Title

Bioeconomic Modeling of the Spatial/Strategic Interactions of Fishermen and Regulators in Alaskan Seasonal Fisheries

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PROJECT NARRATIVE: PROPOSAL FOR BIOECONOMIC MODELING OF THE SPATIAL/STRATEGIC INTERACTIONS OF FISHERMEN AND REGULATORS IN ALASKAN SEASONAL FISHERIES (PROJECT # E/MRE-4).

PROJECT LEADERS

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THE ORIGINAL OBJECTIVE

The original objective, as stated in our proposal, was to use the tools of bioeconomics and econometric analysis to develop and test models of location choice among fishermen in seasonal fisheries. In particular, we wished to determine how fishermen faced with the complex task of allocating their boats across fishing sites and time respond to 1) the monetary and time costs of movement between fishing sites, 2) the presence of heterogeneity both in fishing capital and in the biological productivity of potential fishing sites, 3) the (anticipated) strategic behavior of other fishermen and regulators, and 4) the gradual assimilation of information in an uncertain biological and regulatory environment.

The overall thrust of this objective remained unchanged throughout the grant period. However, discussions with NOAA personnel and other parties connected to the federal fisheries in the North Pacific led us to modify the objective in the first year slightly to address a very important policy issue in this region – the bycatch of prohibited species in the bottom-trawl head and gut (H&G) fleet in the eastern Bering Sea. The rationale for this modification is outlined below.

PROJECT RATIONALE

Prohibited species catch (PSC) by the groundfish fleet in the Bering Sea has been a persistent and mounting policy concern since the early 1990s. Prohibited species are those species that are prohibited for retention by the groundfish fleet, often in an effort to sustain lucrative targeted fisheries for these species. The allowable catch of these species is controlled by the allocation of fleet-wide quotas to particular gear and fishery target combinations. For instance, those fleets using bottom-trawl gear to catch yellowfin sole in the Eastern Bering Sea are limited in the quantities of Pacific halibut, *C. bairdi* tanner crab, and red king crab that they can catch in a given fishing year or season.

Unfortunately, the spatial coexistence of groundfish and PSC species, combined with the relatively low selectivity of non-pelagic trawl gear and a potentially deleterious incentive structure generated by the shared PSC quotas have frequently resulted in a rash of early closures due to prohibited species bycatch. This has caused thousands of tons of groundfish TAC to go unfished, resulting in substantial economic losses to fishermen.

This characterization is especially true for the eastern Bering Sea flatfish fisheries. Flatfish such as rock and yellowfin sole can only be economically harvested through the use of non-pelagic trawls and occupy quite similar habitat ranges to common PSC species such as halibut and crab. This has caused these fisheries to experience unusually high bycatch rates of PSCs. As a result, these fisheries typically close well before the total allowable catch for the flatfish species are caught – usually because the quota for halibut is met or exceeded (Gauvin, Haflinger & Nerini, 1995).

By 1995, many of the fishermen in the H&G fleet had grown tired of "leaving money on the table" through premature closures; as a result, the rock sole fishermen contracted with Sea State to provide them with rapid feedback on bycatch rates for all subscribing vessels (the yellowfin fishermen joined later that season). Data from federal observers was relayed to Seattle where Sea State processed the information, performed statistical extrapolations to account for non-sampled hauls, and then either faxed or electronically transmitted to each vessel a spatial display of individual vessel bycatch rates (displayed at a resolution of one minute of latitude and longitude) for each PSC species. This mechanism greatly lowered the "search costs" associated with bycatch avoidance in that it pooled in a timely and clear manner a substantial portion of the information possessed by each vessel captain. At a later date (in the early 2000s) participants were also provided with a list of vessels and their weekly bycatch rates so that pressure might be brought to bear on vessels whose catch was more "dirty" than the agreed-upon standard.

The program continues today and its proponents have claimed some major successes, including a seven-fold decrease in red king crab bycatch in the roe rock sole fishery within the program's first year (Gauvin, Haflinger & Nerini, 1995). However, critics have charged that this reduction was largely the result of a concurrent closure of a large area with very high past rates of crab bycatch (Holland and Ginter, 2004). Also, the reduction in crab bycatch was met by an attendant rise in halibut bycatch rates; indeed, the rock sole fishery slightly exceeded its allocation of halibut in 1995 and has exceeded it for all but one year since. The implementation of Sea State's technology in the yellowfin sole fishery in the summer of 1995 appears, on the surface at least, to have yielded disappointing results. The excess of halibut PSC catch over quota has actually increased dramatically since the program's inception. A variety of hypotheses have been advanced to explain this finding, including a dilution of the incentive to cooperate by the refusal of four vessels to participate in the program (Gauvin, Haflinger & Nerini, 1995), strong recruitment of halibut into the fishery in the late 1990s, displacement of effort from areas closed for crab protection, and low yellowfin prices (Holland and Ginter, 2004).

THE OBJECTIVES

Our modified objectives (as stated in the Project Narrative from last year) were as follows:

1. To assess the incentives provided to fishermen by a multiple common-quota system such as that employed in the eastern Bering Sea groundfish fisheries. Is the regulatory framework of the fishery responsible for the high bycatch rates and premature closures we observe? How does a common quota system governed by seasonal closures motivate fishermen to employ or develop bycatch reducing fishing technologies? If the current system is perverse, how can it be improved?
2. To understand how information from Sea State and other sources on the spatial distribution of targeted and bycatch species is translated into the choice of fishing location at the individual vessel/haul level.
3. To assess the impact of Sea State in terms of its effectiveness in helping to modify the *incentives* of fishermen toward the minimization of bycatch.
4. To understand the impact of spatial closures for crab habitat protection and bycatch reduction on the flatfish fishery. Did the closures actually cause more harm than good by constraining the spatial choice sets of fishermen to such a degree that they found themselves handicapped in avoiding halibut bycatch?

The first objective is best addressed through conceptual economic modeling, and relies to a large degree on mathematical techniques derived from the field of game theory. Objectives 2-4

are empirical in nature and require the use of well-established tools from discrete choice econometrics (as demonstrated in Smith & Wilen (2002) and Holland & Sutinen (2000) among others), although substantial methodological innovations are required in order to satisfactorily address the applied aspects of the problem. A detailed accounting of the methodological approaches is likely outside the scope of this narrative. However, they are laid out in great detail in Abbott & Wilen (2005a) and Abbott & Wilen (2005b).

It is our belief, despite some previous biologically focused work on bycatch issues in the groundfish fisheries (c.f. Adlerstein, & Trumble, 1998, Spencer, Wilderbuer, & Zhang, 2002), that our work is free of any substantial overlap with current or past research, regardless of funding source. Our focus on the spatial behavior of fishermen and the incentives provided by regulatory measures differentiates our analysis from that in the existing literature.

PROGRESS TOWARD THE OBJECTIVE

Substantial progress has been made toward the project objectives. In the first year we developed a game theoretic model that captures the essential aspects of the flatfish fisheries in the eastern Bering Sea. We have employed this model to show how the common property aspects of the bycatch quota system creates powerful incentives for individual ship captains to fish with too little care, resulting in excessive bycatch, premature season closures and lowered profits. These findings correspond well with real world outcomes. The complexities inherent in a multiple quota system such as that used in the eastern Bering Sea also result in a number of startling observations regarding the effects of many commonly employed policies such as vessel buyout programs and mandated gear restrictions (Abbott & Wilen, 2005a).

Progress in addressing the last three objectives has also been substantial in the last year, although research continues on these questions. We have employed substantial effort in gathering and synthesizing data from a variety of sources. In particular, we have obtained access to high resolution spatial and temporal data from the North Pacific Groundfish Observer Database that provides the dataset needed to estimate the discrete choice models required to address the research objectives. We have spent substantial time defining our sample, cleaning the data, and conversing with NOAA personnel to ensure that we fully understood the properties of the data before conducting our analysis.

Despite the continuing nature of our empirical research, some findings are clear. First, the sharing of information via Sea State has had a substantial impact on the behavior of fishermen engaged in the Bering Sea rock sole fishery. Our empirical analysis suggests that participating fishermen consistently sought out areas with lower bycatch rates of crab and that the increased dispersal of information and mutual pressure to avoid bycatch has raised the response rate to bycatch “hot spots” by over double the prior rate.

The impacts of the Sea State program in the yellowfin sole fishery are more difficult to interpret. In general, there does not appear to be a significant difference in the affinity of participating and non-participating fishermen for halibut bycatch avoidance. Instead, fishermen seem to begin the fishing season avoiding halibut and then begin to fish progressively “dirtier” as the season progresses. The exact cause of this divergence in behavior between the yellowfin and rock sole fishery remains a point of current research.

In addition to our research activities, we have also spent considerable time in disseminating our findings in the form of presentations at professional meetings and publications. We have presented various aspects of our research at the NOAA Fisheries/Sea Grant Fellowship in Population Dynamics and Marine Economics Symposium, the North American Association of Fisheries Economists Forum (Abbott & Wilen, 2005b), the American Agricultural Economics Association Annual Meeting, and the International Institute of Fisheries Economics and Trade Biennial Conference. Furthermore, we have detailed the findings from our conceptual model in a working paper which is currently under revision for a major peer-reviewed environmental

economics journal (Abbott & Wilen, 2005a). All of this research is part of Joshua Abbott's dissertation which is currently in the process of being written and should be completed by mid-Winter, after which several more working papers for future publication will be forthcoming.

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