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Analytical Paper Proposal
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Title: A Closer Look at Management Outcomes in the Atlantic Longfin Squid and Butterfish Fisheries

Introduction: Longfin Squid is a commercially valuable species along the Atlantic coast from Maine to North Carolina. In recent fishing seasons, ex-vessel revenues from longfin have been in the $20-$25 million range (Mid Atlantic Fisheries Management Council: Longfin Informational Document-April 2012). Fishermen most commonly use bottom trawling gear to land longfin, which can be harvested year-round. As is common with bottom trawling, the longfin fishery yields a significant amount of bycatch. One species that is caught in particularly high quantities by fishermen targeting longfin is the Atlantic butterfish. These two stocks are often coterminous along the continental shelf and can be caught by similar mesh sizes (Hendrickson, 2011).

There are two categories of permit holders involved with the longfin and butterfish fisheries. Moratorium permit holders land the vast majority of both species as part of their annual fishing portfolio. However, most butterfish have recently been discarded due to a lack of an available market and strict trip limits that have existed since 2005. Incidental catch permit holders are open access members that generally target a variety of species. These fishermen are subject to different trip limits than the moratorium members, but have also typically discarded butterfish. Within these fleets, there is also a small group of vessels that historically have landed large quantities of butterfish, many for export. In the 1980's and 90's, annual ex-vessel revenues from butterfish ranged from $2 million to $7 million (Mid Atlantic Fisheries Management Council: Butterfish Informational Document-April 2012). In recent years however, these numbers have dropped significantly to around $1 million annually. With smaller butterfish stocks, and consequently, less catch, available export markets have lessened.

To alleviate the pressure put on the butterfish stock from discarding, the Mid Atlantic Fisheries Management Council (MAFMC) passed Amendment 10 to the Atlantic Mackerel, Squid, and Butterfish Fisheries Management Plan (FMP) in September 2010. This Amendment called for the rebuilding of the butterfish stock through a number of measures, most notably, a bycatch mortality cap placed on the longfin squid fishery. The cap stipulates that the longfin fishery must close when the butterfish catch is reached. The cap was placed on the longfin fishery due to a greater amount of butterfish bycatch occurring in it than in any other directed fishery. The goals specified in Amendment 10 were as follows;

1) develop a rebuilding program that allows the butterfish stock to rebuild in the shortest amount of time possible (but not to exceed ten years) and permanently protects the long-term health and stability of the rebuilt stock; and

2) generally minimize bycatch and the fishing mortality of unavoidable bycatch, to the extent practicable, in the squid, Atlantic mackerel, and butterfish (SMB) fisheries;

In 2011, the first year of the mortality cap, the butterfish catch was below the cap, and the longfin fishery avoided an early season closure. If projections hold, the 2012 season will also not be subject to a shortened season. However, both species are subject to trimester quotas, and the first trimester for longfin was cut short due to the cap. At the same time, the butterfish stock appears to be improving, as the Acceptable Biological Catch (ABC) was increased from 1,811mt in 2011, to 4,200mt in 2012, and to 8,400mt for 2013. The trimester quotas are derived from these values, and are highest in the first and third trimesters for both longfin and butterfish. During the summer, both species migrate inshore to spawn and allowable catches are significantly lower.

As a result of the ongoing butterfish stock recovery, the MAFMC has recommended an increased directed butterfish fishery for 2013, with less stringent trip limits for longfin fishermen also landing butterfish. The Council has also recommended the mortality cap to be converted into a discard cap. This simply means that only butterfish that is discarded will be counted against the cap on the longfin fishery, as opposed to the current system in which all butterfish mortality is counted. Landings of butterfish will continue to be counted against the quota. The rationale behind this change is that there will be an increase in butterfish landings relative to discards, and due to relatively low observer coverage rates, a large trip of observed and landed butterfish could skew the cap calculations.

This expansion of the directed butterfish fishery combined with the discard cap on the longfin fishery does create an allocation issue between those two components of the butterfish ABC. Following Boyce (1996), the optimal use of the two fisheries will be where the marginal value for an additional unit of bycatch is equalized. However, not all butterfish caught by longfin fishermen are discarded. Therefore, the marginal benefit of butterfish allowable landings/discards would have to be equalized amongst the three categories of vessels described above to maximize economic yield, although this is not the stated goal of the Council. The Council's goal when allocating the butterfish ABC is that the discard cap and quota should be allocated in such a manner that the ABC can be fully utilized. There is no specific provision in the FMP as to how the ABC should be fully utilized. However the general goals of FMPs,

including promoting growth of U.S. commercial fisheries and providing flexibility to harvesters, are considered.

Using historical landings and discards of butterfish as a benchmark, the selected allocation for 2013 was 47% of the butterfish ABC devoted to the discard cap, 31% for the landings quota, and the remaining to cover other discard mortality in other fisheries. Recognizing that there is a great deal of variety in these fisheries year to year, the National Marine Fisheries Service (NMFS) will have the power to make transfers between allocation sources as well. However, the initial allocation of the ABC still does dictate to a certain extent how tradeoffs will be made between longfin and butterfish harvest.

Purpose: With a number of important management changes being made for the longfin and butterfish fisheries, and more changes likely to come, it is important that stakeholders are aware of the possible outcomes that may arise. The purpose of this paper is to show the conditions that will result in early season closures for either fishery, or both. This information could be helpful to the MAFMC in understanding the management problem they are facing.

Methods: Excel will be used to show if and when the longfin and butterfish fisheries will close based on adjustment of variables. The chosen parameters will then be used to make some general rules about why the particular outcome occurred.

In the Excel sheets, there will be four categories of variables. The first set of variables will be related to allowable catch for longfin and butterfish. They will consist of the longfin ABC, butterfish ABC, and the three components of the butterfish ABC; the landings quota, the discard cap, and the set aside for butterfish caught in other fisheries. The second category will be the number of each type of vessel that is present in the fisheries. The three different types of vessels are those that target both species, those that target longfin and discard butterfish, and those that land butterfish in large quantities, but land some longfin as well. The third category of variables is the catch rates for each of these vessel types. Lastly, the prices for longfin and butterfish will be included.

There will be two different allocation schemes that are explored. The first scenario will consist of a separate allocation to the butterfish discard cap and the squid landings quota. The allocation will be based on the percentage of butterfish caught between all categories of vessels that are discarded. Perfect information will be assumed at first in this model in order to make it clear as to why the outcome is occurring. Stochasticity and real world parameters will later be introduced to better inform

the Council of the policy implications at hand. The six possible outcomes that will be accounted for in this allocation scheme are;

1) Both fisheries remain open.
2) Butterfish remains open; longfin closes early due to longfin quota.
3) Butterfish remains open; longfin closed early due to discard cap.
4) Butterfish closes early; longfin remains open.
5) Butterfish closes early; longfin closes early due to longfin quota.
6) Butterfish closes early; longfin closes early due to discard cap.

The second scenario will not make any allocation between landings and discards of butterfish. Under this management practice, the three categories of fishermen would operate at full capacity until the butterfish ABC is met. Once this occurs, both the longfin and butterfish fisheries would be closed for the remainder to the season. However, if the longfin quota is met before the butterfish ABC, the vessels targeting strictly butterfish would continue to operate. This management process is not what is currently happening under the MAFMC, but the model will provide a good basis for comparison. The three possible outcomes that will be accounted for in this allocation scheme are;

1) Neither fishery closes.
2) Longfin fishery closes early when longfin quota is reached; directed butterfish fishery continues to operate until butterfish ABC is reached.
3) Both fisheries close at the same time because the butterfish ABC has been met. If the longfin quota is not reached, that fishery will close simultaneously with the butterfish fishery. This is because once the butterfish ABC has been fully utilized, longfin vessels can no longer continue to operate, as catching longfin without catching any butterfish is not feasible.

Finally, multiple fishing seasons will be added to the model. This will allow the model to capture the change in future butterfish demand that can occur as current allowable landings are adjusted. The change in butterfish demand will be reflected in the high-volume butterfish fleet getting larger. Inter-temporal analysis will be done for both the separate allocation method and the butterfish ABC only method.

References: Hendrickson, LC (2011). Effects of a Codend Mesh Size Increase on Size Selectivity and Catch Rates in a Small-Mesh Bottom Trawl Fishery for Longfin Squid, *LoligoPealeii*. *Fisheries Research* 108(1):42-51.

Boyce, JR (1996). An Economic Analysis of the Fisheries Bycatch Problem. *Journal of Environmental Economics and Management* 31: 314-336.

Target Journals:

Marine Policy
Aim and Scope http://www.journals.elsevier.com/marine-policy/
Guidelines for Submission http://www.elsevier.com/journals/marine-policy/0308-597X/guide-for-authors

North American Journal of Fisheries Management
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Tasks:

1. Run the deterministic excel model to arrive at the possible management outcomes for a single fishing season.
2. Using the parameters from the model, write out equations to explain why the outcomes occur.
3. Introduce stochasticity and real world parameters into the model.
4. Examine how changes to butterfish market can determine optimal allocation of ABC.

Due Dates:

First Draft: Mid/Late Dec.
Final Draft: Mid Jan.
Defense: Late Jan.

Committee Composition: Lee Anderson (major advisor), George Parsons, Jason Didden