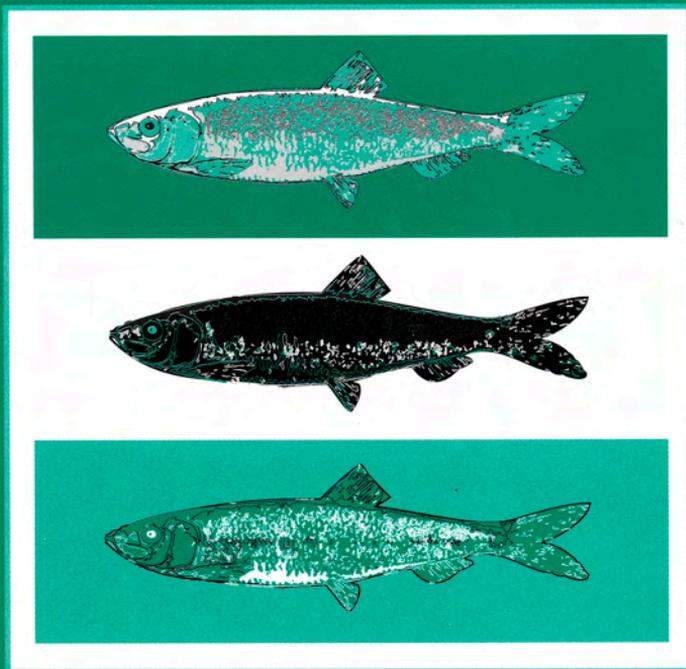


18TH LOWELL WAKEFIELD SYMPOSIUM



HERRING

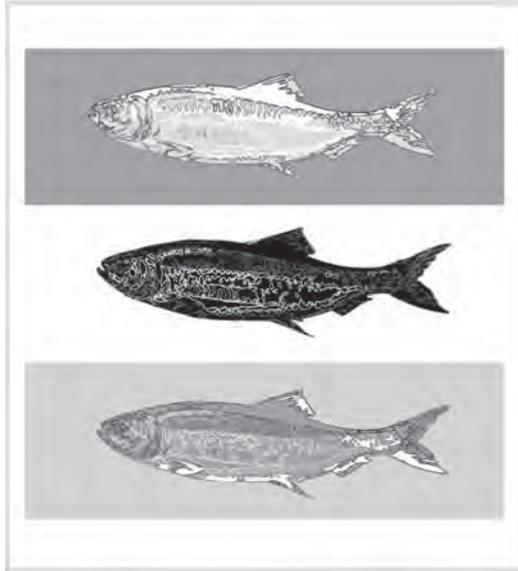
EXPECTATIONS

FOR A NEW MILLENNIUM

**F. FUNK, J. BLACKBURN, D. HAY, A.J. PAUL,
R. STEPHENSON, R. TORESEN, AND D. WITHERELL,
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**UNIVERSITY OF ALASKA
SEA GRANT COLLEGE PROGRAM**

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Changing Markets for Alaska Roe Herring

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Abstract

The Pacific herring fishery is one of Alaska's most important commercial fisheries, with average annual landings during the 1990s of 47,100 tons, an average ex-vessel value of \$28.9 million, and an average first wholesale value of \$80.1 million. Although total landings have been relatively stable, ex-vessel prices and ex-vessel value are highly variable, and declined during the 1990s. This paper examines factors affecting the prices paid for Alaska herring.

The primary product from Alaska's commercial herring fisheries is salted herring roe, a traditional seasonal delicacy in Japan. Roe herring are harvested just prior to spawning, and most are frozen round and exported to Japan for processing. Japan also imports both Pacific and Atlantic herring and roe from several other countries, for production of both salted roe as well as a newer flavored roe product.

Japanese herring roe supply, production, and consumption have declined during the 1990s despite falling prices—reflecting declining demand for traditional herring roe products as lifestyles and tastes change. Changes in wholesale prices from year to year reflect changes in the supply of herring roe to the Japanese market. Changes in prices paid to Alaska processors and fishermen reflect changes in Japanese wholesale prices and the exchange rate between the yen and the dollar.

If Pacific herring harvests remain at levels of the past decade, it is likely that Japanese wholesale prices for salted herring roe—and prices paid to Alaska herring fishermen—will remain low and may fall further. The long-term economic outlook for Alaska herring fishermen is uncertain. Alaska herring may serve as a reminder that viable commercial fisheries depend not only on fishery resources, but also on the markets from which resources derive their value.

Introduction

The commercial fishery for Pacific herring (*Clupea pallasii*) is one of Alaska's most important. As many as 3,000 vessels fish each spring in 20 separate districts. During the 1990s, annual landings of herring in Alaska averaged 47,100 tons, with an average ex-vessel value of \$28.9 million and an average first wholesale value of \$80.1 million.

The primary product from Alaska's commercial herring fisheries is salted herring roe, or *shio kazunoko*, a seasonal delicacy in Japan. The kazunoko trade has supported valuable roe fisheries from San Francisco to Alaska's Norton Sound, as well as in Russia, Atlantic Canada, and northern Europe. Virtually all the products are consumed in Japan.

Total Alaska herring landings have been relatively stable since the early 1980s. In all but three years since 1983, total landings have been between 40,000 and 55,000 t. However, the ex-vessel value of landings has fluctuated much more widely. For example, total ex-vessel value was \$26 million in 1994, \$60 million in 1996, and just \$11 million in 1998 (Fig. 1).

These extreme fluctuations in ex-vessel value have resulted primarily from fluctuations in ex-vessel prices. For example, the average statewide ex-vessel price paid for roe herring was \$470 per ton in 1994, \$1,130 per ton in 1996, and \$283 per ton in 1998. Ex-vessel prices differ from region to region, but reflect the same upward and downward trends from year to year (Fig. 2).

This paper examines the factors responsible for changes in Alaska herring roe prices and value over time. We begin by describing Alaska herring fisheries and primary processing. Next we discuss Japanese herring roe product forms, processing, distribution. We then discuss trends in Japanese herring roe supply and demand, and the relationship between supply and prices paid for herring roe in Japan and Alaska. We conclude with observations on the importance of fisheries markets, and the implications of changing Japanese markets for the Alaska herring roe industry in the future.

The paper is based on a review of a wide variety of published sources, discussions with fishermen and processors, five seasons as a herring fisherman experienced by author T. Johnson, and interviews conducted during a trip to Tokyo, Sapporo, and Rumoi during November 1998. Data for the paper are from a wide variety of sources, many of which are unpublished. Data sources are described in greater detail in the data appendix.

Alaska Herring Fisheries

Pacific herring (*Clupea pallasii*) is a schooling pelagic fish that occurs in great numbers in the north Pacific Ocean and Bering Sea, and is a close relative of the Atlantic herring (*Clupea harengus*). Herring are believed to return to the same rocky shoreline where they hatched to spawn. They spawn sub-tidally or inter-tidally, depositing their adhesive eggs mostly

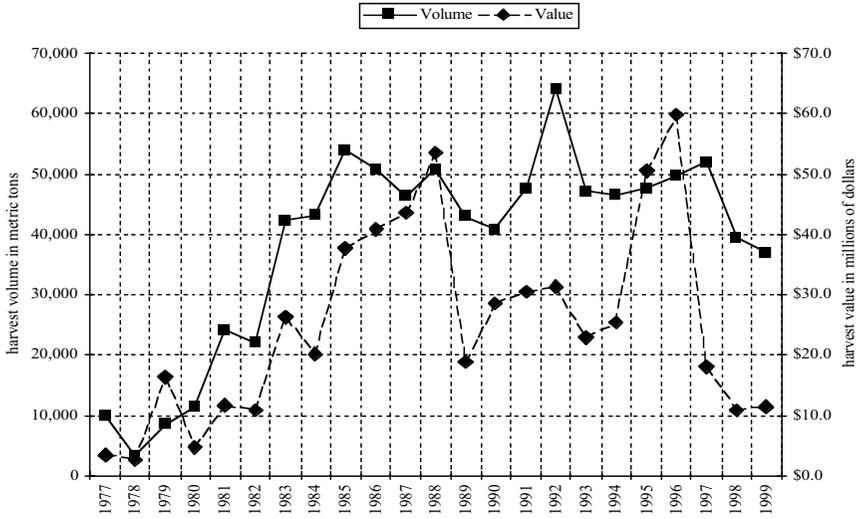


Figure 1. Alaska herring harvest volume and ex-vessel value.

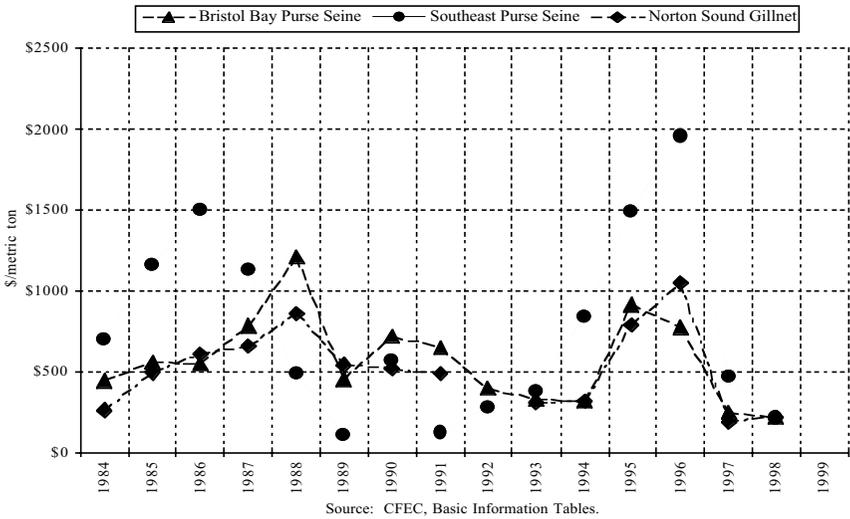


Figure 2. Average ex-vessel prices in selected Alaska herring roe fisheries.

on living substrate such as popweed, ribbon kelp, or bull kelp. After maturity (at age 3-4), spawning occurs every year, with each female fish laying an average of approximately 20,000 eggs.

Great schools of fish migrate shoreward in late winter and spring, first to spawn and then to feed in the nearshore waters until autumn, when they apparently migrate back off shore. Spawning begins as early as December in California, and March in Southeast Alaska and Prince William Sound, and progresses northward to finish as late as mid-June in Norton Sound.

In most areas herring mature and recruit into the fishery at three or four years of age, and may remain in the spawning population for as long as 12 or more years if not taken by the fishery or a predator. Fish in some southern districts reach a harvestable age at approximately 25 cm and 100 grams in weight, whereas catches in the western Bristol Bay and Norton Sound districts typically are 300, 350, or even 400 g at harvest and as much as 40 cm in length.

Alaska's commercial herring fishery dates back to 1878, and by the 1880s was feeding a reduction industry producing herring oil and meal. The reduction fishery peaked in 1929 at more than 78,000 tons (Skud 1960), and continued until 1966, when an oversupplied market no longer supported it.

Alaska sac-roe herring fisheries began in the 1970s and were fully developed as far north as Norton Sound by the early 1980s. Roe fisheries occur in numerous separate districts. Most years the production from the Togiak district in southwestern Alaska is nearly equivalent to the total of all the other districts combined.

Each year, Alaska's sac-roe fishery begins in March in the Southeast Panhandle and progresses to the north and west, ending in Norton Sound usually in early June. Alaska openings are preceded by the San Francisco sac-roe herring fishery which begins in December, and British Columbia openings in February and March.

The objective of the fishery is to produce roe-bearing females from which the egg sacs are removed and processed. Openings in each district are timed to occur just before the bulk of the stock in that area starts to spawn, and may last for as much as several days or as little as 20 minutes, depending on the "ripeness" of the herring and the efficiency of the fleet.

Fishing in some districts is done with gillnets, in some districts with purse seines, and in some districts with both gear types. The relative quality of fish produced by the two gear types varies. Generally gillnets are harder on the fish and lower the quality of carcasses for fillets, but produce higher roe content because they select more effectively for size and maturity due to the fisherman's ability to choose mesh size. In some areas seiners are restricted to fishing deeper waters that are farther from the actual spawning sites, so they tend to catch more immature fish. An advantage of seining, however, is that schools can be sampled without kill-

ing many fish, since the whole set can be released if the fish are found to be “green” (immature), or if the ratio of females to males is too low.

Tenders deliver herring from fishing vessels to floating or shore-based processing plants. Payments to fishermen are based on the roe percentage as well as technicians’ subjective determinations about the quality of the roe. For example, they decide if the skeins are mature or green, based on color and presence of visible blood vessels. They also can downgrade roe if it is misshapen, puffy, twisted, or otherwise imperfect.

Alaska based processors (referred to in the trade as “packers”) freeze most Alaska sac roe herring in the round. In a few Alaska locations, the roe is extracted from the females in local processing plants (as is done in British Columbia and San Francisco). In this case the roes may be brined and partially frozen (“semi-finished”) before shipping, or shipped in the raw, unfinished state.

Most frozen roe herring goes either to Japan for thawing and roe extraction, or to a third country (most commonly China, followed by Korea, Thailand, and Malaysia), where the roe is extracted and re-exported to Japan after processing. Most Bering Sea roe herring goes directly to Japan because the larger carcasses are valuable in the dried herring trade.

Sac-roe herring account for the bulk of Alaska herring harvests. However, Alaska’s herring also support small roe-on-kelp and food and bait fisheries.

Japanese Herring Roe Products

A wide variety of herring roe products are consumed in Japan. These include several different forms of *kazunoko*, a general term for products made with herring roe.

The traditional Japanese herring roe product is salted herring roe (*shio kazunoko*). *Kazunoko* means “prolific eggs,” and the sacs of densely packed tiny golden eggs symbolize fertility and prosperity in traditional Japanese culture. The skeins or sacs are similar in shape and color to, and slightly larger than, orange or grapefruit sections. The eggs are heavily salted, and when bitten into each cell pops individually, giving the sensation of “crunchiness.”

Salted *kazunoko* has been an important part of the *shogatsu* or new year celebration in Japan for centuries. It is traditionally given as a gift to friends, relatives, and especially to business associates in December prior to the three-day new year holiday as a way of wishing one another prosperity and happiness in the new year. Until fairly recently Japanese people normally stayed at home during the three-day new year holiday; women were not supposed to do any cooking, and salted *kazunoko* was one of the special holiday foods.

To be edible salted *kazunoko* must first be soaked overnight in fresh water to remove most of the salt; then with some ceremony it is consumed raw or dipped in soy sauce, in small pieces, using chopsticks.

Kazunoko is never a meal—it is a delicacy normally consumed in amounts of 50 grams or less, perhaps one or two skeins at a time. The flavor is slightly fishy but not particularly rich. Partaking of kazunoko is to partake of the wish for many children, success in business, and good luck in life.

For salted kazunoko, as with other traditional gift products, the cost of the product is deemed a reflection on the esteem in which the giver holds the receiver, so the price has always been high. Salted kazunoko commonly retails for \$20-\$30 per pound (\$9-\$13.65 per kg), depending on grade and packaging. Nearly all retail sales of salted kazunoko occur during the last quarter of each year, most of it in the last month, and consumption occurs mainly during the new year holiday.

Top quality salted kazunoko is perfectly formed, bright color, firm consistency, and is attractively packaged in decorative trays usually of 500 g or 300 g net weights. These are known as “branded gift packs” and represent the standard for the trade. Salted kazunoko gift packs are sold mainly through department store seafood or gift food sections, or in other gift item outlets, such as are found in railway stations and big underground shopping malls. “Home packs” are purchased for home consumption rather than gifting. Home pack roes may be more variable in size and quality, and packaging is less decorative, or product may be sold in bulk packaging such as tubs.

Beginning in the early 1980s the Japanese herring roe processing industry developed a new product that could be made with lesser quality herring roe, called *ajitsuke kazunoko*, meaning flavored or seasoned herring roe. Rather than being heavily salted, it is seasoned or marinated in soy sauce, sake lees, peppers, brandy, or other substances, which flavor and to some extent preserve the roe. Because it does not require freshwater leaching before use, flavored herring roe is portable and convenient. The variety of flavors is attractive to younger Japanese people. Because the sauces discolor and obscure the roes in the package, there is no need to use perfect skeins, and broken and misshapen roes are acceptable.

Atlantic herring roe, which is generally smaller and softer than Pacific herring roe, has never been considered suitable for salted kazunoko. But seeking a substitute for high-priced Pacific roe in the 1980s, processors tried Atlantic roe for flavored kazunoko, and found it acceptable. Today most flavored kazunoko is made from Atlantic roe, with lesser amounts coming from smaller and lower grade Pacific herring roes.

Unlike salted kazunoko, most flavored kazunoko is purchased in supermarkets, and it is significantly less expensive. Consumption is year-round rather than confined to the holiday season, although sales peak at the end of the year. Since the product is not heavily salted it appeals to health-conscious consumers who avoid traditional salted foods, as well as to younger people who care more for variety and convenience than tradition. Flavored kazunoko now accounts for about one-third of the kazunoko sold in Japan.

Other herring roe products consumed in Japan include herring roe-on-kelp (*kazunoko kombu*), a traditional Japanese delicacy, as well as a wide variety of products in which *kazunoko* is mixed with other kinds of fish and vegetables. A by-product of larger sized Alaska roe herring frozen in the round is a dried herring meat product (*migaki nishin*). While of considerable absolute value, these other products are a relatively small part of the herring industry or production from Alaska herring.

Japanese Herring Roe Processing and Distribution

Almost all herring roe is processed on the northern island of Hokkaido. Salted *kazunoko* processing involves soaking in concentrated brine, then in a bleaching tank of hydrogen peroxide, and then in a catalase (an enzyme) that breaks down the hydrogen peroxide to hydrogen and water, which is tasteless and harmless to people. Roes for the gift pack market are sorted and laid out in trays, and then boxed in attractive packages. Processing occurs year-round but intensifies in the fall.

Product may flow from Alaska packers to Japanese retailers in many different ways, but typically through most of the following stages:

- Packer,
- to trading company,
- to wholesaler or distributor (often a processors association),
- to processor,
- to wholesale market,
- to secondary wholesaler,
- to retailer.

Trading firms establish purchase arrangements with packers and buy the product, ship it to Japan or another location for stripping, and inspect and ensure quality. Trading firms sell to wholesalers (which are in some cases associations of processors), and sometimes directly to processors. About 80% of *kazunoko* is sold by processors through wholesale markets (Mitsuhashi), but this share is gradually declining. Anderson (p. 56) estimated that about 42% of salted *kazunoko* retail sales occur in department stores, 26% in supermarkets, and 16% each in retail fish stores and restaurants, while flavored *kazunoko* sales are predominantly (75%) in supermarkets and 20% in fish stores.

Trends in Japanese Herring Roe Supply

Herring and herring roe products have been part of the Japanese diet for centuries. The heyday of the commercial fishery, which occurred primarily around the northwest coast of Hokkaido, was the mid-1950s to the mid-1960s when the Japanese public, emerging from wartime destitution, resumed consumption of traditional favorites. In the 1960s the herring

resource began a precipitous decline. Various explanations are offered, including overfishing, the destructive effects of a major typhoon, and changes in ocean climate regime and current patterns. Whatever the cause or causes, the herring fishery crashed and has never recovered (H. Ando, Japan Marine Products Importers Association, pers. comm.).

As the stocks began to decline in the early 1960s processors had to look elsewhere for sources of herring to supply the growing demand for kazunoko. Japanese herring fishermen turned first to Soviet waters for herring to replace those which had vanished from their shores. When they were unable to meet the demand, their cooperative association, Dogyoren, began importing herring from Soviet suppliers with the help of a few Japanese trading companies. However, in the late 1960s the resource diminished so much that the Soviet government prohibited herring exports.

Soon after, importers began looking to North America for herring, both because of abundant supplies, and because of the belief that the Western political climate and business ethic would be more compatible with theirs. Early importation was from British Columbia, whose herring industry quickly and successfully shifted from a reduction fishery to take advantage of the lucrative new demand for roe herring. Alaska fishermen and processors got into the roe herring industry in the early 1970s, with Japanese importers establishing business relationships with American packers to supply fish.

During the 1980s and 1990s, Alaska accounted for slightly more than half of North American roe herring landings (Fig. 3). However, annual trends in Alaska harvests did not necessarily correspond with trends in the overall supply of Pacific herring roe to the Japanese market. For example, during the period 1993-1996 Alaska landings increased each year while total North American landings declined each year due to declining Canadian harvests.

In the late 1980s a shortage of Pacific herring caused some importers to look to eastern Canada and western Europe for sources of Atlantic herring. The roes are somewhat different, and most Atlantic roe proved to be unsuitable for high quality salted kazunoko. Skeins are smaller, less brightly colored and, most significantly, the eggs are softer and less crunchy. The combination of a different raw material and shifting consumer preferences led to development of flavored kazunoko.

For a time herring import quotas served to limit the supply of raw material, which helped to stabilize the market. Over the years, however, the total import quota was raised incrementally, at first to satisfy growing demand by the processors for raw material, and later in response to political pressure from the United States (Hastings 1995).

As early as the 1960s Japanese importers bought roe herring from the Russian (then Soviet) Far East. For a time this export was prohibited by the Soviet government to protect depleted stocks, but in recent years the trade has resumed, and is believed to be growing. Much of the roe from the Russian Far East is also used to make flavored kazunoko. Russian Far East

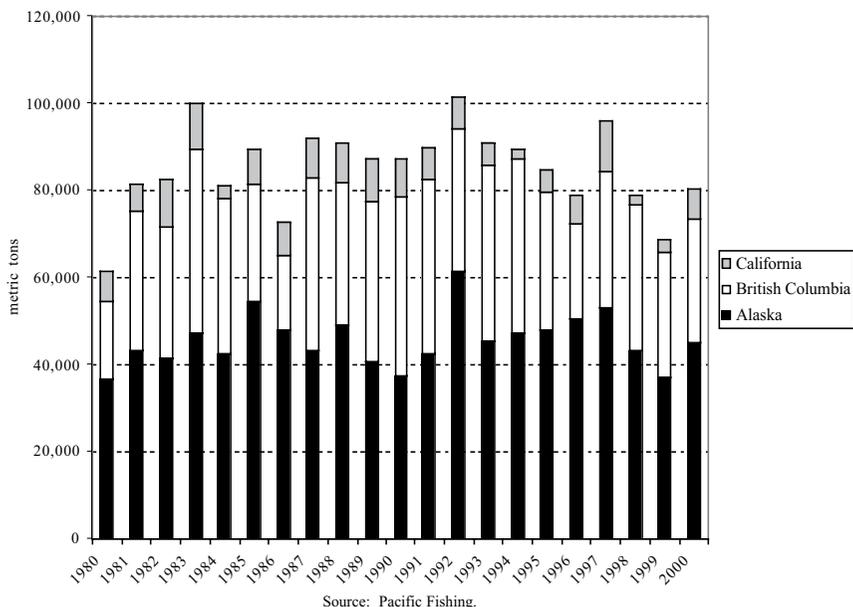


Figure 3. North American roe herring landings.

herring stocks are huge and support landings that have been as high as 250,000 tons in recent years, although most of this catch goes to the domestic “food” (meat) market within Russia rather than to roe export (BANR 1998).

Trends in Japanese Herring Roe Production

Figure 4 shows Japanese trade press estimates of the annual total new supply (excluding carryover inventory) of Pacific and Atlantic herring roe as well as estimates of annual production of salted and flavored herring roe. After increasing rapidly during the 1980s, total herring roe supply and production declined significantly during the 1990s. In general, trends in salted herring roe production are similar to trends in Pacific herring roe supply, since more than 80% of Pacific herring roe is used for salted kazunoko. However, part of the decline in salted roe production during the 1990s was due to a decline in the share of Atlantic herring roe used for salted production from 18% in 1992 to 9% in 1999.

As production declined during the 1990s, so did Japanese consumption of both salted and flavored herring roe. Observers of the Japanese herring roe industry attribute declining herring roe consumption in part to reduced demand resulting from a variety of factors:

- A prolonged recession in Japan.

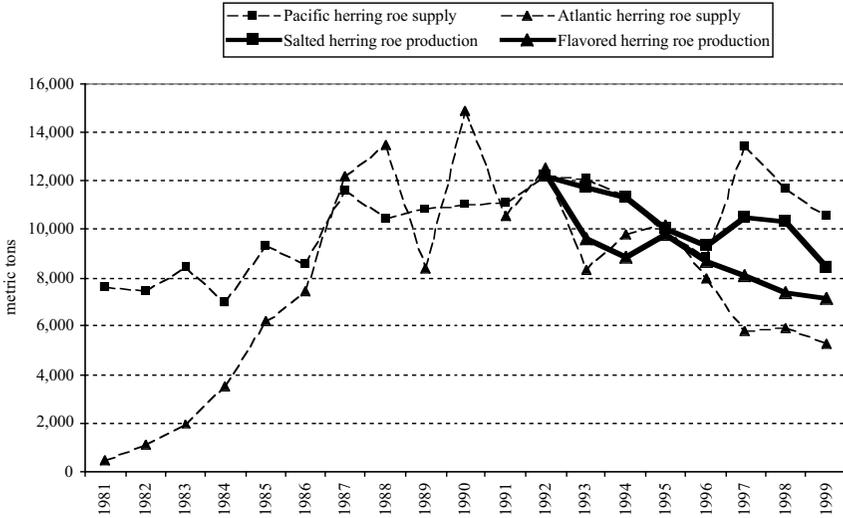


Figure 4. Japanese herring roe supply and estimated production.

- More personal travel during the holidays, resulting in less time at home to participate in traditional activities such as those associated with kazunoko.
- Development of substitute products as holiday gifts, including salted and smoked salmon, smoked ham, and liquor (Anderson et al. 1989).
- Changing corporate culture resulting in a curtailment of company gift-giving, including what one industry participant calls the “moral recomposition of government and industry” (Yasukata Kato, Kato Suisan, pers. comm.) which discourages or prohibits officials from accepting gifts from the corporations they regulate—such as high value branded kazunoko gift packs.
- Changing demographics of Japan’s population. As the generation of people who were born before World War II passes out of the population, so does the biggest group of people who enjoy traditional foods. The younger generation enjoys a much wider variety of foods than their predecessors, and traditional Japanese favorites such as salted kazunoko occupy a smaller part of their annual diet. The younger generation tends to be more health conscious, seeking diets lower in salt. The younger generation is also more convenience-oriented and less patient with the rituals of traditional cooking.

Importers and distributors interviewed for this research generally were pessimistic about the future of herring roe products, expressing a widely held view that demand will continue to diminish into the foreseeable future. However, some of them, and more commonly *kazunoko* processors, believe that demand can be stimulated by lowering the price, developing new products, or employing new ways of marketing familiar products.

Salted Herring Roe Wholesale Prices

Figure 5 shows the average annual wholesale price for salted (*shio kazunoko*) and flavored (*ajitsuke kazunoko*) herring roe at the Tokyo Central Wholesale Market for the years 1984-1999. While actual wholesale prices paid for specific salted and flavored herring roe products vary widely depending upon factors such as grade, size, and origin, average Tokyo wholesale prices serve as indicators of herring roe price trends over time in Japan.

Prices for salted herring roe fluctuate significantly from year to year. Prices exhibit several multi-year price cycles with high points in 1990 and 1996 and low points in 1988, 1993, and 1998. There has been a clear long-term downward trend in prices, which have declined from more than 4,000 yen per kilo in most of the 1980s to less than 3,000 yen per kilo in the late 1990s.

Wholesale prices for flavored herring roe are much lower than for salted herring roe. Flavored herring roe prices also trended downward in the 1980s but were relatively stable in the 1990s. As a result, the price difference between salted herring roe and flavored herring roe declined in the 1990s. Year-to-year changes in flavored herring roe prices appear to be only weakly correlated with changes in salted herring roe prices—suggesting that these products are only weak substitutes.

Figure 6 compares salted herring roe wholesale prices with the total supply of Pacific herring roe and with estimated production and consumption of salted herring roe. (Estimated consumption was calculated by subtracting net inventory accumulation from production.) There has been an inverse relationship between wholesale prices and supply, production, and consumption. The large growth in total supply from 1984 to 1987 was accompanied by a fall in wholesale prices. A period of relatively stable supply was accompanied by relatively stable prices from 1987 to 1991. Higher supply in 1992-1994 was accompanied by another period of low prices. Prices rose as supply fell in 1995 and 1996, and fell sharply as supply, production, and consumption increased in 1997. In 1996 and 1998, the inverse relationship with price is most apparent for consumption—as economic theory would suggest.

In the short-term, salted herring roe wholesale prices are clearly influenced by supply conditions. Lower supply tends to drive prices up while higher supply tends to drive prices down. Prices serve to balance supply

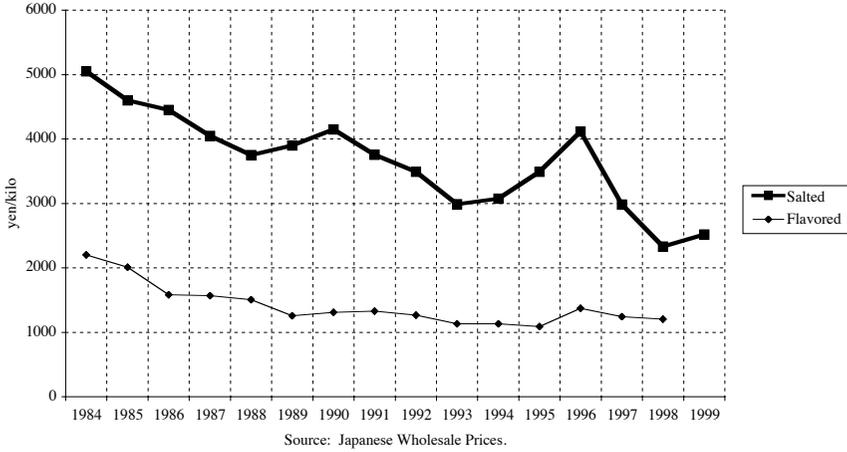


Figure 5. Japanese wholesale prices for herring roe.

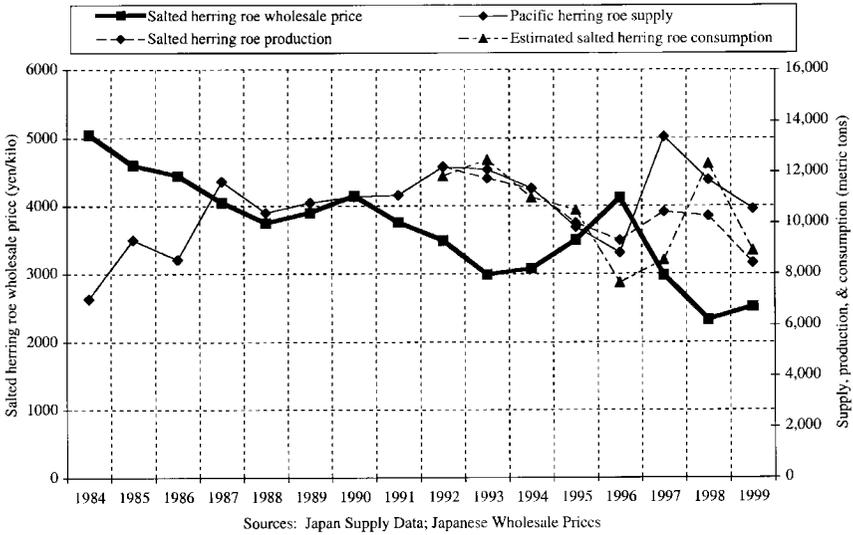


Figure 6. Japanese salted herring roe wholesale price, Pacific herring roe supply, and salted herring roe production and consumption.

and consumption over time (although not necessarily each year, as reflected in changing inventories). Higher prices tend to reduce consumption in years when supply is low; lower prices tend to increase consumption in years when supply is high.

The effects of supply on prices is also evident from frequent articles in the Japanese trade press that closely track Pacific herring roe harvests, imports, and production from American, Canadian, and Russian sources, and attribute changes in market expectations and prices to changes in supply.

The supply-price relationship is more complicated than a simple inverse correlation between total Pacific herring roe supply (or salted roe production or consumption) and average Tokyo wholesale prices. Supply conditions for specific types of Pacific herring roe (such as high-quality Canadian roe) affect prices for specific salted herring roe products. However, detailed supply and price data are not available to investigate these relationships for specific roe products empirically.

Above we discussed industry perceptions that Japanese demand for traditional salted herring roe is declining. The fact that salted herring roe wholesale prices have exhibited a declining trend since the late 1980s, without a corresponding upward trend in average consumption, provides empirical support for this perception.

Because changes in prices from year to year may reflect changes in both supply and demand, it is technically difficult to measure separately the effects of changes in demand and supply on prices. (Here we are using "demand" with the technical economic meaning of the price that buyers are willing to pay for a given total volume, and "supply" with the technical economic meaning of the price that sellers are willing to accept for a given total volume.) However, if prices decline while quantity sold remains constant or decreases, this indicates that demand must have declined, regardless of whether declining supply may also have contributed to the reduction in quantity sold. (In technical economic terms, a decline in both price and quantity sold implies an inward shift in the demand curve, regardless of whether an inward shift in the supply curve has also occurred.)

Table 1 shows average estimated consumption of salted herring roe and average wholesale prices for salted herring roe for four three-year periods. While average prices were 9% lower in 1994-1996 than in 1988-1990, average consumption was 10% lower. Similarly, even though average prices were 23% lower in the period 1997-1999 than in 1991-1993, average consumption was 16% lower. These comparisons suggest that the Japanese demand curve for salted herring roe is indeed shifting inward. Put differently, the prices that Japanese buyers are willing to pay for any given volume of salted herring roe are declining.

Table 1. Average Japanese salted herring roe consumption and wholesale prices of salted herring roe: three-year averages.

	Estimated consumption of salted herring roe (metric tons)	Average wholesale price of salted herring roe (yen per kilo)
Average, 1988-1990	10,737	3,933
Average, 1994-1996	9,713	3,561
Percent change	-10%	-9%
Average, 1991-1993	11,803	3,413
Average, 1997-1999	9,925	2,612
Percent change	-16%	-23%

Note: Estimated average consumption of salted herring roe was assumed to be equal to average supply of Pacific herring roe for years prior to 1992.

Alaska Herring Prices

Alaska herring prices are influenced not only by Japanese wholesale prices but also by the exchange rate between the yen and the dollar. As a result, trends in Japanese wholesale prices measured in dollars differ from trends measured in yen (Fig. 7). The value of the yen relative to the dollar increased sharply between 1984 and 1987 and again from 1992 to 1994. During both of these periods, although wholesale prices in yen declined, wholesale prices measured in dollars increased. In contrast, a fall in the value of the yen between 1995 and 1997 led to a much steeper decline in wholesale prices measured in dollars than in prices measured in yen. More generally, the long-term downward trend in Japanese wholesale prices for salted herring roe was offset for the Alaska herring roe industry in part by an upward trend in the value of the yen relative to the dollar.

Figure 8 compares Japanese wholesale prices for salted herring roe (measured in dollars per ton of herring round weight equivalent, assuming 10% yield) with prices paid for herring to Alaska processors and fishermen. Trends over time in prices paid to Alaska fishermen and processors clearly reflect trends in dollar wholesale prices in Japan. For example, the increase in Japanese wholesale prices between 1994 and 1996 was reflected in higher prices paid to Alaska processors and fishermen, while the decrease in Japanese wholesale prices between 1996 and 1998 was reflected in lower prices paid to Alaska processors and fishermen. The difference or "spread" between Japanese wholesale prices and Alaska ex-vessel prices has remained relatively constant over time.

The correlation between the three price series in Fig. 8 is consistent with a simple model of price determination for Alaska herring. Japanese wholesale prices—as measured in yen—are driven by supply and demand conditions for Pacific herring roe in Japan. Japanese wholesale prices as

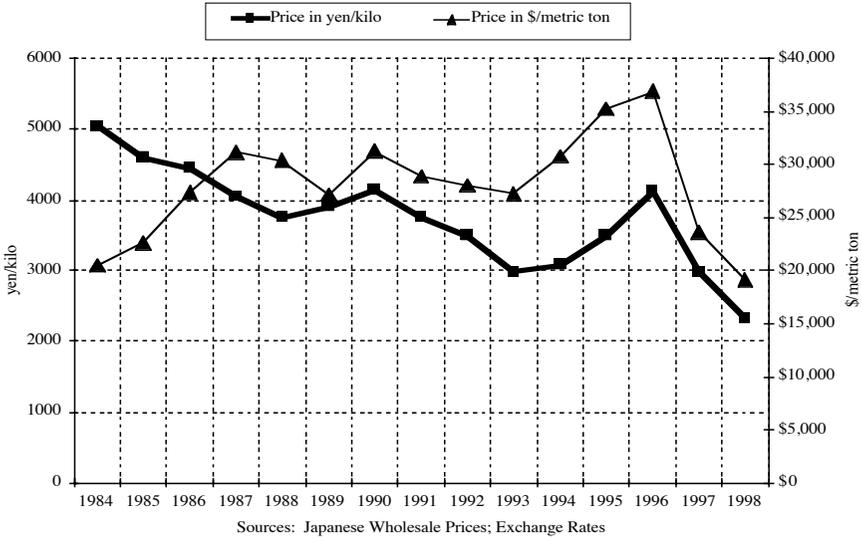


Figure 7. Japanese salted herring roe wholesale prices in yen and dollars.

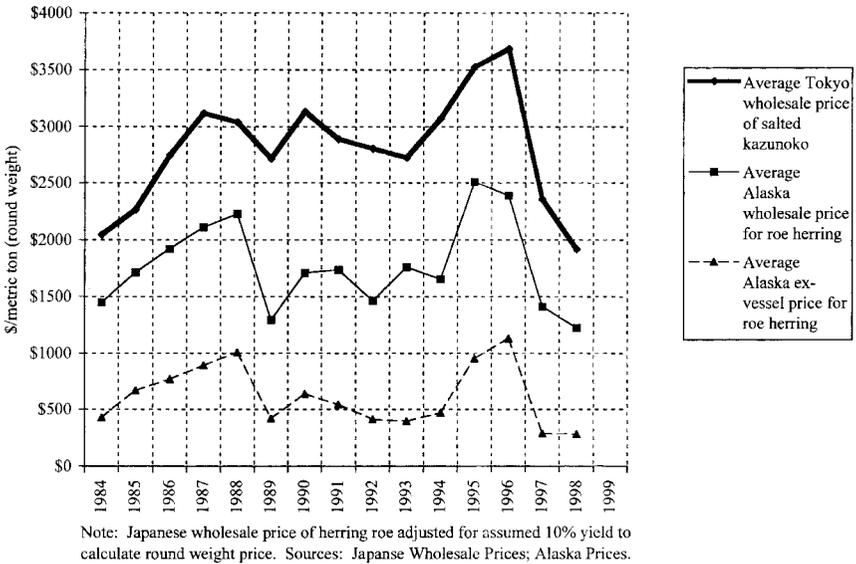


Figure 8. Herring prices: Japanese wholesale, Alaska wholesale, and Alaska ex-vessel.

measured in dollars—reflecting the value of the yen relative to the dollar—drive what Japanese importers are willing to pay Alaska processors for herring. In turn, the prices paid to processors drive what they are willing to pay to fishermen.

In this model, changes in Alaska ex-vessel herring prices reflect changes in Japanese wholesale prices for herring roe. The volatility of Alaska ex-vessel prices reflects the fact that because wholesale prices are much higher than ex-vessel prices (reflecting costs of processing and transportation) a given absolute change in wholesale and ex-vessel prices represents a much greater *relative* change in ex-vessel prices. Thus for example, both the wholesale price and the Alaska ex-vessel price increased by about \$650 per ton between 1994 and 1996. However, in relative terms, the wholesale price increased by only 20%, while the ex-vessel price increased by 140%.

This simple model explains most of the year-to-year variation in Alaska herring ex-vessel prices. (A least squares regression of the annual change in the Alaska ex-vessel price against the annual change in the Japanese wholesale price for the period 1985-1998 had an R^2 value of 74%, indicating that 74% of the variation in the change in ex-vessel prices can be explained by variation in the change in wholesale prices.) However, the actual determination of Alaska ex-vessel prices is of course much more complex, reflecting year-to-year changes in not just wholesale prices but many other factors such as the relative mix of different kinds of herring roe in the Japanese market, processing and transportation costs, and changes in market conditions between the times at which processors buy from fishermen, importers buy from processors, and herring roe is sold at wholesale.

In addition, as was shown in Fig. 2, herring prices differ between Alaska roe herring fisheries, reflecting fishery-specific factors such as roe percent and egg size (which affect the roe value per round pound), fishery location, and harvest volume (which affect processing costs), the number of participating processors (which affects competition), and season timing (which affects when the fish are bought).

If Alaska herring harvests were highly responsive to ex-vessel prices, our simple “top-down” derived-demand model in which Alaska ex-vessel prices reflect Japanese market conditions would be theoretically inadequate to characterize Alaska ex-vessel price determination, because changes in derived demand would be partially offset by supply responses. For example, the price-dampening effects of a reduction in Japanese demand would be partially offset by reduced Alaska herring supply. However, in most districts, herring harvests appear to be price-inelastic, with quotas fully harvested even when prices are low.

Ideally, with enough data and resources it would be possible to develop an econometric model that could quantify the different ways in which supply and demand factors interact to determine prices at different levels in the herring roe market, and to explain and predict how each factor affects Alaska ex-vessel herring prices. In practice, however, this goal is probably elusive. The Japanese herring roe market is too complex—with

too many sources of supply, too many end products, too many end markets, too many competing products, and too many factors affecting consumer demand—and too little data—to formally model this market with any great degree of statistical accuracy.

Conclusions

The Alaska roe herring fishery is almost completely dependent on the Japanese market for salted herring roe. Changes in prices paid to Alaska fishermen for herring reflect changes in Japanese wholesale prices for herring roe (as measured in dollars), but relative changes in prices to fishermen (in percentage terms) are much greater

The factors driving Alaska herring prices are for the most part beyond the control of Alaska herring fishermen or processors. Changes in the exchange rate between the yen and the dollar can magnify or offset changes in Japanese wholesale prices expressed in yen. The supply of Pacific herring roe to the Japanese market, which may vary widely from year to year, reflects not only Alaska harvests but also Canadian harvests—and Russian harvests may play an important role in the future as well. Thus Japanese market prices do not necessarily rise or fall to help offset the revenue impacts of lower or higher Alaska harvests.

Perhaps of greatest concern to the Alaska herring industry should be declining Japanese demand for traditional salted herring roe. If Pacific herring harvests remain at levels of the past decade, it is likely that Japanese wholesale prices for salted herring roe—and prices paid to Alaska fishermen—will remain low and may fall further.

Alaska herring roe harvests have been relatively stable from year to year. But the relative stability of Alaska's herring resource does not guarantee economic stability of the industry. Ex-vessel value has varied widely from year to year, and declined dramatically in the late 1990s. The long-term economic outlook for Alaska herring fishermen is uncertain. Alaska herring may serve as a reminder that viable commercial fisheries depend not only on fishery resources, but also on the markets from which resources derive their value.

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Appendix I: Data Sources

This appendix describes sources for all data provided in the text, tables and figures for this paper. Data for Alaska herring harvest volume and ex-vessel value for the years 1977-1998 (Figs. 1 and 8) were calculated for the years 1977-1998 by summing data for individual herring fisheries from the "Basic Information Tables" posted on the Web site of the Alaska Commercial Fisheries Entry Commission (www.cfec.state.ak.us); data for 1999 are preliminary data from the Alaska Department of Fish and Game Web site (www.cf.adfg.state.ak.us). Data for average ex-vessel prices in selected fisheries (Fig. 2) are also from the Commercial Fisheries Entry Commission Basic Information Tables. Data for North American Roe Herring Landings (Fig. 3) are from the annual "Statspack" issue of Pacific Fishing Magazine. Data for Japanese Pacific and Atlantic herring roe supply (Fig. 4) for 1981-1989 are from Anderson and Kusakabe (1993), Table 2.7, p. 2.17; data for 1990 are Japanese trade press estimates reprinted in BANR 1992; data for 1991-1999 are Japanese trade press estimates reprinted in BANR 2000a. Data for salted and flavored herring roe production (Figs. 4 and 6) were calculated from Japanese trade press estimates of herring roe utilization reprinted in BANR 1993, 1994, 1996, 1999, and 2000a.

Data for Japanese wholesale prices for salted herring roe (Figs. 5, 6, and 7 and Table 1) for 1994-1990 are estimated from a graph of monthly Tokyo Central Wholesale Market Prices provided in Anderson and Kusakabe (1993, p. 2.22), weighted 25% by November prices and 75% by December prices; data for 1991-1998 were calculated from Tokyo Central Wholesale Market (TCWM) monthly data by dividing the total annual sales value by total annual sales volume. Data for 1999 were estimated by adding to the 1998 price the increase between 1998 and 1999 in the average salted herring roe wholesale prices for six Japanese wholesale markets for September-December, reported in BANR 2000b. Data for Japanese wholesale prices for flavored herring roe (Fig. 5) for 1994-1990 are from BANR 1996; data for 1991-1998 were calculated from Tokyo Central Wholesale Market (TCWM) monthly data by dividing the total annual sales value by total annual sales volume. Estimated salted herring roe consumption (Fig. 6 and Table 1) was calculated by subtracting net inventory accumulation (the year-to-year increase or decrease in end-of-January salted herring roe inventories) from salted herring roe production.

Average annual Japanese salted herring roe wholesale prices in dollars (Figs. 7 and 8) were calculated in the same way as average annual prices in yen, except that monthly prices were first converted to dollars per metric ton using monthly exchange rate data from the Web site of the Federal Reserve Bank of St. Louis (www.stls.frb.org/fred/data/exchange/exjpus). Data for first wholesale value and average wholesale prices paid to Alaska processors for roe herring (Fig. 8) were provided by the Alaska Department of Fish and Game and are based on annual Commercial Operator Annual Reports filed by Alaska herring roe processors.

