We demonstrate that knowledge sharing can allow the reduction of FAD numbers, reducing several impacts of FADs without reducing PS fleets' economic profitability. Due to the current state of overcapacity, reducing the total number of FADs would enhance individual vessels' profitability by lowering costs without impacting revenues, while addressing additional externality issues (lower carbon emissions and FAD stranding). An optimum number of FADs can be found with a reduction by a factor 4. A further step in the reduction process would intensify competition between vessels. Information sharing would not only contribute to save search costs (*e.g.* the use of supply vessels) for private benefits, they would also reduce the social costs of air and water pollution (CO<sub>2</sub>, SO<sub>2</sub> and NO<sub>x</sub> emissions, FAD sinking or stranding, degradation of marine habitats, etc) to a significant extent. Social costs associated with silky shark bycatch were deemed low, but they increased with shared knowledge, highlighting trade-offs.

The practical implementation of knowledge-sharing mechanisms in the Indian Ocean may prove challenging. A first approach could strive to minimize coordination costs through an integrated organizational structure. One option involves the establishment of a centralized entity responsible for managing FADs at the ocean-wide level. This organization could be jointly financed by fishing companies and administered either by a coalition of industry actors or directly by the Regional Fisheries Management Organization itself. Such a joint-venture or eco-organization could also provide a FAD recovery service, aimed at mitigating water pollution and coral reef degradation caused by abandoned gears (Imzilen, Lett, Chassot, and Kaplan, 2021). Alternatively, fostering individual incentives for information sharing may encourage behavior aligned with conservation objectives (Hilborn et al., 2005). For example, fishers could be granted preferential access to quotas, reduced monitoring requirements, or eligibility for eco-certification schemes that enhance market value in exchange for knowledge sharing.

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