Final Report

An Economic Analysis of the Market for Maine Sea Urchins

Submitted to:

State of Maine
Department of Marine Resources

Principal Investigators:

James E. Wilen, Ph.D.
Department of Agricultural and Resource Economics
University of California
Davis, California 95616

Cathy R. Wessells, Ph.D.
Department of Environmental and Natural Resource Economics
University of Rhode Island
Kingston, RI 02881

March 3, 1997

Table of Contents

		Page
List of Figures		iii
List of Tables		v
I.	Introduction	1
	A. Focus and Charge of the Study	1
	B. Questions Addressed	2
II.	Background - The World Market for Sea Urchin	4
	A. History of Japanese and U.S. Sea Urchin Fisheries	4
	B. World Landings of Sea Urchin	9
III.	Market Mechanisms -- Determinants of Maine Sea Urchin Prices	14
	A. Derived Demand and Vertical Price Transmission	14
	B. Determinants of Markups	19
	C. Foreign Exchange Markets, Transmission Speed, and Market Power	23
IV.	The Japanese Market	26
	A. The Japanese Retail Market	26
	B. The Japanese Wholesale Market	32
	C. Shipping, Handling, and Import Transactions	40
V.	Processing and Harvesting -- The U.S. Industry	43
	A. Processing	43
	B. Harvesting	49
VI.	Summary and Implications for the Maine Industry	51
	A. Control over Quality	53
	B. Control over Quantity	57
	C. Summary	59

Table of Contents (cont'd)

	Page
References	62
Appendix A -- Summaries of Sea Urchin Regulations	65
Appendix B -- Additional Figures	69
Appendix C -- Tables of Data Used in Figures	74

List of Figures

	Page
Figure 1. Japanese Landings of Sea Urchin, 1956 - 1993	5
Figure 2. California Landings of Sea Urchin, by Area	7
Figure 3. U.S.- Japan Exchange Rate, $/100Yen	8
Figure 4. U.S. Sea Urchin Landings by Coast, 1984 - 1993	10
Figure 5. California and Maine Landings of Sea Urchin, 1987 - 1995	11
Figure 6. Derived Demand for Urchin Roe: Fundamental Forces and Market Linkages	16
Figure 7. Japanese Household Monthly Disposable Income and Food Expenditure, 1994	17
Figure 8. Determinants of Markups	20
Figure 9. Japanese Retail Sea Urchin Markets: Raw Product Attributes and End Uses	27
Figure 10. Tokyo Central Wholesale Market Prices for Domestic vs. Imported Fresh Sea Urchin Roe, 1990 - November 1996	34
Figure 11. Tokyo Central Wholesale Market Prices for Domestic and Imported Fresh Sea Urchin Roe - 1996	36
Figure 12. Tokyo Central Wholesale Market Quantities of Sea Urchin Roe Sold by Source - 1996	37
Figure 13. Total Quantity of Fresh Sea Urchin Roe Sold at Tokyo Central Wholesale Market, 1982 - 1996	38
Figure 14. Fresh/Chilled Sea Urchin Roe: U.S. Export Prices (fas) vs. Japanese Import Prices (CIF)	42
Figure 15. U.S. Exports of Fresh/Chilled Sea Urchin Roe, by Port of Departure, 1994 and 1995	47

List of Figures (cont'd)

	Page
Figure 16. U.S. Exports of Live Sea Urchin, by Port of Departure, 1994 and 1995	48
Figure 17. U.S. Export Prices (fas) to Japan for Fresh Sea Urchin Roe, by Port of Departure, 1991 - 1995	55
Figure 18. U.S. Export Prices (fas) to Japan for Fresh Sea Urchin Roe, by Port of Departure, 1991 - 1995	56
Figure B1. World Landings of Sea Urchin (*Strongylocentrotus spp.* and *Loxiechinus albus*) by Major Country and Area, 1984 - 1993	70
Figure B2. Japanese Imports of Fresh/Chilled Sea Urchin Roe, by Major Source - 1995	71
Figure B3. Annual Japanese Imports of Fresh/Chilled Sea Urchin Roe from All Sources, 1988 - 1995	72
Figure B4. Japanese Imports of Sea Urchin, by Product Type, 1988 - 1995	73

List of Tables

	Page
Table 1. Japanese Imports of Sea Urchin, by Volume	12
Table 2. Annual TCWM Prices for Fresh/Chilled Sea Urchin Roe, 1986 - 1996	33
Table 3. Japanese Tariffs for Sea Urchin Products, 1995	41
Table A1. Sea Urchin Harvesting Regulations (Size Regulations)	68
Table C1. World Landings of Sea Urchin, *Stronglycentrotus spp.*	75
Table C2. Japanese Sea Urchin Landings, 1956 - 1993	76
Table C3. Sea Urchin Landings in Northern and Southern California, 1972 - 1995	77
Table C4. Japanese - U.S. Exchange Rates	78
Table C5. U.S. Landings of Sea Urchin, by Coast 1984 - 1993	79
Table C6. Sea Urchin Landings by State	80
Table C7. Japanese Household Monthly Disposable Income and Food Expenditure	81
Table C8. Tokyo Central Wholesale Market prices for Domestic vs. Imported Fresh Sea Urchin Roe, 1990 - 1996	82-83
Table C9. Prices and Quantities Sold of Fresh Sea Urchin Roe, Imported vs. Domestic, on the Tokyo Central Wholesale Market, 1996	84
Table C10. Total Quantities of Fresh Sea Urchin Roe Sold in TCWM, 1982 - 1996	85
Table C11. Japanese Nominal Import Prices (CIF) and U.S. Nominal Export Prices (Fas) for Fresh Sea Urchin Roe, 1991 - 1994	86
Table C12. U.S. Exports of Fresh Sea Urchin Roe and Live Sea Urchins to Japan, by Port of Departure, 1994 & 1995	87
Table C13. U.S. Exports of Fresh/Chilled Sea Urchin by Port of Departure, 1991 - 1994	88

I. Introduction

A. Focus and Charge of the Study

This study summarizes the results of an investigation of the market for Maine's sea urchins. The study has been conducted over a period of several months. We examined a wide range of published and unpublished descriptive sources of information. We also compiled an extensive data base from both English and Japanese language sources. In addition, we interviewed processors and buyers on both coasts of the U.S. and interviewed Japanese wholesale buyers.

The terms and general focus of this study were laid out primarily in the Request for Proposals (RFP) issued by Maine's Department of Marine Resources in the Fall of 1995. After submitting a proposal for competitive review, ours was selected, a contract was drawn up and funds encumbered as of December 27, 1995. Work began the first part of January and a rough draft was completed July 1996. Comments and additional queries were received in October 1996 and the final draft was submitted March 3, 1997. The original contract provides guidelines for the tasks performed in this study. The primary goal has been to describe the mechanisms which determine and influence prices and the market structure in the sea urchin market. Included in this description is an analysis of the complete marketing chain, from harvest to final consumption, focusing on the determinants of transactions and product flow, including quality, volume, seasonal factors, and other economic forces.

To accomplish the goal of this study we have undertaken several specific tasks. First, we have conducted a thorough analysis and description of the Japanese market for sea urchin roe and roe products, at both the retail and wholesale level. Second, we have examined how quality attributes affect prices in the Japanese market. Third, we have examined trends and conditions

associated with current sources of worldwide sea urchin supply and trade in sea urchin products. Fourth, we have examined how transactions are conducted in the chain connecting Japanese wholesalers with raw product suppliers, documenting where charges are incurred and how transactions are typically made between agents at various stages in the chain. Fifth, we have examined processing practices and costs, paying particular attention to raw product quality and steps taken to encourage high quality. Finally, we have also examined the harvesting sector and links between the harvesters and processors.

B. Questions Addressed

During the project proposal stage, we focused on several fundamental questions that we expected to answer during the research phase of the project. Some of the more important questions we focused on included:

- What are the fundamental forces driving the market for sea urchins worldwide? In the U.S. as a whole? In Maine particularly?

- How does the market for sea urchin operate? What factors promote strong demand and higher prices? How is the influence of these factors transmitted down the chain from the retail market to the market for raw product (ex-vessel market)?

- What role does raw product quality play in the sea urchin market? What are the most important attributes of quality? How is quality translated into price in the marketing chain?

- What activities are conducted and what costs are incurred during conversion from raw product to finished retail product, and how do these affect the markup between various stages of the product chain?

- How do other producing entities impact the market? What similarities and differences exist between their conduct in the market and Maine's? What factors affect quality of raw product from other suppliers and what steps have they taken to promote a high-valued and sustainable industry?

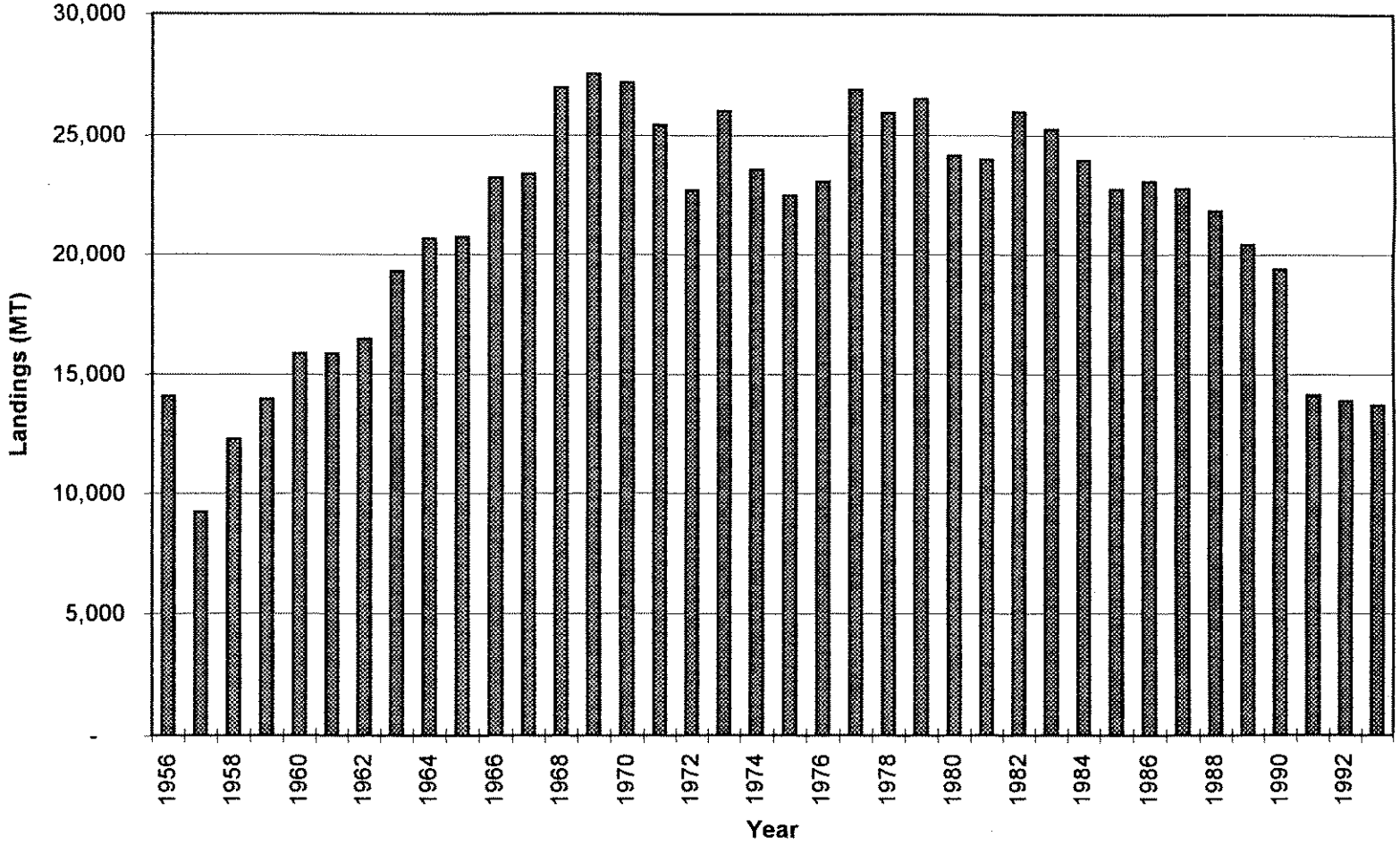
II. Background--The World Market for Sea Urchin

A. History of Japanese and U.S. Sea Urchin Fisheries

Japan has been both the world's largest consumer of sea urchins and the world's largest supplier for most of the industry's history. From its beginnings in the early 1950s, Japan's industry grew steadily until landings of approximately 25,000 metric tons were reached. Figure 1 shows that throughout the late 1960s until the early 1980s, Japanese landings were sustained at a level which fluctuated between 22 and 27 thousand metric tons. In the late 1980s, Japanese landings of domestically harvested urchins began a precipitous and steady decline, reaching recent lows of about 13,000 metric tons (FAO, various years). This decline in domestic landings in turn led to a rather dramatic change in the world market by increasing Japanese demand for alternative supplies of urchin worldwide. In this manner, Japan switched from being nearly self-supporting to becoming a significant importer of sea urchins during the last decade. The first Japanese imports were from the Republic of Korea, and consisted of sea urchin pickled in salt or alcohol. This was followed by shipments of raw sea urchin from the Republic of Korea, and in 1983 air shipments from North America began (JETRO, 1990). The United States has been the chief beneficiary of this strong Japanese demand, with industries on both coasts responding by developing new fisheries.

California began developing a sea urchin industry in the early 1970s, based on the abundant supplies of red sea urchin (*Strongylocentrotus franciscanus*) found mainly near the Channel Islands off Los Angeles. In the 1960s urchins were considered "pests" by many divers because they feed on kelp and compete with valuable abalone for habitat. Recreational divers were encouraged to eradicate urchins during this early period, and kelp harvesters used quicklime

Figure 1. Japanese Landings of Sea Urchin, 1956 - 1993



Source: Ministry of Agriculture, Forestry and Fisheries, various years

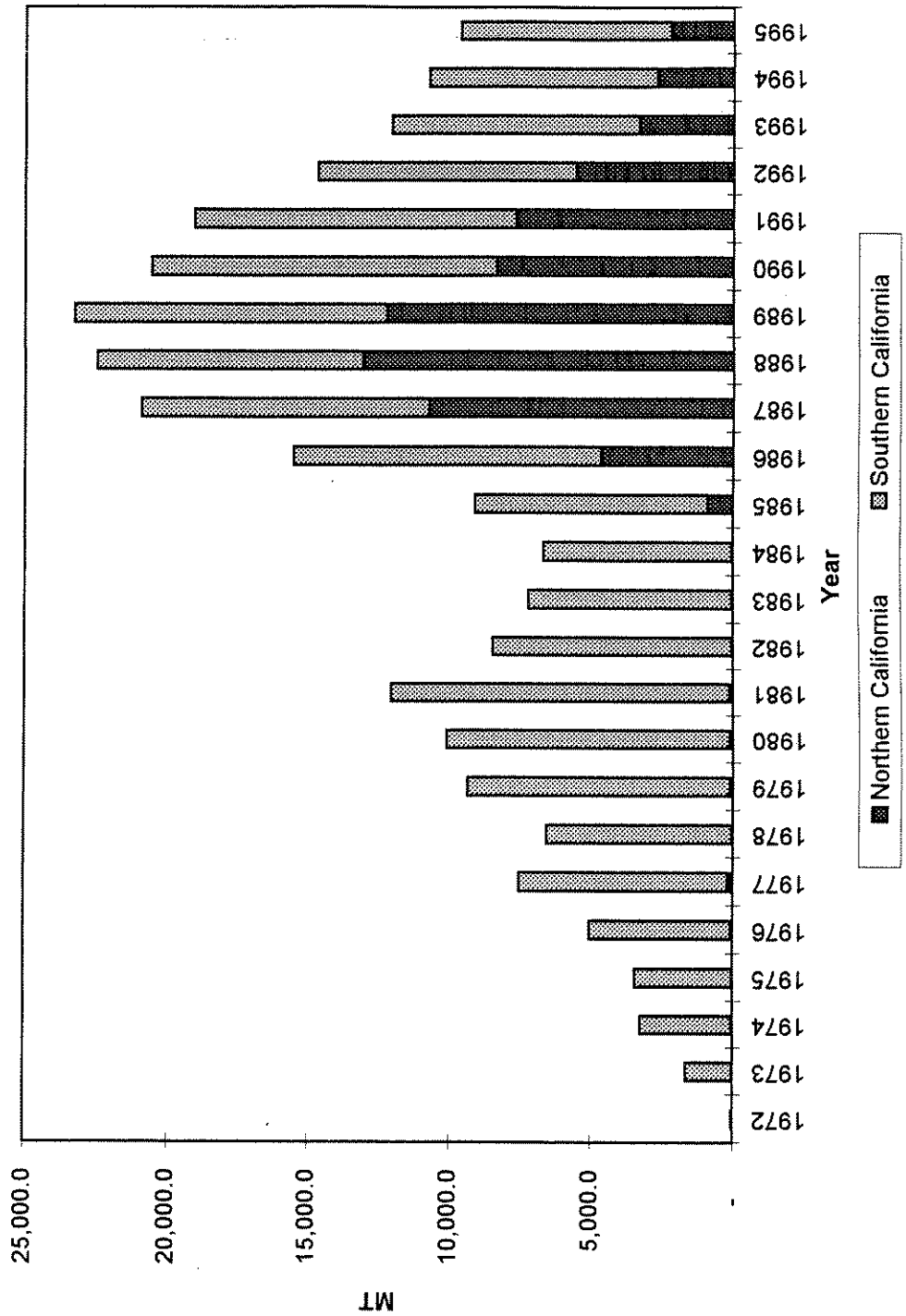
to control urchins in leased kelp beds. In the late 1960s, as Japanese businesses began to develop in Southern California, restaurants and sushi bars began to cater to Japanese culinary demands. During this early period, small volumes of urchin were harvested in order to supply sea urchin roe, *uni,* to these restaurants. During this early period, several processors in Southern California with channels to the Japanese market began experimenting by exporting small volumes of frozen roe and live urchins to Japan. The first major processor in Los Angeles began to export at commercial levels in 1972. Throughout the 1970s landings in Southern California grew slowly, reaching 10,000 metric tons of whole urchins by the end of the decade (see Figure 2). In 1980, Japan reportedly imported something less than 1,000 metric tons of sea urchin products from the U.S., valued at about US$10 million, and mostly produced from the waters of Southern California.

When the Japanese domestic sea urchin fishery began to collapse in the 1980s, the market for U.S. urchin took a dramatic turn as Japanese buyers looked to the U.S. and other sources for new supplies. This change in fundamental forces in the market for imported sea urchin products into Japan was augmented by the increase in the value of the yen during the mid-1980s. As the yen rose in value relative to the dollar throughout this period (see Figure 3), the increased Japanese demand for urchin was amplified in U.S. dollars, and ex-vessel prices rose dramatically.

During the latter part of the 1980s, a large industry harvesting red sea urchin began off the northern coast of California. Total harvest from the Northern California industry surpassed that of Southern California in 1987 (see Figure 2). The harvest from the California industry peaked in 1989 at just over 23,600 metric tons. Since then harvests have fallen rather dramatically, particularly in Northern California, where harvests have plummeted from a peak of 30 million pounds in 1988 to about 4.7 million in 1995. In 1995 total harvest from California fell to about 10,000 metric tons. Catch per unit effort has also fallen steadily in both Northern and Southern parts of the state. Currently the industry and managers are working on plans to address falling yields and total harvests.

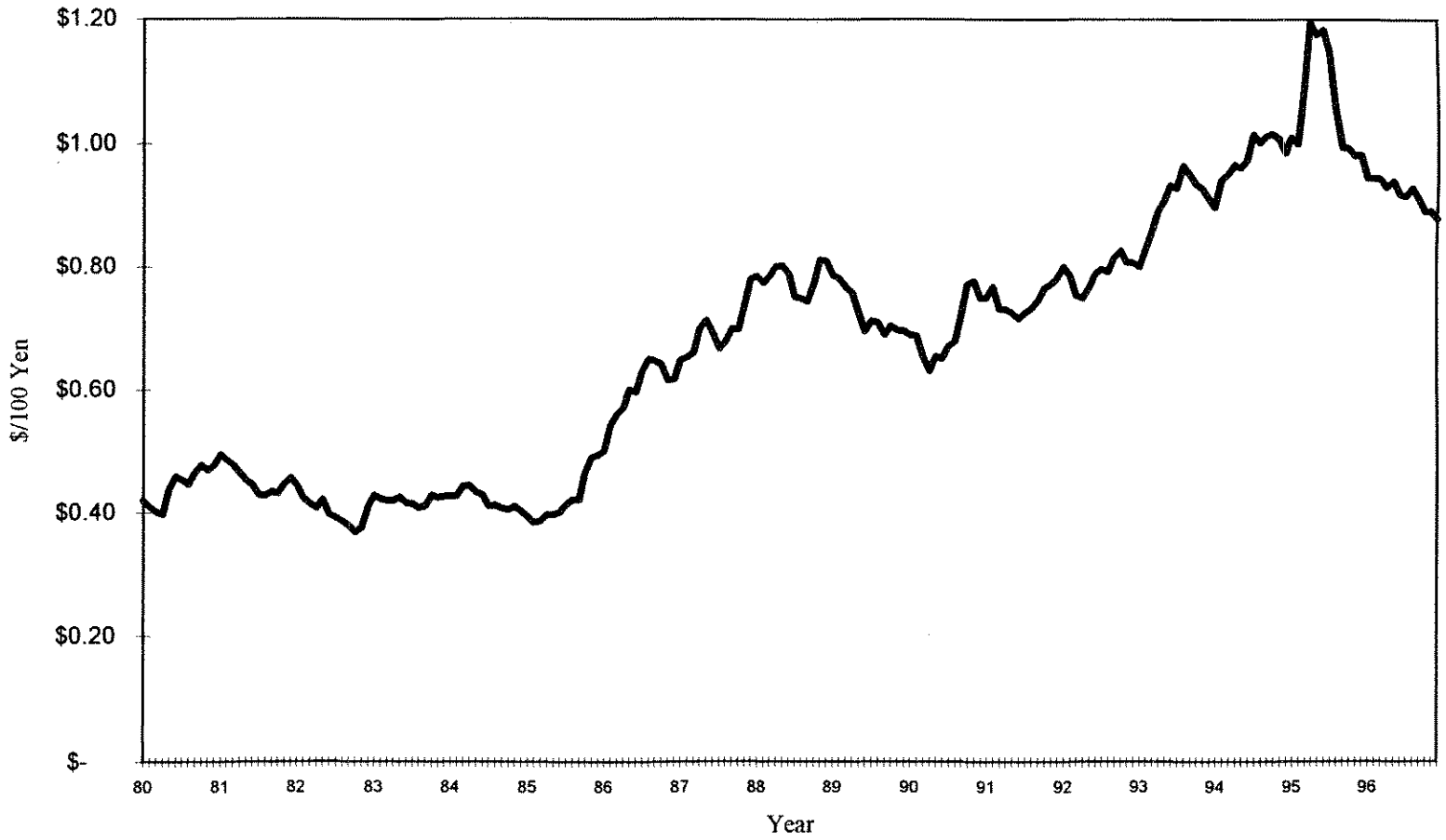
During 1987, the Maine industry also began harvesting green sea urchin

Figure 2. California Landings of Sea Urchin, by Area



Source: California Department of Fish and Game

Figure 3. U.S. - Japanese Exchange Rate $/100Yen



Source: International Monetary Fund, *International Financial Statistics,* various years

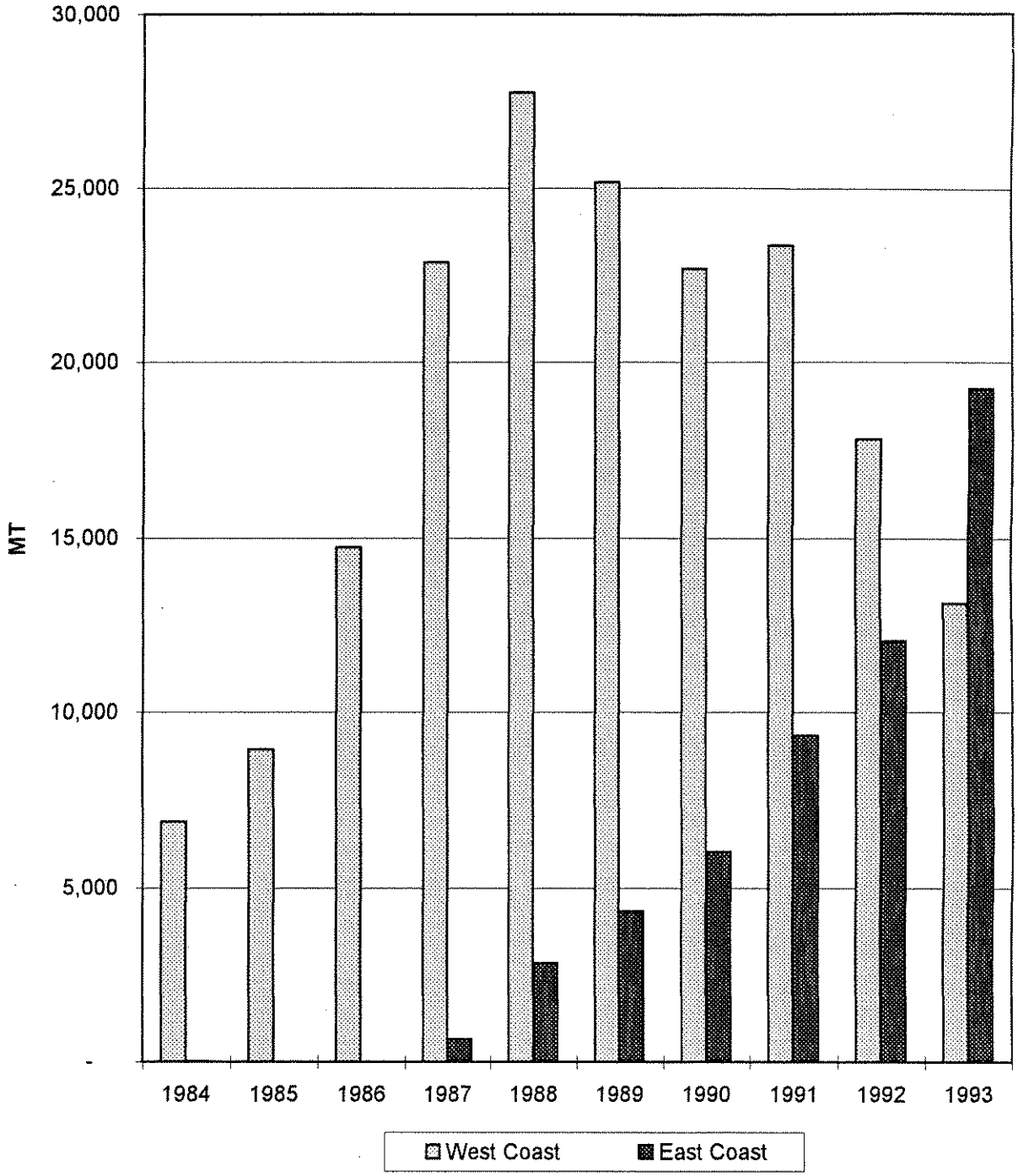
(*Strongylocentrotus droebachiensis*) on a commercial scale. Green urchin had also been harvested in smaller quantities for local ethnic markets (mainly whole urchin sold to Italy and France) for some time off the Maine coast, but in 1987 the industry began harvesting in earnest for the Japanese export market. Much like the patterns witnessed in California, Maine's industry grew at an accelerating pace, reaching a level of 18,600 tons in 1993. Figure 4 shows U.S. landings of sea urchin by West Coast versus East Coast. U.S. landings peaked in 1993 with over 32,000 metric tons. Of that amount, Maine landed approximately 58%, while California landed approximately 37% (see Figure 5). Only 5% of total U.S. landings in 1993 came from states other than California and Maine (primarily Washington, Oregon, and Massachusetts). During the early period, Maine urchins were shipped as live/whole product, but during the past few years as processing improvements have been made, most urchin have been cracked and shipped as fresh and frozen roe.

In summary, the Japanese market is the dominant force driving the worldwide market for sea urchin products. The Japanese consume virtually all of the world's sea urchin. Sea urchin supplies have historically come from the Japanese domestic industry, and more recently from a growing mix of foreign sources. During the 1980s, a dramatic shift in the market occurred as Japanese domestic production fell, the value of the yen rose, and supplies from other sources responded to lucrative marketing conditions. By the early 1990s, Japan's position as dominant harvester and supplier of its own sea urchin market had experienced a dramatic turnabout. In 1993, for example, the U.S. harvested 32,369 metric tons, or 40%, of the world's sea urchin whereas Japan harvested only 16%, compared with 15% and 51%, respectively, in 1984, just 9 years before. In 1994, the volume of imported roe passing through the important Tokyo Central Wholesale Market was four times the volume of domestic roe.

B. World Landings of Sea Urchin

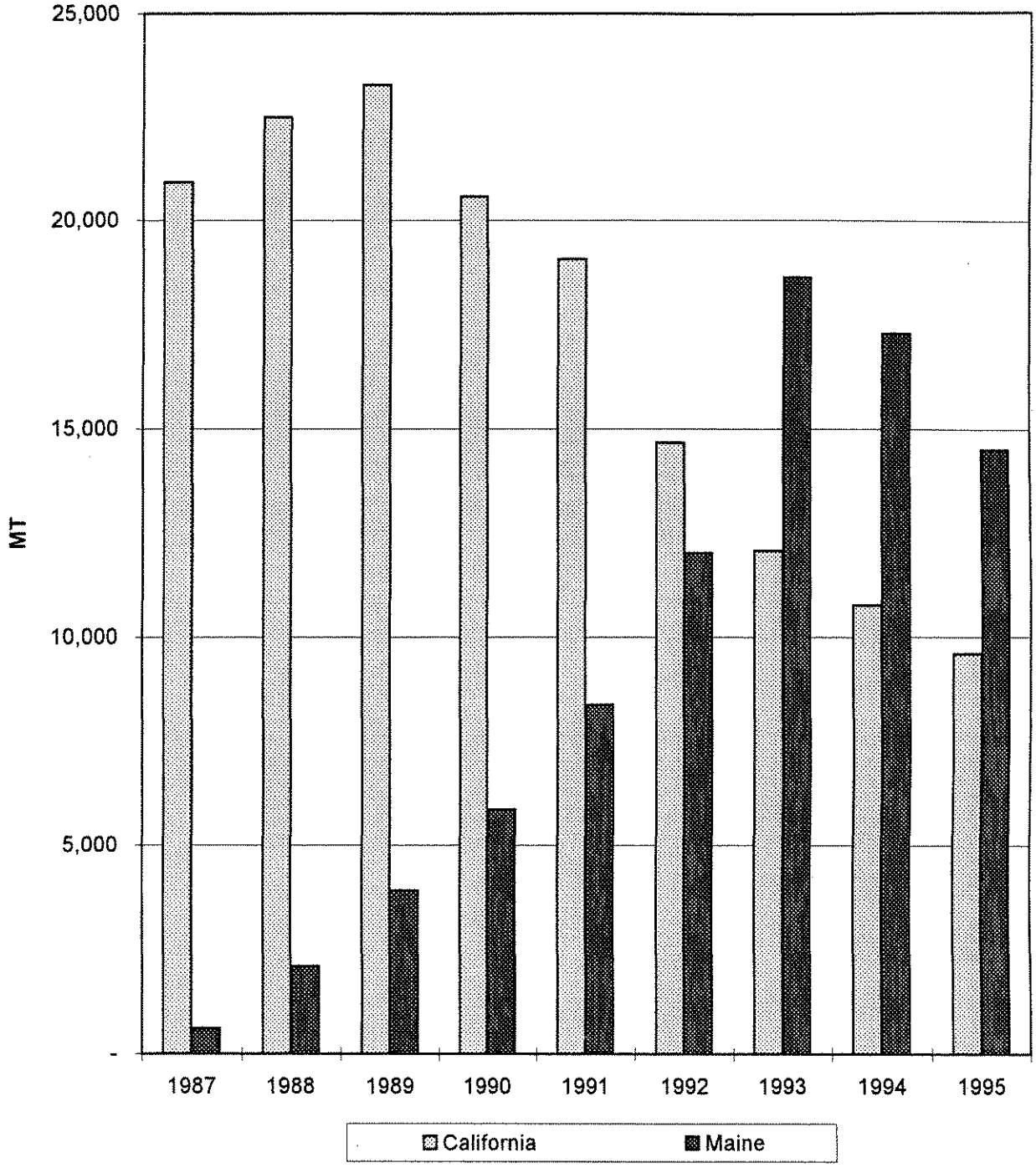
There are currently five countries with significant landings of sea urchin (see Appendix Table C1). In 1993, the United States and Chile produced about 30,000 metric tons each, followed by Japan with 13,000, and the former Soviet Union with 2,000. The U.S. dominates

Figure 4. U.S. Sea Urchin Landings, by Coast, 1984 - 1993



Source: FAO, *Yearbook of Fisheries Statistics, Catches and Landings*, 1993

Figure 5. California and Maine Landings of Sea Urchin, 1987- 1995



Source: California Department of Fish and Game; Maine Department of Marine Resources

the live and fresh roe export market, shipping virtually all of its harvest of fresh roe and fresh whole urchin to Japan (Japan Marine Importers Association, various years). The closest competitor for the Japanese market in this product form is Canada, which in 1995 had exports to Japan worth about one-seventh that of the U.S. (Table 1). In 1995, the U.S. shipped over 3,300 metric tons of live fresh and sea urchin roe to Japan, with a total value of over US$170 million. Canada shipped over 400 metric tons, worth about US$20 million. As Table 1 shows, Japan also imports urchin products other than fresh urchin roe, including frozen roe (dominated by Chile), and dried and salted roe (dominated by North and South Korea).

Table 1. Japanese Imports of Sea Urchin, by Volume (Metric Tons)

	1991	1992	1993	1994	1995
			Fresh/Chilled Roe		
U.S.	2,046	2,032	2,587	3,129	3,373
Korea, S.	513	529	541	440	386
Canada	397	555	367	387	439
Chile	44	47	147	285	364
China	60	129	223	259	238
			Frozen		
Chile	143	242	465	429	830
Canada	158	227	137	147	118
U.S.	344	254	229	98	101
Korea, N.	85	70	27	18	24
			Dried or Salted Roe		
Korea, N.	198	205	228	298	249
Korea, S.	260	300	254	286	231
China	148	113	127	93	99
Philippines	50	62	61	37	36
Chile	19	28	50	34	34

Source: Japan Marine Importers Association

During the past couple of years, the U.S. has also begun to export raw product transhipped from both Canada and Chile. Maine processors receive Canadian raw product just as California

processors receive Chilean product which they process, package, and export to Japan. In the sections to follow, the Japanese market is described in more detail and mechanisms determining how Japanese prices are transmitted to world markets are discussed.

III. Market Mechanisms -- Determinants of Maine Sea Urchin Prices

A. Derived Demand and Vertical Price Transmission

As outlined above, the driving forces behind both current conditions and the evolution of the U.S. sea urchin industry reside in the Japanese market, since Japan consumes most of the world's production. A sensible first step towards understanding the whole chain from the Japanese market to harvesters and processors in Maine is thus to begin with the Japanese market. When economists examine markets for raw products like corn, they point out that the demand for these raw products is actually a "derived demand." By derived demand economists mean that the strength of the demand for the input is itself "derived" from the strength of the demand for the product that it produces. Thus, for example, if the demand for final products such as cereal rises due to (for example) health concerns, then so will the demand for the raw corn input, as well as various other inputs such as seed corn, fertilizer, water, farm land, *etc*. The important point is that fluctuations and trends in farmers' incomes are driven and derived in an important sense from fluctuations and trends in the market for the final product. As the market for the final good changes, so too will the market for the inputs that go into producing that good, including the market for the raw product itself.

The market for a raw product like sea urchin is no different in principle from that for corn or other agricultural raw products including beef, chicken, fruits and vegetables. In the same sense, if we are interested in what determines prices received by Maine harvesters and processors, we must look to the fundamental forces operating in the Japanese domestic consumer food market which drives the demand for these raw products, including sea urchin roe itself. These forces, and

the chain which links them to dockside or ex-vessel prices in Maine, are depicted in Figure 6. One important factor affecting the ultimate price received in Maine, of course, is simply the size of the market, related to total population and population growth in Japan. Japan is the world's largest consumer of fish and fish products and the largest importer of products from suppliers all over the world. Japanese per capita fish consumption is among the highest in the world, reflecting a long history of a nation dependent upon its marine resources for much of its protein (USDC, 1995).

Markets are driven by effective, or monetized demand, and hence the strength of this market will also be affected by economic factors such as average per capita income of Japanese consumers. As average incomes rise, as they have in Japan particularly over the last decade, we expect Japanese consumers to purchase more of some goods, particularly those that have a special or "luxury" status. The extent to which rising population and rising average incomes affect specific food demands also depends upon other important structural forces operating in any economy such as demographics, number of women in the work force, receptiveness to food trends, and advertising and media information, among other things.

In addition to these background forces which drive food demand in general and specific good product demands in particular, the relative prices of specific products also affect food demand. When prices of products rise we expect that to have a dampening effect on the growth in food demand. Similarly, when the prices of products that Japanese consumers regard as substitutes for particular products fall, we expect there to be a shift away from the product in question towards the cheaper substitutes.

Finally, for some products there are historical traditions and customs which influence demand on a seasonal basis. The Japanese market is heavily influenced by special holidays during which consumers celebrate by eating certain traditional foods. In addition, during some of these same holidays, Japanese purchase gifts and distribute them to individuals who are important in their lives. Both factors result in some seasonality in demand, during which there are "spikes" in market strength. Figure 7 shows the spike in food expenditure that occurred in December 1994

Figure 6.
Derived Demand for Urchin Roe:
Fundamental Forces and Market Linkages

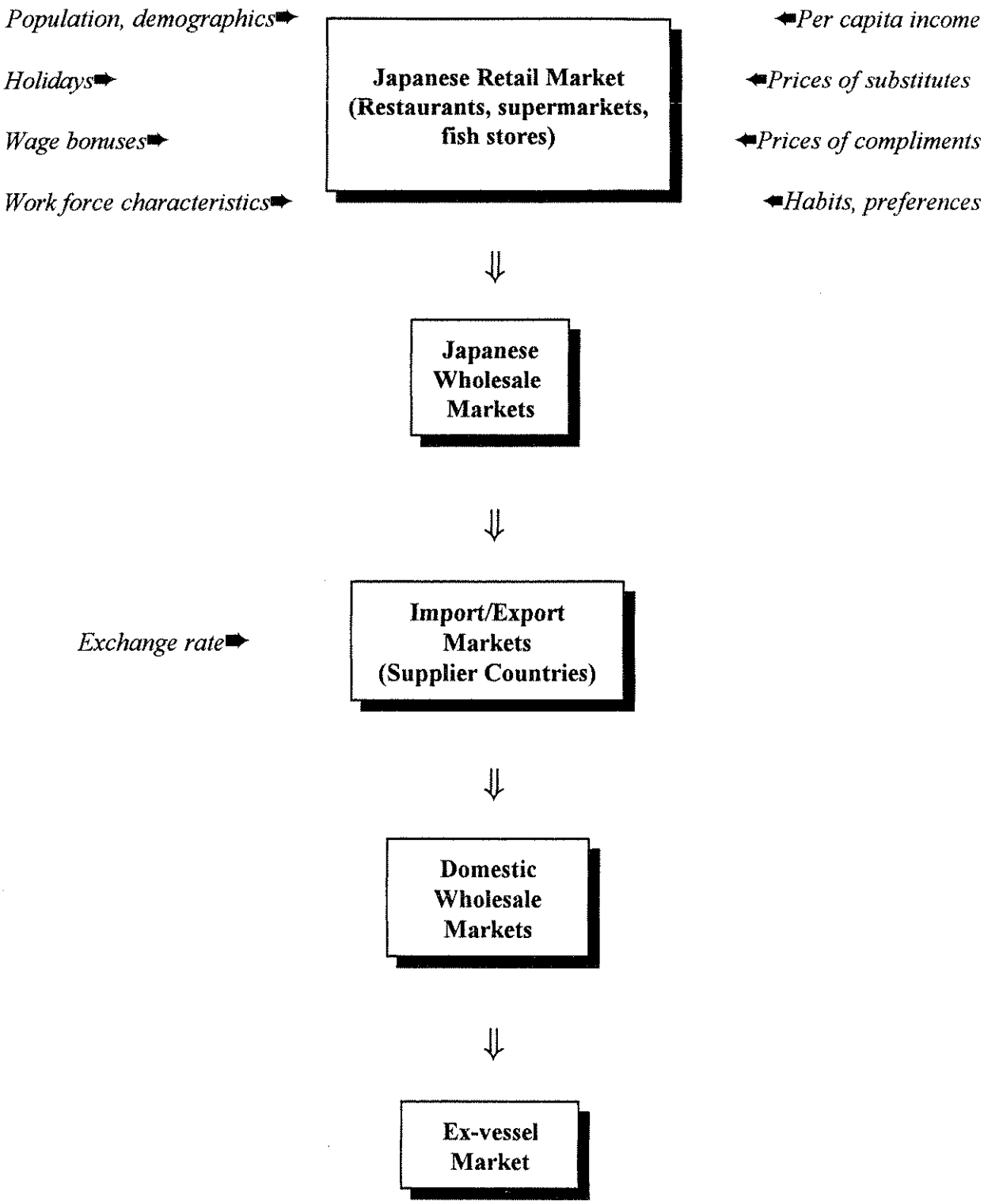
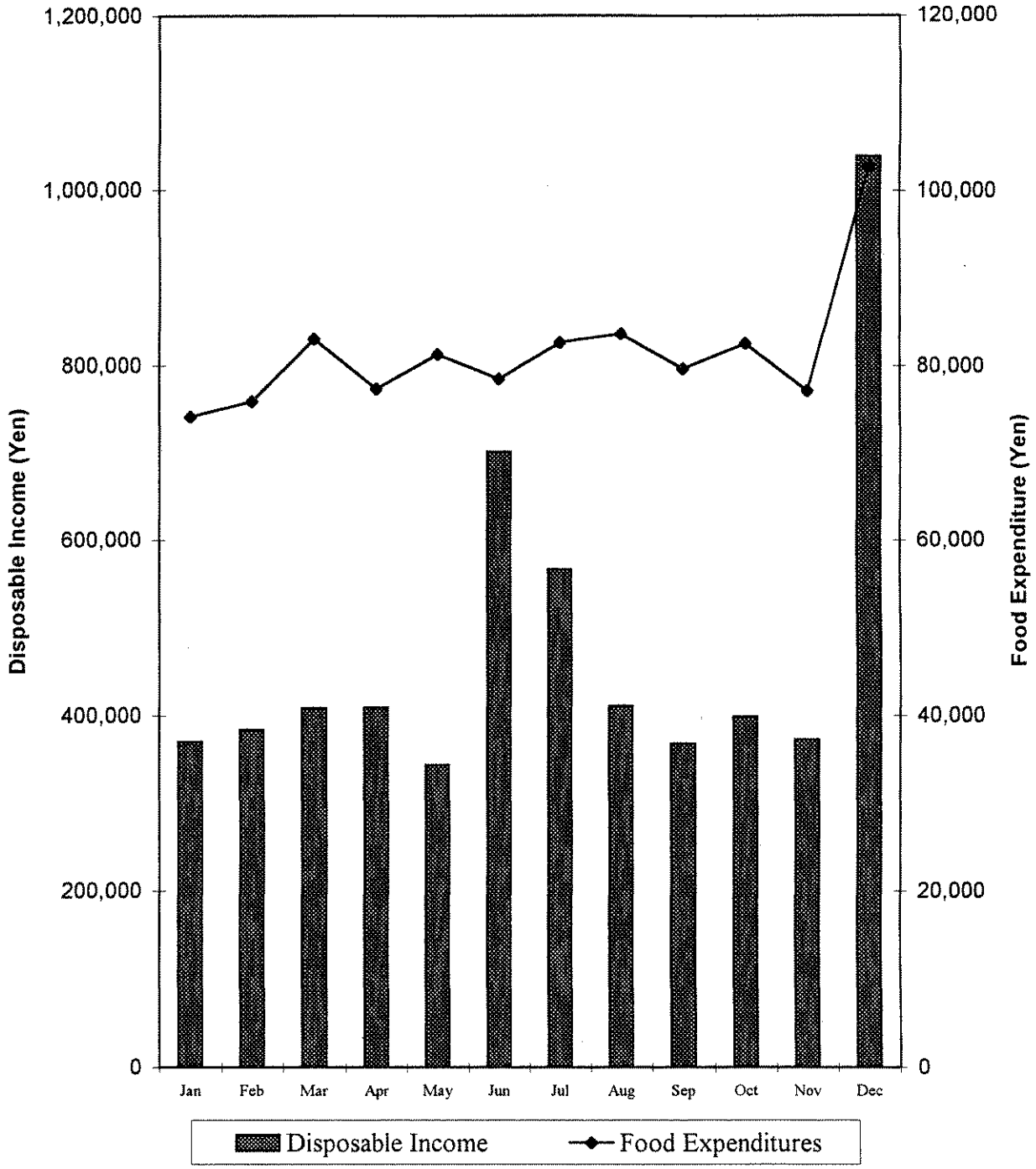


Figure 7. Japanese Household Monthly Disposable Income and Food Expenditure, 1994



Source: Japan, *Annual Family Income and Expenditure Survey*, 1994

by households in Japan. This increase in demand for food occurs every year, reflecting the purchase of food as gifts.

These fundamental forces are expressed in the retail food sectors of the Japanese system, including large and diverse supermarkets, department stores which sell food and other products, and specialty stores such as fish markets. The retail food sector, in turn, transmits the strength of these forces, and short- and long-term changes in them into secondary markets. These secondary markets include: important regional wholesale fish markets such as the Tokyo Central Wholesale Market (TCWM), which are located near consumer centers; smaller wholesale markets located near domestic producing areas; and, dealers who import directly and supply supermarkets without passing sales through the wholesale markets. When demand in the retail sector is strong, retailers bid wholesale prices up. Wholesalers, in turn, are marketers of supplies from various sources, including domestic fisheries and overseas fisheries. When wholesale demands are strong, wholesalers bid up domestically landed product prices and import product prices. In this sense, then, the prices that exporters in the U.S. and other producing nations get is a derived demand also, derived in particular from wholesale markets, which in turn reflect the fundamental forces affecting demands in the Japanese retail consumer market.

It is also the case that export demand is itself affected by exchange rates. When the Japanese yen is strong *vis-a-vis* the dollar, Japanese importers bid the dollar price of U.S. exports up, and hence, even without changes in demand conditions in the Japanese retail sector, U.S. exporters may experience price changes due to exchange rate changes. For example, assume that Japanese wholesalers are willing to pay ¥1,200/lb. for sea urchin roe. If the yen - dollar exchange rate is 120 yen per dollar, then the wholesaler is willing to pay $10/lb. for that roe (¥1,200/lb. divided by 120 yen per dollar). If instead the yen had appreciated against the dollar, rising to 100 yen per dollar, then the Japanese wholesaler is willing to pay $12/lb. (¥1,200/lb. divided by 100 yen per dollar).

At the bottom end of the chain are the suppliers of the raw product itself. Harvesters receive prices for raw urchin that directly reflect the forces in the whole market chain, beginning

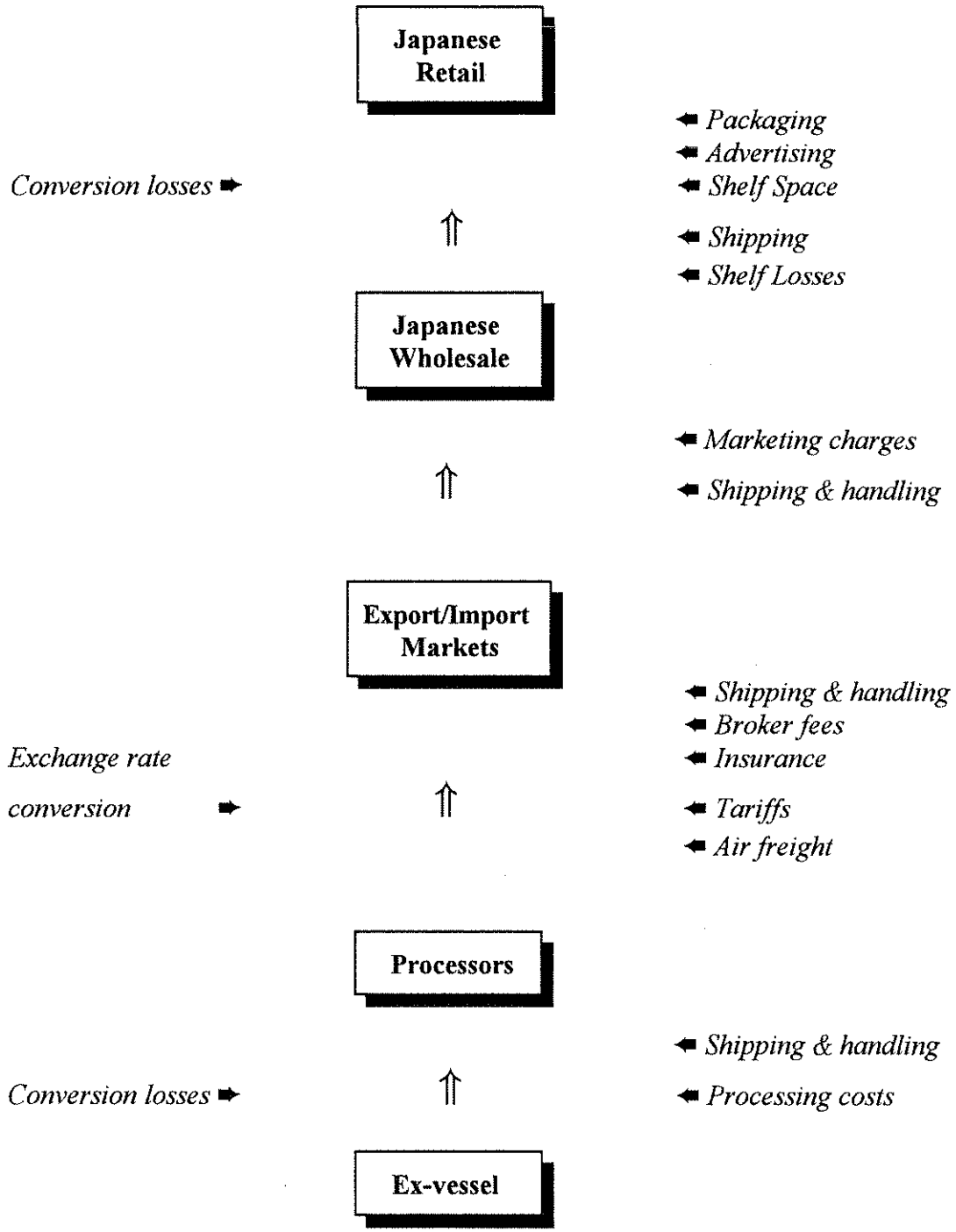
at the retail level and transmitted down through wholesale and export markets. When factors in the retail market change, this sets off a chain of market reactions which eventually reach the primary harvesters. Those forces that are positive (rising per capita incomes, rising prices of substitutes, falling prices of complementary commodities, increased value of the yen) all result in higher prices to harvesters, other things equal. The speed of these reactions and the quantitative magnitudes are in turn determined by a variety of factors to which we turn in the next two sections.

In the next section we discuss "markups" (or markdowns) which refer to the spread between prices at various levels in the marketing chain. As will be seen these are determined mostly by the cost of inputs and services provided as the raw product is converted into finished products as it moves up the chain. The speed with which market effects are transmitted up and down the chain is addressed in the following section. Transmission speed depends upon market structure, the degree of competition, the spread of information, and the nature of contractual and other informal arrangements between participants at various points on the chain.

B. Determinants of Markups

While the fundamental forces that determine raw product prices emanate in the retail sector and are transmitted down through the marketing chain, the raw product itself undergoes changes as it is transformed into final products marketed at the retail level. At each stage of the product transformation chain from harvesting to retailing, there are changes made in product form which successively translate into "value added" at each point. Value is not added without cost, of course, and hence the differences between prices at various stages must at least cover these actual out-of-pocket costs, as well as some normal profit for those responsible for the service. These costs incurred at various stages are basically the reason why we see a large spread between the price harvesters and processors receive, and the price at which a finished product is sold at the retail level. Figure 8 shows some of the charges associated with value-added spread between

Figure 8.
Determinants of Markups



handlers as successive stages of the marketing chain.

At the upper end of the product chain, closer to the point of sale to the consumer, value added is often associated with repackaging and display in the supermarket, combining with other items (*e.g.* as in a take out lunch), advertising, among other things. Often there is some waste during repackaging or shelf-life loss so that there is some conversion loss at the retail level which needs to be covered by retail prices. The important point is that value added at the retail stage is not costless. Indeed, retail prices must cover all costs (display, conversion losses, retailer profits, shelf-loss) above the wholesale input cost, and hence there is a normal "markup" associated with retail/wholesale prices.

For example, suppose that consumers are willing to buy sea urchin roe at 5,000 yen per 100 grams in the supermarket (¥50,000/kg.). Suppose also that the normal conversion loss (from trimming during packaging and from shelf loss) is about 40%, and that it costs 40,000 yen per kilogram to package, display and market roe in the retail store. Then the most that retailers could afford to pay wholesalers for raw sea urchin roe would be 0.6[(50,000-40,000)]=6,000 yen per kilogram. This is the beginning of a chain of transactions which explains why harvesters (and farmers) receive a price for the raw product which is only a fraction of the price they see charged for the finished product in the supermarket.

Retail Price		Packaging, etc		Retailer Net profit		Conversion loss		Wholesaler price
¥ 50,000/kg	-	¥40,000/kg	=	¥10,000/kg	x	(1.0 - 0.40)	=	¥6,000/kg

At the wholesale stage of the market, there are also various charges and commissions which result in markup over free-on-board (FOB), brought to the carrier for shipment, prices. Sea urchin imported into Japan is usually sold either on a consignment basis or on a direct sale basis. Direct sales involve fixed prices pre-negotiated between importers and exporters. Importers assume responsibility for shipments once on the air carrier and they pay marketing charges, shipping/handling, customs brokerage and tariffs upon landing and then sell the shipment

in the wholesale market. For sea urchin sold on a consignment basis, exporters pay import brokers a commission for handling, clearing customs, and delivering the raw product to the auction market. Once at the market, a sales commission must also be paid to cover marketing charges and fees. For Japanese sea urchin passing through the TCWM, for example, a commission is levied at the point of sale. In addition to these charges, a tariff of 9.4% is levied on the CIF value of fresh urchin roe, where CIF refers to cost, insurance and freight value. In summary, at the wholesale stage, there is further markdown of prices retailers are willing to pay, so that sea urchin landed in Japan prior to sale can only fetch a fraction of the wholesale price.

Sea urchin exported to Japan must cover airfreight charges from the point of departure in the U.S. The principal shipping points typically are: Los Angeles and San Francisco for California urchin, New York for Maine urchin, Seattle for Washington urchin, Anchorage for Alaskan urchin. Virtually all sea urchin roe is shipped via air in order to get it to the Japanese market as quickly as possible. Processors deliver shipments in the evening in order to be loaded onto late night cargo shipments to Tokyo. These flights arrive in Tokyo the following morning. There they must be cleared through customs and trucked to the TCWM, a process taking 6-8 hours. Thus, urchin roe shipped out of the U.S. arrives at the market two days after processing, at the earliest. Airfreight rates vary somewhat, but are determined mainly by volume of the shipment.

To bring the product to the FOB stage, the packaged roe or whole urchins must be shipped from the point of processing. Prior to shipping, a significant number of steps are taken which, again, add value to the raw product. At lower stages of the chain, value added comes from activities such as landing, handling, sorting and grading, and packaging the raw urchin. These processing costs are significant and they are responsible for the main share of the wedge between prices paid to harvesters and prices received by processors, adjusting for recovery factors. In addition, at the processing stage, conversion losses (or the opposite, recovery factors) are an important determinant of markup between harvester and processor. For example, suppose a processor can sell sea urchin roe to exporters at $30 per kilo and it costs $16 per kilo to crack,

brine, sort, package, *etc*. If the conversion loss is 88%, processors can afford to pay divers 0.12[30-16]=$1.68 per kilo (76 cents/lb.). On the other hand, if the conversion loss is higher, at 0.92, the price processor can pay drops to 0.08[30-16]=$1.12 (51 cents/lb.). This is why yield is such a significant issue in policy discussions on both the West and East coasts.

Processor Price		Crack, Brine, etc		Processor Profit		Conversion Loss		Diver Price
$30/kg.	-	$16/kg	=	$14/kg	x	(1.0 - 0.88)	=	$1.68/kg
$30/kg.	-	$16/kg	=	$14/kg	x	(1.0 - 0.92)	=	$1.12/kg

C. Foreign Exchange Markets, Transmission Speed, and Market Power

As the above discussion suggests, an understanding of ex-vessel prices in Maine must begin with an understanding of forces operating in the Japanese market. We have reviewed forces that are demand determinants; that is, that cause either sustained or periodic changes in aggregate retail consumer demand. Some of the former include population growth, demographic changes, and per capita income; some of the latter include holidays and gift giving, and wage bonuses. The other side of the picture is the supply of sea urchin, of course. For products that are perishable, fluctuations in supplies should cause changes in market prices. Since the bulk of the sea urchin market handles fresh roe, the sea urchin market essentially clears on a daily basis, with auction prices adjusting to reflect the strength of retail demand relative to supply.

One fact about markets for perishable products that are linked vertically via a series of secondary markets is that prices actually fluctuate relatively little at the retail level but more dramatically at wholesale and ex-vessel levels. This occurs because retail sales cannot be adjusted from day to day without incurring costs, and without losing client relationships built up on the basis of stable prices. What tends to happen at the retail level then, is that supply shortages

simply result in stockouts and temporary supply shortages while prices remain relatively constant. At the wholesale level, however, there is much more vigorous market-clearing action as buyers bid up prices when supplies are short and bid down prices when supplies are abundant. Thus, for example, buyers for supermarkets may be willing to pay prices within a bandwidth that ensures some profits at the retail level. During periods of short supply, stable retail prices may mean that the retail/wholesale margin is squeezed to the point where losses are incurred, but during other periods abundant supplies generate margins that ensure profits over the longer run, on average. The importance of this is that there are often lags between events that stimulate market changes and the time at which those forces actually show up in prices. Slow growth in demand at the retail level will be expressed by buyers in wholesale markets and perhaps without corresponding price increases in supermarkets. This increased wholesale activity generates higher wholesale prices, perhaps stimulating more imports and harvests from supply sources. Temporary shifts in retail demand, due to, for example, holiday gift giving will be anticipated so that both retail and wholesale prices temporarily increase to draw in the needed extra supply.

An important link between wholesale markets located in Japan and ex-vessel prices generated in supplying foreign countries is the exchange rate mechanism. Since the Japanese wholesale market is conducted in Japan, wholesale prices are determined in yen per kilo. When Japanese importers negotiate with U.S. exporters, a conversion from yen to dollars occurs both in the setting of prices and the actual transaction involving exchange of funds. When the yen is strengthened relative to the dollar, Japanese importers bid against each other in U.S. dollars because each yen can buy more dollars. Hence, the price paid to U.S. exporters in dollars rises when the yen strengthens and falls when it weakens. A substantial portion of the run up in ex-vessel values for sea urchin in the 1980s occurred because of the strong yen. Similarly, recent weakening of the yen has put downward pressure on ex-vessel prices in the U.S.

The speed at which exchange rate changes are transmitted from Japanese exporters to U.S. importers depends upon competition. When there are many buyers we expect such changes to be transmitted almost immediately. This rapid transmission may be mitigated, of course, if buyers

and sellers engage in contracts which are denominated in fixed terms in order to insulate participants from exchange rate changes.

Once dollar denominated prices are determined by fundamental forces in Japan and transmitted through to U.S. exporters, they are further transmitted down the marketing chain through processors and ultimately to harvesters. Processing and handling sea urchin roe is labor intensive and requires some skill to produce a high quality raw product. Processors must cover variable and fixed costs of production, make a normal profit on investments and entrepreneurial time. As with importers and exporters, when a reasonable degree of competition exists between buyers, they will not be able to make persistently large markups over a long period of time. Instead, the need to keep production lines active and thereby ensure a steady supply of raw product requires that they will pass fundamental market forces through to the harvesting industry. Hence when demand strengthens in Japan, or when the yen strengthens, ex-vessel prices will rise as these forces are passed through. Prices at the ex-vessel level can be volatile, however, as supplies glut wholesale markets in Japan, as alternative suppliers experience booms and collapses, and as product recovery factors change. As discussed earlier, product recovery factors are critical determinants of ex-vessel prices. A small change in average roe yield can have a dramatic affect on ex-vessel prices. For example, an increase in recovery from 8 to 10% will increase ex-vessel prices 25%.

IV. The Japanese Market

In this section we discuss the Japanese market in more detail. As outlined above, the broad forces driving the retail market are economic and demographic. Contrary to the simple picture presented above, however, the retail and wholesale urchin roe markets are much more complex, and a complete characterization requires consideration of a host of additional details. For example, Figure 9 shows that there are actually many retail markets, ranging from restaurants to retail food supermarkets. In addition, there are many sea urchin roe products, ranging for expensive high-end luxury items consumed only at special occasions, to more commonly available processed products made up of lower grades of raw inputs. These markets are not independent. For example, large supplies of high quality roe available to restaurants may reduce the demand for urchin bought and prepared at home for special occasions. In the next subsection, we present a more detailed picture of how urchin roe is consumed and what kinds of products are marketed. In the following two subsections, we discuss the wholesale market and the import/export transactions process in Japan, with emphasis on how these markets operate and what charges are incurred along the way.

A. The Japanese Retail Market

The driving force determining ex-vessel prices that urchin harvesters receive, as well as import priced received by processors, is the Japanese retail market. It is thus important to have some idea of how urchin is consumed in Japan, and what factors are responsible for changes in consumption. One important fact is that Japanese meals typically contain more variety than

Figure 9.
Japanese Retail Sea Urchin Markets
Raw Product Attributes and End Uses

Raw Product Attributes

Freshness
Color
Size
Texture
Firmness
Uniformity
Wholeness

HIGH QUALITY

LOW QUALITY

Upscale Restaurants
Sushi Bars
- Uni sidedish
- Uni sushi
- Uni with sashimi

Gift Packs
- Cured/flavored in jars
- Mixed uni with herring, Jelly fish, scallops, etc.

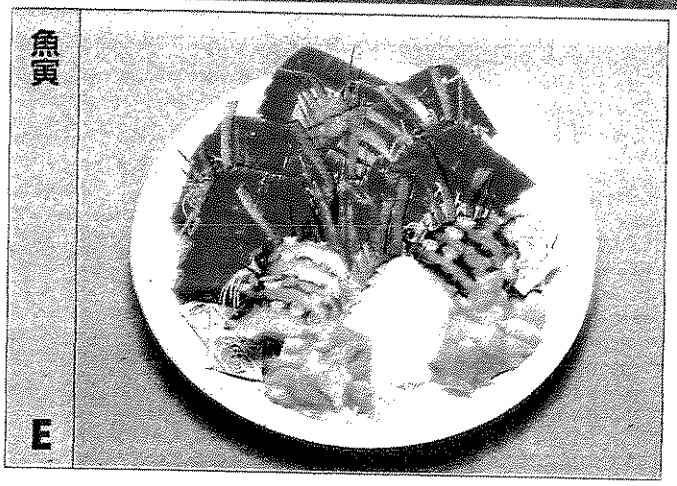
Supermarkets
- Uni with sashimi tray
- Individual packets/trays
- Cured/flavored in jars
- Chinmi
- Dried/salted/steamed

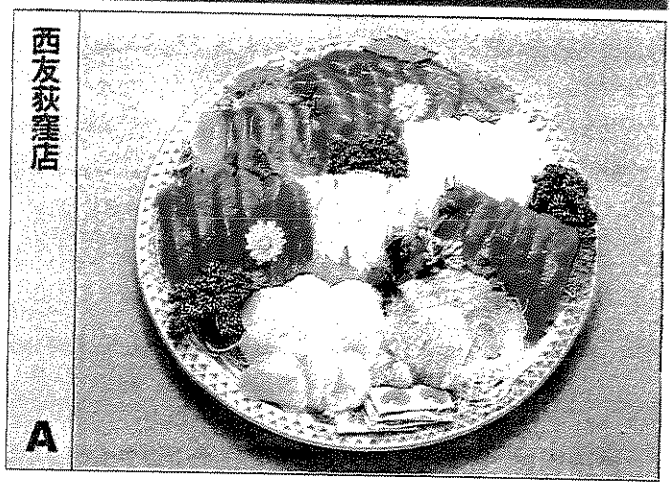
Western meals. For example, a typical home meal might contain several sources of protein, including several different small portions of fish products. Japanese consumers purchase seafood products from large retail food stores and/or less commonly from specialty fish retailers. Seafood is packaged in many ways, individually and often as part of a seafood tray pack. A consumer might purchase, for example, an assorted *sashimi* tray. Sashimi is thinly sliced pieces of fish, and an assorted sashimi tray might include items such as tuna, yellowtail, squid, sea bream, flounder, cold water shrimp, scallop, and cockle. Four or five pieces of each type of fish would be arranged with some green leaves, chrysanthemums and sea weed, on a bed of shaved radish. A shopper would purchase this assorted sashimi tray, bring it home, transfer it to a large platter, and serve. This would be the center piece of a dinner and served with soy sauce and horseradish.

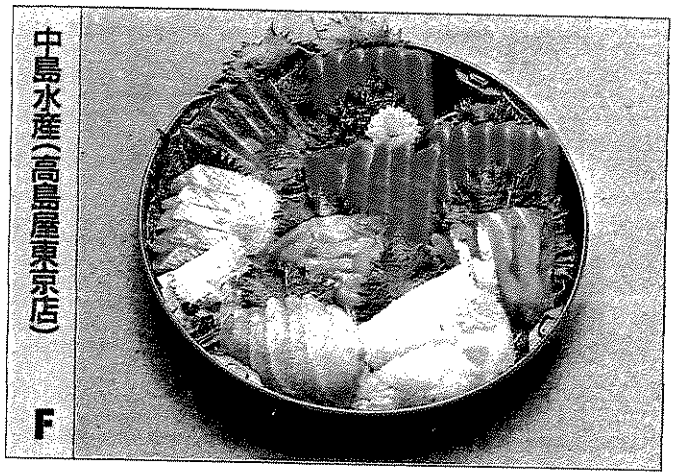
Fresh sea urchin roe is considered expensive, and a luxury reserved for entertaining or for a special occasion. Its purchase for home consumption is thus not a common event and home consumers are not especially knowledgeable about specific quality attributes or about different species and regions of origin. There are traditions of seasonal consumption which have emerged over many decades, however, and these are generally tied to availability of fresh urchin. Demand for fresh domestic urchin is thus stronger during the summer months, which corresponds historically to the period when Japanese domestically produced urchin was of highest quality and abundance. With imports from North America and other sources, urchin is more widely available throughout the season. Still, there is a preference for domestic sources during peak availability and knowledgeable consumers look to purchase during the window of abundance during the summer. This is similar to North America, where Easterners know that lobster are abundant, fresh, and inexpensive in late summer, and Westerners anticipate Dungeness Crab in winter and salmon in summer.

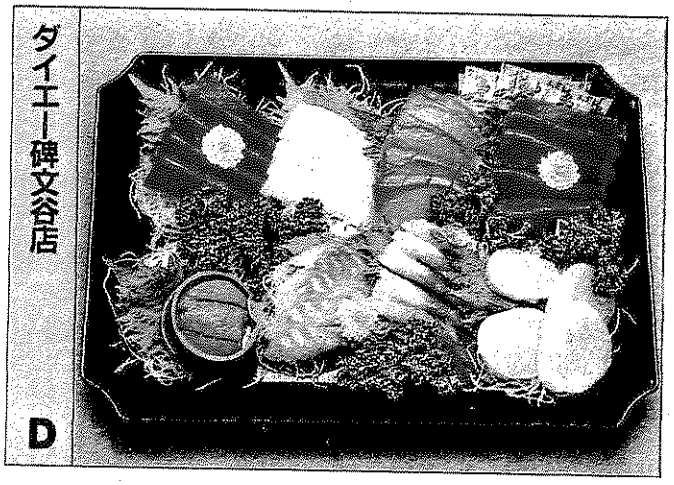
Fresh sea urchin roe might appear in the supermarket either in individual trays or cups or in an assorted sashimi tray. The following page shows a page from a gift catalog, with a variety of assorted sashimi trays. Each tray contains 8 varieties of seafood, priced at ¥4,000. Trays D and G each contain sea urchin roe. In tray G, the sea urchin roe is second from the right on the

8点盛り4000円相当の刺身盛り合わせ









8点盛り4000円で西友が生マグロで最高

8点盛り4000円相当の評上表のような結果となった。刺り合わせの評価はマグロで決ま高点を得たのは生のバチマグロントを稼いだ西友だ。マグロだ000円の価値が十分あると、一意見が一致した。それに続くの丹で、中トロはわずか5切れで0円に見合うという評価だ。ただ大トロはバチマグロを使っていう筋っぽいという。

「一般の消費者には見分けがついが、霜降り肉のように食べやすマグロの大トロだと2切れで40円はする。4000円の盛り合大トロは入りっこない」(関谷氏)

トロの表示には定まった基準ため、小売り店側の裁量にまかさいるのが現状だ。特に「中トロ」濫ぶりは目立つ。今回のチェック中トロの表示ながら、プロの目は赤身と判断されたものがいくった。

「個人的には、これを中トロといいのかと疑問に思うこともある表示に制限がないのだから、まあれるのでは」という某中堅スーパ仕入れマネジャーのホンネも耳に魚体の脂の乗り方にも違いがあから何cmまでが中トロと一概にはられない面もある。だが中トロとするだけで100g当たり200円ほど高れているのは事実。適正表示によ正価格が望まれるところだ。

2500円と4000円の結果べて疑問に感じたのは、イトーヨ

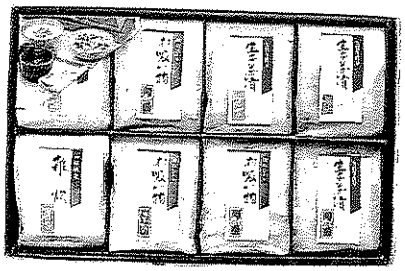
lower row. In tray D, the sea urchin roe is on the bottom left-hand side of the tray. As can be seen, the presentation and color on the trays are quite eye-catching. A sea urchin roe serving, to be included in an assorted sashimi tray as described above, might be about 20-30 grams.

Sea urchin is also served in a restaurant meal as a side dish in a small bowl with soy sauce and horseradish and/or as a sushi meal with rice and sea weed. Generally, the higher grades of urchin are reserved for sushi and sashimi, where freshness and presentation are important. These are re-packaged by retailers and restaurants from the 225-260 gram tray packs which are shipped from the U.S. and other suppliers, and which move through the various wholesale markets or directly to retail chains. Sushi bars and upscale restaurants typically receive the highest quality and freshest uni. Raw uni is often displayed in the wooden trays so that buyers can judge quality. Hence, packaging at the processor level with an eye towards color, texture, and uniformity is important.

Lower grades of urchin are converted into various lightly and heavily processed products. For example, retail food stores carry sea urchin roe packed in slim glass jars 80 to 110 grams each. This product may be cured and/or flavored, and may be either smooth or chunky. These are also found in catalogues to be purchased as gifts, often in gift packs containing several jars. For example, on the next page a catalogue lists five sea urchin products (the bottom five). Product number P9264-9, is two 100 gram jars of cured roe packaged in a box at 3,000 yen. Product number P9265-2 offers two 100 gram jars of cured urchin roe with one 110 gram jar of herring roe with urchin roe for 5,000 yen. The same catalogue offers for purchase another gift pack, containing two 110 gram jars of roe which are a special grade of cured urchin roe, for ¥7,000 (Product P9266-5). The second-to-last product, P9267-8 is a gift pack where each of the two 110 gram jars are labeled with region of origin, Seikaitou and Shimonoseki, and are priced higher than the other two-packs at ¥10,000. Finally, the last product listed is one with two 80 gram jars of cured sea urchin roe, together with a 40 gram jar of each herring roe and jelly for 10,000 yen. These kinds of gifts are given at special occasions, during the gift giving season around the New Year or during the summer after bonuses are received.

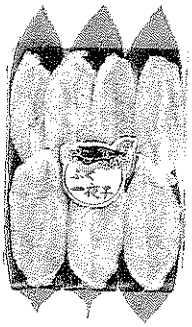
送料込み印の商品はメーカーより陸上急行便または航空便扱いにて直接先様へお届けします。配送料は、小売価格に含まれています。配達不可区域は17ページをご覧ください。

P 9257-1
玄海生茶漬
(CK-50) ……5,000円
紅鮭2・鯛グラ2・鯛2・ふぐ2・えび各(10g3)

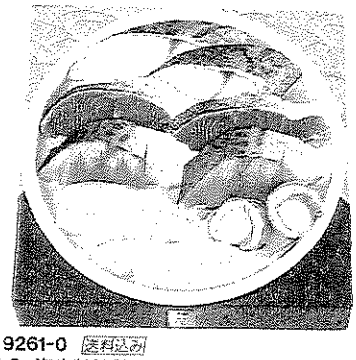


P 9258-4
玄海味くらべ
(KA-50) ……5,000円
ふぐ雑炊(1食)・鯛吸物(3食)各2、ふぐ茶漬・鯛茶漬・紅鮭茶漬・えび吸物各(3食)

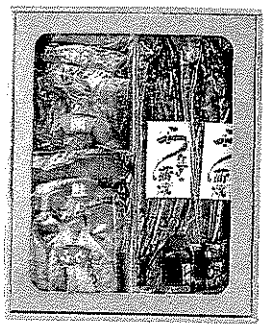
P 9259-7
鮮魚ソフト調味焼
(ST-50) ……5,000円
鯛・さわら・鮭各3切、ふぐ4枚、調味粕・調味みそ各150g、ポン酢2袋



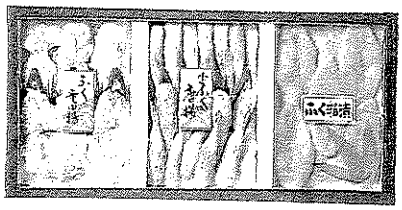
E 9260-7 送料込み
下関日高 ふぐ一夜干
(IFF-050) ……5,000円
ふぐ一夜干510g



E 9261-0 送料込み
竹八 海幸粕漬詰合せ
(KSSD50) ……5,000円
銀鱈・鮭・さわら各2切、ほたて2コ、ふぐ3枚



P 9262-3
うなぎ蒲焼・鮮魚ソフト調味焼
(US-100) ……10,000円
鯛・鮭・さわら各3切、ふぐ3枚、うなぎ2匹、うなぎタレ1本、ポン酢2袋、調味粕・調味みそ各150g

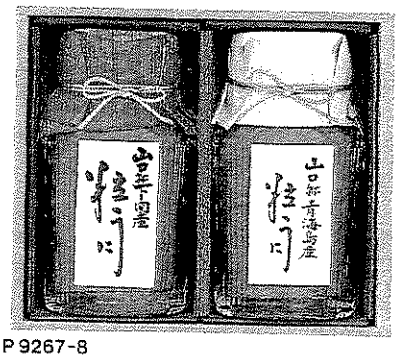


E 9263-6 送料込み
下関日高 生ふく詰合せ
(ITN-050) ……5,000円
ふく竜田揚350g、小ふく唐揚300g、ふく粕漬150g

P 9264-9
小川うに 下関うに
(KE-30) ……3,000円
浜風粒うに・粒うに各100g

P 9265-2
小川うに 下関うに
(KE-50) ……5,000円
浜風粒うに2・数の子うに各110g

P 9266-5
小川うに 下関うに
(KE-70) ……7,000円
金印粒うに・紺印粒うに各110g



P 9267-8
小川うに 下関うに
(KE-100) ……10,000円
青海島産粒うに・下関産粒うに各110g

E 9268-1 送料込み
かつみ 磯詰生うに・うにあえもの詰合せ
……10,000円
磯詰生うに80g2、数の子うに・くらげうに各40g

A third end product which absorbs the lowest quality urchin roe is *chinmi*, which means literally "exotic taste." This product is made from broken skeins of roe, less fresh or runny quality, small and broken roe, *etc*. There are many different kinds of products sold as chinmi, although most are mixtures of urchin roe and some other seafood product. Some of the products mixed with urchin roe include: herring roe, jelly fish, squid, and scallop. These are typically sold in a glass jar or small pouch.

In addition to these products made directly from fresh roe, there are other products made from processed roe. Processed roe may be frozen, steamed and then frozen, or dried and salted. Some of these products are processed overseas and imported directly as processed product into Japan. Korea (North and South) and China are prominent exporters of dried and salted sea urchin roe to Japan. These are then repackaged and sold into the retail distribution chain by processors specializing in preserved roe products. There is also a trade in frozen urchin roe, processed into blocks, imported into Japan, and then further reprocessed into various other products such as chimni. Chile, Canada and the U.S. are dominant exporters of frozen roe into Japan.

B. The Japanese Wholesale Market

The Japanese wholesale market receives both domestically produced fresh urchin roe and imported urchin and urchin roe products. Urchin roe products arrive in the Japanese wholesale system as fresh, shucked and packaged roe, as whole live urchins, and as processed sea urchin roe products. Most of the highest quality imported fresh sea urchin roe is sold in the Tokyo Central Wholesale Market (TCWM). This large auction market handles much of Japan's wholesale fresh fish trade, although there are other wholesale markets such as that in Sapporo.

Several different sale mechanisms are used in the TCWM, including sealed bid auctions, open auctions, and contract sales. Most of the fresh sea urchin handled by the TCWM is sold in open auction. While urchin roe may be differentiated with a specific labeling system by processors in the U.S., it is sold on the wholesale markets without an explicit grading system.

However, urchin may be labeled by place of origin and domestic ("local") urchin is differentiated from imported urchin. Domestically harvested urchin commands a premium which is sometimes double the price. Table 2 shows the differences between average annual wholesale prices in the TCWM for domestic versus imported fresh sea urchin roe (Tokyo Central Wholesale Market Yearbook, various years). Knowledgeable industry sources suggest that the price premium is in part due to a freshness advantage and also due to some market "chauvinism" that favors local products. The freshness advantage exists because local urchin roe can be delivered to the wholesale market within one day of harvest, whereas U.S. urchin roe generally takes 3-4 days. Figure 10 shows the deviations between imported and domestic roe prices on the TCWM on a monthly basis from 1990 - 1996. (The 1996 prices are the average of the prices from January through November, the last month for which data is currently available.)

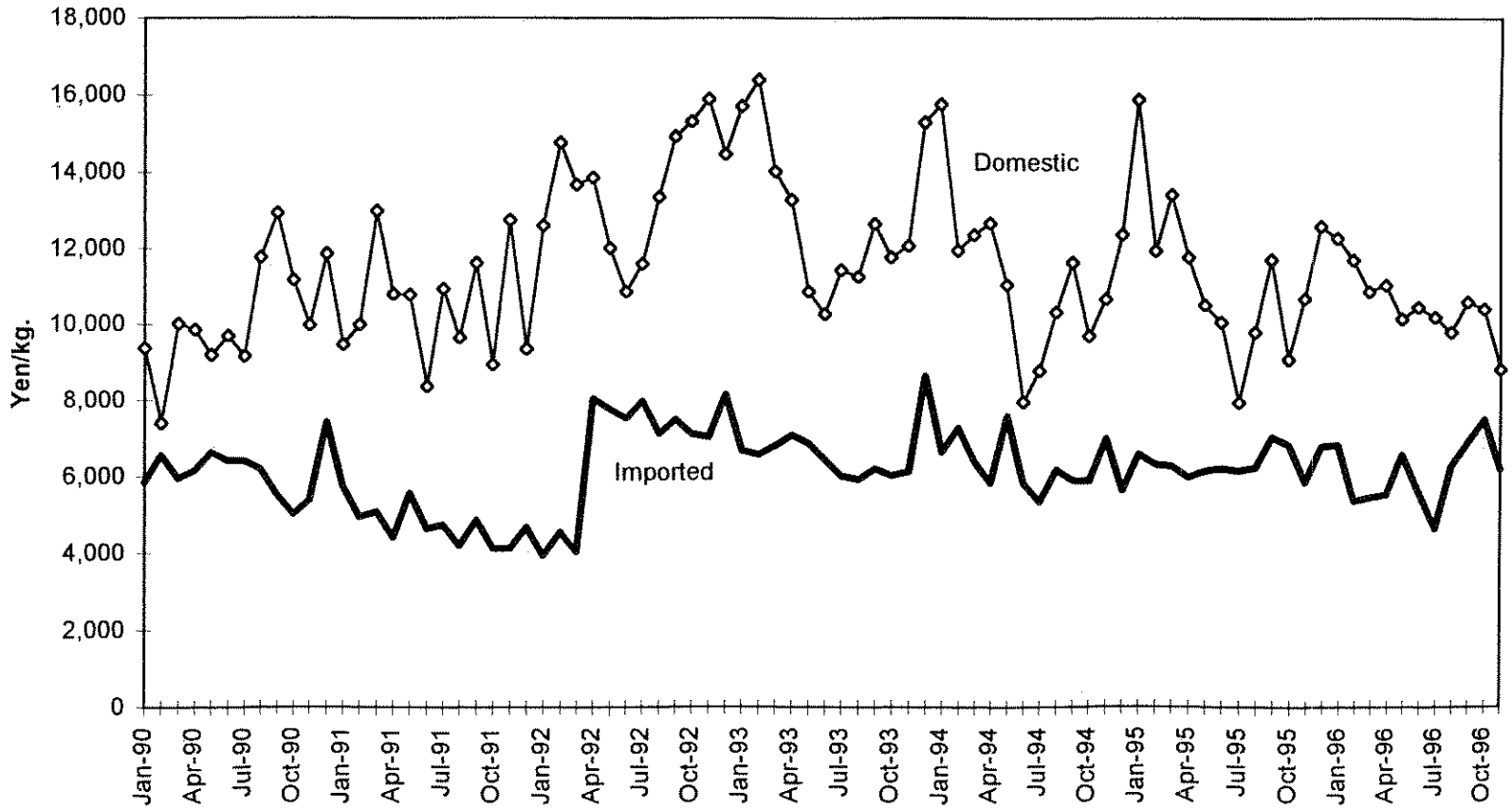
Table 2: Annual TCWM Prices for Fresh/Chilled Sea Urchin Roe, 1986 - 1996

Year	Domestic Price (¥/kg.)	Imported Price (¥/kg.)
1986	7,835	5,578
1987	7,681	5,660
1988	7,486	4,463
1989	7,863	4,868
1990	9,952	6,056
1991	10,283	4,689
1992	12,973	6,259
1993	12,209	6,704
1994	10,551	6,237
1995	10,555	6,388
1996*	10,430	6,057

Source: Tokyo Central Wholesale Market Yearbook, various years.
* Based on data from January - November

Within the markets for both domestic and imported urchin, prices can vary on a temporal scale ranging from daily to monthly. On a daily scale, prices vary widely by lot, reflecting

Figure 10. Tokyo Central Wholesale Market Prices for Domestic vs. Imported Fresh Sea Urchin Roe, 1990 - November 1996



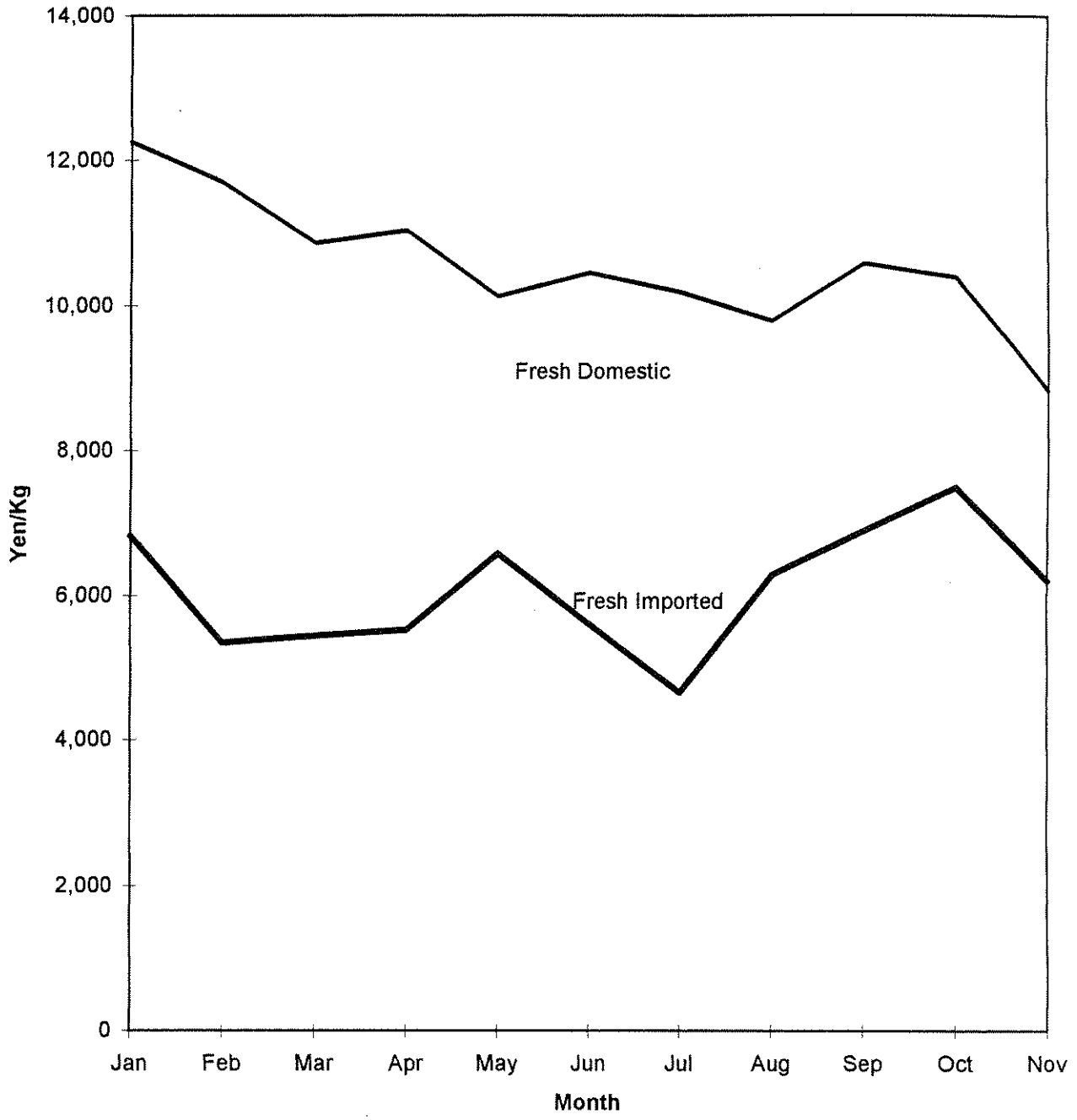
Source: *Tokyo Central Wholesale Market Yearbook*, various years

inherent quality of each lot as well as the daily match up of supply and demand. These factors may be interdependent as, for example, supplies arrive only to be held over while the market is closed either on Sunday or for a holiday. The markets for domestic and imported roe also vary seasonally in a manner that reflects the relative abundance and quality of roe from different urchin populations. Japanese domestic roe peaks in volume during the summer months, just before spawning (Sonu, 1995). During this period, demand is strong because of Japanese preferences for "local" urchin. At the same time, the abundant domestic supplies result in lower-than-average prices for domestic roe (see Figures 11 and 12). Both the strong inherent demand and low prices cause correspondingly low demand and prices for the closest substitute, which is imported urchin. Figure 13 shows how the volume of imported versus domestic supplies of fresh/chilled urchin roe has changed over the period 1982 - 1994, with imported roe at three times the volume of domestic roe.

In both Maine and California, industry/manager groups have arranged closures during these seasonal periods of weak demand. Production from imported sources picks up in the Fall and early Spring as Japanese supplies of domestically caught urchin are reduced. Hence, U.S. urchin shipped during these periods garners a high price because of the relative scarcity of domestic roe. During the month of December, in addition, there is an extra "spike" in the Japanese market as people celebrate the New Year by giving gifts of food items and other luxuries. Hence, the biology of domestic and imported urchin supplies cooperate without coordination to smooth the supplies caused by the normal ebb and flows of quality and quantity roe associated with spawning activities.

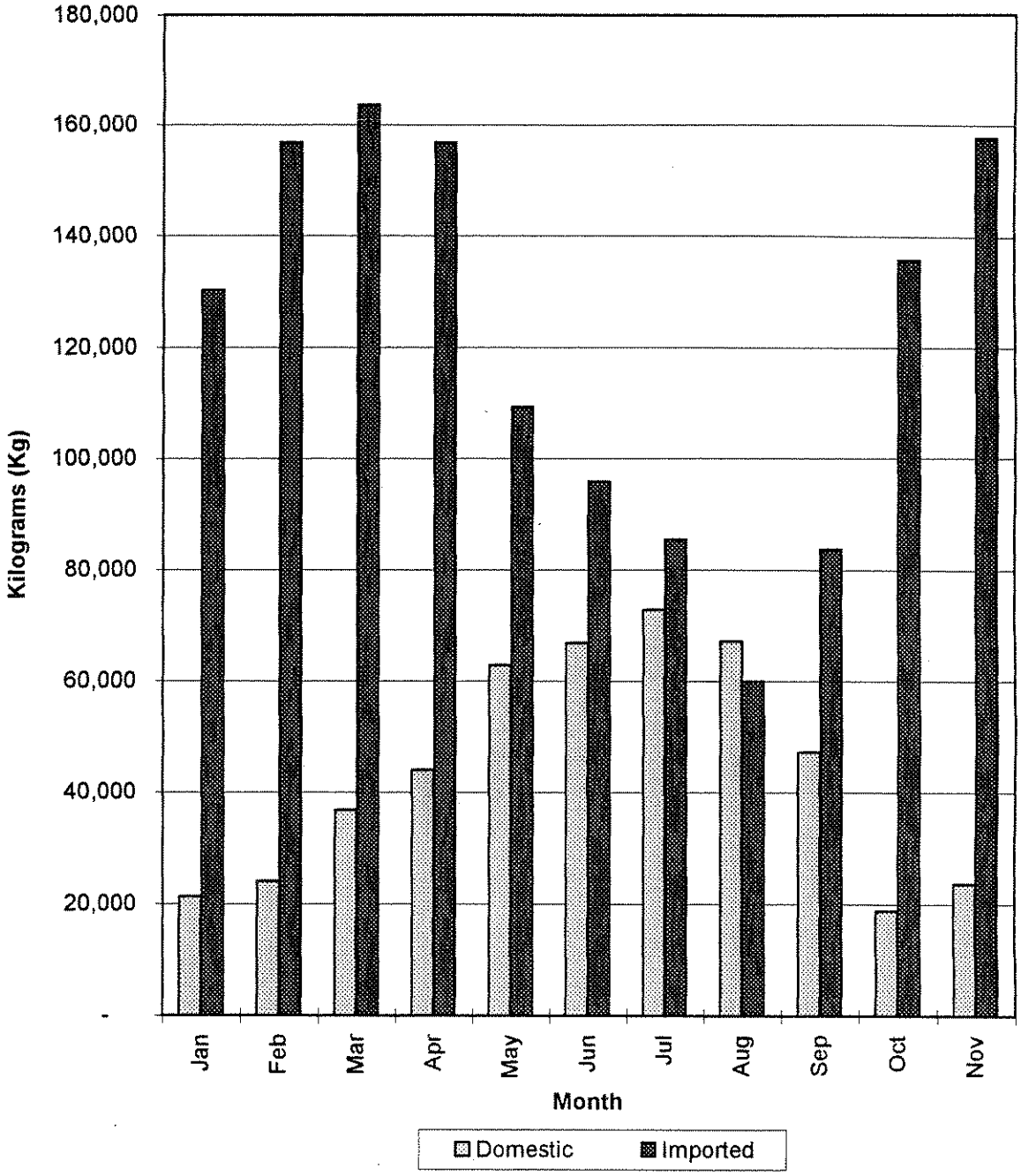
The premium paid for high quality roe is substantial and yet the attributes of quality are subtle to the inexperienced. Factors that are important components of quality include freshness, texture, brightness, color, size, and wholeness of the roe skeins. Generally speaking, highest prices are commanded by firm and unbroken skeins of bright yellow colored roe. Generally color preferences in the TCWM run from bright yellow (highest), to orange, to off color, although some consumers in the Osaka markets seem to prefer bright orange roe. Size of the roe sacks is

Figure 11. Tokyo Central Wholesale Market Prices for Domestic and Imported Fresh Sea Urchin Roe - 1996



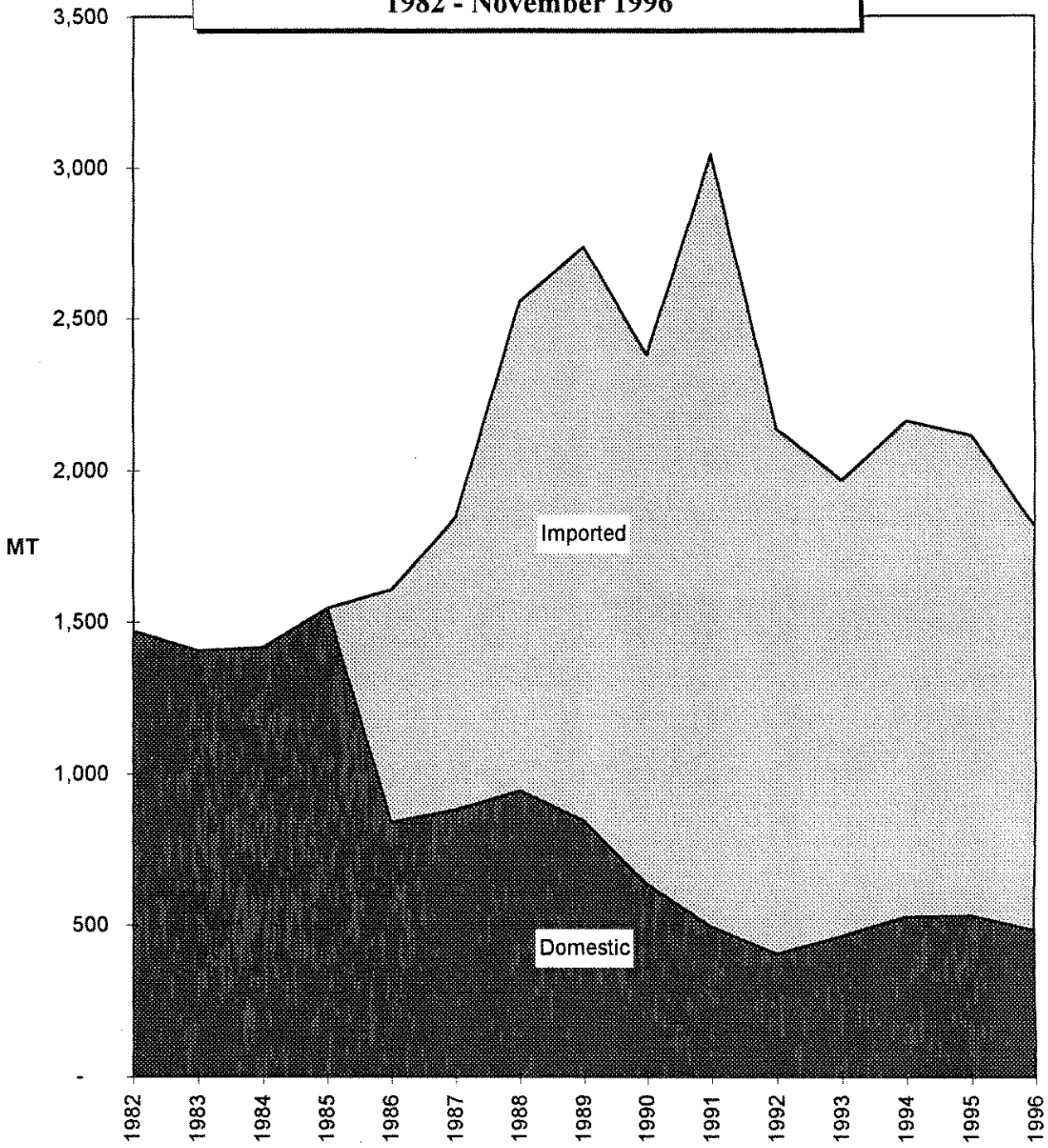
Source: *Tokyo Central Wholesale Market Yearbook*, 1996

Figure 12. Tokyo Central Wholesale Market Quantities of Sea Urchin Roe Sold by Source - 1996



Source: *Tokyo Central Wholesale Market Yearbook,* 1996

Figure 13. Total Quantity of Fresh Sea Urchin Roe Sold at Tokyo Central Wholesale Market 1982 - November 1996



Source: *Tokyo Central Wholesale Market Yearbook*, 1996

important. The crude rule of thumb regarding size is that the closer imported roe is to "local" size, the better. Domestically harvested urchin roe sacks sizes depend, of course, both on the species, on the intensity of harvesting effort, and on minimum size regulations.

In the Japanese urchin fishery, most of the sea urchin comes from Northern Japan (Hokkaido area) where the dominant species is the green sea urchin (Sonu, 1995). In central Japan (Sapporo to Tokyo) red sea urchin are found. Nevertheless, the Japanese local market is dominated by the Hokkaido area production of green urchin. The majority of the Japanese urchin fishery is managed by local fishing cooperatives which set their own regulations regarding allowable harvests, season openings, and size limits (see Appendix Table A1). Most cooperatives have selected size limits equal to or above 4.0 centimeters. For example, about 60% of the catch harvested by Hokkaido Fishery Cooperatives comes from sub-areas with size limits of 4.0 centimeters (1.56 inches) or larger. Another 10% comes from areas with size limits above 4.5 centimeters and about 24% comes from areas with size limits of 5.0 centimeters (Suno, 1995)

Understanding the attributes of domestically produced uni is important because, as suggested above, the closer imported products are to "local" products the higher the price received, other things equal. Interestingly, while California processors have been successful in carving out a lucrative market for red urchin, the green urchin found off the East coast is in fact closer to the high valued domestically harvested urchin from Japan because it is essentially the same species. It is, however, much more difficult to handle, process, and deliver fresh than red urchin. Green urchin seem to be more sensitive to sea temperature changes and a relatively small change in temperatures can cause them to spawn and go soft. In addition, green urchin are harder to keep intact and firm up than red urchin during processing. As a result, red sea urchin from California have dominated the Japanese import market, garnering both higher average prices and more stable prices associated with less variable raw product; at least, until recently. This can be looked at as an opportunity, of course, since green urchin inherently have more potential to mimic local product and consequently earn higher prices.

Packaging is an important facet associated with garnering high wholesale prices. Buyers

look for high and uniform quality in tray packs, which is why at the processing level, the role of the grading technician and packers is important. In some settings, such as sushi bars, tray packs are displayed prominently as indicators of the day's fresh offerings, giving extra weight to the importance of high quality wholesale packaging.

When tray packs arrive during early morning in Japan via airfreight, they are quickly unloaded and arranged to clear customs by customs brokers/importers. This process takes a couple of hours and then shipping via refrigerated truck takes place to bring the uni to the wholesale market. Thus, products shipped from North America during evening flights do not arrive for sale in the TCWM for at least two trading days. Fresh roe sold in the TCWM arrives in stacks of wooden trays topped with wooden covers and tied together with string or bulk packed in foam trays. Wooden tray packs generally command highest prices. Trays come in various sizes, ranging from smaller ones containing 60-80 grams, to intermediate sized trays containing 130-180 grams, to the more common regular sizes containing 225-260 grams (8-9 oz.) or larger trays containing 280-350 grams.

C. Shipping, Handling, and Import Transactions

Fresh imported urchin roe that arrives in Japan incurs certain transactions costs associated with shipping, handling, clearing customs, and wholesale market sales. Air shipments of fresh roe generally arrive early in the morning, after having been shipped out of New York, Los Angeles, or San Francisco the previous night. It generally takes a full day for a shipment to be unloaded from the plane, cleared through customs by the broker/receiver, and shipped to the TCWM, if that is final destination. Thus, whole urchin landed one day will, under the best of circumstances, be processed the next day, shipped, cleared and handled the following day in Japan and sold on the third day.

Shipments of urchin are met by a broker who handles the product through customs and expedites shipment to the wholesale market. The broker is bonded and pays an import tax on an

estimated CIF value (cost, insurance, and freight). The current import tax on imported fresh urchin from North America is 9.4% (Japan Marine Importers Association, 1995). Processed products from some sources pay a 12% tariff, whereas live whole urchins pass customs with no tax. Japan also has a preferential tariff arrangement with some countries under which raw urchin are taxed at 7%. This preferential agreement exists between Japan and China, Chile, and Korea for urchin products. After the product has actually been sold in the market, any overages or underages from the estimated values are settled between the broker and customs bureau.

After physically clearing customs, fresh urchin is transferred to wholesale markets in trucks. The TCWM collects a 5.5% marketing charge for wholesaling services and the broker charges generally around 3% for services rendered in handling, clearing and getting the product to the market. Once a sale is completed, the yen sales value less charges is converted into dollars, and the net proceeds are transferred to the exporter in the U.S.. The total of all charges paid in Japan are thus approximately 20% of the wholesale sale value.

Table 3: Japanese Tariffs for Sea Urchin Products, 1995

Product	General Tariff	GATT Tariff	Preferential Tariff
Fresh or chilled	10.0%	9.4%	7.0%
Frozen	10.0%	9.4%	7.0%
Dried, salted or in brine	10.0%	9.4%	7.0%
Live	Free	Free	Free
Prepared or preserved	12.0%	12.0%	12.0%

Source: Japan Marine Importers Association

Figure 14 shows the effects of the transaction costs between the export prices (free-along-side (fas)) from the U.S. and the CIF import price in Japan.

Figure 14. Fresh/Chilled Sea Urchin Roe
U.S. Export Prices (fas) vs. Japanese Import Prices (CIF)

Sources: Japanese Marine Products Importers Association;
U.S. Bureau of the Census

V. Processing and Harvesting--the U.S. Industry

This section briefly discusses the first two stages in the production chain, namely harvesting and processing. Here we focus on important steps in the process of adding value and the types of transactions made as the product passes up the chain.

A. Processing

Processing whole sea urchin is an important determinant of value added and yet not widely understood. Practices vary, depending upon the quality of the raw product, experience and skills of labor and entrepreneurs, and on the targeted end product market. We will discuss fresh urchin roe processing since it fills the bulk of North American sales to Japan.

Divers generally deliver urchin dockside late in the afternoon after the day's dive. Baskets of whole urchin are unloaded and loaded into totes for delivery to the processing plant. The types of remuneration arrangements vary depending upon processor/diver relationships and convention dictated by regional practices. Divers generally would prefer being paid up-front (in cash) by the processor as urchins are landed. This leaves a considerable amount of risk to be borne by the processor, however, including risk of low quality, low recovery rates, drops in the wholesale market, *etc.* In Maine, buyers take delivery dockside, generally after sampling the urchin lot to determine condition and quality, with prices determined accordingly. An incentive scale is used in Maine, whereby a base price is offered, generally for a specified recovery level such as 10% and then increments over and under the base price are paid for higher and lower recovery factors. A variety of incentive scales has been used over the past few years. Some buyers have a

dramatically lower price for urchin below 10% recovery factor (*e.g.* 20% below base price for recovery less than 10%) and some have a correspondingly larger bonus for high recovery (*e.g.* 5 cents per "point" above 10% up to 13% and then 10 cents per point for 14% and above).

There has been considerable discussion in Maine about the role of buyers who purchase, and divers who deliver, urchin at low recovery factor levels. Anecdotes abound of buyers paying high prices for extremely low quality product ($1 plus per pound for 2-3% roe). Generally these transactions are alleged to be paid by "out of state" buyers who are also "foreigners" and pay cash, transporting urchin out of the state without recording them as landings. For the most part, however, these incidents are viewed as aberrations which occurred more frequently during the early "gold rush" days of the industry in Maine. Most believe that the market system is working on the whole, by providing incentives to select and land higher quality urchin. Exactly what the average level (or minimum) should be depends upon who one is talking with. Some processors believe that recovery factors as low as 8% are profitable, if the roe itself is of high intrinsic quality otherwise (color, firmness, texture). In addition, as discussed above, raw urchin roe is made into several different products, other than high-end fresh uni. Processors serving and profiting from medium and lower ends of the markets will opt for different quality standards than those aiming for just the high end market. Without further intensive investigation of the costs and relative profitabilities of different end product chains, it is difficult to judge this issue definitively.

After whole urchin are unloaded and shipped to the processing plant, they are typically chilled and held overnight to be processed the following day. The processing crew then begins by cracking open the shells and scooping out the gonads with spoons. The roe is placed in stackable plastic straining baskets, sometimes after an additional stage where excess membranes and guts are removed with tweezers or small forks. The stacked baskets are then placed in a trough of iced salt water and a solution of potassium [$KAI(SO_40_2)$] until the roe becomes firm. This soaking lasts anywhere from twenty to ninety minutes, after which the roe is removed and drained.

Packing the roe is the next stage and it may be critical to the ultimate value of the end

product. The highest quality roe is packed in wooden or sometimes plastic trays. These trays are sold by the tray rather than by weight and hence the value of a tray is determined by its size and by the appearance of quality of roe that it contains. Each tray holds several layers of roe and the packer must not only sort and pack by quality, but also display the roe in a manner appealing to the final customers (who may be buying uni in a sushi bar, after looking at the day's display in a tray pack). Various-sized trays are packed, ranging from large trays holding 250-350 grams of roe to small trays and cups holding 80 and 100 grams, respectively. Tray weight can vary considerably, depending upon the density and size of the roe. One large tray may hold anywhere from 20 to 40 pieces of roe, for example.

Packing high-quality roe is labor intensive and a relatively high-skilled operation. As a result, considerable time is spent learning how to pack for highest value. Skilled packers are in short supply and processors must pay reasonable wages and ensure steady work in order to keep them. For this reason, many processors work hard at keeping employees working throughout, and even between, seasons. In Maine, processors are also attempting to keep processing lines in operation over more of the year. Urchin from Canada are increasingly imported for processing and transhipment into the Japanese market. In 1995, for example, the U.S. imported about 3,274 metric tons of whole urchin from Canada, most passing through Maine buyers and processors en route to Japan (Seafood Market Analyst, 1996). The U.S. also imported 310 metric tons of roe from Chile and 172 mt from Mexico, most flowing though the Southern California processing chain also en route to Japan. For example, in California some processors have attempted to augment the use of their urchin processing facilities by also processing abalone, crab, or sea cucumber, although not in significant quantities. During the last couple of years, some California processors have also begun to import whole urchin from other states and from Chile in order to maintain processing lines. In addition, processing from other sources helps a processor maintain a continuous market presence in Japan by supplying product during periods when traditional sources are reduced due to weather, closed seasons, or poor quality. The total volume of live whole urchins exported to Japan from the U.S. last year was 2,656 metric tons and the total

volume of fresh urchin roe was 3,856 metric tons (Seafood Market Analyst, 1996). Figures 15 and 16 show exports of fresh urchin roe and live urchins, respectively, from the U.S. in 1994 and 1995, by ports of departure.

A critical factor determining how raw urchin are processed is its condition as a raw material. The quality of raw material is determined by the fullness of shells (recovery factor), the inherent quality of the roe itself (color, brightness, texture), as well as size. Small urchins cost much more in labor and handling time to yield the same amount of finished raw urchin than large urchin. In addition, roe quality and recovery vary over the season depending upon how much food is available to the urchins, how much competition exists for that food, and when in the spawning cycle the urchin are harvested. In general, as urchins approach spawning, the size and ripeness of gonads improves. In Maine spawning moves from west to east with some variability regionally depending upon environmental conditions including ambient and water temperature, current and wind activity. Spawning in the south generally begins in March and in the north it begins in April, lasting several months in both areas. As spawning progresses, roe quality declines, turning runny, off color and with low recovery factors.

In California, similar patterns exist. Southern California urchins are of highest quality in September, October and November, just before winter spawning in January through March. In Northern California urchins live in colder waters and spawn in March and into the early Spring. At any point in the spawning cycle, urchins may differ in quality locally in a manner dependent upon competition and food supply. Urchins in dense patches may be easier to harvest, for example, but generally will have lower recovery factors than those found in thinner concentrations.

As a consequence of the range in quality, skills and knowledge about packing, and differences in species and sizes, not all urchin roe can be processed as high-valued wood traypack roe sold into high-end restaurants out of the TCWM. Some processors pack whole roe into mini trays (30-50 grams) which are usually sold directly into the Japanese supermarket trade, bypassing the TCWM. Roe may also be packed in a single layer in bulk trays holding up to 1 ½ pounds,

Figure 15a. U.S. Exports Fresh/Chilled Sea Urchin Roe, by Port of Departure, 1994

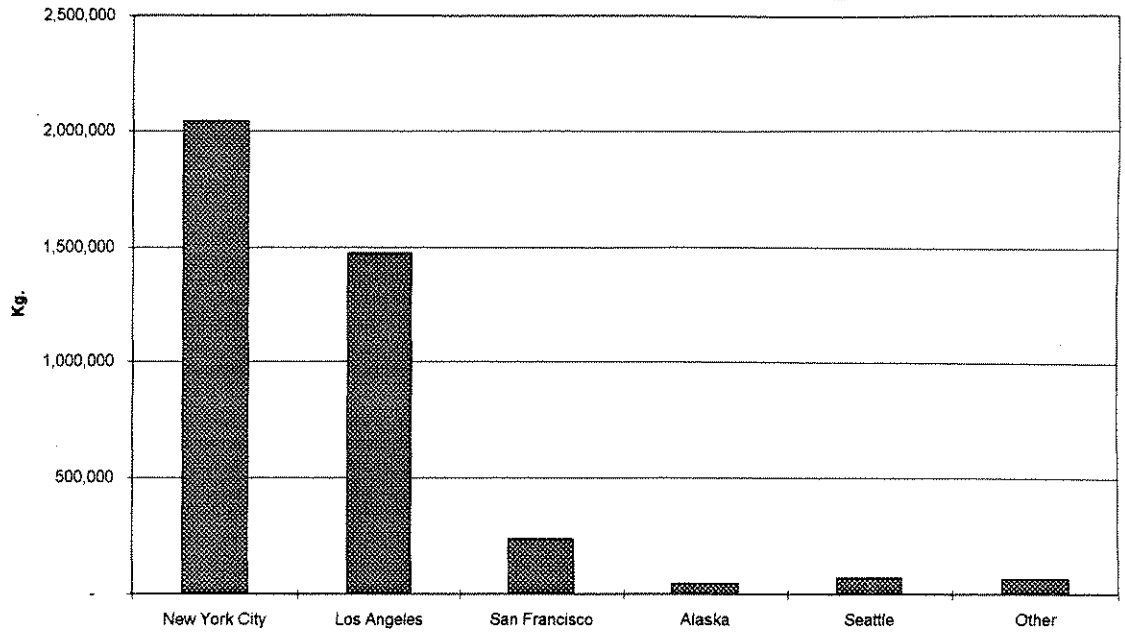
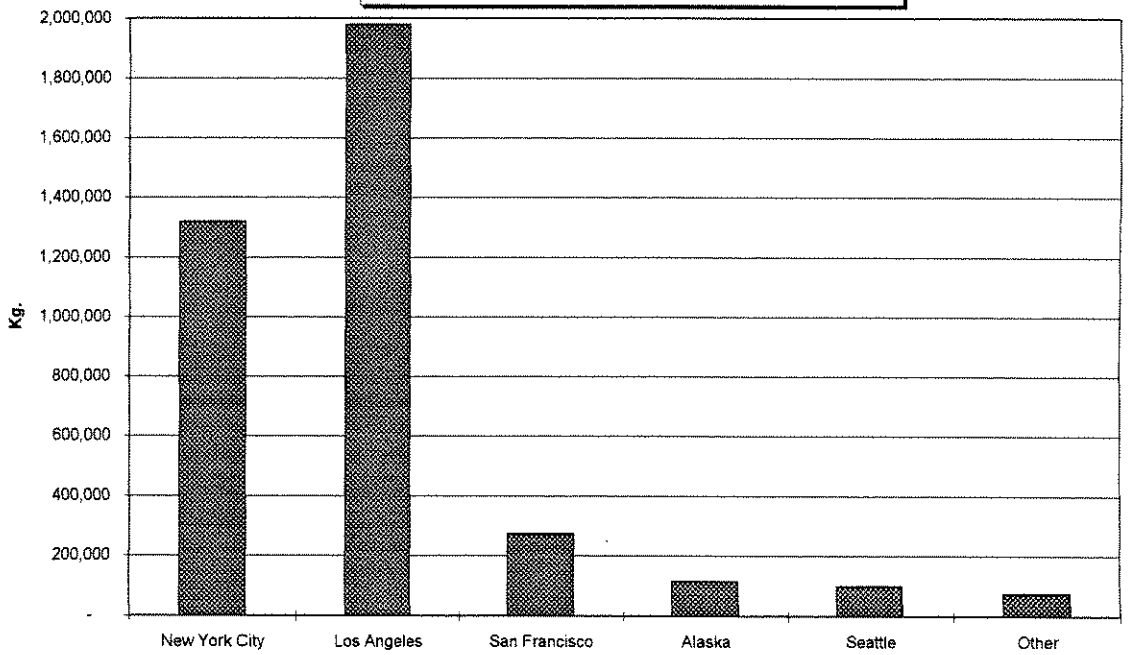
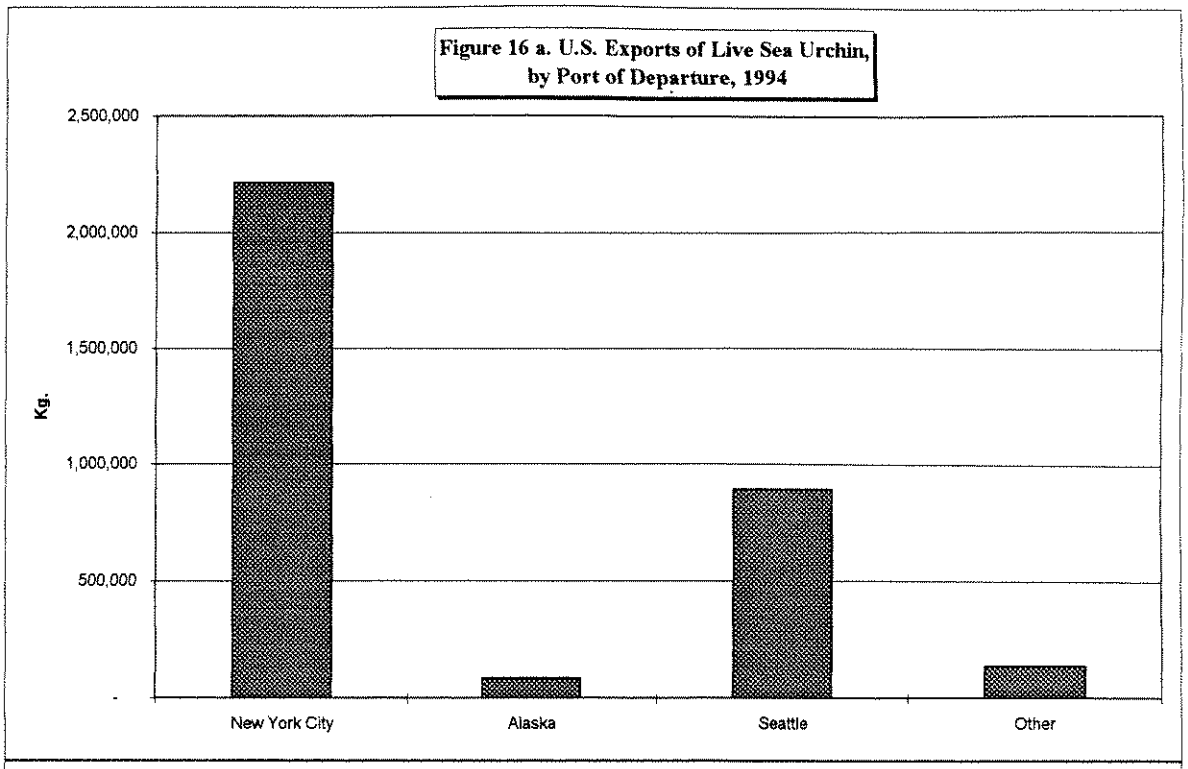
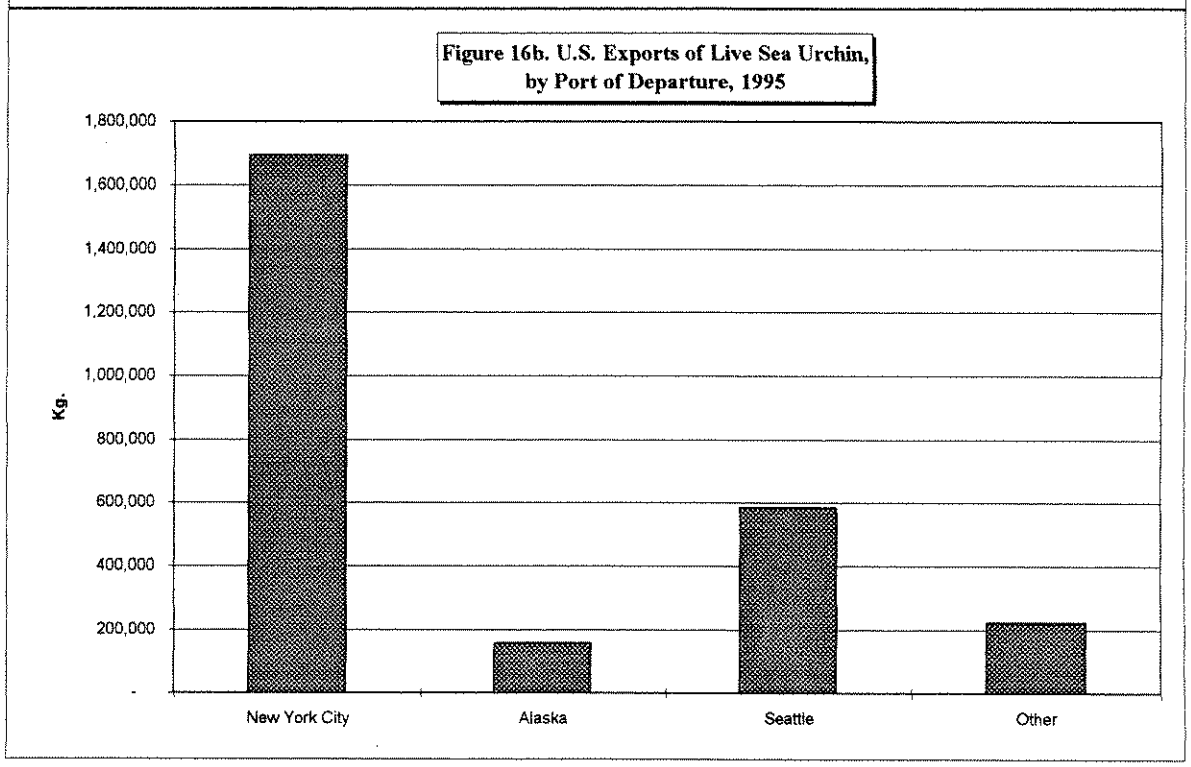


Figure 15b. U.S. Exports Fresh/Chilled Sea Urchin Roe, by Port of Departure, 1995



Source: Seafood Market Analyst, *1995 Year in Review: Seafood Trade Report*





Source: Seafood Market Analyst, *1995 Year in Review: Seafood Trade Report*

which are later re-packaged by supermarkets in cups holding about 100 grams. Some roe is frozen and packed in trays or in crates holding up to forty pounds of roe. This product is generally converted into roe pastes or chinmi products discussed earlier.

Once roe is packed in trays or other containers, it is put together in batches to be transhipped via refrigerated truck and then air shipped. High quality wooden tray packs are grouped in insulated shipping cartons containing forty-two large trays or more smaller trays. Space is left for gel packs to keep the roe chilled. Most California roe is shipped out of San Francisco or Los Angeles airports, whereas most Maine roe is shipped first to Boston and then to New York to be air shipped to Japan. Shipping rates vary somewhat regionally, depending upon both volume, type of pack and airline. A rule of thumb is that airfreight rates to Japan from the West Coast are about one dollar per pound.

B. Harvesting

Harvesting methods for sea urchin are similar in most places, with the bulk of landings taken by divers equipped with scuba gear. Maine is an exception to the rule, in that landings by draggers are also permitted. On the East Coast the procedure for divers is to dive from a smaller diving skiff which is generally transported by a larger vessel (such as a lobster boat) to the grounds. The skiff generally has a tender who watches the diver for safety, hauls totes, among other tasks. Totes are transferred to the mother boat where a culler sorts for size and removes junk. Typically remuneration is based on a share system. A common arrangement is for a 60/40 split between diver and boat owner respectively, out of which the boat owner pays the culler a smaller share or daily wage. Tenders must be licensed and take a safety course and there are no regulations on cullers.

In Maine, a limited entry program was initiated in 1995. The program began with about 3,800 licensed divers. Under the Maine program, licensed divers must take a training/safety course and must be legitimate divers. These training regulations and attrition associated with

declines in catch per unit effort have resulted in a drop in licensed divers to about 1,200, split about evenly between Zones 1 and 2. There has been some discussion of limiting movement between zones in order to control effort. In addition there has been discussion and initiation of several closed seasons, tailored in each zone according to both market conditions and quality of urchin roe.

On the West Coast, diving for urchins is similar except that divers move to and from the grounds in specially constructed urchin diving vessels. Urchin vessels in California average about 25 feet, with a covered cabin in the front and large flat work area in the stern. They are generally powered by a jet drive inboard and they are designed to move to and from diving grounds at high speed. Urchin vessels are generally carry 2-3 men to the grounds, generally a tender and one or two divers, or two divers who alternate diving and tending. When a prospective dive site is reached, the diver or divers begin to collect urchin which they place in totes, generally mesh baskets with hoops made of PVC or pipe. Divers sample under water as they harvest both for minimum size and for roe recovery. The crewman remaining in the skiff watches the scuba gear and for the safety of divers and hauls in the totes. Unlike in Maine, urchin are not sorted aboard the urchin vessel; once they are harvested they are landed. Generally divers dive at depths of from 30-60 feet.

In California, divers must also hold a limited entry permit to dive for urchin. In 1987, when the limited entry program was initiated, 915 divers applied for and were granted licenses. Divers must make at least 20 landings of at least three hundred pounds each during one of the previous two years to renew a license. As a result of this requirement, the number of divers has dropped steadily to a level which, in 1994, reached 550 licensed divers. Licenses are not transferable and current plans in California's limited entry program call for a gradual attrition down to about 300 licensees. During the attrition, provisions have been made to allow access by non-license holders by allocating one new permit for every ten retired as the system contracts.

VI. Summary and Implications for the Maine Industry

In this report, we have compiled and synthesized data and other information from a wide variety of sources. While we have concentrated on the links between the Japanese market and Maine in particular, we have also assembled information about other urchin fisheries with the thought that the readers are likely to be familiar with what is happening in Maine, and less familiar with conditions and practices elsewhere. As discussed in the introduction, our primary charge was to describe how the Japanese market for sea urchin roe operates and explain the links between it and the economic health of the Maine industry.

In many ways, the market for sea urchins is much like the market for any other raw product which eventually finds its way into the retail food market. Raw product prices are determined by supply and demand, and these are driven, in turn, by fundamentals that drive the market for any commodity. At the retail demand level, consumer buying habits and basic preferences, disposable personal income, and prices of other substitute commodities largely determine the price the final product can garner. As the raw product moves up the chain from ex-vessel to processor to exporter to wholesale markets, various conversions are made and charges paid for services and value-added, and these determine the difference between retail and ex-vessel prices. Since this is primarily an export market, the exchange rate is also a vital determinant of prices expressed in U.S. currency.

In other ways, this market is complicated. Japanese food consumption behavior is unfamiliar to Westerners, and the range of products produced from raw urchin is wide. Each of these products has its own sub-market, driven by the same fundamental market forces, but in different ways quantitatively. For example, consumer consumption habits associated with strong

supplies of Japanese urchin in the summer induce some seasonality in the fresh uni market, peaking in summer when quality is highest. In contrast, in the processed market, market fundamentals are relatively constant over the year, except for peaks in June and December, which are associated with wage bonuses and holiday gift giving. We have discussed some of these qualitative patterns in the text, but more understanding could be gleaned by exploring some of the quantitative interrelationships between some of these markets. For example, are there consistent seasonal trends in the prices for imported products and if so, how much could a supplying entity like Maine hope to gain by shifting any annual catches around in order to take advantage of higher prices? Is it worth the trouble? These questions could only be answered with a more refined statistical analysis.

While our task was largely a descriptive one, we realize that the larger questions lying behind this need for information is: how might the Maine sea urchin industry position itself to maximize the value of a raw product in this type of market? Our findings suggest several things. On the one hand, there are some forces about which nothing can be done at the level of the U.S. industry. Exchange rates will always fluctuate and Japanese disposable incomes will also change, reflecting the general health in the economy. Moreover, there is a strong interaction between the supplies of Japanese urchin, their prices, and the prices of imported urchin; when Japanese supplies rise, domestic prices fall, bringing downward pressure on import prices. Hence, there are certain fundamental forces which are among the most important determinants of U.S. prices, but which are outside of the control of anyone in the U.S. industry. It would be useful, again, to have some quantitative understanding of exactly how there fundamental forces affect prices. For example, when Japanese disposable incomes rise or fall, by how much are prices for domestic and imported urchin affected? When Japanese harvests of domestic urchin rise, how much do the prices for local urchin fall, and how do these affect the prices for imported urchin? These questions could be addressed more satisfactorily using the types of econometric models of markets that economists typically use to forecast other commodity markets.

A. Control over Quality

While many forces are indeed beyond control, supplying entities do have some control over the mix and characteristics and the average quality and quantity of the raw product they produce. With respect to quality, as anyone who has participated in the Japanese fish market can attest, quality has a payoff in higher prices, other things equal. Japanese consume a large proportion of protein in fish products, and the spectrum of products sold and consumed is very wide. While average consumers are not often able to discriminate finely across species, origin, and freshness for ordinary processed products or products bought in food supermarkets, they expect and trust that food consumed in quality settings such as high-end restaurants and sushi bars is indeed high quality. In this sense, Japanese food consumption behavior is no different from U.S. consumers purchasing beef. In the U.S., while most retail consumers cannot distinguish between choice and prime grade meat in the market, we expect that a meal in a high-priced steak house would serve prime quality beef. It is the wholesaler segment of the market that grades, sorts, and distributes different qualities of raw product into the various sub-markets according to the willingness to pay of consumers of the final products and Japanese wholesalers who are skilled judges of quality. In the end, higher qualities of raw product, regardless of product type, garner higher wholesale prices, particularly in the Japanese market for fish.

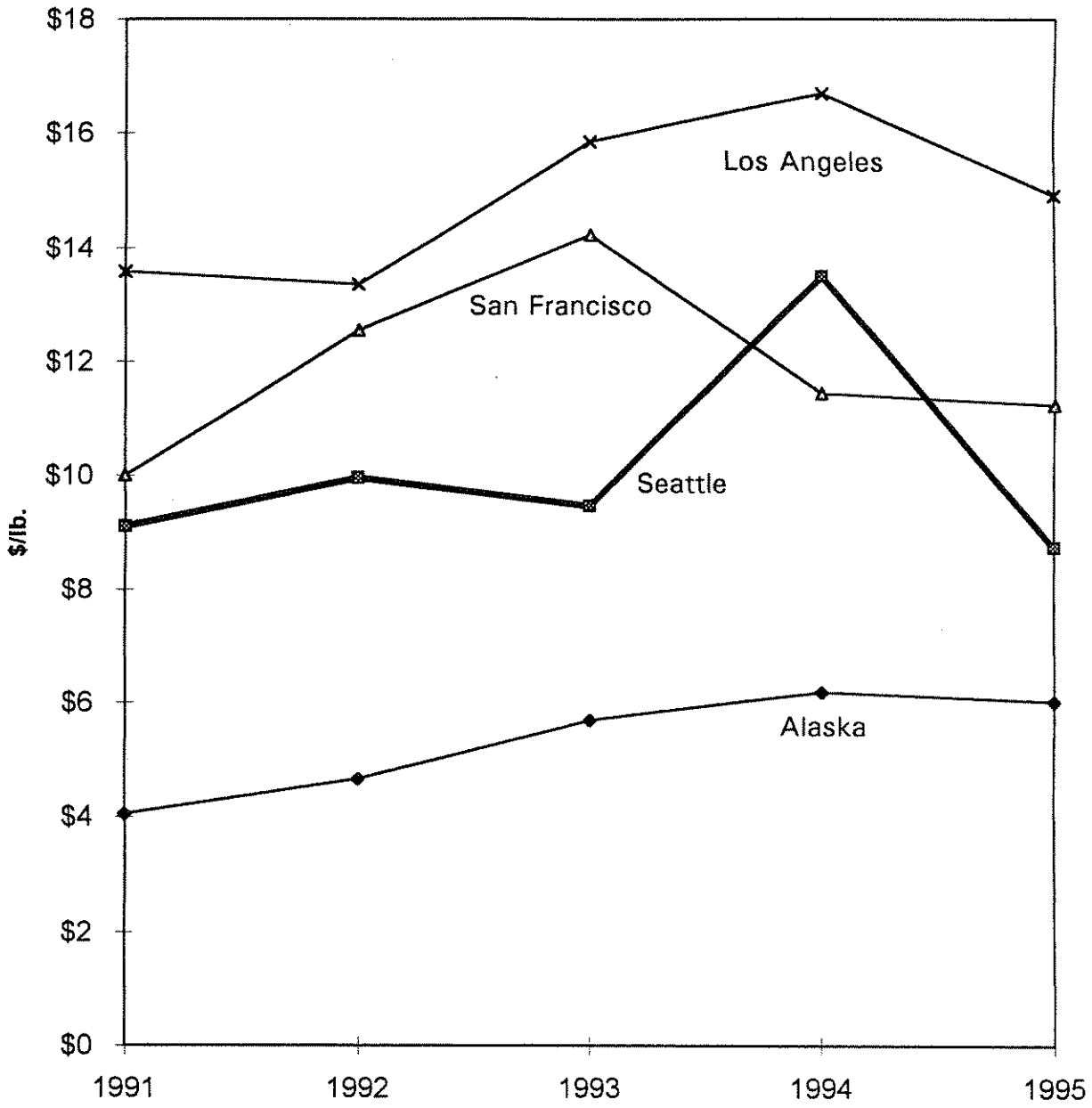
As discussed earlier, fresh raw urchin from Japanese sources command the highest prices, on the order of double imported roe. Knowledgeable buyers suggest that there is both an element of quality and also of pure preference for "local" products in this substantial price premium. This has important implications for the maximum prices that non-local suppliers might expect to achieve. On the one hand, if the chauvinistic preference for Japanese products is rigid, then non-Japanese suppliers might never expect to achieve prices close to those garnered for local product, even if they can deliver a virtually identical product. On the other hand, if the price difference is primarily one of quality differences, there may be ways to narrow, if not fully close, the gap. Maine is well-poised in this market since green urchin are similar to those species that command

the highest Japanese domestic prices. But there are some logistic limits which ultimately will prevent Maine's roe from competing head to head with the best Japanese roe; it is, after all, essentially impossible to get fresh Maine roe into the Tokyo market as quickly as Japanese roe is delivered. Shipping and handling time drives an irreducible wedge between these products in the end. Of interest is the quantitative importance of this and whether it would be cost effective to try alternatives. Quantitative marketing analysts have some experience with these types of questions. For example, some work has been done using conjoint analysis techniques (Kusakabe and Anderson, 1994), which essentially attempts to uncover how much more market participants would be willing to spend for various changes in product quality.

Despite the inherent difficulty (and perhaps impossibility) of approaching the market for the highest priced wholesale products in Japan, it is obvious that forces are already operating to improve value-added in Maine's industry. When Maine's industry began several years ago, conditions at both harvesting, processing, and handling were somewhat chaotic as always occurs in any new market. Competitive forces ensure that participants learn, of course, and generally only those who learn and adapt and find niches survive. There has, in fact, been considerable shake out in this industry over the past year or two as urchin densities have begun to thin out and as profit margins have been squeezed from various market forces. During this period, buyers, processors and handlers have learned more about the intricacies of the Japanese market and how to serve various segments of that market. The success of this learning exercise is reflected in the meteoric rise in the unit value of urchin products shipped out of the East Coast. As Figures 17 and 18 show, for example, the value of exports, per pound of product shipped out of Boston and New York, has increased four to five-fold between 1991 and 1995. This equals or surpasses the more mature suppliers' prices, such as those in California. What this shows, quite simply, is that as the industry has matured and as knowledge has accumulated, more value added has accrued as a result of market forces operating in a competitive environment.

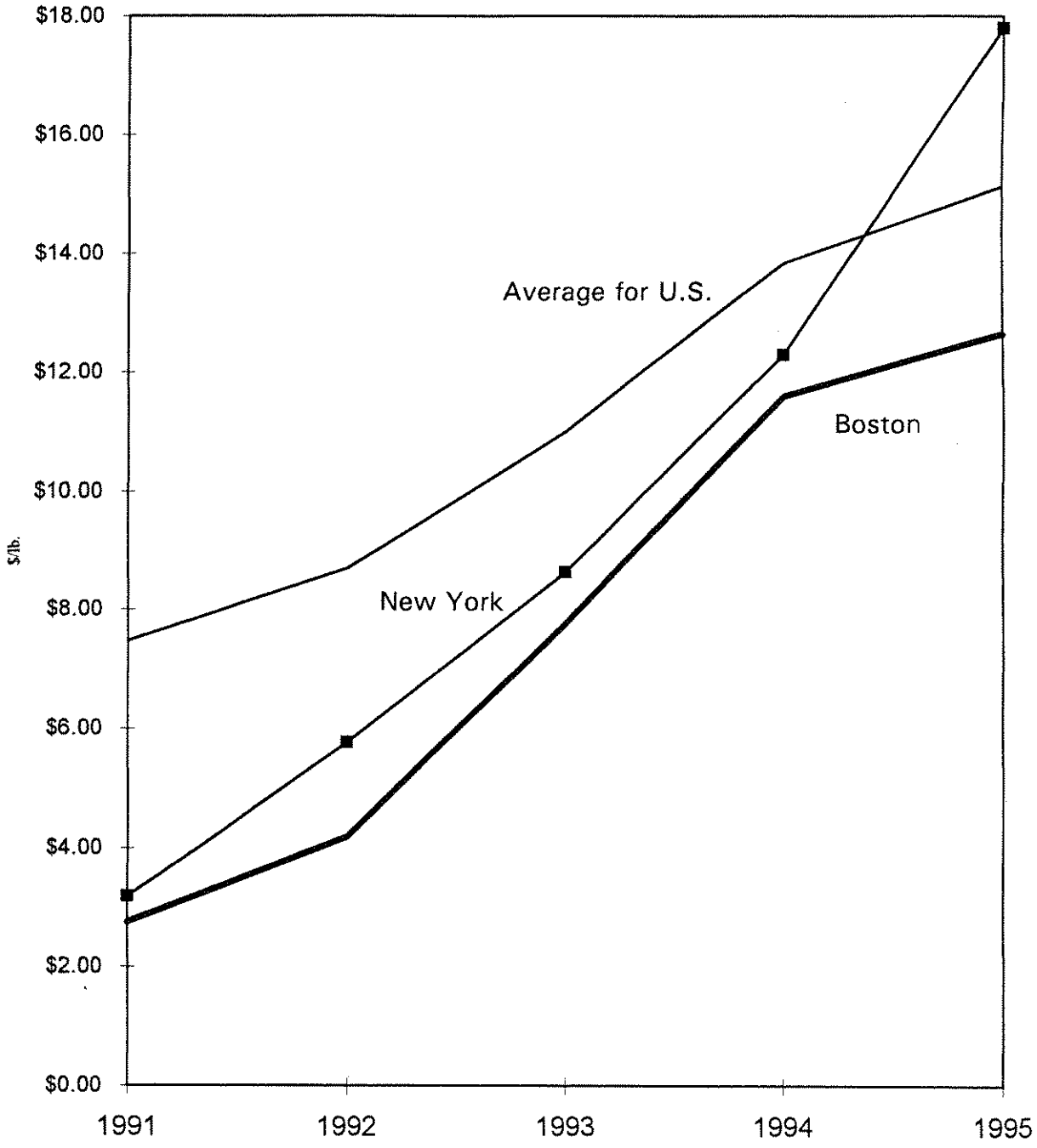
One last point to make regarding quality is that it is easy to forget that there are markets for all types and qualities of raw product. Each has its own potential profit margin and it is not

Figure 17. U.S. Export Prices (fas) to Japan for Fresh Sea Urchin Roe, by Port of Departure, 1991 -1995



Source: U.S. Bureau of the Census

Figure 18. U.S. Export Prices (fas) to Japan for Fresh Sea Urchin Roe, by Port of Departure, 1991 - 1995



Source: U.S. Bureau of the Census

necessarily the case that aiming for the very highest priced end-market is the most profitable strategy for any given supplier. This is because costs of serving different markets vary; simply cracking and freezing roe into blocks is less costly than the labor intensive process of hand sorting and packing for the high-end restaurant trade. Without a very detailed quantitative analysis of the margins for different raw products, it would be difficult to judge whether the industry in Maine is doing the best it can with its resource. Such an analysis would require a more intensive look at the absorptive capacity of various markets for end products in Japan and a detailed look at the costs of processing for these different markets in the U.S.

B. Control over Quantity

Besides quality of the raw product, the other important determinant of the value of earnings from the Maine resource is quantity. Quantity harvested is not independent of quality, of course, and both are inextricably linked up to the biology of the urchin. There are a few general points to be gleaned from our comparison of the workings of urchin fisheries in different regions with what is happening in Maine. First, as everyone understands, the question of maintaining value in this resource is both one of understanding the biology and the market economics. We have brought together a considerable amount of information about what is happening in other areas that are producing urchin products. Some regions have been successful in maintaining both sustainable supplies and high-valued products. In other areas, there are alarming signs of declines in the fisheries. Important and heated debates have arisen in nearly all areas about when declines in catch per unit effort reflect over-harvesting and when they simply reflect "fishing down" previously under-exploited stocks. This is an issue of vital importance and efforts need to be made to continue research into not only local conditions but also conditions unfolding elsewhere so that the Maine industry benefits from a broad range of experience.

Among the several urchin fisheries examined, the range of regulations is surprisingly varied. Virtually all impose a minimum size limit; most are larger than Maine's but Japanese

fisheries generally harvest smaller urchin in their local fisheries. Some impose an additional maximum size limit, reflecting thinking that larger urchin are more effective spawners and that they may provide canopy protection for juveniles. We did not find any fisheries that attempt to regulate roe content. Instead, most let the market dictate quality by providing recovery bonuses of various types. Most urchin fisheries also have imposed limits on effort, generally through a limited entry program. Most of these limited entry programs have kept the fishery considerably smaller than Maine's program, both absolutely and on a basis relative to the resource size. Most also utilize closed seasons, a two-edged regulation that protects urchin during spawning and also shifts effort into periods when roe condition is higher. A few regions are using or are contemplating experimenting with rotating harvest zones and closed areas.

On the minimum size issue, not too much can be concluded without more quantitative understanding of the bioeconomic implications of changing size limits. It seems reasonable to believe, however, that there is not too much to gain in the market by reducing the minimum size. Most processors believe that, at least for the higher grade roe, processing costs increase substantially as urchin get smaller. Whether minimum sizes should be increased is a more difficult issue, and one not easily addressed without more analysis. It could very well be the case that sustainable landings could be increased with a larger gauge after some reduction in landings during the transition phase. This is a complicated issue, however, and one which can only be addressed by biologists and economists with the best available bioeconomic modeling capabilities. We would expect that the Japanese market could absorb increased supplies from Maine without causing prices to fall to the point that revenues drop, but again, without further quantitative analysis of the market, it is difficult to be definitive about this.

With respect to regulations on roe content, as discussed above, we found little interest in such an idea in other supplier regions. From a biological point of view, it makes no difference whether low content or high content urchin are taken, provided that constraints are established on overall harvest levels to ensure adequate recruitment. Most believe that implementing roe content regulations would be difficult to monitor and enforce. In addition, the evidence from elsewhere

is that the market provides incentives to increase roe quality through bonuses and incentives. The extent of these practices vary both from fishery to fishery and often within a fishery by processor. However, there is good evidence that processors will provide the incentives to attract higher quality when it is worth it in terms of wholesale value. In California, divers seem to be shifting diving tactics away from a quantity focus towards a value focus as the resource thins out. Many concentrate on finding patches with smaller numbers of high-value urchins rather than large quantities in poor condition. An issue in Maine is whether it is possible to discover and promote value-oriented behavior among divers. This is partly an issue of science, partly an issue of diver knowledge, and partly one of incentives. Scientists might help, for example, by teaming up with divers to learn about and characterize the conditions under which urchin might be found in uniformly higher quality. Experiments might also be designed which essentially explores how to optimally sample in a setting where quality is unknown. In principle, this is a problem similar to quality control problems typically solved on assembly lines.

C. Summary

In sum, there is much to be learned by both qualitative and quantitative analysis of the urchin market, and by observing the outcomes of management experiments in other urchin fisheries. In most cases, one can never hope to understand every component of these complicated bioeconomic systems with precision. However, there are broad forces operating in the system at large, and many of these are well-exploited already by the industry in Maine. The industry is going through a maturation process that other areas have already gone through, and it is evident that much learning has taken place, over the past couple of years in particular. What fine tuning needs to take place at this point is an open question. Some arenas of further study that would be informative include:

1. More thorough understanding of the intricacies of the first and second tiers of the market in Japan, including product types and final destinations, market size and potential, principle substitute products, other suppliers, marketing chains, and links between and among buyers and sellers, *etc.* This might be handled with a "trade mission" type of visit to Japan, perhaps including representatives from different parts of the industry, managers and fisheries market analysts.

2. Quantitative analysis of the nature of seasonality in prices and interrelationships between local product and import prices. A basic wholesale demand analysis (of the type done by Wessells and Wilen 1994) would be useful, for example. This would clarify whether there are significant marketing opportunities that might exist that could be earned by simply shifting the pattern of Maine's harvest over the season. It might also explore the relationship between the need to have continuous market presence and the benefits of fitting peak periods.

3. Exploration of the nature of the market bias against imported products. Is the price differential between Japanese and imported urchin something that can be reduced by better quality or is it immutable? Some analysis such as Kusakabe and Anderson's 1994 conjoint analysis might be helpful here. Is there anything that can be done to improve and speed delivery of Maine's product and would it ultimately pay?

4. Understanding whether there are more effective ways of sorting at-sea for higher quality would be helpful. Are green urchins of uniform quality in each patch? Is there a way to sample efficiently (on the seabed or on board?) in order to improve landed quality? Would scientific sampling and diver education programs help?

5. Determining the optimal minimum size needs to be pursued, perhaps with a long term

sampling and modeling program. The current size may not be resulting in large amounts of foregone revenues, although one could not be certain without quantifying various dimensions of quality and the sorting through exactly how important size is. Casual observations suggests that Maine urchins are already the most similar to Japanese urchins. While there may be no compelling justifications for reducing the minimum size, there may be gains from increasing it. This could be investigated by examining processing cost differences associated with larger urchins; perhaps a comparison of packing, sorting, and handling productivity per laborer with other areas. An attendant issue is whether there are gains in the spawning biomass to be earned as a result of gauge increases, and how large these might be.

References

Bill Atkinson's News Report (BANR), various issues. B. Atkinson, ed., Seattle, WA.

Canadian Embassy, *Japan Fisheries Market Report*, 1988 - 1994. Prepared by the Agriculture, Fisheries & Consumer Products Section, Tokyo, Japan.

Food and Agriculture Organization of the United Nations, various years. *Yearbook of Fisheries Statistics, Catches and Landings*, Rome, Italy.

Japan Marine Products Importers Association, various years. *Japanese Imports of Marine Products (Statistics)*. Tokyo, Japan.

Japanese External Trade Organization (JETRO). 1990. "Access to Japan's Import Market: The Japanese Market for Mollusks," *Tradescope*, October.

International Monetary Fund, various years. *International Financial Statistics*.

Kusakabe, Y. and J.L. Anderson, 1994. "Conjoint Analysis of the Japanese Salmon Market," In: *Proceedings of the Sixth Conference of the International Institute of Fisheries Economics and Trade, Volume I*, eds. Antona, M., J. Catanzano, and J.G. Sutinen, International Institute of Fisheries Economics and Trade, France:427-436.

Phu, Chi H. 1990. "The U.S. Sea Urchin Industry and its Market in Tokyo," NOAA Technical Memorandum, NOAA-TM-NMFS-SWR-025, August.

Province of British Columbia, various issues. *Fisheries Production Statistics of British Columbia*. Commercial Fisheries Branch, Aquaculture and Commercial Fisheries Branch, British Columbia, Canada.

Reynolds, Julie. 1994. "Economic Analysis of Factors Affecting Prices and Costs in the California Sea Urchin Fishery," M.S. Thesis, Department of Ecology, University of California, Davis.

Seafood Market Analyst. 1996. *1995 Year in Review: U.S. Seafood Trade Report.*

Sonu, Sunee C. 1995. "The Japanese Sea Urchin Market," NOAA Technical Memorandum, NOAA-TM-NMFS-SWR-030, December.

Statistics Bureau, Management and Coordination Agency, various years. *Annual Report on the Family Income and Expenditure Survey*. Japan.

Tokyo Central Wholesale Market, various years. *Tokyo Central Wholesale Market Yearbook: Seafood*, Tokyo, Japan.

United States Bureau of the Census, various years. U.S. *Export Statistics*. Washington D.C.

United States Department of Commerce, National Oceanic and Atmospheric Adminstration, National Marine Fisheries Service, Fisheries Statistics Division, various issues. *Fisheries of the United States*. Washington, D.C.

Washington State Department of Fish and Wildlife, various years. *Washington State Statistical Report*, Olympia, WA.

Wessells, C. R. and J.E. Wilen. 1994. "Seasonal Patterns and Regional Preferences for Seafood in Japan," *Canadian Journal of Agricultural Economics*, 42:87-103.

(This page intentionally left blank)

Appendix A

Summaries of Sea Urchin Regulations

Our findings regarding regulations are germaine to current discussions involving regulation options in the Maine fishery. In nearly all producing regions, rapid industry growth has been followed by declines in catch per unit effort. This is exactly what would be expected as unexploited fisheries become subject to harvesting but at issue is how far to let the process go before curtailing harvest pressures. We have found that most producing regions have adopted various forms of regulations in order to reduce some of the pressures that developed in the late 1980s as export markets developed strength. Most of these regulations have been adopted in the face of considerable uncertainty about the biology and population dynamics of sea urchin. While there has been a substantial amount of new research initiated during the past decade, most biologists will admit that the behavior of sea urchin is poorly understood. In the face of this uncertainty, most biologists have promoted safety first policies as evidence has begun to accumulate about declining abundance. Although there is always debate over when and how much to apply the brakes, in areas where industry representatives are consulted over regulatory measures, the case for some effort regulations has generally been persuasive and often promoted by the industry.

In brief and preliminary form, we outline below the structure of current regulatory measures that have been adopted in various areas where sea urchin harvesting takes place.

Japan

Sea urchin harvesting is regulated by an overlapping institutional arrangement of shared governance between governmental regulatory agencies and local fishery cooperatives. Sea urchin are harvested by divers, and typical regulations include limits on minimum size, on area of harvests, and on open seasons. The region responsible for the largest percentage of catch (Hokkaido) has a minimum size limit imposed of 4 centimeters. Interestingly, almost 40% of the cooperatives have imposed more stringent minimum size limits, with the aim of both improving marketability and curtailing harvests. In the Hokkaido region, 10% of the coops have imposed minimum size limits of 4.5 centimeters, 24% have imposed size limits of 5 centimeters, and about 5% have higher size limits.

California

Sea urchin harvesting is restricted to diving. A limited entry program has been in existence since the mid 1980s and currently there are about 435 licensed divers. Seasonal restrictions are in force in both Southern and Northern California, with closed periods targeted for the summer when prices are low and sea urchin arespawningg. As of 1989, minimum harvestable size was set at 7.6 centimeters (3"). This was increased in 1992, to 83 millimeters (.325 inches) in Southern California, and 89 millimeters (3.5 inches) in Northern California. Recently, more stringent closures have been proposed for Northern California in the face of precipitous reductions in catch per diver hour (40% since 1988). Industry representatives and State biologists are also examining measures including rotating harvesting zones and maximum size limits. The later suggestion has been proposed because there is some evidence that larger urchin provide canopy cover for larvae in addition to more substantive fecundity.

Washington

Regulations were first adopted in 1986 aimed at ensuring sustainable supplies of high quality urchins. Both red and green urchins are harvested in Washington. A limited entry program is in effect, limiting participation to about 70 boats that harvest with divers. The State of Washington divided state waters into 5 roughly equal regions in 1987 and harvesting takes place on 3 year cycles. Seasons generally are open during the winter and early spring period to maximize ex vessel values. Total harvest restrictions were adopted in 1988-89 and were supplemented with size-based quotas in 1993-94. Size limits are designed to protect the smallest and largest 20% of the population. The current size "windows" in place are 102-140 millimeters. in San Juan Districts 1 and 2, and a 83-114 millimeters window in the remaining 3 regions.

Alaska

Harvesting in Alaska in carried out by divers but the industry is currently fairly underdeveloped. Both red and green urchin are harvested and there is currently no limited entry program in place. The Alaska Department of Fish and Game has imposed a harvesting size window of 76-114 millimeters (3-4.5") on red urchin. The green urchin industry is very small at present and not regulated.

Oregon

The industry in Oregon is currently small although participants are confident in its future. In 1988 the Oregon Department of Fish and Wildlife, in consultation with industry representatives, imposed a conservation program on the industry. Regulations include a

limited entry program restricting participation to 92 non-transferable permit holders. A minimum size of 3" is imposed.

British Columbia, Canada

British Columbia harvests both red and green urchin. License limitation was introduced in 1991, with 83 licenses allocated to harvest red urchin and 38 to harvest green urchin. Red urchin landings climbed steadily to a level of about 3000 metric tons in 1990 whereas green urchin landings have leveled off to about 500 tons. Along the North Coast of British Columbia, there are regional quota targets for red urchin which are achieved with staggered openings between October 15 and February 15 to maximize market value. Along the North Coast of British Columbia, red sea urchin are not managed with quotas and closures but instead with rotational harvesting. Green urchin are managed with a season open between October 15 and February 15 and with area quotas. In addition to closures and limited entry, urchin harvesting is regulated with size limits. Green urchin must be at least 55 millimeters (2.145 inches) to be legally landed and red urchin must fall within a 100-140 millimeters (4-5.5 inches) window.

These size regulations are summarized in Table A1.

Appendix Table A1
Sea Urchin Harvesting Regulations
(Size Regulations)

Japan - Hokkaido Cooperatives: *Green urchins*

61.5% cooperatives require greater than 4.0 cms (1.56 inches)
10.1% cooperatives require greater than 4.5 cms (1.75 inches)
23.9% cooperatives require greater than 5.0 cms (1.95 inches)
4.5% cooperatives require greater than 5.5 cms (2.15 inches)

California: *Red urchins*

Southern California greater than 83% (3.25 inches)
Northern California greater than 89% (3.5 inches)

Oregon: *Red/green urchins*

3 inch minimum

Washington: *Red/green urchins*

San Juan Districts - between 10.2 - 14 cms (4 - 5.6 inches)
Other Districts - between 8.3 - 11.4 cms (3.3 - 4.5 inches)

Alaska: *Red urchins*

Between 7.6 - 11.4 cms (3 - 4.5 inches)

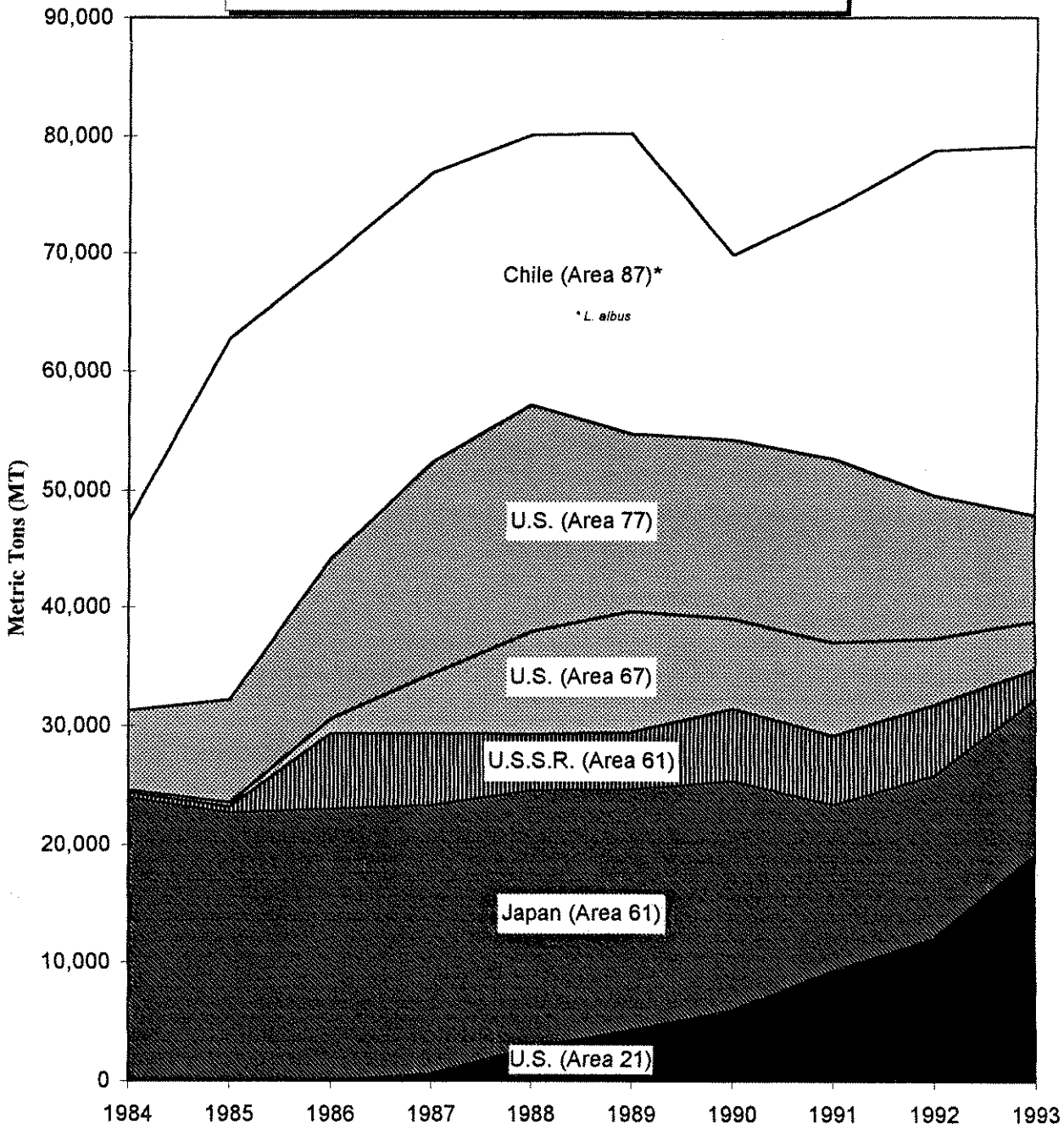
British Columbia

North Coast: *Red urchin* - between 10 - 14 cms (4 - 5.5 inches)
Green urchin - at least 5.5 cm (2.145 inches)

Appendix B

Additional Figures

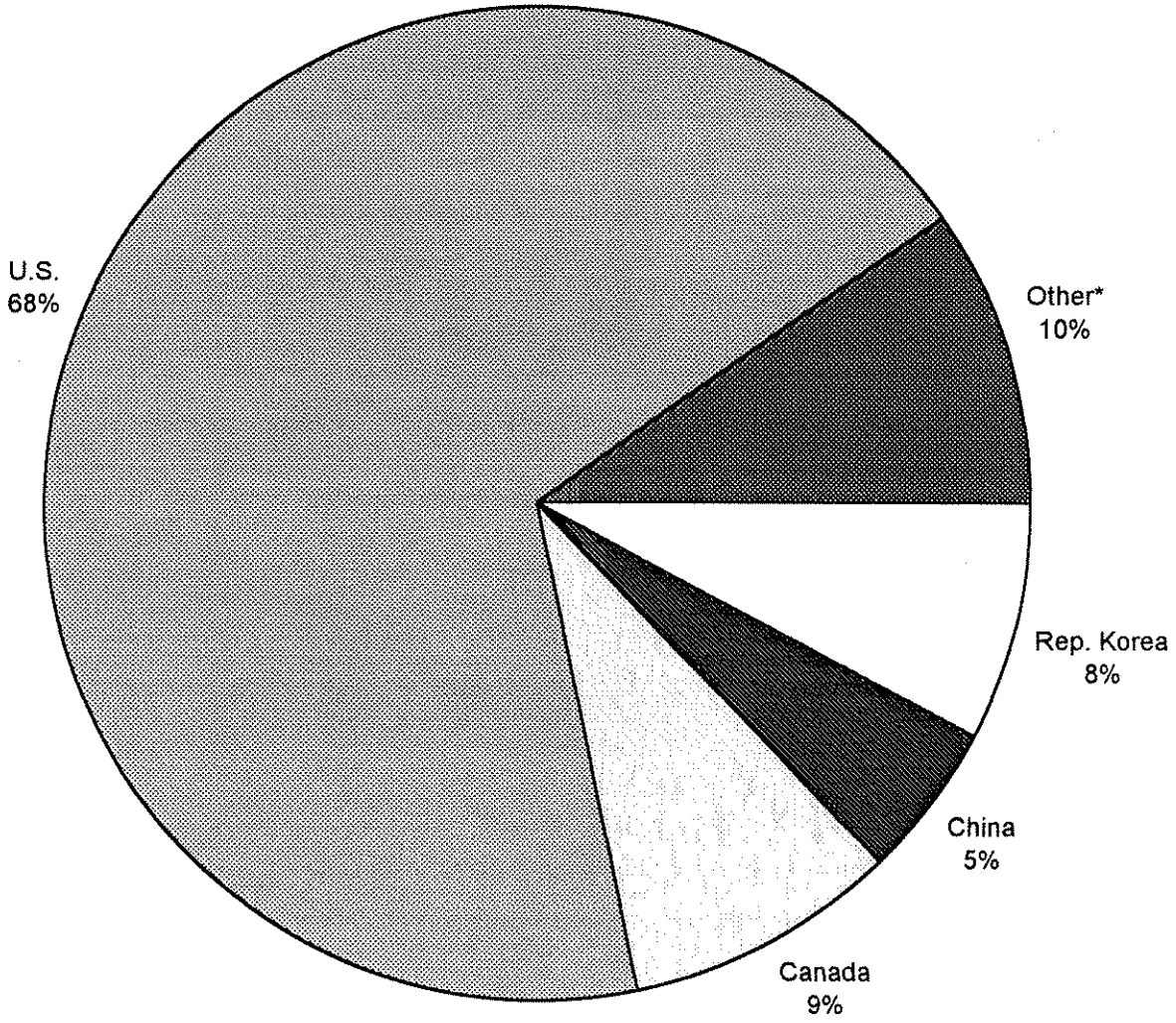
Figure B1. World Landings of Sea Urchin (*Strongylocentrus spp.* and *Loxiechinus albus*) by Major Country and Area 1984 - 1993



Area 21: NW Atlantic; Area 67: NE Pacific
Area 61: NW Pacific; Area 77: E. Central Pacific
Area 87: SE Pacific

Source: FAO, *Yearbook of Fisheries Statistics, Catches and Landings, 1993.*

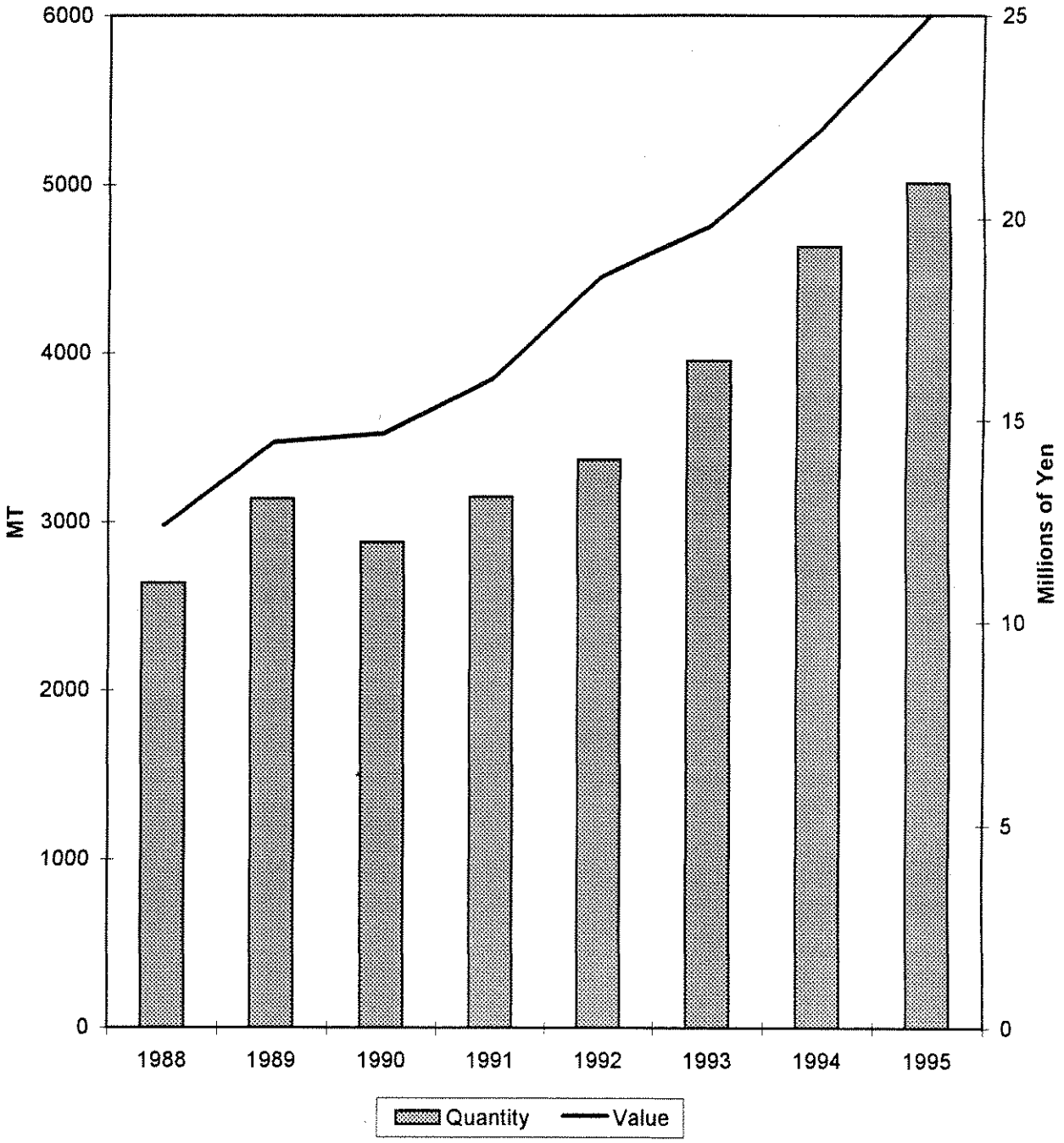
Figure B2. Japanese Imports of Fresh/Chilled Sea Urchin Roe, by Major Source - 1995



* Other includes: Taiwan, Hong Kong, Philippines, Indonesia, Norway, Iceland, Russia, Chile, Australia, New Zealand

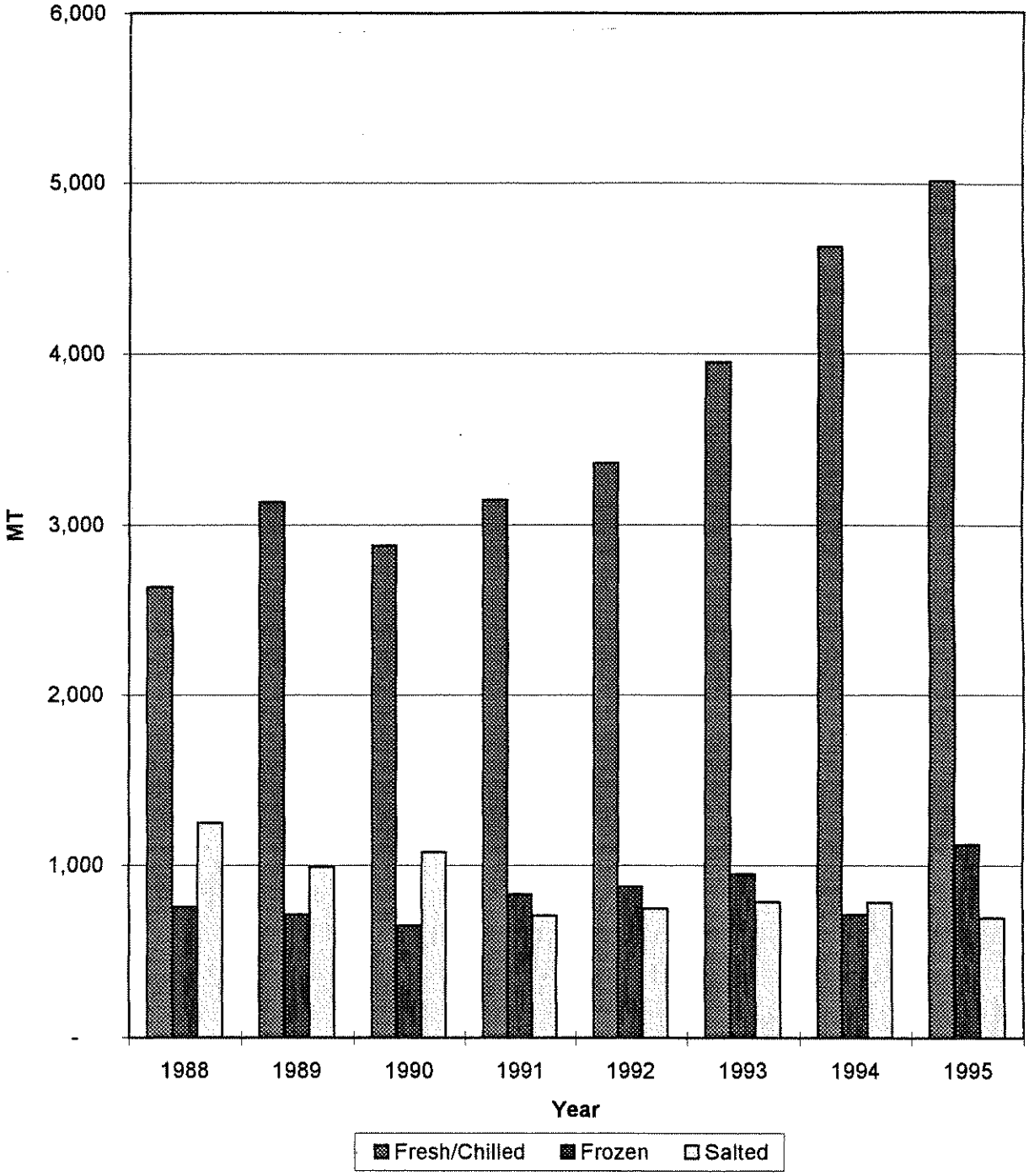
Source: Japanese Marine Product Importers Association, 1994

Figure B3. Annual Japanese Imports of Fresh/Chilled Sea Urchin Roe from All Sources, 1988 - 1995



Source: Japanese Marine Product Importers Association, various years

Figure B4. Japanese Imports of Sea Urchin, by Product Type 1988 - 1995



Source: Japan Marine Product Importers Association

Appendix C

Tables of Data Used in Figures

Table C1: World Landings of Sea Urchin, *Stronglycentrotus spp. (metric tons)*

Year	Canada	U.S.	Japan	U.S.S.R.	Chile*	World Landings
1984		6,901	23,962	436	16,154	47,453
1985		8,941	22,745	514	30,577	62,777
1986		14,749	23,072	6,328	25,408	69,557
1987	47	23,526	22,760	6,030	24,574	76,937
1988	63	30,589	21,812	4,735	22,953	80,152
1989	29	29,504	20,414	4,770	25,527	80,244
1990	109	28,726	19,398	6,065	15,648	69,946
1991	290	32,722	14,136	5,777	21,382	74,307
1992	575	29,848	13,889	5,917	29,197	79,426
1993	1,002	32,369	13,173	2,460	31,300	80,304

**Loxechinus albus*

Source: FAO, *Yearbook of Fisheries Statistics, Catches and Landings,* 1993

Table C2. Japanese Sea Urchin Landings, 1956 - 1993

Year	Landings (mt)
1956	14,077
1957	9,225
1958	12,288
1959	13,973
1960	15,871
1961	15,865
1962	16,477
1963	19,302
1964	20,655
1965	20,722
1966	23,219
1967	23,362
1968	26,977
1969	27,528
1970	27,177
1971	25,434
1972	22,686
1973	26,004
1974	23,573
1975	22,482
1976	23,069
1977	26,898
1978	25,930
1979	26,500
1980	24,158
1981	23,984
1982	25,975
1983	25,254
1984	23,962
1985	22,745
1986	23,072
1987	22,760
1988	21,812
1989	20,414
1990	19,398
1991	14,136
1992	13,889
1993	13,713

Source: Japan, Ministry of Agriculture, Forestry, and Fisheries 1967-1995

Table C3. Sea Urchin Landings in Northern and Southern California, 1972 - 1995 (metric tons)

Year	Northern California*	Southern California**	Total
1972		34.7	34.7
1973	4.9	1,629.1	1,634.0
1974	23.4	3,207.5	3,230.9
1975	1.4	3,438.2	3,439.6
1976	43.1	5,005.3	5,048.4
1977	175.5	7,341.0	7,516.5
1978	23.5	6,534.5	6,558.0
1979	107.4	9,237.6	9,345.0
1980	95.1	9,980.9	10,076.0
1981	105.8	11,929.4	12,035.2
1982	22.9	8,417.2	8,440.1
1983	17.4	7,166.7	7,184.1
1984	28.8	6,650.4	6,679.2
1985	874.4	8,214.2	9,088.6
1986	4,624.7	10,889.2	15,513.9
1987	10,709.2	10,226.4	20,935.6
1988	13,060.5	9,427.1	22,487.6
1989	12,180.4	11,086.6	23,267.0
1990	8,296.6	12,280.5	20,577.1
1991	7,623.0	11,439.7	19,062.7
1992	5,516.7	9,145.7	14,662.4
1993	3,279.3	8,762.4	12,041.7
1994	2,634.6	8,081.1	10,715.7
1995	2,178.2	7,424.1	9,602.3

*Northern California includes Eureka, San Francisco and Monterey districts
**Southern California includes Santa Barbara, Los Angeles and San Diego districts

Source: California Department of Fish and Game

Table C4. Japanese - U.S. exchange rates

Month/Year	Yen/$	$/100 Yen	Month/Year	Yen/$	$/100 Yen	Month/Year	Yen/$	$/100 Yen	Month/Year	Yen/$	$/100 Yen
Jan'1980	238.00	0.42	Apr'1984	225.02	0.44	Jul'1988	133.06	0.75	Oct'1992	121.14	0.83
Feb'1980	244.06	0.41	May'1984	230.81	0.43	Aug'1988	133.58	0.75	Nov'1992	123.82	0.81
Mar'1980	248.60	0.40	Jun'1984	233.22	0.43	Sep'1988	134.58	0.74	Dec'1992	123.95	0.81
Apr'1980	251.44	0.40	Jul'1984	242.72	0.41	Oct'1988	129.31	0.77	Jan'1993	125.02	0.80
May'1980	228.14	0.44	Aug'1984	242.30	0.41	Nov'1988	123.30	0.81	Feb'1993	120.97	0.83
Jun'1980	218.09	0.46	Sep'1984	245.31	0.41	Dec'1988	123.55	0.81	Mar'1993	117.02	0.85
Jul'1980	220.48	0.45	Oct'1984	246.89	0.41	Jan'1989	127.12	0.79	Apr'1993	112.37	0.89
Aug'1980	224.38	0.45	Nov'1984	243.29	0.41	Feb'1989	127.93	0.78	May'1993	110.21	0.91
Sep'1980	214.95	0.47	Dec'1984	247.97	0.40	Mar'1989	130.33	0.77	Jun'1993	107.29	0.93
Oct'1980	209.27	0.48	Jan'1985	254.13	0.39	Apr'1989	131.97	0.76	Jul'1993	107.77	0.93
Nov'1980	213.06	0.47	Feb'1985	260.34	0.38	May'1989	138.08	0.72	Aug'1993	103.72	0.96
Dec'1980	209.90	0.48	Mar'1985	258.44	0.39	Jun'1989	143.91	0.69	Sep'1993	105.25	0.95
Jan'1981	202.20	0.49	Apr'1985	251.67	0.40	Jul'1989	140.67	0.71	Oct'1993	106.94	0.94
Feb'1981	205.76	0.49	May'1985	251.86	0.40	Aug'1989	141.19	0.71	Nov'1993	107.85	0.93
Mar'1981	209.01	0.48	Jun'1985	248.92	0.40	Sep'1989	145.06	0.69	Dec'1993	109.69	0.91
Apr'1981	215.07	0.46	Jul'1985	241.69	0.41	Oct'1989	142.14	0.70	Jan'1994	111.54	0.90
May'1981	220.78	0.45	Aug'1985	237.20	0.42	Nov'1989	143.55	0.70	Feb'1994	106.16	0.94
Jun'1981	224.14	0.45	Sep'1985	237.23	0.42	Dec'1989	143.74	0.70	Mar'1994	105.12	0.95
Jul'1981	232.48	0.43	Oct'1985	214.91	0.47	Jan'1990	145.18	0.69	Apr'1994	103.48	0.97
Aug'1981	233.62	0.43	Nov'1985	204.34	0.49	Feb'1990	145.46	0.69	May'1994	104.00	0.96
Sep'1981	229.83	0.44	Dec'1985	202.75	0.49	Mar'1990	153.19	0.65	Jun'1994	102.69	0.97
Oct'1981	231.42	0.43	Jan'1986	200.10	0.50	Apr'1990	158.61	0.63	Jul'1994	98.54	1.01
Nov'1981	223.79	0.45	Feb'1986	184.60	0.54	May'1990	153.23	0.65	Aug'1994	99.86	1.00
Dec'1981	219.02	0.46	Mar'1986	178.78	0.56	Jun'1990	153.76	0.65	Sep'1994	98.79	1.01
Jan'1982	224.68	0.45	Apr'1986	175.57	0.57	Jul'1990	149.25	0.67	Oct'1994	98.40	1.02
Feb'1982	235.31	0.42	May'1986	166.84	0.60	Aug'1990	147.52	0.68	Nov'1994	99.18	1.01
Mar'1982	240.62	0.42	Jun'1986	167.83	0.60	Sep'1990	138.92	0.72	Dec'1994	101.43	0.99
Apr'1982	244.29	0.41	Jul'1986	158.65	0.63	Oct'1990	129.76	0.77	Jan'1995	99.00	1.01
May'1982	236.97	0.42	Aug'1986	154.11	0.65	Nov'1990	128.93	0.78	Feb'1995	100.04	1.00
Jun'1982	251.11	0.40	Sep'1986	154.78	0.65	Dec'1990	133.73	0.75	Mar'1995	91.93	1.09
Jul'1982	254.96	0.39	Oct'1986	156.05	0.64	Jan'1991	133.59	0.75	Apr'1995	83.67	1.20
Aug'1982	258.69	0.39	Nov'1986	162.68	0.61	Feb'1991	130.53	0.77	May'1994	85.10	1.18
Sep'1982	262.74	0.38	Dec'1986	162.24	0.62	Mar'1991	136.95	0.73	Jun'1995	84.53	1.18
Oct'1982	271.31	0.37	Jan'1987	154.48	0.65	Apr'1991	136.98	0.73	Jul'1995	87.22	1.15
Nov'1982	265.42	0.38	Feb'1987	153.49	0.65	May'1991	138.04	0.72	Aug'1995	94.55	1.06
Dec'1982	242.82	0.41	Mar'1987	151.57	0.66	Jun'1991	139.80	0.72	Sep'1995	100.49	1.00
Jan'1983	232.95	0.43	Apr'1987	142.95	0.70	Jul'1991	138.00	0.72	Oct'1995	100.65	0.99
Feb'1983	236.19	0.42	May'1987	140.48	0.71	Aug'1991	136.85	0.73	Nov'1995	101.92	0.98
Mar'1983	237.96	0.42	Jun'1987	144.52	0.69	Sep'1991	134.59	0.74	Dec'1995	101.81	0.98
Apr'1983	237.70	0.42	Jul'1987	150.20	0.67	Oct'1991	130.90	0.76	Jan'1996	105.84	0.94
May'1983	234.88	0.43	Aug'1987	147.58	0.68	Nov'1991	129.64	0.77	Feb'1996	105.73	0.09
Jun'1983	240.02	0.42	Sep'1987	143.05	0.70	Dec'1991	128.08	0.78	Mar'1996	105.82	0.95
Jul'1983	240.49	0.42	Oct'1987	143.42	0.70	Jan'1992	125.05	0.80	Apr'1996	107.46	0.93
Aug'1983	244.36	0.41	Nov'1987	135.42	0.74	Feb'1992	127.53	0.78	May'1996	106.45	0.94
Sep'1983	242.67	0.41	Dec'1987	128.30	0.78	Mar'1992	132.75	0.75	Jun'1996	108.86	0.92
Oct'1983	233.01	0.43	Jan'1988	127.41	0.78	Apr'1992	133.59	0.75	Jul'1996	109.32	0.91
Nov'1983	235.12	0.43	Feb'1988	129.28	0.77	May'1992	130.67	0.77	Aug'1996	107.75	0.93
Dec'1983	234.39	0.43	Mar'1988	127.44	0.78	Jun'1992	126.91	0.79	Sep'1996	109.75	0.91
Jan'1984	233.95	0.43	Apr'1988	124.84	0.80	Jul'1992	125.66	0.80	Oct'1996	112.36	0.89
Feb'1984	233.64	0.43	May'1988	124.74	0.80	Aug'1992	126.34	0.79	Nov'1996	112.26	0.89
Mar'1984	225.52	0.44	Jun'1988	126.84	0.79	Sep'1992	122.67	0.82	Dec'1996	113.76	0.88

Source: International Monetary Fund, *International Financial Statistics*, various years.

Table C5. U.S. Landings of Sea Urchin, by Coast 1984 -1993

Year	West Coast	East Coast
1984	6,878	23
1985	8,941	-
1986	14,744	5
1987	22,873	653
1988	27,767	2,822
1989	25,178	4,326
1990	22,699	6,027
1991	23,386	9,336
1992	17,809	12,039
1993	13,132	19,237

Source: United Nations, Food and Agriculture Organization, *Yearbook of Fisheries Statistics, Catches and Landings, 1993.*

Table C6. U.S. Sea Urchin Landings by State (metric tons)

Year	California	Maine
1987	20,936.0	616.4
1988	22,487.6	2,107.0
1989	23,266.9	3,908.3
1990	20,576.9	5,853.6
1991	19,062.8	8,372.8
1992	14,662.4	12,021.2
1993	12,073.2	18,630.7
1994	10,764.9	17,313.6
1995	9,602.3	14,514.1

Source: California Department of Fish and Game; Maine Department of Marine Resources

Table C7. Japanese Household Monthly Disposable Income and Food Expenditure, 1994

Month	Disposable Income	Food Expenditures
Jan	370,899	74,228
Feb	384,078	75,966
Mar	408,658	83,015
Apr	409,000	77,383
May	343,765	81,203
Jun	701,241	78,466
Jul	566,164	82,540
Aug	410,885	83,526
Sep	368,305	79,558
Oct	399,048	82,452
Nov	372,847	77,146
Dec	1,039,248	102,679

Source: Japan, *Annual Report on the Family Income and Expenditure Survey*, 1994

Table C8. Tokyo Central Wholesale Market Prices for Domestic vs. Imported Fresh Sea Urchin Roe, 1990 - November 1996

	Fresh Sea Urchin - Domestic			Fresh Sea Urchin - Imported		
	Quantity	Value	Price	Quantity	Value	Price
Year/Month	Kg.	Yen	Yen/Kg	Kg.	Yen	Yen/Kg
1990						
1	44,644	418,523,828	9,375	145,364	850,755,677	5,853
2	53,704	397,403,067	7,400	112,974	741,198,186	6,561
3	58,651	587,781,036	10,022	149,142	888,037,652	5,954
4	54,834	540,909,449	9,864	120,121	741,293,658	6,171
5	79,127	728,862,659	9,211	105,314	699,895,214	6,646
6	78,513	762,108,196	9,707	94,050	604,083,208	6,423
7	95,267	873,497,018	9,169	86,453	556,037,158	6,432
8	55,505	654,224,335	11,787	116,766	724,547,278	6,205
9	39,958	517,105,945	12,941	147,821	817,953,421	5,533
10	21,163	236,785,814	11,189	241,538	1,216,773,107	5,038
11	21,068	210,489,130	9,991	211,555	1,142,014,714	5,398
12	35,431	420,446,730	11,867	210,399	1,564,312,059	7,435
1991						
1	28,885	273,759,527	9,478	162,573	935,413,732	5,754
2	24,538	245,555,528	10,007	177,615	881,207,008	4,961
3	33,787	439,026,003	12,994	185,655	943,700,216	5,083
4	40,683	439,428,415	10,801	239,498	1,060,372,533	4,427
5	54,131	584,042,701	10,789	155,277	865,927,231	5,577
6	74,007	619,513,018	8,371	171,324	796,657,428	4,650
7	65,563	717,583,923	10,945	176,618	836,716,852	4,737
8	63,293	610,648,184	9,648	193,953	816,658,826	4,211
9	34,720	403,533,399	11,623	160,636	782,894,488	4,874
10	18,042	161,237,953	8,937	271,812	1,128,787,606	4,153
11	17,290	220,266,721	12,740	289,485	1,196,363,318	4,133
12	38,618	360,891,101	9,345	367,187	1,718,979,714	4,681
1992						
1	22,460	282,899,657	12,596	242,863	959,371,379	3,950
2	23,897	352,796,930	14,763	188,321	857,827,658	4,555
3	26,602	363,307,780	13,657	239,452	968,864,995	4,046
4	23,637	327,563,629	13,858	133,826	1,075,375,020	8,036
5	38,979	468,425,715	12,017	103,924	806,210,440	7,758
6	60,764	660,919,954	10,877	82,065	617,040,699	7,519
7	73,318	850,828,601	11,605	68,331	545,113,558	7,978
8	49,785	664,719,355	13,352	90,586	645,335,382	7,124
9	30,903	460,975,546	14,917	97,034	726,519,827	7,487
10	14,196	217,346,120	15,310	147,117	1,046,287,832	7,112
11	13,289	211,167,657	15,890	145,916	1,025,966,814	7,031
12	27,093	392,067,572	14,471	191,556	1,560,890,969	8,148
1993						
1	14,601	229,317,945	15,706	139,381	932,076,607	6,687
2	17,078	280,173,606	16,406	131,618	865,201,436	6,574
3	32,203	451,290,862	14,014	134,488	916,772,295	6,817
4	40,171	533,355,408	13,277	110,927	785,802,913	7,084
5	52,580	571,126,361	10,862	102,245	702,692,710	6,873
6	71,387	733,502,510	10,275	75,090	484,995,746	6,459
7	74,712	854,773,888	11,441	79,656	480,898,548	6,037
8	57,559	648,346,194	11,264	92,766	550,513,667	5,934
9	41,179	520,648,893	12,644	110,906	690,247,774	6,224
10	15,126	177,990,458	11,767	173,109	1,045,410,478	6,039
11	19,107	230,353,828	12,056	169,847	1,042,001,366	6,135
12	28,810	440,285,178	15,282	182,868	1,578,490,522	8,632
1994						
1	16,703	263,257,062	15,761	145,687	968,231,913	6,646
2	25,466	304,172,417	11,944	110,110	799,781,909	7,263
3	36,925	455,604,861	12,339	130,454	833,700,406	6,391
4	41,851	529,855,541	12,661	139,334	815,027,963	5,849
5	47,929	529,231,825	11,042	96,172	728,025,165	7,570
6	88,037	699,939,505	7,951	91,385	533,255,467	5,835
7	89,421	784,917,654	8,778	94,791	508,068,983	5,360
8	63,732	657,228,875	10,312	107,755	666,411,137	6,185
9	36,692	427,075,633	11,639	136,284	807,773,476	5,927
10	19,480	188,765,116	9,690	181,059	1,067,960,226	5,898
11	19,218	204,966,850	10,665	145,784	1,019,791,848	6,995
12	42,567	526,232,273	12,362	256,480	1,451,527,414	5,659

Table C8 (cont'd). Tokyo Central Wholesale Market Prices for Domestic vs. Imported Fresh Sea Urchin Roe, 1990 - November 1996

	Fresh Sea Urchin - Domestic			Fresh Sea Urchin - Imported		
	Quantity	Value	Price	Quantity	Value	Price
Year/Month	Kg.	Yen	Yen/Kg	Kg.	Yen	Yen/Kg
1995						
1	18,870	299,537,577	15,874	127,566	841,865,389	6,599
2	22,711	270,961,018	11,931	120,437	762,188,043	6,329
3	28,761	385,242,915	13,395	155,428	975,417,600	6,276
4	37,314	438,987,861	11,765	128,675	770,384,191	5,987
5	56,015	588,752,919	10,511	118,597	729,783,085	6,153
6	74,545	748,979,655	10,047	88,159	548,676,898	6,224
7	103,844	824,393,502	7,939	90,699	559,048,195	6,164
8	67,386	659,067,376	9,780	110,983	691,421,627	6,230
9	43,725	511,988,863	11,709	116,421	817,193,609	7,019
10	20,891	189,191,737	9,056	160,682	1,094,081,135	6,809
11	18,648	198,774,584	10,659	163,997	959,737,996	5,852
12	41,991	527,871,261	12,571	200,757	1,358,961,598	6,769
1996						
1	21,280	260,702,065	12,251	130,200	888,119,233	6,821
2	24,005	280,622,225	11,690	156,810	838,975,568	5,350
3	36,674	398,010,810	10,853	163,632	891,377,829	5,447
4	43,965	484,703,930	11,025	156,755	866,430,894	5,527
5	62,843	636,221,819	10,124	109,353	718,765,982	6,573
6	66,796	697,417,262	10,441	95,790	537,493,749	5,611
7	72,849	742,016,280	10,186	85,440	397,294,273	4,650
8	67,091	656,691,108	9,788	60,065	377,475,987	6,284
9	47,262	500,410,459	10,588	83,743	576,297,187	6,882
10	18,731	194,667,150	10,393	135,779	1,016,010,293	7,483
11	23,592	207,895,051	8,812	157,730	979,432,249	6,210

Source: *Tokyo Central Wholesale Market Yearbook*, various years

Table C9. Price and Quantities Sold of Fresh Sea Urchin Roe, Imported vs. Domestic, on the Tokyo Central Wholesale Market, 1995

	Fresh Sea Urchin - Domestic			Fresh Sea Urchin - Imported		
Month	Domestic Kg. Quantity	Yen Value	Yen/Kg Price	Imported Kg. Quantity	Yen Value	Yen/Kg Price
Jan.	18,870	299,537,577	15,874	127,566	841,865,389	6,599
Feb	22,711	270,961,018	11,931	120,437	762,188,043	6,329
Mar	28,761	385,242,915	13,395	155,428	975,417,600	6,276
Apr	37,314	438,987,861	11,765	128,675	770,384,191	5,987
May	56,015	588,752,919	10,511	118,597	729,783,085	6,153
Jun	74,545	748,979,655	10,047	88,159	548,676,898	6,224
Jul	103,844	824,393,502	7,939	90,699	559,048,195	6,164
Aug	67,386	659,067,376	9,780	110,983	691,421,627	6,230
Sep	43,725	511,988,863	11,709	116,421	817,193,609	7,019
Oct	20,891	189,191,737	9,056	160,682	1,094,081,135	6,809
Nov	18,648	198,774,584	10,659	163,997	959,737,996	5,852
Dec	41,991	527,871,261	12,571	200,757	1,358,961,598	6,769

Source: *Tokyo Central Wholesale Market Yearbook*, 1995

Table C10. Total Quantities of Fresh Sea Urchin Sold In TCWM, 1982 - November 1996 (mt)

Year	Domestic	Imported
1982	1,470	-
1983	1,406	-
1984	1,415	-
1985	1,545	-
1986	841	766
1987	880	968
1988	943	1,614
1989	845	1,894
1990	638	1,741
1991	494	2,552
1992	405	1,731
1993	465	1,503
1994	528	1,635
1995	534	1,582
1996	485	1335

Source: *Tokyo Central Wholesale Market Yearbook*, various years
* Total from January through November

Table C11. Japanese Nominal Import Prices (CIF) and U.S. Nominal Export Prices (fas) for Fresh Sea Urchin Roe

	Japanese Import Price $/lb.	U.S. Export Price $/lb.
Jan-91	14.86	4.87
Feb-91	14.60	6.41
Mar-91	13.17	5.33
Apr-91	14.43	7.73
May-91	13.86	9.08
Jun-91	15.05	11.33
Jul-91	16.19	10.03
Aug-91	15.65	10.44
Sep-91	15.73	8.18
Oct-91	15.93	7.88
Nov-91	15.53	7.86
Dec-91	16.89	8.28
Jan-92	19.38	7.82
Feb-92	18.17	7.80
Mar-92	18.83	7.27
Apr-92	18.26	7.28
May-92	20.43	9.80
Jun-92	15.80	11.96
Jul-92	16.78	9.92
Aug-92	17.50	10.21
Sep-92	16.42	9.50
Oct-92	18.45	8.71
Nov-92	17.13	8.73
Dec-92	17.69	9.25
Jan-93	16.23	9.40
Feb-93	17.47	8.42
Mar-93	17.00	6.95
Apr-93	16.72	8.54
May-93	21.22	12.28
Jun-93	18.61	13.84
Jul-93	22.16	15.08
Aug-93	22.14	13.81
Sep-93	19.63	12.65
Oct-93	20.60	10.93
Nov-93	21.47	11.63
Dec-93	21.26	13.23
Jan-94	21.52	14.05
Feb-94	20.51	11.41
Mar-94	19.60	11.39
Apr-94	18.77	11.33
May-94	20.09	13.80
Jun-94	19.73	13.58
Jul-94	23.16	17.03
Aug-94	22.83	15.28
Sep-94	20.06	15.11
Oct-94	20.23	14.77
Nov-94	21.76	14.97
Dec-94	22.99	15.36

Source: Japan Marine Products Importers Association;
U.S. Bureau of the Census

Table C12. U.S. Exports of Fresh Sea Urchin Roe and Live Sea Urchins to Japan, by Port of Departure, 1994 & 1995

	Fresh Sea Urchin Roe		Live Sea Urchin	
Port	1995 Quantity (kg.)	1994 Quantity (kg.)	1995 Quantity (kg.)	1994 Quantity (kg.)
New York City	1,318,136	2,040,777	1,693,003	2,213,003
Los Angeles	1,978,291	1,476,258	-	-
San Francisco	272,018	233,448	-	-
Alaska	113,740	44,155	157,015	85,898
Seattle	97,803	68,084	582,896	890,966
Other	76,163	64,420	222,907	137,163

Source: U.S. Bureau of the Census

Table C13. U.S. Exports of Fresh/Chilled Sea Urchin Roe by Port of Departure, 1991 - 1994

Volume (Kg)

Year	Boston	New York	Alaska	Seattle	San Fran	Los Angeles	total
1991	366102	1484662	40748	250540	623528	1109688	4060330
1992	298250	1433163	53834	157228	360266	958211	3380705
1993	68801	2241098	67622	111986	214152	1175704	4011529
1994	14800	2038046	44155	68084	233416	1475651	3923175
1995	6300	4187546	378595	251582	881142	6713533	12562067

Value ($)

Year	Boston	New York	Alaska	Seattle	San Fran	Los Angeles	total
1991	2217791	10423094	363936	5027101	13748340	33206580	66906056
1992	2760064	18216861	553776	3451816	9956293	28207054	64826691
1993	1177688	42640959	847911	2335183	6718790	41054060	97230315
1994	378115	55224407	601356	2025906	5888475	54344789	119745799
1995	175924	164344553	5027686	4848537	21826163	221268474	420380792

Price ($/lb.)

Year	Boston	New York	Alaska	Seattle	San Fran	Los Angeles	total
1991	2.75	3.18	4.05	9.10	10.00	13.57	7.47
1992	4.20	5.77	4.67	9.96	12.54	13.35	8.70
1993	7.76	8.63	5.69	9.46	14.23	15.84	10.99
1994	11.59	12.29	6.18	13.50	11.44	16.70	13.84
1995	12.67	17.80	6.02	8.74	11.24	14.95	15.18

Source: U.S. Bureau of the Census