Fukushima Fishery Recovery Project

~From the aspect of recreational fishery~

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Abstract

After the Fukushima-Daiichi Nuclear Power Plant (FDNPP) accident in 2011, the concerns about radioactive level in fishery products have risen. Fukushima fishery industry were strongly regulated and monitored to prevent health effects on people and environment. However, recent research of the radioactivity level in fish caught in Fukushima shows a sharp decrease. Although this decrease of contamination level in fishery product has a positive effect on fishery industry, the issues from this phenomenon is still ongoing among the fishermen community. We identified one issue about an indirect effect from recreational fishery activity which may cause a negatively impact on Fukushima fishery industry's reputation. We approached this problem by conducting interview questions with fishermen cooperatives. Through this interview, we found that no reports on bad reputation came from recreational fishery activity, yet there are some possibility that recreational activity may negatively impact retrieval of Fukushima fishery industry's reputation because regulation on recreational fishery activities are not well-regulated and monitored. To retrieve Fukushima fishery industry, we proposed two solutions: establishing a well-managed fishing park and introducing recreational fishery licensing system. In addition, organizing and holding out-reach public event regularly that is associated with fishery products is needed to keep on spreading and informing commercial fishermen's anxiety toward the public. Effective regulation, frequent monitoring, and participation from every communities are essential keys to achieve goals.

Keywords: cesium, commercial fishery, radioactivity, fishery industry, Fukushima, recreational fishery

1. Introduction

In March 2011, the largest earthquake in Japanese history with the magnitude of 9.0 hit the eastern side of Japan, following by a successive 40-meter high tsunami (Buesseler 2014). This process caused the Fukushima-Daiichi Nuclear Power Plant (FDNPP) accident by a prolong loss of power and heat sink for emergency cooling, which was not prepared in the safety of the design (Baba 2013). This largest incident released radioactive substances, especially radioactive iodine, strontium (^{90}Sr), and cesium (^{134}Cs and ^{137}Cs) which released a high concentration of contamination of Fukushima terrestrial and marine environment (Buesseler 2014). These radioactive substances decayed with a half-life of 8 days for ^{131}I, 30.17 years for ^{137}Cs, 2.06 years for ^{134}Cs, and 28 years for ^{90}Sr (Buesseler et al. 2015; Povinec and Hirose 2015). More than 40% of marine fish species in Fukushima area were found to have higher radioactive cesium than the Japanese regulatory limit, 100 Bq/kg during April 2011 to April 2012 (Wada et al. 2013). Scientists used simulation model and predicted that the direct leakage of ^{137}Cs in the ocean was around 3.6-5.9 PBq after the great disaster and 10-15PBq for the atmospheric deposition to ocean surface (Buesseler 2014; Tateda et al. 2015). The unintentional consequences created a large deposition of radioactive substance to the ocean sediment that negatively impacted benthic organisms (Sohtome et al. 2014). Benthic sediment was found to have higher level of cesium than other main zones, reducing ability of benthic invertebrates and demersal fish to detoxify cesium substances in the body (Tateda et al. 2013; Sohtome et al. 2014). Still, the level of contamination in marine organisms also depended on other factors; such as, the accumulation of food intake, the size of individuals, and the reproduction cycle of organisms (Paloheimo and Dickie 2011). Since the level of radioactive substances was higher in sediment along the shoreline, the low lateral fluxes of toxic substances on the seafloor and movement of the sediments along the shelf provided information for long-term level of cesium in coastal Japan and for the Coastal fisheries to prevent seafloor species harvesting (Buesseler 2014).

In the summary of monitoring on Fukushima fishery products 2015, Fisheries Agency of Japan (FA) reported that the radioactivity level have been decreasing rapidly since after the great disaster and showed no high reading (above 25Bq/kg) in major exporting species, including Sardines and Mackerels. However, this information was the result of commercial product samplings which excluded the

none-commercial products that might come from other activity; for example, recreational fishing. The lacks of informative communication and the regulation on such activity led to a concern among consumers, government, company, and fishermen who involved in Fukushima fishery industry (Yagi 2014). Tokyo Electric Power Company (TEPCO), recently reported that the new underground sea-side impermeable wall along the coast line at Fukushima Daiichi Nuclear Power Station (figure 1.1, 1.2) that block groundwater from units 1 to 4 to flow into the port area has been completed on October 26, 2015,. This construction is expected to minimize the leakage of contamination into the ocean and believed to help increase consumers' confidence in consuming Fukushima fishery products.

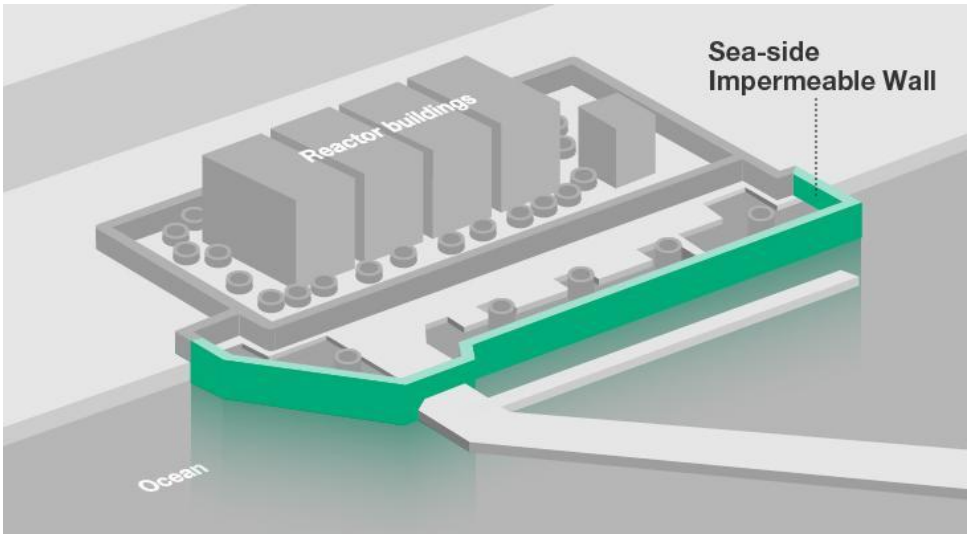


Figure 1.1: TEPCO's construction of sea-side impermeable wall

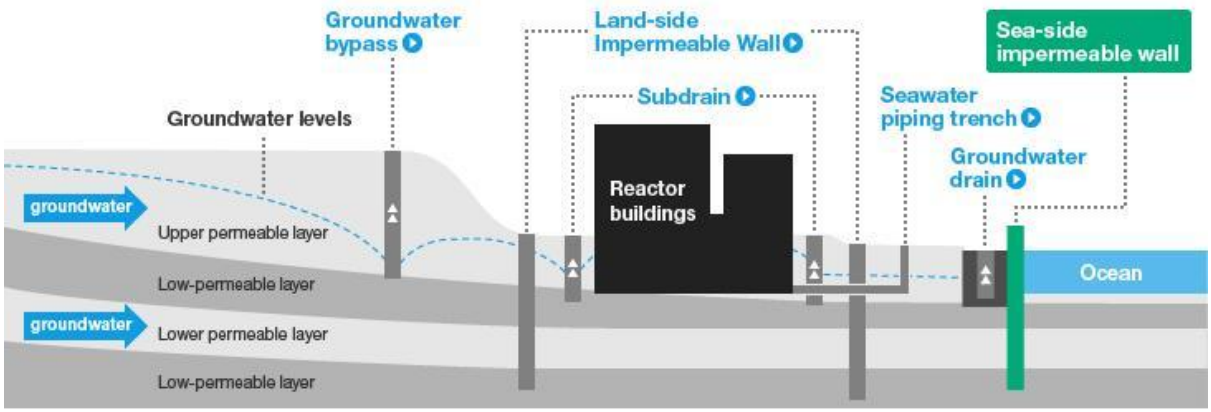


Figure 1.2: The picture shows the process of groundwater flows. Sea-side Impermeable wall blocks groundwater flows which might contain radioactive substances to release into the ocean. The groundwater behind the wall is pumped up, treated, and discharged before going into the ocean by sub-drain system.

An indirect effect of recreational fishery on Fukushima Fishery Industry will be the main focus for this research paper. Schmidt's paper (2003) mentioned that in some cases, Japanese recreational fish catch were higher than the catch by the

commercial activity. The level of contamination in recreational fish stocks are found to be vulnerable depending on fishermen's activity (Fisher *et al.* 2013). Because the recreational fishery is not well-regulated in Japan and still lacks of enforcement, commercial fishermen and fishermen cooperatives are worried that illegal selling of fish products from recreational fishermen may spread the rumors of toxic fish to consumers (Ruddle and Segi 2006). This research paper thus aims to retrieve Fukushima fishery industry and consumer's confidence by identifying fishery community problems, providing accurate information, and proposing a solution to a problem. We first conducted literature reviews to gain information and identify the issues that have not been well-studied in scientific community. The literature information included level of contamination in Fukushima fish, policy and management on fishery products, consumer's confidence data, and recreational fishery activities. Then, we conducted a field survey, interviewing commercial fishermen and fishermen cooperatives to understand stakeholders' issues and their needs. After that, we gathered all information and analyzed the problems. Finally in discussion, we proposed ideal solutions on how can recreational fishery can be properly managed and monitored. The proposed solutions can be adapted and implemented in the future to serve the needs of fishery communities.

2. Level of Contamination in Fish in Fukushima

Since the accident at the Fukushima Daiichi Nuclear Power Station (FDNPS) operated by the Tokyo Electric Power Company (TEPCO) in March 2011, the Government of Japan, concerned local governments and concerned organizations have joined forces to ensure the safety of fishery products by, for example, monitoring fishery products and restricting shipments when limits are exceeded.

2.1. Basic policy for inspections on radioactive materials in fishery products

The policy was made by the Japanese Fisheries Agency in May 2011. This aims to strengthen inspection on radioactive materials in fishery products. In case of the northern part of Fukushima prefecture, the decision on whether fishing operation is possible depends on the analysis results of the inspection. A sampling is conducted once a week in principle at the main landing ports of each designated area. Major species caught in each fishing season should be selected as the target species for inspection. In other words, species sampled should cover a wide

spectrum of marine habitat from the bottom to the surface, at various stages of their life cycles and undertake various kinds of migrations.

Regarding the sample size, according to the instructions from Fisheries Agency to local governments and other organizations, it should be sufficient means 5 kg or more per species with sampling site and date recorded.

The publication and report to the Ministry of Health, Labor and Welfare should be done by the prefectural government of the concerned area.

2.2. Fish sampling and testing

The methods used to detect radioactive Cesium is the gamma ray spectrometry radionuclide assay. Since 2011 until now, about 66,500 samples of more than 400 fish species have been inspected for Cesium (Cs) from Fukushima and other prefectures and mainly from commercial fisheries. Fish from recreational fishermen are not tested. According to the report on the Monitoring of Radionuclides in Fishery Products in April 2015, the Fisheries Agency reported that the suspension of fisheries in coastal and bottom areas for all species except 27 fishes (caught a trial basis at the limited offshore area of Fukushima of 20 km away from the FDNPS) represented a remarkable decrease on Cesium radioactive concentration and except trial fishing. Cs is most represented in the inspection because it takes longer time to measure other elements. The limits set radioactive cesium as the representative radionuclide, due to its large effect on internal radiation exposure to other radionuclides considered like plutonium, strontium 90 and ruthenium 106). Moreover, in order to ensure the safety, the effective dose from these radionuclides other than Cs in fishery product is assumed to be the same as that from radioactive cesium. This assumption is applied when radioactive Cs standard limit (100 Becquerel per kg wet) for food was established.

The Fukushima prefecture held as well fish testing and the results are shared to distributors and consumers in order to tackle bad rumors regarding to fishery products from Fukushima. Monitoring was implemented since 2011 after the power nuclear accident within 20 km from Daiichi Nuclear Power plant station. The fish test is targeting 67 species as of November 2015.

2.3. Results of radioactive cesium inspections for fishery products

Figure 2.1 displays cumulative totals of all nationwide inspections from March 2011 to January 2015.Of the 66,500 samples, 95.5% were found to have radioactive cesium concentrations within the current limit of 100 Bq/kg. In Fukushima prefecture, 91.1% of samples were within 100 Bq/kg, 53% of samples taken in the period immediately following the FDNPS accident were over 100 Bq/kg; however, in the single year after the accident, that proportion dropped by half.

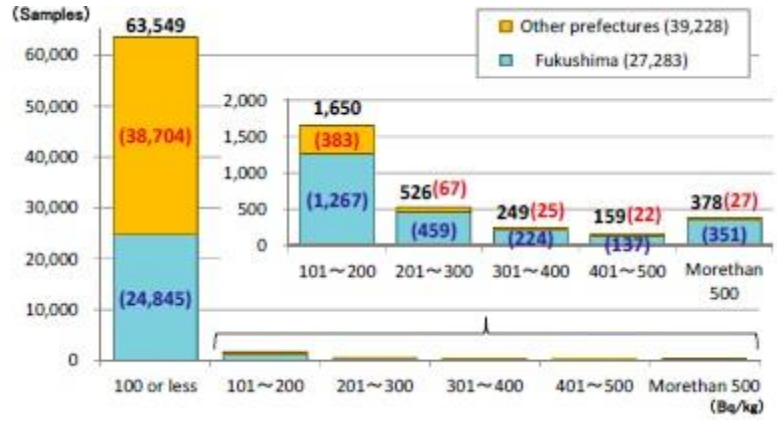


Figure 2.1. Nationwide Fishery Products inspection results

Fukushima prefecture is conducting monitoring surveys for radioactive cesium that involve 180 samples per week. It was confirmed that a statistically significant decrease in radioactive cesium concentrations in Fukushima prefecture's marine products within every fish species tested since the immediate post-accident period. The results of the test indicated that there was no statistically significant increase in radioactive cesium concentrations from Fukushima marine products. Later, it was confirmed that for almost all fish species (freshwater and marine species in the figures 2.2 and 2.3 below), the probability that radioactive cesium concentration will exceed 100 Bq/kg on April, 2015, is effectively zero.

Figure 2.2. Inspection results for Fukushima prefecture Marine Fish species (by fiscal year)

Figure 2.3. Inspection results for Fukushima prefecture Freshwater Fish species (by fish species)

Therefore, as a result of radioactive cesium monitoring, almost all main fishery products are confirmed to be under the Standard Limit in whole Japan including Fukushima prefecture (100 Bq/kg) since April 2012. Moreover, there is a gradual increase of target fish species and expansion of allowed fishing areas.

The Fukushima Prefecture confirmed in its latest test result this November that:

- For marine products, the radioactive cesium which exceeded standard value 100Bq/kg about all specimens was not detected;
- For fish of river, wetlands, the radioactive cesium which exceeded standard value 100Bq/kg about all specimens was not detected and;
- For cultured fish of the inner surface of the water, the radioactive cesium was not detected on all specimens.

TEPCO affirmed all above results through its own annual monitoring and found that concentrations of radioactive cesium in fish species are steadily decreasing with the passage of time, although at a rate that is slower than other marine areas. It can be seen that the percentage of samples exceeding 100 Bq/kg in 2014 is extremely small.

3. Fisheries Situation in Fukushima

This section provided information of how disaster affected the fisheries in Fukushima by comparing the fishery situation before and after disaster.

3.1 Fukushima fishery overview before the disaster.

Fukushima's coast is about 167 kilometers long, and contains 10 fishing ports. The offshore of Fukushima is the border of Kuroshio currents and Oyashio, currently making it a good fishing spots with more than 100 kinds of fish caught (Kudo 2014). According to the Ministry of Agriculture, Forestry and Fisheries (MAFF), before the disaster in 2008, 1,773 people worked at fishery sector and the number of

young people was relatively high in Fukushima. The fishery production was about 20 billion yen ($US 200 million) with 100 thousand tons of fishery products. About half of which was sold through 12 local markets in Fukushima. There were 743 management bodies with 865 fishing boats, and the numbers of processing plants and refrigeration plants were 135 and 111 respectively.

3.2 The damage to Fukushima Fishery caused by the disaster

After the disaster in 2013, the number of people working at fishery sector dropped to 409 (23.1%), and the fishery production decreased to about 8 billion yen (about $65,000) (38.9%) with 45 thousand tons (45%) (MAFF 2013). Comparing to the other two prefectures which was damaged by the disaster in Tohoku (Iwate and Miyagi), Fukushima's damage was the severest. In terms of fishery production, production decreased to 68.8% in Miyagi and 69.2% in Iwate. In addition, the disaster closed down 11 out of the 12 markets with 87 processing plants (64%) and 63 refrigeration plants (57%) operating (MAFF 2013). The most disastrous situation is that there are only 14 management bodies with 32 fishing boats which is 1.9% and 3.7% of what it used to be (MAFF 2013).

3.3 Changes in regulation

The disaster also forced the government to set regulations on shipping the fish caught in Fukushima restricted to 29 species for shipping as shown in Table 3 (MAFF 2015). It accounted for about 23% of the production value of Fukushima fisheries in 2010 (MAFF 2015).

Table 3. The restricted species for shipping in Fukushima

Fat greenling (*Hexagrammos otakii*)	**Jacopever (*Sebastes schlegeli*)**	**Purple puffer (*Takifugu pardalis*)**
Red tonguesole (*Cynoglossus joyneri*)	**Japanese black porgy (*Acanthopagrus schlegelii*)**	**Bastard halibut (*Paralichthys olivaceus*)**
Japanese sand lance (*Ammodytes personatus*) *Except juvenile fish	**Common Skete (Okamejei kenojei)**	**Spotted halibut (*Verasper variegatus*)**

Stone flounder (*Kareius bicoloratus*)	**Cherry salmon (*Oncorhynchus masou*)**	**Whitespotted conger (*Conger myriaster*)**
Japanese rockfish (*Sebastes thompsoni*)	**Saburou (*Occella iburia*)**	**Marbled sole (*Pleuronectes yokohamae*)**
Surfperch (*Ditrema temmincki temmincki*)	**Japanese rockfish (Sebastes cheni)**	**Flathead (*Platycephalus sp.*)**
Dark sleeper (*Physiculus maximowiczi*)	**Japanese sea bass (*Lateolabrax japonicus*)**	**Barfin flounder (*Verasper moseri*)**
False kelpfish (*Sebastiscus marmoratus*)	**Long shanny (*Stichaeus grigorjewi*)**	**Spotbelly rockfish (*Sebastes pachycephalus*)**
Fox jacopever (*Sebastes vulpes*)	**Starry flounder (*Platichthys stellatus*)**	**Stimpson's hard clam (*Mercenaria stimpsoni*)**
Black cow-tongue (*Paraplagusia japonica*)	**Slime flounder (*Microstomus achne*)**	

3.4 Effect to the consumer consciousness

The disaster affected the consumer consciousness in Tokyo metropolitan area. According to the survey conducted by Fukushima Federation of Societies of Commerce and Industry (FFSCI) in 2014, about 30% of the consumers in Tokyo are not willing to buy food produced in Fukushima, and the percentage has not changed much in recent 2 years (Figure 3). The fishermen are suffering from this bad rumor, and one of the causes is that most consumers do not know the inspection results of contamination level. It can be implied by the result of the survey that 65.4% of the consumers in Tokyo area expected the radiation test results to be announced (FFSCI 2015). There are various causes of bad rumor, and even recreational fishing may cause it. Even if the commercial fishermen comply with the restriction, recreational fishermen might sell fish that is prohibited, which lead to another problem of health damage in consumers.

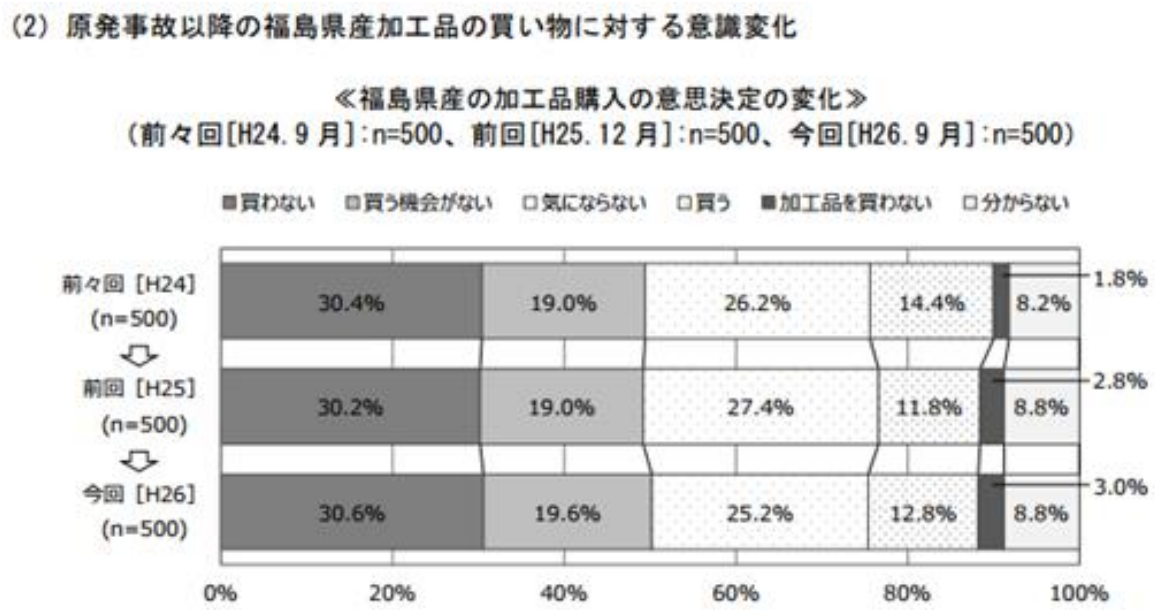


Figure 3 Consumer survey on the willingness to buy the food produced in Fukushima

4. Commercial Fishery Data

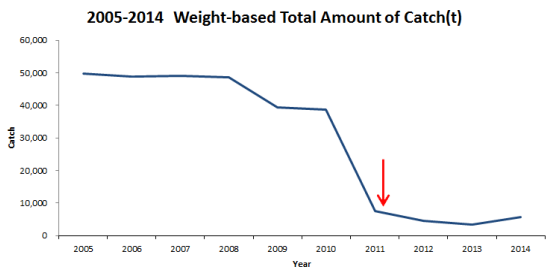


Figure 4.1 Trend of Total Amount of Catch (Weight) during 2005-2014

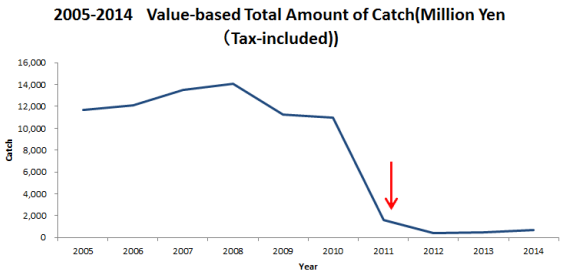


Figure 4.2 Trend of Total Amount of Catch (Price) during 2005-2014

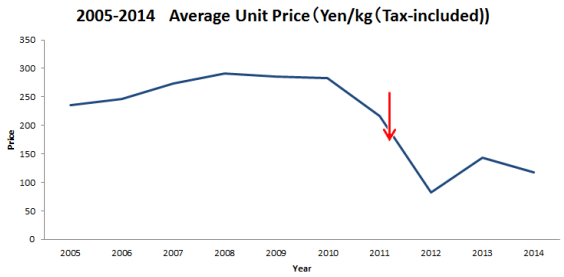


Figure 4.3 Trend of Average Unit Price during 2005-2014

Figure 4.1-4.3 showed trends of fishery statistics data of Fukushima prefecture from 2005 to 2014, according to Fukushima prefecture website. Red vectors pointed to the year 2011 when the Great East Japan Earthquake hit. Figure

4.1 showed the total amount of catch per year based on weight. It was decreased from 49,729 t in 2005 to 5,644 t in 2014(11%.3 of 2005). Figure 4.2 showed the total amount of catch per year based on value. It was 11,667 million yen (about $95.6 million) in 2005 and decreased to 658 million yen ($5.4 million) in 2014 (5.6% of 2005). Figure 4.3 showed the average unit price per year. In 2005 the price was 235 yen ($2) per kg, and it decreased to 117 yen ($1) per kg (49.8% of 2005) in 2014. The bottom price was 82 yen (70 cents) in 2012. After 2011, all of them went down.

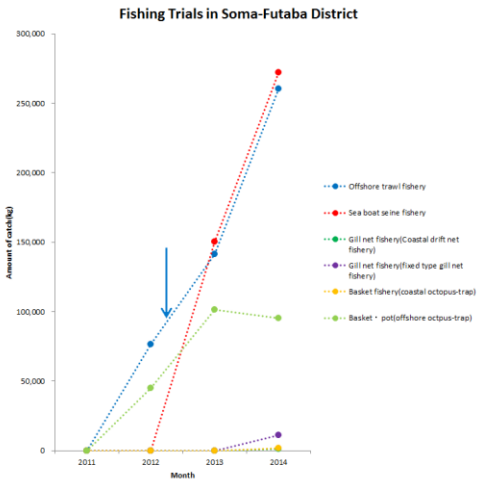


Figure 4.4 Trend of Trial Fishing in Soma-Futaba District

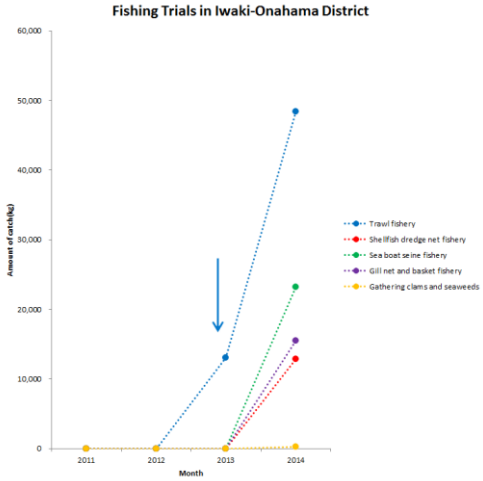


Figure 4.5 Trend of Trial Fishing in Iwaki-Onahama District

Figure 4.4-4.5 showed the amount of catch in fishing trials per year in 2 districts, Soma-Futaba (Figure 4.4) and Iwaki-Ohanama (Figure 4.5), respectively (according to Fukushima Prefecture Website).Trials in Soma-Futaba district was started in July 2012, and in Iwaki-Onahama district it was started in October 2013. Blue vectors pointed the year when trials were started. Amount of catch in each fishery have increased since its beginning except gill net (coastal drift net) fishery in Soma-Futaba district.

Table 2 Damage overview of fishing boats in each areas (September 2011; Annual report for 2014.4.1-2015.3.31 by Soma-Futaba Fisheries agency)

		Registered boats	Found	Total loss	Not joined insurance	Not found yet
Shinchi		45	33	12	0	0
Matsukawaura		236	19	217	0	0
Haragama	Trawl fishery	29	20	9	0	0
	Small fishing boats	204	110	68	26	0
Isobe		63	1	60	2	0
Kashima		47	5	41	1	0
Ukedo		94	7	30	0	57
Tomioka-Okuma		13	5	0	0	8
SUM		731	200	437	29	65

Table 2 showed the damaged overview of fishing boats in each districts. More than 90% of registered boats have been found, but in Ukedo and Tomioka-Okuma districts many of them have not found yet. In Matsukawaura, Isobe and Kashima districts, almost all registered boats were total loss.

Table 3 Target Species of Trial Fishery (JF Fukushima Website)

	Standard Japanese name	English name	Scientific name
1	ミズダコ	Giant pacific octopus	*Enteroctopus dofleini*
2	ヤナギダコ	Chestnut octopus	*Octopus conispadiceus*
3	シライトマキバイ	Whelk	*Buccinum isaotakii*
4	キチジ	Thornyhead	*Sebastolobus macrochir*
5	ケガニ	Horsehair crab	*Erimacrus isenbeckii*
6	スルメイカ	Japanese common squid	*Todarodes pacificus*

7	ヤリイカ	Spear squid	*Loligo(Heterololigo) bleekeri*
8	エゾボラモドキ	Whelk	*Neptunea intersculpta*
9	チジミエゾボラ	Whelk	*Neptunea constricta*
10	ナガバイ	Whelk	*Beringius(Neoberingius) polynematicus*
11	アオメエソ	Bigeyed greeneye	*Chlorophthalmus albatrossis*
12	ミギガレイ	Rikuzen sole	*Dexistes rikuzenius*
13	ズワイガニ	Queen crab	*Chionoecetes opilio*
14	コウナゴ	Sand eel	*Ammodytes personatus*
15	ヤナギムシガレイ	Willowy flounder	*Tanakius kitaharae*
16	ユメカサゴ	Scorpionfish	*Helicolenus hilgendorfi*
17	キアンコウ	Angler fish	*Lophnius litulon*
18	シラス	Whitebait	
19	アカガレイ	Flathead flounder	*Hippoglossoides dubius*
20	サメガレイ	Roughscale sole	*Clidoderma asperrimum*
21	アカムツ	Blackthroat seaperch	*Doederleinia berycoides*
22	チダイ	Crimson sea-bream	*Evynnis tumifrons*
23	ヒレグロ	Korean flounder	*Glyptocephalus stelleri*
24	マアジ	Japanese horse-mackerel	*Trachurus japonicus*
25	メダイ	Bream	*Hyperoglyphe japonica*
26	ケンサキイカ	Swordtip squid	*Loligo(Photololigo) edulis*
27	ジンドウイカ	Japanese squid	*Loliolus(Nipponololigo) japonica*
28	ベニズワイガニ	Red snow crab	*Chionoecetes japonicus*
29	ヒゴロモエビ	Prawn	*Pandalopsis coccinata*

30	ボタンエビ	Pink prawn	*Pandalus nipponesis*
31	ホッコクアカエビ	Deepwater prawn	*Pandalus eous*
32	イシカワシラウオ	Icefish	*Salangichthys ishikawae*
33	スケトウダラ	Alaska pollock	*Theragra chalcogramma*
34	アワビ	Abalone	*Haliotis spp.*
35	ヒラツメガニ	Swimming crab	*Ovalippes punctatus*
36	ガザミ	Gazami crab	*Portunus trituberculatus*
37	ホッキガイ	Sakhalin surf clam	*Pseudocardium sachalinense*
38	マイワシ	Sardine	*Sardinops melanosticctus*
39	マサバ	Chub mackerel	*Scomber japonicus*
40	ゴマサバ	Southern mackerel	*Scomber australasicus*
41	ウマヅラハギ	Filefish	*Thamnaconus modestus*
42	オオクチイシナギ	Seabass	*Stereolepis doederleini*
43	カガミダイ	John Dorey	*Zenopsis nebulosa*
44	カナガシラ	Searobin	*Lepidotrigla microptena*
45	ソウハチ	Souhachi-flounder	*Cleisthenes pinetorum*
46	ホウボウ	Bluefin searobin	*Chelidonichthys spinosus*
47	マガレイ	Brown sole	*Pleuronectes herzensteini*
48	マダイ	Red sea-bream	*Pagrus major*
49	マトウダイ	John dory	*Zeus faber*
50	オキナマコ	Sea cucumber	*Parastichopus nigripunctatus*
51	サワラ	Japanese-Spanish mackerel	*Scomberomorus niphonius*
52	ブリ	Japanese amberjack	*Seriola quinqueradiata*

53	シロザケ	Chum salmon	*Oncorhynchus keta*
54	ヒメエゾボラ	Whelk	*Neptunea arthritica*
55	モスソガイ	Whelk	*Volutharpa ampullacea*
56	サヨリ	Halfbeak	*Hyporhamphus sajori*
57	マダラ	Pacific cod	*Gadus macrocephalus*
58	キタムラサキウニ	Northern sea urchin	*Strongylocentrotus nudus*
59	ショウサイフグ	Globefish	*Takifugu snyderi*
60	ナガレメイタガレイ	Finespotted flounder	*Pleuronichthys japonicus*
61	ホシザメ	Smooth dogfish	*Mustelus manazo*
62	ムシガレイ	Round-nose flounder	*Eopsetta grigrjewi*
63	メイタガレイ	Frog-flounder	*Pleuronichthys cornutus*
64	アコウダイ	Rockfish	*Sebastes matsubarae*
65	カンパチ	Greater amberjack	*Seriola dumerili*
66	シラウオ	Icefish	*Salangichthys microdon*
67	タチウオ	Largehead hairtail	*Trichiurus japonicus*

5. Interview and Analysis

In the 3rd Fukushima Fishery Revival Council held on October 28th, 2015, it said that the number of recreational fishermen was increasing and they might disturb the revival of Fukushima fishery. As this is a relatively new problem, no survey or study has been done until now. Through an interview survey, we got a grasp of the current situation, and we will suggest couple solutions.

5.1 The outline of field survey in Fukushima

In order to investigate the recreational fishermen problem, we conducted the interview survey from fishermen in Fukushima on November 4th, 2016. We

interviewed fisheries cooperative association in Soma and Iwaki. The sections below are provided to discuss the outline of interview and analysis.

- **Soma-Futaba Fisheries Cooperative Association**

Interview to: Shoichi Abe (Councilor of Soma-Futaba Fisheries Cooperative Association)

Recreational fishermen are divided into 2 types. One is those using fishing boat through companies, the other is fishing from land. There is almost no troubles with fishing boat companies near Soma port. In Soma region, those companies conduct recreational fishing trials, therefore they restrict the place and species like fishing trials. Moreover, fisheries cooperative association obliges the fishing boat companies to report the place and species catching. Soma region is far from metropolitan city like Tokyo, the number of recreational fishermen is not high and the number of company is only 4. It is a reason why the number of troubles is almost no. But it is also true that there are people who catch and take restricted fish covertly. For example, there is an actual report that somebody using the boat catch rockfish.

Unlike fishing boat companies, there are many troubles with fishermen from land. Fisheries Cooperative Association cannot prohibit recreational fishing, and they are worried about recreational fishery activity. As fish caught by recreational fishermen are not inspected, there is some possibility of appearing contaminated fish on market. It may causes expansion of bad reputation.

Picture 1. Building of the Soma-Futaba Fisheries Cooperative Association

・ **Iwaki Fisheries Cooperative Association**

Interview to: Tetsu Nozaki (Chairman of JF Fukushima), Tetsuji Suzuki (Managing Director of JF Fukushima), Kenji Nakata (Executive Director of JF Fukushima)

Near Iwaki port, troubles with those using fishing boats are many and serious. Comparing with the years before disaster, the numbers of people and boats are decreasing, but there is still a demand for fishing boats because many people still come from Tokyo. Fisheries Cooperative Association have tried to organize the recreational fishing boat company to solve this problem until now, still, those companies didn't accept their opinions because the companies don't belong to Fisheries Cooperative Association.

The number of fishing from land is also high. They worry about recreational fishermen like Soma region. The association cannot solve this problem, but there is a solution that closing the parking area near the port would be beneficial.

Picture 2. “Fighting Fukushima” Flag in the Iwaki Fishing Cooperative Association

5.2 Analysis

At this stage, there is no report that recreational fishermen caused an expansion of bad reputation. It is also true that recreational fishermen may disturb the revival of Fukushima fishery because recreational fishermen are not affected by place restriction and inspection of fish species unlike commercial fishermen. It is essential to make immediate regulation on recreational fishing.

To avoid appearing restricted fish caught by recreational fishermen, not being eaten by themselves, it is important to change their perspective and monitor activity. To achieve these things, we have to make place where fishermen tell accurate information about prohibition of fish, what fishermen can do to retrieve Fukushima fishery. Only after that, so can fishermen concentrate on what they have to do for retrieval.

To make fishing parks is one of the possible solutions. Before the giant earthquake in 2011, there were many fishing parks or ports available, but after that all parks and ports were damaged. To introduce the system of fishing license also

can be one of the possible solutions. In next chapter, we consider various possible ways to solve the Fukushima fishery industry problem.

6. Discussion and proposed solutions about recreational fishery issues

6.1. Adaptive Management Plan

According to Food and Agriculture Organization of the United Nations, if you want to find out adaptive management of recreational fisheries, first of all, you need to define the problem (see figure 5).

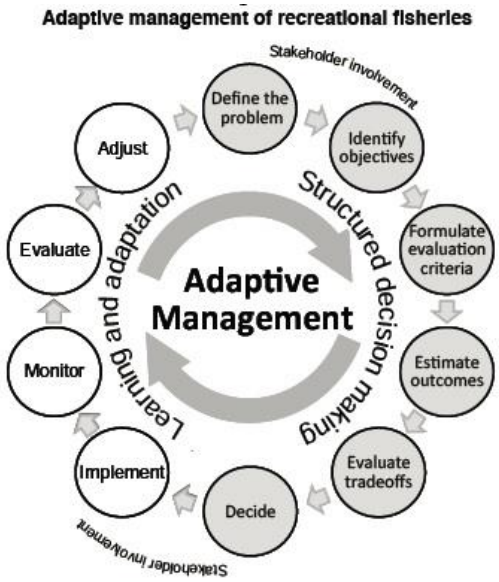


Figure 5: Adaptive Management of Recreational Fisheries (FAO 2012)

In general, issues related to recreational fisheries occurred in term of inappropriate habits of visitors (to throw away garbage, to leave garbage, to fish in prohibited area, and so on) and ignorant of regulation (to ignore the instruction from Fishing Cooperate Association, and etc.) of recreational fishermen, and anxieties of commercial fishermen are caused by recreational fisheries. In the Ruddle and Segi's paper (2006), the authors pointed out five issues related to recreational fisheries. Those issues included the recreational free-rider, loopholes of regulations, difficulty of organizing recreational fishermen, lack of organization from outsiders, and the absence of substantial monitoring. However, situation in Fukushima prefecture is quite different from general case because of high contamination level in marine organisms caused by a large-scale release of radioactive substances from the FDNPP.

As a result of the interview conducted on 4th November, 2015, it is clarified that issues related to recreational fisheries in Fukushima prefecture indicate not only inappropriate behavior of visitors and ignorant of regulation by recreational fishermen, and anxieties of commercial fishermen caused by recreational fisheries, but also worries about bad rumor spread by recreational fishermen's activity such as the distribution of prohibited fish species. In the conference of Fukushima Prefecture Fisheries Reconstruction Committee which was established to reconstruct the fishing industry and to restart fisheries operations, the discussions appeared as follows "Even if we start fishing operation again, consumers would not buy our fish. In the worst case, all domestic fish products would be targets of bad rumors. If we do nothing, however, associated distribution/wholesale, food/retail, restaurant and consumers in the coastal area of Fukushima would disappear." Moreover, according to the result of the monitoring test, fish contamination level by radio-active cesium is higher in coastal area more than in offshore area. Under these circumstances, their anxiety toward spreading of bad rumor caused by recreational fisheries has become bigger and bigger.

Therefore, in this paper, anxiety toward spreading of bad rumor caused by recreational fisheries is the defined problem, and possibility of two possible solutions proposed in the previous chapter are discussed below. Further research findings will be needed in the future in order to achieve the revitalization of Fukushima Fishery Industry.

6.2 Possible solutions

6.2.1. Solution 1: Establishment of fishing parks

First possible solution is the establishment of community fishing parks, where people can interact with coastal ecosystem, utilizing and managing wildlife resources. Fishing park will provide ecosystem services to serve the benefit within community both socially and economically. Fishing park should be well-managed and well-regulated in order to maintain the health of coastal ecosystem. To make it properly manage and easier to monitor, specifying designate areas for each recreational activities must be taken into consideration. In addition, some more attractive ideas such as the settlement of the radiation measuring instruments or parking area have to be considered.

This is just an idea to reduce the number of issues related to recreational fishery, and it will not cover recreational fishing boats. Therefore, Fisheries Cooperative needs to have another idea to deal with fishing boats issue. In Soma-Futaba area, there are 4 recreational fishing boats and all of those have connection with Soma-Futaba Fishing Cooperative Association. On the other hand, there are a lot of recreational fishing boats and private boats in Iwaki area, and they are not organized. Because of these current situation, it can be more urgent issue in Iwaki.

6.2.2. Solution 2: Introduction of fishing license

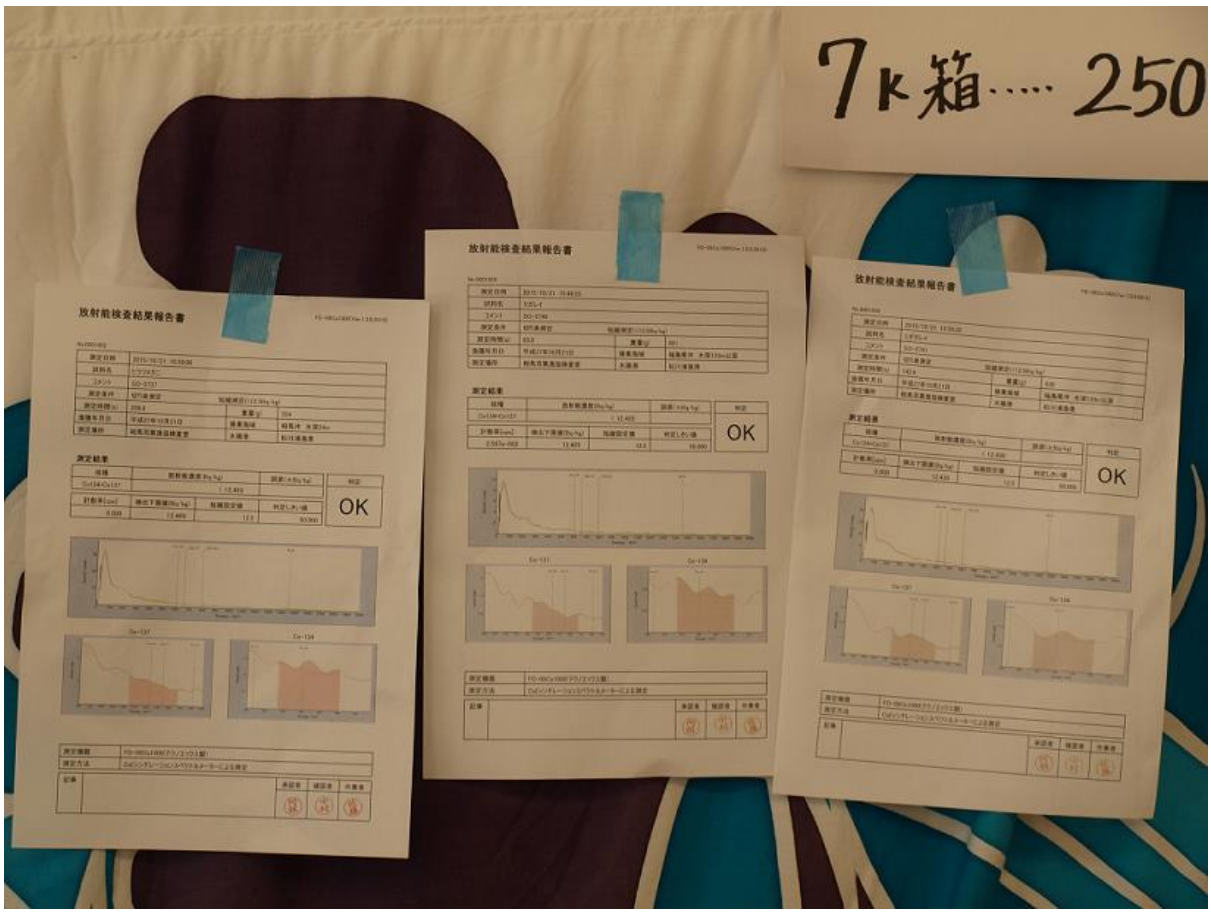
Second possible solution is the introduction of fishing license which is a regulatory or legal mechanism to control fishing. This solution intends to decrease the anxiety of commercial fishermen by decreasing the number of recreational fishermen. However, there is a need to give some incentives such as the prize for the man who catch the biggest fish in the park to avoid blames, and also some punishment such as the fine for the recreational fishermen who fished without fishing license.

The licensing system is introduced in all over the world. For example, in New Zealand, it is prohibited to sell fish without having a fishing permit which is controlled by Ministry of Primary industry (Ministry of Primary industry, 2015). In Western Australia, recreational fisherman has to pay to receive recreational fishing license, and the fee is used to maintain the resources of fish (Government of Western Australia Department of Fisheries, 2015). These licensing systems can be a useful reference in organizing license system in Japan especially in Fukushima, however, there are things needed to be done beforehand. For example, interview survey on recreational fisherman asking the willingness to buy fishing licenses is needed to examine if introducing the license is realistic or not.

6.2.3. Additional Proposal: Holding events regularly

There are many public events related to fishery products currently held by Fisheries Cooperatives or some other organizations. For example, Soma-Futaba Fisheries Cooperative holds some events such as the fishery products tasting events or fish cooking classes.

Two possible solutions still have vulnerability because these solutions will be applied to only some parts of recreational fishermen and have only limit effect. Therefore, it is also important to keep informing current fishery situation of each area through the events along with the action for two possible solutions.



Picture 3. Certification of the low contamination caused by radio-active cesium.
If you know the existence of it, you will not believe bad rumor occurred from recreational fisheries.
This kind of information should be more informed to citizens.

References Cited

Baba, M. 2013. Fukushima accident: What happened?. *Radiation Measurement,* 55:17-21.

Buesseler, K.O. 2014. Fukushima and ocean radioactivity. *Oceanography* 27(1):92–105.

Buesseler, K.O., German, C.R., Honda, M.C., Otosaka, S., Black, E.E., Kawakami, H., Manganini, S.J., and Pike, S.M. 2015. Tracking the fate of particle associated Fukushima Daiichi cesium in the ocean off Japan. *Environmental Science&Technology,* 49:9807-9816.

Fisher, N.S., Beaugelin-Seiller, K., Hinton, T.G., Baumann, Z., Madigan, D.J., and Garnier-Laplace, J. 2013. Evaluation of radiation doses and associated risk from the Fukushima nuclear accident to marine biota and human consumers of seafood. *PNAS,* 110(26):10670-10675.

Fisheries Agency of Japan (FA). 2015. Report on the monitoring of radionuclides in fishery products, April 2015. 135 pp

Fukushima Federation of Societies of Commerce and Industry. 2015. Consumer's willing-to-buy survey on fishery product from Tokyo and Fukushima prefectures (in Japanese). Available online: http://www.f.do-fukushima.or.jp/image/270123_shouhishaishiki_pressrelease.pdf

Government of Western Australia Department of Fisheries. 2015. Recreational fishing guide 2015. Available online:

http://www.fish.wa.gov.au/documents/recreational_fishing/rec_fishing_guide/rules_guide_statewide.pdf

Kudo, Y. 2014. The current situation of Fukushima Fishery and the approach taken for revival. National Diet Library reference no.767:55-75

Ministry of Agriculture, Forestry and Fishery (MAFF). 2013. The overview of fishery in the 3 prefectures which suffered from the disaster (in Japanese). Available online: http://www.maff.go.jp/j/tokei/census/fc/2013/pdf/hisai_gaiyou_270826.pdf

Ministry of Primary Industries. 2015. Fishing rules. Available online: http://www.mpi.govt.nz/travel-and-recreation/fishing/fishing-rules/

Paloheimo, J.E., and Dickie, L.M. 1966. Food and Growth of Fishes: III. Relations among food, body size, and growth efficiency. *Journal of the Fisheries Research Board of Canada,* 23(8):1209-1248.

Povinec, P.P., and Hirose, K. 2015. Fukushima radionuclides in the NW Pacific, and assessment of doses for Japanese and world population from ingestion of seafood. *SCIENTIFIC REPORTS*, 5:9016.

Ruddle, K., and Segi, S. 2006. The management of inshore marine recreational fishing in Japan. *Coastal Management*, 34(1), 87-110.

Schmidt, C.C. 2003. Fisheries and Japan: A case of multiple roles?. *Paper prepared for the International Symposium on Multiple Roles and Functions of Fisheries and Fishing Communities, 13 February 2003, Aomori, Japan.*

Sohtome, T., Wada, T., Mizuno, T., Nemoto, Y., Igarashi, S., Nishimune, A., Aono, T., Ito, Y., Kanda, J., and Ishimaru, T. 2014. Radiological impact of TEPCO's Fukushima Dai-ichi Nuclear Power Plant accident on invertebrates in the coastal benthic food web. *Journal of Environmental Radioactivity*, 138:106-115.

Tateda, Y., Tsumune, D., and Tsubono, T. 2013. Simulation of radiactive cesium transfer in the southern Fukushima coastal biota using a dynamic food chain transfer model. *Journal of Environmental Radioactivity*, 124:1-12.

Tateda, Y., Tsumune, D., Tsubono, T., Aono, T., Kanda, J., and Ishimaru, T. 2015. Radiocesium biokinetics in olive flounder inhabiting the Fukushima accident-affected Pacific coastal waters of eastern Japan. *Journal of Environmental Radioactivity*, 147:130-141.

Tokyo Electric Power Company (TEPCO). 2015. Closing of the seaside impermeable wall has been completed.

Wada, T., Nemoto, Y., Shimamura, S., Fujita, T., Mizuno, T., Sohtome, T., Kamiyama, K., Morita, T., and Igarashi, S. 2013. Effects of the nuclear disaster on marine products in Fukushima. *Journal of Environmental Radioactivity,* 124:246-254.

Fukushima Prefecture (2015). Radioactivity result of a measurement of marine product of Fukushima. Available online: http://www.pref.fukushima.lg.jp.e.od.hp.transer.com/sec/36035e/suisanka-top.html

Fisheries Agency of Japan (2015). Report on the monitoring of radionuclides in Fishery Products (March 2011 - January 2015). Available online: http://www.jfa.maff.go.jp/

Food and Agriculture of the United Nations (2012). Recreational Fisheries. Rome. 194 pp.

Yagi, N. 2014. The state of fishing industry in Fukushima after the nuclear power plant accident. *Global Environmental Research,* 18:65-72.

ANNEXES

This link shows tables showing the last test result done by the Fukushima prefecture http://www.pref.fukushima.lg.jp/uploaded/attachment/142823.pdf

Here are the list of the 67 species monitored by Fukushima Prefecture: http://www.pref.fukushima.lg.jp.e.od.hp.transer.com/uploaded/attachment/143136.pdf