Discussion and Conclusions

Our model suggests that the DHC fleet's fishing potential under the restricted open access regime is significant, especially if fishers are illegally participating in the fishmeal market.

The current management practices can threaten the health of the fishery due to the exclusion of the artisanal and LS fleets from TAC allocations, lack of enforcement, and incentives for misreporting catches.

The model shows that the current DHC regulation leads to a less than optimal protected stock as a result of unaccounted artisanal and LS fishing pressure and reduces catch per unit effort (CPUE). This increases fishing costs to all fleets. In addition, profits for all fleets are lower under the current open access management than they could be if the DHC fleet is included in the National TAC.

Allocating a specific TAC to these fleets could provide biological, economic, and social benefits to the fishery as long as it is effectively enforced. A TAC allocation that leaves more fish in the water as protected biomass can lead to increased profits in all fleets, as well as provide ecosystem benefits that will result from a healthier fish stock. The TAC allocation can act as a policy tool with which the added benefits can be distributed between fleets based on the desired outcome.

A comparison between the potential artisanal and LS profits under DHC and fishmeal market conditions reveals that the DHC mandate reduces the overall economic value of the fishery. Importantly, the substantial reductions in profits are entirely borne by the artisanal and low scale 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.

Recommendations

1. A national total allowable catch for the anchoveta fishery should be implemented, which includes the industrial, low-scale, and artisanal fleets
2. The government should determine the ability of the DHC mandate to accomplish social goals
3. The current regulation (DS-005-2012) should address:
   a) Technical information supporting the creation of the new reserve zone for DHC (5-10 nautical miles)
   b) Include season closures during spawning periods for the LS fleet
   c) Incorporate SISESAT (satellite tracking system) to the LS fleet
   d) Include the LS and artisanal fleets, and all DHC and residual plants in the anchoveta enforcement program
4. The Nature Conservancy should leverage interest from the fishmeal industry to support a TAC allocation process for the artisanal and LS fleets, as economic gains for the whole anchoveta fishery can be generated

Future Study

- Conduct a quantitative analysis of an Individual Quota system for the artisanal and low scale fleets
- Explore how the new fishery regulations affect the processing sectors of the anchoveta industry
- Evaluate the real dimension and effects of the anchoveta black market for fishmeal
- Analyze the feasibility of compensation or incentive programs to influence the price of DHC raw material

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Image credits: fooduniversity.com (anchoveta), Yoel Kirschner (artisanal fishing boats), University of Texas at Austin (map of Peru).

Assessing Management Strategies for the Artisanal Sector of the Peruvian Anchoveta Fishery

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The Peruvian Anchoveta Fishery

Region of study: north/central Peruvian anchoveta stock

The Peruvian anchoveta (anchovy) fishery is the largest single species marine fishery in the world and is a significant contributor to Peru's economy. The fishing fleet for anchoveta is separated into three sectors: industrial, low-scale (LS), and artisanal. The industrial fleet's harvest is restricted by a total allowable catch (TAC), which is calculated as the difference between the total biomass and protected stock (the amount of fish left in the water each year to ensure long-term productivity of the fishery). However, the artisanal and low-scale (collectively referred to as the direct human consumption [DHC] fleet) fleets are managed under a restricted open access (OA) regime, and are not subject to restrictive harvest quotas, and effectively fish from the protected stock. 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, a government mandate requires the artisanal sector to sell its entire catch for direct human consumption (DHC) in an effort to lower domestic malnutrition rates and increase jobs.

Engraulis ringens

Problem Statement/Significance

Despite the DHC mandate, the potential for economic gains and poor enforcement incentivize fishers to sell most of their catch to fishmeal plants and misreport landings. The lack of a fishing limit (TAC) 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

The objectives of this project are to evaluate current and alternative management strategies for the artisanal and low-scale sectors of the anchoveta fishery, and determine a regulatory approach that will:

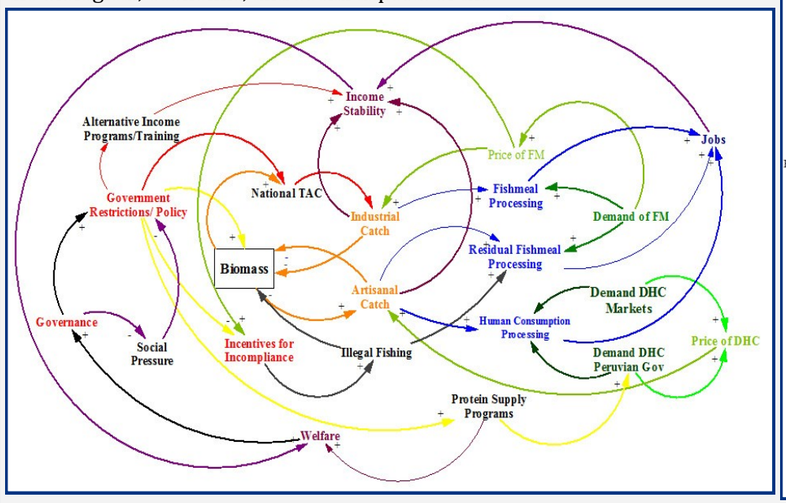
1. Ensure the sustainability of the anchoveta biomass
2. Improve the economic value of the fishery
3. Protect the jobs and livelihoods of those who rely upon this resource

Qualitative Approach

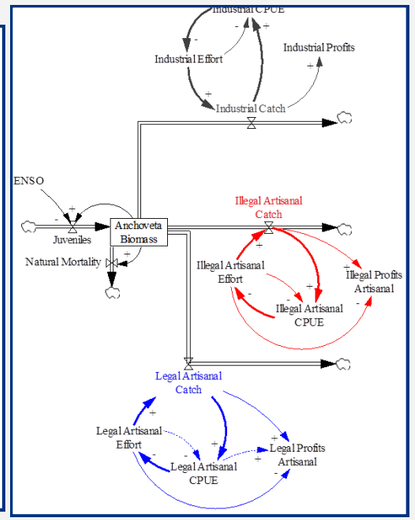
We completed a qualitative analysis on order to characterize both the industrial and DHC sectors of the anchoveta fishery. Fleet capacities, landings, processing capacities, and production were determined using available data. Using this approach we identified potential threats to the biological, economic, and social aspects of the fishery and drivers of these threats.

A system thinking approach was used to address the complexity of the anchoveta fishery and understand the interactions among the different stakeholders and the environment. A casual loop diagram (CLD) representing the biological, economic, and social aspects of the anchoveta fishery was developed by examining the different forces that interact in the fishery. The diagram shows how the fish stock is affected by fishing pressures, which are influenced by market, political, and social dimensions.

The goal of this system thinking process was to identify the causes of the perverse incentives and drivers of illegal and unsustainable behaviors present in the fishery, and identify intervention points for applied policy solutions to effectively eliminate those incentives and avoid threats to sustainability of the fishery.

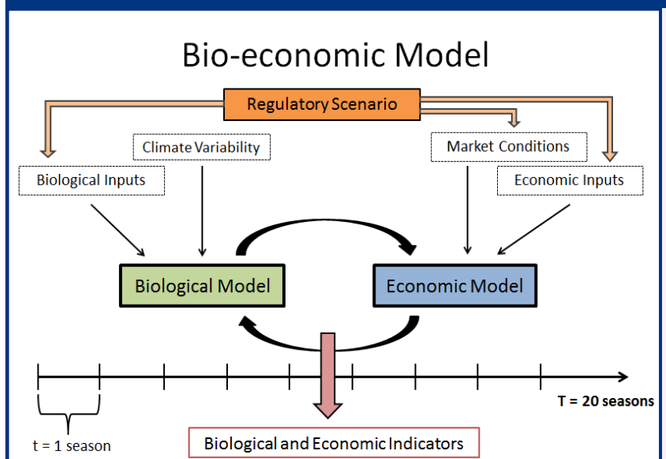


Causal loop diagram representing anchoveta fishery dynamics (intervention points in red)



CLD representing fishing activity of fleets

Quantitative Approach — Bio-economic Model



An integrated bio-economic model was used to quantitatively assess the tradeoffs between current and alternative regulatory scenarios.

The model contains both a biological and economic component that are linked to create a dynamic representation of the biological aspects of the anchoveta, and the harvest behavior of the industrial and artisanal fleets.

It 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 climate scenarios, and market conditions.

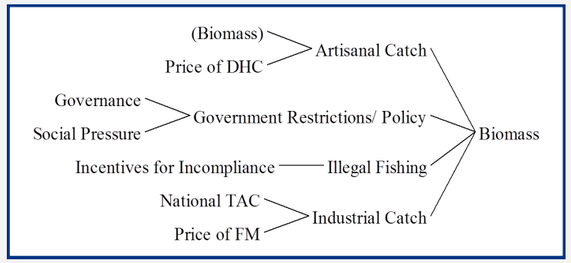
Each regulatory scenario applied to the model alters these inputs, generating different outputs that are tracked by the model at each season, including biomass, catch, and profits.

Results

The results from both the qualitative and quantitative approaches resulted in characterizations of the status quo and the potential for different management options to affect the anchoveta biomass and industry profits.

Qualitative Analysis Results

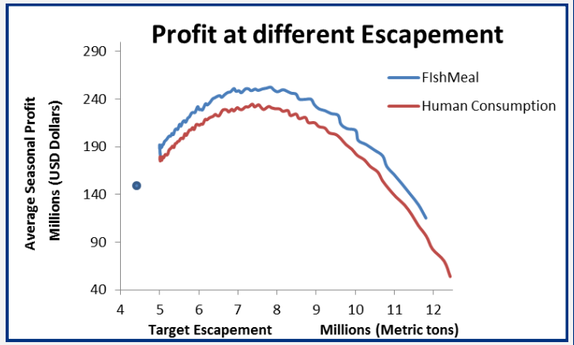
- A lack of management has resulted in overcapacity in both the DHC fleet and the fishmeal processing sector
- Higher prices for the resource in the fishmeal market, high costs associated with fishing for the DHC market, and constant demand from the fishmeal processing plants incentivize fishers in the DHC fleet to illegally supply fish to the fishmeal market
- Loopholes in the current laws and a lack of resources limit the amount of monitoring and enforcement within the fishery
- The artisanal and low scale fleets' harvests are unrestricted and unmonitored, creating a situation in which authorities are not able to accurately assess their levels of exploitation
- Because anchoveta are the base of the Humboldt Current food chain, a decreased anchoveta population can have deleterious effects on the surrounding environment and other important coastal fisheries as a whole



This chart was created using the causal loop diagram representing the fishery dynamics, and it shows which aspects can affect on the biomass.

Biological Results of Management with a TAC

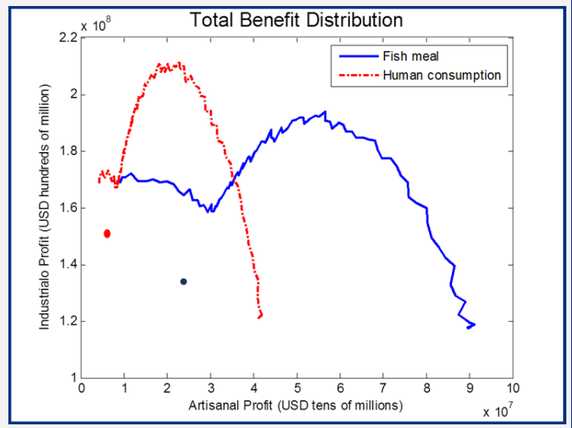
- Under the current artisanal and LS regulation, the fleets extract the most from the biomass, and the extraction levels can be considerably higher than what is reported by Peruvian officials
- Biomass could increase as the national TAC decreases and biomass set aside as the protected stock (target escapement) increases
- Risk to the biomass posed by fishing pressure increases during extreme climate conditions like strong El Niño events



As the protected fish stock (target escapement) 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. Different markets are shown in red and blue.

Economic Results of Management with a TAC

- Profits for the whole fishery are lower in both market conditions under open access management
- The total value of the fishery could increase as biomass increases, due to higher fishing efficiency
- Both the industrial and DHC fleets can experience increased profits when the DHC fleet is managed under a TAC
- The DHC 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 greater biomass levels



The added benefit from implementing a TAC on the DHC fleet (labeled here as artisanal) can be distributed between fleets.