ECONOMIC ANALYSIS OF HAWAII FISHERIES: A SURVEY

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INTRODUCTION

Literature on Hawaii fisheries can generally be separated into three categories according to emphasis of the study: economic, biological, and descriptive. This report is intended to present a summary of the methodology and findings of published studies of Hawaii fisheries with an economic emphasis.[1] The first section is a review of studies which consider production and market analysis for various fisheries. The second section is a review of feasibility studies for alternative skipjack tuna baitfish.

GENERAL FISHERIES STUDIES

Rigorous economic analysis of the Hawaii fisheries essentially began with Hale's (1964) study, prepared as a background paper on which to base potential legislative fishery policies. Data used were Hawaii State Fish and Game records for the years 1948-63. Hale divides the fishery: 1) high seas, pelagic fishery including tuna and mahimahi, 2) shallow water and handline fishery, and 3) shellfish, pondfish, and other minor species. He also defines three categories of commercial fishermen: full-time (occupational) fishermen, part-time (supplemental income) fishermen, and sport fishermen. Hale also presents a description of markets for aku (skipjack tuna) and ahi (yellowfin and bigeye tunas). The method of analysis is descriptive which includes tabulation of vessel numbers, fishing employment, annual catch, and value of various species, from which he arrives at the conclusion that "the industry will vanish as a viable economic activity in the near future." This conclusion is based on continuation of observed trends in the fishery: 1) downward trend in the number of powered fishing vessels, 2) decline in number of fishermen, 3) declining value of total catch, and 4) lower personal income of fisherman relative to other skilled occupations.

Given this conclusion, he suggests to the legislature possible courses of action. The first would be to do nothing, allowing the industry to decline naturally. The fishing industry is no different from any other in a free enterprise system operating under principles of profit maximization. The natural decline of the industry would release resources to higher valued, more efficient uses.

Given past legislative actions which indicate the legislature's unwillingness to allow the industry to die naturally, Hale recommends a comprehensive effort to expand the fishery (as opposed to attempting short-term solutions). This recommendation is justified on the grounds that local production must compete with foreign production which is governmentally subsidized. Hale suggests the establishment of a loan program to encourage new capital; a new location for the fish market; advertising to increase demand; improved marketing strategies; and stabilization of fishermen's income. He

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[1]Unpublished reports are listed in the bibliography for completeness but are not reviewed here.

points out the need for increased research on consumer demand, canned tuna demand, vessel design, and storage facilities.

Shang (1969) attempts to determine the important factors that are responsible for the lack of growth of the industry. Data used were from State Fish and Game for 1953-66. Shang's methodology was a cost-revenue analysis based on estimated annual vessel catch (885,000 lb) and estimated average costs of fishing operations. The cost-revenue method was used after analysis showed that the decline in catch could not be attributed to a change in fishing conditions over time. Shang estimated both the present value and internal rate of return. He presented tabulations of the estimated minimum ex-vessel price required for various initial investments in a vessel, and the internal rates of return on investment based on various ex-vessel price levels.

Shang estimated three sets of demand functions. The first, an aggregate demand of the cannery and fresh fish market faced by producers, resulted in a demand elasticity of -5.5. This high elasticity resulted from the almost perfectly elastic cannery demand. The second, a cannery demand, showed: a) the monthly ex-vessel price of yellowfin tuna in Hawaii is determined by the Japanese export price of yellowfin tuna, and b) a high positive correlation ($R^2 = 0.98$) between the west coast prices of yellowfin tuna and the Hawaii price of skipjack tuna. The third set of demand functions are for the fresh fish market: one for the peak fishing season and one for the off-season. In both, price was a significant determinant of the monthly quantity sold. However, less than one-third of the quantity variation was explainable by either function. Shang states that "reliable data on price and quantity demanded of fresh skipjack tuna is scarce. The levels of price used here are the average selling prices from the Hawaiian Tuna Packers" (Shang 1969:83).

Shang explains the stagnation of the local tuna industry by the low, relatively stable price of tuna and by the increasing costs of fishing, which together result in a low profit margin. Given his cost-revenue analysis, Shang suggests that if tuna production could be increased by at least 50%, investment would be profitable even if the annual price level was as low as 10.8 cents per pound. Possible means of achieving this level of productivity would be through decreased bait mortality, increased information on the probability distribution of fish, or the adoption of new fishing technology.

Shang's study was the first to employ econometric techniques in analysis of a Hawaii fishery. Whereas Hale suggested the State vessel loan program, Shang analyzed the effects of the program and examined market potential, cost factors, and the impact of imports. His study was based on average ex-vessel prices and estimated costs which were the best available data at the time.

Ahsan et al. (1972) assessed the cost-earning situation for both the aku and ahi fleets. The study was conducted for 1971 using cost-earning data derived primarily from survey information. Historical State Fish and Game catch and revenue data were presented for 1960-70. The methodology was application of standard budgeting techniques.

The average earnings of boat owners and crew members were estimated. For aku boat owners, the average annual income before taxes was $20,691 for high-earning boats, $9,258 for average-earning boats, and $4,269 for low-earning boats. The estimated hourly wages of aku fishermen was $1.71. For ahi boat owners, the average annual income before taxes was $5,565 for high-earning boats, $1,039 for average-earning boats, and -$2,030 for low-earning boats. The estimated average annual income for ahi fishermen was $4,422, $3,548, and $1,837 for high, average, and low-earning boats, respectively. Ahsan et al. conclude that low earnings relative to other occupations and limited markets are the major factors restricting the expansion of the industry.

This conclusion is consistent with prior research indicating that relatively high costs are an inhibiting factor for entry into the industry. The authors, however, contradict Shang's finding by asserting that limited markets are a constraint. Their study, which addressed questions of production costs, does not permit any statements concerning market demand conditions.

Hoffman and Yamauchi (1972) undertook a comprehensive survey and analysis of the State's recreational fisheries. The study presented the first detailed estimates of fisherman participation, characteristics, and expenditures on recreational fishing. The selection of population and sampling technique are described in detail.

Total estimated number of fishermen in the State was 122,400 with about 75% from the City and County of Honolulu. Distribution of this participation was 68% from shoreline fishing, 12% fishing from a boat, and 10% fishing while diving. The study also presented the following characteristics of the Hawaii recreational fisherman--51% were head of household and 50% were between 12 and 32 yr of age. The major ethnic groups of fishermen were 37% Japanese and 22.4% Caucasian. Forty-six percent of all fishermen had completed high school and an additional 32.7% had "some college" or had completed college. Furthermore, 40.3% classified themselves in a $2,000-$5,999 income category and 48.4% were regularly employed as federal employees, retail and wholesale personnel, or as students.

Hoffman and Yamauchi estimated about 4.3 million total fishing days taken per year with two-thirds of these days taken by fishermen from the City and County of Honolulu. The statewide average annual fishing days per fisherman was calculated as 35.8 with wide variation about this mean by County. Of the total days fished, 90.7% involved saltwater fishing. Maps were presented showing preferred fishing areas around each County.

Lastly, the economic impact of recreational fishing expenditures on Hawaii State income was calculated. Annual expenditures were estimated at about $16.1 million or about $132 per year per fisherman. Expenditures on equipment accounted for about 40% of the total. The total multiplier impact on State income was calculated as $11.5 million annually, after leakages were taken into account.

Hoffman and Yamauchi clearly describe the methodology and limitations of their study. They also suggest areas for future research on recreational fisheries.

Comitini's (1977) study was the first to use the production function approach to analyze the behavioral characteristics of the industry. Comitini utilized new State Fish and Game data on catch levels, average price, and vessel characteristics. This study considers trips per vessel, mortality of baitfish, and value of catch per vessel for the years 1949-72. Regression methods were used in the estimation of a Cobb-Douglas production function model.

Capital was measured two ways: (a) as the gross tonnage of each vessel, and (b) as the annually depreciated capital value of each vessel. Seasonality of catch and qualitative characteristics of the vessels were also considered using the dummy variable method. Comitini's results show that 1) using gross tonnage as a measure of capital input is inferior to using depreciated capital value; 2) natural fluctuations in resource availability are significant and should be considered; 3) vessels are not homogenous as indicated by the significance of the vessel dummy variables. A linear relationship was also estimated. From this, Comitini derived an "index of fishing effectiveness" and expected catch. This index captures differences in vessel that had not previously been evaluated. Specifically, the study cites differences in entrepreneurial ability and strategy of fishing. The computation of marginal products and relative shares of labor and capital indicate that these shares are not significantly different from the traditional 60:40 split of the catch observed in the fishery. Comitini concludes that "the major constraints to Hawaiian skipjack tuna fisheries development lie in the skipjack tuna resource potential relative to the opportunity costs of capital and labor, and also the costs of obtaining baitfish" (Comitini 1977:40). He recommends two solutions to the apparent stagnation of the industry: 1) shift to a higher production ray through a change in fishing technique or 2) move along the same production ray but reduce bait mortality so that production can be increased from current techniques.

On the demand side, Garrod and Chong (1978) provide a description of the major structural characteristics of the fresh fish market in Hawaii. Specifically, they examine the hypothesis that the market is not operating in a manner conducive to expansion. They present tabulated data on a number of industry characteristics.

Garrod and Chong also describe in detail the market structure and practices. They analyze structural attributes of the market which may be "conducive to misconduct, high prices, low efficiency, poor product quality, and a general low standard of performance" (Garrod and Chong 1978:18). In particular, they assess the following three attributes: ease of entry into the market, degree of buyer and seller concentration, and absolute number of firms.

They conclude that barriers to entry may exist because the market is well established. The new entrant faces normal economic barriers as well as the requirement to compete against the goodwill and marketing know-how

of the established firm. They develop a concentration index at the wholesale level based on number of employees of each firm. Garrod and Chong conclude that, given the small number of wholesalers and the fact that number of employees is a poor proxy for market share, their concentration index does not provide evidence of a concentrated market. They suggest, however, that the small number of firms may imply the presence of market leadership. Using the absolute number of firms as a measure, Garrod and Chong describe the market as oligopolistic and oligopsonistic.

The discussion on price determination in the fresh fish market is apparently based on interviews with fish dealers and observations at the various market outlets. Garrod and Chong consider factors not previously given much attention in market analysis. For example, they point out that: 1) the fish dealers generally set their prices on the basis of the morning auction price; 2) that price varies by species and conversion rate (percent of whole fish that is saleable); 3) that availability of proper storage and perishability of the fish are important in price determination especially at the end of the day; 4) that the minimum negotiated price for aku has benefited the aku fisherman and could serve as an example to other fishermen; and 5) that allegations of collusion among large buyers "could not be verified empirically" (Garrod and Chong 1978:21).

Lastly, they consider alternative marketing systems and present a "scenario" which might develop if adoption of modern technology occurred. They suggest that cost-reducing innovations often result in fewer persons producing more, that is, a more concentrated market (Garrod and Chong 1978:23). This result is because the increased volume of fish available for sale would force price down, driving less efficient firms out of the industry. Their final observation is that markets evolve to meet the situation and that the existing market structure may be the most viable.

Garrod and Chong are the first to attempt an industry or market study, and lay a theoretical framework for a study of the market, with consideration of both demand and supply. Data are lacking to actually test many of the questions posed by Garrod and Chong.

Although the research area of the above studies is the same, there are variations in emphasis and methodology. Generally, the authors have attempted to describe the fishery and explain why there has been no entry or expansion. The conclusions consistently point to increasing costs and market limitations as reasons for the "declining" or "stagnating" industry. There have also been allusions both in the economic studies and the descriptive literature to some type of "sinister" collusion in the fresh fish market. Garrod and Chong propose that the existence of collusion (which they were unable to verify empirically) may be a result of natural evolutionary tendencies within the market.

Both cost and market analyses for skipjack tuna have used the average price derived from Hawaii State Fish and Game data. Finally, except for Garrod and Chong, the emphasis of the previous research has been on the supply side. To date, supply and demand have not been empirically or

theoretically analyzed together.[2] Hoffman and Yamauchi presented the first major background information on which to base analysis of the recreational fisheries.[3]

BAITFISH STUDIES

Shang and Iversen (1971) present an economic feasibility study for the production of threadfin shad as a live bait for Hawaii's skipjack tuna fishery. They estimate a break-even price for nehu, Stolephorus purpureus, the major baitfish species used in the fishery. The calculation of this price is based on the income foregone to fishermen when they are fishing for bait instead of fishing for skipjack tuna. They estimate a break-even (maximum) price of nehu per bucket as $12.70 (year-round), $13.80 (peak fishing months), and $11.00 (other fishing months). Catch rates with either nehu or shad are about equal but shad has about a 10% lower mortality rate than nehu, which increases returns to a bucket of shad bait. The estimated break-even (maximum) price of shad if $14.60 and $13.80 (year-round), $15.90 and $15.00 (peak fishing months), and $12.60 and $12.00 (other fishing months) using 10 and 16% mortality of shad, respectively.

Using present-value analysis, estimates of production break-even (minimum) prices are presented for 10 and 16% mortality rates. This analysis includes investment costs, operation costs, and net present value at varying discount rates. Results indicate that shad operation is feasible with an annual production of 3,660 buckets of shad per 10-acre pond unit and with the selected range of discount rates (6-14%).

Crumley (1977) considers the commercial production of tilapia, Tilapia mossambica, for use as baitfish in the Hawaiian skipjack tuna fishery. Crumley uses Shang and Iversen's formulas to reestimate the break-even price of nehu at $30.12 per bucket. He then estimates construction and operating costs of tilapia production which result in cost per bucket of tilapia of $17.56 which includes a 20% "profit" for the producer.

Herrick (1977) estimated the cost per bucket for production of the topminnow, Poecilia vittata, for use as a baitfish in the Hawaii skipjack tuna fishery. This study is based on depreciated annual capital costs plus operating costs for outputs of 3,000 bucket/yr output and 30,000 bucket/yr output. The topminnow has not been proven to be as effective as nehu. Estimated production costs were $12.93 per bucket and $3.69 per bucket for 3,000 and 30,000 bucket/yr, respectively.

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[2]See Hudgins (1980a) for market model of Hawaiian skipjack tuna.

[3]See Adams (1980) for recent recreational fisheries research.

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