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Project Proposal Title: A Dynamic Model to Evaluate the Effect of Regulation on the Hawaii Commercial Fisheries

Funding Agency: NOAA, NMFS

1. Purpose of the Project

Time-area closure is fast becoming a popular regulatory tool that can be used to protect endangered or depleted fish species. However, there is very little theoretical and empirical work on this important issue. Most traditional models in fisheries economics neglect the element of spatial heterogeneity in fishing, and hence cannot quantify the impacts of time-area closures. The primary objective of this project is to develop an economic model for a multi-species fishery that incorporates the spatial distribution of effort and fish stocks, and to apply the model to the Hawaii longline fishery. Given the estimated initial stocks of the major species within each five by five degree grid per period, fishing trips are allocated over space to locations of maximum net return per trip, which decline with harvest because of stock externalities. This allocation procedure yields a derived demand for fishing labor. On the other hand, the estimated supply function for labor in the fishery is upward-sloping due to fisher's labor-leisure tradeoff. The equilibrium allocation of fishing trips are obtained by equating the derived demand with the supply function. The results reveal the importance of "substitution effects" of area closures. For example, if the North Pacific is closed to protect sea turtles, fishing effort will be reallocated to near-shore areas, which may increase the harvest of near-shore species (yellowfin and bigeye tunas and striped marlin). While fishers can mitigate their income loss by substituting fishing locations, area closures may significantly reduce the stocks of near-shore species and adversely affect catches by competing fleets, such as handliners and trollers. The model can provide quantitative estimates of economic profits and losses for a range of policy questions.

2. Progress During FY 2001.

The model was improved to incorporate multiple fishing set types (tuna and swordfish-targeted sets). First, all longline catch and effort data were divided according to set types, and next were summarized by fishing area (five-by-five degree square) and month. Catchability coefficients of the six major species with each set type were estimated, assuming that the Hawaii pelagic fishery is in a long-run equilibrium. Using the 1995 logbook and HDAR data, the model validation and the empirical analysis of area closure policies, such as reduction of inshore gear conflict and conservation of offshore turtle populations, were conducted. The results were published in the premier fishery economics journal, *Marine Resource Economics*. (Chakravorty and Nemoto, 2001), and were presented at the PFRP PI's meetings in December 2000 and at the Lake Arrowhead Tuna Conference (Nemoto 2001).

In the second half of FY 2001, we first expanded the period of the analysis to the three years (1995 - 97). Next, we extended the model to incorporate net migration in and out of each area (five-by-five degree square) which enables the model to incorporate the dynamic effects of regulatory policies. In the previous model (without migration), there is no effect of any changes in residual stocks (subtracting catches from initial stocks) in the present period, on the initial stocks in the next period. The final doctoral dissertation defense for Keiichi Nemoto was successfully completed during Spring 2001 (Nemoto 2001)

3. Plans for the Next Fiscal Year.
The model with migration is being used to predict the spatial allocation of vessels by grid, and this prediction is being compared to the previous model which had no migration of fish between grids. Next, the migration model will be used to predict the effect of area closures, that is, when certain grids are closed, the stocks recover over time which leads to movement of fish to adjacent grids and therefore higher economic returns.

4. List of Papers Published in Referred Journals during FY 2001:
Chakravorty, Ujjayant, and Keiichi Nemoto, 2001. Modeling the Effects of Area Closure and Tax Policies: A Spatial-Temporal Model of the Hawaii Longline Fishery.
Marine Resource Economics 15:179-204.

5. Other Papers, Technical Reports, meeting presentations, etc.
Nemoto, Keiichi and Ujjayant Chakravorty. 2001. Modeling the Impacts of Area Closures on the Hawaii Longline Fishery: A Spatial-Temporal Economic Model Incorporating Fish Movement. Presentation at the 52nd Annual Tuna Conference, Lake Arrowhead, California, May 21-25, 2001.

Nemoto, Keiichi, and Ujjayant Chakravorty. 2000. A Spatial Fishery Model Incorporating Migration. Presentation at PFRP Principal Investigators Meeting, December 5-7, 2000, Honolulu.

6. Names of students graduating with MS or Ph.D. degrees in FY2001.
Nemoto, Keiichi, 2001. Modeling the Impacts of Area Closures on the Hawaii Longline Fishery: A Spatial-Temporal Economic Model Incorporating Fish Movement. Ph.D. dissertation. University of Hawaii at Manoa (December 2001).