

## **FY2011 Radioactive Material Monitoring of Aquatic Organisms**

### 1. Survey Overview

Samples of aquatic organisms (aquatic insects, algae, crustaceans, shellfish, and fish, etc.) were collected mainly in Fukushima Prefecture and concentrations of radioactive cesium and radioactive strontium in the samples were measured (survey period: December 2011 to February 2012).

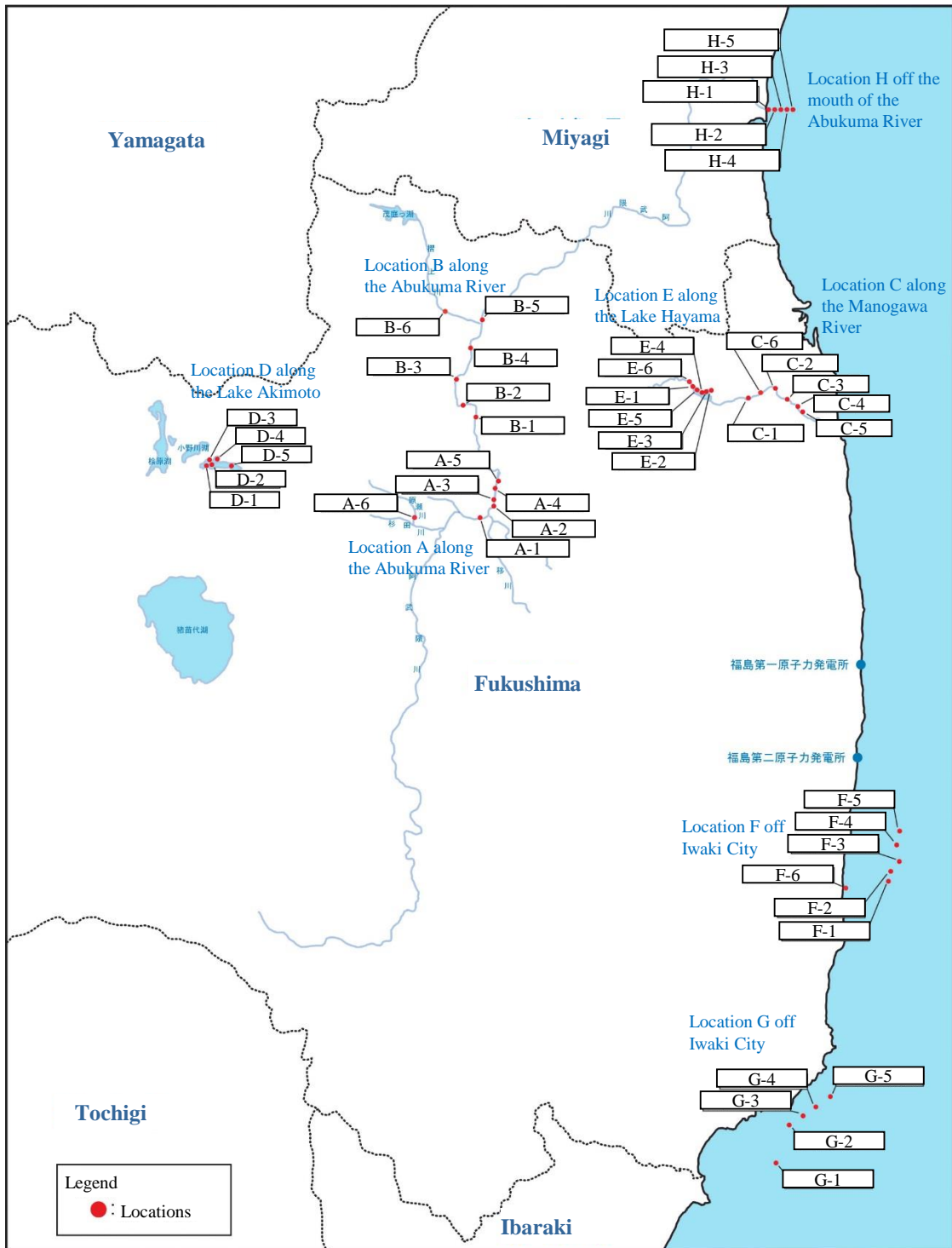
In order to clarify the environment of the water areas where aquatic organisms live, surveys were also conducted on general items concerning water and sediments (COD, TOC, SS, and turbidity, etc. for water samples and TOC, ignition loss, and grain size distribution, etc. for sediment samples) and activity concentrations in these water areas.

The following water areas were selected based on the results of the FY2011 Radioactive Material Monitoring in the Water Environment in and around Fukushima Prefecture, as well as the results of the measurement of radioactive materials in fisheries products conducted by other relevant organizations and interviews with local fishermen.

- (i) Rivers: Abukuma River, Mano River
- (ii) Lakes: Lake Hayama, Lake Akimoto
- (iii) Sea areas: Off Iwaki City, off the mouth of the Abukuma River

○ Survey locations and dates

Area	Targeted water areas		Item	Survey dates	Remarks	
River area	Abukuma River A	Chieko-ohashi Bridge to Inoentei Dam (incl. tributaries)	Aquatic organisms sampling	February 8, 2012	Aquatic insects, Fish (Harase River (tributary))	
			Water/sediment sampling	December 27, 2011	Within the targeted water area (A1—A5)	
	Abukuma River B	Downstream part of Inoentei Dam to Taisho Bridge (incl. tributaries)	Aquatic organisms sampling	December 27, 2011	Fish (Taishobashi Bridge)	
			Water/sediment sampling	December 27, 2011	Within the targeted water area (B1—B5)	
	Mano River	Zennami Bridge to Ochiai Bridge	Aquatic organisms sampling	December 26, 2011	Fish (Ochiaibashi Bridge)	
			Water/sediment sampling	December 26, 2011	Within the targeted water area (C1—C5)	
	Lake area	Lake Akimoto D		Aquatic organisms sampling	December 21, 2011	Fish, etc.
				Water/sediment sampling	December 21, 2011	Within the targeted water area (D1—D5)
		Lake Hayama E		Aquatic organisms sampling	December 27, 2011	Fish
Water/sediment sampling				December 27, 2011	Within the targeted water area (E1—E5)	
Sea area	Offshore of Iwaki City F	Sea area around Hisanohama	Aquatic organisms sampling	January 13, 2012	Fish, etc.	
			Water/sediment sampling	January 13, 2012	Within the targeted water area (F1—F5)	
	Offshore of Iwaki City G	Sea area around Nakoso	Aquatic organisms sampling	January 13, 2012	Fish, etc.	
			Water/sediment sampling	January 13, 2012	Within the targeted water area (G1—G5)	
	Location K off the mouth of the Abukuma River	Sea area in front of the Abukuma River Estuary	Aquatic organisms sampling	February 22, 2012	Shellfish	
			Water/sediment sampling	February 22, 2012	Within the targeted water area (H1—H5)	
			Aquatic organisms sampling	February 26, 2012	Fish	



Map showing locations for Radioactive Material Monitoring of Aquatic Organisms

## 2. Survey Items and Locations, etc.

### 2.1 Survey Items

Targeted aquatic organisms, measurement items for water samples and sediment samples, and analyzed samples are as shown in the table below.

For all samples of aquatic organisms, analysis of radioactive cesium was conducted. Additionally, for samples of large fish higher on the food chain, organisms with structure (shellfish, etc.), and other samples for which a sufficient amount could be collected, analysis of Sr-90 was also conducted.

The analysis of radioactive cesium and general survey items was conducted with regard to sediment samples collected at five locations in each water area. For the analysis of general survey items and radioactive materials (water samples) and analysis of Sr-90 (sediment samples), samples collected at the locations where aquatic organism samples were scheduled to be collected or other locations where clay particles and coarse particulate organic matters (CPOMs) are supposed to accumulate due to inflows from the surrounding environment, etc. (two locations in each water area) were used.

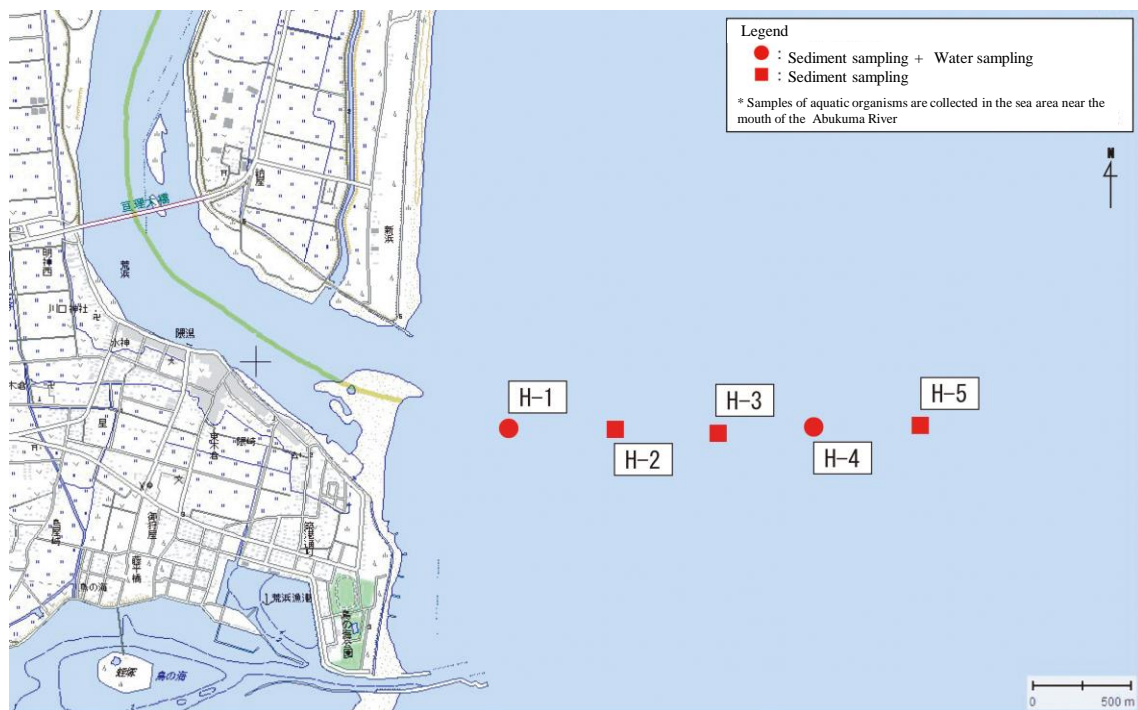
#### ○ Survey targets and items

Target	Measurement item		Analyzed samples
Aquatic Organisms	Radioactive materials	Radioactive cesium (Cs-134,Cs-137)	All samples
		Radioactive strontium (Sr-90)	Large fish, Shellfish, and other samples for which a sufficient amount could be collected
Water	Radioactive materials	Radioactive cesium (Cs-134,Cs-137)	Samples collected at two locations for each water area
		Radioactive strontium (Sr-90)	
	General items	pH	
		BPD	
		COD	
		DO	
		Electrical conductivity	
		Salinity	
		TOC	
		SS	
Turbidity			
Sediments	Radioactive materials	Radioactive cesium (Cs-134,Cs-137)	Samples collected at five locations for each water area
		Radioactive strontium (Sr-90)	Samples collected at two location for each water area
	General items	pH	Samples collected at five locations for each water area
		Oxidation-reduction potential	
		Water content	
		TOC	
		Ignition loss	
		Soil particle density	
		Grainsize distribution	

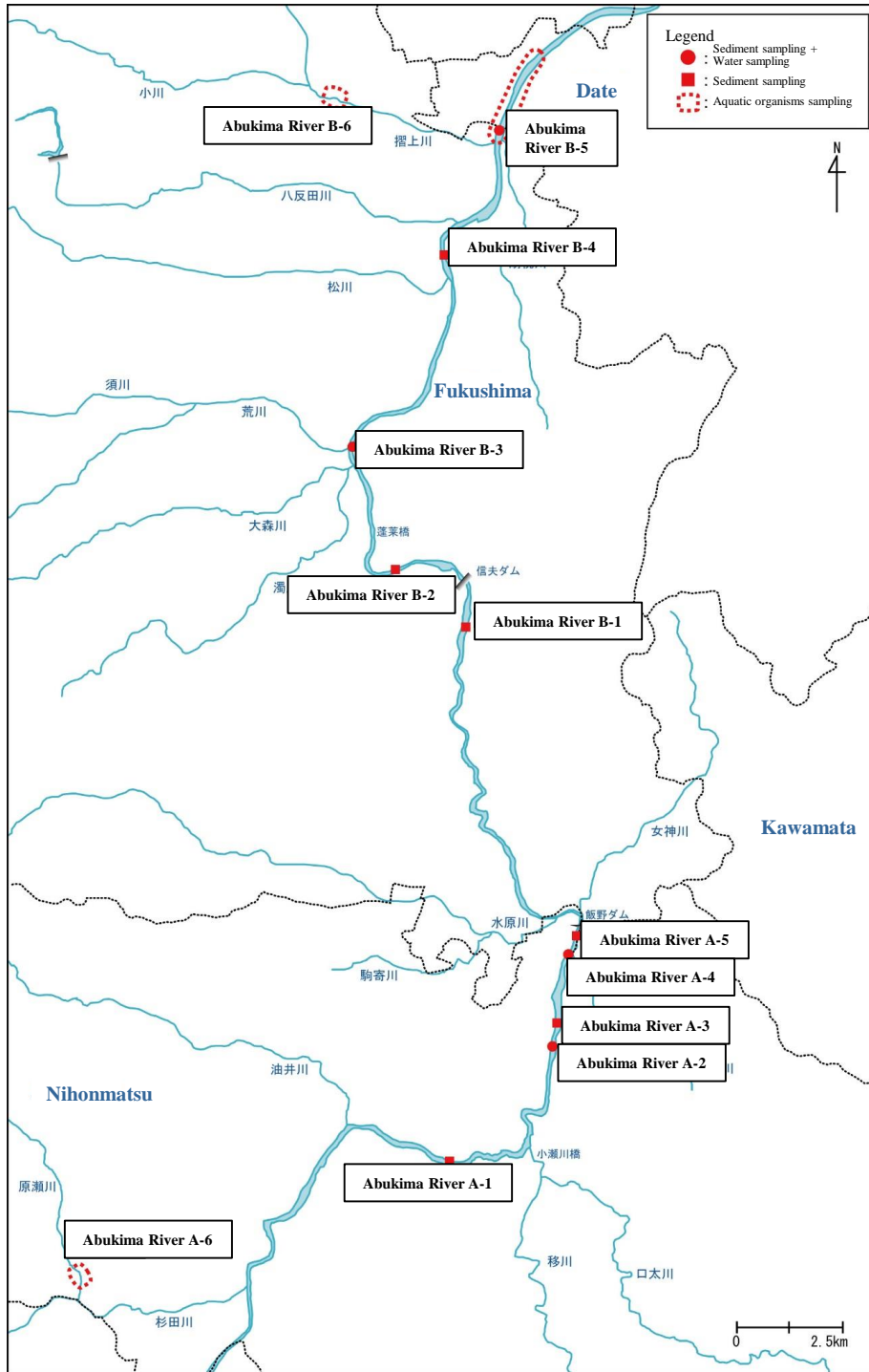
## 2.2 Survey Locations at Respective Water Areas

### (1) Tributaries to the Abukuma River (Location A along the Abukuma River; Location B along the Abukuma River; Location H off the mouth of the Abukuma River)

As water areas where clay particles and CPOMs are supposed to accumulate topographically, Location A along the Abukuma River was set from the Chieko-ohashi Bridge (Nihonmatsu City, Fukushima Prefecture) to the Iinoentei Dam (Horai Dam), and Location B along the Abukuma River was set from the Iinoentei Dam to Taisho Bridge (Date City, Fukushima Prefecture) as water areas containing the zone where the Nigori River, Arakawa River, Matsukawa River, Surikami River, and other tributaries inflow. Additionally, the sea area in front of the mouth of the Abukuma River was set as Location H off the mouth of the Abukuma River as water areas where the outflow of radioactive materials through the Abukuma River is suspected.



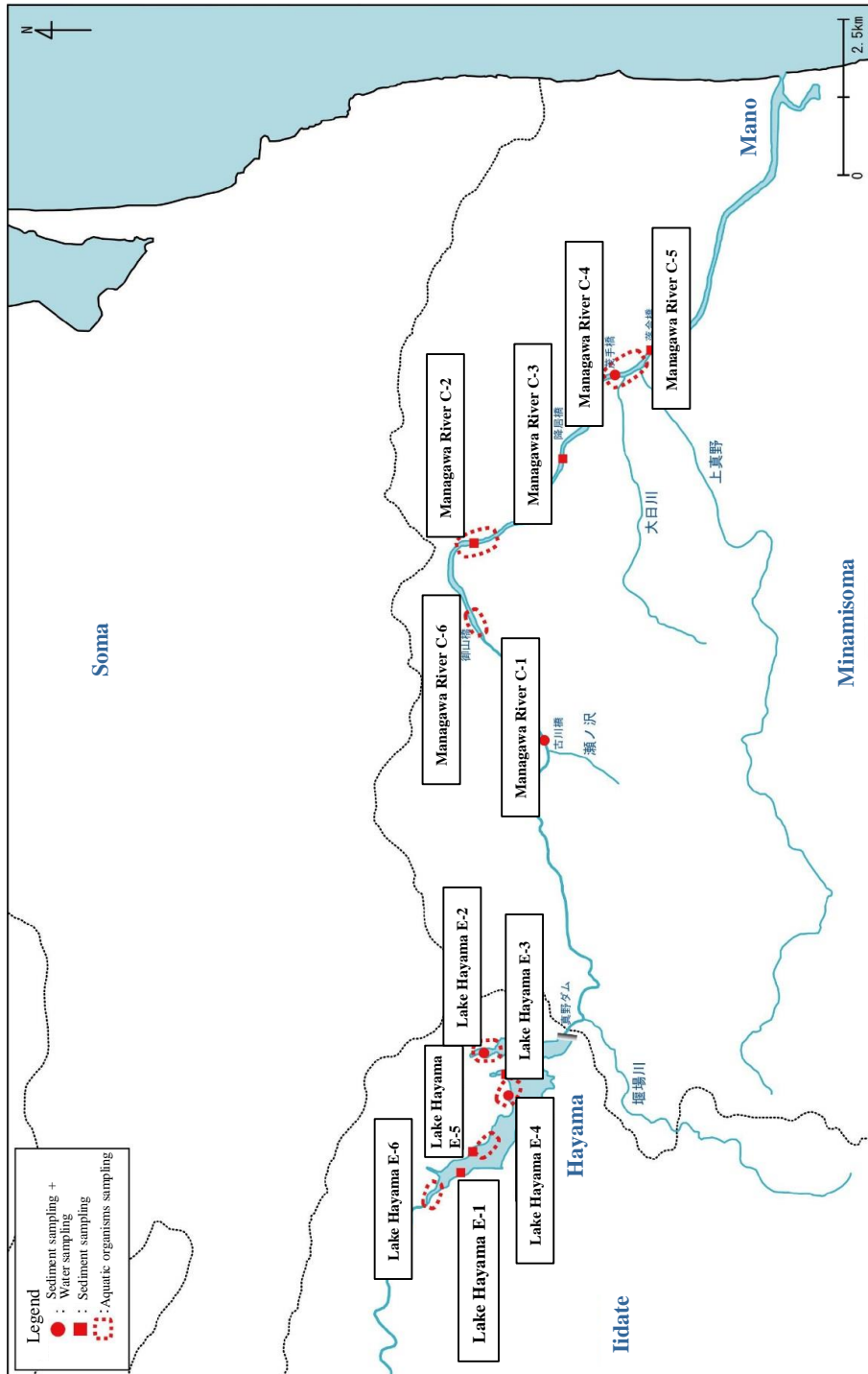
Detailed map showing Location H off the mouth of the Abukuma River



Map showing Location A and Location B along the Abukuma River

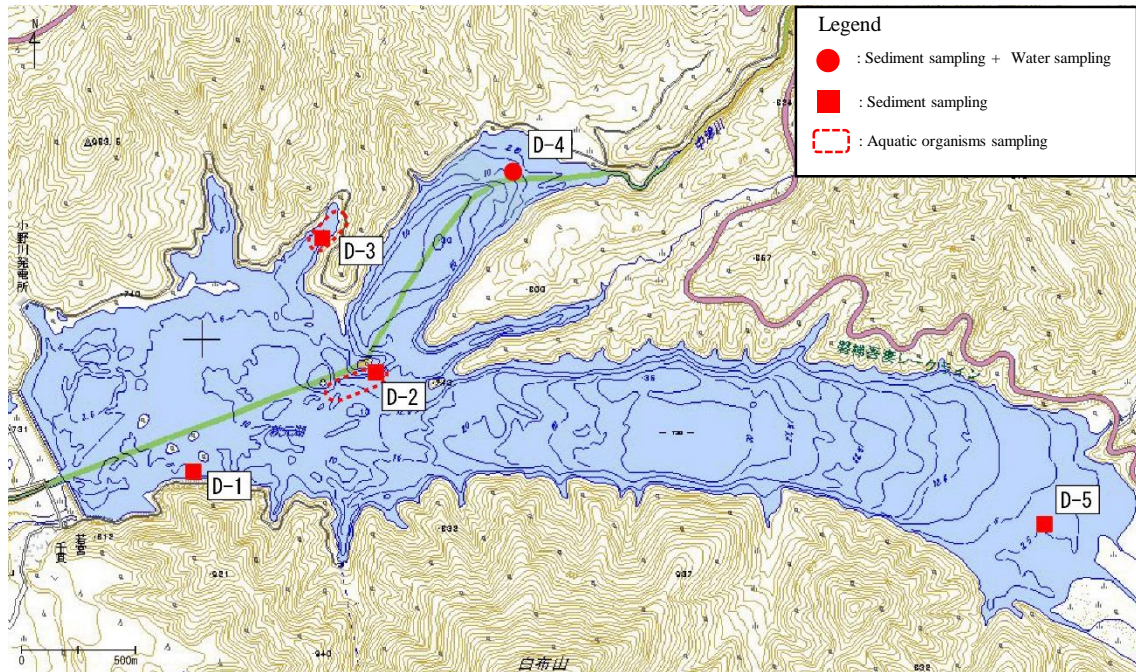
(2) Tributaries to the Mano River (Location C along the Mano River and Location E in Lake Hayama)

Surveys were conducted at Location E in Lake Hayama, which covers the lake (Mano Dam) as a whole, and at Location C along the Mano River, which covers from Yoshinami Bridge to Ochiai Bridge (Kashima Ward, Minamisoma City, Fukushima Prefecture) (downstream area of Lake Hayama).



Map showing monitoring locations along the Monogawa River

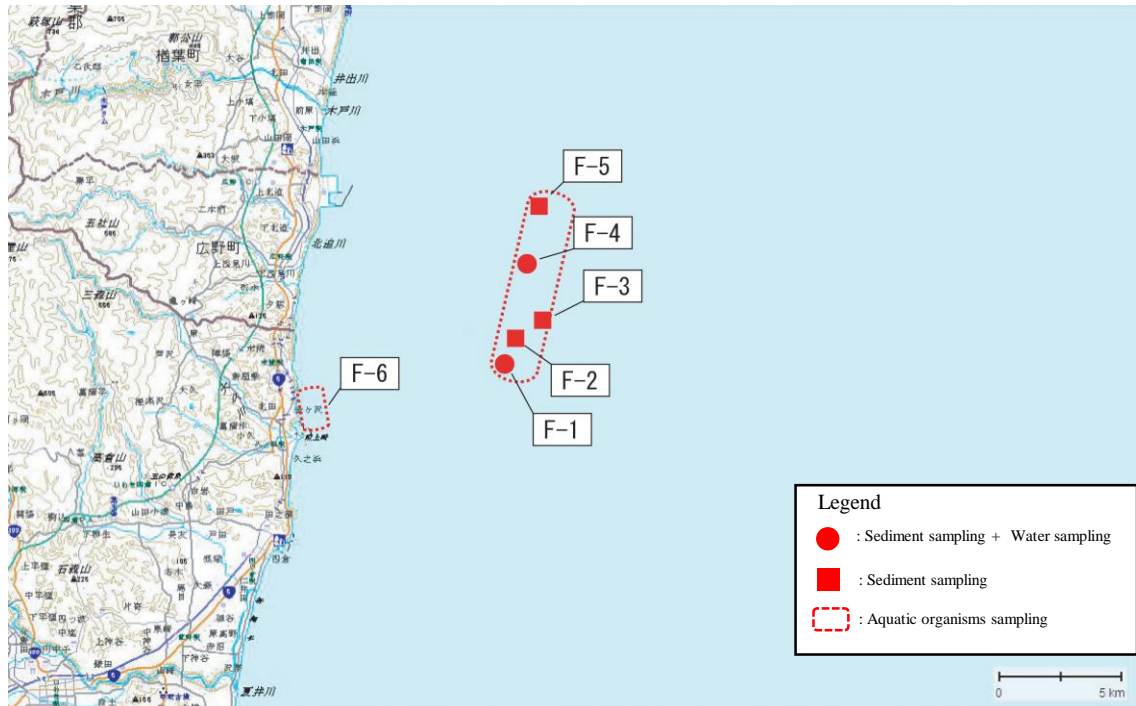
(3) Lake Akimoto (Location D in Lake Akimoto)



Detailed map showing Location D in Lake Akimoto

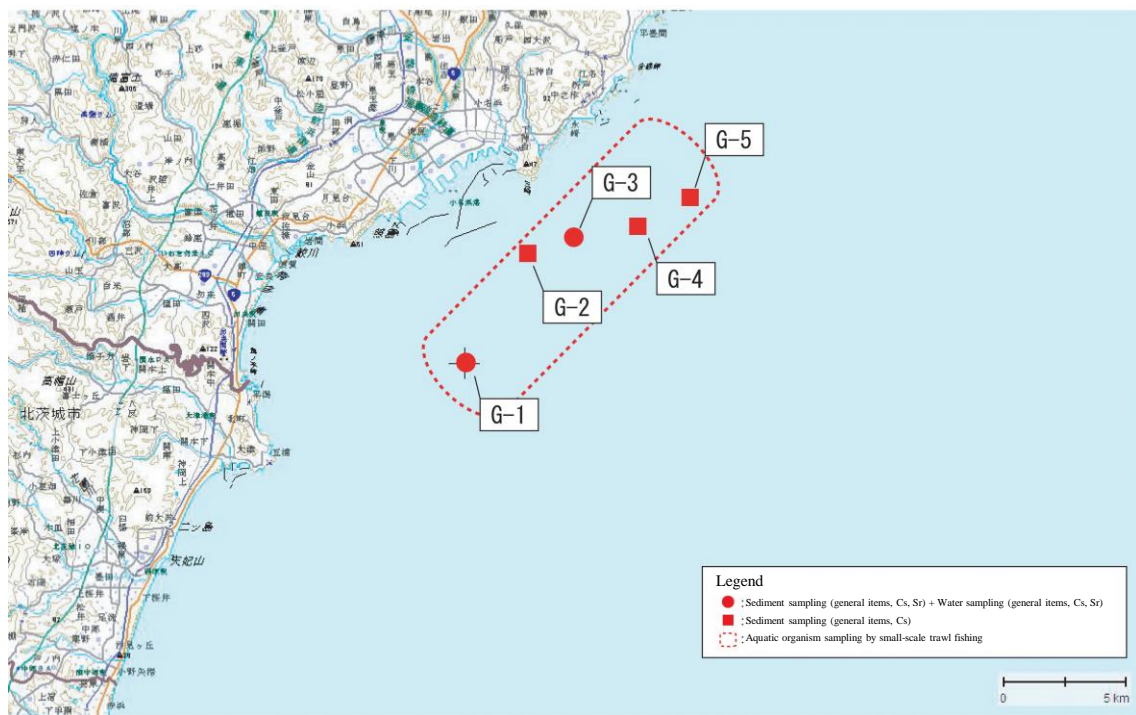
(4) Off Iwaki City (Location F off Iwaki City, Location G off Iwaki City)

Surveys were conducted at Location F off Iwaki City (sea area around Hisanohama) and at Location G off Iwaki City (sea area around Nokoso).



Detailed map showing Location F off Iwaki City (sea area around Hisanohama)





Detailed map showing Location G off Iwaki City (sea area around Nakoso)

### 3. Results

The FY2011 survey was conducted in the winter time when water temperature is low and organisms are relatively inactive, and the sampling of aquatic organisms itself was rather difficult. Therefore, the number of samples was not sufficient, but concentrations of radioactive cesium in aquatic organisms in freshwater areas were relatively higher compared with those in aquatic organisms in seawater areas.

The tendency that activity concentrations are higher in large aquatic organisms higher on the food chain (such as Trout and Bass in freshwater areas and Pleuronectiformes and Perciformes in seawater areas) was common for organisms both in freshwater areas and seawater areas.

Concentrations of radioactive cesium in water and sediment samples collected from the same river system tend to be higher for those collected at zones where water stalls (dams, etc.) and such tendency was especially notable for samples collected at points where water inflows into such zones. Concentrations of radioactive strontium in sediment samples showed the same tendency as that of radioactive cesium, while concentrations of radioactive strontium in water samples were higher for samples collected in seawater areas.

○ Outline of the measurement results of radioactive cesium (Cs-134 + Cs-137)

(i) Rivers and lakes

Unit: Bq/kg-wet

	Aquatic insects	Crustaceans	Fish	CPOMs (dead leaves, etc)
Abukuma River A	340 (3 species)	156 (1 species)	61-171 (3 species)	920
Abukuma River B	330 (4 species)	—	155-680 (3 species)	1,120
Mano River C	670 (3 species)	—	190-2,600 (4 species)	1,140
Lake Akimoto D	—	180 (1 species)	167-510 (8 species)	—
Lake Hayama E (Mano Dam)	520 (5 species)	—	91-1,010 (5 species)	800

\* As the number of aquatic insect samples was small, measurement was conducted by mixing samples for each water area and each location.

(ii) Sea areas

Unit: Bq/kg-wet

	Algae	Sea urchin, starfish, trepan	Shellfish		Squid, octopus	Fish
			Molluscan body	Shell		
Location F off Iwaki City (Hisanohama)	27; 150 (2 species)	7.1-212 (4 species)	42; 67 (2 species)	4.7; 27 (Same as on the left)	6.8-18.0 (5 species)	12.2-260 (19 species)
Location G off Iwaki City (Nakoso)	—	9.6 (1species)	—	—	5.0-11.5 (3 species)	27.3-163 (11 species)
Location H off the mouth of the Abukuma River	—	—	20 (1species)	3.6 (Same as on the left)	—	2.15 (1 species)

(Note) Dissolution test of radioactive materials from sediments

A dissolution test (based on the Notice of the Environment Agency No. 46 [publicized on August 23, 1991]) was conducted for collected sediment samples in order to check whether radioactive materials accumulated in sediments in public water areas are discharged again into water due to being stirred with the influence of waves or flooding caused by rainfall.

Sediment samples collected at locations where activity concentrations were considered to be relatively high, respectively at Location C along the Mano River, Location E in Lake Hayama, and Location F off Iwaki City (Hisanohama), were used for the test so that comparisons may be made among sediment types (grain size distribution, inclusion of organic matters, etc.).

Obtained concentrations of radioactive cesium in the eluate were as follows:

River sediments (Mano River): Cs-134: 0.016 - 0.022 Bq/kg (dry); Cs-137: 0.022 - 0.030 Bq/kg (dry)

Lake sediments (Lake Hayama): Cs-134: 0.033 - 0.080 Bq/kg (dry); Cs-137: 0.041 - 0.10 Bq/kg (dry)

Sea sediments (off Iwaki City (Hisanohama)): Cs-134: 0.13 - 0.14 Bq/kg (dry); Cs-137: 0.17 Bq/kg (dry)

All these values were lower than the concentration levels in river water, lake water, and seawater samples collected in the respective sampling locations. Concentrations of radioactive cesium in the eluate were highest in that from sea sediment samples, followed by that from lake sediment samples and that from river sediment samples. The dissolution rate was highest for sea sediment samples, and was the same for river sediment samples and lake sediment samples.

Property of sediment samples used for the dissolution test

Area	Samples		Sample mass [Kg-wet]	Water content (%)	Dry sediment mass [Kg-dry]	Percentage of particulate elements (%)	<sup>134</sup> Cs [Bq/kg (dry)]	<sup>137</sup> Cs [Bq/kg (dry)]
River	Mano River	C-1	8.6	28.4	6.2	1.9	1,200	1,700
		C-3	7.1	10.0	6.4	0.4	490	660
		C-4	9.8	20.8	7.8	1.5	580	780
Lake	Lake Hayama	E-1	2.7	61.3	1.0	66.7	3,900	5,400
		E-2	3.3	59.6	1.3	61.8	1,800	2,400
		E-4	2.9	59.6	1.2	66.5	4,400	5,800
Sea area	Hisanohama	F-1	2.7	30.4	2.0	6.4	440	610
		F-2	2.9	23.8	2.0	5.8	530	740
		F-4	2.8	22.9	1.5	3.3	250	330

Note) The percentage of particulate element is the content rate of clay and silt

Results of the dissolution test

Area	Samples	Sample (dry sediment) mass [Kg-dry]	Solvent mass [L]	<sup>134</sup> Cs in sample [Bq/kg (dry)]	<sup>137</sup> Cs in sample [Bq/kg (dry)]	<sup>134</sup> Cs in eluate [Bq/L]	<sup>137</sup> Cs in eluate [Bq/L]	Dissolution rate of <sup>134</sup> Cs [%]	Dissolution rate of <sup>137</sup> Cs [%]	
River	Mano River	C-1	6.2	62	1,200	1,700	0.022	0.030	0.02	0.02
		C-3	6.4	64	490	660	0.016	0.022	0.03	0.03
		C-4	7.8	78	580	780	0.018	0.022	0.03	0.03
Lake	Lake Hayama	E-1	1.0	10	3,900	5,400	0.080	0.10	0.02	0.02
		E-2	1.3	13	1,800	2,400	0.044	0.054	0.02	0.02
		E-4	1.2	12	4,400	5,800	0.033	0.041	0.01	0.01
Sea area	Hisanojima	F-1	2.0	20	440	610	0.13	0.17	0.3	0.3
		F-2	2.0	20	530	740	0.14	0.17	0.3	0.2
		F-4	1.5	15	250	330	0.14	0.17	0.6	0.5

Note) Dissolution rate = (Amount of radioactive cesium contained in the eluate equivalent to the volume of the mixed liquid used for the dissolution test) / (Amount of radioactive cesium in the analysis sample used for the dissolution test) × 100

The dissolution rate was calculated for each type of radionuclide.