

JIMAR-PFRP Progress Report for FY 2000

A Dynamic Model to Evaluate the Effect of Regulation on the Hawaiian Pelagic Fishery

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1. A plain English, jargon-free section describing the purpose of your project and some indicative results.

Time-area closures are fast becoming a popular regulatory tool that can be used to protect endangered or depleted marine 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 the 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 to the Hawaii longline fishery. With the instantaneous catch function and the estimated initial stocks of the major species at each specific location per period, fishing trips in each period are allocated over space to locations of maximum net return per trip, which declines 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 Hawaiian Ocean is closed to protect sea turtles, fishing effort will be reallocated to the near-shore, which might 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, it may significantly reduce the stocks of near-shore species and adversely affect catches by competing fleets, such as handliners and trollers.

2. What you have accomplished in the past 12 months (or since you received funding). If there have been problems, they should be discussed thoroughly.

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 five major species with each set type were estimated, assuming that the Hawaii pelagic fishery is in a long-run economic 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 are presented in a JIMAR technical report (Chakravorty and Nemoto, 2000), and a PFRP newsletter (Chakravorty, 2000).

In the second half of FY 2000, we first expanded the period of the analysis to the three years (1995 - 97). Next, we are extending the model to incorporate net migration in and out of each

area (five-by-five degree square) over months, 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 extended model with migration will account for the effects of a change in harvests in each square in a period, caused by a regulatory policy, on fish stocks of the adjacent areas (including the original area) in the next period.

3. What you intend to accomplish in the next 12 months.

We will complete the above extended model with migration and conduct economic analyses of various regulatory policies, particularly focusing on time-area closure for protecting sea turtles, and other endangered species.

4. Budget for the next round of funding for multi-year projects.

A budget to continue the research project for another year is under request.

5. List of Papers Published in Referred Journals during FY 2000

Chakravorty, Ujjayant and Keiichi Nemoto, "Modeling the effects of area closure and tax policies: a spatial model of the Hawaii longline fishery," in review, *Marine Resource Economics*, 2000.

6. Other Papers, Technical Reports, etc.

Chakravorty, Ujjayant , "The substitution effect of area closures", *Pelagic Fisheries Research Program (PFRP) Newsletter*, Vol. 5, No. 2, 2000.

Chakravorty, Ujjayant, and Keiichi Nemoto, *Modeling The Effects of Area Closure and Tax Policies: A Spatial Model of the Hawaii Longline Fishery*, Pelagic Fisheries Research Program (PFRP), SOEST 00-02, JIMAR Contribution 00-329.

Chakravorty, Ujjayant, and Keiichi Nemoto, "A spatial-dynamic model for the allocation of fishing effort with application to the Hawaii longline fishery," presented in *Tuna Conference*, Lake Arrowhead, California, 24-27 May 1999.

Chakravorty, Ujjayant, Keiichi Nemoto, KinPing Tse, and John Yanagida, "A spatial-dynamic model for the allocation of fishing effort: application to the Hawaii longline fishery," in U. Chakravorty and J. Sibert (Eds.), *Ocean-Scale Management of Pelagic Fisheries: Economic and Regulatory Issues*, Proceeding of an International Workshop organized by Pelagic Fisheries Research Program (PFRP), JIMAR Contribution 99-321: 65-88.