Report on the Monitoring of Radionuclides in Fishery Products (Summary)

April 2015

Fisheries Agency of Japan

Update of the Report by FAJ

- Since the Fukushima Daiichi NPS accident in March 2011, the Japanese government, local governments and relevant organizations have worked cooperatively for ensuring safety of fishery products.
- The FAJ report in May 2014 gave a summary of information and knowledge obtained by then, in order to promote accurate understanding of Japanese fishery products domestically/internationally.
- Almost four years have passed since the accident, and the level of radioactive Cs in fishery products has declined substantially.
- However, concerns still remain among some consumers, and some countries and regions still maintain their import restrictions.

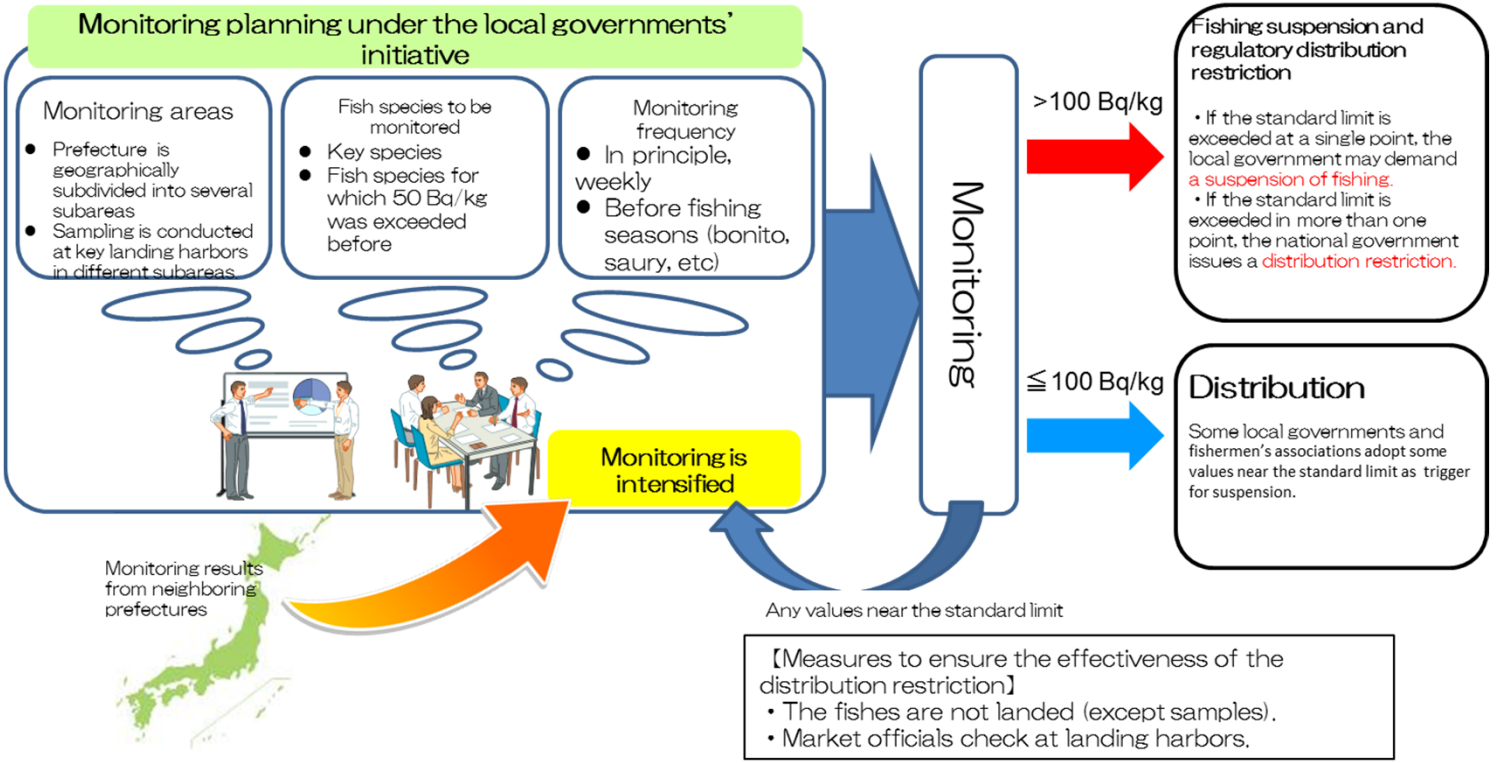
  → FAJ updated the Report in April 2015.

Ⅰ Measures to Secure the Safety of Fishery Products

1. Framework for Securing the Safety of Fishery Products
2. Monitoring Plan of Local Government
3. Actions to be taken in the event that the standard limit is exceeded
4. Inspection Results of Fishery Products
5. Inspection Results for Other Radionuclides than Cesium
6. Radioactive Cesium in Ocean Water

1. Framework for Securing the Safety of Fishery Products

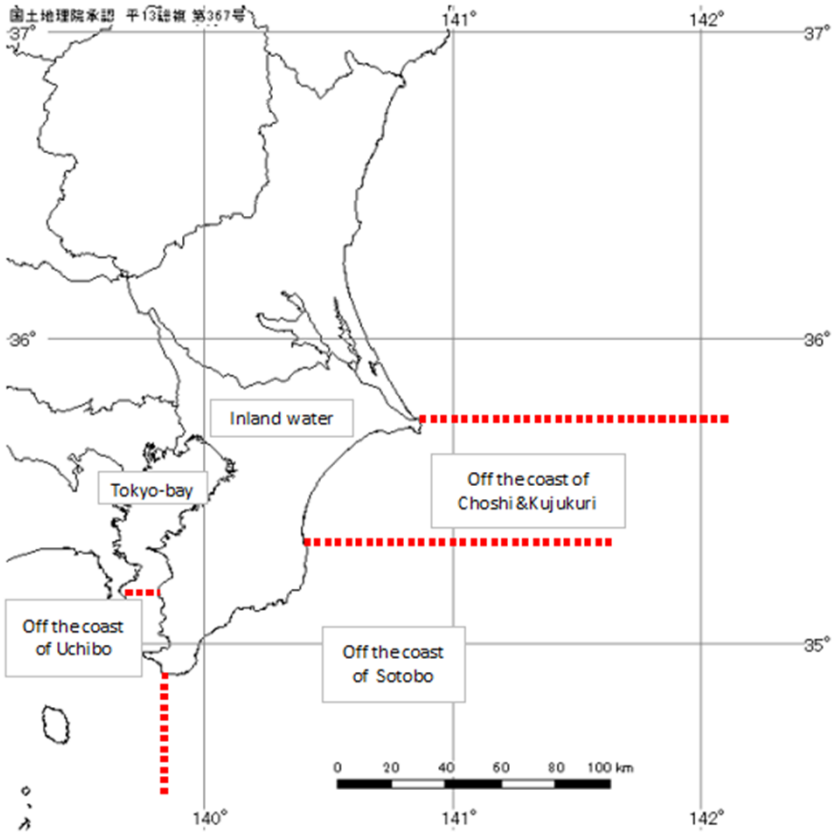
- The Japanese Government's Nuclear Emergency Response Headquarters establishes and updates "Concepts of Inspection Planning and the Establishment and Cancellation of Items and Areas to which Restriction of Distribution and/or Consumption of Foods concerned Applies" ("the Guideline" hereinafter).
- Monitoring is focused on major fish species and those species which exceeded 50 Bq/kg in the previous year.
- For the species which exceeds the standard limit in more than one point, the restrictions on distribution are imposed by the head of the Nuclear Emergency Response Headquarters (i.e. the Prime Minister of Japan).



2. Monitoring Plan of Local Governments

In case of Chiba Prefecture

6 zones: 4 fishing zones, inland fishery and aquaculture



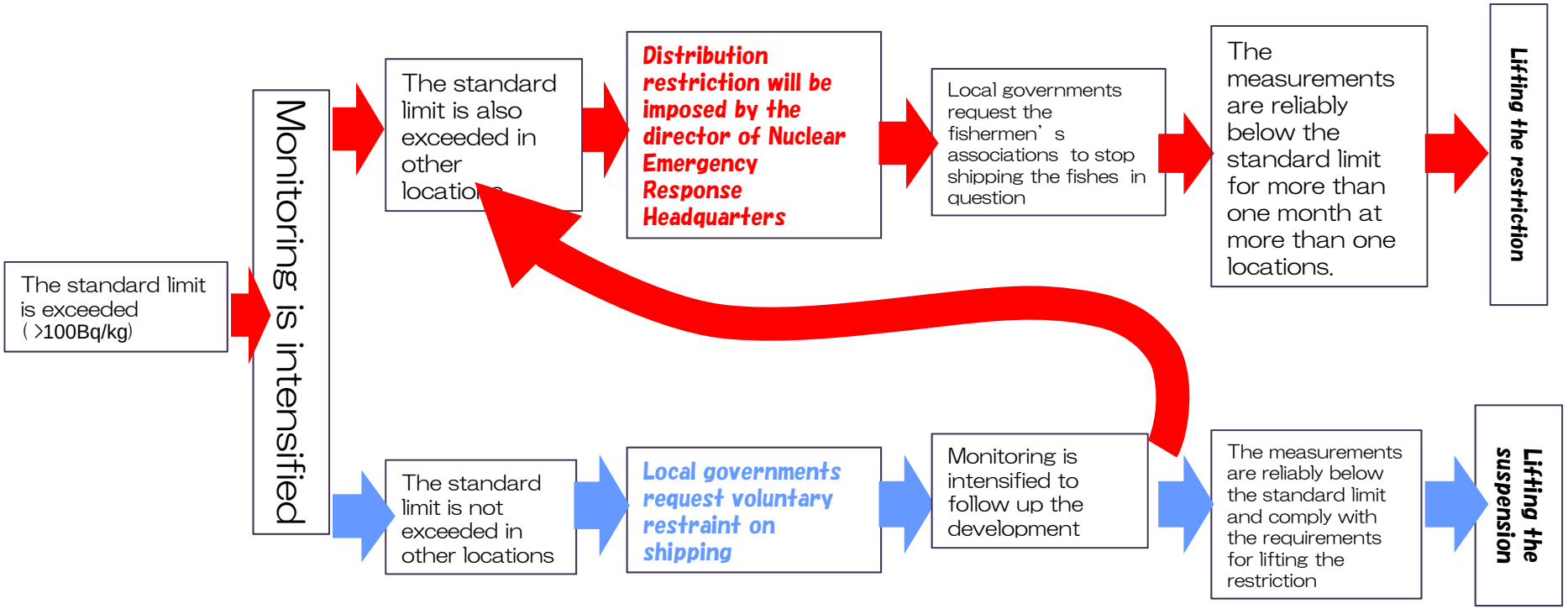
- ○ Each local government establishes Monitoring Plan in accordance with “the Guideline”
- ○ Local governments divide their marine fish areas by taking account of fishing activities or distribution of fish species.
- ○ Monitoring is conducted for each zone based on monitoring plans.
- ○ If radioactive cesium levels exceed or are close to the standard limit, the frequency of monitoring is intensified.

3. Actions to be taken in the event that the standard limit is exceeded

○ In case a fishery product exceeds the standard limit (100 Bq/kg), the lot containing the product is recalled pursuant to the Food Sanitation Act.

○ In addition, the distribution of the fishery species is suspended, either by the local government's request or the head of the Nuclear Emergency Response Headquarters' imposition, depending on the following inspection results.

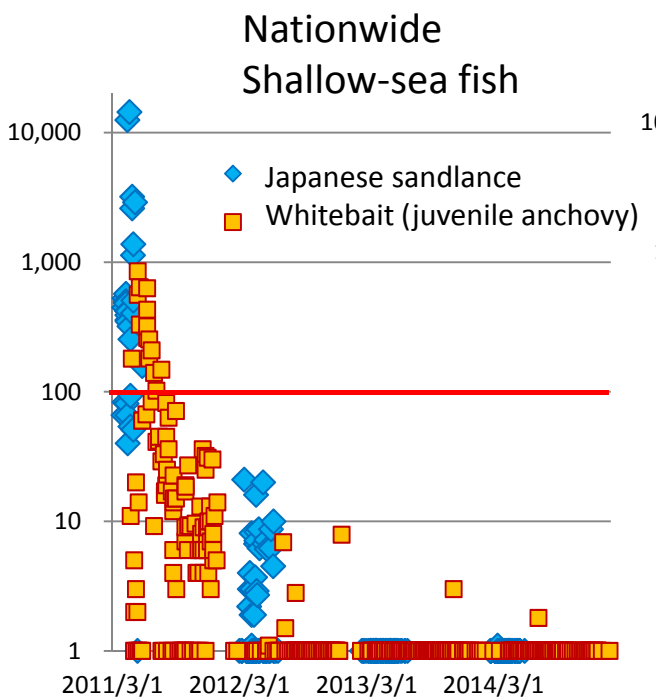
Workflow for voluntary distribution suspension or regulatory shipping restriction for sea fish.

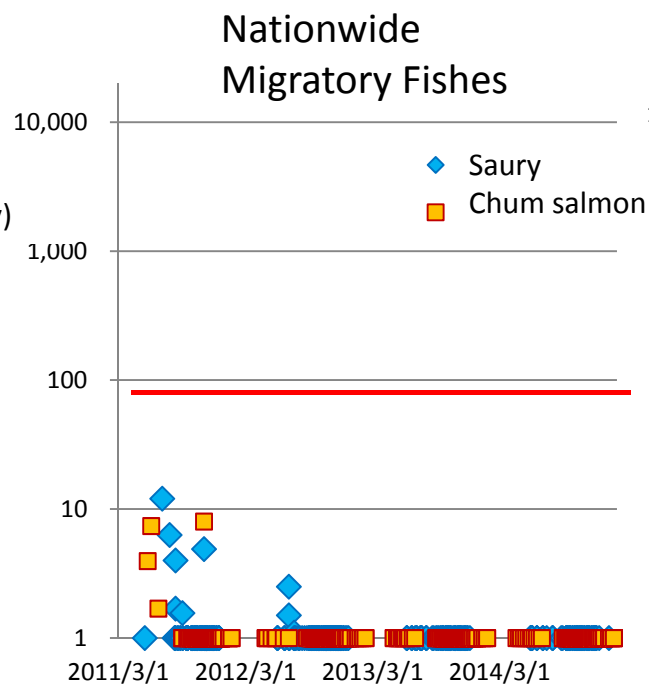


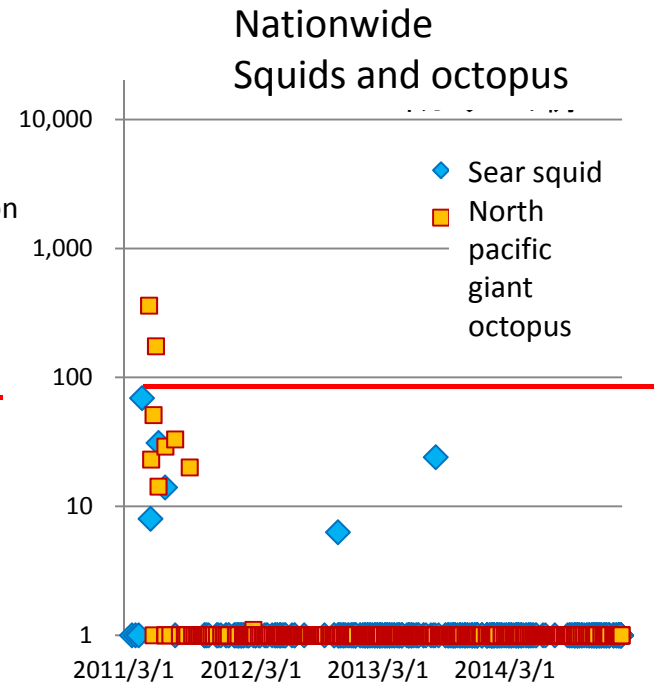
Note: Local governments and fishermen's associations have their own criteria and requirements in place for voluntary distribution suspension. The chart only shows a typical example.

4. Inspection Results of Fishery Products (1)

- Since the accident (March 2011) to January 2015, about 66,500 samples of more than 400 fish species were inspected for cesium.
- Those inspection results show the following:
  - Shallow-sea fishes, Squid and Octopus;
    While radioactive cesium concentrations were high in the immediate post-accident period, the levels dropped off quickly.
  - Migratory fishes; No sample has ever exceeded 100 Bq/kg.







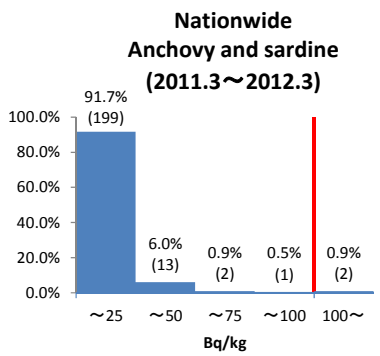
Inspection Results of Fishery Products (2)

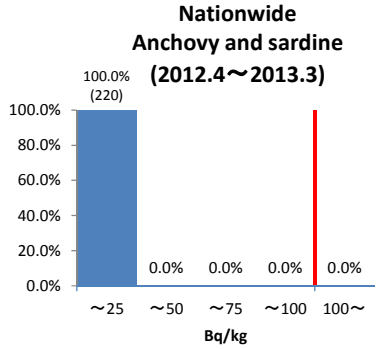
- In FY 2014, high readings (above 50 Bq/kg) were rarely observed in main fishery species and major export species, including bottom fish.
- Anchovy/Sardines and Mackerels, which are major fisheries species in the Pacific off the East Coast of Japan, have shown no high readings (above 25 Bq/kg) since FY 2012.

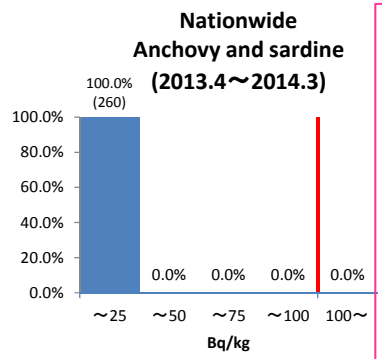
Surface Layer

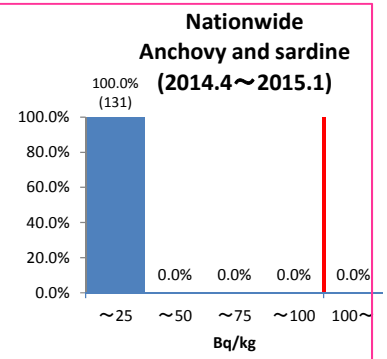
Anchovy and Sardine (Nationwide)

Export in 2014
13,786 t, ¥1,335 million,
Destination : Thailand, Vietnam, Malaysia, etc.





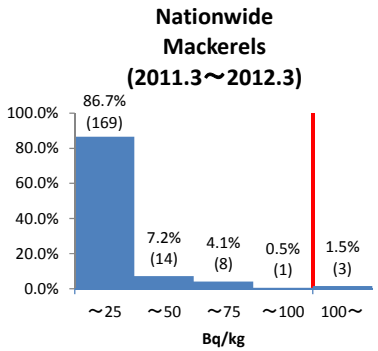


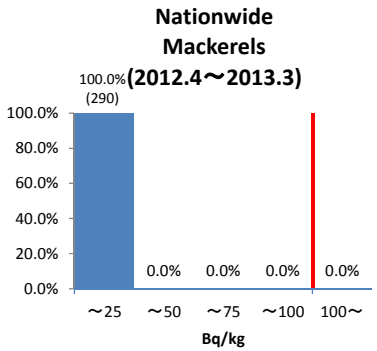


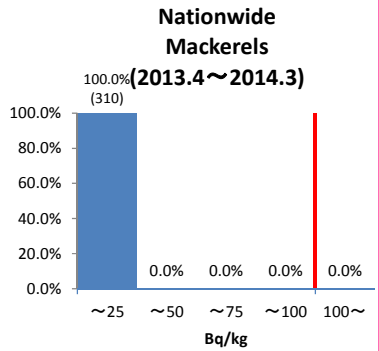
Intermediate Layer

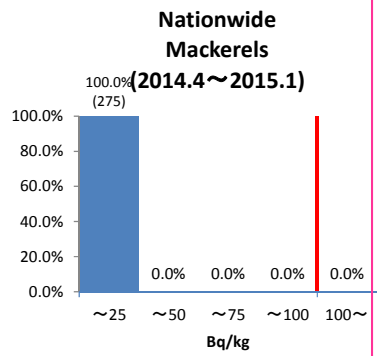
Mackerels (Nationwide)

Export in 2014
105,906 t, ¥11,513 million, Destination : Thailand, Egypt, Vietnam, etc.









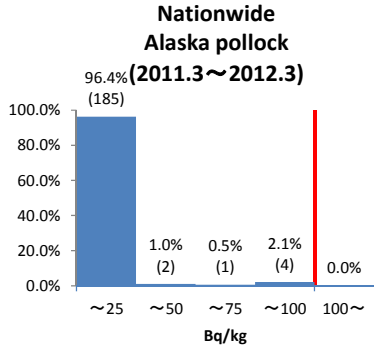
Inspection Results of Fishery Products (3)

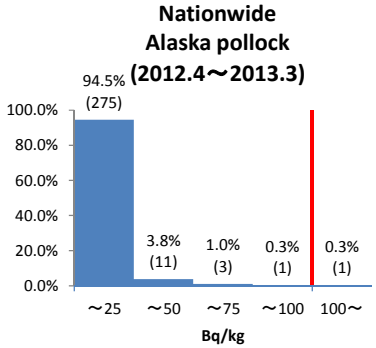
In bottom fish, the trend varies with species. Some species showed almost no readings in excess of the standard limit since immediately after the accident.

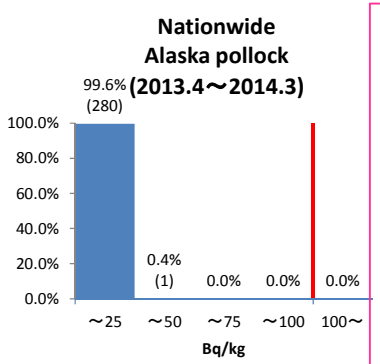
Bottom layer

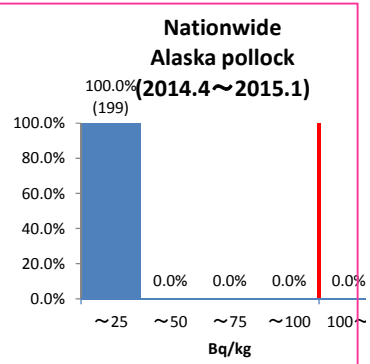
Alaska pollock (Nationwide)

Export in 2014
41,445t, ¥4,610 million,
Destination : China, Korea Russia, etc.

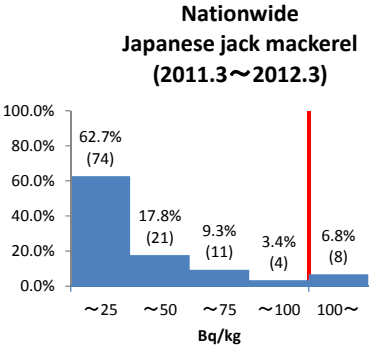


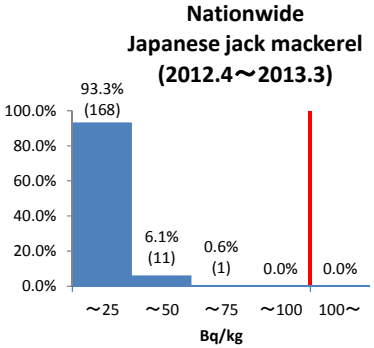


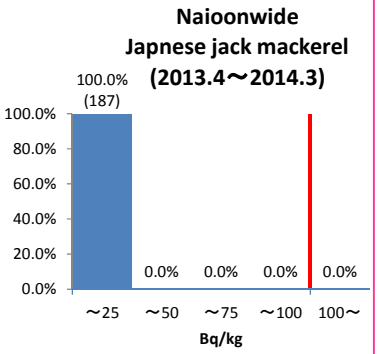


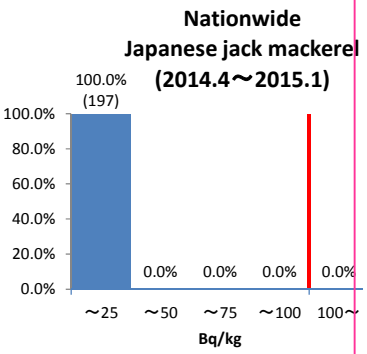


Japanese jack mackerel (Nationwide)



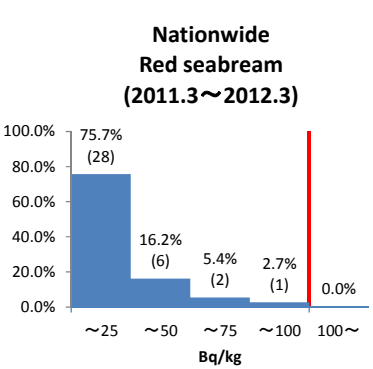


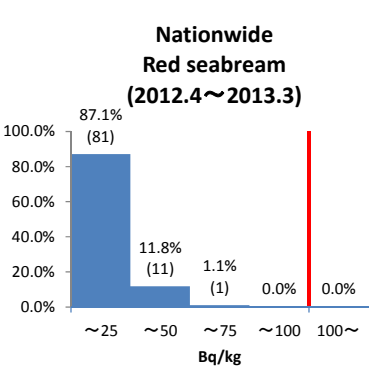


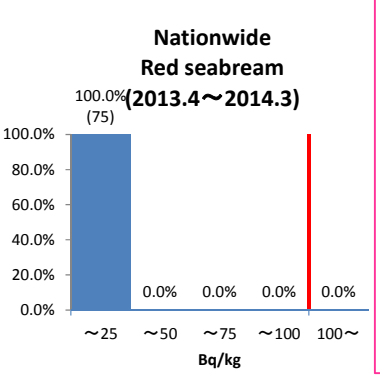


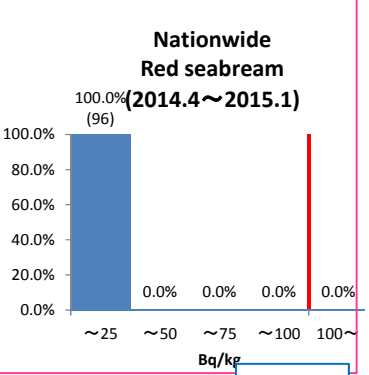
Red seabream (wild) (Nationwide)

Export in 2014
(live) 1,869t, ¥1,311 million, Destination : Korea, etc.
Mainly farmed fish is exported.







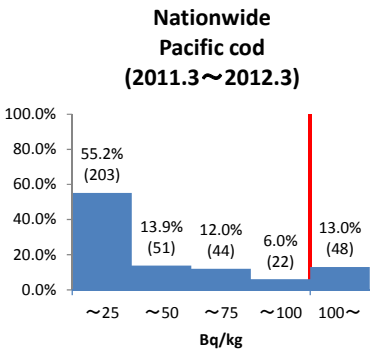


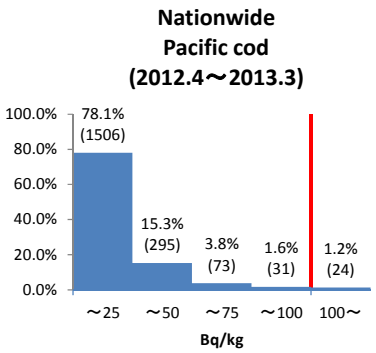
Inspection Results of Fishery Products (4)

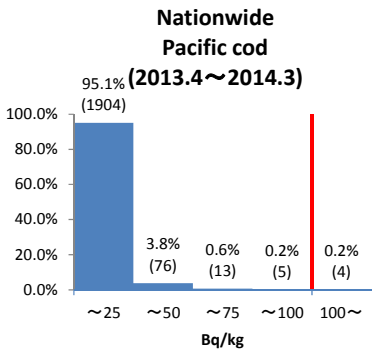
Bottom layer

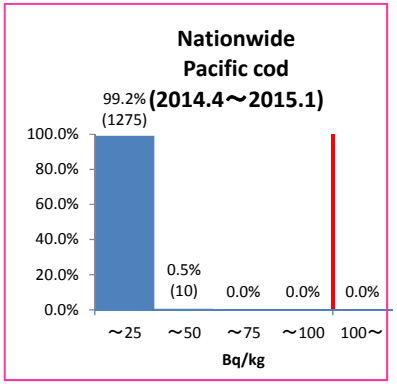
Pacific cod (Nation wide)

Export in 2014
3,045t, ¥658 million,
Destination : NZ, China Hong Kong, etc.



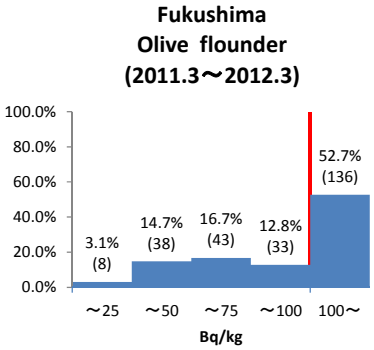


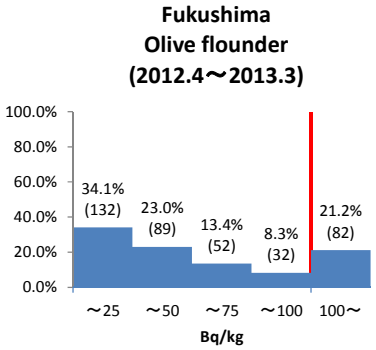


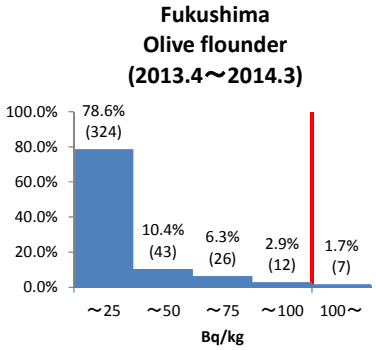


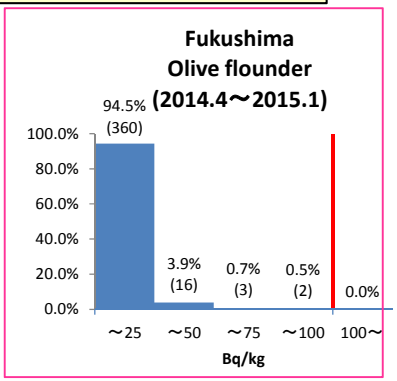
Pacific cod: In FY 2012, readings in excess of the standard limit were observed in a comparatively broad range. The level has declined since FY 2013. In FY 2014, no sample exceeded the standard limit, including those taken in Fukushima offshore. In January 2015, distribution restriction of pacific cod captured in Fukushima offshore was lifted.

Olive flounder (Fukushima)









Olive flounder in Fukushima: 52.7% (in FY 2011) and 21.1% (in FY 2012) of the samples exceeded 100 Bq/kg. The level has substantially declined since FY 2013. In FY 2014, all samples were within 100 Bq/kg.

Inspection Results of Fishery Products (5)

Almost none of migratory species has shown high value since immediately after the accident.

Migratory fish

Tunas and marlins (Nationwide)

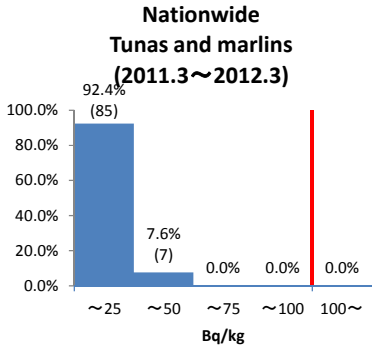
Export in 2014
28,068t, ¥10,344 million,
Destination : Thailand, Guam, Vietnam, etc.

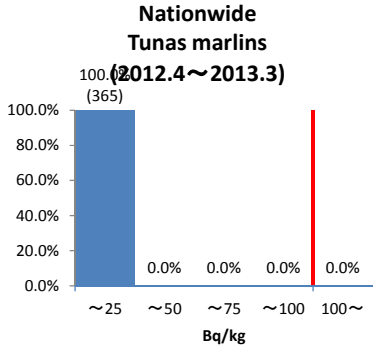
Skipjack (Nationwide)

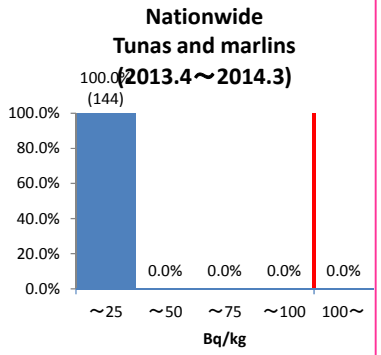
Export in 2014
35,422t, ¥5,438 million,
Destination : Thailand, Indonesia, China, etc.

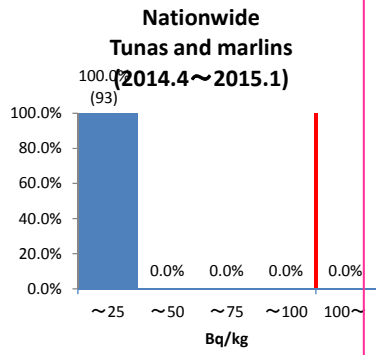
Amberjacks (Nationwide)

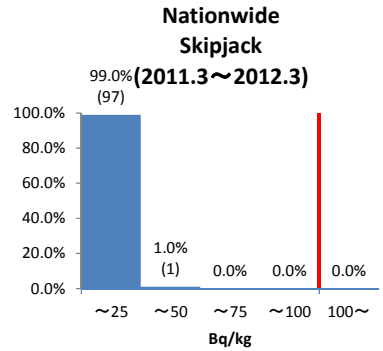
Export in 2014
6,323t, ¥10,012 million,
Destination : USA, Hong Kong ,Thailand, etc.

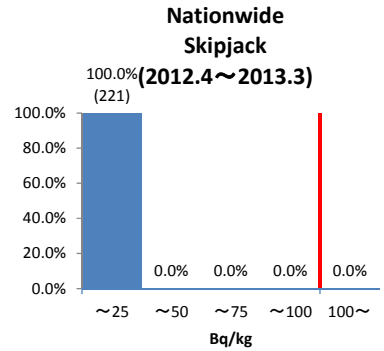


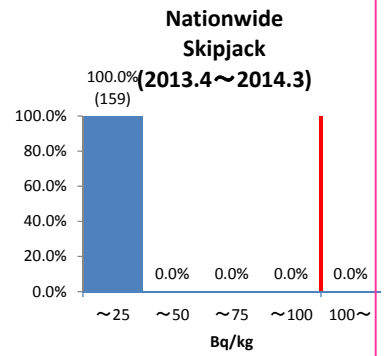


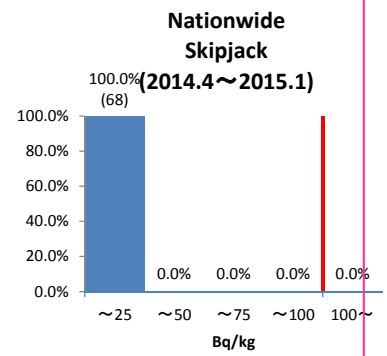


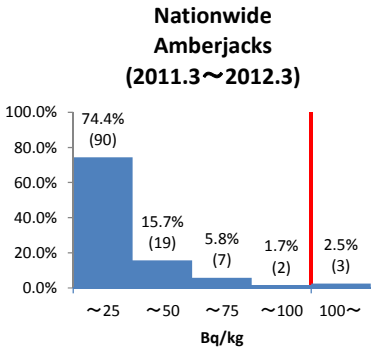


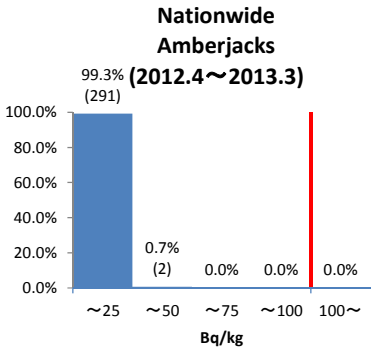


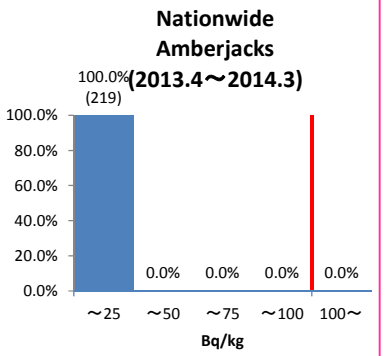


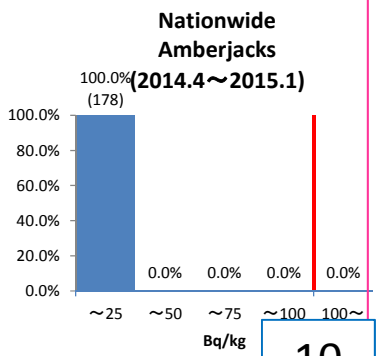










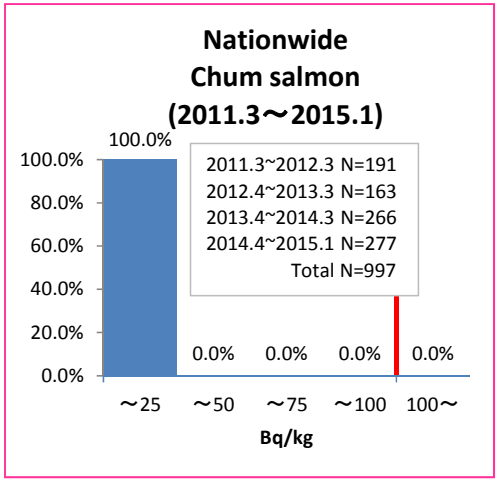


Inspection Results of Fishery Products (6)

Migratory fish

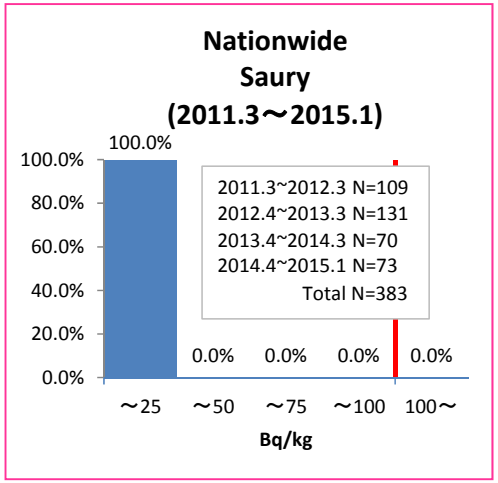
Chum salmon (Nationwide)

Export in 2014
37,870t, ¥11,445 million
Destination: China, Thailand , Vietnam, etc.



Pacific saury (Nationwide)

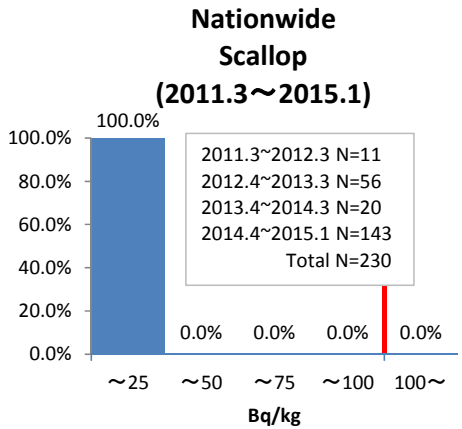
Export in 2014
9,495t, ¥1,183million
Destination： Russia, China, Thailand, etc.



Farmed species

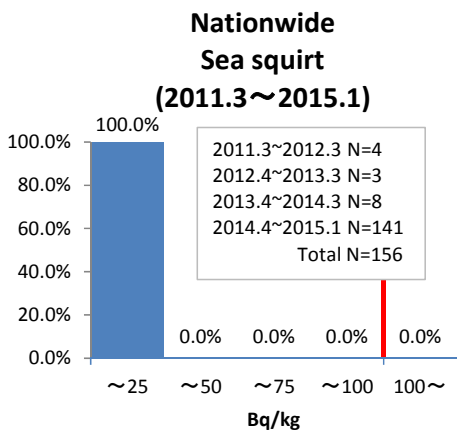
Main farmed species have consistently displayed low readings.

Scallop (Nationwide)



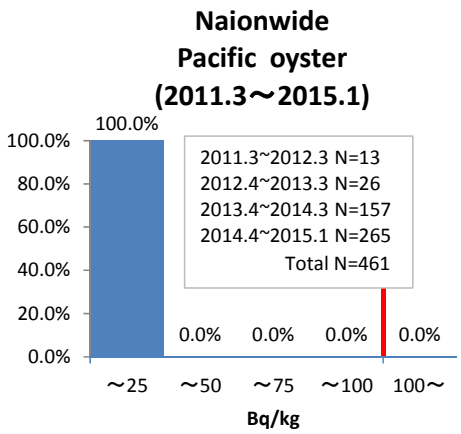
Export in 2014
56,012t, ¥44,670 million
Destination: USA, China, Vietnam, etc.

Sea squirt (Nationwide)



Export in 2014
1,552t, ¥456 million
Destination: Korea

Pacific oyster (Nationwide)



Inspection Results of Fishery Products (7)

○ Importing countries have detected no sample in excess of the standard limit from fishery products exported from Japan at their boarder inspection.

→ confirm effectiveness of safety management framework of Japan

In response to the Fukushima Dai-ichi NPS accident, some countries/regions introduced import restrictions (requirement of test certificate of radioactive material, strengthened inspection at the boarder etc.)

Test results of Japanese fishery products in The Republic of Korea

Year	No detection		Detection of trace amounts (customs cleared)		Detection of trace amounts (customs rejected)	
	Number of inspections	Weight (tons)	Number of inspections	Weight (tons)	Number of inspections	Weight (tons)
2011	4,126	15,993	21	149	—	—
2012	4,729	20,526	101	2,704	—	—
2013	5,328	20,543	9	160	(*1) 1	0
2014	5,290	18,265	—	—	(*2) 4	20
2015 (*3)	1,424	4,863	—	—	—	—
Total	20,897	80,190	131	3,013	5	20

*1:1Bq/kg, *2:1Bq/kg, 1Bq/kg, 3Bq/kg, 2Bq/kg, *3:January to March 19, 2015

5. Inspection for Other Radionuclides than Cesium (1)

- FAJ has also tested fishery products for strontium-90, plutonium and americium-241.
- A total of 80 samples from 2011 to March 2015 were tested for strontium-90, and 18 samples for plutonium and 13 samples for americium-241. The concentrations were largely at the same levels as before the accident*, and far below the assumption** that was made in calculating the standard limit.

** The effective dose of other radionuclides combined would be equal to that of radioactive cesium for marine species.

The concentrations of radioactive strontium, plutonium and americium in fishery products (sampled between 04/11/2011 and 10/15/2014)

Nuclides	# of samples	< LOD		Range (Bq/kg)	Notes : Cs134+137 (Bq/kg)
		# of samples	LOQ (Bq/kg)		
Sr-90	80	58	0.0077-0.04	0.016-1.2	N.D.-970
Pu-238	18	5	0.00053-0.00093	-	0.054-1.23
Pu-239＋240	18	4	0.00085-0.00093	0.0011	
Am-241	13	1	0.00041-0.0018	0.0015	N.D.-1.23

*** Ranges of radionuclides' levels observed before the accident**

Sr-90	<LOD-0.26 Bq/kg
Pu-238	<LOD-0.0016 Bq/kg
Pu-239+240	<LOD-0.073 Bq/kg
Am-241	0.00048-0.0046 Bq/kg (literature data)

(Source: Nuclear Regulation Authority (http://search.kankyo-hoshano.go.jp/servlet/search.top))

5. Inspection for Other Radionuclides than Cesium (2)

○ Survey was conducted for radionuclides listed in the CODEX guidelines in commonly exported fish species and main fish species inhabiting the Pacific Ocean off of eastern Japan.
(Except for some radionuclides which have extremely long or short half-lives)

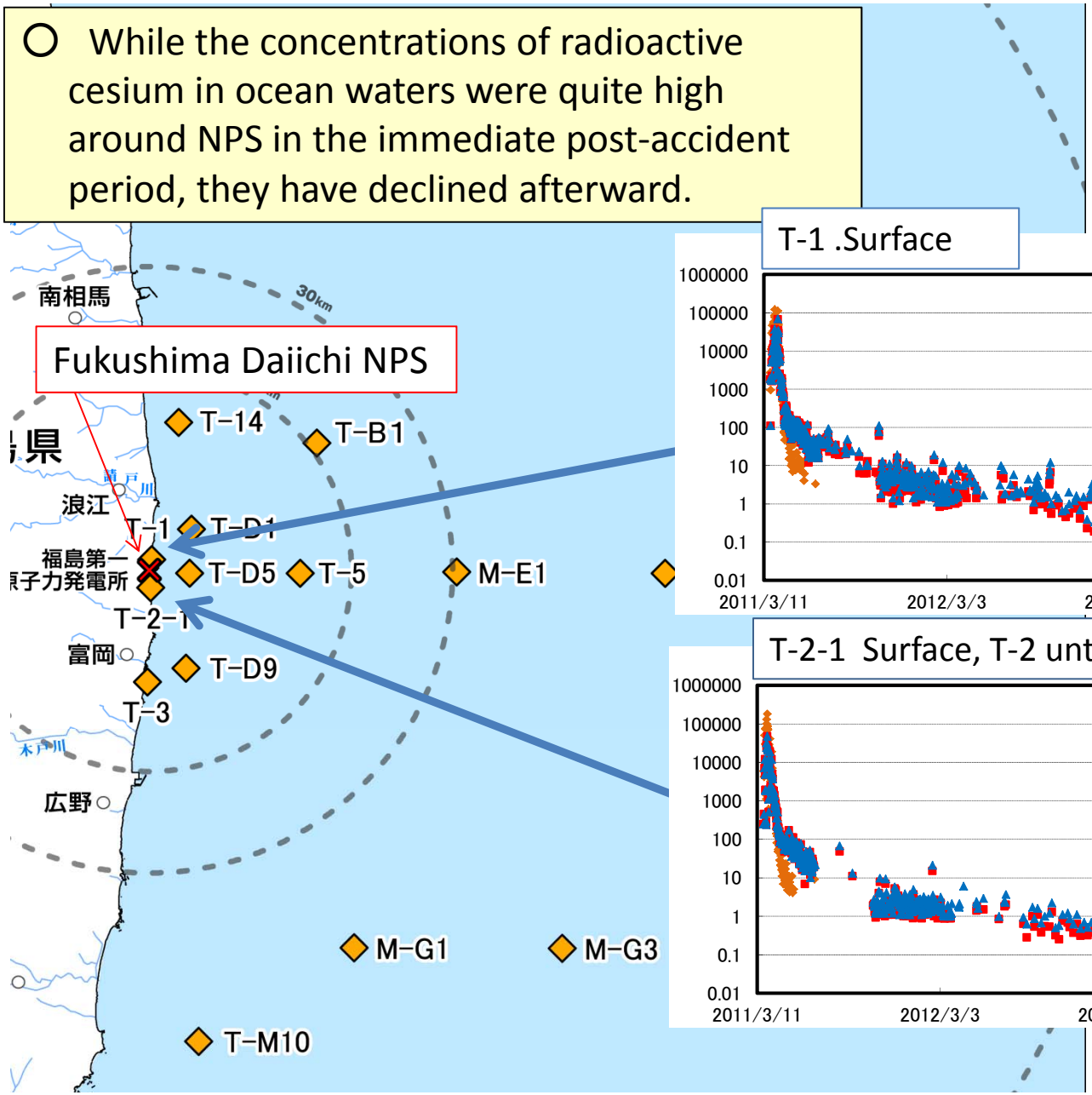
Radionuclide	Infant foods (Bq/kg)	Foods other than infant foods (Bq/kg)	Measured value, Detection limit		Maximum detection value (All "N.D." indicate maximum detection limits)	Group total
Pu-238	1	10	Measured value	N.D.	0.0015	3
			Detection limit	0.00049 - 0.0015		
Pu-239 + Pu-240			Measured value	N.D. - 0.0023	0.0023	
			Detection limit	0.00048 - 0.0014		
Am-241			Measured value	N.D.	2.8	
			Detection limit	0.67 - 2.8		
Sr-90	100	100	Measured value	N.D.	0.019	9
			Detection limit	0.018 - 0.019		
Ru-106			Measured value	N.D.	7.3	
			Detection limit	2.9 - 7.3		
I-129			(Unmeasured)			
I-131			Measured value	N.D.	0.66	
			Detection limit	0.27 - 0.66		
U-235			Measured value	N.D.	1.3	
			Detection limit	0.60 - 1.3		
S-35	1,000	1,000	(Unmeasured)			8
Co-60			Measured value	N.D.	1.1	
			Detection limit	0.41 - 1.1		
Sr-89			Measured value	N.D.	0.17	
			Detection limit	0.067 - 0.17		
Ru-103			Measured value	N.D.	0.90	
			Detection limit	0.33 - 0.90		
Cs-134			Measured value	N.D.	0.69	
			Detection limit	0.31 - 0.69		
Cs-137			Measured value	N.D.	0.70	
			Detection limit	0.34 - 0.70		
Ce-144			Measured value	N.D.	4.7	
			Detection limit	2.0 - 4.7		
Ir-192			(Unmeasured)			
H-3,C-14,Tc-99	1000	10,000	(Unmeasured)			

Inspection Results
- Sampled from Dec 20, 2014 to Jan 5, 2015
- 8 speicies (Sardines, Salmon, Mackerels, Pacific saury, Alaska pollock, Scallop, Sea squirt, Red seabream)

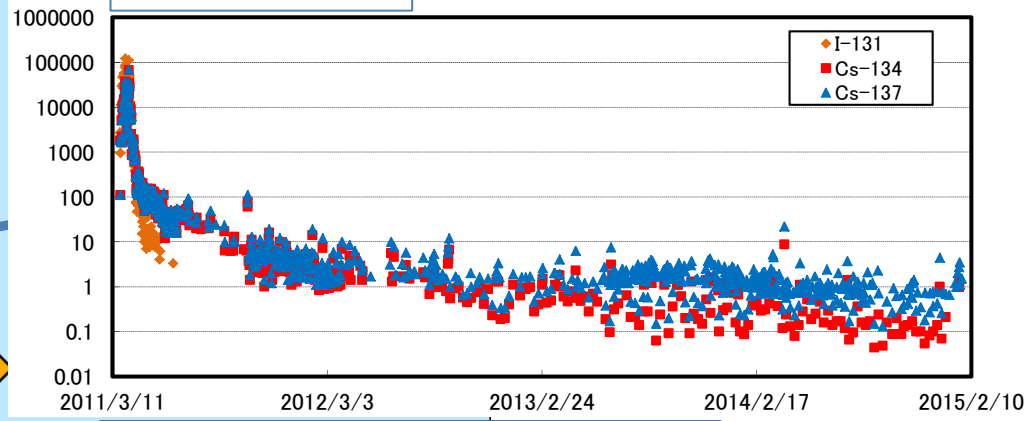
For each group, total of the maximum detection value does not exceed the CODEX guideline level.

6. Radioactive Cesium in Ocean Water

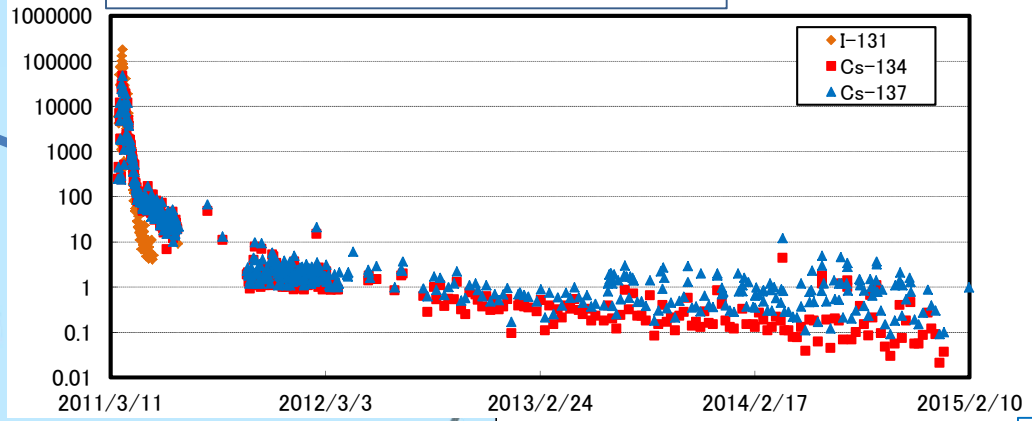
○ While the concentrations of radioactive cesium in ocean waters were quite high around NPS in the immediate post-accident period, they have declined afterward.



T-1 .Surface



T-2-1 Surface, T-2 until Nov 2012

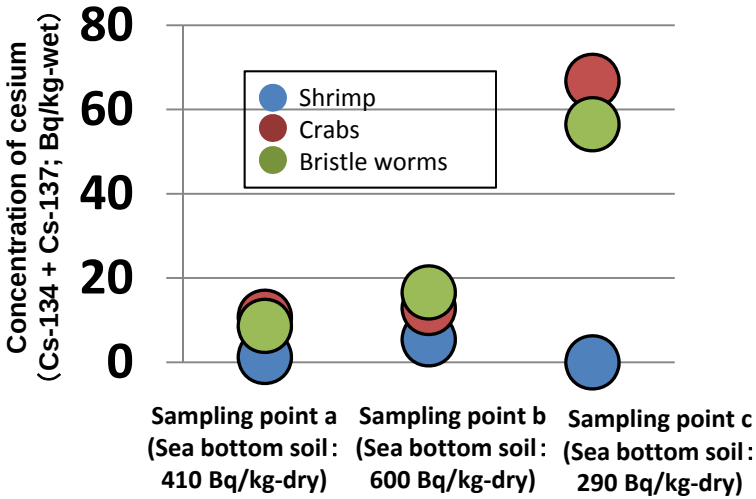


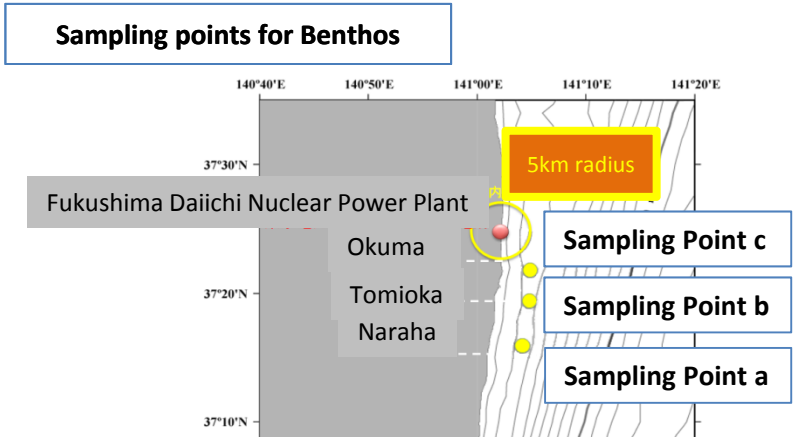
Ⅱ　Research Activity

Research Activity (1)

○ On the mechanism by which radionuclides are transferred to fishery products, new findings have been obtained .

(1) No correlation was found between the radioactive cesium concentrations of benthos and those of marine soils.

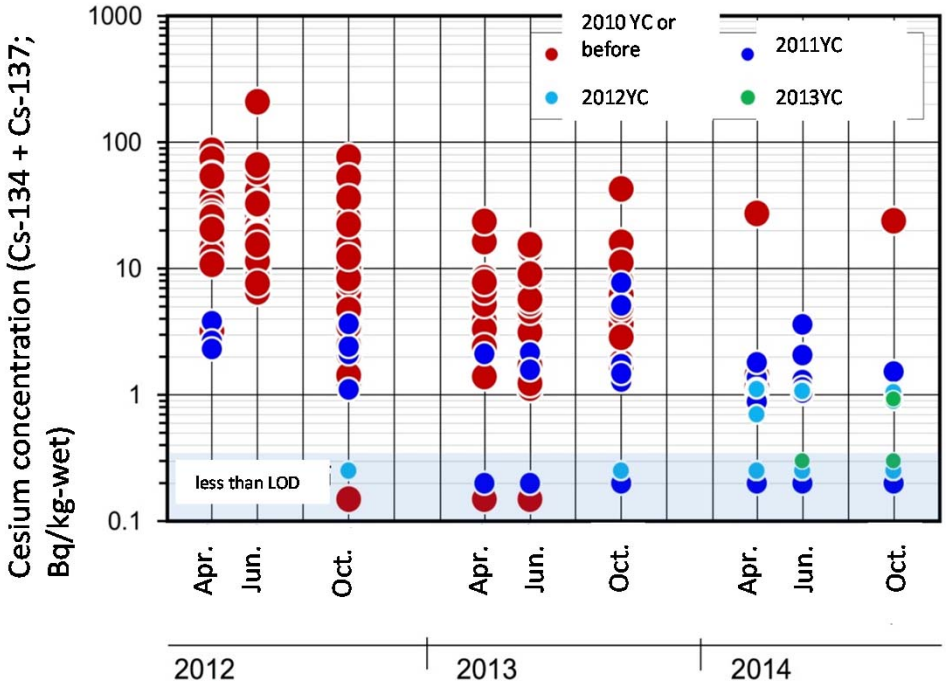




(2) For Olive flounder and Pacific cod;

① Little radioactive cesium was taken in by the birth year classes born after the accident (2011 or later).

② Little intake of radioactive materials took place in the winter of 2012 or later.

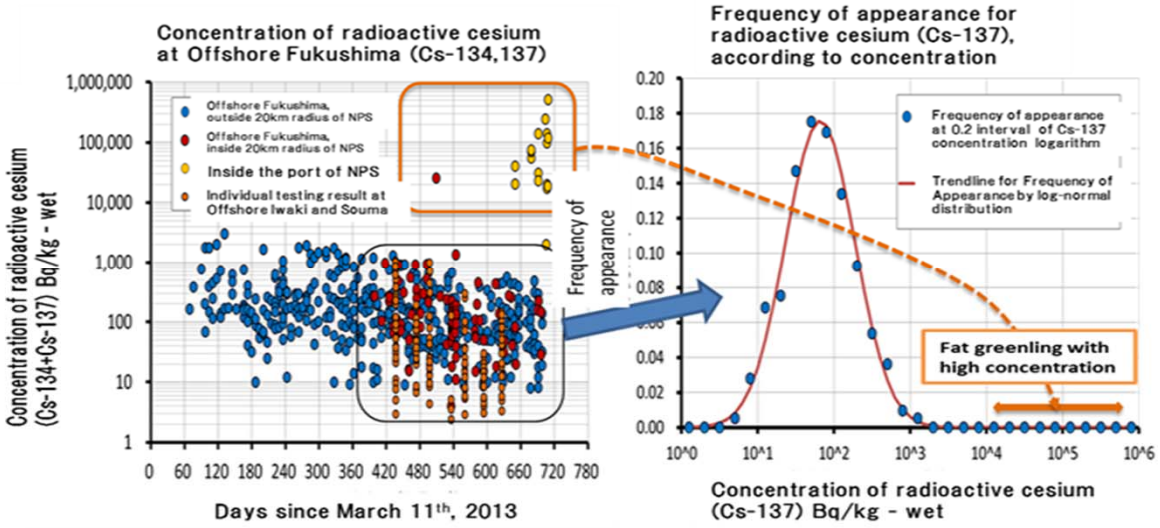


Chronological Trend of Radioactive Cesium Concentration within Pacific Cod Sampled offshore Fukushima

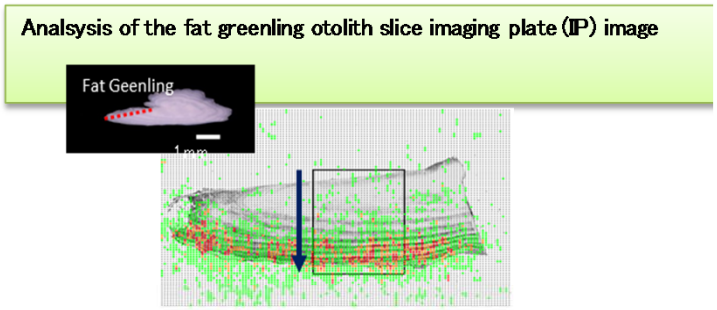
Research Activity (2)

- ○ In August 2012 a highly contaminated fat greenling, with radioactive Cs level of 25,800Bq/kg, was taken at the point approx. 20 km from the Fukushima Daiichi NPS.
- ○ Analysis of the otolith revealed that primary location of the β-rays' emission corresponded to spring/summer 2011, and hence this sample was judged to have been contaminated shortly after the accident through exposure to highly-contaminated waters.
- ○ In light of the improved situation of pollution around the NPS, it is important to prevent marine organism from expanding from the inside of the port of the NPS. TEPCO has installed nets at the port entrance and carries out exterminations inside the port.
- ※ This study was published in *the Scientific Reports* of *the Nature*: **"Radiocesium contamination of greenlings (*Hexagrammos otakii*) off the coast of Fukushima"** (Scientific Reports 4, Article number: 6851)

Concentrations of Radioactive Cesium within Fat Greenlings in the Waters off Fukushima



Analysis of the Highly-Contaminated Fat Greenling's Otolith



IP measurement image of a slice (red line in the picture represents the cross-section location) of the highly-contaminated fat greenling otolith from the mouth of the Ota River. The colors represent the size of response, from largest to smallest: black, green, orange, red.

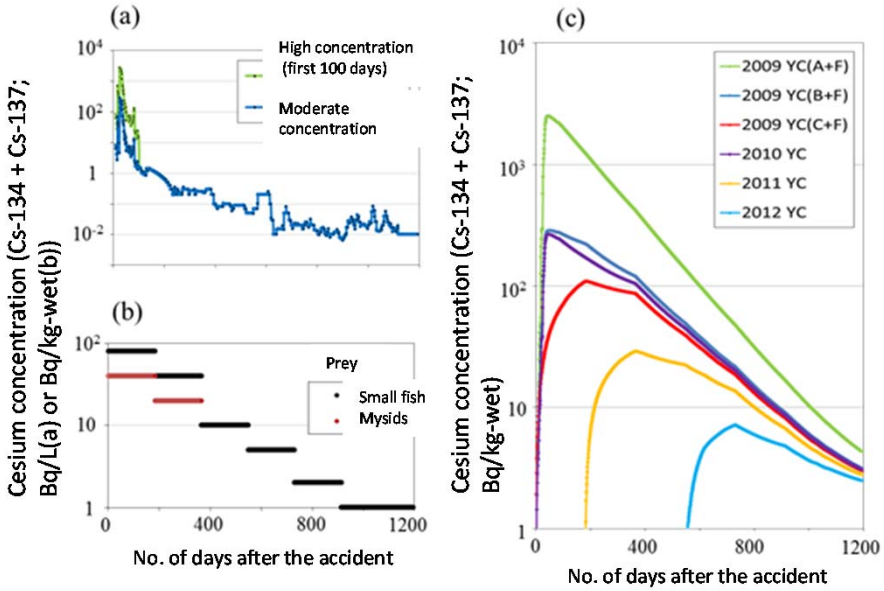
Research Activity (3)

- Breeding experiment of Korean lugworm, olive flounder and Japanese black porgy was conducted, using water tanks containing seafloor soil (68-341Bq/kg) collected off Fukushima to duplicate field environment.
- The result showed that the ratio of Cs-137 concentration [lugworm/seafloor soil] is between 1/20 and 1/40.
- And that Cs-137 migrated from the seafloor soil to the bodies of olive flounder and Japanese black porgy is negligible.

- Simulation of changes in radioactive cesium concentration in olive flounder was conducted, using time series variation data for cesium concentration in seawater and prey organisms.
- The result showed that the concentration of birth year classes prior to the accident (2009, 2010YC) is higher than that of birth year classes after the accident (2011, 2012 YC).
- Fish which experienced highly contaminated water (A + F) could be affected for a long period of time.
- As most of future catches will be fish born after the accident, it is predicted that samples that exceed the standard limit will further decrease.

Results of Korean Lugworm Breeding Experiment
(3 seafloor soil types, 2 tanks each)

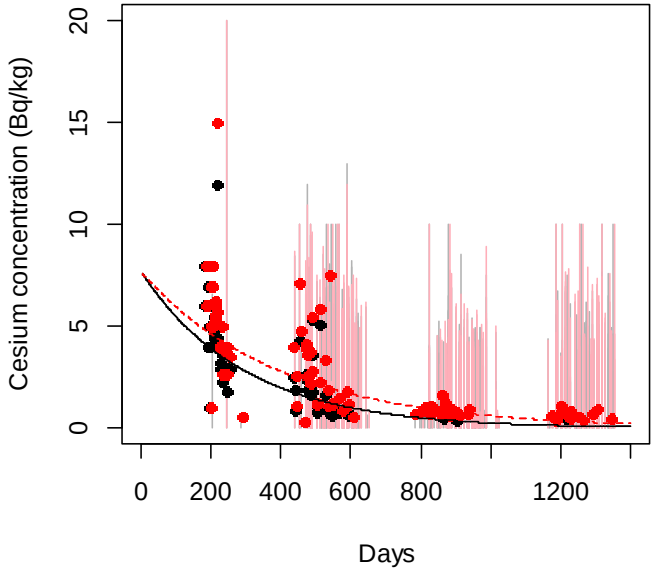
Sampling location		Seafloor soil concentration (n=16) Bq/kg-wet (Average during breeding period)	Korean lugworms (n=10) Bq/kg-wet (Average after 21st day [concentration stabilizes])	Breeding seawater (n=15 or 16) mBq/kg (Average during breeding period) <Raw seawater: 18.6±7.85>
Southern side of sea area near TEPCO's Fukushima Daiichi NPS (37°25'N, 141°02'E)	①	341±38.8	11.7±5.79	52.2±21.1
	②	333±42.3	11.4±2.54	86.5±36.9
Offshore area of Hirono (37°16'N, 141°02'E)	①	136±7.53	5.15±2.48	22.3±6.29
	②	162±27.5	7.48±3.21	24.9±7.52
Offshore area of Yotsukura (37°05'N, 140°59'E)	①	88.7±8.46	4.93±3.62	27.6±25.4
	②	67.8±6.04	3.88±2.59	20.3±7.26



Simulation on Changes in Radioactive Cesium Concentrations in Olive Flounder

Research Activity (4)

- Evaluation of probability that Cs level in fishery products exceeds 100Bq/kg as of April 1, 2015 was conducted.
- With regard to 68 fish species targeted, this probability was evaluated by using Weibull distribution and estimating parameters based on maximum likelihood estimation that took detection limits into account.
- Rapid decreases in cesium concentrations were observed in the data for each of the targeted fish species and prefectures.
- The result estimated that the probability is effectively zero for main target species.



Japanese Amberjack (Iwate)

(The red dots show measured values for Cs-137 and the black dots show measured values for Cs-134. The red and black vertical lines show detection limit data. The red dotted line and black line are predictions of average values based on the model.)

Probability of Exceeding 100 Bq/kg as of April 1, 2015, based on Model Analysis

Prefecture	Species	Pr (Cs-134+Cs-137 > 100)
Aomori	Japanese amberjack	1.06×10^{-292}
	Scallop	3.00×10^{-111}
	Chub mackerel	0
	Giant Pacific octopus	0
	Chum salmon	9.36×10^{-139}
	Alaska pollock	2.63×10^{-160}
	Japanese flying squid	0
Iwate	Scallop	0
	Common sea squirt	0
	Chub mackerel	0
	Pacific saury	0
	Chum salmon	0
	Alaska pollock	1.07×10^{-44}
	Japanese flying squid	0
Miyagi	Scallop	0
	Skipjack tuna	0
	Common sea squirt	0
	Pacific oyster	0
	Chub mackerel	0
	Swordfish	0
	Alaska pollock	0
	Blue shark	0
Fukushima	Common octopus	3.03×10^{-29}
	Chub mackerel	0
	Giant Pacific octopus	7.33×10^{-122}
	Chum salmon	0
	Alaska pollock	4.18×10^{-29}
	Japanese flying squid	6.80×10^{-97}
	Chestnut octopus	7.25×10^{-126}
Ibaraki	Japanese amberjack	0
	Common octopus	0
	Chub mackerel	0
	Alaska pollock	0
	Japanese flying squid	0
	Spear squid	0
Chiba	Albacore	0
	Japanese amberjack	0
	Skipjack tuna	3.33×10^{-103}
	Chub mackerel	0
	Pacific saury	0
	Japanese flying squid	0
	Spear squid	0

Note: Values of less than 10^{-300} are considered to be "0."

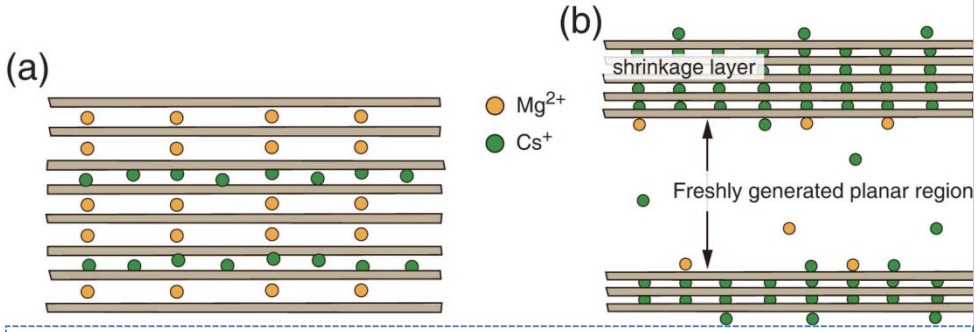
Research Activity (5)

○ New report was made on the mechanism of Cs absorption onto soil clay, that is well-studied in land-based studies

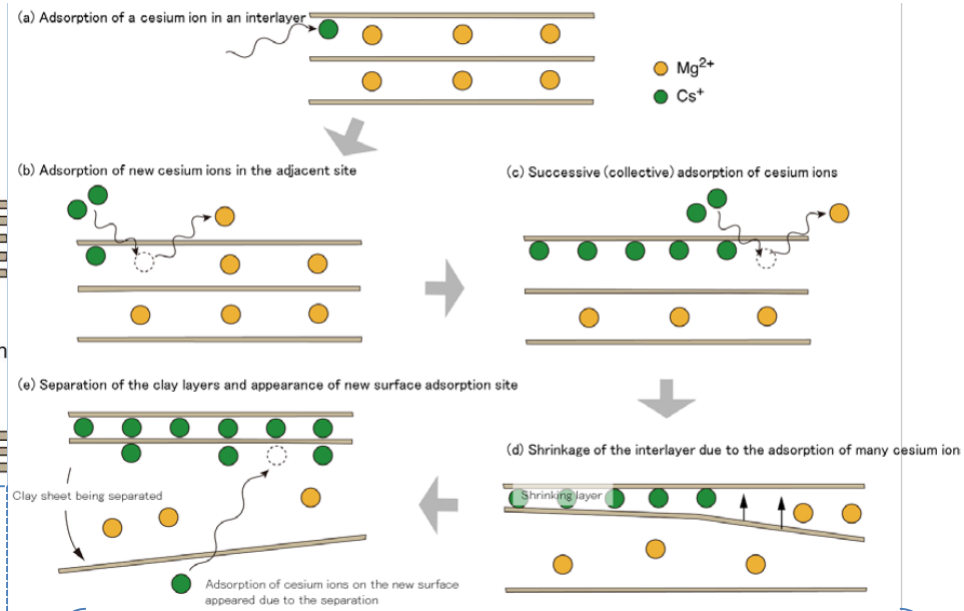
○ Structural change in vermiculite (one of clay minerals) at the absorption of Cs-ion were observed using a method called “Small Angle X-ray Scattering”.

※ This study was published in *the Scientific Reports* of *the Nature*: **“Collective Structural Changes in Vermiculite Clay Suspensions Induced by Cesium Ions”** (Scientific Reports 4, Article number: 6585）*

- Schematic illustrations of the crystal domain of vermiculite clay with Cs+. (a) Collective intercalation (localization) of Cs+ in the selective layer spaces and (b) segmentation of the crystal domain of vermiculite clay, providing fresh planar adsorption sites for Cs+.



- Adsorption of cesium one after another like Domino Topping and schematics of structural change of vermiculate



＊the group of Dr. Ryuhei Motokawa (Assistant Principal Researcher, JAEA), Dr Tsuyoshi Yaita (Unit Manager, JAEA), Dr. Hitoshi Endo (Associate Professor, High Energy Accelerator Research Organization), Dr. Shingo Yokoyama (Principal Research Scientist, Central Research Institute of the Electric Power Industry), and Dr. Shotaro Nishitsuji (Assistant Professor, Graduate School of Science and Engineering, Yamagata University

TOPICS Fukushima 26 Jan 2015 No. 58Japan Atomic Energy Agency (JAEA)
http://fukushima.jaea.go.jp/english/topics/pdf/topics-fukushima058e.pdf

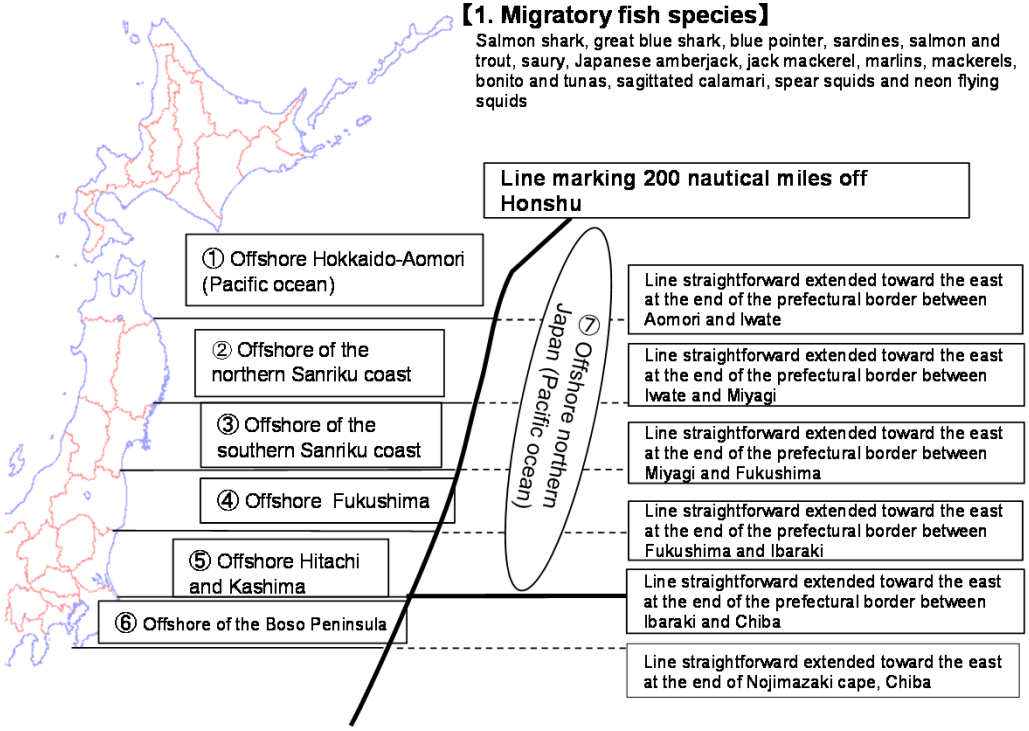
Ⅲ　Provision of Information, Domestically and Internationally

1. Labelling of Harvest Area
2. Risk Communication and Current Situation of Import Restriction

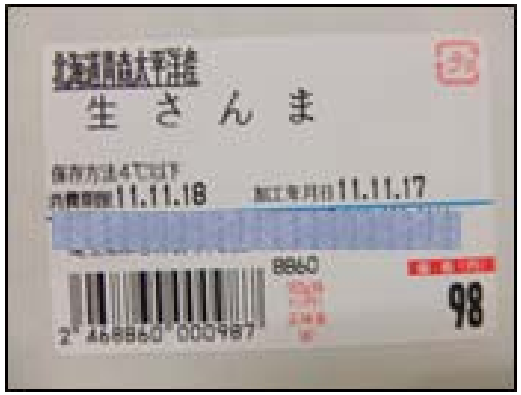
1. Labelling of Harvest Area

- In accordance with the Labelling Standard for the Quality of Fresh Food, which is based on the Act for Standardization and Proper Labeling of Agricultural and Forestry Products, harvest area shall be indicated, but in case that it is difficult, port of landing or the prefecture where the port is located can be indicated alternatively.
- Starting October 2011, Fisheries Agency recommends that, for raw fishery products from the east coast of Honshu, Japan, the harvest area should be indicated.
- Harvest area should be clarified even for those species which migrate beyond prefectures, such as mackerel, Pacific saury etc..

How Eastern Japan's sea production zone names are displayed



Examples



2. Risk Communication and Current Situation of Import Restriction

【 Domestic consumer awareness】

○ According to the survey by the Consumer Affairs Agency on consumer awareness, consumers stating that they “hesitate to buy food products made in Fukushima because they wish to buy food that does not contain radioactive materials” amounted to 19.4% of all respondents in February 2013, although this figure fell to 15.3% in February 2014.

【Import regulations 】

○ After the Fukushima Daiichi NPS accident, many countries imposed import restrictions on Japanese fishery products (e.g. requirement for test certificate of radionuclides, ban on import of fishery products from certain prefectures).

○ Until now, 13 countries lifted these restrictions (e.g. Vietnam (Sep. 2013), Australia (Jan. 2014)). In addition, some of other countries eased restrictions as follows:

EU: Test certificate of radioactive material - 10 prefectures => 8 prefectures (Jan. 2014)

Thailand: Test certificate of radioactive material - 8 prefectures => 3 prefectures (Nov. 2014)

Example of Website

【Monitoring results】

Item	Radioactive Caesium (Bq/kg)		
English	Total Standard limit for Radioactive Cesium in fish: 100Bq/kg	Radioactive Caesium (Bq/kg) Cesium-134	Radioactive Caesium (Bq/k Cesium-137
Saffron cod *(Eleginus gracilis)*	Not detectable	Not detectable (<0.369)	Not detectable (<0.407)
Alaska pollock *(Theragra chalcogramma)*	Not detectable	Not detectable (<0.563)	Not detectable (<0.564)
Pacific cod *(Gadus macrocephalus)* (over 1 kg)	Not detectable	Not detectable (<0.409)	Not detectable (<0.457)
Pacific cod *(Gadus macrocephalus)* (over 1 kg,Liver part)	Not detectable	Not detectable (<1.65)	Not detectable (<5.59)

Briefing sessions

【Briefing Organizers】

Producers: Fishery cooperatives-affiliated groups and fishery product processors

Distributors: Tsukiji Market wholesaler, intermediate wholesalers and traders and mass retailers

Others: Consumer groups and journalists

December 10, 2013
Briefing and discussion session for foreign journalists at Marine Ecology Research Institute

Future Challenges

- Sufficient measures have been taken for ensuring safety of fishery products.

- For provision of safe fishery products, to continue monitoring and other efforts such as elucidation of mechanism for contamination.

- To provide appropriate information domestically and internationally, address unfounded reputational damages and misinformation, and encourage regulating countries to lift import restrictions.