Marine Resource Economics, Volume 7, pp. 209–228
Printed in the USA.

0738-1360/92 $3.00 + .00

Innovations and Progress in Seafood Demand and Market Analysis

CATHY ROHEIM WESSELLS
JAMES L. ANDERSON

Department of Resource Economics
University of Rhode Island
Kingston, RI 02881

Abstract *The purpose of this paper is to review several economic studies which present a spectrum of interesting and creative approaches to analyzing the market for fish and seafood. These studies form a basis from which to offer recommendations for further improving analysis of fish demand and markets. We do so in an effort to advocate the potential of this area of research in the decisions which promote efficient use of the world's fisheries resources. Each of the reviewed approaches has its merits and limitations, depending on the issue at hand, quality of the data and skills of the researcher. The approaches are categorized as either demand studies following more traditional commodity market analysis methods or as market research studies.*

Keywords Seafood, demand, marketing, international trade.

Introduction

While there have been a plethora of economic studies focusing on fisheries management issues, until the last decade little serious attention had been given to the demand side of the seafood industry. Economists have argued for many years that 'rational fishery management must evolve from the objective of maximizing the net economic yield of the resource' (Crutchfield and Pontecorvo, 1969), although little consideration has been given to market conditions. However, it is hoped the experiences of recent years have shown fisheries economists, fishery managers and resource users that naively focusing on the harvest component alone is not sufficient to maximize the returns to members of the seafood industry or society as a whole. While the past decade has recorded some limited successes in the difficult area of fisheries management, both the successful and not-so-successful management schemes often have had dramatic impacts on seafood markets, fishermen's incomes and social welfare. For example, the lobster and salmon fisheries have been quite successful in increasing harvest. In the U.S., the 1990 American lobster harvest has increased by 65 percent since 1980, and the salmon harvest has increased steadily to record levels in 1989, 28 percent over the 1980 harvest (USDC 1991). However, real prices for both lobster and salmon have declined during the same time period as demand has grown at a slower pace than

Comments from two anonymous reviewers are gratefully acknowledged. Partial funding provided by USDA/CSRS Grant No. 92-34276-6963 and the Rhode Island Agricultural Experiment Station. This manuscript is Rhode Island Agricultural Experiment Station Contribution 2676.

supply. One need only read the headlines to understand that the relatively successful management of these fisheries has not necessarily led to higher net economic yields from the resource.

In other fisheries, management schemes have distorted the market to the point where revenues to fishermen are lower than they could be. For example, in Pacific halibut fisheries, the season has been condensed to the point where the entire year's fishery takes place in a matter of hours, with subsequent landings unloaded on overwhelmed processors. This leads to a lower quality product which in turn leads to lower prices received by both processors and fishermen and, equally important, to a misallocation of resources. New management schemes are being proposed which address these problems. For example, the introduction of individual vessel quotas for halibut in British Columbia was brought about, in part, in response to the apparent demand for fresh, high quality halibut available year around, rather than year around availability of frozen halibut of lesser quality.

The advent of aquaculture has served as an impetus to changing the way fish is marketed. The special ability of aquaculture to control season length, size of the harvest, product attributes, and timing of product arrival on the market has sparked increased interest in the demand side of the fishing industry. The importance attached to marketing and demand issues by the aquaculture industries is forcing managers and users of traditional fisheries resources to begin considering implications of their actions on the market to an extent not seen prior to the emergence of large scale aquaculture industries.

In response to these challenging issues and industry need for more market knowledge, the past decade has seen a surge in the number and variety of market analyses of fisheries products. Topics addressed range from the impact of aquaculture development on prices and international trade, to evaluating effects of advertising on demand, to estimating impacts of management policies on seafood markets. Recent studies have covered most major species, including shrimp, salmon, groundfish, lobster and catfish, to name a few. The research has ranged from studies which are highly aggregated across nations and species, to highly disaggregated analyses of specific species, product forms and consumers.

The more highly aggregated studies tend to focus on important questions of general concern to the food sector through estimates of demand elasticities. The estimated demand elasticities are used to evaluate such issues as the effects of changing incomes, prices and macroeconomic climates as well as fisheries management policies on the markets for fisheries products.

With the increasing supply of aquacultured fish and seafood products, there has been a corresponding increase in interest in micro-oriented issues, such as the potential demand for new or differentiated products and the effects of advertising on consumer's demand. Answers to these equally important questions have become necessary as seafood markets have become progressively more competitive.

The purpose of this paper is to present a spectrum of creative, innovative and interesting approaches used by researchers to analyze the demand for and markets of fish and seafood. Each approach has its merits and limitations depending on the issue at hand, quality of the data and skills of the researcher. These approaches may be categorized either as studies following more traditional commodity market analysis methods, or as market research studies following approaches used by the business marketing profession. It is important to note that

the goal of this paper is not to review each of the many contributions to the seafood demand and market analysis literature. Instead, the goal is to illustrate, by creating a snapshot of the 'state-of-the-art' in seafood demand and market analysis, the potential contribution of this area of research to the efficient use of the world's fisheries resources.

Approaches Using Traditional Commodity Market Analysis

Analyses of fish and seafood markets have evolved continually over the past thirty years. The earliest studies of seafood products include Crutchfield and Zellner (1962); Farrell and Lampe (1965); Bell (1968); Norton and Waugh (1969); Nash and Bell (1969); and Bell (1972). Studies on salmon markets include Wood (1970); Onuorah (1973); Wang (1976); Abraham (1979); DeVoretz (1982); Kabir and Ridler (1984); Lent (1984); Bird (1986); Anderson and Wilen (1986); Reily (1986); Kikuchi (1987); Herrmann and Lin (1988); Herrmann, Lin and Mittelhammer (1988); DeVoretz and Salvanes (1988); Herrmann (1990); Wessells (1990); and Wessells and Wilen (1990). Studies of groundfish markets include: Capalbo (1976); Bockstael (1977); Tsoa, Schrank and Roy (1982); Crutchfield (1985); Squires, Herrick and Hastie (1987); and a host of papers in Schrank and Roy (1991). Shrimp markets are analyzed in Doll (1972); Blomo, Nichols, Griffin and Grant (1982); Prochaska and Keithly (1984); Thompson, Roberts and Pawlyk (1984); and Saito, Johnston and Siaway (1984); while lobster markets are the focus in Botsford, Wilen and Richardson (1986); Richardson and Gates (1986); Wang and Kellogg (1988); and catfish markets in Kinnucan, Sindelar, Wineholt and Hatch (1988); Hatch, Zidack and Kinnucan (1989); Kinnucan and Venkateswaran (1990), and Nyankori (1991). Studies of other species or groups of species include Edwards (1981), Brooks (1987), Cheng and Capps (1988), Lin (1990), Wellman (1990), Perry (1990), Anderson and Brooks (1991), and Capps and Lambregts (1991).

Arguably, the most comprehensive study of seafood markets completed prior to the 1980's is Bockstael's (1977) study of the groundfish market. This study is an excellent example of seafood market analysis, where several levels of the market and interactions between these levels are incorporated. Specifically, this study tied the retail and import demand sectors, through the wholesale sector, to the ex-vessel level through a block recursive, simultaneous econometric model. The components of the block recursive simultaneous equation model were equations representing: a) consumer demand for three product types (fresh groundfish, frozen groundfish, and fish sticks and portions); b) the price mark-up between the retail, wholesale and ex-vessel market levels; c) wholesale demand, as a function of cold storage holdings; and, d) import demand for U.S. groundfish. This study, which was state-of-the-art research at the time, is a comprehensive and thorough analysis of the groundfish industry, and as such, should be recommended reading for any researcher of seafood markets.

International Trade Modelling

Herrmann and Lin (1988) tackled some of the complexities of the world salmon market by focusing on factors which influence U.S. and European Community (EC) demand for Norwegian aquacultured salmon. In this study, a simultaneous system of structural equations was specified which assumed that exporters in

Norway allocate salmon either to the U.S. market or the EC market, depending on factors such as the prices in each market and the relative exchange rates. Included as other factors which influence the market are the effects of changes in the Norwegian supply of Atlantic salmon and changes in the ex-vessel price of chinook (a hypothesized substitute), on the demand for Norwegian salmon in the U.S. and EC. Import demand in the U.S. was specified as a function of the price in the U.S., the Washington ex-vessel price of fresh chinook salmon, and income and seasonal dummy shifters. Import demand in the EC was specified in the same way as the U.S. demand equation, except that the free-on-board (FOB) prices of frozen chinook were used as the substitute good. The export supply equation to the U.S. from Norway was specified as a function of the price for the salmon received from the U.S., the price received from the EC, the total exports of Norwegian salmon, and a one month lagged quantity. Identities specified that all Norwegian exports go either to the U.S. or to the EC.

Using monthly data from January 1983 through March 1987, the authors found that demand for Norwegian Atlantic salmon was price and income elastic in both the U.S. and the EC, and that demand was highly seasonal. Frozen chinook salmon was found to be a weak substitute for Norwegian Atlantic in Europe. The reported own-price elasticity was -1.97 in the U.S. and -1.83 in the EC. Income elasticity was reported to be 4.51 in the U.S. and 2.73 in the EC. In all, the results indicated that either a) the Norwegians exercise some market power, or b) prices are not efficiently determined.

The above study was among the first to use a traditional commodity analysis approach to model the market for farmed Norwegian salmon. The approach enabled the researchers to simulate the effects of changes in prices, exchange rates and tariffs on demand for Norwegian farmed salmon in the U.S. and EC. Therefore, techniques such as these can be used to analyze policy issues (such as the countervailing duty and dumping charges brought against Norwegian producers in 1990).

However, the study was not without its limitations. In a problem which also plagued Reily (1986) and Kabir and Ridler (1984), focusing on the North American market for farmed Atlantic salmon, the immature nature of the salmon aquaculture industry during the time period studied may indicate that the demand curve estimated by Herrmann and Lin actually captures a series of demand shifts of a growing market. In an unestablished market, lagged quantities, which are included in the supply equation, are not sufficient to capture shifts in demand. Due to the nature of Norwegian farmed salmon, as supplies have grown, demand for the product has expanded from being a virtually exclusive up-scale restaurant commodity to other restaurants and supermarkets. Each of these sectors is likely to have differing demand elasticities which are obscured in an aggregate model which does not account for demand shifts and expansion into new markets. In addition, the supply equation is not a true supply equation in that lagged quantity is insufficient to capture the decisions which go into production of farmed salmon (which in the early 1980's was a very dynamic industry), such as prices of inputs, changing technology and growing capital stocks.

The aforementioned work and related research were extended in Herrmann (1990). One of the purposes of this research was to evaluate the impact of increasing salmon aquaculture production on U.S. wild and farmed salmon markets. To accomplish this, factors which affect world trade flows of both Pacific and Atlantic salmon, farmed and wild, were analyzed using a 36 equation econometric

model. Unfortunately, lack of data for some critical variables (*e.g.* U.S. wholesale quantities) prevented the estimation of parameters of the U.S. wholesale and canned markets for Pacific salmon.

In this ambitious model of world salmon trade, exports from Norway to the EC and the U.S. were included as well as trade of other Atlantic salmon, high-valued Pacific salmon (chinook, coho and sockeye) and low-valued Pacific salmon (pink and chum) between North America, the EC and Japan. For reasons which included the limited availability of sample data (quarterly from 1983 through 1988), the estimation technique developed was a Bayesian bootstrapping procedure applied to two stage least squares (2SLS) estimators. *A priori* assumptions about the distribution of the parameters are used in the Bayesian approach where the integrated likelihood function was replaced by a bootstrapped approximation. This particular technique had not previously been tried within the seafood demand literature. A feature of this technique is that it allows the researcher to take advantage of prior information by imposing a certain amount of structure on the model, which may not be possible given limitations in the sample size or in the data. For example, the prior density function for own-price in the North American import demand function was assumed such that the own-price elasticity could not be positive, could not be smaller than -5, had a 75% chance of falling between -4 and -1, a 12.5% chance of falling between -5 and -4, and a 12.5% chance of falling between -1 and 0. Given the relatively small sample size and the apparent number of unexplained outliers in the data (as evidenced by the frequent use of dummy variables), this prior was used to overcome these data limitations.

It is worth noting, however, that caution should be applied when employing the Bayesian technique. It is possible that the prior distributions may impose unnecessary structure on the model. For example, the model may be forced to consider a range of parameter values that it might not have otherwise because the range was specified too broadly, or conversely, restrain it from considering parameter estimates which are the true parameters but outside of the range. It follows then that results are often dramatically altered with changes in the *a priori* assumptions. Therefore, the credibility of the parameter estimates is strongly influenced by the credibility of the prior, and the use of the prior in establishing its probability distributions.

Results obtained by Herrmann indicate own-price, short-run elasticities for Atlantic salmon of -1.34 (-2.18 in the long-run) in the U.S. and -1.94 (-4.32 in the long-run) for the EC. Given the estimated parameters, simulations were performed on alternative scenarios involving key variables in the trade model. These included substantially increasing aquacultured production of Atlantic salmon, as well as increasing landings of Pacific salmon, and simulating fluctuations in the exchange rates between the relevant countries and changes in tariff structures. The study indicated that farmed Atlantic salmon and high-valued Pacific salmon species (chinook, coho and sockeye) are substitutes to some degree in the U.S. and EC. The study also found that a 10 percent decrease in exports of Norwegian salmon to the U.S. would only cause the ex-vessel price of 'high-valued' Pacific salmon to increase by 0.53 percent.

Incorporating Product Characteristics in Demand

Management policy disputes between the U.S. and Canada regarding minimum lobster catch size led Wang and Kellogg (1988) to address the question of the

market impact of increases in the minimum size for American lobster.[1] Research completed prior to Wang and Kellogg for the most part ignored different price structures faced by the various size classes of lobsters (*e.g.* Acheson and Reidman 1982) primarily because disaggregated data are, at best, difficult to obtain. Other studies of the lobster markets, including Botsford, Wilen and Richardson (1986) and Richardson and Gates (1986), incorporated differential pricing based on product attributes (*e.g.* size); but focused specifically on the ex-vessel market level. Wang and Kellogg modeled both wholesale and ex-vessel level demand while incorporating effects of size on wholesale prices.

Wang and Kellogg's model of the wholesale market incorporated the disaggregated size classes by specifying the wholesale price of lobsters (aggregated over size groups) as a function of the percentage of small lobsters in the total supply. The hypothesis was that a larger proportion of small sized lobsters would tend to drive down the wholesale price. In addition, U.S. domestic landings, Canadian imports, inventories, real U.S. disposable income, and seasonal demand dummy variables were included in the equation. Ex-vessel demand was specified as derived demand from the wholesale level, where ex-vessel price was a function of the wholesale price and total landings. Total landings were held fixed. Lack of data prevented the inclusion of the retail level of the market.

It was hypothesized that changes in the size limits would initially affect both total landings and the size distribution of the landings. Using monthly data from March 1974 through June 1979, the results for the wholesale demand equation indicated that the lobster sizes have statistically significant effects on the wholesale and ex-vessel prices. The model showed that an increase in the minimum size for lobster would have two short term effects: 1) a decrease in total landings as part of supply; and, 2) a decrease in the percentage supplied of small lobsters. The long term effects would be somewhat different: an increase in the total landings, but a decrease in the percentage of small lobsters. Since the price flexibility was less than one in both markets, a smaller percentage of small lobsters in the supply would be associated with higher prices and revenues.

While these results yield insights to the lobster market and the controversial issue of allowable lobster size for catch, this contribution was constrained by lack of data. As a result the study failed to address the market substitutability between size classes, effects of inventory adjustment, and substitution of products such as frozen lobster tails.

Exploring Market Integration and Price Transmission

Prior to the institution of the 200 mile Exclusive Economic Zone (EEZ), Japan caught substantial quantities of many species of fish in the Northeastern Pacific, including sablefish, or black cod. In the period post-1977, the Japanese increased their imports substantially, from virtually none in 1977 to 12,000 metric tons in 1986. Squires, Herrick and Hastie (1989) question the extent to which U.S. and Japanese sablefish markets have become integrated. To determine the level of integration of the markets, the Tokyo Central Wholesale Market and the U.S. ex-vessel markets in Alaska and the Pacific coast were considered. While the

[1] In another study which incorporates product characteristics, Blomo, Nichols, Griffen and Grant (1982) distinguished shrimp by size classes.

majority of Pacific coast production of sablefish remains in the U.S., most of the Alaskan production is exported to Japan.

To test whether or not price integration between the U.S. and Japanese sablefish markets exists, the authors followed a dynamic model of spatial price differentials from a central market to local markets for a tradeable good proposed by Ravallion (1986). This model, as outlined by Ravallion, permits each local price series to have its own dynamic structure, allows for correlated local seasonality or other characteristics, and provides for interlinkages with other local markets. Alternative hypotheses of integration of markets by price and market segmentation are encompassed within a more general model, allowing for nested statistical testing. Finally, the model distinguishes between instantaneous market integration and long-run integration. Thus, while short-run integration may be statistically rejected by the data, it is still a possibility that there may be long-run integration.

Ravallion's model is represented by a single equation in which the current price in the local market is a function of lagged prices in the local market, current and lagged prices in the central market and non-price explanatory variables of price in the local market. In the Squires, Herrick and Hastie application, the ex-vessel price in the Pacific coast market was modelled as a function of contemporaneous and lagged prices of Tokyo wholesale prices, past ex-vessel prices in the Pacific coast market and other exogenous variables. Likewise, the ex-vessel price in the Alaskan market was formulated as a function of contemporaneous and lagged prices of Tokyo wholesale prices, past ex-vessel prices in the Alaskan market and other exogenous variables.

In the context of this application, the hypothesis that there is market segmentation implies that changes in the Tokyo wholesale prices will have no immediate or lagged effect on ex-vessel prices in the local (Alaska or Pacific coast) market. No effect implies that the ex-vessel price in the, for example, Alaskan market depends only on its own lagged values and local market characteristics. The existence of short run market integration implies that a wholesale price change in the Tokyo market will be immediately and fully passed on to the local market. A weaker form of this hypothesis is that the lagged effects need only vanish on average.

The estimation process used average monthly market price data for the Tokyo Central Wholesale Market during 1981–1986. The data pertain to an auction market and hence the only major aggregation of prices is over size and quality of sablefish. The authors found that the Pacific coast ex-vessel and Tokyo wholesale markets are indeed segmented, implying that changes in the Tokyo market prices have had no effect on the prices of the Pacific coast market. They felt this was due to the fact that most of the Pacific coast's production of sablefish is consumed in the U.S. However, the Tokyo wholesale and Alaska ex-vessel markets were shown to be well integrated by prices. In a period longer than one month, changes in Alaska prices may be attributed to changes in Tokyo prices and past spatial price differentials between the two markets. Therefore, the authors concluded that changes in trade policies by the Japanese, changes in the exchange rate and changes in Japanese consumer tastes and preferences are all likely to affect the prices received by fishermen in Alaska.

Recent work by Nyankori (1991) used a similar approach to test hypotheses about the nature of price transmission between the various domestic market levels

in the catfish industry. Hypotheses regarding the extent to which changes in production costs, processing costs and retail prices, and the time lags involved, were tested since many of the processing firms are farmer-owned cooperatives which exert some market power. Results indicate that the direction of price transmission is from the farm level to the wholesale level, rather than from the wholesale to farm level. More formally, the author found that Granger causality exists between farm and wholesale prices of catfish.

A potentially large problem that this methodology may encounter is the effect of multicollinearity. If, for example, the difference in the ex-vessel price and the wholesale price is characterized by a simple mark-up rule, then the prices which are being tested for integration may, at the extreme, be perfectly collinear. With near collinearity, most of the variation in the dependent variable may be attributed to any one of the lagged dependent prices or any of the local prices, while not attributed to any of the other lagged prices. This will affect the results, and may lead to the interpretation that the markets are not integrated over the long run when in fact they are. An additional concern is how the length of the lag is chosen. Altering the lag length may also affect the test results.

Incorporating Uncertainty into Decision-making

A unique study of wholesalers' role in the seafood market is found in Lent (1984). This research modeled short-run decision making behavior of buyers and sellers at the wholesale level, and incorporated uncertainty into the model. The uncertainties arise from imperfect information on seasonal variations in production, price and quality variation, and changing government regulations. Lent presents a model designed to simulate the behavior of the market for fresh/frozen Pacific salmon which postulates a price-setting equation for each seller and a quantity accepting relationship for the wholesale buyers of salmon.

The model was based on a seafood market which in the short run is in a state of 'disequilibrium'. In addition, the assumption was made that firms decide to produce only if marginal cost equals marginal revenue, or price is above average cost. The model consisted of two equations. The first was an "asking" price equation. The purpose of this equation was to capture the price searching behavior of the sellers. The assumption was made that the seller specifies an asking price which is a function of the previous period's average price, costs in period t, the difference between the previous period's desired level of sales to actual sales and the number and variance of observed prices. Desired sales were unobservable, so a proxy, last period's sales, was used. As the market moves through the season, the seller's asking prices are revised as more information on average industry prices and costs become known as well as production and sales. The buyers may accept or reject this "asking" price depending on their knowledge of prices offered by other sellers in the industry. The second equation, then, consisted of the quantity demanded by the buyers, which in turn was a function of the asking price of *firm i* (endogenously) minus the average of observed prices across all firms for that time period. The asking price was calculated as the quantity weighted average prices offered by *firm i* across all transactions during each week.

Primary data were collected from observations on sales invoices of Pacific salmon wholesalers obtained during a 1977–78 study of the Pacific Northwest salmon industry. Observations were taken by consent from various firms, includ-

ing two in California, two in Oregon, and five in Washington (which also included some Alaskan operations). Prices and sales were recorded for each firm for every transaction within the season.

Two species, chinook and coho, were chosen for empirical estimation since these were the only two species for which observations occurred for all nine firms. The products were further distinguished by size (small, medium and large) and method of catch (gill net or troll). The model was estimated, using weekly observations with equations for each product by firm, to discern between peculiarities of sellers, such as relative size, geographic location, penchant for few large sales (versus numerous small sales) and price or quality variations.

The empirical results determined that the asking price equation was significant, suggesting sellers do behave as price-searchers. The seller's response to the average industry price, when modifying its own price, is tempered as the variance of the set of observed prices increases. This perhaps reflects a lower assessment of the quality of information gleaned from a set of prices with a higher variance. The estimation of the relatively simple buyer's equation indicated that this model may not have entirely captured the purchasing behavior. In addition, other variables were missing, such as the buyers' cost of price searching and buyer/seller loyalty, and may have been required to appropriately specify the model.

Analyzing Household-Level Seafood Expenditures

Due to the significant growth in farm-raised salmon supplies worldwide, there has been an increasing amount of effort by some in the industry to expand the international markets for fresh farmed salmon. A focus of many salmon exporters has been the potentially lucrative Japanese market. In view of this, Wessells and Wilen (1990) addressed the question of the extent to which other seafoods in Japan substitute for salmon and the influence of region of residence and seasonality on household consumption of salmon. The approach used was a system of equations to model retail demand for seafood in Japan, which incorporated intertemporal and regional patterns of consumption and price relationships between major fish species.

There are two features of this study which differentiate it from others. First, this study incorporated both seasonal and regional variation in Japanese demand for seafood within the system. This is of particular importance in the Japanese market where consumer preferences for the various seafood products vary because of historical consumption patterns which differ by area. Second, unlike other studies of Japanese retail demand for protein sources including beef, pork, poultry, and fish (Kikuchi 1987; Herrmann, Mittlehammer and Lin 1989; Hayes, Wahl and Williams 1990), this study focused its attention on seafood demand. Other studies of Japanese demand for protein sources pre-suppose Western style preferences by assuming that the Japanese consumer substitutes seafood for beef, pork and poultry. Substitution between seafood products has, for the most part, been ignored.

Wessells and Wilen utilized data which represented the average Japanese household within each of two regions, northern versus southern Japan. The data were obtained both from surveys of household income and expenditures and from government retail price surveys, the latter of which provided retail price data by species of fish at city levels. Regional data were comprised of household expen-

ditures on seafood, broken down as fresh salmon, tuna, cuttlefish, horse mackerel, flounder, yellowtail, shrimp and lobster, shellfish, sea bream and other fresh fish, and salted salmon, salted cod roe and other salted and dried fish. Retail price and expenditure data were aggregated over households and over districts within each region as well as over value-added products, presentation and grades of seafood eaten at home. This system was hypothesized to be separable from other consumables (including meats, a restriction which Hayes, Wahl and Williams (1990) failed to reject).

Estimation utilized pooled cross-section and time series data with monthly data from 1980 through 1989 and the two cross-sectional units. Due to the large number of equations, the linear approximation of the Almost Ideal Demand System (AIDS) was chosen as the specification for the demand system.

A pair of interesting results illustrated the different consumption behavior patterns exhibited regionally as well as seasonally and which may have particular implications for North American sockeye salmon. The role of sockeye salmon in the fish consumption system is relatively complicated. In southern Japan, where fresh/frozen salmon consists primarily of sockeye, results indicated that fresh/frozen salmon competes strongly in the summer months with the complex of fish, including fresh cuttlefish, yellowtail, tuna, sea bream and horse mackerel. However, for the rest of the year, when the majority of salmon (hence sockeye) is consumed primarily as a salted product, it competes in a very different market, one characterized by more staple-like consumption with competition from more common items like salted cod roe and domestically caught chum (both fresh and salted).

Elasticities indicated that most species of seafood in Japan tend to be price elastic, except sea bream in southern Japan. In addition to the regional regressions, a regression was run using aggregated data for all of Japan. Elasticities calculated from the aggregated estimation indicated that there is a possibility for misleading conclusions from over-aggregating consumption across Japan. In general, there were significant divergences in elasticity estimates for the separate regions versus Japan as an aggregate for both price and expenditure elasticities.

Focusing again on household consumption of seafood at home, Cheng and Capps (1988) analyzed household expenditures using micro level U.S. data. Consumption of three species of shellfish (crabs, oysters, shrimp) and five species of finfish (cod, flounder/sole, haddock, perch, snapper) was investigated. This study is of particular interest for two reasons. First, data for this study came from surveys of home consumption of all seafood and included 9,422 households across the U.S. The data were gathered on both species-specific and product form-specific expenditures on seafood in 1981. Second, the statistical procedures utilized in this study address missing observation problems inherent in this type of data set.

A large number of the observations on household expenditures indicated zero expenditure levels, even for the more commonly consumed items chosen for the model. Therefore, a Heckman two-step procedure was used in the econometric estimation of the expenditure equations. Use of this procedure alleviates problems generated by ordinary least squares estimation, namely inconsistent estimates resulting from selectivity bias.

The first step of the Heckman two-step procedure uses a tobit procedure to generate an inverse Mills ratio. The inverse Mills ratio is an instrumental variable

that incorporates the latent variables which generate zero expenditure decisions. The instrument was, in the second step of the procedure, included as an explanatory variable in the expenditure equations. These expenditure equations were then estimated using generalized least squares using the data from the non-zero expenditure observations.

Results of the Cheng and Capps study indicated that demographic characteristics do indeed play a role in demand for seafood. These characteristics included occupation of household head, region of residence, urbanization, number of children, race, and religious affiliation. More significantly, household expenditures on fresh and frozen seafood products consumed at home were more sensitive to changes in own-price than to changes in prices of poultry and red meat. In general, the demand for fresh and frozen seafood commodities was found to be price inelastic. Income elasticities were generally positive, but insignificant. Regarding the estimation procedure, the authors found that if they had chosen to delete observations which corresponded to zero expenditure levels, sample selection bias would have occurred, particularly in the demand for shellfish.

A study by Wellman (1990) also used household level micro data, published by the U.S. Department of Agriculture. Wellman estimated a system of household demand equations, also incorporating demographics, using the Almost Ideal Demand System. Similar to the Cheng and Capps study, the data contained several zero expenditure observations. To partially combat this problem the goods were aggregated somewhat. In addition, a methodology was used to include the information from the zero expenditure observations. However, instead of using the Heckman procedure, Wellman followed a procedure advocated by Heien and Wessells (1990) which utilizes the entire data set in the second step. The results were similar to those of Cheng and Capps in that the demand for various types of seafood were for the most part price and income inelastic.

Inelastic demand for seafood is uncommon in the rest of the literature. It is possible that this discrepancy is a result of the nature of the household data in the sense that households may confuse or, in the extreme, not know the species purchased when recording their expenditure data. In addition, fresh fish purchases are often made on a per portion (steak, fillet or individual shell) basis, in which case the respondent may not know or remember the quantities purchased when recording their consumption of fresh and frozen fish. Either of these occurrences will undermine the results. Also, because a large number of households do not consume significant quantities of seafood, a substantial amount of aggregation over species is necessary to obtain a reasonable number of non-zero observations. As a result, the substitution effects between species is often obscured, which in turn affects elasticity estimates.

Analyzing Advertising Effects on Retail Demand

In addition to impacts of changing prices, incomes and demographics on consumer demand for seafood, several researchers have explored the impact of advertising on consumer demand. The advertising may be specific to particular species, as in supermarket advertisements, or generic advertisements such as that used by the National Fish and Seafood Promotion Council or the Alaska Seafood Marketing Council. To investigate the effect of the former, Brooks and Anderson (1991) used primary data from supermarket sales of seafood in southern New

England (Rhode Island and Massachusetts). In order to account for the effects of changing prices, advertising and seasonality on seafood demand, the researchers gathered data directly from two individual supermarkets. Both firms were members of the same large supermarket chain. Of the two supermarkets chosen, one was in a coastal community, the other further inland. Data were compiled with the supermarkets' cooperation over an 81-week period from May 1982 through November 1984. This approach is limited in its generality, in that conclusions can be only be based on the region from which the primary data came. Generalizations of the results across other regions of the country depend on how closely the profiles of the surveyed consumers in the Northeast match with those in the rest of the country.

The impact of retail pricing, seasonality, and advertising on demand were examined for fresh cod and flounder fillets, and bay scallops. Supermarket sales were assumed to be dependent on price, substitute fish prices, income, advertising, substitute advertising and seasonal factors such as the Lenten season. Advertising effects were captured by using a binary variable, where the variable equalled one if the price and species were advertised during the week and zero otherwise. In addition, a cumulative variable was created to capture effects of substitute species advertising on the sales of the species in question. For example, in modelling fresh flounder demand, if fresh flounder was advertised for a particular week, along with four other fresh substitute seafood products, the dummy for advertising was one and the cumulative variable was four. Seasonality was also incorporated, with the Lenten season being singled out.

The results indicated that retail demand was significantly affected by own price (negative effect), Lent (positive effect) and own advertising (positive effect). The effect of advertising of other species was found to be insignificant. In all cases but one (flounder fillets at the inland store), the retail price elasticities were elastic.

Recent work by Capps and Lambregts (1991), recognizing the limitations of using secondary aggregate data when trying to understand details of advertising on a market, obtained scanner data from a retail food firm in Houston, Texas. This type of data allowed the researchers to analyze current market conditions in a dissaggregated way. A simple linear functional form was estimated within a seemingly unrelated framework to evaluate demand for nineteen species of fish. The approach used is comparable to that of Brooks and Anderson (1991), and it is interesting to note that the elasticities of similar products were of a similar order of magnitude in the two studies. In addition, in contrast to Cheng and Capps (1988) and Wellman (1990), the elasticities are generally price elastic.

Kinnucan and Venkateswaran (1990) studied the effects of generic advertising of catfish on consumers' perceptions and purchasing behavior. The catfish industry is one of the largest aquaculture industries in the U.S., with grower sales in 1989 of $323 million (USDA 1991). The advertising budget for this generic promotion has been as much as $1 million per year.[2]

The researchers followed the theory of buyer behavior from the marketing literature (Ajzen and Fishbein 1988; Fishbein 1963; Holbrook 1979). These theo-

[2] While this is a considerable amount of money, it still does not compare to yearly generic advertising budgets of beef ($80 million), dairy ($200 million) and pork ($30 million) (Armbruster and Frank 1988).

ries suggest that the flow of advertising affects sales indirectly through its effect on consumers' beliefs about relevant product attributes which in turn affect consumer attitudes. Advertising can be used to modify the set of product attributes deemed relevant by the consumer. This is particularly important for farmed catfish, in order to differentiate it from the negative picture some consumers have of a bottom feeding scavenger in muddy rivers. These modified beliefs then lead to improved attitudes toward the product, which in turn affect purchasing intentions, and culminate in a purchasing decision.

To capture the process, an eight equation model was developed where subsets of these equations captured effects of catfish advertising on catfish awareness, beliefs about catfish attributes, attitudes toward catfish and actual demand for catfish. The researchers used a household level data set with 3600 observations obtained from a nationwide telephone survey conducted in 1988, which was specifically designed to elicit consumer demand for catfish and their awareness of catfish advertising.

The first pair of equations relate awareness of the catfish advertisements and catfish products to socioeconomic characteristics of the household. Three additional equations captured beliefs about catfish products by regressing rankings of nutritional value, flavor and odor against socioeconomic variables. Attitudes toward catfish were estimated by regressing the consumers' ranking of catfish, relative to other fish and seafood, on their rankings of nutritional value, flavor and odor, and frequency of consumer purchases of catfish at home and in restaurants. Finally, two demand equations regressed purchases at home and in restaurants, respectively, against whether or not the consumer had seen the advertisements, the ranking of catfish relative to other fish and seafood and other exogenous variables affecting purchases of catfish for consumption at home or in the restaurant.

Results indicated that the generic advertising campaign for catfish did three things in its first year. First, it increased consumers' awareness of farm-raised catfish by 15 percent. Second, consumers' perceptions and attitudes toward catfish improved by 3 to 6 percent. Third, at-home and restaurant purchases increased by 12 to 13 percent.

The above research falls into a broader category of how the effects of additional information about products affect consumer demand. Information aimed at promoting the positive aspects of fish and seafood is increasingly appearing before the consumer.[3] Information about seafood, in particular seafood safety, has also appeared in the form of negative media publicity. Effects of both positive and negative information on consumer demand for fish and seafood are important pieces of information to the fishing industry. Approaches such as those used by Brooks and Anderson, Capps and Lambregts, and Kinnucan and Venkateswaran may serve as a basis for future important research on these effects.

Approaches Using Market Research Techniques

There are several useful features of traditional market and demand analysis, particularly in the studies discussed above. These studies help explain the mecha-

[3] The National Fish and Seafood Promotion Council created its 'spokesfish' to encourage the U.S. consumer to eat fish and seafood twice a week. In contrast to other generic advertising programs, NFSPC's 1990 budget was $8.75 million (Marris 1989).

nisms and structure of seafood markets and how they work. In addition, they can be used to generate predictions of impacts of such factors as changing demographics of consumers, changing management policies, and changing trade environments on the demand for fish and seafood products. However, there are several types of questions that traditional market and demand analysis is less well suited to answering. These include many practical questions commonly asked by businesses in the industry. What new products should be produced? Should production be shifted from one product form to another? How do consumers perceive competing products? What particular attributes of the products do consumers demand? These questions, among others, are for the most part not compatible with the types of data many traditional demand analyses use.

It is therefore worthwhile to discuss the rapidly growing literature of market research studies which generally use primary data and often employ multiattribute market research techniques, such as perceptual mapping techniques, focus groups, self-explicated utility analysis, conjoint analysis and other econometric models. Many of these techniques originated in psychology and business marketing literature, increasingly, however, economists have seen the merits of these techniques in their studies of markets for both private goods and non-market public goods such as environmental quality.

The bulk of market research tends to be relatively descriptive and, since it also tends to be useful in strategic decision making, much of the research is proprietary or has restricted circulation. Some valuable market research of primarily a descriptive nature includes many reports funded by the Department of Fisheries and Oceans, Canada (such as Egan and Gislason 1990; Kusakabe and Anderson 1989). Work by Shaw and others have been published by the Institute of Retail Studies at the University of Sterling. Reports from the Center for Applied Research, Norwegian School of Economics and Business Administration (such as Shaw and Gabbott 1990), the Market Research Series from the Irish Sea Fisheries Board, and the Globefish Research Programme reports published by the Food and Agriculture Organization (FAO), provide useful market details.

Market studies, other than purely descriptive analysis, focus on understanding consumer/buyer behavior—what will a buyer choose to purchase among reluctant alternatives, how much will he pay, what trade-offs are made in the purchasing decision, and what are consumer attitudes regarding various products. Focus groups are valuable in obtaining answers to these types of questions, but are limited to very small groups of consumers. Although results can be obtained quickly and in great detail, the approach is relatively expensive, is usually difficult to generalize because of small sample size, and may be influenced by the inherent biases of the focus group leader. Only limited research has been conducted on seafood using focus groups; examples include Miklos (1981) and Data Development Corporation (1988).

Multiattribute Market Research

Recently, conjoint analysis and self-explicated utility approaches have been used to understand buyer trade-offs in product preferences and purchase decisions. The methods are similar to contingent valuation approaches used by environmental economists where personal preferences are determined by eliciting a willingness to pay for non-market goods. (See Mitchell and Carson (1989), for an in-

depth discussion). The approach taken for market goods is usually known as conjoint analysis (Green and Wind 1975). The underlying concept is that the utility a purchaser derives from a product is a function of the product's attributes. Willingness to pay is not measured directly; rather, the degree of preference (utility) is measured.

Several variations of these approaches have been used to characterize seafood markets, such as studies of the U.S. salmon market (Anderson and Brooks 1986, and Anderson 1988), the Japanese salmon market (Anderson and Kusakabe 1989) and the striped bass market (Wirth, Halbrendt and Vaughn 1991).

In general, the information derived from these studies is quite rich—especially from the seafood industry's market research perspective. The results give direct estimates of the relative value of various attributes and attribute levels. By using this information, specific products can be compared in terms of relative preference. A particularly good example is consumer preference for (established) wild salmon versus the (new) product, aquacultured salmon. As mentioned above, given the constantly shifting supply curve of farmed salmon over the past decade, attempts to estimate the demand for Norwegian salmon may lead to elasticity estimates which are overly elastic. Market research presents an opportunity to explore the price elasticity of a new product in another manner.

For example, to determine Japanese buyer trade-offs in salmon product preferences, Anderson and Kusakabe (1989) conducted in-person surveys through a self-explicated utility approach. Personal interviews of 102 buyers were completed in Tokyo, Japan, to assess the most important characteristics of salmon that Japanese buyers purchase. Buyers were differentiated as those purchasing for trading companies, retail markets or restaurants. The survey was designed to determine the buyer's perception of the relative importance of attribute categories (*i.e.* species, region of origin, fat content) and the relative importance of specific attribute levels (*i.e.* the species attribute and its levels, coho, chinook, sockeye, pink, chum, Atlantic).

While methodologies such as this are not designed to calculate price elasticities, conclusions can be drawn on Japanese demand for Norwegian Atlantic salmon, as well as other salmon species from other countries. Results of this particular survey showed that buyers for large retailers did not rate Norwegian Atlantic salmon very highly relative to, for example, wild caught frozen sockeye from Canada. However, for those same buyers, frozen troll-caught coho or chinook and farmed coho and chinook would be close substitutes if closely priced. In contrast, restaurant buyers generally preferred fresh products to frozen sockeye, and rated Atlantic salmon from Norway among their most preferred.

There were also several other conclusions identified from the results of the survey. First, Canadian salmon was found to have a more favorable image among traders and large retailers than Alaskan salmon. Second, the study determined that the most important attribute categories (in decreasing order) were: price, quality (freshness), species, color, appearance and origin for traders; quality (freshness), price, color, appearance, fat content, supply and origin for retailers; and quality (freshness), state (fresh/frozen/salted), price, product form, color, appearance and origin for restaurants.

In more recent work, Anderson and Bettencourt (1991) used a two-limit tobit technique to estimate a hybrid conjoint model of the restaurant and retail market for salmon products in the U.S. In the hybrid model, the respondent's self-

explicated attribute importance rating is used to weight the dependent variables. This model was found to outperform traditional models and was quite effective at predicting the most and least preferred salmon products among an eight-product choice set.

Discussion and Summary

It is quite challenging to attempt to construct complete yet realistic economic models of seafood markets; the market is inherently international, heterogenous and dynamic. It is even more challenging to empirically estimate these models without unduly sacrificing the structure of the model. Lack of data, as well as lack of reliability and accuracy of available data are common problems. These particular constraints are also common in fisheries management research. However, the failure to have complete data on observable phenomena such as sales, trade and prices seems somewhat less excusable than failure to have complete data on virtually unobservable stock size and recruitment.

Demand and market research have improved considerably over the last decade, due in part to better data and continued attraction of new talent who bring new ideas and techniques to the field. One of the trends in seafood market research in the last decade has been the move toward using more disaggregated data to gauge market sensitivity to changes in product characteristics, uncertainty and demographics, and increased promotion, education and media events. This has occurred in response to the difficulty of capturing the short term dynamics of seafood markets using aggregated, secondary time series data. Lengthy time series data may be useful in capturing the long term dynamics of seafood markets, especially if reasonable attention is given to hypotheses tests regarding structural change. On the other hand, as many of the studies discussed above have shown, high returns can be expected from research based on short term time series data which contain greater and richer detail on the market. Additionally, the techniques used have increased in diversity to address both data limitations and increased disaggregation of the data. As seafood market researchers, we must continue to explore new techniques which compliment traditional market analysis approaches with techniques from outside the traditional, such as those in the market research field.

If the demand side of the fisheries economics discipline continues to attract creative researchers to study the market at all levels, from aggregated to detailed market segments, and there is a continued effort to improve and increase the amount of available data and continual pursual of new techniques to analyze the data, then studies of the fisheries sector will continue to improve. It must continue to improve in order for our profession to be more valuable to the retail sector, fishermen, processors, fisheries managers and others in the seafood industry. Hopefully, as researchers provide astute analyses of market and demand behavior and the interactions of the harvest component of the industry with the market, more efficient use will be promoted of all the resources invested in the world's fishery and aquaculture industries.

References

Abraham, G. 1979. Canadian chum salmon export market study. M.S. Thesis. Oregon State University, Corvallis, OR.

Acheson, J. M., and R. Reidman. 1982. Biological and economic effects of increasing the minimum legal size of American lobster in Main. *Transactions of the American Fisheries Society* 111:1–12.

Ajzen, I., and M. Fishbein. 1980. *Understanding Attitudes and Predicting Social Behavior.* Prentice Hall. Englewood Cliffs, NJ.

Anderson, J. L., and J. E. Wilen. 1986. "Implications of private salmon aquaculture on prices, production, and management of salmon resources." *American Journal of Agricultural Economics* 68:866–879.

Anderson, J. L. 1988. "Current and future market for salmon in the United States." *in Proceedings of Aquaculture International Congress and Exposition.* Vancouver Trade and Convention Centre. Vancouver, BC., Sept. 6–9:81–88.

Anderson, J. L., and S. Bettencourt. 1991. "Using a conjoint approach to model product preferences: The New England market for fresh and frozen salmon." URI/AES No. 2678. University of Rhode Island, Kingston, Rhode Island, p. 27.

Anderson, J. L., and P. Brooks. 1986. "Conjoint analysis of the New England salmon market." Report prepared for Canadian Department of Fisheries and Oceans, Vancouver, BC.

Anderson, J. L., and Y. Kusakabe. 1989. *Analysis of the Japanese Salmon Market.* Canadian Department of Fisheries and Oceans, Economic and Commercial Fisheries Report No. 56. D.F.O. Vancouver, BC.

Armbruster, W. J., and G. Frank. 1988. "Generic agricultural commodity advertising and promotion: Program funding, structure and characteristics." *In* A. E. Extension 88-3. Cornell University, Ithaca, N.Y.

Bell, D. 1978. *Socio-Economics of the Idaho, Washington, Oregon and California Coho and Chinook Salmon Industry.* Final Report to the Pacific Fishery Management Council. Portland, Oregon.

Bell, F. 1968. "The Pope and the price of fish." *The American Economic Review* 58:1346–50.

Bell, F. 1972. "Technological externalities and common property resources: An empirical study of the U.S. northern lobster fishery." *Journal of Political Economy* 80:148–158.

Bird, P. 1986. "Econometric estimation of world salmon demand." *Marine Resource Economics* 3:169–182.

Blomo, V., J. Nichols, W. Griffin, and W. Grant. 1982. "Dynamic modelling of the Eastern Gulf of Mexico shrimp fishery," *American Journal of Agricultural Economics* 64:475–482.

Bockstael, N. 1977. *A Market Model for New England Groundfish.* University of Rhode Island, Agricultural Experiment Station Bulletin No. 422.

Botsford, L. W., J. E. Wilen, and E. J. Richardson. 1986. "Biological and economic analysis of lobster fishery policy in Maine." Report submitted to the Committee on Maine Resources, State of Maine, Portland.

Brooks, P. M., and J. L. Anderson. 1991. "Effects of retail pricing, seasonality and advertising on fresh seafood sales." *Journal of Business and Economic Studies* 1:55–68.

Brooks, P. M. 1987. The retail value of extending shelf life of fresh seafood. M.S. thesis, University of Rhode Island, Kingston, RI.

Capalbo, S. M. 1976. An analysis of the market structure of the food fish processing sector of the U.S. fishery industry. M.S. thesis, University of Rhode Island, Kingston, RI.

Capps, O., and J. Lambregts. 1991. "Assessing effects of prices and advertising on purchases of finfish and shellfish in a local market in Texas," *Southern Journal of Agricultural Economics* 23:181–194.

Cheng, H., and O. Capps. 1988. "Demand analysis of fresh and frozen finfish and shellfish in the United States." *American Journal of Agricultural Economics* 70:533–542.

Crutchfield, J., and G. Pontecorvo. 1969. *The Pacific Salmon Fisheries: A Study of Irrational Conservation,* Baltimore: The Johns Hopkins Press.

Crutchfield, J., and A. Zellner. 1962. *Economic Aspects of the Pacific Halibut Fishery*. Fishery Industrial Research, Vol. 1, No. 1, U.S. Department of Interior, Washington, D.C.

Crutchfield, S. R. 1985. "An econometric model of the market for New England groundfish." *Northeast Journal of Agricultural and Resource Economics* 14:128–143.

Data Development Corporation. 1988. *Analysis of Consumer Attitudes Towards Fish and Seafood*. Prepared by Foodservice Research and Marketing, Division of Data Development Corporation for the National Fish and Seafood Promotional Council, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.

DeVoretz, D. 1982. "An econometric demand model for Canadian salmon." *Canadian Journal of Agricultural Economics* 30:49–59.

DeVoretz, D., and K. Salvanes. 1988. "Demand for Norwegian farmed salmon: A market penetration model." A paper presented at the International Institute of Fisheries Economics and Trade, Denmark.

Doll, J. P. 1972. "An econometric analysis of shrimp ex-vessel prices 1950–68." *American Journal of Agricultural Economics* 54:431–40.

Edwards, Steven F. 1981. Econometric and welfare analysis of the Atlantic sea scallop markets. M.S. thesis, University of Rhode Island, Kingston, RI.

Egan, D., and G. Gislason. 1989. *U.S. Salmon Consumer Survey*. Economic and Commercial Analysis Report No. 23. Market Analysis Group, Commercial and Market Analysis Division, Canadian Department of Fisheries and Oceans, Ottawa, Canada.

Farrell, J., and H. Lampe. 1965. "The New England fishing industry: Functional markets for finned food fish I and II." Agricultural Experiment Station Bulletin #379, University of Rhode Island, Kingston, RI.

Felixson, T., P. G. Allen, and D. A. Storey. 1987. "An econometric demand and supply analysis for fresh New England groundfish: With emphasis on the role of Canadian imports." *Northeastern Journal of Agricultural and Resource Economics* 16:24–34.

Fishbein, M. 1963. "An investigation of the relationships between beliefs about an object and the attitudes toward that object." *Human Relations* 16:233–40.

Green, P. E., and Y. Wind. 1975. "A new way to measure consumers' judgements." *Harvard Business Review* 53:107–117.

Green, P. E., and V. Srinivasan. 1978. "Conjoint analysis in consumer research: Issues and outlooks" *Journal of Consumer Research* 5:103–123.

Hatch, U., W. Zidack, and H. Kinnucan. 1989. "Market dynamics of the U.S. catfish industry." Paper presented at the Western Economic Association annual meetings.

Hayes, D., T. Wahl, and G. Williams. 1990. "Testing restrictions on a model of Japanese meat demand." *American Journal of Agricultural Economics* 72:556–566.

Heien, D., and C. R. Wessells. 1990. "Demand systems estimation with micro-data: A censored regression approach." *Journal of Business Economics and Statistics* 8:365–371.

Herrmann, M., R. C. Mittlehammer, and B. Lin. 1989. "Applying Almon-type polynomials in modelling seasonality of demand: The case of the Japanese demand for salmon." A paper presented at the American Agricultural Economics Association annual meetings, Baton Rouge, LA.

Herrmann, M., and B. Lin. 1988. "The demand and supply of Norwegian Atlantic salmon in the United States and the European Community." *Canadian Journal of Agricultural Economics* 36:459–471.

Herrmann, M. 1990. An economic analysis of world salmon markets: Effects of salmon farming. Ph.D. dissertation, Washington State University, Pullman, WA.

Holbrook, M. B. 1979. "Beyond attitude structure: Toward the informational determinants of attitude." *Journal of Marketing Research* 15:545–56.

Kabir, M., and N. B. Ridler. 1984. "The demand for Atlantic salmon in Canada." *Canadian Journal of Agricultural Economics* 32:560–568.

Kikuchi, A. 1987. Salmon consumption at the household level in Japan. M.S. thesis, Oregon State University, Corvallis, OR.

Kinnucan, H., S. Sindelar, D. Wineholt, and U. Hatch. 1988. "Processor demand and price-markup functions for catfish: A disaggregated analysis with implications for the off-flavor problem." *Southern Journal of Agricultural Economics* 20:81–91.

Kinnucan, H., M. Venkateswaran, and U. Hatch. 1990. "Effects of catfish advertising on consumers' attitudes, purchase frequency and farmers' incomes." Alabama Agricultural Experiment Station, Auburn, AL, Bulletin 307.

Kinnucan, H., and M. Venkateswaran. 1990. "Effects of generic advertising on perceptions and behavior: The case of catfish." *Southern Journal of Agricultural Economics* 22:137–151.

Kusakabe, Y., and J. L. Anderson. 1989. *The Japanese Seafood Market: Salmon.* Economic and Commercial Analysis Report No. 23. Market Analysis Group, Commercial and Market Analysis Division, Canadian Department of Fisheries and Oceans, Ottawa, Canada.

Lent, R. J. 1984. Uncertainty, market disequilibrium and the firm's decision process: Applications to the Pacific salmon market. Ph.D. dissertation, Oregon State University, Corvallis, OR.

Lin, B. 1984. "An econometric analysis of salmon markets." Paper presented at the International Institute of Fisheries Economics and Trade, Christchurch, New Zealand.

Lin, B., M. Herrmann, T. Lin, and R. Mittelhammer. 1989. "Forecasting the price of farmed Atlantic salmon: An integrated econometric and time series approach." *Agribusiness: An International Journal* 5:477–488.

Lin, C. T. 1991. Consumer shellfish safety perceptions and consumption behavior. Ph.D. dissertation, University of Florida, Gainesville, FL.

Marris, Katherine. 1989. America's Spokesfish. An ad campaign "as fresh as the product it's selling." *Seafood Business.* 8, No. 6.

Miklos, P. 1981. *Consumer Attitudes Toward Seafood–A Qualitative Research Report.* A report prepared for the Food Marketing Institute, Washington, D.C. in cooperation with the National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, Washington, D.C.

Mitchell, R. C., and R. T. Carson. 1989. *Using Surveys to Value Public Goods: The Contingent Valuation Method.* Resources for the Future. Washington, D.C.

Nash, D. A., and F. W. Bell. 1969. "An inventory of demand equations for fishery products." Division of Economic Research, Bureau of Commercial Fisheries Working Paper No. 10.

Nyankori, J. 1991. "Price transmission in the catfish industry with specific emphasis on the role of processing cooperatives," *Southern Journal of Agricultural Economics* 28:247–252.

Perry, J. S. 1981. An econometric analysis of socioeconomic and demographic determinants of fish and shellfish consumption in the U.S. Ph.D. dissertation, University of Florida, Gainesville, FL.

Prochaska, F. J., and W. R. Keithly. 1985. "Market impacts of U.S. shrimp imports" *in Proceedings of the Workshop on Shrimp and Prawn Markets.* Sponsored by the International Institute of Fisheries Economics and Trade and the South Carolina Wildlife & Marine Resources Department in Charleston, South Carolina.

Onuorah, M. C. 1973. Foreign and domestic trade in canned salmon of the U.S. and Canada: The effect on the derived demand of the fishermen. M.S. thesis. Oregon State University, Corvallis, OR.

Ravallion, M. 1986. "Testing market integration." *American Journal of Agricultural Economics* 68:102–109.

Riely, P. L. 1986. An economic analysis of the market for Atlantic salmon aquaculture. Ph.D. dissertation, University of Rhode Island, Kingston, RI.

Saito, E., R. S. Johnston, and A. Siaway. 1985. "The Japanese market for shrimp." *in Proceedings of the Workshop on Shrimp and Prawn Markets*. Sponsored by the International Institute of Fisheries Economics and Trade and the South Carolina Wildlife & Marine Resources Department in Charleston, South Carolina.

Shaw, S., and M. Gabbott. 1990. *An International Study of the Marketing of Farmed Salmon*. Report No. 05/1990. Center for Applied Research, Norwegian School of Economics and Business Administration. Department of Economics, University of Oslo, Norway.

Schrank, W. E., and N. Roy (eds.) 1991. *Econometric Modelling of the World Trade in Groundfish*. NATO AIS Series E: Applied Sciences–Vol. 201.

Squires, D. 1986. "Ex-vessel price linkages in the New England fishing industry." *Fisheries Bulletin U.S.* 84:437–442.

Squires, D., S. Herrick, and J. Hastie. 1989. "Integration of Japanese and United States sablefish markets." *Fisheries Bulletin U.S.* 87:341–351.

Thompson, M. E., K. J. Roberts, and P. W. Pawlyck. 1985. "Structural change in U.S. shrimp markets." *in Proceedings of the Workshop on Shrimp and Prawn Markets*. Sponsored by the International Institute of Fisheries Economics and Trade and the South Carolina Wildlife & Marine Resources Department in Charleston, South Carolina.

Tsoa, E., W. E. Schrank, and N. Roy. 1982. "U.S. demand for selected groundfish products, 1967–80." *American Journal of Agricultural Economics* 64:483–489.

U.S. Department of Agriculture. 1991. *Aquaculture Situation and Outlook*. Commodity Economics Division, Economic Research Service, Washington, D.C.

U.S. Department of Commerce. 1991. *Fisheries of the United States*. NOAA, NMFS, Washington, D.C.

U.S. Department of Commerce. 1991. *Analysis of Consumer Perspectives of Fish and Seafood*. USDC, NOAA, National Fish and Seafood Promotion Council, Washington, D.C.

Wang, S. D., and C. B. Kellogg. 1988. "An econometric model for American lobster." *Marine Resource Economics* 5:61–70.

Wang, D. H. 1976. An econometric study of the Canadian sockeye salmon market. Ph.D. thesis, Oregon State University, Corvallis, OR.

Waugh, F. H., and V. J. Norton. 1967. "Some analyses of fish prices." Working paper no. 32. U.S. Department of Commerce, Bureau of Commercial Fisheries, Washington, D.C.

Wellman, K. 1990. Chicken of the sea?: The U.S. consumer retail demand for fish products. Ph.D. dissertation, University of Washington, Seattle, WA.

Wessells, C. R. 1990. An economic analysis of the Japanese salmon market: Consumption patterns, the role of inventories and trade implications. Ph.D. dissertation, University of California, Davis, CA.

Wessells, C. R., and J. E. Wilen. 1990. "Seasonal patterns and regional preferences for salmon in Japan." Paper presented at the American Agricultural Economics Association meetings, Vancouver, B.C.

Wirth, F. F., C. K. Halbrendt, and G. F. Vaughn. 1991. "Conjoint analysis of the mid-Atlantic food-fish market for farm-raised hybrid striped bass." *Southern Journal of Agricultural Economics* 23:155–164.

Wood, W. R. 1970. A demand analysis of processed salmon from the West Coast. Ph.D. thesis, Oregon State University, Corvallis, OR.