Final Report

To
Pelagic Fishery Research Program (PFRP)
Joint Institute for Marine and Atmospheric Research
School of Ocean and Earth Science and Technology
University of Hawaii

July 1997

Project title: Local Pelagic Catch and Effort Data Analysis and Integrated Modeling to Quantify the Effects of Local Fisheries on Fish Availability (RCUH project 2041)
Funding agency: NOAA, NMFS
Principal Investigator: Dr. Christofer Boggs NMFS/SWFSC Honolulu Laboratory
Staff: Dr. Xi He (through 12/96), Daniel Curran, Xian Zhou (through 10/96) , Min Jun Wang

Purpose of the project

1. Establish a comprehensive catch and effort database for Hawaii pelagic fisheries. Provide annotated databases that include all available historical data on catch and effort by different components of Hawaii's pelagic fisheries.

2. Establish a meaningful time series of pelagic fish availability and fishing pressure in Hawaii. Compute time series (1948-1992) of catch per unit effort (CPUE) and standardized fishing effort, at monthly resolution, for yellowfin and bigeye tunas, blue and striped marlins, mahimahi, and ono (wahoo).

3. Develop analytical models for variation in pelagic fish availability (CPUE) in Hawaii. Analyze the CPUE time series in relation to potential influences including total local fishing effort and effort by specific fishery components.

Summary of Accomplishments

Funding was received at the University in August 1993, and staff began work in February-April 1994. An extension was filed to continue spending on this project through the end of the cooperative agreement (June 1997) The project has assembled all available data on catch and effort statistics for Hawaii pelagic fisheries, with emphasis on the six most valuable pelagic species. Confidential annotated databases were created from Hawaii's Division of Aquatic Resources (HDAR) data and from wholesale market data. Nonconfidential monthly, and yearly summaries of troll, handline and longline catch of pelagic species were produced as well as custom data summaries requested by PFRP projects and other clients. Errors and problems with the fishery statistics were addressed including catch underreporting, species misidentification,

lumping of catches, inadequate classification of fishing effort, and exclusion of zero-catch trips. In most cases, practical solutions to these data problems were found and meaningful time series of CPUE were estimated. Time series analysis of HDAR data did not show any consistent pattern of negative effects on tuna CPUE resulting from increases in fishing. Results for blue marlin and mahimahi are less clear and require further evaluation.

Fishery data summaries:

Project 2041 has been an important source of fishery statistics for the family of PFRP Projects and other clients. A non-confidential report giving quarterly and yearly summaries and maps of longline catches and effort by five degree squares for 1991-1994 was published and a report updating the data through 1996 is nearly finished. The data in these reports were requested by FAO for use in compiling a comprehensive atlas of Pacific tuna and billfish catches (Carocci and Majkowski 1996). Our publication was used as the basic input for PFRP Project # 2118 ("A dynamic model to evaluate the effects of regulation...") and the data files were supplied to the Western Pacific Regional Fishery Management Council (WPRFMC) Pelagic Plan Team to generate maps of Pacific-wide tuna and billfish catches for the 1996 Annual Report. Customized non-confidential fishery data summaries were also provided to PFRP Project #2042 ("Design of tag-recapture experiments...") and Project #2064 ("A tag and release program...").

Estimation of under-reporting and raising factors for HDAR data

Information from independent fish dealers, wholesale market monitoring projects, and previous studies were used to gauge the amount of fish not reported to HDAR by different fishery sectors. Previous studies found substantial under-reporting problems by Hawaii longline vessels from 1979 to 1989. The accuracy of reports by Hawaii's handline and troll fleets had never been carefully examined.

Comparative information on handline and troll catch was available for only three years (1980, 1981, and 1988). These years showed that under-reporting by handline and troll fishermen was not too severe with reported catches to HDAR representing about 80% of actual total catch. Only a few years of comparative data for handline and troll fisheries exists making any quantification of trends in under-reporting difficult. Since the possible comparisons did show that reported catches were not grossly inaccurate, we focused our under-reporting study on the longline sector of Hawaii's pelagic fishery. A set of raising factors were estimated to correct for under-reporting by longliners to HDAR. Total catches of six species were estimated from HDAR-independent data and compared with existing HDAR catch reports to determine suggested raising factors. These can be found on the PFRP home page (at http://www.soest.hawaii.edu/PFRP/pfrp1.html).

Creation of catch per unit effort indices for Hawaii's handline and troll fisheries

Commercial catches reported to HDAR are the only continuous long-term time series of data on Hawaii's handline and troll fisheries. The validity of HDAR data used has often been called into question. Specifically, HDAR data suffers from the lack of a specific measure of effort due to the reporting of catches by date, and until 1989 information on unsuccessful fishing trips (zero catch trips) was absent from the database. To address these problems we used dates of catch from 1970-92 as a measure of effort (fishing days) and examined intervals between dates fished as a second variable (Fig. 1). In 1978-79, catch per days fished (CPDF) was anomalous for catches reported one month apart, strongly suggesting that catches for many days fished were summed in monthly reports. The time series of all six species examined were improved by elimination of the monthly reports in those years. For other years, CPDF data stratified by intervals between reports, showed similar trends for different intervals. Thus, corrected CPDF data appear to provide a useful index of fluctuations in troll and handline fishery performance.

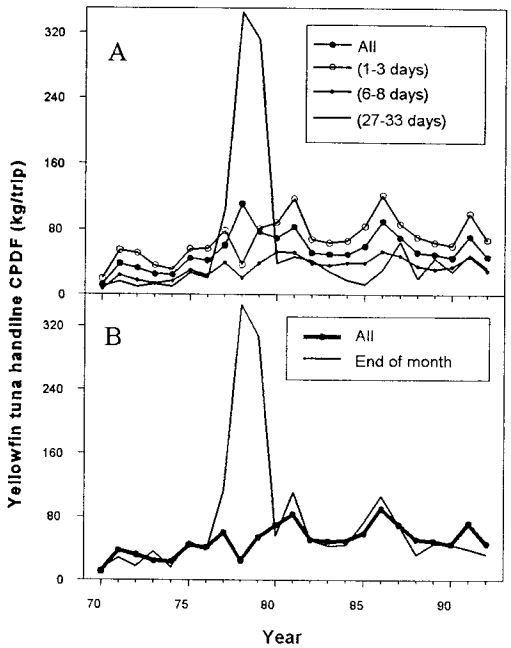

Figure 1. Time series of yellowfin tuna CPDF by Hawaii handline fishery 1970-1992. (A) Shows all trips and trips stratified by reporting interval. (B) Shows all trips with monthly summary trips for 1978-79 deleted and monthly trips as a separate group.

Frequency distributions of CPDF for any one species are sometimes highly skewed and include substantial frequencies of zero CPDF. A modified negative binomial distribution fit to the CPDF provided mean catch rates that differed very little from simple arithmetic means. Other analyses showed that mean CPDF, excluding days which caught no species at all, was highly predictive of mean CPDF including zero catch days (Fig. 2). Thus, lack of data on fishing days with no catch throughout much of the time series does not invalidate the use of CPDF as an index of fishery performance.

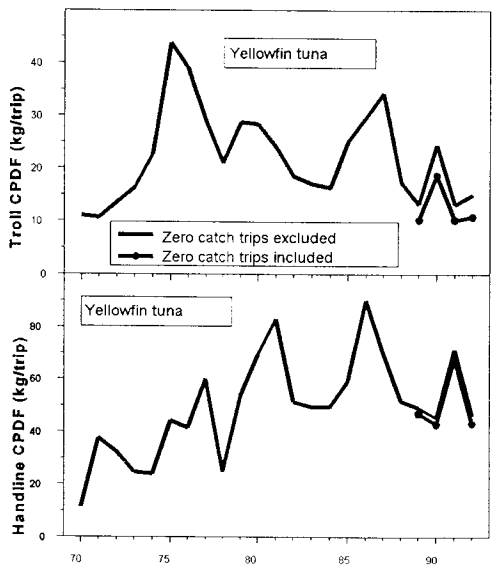

Figure 2. Time series of yellowfin tuna CPDF by Hawaii handline and troll fisheries from 1970-92 with and without zero catch trip data.

These and other problems with the Hawaii pelagic fishery statistics are described in a manuscript that will soon be submitted for publication in Fishery Bulletin. These and other data problems and some methods for dealing with them have been communicated to other project PIs and have been useful in their analyses and models (i.e. PFRP Project #2066 (" A multiobjective programming model of Hawaii commercial fisheries...").

Simulation modeling and time series analysis of catch and CPUE

Hawaii commercial fisheries data only provide time series of total catch and indices of CPUE. We examined a tool that can be used to estimate fisheries impacts on local fishery performance when only time series of catch and CPUE data are available. We used simulations to model relationships between total catch and CPUE and patterns of these relationships under different scenarios of key parameters: migrations rates, fishing mortality, and catchability. We then analyzed time series of total catch and CPUE produced by these models using time series transfer function models. We also applied the transfer function models to real commercial fisheries data from Hawaii's yellowfin tuna fisheries. Finally, we compared the results from the simulation models and the real data were used to estimate the power of the transfer function models to detect local fishery impacts.

The simulation models were run at monthly time steps for 30 years. The models include stochastic processes in migration rates, fishing mortality, and catchability. Each scenario was run 1000 times. Total catches of yellowfin tuna from 1962 to 1994 were estimated for three fishing gear types: longline, troll, and handline. Results indicated that total catches by Hawaii's fishery sectors have low probabilities of affecting local CPUE for yellowfin tuna. Further analysis is focusing on additional species especially blue marlin and mahimahi.

Citation:

Carocci, F. and J. Majkowski (editors). 1996. Pacific tunas and billfishes. Atlas of commercial catches. Rome, FAO. 9p., 28 maps.

Publications:

Curran, D. S., C. H. Boggs, and X. He., 1996. Catch and effort from Hawaii's longline fishery summarized by quarters and five degree squares. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-SWFSC-225, 68 p.

He, X., C. H. Boggs, and K. A. Bigelow, 1997 (in press). Cluster analysis of longline sets and fishing strategies within the Hawaii-based Fishery. Fisheries Research (July 1997).

He, X., and C. H. Boggs, 1996. Do Local Catches Affect Local Abundance? Time Series Analysis on Hawaii's Tuna Fisheries. Pages 224-240 *In* Shomura, R.S., J Majkowski, and R.F. Harman (Eds.) Status of interactions of Pacific tuna fisheries in 1995. Proceedings of the Second FAO Expert Consultation on Interactions of Pacific Tuna Fisheries. Shimizu, Japan, 23-31 January 1995. FAO Fisheries Technical Paper 365. 612 p.

He, X., and C. H. Boggs, 1996 (in press). Estimating fisheries impacts using commercial fisheries data: simulation models and time series analysis of Hawaii's yellowfin tuna fisheries. Pages 557-563 *In* Second World Fishery Congress Proceedings, Vol. 2. July 28-August 1, 1996, Brisbane, Australia.

Manuscripts:

Boggs, C.H., D.S. Curran, and X. He. Hawaii's pelagic troll and handline catch rates: do catch dates represent days fished? (For submission to Fishery Bulletin, in review).

Boggs, C. H. and X He. Time series analysis of catch rates for blue marlin (*Makaira mazara)* and mahimahi (*Coryphaena hippurus*) in the Hawaii troll fishery. (For submission to Fishery Bulletin, in preparation).

Curran, D.S., M.J. Wang, and C. H. Boggs. Catch and effort from Hawaii's longline fishery summarized by quarters and five degree squares, 1991-1996. (Intended as a NOAA NMFS Technical Memorandum, in preparation).

He, X, and C. H. Boggs. Fishing vessel as predator: the ideal free distribution and vessel movement in the Hawaii longline fishery. (For submission to Fishery Bulletin, in review).

Future Plans

Although the project has reached the end of its funding the PI and his associates remain involved in related projects and will continue to evaluate and publish results (see manuscripts, above) during the coming year.

Budget

No further funding is requested for this project.