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LARRY O. ROGERS for the degree of DOCTOR OF PHILOSOPHY

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Title: THE DEMAND FOR BUFFALOFISH, A PROXY FOR CARP

Abstract approved: ______________________

Richard S. Johnston

Little attention has been given to the question of the economic feasibility of a pond-food-carp industry in the United States. Yet, as the trend in farm-raised catfish indicates, it is likely that the pond-food-fish industry will play an increasingly important role in helping to meet the domestic demand for fresh, fresh-water fish.

Since the domesticated carp industry is the most important pond-food-fish industry in the world, it is possible that under certain conditions of supply and demand, the pond-food-carp industry may also become important in the United States. If so, then it will be important to understand the nature of its demand and the underlying forces which help to shape that demand. This was the aim of this study.

Since no domestic supply of the pond-food-carp exists, it was decided that if a proxy species, similar to the carp in terms of physical and market characteristics could be found, then this species could be used to estimate the potential demand for the pond-food-carp, or at least reveal the important factors affecting that demand. The buffalofish was chosen as the best candidate for this task.

As part of this study, the individual components of the Chicago fresh fish market were discussed. It was seen that the inland commercial fishery is distinct from its salt-water counterparts primarily in terms of the level of capital investment. The wholesale fresh fish market was described as an oligopsony in the purchase of fish and an oligopoly in the sale of fish. The retail fresh fish market was seen to be dominated by large chain food stores.

It was seen that in the case of oligopsonistic buying, fish price spreads can reflect not only supply and demand conditions, but other factors such as personal relationships and bargaining power as well.

Based upon the characteristics of an open-access fishery which were described, and upon certain assumptions, a hypothesis of a downward sloping average cost curve of fish was obtained. If such a hypothesis is true, then observations of wholesale price and quantities may not trace out the demand curve of the wholesaler but may include aspects of the short-period average total cost curve of the fisherman as well.

Subject to this complication, a basic demand equation for buffalofish was developed. It was specified as a price-dependent, distributed lag, linear regression, equation. The results of the analysis are given below.

During the period covered (1958-1977), in general, the estimated results suggest that the price of buffalofish would increase by one to two cents per pound during a given month if buffalofish receipts decreased by 100,000 pounds. On the other hand, if the increase in receipts were sustained for a period of two months, the price of buffalofish, in general, would decrease by two to four cents per pound.

The demand for buffalofish was found to be relatively price inflexible, which means that the total revenue of the fishermen would increase with increasing deliveries of buffalofish. With the exception of 1960, the years in which the sustained price flexibility coefficient exceeded unity coincided with the occurrence of adverse publicity.

An alternative model was specified and involved a system of equations. A two-stage least squares system was used to estimate the parameters of the demand equation and the results suggested that the supply of buffalofish may be treated as an exogenous variable.

Finally, an examination of the relationship between the price of buffalofish and receipts of feral carp was conducted. The results suggest that, while the wholesale demand for carp may respond relatively rapidly to changes in buffalofish prices, supply adjustments probably take place with a lag.

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I. INTRODUCTION

Background Information and Justification

Economic feasibility essentially refers to the profitability of an economic endeavor. Thus, economic feasibility analysis, if it is to be complete, must consider both the costs (supply) and revenues (demand) associated with a particular endeavor. For reasons explained below, this paper considers only the revenue side of a hypothetical industry.

Many economic feasibility studies focusing on supply alone have been conducted. Such an approach can be justified for a product with a well established market, and for which relative output expansion will be small. On the other hand, for a new product for which there is no established market, or for a product whose supply will likely expand significantly, a single-sided, cost approach will likely be unsatisfactory.

When production costs are known or easily discernible, demand analysis alone often gives sufficient insight into a problem. Yet, because of the complex interaction of market forces, demand is usually difficult to estimate.

This paper focuses on the demand for, rather than the supply of, pond-food-carp for several reasons. First, production techniques for pond-food-carp have long been known. Many excellent texts on the topic are available [31, 52]. Second, excellent economic studies on the costs of production for pond-raised fish in the United States are available [21, 24]. Hence, much of the information required for cost analysis of pond-food-carp is already available. Finally, demand studies for aquaculture are in their infancy. There are apparently no such studies for a United States pond-food-carp industry.[1/]

Benefits

Oftentimes, the major ramifications stemming from research are not, and perhaps cannot be foreseen. Nevertheless, it is hoped that the results of this study will be beneficial to several groups of citizens, including commercial fishermen, others engaged in the fresh water fishery, lenders, potential pond-food-carp entrepreneurs, policy makers, reseachers, and consumers.

Wholesalers, retailers, and consumers stand to benefit if, as a result of this study, the supply of fresh fish is increased.

Commercial fishermen, in order to determine the economic feasibility of using holding pens,[2/] need to consider the effect on price of withholding fish from the market. Hence, the fishermen must have some understanding of the factors which affect demand and the magnitude of the price flexibility of demand.

[1/] Interestingly, the Chinese, who have cultured the carp for thousands of years, apparently have not conducted a demand study for carp. Personal communication. Lue On-feng, Chief, Fisheries Research Institute, Kwangtung Province, Peoples Republic of China.

[2/] Nets placed in lakes, rivers, etc. for holding live fish.

At the same time, both private and government lenders can use these results in deciding whether or not to finance the construction of holding pens.

Potential pond-food-carp entrepreneurs must estimate the effect of their output, as well as the output of potenital competitors, on the market price of pond-food-carp. They may also wish to consider the effect on the price of pond-food-carp if fluctuations in the supply of buffalofish are reduced due to the use of holding pens. In either case, the entrepreneur must be concerned about the potential level and shape of the demand curve for the pond-food-carp, and the factors which affect that demand.

Wholesalers and retailers stand to benefit from a uniform supply of fish. Wholesale dealers, for example, would be able to adjust their plant capacity, workforce, and sales program to obtain increased profits if supply were known. Retailers, on the other hand, would find it easier to feature advertising programs if purchase price and quantity were known in advance.

Some consumers would likely benefit from an increased supply of fresh fish through the growth of the pond-food-fish industry.

Policy makers and lenders may find this research helpful in their appropriation or lending decisions regarding a pond-food-carp industry or enterprise.

Finally, researchers who are interested in estimating the demand for a product whose supply is not already on the market may find this research useful from a methodological perspective.

Losses

Potential market changes stemming from this study may also have a negative impact on some groups or individuals. Those consumers who benefit from low prices when supplies are heavy, may lose if the periodic market gluts of fresh fish are eliminated. Those fishermen who benefited from the periodic high prices of buffalofish may also lose if the supply were steady. Wholesale dealers who profit from market uncertainty may lose if supply and price were stable. Further, since pond-food-fish are generally marketed when the price is high, pond-food-buffalofish producers may lose if the price of buffalofish were stable. Finally, if the price of buffalofish declines as a result the introduction of a pond-food-carp industry, the pond-food-buffalofish producers may lose.

Importance of Problem

Animal protein, including fish, forms an important component of human nutrition. In 1977, world production of edible fishery products was estimated to be around 53 million metric tons [20]. Allowing for a 40 percent loss due to processing, and estimating protein content at 19 percent, then this production represents enough high quality protein to meet the total annual protein requirement of a nation of 380 million people.

The fishing industry is the oldest industry in the nation. The teeming waters of the Atlantic Ocean and coastal rivers provided an important part of the early American diet. But as the population shifted inland, the relative importance of fish in the American diet decreased. In 1975, per capita consumption in the United States is estimated to be around 12.1 pounds [65]. Still, this represents a total fish consumption of 1,278,970 metric tons.

The year 1977 marks a turning point in the U.S. fishing industry. For the first time, the trend toward declining domestic catches and rising imports was reversed. Net imports of edible fishery products stood at approximately 837,000 metric tons, which represented a four or five percent drop from 1976 in the U.S. supply [42]. However, total imports of edible fishery products remained well over 2 billion pounds [Table 1], while imports of less important ("other") fresh and frozen fish stood at nearly 200 million pounds in 1978, an increase of 10 million pounds in two years [65].

Some of the major reasons for this failure of the U.S. fishing industry to meet domestic demand are: 1) costs which are higher than those of competing suppliers due to high labor costs, diminished fish stocks, or inefficient fishing methods; 2) pollution, which reduces stocks, lowers quality or reduces demand for domestic fish because of health concerns; and 3) competition for the use of water resources from recreational, agricultural, utility and industrial users.

Some experts argue that the high level of imports is cause for concern. What the alarmists fail to consider, however, is that through foreign trade, countries which enjoy a comparative advantage in the production of one commodity may exchange with a country which has a comparative advantage in another commodity. Through this process,

Table 1. Imports of edible fishery products

	1000/pounds
1953	726,194
1954	803,389
1955	771,012
1956	787,866
1957	884,024
1958	991,479
1959	1,113,624
1960	1,067,460
1961	1,061,662
1962	1,222,836
1963	1,196,977
1964	1,318,099
1965	1,398,416
1966	1,593,714
1967	1,470,437
1968	1,741,365
1969	1,706,571
1970	1,873,300
1971	1,785,470
1972	2,341,138
1974	2,266,880
1975	1,913,089
1976	2,228,475
1977	2,177,010
1978	2,420,765

Source: United States Department of Commerce, NOAA, NMFS, Fishery of the United States, Statistical Digest Nos. 36-67 and Fisheries of the United States, 1978, Current Fishery Statistics No. 78.

both countries can become better off than before trade. Thus, for example, Cost Rica may sell bananas to the United States and import refrigerators, while the United States may import bananas and export refrigerators to the benefit of both countries.

It is likely that for years to come, foreign nations will continue to hold a comparative advantage over the United States in deep sea ocean fishing. The economic potential of pond-food-carp production lies not in import substitution for frozen fillets but in its potential for supplying local demand for fresh fish. If this production is carried out near population centers, then the potential for energy, and hence cost, savings are increased since transportation requirements are reduced. Further, local production of fresh fish eliminates or reduces the need for freezing and packing, which also reduces the level of energy input. Finally, it is hoped that such an industry, if it develops, will utilize more fully non-utilized or underutilized resources such as land or labor. However, the only important criterion for the success of any industry is that it use the nation's resources in such a way that the industry earns a profit. This is the test of the marketplace.

Objective of Study

The major objective of this study is to examine the wholesale market for buffalofish in Chicago in order to estimate the wholesale demand for buffalofish and the potential demand for pond-food-carp.

Appropriateness of the Carp as a Pond-Food-Fish

Of the 25,000 or so species of fish, probably no more than two or three dozen of them are cultured as food. Of these species, the carp is the most widely cultured worldwide in terms of geography and amount. In this country, both the channel catfish and the rainbow trout have enjoyed years of commercial success - the trout being considered a high-valued species while the catfish is considered to be a moderate-valued species.

The biology of the domestic carp is well known. Among the desirable traits for carp culture, its supporters would list the following:

1. high fecundity (up to 2.2 million eggs) [61].
2. ability to thrive in turbid (up to 165,000 ppm silicon dioxide equivalents) polluted water [48].
3. ability to survive wide ranges of temperature (0°C to 36°C) [60,76], salinity (fresh to 7,200 ppt salt) [59], and ph (5.0 to 10.0) [47].
4. omnivorus feeding ability and low animal protein requirement [47].
5. hardiness (able to live for 14 months without food) [25] and (able to live at least 14 days without water) [14].
6. resistance to many diseases and parasites [14].
7. nonfish-eating nature under ordinary conditions [44].

On the other hand, opponents of the carp claim that it:

1. has a "muddy" taste

2. has a large number of intra-muscular bones
3. is unappealing because it lives in polluted water
4. has a coarse, dry texture
5. has grey colored flesh.

Interestingly, the desirable traits listed generally relate to supply or cost factors; while the disadvantages of the carp are basically demand factors. Once again we are reminded that both supply and demand must be considered in an economic evaluation of a potential enterprise or industry.

There is no gainsaying that from a biological (and cost) point of view, the carp has many advantages. Studies have shown that for some lands, the animal protein yield from carp production equals or exceeds that from hog production.[3] In assessing the appropriateness of the carp for commercial culture, from the demand side, two important facts must be borne in mind. First, the cultured or domestic carp is deeper bodied than the "wild" carp, and has a scale pattern ranging from completely "naked" to fully scaled. Second, the pond-food-carp is reared under semi-controlled conditions in which both the food supply and water condition are controlled. Proper control of these two factors eliminate almost entirely the problem of a "muddy" taste.

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[3] One researcher found that fish culture, especially carp, is equal to and at times exceeds the efficiency of livestock (cattle) protein production [55].

Another researcher, in a study which compared the economic potential of aquaculture, land animal husbandry, and ocean fisheries in Taiwan, found that the estimated average cost of production of protein from aquaculture (brackish water, fresh water and shallow sea) was lower than the average cost of protein production from hog farming [54].

The remaining major problem often given by opponents of the carp - large numbers of small intra-muscular bones - can be ameliorated in one of two ways. First, since the larger fish have larger bones, raising larger-sized fish reduces the problem. However, since the growth rate of fish eventually decreases as the size of the animal increases, this remedy usually will increase cost since the increase in value of the larger fish may not offset the relatively large fixed costs associated with fish culture. Consequently, raising fish large enough to significantly reduce the small-bone problem may not be economically justified. Secondly, the small-bone problem can be "solved" by proper cooking methods. If the flesh of the carp is scored at approximately one inch intervals down to the bones, and then deep-fat fried, the small bones soften and can easily be eaten just as the small bones in sardines are cooked and eaten. This second approach would involve consumer education.

The Buffalofish as a Proxy for the Pond-Food-Carp

Since the pond-food-carp is not currently marketed in the United States,[4/] the usual statistical methods of demand analysis cannot be directly applied. It was decided that the use of a proxy species would afford a somewhat novel and, it is hoped, accurate means for indirectly

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4/ In a test of the American market for the pond-food-carp, 100,000 pounds of whole, sliced and ground domestic carp from Israel were imported into New York during 1970-1971. The product was considered a gourmet item and was fairly well received. Nevertheless, it did not prove economically feasible and was discontinued [5].

estimating the demand for the pond-food-carp, or at least some of the factors affecting that demand.

Two organisms were considered as likely proxy candidates - the common or feral carp,[5/] and the bigmouth buffalofish (Ictiobus cyprinellus).

The common carp was rejected as a proxy for two reasons. First, its quality (taste) is inferior to the pond-food-carp. The common carp often lives in warm polluted waters that are unsuitable for many species. These waters often impart an off-flavor or "muddy" taste to the carp, which consumers find objectionable. The second reason for rejecting the feral carp as a proxy was the lack of appropriate data. The only price series on the feral carp was maintained by the Chicago office of the National Marine Fisheries Service. This series was discontinued in 1971, presumably because the declining volume of carp receipts did not justify maintaining the data. For many years preceding the discontinuance of the price series, the wholesale price of carp in Chicago varied little [Table 2]. This lack of price variation was undoubtedly due to a highly price-elastic supply relationship: the available supply of carp greatly exceeded its demand. The carp, as an incidental catch, (except in rough fish removal or control programs) was dumped or sold

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[5/] A feral organism is one that was previously domesticated but has escaped and become established in the wild. It is to be distinguished from a truly wild, never domesticated animal. Thus, the "wild" carp found in the United states today is feral since it is an evolved form of the domesticated carp introduced into this country from Germany. Terms commonly applied to the feral carp are: 1) common carp, 2) German carp, 3) Israeli carp, and 4) wild carp. However, it should be noted that the preferred usage of the terms "German" or "Israeli" carp is in reference to the domestic varieties used in or originating from, Germany or Israel, respectively.

Table 2. Chicago wholesale price of No. 1 carp

	Cents per Pound											
Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1951	5	5-6	5-7	4-7	4-6	5	5-6	5-8	6-12	4-8	5-8	5-8
1952	7-8	7-9	7-10	4-11	4-6	4-7	5-8	5-7	5-8	6-7	5-8	5-7
1953	5-8	5-7	6-8	4-6	4-5	4-6	5-7	4-7	4-6	4-6	5-8	6-7
1954	4-8	5-7	5-7	4-8	3-6	4-6	4-7	4-8	7-9	5-8	7-8	5-8
1955	6-8	5-7	4-8	4-9	4-7	5-7	5-8	7-8	6-9	7-8	7-8	7-8
1956	6-8	7-9	5-7	5-6	5-7	4-6	4-7	5-8	6	5-7	6-7	7-8
1957	7-8	6-8	5-7	5-7	5-6	4-5	5-7	6-7	6-8	5-7	7-8	7-8
1958	6-10	7-9	7-9	4-7	5-7	4-6	5-7	6-7	6-7	5-8	6-7	5-8
1959	5-7	5-7	5-7	5-8	4-7	5-6	5-6	6	5-8	6-8	6-7	5-7
1960	5-7	4-7	6-8	3-6	4-7	4-6	4-6	4-6	5-9	6-7	6-7	6-8
1961	5-8	5-8	4-7	4-6	4-6	5-6	5-6	5-7	5-6	5-7	5-8	6-7
1962	6-7	5-7	6-7	4-6	4-7	5-7	5-7	5-7	5-8	5-6	5-6	4-5
1963	4-6	5-6	5	4-5	5	5	5	5	5-6	5	5	5
1964	2-5	3-4	4	4-5	-	-	3-5	4-6	4-5	4-5	4-5	4-5
1965	4-5	4-5	4-5	4-5	3-4	3	3	3-4	3-6	4-5	4-6	4-6
1966	4-7	6-7	4-7	4-6	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
1967	4-5	4-5	3-5	3-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
1968	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-6	4-5	4-5	4-5
1969	4-5	4-5	4-6	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
1970	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5	4-5
1971	4-5	4-5	4-5	4-5	-	-	-	-	4-5	4-5	4-5	4-5

Source: U.S. Dept. Commerce, NMFS, Chicago Market News, Annual Summaries.

as fertilizer, animal feed or for human consumption according to whether its price was less than or equal to the cost of shipping or handling. This phenomenon of little price variation over time for the carp will be discussed in greater detail in Chapter V.

The other proxy species considered was the buffalofish. The buffalofish and the carp are only distantly related (both are ostomids). Nevertheless, they are superficially similar, and consumers often purchase the lower-valued carp thinking that the buffalofish is being purchased.[6/]

But the similarity of the two species goes beyond that of size, shape, color and scale pattern. It also includes bone formation, flesh texture, and fat content (when raised in the same environment). Only in the area of taste is there an important difference between the buffalofish and the carp; and this difference is largely due to the waters within which the two species live. The buffalofish flavor is thought by many to be superior to that of the carp. Largely because of this flavor difference, the buffalofish is generally considered to be a more desirable species than the feral carp. This can be seen in the marketplace where the buffalofish commands a price considerably above that of the carp.

However, in Israel, where the pond-food-carp industry is large and well established, attempts to establish a pond-food-buffalofish industry

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[6/] One Chicago wholesale dealer reported that he has on occasion, sold the carp as buffalofish to unsuspecting customers. The author was deceived by the same tactic at a retail fish market in Ontario, Canada some years ago. The deception was pointed out by his father to whom the fish were given for preparation.

failed because the consumers preferred the flavor of domestic carp to that of the buffalofish. Consequently, it is possible that the American consumer would prefer the pond-food-carp over the buffalofish. If so, then the demand for buffalofish in the United States would underestimate the demand for pond-food-carp.

Another similarity between the buffalofish and the carp is the consuming populations. Both fish are consumed primarily by Blacks, Jews, and certain other ethnic groups.

Because of these considerations (physical similarity, similar ediibility characteristics, and similarity of consuming populations), and because of the availability of suitable data, the buffalofish was selected as a proxy in this study for estimating the demand for the pond-food-carp.

CHAPTER II. THE CHICAGO FRESH FISH MARKET

A marketing and distribution system for a product begins with its sources of supply and ends with its purchase by household consumers. Between these two are the producers or processors, intermediaries and distributors, which together with the suppliers and consumers form a marketing channel or chain [38].

Because of the extreme perishability of fresh fish, each link in its marketing chain is important. However, since the fisherman usually sells his product directly or indirectly to the wholesaler, and since, for many species, little processing or change in the form of the fish occurs between the fisherman and wholesale levels, the behavior of prices at the wholesale level is important. Further, many wholesale fish markets have characteristics of an oligopsony,[7/] which further increases the importance of the wholesale market on fish prices.

After briefly discussing both the source of most domestic fresh fish supplies into Chicago, and the Chicago fresh fish retail market, this chapter then focuses on the nature and structure of the Chicago wholesale fish market.

Inland Commercial Fishermen

Inland commercial fishermen are typically small independent enterprises. The fisheries are predominantly single proprietorships with a

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[7/] Oligopsony refers to the control of buying by a few firms. Monopsony refers to the control of buying by a single firm.

few partnerships. In partnerships, both partners usually possess a license or state contract. In most states, entry into the fishery is "open" in the sense that for a small fee, a fishing license can be obtained. However, because of low income and return on investment, entry into the commercial fisheries is not high [9]. In some states, commercial fishing is done by state crews or through private contract with fishermen as part of state "rough" fish removal or control programs.

Since fish must be sought and captured, the fisherman is more akin to a hunter than a farmer. The capture of fish is dependent on the weather, the season, skill and luck. In states where fish are netted through the ice, snow accumulations and low temperatures hamper fishing activities. Often, winter storms and high winds prevent fishing activities entirely. Further, fish migrations, dispersion or location can be affected by the weather and season. Finally, water temperature, fluctuations in water level, growth of food organisms, diseases, parasites, pollution, prey and many other factors affect the capture of fish.

The Retail Market

Historically, retail fish sales in Chicago were channeled primarily through small fish stores, butcher shops, grocery stores, and vertically integrated wholesale/retail establishments. These channels are still used today. However, the majority of the fresh frozen fish retailed in the Chicago area is now sold through large chain food stores.

The retail market for buffalofish can theoretically be segmented into: 1) ethnic restaurants, 2) large chain food stores, 3) small grocery stores, and vertically integrated sales.

As in other parts of the United States, the introduction of frozen fishery products has resulted in a shift from fresh to frozen fish products. Today, frozen fishery products sales far outstrip the sale of fresh fish in the Chicago retail market. The acceptance of filleted, breaded or otherwise prepared fish by the consumer is based largely on consumer preference for convenience foods which represent savings in cost and preparation time. Additionally, frozen products are preferred by fish retailers because of their ease in handling and storability. Finally, institutions prefer many of the frozen fish products because of the convenience factor and the ability to control portions.

In spite of the shift toward frozen fish products, the fresh fish market has remained a vital part of the Chicago fish trade. Some species, such as buffalofish, are still marketed almost exclusively as fresh fish. Further, many chain food stores in Chicago maintain a fresh fish counter which is serviced by a fish butcher who custom-prepares fresh fish by scaling, filleting, steaking, etc. for the shopper.

The Wholesale Market[8/]

Description[9/]

Fresh fish (fish that have never been frozen) are received daily, exclusive of Sunday and holidays, from Canada and all parts of the United States. Fresh water fish usually arrive by truck from various shippers, including fishermen and truckers who buy from fishermen, as well as from exporters and other wholesalers. High valued ocean fish are often air-shipped to Chicago.

These fresh fish arrive in several forms which include:

1. Round or whole - fish that have not been processed.
2. Drawn or gutted - fish that have had the internal organs removed. Gutting improves the keeping quality of fish and is practiced during warm summer months or when fish are not marketed promptly.
3. Dressed - drawn fish with gills removed. This further increases the keeping quality of fish.
4. Skinned - fish that have had the skin removed. This process is used on catfish and bullheads.
5. Filleted - fish portions from which the skeletal bones have been removed.

[8/] The Chicago wholesale fish market, like the New York wholesale fish market, is often referred to as the Fulton Fish Market. Both markets were originally located mainly on Fulton Street in their respective cities. Because of urban construction few dealers in Chicago are located on Fulton Street. However, most are located in the same general old Fulton Market area.

[9/] This section is taken largely from [9].

After arrival, the fish are iced or re-iced and held stacked on pallets in wooden boxes or wax-impregnated paper boxes in large coolers. Some fish are displayed in boxes or display cases for sale to walk-in customers.

Delivery to retailers is made primarily during the early part of the week. Fish reaching the dealer late in the week often must be held over the weekend. Thus, fish reaching the dealer during the early part of the week usually command higher prices than fish arriving toward the end of the week.

Trends

The refrigerated truck has largely replaced the refrigerated rail car as a means of transporting fish into and out of the Chicago wholesale market. Trucks provide point-to-point delivery and scheduling flexibility, both of which are important for shipping a commodity which is highly perishable and whose production is variable.

Table 3 shows the relative decline of fish shipments by rail and the growth of fish shipments by truck into Chicago during the past years. In 1950, approximately 30 million pounds of fish were shipped by rail into Chicago. By 1971, approximately one million pounds were delivered by rail. This represented a decline from 29 percent to only two percent of total fish receipts by rail.

The change in the major shipping method of fish from rail to truck enabled shippers to by-pass the Chicago market. The downward

Table 3. Chicago wholesale fish receipts by mode of transportation

	1,000 pounds/percent			
Year	Truck	Express	Freight	Total 100%
1950	47,278 (44%)	29,228 (27%)	30,239 (29%)	106,745
1951	54,592 (51%)	27,575 (26%)	25,007 (23%)	107,175
1952	61,338 (52%)	28,873 (25%)	26,662 (23%)	116,873
1953	56,404 (50%)	27,613 (24%)	29,806 (26%)	113,823
1954	64,262 (55%)	29,268 (25%)	23,083 (20%)	116,612
1955	65,633 (59%)	24,867 (22%)	21,317 (19%)	111,817
1956	68,794 (64%)	20,787 (20%)	16,785 (16%)	106,366
1957	63,043 (69%)	15,062 (17%)	13,122 (14%)	91,227
1958	63,197 (68%)	16,306 (18%)	12,818 (14%)	92,321
1959	66,514 (72%)	15,510 (17%)	10,466 (11%)	92,493
1960	65,959 (76%)	11,275 (13%)	9,793 (11%)	87,027
1961	60,979 (78%)	7,770 (10%)	9,364 (12%)	78,113
1962	64,958 (87%)	2,504 (3%)	7,008 (9%)	74,470
1963	54,465 (86%)	1,940 (3%)	6,734 (11%)	63,139
1964	52,799 (88%)	1,673 (3%)	5,492 (9%)	59,964
1965	56,538 (91%)	1,280 (2%)	4,319 (7%)	62,137
1966	51,963 (90%)	957 (2%)	4,663 (8%)	57,552
1967	49,764 (91%)	407 (1%)	4,278 (8%)	54,449
1968	48,939 (91%)	310 (1%)	4,615 (9%)	53,863
1969	51,156 (94%)	281 (1%)	3,225 (6%)	54,662
1970	47,099 (97%)	356 (1%)	888 (2%)	48,343
1971	43,390 (97%)	474 (1%)	929 (2%)	44,789

Source: U.S. Dept. Commerce, NMFS, Chicago Market News, Annual Summaries.

Note: Express includes air express.

trend in Chicago wholesale fish receipts can be seen in Table 4. In 1952, Chicago annual wholesale fish receipts reached a peak of nearly 117 million pounds. Since then, wholesale fish receipts have declined almost steadily so that by 1974, annual receipts had fallen to around 40 million pounds. This represents a decline of approximately 70 percent during the twenty-two year period.

Another factor which probably played a role in the decline of the Chicago wholesale fish market was the activities of labor unions. Increased labor costs and tie-ups resulting from union activity may have provided a stimulus for shippers to by-pass the Chicago market. One example of these union activities is given in the December 2, 1970, daily report of the Chicago Market News:

> Members of the United Seafood Union in Fulton Fish Market went on strike Tuesday morning, December 1, 1970, as no contract was signed by November 30 deadline. Picket lines were up and the market was virtually shut down.
>
> However, later in the morning, the strike was settled, workers have won a $52.00 package for next 3 years. Fulton Fish Market will be open for business on Wednesday, December 2 [67].

A strike by REX truck drivers in April, 1957 also revealed the impact organized labor had on the Fulton Fish Market. As reported in the April, 1957 monthly report of the Chicago Market News:

> Chicago market was seriously affected by a transportation tieup during the latter part of April resulting from a REX truck drivers labor dispute. Market operators were handicapped in making LCL (less-than-carlot) express shipments to outlying points and resorted to other means of transportation--mostly truck which did not prove very effective in long distance hauls of smaller orders. An embargo placed by the Express Agency cut off all LCL fishery products deliveries to the Chicago area. Fresh fish to the Chicago market during that period were predominantly by truck transportation [66].

Table 4. Chicago wholesale fish market, selected receipts, annual summary, 1950-1977

	Receipts, 1000 Pounds						
Year	Buffalo-fish	Carp	Lake Smelt	Fresh water fish	Salt-water fish	Shell-fish etc.	All Fish
1950	2,724	3,296	1,307	42,055	39,702	24,988	106,745
1951	2,555	3,115	1,167	41,632	38,360	27,184	107,175
1952	3,609	3,641	1,288	46,362	40,857	29,654	116,873
1953	3,237	4,522	1,638	46,592	40,352	26,879	113,823
1954	4,384	5304	1,283	53,698	35,417	27,498	116,612
1955	4,412	4,162	1,262	50,171	34,655	26,990	111,817
1956	3,795	3,320	1,534	46,232	32,006	28,129	106,366
1957	3,745	2,471	751	39,107	27,774	24,346	91,227
1958	3,413	2,323	990	39,554	30,105	22,662	92,321
1959	4,792	2,429	985	39,307	26,081	27,106	92,493
1960	5,051	2,359	910	37,012	25,635	24,380	87,027
1961	4,404	1,481	703	32,671	21,993	23,450	78,113
1962	4,512	1,387	645	30,606	22,443	21,421	74,471
1963	3,890	1,202	414	26,352	18,756	18,022	63,139
1964	4,086	907	437	24,661	18,017	17,286	59,964
1965	4,292	1,013	513	25,932	18,467	17,738	62,137
1966	3,898	882	566	22,124	18,478	16,951	57,552
1967	3,930	790	375	21,930	16,391	16,128	54,449
1968	3,408	752	375	20,622	17,139	16,103	53,864
1969	4,318	876	450	21,023	18.057	15,103	54,183
1970	4,231	714	323	20,310	13,534	14,499	48,343
1971	4,416	833	358	18,533	13,612	12,644	44,789
1972	4,128	745	312	17,062	14,527	12,223	43,813
1973	3,246	495	277	14,368	13,806	11,189	39,362
1974	3,646	509	330	14,679	12,302	13,278 a/	40,259
1975 a/	5,518 b/	458	433				
1976	5,402 b/	514	481				
1977	6,020 b/	455	488				

a/ Separate statistics on saltwater and shellfish were discontinued in 1975.

b/ Estimated quantities, one of more weekly reports missing.

Source: U.S. Department of Commerce, NMFS, Chicago Fishery Market News Report, monthly summaries for 1950 - July, 1965.

U.S. Department of Commerce, NMFS Chicago Fishery Market News Report, daily reports for August, 1965 - 1972.

U.S. Department of Commerce, NMFS, Boston Market News Report, Chicago receipts and prices for 1973 - 1977.

The July Market News reported that the strike was settled near the end of the month, having lasted for 3 months, and that the strike, "seriously affected the Chicago wholesale fish business." [66]

Today the downward trend in the number of wholesale fish dealers in Chicago appears to have ended. In fact, the market exhibits new vitality through expansion and modernization. One dealer has recently constructed new facilities. Another has extensively remodeled his plant, while several other dealers have indicated that they plan to expand or modernize within the near future. (Personal communication, Bob Ruben, National Marine Fisheries Service.)

Market Structure

A marketing chain for fresh fish is shown in Figure 1. The primary producers (fishermen) and the shippers make up the first link. Wholesale dealers usually form the second link. However, for some fish such as catfish and bullheads, processors form the second link. The final link in the distribution channel consists of retailers. Sales to other wholesalers ultimately reach this level, also.

The fishermen and truckers are basically unorganized and have little information about the day-to-day market conditions for fresh fish. Prices received by the fishermen vary and there is no posted daily or weekly price list. Among the factors which may account for variations in the prices received by the fishermen are, 1) differences in the quantity of fish received by the dealer, 2) differences in the quality of fish delivered, 3) differences in the day of the week, and

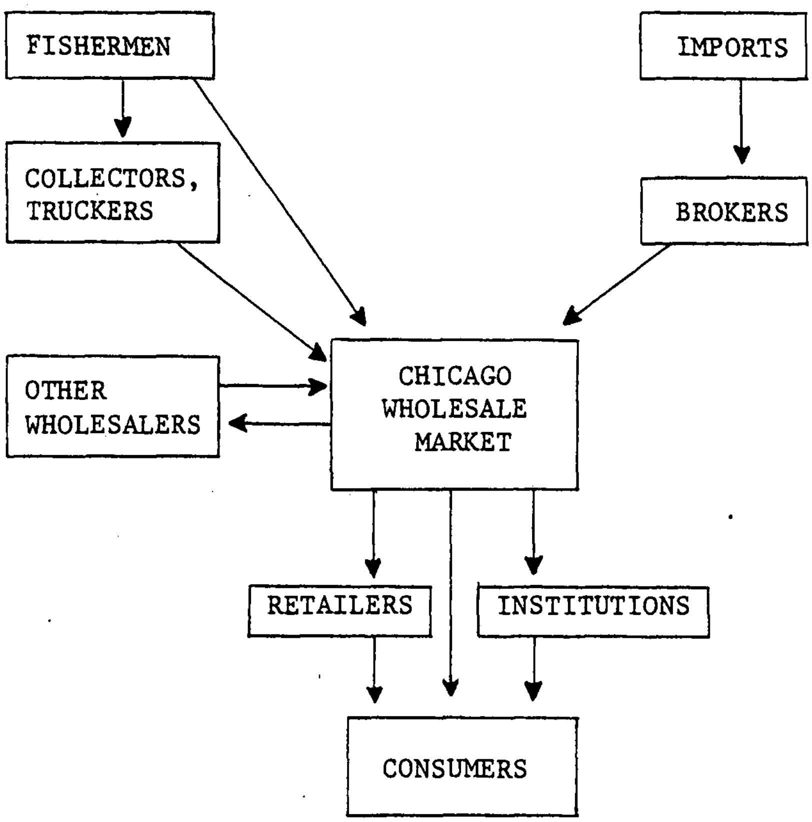

Figure 1. Chicago Fresh Fish Marketing Channel.

4) other factors, including the relationship between the dealer and shipper, affecting wholesale demand.

The only likely major difference in the wholesaler's selling price of fresh fish is between the large chain food stores and the other retail outlets. Since the large chain food stores have a high degree of buying power, and access to a great deal of market information, it is likely that they are able to win price concessions not available to the smaller retailers.

Over the years, the number of wholesale dealers in the Chicago fish market has declined. Today, only six major fresh fish dealers remain. These dealers exchange fish among themselves and with dealers located in other cities. This buying and selling operation can result in nearly identical fresh fish prices. However, many fishermen feel that the identical prices they are quoted is a result of collusion. It is true that limited numbers of dealers and close working relationships might be conducive to collusive activity. However, the existence of identical prices is not sufficient evidence of such activity.

One of the most serious attacks on the structure of the Chicago wholesale fish market can be found in a Canada Fish Commission report which is quoted at some length below.

> The fresh whole or dressed freshwater fish trade in Chicago ... is dominated by a few firms ... Other wholesalers as well as retail outlets are dependent upon these firms for fresh whole or dressed fish and, to a considerable extent, for frozen dressed fish and fresh fillets. Processors of frozen fillets and other fresh and frozen items have been able to by-pass this monopsony to some extent by selling direct to chain retail food stores ...
>
> ... one cannot fail to be impressed with the low standard of ethics that becomes manifest all too often in the trade, apart

from evidences of collusion (for example, of tacit agreement on buying and selling prices and allocation of supplies) that one would expect from dealers where an oligopolistic structure of distribution exists. According to the allegations recited during the course of our field surveys, shippers have been defrauded through false or excessive claims for quality deterioration or non-delivery of fish shipments, through non-settlement or delayed settlement for fish received, and through a number of other artful practices including the device of contrived bankruptcy ... Certain freshwater fish dealers evince a willingness to "take the cash and let the credit go" - to pursue the objective of immediate gain without regard to long-run effects on their business or on the industry ...

Confronted with only a limited number of buyers for his product, the fisherman or packer is at a considerable disadvantage even in the absence of unethical buyers' practices. The wholesaler often appears to know what price others are offering; in any case, his knowledge and experience give him the advantage in a market in which demand, supplies, and prices are as variable as in the fresh lake fish markets. The fisherman's difficulty is particularly great in the heavy fishing season; when catches are plentiful, he might have to spend several hours on the telephone calling dealers to dispose of the day's catch, instead of having a choice of offers from dealers as might be the case when market supplies are light. There may be little opportunity to investigate the credit rating of a buyer new to him. He may attempt to limit the amount of credit extended to any buyer by requiring a deposit to be made against shipments or payment for one shipment before another will be made, but he has to sell his fish without delay and cannot always withhold shipment. By telephone he may be promised early settlement or may be told that a cheque is in the mail or may be offered a higher price. Eventually, he may have to accept exorbitant rebate claims or write off part of the debt to get a settlement, or may lose the whole amount because he considers legal action to collect would be too expensive.

Bankruptcies of wholesale firms, real or contrived, have taken a toll from fishermen and packers and processors. Sometimes a claim of non-delivery is difficult to contest when a shipment has been picked up by truck: the truck driver's signature may be false or he may be no longer employed by the company. Another opportunity for collusion among dealers to defraud the shipper may be afforded by the U.S. Express Agency's alleged practice of selling a fish consignment for the express charges if the consignee has not appeared within a specified time to claim the shipment. Other dealers might be on hand, by arrangement, to buy the fish at the bargain price. [12]

It is uncertain if these charges are true, even though the Chicago wholesale fresh fish market is an oligopsony. Further, the alleged practices took place during an earlier time period and were aimed at non-Americans. However, during this research, some of the same complaints mentioned in the report were heard from United States fishermen and shippers. In any case, the theoretical demand model developed in this study is based upon the assumption of an oligopsonistic wholesale market.

III. DERIVED DEMAND, MARKETING MARGINS AND PRICE SPREADS

Derived Demand

The demand for a commodity at each level of production ultimately stems from its demand as a final consumption good by the consumer. Demand for a commodity as an input for a final consumption good is called "derived demand". Derived demand differs from primary or consumption demand by processing and distribution costs, often collectively referred to as "marketing margin". This relationship between the two demand curves is shown in Figure 2. The curve labeled D represents primary demand. The schedule of marketing and processing costs is given by the line labeled ACPM. The derived demand curve DD, is obtained by subtracting marketing and processing costs from primary demand. Thus, the derived demand curve gives the maximum price the producer would be willing to pay for the input.[10/]

Derived demand at any level in the production process or marketing channel is obtained by subtracting the marketing margin, as defined above, from the demand curve at that level. Thus, by subtracting marketing costs of the wholesale distributor, for example, from the derived demand of the retailer, one would obtain the wholesalers, derived demand curve. This is illustrated in Figure 3, where DD represents

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10/ The basic assumption required to obtain a derived demand curve in this way is that the product is made using inputs in fixed proportions.

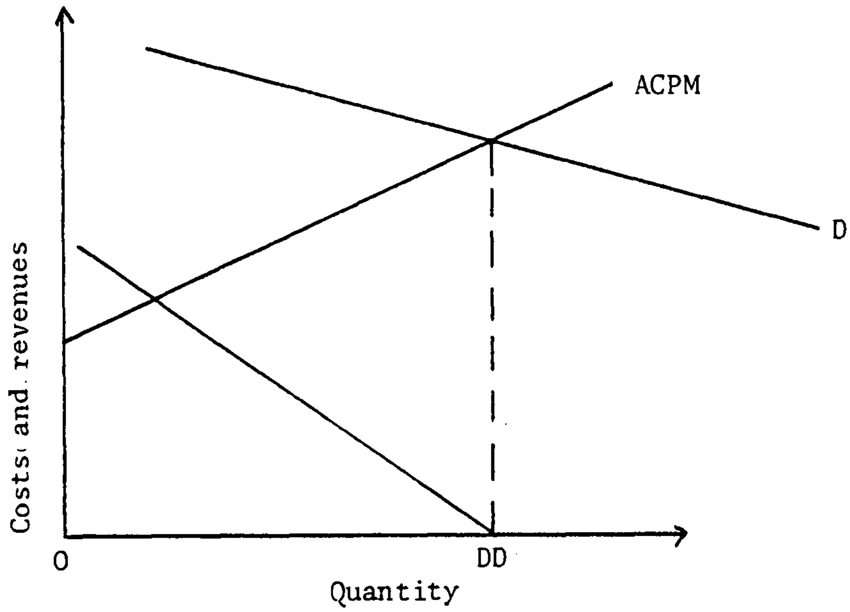

Figure 2 . Derived demand, retail.

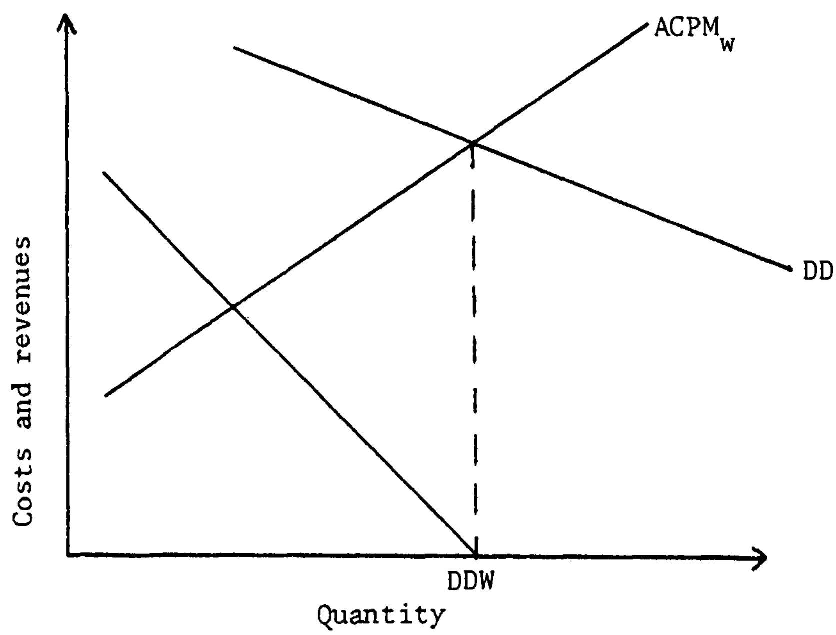

Figure 3 . Derived demand, wholesale.

the derived demand of the retailer, and $ACPM_w$, the marketing costs of the wholesaler. Then the derived demand curve for the wholesaler, DD_w, is obtained by subtracting $ACPM_w$ from DD.

The demand curve of immediate interest to the entrepreneur is the one faced by him/her. However, in some instances, it would be useful for the entrepreneur to have information about the level and shape of the market demand curve, especially if his actions are likely to be matched by his competitors, or if his sales comprise a significant portion of the market volume.

In many situations, the single most important aspect of demand, other than its level, is its own-price elasticity (or the related concept of own-price flexibility).[11/] However, too often the entrepreneur has little or no information concerning price elasticities.

In empirical work it is often impossible to estimate directly price elasticities (flexibilities) of demand for a product at each

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[11/] Own-price elasticity and flexibility are point concepts. When a demand function is written as quantity dependent [Q = f(P)], then price elasticity at point $(\overline{Q},\overline{P})$ is $E_p = \frac{dQ}{dP}\,\frac{\overline{P}}{\overline{Q}}$. When the demand curve is specified as price dependent [P = f(Q)] then price flexibility at $(\overline{P},\overline{Q})$ is $F_p = \frac{dP}{dQ}\,\frac{\overline{Q}}{\overline{P}}$. In this example, $\frac{1}{E_p} = F_p$. However, with more complex demand functions, say, $P = f(Q_t, Q_{t-1})$ and $Q = f(P_t, P_{t-1})$ the partial derivatives must be compared. Since different variables are held constant, it cannot be assumed that the partial derivatives $\frac{\partial Q}{\partial P}$ and $\frac{\partial P}{\partial Q}$ are reciprocals of each other [63].

level in the marketing channel. However, when knowledge of marketing margins and of elasticity at one level exists, estimates of elasticities at other levels can be made. Consequently, the relationship between those two concepts will be explored in greater detail below.

Marketing Margin

A marketing margin may be defined as (1) a difference between the price paid by the seller and the price received from its sale, or as (2) the price of a collection of marketing services which is determined by the demand for and supply of such services [63].

The price of each marketing service is determined by the interaction of its supply and demand functions. In a fishery, for example, those services would include transportation, icing, boxing, processing, etc. Figure 4 illustrates how the price of each of these inputs may be determined.

The equilibrium price, P_e, is determined by the intersection of the demand curve, D, and the supply curve, S, of an input. With an increase in demand for the productive service to say D', the equilibrium price will rise to P'. At any given level of output, the sum of the price times quantity of each marketing service is the marketing margin.

For some products, such as fresh fish, which retain their identity throughout the marketing channel, it is relatively easy to define theoretically the marketing margin. In some instances, the estimation of the cost of marketing services would not be too difficult. When

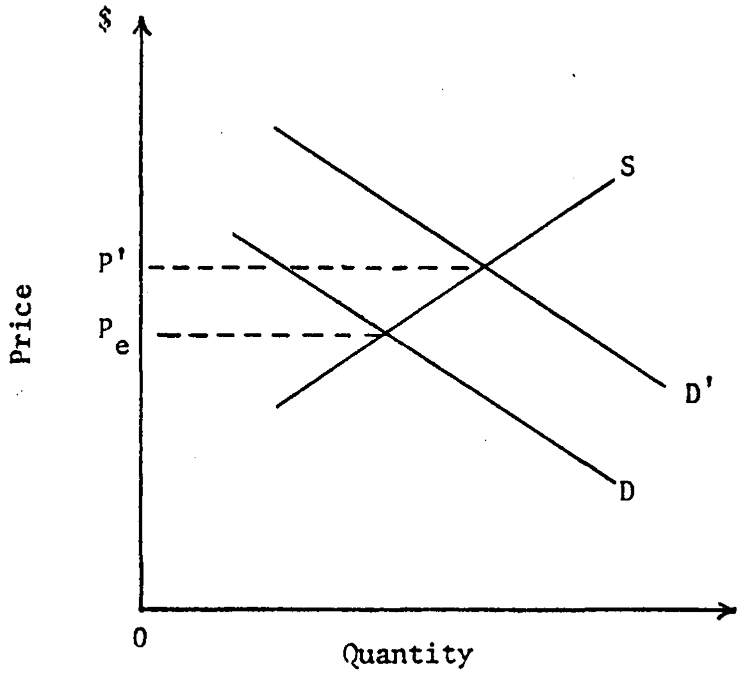

Figure 4. Supply and demand for a productive service: increasing cost.

the number of services is large, however, substantial aggregation would be required. Under these circumstances, the cost-of-services approach may be difficult. For this reason, and because the assumptions of constant supply functions and fixed proportions may not hold, in empirical work it is often more useful to define marketing margin simply as the difference between the purchase and sale price.

Problems in Empirical Analysis of Marketing Margins

Secondary Data

A major problem in the use of empirical data for marketing margin analysis is comparability of data. The researcher must be assured that the definitions of cost and price are consistent. When using secondary data it is often impossible to assure comparability of data because cost and price are not often clearly defined or sufficiently detailed. Illustrations of the problem of comparability of cost and price data arising from the use of secondary data can be found in the Chicago Market News Report of wholesale fish prices.

Prior to June 1976, wholesale fish prices listed in the Chicago Market News Report represented the price (spread) paid by dealers to shippers. This price was derived from information voluntarily supplied by wholesale firms in the Chicago fish market. The number of dealers, and the particular individuals within a firm supplying this information during any given time period were not reported; nor was the definition of "wholesale price" given in the Reports. If the definition of "wholesale price" differed among the respondents, then it is likely that changes in the reported wholesale price occurred because of these definitional differences.

The example mentioned above is concerned with changes in definition stemming from changes in the population sampled. However, after June 1976, the Chicago Market News office changed its own definition of the "wholesale price" of fish. The earlier definition referred to the wholesaler's purchase price while the new definition refers to the wholesaler's selling price. This change was unreported but was suspected by the author since the results of regression analysis of the data differed between the pre- and post-1976 periods.

The change in definition by the Chicago Market News office was subsequently confirmed in a personal interview with the Chicago Market News reporter.

Primary Data

The use of primary data is no guarantee that cost and price definition problems will not arise. The researcher must use care in wording questions and structuring the interview or questionnaire to assure that all participants are responding to the same question. A question such as "what is the price you pay for each species?", may elicit different responses according to its interpretation. For example, one respondent may include the cost of boxes, ice, and transportation in his calculation of the price paid; while another respondent may not

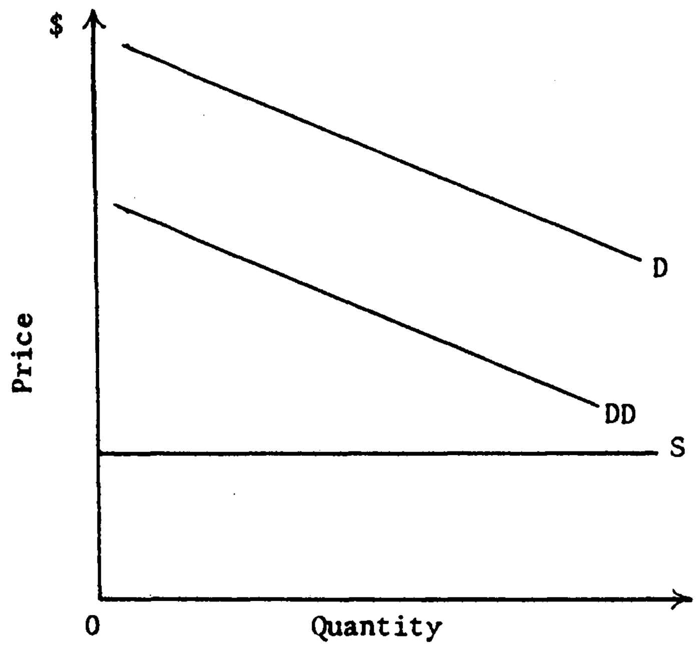

Figure 5. Supply and demand for a productive service: constant cost.

include these cost items in his reported price.12/

Similarly, it may not be accurate to report that "For frozen fish ... the markups range from 10 to 25 percent for major wholesalers ...", unless each dealer is responding accurately to the same questions.13/

Finally, empirical estimates of fish price spreads can be affected by the size of the firm or differences in product quality or grade. Each of these problems will be given attention in later chapters.

12/ One column in a questionnaire to be filled in by wholesalers was titled, "The price you pay for each species cents/pound" [9].

13/ The wide range of markups by wholesalers as reported in Table 5 tends to indicate that different definitions of markup were used [33].

Characteristics of Marketing Margins

The behavior of marketing margins depends on the nature of the supply of productive services. When supply is perfectly elastic, the margin will be constant. This is illustrated in Figure 5, where the marketing margin is constant since the two demand curves D and DD, are parallel and supply, S, is perfectly elastic.

When the supply curve of services is upward sloping, margin increases with quantity (Figure 6). However, it has been noted that empirical evidence is not always consistent with the assumption of a positively sloped supply curve of productive services [10,63]. It has also been pointed out that it may be more realistic to assume that economies of scale in providing these services exist, and therefore, the supply curve of marketing services could be negatively sloped over some range resulting in decreasing margins as quantity increases [63].[14/] The behavior of the marketing margin when the supply curve of marketing services is downward sloping is shown in Figure 7.

Empirical Estimates of Fish Price Spreads

Undoubtedly, the paucity of available data and the difficulty of obtaining primary data have played a major role in limiting fish price spread studies in North America. In this section, several studies that have touched upon or focused on fish price spreads are reviewed. With

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[14/] It is sometimes difficult to identify supply equations and demand equations separately and to assure that empirical analysis is not merely tracing out equilibrium points.

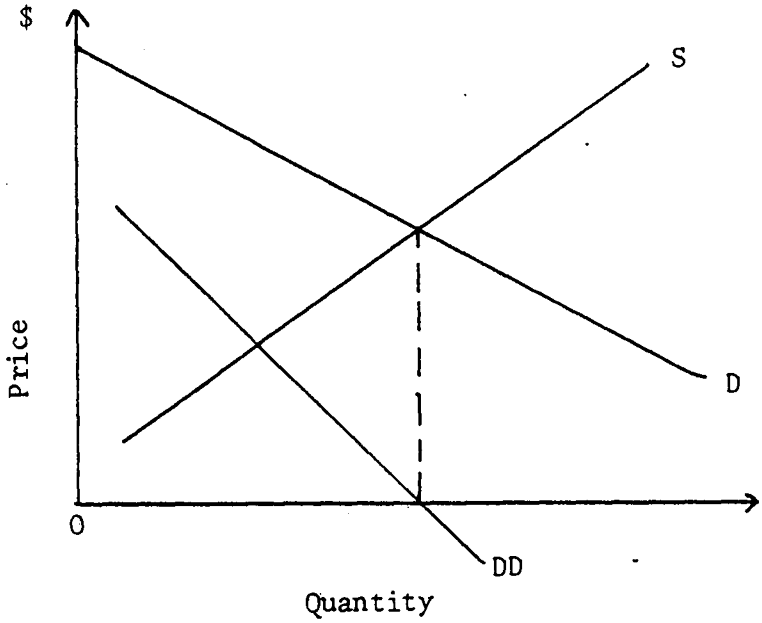

Figure 6 . Marketing margin with increasing costs of productive services.

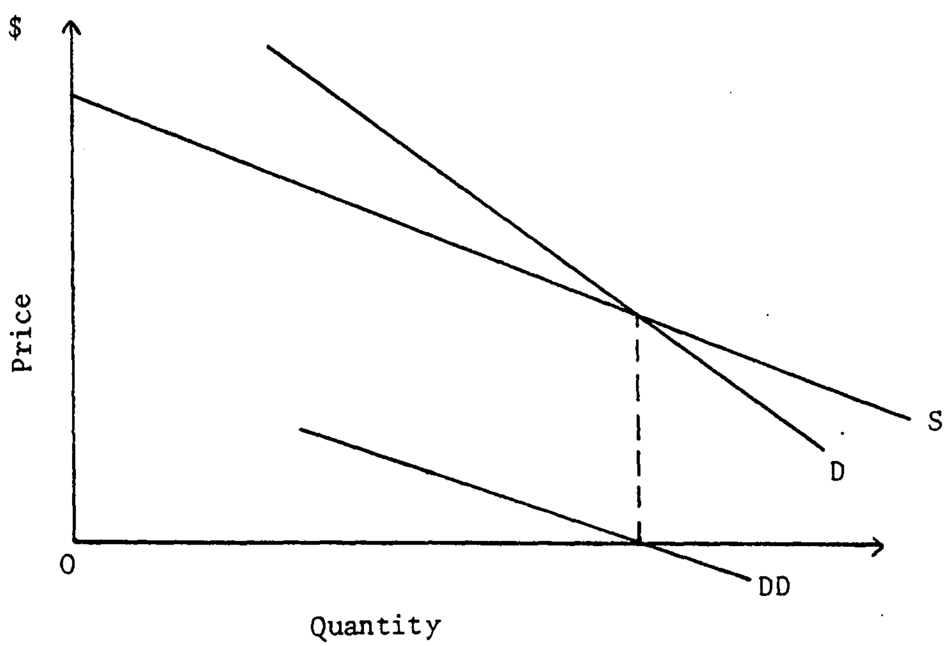

Figure 7 . Marketing margin with decreasing costs of productive services.

the exception of a recent National Marine Fisheries Service analysis [45], these studies focus little on price spreads.

From a survey of wholesale fish dealers it was reported that the average wholesale margin for fresh fish was 7.0 cents per pound [71]. Regional variations in markup were attributed to transportation costs, which implies that these costs were included in markup.

From a survey of Ohio wholesale fish dealers it was found that the wholesale markup for fresh fish sold to: (1) walk-in buyers ranged from 20-35 percent; (2) restaurants ranged from 10-22 percent; (3) institutions ranged from 10-20 percent; and (4) other wholesalers ranged from 8-15 percent [33].

Price spreads for dressed pickerel and whitefish exported to the United States from Canada for selected days in 1961 were given in the appendix of [12]. The price spreads for pickerel for six of the ten days listed in the report are given in Table 5.

Price spreads for farm raised catfish for 1968 and 1969 were given in a report [70]. These spreads are listed in Table 6.

The fish price spread analysis compiled by Penn, 1974, is the most complete done to date. Some of his findings are: (1) retail prices of fish vary widely from store to store within a given market area, (2) retail prices of fish are independent of sales and cost, (3) ex-vessel prices are more influenced by the supply from the stock in the sea than by the demand in the retail market, (4) processor price declines usually followed declines in ex-vessel

Table 5. Price spreads and markups[a] for dressed pickerel (selected days)

	Days					
	June 12	June 17	June 24	July 22	August 3	Sept. 15
Price Received by:						
Fisherman	25-28¢	20-24¢	22-26¢	16-20¢	18-26¢	18-26¢
Processor	38	38	34	41	41	47
Exporter	50	50	50	54	54	56
Margin						
Processor	10-13¢	14-18¢	8-12¢	21-25¢	15-23¢	21-29¢
Exporter	12	12	16	13	13	9
Markup						
Processor	40-46%	58-90%	31-55%	105-156%	58-128%	81-161%
Exporter	32%	32%	47%	32%	32%	19%
Total Margin	22-25¢	26-30¢	24-28¢	34-38¢	28-36¢	30-38¢
Total Markup	113%	127%	108%	200%	146%	155%

[a] Markup at any level can be calculated in two ways: the quotient of the margin divided by the cost of sales, <u>or</u> the quotient of the margin divided by the price of sales. The first method is used here.

Source: Canadian Fish Commission, Report of Commission of Inquiry into Freshwater Fish Marketing, 1965.

Table 6. Price spreads for Farm raised catfish

	Year	
	1968	1969
Price received by:		
Fish Farmer	.38	.41
Processor	.78	.88
Wholesaler	.98	1.10
Retailer	1.27	1.43
Margin		
Processor	.40	.47
Wholesaler	.20	.22
Retailer	.29	.33
Markup		
Processor	105%	115%
Wholesaler	26%	25%
Retailer	30%	30%
Total Margin	.89	1.02
Total Markup	234%	249%

Source: United States Department of Interior, Bureau of Commercial Fisheries. A program of research for the catfish farming industry. Ann Arbor, Mich. 1970.

prices, and (5) wholesale margins remain fairly stable.[15/]

Average annual margins and markups of several fish products from the Penn study are given in Table 7.

The price spreads given above, while not comparable, demonstrate that there is room for interesting empirical work in that area. Further, it is apparent that the limited amount of empirical work to date in fresh water fish marketing is not sufficient for estimating demand elasticities at various levels in the marketing channel. Hence, it is crucial that demand analysis, as well as price spread analysis, be conducted for various species if these elasticities are to become known.

In the next chapter, the focus will shift toward the major emphasis of this paper - the demand for buffalofish at wholesale in the Chicago fish market. It should be kept in mind however, that the buffalofish is being used as a proxy for the pond-food-carp.

[15/] With respect to stability, Penn is probably referring to the behavior of margins over time within a given class of products such as fresh fillets or fish steaks. However, this cannot be determined from the data in Table 7, which compares margins of the various product classes.

Table 7. Annual average margin and markup of finfish and shellfish, 1969-1971

	Fresh[a/] Fillets	Frozen Ocean Perch	Fish[b/] Steaks	Canned Tuna	Fresh Crab Meat	Frozen Peeled Shrimp
Price Received by:						
Harvesting	.50	.16	.55	.39	.57	1.11
Processing	.75	.31	.86	.68	1.45	1.61
Wholesale	.86	.40	1.18	.79	1.72	1.94
Retail	1.19	.64	1.43	.98	2.38	2.40
Margin						
Processing	.25	.15	.31	.29	.88	.50
Wholesale	.11	.09	.32	.11	.27	.33
Retail	.33	.24	.25	.19	.66	.46
Markup						
Processing	50%	94%	56%	74%	154%	45%
Wholesale	15%	29%	37%	16%	19%	20%
Retail	38%	60%	21%	24%	38%	24%
Total Margin	.69	.48	.88	.59	1.81	1.29
Total Markup	138%	300%	160%	151%	318%	116%

[a/] Haddock, Flounder, Cod.

[b/] Halibut, King Salmon, King Salmon (dressed).

Source: Penn, 1974.

IV. THEORETICAL MODEL DEVELOPMENT

Demand is usually defined as a functional relationship involving the quantity of a good or service, its price, income level, price of substitute goods, etc. Economic theory is useful in formulating both demand models and hypotheses related to those models. For example, economic theory, via the Law of Demand, asserts that the price and quantity of a good are inversely related. This means that as the price of a commodity increases, eventually the quantity demanded will decrease, if all other factors which affect demand remain constant. Thus, in empirical work, this expected inverse relationship is often used to make predictions about consumer behavior.

Economic theory also indicates the categories of variables which affect demand, and hence should be considered for inclusion in a demand equation. In some cases, the theory indicates the expected direction of the effect of these variables on demand.

While economic theory is useful in empirical analysis, there remains an important and substantial gap between theory and model building which must be filled by the economist. For example, while the relationship between amount demanded and price is expected to be negative, the structure of this relationship, i.e., linear, additive, logarithmic, etc., is not specified. Thus, in the application of theory, economics becomes both a science and an art.

In the first section of this chapter, some of the characteristics of an open-access fishery are examined and both the short and long run average cost curves for fish are derived. In the next section, the mechanism for the establishment of market equilib aium in the wholesale fresh fish market is described by using the short-run average cost curve of fish and the theory of monopoly markets. In the final two sections, other factors which affect demand, and model formulation are discussed.

Open-Access Fisheries[16/]

Population Dynamics

Within a given habitat, a fish population will expand to some maximum biomass. At this level, additions to the biomass through recruitment[17/] (hatchings, births, etc.) and growth of individuals, are exactly offset by mortalities due to age, disease, predation, etc. Populations of this type often can be realistically depicted by a growth model of the type popularized by Schaefer [49, 50, 51]. This is shown in Figure 8, where P^* represents the maximum population size (biomass). At P^*, the net rate of growth of the population is zero. When the population is zero, the net rate of growth is also zero since there is no population. Between zero and P^*, generally the net rate of growth of the population is positive. The biological basis for such growth can be viewed in terms of additional food or living space available when the population is not at its maximum level. For simplicity,

16/ The discussion in this section is taken largely from [2].

17/ Recruitment refers to the entry of fish into the population.

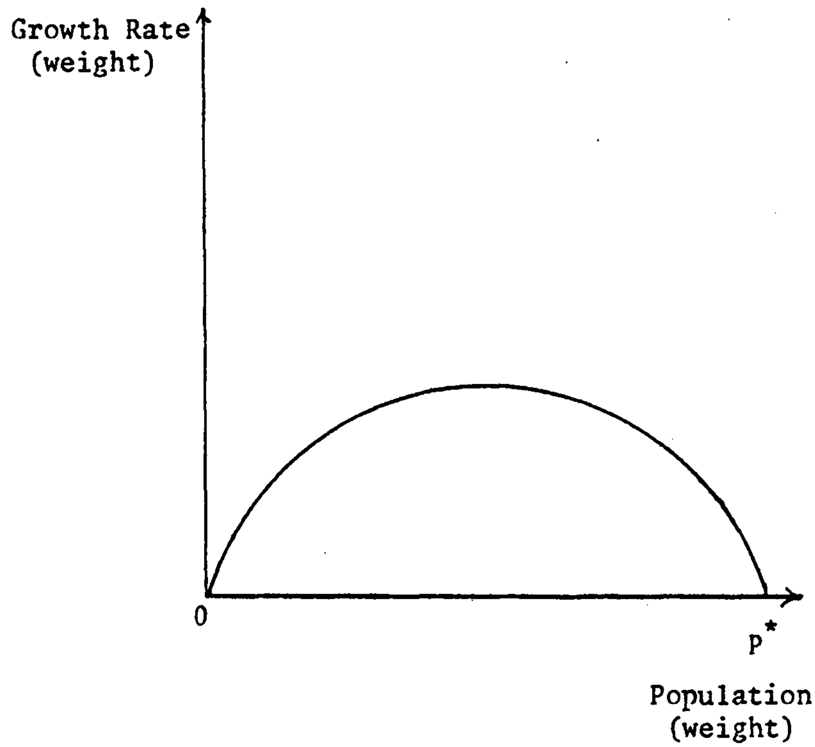

Figure 8. Population growth.

we have drawn this growth curve as bell-shaped. However, modifications of its shape, e.g., skewed to the left, or shifted to the right, while perhaps adding more realism under certain conditions, would not materially alter the analysis.

When man harvests a previously unexploited fish stock, he becomes another predator. Thus, as the fish population is reduced because of fishing activity, the rate of growth becomes positive. Each level of fishing effort[18/] has associated with it a given equilibrium population

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18/ Fishing effort refers to the collection of production inputs which are applied to the fish population, i.e., the number and size of boats, nets, or other fishing gear, the amount of time spent fishing, the number of fishers, etc.

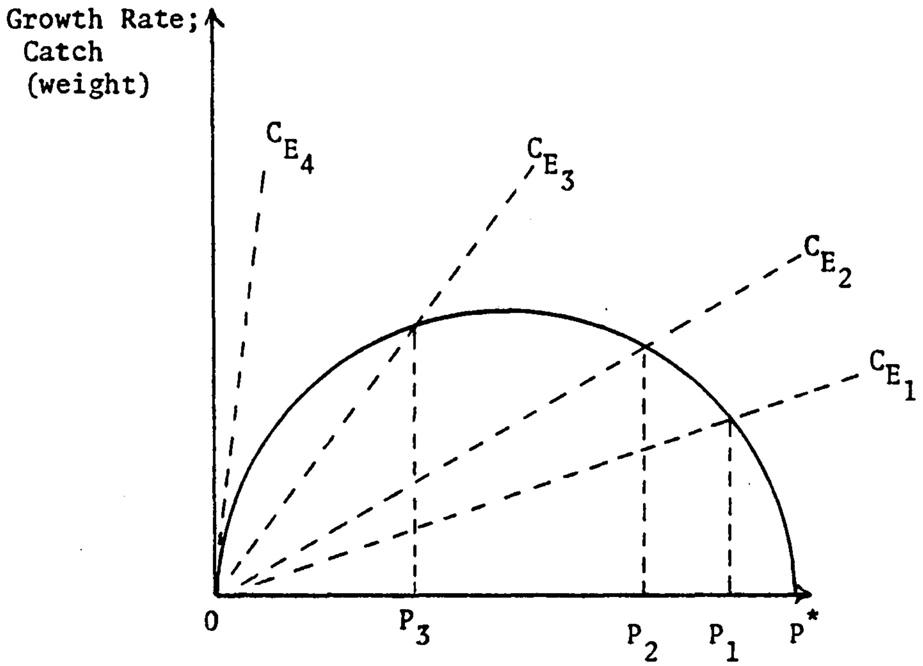

Figure 9. Population equilibrium.

where the rate of catch equals the rate of growth of the population. This is shown in Figure 9. The curves labeled C_E show, for a given level of fishing effort, E (where $E_1 < E_2 < E_3 < E_4$), the relationship between population and the harvest or catch per period of time. Given the growth curve, equilibrium populations will be P_1, P_2, and P_3 for effort levels of E_1, E_2, and E_3, respectively. Equilibrium catch for these same levels of effort is established at C_1, C_2, and C_3. No equilibrium catch is attainable for effort level E_4 since this effort is so large that the population will be destroyed.

From the above relationship, it is now possible to relate yield (catch) to effort as is done in Figure 10. This sustainable yield or

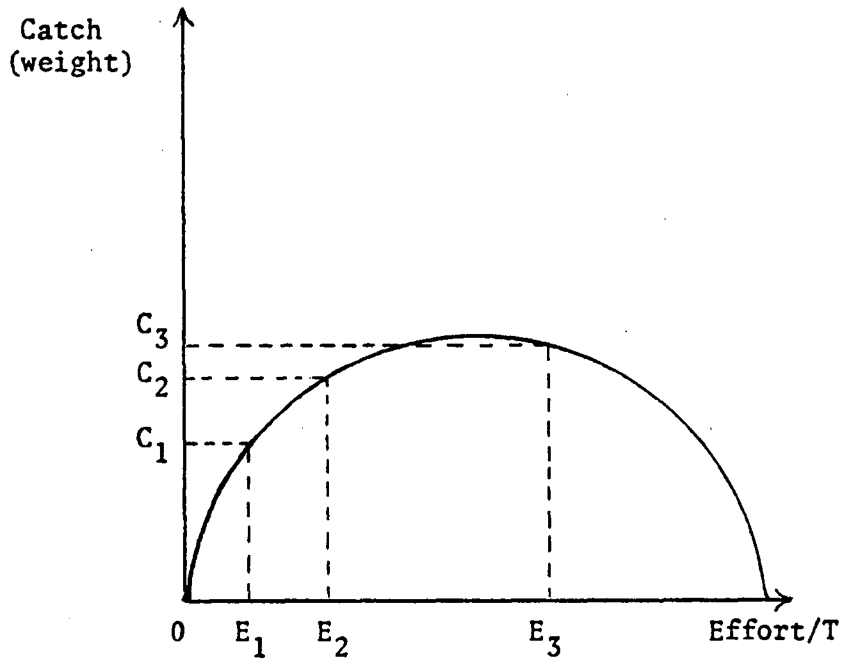

Figure 10. Sustainable yield.

sustained yield curve then relates the long-term yield of a fish stock to a given level of effort.

Short-term (seasonal or annual) variations in harvest can be thought of as due to differences in the schooling of fish, short-term fluctuations in the fish population due to changes in the population of their competitors, or in their food supply, changes in weather conditions, etc.

Total Cost and Total Revenue

Total revenue is a function of both the quantity sold and the price received. In general, the market price varies with the level of demand and the quantity sold, so that increased quantities can be sold only by lowering the price. The shape of the total revenue curve of a fishery will be similar to that of the sustained yield curve of effort when price elasticity of demand is greater than unity in absolute value at quantities corresponding to the maximum level on the sustained yield curve. Otherwise, the total revenue of effort curve will have two peaks. The upper diagram in Figure 11 depicts the former while the lower diagram illustrates the latter, where TR represents total revenue.

Also drawn in Figure 11 is the total cost curve, TC, which is linear in this example, under the assumption that cost per unit of effort does not change with effort. Long-term equilibrium occurs at the point of intersection of the total cost and total revenue curves. At any other point, the fishery would not be stable. For example, if the level of effort were E_2, then revenue would be greater than costs and fishermen would be attracted to the fishery. Also, those presently engaged in the fishery would want to increase effort since its cost is less than the revenue attainable. The net result would be to drive the level of effort up to the point where total cost equals total revenue. Beyond E_e, cost exceeds revenue and there would be a tendency for the level of effort to decline.

Long-Run Total and Average Cost of Fish

The long-term supply curve of effort, and hence fish, can be derived by varying the price of fish. As the price of fish increases, say due to an increase in the demand for fish, the total revenue curve

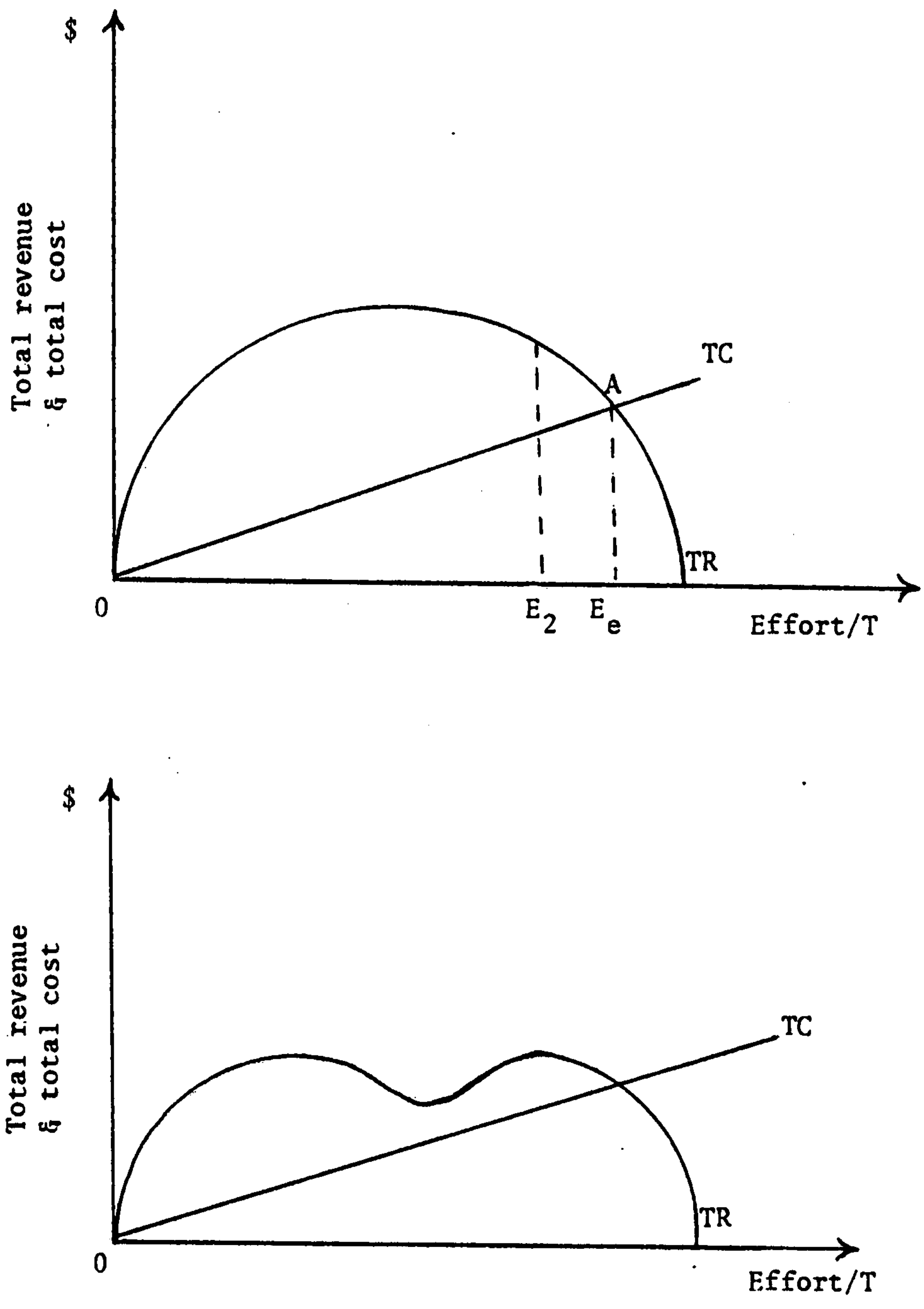

Figure 11. Total revenue and total cost curves of open-access fisheries .

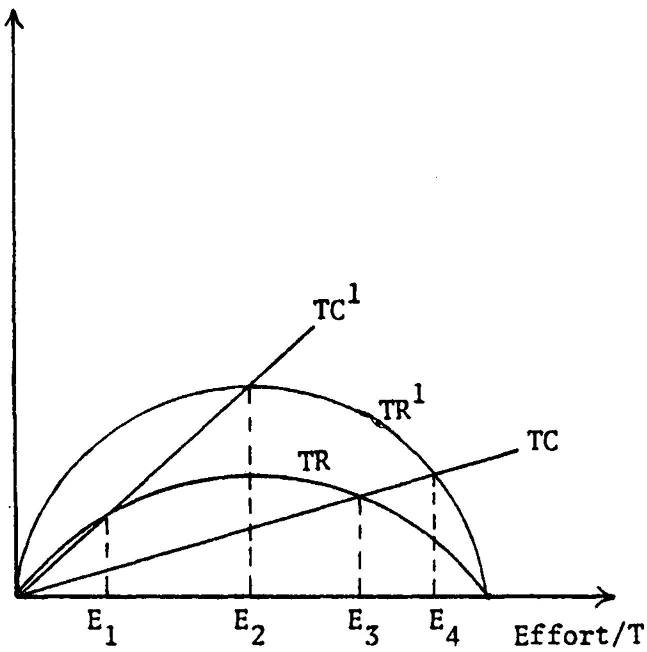

Figure 12. Changes in equilibrium effort and total cost.

will shift up. This is shown in Figure 12 as an upward shift of TR to TR^1. In general, this will cause an increase in effort. However, if the fishery is operating at a point beyond the maximum sustainable yield, the increase in fishing pressure will actually decrease the level of catch. In the example in Figure 12, an increase in effort from E_3 to E_4 will result in a lower catch. If the per unit cost of effort had been greater than TC, say TC^1, then the fishery would have been operating to the left of the maximum sustainable yield and, in the case depicted, the increase in price would result in both an increase in effort and catch. Tracing out all the equilibrium points along a given cost curve and various total revenue curves, will yield a long-run relationship between total revenues and effort and, hence,

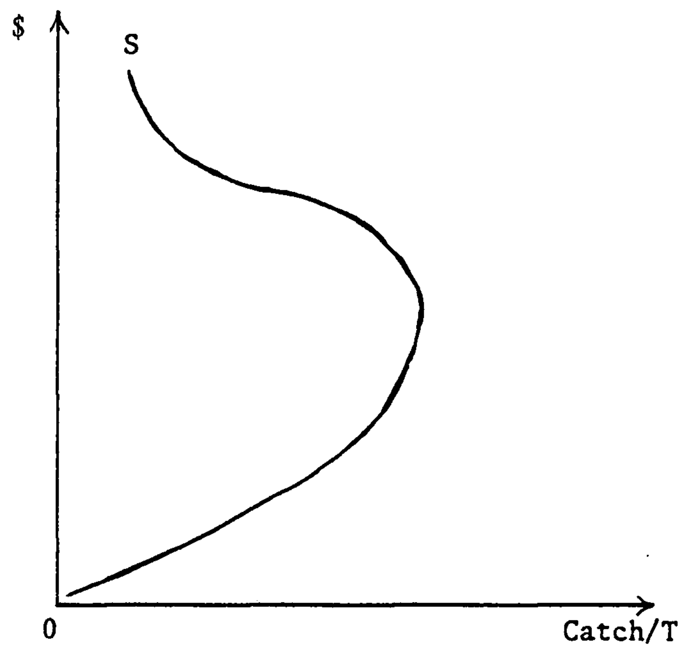

Figure 13. Long-run supply of fish.

fish. Figure 13 depicts such a relationship. After the maximum sustainable yield (MSY) is reached, the curve becomes backward bending as catch declines with increased price and effort.

The curve in Figure 13 relates quantities supplied to both long-run total cost and revenue of fish as the price of fish varies. Long-run average cost can be obtained by dividing total cost by the quantity of fish. The long-run average cost curve will have the same general shape as the long-run total cost curve. In the analysis which follows, it is assumed that harvest takes place with an effort level less than that corresponding to maximum sustainable yield. Also, long-run average cost is represented by a straight line. However, this simplification will not seriously alter the results.

Short-Term Effort and Declining Short-Run Average Cost

In many inland commercial fisheries, the short-run effort of full-time fishermen tends to remain constant. This stability of effort is based primarily on the behavior of short-run costs, and on certain characteristics of inland commercial fisheries.

Many costs associated with a fishing business, such as insurance, licenses, depreciation and moorage, are fixed in the short-run. In addition, out-of-pocket or variable costs of effort, in some fisheries, is determined by the practice of paying crews a share based on the total catch or total receipts of the crew. Also, if there are few opportunities for employment elsewhere, the cost of wages will be relatively low. Further, if there are incentives to retain the crew, then a certain portion of some otherwise variable costs such as repair, fuel, and food may be considered fixed. Under these conditions, short-run variable costs are a relatively small proportion of total costs. Thus, in the usual range of fish prices, short-run variable costs are likely to be recovered. Therefore in the short-run, effort is not likely to decline.

On the other hand, an increase in profit is not likely to cause a significant increase in short-run effort. There are several reasons for this. First, some gear is selective in that it can be used for only certain types of fish. For example, smelt nets can be used for chubs or herring but not for sheepshead or bass; and catfish "trot" lines are ineffective for harvesting buffalofish. Secondly, in general, fishermen harvest mixed types of fish so that increased profitability for a particular species does not cause effort to expand for that species since it cannot be singled out for capture. Third, the purchase of boats, nets or other relatively expensive gear in response to price increases that are perceived to be short-lived is not likely to occur in a fishery that is characterized by small, low-capitalized, unincorporated units. Finally, the length of fishing time is often difficult to expand since fish must be landed in good condition at the early part of the week to command a top price.

Thus, because of the behavior of short-run costs, and the characteristics of the fishery, short-run effort tends to remain constant.

If we assume that effort is fixed in the short-run, then the short-run average cost of fish varies inversely with catch, and the curve representing those costs is a rectangular hyperbola. In Figure 14, the curve labeled SRAC represents the short-run average cost of fish. Short-run average cost equals long-run average cost only when the actual harvest equals the planned or long-run (equilibrium) harvest. Hence, SRAC intersects LRAC at the point of long-run equilibrium.

Equilibrium in the Wholesale Fresh-Fish Market

In this section, the assumption that fishermen sell in pure competition is retained. On the other hand, it is assumed that the wholesalers, who deal both as buyers and sellers, are organized under a

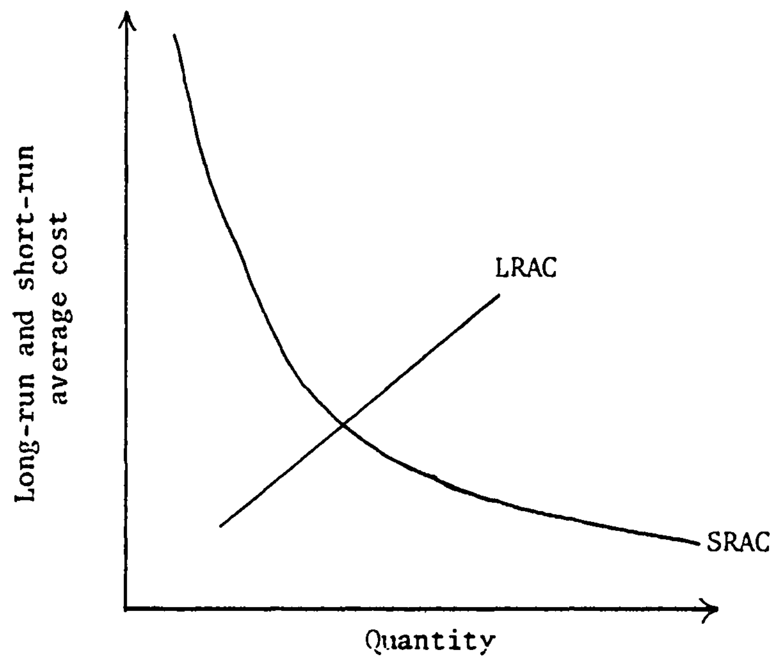

Figure 14. Long-run and short-run average cost.

buying and selling agreement.[19/] That is, it is assumed that wholesalers act as monopsonists in the purchase of fish and as monopolists in the sale of fish.

Under monopoly selling the monopolist must consider the impact of price decreases on all previous units when sales expand. In Figure 15, DD is the wholesalers' derived demand for buffalofish when the wholesale market is perfectly competitive. That is, it is constructed under the assumption that the wholesalers' selling price is constant. The curve DMR shows the addition to the wholesalers' total net revenue

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[19/] In this simplified chain, truckers and other middlemen are excluded. However, this does not seriously affect the analysis which follows since the produce - fresh fish - is highly perishable and thus must be quickly sold. Further, these omitted middlemen have little market power and cannot control prices or supplies.

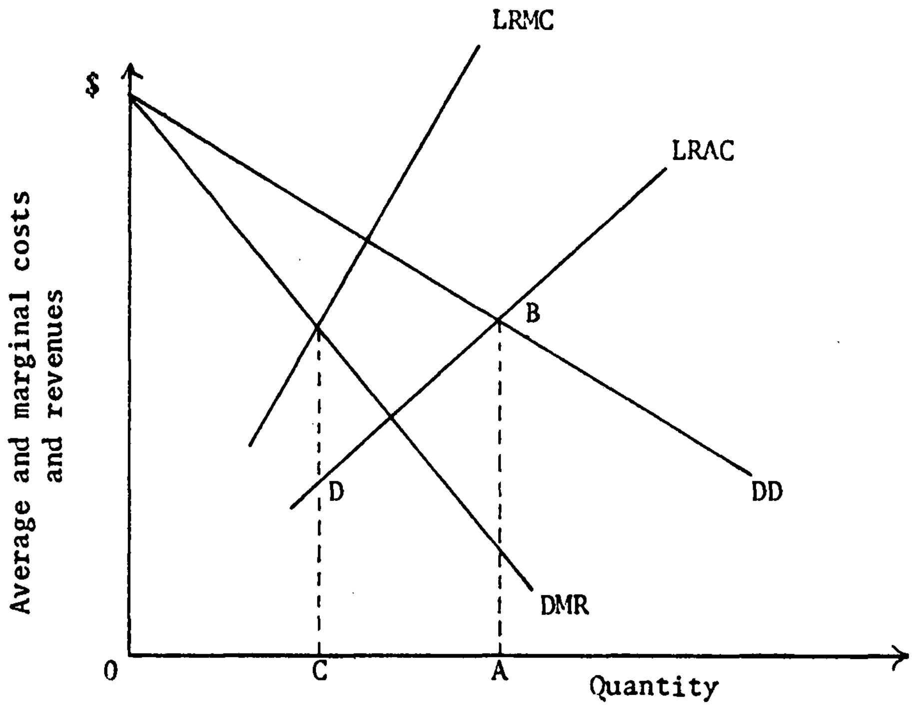

Figure 15. Equilibrium in the wholesale fresh fish market.

as each successive unit of buffalofish is processed and distributed. It reflects the change in selling price faced by wholesaler acting as monopolists. Thus, DD can be viewed as a "Value Marginal Product" curve, while DMR is a "Marginal Revenue Product" curve.

Further, the LRMC curve is marginal to the long-run average cost curve. Hence, LRMC shows the addition to total cost as buffalofish are purchased. Under pure competition, the equilibrium quantity and price would be OA and AB, respectively. However, under the assumption that the monopolistic wholesaler is also a monopsonistic purchaser, buying from the unorganized fishermen, he would buy OC units of buffalofish, at a price of DC, as determined by the intersection of the curves, DMR and LRMC. The equilibrium solution is not determined by the intersection of LRMC and the derived demand curve, but rather is

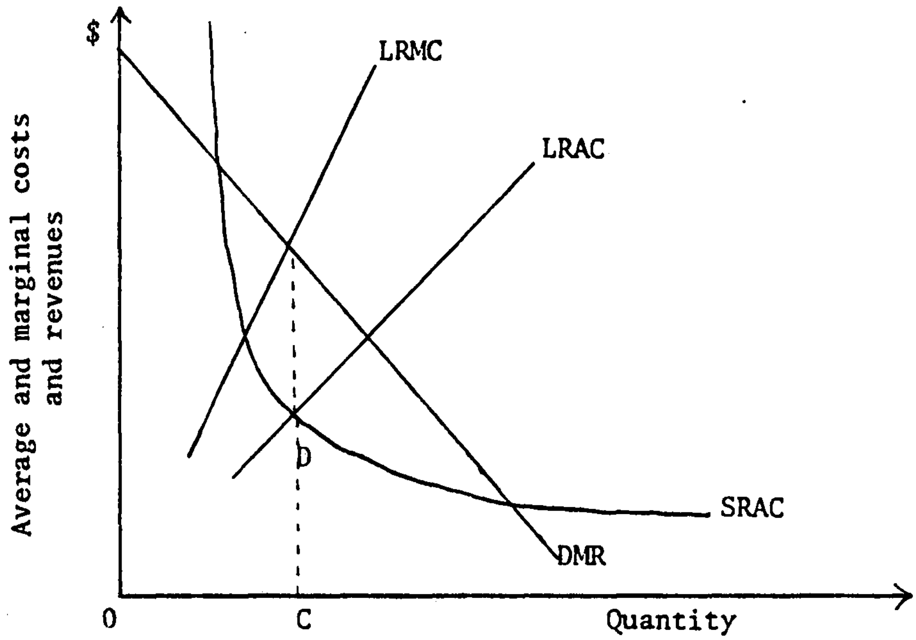

Figure 16. Short-run average cost and price .

determined by the intersection of LRMC and the derived marginal revenue curve since the monopolist must consider the impact of price decreases on all previous units as sales expand.

In Figure 16, DD has been omitted and the short-run average total cost of fish curve, SRAC, has been added. During periods of "deficient" short-run supply, that is, when quantity supplied is less than "planned" quantity, OC, the price received by the fishermen may be greater than long-run average total cost (CD in Figure 16). This could occur since competition among dealers for the reduced supply in the various market areas may temporarily weaken the monopsony. On the other hand, during periods of "excess" supply, the price paid to the fishermen may fall below LRAC since the monopsonist's power will have been restored.

If payment to the fishermen is made more or less according to their short-run average total cost curve, then the fishery will be in long-run equilibrium in the sense that "planned" effort will be that corresponding to sustainable output, OC. Further, under these conditions, observations of price and quantity will not trace out the demand curve of the wholesaler but rather the short-period average total cost curve of the fisherman. If this occurs, then the estimated absolute value of the price elasticity would be unity but it would not reflect the price elasticity along curve DMR.

Factors Which Affect Demand

Demand refers to the price/quantity relationship of a commodity when all other factors which affect demand are held constant. In this section, some of the major factors which affect demand will be considered. These factors:

1. Population - changes in the size of the consuming population result in a shift in demand in the same direction.
2. Consumer income - changes in consumer income are likely to affect demand. For most or "normal" goods, changes in income and demand move in the same direction. When changes in income and demand move in opposite directions, the good is said to be "inferior".
3. Consumer tastes and preferences - changes in consumer tastes and preferences for a commodity cause the demand to shift.

4. Price of other goods - when a change in the price of a good causes the demand of a related good to shift in the same direction, the two goods are said to be substitutes.[20/]

Population and Income

Blacks, Jews, and Asian immigrants are the major consumers of buffalofish, with Blacks constituting the largest percentage [71]. The size of the consuming population and the price of buffalofish are expected to be directly related. Within the usual range of prices and income, the income level of the consuming population and the price of buffalofish are expected to be directly related.

Consumer Tastes and Preferences

Source

It is felt by some that price is a major factor in the purchase of buffalofish. It is true that the buffalofish is one of the lower-priced fresh, fresh-water fish. However, at a retail price of $1.49

[20/] When related goods are in a demand equation, it is possible to define the cross-flexibility of demand. In the demand equation, $P_B = f(Q_B, Q_s)$ the price cross-elasticity of demand is defined as

$\eta_{bs} = \frac{\partial P_B}{P_B} \div \frac{\partial Q_s}{Q_s}$. When $\eta_{bs} < 0$ the two goods are classified as substitutes. When $\eta_{bs} > 0$ the two goods are complements. In empirical analysis, often it is the substitute relationships that are of interest.

(Chicago, July 1979), and with a dressed out weight of 60 percent, the buffalofish can hardly be considered a low-price source of animal protein. In fact, compared to the price of many frozen ocean fish fillets, and some cuts of beef and pork, the buffalofish takes on the characteristics of a premium food item. Considering this relatively high price for buffalofish, it may not be surprising that Blacks, when purchasing buffalofish, often purchase shrimp or lobster at the same time (Bob Ruben, personal communication).

Researchers agree that for many food items, taste is acquired over time, and that food consumption patterns often persist for many years. Because of the persistence of eating patterns, some fish marketing specialists feel that the consumption of buffalofish by Blacks in Chicago is a result of southern immigrants having retained their old food habits.

Changes

In many cases, changes in tastes and preferences occur gradually over time. These changes are usually the result of the interaction of many forces. As a consequence, the effects of those changes are often difficult to quantify. When changes in tastes or preferences are large, however, and occur over a relatively short period of time, the underlying cause(s) and effect(s) may be discernible.

Advertising and publicity may have a significant effect on consumer demand. The researcher who must rely on secondary data may not be aware of the occurrence of various advertising programs, or publicity campaigns and hence, may not be able to include them in the demand equation.

The Chicago fish market has benefited from a long history of advertising. For years, articles on seafood preparation have appeared in the Chicago daily newspapers. Other print media, as well as radio and TV programs have contributed to the demand for fish in the Chicago market. In addition, the large chain food stores feature weekly specials on fresh and frozen fish products. Often these specials include fresh fish as "loss leaders" (Al Autin, personal communication). Thus, it is likely that the Chicago housewife is a sophisticated seafood shopper.

On the negative side, adverse publicity has also affected the tastes and preferences of the Chicago seafood consumer. One documented case in which adverse publicity affected seafood consumption in Chicago occurred in 1963 and was reported in the Chicago Market News which stated:

> Seven deaths attributed to botulism in Great Lakes smoked fish products resulted in the F.D.A. and various city and state health officials issuing emergency regulations governing the processing, sale, and transportation of smoked fish. The actions resulted in a month long barrage of publicity and a marked decline in the sale of fresh, frozen, and smoked fish in Chicago. Consumer confidence in Great Lakes species of fish generally, and smoked fish specifically, had not been regained by the end of the month ... By months end no relief was in sight. [66 (October, 1963)].

The effect of this publicity in Chicago was manifested in depressed fish prices and reduced sales. By December, prices had become abnormally depressed, reflecting the continued publicity and scare surrounding the botulism problem. It was reported that,

> Continued publicity throughout the month concerning "botulism" poisoning connected with Great Lakes fish kept fresh water sales down considerably. Even though a few articles were published emphasizing that "botulism" pertained only to smoked fish, much of the misguided public retained the opinion that it pertained to all fish ... [66 (December, 1963)].

According to the data, during the first half of 1964, the market remained weak. In January the effects of the publicity were still being felt in the Chicago fish market. Another Market News reporter stated:

> There were price drops early in January for fresh-water fish. This was the lingering results of slowed-down consumer demand caused by nearly three months of adverse botulism publicity. However, slow but constant improvements in demand occurred after mid-January [66 (January, 1964] .

As these examples have shown, adverse publicity affects not only a particular species, but may be generalized to other fish as well. However, fortunately for the fishing industry, the major effects of adverse publicity apparently dissipate fairly quickly.

The 1970 mercury contamination of Lake Erie fish presents another example of both the impact of adverse publicity on the consumer (and sports fisherman), and the relative quickness of recovery from that publicity by the public. In 1970, public attention was focused on the mercury contamination of fresh-water fish when Michigan closed Lake Erie to commercial fishing in April of that year because of possible poisoning from high levels of mercury [69 (No. 66, p. 304)]. By then, newspapers had begun to publicize the problem. This publicity affected both the commercial fish market and the sport-fishery. Yet, as publicity died down, in the case of sports-fishing at least, business returned to normal. As one writer states:

> The sport-fishing business also slumped when fishermen heeded public warnings not to eat the fish, Canadians and Americans were faced with enormous economic losses if the ban continued ... Faced with these enormous financial losses from sport-fishing revenues, pressures soon mounted for a more liberal policy. Then the Ontario (government) ... instituted ... a policy called "Fish for Fun." The Americans followed with an equivalent catch-and-release program ... although this new option was publicized before the normally crowded Memorial Day weekend in 1970, boat rentals were down nearly 100% on Lake St. Clair, few fishing licenses were sold, and the fishing camps were nearly empty. Later in the season the provincial government encouraged the Fish for Fun policy by offering the tourist camp operators loans of approximately 35% of their gross revenues to stay open. A compensation plan was also considered but never initiated for bait dealers, gas stations, and other businesses indirectly affected by tourism. However, this proved to be unnecessary, because business gradually returned to normal after mercury pollution was no longer front-page news. [15]

Finally, an example of the tendency for adverse publicity to affect a whole class of fish, and for these effects to quickly decline can be found in the salt water fishery as well. In December, 1970, the public learned that tuna contained large (0.75 ppm) of mercury. In early 1971 the FDA began to recall canned tuna from the market. According to one observer, the affect of the tuna scare was felt in the swordfish market. He reported that "a Californian restaurateur, noted that orders for swordfish dropped from an average of 500 to 30 a day when the tuna scare began and subsequently rose or fell with the newspaper headlines." [15]

Consumer tastes for fishery products tend to be volatile and are especially sensitive to the availabilty of the product, advertising, and publicity. In empirical estimates of demand, it would be desirable to account for such factors. Dummy variables are often used to represent changes in consumer tastes and preferences.

Price or Availability of Other Goods

It is unlikely that, within the normal range of prices, changes in the price of complementary goods would have a significant impact on the demand for buffalofish. Hence, consideration of the effect of prices and availability of other goods on the demand for buffalofish was limited to a search for substitutes.

Undoubtedly, fish are the best substitutes for fish. That is, the most likely substitutes for a particular species of fish are other fish species. Thus, it is important to examine the role of several fish species in the demand for buffalofish. The catfish (bullhead), sheepshead, lake perch, carp, and lake smelt are low to moderate priced freshwater fish and are marketed fresh. They may be viewed by consumers as substitutes for buffalofish.

Some researchers have found that other animal protein sources such as broilers and hogs are substitutes for fish. An identifiable substitutional relationship between these foods and buffalofish may exist.

Cost of Productive Services

The wholesale market derived demand curve is based, in part, on the cost of marketing services. If the overall cost of those services increases, other things remaining the same, the wholesale derived demand will decrease.

In summary, the wholesale market demand for buffalofish depends on consumer demand for buffalofish as well as the cost of providing marketing and distribution services.

In the next section, a model is constructed which specifies as many of the variables which affect wholesale demand as were feasible to quantify.

Model Formulation

Time Considerations

The importance of time in economic analysis becomes acutely apparent when using time-series analysis. In analysis which covers a period of time, several time-related considerations must be taken into account. Among these considerations are: 1) the length of the period covered, i.e., number of years, months, etc.; 2) the time unit for analysis, e.g., annual, quarterly, monthly, etc.; 3) the length of run in which adjustments to changes are presumed to be made; and 4) the nature of supply over time. In this section, each of these four topics will be treated.

Length of Period

In general, long periods are more desirable than shorter periods because of the increase in the degrees of freedom as the period lengthens. On the other hand, if the analysis is to be applicable to today's conditions, the time series should cover a fairly homogeneous period.

The period used in this study begins in 1958. By 1958, the U.S. economy had become fairly stabilized following the 1954 recession. In addition, the data collecting procedures of the Chicago office of the NMFS had become stabilized by that time.[21/]

Time Unit of Analysis

The second time consideration in time-series analysis refers to the time unit used for analysis. For some problems, annual units are logically most suitable; but for other problems, quarterly or monthly data may be best. For this study it was felt that the estimation of monthly variations in demand would be appropriate, and at the same time not require an overly complex model.

Length of Run

The use of time-series analysis implies that market adjustments take place over time. Two basic explanations for delayed adjustments are usually offered. First, adjustment is costly and difficult. Second, "expectations of future conditions are not completely revised on the basis of the current values of the exogenous variables." [29] As will be seen below, it is this second explanation that forms the theoretical basis for the model used in this paper.

[21/] Changes in data collection procedures were made by the Chicago NMFS office in the mid-seventies when the definition of the wholesale price was changed from the wholesale buying price to the wholesale selling price.

Market adjustment may follow many possible paths. In Figures 18 and 19 [after 63] two of these possible paths are shown. In Figure 18, when quantity changes, price adjustments occur gradually. In Figure 19, initial price adjustment is gradual, but after a period of time, the adjustment becomes more rapid.

Since the early part of the century when Irving Fisher invented the distributed lag model, the concept has been applied to a great variety of problems [40]. However, such models must be based on theory if they are to be useful. As one researcher noted:

> Without strong theoretical justification for a particular form of lag distribution, and perhaps even a strong prior belief about the quantitative properties of that distribution and the factors on which those properties depend, it is generally impossible to isolate the lag distribtion in any very definitive way from the sort of data generally available. [40]

The theoretical justification for a distributed lag model in this study rests upon the assumption that because of market uncertainty, fresh fish dealers tend to maintain given price levels by adjusting carry-over stocks (fish carried over from day-to-day or over the weekend). Thus, an initial increase in supply may cause price to fall somewhat as carry-over stocks are allowed to rise. If the increased supply rate is maintained, eventually the upper limit of stock rotation is reached and price will fall sharply. On the other hand, decreases in supply will have a diminished effect while carry-over stocks are reduced. But as conditions of short supply continue, the dealer will be forced to pay a higher price as competition for the available supply becomes keen.

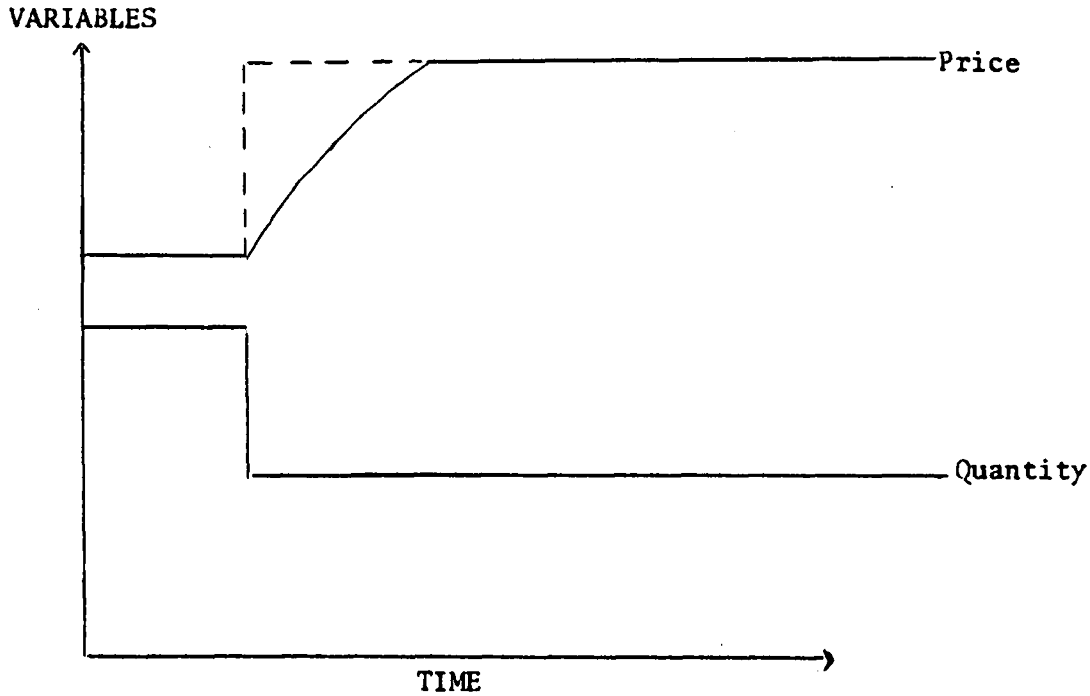

Figure 17. Example of a lagged price adjustment to a quantity change: smooth adjustment.

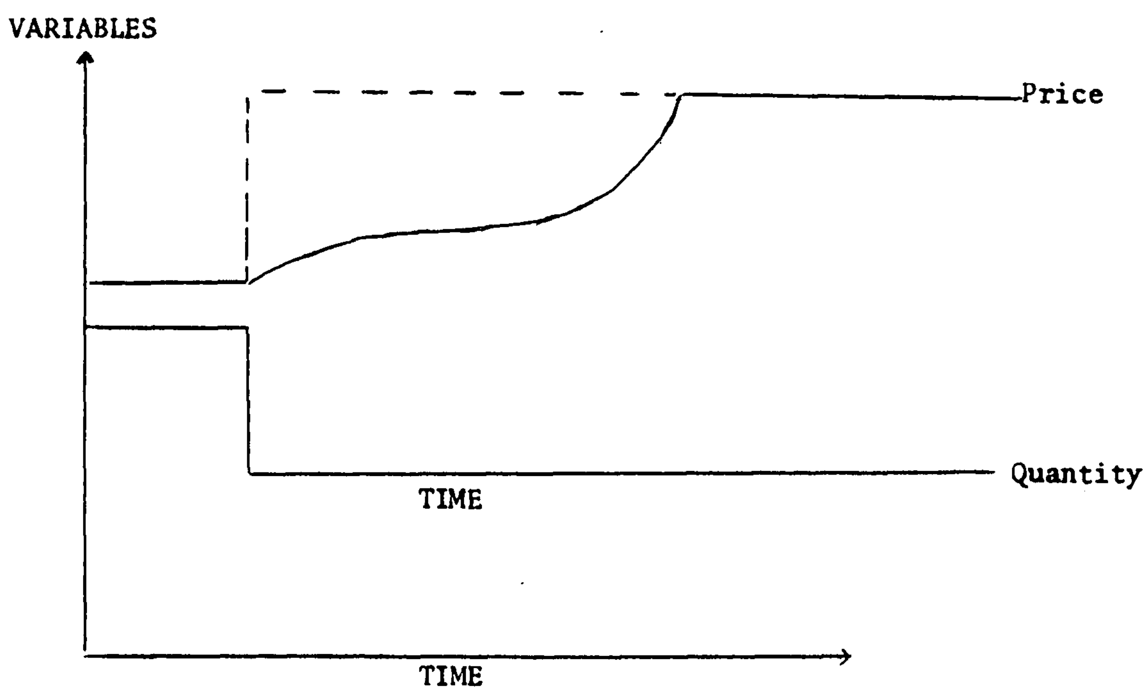

Figure 18. Example of a lagged price adjustment to a quantity change: variable adjustment.

The assumption of stock or inventory adjustments in response to changes in supply form the theoretical basis for the distributed lag model developed in this study. This model therefore includes the history of the exogeneous variables, in the form $Y_t = B_1 + B_2X_t + B_3X_{t-1} + \ldots + U_t$. The basic drawback of this model is the possibility of a high degree of multicollinearity. That is, the values of the exogenous variables may be highly correlated over time. However, this model does not impose a rigid structure on the pattern of coefficients.

Supply

In the usual specification of demand, quantity is the dependent variable. For many agricultural commodities, price is introduced as the dependent variable since, once the crop has been planted, quantity, in general, is not affected by price. Hence, for those goods, given the quantity, what remains to be determined is the price that will clear the market.

The inland commercial fishery resembles agriculture in the sense that during the fishing season the quantity caught is largely independent of price. There are several reasons for this independence. First, since fresh fish are perishable, fishermen and shippers are not able to withhold the catch from the market. Second, because of buyer control, it is generally not possible for shippers or fishermen to sell to various markets in response to price differences. Finally, as was seen earlier, the rate of harvest is largely independent of price due to the tendency for fishing effort to remain constant in response to changing prices, and the tendency of fishing success to depend on such factors as luck, skill, and the weather. Thus, during a given fishing season, the supply of fish to the wholesale market is not generally a function of price.

Model

The basic model used in this study introduces price as the endogenous variable.

The functional model used in this study is

$$P_t^B = f(Q_{t-n}^B, Q_{t-n}^s, Y_t, P_{t-n}^s)$$

where

P_t^B = wholesale price of buffalofish in Chicago in time t; (cents per pound) deflated by the Consumer' Price Index (1967 = 100);

Q_{t-n}^B = receipts of buffalofish in Chicago wholesale fish market (1,000 pounds) in time t-n;

Q_{t-n}^s = receipts of other fish in Chicago wholesale fish market (1,000 pounds) in time t-n;

P_{t-n}^s = farm price of animal protein substitutes deflated by the Consumer's Price Index (1967 = 100) in time t-n;

Y_t = per capita disposable income (dollars per capita); deflated by the Consumer's Price Index (1967 = 100) in time t;

$$t = 1, 2, 3, \ldots T$$

where

$$T = \text{last month of observation;}$$

and

$$n = 0, 0.5, 1, 1.5, 2.$$

This says that the real price of buffalofish is determined by the quantity of buffalofish received, the quantity of fish substitutes, the price of animal protein substitutes, and consumer income.

The specific variables considered are:

X_1 = deflated wholesale price of buffalofish

X_2 = receipts of buffalofish in the Chicago wholesale fish market

X_3 = receipts of smelt in the Chicago wholesale fish market

X_4 = receipts of sheepshead in the Chicago wholesale fish market

X_5 = receipts of catfish in the Chicago wholesale fish market

X_6 = receipts of lake perch in the Chicago wholesale fish market

X_7 = receipts of fresh carp in the Chicago wholesale fish market

X_8 = deflated farm price of hogs

X_9 = deflated farm price of broilers

X_{10} = real per capita disposable personal income

The hypotheses tested are:

$$H_o: f_2, f_3, \ldots f_{10} = 0$$

$$H_a: f_2, f_3, \ldots f_7 < 0; f_8, f_9, f_{10} > 0.$$

V. PROCEDURES AND RESULTS

Data

The National Marine Fisheries Service (NMFS) lists wholesale fishery price data as a price range of the high and low price of a particular species for a given period (day, week, month, or year). In the case of fresh fish, these price ranges reflect differences in quality, in the amount of fish on hand, in the quantity delivered, and in the personal relationship between the dealer and shipper as well as changes in the factors which affect demand.

Price ranges are reported for two categories - size and form. Thus, there may be many price ranges for an individual species. For example, if a fish is marketed in three sizes, i.e., small, medium, and large, and in three forms, i.e., whole, gutted, and frozen, then there will be nine price ranges for that species.

Buffalofish are shipped predominantly in-the-round (whole) and are classified as large (2-4 pounds), No. 1 (4-8 pounds), or jumbo (over 8 pounds). Wholesale price ranges are reported for each of these three size categories. Unfortunately, wholesale receipts are reported only as the total weight of all size categories combined. Thus, it is impossible to associate a given price range with a given quantity of fish.

For this study it was decided that the middle or "average" price in the price range for the "middle" size (No. 1) buffalofish would be used to represent the "price of buffalofish."

Since it was felt that the important price variables were the relative prices, the prices were deflated (divided) by the Consumer's Price Index.

One problem encountered with the use of these data was that the weekly reports could be combined into summaries consisting of either four or five weeks, but that these summaries are not equivalent to monthly reports which are based on the calendar month. Consequently, since the time unit of analysis for this study is based upon the calendar month, a method was required to make the weekly reports comparable to the monthly reports.

While there are several procedures which can be used to increase the comparability of the data, for this study it was decided that the data would be based on a four week "month". This was accomplished by reducing quantities in the monthly reports by 2/30 or 3/31, depending on whether the month contained thirty or thirty-one days, and by reducing any quantities in any five week monthly summary by 1/5. The adjusted and unadjusted data are given in the Appendix.

A complete set of data for the Chicago wholesale fresh fish market was not available. Prices were available from 1950 to June 1965, and quantities were available through 1971. Consequently, the available data from 1960-1964 were used to tentatively assess the hypotheses and to generate new hypotheses.

Population and income data specifically related to the consuming population were not available. Several proxy variables were used, including the Chicago unemployment rate.

Scattergrams, simple correlation matricies, and regressions were obtained using data on receipts of carp, hogs, broilers, catfish, sheepshead, smelt, and lake perch and various transformations of these variables including lagged receipts and prices, squared quantities, products of two quantities, and sums of quantities. That is, regression techniques were employed to estimate the parameters of alternative forms of the model discussed at the end of Chapter IV. Throughout the five year (1960-64) period, the most promising candidates for inclusion in the regression in terms of the significance and consistency of the regression coefficients were the current and lagged quantities of buffalofish and smelt. The variable which measured catfish quantities was also significant in the equations during these years.

Buffalofish data through 1977 were obtained from the Market News Reporter. Additional regressions were run. These results were consistent with the earlier findings.

Additional smelt data were sought. No such data were available however, as smelt data collection was discontinued in 1968.

Separate regressions were run, first using only buffalofish price and quantity data (1958-1977) and then using both buffalofish and smelt data (1958-1967).

Criteria for Evaluation

The criteria for evaluating the results of this study were based on: (a) a consideration of how well the outcome corresponded to the *a priori* expectations discussed in the last chapter (b) the consistency between the sample observations (c) the views of other qualified observers and (d) statistical tools.

The statistical tools include the t and F tests for significance of the individual estimated regressions coefficients and groups of estimated coefficients, respectively. While the actual level of significance was not rigidly set, a significance level of ten percent was considered acceptable.

The R^2 statistic was used to examine the goodness of fit of the estimated regression equation and to reveal the amount of variation in the price of buffalofish that was "explained" by the fitted variables.

The Durbin-Watson or d statistic was used to test the assumption that the error terms were not autocorrelated. When autocorrelation of the error terms exist, the estimated variance of the regression coefficients will be biased and the tests of significance will lead to incorrect statements.

Tentative Results

The tentative results for the buffalofish and smelt regressions were presented to Oregon State University faculty members who suggested that: (1) a variable was needed to explain the apparent annual shifts in demand, (2) an income variable was needed, (3) the distributed lag model should be improved, and (4) a simultaneous equations system should be estimated.

In response to the first suggestion, the basic model was changed to the form

$$P_t^B = \beta_o + \beta_1 Q_t^B + \beta_2 Q_{t-1}^B + \beta_3 Q_t^s + \beta_4 Q_{t-1}^s + \varepsilon_i,\underline{22/}$$

where,

B = Buffalofish

S = Smelt

ε = Error Term

and estimated. However, only two modified versions of these equations are discussed here because of their interesting implications. These

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22/ Of course the full specification of the regression model includes a specification of the probability distribution of the disturbance and a statement telling how the values of the explanatory variables are determined. These specifications or assumptions are:

1) e_i is normally distributed

2) $E(e_i) = 0$

3) $E(e_i^2) = \sigma^2$

4) $E(e_i e_j) = 0,\ i \neq j$

5) Each of the explanatory variables is nonstochastic with values fixed in repeated samples and such that, for any sample size,

$$\sum_{i=1}^{n} (X_{ik} - \overline{X}) \frac{2}{n} \text{ is a finite number different from zero}$$

for every K = 2, 3, ... K.

6) The number of observations exceeds the number of coefficients to be estimated.

7) No exact linear relationships exists between any of the explanatory variables [32].

Further, the linear specification was chosen for simplicity. The relationship may indeed be a straight line, or over modest ranges of the data, a straight line may be a reasonable approximation for many complicated functional forms.

equations are:

$$1. \quad P^B = \beta_o + \beta_1 Q_t^B + \beta_2 Q_{t-1}^B + \varepsilon_i$$

$$2. \quad P^B = \beta_o + \beta_1 Q_t + \beta_2 Q_{t-1}^B + \beta_3 Q_{t-1}^s + \varepsilon_i$$

The summary results of the regressions for equation 1 are given in Table 8. The first twenty are annual regressions, while the last three cover a period of years. All of the regressions use monthly data. However, dummy variables for years are used in the last three regressions. Additional statistics for these last three regressions are given in Table 9.

One interesting observation from the annual regressions in Table 8 is that with the exception of a few years,[23/] both the regression coefficients and the intercept terms remained fairly stable over the period of analysis. The regression coefficients for buffalofish receipts generally ranged from -0.01 to -0.02, while the intercept term ranged from 19 to 39. The intercept terms and coefficients for the longer period regressions also fell within these ranges.

In column five, a novel term, which will be called the "sustained effect coefficient" has been computed by summing the two regression coefficients. The sustained effect coefficient gives the expected change in the price of buffalofish for a change in buffalofish receipts that is sustained or maintained for two or more periods (months).

23/ Because a change in the definition of price occurred around 1975, this discussion is based on the period preceding 1975. The several "expections" referred to above occurred prior to 1975 and will be discussed in a later section along with a discussion of the effect of adverse publicity on the demand of buffalofish.

Table 8. Basic demand equations for buffalofish, monthly data

Year	Regression Coefficients: Constant	Regression Coefficients: Q_t	Regression Coefficients: Q_{t-1}	Regression Coefficients: $\Sigma Q_t, Q_{t-1}$ [b/]	Price Flexibility Coefficients [a/]: Q_t	Price Flexibility Coefficients [a/]: Q_{t-1}	Price Flexibility Coefficients [a/]: $\Sigma Q_t, Q_{t-1}$ [b/]	Adjusted R^2	D.W. [c/]
1958	33.1	-0.0091	-0.0296	-0.0387	.12	.39	.51	.24	1.29
		(.017)	(.017)						
1959	31.7	-0.0204	-0.0126	-0.0330	.44	.26	.70	.55	1.73
		(.009)	(.008)						
1960	39.4	-0.0130	-0.0335	-0.0485	.29	.80	1.09	.47	1.54
		(.012)	(.012)						
1961	33.1	-0.0027	-0.0192	-0.0219	.06	.42	.48	.37	1.54
		(.010)	(.010)						
1962	21.8	+0.0052	-0.0238	-0.0186	+.13	.61	.48	.23	0.59
		(.010)	(.010)						
1963	22.9	-0.0197	-0.0120	-0.0316	.50	.30	.80	.46	0.99
		(.007)	(.007)						
1964	30.3	-0.0282	-0.0252	-0.0535	.79	.71	1.50	.62	1.92
		(.009)	(.009)						
1965	24.0	-0.0134	-0.0157	-0.0291	.34	.41	.75	.86	1.55
		(.003)	(.003)						
1966	24.2	-0.0085	-0.0215	-0.0300	.17	.43	.60	.20	2.54
		(.021)	(.013)						
1967	26.5	-0.0150	-0.0256	-0.0406	.31	.53	.84	.64	2.11
		(.007)	(.006)						
1968	25.5	-0.0098	-0.0322	-0.0420	.18	.60	.78	.62	2.44
		(.010)	(.010)						
1969	26.3	-0.0008	-0.0350	-0.0358	.02	.76	.78	.79	1.13
		(.007)	(.007)						
1970	31.0	-0.0251	-0.0283	-0.0534	.55	.61	1.16	.59	2.69
		(.010)	(.010)						
1971	30.8	-0.0197	-0.0256	-0.0452	.43	.56	.99	.72	1.29
		(.009)	(.010)						

(continued)

Table 8. (continued)

Year	Regression Coefficients: Constant	Q_t	Q_{t-1}	$\Sigma Q_t, Q_{t-1}$ [b]	Price Flexibility Coefficients [a]: Q_t	Q_{t-1}	$\Sigma Q_t, Q_{t-1}$ [b]	Adjusted R^2	D.W. [c]
1972	21.0	-0.0092 (.010)	-0.0129 (.011)	-0.0221	.22	.31	.53	.21	1.08
1973	18.8	-0.0153 (.011)	-0.0065 (.012)	-0.0218	.30	.13	.43	.07	0.91
1974	19.6	-0.0013 (.004)	-0.0239 (.003)	-0.0252	.03	.51	.54	.83	1.99
1975	17.3	+0.0008 (.007)	-0.0138 (.006)	-0.0130	+.02	.43	.41	.28	1.07
1976	17.2	-0.0081 (.016)	+0.0004 (.015)	-0.0077	.24	+.01	.23	-.18	0.37
1977	22.9	+0.0008 (.004)	-0.0090 (.004)	-0.0082	+.02	.22	.20	.29	1.81
1958-67 [d]	23.7	-0.0124 (.003)	-0.0177 (.003)	-0.0301	.27	.39	.66	.76	1.55
1968-77 [d]	31.9	-0.0095 (.003)	-0.0174 (.003)	-0.0269	.22	.40	.62	.54	1.77
1958-77 [d]	32.9	-0.0111 (.002)	-0.0179 (.002)	-0.0290	.25	.41	.66	.68	1.33

Note: Standard error of respective coefficients given in parentheses.

a/ Flexibilities are negative unless otherwise noted.

b/ Σ equals sum of coefficients of two preceding columns, e.g., (-0.0091) + (-0.0296) = -0.0387.

c/ Durbin-Watson statistic.

d/ Equations with dummy variables for years. See following four tables.

Table 9. Demand equation for buffalofish, with dummy variables for years:

Variable	Coefficient	S.E.[b]	Adjusted R^2
1958-1967[a]			
Constant	23.7		.76
Q_t	-0.0124	.003	
Q_{t-1}	-0.0177	.003	
$\Sigma Q_t, Q_{t-1}$[c]	-0.0301		
Q^s_{t-1}[d]	-0.0057	.004	
D1 (1958)	7.28	.82	
D2 (1959)	7.48	.85	
D3 (1960)	8.49	.91	
D4 (1961)	4.18	.81	
D5 (1962)	2.84	.84	
D6 (1963)	-1.00	.79	
D7 (1964)	-1.10	.81	
D8 (1965)	0.99	.81	
D9 (1966)	0.90	.78	
1968-1977[a]			
Constant	31.86		.54
Q_t	-0.0095	.003	
Q_{t-1}	-0.0174	.003	
$\Sigma Q_t, Q_{t-1}$[c]	-0.0269		
D11 (1968)	-10.32	1.13	
D12 (1969)	-7.87	1.01	
D13 (1970)	-9.11	1.04	
D14 (1971)	-7.24	1.00	
D15 (1972)	-9.26	1.02	
D16 (1973)	-11.66	1.14	
D17 (1974)	-11.71	1.11	
D18 (1975)	-9.16	.94	
D19 (1976)	-6.72	.92	

(continued)

Table 9. (continued)

1958-1967[a]			
Variable	Coefficient	S.E.[b]	Adjusted R^2
Constant	23.16		.39
Q_t	-0.00855	.0031	
Q_{t-1}	-0.00757	.0029	
$\Sigma Q_t, Q_{t-1}$	-0.01612		
D1 (1958)	3.25	1.31	
D2 (1959)	1.83	1.22	
D3 (1960)	2.55	1.21	
D4 (1961)	-0.85	1.23	
D5 (1962)	-2.35	1.23	
D6 (1963)	-5.26	1.26	
D7 (1964)	-5.56	1.25	
D8 (1965)	-3.75	1.24	
D9 (1966)	-3.13	1.28	
D10 (1967)	-3.92	1.29	
D11 (1968)	-4.50	1.33	
D12 (1969)	-2.73	1.26	
D13 (1970)	-3.79	1.27	
D14 (1971)	-2.22	1.25	
D15 (1972)	-4.11	1.26	
D16 (1973)	-5.79	1.34	
D17 (1974)	-5.96	1.32	
D18 (1975)	-4.63	1.22	
D19 (1976)	-2.47	1.21	

(continued)

Table 9. (continued)

1958-1977 (selected dummy variables)			
Variable	Coefficient	S.E.[b/]	Adjusted R^2
Constant	32.9		.68
Q_t	-0.0111	.002	
Q_{t-1}	-0.0179	.002	
$\Sigma Q_t, Q_{t-1}$	-0.0290		
D1 (1958-1960)	-2.42	.74	
D2 (1961)	-5.86	.88	
D3 (1962)	-7.18	.87	
D4 (1963-1964)	-10.84	.80	
D5 (1965-1967)	-8.17	.90	
D6 (1968)	-10.77	.96	
D7 (1969)	-8.17	.90	
D8 (1970)	-9.46	.92	
D9 (1971)	-7.53	.90	
D10 (1972)	-9.58	.91	
D11 (1973-1974)	-12.13	.87	
D12 (1975)	-9.34	.87	
D13 (1976)	-6.85	.86	

[a/] Summary statistics given in Table 8.

[b/] Standard error.

[c/] See footnote b in Table 8.

[d/] Lagged smelt receipts.

It can be shown that the sum of the two regression coefficients does indeed give the change in the price of buffalofish for a sustained change in receipts. Consider the equation

$$P_t = \beta_o + \beta_1 Q_t + \beta_2 Q_{t-1}$$

so that

$$dP_t = \beta_1 \, dQ_t + \beta_2 \, dQ_{t-1}.$$

For sustained changes,

$$dQ_t = dQ_{t-1}.$$

Therefore,

$$dP_t = (\beta_1 + \beta_2) \, dQ_t.$$

Hence

$$\frac{dP_t}{dQ_t} = \beta_1 + \beta_2.$$

Q.E.D.

Since the coefficient of sustained change ranges from approximately -0.02 to -0.05, then a 1,000 pound increase in buffalofish receipts that was sustained for a period of two or more months, other things remaining the same, would be expected to result in a two to five cents a pound decrease in the wholesale price of buffalofish.

Price Flexibilities

Price flexibility may be defined as the percentage change in price associated with a given percent change in quantity. Since this is a point concept, price flexibility will, in general, vary along the demand curve.

Following the usual practice, the price flexibilities in this analysis were computed at the means of price and quantity. Hence, extrapolation from these points may yield erroneous results.

The price flexibility coefficients in Table 8, are listed in columns six and seven. It can be seen that no estimated flexibility coefficient exceeds 1.00 in absolute value, which means that the price of buffalofish is relatively inflexible with respect to buffalofish receipts in the current or previous month.

Price flexibility is related to total revenue. Since total revenue equals price times quantity, then, when the price flexibility coefficient is less than one, that is when the percentage change in price is smaller than the percentage change in quantity, an increase in sales to the Chicago market will result in an increase in total revenue for the fishermen.

Hence, small increases in buffalofish shipments to the Chicago wholesale fish market during the current or previous month would not be expected to decrease the total revenue of the fishermen.

To assess the impact of a sustained change in buffalofish receipts on the total revenue of the fisherman, another apparently novel term has been introduced. This term, which will be called the "sustained price flexibility coefficient" is computed by summing the two price flexibility coefficients. That the sustained price flexibility coefficient can indeed be used in this manner can be seen by considering the equation

$$P_t = \beta_o + \beta_1 Q_t + \beta_2 Q_{t-1} + \varepsilon_i,$$

so that the sum of the elasticities is given by

$$\eta_t + \eta_{t-1} = \beta_1 \frac{\overline{Q}_t}{\overline{P}_t} + \beta_2 \frac{\overline{Q}_{t-1}}{\overline{P}_t}$$

$$\cong (\beta_1 + \beta_2) \frac{\overline{Q}_t}{\overline{P}_t} \text{ since } \overline{Q}_t \cong \overline{Q}_{t-1}.$$

Furthermore,

$$TR = P_t \, Q_t$$

and

$$\frac{dTR}{dQ_t} = P_t + \frac{dP_t}{dQ_t} Q_t = \left(\frac{P_t}{P_t} + \frac{dP_t Q_t}{dQ_t P_t}\right) P_t$$

$$= \left(1 + \frac{dP_t Q_t}{dQ_t P_t}\right) P_t$$

$$= \left(1 + (\beta_1 + \beta_2) \frac{Q_t}{P_t}\right) P_t \text{ since } \frac{dP_t}{dQ_t} = \beta_1 + \beta_2$$

$$= \left[1 + (\eta_t + \eta_{t-1})\right] P_t$$

Q.E.D.

Therefore, if the sum of the price flexibility coefficients of demand for buffalofish is less than 1.00 in absolute value, small sustained increases in shipments to the Chicago wholesale fish market by the fishermen would be expected to increase total revenue.

In examining the sums of the price flexibility coefficients for buffalofish (Table 8), we see that with the exception of approximately four years, the sums of the price flexibility coefficients were less than unity. Thus, in most cases, a sustained increase in buffalofish shipments to the Chicago market would not have reduced total revenue for the fishermen.

The years in which the sum of the price flexibility coefficients exceeded unity, with the exception of 1960, coincided with the occurrence of adverse publicity surrounding botulism and mercury pollution problems. The regression results for years are examined in greater detail in a later section.

In the annual regressions in Table 8, with the exception of 1973, the adjusted R^2 ($\bar{R}^2$) ranged from 20 to nearly 90 percent, with the "average" (the 1958-77 regression) being around seventy percent. This means that approximately seventy percent of the variation of the observed price of buffalofish can be attributed to the variation in the fitted values of the price of buffalofish. The high $\bar{R}^2$ also indicates that the regression equation fits the observations well.

The $\bar{R}^2$ values for the 1958-77 and 1968-77 periods (0.68 and 0.54, respectively) were lower than the $\bar{R}^2$ value for 1958-67 period, probably because of the overall low fit after 1975.

The average value of the Durbin-Watson (D.W.) statistic for the annual regressions is less than 2.00. However, since this statistic is not reliable for small samples, the longer-period or pooled regressions must be examined. For the 1958-67 period, the D.W. statistic was 1.55 which is inconclusive at the one percent level. However, for the 1968-77 and 1958-77 periods, the D.W. statistic is 1.17 and 1.33, respectively, which is less than the tabular lower bound. Hence, it is likely that the standard errors given in Table 8 for the pooled regressions are smaller than they would be if corrections for autocorrelation were made.

The appropriateness of using pooled data in the last three equations in Table 8 rests on whether or not the slope coefficients (β_1 and β_2) are equal. The test difference in slopes becomes the test of whether all the slope dummies are zero. This was tested by the model containing all the interaction terms, written as

$$P^B = \beta_o + \beta_1 Q_t^B + \beta_2 B_{t-1} + \beta_3 D_1 + \beta_4 D_2 + \dots + \beta_{21} D_{19} + \beta_{22} (D_1 Q_t) + \beta_{23} (D_2 Q_t) + \dots \beta_{40} (D_{19} Q_t) + \beta_{41} (D_1 Q_{t-1}) + \beta_{42} (D\ Q_{t-1}) + \dots + \beta_{59} (D_{17} Q_{t-1})$$

where

D = Dummy for years

The interaction between variables measuring years and buffalofish quantities was not significant. Hence, it appears that the slope coefficient of the regression equations are not significantly different from each other.

The regression results from the other version of the equation $P^B = f(Q_t^B, Q_{t-1}^B, Q_{t-1}^s)$ are given in Table 10. These tentative findings were discussed with the NMFS personnel who concurred

Table 10. Influence of smelt in demand equation

Year	Regression Coefficients Q_t^B	Q_{t-1}^B	Q_{t-1}^s	$\bar{R}^2$
1958	-0.0091 (0.017)	-0.0296 (0.017)		.24
1958	-0.0072 (0.017)	-0.0104 (0.022)	-0.0131 (0.0099)	.30
1959	-0.0204 (0.0086)	-0.0126 (0.0079)		.55
1959	-0.0217 (0.0092)	-0.01612 (0.0103)	0.00421 (0.0074)	.51
1960	-0.0130 (0.0116)	-0.0355 (0.0120)		.47
1960	-0.00327 (0.0161)	-0.02725 (0.0154)	-0.01863 (0.0214)	.45
1961	-0.0027 (0.010)	-0.0192 (0.010)		.37
1961	-0.01791 (0.013)	-0.00905 (0.014)	-0.01328 (0.013)	.37
1962	0.0052 (0.0101)	-0.0238 (0.0104)		.23
1962	0.0152 (0.0139)	-0.0155 (0.0140)	-0.02591 (0.0246)	.23
1963	-0.0197 (0.0072)	-0.0120 (0.0071)		.46
1963	-0.01825 (0.0083)	-0.00973 (0.0093)	-0.00638 (0.0156)	.40
1964	-0.0282 (0.0091)	-0.0252 (0.0091)		.62
1964	-0.02347 (0.01096)	-0.01883 (0.0122)	-0.02573 (0.0318)	.61
1965	-0.0134 (0.0033)	-0.0157 (0.0035)		.86
1965	-0.01357 (0.0045)	-0.01595 (0.0048)	0.0094 (0.0127)	.84
1966	-0.0085 (0.0122)	-0.0215 (0.0125)		.20
1966	-0.0074 (0.0129)	-0.0171 (0.0157)	-0.01164 (0.0226)	.13

(continued)

Table 10. (continued)

Year	Regression Coefficients			$\bar{R}^2$
	Q_t^B	Q_{t-1}^B	Q_{t-1}^s	
1967	-0.0150 (0.0066)	-0.0256 (0.0063)		.64
1967	-0.00927 (0.0076)	-0.01454 (0.0010)	-0.02930 (0.0212)	.67

Note: B = Buffalofish, S = Smelt, Q = Quantity, $\bar{R}^2$ = Adjusted R^2.

Standard errors are given in parentheses.

with the buffalofish price/quantity relationship, but did not accept the inverse relationship between smelt receipts and the price of buffalofish. They stated that the smelt and buffalofish markets are entirely separated, and that the consuming populations are entirely different.

These findings, and the views of the NMFS personnel were relayed to a retired Minnesota fisherman, Roy Oberg, who confirmed the possibility that smelt could have affected the price of buffalofish, and other species as well, prior to 1968 because until that time, large quantities of fresh smelt were shipped to the Chicago wholesale fish market from the Duluth smelt fishery. In 1967, he reported, the dock site in Duluth was condemned for a new highway, which effectively ended the Duluth smelt fishery.

Since that time, fresh smelt receipts in Chicago have continually declined, being replaced by frozen smelt, largely from Ontario, Canada. (Bob Ruben, personal communication)

The discussion with Mr. Oberg was relayed to the NMFS personnel who still were not convinced. To "solve" the problem, a telephone interview with a fish broker (Bob Kradin) was arranged by Mr. Ruben. The broker, who has many years of experience in the Chicago wholesale fish market, pointed out that in the Chicago market area, smelt are consumed largely by whites and are not accepted by Blacks. Hence, stores catering to Blacks do not carry smelt. He did point out, however, that the frozen and fresh smelt markets are completely different, and that the ultimate consumer in each market may be different.

Because fresh smelt were available in Chicago throughout the year prior to 1968, it is possible that smelt receipts did have an impact on the price of buffalofish, perhaps indirectly through a third species, such as bass, which is consumed by both populations.

However, two findings tend to refute this hypothesis. First, the annual regression coefficients for smelt are highly insignificant. Second, the inclusion of smelt in the equation usually did not improve the adjusted R^2 (Table 10).

However, these results may have been due to multicollinearity. In fact, monthly receipts of smelt and buffalofish are fairly highly correlated (simple r = 0.62).

On the other hand, the simple r may not reveal the presence of multicollinearity. However, if there is a fairly high degree of multicollinearity, as suspected from the high simple r, then the sample variance of the estimated coefficients is increased, which in turn will result in a very low t-statistic (against a null hypothesis that the coefficient is zero).

In Table 10, it can be seen that in general, when smelt quantities are added to the equation, the significance of the estimated coefficients decreased, while the variance of the $\hat{\beta}$'s increased. Thus, it is possible that a fairly high degree of multicollinearity is present. Nevertheless, multicollinearity may not be a problem in these equations. It may be that smelt quantities do not have an important influence on the mean of the price of buffalofish.

If it is assumed that multicollinearity is not a problem, then a test can be used to evaluate the influence of the addition of smelt quantities on the mean of the price of buffalofish.

The extended equation is

$$\text{(a)} \qquad P^B = \beta_o + \beta_1 Q_t^B + \beta_2 Q_{t-1}^B + \beta_3 Q_{t-1}^s + \varepsilon_i$$

while

$$\text{(b)} \qquad P^B = \beta_o + \beta_1 Q_t^B + \beta_2 Q_{t-1}^B + \varepsilon_i$$

is the original equation. Then the appropriate test of the null hypothesis

$$H_o\colon \beta_3 = 0$$

against the alternative that H_o is not true is

$$F = \left[\frac{SSR_A - SSR_B}{SSE_A}\right] \left[\frac{n - A}{A - B}\right]$$

where the subscript A denotes the values pertaining to the extended set of explanatory variables, and the subscript B denotes the values pertaining to the original set of explanatory variables.[24/]

Since, SST = SSR + SSE, the value of the appropriate F statistic for the equations for 1958 in Table 10 then is

$$\begin{aligned} F &= \left[\frac{(SSR_A / SST) - (SSR_B / SST)}{(1 - SSR_A / SST)}\right] \left[\frac{n - A}{A - B}\right] \\ &= \left[\frac{R_A^2 - R_B^2}{1 - R_A^2}\right] \left[\frac{n - A}{A - B}\right] \\ &= \left[\frac{0.49 - 0.38}{1 - 0.49}\right] \left[\frac{12 - 4}{4 - 3}\right] = \left[\frac{0.11}{0.51}\right] [8] \\ &= 1.7 \end{aligned}$$

$$F^{\alpha}_{A-B,\ \bar{n}-A}\ 0.05 = F^{\alpha\ 0.05}_{1,\ 8} = 5.32$$

24/ Since $\sqrt{F} = t$, then the t-test may also be used.

Since tabular F is less than calculated F at the 5 percent level of significance, the null hypothesis cannot be rejected. That is, there is no reason to believe that the addition of the lagged quantity of smelt contributes to the explanation of variations in the price of buffalofish.

The results of this test for the other years were the same. Based upon these results and the considerations of others who have considerable knowledge concerning the Chicago wholesale fish market, the variable measuring smelt quantities was dropped from the model.

Suggestions again were solicited for potential substitutes for buffalofish from the NMFS personnel. The suggestion offered for a substitute was the headless and gutted (H & G) whiting - a frozen form of an Atlantic Ocean species.

Data for receipts of whiting in Chicago were not available. In addition, the price series was incomplete. Nevertheless, the variable prices were included in the regression model in the form

$$P_t^B = \beta_o + \beta_1 Q_t^B + \beta_2 Q_{t-1}^B + \beta_3 P_t^w + \beta_4 P_{t-1}^w + \varepsilon_i$$

The estimated regression coefficients for prices of whiting were not significant, nor did the inclusion of variables which measured whiting prices increase the adjusted R^2.

Finally, an unemployment variable was brought into the model as a proxy for income. The summary results are given in Table 11.

Table 11. Demand equation with unemployment variable

Years	Constant	Q_t^B	Q_{t-1}^B	N	$\bar{R}^2$
1960-67	15.14	-0.0035	-0.0098	+0.9473	.06
		(.0049)	(.411)	(.005)	
1968-77	15.65	+0.0026	-0.0073	+0.0641	.00
		(.0044)	(.0043)	(.235)	

Note: N = unemployment rate in Chicago.

Standard errors given in parentheses.

Although not all of the estimated coefficients in the equations are significant, the implications of these coefficients are worth noting. In both equations the rate of unemployment was directly related to the price of buffalofish, which suggests that an increase in the rate of unemployment and thus, perhaps a decrease in income would result in an increase in the price of buffalofish.

Two-Stage Procedure

To test the possibility that buffalofish receipts in the Chicago wholesale fish market are not exogenously determined, a system of equations was specified and two-stage least squares was used to estimate the parameters. In the two-stage least squares system, each included endogenous variable is regressed against the complete set of variables, and the predicted, rather than the actual values of the endogenous variables are used in the structural equation.

The two-stage least squares model was

(c) $P^B = f(\hat{Q}^B_t, Q^B_{t-1}, Q^s_{t-1}, N_t)$

(d) $\hat{Q}^B_t = g\ (P^B_t, Q^{US}_t, N_t)$

where

N_t = unemployment rate

Q^{US}_t = total U.S. buffalofish production

The results are given in Table 12.

Table 12. Two-stage least squares equation

Years	Constant	Q^B_t	Q^B_{t-1}	Q^s_{t-1}	N	$\bar{R}^2$	D.W.
1958-67	68.18	-0.283	0.0832	0.0836	2.187	.51	.96
		(0.035)	(0.013)	(0.011)	(0.291)		

Note: Standard errors given in parentheses.

The sign for the estimated coefficients for the lagged quantities of buffalofish and smelt did not agree with a priori expectations. Furthermore, while, strictly speaking, the $\bar{R}^2$ statistic has little meaning under two-stage least squares, it does appear that a better fit is provided by ordinary least squares and, in addition, it appears that autocorrelation is less severe with the single equation model (see Tables 8 and 9).

For these reasons and for convenience, the single equation model was selected as the most acceptable. Thus, it is assumed that the quantity of buffalofish received in the Chicago wholesale fish market may be exogenously determined. Further research in this area may be fruitful.

Quantity Dependent OLS Model

To test the quantity dependent OLS model, linear forms of the following equations were estimated:

$$Q_t^B = f(P_t^B, P_{t-1}^B)$$

and

$$Q_t^B = f(P_t^B, Q_t^{US}, N)$$

where Q_t^{US} = total U.S. harvest of buffalofish in time t were regressed. The results are listed in Table 13.

Table 13. Quantity dependent equations

Years	P_t^B	Q_t^{US}	N	P_{t-1}^B	$\bar{R}^2$
1958-67	-9.05			7.51	.14
	(2.10)			(1.97)	
1960-67	-5.62	-0.0205	15.43		.12
	(2.53)	(0.0114)	(11.52)		
1960-67	-3.44		29.46		.10
	(2.25)		(8.60)		
1968-77	-3.05		-4.90	2.78	.18
	(.841)		(1.29)	(.850)	

Note: Standard errors given in parentheses.

The estimated coefficients for the lagged price of buffalofish were not in accord with *a priori* expectations. Also, the sign of the coefficient for the unemployment variable was not consistent. Therefore, the price dependent model was selected as the most acceptable from a statistical viewpoint.

Omission of Relevant Explanatory Variables[25]

One of the common problems in empirical analysis is the omission of relevant explanatory variables from the equation. In this section, the effect of those omissions will be discussed.

Suppose the equation

(1) $$Y_i = \beta_o + \beta_1 X_1 + \varepsilon_i$$

where Y = price of buffalofish

and X_1 = quantity of buffalofish

is estimated, but that the correct specification is

(2) $$Y_i = \beta_o + \beta_1 X_1 + \beta_2 X_2 + \varepsilon_i$$

where X_2 = quantity of a substitute.

Then it is of interest to know the effect of this omission on the estimates of β_o and β_1 in equation (1).

For β_1,

$$E\ (\hat{\beta}_1) = E\ \frac{\Sigma(X_{i1} - \overline{X})\ (Y_i - \overline{Y})}{\Sigma(X_{i1} - \overline{X}_1)^2}$$

But from (2),

$$Y_i - Y = \beta_1\ (X_{i1} - \overline{X}_1) + \beta_2\ (X_{i2} - \overline{X}_2) + (\varepsilon_i - \overline{\varepsilon})$$

so that

$$E\ (\hat{\beta}_1) = E\ \frac{\Sigma(X_{i1} - \overline{X}_1)\ [\beta_1\ (X_{i1} - \overline{X}_1) + \beta_2\ (X_{i2} - \overline{X}_2) + (\varepsilon_i - \overline{\varepsilon})]}{\Sigma(X_{i1} - \overline{X}_1)^2}$$

$$= \beta_1 + \beta_2\ d_{21}$$

where $d_{21} = \dfrac{\Sigma(X_{i1} - \overline{X}_1)\ (X_{i2} - \overline{X}_2)}{\Sigma(X_{i1} - \overline{X}_1)^2}$.

---

[25] This discussion closely follows [32].

Hence, if β_2 is different from zero, the OLS estimate of β_1, based on (1) is biased unless $d_{21} = 0$, e.g., X_{i1} and X_{i2} are uncorrelated. The direction of the bias depends on the sign of β_2 and the direction of correlation between X_{i1} and X_{i2}.

If both β_2 and d_{21} are of the same sign the bias will be positive, otherwise the bias will be negative.

For β_o,

$$E\ (\hat{\beta}_o) = E(\overline{Y} - \hat{\beta}_1\overline{X}_1) = (\beta_o + \beta_1\overline{X}_1 + \beta_2\overline{X}_2) - (\beta_1 + \beta_2 d_{21})\ \overline{X},$$

$$= \beta_1 + \beta_1 X_1 + \beta_2\overline{X}_2 - \beta_1\ \overline{X}_1 - \beta_2 d_{21}\overline{X}_1$$

$$= \beta_o + \beta_2\overline{X}_2 - \beta_2 d_{21}\overline{X}_1$$

$$= \beta_o + \beta_2 d_{20}$$

where $d_{20} = \overline{X}_2 - d_{21}\overline{X}_1$

Hence, given that $\beta_2 \neq 0$, then as long as

$$\overline{X}_2 - d_{21}\overline{X}_1 \neq 0$$

the OLS estimator of β_o based on (1) will be biased.

In summary then, if the omitted explanatory variable is correlated with the included explanatory variable, the OLS estimators of β_o and β_1 will be biased. If the two variables are not correlated, then β_1 will not be biased but β_o will, in general, be biased. However, in this case the estimator of the variance of $\hat{\beta}_1$ will be biased upward so that significance tests and confidence intervals will be unduly conservative. ([32] p. 394)

Impact of the Omission of Relevant Variables on the Demand Equation

In the basic demand equation used in this study, several variables were omitted, some of which are likely relevant. Thus, it is important to estimate the potential impact of the omission of these variables on the regression coefficients obtained in this study. In this section, the potential impact of the omission of variables which measure income, substitute quantities and changes in preference on the estimated demand equation will be considered.

Income

If buffalofish is a "normal" good, then income and price will be positively related. Thus, if income and buffalofish receipts are positively correlated, and if the income variable is excluded from the equation the expected direction of bias on the coefficients for buffalofish receipts will be positive. However, with more than one omitted variable, the case becomes more complicated.[26/]

Two types of income changes may be distinguished. One type, which will be called "temporary", occurs as the result of layoffs or overtime. It is unlikely that this temporary change in income would be correlated with buffalofish receipts, and hence, would have no impact on the regression coefficients for buffalofish.

[26/] This topic is treated usually under the heading of "specification errors" in some econometric textbooks.

A second type of income change, which will be called "long-term", is related to the business cycle and is manifested in long term unemployment changes in gross national product. Long-term changes in income will likely be positively related to buffalofish receipts since a decrease in demand will reduce the long-term quantity supplied. Hence, if the variable measuring income is important, and highly correlated with the price of buffalofish, it is likely that its omission will exert an upward bias on the estimated regression coefficients.

Substitutes

Substitutes for fish may be grouped into three categories which are: (1) any food item (2) animal protein and (3) other fish. In general, other species are closer substitutes for a particular fish than is any general food item, or animal protein substitutes. Therefore, this discussion will explore the possible impact on the regression coefficients for buffalofish when quantities of other relevant species are omitted from the equation.

There may be a high degree of correlation between buffalofish receipts and receipts of other species, such as the carp, which are usually harvested along with the buffalofish. As can be seen in Table 14, with the exception of 1975 where the data are questionable, there is a relatively high degree of correlation between monthly carp and buffalofish receipts in the Chicago wholesale fish market. On the other hand, the correlations between buffalofish receipts and quantities of some Great Lakes species such as perch or smelt may be small or negative (Table 15).

Table 14. Correlation between buffalofish and carp receipts in the Chicago wholesale fish market

Year	Correlation
1958	.76
1959	.75
1960	.50
1961	.71
1962	.81
1963	.70
1964	.82
1965	.55
1966	.26
1967	.43
1968	.76
1969	.76
1970	.59
1971	.70
1972	.78
1973	.55
1974	.46
1975	.05
1976	.25
1977	.56

Table 15. Correlation between buffalofish receipts and quantities of various Great Lakes species, 1960-1965

	Perch	Catfish	Smelt	Sheepshead
Buffalofish	.19	.47	-.08	.30

Tastes and Preferences

An increase in the preference for a good tends to shift its demand curve upward, while a decrease in the preference for a good tends to reduce its demand. Further, increases or decreases in demand for a perishable commodity are sometimes reflected in increases or decreases in its price. Therefore, if a variable which measures preference was brought into the demand equation in the same way as the quantity variables were, then the preference variable would be directly related to the price of buffalofish. In addition, if changes in tastes or preferences are positively correlated with receipts, then the omission of a variable which measures preferences could create a positive bias on the coefficients of the remaining explanatory variables.

Advertising programs or publicity are two of the major means by which consumer tastes or preferences are altered. Unfortunatley, historical data measuring the occurrence and level of relevant advertising programs are usually not available. On the other hand, historical data for the occurrence of adverse publicity may sometimes be available.

In this study, two instances of adverse publicity surrounding fresh water fish were discovered: the 1963 botulism scare and the 1970 mercury pollution publicity. In order to assess the potential impact of the omission of consideration of these two events on the regression coefficients in the demand equation, it must be determined whether or not the coefficient of the publicity variable is significant and whether or not the variable is correlated with buffalofish receipts.

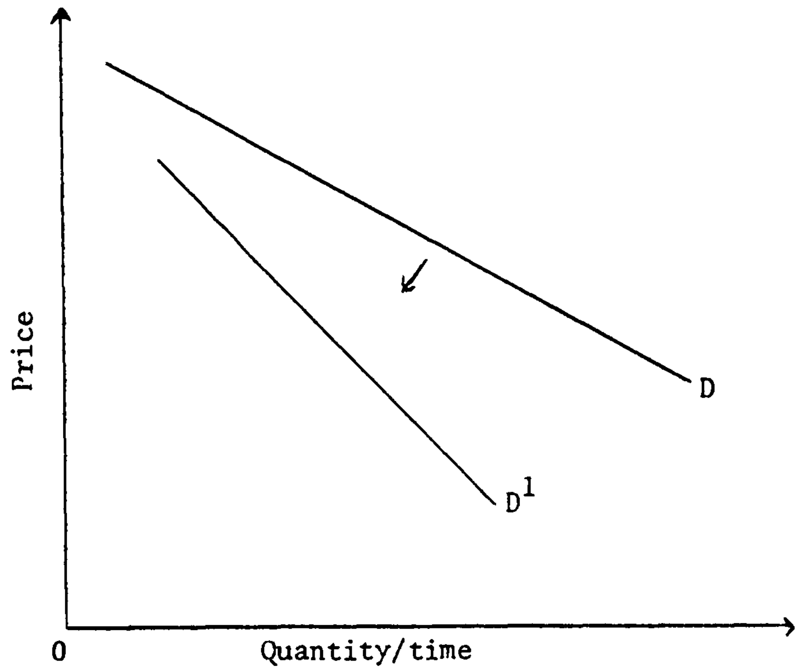

Figure 19. Effect of adverse publicity on the demand for buffalofish.

By examining the regression coefficients for each year, or the sum of the regression coefficients, (Table 8) it appears that the three major shifts in the intercept term and the regression coefficients occurring between 1967 and 1972 coincided with the 1963 botulism (1964) and the 1970 mercury pollution publicity (1970-1971).

Graphically, this can be shown as a downward shift in the demand curve. This is shown in Figure 19. During the two periods of adverse publicity, the intercept term became more positive and the coefficients for buffalofish became more negative. Since price declined during these periods (Table 16), this means that the demand curve for buffalofish shifted down from D to D^1. Therefore, it would appear that publicity is a significant variable whose sign is positive.

On the other hand, it is possible that the adverse publicity surrounding the Great Lakes species resulted in a decline in buffalofish

Table 16. Chicago wholesale price of No. 1 buffalofish

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1958	21.5	23.0	17.5	16.5	16.0	17.5	22.0	21.5	20.0	18.5	18.5	19.0
1959	19.0	20.0	15.0	12.5	13.5	13.5	19.5	19.5	17.5	14.5	16.5	13.5
1960	18.0	21.0	22.0	9.0	11.0	18.0	16.5	17.0	18.0	15.0	18.0	16.0
1961	16.5	15.0	11.5	12.5	11.5	14.5	17.5	16.5	15.5	14.0	15.0	16.0
1962	18.0	15.5	16.0	12.0	10.0	12.5	12.0	13.0	14.0	12.0	11.0	13.5
1963	13.0	12.0	10.0	10.0	8.5	13.0	14.0	12.5	13.0	11.0	11.0	11.0
1964	10.0	10.0	8.0	8.5	7.0	10.5	13.5	15.5	14.0	12.5	14.0	11.0
1965	11.0	12.0	11.0	10.0	9.5	12.0	13.0	16.2	15.6	14.0	16.0	16.0
1966	15.5	18.5	12.5	14.6	13.0	11.5	15.0	17.0	17.5	15.0	14.0	16.0
1967	14.5	13.5	13.5	14.0	12.0	12.0	15.0	18.5	16.5	15.0	13.5	15.0
1968	16.0	13.0	14.5	13.0	11.0	12.0	16.5	18.0	17.0	15.0	18.5	15.5
1969	20.5	21.5	17.0	11.0	12.0	15.0	15.5	17.5	17.0	16.0	17.0	17.0
1970	19.0	18.0	13.5	13.0	11.5	13.5	17.0	19.0	13.5	21.0	23.0	15.7
1971	20.0	20.0	15.5	11.0	12.0	11.0	15.5	19.0	23.0	25.0	25.0	23.0
1972	19.5	20.5	15.0	13.0	13.0	15.0	16.0	20.0	22.0	14.5	16.5	17.0
1973	20.5	19.5	15.0	18.0	15.5	17.5	21.0	25.5	26.0	20.0	15.0	19.0
1974	25.0	20.5	17.5	17.0	17.0	18.0	23.5	26.0	25.5	19.0	21.0	21.0
1975	22.5	19.0	21.0	19.0	14.0	21.0	26.0	28.0	27.5	19.0	22.0	23.0
1976	23.0	27.0	21.0	19.0	20.0	20.0	21.0	22.0	31.0	31.0	30.0	37.5
1977	38.0	34.0	32.0	36.0	36.0	38.0	39.0	37.5	35.0	35.0	37.5	41.0

Source: U.S. Department of Commerce, NMFS, Chicago Market News Report.
U.S. Department of Commerce, NMFS, Boston Market News Report.

receipts in the Chicago market, as fish were diverted to other markets, such as St. Louis or Memphis, where the supplies of fresh fish are not normally identified with the Great Lakes, and where adverse publicity was likely lower. Yet, from an examination of the data in Tables 4 and 17, it does not appear that these diversions actually took place.

This can be explained if it is recalled that under the assumption of monopsony power, shippers are not free to divert fish to other markets. However, dealers who normally sell a small proportion of their receipts to wholesalers outside of the market area may increase export sales during periods of adverse local publicity. Under these circumstances Chicago buffalofish receipts would not necessarily change and thus, publicity may appear to have no effect on these receipts.

Since it appears that buffalofish receipts are not correlated with adverse publicity, then, in the absence of other variations of the basic assumptions of ordinary least squares, the estimates of the buffalofish coefficient are not likely to be biased when all of the data are combined. On the other hand, if buffalofish receipts and publicity are correlated, then the estimates of the buffalofish receipts coefficients are likely to be biased upward. For this latter case the regression coefficients for the 1968-77 and 1958-77 periods would be positively biased. While the existence of this bias cannot be proved, it can be noted that the estimate regression coefficients for those two periods are more positive than the regression coefficients for the 1958-67 period, which did not include the two adverse publicity events.

Table 17. United States buffalofish production and Chicago wholesale receipts for buffalofish and all fresh-water fish, 1950-77

	---------Receipts, 1000 Pounds---------		
Year	Buffalofish	Freshwater Fish	U.S. Production Buffalofish
1950	2,724	42,055	25,873
1951	2,555	41,632	25,790
1952	3,609	46,362	25,721
1953	3,237	46,592	25,632
1954	4,384	53,698	17,343
1955	4,412	50,171	18,377
1956	3,795	46,232	17,456
1957	3,745	39,107	14,009
1958	3,413	39,554	15,335
1959	4,792	39,307	17,138
1960	5,051	37,012	16,796
1961	4,404	32,671	15,823
1962	4,512	30,606	18,508
1963	3,890	26,352	18,295
1964	4,086	24,661	18,475
1965	4,292	25,932	18,230
1966	3,898	22,124	18,034
1967	3,930	21,920	18,679
1968	3,408	20,622	19,095
1969	4,318	21,023	17,599
1970	4,231	20,310	22,889
1971	4,416	18,533	22,266
1972	4,128	17,062	24,855
1973	3,246	14,368	26,110
1974	3,646	14,679	25,406
1975 a/	5,518 b/		
1976	5,402 b/		
1977	6,020 b/		

a/ Separate statistics on saltwater and shellfish were discontinued in 1975.

b/ Estimated quantities, one or more weekly reports missing.

Source: U.S. Department of Commerce, NMFS, Chicago Fishery Market News Report, Monthly summaries for 1950-July, 1965.
U.S. Department of Commerce, NMFS Chicago Fishery Market News Reports for August, 1965-1972.
U.S. Department of Commerce, NMFS, Boston Market News Report, Chicago receipts and prices for 1973-1977.
U.S. Department of Commerce, NMFS, Current Fishery Statistics of the U.S.

Results from Other Studies

It is interesting to contrast research results of others with those reported here. This section reports on these other findings.

Waugh and Norton [72], using monthly data, examined seasonal variation in fish prices for various species, including the buffalofish. Data from the Chicago wholesale fish market (NMFS) were used for the buffalofish price analysis.

Two equations were estimated.

(1) $P_t^B = f(Q_t, Q_{t-1}, Q_{t-2}, Q_{t-3}, Y_t)$

and

(2) $P_t^B = f(Q_t, Q_{t-1}, Q_{t-2}, Q_{t-3}, Y_t, \text{Sin } 30t°, \text{Cos } 30t°)$

where

P_t^B = ex-vessel price of buffalofish in month t, in cents per pound;

$Q_t, Q_{t-1}, Q_{t-2}, Q_{t-3}$ = landings in month t t-1, t-2, and t-3, respectively, in thousands of pounds;

Y_t = total undeflated income for month t.

The results from (1) were not given.

The regression for (2) was,

$$P_t = 0.0320 - \underset{(1.15)}{0.0600}\, Q_t + \underset{(5.97)}{0.2657}\, Y_t + \underset{(1.63)}{0.0065} \text{ Cos } 30t° - \underset{(2.47)}{0.0113} \text{ Sin } 30t°$$

$R^2 = .47$ D.W. = 1.05 t-values in parentheses

Equation (2) was respecified as a logarithmic function. Its summary was given as,

$$P_t = -\ 0.6254 - \underset{(1.11)}{0.1296} \text{ Log } Q_t - \underset{(6.05)}{0.9400}$$

$$\text{Log } Y_t + \underset{(1.67)}{0.0188} \text{ Cos } 30t° - \underset{(2.86)}{0.0367} \text{ Sin } 30t°$$

In addition to these results, Waugh and Norton also noted that meat, poultry, other food and fish appear to have relatively little effect on the price of a particular fish species. They report that the:

> Results suggest that the interrelations of demand are usually small; that the price of any given species of fish seems to respond mainly to changes in the supply of that particular species. Even the price of a particular size of haddock or cod, for example, seems to depend mainly upon the supply of that particular size. [72]

Waugh and Norton's findings that the price of a particular species is largely determined by its own supply is supported by the results in the present study.

Another study, which was conducted by Blaufuss [9], examined the behavior of carp, bullheads, and buffalofish prices in the Chicago wholesale fish market. Using quarterly data for 1954-1965 and buffalofish and carp production for a five-state region, Blaufuss obtained the following results:

(3) $$P^B = 1.99 + \underset{(.0481)}{0.1517} \text{ Log } Q^{BPDXN} + \underset{(.205)}{0.3604} \text{ Log } P^C +$$

$$\underset{(.1648)}{0.2197} \text{ Log } P^{BH} + \underset{(.2626)}{0.1902} \text{ Log } Y - \underset{(.9929)}{1.3593} \text{ Log CPI}$$

$$R^2 = .81$$

$$(4) \quad P^C = 1.02 - 0.1081 \text{ Log } Q^{BPDXN} + 0.3534 \text{ Log } P^B - 0.2049 \text{ Log } P^{CH}$$

$$R^2 = .75$$

where

P^B = wholesale price of buffalofish in Chicago

Q^{BPDXN} = bullhead production in the area

P^C = Chicago wholesale price of carp

P^{BH} = Chicago wholesale price of bullheads

Y = per capita disposable income

CPI = Consumer's Price Index

$Q^{B(PX)}$ = buffalofish production in the area

P^{CH} = price of chicken

and

numbers in parentheses are standard errors.

Buffalofish production was not used in equation (3), since it "did not serve as a significant variable."

The above, rather unsatisfactory, results led to the formulation of two additional models based upon Chicago wholesale receipts rather than area production. Further, the time period of analysis was shortened to seven years (1960-1966) since the researcher felt that the twelve year period may hide, "significant seasonal price-quantity relationship(s)."

The results obtained for buffalofish and carp in the two respecified equations were:

$$(5) \quad P^B = 1.737 - \underset{(0.169)}{0.7802} \text{ Log } Q^B + \underset{(0.159)}{0.9187} \text{ Log } P^C + \underset{(0.176)}{0.7658} \text{ Log } P^{BH}$$

$$R^2 = 0.69$$

$$(6) \quad P^C = -\,0.2088 + \underset{(0.055)}{0.2455}\ \text{Log}\ Q^C + \underset{(0.097)}{0.2903}\ \text{Log}\ P^B$$

$$R^2 = 0.62$$

where

Q^B = Chicago wholesale receipts of buffalofish

Q^C = Chicago wholesale receipts of carp

and

numbers in parentheses are standard errors.

All of the estimated coefficients in the two equations (5 and 6) were statistically significant at the 95 percent level. Also, the relationship between buffalofish receipts and prices was negative. However the relationships between the price of carp and buffalofish, and the price and quantity of carp were positive.

Since $\partial P^B / \partial Q^B < 0$ and $\partial P^C / \partial Q^C > 0$, Blaufuss hypothesized that,

> The price of buffalofish is the controlling variable on the Chicago market, e.g., price of carp responds to changes in price of buffalofish and provides impetus to fishermen to increase or decrease the harvesting of carp. [9, p. 60]

Blaufuss also offered two hypotheses to explain the positive relationship found between carp receipts and prices, namely:

> (1) The supply function rather than the demand function is affecting the market; as price rises, fishermen begin to fish more and flood the market, dropping price ... (2) the price and marketing data appearing in the Bureau of Commercial Fisheries (now NMFS) Chicago reports are not representative of true market transactions. [9, p. 61]

The role of feral carp in the market for buffalofish is explored in the next section.

Feral Carp

Because of the possible importance of feral carp as a substitute for buffalofish, and because of the results reported in Blaufuss' study, the market relationship between feral carp and buffalofish was further explored. The hypotheses used in this exploration were derived, in part, from a consideration of the domestic carp fishery.

The carp fishery in the Untied States may be divided into three categories: (1) rough fish removal programs, (2) incidental harvest, and (3) primary species. Carp harvested under state rough fish control removal programs enter both the fresh fish and animal feed markets. When these programs are being conducted, the fresh fish market becomes glutted. At these times, some fish are dumped by the fishermen as the most economical way to dispose of them.

Most of the carp caught incidental to the harvesting of other species are sold to wholesale fresh fish dealers who, in order to maintain good relations with the fishermen, often purchase more than can be profitably sold. Dealers report that the excess carp bought under these conditions are discarded.

Finally, the bulk of the carp harvested as the targeted species are usually sold to one buyer or to one of his subsidiaries. Apparently most of these fish enter the pet or animal feed markets, while a smaller part may go to the gefilte fish producers in New York.

Because of these supply conditions, it is likely that the long-run supply curve of carp is nearly horizontal in the relevant range, so that changes in the demand for carp would not be reflected in its price.

As was shown earlier in Table 2, the reported wholesale price for carp is relatively stable.

Under these conditions, price does not serve as a signal to the carp fishermen, rather, the dealer must communicate his demand. Thus, changes in demand would be observed as changes in receipts of carp.

Since the price of carp is relatively stable, then changes in the demand for carp would not directly affect the demand for buffalofish through carp prices. On the other hand, if the two species are substitutes, then changes in the price of buffalofish would be expected to be positively related to the demand for carp. That is, $\partial Q^C / \partial P^B > 0$. To test this hypothesis, the equation

$$Q_t^C = f(P_t^B, P_{t-1}^B)$$

was specified. The results of the OLS regressions for the equation are given in Table 18.

The estimated coefficients for the lagged price of buffalofish were positive, as was expected. However, the estimated coefficients for the current price of buffalofish were negative. To explain these results, the hypotheses were modified to include a lagged response of supply. Thus, at time t, because of the lagged response of supply, the change in the price of buffalofish has no impact on the supply of carp. Hence, the estimated coefficient for the price of buffalofish in time t need not be positive. However, in the next period, after the supply of carp has been allowed to adjust, the relationship between the price of buffalofish and carp are positive.

Table 18. Wholesale demand for feral carp in Chicago (dependent variable: wholesale carp receipts)

Independent Variables	Coefficients	S.E.	$\bar{R}^2$ a/	D.W. b/
1958-1967				
(Constant)	63.33	(26.51)	.62	1.78
Wholesale price of buffalofish	-1.27	(1.50)		
Lagged wholesale price of buffalofish	1.03	(1.19)		
D1 (1958)	137.18	(19.98)		
D2 (1959)	142.98	(17.99)		
D3 (1960)	137.38	(18.00)		
D4 (1961)	63.94	(16.82)		
D5 (1962)	55.41	(16.50)		
D6 (1963)	39.56	(16.72)		
D7 (1964)	15.04	(16.93)		
D8 (1965)	19.74	(16.55)		
D9 (1966)	14.92	(16.53)		
1968-1977				
(Constant)	45.62	(15.19)	.31	1.48
Wholesale price of buffalofish	-3.35	(.805)		
Lagged wholesale price of buffalofish	2.76	(.821)		
D11 (1968)	18.86	(8.53)		
D12 (1969)	30.83	(8.34)		
D13 (1970)	16.03	(8.53)		
D14 (1971)	28.27	(8.31)		
D15 (1972)	18.49	(8.65)		
D16 (1973)	0.23	(8.93)		
D17 (1974)	1.17	(9.08)		
D18 (1975)	-1.80	(9.30)		
D19 (1976)	4.38	(8.78)		

(continued)

Table 18. (continued)

1958-1977				
Independent Variables	Coefficients	S.E.	$\bar{R}^2$ a/	D.W. b/
(Constant)	105.15	(15.31)	.71	
Price of buffalofish	-3.46	(0.84)		
Lagged price of buffalofish	0.52	(0.77)		
D1 (1958)	153.62	(13.76)		
D2 (1959)	151.94	(13.33)		
D3 (1960)	146.73	(13.33)		
D4 (1961)	66.79	(13.17)		
D5 (1962)	53.70	(13.21)		
D6 (1963)	32.31	(13.42)		
D7 (1964)	6.10	(13.53)		
D8 (1965)	15.05	(13.32)		
D9 (1966)	14.18	(13.19)		
D10 (1967)	-2.66	(13.24)		
D11 (1968)	-6.79	(13.24)		
D12 (1969)	6.75	(13.20)		
D13 (1970)	-9.50	(13.24)		
D14 (1971)	4.15	(13.19)		
D15 (1972)	-7.53	(13.28)		
D16 (1973)	-28.21	(13.36)		
D17 (1974)	-28.16	(13.42)		
D18 (1975)	-32.52	(13.51)		
D19 (1976)	-23.62	(13.31)		

a/ Standard error.

b/ Durbin-Watson statistic.

The negative coefficient for the current price of buffalofish may reflect demand conditions for buffalofish. However, as mentioned earlier, the quantity of carp did not serve as a significant variable in the demand equations for buffalofish.

The hypotheses offered by Blaufuss were related to changes in the price of carp. However, the available data reflected rather stable prices for carp. Consequently, those hypotheses could not be supported. Yet, the notion that, "the price of buffalofish is the controlling variable on the Chicago market ..." may be valid if it is interpreted to mean that the price of carp has little impact on the price of buffalofish.

VI. SUMMARY, CONCLUSIONS AND IMPLICATIONS

Summary and Conclusions

In this study, the individual components of the Chicago fresh fish market were discussed. It was seen that the inland commercial fishery is characterized by small, low-capitalized, non-incorporated units. The wholesale fresh fish market was described as an oligopsony in the purchase of fish and an oligopoly in the sale of fish. The retail fresh fish market was seen to be dominated by large chain food stores.

The demand for buffalofish by the retailers and wholesalers was seen to be derived from the consumers' demand for the final product. The gap between the price paid and received by the intermediaries was defined as a price spread or marketing margin.

It was seen that, in the case of oligopsonistic buying, fish price spreads can reflect not only supply and demand conditions, but other factors such as personal relationships and bargaining power as well.

Based upon the characteristics of an open-access fishery and upon certain assumptions, a hypothesis of a downward sloping average cost curve of fish was obtained. By utilizing this hypothesis, it was argued that estimated relationships may be tracing out, through part of the range, an "average cost" curve.

The theoretical consideration used in the demand analysis centered primarily on the problems associated with measures for price and quantity, as well as measures for the other factors which affect demand.

The procedures followed in obtaining, adjusting, and screening the data for variables to be included in the demand equation were given.

The basic demand equation that was developed and used for the buffalofish was a price-dependent, distributed lag, linear regression, equation. The results of this analysis are given below.

During the period covered (1958-1977), in general, the estimated results suggest that the price of buffalofish would increase by one to two cents per pound during a given month if receipts decreased by 100,000 pounds, while a sustained decrease of the price of buffalofish, in general, would change by two to four cents per pound if those receipts were sustained.

The "demand" for buffalofish was found to be relatively price inflexible, which means that the total revenue of the fishermen would likely increase with small increases in deliveries of buffalofish. With the exception of 1960, the years in which the sustained price flexibility coefficients exceeded unity coincided with the occurrence of adverse publicity. As argued earlier, both demand and average cost phenomena may have been measured here.

It was found that specifying the model as a system of equations did not improve the results. Thus, it was assumed that either the supply of buffalofish is largely exogenous to the model or that the system of equations were misspecified. Further work here may be fruitful.

Finally, in examining the relationship between the price of buffalofish and receipts of carp, it was observed that the coefficients for the current price of buffalofish were negative, but that the coefficients for the lagged price of buffalofish were positive. The hypothesis offered to explain these results incorporated the notion that the price of buffalofish is an important variable explaining carp receipts but the influence is a lagged one.

Implications for Other Research

In all research, conclusions must be stated as tentative since no theory or hypothesis can ever be "proved." While the results of this study seem plausible, additional research is nevertheless needed.

In terms of the model developed here, the basic demand equation should be broadened to include substitute goods. It would also be desirable to include variables for tastes and preferences, as well as income in the demand equation.

In terms of the fresh water fish industry, the behavior of price spreads or marketing margins at various levels in the marketing channel needs to be explored.

Finally, the role of aquaculture in supplying domestic needs for fresh fish, and the economic feasibility of an export program based on underutilized fresh water species needs to be examined.

Indeed, much more research needs to be done.

BIBLIOGRAPHY

1. American Fisheries Society. A List of the Common and Scientific Names of the Better Known Fishes of the United States and Canada. Am. Fish. Soc. Spec. Bul. 1. p. 45. 1948.

2. Anderson, L.G. The Economics of Fisheries Management. The John Hopkins University Press. Baltimore, 1977.

3. Anonymous. New World Record Fish. Field and Stream, Vol. 58, No. 11: 67-69, 1954.

4. Anonymous. A Record Carp?. Iowa Conservationist. Vol. 14, No. 7, p. 148, 1955.

5. Anonymous. Pond-Grown Frozen Israeli Carp Adds Dimension to Aquaculture. Quick Frozen Foods: 91, 92, 96. May, 1971.

6. Bardach, J.E., J.H. Ryther, and W.O. McLarney. Aquaculture: The Farming and Husbandry of Freshwater and Marine Organisms. Wiley-Interscience. New York, 1972. 305 p.

7. Barth, Glenn R. An Economic Study of the Processing and Marketing of Montana Commercial Fisheries Products. Bur. Comm. Fisheries. Project No. 1-45-R, 1968. 99 p.

8. Black, Edgar C.. Upper Lethal Temperatures of Some British Columbia Freshwater Fishes. J. Fish. Res. Bd. Can., Vol. 10, No. 4: 196, 1953.

9. Blaufuss, Lawrence Gene. Commercial Markets for North Dakota Fish. Unpublished M.S. Thesis. North Dakota State University, 1966. 132 p.

10. Buse, R.C.. Total Elasticities: A Predictive Device. J. Farm. Econ. Vol. 40: 881-891, 1958.

11. Canada Bureau of Statistics. Fisheries Statistics of Canada (Summary). 1962-1974.

12. Canadian Fish Commission. Report of Commission of Inquiry into Freshwater Fish Marketing. Queen's Printer. Ottawa, Canada, 1966.

13. Capalbo, Susan Marie. An Analysis of the Market Structure of the United States Fishing Industry. Unpublished M.S. Thesis. Univ. Rhode Island, 1976.

14. Cole, L.J. The German Carp in the United States. U.S. Bur. Fish. Rep.: 523-641, 1904.

15. D'itri, P.A., and F.M. D'itri. Mercury Contamination: A Human Tragedy. John Wiley & Sons. New York, 1977.

16. Draper, N.R. and H. Smith. Applied Regression Analysis. John Wiley & Sons, Inc. New York, 1966. 407 p.

17. Due, John F. and R.W. Clower. Intermediate Economic Analysis: Resource Allocation, Factor Pricing, and Welfare. Richard D. Irwin, Inc. Homewood, Ill., 19771.

18. Ferguson, C.E. Microeconomic Theory. Richard D. Irwin, Inc. Homewood, Ill., 1972. 565 p.

19. Fisheries Price Spread Studies. Report of the Royal Commission on Price Spreads. Vol. IV: 402-565, 1960.

20. Food and Agricultural Organization. Yearbook of Fishery Statistics. FAO. Rome, Italy, 1977.

21. Foster, T.H. Cost-Size Relationships in the Production of Pond-Raised Catfish for Food. Miss. State Univ. Ag. & Forest Exp. Sta. Bull. 792, 1972.

22. Frick, Harold C. Economic Aspects of the Great Lakes Fisheries of Ontario. Fish. Res. Bd. Canada. Bull. No. 149, 1965.

23. Friedman, M. Price Theory: A Provisional Text. Aldine Publishing Co. Chicago, Ill., 1962.

24. Garner, C.R. and W.A. Halbrook. Catfish Production in Southeastern Arkansas: Estimated Requirements, Costs, and Returns for Two Sizes of Farms. Univ. of Arkansas. Fayetteville. Ag. Exp. Sta. Report Series 203, 1972.

25. Gas, N. and J. Noailliac-Depeyre. Studies on Intestinal Epithelium Involution During Prolonged Fasting. J. Ultrastruct. Res. Vol. 56: 137-151, 1976.

26. Gillespie, S.M. and J.L. Gregory. A Study of the Marketing Channels for Fresh Finfish in the Texas Fishing Industry, Texas A&M University. College Station, Texas, 1971.

27. Gruber, Robert J. Problem Areas in Seafood Distribution in the Future of the Fishing Industry of the United States. Ed. by DeWitt Gilbert. Univ. Wash. Publ. Fish. N.S. Vol. 4: 227-232, 1968.

28. Hamlisch, R. and R.A. Taylor. The Demand for Fish as Human Food. Food and Agricultural Organization. Rome, Italy.

29. Hanushek, E.A. and J.E. Jackson. Statistical Methods for Social Scientists. Academic Press. New York, 1977. 374 p.

30. Holt, S.K. The Contribution of Freshwater Fish Production to Human Nutrition and Well-Being. The Biological Basis of Freshwater Fish Production. S.D. Gerking, John Wiley & Sons, Inc. New York, 1966. 495 p.

31. Huet, Marcel. Textbook of Fish Culture. Fishing News (Books) Ltd. London, 1970. 427 p.

32. Kmenta, J. Elements of Econometrics. Macmillan Publishing Co., Inc. New York, 1971. 655 p.

33. Konopa, L.J. Survey of Wholesalers Handling Fish in Cuyahoga and Summit Counties, Ohio. The Inst. for 21st Century Business. Kent State U. Kent, Ohio, 1973.

34. McCrimmon, H.R. Carp in Canada. Fish. Res. Bd. Canada. Bull. No. 165, 1968. 93 p.

35. McIvor, G.H. Report of Commission of Inquiry into Freshwater Fish Marketing. Canadian Dept. Fish. Publ., 1966. 130 p.

36. Mack, Jerry. Catfish Farming Handbook. Edicatop Books, Inc. San Angelo, Texas, 1971. 195 p.

37. MacKenzie, W.C. The Demand Outlook for the Canadian Fisheries. Resources. Vol. 2: 759-774.

38. Mulvihill, D.F., and L.J. Konopa. A Marketing Communications and Physical Distribution System to Provide the Midwest With Coastal Fish. The Institute for 21st Century Business. Kent State Univ. Kent, Ohio, 1974.

39. National Academy of Science. Recommended Daily Dietary Allowances. Natl. Res. Council. Washington, D.C., 1974.

40. Nerlove, M., D.M. Grether, and J.L. Carvalho. Analysis of Economic Time Series: A Synthesis. Academic Press. New York, 1979.

41. Nicholls, W.H. A Theoretical Analysis of Imperfect Competition with Special Application to the Agricultural Industries. Iowa State College Press, Ames, Iowa, 1941. 384 p.

42. Organization for Economic Cooperation and Development. Review of Fisheries in OECD Member Countries. OECD, 1977.

43. O'Rourke, A.D. and D.B. DeLoach. The California Fresh and Frozen Fishery Trade. Calif. Ag. Exp. Sta. Bull. 850, 1971.

44. Panov, D.A., L.G. Motenkova, and V.G. Certichin. Conditions Under which Juvenile Carp Start Feeding on Herbivorous Fish in Multispecies Cultivation (Experimental Studies). Voprosy Ichtiol. Vol. 13, No. 6: 915-920, 1973.

45. Penn, Edwin. Price Spreads and Cost Analysis for Finfish and Shellfish Products at Different Marketing Levels. NOAA Tech. Rept. NMFS. SSRF-676, 1974.

46. Pitt, T.K., E.T. Garside, and R.L. Hepburn. Temperature Selection of the Carp (Cyprinus carpio Linn.). Canadian J. Zool. Vol. 34: 55-557, 1956.

47. Rehder, D.D. Some aspects of the Life History of the Carp, Cyrinus carpio (Linnaes) 1785, Near East and Europe. FAO, Fisheries Synopsis 31.2, 1966.

49. Schaefer, M.B. Some Aspects of the Dynamics of Populations Important to the Management of Commercial Marine Fisheries. Inter-Am. Trop. Tuna Comm. Bull. Vol. 1: 25-26, 1954.

50. Schaefer, M.B. Some Considerations of Population Dynamics and Economics in Relation to the Management of the Commercial Marine Fisheries. J. Fish. Res. Bd. Canada. Vol. 14, No. 5: 669-681, 1957.

51. Schaefer, M.B. Biological and Economic Aspects of the Management of Commerical Marine Fisheries. Trans. Am. Soc. Vol. 99:100-104, 1959.

52. Schaeperclaus, W. Textbook of Pond Culture: Rearing and Keeping of Carp, Trout, and Allied Fishes. Translated by Calif. Dept. Fish & Game, 1933. 213 p.

53. Schneberger, E. The Biological and Economic Importance of the Smelt in Green Bay. Trans. Am. Fish. Soc. Fol. 66: 139-142, 1936.

54. Shang, Yung C. Comparison of the Economic Potential of Aquaculture Land Animal Husbandry, and Ocean Fisheries: The Case of Taiwan. Aquaculture. Vol. 2: 187-195, 1973.

55. Shpet, G.I. Comparative Efficiency of Fish Culture and Other Agricultural Activities Per Unit or Area Used. Hydrobiol. J. Vol. 8, No. 3: 46-50, 1972.

56. Sigler, William F. The Ecology and Use of Carp in Utah. Utah State Univ. Logan Agri. Exp. Sta. Bull. 405, 1958. 63 p.

57. Sklower, A. Carp Breeding in Palestine. Arch. Fisch Wiss. Vol. 2: 90-119; Vol. 3: 42-54, 1950.

58. Smiley, C.W. Some Results of Carp Culture in the United States. Report, U.S. Fish Commission for 1884: 657-890, 1886.

59. Soller, M., Y. Shchori, R. Moav, G. Wohlfarth, and M. Lehman. Carp Growth in Brackish Water. Bamidgeh, 17(1):16-23.

60. Stigler, G.J. The Organization of Industry. Richard D. Irwin, Inc. Homewood, Ill., 1968.

61. Swee, U.B. and H.R. McCrimmon. Reproductive Biology of the Carp Cyprinus carpio L., in Lake St. Lawrence, Ontario. Trans. Am. Fish. Soc. Vol 95, No. 4: 372-380, 1966.

62. Tobolski, J.J. A Study to Determine the Export and Domestic Markets for Currently Underutilized Fish and Shellfish. Earl R. Combs, Inc. Mercer Island, Wash., ed. 1978.

63. Tomek, W.G. and K.L. Robinson. Agricultural Product Prices. Cornell University Press. Ithaca, N.Y., 1972. 376 p.

64. United States Department of Agriculture. Nutritive Value of Foods. USDA. Ag. and Res. Serv. Home and Gardens Bull. 72, revised 1977.

65. United States Department of Commerce. Fisheries of the United States 1977-1978. Current Fishery Statistics. Statistics and Market News Div. NOAA. National Marine Fisheries Service. Washington D.C. March, 1978-1979.

66. United States Department of Commerce. Fishery Market News Report. NOAA. National Marine Fisheries Service. Market News Branch, Monthly Summaries. Chicago, 1950-1965.

67. United States Department of Commerce. Fishery Market News Report. NOAA. Natinal Marine Fisheries Service, Market News Branch. Chicago, Ill. 1965-1972.

68. United States Department of Commerce. Fishery Market News Report. NOAA. National Marine Fisheries Service, Market News Branch. Boston, 1973-1979.

69. United States Department of Commerce. Fishery Statistics of the United States (Statistical Digest). NOAA. National Marine Fisheries Service. Washington, D.C., 1952-1974.

70. United States Department of the Interior, Bureau of Commercial Fisheries. A Program of Research for the Catfish Farming Industry. Ann Arbor, Mich., 1970.

71. Uallen, I.E. The Direct Effect of Turbidity on Fish. Oklahoma Agr. Mech. Coll. Biol. Bull. 48(2):1-27, 1951.

72. Walters, M.A. Wholesale Market Demand for Buffalofish. University of Arkansas. Publication E-24, 1961.

73. Waugh, F.W. and V.J. Norton. Some Analyses of Fish Prices. Bur. Comm. Fish. U.S. Dept. Interior. 199 p.

74. Wurtz, A.G. and C.J.H. Simpson. The Culture of Carp (Cyprinus carpio) in Ponds in Uganda. E. Afr. Agric. For. J. 26(2):111-6 (1960).

APPENDIX

Table A-1. Chicago receipts of fresh buffalofish, 1957-1977

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1957	320.4	347.9	321.1	414.1	307.6	243.0	305.5	206.5	351.7	359.7	282.1	281.6
1958	300.1	290.2	367.5	356.3	286.2	249.0	225.0	211.9	298.3	302.5	246.4	279.7
1959	277.5	327.0	487.4	526.4	538.3	376.6	399.2	301.4	395.8	440.0	332.8	289.7
1960	422.8	361.9	504.9	628.8	415.7	375.9	409.3	358.2	487.4	386.5	353.0	346.5
1961	389.2	354.9	468.2	353.3	403.9	329.0	281.4	411.3	281.1	347.4	395.8	318.4
1962	391.6	358.4	420.9	525.5	415.5	367.8	306.7	297.1	333.4	448.9	347.7	298.2
1963	344.7	350.7	400.8	366.8	382.7	257.7	297.2	285.4	253.4	365.0	249.9	336.1
1964	400.9	312.0	422.6	439.1	328.4	329.5	257.9	288.2	327.8	369.8	262.9	347.3
1965	387.0	380.3	400.1	568.1	389.7	361.9	279.4	227.0	357.0	422.0	223.0	301.0
1966	304.0	313.0	386.0	439.0	337.0	306.0	290.0	271.0	353.0	357.0	270.0	289.0
1967	351.0	259.0	480.0	342.0	369.0	358.0	219.0	250.0	394.0	298.0	316.0	317.0
1968	289.0	289.0	441.0	341.0	274.0	269.0	190.0	298.0	255.0	207.0	306.0	233.0
1969	283.0	343.0	463.0	465.0	478.0	280.0	278.0	374.0	352.0	371.0	327.0	285.0
1970	225.8	352.0	411.6	339.4	512.8	295.7	386.4	336.0	266.2	336.9	236.8	397.3
1971	312.3	297.0	465.1	692.6	419.9	329.7	375.9	331.6	261.2	330.3	227.2	364.2
1972	371.4	329.0	599.3	406.3	364.0	350.9	284.3	278.3	273.8	270.4	297.4	302.7
1973	314.4	384.4	389.6	272.2	308.3	288.4	177.3	305.2	133.2	235.6	324.3	148.7
1974	304.0	333.3	507.8	309.6	409.3	217.7	158.6	295.2	310.6	266.8	305.5	227.3
1975	457.5	384.8	535.5	511.5	446.9	304.8	277.9	550.4	449.9	452.1	322.4	309.4
1976	356.2	404.5	711.4	461.4	422.6	509.8	361.4	405.4	546.9	397.5	478.6	357.0
1977	476.8	575.1	735.7	595.9	438.3	443.0	416.0	584.3	473.2	469.6	413.4	403.5

Source: U.S. Dept. Commerce, NMFS, Chicago Market News Report for 1957-1972.
U.S. Dept. Commerce, NMFS Boston Market News Report for 1973-1977.

Table A-2. Hogs: Monthly average price per pound received by Illinois farmers

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1959	16.2	15.3	15.6	15.8	15.5	15.0	13.0	13.5	13.1	12.6	12.0	11.1
1960	12.1	13.1	15.0	15.5	15.4	16.0	16.5	16.3	15.6	17.0	16.9	16.4
1961	16.7	17.7	17.0	16.8	16.1	15.9	16.6	17.2	17.4	17.0	15.9	16.3
1962	16.7	16.4	16.0	15.6	15.4	16.1	17.2	17.6	18.4	16.8	16.4	15.9
1963	15.4	14.8	13.7	13.6	14.4	16.1	17.0	16.6	15.4	15.2	14.3	13.6
1964	14.2	14.2	14.0	14.1	14.1	15.0	15.7	15.5	16.2	15.1	13.8	14.5
1965	15.4	16.5	16.5	16.9	20.3	22.6	23.3	24.1	21.9	23.2	23.7	26.9
1966	27.4	27.3	23.7	22.3	22.7	23.1	23.2	24.9	22.1	20.9	19.2	18.7
1967	19.2	18.7	17.8	16.8	22.6	21.2	21.8	20.4	19.1	18.2	17.4	17.0
1968	17.9	19.1	18.8	18.6	18.1	19.5	20.9	19.0	19.5	18.0	17.7	18.2
1969	19.1	19.7	20.2	19.8	22.6	24.3	25.4	26.0	24.7	24.6	25.1	26.5
1970	26.5	27.6	25.7	24.1	23.5	23.7	24.0	21.9	19.6	18.1	16.0	15.4
1971	15.5	19.0	16.9	15.8	16.8	17.6	19.4	18.5	17.8	19.5	19.0	19.8
1972	22.9	25.7	23.7	22.7	25.3	26.1	27.8	27.9	27.7	27.0	26.8	29.8
1973	31.2	33.5	38.4	35.1	35.7	37.6	41.5	56.5	43.6	40.8	40.3	38.6
1974	40.5	39.7	35.3	31.5	26.8	24.0	33.4	36.0	33.8	37.6	36.6	38.6
1975	38.4	38.1	38.3	39.3	44.0	46.3	53.3	54.6	58.2	58.1	49.4	48.4
1976	48.0	47.7	45.1	46.6	47.5	48.5	47.3	42.2	39.8	33.1	31.4	36.3
1977	37.8	39.1	37.6	36.2	40.4	41.3	44.4	42.1	40.4	39.8	38.1	

Source: Agricultural Prices; Annual Summary. USDA Crop Reporting Board.

Table A-3. Broilers: monthly average price per pound received by Arkansas farmers

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1959	15.9	15.6	15.5	15.2	15.0	14.8	15.3	14.9	13.9	13.5	14.3	16.3
1960	16.4	16.8	17.2	17.1	17.1	17.3	16.9	15.8	14.9	15.1	15.2	15.1
1961	15.6	16.6	15.5	14.2	13.4	12.0	11.3	12.0	10.2	10.7	11.9	14.5
1962	15.3	16.1	15.7	14.5	13.8	13.5	13.9	14.5	15.4	14.2	13.8	13.8
1963	13.8	15.1	14.5	14.5	14.0	13.5	13.6	13.4	12.0	13.1	13.5	12.6
1964	13.4	13.3	13.4	12.0	12.8	13.0	14.0	13.8	13.8	13.5	13.9	13.0
1965	13.5	14.0	14.6	14.0	14.4	14.6	14.5	1.40	13.6	13.5	13.6	14.0
1966	15.8	15.9	16.7	15.5	16.2	15.9	15.6	15.0	13.7	12.5	13.1	11.5
1967	13.0	14.5	13.5	13.0	12.5	12.5	13.5	12.5	12.0	12.0	11.0	11.0
1968	12.5	14.0	14.0	13.5	14.0	14.5	15.0	14.5	13.5	12.0	13.0	13.0
1969	13.5	14.5	14.5	14.5	15.0	15.5	17.5	16.5	15.5	14.5	14.5	14.0
1970	14.5	14.0	14.0	13.5	13.5	13.0	12.5	12.5	12.5	11.5	13.0	11.0
1971	12.0	13.0	13.0	13.0	14.5	14.5	15.0	14.0	13.5	13.0	12.5	12.0
1972	13.5	14.0	14.0	12.5	13.0	14.0	15.0	14.5	15.0	14.0	13.0	15.0
1973	17.0	20.0	24.0	25.0	23.5	24.0	29.0	37.0	26.0	22.5	19.5	21.0
1974	22.5	23.0	22.0	20.0	19.5	18.5	20.0	21.0	22.0	22.0	23.5	22.5
1975	23.5	23.5	23.0	23.0	25.0	28.0	30.0	29.5	30.0	28.0	26.5	23.0
1976	24.0	25.0	24.5	23.0	24.5	24.0	24.5	24.0	22.0	20.5	19.5	19.5
1977	21.5	24.0	23.5	24.0	24.0	24.5	25.5	24.5	23.5	22.5	21.5	

Source: Agricultural Prices, Annual Summary, USDA, Crop Reporting Board, Statistical Reporting Service.

Table A-4. Consumer's Price Index for urban wage earners and clerical workers: U.S. city average, food - Series B (1967 = 100)

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1957	82.8	83.1	83.3	83.6	83.8	84.3	84.7	84.8	84.9	84.9	85.2	85.2
1958	85.7	85.8	86.4	86.6	86.6	86.7	86.8	86.7	86.7	86.7	86.8	86.7
1959	86.8	86.7	86.7	86.8	86.9	87.3	87.5	87.4	87.7	88.0	88.0	88.0
1960	87.9	88.0	88.0	88.5	88.5	88.7	88.7	88.7	88.8	89.2	89.3	89.3
1961	89.3	89.3	89.3	89.3	89.3	89.4	89.8	89.7	89.9	89.9	89.9	89.9
1962	89.9	90.1	90.3	90.5	90.5	90.5	90.7	90.7	91.2	91.1	91.1	91.0
1963	91.1	91.2	91.3	91.3	91.3	91.7	92.1	92.1	92.1	92.2	92.3	92.5
1964	92.6	92.5	92.6	92.7	92.7	92.9	93.1	93.0	93.2	93.3	93.5	93.6
1965	93.6	93.6	93.7	94.0	94.2	94.7	94.8	94.6	94.8	94.9	95.1	95.4
1966	95.4	96.0	96.3	96.7	96.8	97.1	97.4	97.9	98.1	98.5	98.5	98.6
1967	98.6	98.7	98.9	99.1	99.4	99.7	100.2	100.5	100.7	101.0	101.3	101.6
1968	102.0	102.3	102.8	103.1	103.4	104.0	104.5	104.8	105.1	105.7	106.1	106.4
1969	106.7	107.1	108.0	108.7	109.0	109.7	110.2	110.7	111.2	111.7	112.2	112.9
1970	113.3	113.9	114.5	115.2	115.7	116.2	116.7	116.9	117.5	118.1	118.5	119.1
1971	119.2	119.4	119.8	120.2	120.8	121.5	121.8	122.1	122.2	122.4	122.6	123.1
1972	123.2	123.8	124.0	124.3	124.7	125.0	125.5	125.7	126.2	126.6	126.9	127.3
1973	127.7	128.6	129.8	130.7	131.5	132.4	132.7	135.1	135.5	136.6	137.6	138.5
1974	139.7	141.5	143.1	143.9	145.5	140.9	148.0	149.9	151.7	153.0	154.3	155.4
1975	156.1	157.2	157.8	158.6	159.3	160.6	162.3	162.8	163.6	164.6	165.6	166.3
1976	166.7	167.1	167.5	168.2	169.2	170.1	171.1	171.9	172.6	173.3	173.8	174.3
1977	175.3	177.1	178.2	179.6	180.6	181.8	182.6	183.3	184.0	184.5	185.4	186.1

Source: U.S. Dept. of Labor, Bureau of Labor Statistics.

Table A-5. Chicago receipts of fresh carp, 1957-1977

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1957	228.9	211.4	265.9	254.2	198.9	202.8	232.9	111.8	232.6	163.6	186.4	181.7
1958	212.8	024.9	353.6	243.9	167.0	152.7	189.7	134.9	216.8	126.6	142.7	177.0
1959	177.7	144.4	261.3	321.3	247.1	202.2	295.5	136.7	161.5	180.4	127.5	174.5
1960	293.3	196.6	283.7	024.4	150.4	189.5	212.6	127.5	251.1	140.0	143.3	160.9
1961	148.5	120.4	172.7	134.7	107.7	91.4	116.4	173.0	102.9	102.3	117.3	93.7
1962	151.1	117.3	161.8	173.1	98.0	117.8	78.9	89.8	93.0	117.9	103.0	85.1
1963	112.7	114.2	176.2	124.1	107.6	90.7	85.6	75.8	94.2	80.7	57.5	83.0
1964	90.8	52.4	109.0	123.0	45.5	61.4	52.4	81.3	78.7	71.3	46.8	94.1
1965	93.8	65.4	89.0	129.2	70.8	77.8	47.7	56.6	76.0	80.1	67.2	144.8
1966	59.1	66.7	110.2	119.3	48.7	153.2	57.6	62.6	83.7	48.4	59.4	100.6
1967	50.3	62.8	98.5	91.4	68.5	51.3	44.9	55.3	75.6	48.7	50.5	85.2
1968	60.4	52.8	116.9	81.5	50.8	39.4	38.6	52.3	78.2	37.4	58.6	60.8
1969	81.5	75.4	143.6	90.8	76.1	41.2	55.8	72.4	67.9	61.8	48.9	65.2
1970	38.8	61.1	73.9	59.8	76.0	46.5	45.9	43.3	63.4	63.4	50.3	70.9
1971	90.4	59.6	85.9	154.3	51.8	42.4	43.7	51.8	65.0	54.3	54.3	73.1
1972	70.9	74.7	134.7	87.8	60.9	39.3	49.8	51.5	57.7	24.5	35.4	57.5
1973	42.3	44.2	84.2	81.1	47.7	35.1	30.9	40.2	16.6	28.0	22.8	22.0
1974	61.2	45.8	39.6	81.4	57.6	33.7	21.6	31.2	25.1	37.3	36.7	37.7
1975	72.9	30.3	35.8	57.5	33.5	23.9	30.8	32.4	17.0	32.0	32.9	59.7
1976	45.9	52.2	70.6	86.6	41.4	28.3	31.3	30.9	31.0	27.0	23.8	44.5
1977	23.8	27.0	82.6	56.9	48.3	31.5	27.3	31.4	43.0	23.2	20.0	40.0

Source: U.S. Dept. Commerce, NMFS, Chicago Market News.

Table A-6. Chicago receipts of fresh smelt, 1957-1977

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
	1000 pounds											
1957	67.9	154.3	211.4	139.4	68.8	16.3	8.4	15.9	11.5	9.5	18.4	29.3
1958	64.7	196.2	221.9	253.4	74.2	16.7	34.9	18.2	18.5	27.7	26.2	37.0
1959	181.4	70.8	198.0	315.4	150.7	40.5	19.2	14.6	15.3	21.8	34.9	23.5
1960	39.5	103.4	274.2	142.8	107.0	33.3	32.1	15.0	19.0	28.6	59.8	55.5
1961	51.8	110.7	177.1	112.9	64.8	20.9	22.6	23.3	18.0	32.4	37.3	31.3
1962	34.1	61.3	133.5	146.8	72.0	27.6	17.1	15.7	18.1	37.6	38.5	42.3
1963	46.0	27.8	45.9	117.2	81.0	11.9	13.2	15.1	17.2	25.0	4.9	8.5
1964	38.3	54.9	86.0	70.4	30.2	1.3	7.4	9.7	19.5	35.9	34.4	49.4
1965	38.3	31.0	72.9	108.4	74.6	34.2	24.4	22.9	16.2	30.9	16.7	33.7
1966	26.4	31.7	87.2	147.2	61.1	35.6	32.3	33.6	36.2	30.4	38.5	38.2
1967	31.5	33.5	42.8	80.9	52.4	37.0	13.4	18.6	27.1	24.1	19.2	44.5
1968	14.4	43.3	61.9	65.4	42.1	24.0	18.4	23.2	22.0	17.0	29.1	20.5
1969	56.6	49.6	65.6	65.8	73.9	21.1	16.1	20.3	20.4	30.5	22.0	30.8
1970	26.3	21.6	32.9	46.8	32.4	23.3	20.3	18.2	22.1	22.5	20.6	25.3
1971	28.8	21.1	65.5	69.8	48.4	20.9	10.7	14.0	10.5	21.0	19.9	24.6
1972	43.5	36.6	10.7	37.2	57.8	22.0	19.6	20.3	16.1	9.0	21.0	18.3
1973	17.5	27.6	29.0	67.3	44.6	6.4	8.4	8.3	12.7	17.6	18.1	19.8
1974	36.9	17.1	28.0	33.1	58.6	26.0	3.4	9.7	16.9	21.2	22.9	56.2
1975	39.6	44.5	59.8	41.2	71.6	56.8	11.2	25.8	15.4	26.2	12.7	27.7
1976	33.1	64.4	109.9	73.1	48.4	47.8	20.9	15.9	30.8	23.5	17.4	36.5
1977	11.0	9.7	41.0	77.0	62.5	46.4	27.4	43.7	31.4	46.1	40.3	52.0

Source: U.S. Dept. Commerce, NMFS, Chicago Market News.

Table A-7. Supply of carp

	Regression Coefficients			
Year	Constant	Current Price of Buffalofish	Lagged Price of Buffalofish	Adjusted R^2
1958-67	63.33	-1.2664 (.40)	1.0333 (.39)	.62
1968-77	45.60	-3.3540 (.00)	2.7622 (.00)	.31
1958-77	105.00	-3.4671 (.00)	0.5212 (.50)	.71

Table A-8. U.S. unemployment rate[a/]

Year	Rate
1950	4.9
1951	3.1
1952	2.8
1953	2.7
1954	5.0
1955	3.9
1956	3.6
1957	3.8
1958	6.1
1959	4.8
1960	4.9
1961	6.0
1962	4.9
1963	5.0
1964	4.6
1965	4.1
1966	3.3
1967	3.4
1968	3.2
1969	3.1
1970	4.5
1971	5.4
1972	5.0
1973	4.3
1974	5.0
1975	7.8
1976	7.0
1977	6.2

[a/] Unemployment as percent of civilian labor force.

Source: U.S. Department of Labor, Bureau of Labor Statistics.