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The Challenge of Reconstructing Coho Salmon Aquaculture after the Great East Japan Earthquake and Tsunami in 2011

Ikutaro SHIMIZU^{*1}, Tsuyoshi TANAKA^{*2}, Hideki MIURA^{*3}, and Kohichi SAOTOME^{*4}

Abstract: The wholesale price of farmed salmon in local fish markets showed higher prices before the tsunami in 2011. Though farmed coho salmon started being landed again by the support of national funding in 2012, the price of the farmed salmon slumped. A higher price is necessary to maintain the farming facilities for management. This paper aims to clarify the causes of the price drop of Sanriku coho salmon and the issues in the reconstruction process of coho salmon aquaculture. The most important cause of the price drop of Sanriku coho salmon was that consumers' purchasing patterns changed from Sanriku coho salmon to imported salmon due to the lack of Sanriku coho salmon in 2011. We hope to supply fresh Sanriku coho salmon at prices between imported fresh Atlantic salmon and frozen rainbow trout in consumer markets. It is necessary to improve the traditional aquaculture system and to develop brand value for Sanriku coho salmon. Sales promotion is expected to drive the price of the fresh coho salmon up to a fair level.

Key words: coho salmon, aquaculture, Miyagi prefecture, tsunami, reconstructing, and price analysis

Aquaculture of coho salmon (*Oncorhynchus Kisutch*) is one of the most important fisheries in Miyagi prefecture, Tohoku, where the annual production was more than 10,000 tons until 2010 (Fig. 1). However, the Great East Japan Earthquake hit the Pacific coast area of eastern Japan on March 11 in 2011. The tsunami destroyed nearly all the farming facilities, local fish markets, and processing firms in the Sanriku region, and suspended coho salmon farming. One year later, farmed coho salmon started being landed again with help from national funding. Fortunately, the tsunami did not affect the coho salmon juveniles which were located inland. While the wholesale prices of the farmed salmon in local fish markets showed higher prices (more than 400 yen/kg) before the tsunami, the price of the

farmed salmon slumped (less than 200 yen/kg) in 2012 (Fig. 2). Prices higher than 370 – 380 yen/kg is necessary to maintain the farming facilities and bread even. Understanding the causes of the slump is necessary to reconstruct Sanriku salmon aquaculture.

This paper clarifies the causes of the price drop of Sanriku coho salmon and the issues in the reconstruction process of coho salmon aquaculture. We conducted interviews at fisheries cooperatives, farming facilities, local fish markets, seafood processing firms, and wholesale markets in Miyagi prefecture in September and October 2012, and general merchandising stores in the Tokyo area in November 2012. In addition, the relational expressions of salmon price and fishmeal price were

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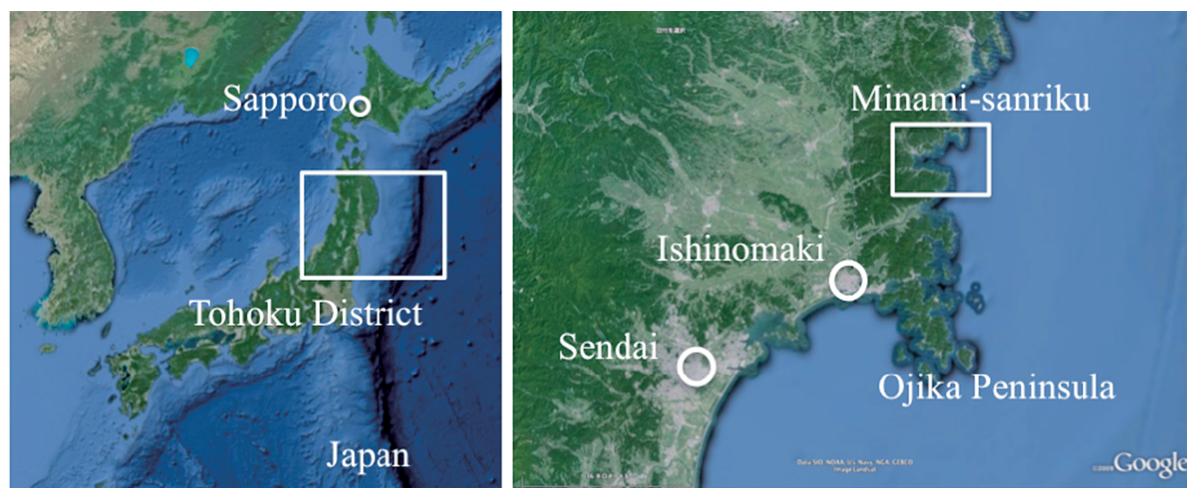


Fig. 1. Maps of Japan on the left and the Sanriku region in the Tohoku district on the right prepared by the Google Maps.

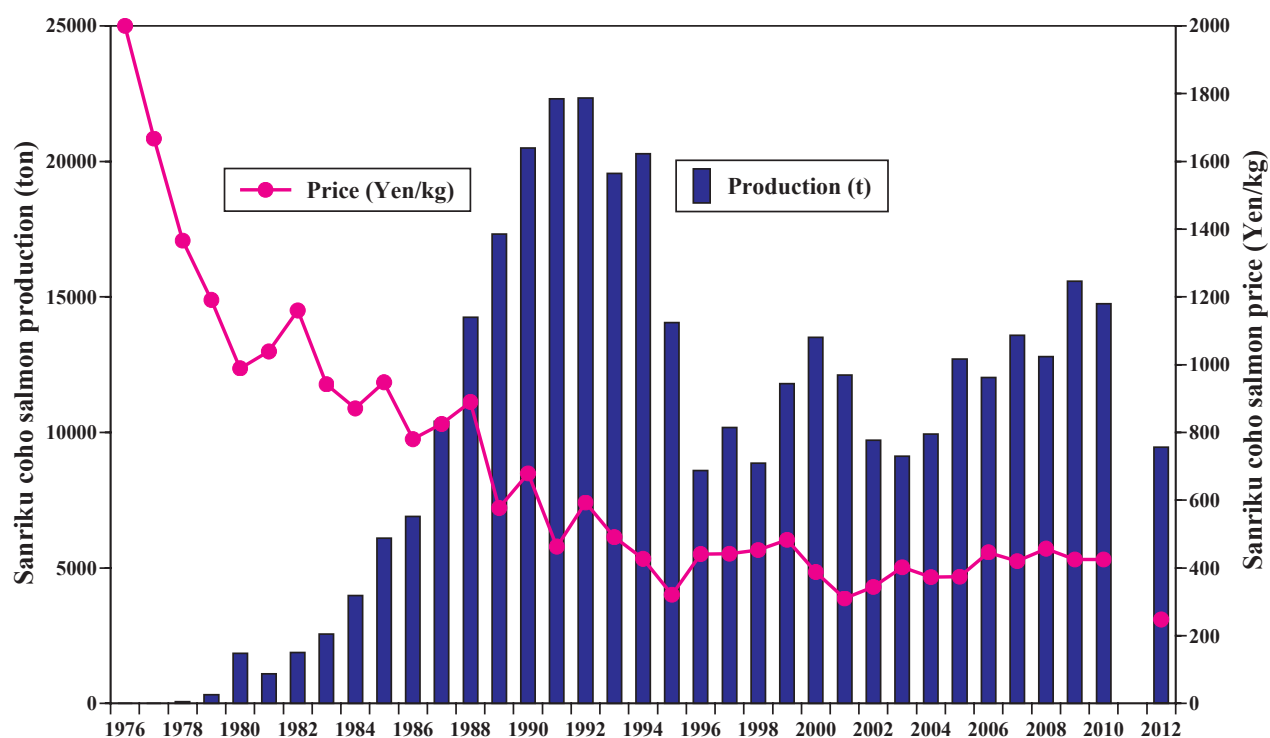


Fig. 2. Variation of production and price of Sanriku farmed coho salmon from 1976 to 2012. The landing of 2011 was nothing by the damage of tsunami. These data were supplied by JF-Miyagi, 2012: Data of landing amounts and values of farmed coho salmon in Miyagi prefecture.

measured with the software R (<http://www.r-project.org>).

Process of coho salmon aquaculture in Japan

Domestic eyed eggs of coho salmon are supplied from inland hatcheries (Koshimizu and Sarabetsu)

in Hokkaido and a part of eyed eggs are imported from a company in the US (AquaSeed Corporation in Washington) to inland fish farms in the Tohoku district. Coho salmon fry are produced by inland fish farms in Iwate and Miyagi prefectures from December to the next October (Fig. 3). Coho salmon fry (total length: 140–180 cm) are

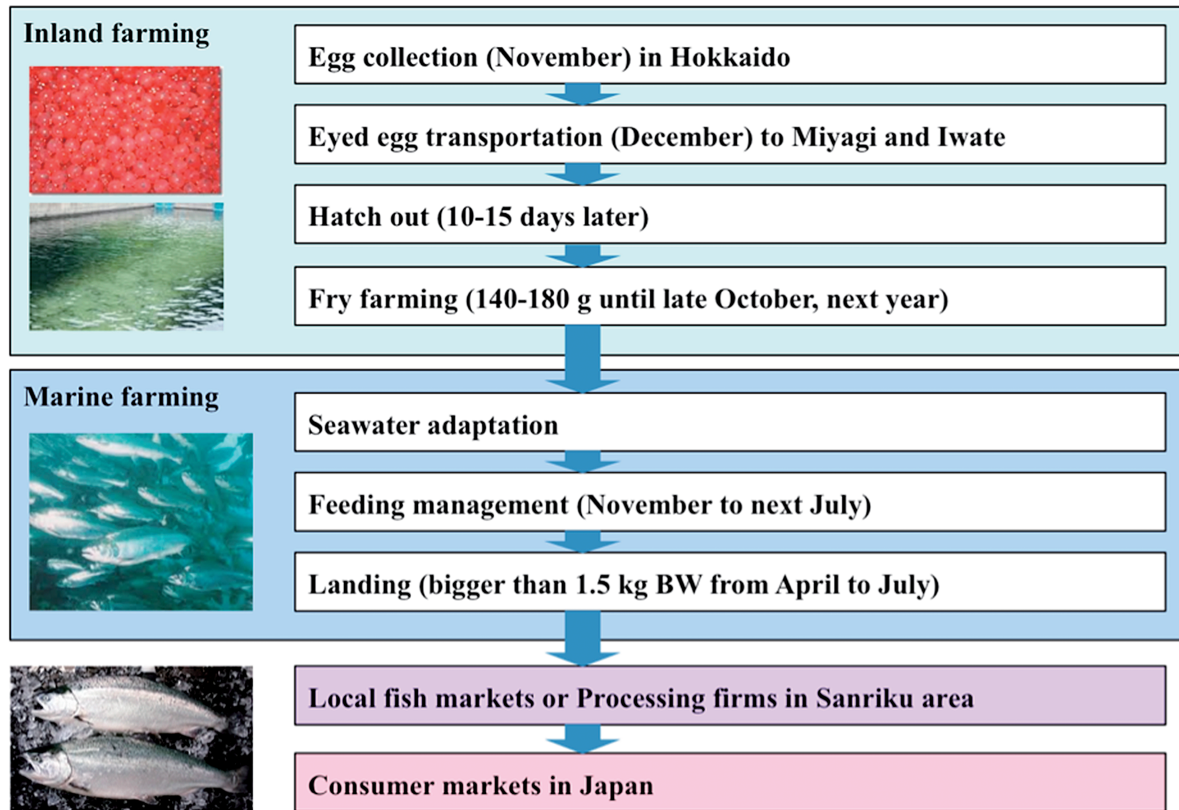


Fig. 3. Farming schedule of Sanriku coho salmon. Inland farming is consisted from eyed egg production in Hokkaido and fry farming in Miyagi and Iwate prefectures. Marine farming is operated along Sanriku coast in Miyagi prefecture.

transported to marine cages in the Sanriku region. The fish farmers begin to land coho salmon after they grow bigger than 1.5 kg body weight from April until early August. Landed farmed coho salmon are transported to processing facilities and they are supplied to consumer markets around Japan.

Causes of the price drop of Sanriku coho salmon

Based on the interviews, the causes of the price drop in domestic farmed coho salmon (Sanriku coho salmon) can be as follows;

- (1) The mass imports of Chilean farmed coho salmon starting autumn 2011 reduced the domestic wholesale price,
- (2) Low seawater temperature in the winter 2012 suppressed the growth of Sanriku coho salmon,
- (3) Late landing of Sanriku coho salmon in the spring 2012 affected supply in June,
- (4) The spread of rumors about radiation caused by the accident at Fukushima nuclear power plant decreased the demand for Sanriku coho salmon,
- (5) Avoiding prolonged cold storage and increase in fresh supply of Sanriku coho salmon reduced the price of the farmed coho salmon, and
- (6) The discontinuation of the supply of Sanriku coho salmon in 2011 changed consumers' purchasing pattern from Sanriku coho salmon to imported salmon.

Issues about coho salmon aquaculture

The price of Sanriku coho salmon is synchronized with the import price of frozen farmed coho salmon and frozen farmed rainbow trout from Chile, and has decreased since the 1980s (Fig. 4). The import price of frozen Chilean coho salmon (IPCCS) is synchronized with the import price of frozen Chilean rainbow trout (IPCRT). IPCCS (yen/kg/year) was explained by the imports (tons/year) of frozen Chilean coho salmon (IQCCS) and IPCRT (yen/kg/year) from 1989 to 2010. The data was used by the

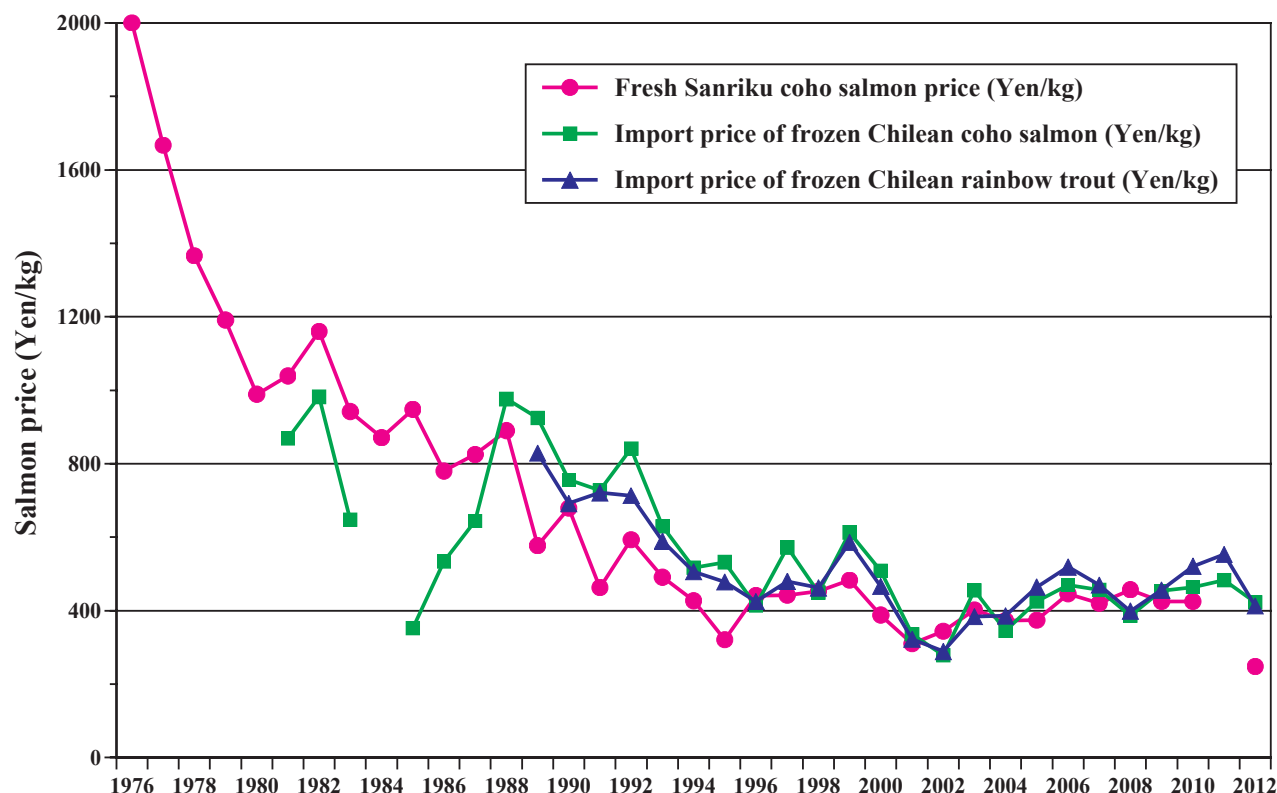


Fig. 4. Prices of fresh Sanriku coho salmon, frozen imports of coho salmon and rainbow trout from Chile between 1976 and 2012. The prices of fresh Sanriku coho salmon were supplied from JF-Miyagi and import prices were provided by the trade statistics, Ministry of Finance of Japan.

trade statistics, Ministry of Finance of Japan Trade statistics (<http://www.customs.go.jp/toukei/>).

This study employed a conventional double-log demand equation model with the estimation results as follows:

$$\text{Log (IPCCS)} = 1.395 - 0.077\text{Log (IQCCS)} + 0.910\text{Log (IPCRT)} \\ (1.308) \quad (-2.104)^* \quad (7.752)^{***}$$

$$\text{Adjusted } R^2 = 0.928, \text{DW} = 2.54, n = 22$$

The statistical significant code: ***, **, and * suggests p-value under 0.005, under 0.01, and under 0.1, respectively. DW is Durbin-Watson ratio.

The price (yen/kg/year) of fresh Sanriku coho salmon (PSCS) was explained by the import price (yen/kg/year) of frozen Chilean rainbow trout (IPCRT) from 1989 to 2010. The data was used by the local market price of JF (Japan Fisheries Cooperatives) –Miyagi and the trade statistics (<http://www.customs.go.jp/toukei/>), Ministry of Finance of Japan.

This regression model was estimated by step AIC as follows:

$$\text{Log (PSCS)} = 2.494 + 0.578\text{Log (IPCRT)} \\ (4.114)^{***} (5.911)^{***}$$

$$\text{Adjusted } R^2 = 0.618, n = 22$$

The result shows the import price of frozen Chilean coho salmon increases by 0.91% as the import price of frozen Chilean rainbow trout increases 1%. In addition, the price of fresh Sanriku coho salmon increases by 0.58% as the import price of frozen Chilean rainbow trout increases 1%.

In the Japanese salmon market, the highest priced salmon is fresh Atlantic salmon imported from Norway (Fig. 5). The second highest priced salmon are frozen sockeye salmon imported from Alaska, frozen rainbow trout or frozen coho salmon imported from Chile. The lowest priced salmon are domestic chum salmon and export chum salmon to China. One of the most important characteristics of Sanriku coho salmon aquaculture is market differentiation by being a fresh product. In addition, the supply of fresh seafood in spring has been less than other seasons in the Sanriku region. We hope to move the

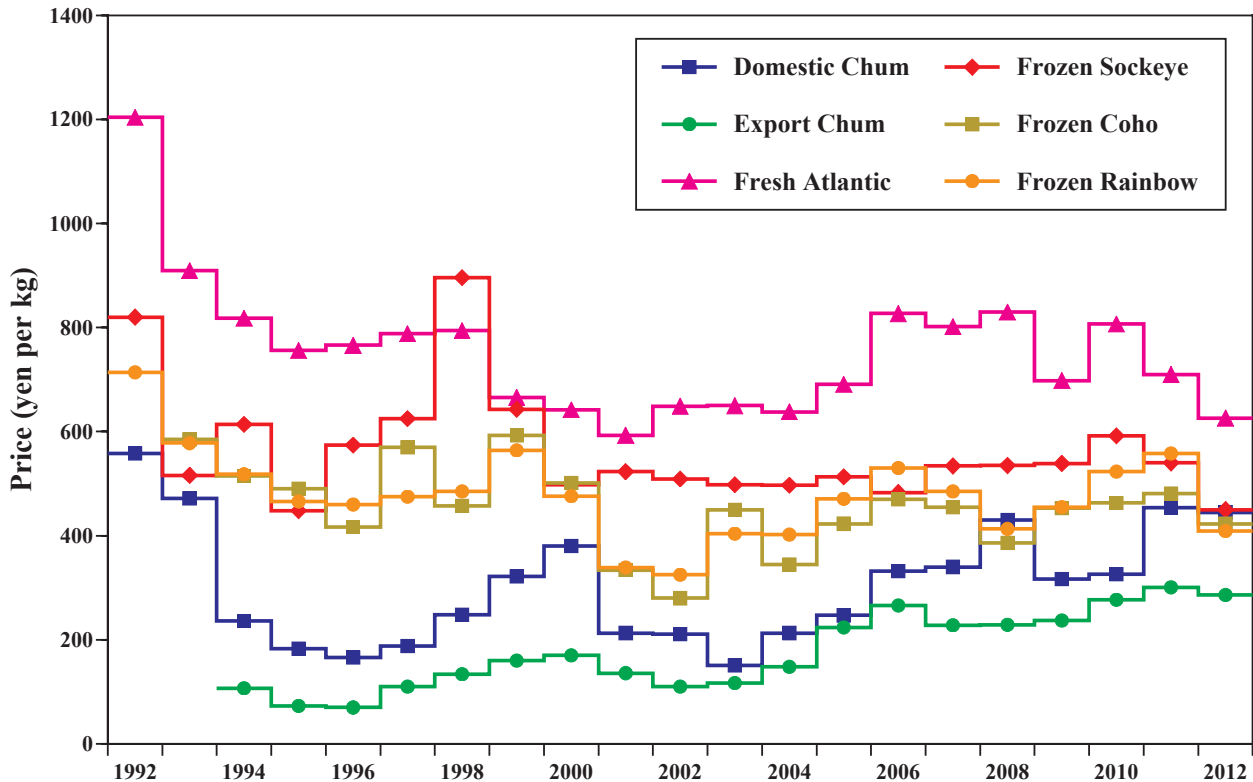


Fig. 5. Prices of salmons in Japanese market. The highest price is fresh Atlantic salmon from Norway. The secondary prices are frozen sockeye salmon imported from Alaska, and frozen rainbow trout and frozen coho salmon imported from Chile. The third prices are domestic chum salmon in Japan and export chum salmon to China. The prices were provided by the annual report (Hokkaido Stationary Net Fisheries Association, 2012: Annual report of salmon distribution in Hokkaido. 96 pp.).

price of fresh Sanriku coho salmon to be between fresh Atlantic salmon and frozen rainbow trout in consumer markets.

Issue about fishmeal in Japan

One of the common issues about Sanriku coho salmon aquaculture system (from eyed eggs production, and fry production, to seawater farming) is the impact on feed costs due to import price of foreign produced fishmeal. The price increase of imported fishmeal has impacted the economics of inland and seawater fed aquaculture. The import price (yen/kg/year) of fishmeal in Japan (JFIP) was explained by the export quantity (tons/year) of Peruvian fishmeal (PFEQ), the fishery production (tons/year) of Peruvian anchovy (PAFQ) and the import quantity of fishmeal in China (CFIQ). The

data was used from 1984 to 2009 of the FAO statistics, FishStatJ^{*5}. This model with estimation results by step AIC is as follows:

$$\begin{aligned} \text{Log (JFIP)} = & 8.860 - 0.071\text{Log (PAFQ)} \\ & (7.336)^{***} \quad (-1.465) \\ & - 0.410\text{Log (PFEQ)} + 0.182\text{Log (CFIQ)} \\ & (-3.226)^{**} \quad (3.427)^{**} \end{aligned}$$

$$\text{Adjusted } R^2 = 0.635, n = 26$$

In addition, the import quantity (tons/year) of fishmeal in Japan (JFIQ) was explained by the fish aquaculture production (tons/year) in Japan (JAPQ) and the export quantity (tons/year) of Peruvian fishmeal (PFEQ). The data was used from 1979 to 2009 of the FAO statistics, FishStatJ. This demand model is defined below:

$$\begin{aligned} \text{Log (JFIQ)} = & 27.001 + 2.389\text{Log (JAPQ)} \\ & (-2.057)^* \quad (2.089)^* \end{aligned}$$

^{*5} (<http://www.fao.org/fishery/statistics/software/fishstatj/en>), Software for fishery statistical time series of FAO

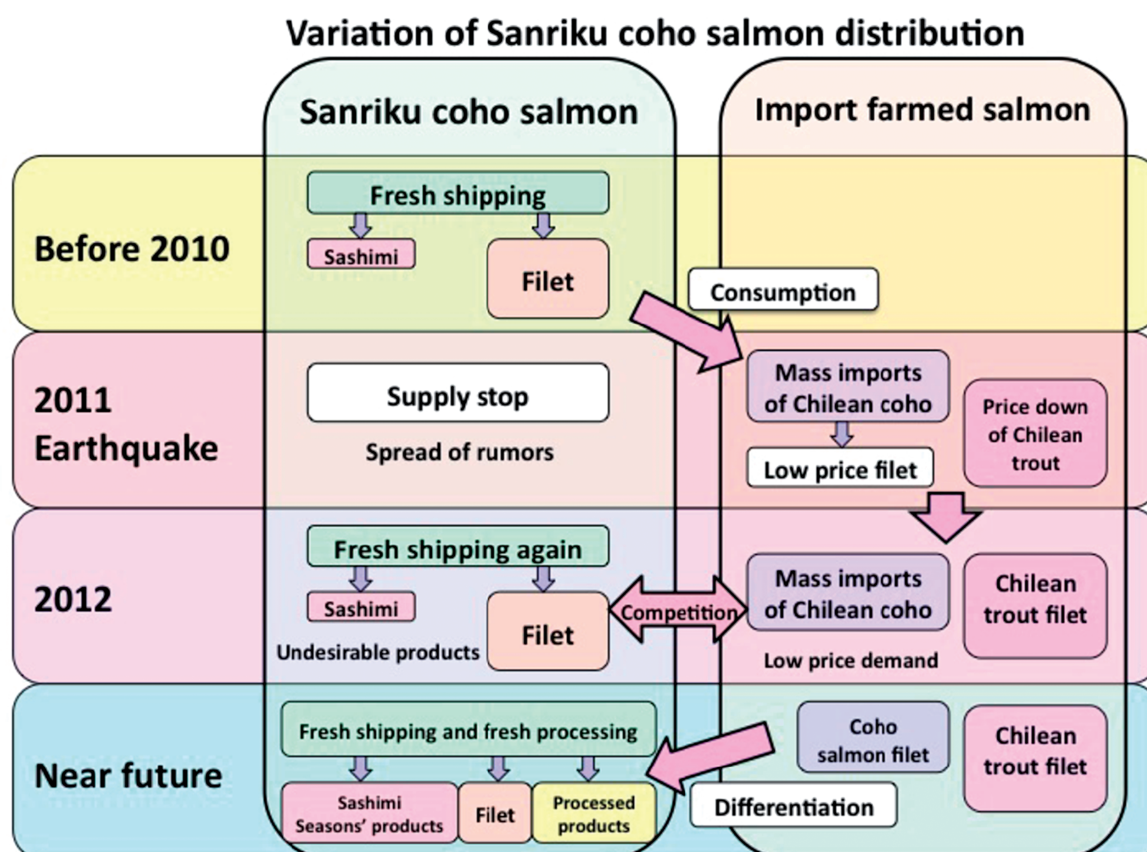


Fig. 6. Distribution image of Sanriku farmed coho salmon and import farmed salmon from Chile in Japanese market before and after the earthquake of 2011.

$$+ 0.663 \text{Log (PFEQ)} \\ (3.930)^{***}$$

Adjusted $R^2 = 0.614$, DW = 1.86, $n = 31$

The import price of fishmeal in Japan decreases by 0.41% as the export quantity of Peruvian fishmeal increases 1%. The import quantity of fishmeal in Japan increases by 2.4% as the fish aquaculture production in Japan increases 1%. We hope fishmeal production would be stable in the near future. At the same time, the development of feed with low fishmeal rate will be expected.

Conclusions

It is important to supply fresh salmon for consumer markets by the Golden Week holidays (from late April to early May) in Japan. It is necessary to improve the traditional aquaculture system and to create a new brand value for Sanriku coho salmon. Sales promotion is expected to drive

the price of fresh coho salmon up to a fair level. We believe that the development of Sanriku coho salmon aquaculture contributes to the reconstruction of regional industries in Miyagi prefecture. All of the Chilean farmed coho salmon and rainbow trout are imported frozen. We believe that one of the most important characteristics of Sanriku coho salmon for market differentiation is freshness (Fig. 6).