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DEMAND ANALYSIS for CANNED RED (sockeye) SALMON AT WHOLESALE

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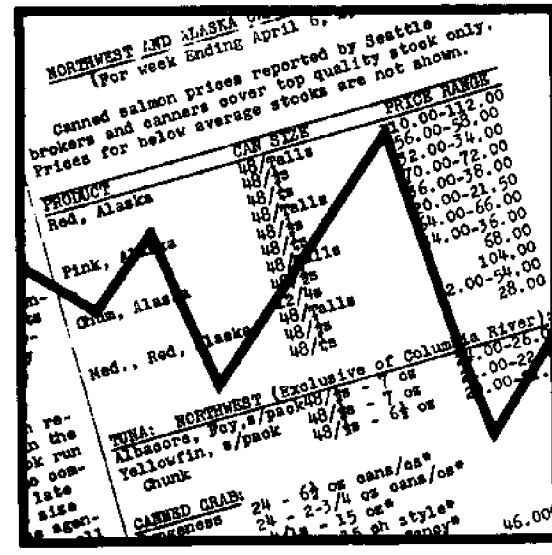

Special Report 411
Agricultural Experiment Station

Oregon State University
Sea Grant College Program
Publication no. ORESU-T-74-001

May 1974
Corvallis, Oregon

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AUTHORS: Richard S. Johnston is an Associate Professor, Department of Agricultural Economics, Oregon State University. W. Robert Wood, formerly a Graduate Research Assistant, Department of Agricultural Economics, Oregon State University, is an Economist with Mayflower Farms, Portland, Oregon.

This research was supported in part by Institutional Sea Grant No. 2-35187. The Oregon State University Sea Grant College Program is cooperatively supported by the National Oceanic and Atmospheric Administration, within the U.S. Department of Commerce, by the State of Oregon, and by participating local governments and private industry.

ACKNOWLEDGEMENTS:

Several individuals have been very generous in providing assistance to two people whose familiarity with the salmon market was limited, at best. In this respect, Mr. William Jensen, formerly General Manager of the Portland Fish Company and now Associate Professor of Accounting at Lewis and Clark College, must be identified for particular acknowledgement. Others who have been most helpful include Dr. Darrel A. Nash, Acting Chief, Economic Research Division, National Marine Fisheries Service; Mr. Stanford R. Beebe, Director, Division of Industry Statistics, National Canners Association; Mr. K. Vaughn and Mr. R. Lee of the National Canners Association; Mr. Robert Silver, Chairman, Canned Salmon Institute; Dr. Stephen Mathews of the Washington State Department of Fisheries; and Mr. DeWitt Gilbert of the International Pacific Salmon Fisheries Commission. Mr. Der Hsiung Wang and Mr. Christopher Carter have provided valuable assistance through both gathering and analyzing data. Dr. William Brown and Mr. David Fawcett also provided valuable technical assistance. Dr. John Edwards advanced several suggestions which led to substantial changes in the approach. Dr. Albert Halter provided a constructive review of the manuscript. Some of the research was conducted while the senior author was on "detached service" at the University of British Columbia. Dr. George Winter, Chairman of the Department of Agricultural Economics and his staff, were most generous in providing various kinds of assistance and an atmosphere conducive to research. Their kindness is gratefully acknowledged. Finally, Dr. Emery Castle, formerly Head of the Department of Agricultural Economics and now Dean of the graduate School at Oregon State University, must be singled out for special thanks for his unending encouragement and continuing support.

A DEMAND ANALYSIS FOR CANNED RED (SOCKEYE) SALMON AT WHOLESALE--A PROGRESS REPORT

Richard S. Johnston and W. Robert Wood

ABSTRACT:

The report begins with a brief discussion of certain aspects of the production and consumption of Pacific Coast salmon. This is followed by a description of some structural characteristics of the market for canned salmon. The next section of the report reviews some of the earlier work on demand for canned salmon. This leads into the presentation of the econometric model developed in the present study to estimate the parameters of the postulated demand relationships. This section also presents the results of the statistical analysis. Finally, the report discusses progress to date, advances additional hypotheses generated by the research, and describes how the reported research is affecting on-going analysis.

INTRODUCTION

Around the world, much of the interest in the question of "ownership of the sea" is associated with the argument that management of fisheries by governments (either singly or collectively) is required to "conserve" the fisheries resources: to prevent overfishing and control pollution. Canada, for example, has reduced the number of its commercial salmon fishermen by a government "limited entry" program [7]. Recently Canada also announced intentions of supporting a 200 mile limit at the forthcoming Law of the Sea conference on the grounds that, while she can control Canadian fishermen under present 12-mile limits, she is unable to control the fishing of foreign fleets [8]. Suppose such programs are "successful" -- that is, suppose that governments do involve themselves more in management programs and that such programs result in increased catches of various species. What are the

likely impacts on prices of such species? Will these impacts differ among countries? If so, on what will they depend: the nature of the institutions in the various countries? The nature of seafood demand in these countries? There is interest in the United States in limited entry programs. Would the effects be the same here as they are in Canada? These are questions which merit the attention of those who contemplate such programs.

In the last few years, important advances in the fields of physiology, nutrition, and pathology have resulted in renewed interest in fish hatcheries to mitigate losses of fish--particularly salmon--from hydroelectric power stations. Experimental rearing of chum salmon in salt water, as opposed to fresh, has shown substantial returns. Artificial spawning channels are being developed successfully. If these and related programs result in increased fishing production, what will be the impacts on prices and on the incomes of those in the fishery?

On-going economic analysis at Oregon State University is motivated by an interest in these and related questions. Relationships between quantities and prices are viewed by the economist in terms of "supply and demand": the market for the good in question.

This is a progress report on research being conducted at Oregon State University to describe the market for Pacific Coast salmon. The report details the work designed to estimate the parameters of the demand functions facing U.S. processors of canned Pacific Coast sockeye (red) salmon. As such, it reports on only a small portion of the total research effort being devoted to the study of the salmon market. It is being published at this time to report accomplishments to date, to indicate to interested persons the nature of the research in progress, and to encourage critical reviews of the approaches being used.*

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* The earliest work on this project was undertaken by W. Robert Wood, whose master's thesis, A Demand Analysis of Processed Salmon from the West Coast [26], was recognized as one of the three outstanding masters' theses for 1970 by the American Agricultural Economics Association. Wood's research was concerned with the demand--primarily at wholesale--for the various species of canned salmon. The present report focuses on his results for sockeye salmon. Wood's thesis research was supervised by Richard S. Johnston, who is continuing the research.

I PRODUCTION AND CONSUMPTION OF SALMON

Salmon accounts for a large portion of both the physical volume and ex-vessel value[1/] of the marine life caught in Pacific Coast waters. As shown in Table 1, for the years 1965 to 1970 the U.S. salmon catch represented 26.3 percent of the total annual volume of fish, shellfish, and whole species caught in Pacific Coast fisheries by American fishermen. For the same period, the average annual ex-vessel value of salmon represented 39.2 percent of the revenue received by Pacific Coast domestic fishermen for all fish. In 1970, the value of the U. S. salmon catch from Pacific Coast fisheries represented 16.1 percent of the value of the U.S. catch of fishery products. This was second only to shrimp, whose value accounted for 21.2 percent of the total value of seafood landed by U.S. fishermen (see Table 2).

Table 1: Landings of U.S. Pacific Coast Fisheries (1965-1970)

	Salmon		Total fish, shellfish and whale	
Years	Quantity (1,000 lb.)	Value ($1,000)	Quantity (1,000 lb.)	Value ($1,000)
1965	326,806	65,123	1,146,725	148,363
1966	387,512	73,465	1,253,637	168,126
1967	216,664	48,533	1,134,735	140,377
1968	327,609	66,674	1,117,449	170,394
1969	246,200	54,700	1,147,700	175,400
1970	410,119	98,687	1,470,162	234,795
TOTAL	1,914,910(a)	407,182(b)	7,270,408(c)	1,037,455(d)

$\frac{(a)}{(c)}$ = 26.3 percent

$\frac{(b)}{(d)}$ = 30.2 percent

SOURCE: [2, Numbers 59 to 62 and 20, Number 5600].

1/ "ex-vessel value" refers to the product of the total poundage and the per pound price paid to fishermen for their catch.

Table 2: Volume and Values for Selected Seafood Species, 1970

	Relative volumes of U.S. landings for some seafood species, 1970*	
	Quantity (1,000 lb.)	Percent of U.S. total
Menhaden	1,837,492	37.4
Salmon	410,119	8.4
Tuna	393,494	8.0
Shrimp	367,469	7.5

	Relative ex-vessel values of U.S. landings for some seafood species, 1970*	
	Value ($1,000)	Percent of U.S. total
Shrimp	129,758	21.2
Salmon	98,687	16.1
Tuna	74,963	12.2
Oysters	53,603	8.7
Lobster (North.)	34,152	5.57
Menhaden	34,084	5.56

* Calculated from [20, No. 5900, pp. 11-13].

Data published by the National Marine Fisheries Service (formerly the Bureau of Commercial Fisheries) indicate that only minute quantities of salmon are registered as being commercially caught in areas other than Pacific Coast waters.[2/] This report deals only with salmon originating in the fisheries of the Pacific Coast.

Five species of salmon are consumed domestically. Their common names are: (1) chinook or king, (2) chum or dog, (3) coho or silver, (4) pink or humpback, and (5) sockeye or red. When the word salmon appears in this report, it refers collectively to the five species. When a particular species is discussed, the name is specified.

Each species exhibits different characteristics in appearance. For example, edible meat of the sockeye salmon is red; meat of the chum salmon is more pale. Such characteristics are among the factors leading to different market prices for the different species. Historically, red meat of the sockeye salmon has commanded higher prices than the paler meat of the chum.[3/]

[2/] These other areas include the Atlantic Coast fisheries and the Great Lakes.

[3/] It is tempting to argue that consumers prefer sockeye to chum salmon. However, such a statement does not necessarily follow from the observation that sockeye prices are higher than chum prices. For one thing, the verb "prefer" is ambiguous in this context. Consumer preferences underlie consumer demand. But market prices are determined in the market place by both demand and supply characteristics. It is difficult to separate these influences.

Furthermore, what does it mean to say that consumers prefer sockeye to chum salmon? Does this mean that, at identical prices for both species, every consumer would purchase a larger quantity of sockeye than of chum salmon? Is this independent of each consumer's money income? For an interesting study of behavioral patterns of consumers of canned salmon see [11].

Salmon reaches the consumer in either a fresh or a processed form. An important determinant of the form is the physical characteristics of the fish. Pink, chum, and sockeye salmon account for the bulk of the "annual pack", a term which refers to the amount of salmon processed into the canned form each year.[4/] Chinook and coho salmon are important in the fresh and frozen markets. However, the bulk of the salmon catch reaches the consumer in processed form. In 1970, the figure was 68.1 percent.[5/]

The per capita consumption of canned salmon in the United States has been decreasing since the 1930s, when the total salmon catch (and the resulting production of salmon products) was at its highest. Table 3 shows the annual domestic landings, the annual pack of salmon, and the annual per capita consumption of canned salmon for 1947 to 1970. Figure 1 depicts how the landings of salmon have decreased substantially since 1936.

The decreases in per capita consumption of canned salmon may be partly the result of a decline in the natural supply of salmon and an increase in the population of the United States. As Waugh and Norton point out, however, "in the 1920s and 1930s, salmon accounted for most canned fish consumption. But since the 1960s tuna has been the major canned fish item in the diets of the American consumer. Obviously, salmon competes with tuna (and tuna competes with salmon)" [25, p. 95]. It has also been suggested that consumers are switching from canned to fresh and frozen salmon and that this may be the result of improved supply conditions in fresh and frozen salmon distribution [24, p. II,11].

Factors noted as contributing to reduced landings over the years have been over-fishing, dams, and destruction of spawning grounds [14].

[4/] For the period from 1960 to 1970, the three species accounted for an annual average of 92.6 percent of the total salmon pack.

[5/] See Appendix Table I.

Table 3: The quantity of landings, pack, foreign trade, and per capita consumption of canned salmon for 1947-1970

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	Landings of Salmon						Pack of Salmon						Foreign Trade of canned salmon		Per Capita consumption canned salmon
Year	Total	Chinook	Coho	Sockeye	Pink	Chum	Total	Chinook	Coho	Sockeye	Pink	Chum	Imports	Exports	Pounds
	Millions of Pounds						Millions of Pounds						Millions of Pounds		
1947	498.0	53.2	38.1	157.0	191.5	58.2	269.6	16.9	14.7	92.4	112.9	32.7	0.0	61.6	1.3
1948	403.9	46.1	41.0	124.5	113.4	78.9	230.6	16.3	17.3	83.4	62.8	50.8	0.9	2.6	1.6
1949	431.6	39.6	40.8	78.0	273.2	52.7	264.7	10.0	13.3	51.6	155.3	34.5	0.9	12.8	1.6
1950	328.7	36.6	40.2	91.5	85.8	74.6	206.6	10.0	18.8	61.8	52.7	63.3	0.5	1.7	1.4
1951	374.2	43.2	52.1	66.2	147.6	65.1	222.3	11.8	22.4	44.9	96.1	47.1	0.6	2.1	1.4
1952	352.2	40.8	44.4	110.1	79.5	77.4	213.4	7.8	19.5	67.5	56.5	62.1	9.5	1.4	1.4
1953	313.0	39.2	28.7	83.3	97.2	64.6	186.7	7.6	9.9	55.8	67.0	46.4	12.2	2.3	1.3
1954	324.6	36.4	31.6	91.7	88.7	76.2	199.1	6.2	10.3	63.5	55.3	63.8	11.3	7.2	1.1
1955	289.9	42.8	28.7	57.6	128.2	32.6	157.3	8.5	10.0	36.0	80.4	22.4	13.0	10.4	1.0
1956	324.3	38.2	29.7	94.2	102.2	60.0	167.9	7.9	9.0	56.8	57.4	37.0	28.8	5.2	1.1
1957	265.2	30.5	26.8	67.5	71.7	68.7	153.5	6.8	9.8	46.2	46.3	44.4	24.4	6.7	1.0
1958	307.5	27.6	23.3	67.8	120.8	68.0	178.9	6.6	7.3	45.6	75.3	44.1	29.2	9.2	1.1
1959	201.6	27.4	20.2	53.8	61.7	38.5	117.8	6.0	9.1	35.4	39.4	27.9	31.2	13.8	0.9
1960	235.5	24.1	13.7	95.3	52.6	49.8	135.7	4.8	4.4	63.2	32.9	30.4	19.1	11.9	0.7
1961	310.4	27.0	23.2	103.6	108.5	48.1	177.1	5.5	7.9	69.2	65.0	29.5	7.2	7.2	0.8
1962	314.5	25.1	27.8	58.0	143.3	60.3	182.3	5.6	7.6	40.2	92.9	36.0	6.8	9.0	0.9
1963	294.1	27.2	28.1	43.4	156.6	38.8	157.7	4.6	7.9	29.1	93.9	22.2	1.2	10.2	0.9
1964	352.3	28.8	38.1	57.3	162.3	65.8	180.3	4.6	10.5	37.3	93.1	34.8	0.2	20.9	0.7
1965	326.9	29.3	38.5	148.1	79.7	31.3	174.3	6.3	9.0	98.0	45.6	15.4	0.1	24.9	0.9
1966	387.5	27.2	38.8	102.0	163.0	56.5	209.0	4.0	9.9	66.5	99.3	29.3	0.6	20.5	0.8
1967	206.4	27.2	34.2	64.7	48.3	32.0	99.6	4.4	6.7	41.5	29.6	17.4	0.1	20.5	0.7
1968	327.7	24.9	38.7	54.1	148.5	61.5	165.4	3.4	7.9	34.3	88.4	31.4	5.0	5.7	0.7
1969	246.2	23.5	19.7	71.3	113.2	18.5	120.8	3.4	2.9	43.3	62.4	8.8	2.1	15.5	0.7
1970	410.2	31.7	43.7	159.6	117.8	57.4	183.4	2.4	6.5	87.9	64.3	22.3	2.4	16.8	0.7

SOURCE: [2, Numbers 21-62 and 20, Numbers 5254,5300,5324, 5560 5600, 5900]

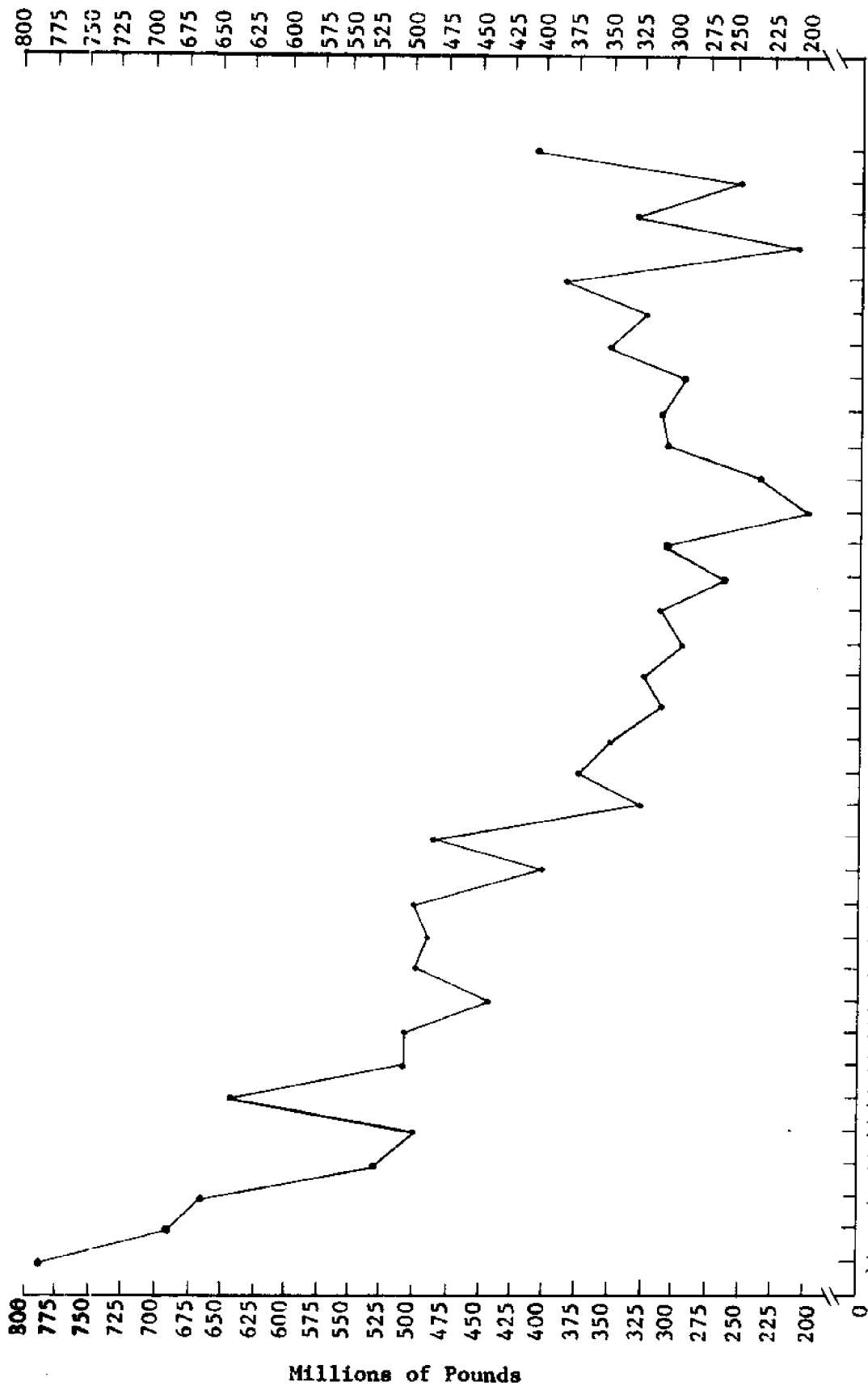

Figure 1. Salmon landings for the Pacific Coast fisheries, 1936-1970. SOURCE: Table 3.

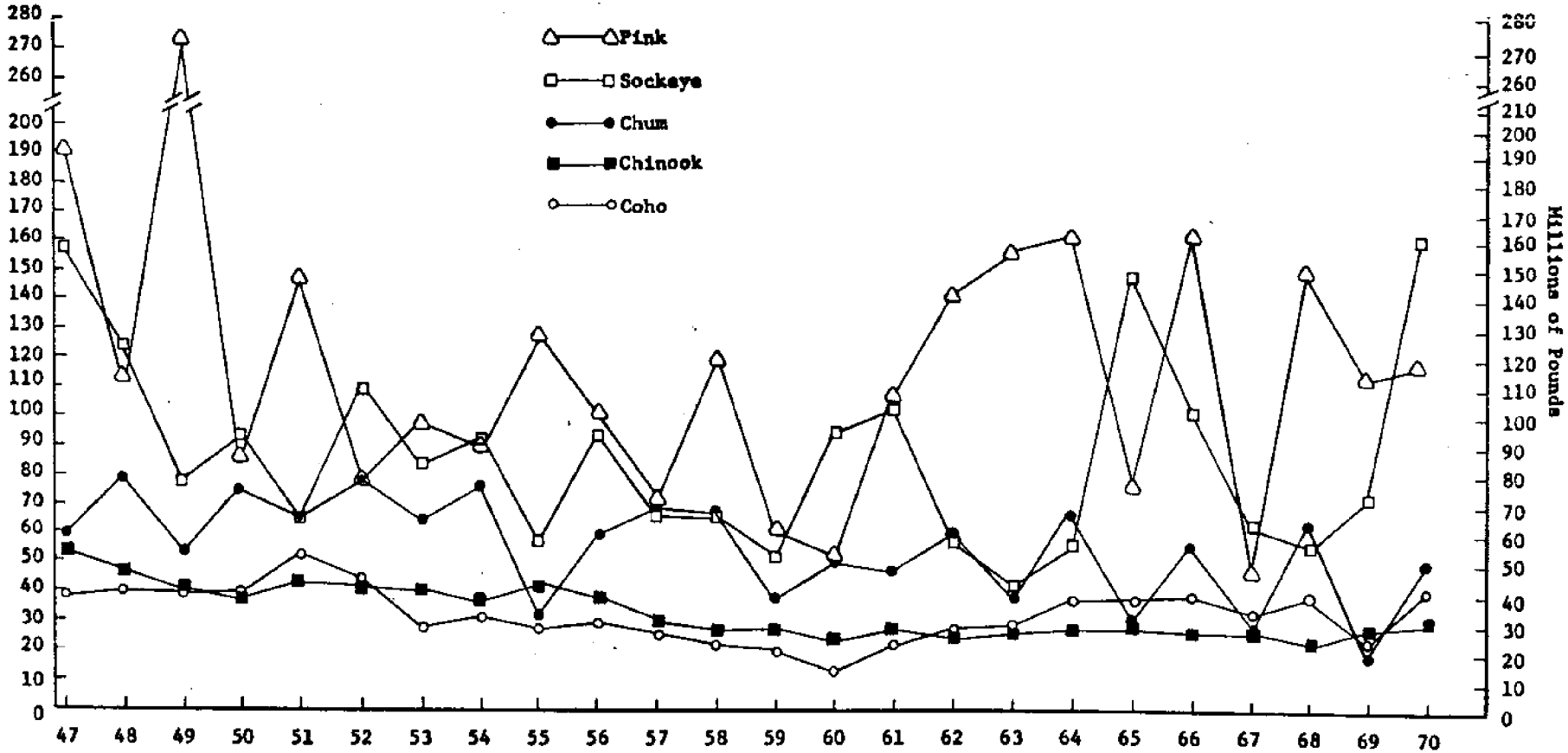

Figure 2. Quantity of landings for each species of salmon from 1947-1970. SOURCE: Table 3.

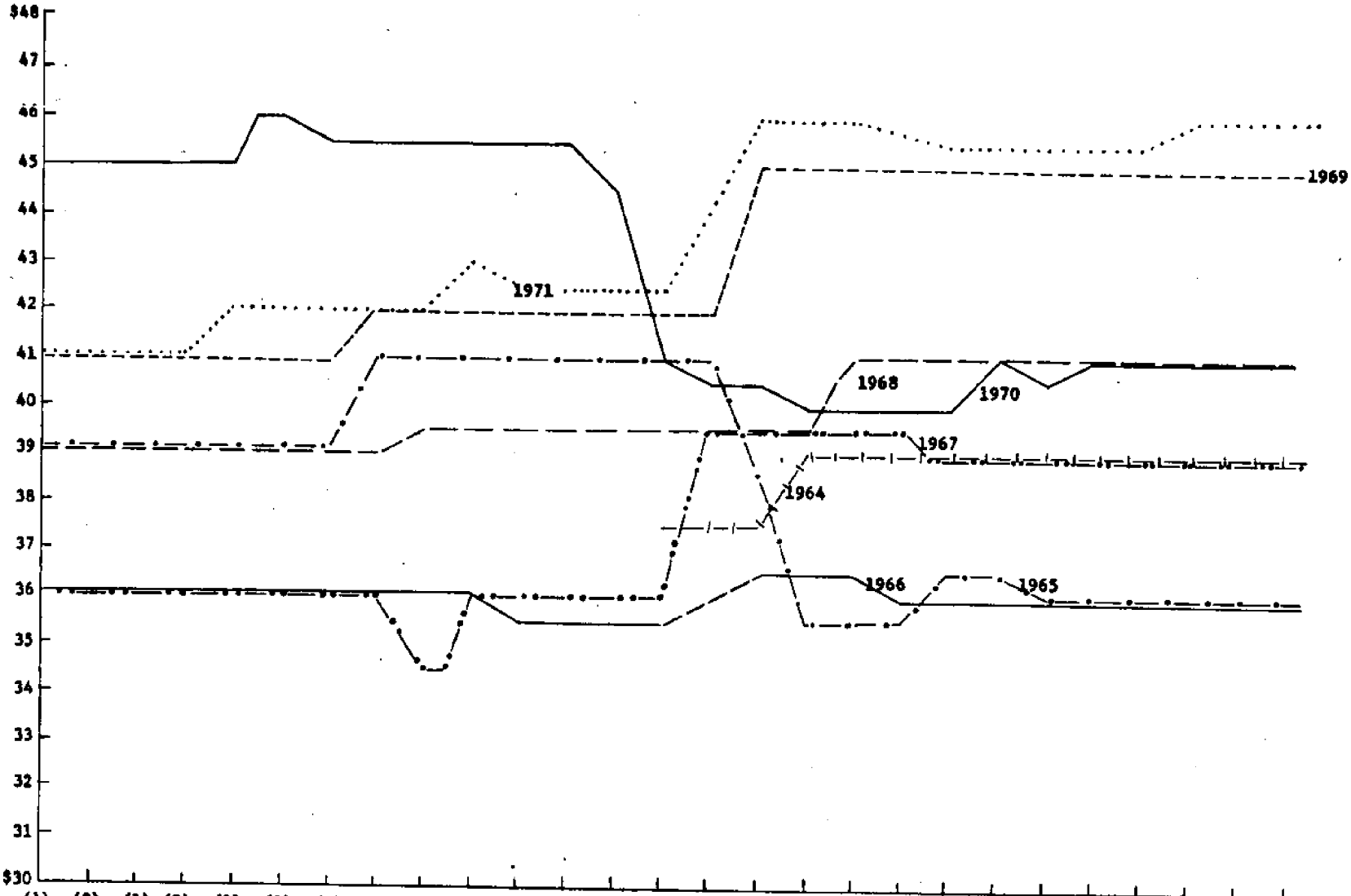

Figure 3: Biweekly Prices, Canned Alaska Red Salmon (price per case: 48 one-pound cans; f.o.b. factory) SOURCE: [9].

Figure 2 depicts domestic landings for each of the important species of salmon. It should be noted that Alaska produces five times the catch of salmon taken from the waters of the other Pacific Coast states--Washington, Oregon, and California--combined.[6/]

All species of Pacific salmon begin their lives in fresh water, grow and mature in the ocean and return to spawn and die in the streams in which they were reared. The young of pink and chum salmon move directly to sea. Unlike other salmon, pinks always return to spawn at the same age--their second year. Chum salmon mature at about four years. Sockeye salmon, after a year or two in fresh water, make two or three annual circuits of the North Pacific before returning inland to spawn. Young chinook spend from a week to a year in fresh water, then swim to sea for three or four years. Coho salmon spawn at the age of three or four years. The timing of the return to their birthplace varies little from year to year for the Pacific salmon and it is during this period that salmon are harvested by the commercial fishery.

This report is particularly concerned with sockeye salmon *(Oncorhynchus nerka)*. Commercially, the sockeye is known for the color and quality of its flesh. It is "very red, very rich in oil, and holds both color and flavor well under all conditions of storage" [13, p. 6]. Its weight at maturity is between 3 and 7 pounds. Haig-Brown states further, "with the color and quality of its flesh, the sockeye's obvious peculiarities are that it rarely ascends a stream or river system without lakes, and it takes a lure in salt water far less frequently than do the other species" [13, p. 6]. Thus, they are caught primarily by nets and purse seines.

The bulk of the sockeye salmon are landed as they make their way to spawn in British Columbia's Fraser River and the eleven major sockeye rivers of Alaska's Bristol Bay. Oregon's Columbia River also has a small run of this species. The complete range of the sockeye salmon is from Oregon westward along the North Pacific Ocean and Bering Sea coast of North America to the northern Kuril Islands and along the northern and northeastern shores of the Sea of Okhotsk [16].

6/ Although concern of this report is with the demand for salmon landed at U.S. ports, it should also be kept in mind that Canadian landings constitute almost one-third of the total landings of Pacific salmon in North American ports.

II THE STRUCTURE OF THE MARKET FOR CANNED SALMON

In this section a few comments are made about some institutional factors which play a role in the determination of market prices and sales of processed salmon. The results of only a cursory investigation are presented here. A more exhaustive description of market structure and of the conduct of market participants must await the findings of on-going research at Oregon State University and elsewhere.

A. The Fishing Vessel and the Processing Unit

Salmon are channeled through three basic market levels for processing. At the primary, or "ex-vessel" level, the fisherman supplies the raw fish to the processor. In some cases, the fishermen are an integrated portion of the processor's operation. The second level through which the salmon passes is the processor wholesale-retailer level. At this level, the raw fish is transformed into various salmon products and sold to retail buyers. In some cases, a separate wholesaling function is performed, involving, then, an additional market transaction. The final step in the marketing channel is the retail level where the salmon product reaches the consumer.

At the primary level, the market is characterized by a relatively large number of salmon fishermen selling to a relatively small number of salmon processors. Table 4 presents data on the numbers of salmon fishing boats and vessels for 1968.

Table 5 summarizes data which appeared in a trade publication, The Pacific Fisherman, (now part of the National Fisherman).[7/] Rubinstein, pointing out that pack figures are contributed to this publication on a voluntary basis, discusses some of the difficulties involved in using these figures to describe the structure of the processing sector (especially concentration):

7/ The National Fisherman absorbed the Pacific Fisherman in 1967. The National Fisherman also includes the former Atlantic Fisherman and Maine Coast Fisherman.

> The pack figures refer to the ownership of the salmon after processing, not to the number of cases actually packed by a firm. Since many firms have part or all of their pack processed in another canner's plant, there is a wide discrepancy between these two aspects of concentration ... . Fortunately, concentration in the industry in terms of ownership of the pack ... is in relatively close agreement with the criterion of ownership and control on which concentration measures should be based. Interpretation of the pack figures is complicated by the substantial amount of overlapping and shifting of ownership and control within the industry. Shifts in ownership are often never made public. If firm A has a third ownership in another firm B, the question of control of the pack of firm B becomes rather touchy. Firm C may be a wholly owned subsidiary of firm D, yet its pack figures may appear separately in Pacific Fisherman. Firm E and firm F, while separately owned, may work very closely together in both production and marketing in the sense that they are not competitive; in this instance, separate ownership does not mean separate control. On the other hand, two firms may be jointly owned but operated independently. Another complicating factor is the tendency of small firms to be financed by the larger packers or market their packs through the sales organizations of large firms, another example of ownership divorced from control at the production or marketing level [23, pp. 46 and 47].

The data suggest that there is a fairly substantial difference between the structure of the fishing sector and the structure of the processing sector of the industry. However, the data conceal several important structural phenomena, including contractual arrangements between fishermen and processors and including cooperative agreements among fishermen.[8/]

On the selling side, many changes have taken place in the industry since its inception in the late nineteenth century. The early salmon packers relied on wholesale grocers and food brokers to market their products. "As the industry reached considerable proportions, the selling agents specializing in the marketing of canned salmon became of increasing importance ... . With the growth of more powerful salmon-canning companies, resulting from integrations, mergers, and consolidations," the 1920s and 1930s saw the development of the large packer-broker [10, p. 70].

8/ The 1971 issue of the National Fisherman yearbook lists 26 cooperatives in the West Coast states (including Alaska) engaged in marketing and/or bargaining for salmon fishermen.

Since then "the concentration of sales outlets has shifted into the hands of a few large packers" and "marketing concentration has been substantially higher than concentration at the processing level" [23, p. 86 and p. 46].

Leadership, in announcing prices for canned salmon, is generally taken by the large processing companies. These opening prices are announced each year in late August or early September when the greater part of the packing is over and a good estimation of the total pack is available. Small packers generally fall in line after the large fish processing firms have issued their price quotations [see 22, Sept., 1957, p. 50, for one example]. Seasonal price variation does occur, however, due, presumably, to revised estimates by the sellers of the magnitudes of the variables included in this study as arguments of the demand functions of canned salmon buyers. As shown in Figure 3, the wholesale prices of canned red salmon have tended to stabilize in December in recent years.

Table 4: The Numbers of Fishermen and Crafts in the Salmon Fishery (1968)

		Purse seine (1)	Anchor, set or stake (2)	Drift (3)	Total (4)=(1)+(2)+(3)	Troll line (5)	Total (4)+(5)
Fishermen		7,022	3,021	7,396	17,439	13,237	30,676
Craft	Vessels	1,038	47	901	1,986	2,340	4,326
	Boats	1,652	2,578	4,911	9,141	4,700	13,901

SOURCE: [2, 1968]

NOTE: A "vessel" is a craft having a capacity of 5 net tons or over.
A "boat" is a craft having a capacity of less than 5 net tons.

Table 5: Concentration in the Canned Salmon Industry: 1955, 1960, and 1965

Year	Percentages of the packs of Red, Pink, and all canned Salmon packed by the Top 4 and the Top 8 processing companies					
	Red		Pink		Total Pack	
	Top 4 (%)	Top 8 (%)	Top 4 (%)	Top 8 (%)	Top 4 (%)	Top 8 (%)
1955	38.9	55.3	32.7	52.7	29.4	46.8
1960	47.1	66.6	44.0	64.0	40.5	57.6
1965	56.0	75.1	46.3	67.6	50.0	65.0

SOURCE: [22, 1956, 1961, and 1965]

B. Some Factors Affecting Prices and Exchange Quantities of Processed Salmon

The quantity of salmon landed in any year importantly affects the total pack of processed salmon which, in turn, is the important "supply" variable affecting the wholesale price of processed salmon. Sockeye salmon fishing by U.S. fishermen takes place when the mature fish return to their native streams to spawn. The timing of this migration varies among streams but, over the entire Pacific coast, it generally begins in late June and ends in September [15, p.2]. The bulk of the sockeye salmon pack is canned, as opposed to entering the fresh market, and packing follows the same pattern, although some packing is done as late as November. It is, therefore, convenient to think of the marketing year as running from July to the following June. It is particularly convenient since much of the relevant data is published annually for two dates: July 1 and January 1.

In addition to the salmon pack, another important component of the total quantity available for consumption during any marketing year is the carry-over of salmon stocks from the previous year and available at the beginning of the marketing year. The level of such inventories is influenced by the previous year's landings and wholesale price, together with expectations regarding supply and demand conditions. In turn, the magnitude of the year's ending inventory is importantly determined by the year's wholesale price and pack together with expectations regarding supply and demand conditions in

the following year.[9/] Other supply related variables include those conditions in the foreign markets. The United States exports canned salmon to the United Kingdom and imports canned salmon from Canada and Japan.[10/] On the demand side, it is hypothesized that the size of the population, personal disposable income, and conditions in the markets for canned salmon substitutes are important determinants of the retail price. The retail price, in turn, influences and is influenced by the wholesale price, which is also affected by conditions in the markets for transportation services, processing services, and other "marketing" activities. The various individuals and agencies, who buy from packers for resale (either to other intermediaries or to consumers) will be referred to as "distributors" in this study.

A complete discussion of the market for any commodity would be complex, indeed. An economic analysis of such a market can hope only to identify broad relationships among variables. This, of necessity, involves ignoring some relationships which may be important where specific transactions are concerned. The decision concerning which variables and interrelationships to include in any analysis depends on the nature of the cost/benefit calculations performed by the researcher himself. This study attempts to quantify some relationships: those between quantities demanded and alternative prices at various levels, for example. For many questions, the direction of the relationship is as important as the magnitude of the relationship. For example, is a larger pack associated with an increase, a decrease, or no change in dollar receipts from the sale of canned salmon?

Thus, while the discussion in this section may have failed to include mention of some economic variables and relationships (such as the role of the market for fresh salmon) it is hypothesized that including such variables would yield benefits which do not exceed the costs. Such hypotheses remain, of course, to be tested. Further, some of the relationships discussed in this section are not treated explicitly in the empirical section to follow. This is, in part, the result of data limitations and, in part, the result of cost-benefit decisions similar to those described above.

[9/] Inventories are also held at the retail level. At this level, of course, retail prices are important determinants of the size of the stock.

[10/] These are the principal--not the only--countries with which the U.S. trades in canned salmon.

III SOME ANALYSES OF THE DEMAND FOR CANNED SALMON

In November, 1968, the Division of Economic Research of the Bureau of Commercial Fisheries (now the National Marine Fisheries Service) held a conference on the demand for fishery products. The purpose of the conference was "to draw together on a species basis all the statistical demand relationships which had been computed by various researchers" [17 p. i]. The conferees then chose a demand function for each species "as the best specimen so far in this area" [ibid]. For canned U.S. salmon, the following equation was selected:

$$\log Y = \underset{(-0.030)}{-0.006 \log X_1} \underset{(-3.818)}{- 1.628 \log X_2} \underset{(2.351)}{+ 0.308 \log X_3} \text{ where}$$

numbers in parentheses are t-values and

where Y = Per capita consumption of canned salmon

X_1 = Price of canned salmon[10a/]

X_2 = U.S. Personal Income

X_3 = Price of canned tuna[10a/]

Variables X_1, X_2, and X_3 are deflated, presumably by the Consumer Price Index. Annual data for 1947-1965 were used. For this equation the R^2 statistic was 0.889. The computed price and income elasticities are -0.006 and -1.628, respectively. The interesting results of this study include the finding that the demand for canned salmon, as described by the above equation, is highly inelastic. Tuna and salmon emerge as apparent substitutes in consumption. Presumably, the negative and statistically significant coefficient on the income variable was not expected. Whether this is the result of econometric difficulties or whether, indeed, canned salmon is an "inferior good" is an interesting question and one that is explored in this study.

A 1969 study by Waugh and Norton [25] used annual data (1930 to 1940 and 1946 to 1967) to examine consumption relationships between canned salmon and

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10a/ Whether these are wholesale or retail prices is not specified in [17].

canned tuna. Their statistical equations treating salmon as the dependent variable are:

$$q_s = 4.088 - \underset{(-4.743)}{0.914}\ \text{inc.} - \underset{(-2.276)}{0.034}\ p_s - \underset{(-0.539)}{0.012}\ p_t$$

and

$$\log q_s = 0.342 - \underset{(-5.434)}{1.294}\ \log \text{inc.} - \underset{(-0.727)}{0.170}\ \log p_s + \underset{(1.565)}{0.201}\ \log p_t$$

where: q_s is per capita consumption of salmon (pounds).

p_s is the average wholesale price of all sizes and varieties of canned salmon, deflated by the BLS Index of Wholesale Prices (dollars per case).

p_t is the average wholesale price of all sizes and varieties of canned tuna, deflated by the BLS Index of Wholesale Prices (dollars per case).

Inc. is consumer disposable income per capita, deflated by the BLS Index of Consumer Prices.

The numbers in parentheses are t-values.

For both equations, the R^2 statistics are quite high (.89 and .92 respectively). Here, again, salmon and tuna appear to be substitutes in consumption. Also, the estimated coefficient on the income variable is, once again, negative and the price elasticity of demand for canned salmon is computed to be less than unity.

In another 1969 study, Nash, Sokoloski, and Cleary looked at demand factors for Alaskan fishery products and found that population and income do not have significant effects on canned salmon prices [18]. The study presents estimated equations for each of the five species of canned salmon.

That for canned red salmon is:

$$\log P^r = 1.81 - .17 \log Q^r + .18 \log P^p$$
$$(-4.98) \qquad (1.82)$$

where

P^r = Price of canned red salmon[10b/]

Q^r = Consumption of canned red salmon[10b/]

P^p = Price of canned pink salmon[10b/]

The R^2 statistic was .62. The equation suggests that, for red salmon, the demand is rather price-elastic. Indeed, this turned out to be the case for each of the species when examined separately.

In the 1970 thesis prepared by W. Robert Wood and referred to in the introduction, analysis was made of all canned salmon taken together and of sockeye, pink and chum, and chum taken separately were analyzed [26]. Several different specifications were made on the wholesale demand equation for all canned salmon. This included several formulations in which price was specified as the dependent variable. In all such cases, the price elasticity of demand, as calculated at the mean values of the variables, exceeded unity. In four of five of the equations, the coefficient on income was positive. However, when the equation was re-specified so that consumption became the dependent variable, different results emerged. In this case, the estimated price elasticity was substantially below unity and the coefficient on the income variable was negative These results suggest that there are substantial econometric problems involved.

Two specifications were made of the demand equation for canned red salmon. In both cases, price was treated as the dependent variable. The rationale for this approach was that since pack and landings figures are highly correlated[11/] and since salmon landings are determined largely by biological--as opposed to current price—conditions, the "quantity" variable could be treated as predetermined for estimation purposes.

10b/ From the discussion in [18] it is not clear whether the prices are measured at the wholesale or the retail level and whether consumption is measured on an aggregate or a per capita basis.

11/ The simple R^2 statistic, using data for 1947 to 1967, was found to be .922.

$$P^r = .49737 - .00072Q^s - .05673R - .00009\frac{Y}{N} + .000009M^c + .00251N$$
$$(-1.280) \quad (-2.288) \quad (-.640) \quad (.114) \quad (.897)$$

and

$$P^r = .70153 - .00240Q^s + .000013Q^sN - .00039N + .00040M^t$$
$$(-.587) \quad (.572) \quad (-.734) \quad (.989)$$

(Numbers in parentheses are t-statistics.)

where P^r = The wholesale price of canned red salmon.

Q^s = The U.S. annual pack of red salmon, adjusted for imports and exports.

R = The ratio of the previous year's landings of red salmon to the current year's landings.

Y = Disposable personal income deflated by the Consumer Price Index.

N = Population of the United States.

M^c = Quantities of canned meat and meat products.

M^t = The quantity of canned tuna.

The R^2 statistics for the two equations were .577 and .391, respectively. In both cases, the price elasticities, calculated at mean values of the variables, exceeded unity (approximately 6.5 and 5.0, respectively, in absolute values). Also, in each case, the coefficient on the income variable was negative. As can be seen, the t-values are very low, in part because of a high degree of intercorrelation among the independent variables.

One difficulty with this work lies in the problem of knowing how well the model correctly specifies the demand relationship. This has also, no doubt, been a problem of other studies reviewed. While the quantity of red salmon landed and, perhaps, the pack in any one year may be treated exogenously, the quantity consumed in that year is, no doubt, an endogenous variable. Unfortunately, however, data on wholesale consumption are difficult to obtain. One problem is that the size of the salmon harvest is uncertain until after harvesting begins in mid-summer. Thus, as revealed in Fig. 3

(Section II) there is generally an adjustment in wholesale prices about that time and any averaging of prices over the calendar year would conceal the differences in supply conditions that may prevail, as between the pre- and post- harvest periods. On the other hand, wholesale consumption figures for marketing years have not been available until recently. Another piece of important data not available until recently is information on carryover stocks. Prior to 1964, inventory data were not available.[12/]

In the Wood study just discussed, R was used as a proxy for inventory on the postulate that landings in the previous year and the expected landings in the current year (as measured by their actual values) importantly determine inventory levels. This was an unsatisfactory procedure, however, since inventory data are necessary not only as an explanatory variable in a demand relationship but are also necessary to the calculation of the wholesale consumption figures themselves. For this reason it was decided to look more closely at the years since 1964 and to conduct an analysis using the data for this more recent period. It was also decided, as indicated earlier, to focus on the market for red salmon.

IV AN ECONOMETRIC MODEL OF THE WHOLESALE DEMAND FOR CANNED SOCKEYE SALMON

Physical and economic characteristics of the market for canned red salmon have been discussed in previous sections. The following econometric model is specified to take explicit account of what appear to be the more important aspects of market structure and conduct:

$$P_r^W = f\ (K_r, K_p, S_r^C) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

$$Q_r^W = G\ (I, P_r^W, N, P_T^R) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (2)$$

where:

P_r^W = December's wholesale price of canned red salmon, deflated by the wholesale price index.

K_r, K_p = Packs of canned red and pink salmon, respectively.

S_r^C = July 1 canners' stocks of canned red salmon.

Q_r^W = Total disappearance of canned red salmon at wholesale. It is for any year, t,

$$S_{r,t} + K_{r,t} - S_{r,t+1}^C \ .$$

I = U.S. total personal disposable income, deflated by the Consumer Price Index (CPI).

N = U.S. population.

P_T^R = Retail price of canned tuna, deflated by the CPI.

A linear relationship is specified among the variables and a two-step procedure is used to estimate the parameters. Under the first step, December wholesale prices are predicted from equation (1). These predicted prices are then used in equation (2) as the price variable, P_r^W.

The rationale for this procedure is, roughly, that step 1 specifies a supply equation while step 2 specifies a demand equation. The assumption is made that the bulk of the annual sales are made at the price prevailing in December. The December price and the season opening price are not necessarily the same, and it is likely that this discrepancy is the result of revised expectations regarding supply and demand conditions. Thus, actual and expected supply and demand conditions jointly determine the December price. In this model, the December price is treated as an "asking" price whose magnitude is determined by the size of the red and pink packs and inventory of reds. (This price is deflated by the Wholesale Price Index.) It is hypothesized that the asking price is negatively related to the size of the pink and red packs and to the size of the inventory. In fact, the result, using annual data for 1964-1971,[13/] [14/] is:

$$P_r^w = 47.324 - \underset{(-4.2339)}{.05679}\ S_r^c - \underset{(-6.77335)}{.044166}\ K_r - \underset{(-1.29870)}{.00831}\ K_p \quad \ldots\ . \quad (1a)$$

Inventory and pack figures are measured in units of 10,000 standard cases.[15/] Prices are measured in dollars per standard case of one-pound cans and are deflated by the BLS index of wholesale prices (1967 = 100). The numbers in parentheses are t-statistics, and the R^2 statistic for the equation is .924.

13/ The analysis is limited to this period because only since 1964 have inventory data been available. It should be noted that the 1971 marketing year was characterized by some peculiar circumstances: a late run, a dock strike which closed West Coast ports for over four months, and President Nixon's "New Economic Policy". The latter effectively froze canned salmon prices at their 1970 levels for two months beginning mid-August and curtailed their movement thereafter. In addition, on December 18, 1971, the U.S. dollar was devalued by 8 percent. These circumstances call into question the inclusion of data for the 1971 year. In fact, the difference between the "actual" and the "predicted" prices for the 1971 observation is less than 6 cents. Furthermore, with so few observations it was felt that excluding the 1971 data would be very costly by statistical standards.

14/ Relevant data appear in Appendix Table II.

15/ A "standard case" is 48 one-pound cans of salmon. Salmon is sold in various can sizes (1/4, 1/2, 1, and 4 pound cans) and, therefore, data are converted to standard-case equivalents.

The coefficients on the red pack and red stocks variables have the expected signs and are statistically significant (one-tailed test at the 95 percent probability level). The coefficient on the pink pack variable has the expected sign but is not statistically different from zero at the 95 percent probability level.[16/]

In the second step, the prices predicted by equation (1) are treated as observations on an exogenous variable in the second equation. The reasoning is as follows: the demand facing the canners is, essentially, the retailer's derived demand for canned red salmon; i.e., the retailer's "marginal revenue product" curve. Thus, the quantity demanded by retailers is, essentially, dependent on the price charged by canners and the price paid by consumers. The prices charged by canners are those predicted by step 1. The price paid by consumers for a given quantity is the result of the interaction of retailers' supply and consumers' demand, the latter involving income levels, prices of substitutes, and the size of the consuming population. In fact, then, equation (2) should include retail prices explicitly and the model should be expanded to include retail supply and consumer demand equations. Unfortunately, retail price data for canned red salmon are not available. Thus, those consumer demand variables related to retail prices are included explicitly in the equation. Equation (3), then, is really a "partially reduced form" equation.

Thus, in the second step, the total annual disappearance (that is, disappearance during the marketing period) is hypothesized to be negatively related to the deflated December wholesale price of canned red salmon. This consumption is also hypothesized to be positively related to the retail price of canned tuna[17/] (suggestive that canned red salmon and canned tuna are substitutes in consumption by final consumers);[18/] positively related to U.S.

16/ It does have a statistically significant negative value at the 92 1/2 percent level (one-tailed test).

17/ Deflated by the Consumer Price Index.

18/ It is also hypothesized that red salmon and pink salmon compete in final consumption. Unfortunately, retail prices of canned pink salmon are not available. However, it is hoped that including tuna price will help account for this substitutional relationship.

disposable personal income[19] and to U.S. population. In fact, the estimated equation, using data for 1964-1971, is:

$$Q_r^W = -10{,}636{,}173.9 - \underset{(-2.125)}{9103.223}\, I - \underset{(-5.363)}{138867.4}\, \hat{P}_r^W + \underset{(2.462)}{126.984}\, N - \underset{(-1.429)}{69733.399}\, P_T^R \quad \ldots\ldots\ldots\ldots \quad (2a)$$

Again, t-values are in parentheses. Consumption, Q_r^W, is measured in standard cases, while income, I, is measured in billions of dollars. Units of 1,000 persons are used for the population variable, N, and the retail price of canned tuna (6 1/2 oz. can), P_T^R, is measured in cents and is deflated by the Consumer Price Index. The red price predicted from step 1, $\hat{P}_r^W$, is in dollars per standard case.

The R^2 statistic for the equation is .949. The estimated coefficients on the predicted red price and U.S. population variables have the expected signs--and both are statistically different from zero (one-tailed test) at the 95 percent level. The estimated coefficients on the income and retail tuna price variables both have unexpected negative signs. Furthermore, a one-tailed test of the statistical significance of these coefficients reveals that the income coefficient is significiently less than zero at the 95 percent probability level. One is tempted to conclude that canned red salmon is an inferior good. However, a closer inspection of the results suggests that care is needed in making any such interpretation. The income and population variables are highly interrelated, suggesting that it is difficult to "sort out" the effects of each. This is the problem of intercorrelation, which results in ordinary least squares providing imprecise estimates of the unknown coefficients.

Two procedures are used to try to deal with this difficulty. First, the parameters in (2) are estimated by employing an estimation technique known as "ridge regression".[20] Basically, this procedure involves

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[19] Deflated by the Consumer Price Index.

[20] This technique is carefully described in [1].

augmenting the principal diagonal elements in the variance-covariance matrix that is used to obtain ordinary least squares estimates and, in so doing, seeks to reduce the variance of these estimates by reducing the effect of intercorrelation among the explanatory variables. Use of this procedure does, indeed, result in a change of sign in the income coefficient.[21/] However, as pointed out by Brown [1], the procedure is of questionable appropriateness when the "true" values of the parameters do not have identical signs. Since it is expected that the price and income coefficients are negative and positive, respectively, little confidence can be placed in the ridge regression estimates.

But the results do suggest that an alternative specification of the model could yield interesting results.[22/] When total quantity and total income are replaced by their per capita counterparts, the following equation is obtained:

$$\frac{Q_r^w}{N} = 25.0170 + \underset{(.8726)}{10.1827}\ \frac{I}{N} + \underset{(.09208)}{.02419}\ P_T^R \underset{(-3.3669)}{-.58938}\ \hat{P}_r^w \quad \ldots\ldots \quad (2b)$$

All variables are defined as before. They are measured such that $\frac{Q_r^w}{N}$ is in units of "standard cases per 1,000 persons and $\frac{I}{N}$ is in units of $10,000 per capita. The figures in parentheses are t-statistics.

Under this specification, the R^2 statistic falls to .84. Only the coefficient on the red price variable, $\hat{P}_r^w$, is statistically significant at the 95 percent confidence level. The Durbin-Watson test for autocorrelation fails to deny or confirm the presence of autocorrelation.[23/] The estimated price and income elasticities are -3.79 and .531, respectively. The implications of these findings are discussed in the next section.

21/ The procedure results in several estimates, depending upon the extent of augmentation of the principal diagonal elements of the variance-covariance matrix. The estimated price and income elasticity figures are approximately -2.0 and 0.2, respectively.

22/ In private conversation, Brown points out that, with positive correlations between the income variable and each of the other explanatory variables, one would expect ridge regression estimates of the income coefficient to to be biased downward by the other negative coefficients. Thus, the ridge regression results here could be interpreted as providing some evidence that the income coefficient is positive.

23/ A test for autocorrelation is not very meaningful when so few observations are involved.

V SOME IMPLICATIONS OF THE ANALYSIS AND ADDITIONAL HYPOTHESES

A. Implications

From results reported in the previous section, it seems that the hypothesis that wholesale prices and the quantities demanded of canned red salmon are negatively related can be accepted, tentatively, at least. The results suggest that the wholesale demand is price-elastic and that a 10 percent increase in the pack of canned red salmon would be associated with a 1 1/2 percent (approximate) decrease in the (deflated) December wholesale price of red salmon. This, in turn, would be associated with a 5.6 percent (approximate) increase in purchases at wholesale.[24/]

This finding must be interpreted with caution. In the first place, the figures must be modified if the 10 percent change in pack size is accompanied by changes in the magnitudes of the other "independent" variables of equations (1a) and (2b). Furthermore, the figures are appropriate only for a "one shot" change in pack size, that is, only for a deviation in pack size away from its average (1964-1971) level and, in turn, associated with a deviation in the red salmon price away from its average (1964-1971) level.

Assigning to the variables (I/N), P_T^R, S_r^c, and K_p in equation (1a) and (2b) their average values and solving these two equations simultaneously leads to the finding that, when the red pack is 1.3 million standard cases, the quantity purchased by distributors during that marketing year is also 1.3 million standard cases. This suggests that, for larger packs, distributors add to their inventory levels while, for smaller packs, inventory levels at the distributor level are reduced.[25/] The ability and willingness of distributors to hold inventories is consistent with the finding that the demand at wholesale is price-elastic. Storage capacity may well have a

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[24/] From equation (1a), $\frac{\delta P_r^w}{\delta K_r} \cdot \frac{K^r}{P_r^w} = .148$ and, from equation (2b), the estimated price elasticity of demand is 3.79. These elasticity figures are calculated at the mean values of the relevant variables.

[25/] This result is predicated on the assumption that the wholesale price of canned red salmon will move to its equilibrium level. The inventory levels referred to pertain to the July 1 date.

bearing on price and income changes (at wholesale) associated with changes in pack size through, say, government regulatory and hatchery programs. In general, however, it appears that programs leading to increased landings of red salmon and, in turn, larger pack sizes, would be associated with increases in the total receipts at wholesale generated by sales of canned red salmon.[26/]

This is a finding which seems to be helpful in addressing the questions raised in the Introduction. However, the statistical results raise new questions: with fairly low t-values in equation (2b), have the "correct" variables been included in the model? If so, have they been measured properly? Could the R^2 statistic be increased by an alternative specification?

Accordingly, an hypothesis-generating phase seems appropriate. In the discussion which follows, alternative specifications and new variables are introduced. The hypotheses generated are discussed and suggestions for testing them are indicated.

B. Additional Hypotheses

One variable which has been excluded from explicit consideration so far is the level of distributors' stocks of canned red salmon. The finding that distributors make net additions to or reductions in their inventory levels as the pack size exceeds or falls below 1.3 million standard cases may be an appropriate description of the actual situation for a one- or two-year period. However, when relatively large or relatively small packs persist, further explanation is required. One solution is to add a "distributors' inventory" variable as a shifter of the demand relationship. Unfortunately, data on this variable are not available. Data on total canned salmon inventories held by distributors have been published since 1965, however. To generate the needed data, these "total" figures are multiplied by the proportion of the total canners' salmon stocks consisting of the red species.

26/ This does not necessarily mean, however, that, with increased landings of red salmon, the total receipts from all canned salmon sales will increase at wholesale. Wholesalers may experience concurrent declines in their receipts from sales of canned pink, chum, and other salmon. Such substitutional relationships are explored in the next section.

The resulting figures[27] represent estimates of what would be the 1965-1971 July 1 stocks of red salmon in the hands of distributors under the assumption that

$$\frac{\text{Canners' July 1 stocks of reds}}{\text{Canners' July 1 stocks of all canned salmon}} = \frac{\text{Distributors' July 1 stocks of reds}}{\text{Distributors' July 1 stocks of all canned salmon}}$$

This new variable can then be introduced into equation (2b) as a replacement for the retail price of canned tuna. It is expected to be negatively related to quantity demanded at given levels of wholesale price and per capita income. The results are:

$$\frac{Q^w_r}{N} = 30.155 + \underset{(3.928)}{23.501}\,(I/N) - \underset{(-13.175)}{.79046}\,\hat{P}^w_r - \underset{(-5.834)}{1.0783}\,\frac{S^d_r}{N} \quad \ldots . \quad (3)$$

where Q^w_r, (I/N), and $\hat{P}^w_r$ are as defined earlier and where $\frac{S^d_r}{N}$ is the per capita July 1 inventory level of canned red salmon in the hands of distributors, measured in standard cases per thousand persons. The numbers in parentheses are t-statistics and the R^2 statistic is .985. The estimated price and income elasticities are -4.8 and 1.20, respectively.[28]

With these results one is tempted to shout "Eureka" and wait for additional data to test the hypothesis that equation (3) is the wholesale demand for canned red salmon. However, with so few observations, caution is advised. For example, no measure of substitutes for canned red salmon appears in the equation. Thus, in the next step, yet another variable is introduced into the model: wholesale pink prices. Since pink prices are determined in a market similar to the market for canned red prices, a price-predicting equation is used to generate values for this variable.[29]

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[27] See Appendix Table III.

[28] Re-introducing the tuna price variable has only a small impact on the coefficients of the other variables. The standard error of the estimated coefficient on the tuna price variable is high.

[29] The equation is

$$P^w_p = 47.678 - \underset{(-6.475)}{.01574}\,S^c_p - \underset{(-3.359)}{.00413}\,K_r - \underset{(-5.043)}{.00459}\,K_p - \underset{(-3.120)}{.00739}\,S^c_r \quad \ldots . \quad (4)$$

where K_r, K_p, and S^c_r are defined as before. The dependent variable, P^w_p, is the December wholesale price of a standard case of pink salmon, deflated by the wholesale price index; S^c_p is July 1 canners' stocks of canned pink salmon. All quantity variables are measured in thousands of standard cases. Numbers in parentheses are t-statistics and the R^2 value for the equation is .948.

Postulating that distributors may substitute canned pink salmon for canned red salmon if prices of the former become relatively inexpensive, it can be expected that the consumption and pink price variables would be positively related at given values of the other variables. While the results of the analysis are consistent with these expectations, the t-statistic associated with the coefficient on the pink price variable is low.[30/]

Inspection of these results reveals the income and pink price variables to be highly intercorrelated (r = .96). When the equation is re-run without the income variable the t-statistic associated with the estimated coefficient on the pink price variable rises substantially.[31/] This suggests that in the earlier models, perhaps the income variable is serving as a proxy for the wholesale price of canned pink salmon. When the red price is deflated by the price of pinks, the results give additional support to the "proxy" notion[32/] and, in fact, yield a negative income coefficient whose standard error is relatively low.

These results may be associated with having so few observations. Work is under way to increase the number of observations by dividing the marketing year into sub-periods. Hopefully, this will help reduce the intercorrelation problem. Preliminary results suggest that the wholesale demand

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30/ The estimated equation is:

$$\frac{Q^w_r}{N} = \underset{}{29.767} + \underset{(1.366)}{17.321}\,(I/N) - \underset{(-11.495)}{.78636}\,\hat{P}^w_r - \underset{(-3.807)}{.98962}\,\frac{S^d_r}{N} + \underset{(.577)}{.071367}\,\hat{P}^w_p \quad . \quad (5)$$

where Q^w_r, (I/N), $\hat{P}^w_r$, and S^d_r are defined as before and where $\hat{P}^w_p$ is the predicted December wholesale price of canned pink salmon, deflated by the Wholesale Price Index (1967 = 100) and measured in dollars per standard case. Numbers in parentheses are t-statistics and the R^2 value is .987.

31/ The estimated equation is

$$\frac{Q^w_r}{N} = 29.502 - \underset{(-10.470)}{.75041}\,\hat{P}^w_r - \underset{(-3.213)}{.79795}\,\frac{S^d_r}{N} + \underset{(2.850)}{.21413}\,\hat{P}^w_p \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad . \quad (6)$$

$R^2 = .975$

32/ The estimated equation is

$$\frac{Q^w_r}{N} = 42.579 - \underset{(-2.092)}{47.681}\,(I/N) + \underset{(.019)}{.014318}\,\frac{S^d_r}{N} - \underset{(-2.717)}{16.271}\,(\hat{P}^w_r - \hat{P}^w_p) \quad . \quad . \quad . \quad . \quad (7)$$

$R^2 = .739.$

for canned red salmon may shift over the marketing season, but further testing of this hypothesis will require a different specification of economic relationships than have been used so far. It is instructive to reconsider the earlier statement regarding the expected impact of an increase in landings of red salmon. In discussing equations (1a) and (2b) (in Section V A) it is argued that larger red packs would be associated with increases in the total receipts at wholesale generated by sales of canned red salmon. When pink prices are included explicitly in the model, as in equations (4) and (5), the following result emerges: a 10 percent increase in the pack of canned red salmon is associated with a 1 1/2 percent decrease in the (deflated) December wholesale price of red salmon and a 1 3/4 percent decrease in the (deflated) December wholesale price of pink salmon.[33/] The impact of the red price change would, in turn, be a 7.2 percent increase in purchases of red salmon at wholesale while the impact of the pink price change would be a .6 percent decrease in red salmon purchases.[34/] Thus, even when the effects of changes in the pink price are included explicitly, the net effect of an increase in the pack of red salmon (when calculated at the mean values of the relevant variables) appears to be an increase to wholesalers in total receipts from the sale of red salmon (where prices are deflated by the wholesale price index).

Here is where the analysis stands. A seasonal demand analysis is being conducted and a study of impacts of changes in the export markets and in the markets for fresh salmon, has begun. New data are becoming available. The next progress statement should report on results of testing the hypotheses generated here.

33/ From equation (4) $\frac{\partial P_p^w}{\partial K_r} \cdot \frac{\bar{K}^r}{\bar{P}^w} = -.174$.

34/ From equation (5), the direct- and cross-price elasticities are -4.82 and .341, respectively.

Table A-1: The Proportion of Total Salmon Landings That were Marketed in the Canned Form for the Period 1960-1970

Year	Quantity of landing	Quantity of pack	Difference	Percentage Pack is of landings
		Millions of Pounds		
1960	235.4	207.1	28.3	88.0
1961	310.4	270.1	40.3	87.0
1962	314.6	277.7	36.9	88.3
1963	294.2	240.7	53.5	81.8
1964	352.3	274.6	77.7	77.9
1965	326.9	265.5	61.4	81.2
1966	387.7	318.3	69.4	82.1
1967	218.2	151.4	66.8	69.4
1968	329.6	251.9	77.7	76.4
1969	246.2	186.4	59.8	75.7
1970	410.1	279.2	130.9	68.1
Average	311.4	247.5	63.9	79.5

Note: To convert a pound of canned salmon to a representative pound of salmon at landing, a factor of 1.522 is used. This factor was found to be reliable by the Bureau of Commercial Fisheries.

SOURCES: [2, 1960-1968 and 20, NO. 5300 and No. 5600].

Table A-II: Data Used in Equations 1a, 2a, and 2b

Year (July 1-June 30)	Average of December wholesale prices for canned red salmon (dollars per standard case of 48 one-pound cans, deflated by Wholesale Price Index, 1967 = 100)	Annual pack of canned red salmon (data converted to standard cases of 48 one-pound cans)	Annual pack of canned pink salmon (data converted to standard cases 48 one-pound cans)
1964	$ 41.18	777,000	1,940,000
1965	37.27	2,041,000	950,000
1966	36.07	1,386,000	2,069,000
1967	39.00	863,000	616,000
1968	40.00	715,000	1,842,000
1969	42.25	881,000	1,261,000
1970	37.14	1,831,000	1,340,000
1971	39.43	1,379,000	1,194,000

Year (July 1-June 30)	Canner's stocks of canned red salmon on July 1 (data converted to cases of 48 one-pound cans)	Disappearance of canned red salmon (data converted to standard cases of 48 one-pound cans)	Population as of the the end of the marketing year (in units of 1000 people)
1964	121,700	843,900	193,162
1965	54,800	1,469,579	195,468
1966	626,221	1,408,521	197,656
1967	603,700	1,022,800	199,721
1968	443,900	1,017,100	201,678
1969	141,800	976,500	203,777
1970	46,300	1,567,978	206,017
1971	309,300	1,452,722	208,698

Year (July 1-June 30)	Retail price in costs of a 6 1/2 oz. can of tuna as of October and deflated by CPI where 1967 = 100)	Personal disposable income (measured in billions of dollars and deflated by CPI where 1967 = 100)
1964	34.77	535.5
1965	33.97	570.3
1966	36.73	603.7
1967	34.30	629.4
1968	33.49	661.1
1969	33.06	683.9
1970	35.86	693.3
1971	36.36	710.1

SOURCES: [2], [3], [4], [5], [6], [9], [12], [19], [20], [21], [22].

Table A-III: Additional Data Used in Equations (3) to (7)

Year (July 1-June 30)	Average of December wholesale prices for canned pink salmon (dollars per standard case of 48 one pound cans, deflated by Wholesale Price Index, 1967 = 100)	Distributors' stocks of canned red salmon on July 1 (data connected to standard cases of 48 one pound cans)
1964	$22.70	—
1965	27.95	37,285
1966	27.55	318,451
1967	29.50	192,528
1968	30.37	209,049
1969	31.45	70,114
1970	32.60	61,726
1971	31.63	199,392

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