The State of Fishing Industry in Fukushima after the Nuclear Power Plant Accident

Nobuyuki YAGI

Graduate School of Agricultural and Life Sciences, The University of Tokyo
1-1-1 Yayoi, Bunkyo, Tokyo, 113-8657 Japan
e-mail: yagi@fs.a.u-tokyo.ac.jp

Abstract

The large-scale release of radioactive substances from the Fukushima Dai-ichi Nuclear Power Plant operated by the Tokyo Electric Power Company caused significant damages to local fisheries in March 2011. Japan's government did not revoke fishing licenses in Fukushima, but the Fukushima Prefectural Federation of Fisheries Cooperative Association immediately suspended all commercial fishing activities in Fukushima waters. The government issued instructions prohibiting the sale of certain marine products caught in the waters off Fukushima Prefecture due to food safety concerns. The prohibitions have been lifted gradually and, in June 2012, the Fisheries Cooperative Associations decided to resume fishing activities for three species (two octopus species and one shellfish species). Landed octopus and shellfish were actually sold with a label indicating Fukushima as their point of origin. Although other species were added to the list over the course of 2013, the scale of operation is far less smaller compared with the situation before the tsunami. Full recovery of Fukushima's fisheries is hardly expected in one or two years. Several options for addressing weak consumer confidence are discussed.

Key words: cesium, consumer confidence, fishery, Fukushima, value-chain

1. Introduction

The tsunami triggered by the Great East Japan Earthquake on March 11, 2011 damaged around 29,000 fish boats and 319 fishing ports in Japan (Fisheries Agency of Japan, 2014a). Each of these figures accounts for some 10% of the respective national totals. Since the disaster, approximately 17,000 of these boats and 289 of the ports have returned to operations as of January 31, 2014 (Fishery Agency of Japan, 2014a).

Despite the unprecedented scale of the disaster, the rehabilitation of the fisheries in the tsunami-damaged areas has been relatively expeditious in terms of the fishing capacity as measured in the number of boats and ports. However, if the level of fish sales (*i.e.*, the amount of fishery production) is employed as a metric for recovery, progress has been considerably slower in these areas.

2. The Status of Fishery Production in the Disaster-affected Areas of Northeastern Japan

Immediately following the disasters of March 11, 2011, rumors emerged that Japan would face a shortage in the supply of seafood products. In reality, however, the Japanese market did not suffer from such a lack of supply, as illustrated in Fig.1, which provides a comparison of monthly landing volumes of major fishery products in Japan from 2009-2012.

Japan's annual fisheries production patterns are characterized by peak levels in autumn, from September to November, with the lowest levels in spring. The prevailing patterns have remained consistent both before and since the disaster. This seasonal variation in landings can be primarily explained by seasonal migration patterns of fish stocks, many of which migrate to Japan's coastal areas from areas further offshore.

It should be noted from Fig. 1 that no tangible changes in monthly landing volumes are evident between the years before and after the disaster in Japan. One reason is that, although a number of boats were damaged, most were small-sized boats which weighed less than five gross tons and had limited production capacity. Many fishing vessels categorized as large- or medium-sized boats, with correspondingly higher production efficiencies, were located off the coast when the tsunami hit and escaped the damage. This allowed such vessels to continue their operations following the disaster.

A large quantity of marine products are also imported to the Japanese market, meaning that a slight increase or decrease in domestic production volumes would not significantly impact the short-term domestic supply or

demand conditions.

Another perspective on the magnitude of the damages to fishery production in Japan is provided in Fig. 2, which indicates long-term changes in national fisheries production over a 50+ year timeframe. In the figure, "inland fisheries" refers to freshwater aquaculture and capture fisheries in rivers and lakes, while "coastal fisheries" describes capture fisheries within Japanese jurisdiction using vessels weighing less than ten gross tons. Likewise, "offshore fishery" refers to capture fishery activities conducted primarily within Japanese jurisdiction using vessels weighing ten gross tons or more, and "long-distance fisheries" are those operated beyond the limits of Japan's national jurisdiction.

Japan's long-distance fisheries peaked in the 1970s, but the total production expanded until the late 1980s due to a sudden increase in stocks of Japanese sardine (*Sardinops melanostictus*). After 1988, the total production declined sharply, reflecting a sudden decrease in Japanese pilchard due to high natural mortality during their juvenile larvae stage (Shima, *et al*. 2012). During the same period, Japan lost certain long-distance fishing grounds located within the 200 mile zones of foreign countries, including the USA and the Soviet Union (Shima, *et al*. 2012). The rate of decline in total production slowed somewhat after the 2000s, but another notable decrease was observed in 2011 due to the disaster. A slight recovery was recorded in 2012.

At the same time that the rapid decline was occurring during the 1990s and later in the production of Japan's fisheries industry, the level of imports of fisheries products from overseas significantly increased. This trend

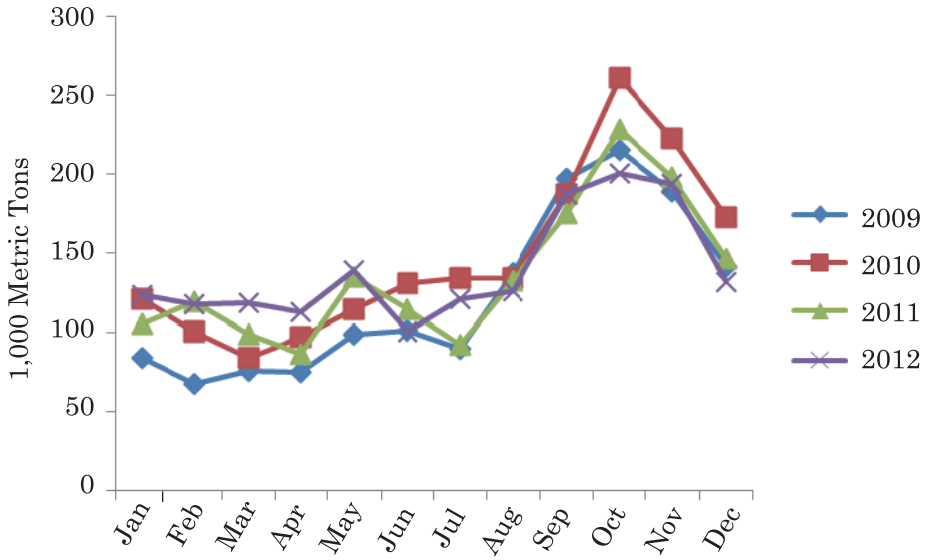

Fig. 1 Landing volumes of major marine products in Japan (source: prepared by the author based on Japan Fisheries Information Service Center Data; unit: 1,000 metric tons).

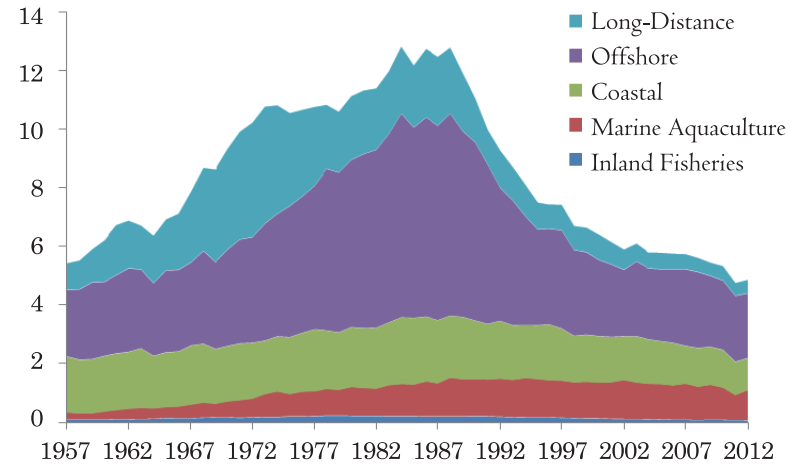

Fig. 2 Long-term production trends in Japanese fisheries (data source: annual reports on aquaculture and fisheries statistics, Ministry of Agriculture, Forestry and Fisheries, Japan; unit: million metric tons).

was aided by a strengthening of the Japanese yen, which pushed up imports of foreign products (Shima, *et al*. 2012). In addition, the import tariffs imposed by Japan on fisheries products are relatively low, measuring just 4% on average (OECD, 2003). Income levels of fishers in Japan are also low as they face increasing global competition and escalating prices for fuel and other materials (Shima, *et al*., 2012). The labor force is also decreasing in size with ageing, with the majority of fishers in Japan now over 60 years of age (Ministry of Agriculture, Forestry and Fisheries, 2008).

Figure 3 compares the volume of fishery products landed from January 2010 to May 2012 at the ports of Ofunato, Kesennuma, Onagawa, and Ishinomaki, all of which are located in Japan's tsunami-affected northeastern region. Before the disaster, these ports recorded peak production levels from the summer to autumn months, and their lowest landing volumes around the spring. As previously mentioned, the seasonal migration patterns of major fish species, including Pacific saury and chum salmon, which approach near-shore waters in autumn, contribute to this seasonal cycle.

All four ports recorded several months with no landings following the disasters of March, 2011. But even before this point, the season had been characterized by lower landing volumes. After the resumption of landings in July 2011, the volume recovered to approximately 50% of the 2010 level by the peak season of autumn, 2011.

The recovery in 2011 (the year of the disaster) is remarkable considering that most of the region's landing ports were almost completely destroyed by the tsunami. Major fishing ports in the affected areas of northeastern Japan's Tohoku region rapidly recovered their functions during the year of the disaster. Recovery of ports plays a critical role in the landing of fish. During interviews conducted by the author in Kesennuma in February 2012, a local processor reported. "Many offshore fishing boats wanted to land skipjack-tuna at Kesennuma in the summer of 2011 as in pre-disaster years, but we were forced to reject many of them because only a portion of the onshore processing facilities and distribution infrastructure had been rehabilitated from the disaster. These boats went to Ofunato and landed their catch there." Likewise, a respondent in Ofunato explained, "When the Kesennuma market is closed, Ofunato has a larger volume of bonito. Local stakeholders are happy about it."

Although major fishing ports in the tsunami-affected area rapidly recovered their functions during the year of the disaster, many small ports remain damaged and few residents have returned to their surrounding areas. A gap in the recovery across the affected region exists, and seems to widening.

In addition, the recovery slowed down over the course of 2012 and 2013 – even for major fishing ports - as shown in Fig.3. It can be argued that this slowing down of the recovery is attributable not only to the status of the ports or boats in the production venues, but also to the performance of distribution and marketing networks for fishery products in primary consumption areas (such as Tokyo or Osaka). These considerations are relevant because the fishery industry constitutes not only fishers, but also a range of processors, distributors, retailers and other service providers. Further discussion of this aspect is provided in the following section.

3. The Status of Fishery Products in Major Consumption Markets

Before the March 2011 disaster, the tsunami-affected area produced approximately 10% of Japan's marine products. Since about half of the marine products consumed in Japan are imported from overseas, this region's share of the Japanese market is around 5%. Production

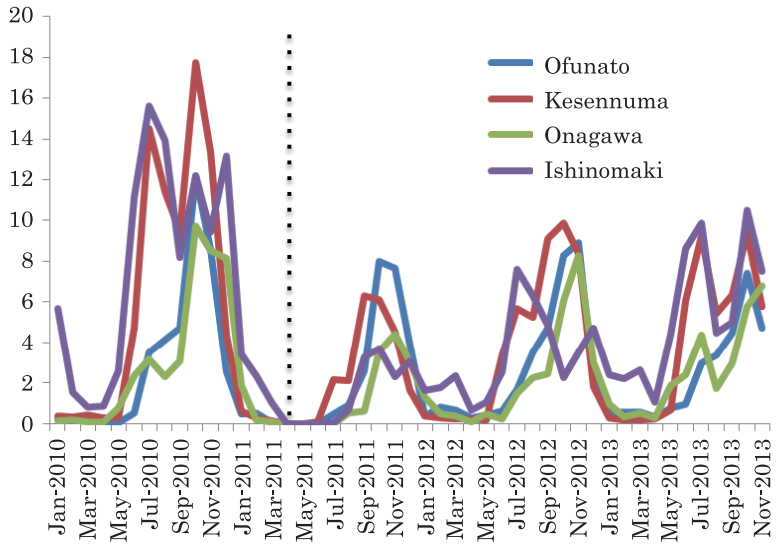

Fig. 3 Landing volume in major fishing ports in the tsunami-damaged areas before and after the disaster (source: prepared by the author based on data from the Japan Fisheries Information Service Center; unit: 1,000 tons). The vertical dotted line indicates when the tsunami disaster occurred.

shortfalls can therefore be offset rather easily with products from other Japanese prefectures or countries. There is a considerable possibility of fishery products generated by the area being forgotten by markets in Tokyo or Osaka if there is a cessation of production across multiple years.

Previous literature has noted that in the case of Japan's fishery distribution, the market power rests with retail stores and consumers, and even if ex-vessel prices for fishery products decrease, their retail prices do not change for a certain period (Sakai *et al.,* 2012; Nakajima *et al*., 2011). In other words, supermarkets exercise greater market power over the value chain, as reflected for example in their requirement for wholesalers to deliver seafood products at a consistent schedule, volume, price and quality (the so-called "four constant conditions"). Producers who fail to meet these conditions may be unable to keep their products on store shelves. If they repeatedly fail to fulfill all these requirements, their products will be replaced with those of other prefectures or overseas producers. Subsequently, they will face difficulties in regaining their market outlets regardless of progress towards reconstruction of the area.

Other players in value chain also follow their own business priorities. Local processing or distribution companies, as compared with local fishers, have a relatively easier time moving to other areas and establishing new businesses without returning to the tsunami-affected areas. This is due to fishing activities being geographically linked to specific marine areas designated by fishing licenses, while processing or distribution industries are under no such administrative requirements. In fact, some of the largest processing facilities in the disaster-affected region decided to relocate their factories outside of these areas, and they still have not returned to the region.

Additionally, consumers are sensitive to the possible contamination of fishery products due to radioactive substances. Prior to going into more detail on this issue, the next section provides an overview of the most recent state of the fisheries industry in Fukushima Prefecture.

4. The Current Status of the Fisheries Industry in Fukushima Prefecture

In Fukushima, significant damage has been caused by the large-scale release of radioactive substances from the Fukushima Dai-ichi Nuclear Power Plant operated by the Tokyo Electric Power Company (TEPCO). On March 15, 2011, the Fukushima Prefectural Federation of Fisheries Co-operative Association (hereafter referred to as the Fukushima FCA) voluntarily stopped fishing operations in the waters inside Fukushima Prefecture.

The government did not revoke fishing licenses in Fukushima, but issued instructions prohibiting the sale of certain marine products caught in the waters off Fukushima Prefecture due to food safety requirements. The allowable level of radioactive cesium set by the Japanese government was 500 Bq/kg until March 31, 2012, but this was reduced to 100 Bq/kg on April 1, 2012 for all fisheries products (Fisheries Agency of Japan, 2014b). In addition, the national government established species-specific prohibitions on sales and marketing for certain agricultural and fishery products originating from certain areas regardless of the actual measured levels of radioactive substances.

Some fishing activities in the prefectures neighboring Fukushima (namely Miyagi and Ibaraki) were also suspended after the TEPCO accident, but most of these have been lifted. Marketing and distribution of most species from Miyagi and Ibaraki were allowed as of February 2014. Prohibitions, however, continue in Ibaraki for seven marine species, including sea bass (*Lateolabrax japonicus*) and five freshwater species including char (*Salvelinus richardson*) (Ibaraki Prefecture, 2014). Likewise, prohibitions exist on two marine species and five freshwater species in Miyagi (Miyagi Prefecture, 2014).

From March 2011 to June 2012, all commercial fishing activities in Fukushima waters were suspended. During this period, various governmental institutes collected and analyzed samples of marine organisms and released information on levels of radioactive substances. Based on these data, which are available online, the list of sales prohibitions has been periodically revised by governments. As of December 2013, a prohibition was in effect for 40 marine species living in Fukushima waters (Fukushima Prefecture, 2014).

Before the accident, the fisheries industry in Fukushima was more successful than the national average in terms of sales and the existence of young successors to continue fishing activities. One possible reason for this success was cooperation between fishing boats and onshore fish distributors to improve product values through due-care handling of landed fish. In the Soma Futaba district of northern Fukushima, "beach mothers" carefully selected the landed fish, discerning brokers bought the selected fish at reasonable prices, restaurants and retail shops purchased fish from trusted brokers, and consumers who favored such establishments did their shopping or had meals there (Yagi, 2013). The connection between local fishers and consumers is considered relatively strong in the Fukushima region (Yagi, 2013).

Many of the fishers in Fukushima have been receiving a certain level of compensation from TEPCO since the nuclear accident. Legally, TEPCO, as the nuclear power plant operator, is obligated to compensate fishers for voluntarily stopping their operations in Fukushima (Fisheries Agency of Japan, 2012). Although TEPCO is paying compensation, there are many complaints from fishers. These include (i) some fishers are unable to submit evidence to calculate the amount of actual damage because sales slips dated before the accident were lost during the tsunami, resulting in inappropriate compensation to such fishers, (ii) processing/distribution companies are considering leaving Fukushima as they cannot get adequate compensation, and (iii) fishers can neither estimate how long they need to continue the cessation of their operation nor make long-term plans for the future (Yagi, 2013).

5. Movements Toward a Limited Resumption of Fishing Operations in Fukushima

Under these circumstances, the Fukushima Prefectural Federation of Fisheries Cooperative Association launched the "Fukushima Prefectural Fisheries Reconstruction Committee" with the aim of reconstructing the fisheries industry and restarting fisheries operations. The committee has repeatedly discussed key obstacles to restarting fishing operations.

The author is a member of this committee and recalls that the main focus of its discussions was as follows: "Even if we start fishing operations again, consumers will not buy our fish. In the worst case, all domestic fish products will be targets of bad rumors. If we do nothing, however, associated distribution/wholesale, food/retail, restaurants and consumers in the coastal area of Fukushima will disappear."

In the face of these conditions, the author took note as a participant that the committee discussed issues including the following:

- Among marine organisms collected at sea along the coast of Fukushima for a monitoring survey, radioactive cesium was detected in squid and octopuses immediately after the accident, but as the level of radioactive substances in the seawater decreased, no cesium was detected in later samples;
- These findings are consistent with the IAEA report that shows marine invertebrate animals to have low concentration factors compared to fish (figures calculated by dividing the level of cesium contained in the body by the level of cesium contained in the water) (IAEA, 2004);
- On the other hand, as of June 2012, more than 100 Bq/kg of radioactive cesium was still being recorded in Japanese sea bass and other fish species living in the coastal area;
- Radioactive cesium contained in water, sediment or marine organisms enters into the bodies of fish, meaning that low levels of cesium in the former areas should translate into low cesium levels within the bodies of fish;
- A monitoring survey conducted after the accident showed that the level of radioactive substances in the bodies of fish is site-specific; it is higher in samples collected near the nuclear plant and becomes lower in those collected in deeper ocean areas; and
- According to an IAEA report (IAEA, 2004), saltwater fish tend not to accumulate cesium at as high of levels as freshwater fish. This mechanism can be explained as follows: in freshwater, the osmotic pressure of a fish's body fluids is higher than that of the surrounding water, and the fish actively cycle water out of their bodies while retaining salt and minerals in order to maintain normal levels of osmotic pressure. During this process, cesium accumulates within the collected salt and minerals. On the other hand, the osmotic pressure in the bodies of saltwater fish is lower than that of the surrounding seawater. To prevent the loss of too much water from their bodies and to maintain balance, saltwater fish actively cycle salt and minerals – along with cesium – out of their bodies.

Several analyses have also been conducted by independent researchers outside the government. Kikkawa *et al*. (2014) used published data for 8,683 samples of aquatic animals and plants obtained off the coast of Fukushima from 2011 to 2013 and evaluated the levels of radioactive cesium (134Cs+137Cs) for 95 species (a total of 97 fishery items including two species that are marketed separately for adult and immature stages). Their results of cluster analysis using parameters of annual average and standard deviation of radioactive cesium concentration levels indicated that the 97 items could be categorized into four groups. The first group had lower concentrations and lower variability across both the first and second years (60 items); the second group showed a decline in concentration levels in the second year, but remained high (21 items); the third group had extremely high initial concentrations, but the levels became almost undetectable in the second year (one item); and the fourth group exhibited high contamination levels across the two years (15 items) (Kikkawa *et al*., 2014). The researchers argued that almost all the items in the first and third groups satisfied the government's food safety standards in the second year. On the other hand, products in the second and the fourth groups did not satisfy the standard, and needed to be closely monitored (Kikkawa *et al*., 2014).

In June 2012, taking into account the above information, the Fukushima Prefectural Federation of Fisheries Cooperative Associations (hereafter referred to as the Fisheries Cooperative) decided to resume fishing activities for three species (two octopus species and one shellfish species) living at depths of more than 150 meters in ocean areas approximately 60-90 km from the troubled nuclear power plant. Because the government did not revoke fishing licenses for fishers in Fukushima after the nuclear power plant accident, the fishermen themselves were left to decide whether to resume commercial fisheries targeting species which meet government food safety standards. The Fisheries Cooperative chose three invertebrate species based on information derived from (i) previous literature published by the IAEA indicating that concentrations of radioactive cesium were low in marine invertebrate animals (IAEA, 2004) and (ii) results from monitoring after the Fukushima accident that were consistent with the conclusions of the IAEA report.

This signifies a limited resumption of fishing activities. Limitations include (i) days of operation (usually less than five days a month), (ii) the amount of landed fish (usually less than ten tons a day), and (iii) the number of vessels involved in fishing operations and market distribution. These restrictions are considered necessary in order to maintain a high frequency of monitoring for radioactive substances and to ensure traceability following landing of marine products. When any product exceeds the standard levels of radioactive substances found

at sites receiving shipments, all products are to be called back immediately.

Landed octopus and shellfish were actually sold with a label indicating Fukushima as their point of origin. Most of these were sold in local supermarkets in the area, and sold out very quickly due most likely to the small quantity of available items and a number of consumers wishing to help their local fishers by purchasing their products.

The committee noted that some consumers are likely to have objections to the limited resumption of fishing activities, saying that no fishing operations should be allowed when there is a possibility that marine products with higher levels of radioactive substances might be on the market. Some may also object to the limited checking for radioactive substances, not for the full catch, but only a sample. The committee argued, "Each individual has a right to select what they want. Rather than trying to persuade consumers that Fukushima products on the market are safe, it is better to label the products clearly as originating from Fukushima and allow consumers to make their own decisions about consumption behaviors."

The number of species allowed under limited fishery operations gradually expanded in 2012: seven species were added in August, and another three species were added in November. An additional 18 species were added to the list over the course of 2013. Thus a total of 31 species are subject to limited fishery operations as of February 2014 (Fukushima FCA, 2014).

6. Discussion

Based on these observations, full recovery of Fukushima fisheries is hardly expected in one or two years. Some options for reconstruction of the fisheries industry under these circumstances can be proposed as follows:

First, issues related to weak consumer confidence following the accident at the Fukushima Daiichi Nuclear Power Plant need to be addressed. Numerous incidents of weak consumer confidence in fisheries products from the tsunami-affected areas have been reported by newspapers (such as a *Yomiuri* newspaper article on May 14, 2012 (in Japanese)) and other media in Japan. Our team has also conducted an online survey of consumer attitudes toward products from the tsunami-affected region, with a particular focus on Miyagi (a neighboring Prefecture north of Fukushima). The results show that consumers' willingness to pay for Miyagi salmon products is relatively high because they wish to contribute to the recovery of the tsunami-affected areas by purchasing these fisheries products. At the same time, consumers have a certain hesitation to buy fisheries products from these areas because of concerns over possible contamination from radioactive substances. (The data are from the author's own research with his team. A separate publication is planned on this research). If the establishment of accurate traceability mechanisms in the value chains can play a role in reducing their concerns, it can be an effective countermeasure to help increase consumer confidence in fishery products originating in the tsunami-affected areas.

Second, it should be noted that reforming the value chains of fishery products not only contributes potentially to increasing consumer confidence, but also to addressing various unresolved fishery issues. Even before the tsunami, the Ministry of Agriculture, Forestry and Fisheries (MAFF) of Japan frequently advocated the need for producers to be directly involved in product sales in order to increase the income of fishers or agricultural farmers. MAFF published a report indicating that, while producers receive 24.7% of the retail price of the fish, retailors receive 38.5% and middlemen/distributers receive the remaining share (36.8%) (Fisheries Agency of Japan, 2009).

The idea here is to enlarge the share of producers in the value chain. In Japan, it is extremely difficult to raise the price of fishery products in retail markets due to the existence of competing products, a challenge that is further exacerbated by the steady increase in imports of fishery products, a strong Japanese yen and low tariff rates (Shima, *et al*., 2012) The income level of fishers has therefore fallen due to increasing global competition and escalating fuel costs, leaving expansion of the share of Japanese fishers in the value chain as a final option for strengthening their position (Shima, *et al*., 2012).

If reforming the value chains of fishery products can help to reverse the current weak position of producers in the value chain (compared with retailers as pointed out by Nakajima (2011)), this could provide a solution to the economic weakness of Japan's fish harvesting sectors as a whole that pre-dates the March 2011 disaster. Such a shift may take the form of new e-commerce business mechanisms to sell products more efficiently to urban consumers, and any other form of direct marketing to consumers would also be useful.

Increased communication between producers and consumers may also help increase consumer confidence and their participation in resource conservation through purchasing practices as informed consumers. Consumers generally do not have proper information about the manner in which fishery and aquaculture products are generated and harvested. It has been pointed out that misperceptions can also have an adverse effect on the conservation and sustainable use of natural resources. While bluefin tuna and other over-exploited species exist, supermarkets in Japan sell these every day at slashed prices after dinner time to avoid retaining unsold stockpiles of perishable sashimi, fostering a misperception among consumers that bluefin tuna is abundant and therefore sold at dumping prices (Yagi, 2011).

The Food and Agriculture Organization (FAO) of the United Nations has indicated that "about 29.9 percent of stocks are overexploited, producing lower yields than their biological and ecological potential" and "the proportion of non-fully exploited stocks has decreased gradually since 1974 when the first FAO assessment was completed" (FAO, 2012). Because the end price of fish is

sometimes cheap, consumers are usually unaware of the scarcity of such fish resources. Likewise, although IUU (illegal, unreported and unregulated) fisheries are detrimental to bluefin tuna and other fish resources, consumers are generally unaware of the existence of IUU fishing activities. Furthermore, price-conscious consumers may select cheap products harvested through IUU activities over fish products harvested by fishers who commit their own resources at their own expense to conservation management. This may induce adverse selection problems (OECD, 2004). In addition to providing food safety information, it would be useful to make information on the state of resource conservation available to encourage and maintain sustainable consumption activities.

Increased exchange of information between consumers and producers can also provide incentives for fishers to strengthen their conservation efforts. Current business practices aim at harvesting a wide variety of fish of different species and different sizes, without being fully aware of consumer preferences, and then showcasing them at retail shops. As a consequence, many fish are left unsold in supermarkets or other consumption sites, and are discarded. The key to solving the problem of post-harvest losses is to receive information on consumer consumption trends prior to engaging in fishing activities. Developing new value-added products with a longer preservation period and promoting these among consumers may be another way to address this issue.

In order to increase communication between producers and consumers, it could also be effective to shorten the distribution channel. Domestic fish distribution in Japan is composed of multiple layers of traders with two stages of wholesale markets – at the landing site and at the consumption site. The first landing site handles the harvested fish and includes middlemen and distributors, while the consumption site wholesale market (such as Tsukiji Market in Tokyo) is located in cities and includes wholesalers and brokers. Retailers are then added to the value chain. Information about the production site is hard to communicate to consumers across this long value chain.

One possible measure is to establish a shortened distribution channel that directly connects producers and consumers through an e-commerce system. This is not meant to replace existing distribution channels, but rather supplement them. It may spur the establishment of a new type of food system in which specific consumer preferences come first, and production activities take place after specific market demands are recognized. This system could be referred to as a Just-In-Time method for the fisheries industry, which would contribute to resource conservation and to increased consumer confidence. It could thus help to revive Fukushima's troubled fishery industry following the accident at the nuclear power plant. Although this approach has never been introduced to any area in Japan, it would be worth trying in an effort to support the rehabilitation of fisheries in Fukushima and other tsunami-affected areas.

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Nobuyuki YAGI

Nobuyuki YAGI is an associate professor at the University of Tokyo. His area of study includes marketing and consumer behaviors as well as the economics of ocean conservation. He received his MBA from the Wharton School of the University of Pennsylvania, Philadelphia, USA, and his PhD from the Graduate School of Agricultural and Life Sciences, the University of Tokyo, Japan. He has been an elected member of the Executive Committee of IIFET (International Institute of Fisheries Economics & Trade) since 2014 and of an expert panel for the IPBES (Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services) since 2014. He served as a bureau member for the OECD Committee for Fisheries from 2003 to 2008 and as a friend of the Chair (Rules Negotiation on fisheries subsidies) of the WTO from 2007 to 2008. His publications include a report coauthored with others in 2012 on the applicability of ITQs in Japanese fisheries, comparing rights-based fisheries management in Iceland, Japan and the United States, which appeared *Marine Policy*.

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