

Assessing management strategies for the artisanal sector of the Peruvian Anchoveta Fishery

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Background

The Peruvian anchoveta (anchovy) fishery is the largest single species marine fishery in the world. The fishing fleet for anchoveta is separated into three sectors:



Region of Study: Range of the North-Central Anchoveta Stock

industrial, low-scale, and artisanal. While the industrial fleet's harvest is restricted by a total allowable catch (TAC), or quota, both the artisanal and low-scale fleets (collectively referred to as the artisanal fleet) are managed under a restricted open access regime, and are not subject to harvest quotas. One hundred percent of the industrial fleet's catch is processed into fishmeal, and most is exported for use in the growing global aquaculture and livestock industries. In contrast, the government mandates the artisanal sector to sell its entire catch for direct human consumption (DHC Mandate) in an effort to lower domestic malnutrition rates and increase jobs.

Problem Statement

Despite the DHC mandate, the potential for economic gains and poor enforcement incentivize artisanal fishers to illegally sell most of their catch to fishmeal plants and misreport landings. The lack of a quota for this fleet combined with rampant illegal activity creates an unchecked fishing pressure that threatens the sustainability of the anchoveta stock. This not only puts the continued ecological productivity of the Humboldt Current System at risk, but also the social welfare of thousands of individuals and families living in Peru's coastal communities.



Project Objectives

Evaluate current and alternative management strategies for the artisanal sector of the anchoveta fishery, and determine a regulatory approach that will:

- 1) Ensure the **sustainability of the anchoveta biomass**
- 2) Improve the **economic value** of the fishery
- 3) Protect the **jobs and livelihoods** of those who rely upon this resource

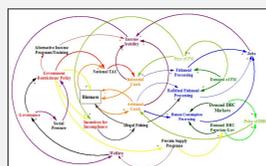
Qualitative Analysis

Literature and Data Analysis

- Characterized the industrial and artisanal sectors of the anchoveta fishery in terms of fleet capacities, landings, processing capacities, and production.
- Identified potential threats to the biological, economic, and social aspects of the fishery and drivers of these threats.

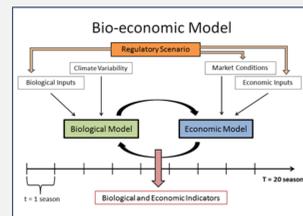
System Thinking Approach

- Developed a causal loop diagram to represent the biological, economic, and social aspects of the anchoveta fishery and how they interact.
- Identified causes of perverse incentives present in the fishery and intervention points for applied solutions.



Causal Loop Diagram: Representation of anchoveta fishery dynamics

Bio-economic Model

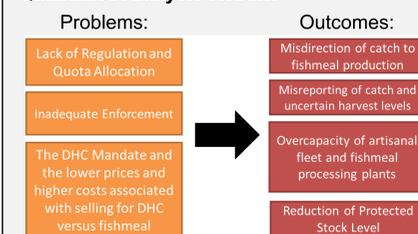


We developed a bio-economic model to quantitatively assess the tradeoffs between current and alternative regulatory scenarios for the anchoveta fishery. Biological and economic components are linked to create a dynamic representation of the biological aspects of the anchoveta, and the harvest behavior of the industrial and artisanal fleets. The model is run over a 20-season time-horizon, with each time-step representing one fishing season. Each component of the model depends on associated biological and economic parameters, variable El Niño climate intensities, and market conditions. Regulatory scenarios applied to the model alter these inputs, generating different outputs that are tracked by the model at each season and over the time-horizon, including biomass, catch, fishery profits, and distribution of profits between fleets.



Results

Qualitative Analysis Results



This cartoon depicts the problems identified in the current artisanal regulatory regime, and the resulting outcomes

Biological Model Results

- Biomass could increase as the national anchoveta quota decreases and the biomass designated as the protected stock (target escapement) increases.
- As the protected fish stock increases, the average seasonal profit generated by the fishery also increases until a certain point. This suggests that a decrease in total yields and increase in protected biomass can lead to profit gains (Figure 1).
- Under extreme climate conditions, such as strong El Niño events, the risk to the biomass posed by fishing pressure increases

Economic Model Results

- Profits for the whole fishery are lower in both market conditions under open access management.
- Both the industrial and artisanal fleet can experience increased profits when the artisanal fleet is managed under a quota system.
- The total value of the fishery could increase as biomass increases, due to higher fishing efficiency.
- The artisanal fleet can significantly increase profits if fishing for the fishmeal market
- Fishers can simultaneously reduce harvest levels and increase profits due to efficiency improvements associated with a larger biomass.



This chart shows the aspects of the fishery that can have an effect on the anchoveta biomass

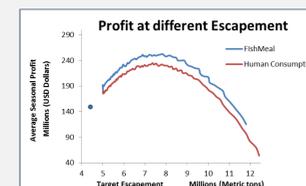


Figure 1: Average seasonal fishery profits given an artisanal quota allocation over different protected stock levels (target escapement) and under fishmeal and human consumption (DHC) market conditions. The blue dot represents the current management conditions.

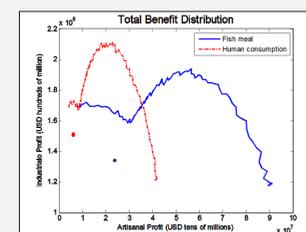
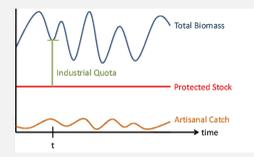


Figure 2: The added benefit from implementing an artisanal quota system can be distributed between fleets. The blue and red dots correspond to the status quo under the fishmeal and DHC market, respectively.

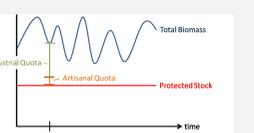


Model Scenarios

Artisanal Restricted Open Access (Status Quo): Under the current regulatory system, the industrial fleet is allocated a quota each season (t) above the protected stock level, which is the size of the anchoveta stock that should be left in the water to ensure the health of the population. The artisanal catch is not restricted by a quota, and effectively lowers the intended protected stock level.



Artisanal Quota: As an alternative regulatory approach, a National quota is set each season (t) above the protected stock level, and is allocated, in varying proportions, to the industrial and artisanal fleets. The artisanal catch does not affect the protected stock level in this case.



Protected stock level: For each regulatory scenario, we also investigated the effect of raising and lowering protected stock levels on total biomass and profits over time.

DHC Mandate: We analyzed the implications of the current DHC mandate by exploring the effect of two distinct market conditions. The first represents prices and costs associated with sale of artisanal catch for DHC, and the second reflects the relatively higher prices and lower costs associated with sale of artisanal catch for fishmeal.

Conclusions & Discussion

Problems with the Status Quo

- Exclusion of the artisanal fleets from quota allocations, lack of enforcement, and incentives for misreporting catches threaten the health of the fishery.
- Unaccounted artisanal fishing pressure lowers the protected stock level, reduces catch per unit effort, and increases fishing costs to all fleets.
- Profits for the entire fishery are lower than what they could be under an artisanal quota management strategy.

Consequences of the DHC Mandate

- The DHC mandate reduces the overall economic value of the fishery, where the substantial reductions in profits are entirely borne by the artisanal sector.
- The mandate creates a situation in which the biomass is increasingly threatened by unregulated and unreported fishing activity, and the actual contribution of raw material to achieving the mandate's goals of lowering malnutrition rates and creating jobs is uncertain.

Potential in Regulatory Alternatives

- Biological, economic, and social benefits to the fishery could be realized with the allocation of a specific quota to the artisanal fleets, as long as it is effectively enforced.
- Raising the protected stock level can lead to increased profits in all fleets, as well as ecosystem benefits that will result from a larger anchoveta population.
- Quota allocation can act as a policy tool with which the added benefits can be distributed between fleets based on the desired outcome.

Acknowledgements & Further Information

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Image Credits: University of Texas at Austin (map of Peru), Robert Yin (anchovy school), Yoel Kirschner (artisanal fishermen, fishing vessels, DHC plant workers, fishermen unloading harvest)

Further Information
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