

FY2015 Radioactive Material Monitoring of Aquatic Organisms (October)

1. Survey Overview

Samples of aquatic organisms (algae, aquatic insects, crustaceans, shellfish, fish, and amphibians, etc.) were collected mainly in Fukushima Prefecture and concentrations of radioactive cesium and radioactive strontium in the samples were measured (survey period: October 5 to 30, 2015).

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 past Radioactive Material Monitoring of Aquatic Organisms and 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, Uda River, Mano River, Niida River, and Ota River
- (ii) Lakes: Lake Hayama, Lake Akimoto, Lake Inawashiro
- (iii) Sea areas: Off the mouth of the Abukuma River, off Soma City, off Iwaki City

○ Survey locations and dates

| Area | Targeted water areas | Zone | Item | Survey dates | Remarks | |
|-------------------------|----------------------|---|--|------------------------------------|---|---|
| River area | A | Shinfuna Bridge to the Inoentei Dam; Harase River (a tributary) | Aquatic organisms sampling | October 21, 2015 | Algae, flora, aquatic insects, crustaceans, fish, amphibians, fallen leaves, etc. | |
| | | | Water/sediment sampling | October 20, 2015 | (Water sampling) A-1, A-2 (Sediment sampling) A-1, A-2 | |
| | B | Abukuma River | Confluence with the Matsukawa River (a tributary) to Taisho Bridge; Surikami River (a tributary) | Aquatic organisms sampling | October 6, 7, 15, and 30, 2015 | Algae, flora, aquatic insects, fish, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 20, 2015 | (Water sampling) B-1—B-3 (Sediment sampling) B-1—B-3 |
| | C | Uda River | Kawahira Bridge to Horita Bridge; Around Tamano Bridge | Aquatic organisms sampling | October 22, 2015 | Algae, flora, aquatic insects, crustaceans, fish, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 21, 2015 | (Water sampling) C-1—C-6 (Sediment sampling) C-1, C-2, C-4—C-6 |
| | D | Mano River | Zennami Bridge to Ochiai Bridge | Aquatic organisms sampling | October 23, 2015 | Algae, flora, aquatic insects, crustaceans, fish, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 23, 2015 | (Water sampling) D-1—D-5 (Sediment sampling) D-1—D-3, D-4a, D-5 |
| | E | Nada River | Kayanoki Bridge to Sugauchi Bridge | Aquatic organisms sampling | October 25, 2015 | Algae, flora, aquatic insects, crustaceans, fish, amphibians, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 22, 2015 | (Water sampling) E-1—E-5 (Sediment sampling) E-1, E-2a, E-3—E-5 |
| | F | Ota River | Yaeyoneita Bridge to Memezawa district | Aquatic organisms sampling | October 24, 2015 | Algae, flora, aquatic insects, crustaceans, fish, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 24, 2015 | (Water sampling) F-1—F-6 (Sediment sampling) F-1—F-5 |
| G | Lake Hayama | | Aquatic organisms sampling | October 14, 16, 25, and 26, 2015 | Algae, flora, aquatic insects, crustaceans, fish, amphibians, fallen leaves, etc. | |
| | | | Water/sediment sampling | October 26, 2015 | (Water sampling) G-1, G-3, G-5 (Sediment sampling) G-1—G-5 | |
| Lake area | H | Lake Akinoto | Aquatic organisms sampling | October 19, and 21, 2015 | Algae, flora, aquatic insects, crustaceans, fish, amphibians, fallen leaves, etc. | |
| | | | Water/sediment sampling | October 21, 2015 | (Water sampling) H-1, H-3, H-5 (Sediment sampling) H-1—H-5 | |
| | I | Lake Inawashiro | North bank | Aquatic organisms sampling | October 20, 2015 | Fish, fallen leaves, etc. |
| | | | | Water/sediment sampling | October 20, 2015 | (Water sampling) I-1, I-3 (Sediment sampling) I-1—I-4 |
| J | Lake Inawashiro | South bank | Aquatic organisms sampling | October 5, 7, 11, 18, and 20, 2015 | Algae, flora, aquatic insects, crustaceans, shellfish, fish, amphibian | |
| | | | Water/sediment sampling | October 20, 2015 | (Water sampling) J-1 (Sediment sampling) J-1 | |
| Sea area | K | Off the Abukuma River Estuary | Sea area in front of the Abukuma River Estuary | Aquatic organisms sampling | October 27, 2015 | Crustaceans, Fish |
| | | | | Water/sediment sampling | October 27, 2015 | (Water sampling) K-2 (Sediment sampling) K-1—K-3 |
| | L | Offshore of Soma City | Matsukawaura | Aquatic organisms sampling | October 22, and 28, 2015 | Seaweed, algae, crustaceans, shellfish, fish |
| | | | | Water/sediment sampling | October 28, 2015 | (Water sampling) L-2, L-3 (Sediment sampling) L-1—L-3 |
| | M | Offshore of Iwaki City | Offshore of Hisanohama | Aquatic organisms sampling | October 22, and 23, 2015 | Seaweed, algae, sea urchin, crustaceans, shellfish, fish |
| Water/sediment sampling | | | | October 23, 2015 | (Water sampling) M-2 (Sediment sampling) M-1—M-3 | |

2. Survey Items and Locations, etc.

2.1 Survey Items

For all samples of aquatic organisms, analysis of Cs-134 and Cs-137 was conducted. Additionally, for samples of large fish, analysis of Sr-90 was also conducted.

With regard to surveys of water and sediments, locations where aquatic organism samples were scheduled to be collected and where clay particles and coarse particulate organic matters (dead leaves at the bottom, etc.) are supposed to accumulate due to inflows from the surrounding environment, etc. were selected for the analysis of radioactive materials and general survey items.

Survey items and samples for aquatic organisms, water, and sediments are as shown in the following table.

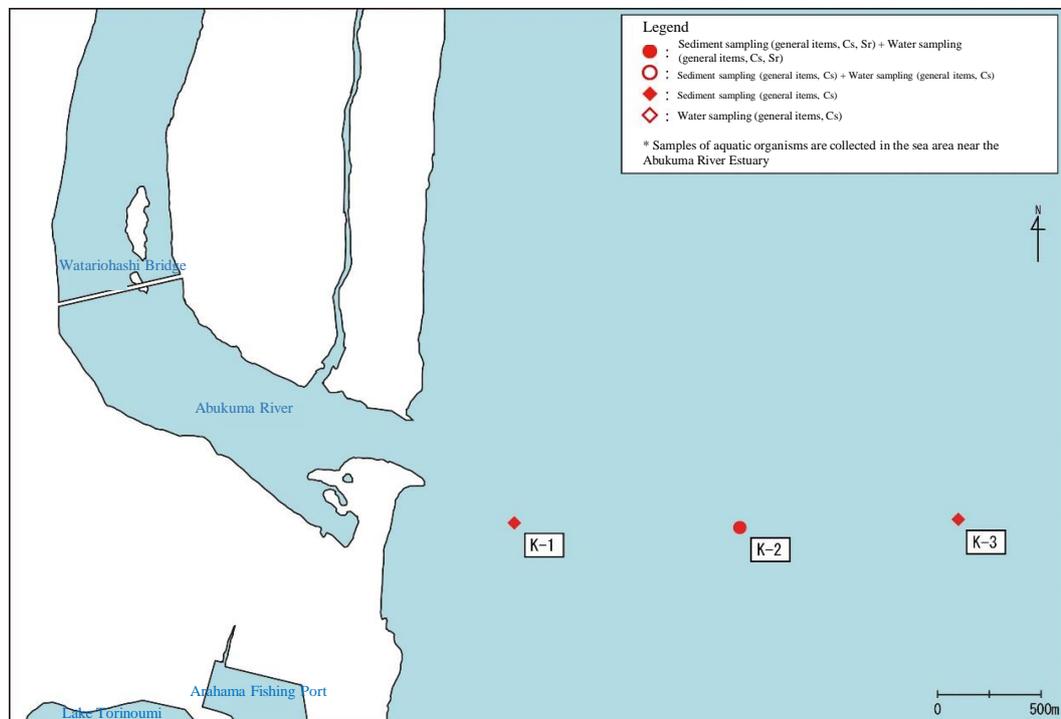
○ Survey targets and items

| Target | Measurement item | | Analyzed samples |
|-------------------|-----------------------|------------------------------------|--|
| Aquatic Organisms | Radioactive materials | Radioactive cesium (Cs-134,Cs-137) | All samples |
| | | Radioactive strontium (Sr-90) | Large fish |
| Water | Radioactive materials | Radioactive cesium (Cs-134,Cs-137) | Samples collected at one to six locations for each water area |
| | | Radioactive strontium (Sr-90) | Samples collected at one location for each water area |
| | General items | pH | Samples collected at one to six locations for each water area |
| | | BOD (Biological oxygen demand) | |
| | | COD (Chemical oxygen demand) | |
| | | DO (Dissolved oxygen level) | |
| | | Electrical conductivity | |
| | | Salinity | |
| | | TOC (Total organic carbon) | |
| | | SS (Suspended solids) | |
| Turbidity | | | |
| Sediments | Radioactive materials | Radioactive cesium (Cs-134,Cs-137) | Samples collected at three to five locations for each water area |
| | | Radioactive strontium (Sr-90) | Samples collected at one location for each water area |
| | General items | pH | Samples collected at three to five locations for each water area |
| | | Oxidation-reduction potential | |
| | | Water content | |
| | | TOC (Total organic carbon) | |
| | | IL (Ignition loss) | |
| | | Soil particle density | |
| | | Grainsize distribution | |

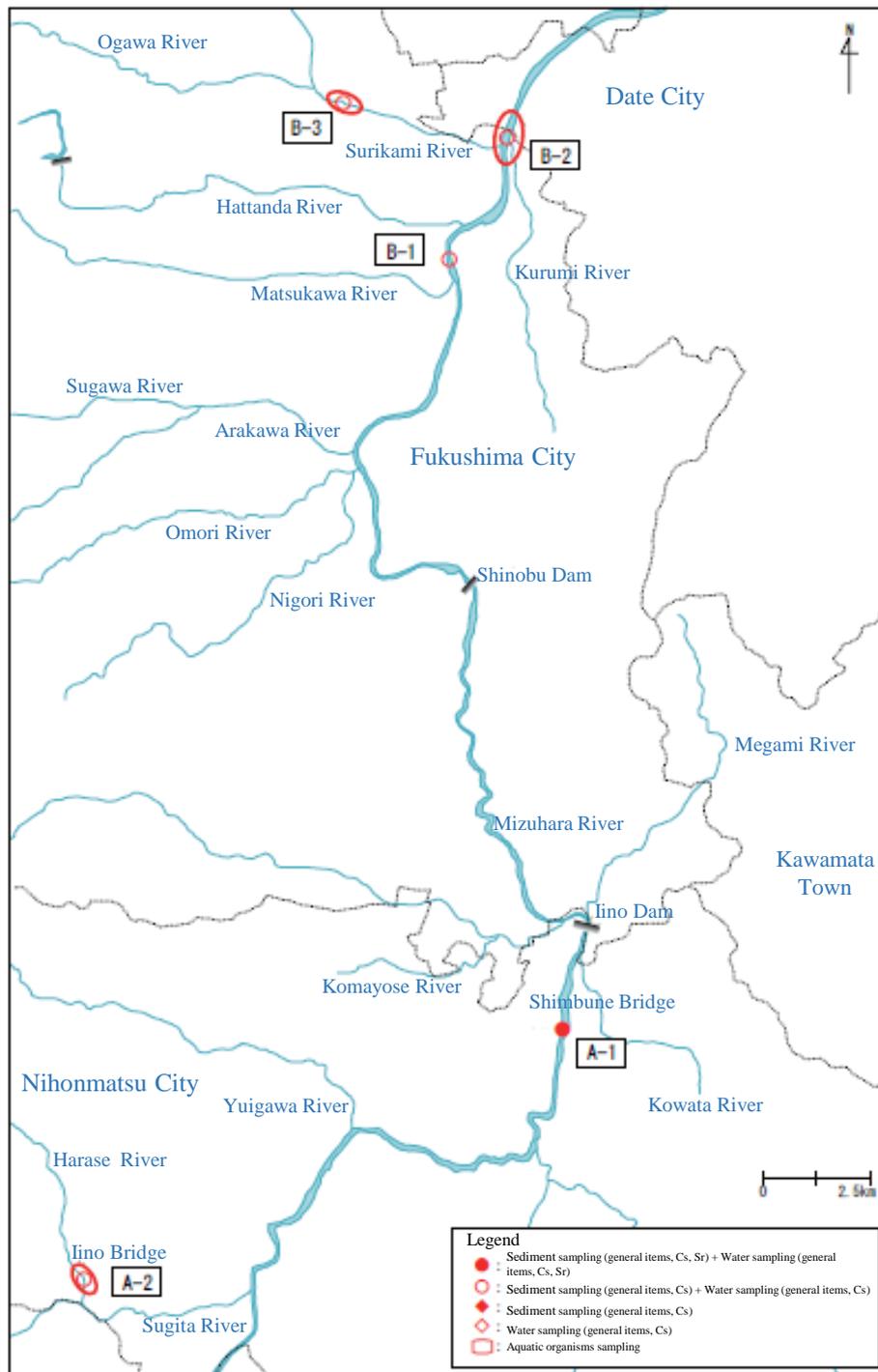
2.2 Survey Locations at Respective Water Areas

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

As water areas where clay particles and CPOMs (dead leaves at the bottom, etc.) are supposed to accumulate topographically, Location A along the Abukuma River was set from the Harase River (a tributary to the Abukuma River) and Shinfuno Bridge (Nihonmatsu City, Fukushima Prefecture) to the Iino Dam, and Location B along the Abukuma River was set from the confluence with the Matsukawa River to Taisho Bridge (Date City, Fukushima Prefecture) as well as the zone where a tributary to the Surikami River inflows. Additionally, Location K was set off the mouth of the Abukuma River in order to survey the sea area in front of the mouth of the Abukuma River, where the outflow of radioactive materials through the Abukuma River is suspected.



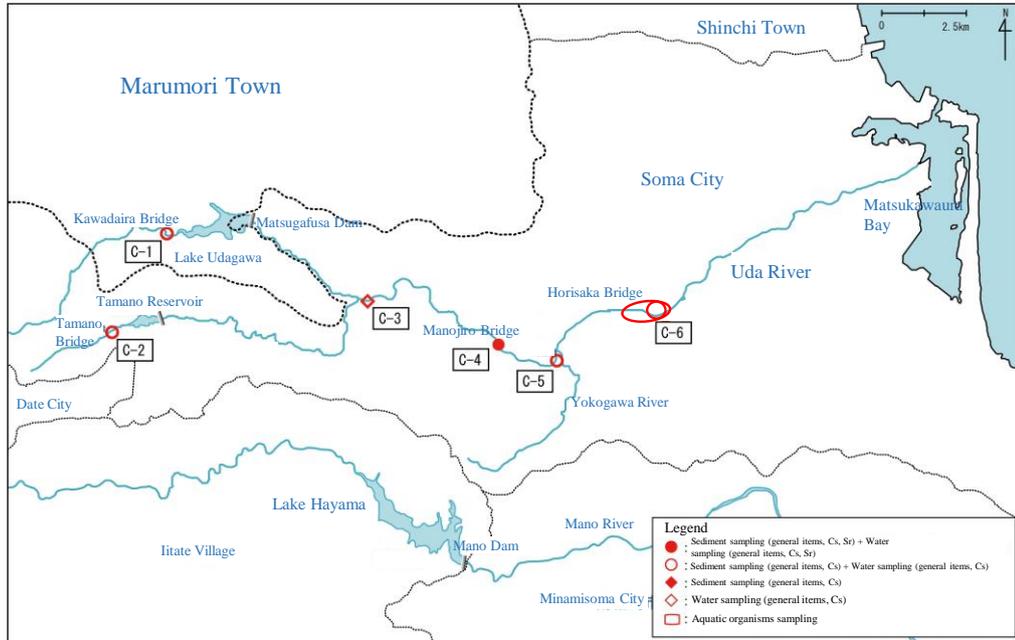
Detailed map showing Location K off the mouth of the Abukuma River



Map showing Location A and Location B along the Abukuma River

(2) Location C along the Uda River

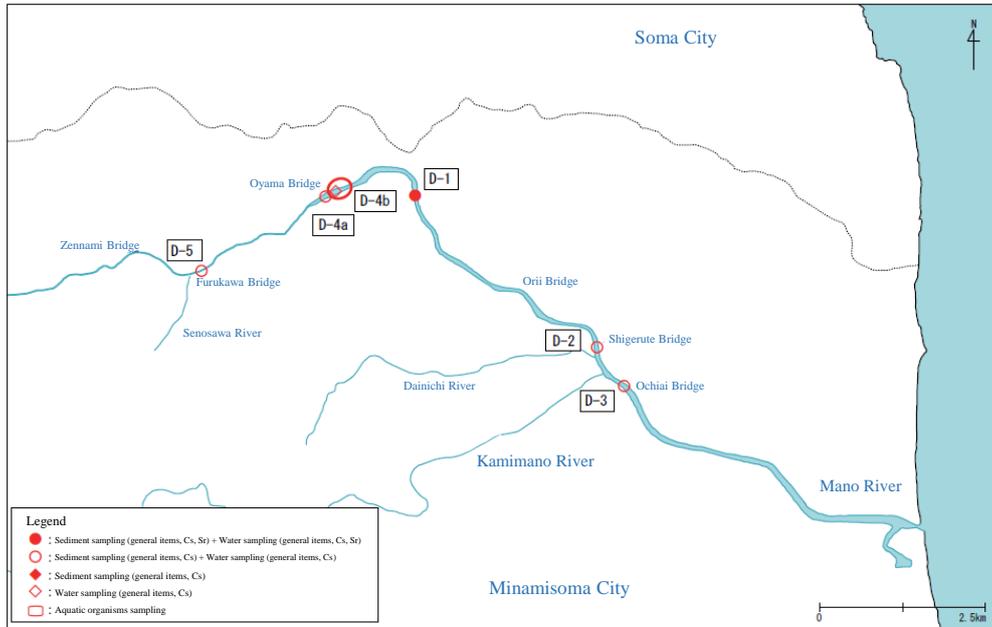
Surveys were started in the autumn term of FY2012 for the location from Kawahira Bridge to Horisaka Bridge, where water flows into the Matsugafusa Dam (Lake Udagawa), and around Tamano Bridge, where water flows into the Tamano Reservoir (a tributary to the Tamano River).



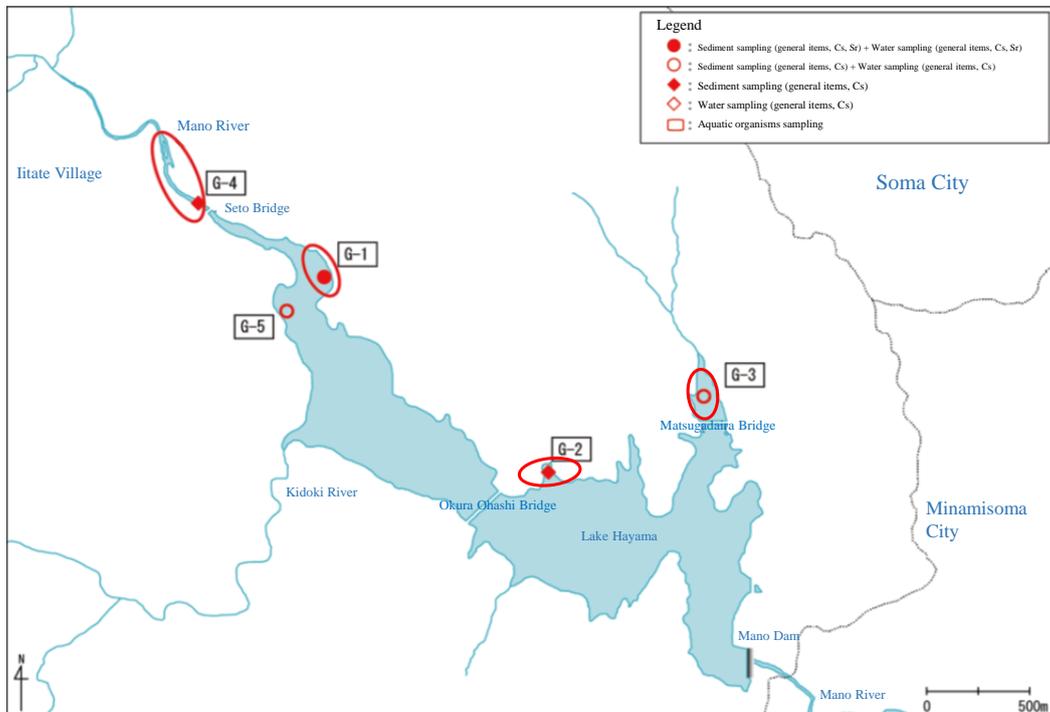
Detailed map showing Location C along the Uda River

(3) Tributaries to the Mano River (Location D along the Mano River; Location G in Lake Hayama)

Surveys were conducted at Location D along the Mano River, which covers from Zennami Bridge to Ochiai Bridge (Kashima Ward, Minamisoma City, Fukushima Prefecture), and at Location G in Lake Hayama (Mano Dam), which covers the lake as a whole and inflow points.



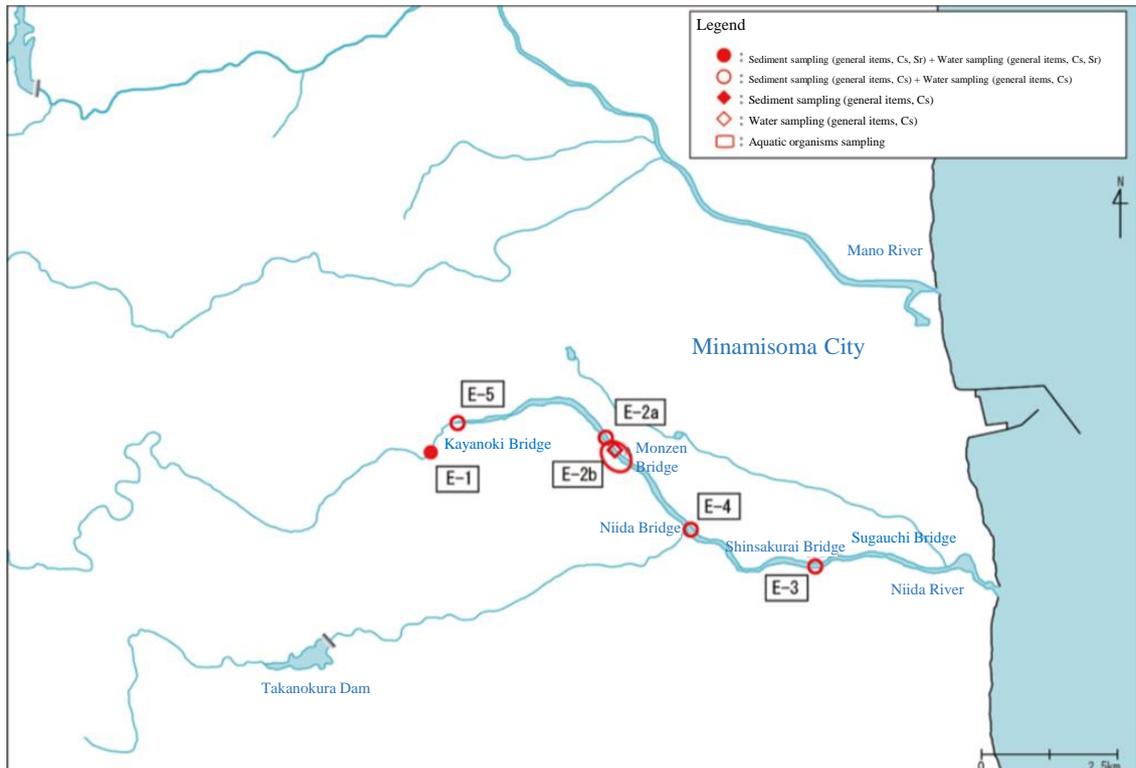
Detailed map showing Location D along the Mano River



Detailed map showing Location G in Lake Hayama (Mano Dam)

(4) Location E along the Niida River

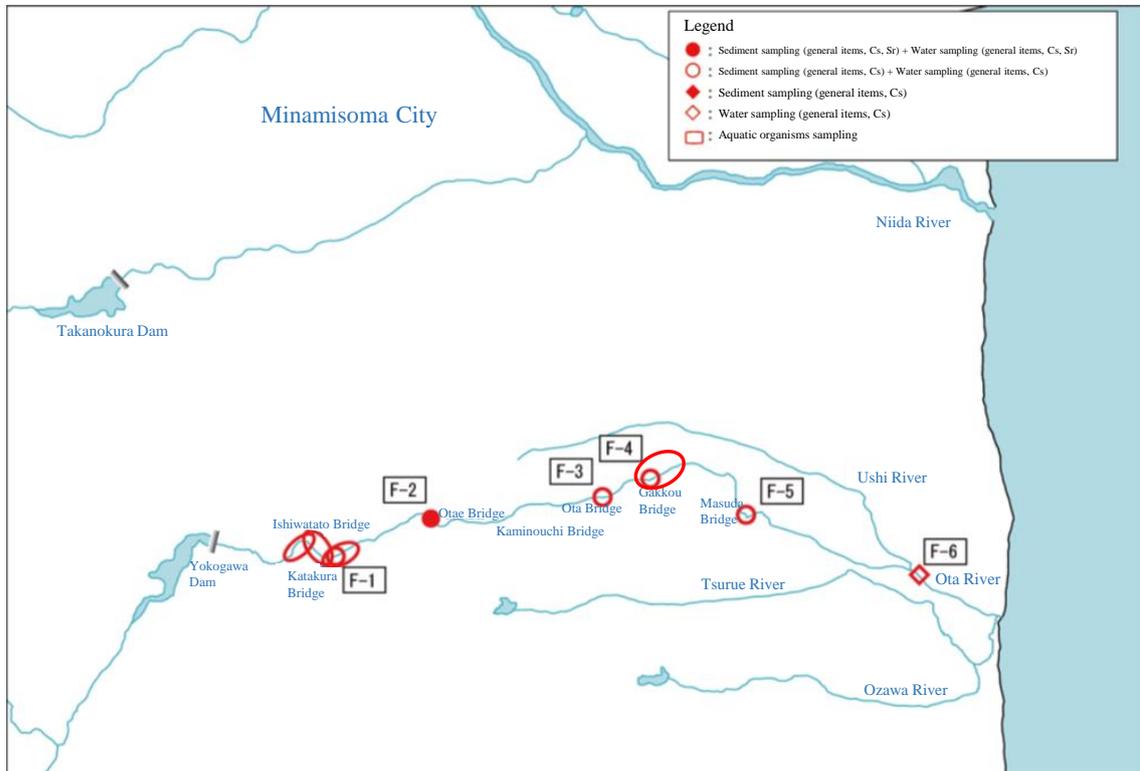
Surveys were conducted from Kayanoki Bridge to Sugauchi Bridge.



Detailed map showing Location E along the Niida River

(5) Location F along the Ota River

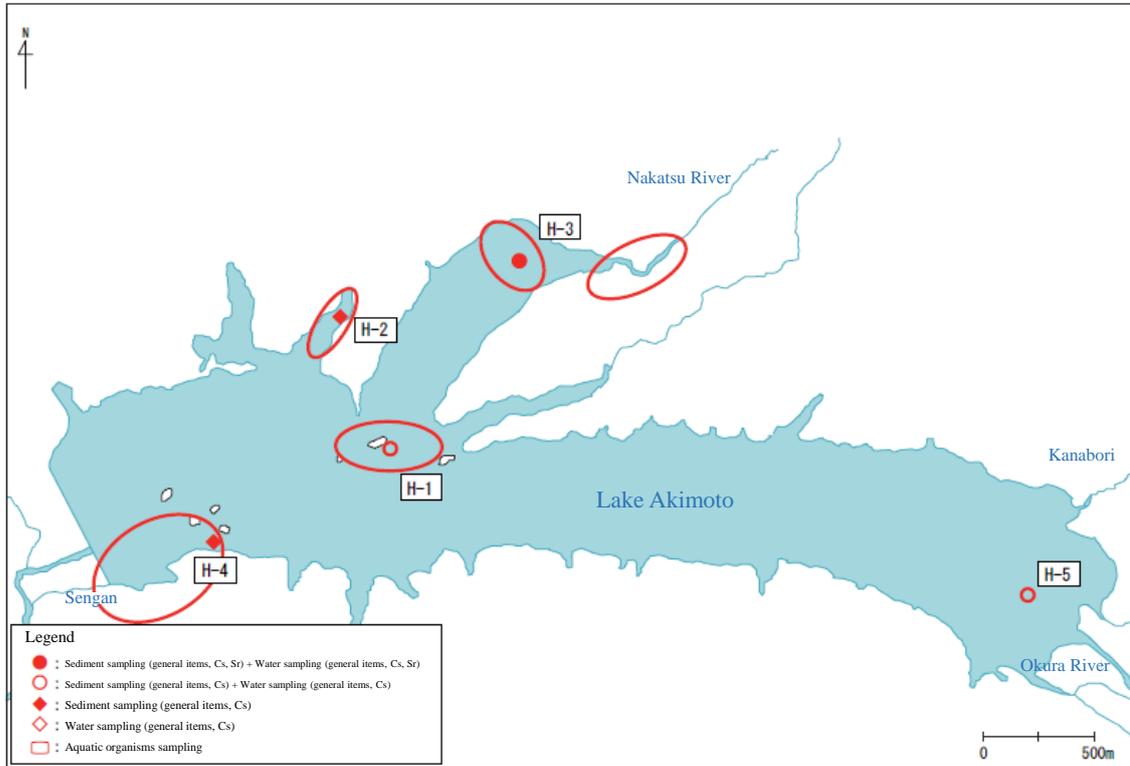
Surveys were started in the autumn term of FY2012 for the location from Yaeyonezaka Bridge to Memezawa District.



Detailed map showing Location F along the Ota River

(6) Location H in Lake Akimoto

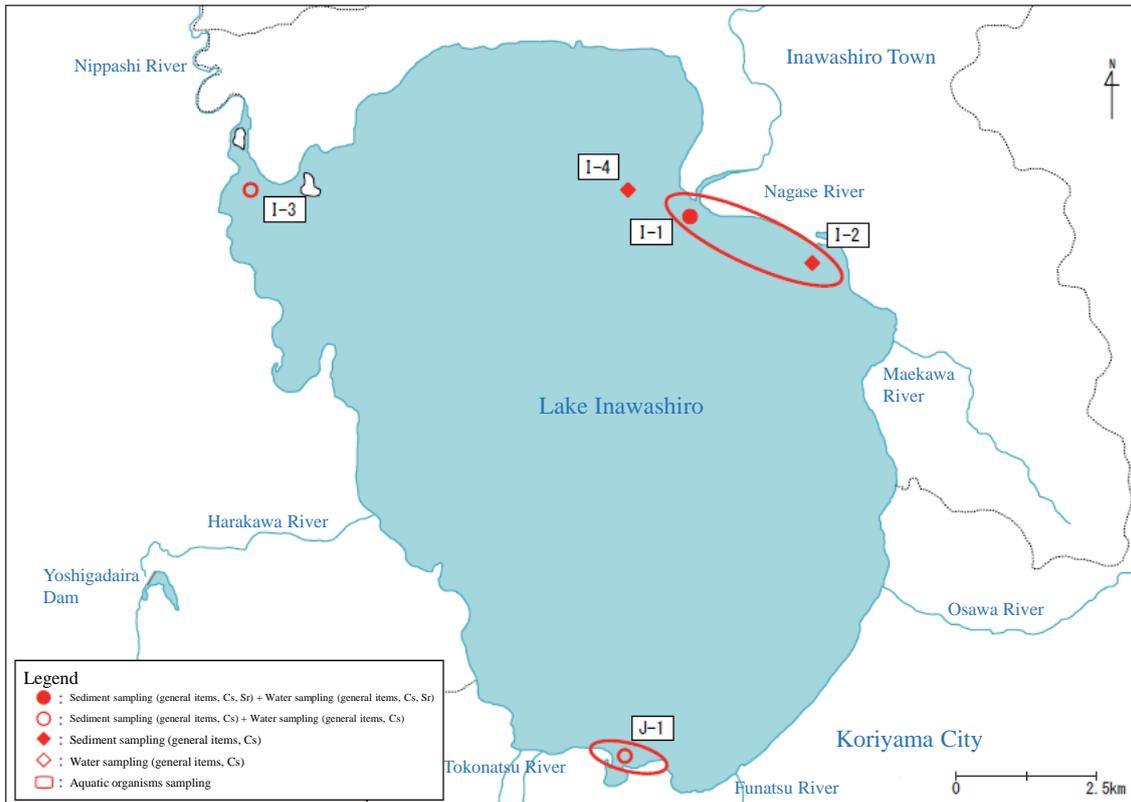
Surveys were conducted in the whole area of Lake Akimoto, the confluence with the Nakatsu River, and around Lake Akimoto.



Detailed map showing Location H in Lake Akimoto

(7) Location I (North Lakeside) and Location J (South Lakeside) in Lake Inawashiro

Surveys were conducted at around the point where the Nagase River inflows into Lake Inawashiro, and at around the point where lake water flows out into the Nippashi River (at the north lakeside), and at the south lakeside.

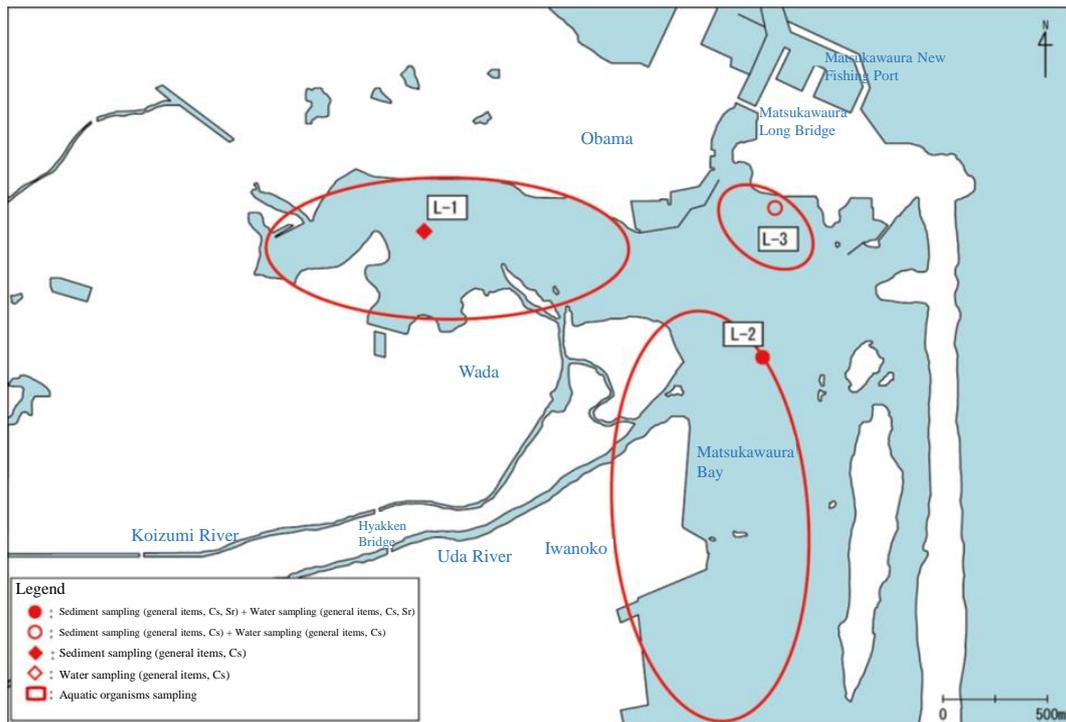


Detailed map showing Location I (north lakeside) and Location J (south lakeside) in Lake Inawashiro

(8) Location L off Soma City

Surveys were conducted within the Matsukawaura Bay, centering on the estuary region of the Uda River.

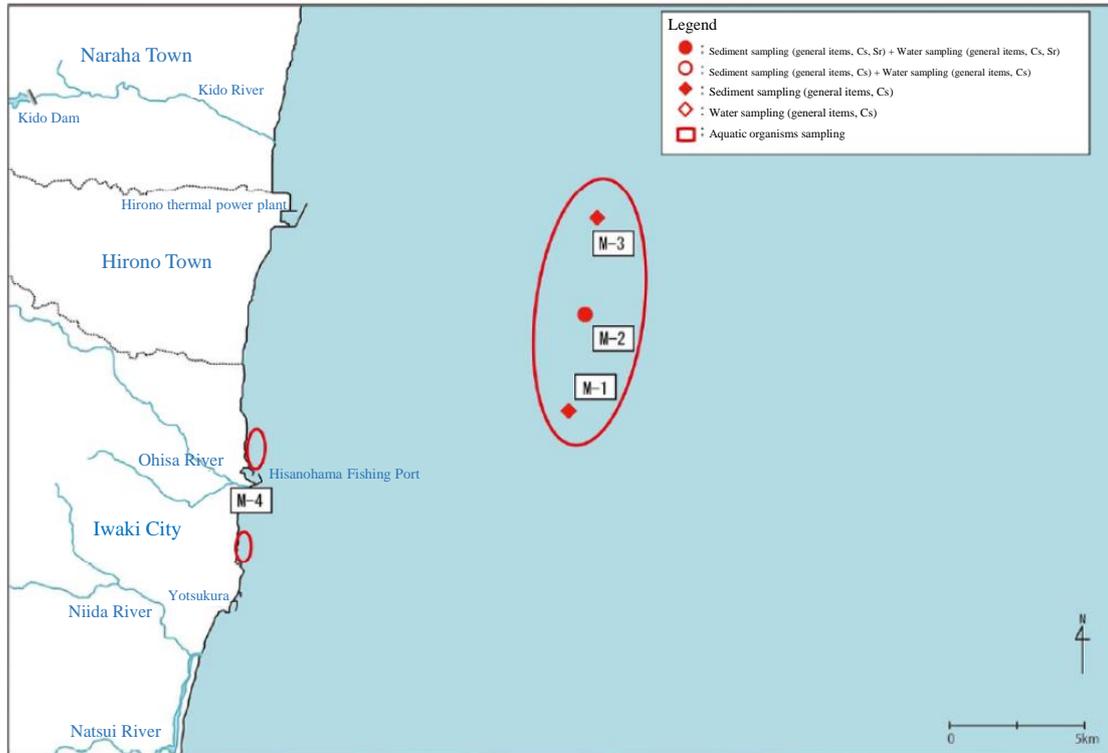
Sampling point in Location L-2 was expanded to the south in the FY2015 survey because sampling was impossible at the conventional point due to bank protection work.



Detailed map showing Location L off Soma City (Matsukawaura Bay)

(9) Location M off Iwaki City

Surveys were conducted off the Hisanohama Fishing Port and coastal areas in Hisanohama.



Detailed map showing Location M off Iwaki City

3. Results

Comparing concentrations of radioactive cesium in aquatic organisms in freshwater areas and seawater areas, aquatic organisms in freshwater areas showed relatively higher concentrations than those in seawater areas, as was observed in the past monitoring surveys.

Regarding concentrations of radioactive cesium in the water environment, concentrations in sediment samples collected from the same river system tend to be higher for those collected at zones where water stalls (dams, etc.), as in the cases of the past monitoring surveys.

Concentrations of radioactive strontium in sediment samples were higher for those collected in freshwater areas, but no difference was observed between water samples collected in freshwater areas and those collected in seawater areas. This tendency was unchanged from the times of the past monitoring surveys.

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

(i) Rivers and lakes

Unit: Bq/kg-wet

| Water area | | Time | Algae, Flora | Aquatic insects | Crustaceans | Shellfish (Molluscan body) | Fish | Amphibia | CPOMs (fallen leaves, etc.) |
|----------------------|-----------------|--------------------|-------------------------|-------------------------|-------------------------|----------------------------|-------------------------|-----------------------|-----------------------------|
| Abukuma River System | Abukuma River A | FY2015 Oct. | 145 | 21.3 , 25.5 (2 species) | 10.6 | — | 14.0 - 34.7 (3 species) | 11 | 26.0 |
| | | FY2015 Aug. | 175 | 25.1 , 27.7 (2 species) | 35.2 | 17.3 | 12.6 - 16.4 (4 species) | 52 | 288 |
| | | FY2015 Jun. | 257 | 19.8 - 40.3 (3 species) | 16.4 , 21.4 (2 species) | 26.3 | 5.2 - 14.8 (5 species) | 8.8 - 152 (3 species) | 442 |
| | Abukuma River B | FY2015 Oct. | 72 | 3.2 - 25.7 (4 species) | — | — | 7.7 - 38.5 (7 species) | — | 22.1 |
| | | FY2015 Jul. - Sep. | 123 | 5.2 - 50.9 (3 species) | 22.7 | — | 9.0 - 136 (14 species) | 111 | 36.8 |
| | | FY2015 Jun. | 8.5 , 125 (2 species) | 4.6 - 41 (3 species) | 25.4 | 68 | N.D. - 66 (9 species) | 138 , 267 | 30 |
| Uda River C | | FY2015 Oct. | 232 | 11 | 24.1 , 37.9 (2 species) | — | 15.4 - 23.7 (4 species) | — | 66 |
| | | FY2015 Aug. | 249 | 11 , 23.5 (2 species) | 19.1 , 24.2 (2 species) | — | 9.8 - 30.5 (3 species) | — | 23.8 |
| | | FY2015 Jun. | 439 | 6.9 - 88 (3 species) | 19.3 - 32.9 (3 species) | — | 6.5 - 20.8 (4 species) | 34.3 | 118 |
| Mano River System | Lake Hayama G | FY2015 Oct. | 11.1 , 480 (2 species) | 17 - 225 (4 species) | 54 | — | 53 - 432 (8 species) | 830 | 60 |
| | | FY2015 Aug. - Sep. | 17.6 , 1640 (2 species) | 38.6 - 227 (3 species) | 71 | — | 58 - 600 (6 species) | — | 351 |
| | | FY2015 Jun. - Jul. | N.D. , 2140 (2 species) | 76 | 122 | — | 9.7 - 650 (12 species) | — | 403 |
| | Mano River D | FY2015 Oct. | 308 | 36.5 - 165 (3 species) | 40.5 - 209 (3 species) | — | 30.2 - 91 (7 species) | — | 271 |
| | | FY2015 Aug. | 192 | 29.0 - 89 (3 species) | 37.2 , 163 (2 species) | 288 | 18.8 - 150 (6 species) | — | 426 |
| | | FY2015 Jun. - Jul. | 192 | 19.4 - 190 (3 species) | 75 - 164 (4 species) | 100 | 14.4 - 203 (14 species) | — | 236 |
| Niida River E | | FY2015 Oct. | 344 | 33.5 - 460 (5 species) | 74 - 124 (3 species) | — | 78 - 115 (5 species) | 202 | 329 |
| | | FY2015 Aug. | 341 | 71 - 300 (3 species) | 70 , 82 (2 species) | — | 56 - 212 (6 species) | 1070 | 172 |
| | | FY2015 Jun. | 680 | 59 - 472 (3 species) | 163 , 202 (2 species) | — | 44.5 - 193 (8 species) | — | 356 |
| Ota River F | | FY2015 Oct. | 5200 | 383 | 108 , 600 (2 species) | — | 94 - 1730 (8 species) | — | 610 |
| | | FY2015 Aug. | 421 | 150 - 478 (3 species) | 186 - 570 (3 species) | — | 540 , 1050 (2 species) | — | 76 |
| | | FY2015 Jun. | 1810 | 140 - 520 (3 species) | 431 - 620 (3 species) | — | 247 - 930 (4 species) | 361 , 488 (2 species) | 69 |

* ND means to be below the detection limit.

* Organisms were collected in or around the targeted water areas.

* Basically, measurement was conducted for all targeted samples, not limited to edible parts.

* Since the autumn term of FY2012, sampling and analysis of aquatic insects had been conducted separately for four categories (Plecoptera, Trichoptera, Odonata, and Megaloptera) (by feeding habit and type). Since the FY2014 June-July Survey, Ephemeroptera was added and sampling and analysis were conducted for five categories.

Unit: Bq/kg-wet

| Water area | | Time | Algae, Flora | Aquatic insects | Crustaceans | Shellfish (Molluscan body) | Fish | Amphibia | CPOMs (fallen leaves, etc.) |
|--------------------|---|-----------------------|----------------------------|---------------------------|-------------|----------------------------------|----------------------------|----------------------------|-----------------------------------|
| Lake Akimoto H | | FY2015 Oct. | 16.6 , 51 (2 species) | 12 | 28.3 | — | 21.6 - 161 (8 species) | 19.1 , 23.3 (2 species) | 13.9 |
| | | FY2015 Aug. - Sep. | 122 , 197 (2 species) | 9.2 | 42.8 | 21.6 | 18.3 - 74 (9 species) | 14.1 , 33.6 (2 species) | 108 |
| | | FY2015 Jun. | 13.8 , 219 (2 species) | N.D. - 229 (3 species) | 39 | 7.1 | 16.3 - 126 (12 species) | 10.5 - 151 (3 species) | 42.4 |
| Lake Inawashiro | Lake Inawashiro I (north lakeside) | FY2015 Oct. | — | — | — | — | 5.35 - 93 (6 species) | — | 2.3 |
| | | FY2015 Aug. | — | — | — | — | 8.9 - 104 (5 species) | — | 42.2 |
| | | FY2015 Jun. | — | — | — | — | 5.9 - 95 (9 species) | — | 25.6 |
| | Lake Inawashiro J (south lakeside) | FY2015 Oct. | N.D. - 2.23 (3 species) | 2.1 | 11.1 | 9.5 | 1.4 - 113 (9 species) | 2.0 , 2.8 (2 species) | — |
| | | FY2015 Aug. | 0.89 - 1.6 (3 species) | — | — | 1.6 | N.D. - 30.1 (7 species) | 0.7 , 1.9 (2 species) | — |
| | | FY2015 Jun. | N.D. - 28 (3 species) | N.D. | 8.9 | N.D. , 3.1 (2 species) | N.D. - 56 (11 species) | 1.7 - 19.1 (3 species) | — |

* ND means to be below the detection limit.

* Organisms were collected in or around the targeted water areas.

* Basically, measurement was conducted for all targeted samples, not limited to edible parts.

* Since the autumn term of FY2012, sampling and analysis of aquatic insects had been conducted separately for four categories (Plecoptera, Trichoptera, Odonata, and Megaloptera) (by feeding habit and type). Since the FY2014 June-July Survey, Ephemeroptera was added and sampling and analysis were conducted for five categories.

(ii) Sea areas

Unit: Bq/kg-wet

| Water area | Time | Seaweed,algae | Polychaeta | Sea urchin, starfish, trepang | Crustacean s | Shellfish (Molluscan body) | Squid, octopus | Fish |
|--|----------------|----------------------------|------------|----------------------------------|----------------------------|----------------------------------|-------------------|-----------------------------|
| Location K off the mouth of the Abukuma River | FY2015 Oct. | — | — | — | 1.0 | — | — | 1.2 - 5.6 (6 species) |
| | FY2015 Aug. | — | — | — | 0.29 | — | — | N.D. - 6.2 (5 species) |
| | FY2015 Jun. | — | — | — | 0.35 | — | — | 0.41 - 1.33 (6 species) |
| Location L off Soma City (Matsukawaura Bay) | FY2015 Oct. | 1.48 , 4.4 (2 species) | — | — | N.D. , 2.3 (2 species) | 1.49 , 5.58 (2 species) | — | 2.5 , 11.9 (2 species) |
| | FY2015 Aug. | 3.43 , 11.2 (2 species) | — | — | 1.3 , 2.1 (2 species) | 1.41 , 2.00 (2 species) | — | 2.8 - 14.8 (3 species) |
| | FY2015 Jun. | 0.47 - 34 (3 species) | — | — | N.D. - 3.66 (3 species) | 0.80 , 2.03 (2 species) | — | N.D. - 3.7 (8 species) |
| Location M off Iwaki City (Hisanohama) | FY2015 Oct. | 1.25 | — | 0.73 | 5.3 | 2.28 | — | N.D. - 11.8 (9 species) |
| | FY2015 Aug. | 10.0 | — | 0.79 | 2.34 | 0.72 | — | 0.95 - 30.8 (9 species) |
| | FY2015 Jun. | N.D. | — | 2.9 , 3.13 (2 species) | — | 0.66 | — | N.D. - 11.9 (16 species) |

* ND means to be below the detection limit.

* Basically, measurement was conducted for all targeted samples, not limited to edible parts.