Projections of Future Bristol Bay Salmon Prices

By

Gunnar Knapp
Professor of Economics
Institute of Social and Economic Research
University of Alaska Anchorage

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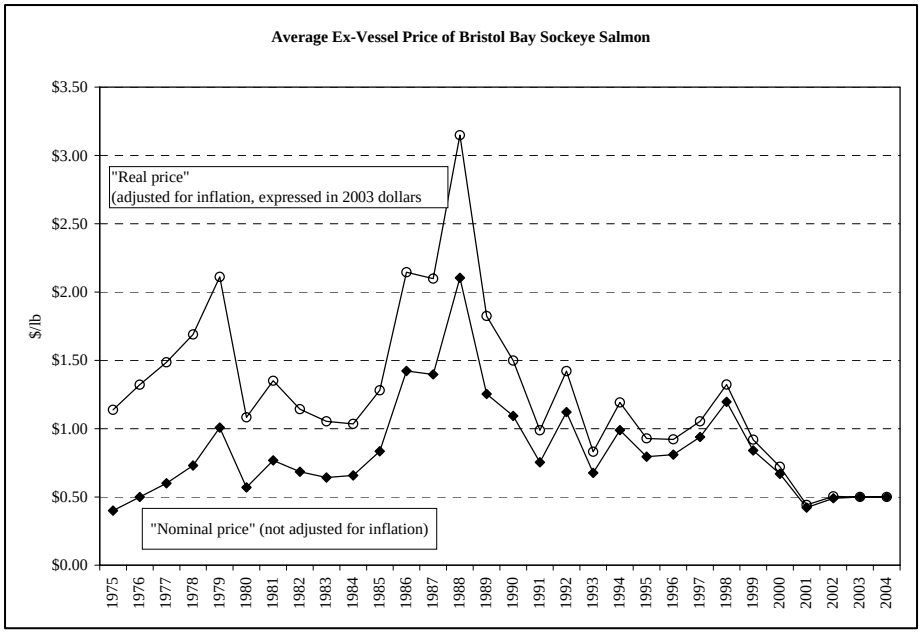
EXECUTIVE SUMMARY

The Commercial Fisheries Entry Commission (CFEC) requested this study for help in forecasting future ex-vessel prices of Bristol Bay sockeye salmon. CFEC plans to use the forecasts in analyzing the "optimum number" of limited entry permits in the Bristol Bay drift gillnet salmon fishery.

The study describes markets for Bristol Bay sockeye salmon products and how market conditions affect ex-vessel prices. The study develops an equation for forecasting future sockeye salmon ex-vessel prices based on assumptions about future Bristol Bay harvests and future farmed salmon wholesale prices. This equation is used to forecast a range within which future sockeye salmon ex-vessel prices are likely to fall.

EX-VESSEL PRICE TRENDS

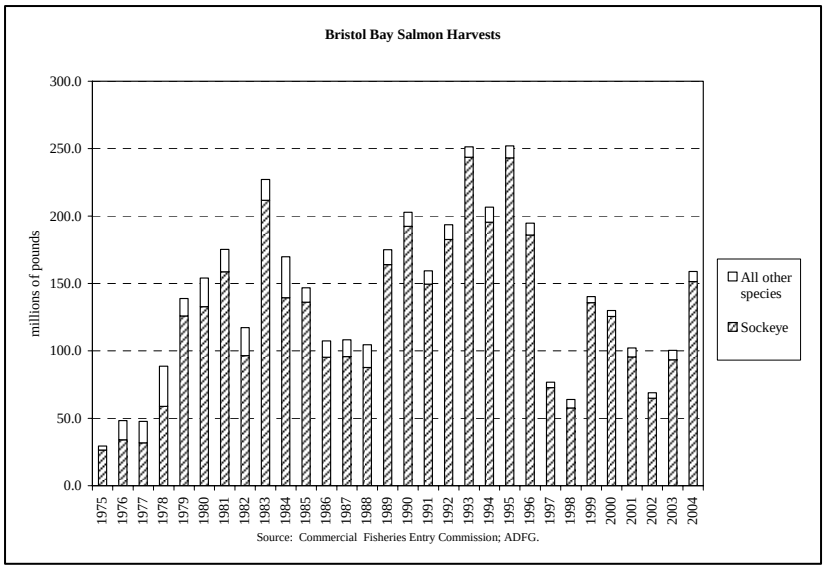
Ex-vessel prices for Bristol Bay sockeye salmon have fluctuated widely over the past three decades. "Real" prices (adjusted for inflation) have declined significantly. Since 2000, prices have averaged only about one-third the average price level of the 1980s.



This study is posted on the internet at
www.iser.uaa.alaska.edu/iser/people/knapp and at
www.cfec.state.ak.us.

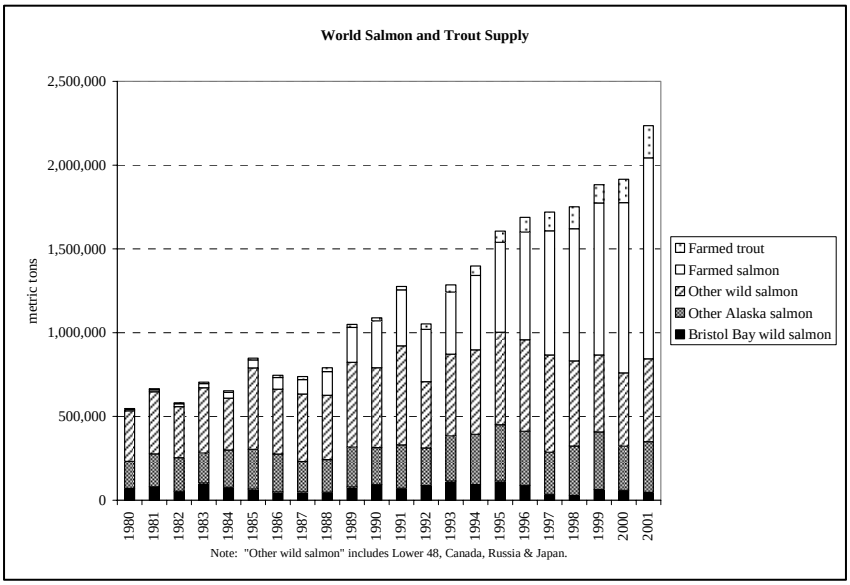
BRISTOL BAY SALMON HARVESTS

Bristol Bay sockeye salmon harvests increased from depressed levels of less than 50 million pounds in the mid-1970s to more than 150 million pounds annually for the years 1989-1996. Since 1997, sockeye salmon harvests have averaged much lower, with harvests of less than 140 million pounds in every year since 1997 except for 2004, and less than 75 million pounds in 1997, 1998 and 2002.



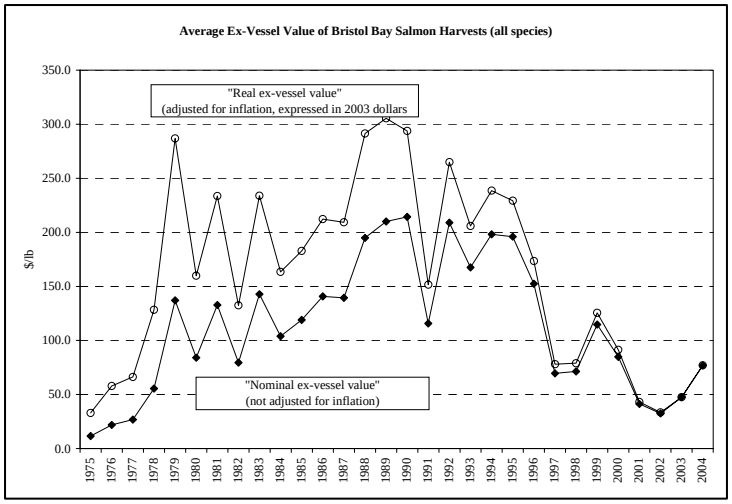
BRISTOL BAY SHARE OF WORLD SALMON SUPPLY

In 1980, total world salmon supply was less than 550 thousand tons, of which 98% was wild. By 2001 world supply had more than quadrupled to more than 2.2 million tons, 62% of which was farmed.



In 1980, Bristol Bay salmon accounted for 13% of world salmon supply, and the Bristol Bay catch was a significant factor affecting world salmon prices. By 2001, Bristol Bay accounted for only 2% of world salmon supply, and Bristol Bay catch was a far less important factor affecting world salmon prices.

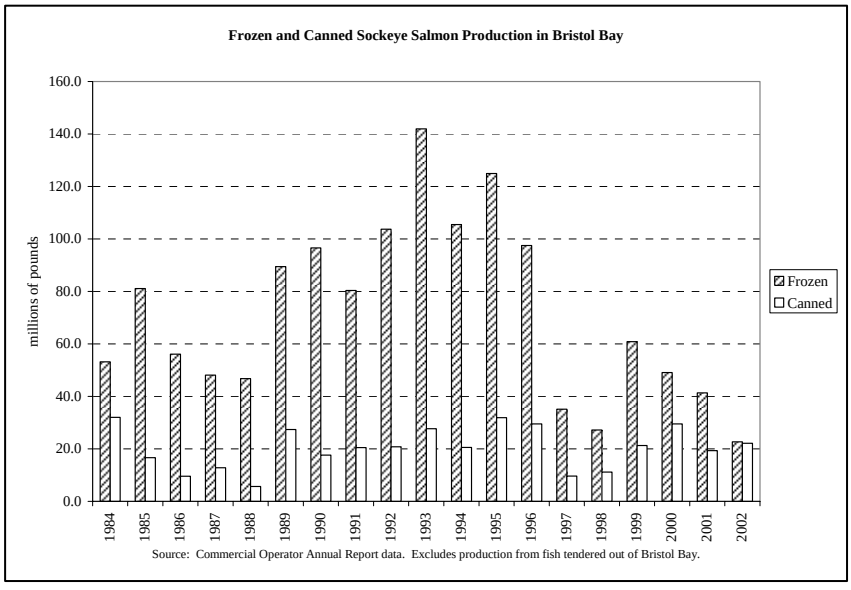
VALUE OF BRISTOL BAY SALMON HARVESTS



The combined effect of a decline in prices and a decline in harvests has been a dramatic decline in the ex-vessel value of the Bristol Bay salmon fishery. In twelve of the seventeen years between 1979 and 1995, the real ex-vessel value of the Bristol Bay salmon harvest exceeded $200 million. During seven of the eight years between 1997 and 2004, the real ex-vessel value of the Bristol Bay harvest was less than $80 million.

BRISTOL BAY SALMON PRODUCTS AND MARKETS

Almost all Bristol Bay sockeye salmon is processed into frozen or canned salmon. Very little is sold fresh. The relative share of canned production has increased in recent years. The combined result of lower harvests and a lower frozen share of production has been a dramatic decrease in frozen salmon production.



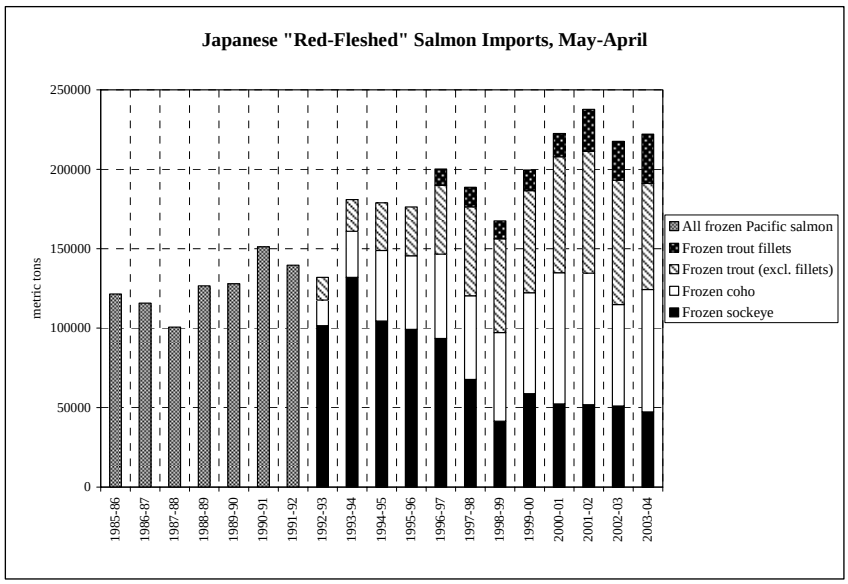
Most Bristol Bay frozen sockeye salmon is exported to Japan. Most Bristol Bay canned salmon is exported to the United Kingdom, Canada and other markets. Relatively little Bristol Bay sockeye salmon is consumed in the United States domestic market.

FROZEN SOCKEYE SALMON MARKET

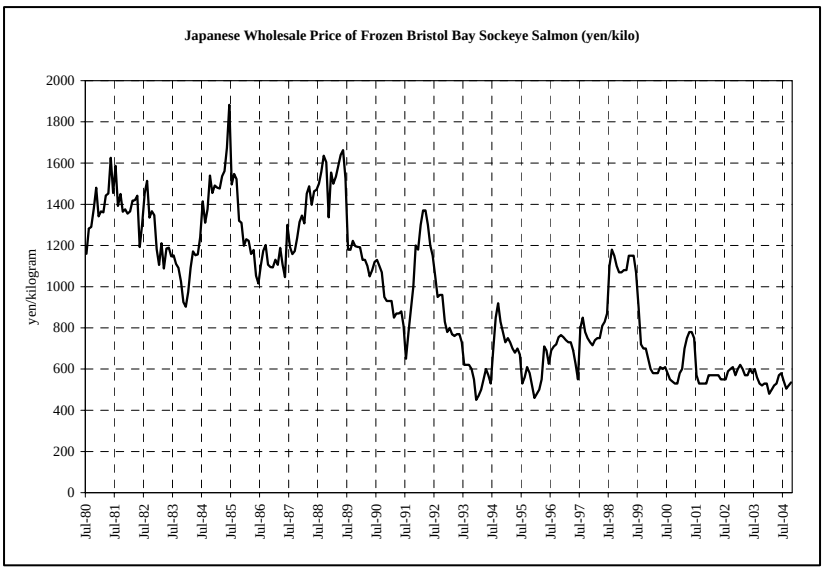
The Japanese frozen salmon market is the most important market for Bristol Bay sockeye salmon. In the Japanese market, wild sockeye salmon competes directly with farmed coho salmon and farmed trout. The Japanese consider these species to be "red-fleshed" salmon.

During the 1990s, Japanese imports of farmed Chilean coho and farmed Chilean and Norwegian trout grew rapidly, while imports of wild sockeye declined. As a result, the share of frozen sockeye in Japanese red-fleshed salmon imports declined from 77% in 1992 to just 21% in 2001.

Japan imports sockeye salmon from Bristol Bay, other parts of Alaska, Canada and Russia. Japanese imports of sockeye salmon from Bristol Bay and other parts of Alaska declined dramatically after 1995, while imports of sockeye from Russia increased. The Bristol Bay share of Japanese sockeye salmon imports fell from 59% in 1995 to only 27% in 2003. This, together with increasing farmed salmon imports, caused the share of Bristol Bay sockeye in total red-fleshed salmon imports to fall from 33% in 1995 to only 6% in 2003.

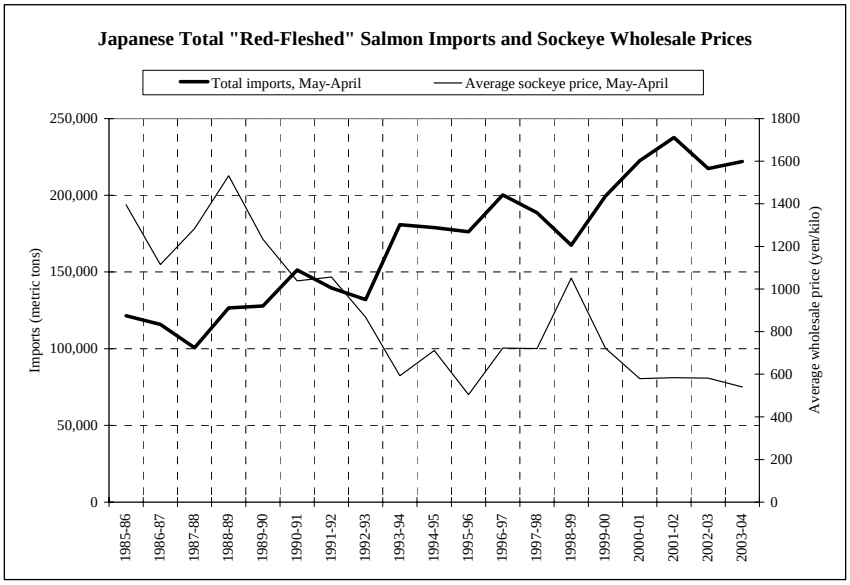


Japanese wholesale prices for sockeye salmon ranged between 1100 and 1500 yen/kilogram for most of the 1980s. In the 1990s, prices fell to much lower levels, and have been below 600 yen per kilogram for most of the past three years.



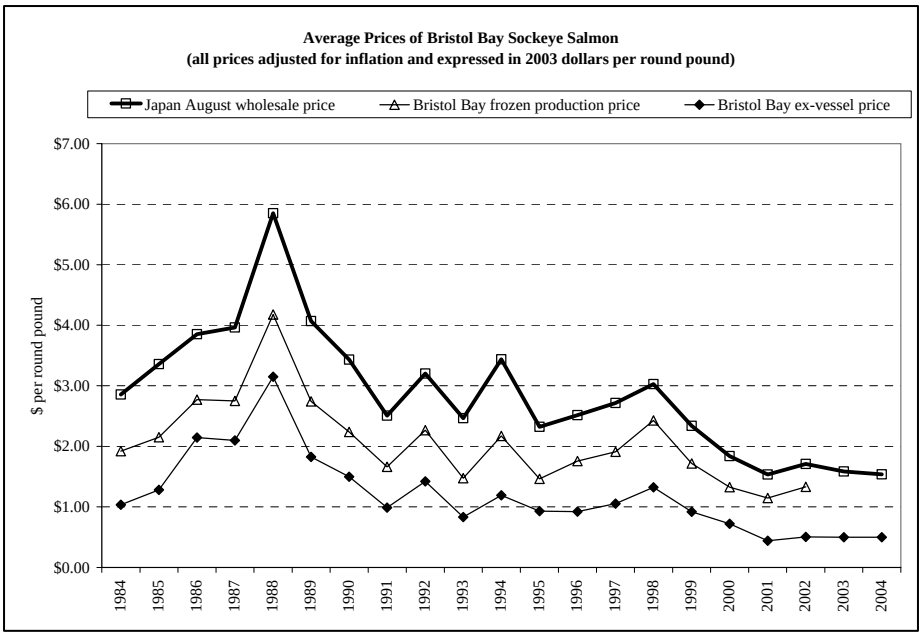
Historically, Japanese wholesale prices have cycled over periods of 1-3 years. A major factor contributing to these price cycles has been variations in wild salmon harvests. Sockeye wholesale prices have often risen or fallen sharply in July, when the total wild sockeye harvest first becomes apparent.

Historically there has been an inverse relationship between total Japanese imports of frozen "red-fleshed" salmon and average annual sockeye wholesale prices received by importers. Prices have generally fallen when total imports have risen, and vice versa, resulting in a "mirror-image" relationship between total imports and average annual sockeye prices.



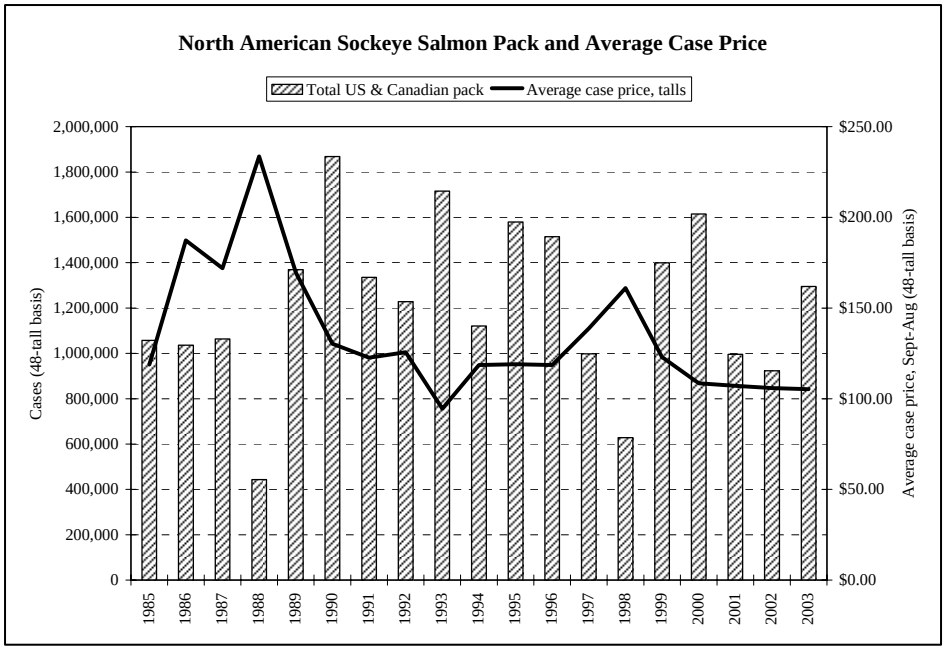
The Japanese wholesale price received by importers determines what importers are willing (and able) to pay processors for frozen sockeye salmon in yen. The exchange rate between the yen and the dollar, in turn, determines how these yen prices convert to prices importers are willing (and able) to pay processors for frozen sockeye salmon in dollars. Increases in the value of the yen contributed to a rapid increase in Japanese wholesale prices, expressed in dollars per pound, between 1985 and 1988. Increases in the value of the yen helped offset the effects of declining Japanese wholesale prices during the 1990s.

For the past two decades, both the frozen production price importers pay to processors, as well as the ex-vessel price processors pay to fishermen, have clearly tracked with Japanese wholesale prices for frozen Bristol Bay salmon. When Japanese wholesale prices have gone up, ex-vessel prices have gone up. When Japanese wholesale prices gone down, ex-vessel prices have gone down. This suggests that Japanese wholesale prices have a direct effect on ex-vessel prices.

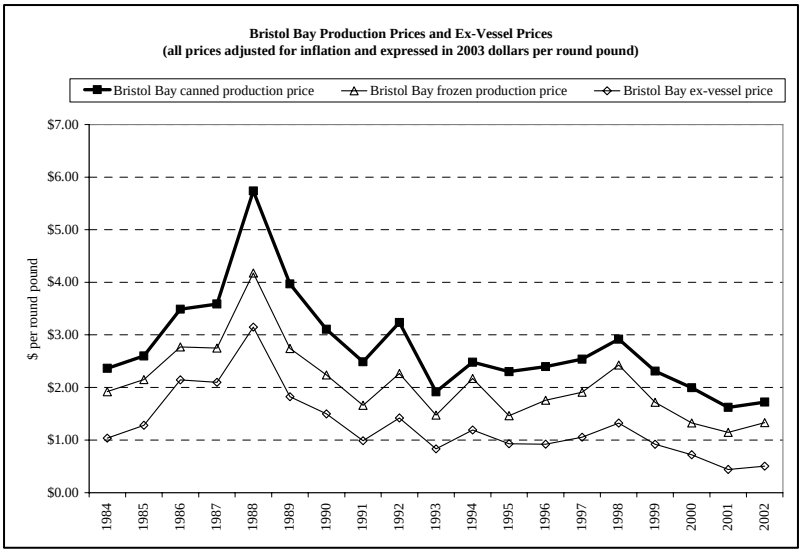


CANNED SOCKEYE SALMON MARKET

Bristol Bay typically accounts for between one-third and one-half of the North American canned sockeye salmon pack. In the short-term, canned sockeye salmon wholesale prices tend to be driven by the available supply. Prices tend to fall when the canned sockeye pack is large, and especially when there is a large pack combined with large carryover inventories from previous years' pack—and vice versa. Other factors affecting canned sockeye salmon wholesale prices include supply and price trends for canned pink salmon as well as exchange rates between the British pound and the dollar.



Production prices (first wholesale prices) for Bristol Bay canned sockeye are closely correlated with production prices for frozen sockeye and ex-vessel prices. The higher production prices for canned sockeye salmon reflect higher costs of canning compared with freezing.



The close correlation between canned and frozen wholesale prices suggests that similar factors affect wholesale prices for both products, most importantly total North American sockeye harvests. Shifts in the relative shares of canned and frozen production, in response to changes in relative prices, also help to keep wholesale price trends similar for both products.

EX-VESSEL PRICE FORECASTING EQUATION

This study recommends that CFEC use the following equation for purposes of forecasting future Bristol Bay sockeye salmon ex-vessel prices:

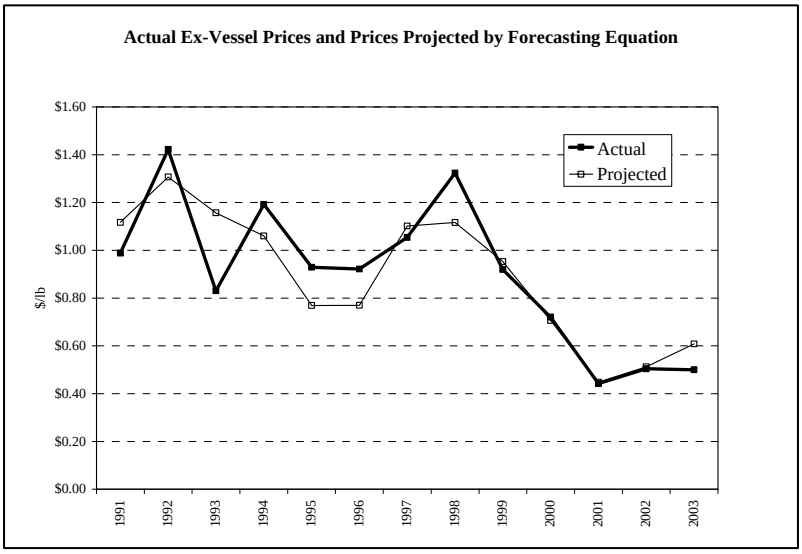
ln (Ex-Vessel Price)	= 4.22 - .531 ln (Bristol Bay Sockeye Harvest) + 1.39 ln (Farmed Coho Wholesale Price), where:
Ex-Vessel Price	= Bristol Bay sockeye real ex-vessel price (real 2003 dollars per pound)
Bristol Bay Sockeye Harvest	= Total Bristol Bay commercial sockeye harvest (metric tons)
Farmed Coho Wholesale Price	= Simple annual average Japanese wholesale price for frozen coho (real 2003 dollars per pound)

This equation was estimated using Ordinary Least Squares regression analysis, as summarized below:

Independent variables	Estimated coefficient	Standard deviation	t-statistic
Intercept	4.215984836	1.509903613	2.79
ln (Bristol Bay Sockeye Harvest)	-0.530561022	0.152111312	-3.49
ln (Farmed Coho Wholesale Price)	1.397895537	0.212012462	6.59

Years	1991-2003
Number of observations	13
Degrees of freedom	10
R-squared	0.830
Adjusted R-squared	0.796

The negative coefficient for the Bristol Bay sockeye harvest in the price forecasting equation implies that higher Bristol Bay sockeye harvests result in lower ex-vessel prices, and vice versa. This inverse effect reflects the effects of harvests on supply to the Japanese frozen salmon market, the canned sockeye market, and the sockeye roe market. The positive coefficient for the farmed coho wholesale price in the price forecasting equation implies that higher farmed salmon prices result in higher ex-vessel prices, and vice versa.



Higher wholesale prices for farmed salmon (a substitute for sockeye salmon) tend to increase demand for sockeye salmon, and vice versa.

This equation was recommended for forecasting future ex-vessel prices because it is theoretically sound, it does reasonably well at projecting historical changes in ex-vessel prices, and it is possible to make informed assumptions about future values of the two explanatory variables—Bristol Bay sockeye harvests and farmed coho wholesale prices—which "drive" the forecasts.

Forecasted Bristol Bay Prices for Different Combinations of Explanatory Variables

Ex-change rate	Farmed Coho Wholesale Price		Bristol Bay Sockeye Salmon Harvest (metric tons)							
	yen/kilo	$/lb	30,000	40,000	50,000	60,000	70,000	80,000	90,000	100,000
90	350	$1.76	$0.63	$0.54	$0.48	$0.44	$0.40	$0.38	$0.35	$0.33
	400	$2.02	$0.76	$0.65	$0.58	$0.53	$0.49	$0.45	$0.42	$0.40
	450	$2.27	$0.90	$0.77	$0.68	$0.62	$0.57	$0.53	$0.50	$0.47
	500	$2.52	$1.04	$0.89	$0.79	$0.72	$0.66	$0.62	$0.58	$0.55
	550	$2.77	$1.19	$1.02	$0.91	$0.82	$0.76	$0.71	$0.66	$0.63
	600	$3.02	$1.34	$1.15	$1.02	$0.93	$0.86	$0.80	$0.75	$0.71
	650	$3.28	$1.50	$1.29	$1.14	$1.04	$0.96	$0.89	$0.84	$0.79
100	350	$1.59	$0.54	$0.47	$0.42	$0.38	$0.35	$0.32	$0.30	$0.29
	400	$1.81	$0.66	$0.56	$0.50	$0.45	$0.42	$0.39	$0.37	$0.35
	450	$2.04	$0.77	$0.66	$0.59	$0.54	$0.49	$0.46	$0.43	$0.41
	500	$2.27	$0.90	$0.77	$0.68	$0.62	$0.57	$0.53	$0.50	$0.47
	550	$2.49	$1.02	$0.88	$0.78	$0.71	$0.65	$0.61	$0.57	$0.54
	600	$2.72	$1.16	$0.99	$0.88	$0.80	$0.74	$0.69	$0.65	$0.61
	650	$2.95	$1.29	$1.11	$0.99	$0.90	$0.83	$0.77	$0.72	$0.68
110	350	$1.44	$0.48	$0.41	$0.36	$0.33	$0.30	$0.28	$0.27	$0.25
	400	$1.65	$0.57	$0.49	$0.44	$0.40	$0.37	$0.34	$0.32	$0.30
	450	$1.86	$0.68	$0.58	$0.52	$0.47	$0.43	$0.40	$0.38	$0.36
	500	$2.06	$0.79	$0.67	$0.60	$0.54	$0.50	$0.47	$0.44	$0.41
	550	$2.27	$0.90	$0.77	$0.68	$0.62	$0.57	$0.53	$0.50	$0.47
	600	$2.47	$1.01	$0.87	$0.77	$0.70	$0.65	$0.60	$0.57	$0.53
	650	$2.68	$1.13	$0.97	$0.86	$0.78	$0.72	$0.67	$0.63	$0.60
120	350	$1.32	$0.42	$0.36	$0.32	$0.29	$0.27	$0.25	$0.24	$0.22
	400	$1.51	$0.51	$0.44	$0.39	$0.35	$0.32	$0.30	$0.28	$0.27
	450	$1.70	$0.60	$0.51	$0.46	$0.42	$0.38	$0.36	$0.33	$0.32
	500	$1.89	$0.70	$0.60	$0.53	$0.48	$0.44	$0.41	$0.39	$0.37
	550	$2.08	$0.79	$0.68	$0.61	$0.55	$0.51	$0.47	$0.44	$0.42
	600	$2.27	$0.90	$0.77	$0.68	$0.62	$0.57	$0.53	$0.50	$0.47
	650	$2.46	$1.00	$0.86	$0.76	$0.69	$0.64	$0.60	$0.56	$0.53
130	350	$1.22	$0.38	$0.32	$0.29	$0.26	$0.24	$0.22	$0.21	$0.20
	400	$1.40	$0.45	$0.39	$0.35	$0.31	$0.29	$0.27	$0.25	$0.24
	450	$1.57	$0.54	$0.46	$0.41	$0.37	$0.34	$0.32	$0.30	$0.28
	500	$1.74	$0.62	$0.53	$0.47	$0.43	$0.40	$0.37	$0.35	$0.33
	550	$1.92	$0.71	$0.61	$0.54	$0.49	$0.45	$0.42	$0.40	$0.37
	600	$2.09	$0.80	$0.69	$0.61	$0.56	$0.51	$0.48	$0.45	$0.42
	650	$2.27	$0.90	$0.77	$0.68	$0.62	$0.57	$0.53	$0.50	$0.47

Note: Between 1978 and 2003 the Bristol Bay sockeye harvest averaged 62,000 mt, and ranged from a low of 26,000 mt to a high of 110,000 mt. Between 1990 and 2004 the exchange rate between the yen and the dollar averaged about 118 yen/dollar, with a high of 158 and a low of 84. Between 1995 and 2003 the Japanese wholesale price for farmed Chilean coho averaged 566 yen/kilo, with an (annual average) low of 350 yen/kilo and a high of 800 yen/kilo.

EX-VESSEL PRICE FORECASTS

For the purpose of forecasting ex-vessel prices, this study assumes that future Bristol Bay sockeye harvests will be in the same range as they were during the period 1978-2003.

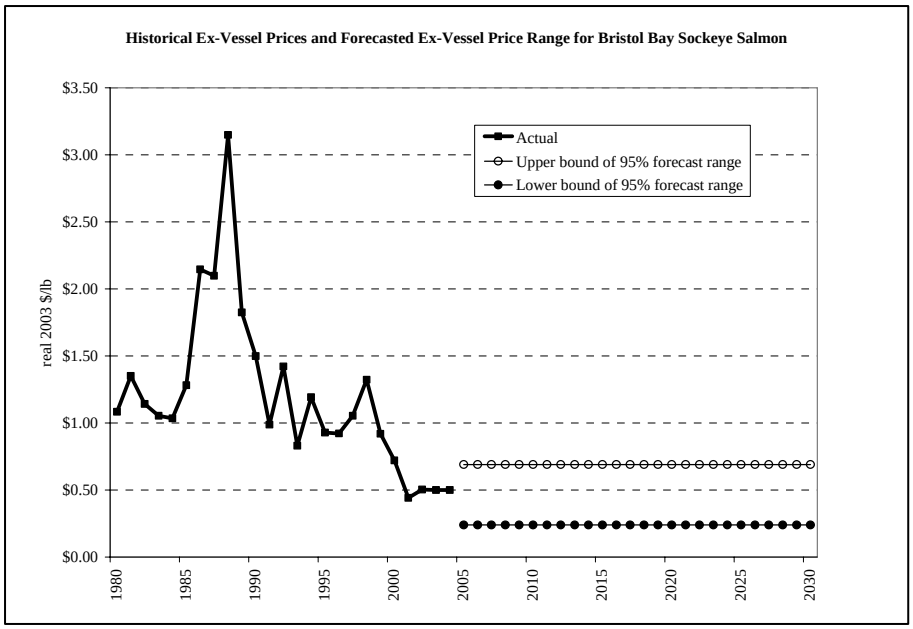
Distribution of Bristol Bay Sockeye Harvest Volume, 1978-2003 (metric tons)

Bristol Bay sockeye harvest (mt)	20,000-40,000	40,000-60,000	60,000-80,000	80,000-100,000	100,000-120,000
Number of years	5	7	7	5	2

Economic theory suggests that future farmed salmon prices will average—over the long-term--close to the cost of production. When prices are above the cost of production, profits will cause salmon farmers to increase production, causing prices to fall. When prices are below the cost of production, losses will cause salmon farmers to decrease production, causing prices to rise. However, over shorter periods of time, prices may fluctuate well above or below the average cost of production.

For forecasting purposes, the study recommends that CFEC assume that future Japanese wholesale prices for coho salmon will average about $1.63/lb. This is a rough estimate of the current total production and distribution cost for Chilean farmed coho salmon sold in Japan. The study recommends assuming that farmed coho wholesale prices will vary above and below this average with a standard deviation of $.20/lb (implying that 95% of the time average annual coho wholesale prices would be between $1.24/lb and $2.02/lb).

Given these assumptions, the equation forecasts that 95% of the time, future ex-vessel prices for Bristol Bay sockeye salmon will be between $.24/lb and $.69/lb.



Forecasted Cumulative Probability Distribution for Ex-Vessel Price

Cum. Probability	1.0%	2.5%	5.0%	50.0%	95.0%	97.5%	99.0%
Price	$0.22	$0.24	$0.26	$0.40	$0.64	$0.69	$0.75

Note. The top row shows the probability that the actual price would be less than price shown in bottom row.

This forecasted price range depends upon numerous assumptions, including the range of future Bristol Bay harvests, the range of future Japanese wholesale prices for farmed coho salmon, and the ability of the simple forecasting equation to correctly predict prices in complex world salmon markets for decades into the future. Actual future ex-vessel prices for Bristol Bay salmon could be outside of this range for many reasons. The following are only a few examples:

- Future Bristol Bay harvests—as well as other wild salmon harvests--could be lower or higher than they were in the period 1978-2003.

- Average farmed salmon wholesale prices could trend downward if farmed salmon production costs continue to decline due to factors such as improved survival rates, growth rates, feed conversion efficiency, and productivity. This would put downward pressure on wild salmon prices, including Bristol Bay ex-vessel prices.

- Average farmed salmon prices could rise if farmed salmon production costs rise due to increasing feed prices, stricter environmental regulation, or higher marginal costs as farming expands into higher-cost regions. Higher farmed salmon prices would likely lead to higher wild salmon prices, including Bristol Bay ex-vessel prices.

- Relative consumer preferences between farmed and wild salmon could shift over time. Depending on how preferences shift, this could either tend to raise or lower prices for wild salmon.

- Improved transportation infrastructure for the Bristol Bay region could lower costs for Bristol Bay processors, which would tend to raise ex-vessel prices.

Total world demand for salmon is likely to grow as population and income increases, but this will not necessarily cause Bristol Bay prices to rise above levels projected by the forecasting. Rising demand will bring about increased production of farmed salmon, which will tend to hold down future prices of both farmed and wild salmon.

The price forecasting equation recommended by this study is relatively simple. Much more complex equations could be estimated to examine how different factors affected past prices. However, complex equations are of little use for forecasting future prices unless there is a way to forecast the explanatory variables which drive them.

This study's forecasts for the range of future ex-vessel prices for Bristol Bay sockeye salmon are reasonable given the inherent constraints of limited data, the complexity of world salmon markets, and the likelihood of continued rapid change in salmon markets.