

Implementation Guides on Sea Area Monitoring

1. Tasks of sea area monitoring

The distribution of radioactive materials is different among seawater, sediment and marine biota. Table 1 shows the tasks of sea area monitoring, which take into account the differences.

Table 1: Task of sea area monitoring

Sample	Tasks of sea area monitoring	Aims of Comprehensive Radiation Monitoring Plan
Seawater	To measure concentrations of radioactive materials including Cs-134/137.	(f)
Sediment	To determine distribution and time-dependent migration of radioactive materials.	(f)
Marine biota	To measure concentrations and determine their pathways.	(b), (c), (e) and (f)

2. Monitoring organizations

Organizations involved in sea area monitoring are as follows:

- Nuclear Regulation Authority (NRA);
- Fisheries Agency;
- Ministry of Land, Infrastructure, Transport and Tourism (MLIT);
- Japan Coast Guard;
- Ministry of the Environment (MOE);
- Fukushima Prefectural Government;
- Tokyo Electric Power Company Holdings, Inc. (TEPCO);
- Local governments;
- Local fishery unions; and
- Research institutes (as necessary).

The NRA plays the role as headquarters of monitoring organizations.

3. Sea areas to be monitored

The sea area around Fukushima Daiichi NPS is divided into the following four areas in terms of their distance from the NPS:

- (a) Area close to Fukushima Daiichi NPS: The area within approximately 3km from Fukushima Daiichi NPS.
- (b) Coastal area: The area within approximately 30km from the coastline (including river outlets) of Aomori (a part of Aomori), Iwate, Miyagi, Fukushima and Ibaraki Prefectures;
- (c) Off-shore area: The area between approximately 30km and 90km from the coastline;

(d) Outer sea area: The area approximately 90km and more far from the coastline.

In addition to the above-described sea areas, Tokyo Bay is the concerned area to be monitored.

(e) Tokyo Bay: The area where radioactive materials are highly likely to flow in via rivers and be deposited.

4. Monitoring materials and methods

Radionuclides that must be measured are Cs-134 and Cs-137. Other radionuclides are to be analyzed as necessary.

Seawater

When a leakage of contaminated water has occurred or is found, TEPCO and the central governmental organizations work together to obtain more seawater samplings as necessary in a prompt way.

(a) Area close to Fukushima Daiichi NPS (Table 2)

Monitoring materials and methods are revised, when TEPCO installs underwater in-situ measurement detectors.

Table 2: Sea water monitoring close to Fukushima Daiichi NPS

Sampling points	Radionuclide	Detection limit (Bq/L)	Monitoring frequency	Sampling depth ^{*1}	Monitoring organization
T-1, T-2 (Fig.3)	Cs-134	1	Once/day	Surface layer	TEPCO
	Cs-137	1x10 ⁻³	Once/week		
	H-3	1	Once/week		
	Sr-90	1x10 ⁻³	Once/month		
	Pu-238 ^{*2} Pu-239+240	1x10 ⁻⁵	Once/6 months		
T-0-1, T-0-2, T-0-3, T-0-1A, T-0-3A (Fig.3)	Cs-134 Cs-137	1	Once/week	Surface layer	TEPCO
	H-3	1			
M-101, M-102, M-103, M-104 (Fig.3)	Cs-134 Cs-137	1x10 ⁻³	Once/month	Surface layer	NRA
	H-3	4x10 ⁻¹			
	Sr-90	1x10 ⁻²			
F-P01, F-P02, F-P03, F-P04 (Fig.3)	Cs-134 Cs-137	1x10 ⁻³	Once/month	Surface layer	Fukushima Prefectural Government
	H-3	1			
	Sr-90	1x10 ⁻³			
	Pu-238 Pu-239+240	1x10 ⁻⁵			

*1: "Surface layer" is defined as the layer between sea level and 2m below sea level.

*2: U-234, U-235, U-238, Am-241, Cm-242 and Cm-243+244 should be measured when Pu-238 is detected.

* Total Beta is to be analyzed as necessary to screen radioactivity in sea water.

(b) Coastal area (Table 3)

Table 3: Sea water monitoring in coastal area

Prefecture	Sampling points	Radionuclide	Detection limit (Bq/L)	Monitoring frequency	Sampling depth ^{*1}	Monitoring organization
Iwate	E-31, E-32 (Fig.1)	Cs-134 Cs-137	1	Once/6 months	Surface and bottom layers	MOE
Miyagi	T-MG0, T-MG1, T-MG2, T-MG3, T-MG4, T-MG5, T-MG6 (Fig.1)	Cs-134 Cs-137	1×10^{-3}	Once/month	Surface and bottom layers	TEPCO
	E-41, E-42, E-43, E-44, E-45, E-46, E-47, E-48, E-49, E-4A, E-4B, E-4C (Fig.1)	Cs-134 Cs-137	1	Once/1-6 months	Surface and bottom layers	MOE
Fukushima	T-3, T-6 (Fig.4)	Cs-134 Cs-137	1×10^{-3}	Once/week	Surface layer	TEPCO
		H-3	4×10^{-1}	Twice/month		
	T-5, T-D1, T-D5, T-D9 (Fig.4)	Cs-134 Cs-137	1×10^{-3}	Once/week	Surface and bottom layers	TEPCO
		H-3	4×10^{-1}	Twice/month	Surface layer	
		Sr-90 Pu-238 Pu-239+240	1×10^{-3} 1×10^{-5}	Once/month Once/6 months		
	T-4 ^{*2} , T-11, T-14 (Fig.4)	Cs-134 Cs-137	1×10^{-3}	Once/week	Surface and bottom layers	TEPCO
T-S1, T-S3, T-S4, T-S5, T-S7, T-S8, T-B1, T-B2, T-B3, T-B4, T-13-1, T-7, T-18, T-12, T-17-1, T-20, T-22, T-MA, T-M10 (Fig.2, Fig.4)	Cs-134 Cs-137	1×10^{-3}	Once/month	Surface and bottom layers	TEPCO	

	E-71, E-72, E-73, E-74, E-75, E-76, E-77, E-78, E-79, E-7A, E-7B, E-7F, E-7G, E-7H, E-7I (Fig.2, Fig.4)	Cs-134 Cs-137	1	Once/1-2 months	Surface and bottom layers	MOE
	F-P05, F-P06 (Fig.4)	Cs-134 Cs-137	1x10 ⁻³	Once/month	Surface layer	Fukushima Prefectural Government
H-3		1				
Sr-90		1x10 ⁻³				
Pu-238 Pu-239+240		1x10 ⁻⁵				
	20 points off the coast of Fukushima Prefecture (fishing ports and shallow water fishing fields) (Fig.2)	Cs-134 Cs-137* ³	1		0-7m below sea level	
Ibaraki	T-A, T-B, T-C, T-D, T-E, T-Z (Fig.5, Fig.6)	Cs-134 Cs-137	1 * ⁴	Once/month	Surface and bottom layers	TEPCO
	E-81, E-82, E-83, E-84, E-85 (Fig.5, Fig.6)	Cs-134 Cs-137	1	Once/3-4 months	Surface and bottom layers	MOE

*1: "Surface layer" is between sea level and 3m below sea level. "Bottom layer" is between sea bottom and 5m above sea bottom.

*2: Only surface seawater at the sampling point T-4 is obtained.

*3: H-3 is additionally measured at the some sampling points.

*4: Detection limit will be changed to 1x10⁻³Bq/L.

* Total Beta is to be analyzed as necessary to screen radioactivity in sea water.

(c) Off-shore area (Table 4)

Table 4: Sea water monitoring in off-shore area

Sampling points	Radionuclide	Detection limit (Bq/L)	Monitoring frequency	Sampling depth ^{*2}	Monitoring organization
M-A1, M-A3, M-MI4, M-B1, M-B3, M-B5, M-C1, M-C3, M-D1, M-D3, M-E1, M-E3, M-E5, M-F1, M-F3, M-G0, M-G1, M-G3, M-G4, M-H1, M-H3, M-I0, M-I1, M-I3, M-J1, M-IB2, M-J3, M-K1, M-IB4, M-L1, M-L3, M-M1 (Fig.1, Fig.2, Fig.5, Fig.6)	Cs-134 Cs-137 ^{*1}	1x10 ⁻³	Once/3 months	Surface and middle and bottom layers	NRA

*1: Sr-90 and H-3 are additionally measured at some sampling points considering the consistency of the past monitoring results.

*2: "Surface layer" is defined as the layer between sea level and 2m below sea level. "Bottom layer" is defined as the layer between sea bottom and 40m above sea bottom. "Middle layer" is defined as the layer between 2m below sea level and 40m above sea bottom. Some monitoring activities are conducted at 50m or 100m below the sea level.

* Total Beta is to be analyzed as necessary to screen radioactivity in sea water.

(d) Outer sea area (Table 5)

Table 5: Sea water monitoring outer sea area

Sampling points	Radionuclide	Detection limit (Bq/L)	Monitoring frequency	Sampling depth	Monitoring organization
M-10, M-11, M-14, M-15, M-19, M-20, M-21, M-25, M-26, M-27 (Fig.7)	Cs-134 Cs-137	1x10 ⁻³	Once/6 months	Surface (0-2m), 100m, 200m, 300m and 500m below sea level	NRA
K-1, K-2, K-3, K-4 (Fig.8)	Cs-134 Cs-137 Sr-90	1x10 ⁻³	Once/year	Surface (0-2m), 800m below sea level	Japan Coast Guard

(e) Tokyo Bay (Table 6)

Table 6: Sea water monitoring in the Tokyo Bay

Sampling points		Radionuclide	Detection limit (Bq/L)	Monitoring frequency	Sampling depth *	Monitoring organization
River outlet	E-T1, E-T2, E-T3, E-T4, E-T5, E-T6, E-T7, E-T8 (Fig.9)	Cs-134 Cs-137	1	4-7 times/year	Surface and bottom layers	MOE
	E-T1, E-T2, E-T3, E-T4 (Fig.9)		1x10 ⁻³	Once/year	Surface layer	NRA
Center of the bay	K-T1, K-T2 (Fig.9)	Cs-134 Cs-137	1x10 ⁻³	6 times/year	Surface layer	NRA
	M-C6, M-C9 (Fig.9)			Once/year		
Around the center of bay-mouth	KK-U1 (Fig.9)	Cs-134 Cs-137	5	Once/month	Surface layer	MLIT
			1x10 ⁻³	Once/year		NRA

* "Surface layer" is defined as the layer between sea level and 2m below sea level. "Bottom layer" is defined as the layer between sea bottom and 2m above sea bottom.

Sediment

(a) Area close to Fukushima Daiichi NPS (Table 7)

Table 7: Sediment monitoring close to Fukushima Daiichi NPS

Sampling points	Radionuclide	Detection limit (Bq/kg dry)	Monitoring frequency	Monitoring organization
T-1, T-2 (Fig.3)	Cs-134 Cs-137	1	Once/month	TEPCO
	Sr-90	2	Once/2 months	
	Pu-238*	3x10 ⁻²	Once/6 months	
	Pu-239+240			
F-P01, F-P02, F-P03, F-P04 (Fig.3)	Cs-134 Cs-137	1	Once/3 months	Fukushima Prefectural Government
	Sr-90	2x10 ⁻¹		
	Pu-238	2x10 ⁻²		
	Pu-239+240			

* U-234, U-235, U-238, Am-241, Cm-242 and Cm-243+244 should be measured when Pu-238 is detected.

(b) Coastal area (Table 8)

Table 8: Sediment monitoring in coastal area

Prefecture	Sampling points	Radionuclide	Detection limit (Bq/kg dry)	Monitoring frequency	Monitoring organization
Iwate	E-37, E-38, E-39, E-3A (Fig.1)	Cs-134 Cs-137	1	Once/year	MOE
	E-31, E-32 (Fig.1)	Cs-134 Cs-137*	1x10 ¹	Once/6 months	
Miyagi	E-4F, E-4G, E-4H, E-4I, E-4J, E-4K, E-4L, E-4M (Fig.1)	Cs-134 Cs-137	1	Once/year	MOE
	E-41, E-42, E-43, E-44, E-45, E-46, E-47, E-48, E-49, E-4A, E-4B, E-4C (Fig.1)	Cs-134 Cs-137*	1x10 ¹	Once/1-6 months	
Fukushima	T-3, T-4, T-5, T-11, T-14, T-B1, T-B2, T-B3, T-B4, T-D1, T-D5, T-D9, T-S1, T-S3, T-S4, T-S5, T-S7, T-S8, T-①, T-②, T-③, T-④, T-⑤, T-⑥, T-⑦, T-⑧, T-⑨, T-⑩, T-⑪, T-⑫, T-⑬ (Fig.2, Fig.4)	Cs-134 Cs-137	1	Once/month	TEPCO
	T-7, T-12, T-13-1, T-17-1, T-18, T-20, T-22, T-M10, T-MA, (Fig.2, Fig.4)	Cs-134 Cs-137	1	Once/2 months	TEPCO
	E-7C, E-7D, E-7E, E-7F, E-7G, E-7H (Fig.2)	Cs-134 Cs-137	1	Once/year	MOE
	E-71, E-72, E-73, E-74, E-75, E-76, E-77, E-78, E-79, E-7A, E-7B, E-7F, E-7G, E-7H, E-7I (Fig.2, Fig.4)	Cs-134 Cs-137*	1x10 ¹	Once/1-2 months	
	F-P05, F-P06	Cs-134	1	Once/3 months	Fukushima

	(Fig.4)	Cs-137		Prefectural Government	
		Sr-90	2×10^{-1}		
		Pu-238 Pu-239+240	2×10^{-2}		
	42 points off the coast of Fukushima (sea bottom) (Fig.2)	Cs-134 Cs-137	1×10^1	Once/month to twice/year	
Ibaraki	E-81, E-82, E-83, E-84, E-85 (Fig.5, Fig.6)	Cs-134 Cs-137*	1×10^1	Once/3-4 months	MOE

* Sr-90 is measured as necessary in some sampling points (e.g., sampling points where high Cs-134 and Cs-137 levels were found).

(c) Off-shore area (Table 9)

Table 9: Sediment monitoring in off-shore area

Sampling points	Radionuclide	Detection limit (Bq/kg dry)	Monitoring frequency	Monitoring organization
M-A1, M-A3, M-MI4, M-B1, M-B3, M-B5, M-C1, M-C3, M-D1, M-D3, M-E1, M-E3, M-E5, M-F1, M-F3, M-G0, M-G1, M-G3, M-G4, M-H1, M-H3, M-I0, M-I1, M-I3, M-J1, M-IB2, M-J3, M-K1, M-IB4, M-L1, M-L3, M-M1 (Fig.1, Fig.2, Fig.5, Fig.6)	Cs-134 Cs-137 *	1	Once/3 months	NRA

* Sr-90, Pu-238, Pu-239+240, Am-241, Cm-242 and Cm-243+244 are measured in some sampling points (e.g., sampling points where high Cs-134 and Cs-137 levels were found) with the detection limits as follows;

- Sr-90: 1×10^{-1} Bq/kg of dry sediment
- Pu-238 and Pu-239+240: 1×10^{-2} Bq/kg of dry sediment
- Am-241: 2×10^{-2} Bq/kg of dry sediment
- Cm-242 and Cm-243+244: 1×10^{-2} Bq/kg of dry sediment

(d) Outer sea area

Monitoring is not conducted for sediment in outer sea area.

(e) Tokyo Bay (Table 10)

Table 10: Sediment monitoring in Tokyo Bay

Sampling points		Radionuclide	Detection limit (Bq/kg dry)	Monitoring frequency	Monitoring organization
River outlets	E-T1, E-T2, E-T3, E-T4, E-T5, E-T6, E-T7, E-T8 (Fig.9)	Cs-134 Cs-137	1x10 ¹	4-7 times/year	MOE
	M-C1, M-C3, M-C4, M-C7, M-C8, M-C10, C-P1, C-P2, C-P3, C-P4, C-P5, C-P8 (Fig.9)		1	Once/3 months	NRA
Center of the bay	K-T1, K-T2 (Fig.9)	Cs-134 Cs-137	1	6 times/year	NRA
	M-C2, M-C5, M-C6, M-C9 (Fig.9)	Cs-134 Cs-137	1	Once/3 months	NRA

Marine biota

Monitoring is conducted for marine biota in the sea areas mainly facing to Fukushima Prefecture with reference of the previous monitoring results, as shown in the Table 11.

Table 11: Marine biota monitoring

Sea area to be monitored (See the above-described paragraph 3)	Monitoring subject	Radionuclide	Detection limit (Bq/kg wet)	Monitoring frequency	Monitoring organization
(b)	Fish and shellfish	Cs-134 Cs-137 *1	1x10 ¹	once/month	TEPCO
(b), (c) and (d)	Fishery products	Cs-134 Cs-137		once/week *2	Fisheries Agency
(b)	Marine biota including fish, shellfish and prey organisms *3	Cs-134 Cs-137 *1	1x10 ⁻³ to 1x10 ⁻²	once/3-4 months	MOE

*1: The concentration of Sr-90 is measured as necessary with the detection limit of 2x10⁻² Bq/kg of wet weight.

*2: Monitoring frequency can be changed according to the past results.

*3: Prey organisms are subject to monitoring so that the monitoring results can be used to figure out dynamics of radioactive materials in the marine.

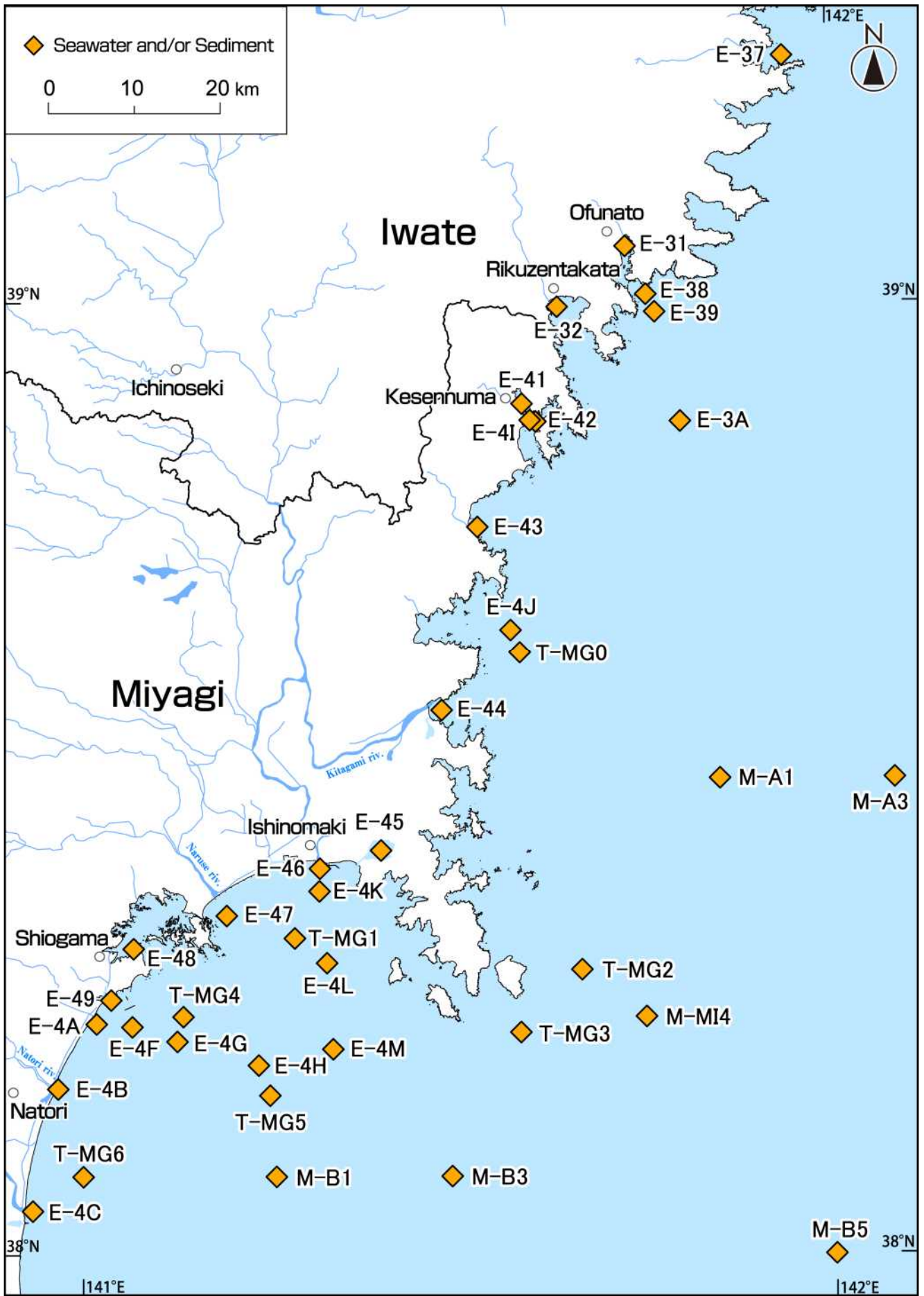


Fig. 1

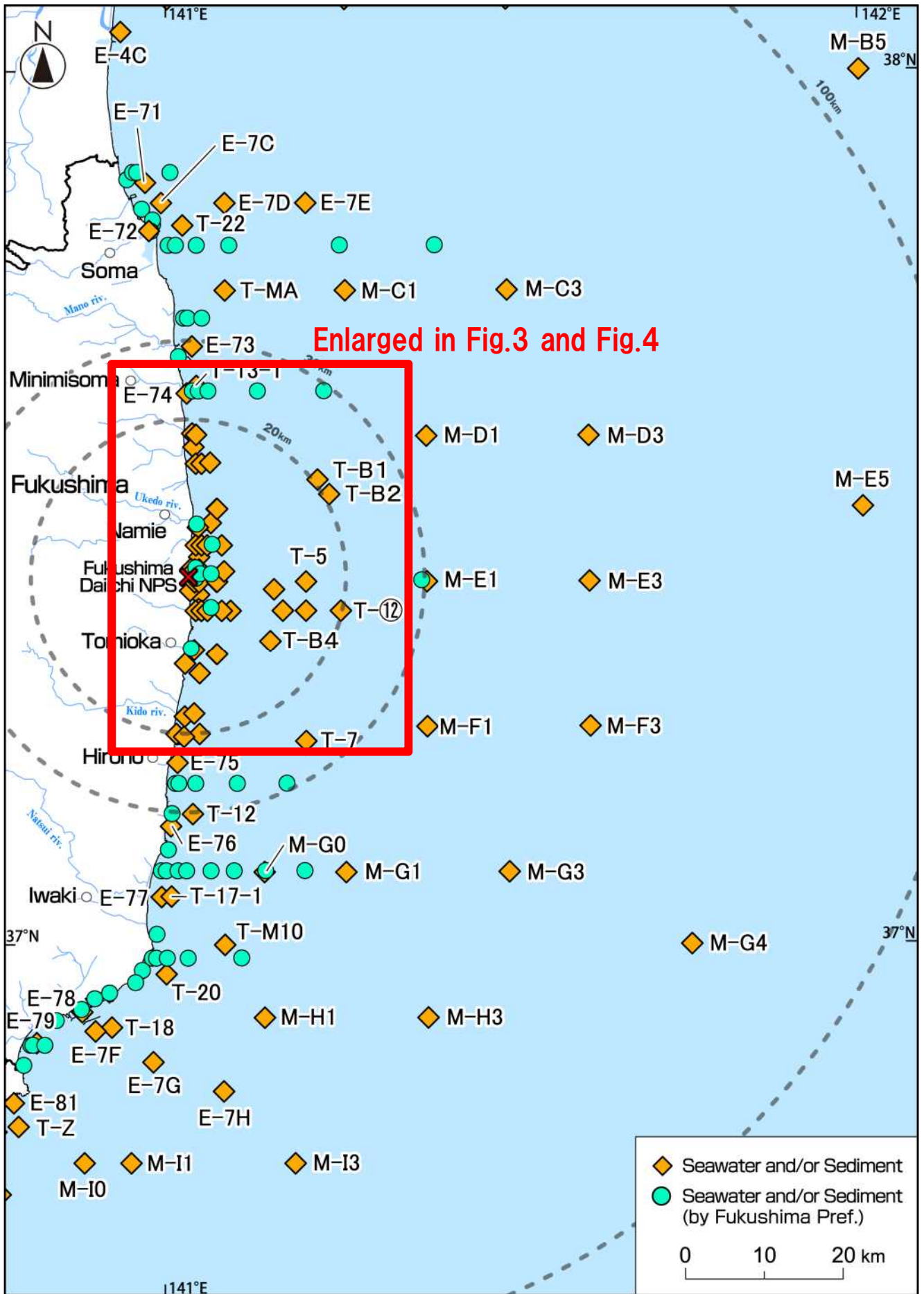


Fig.2

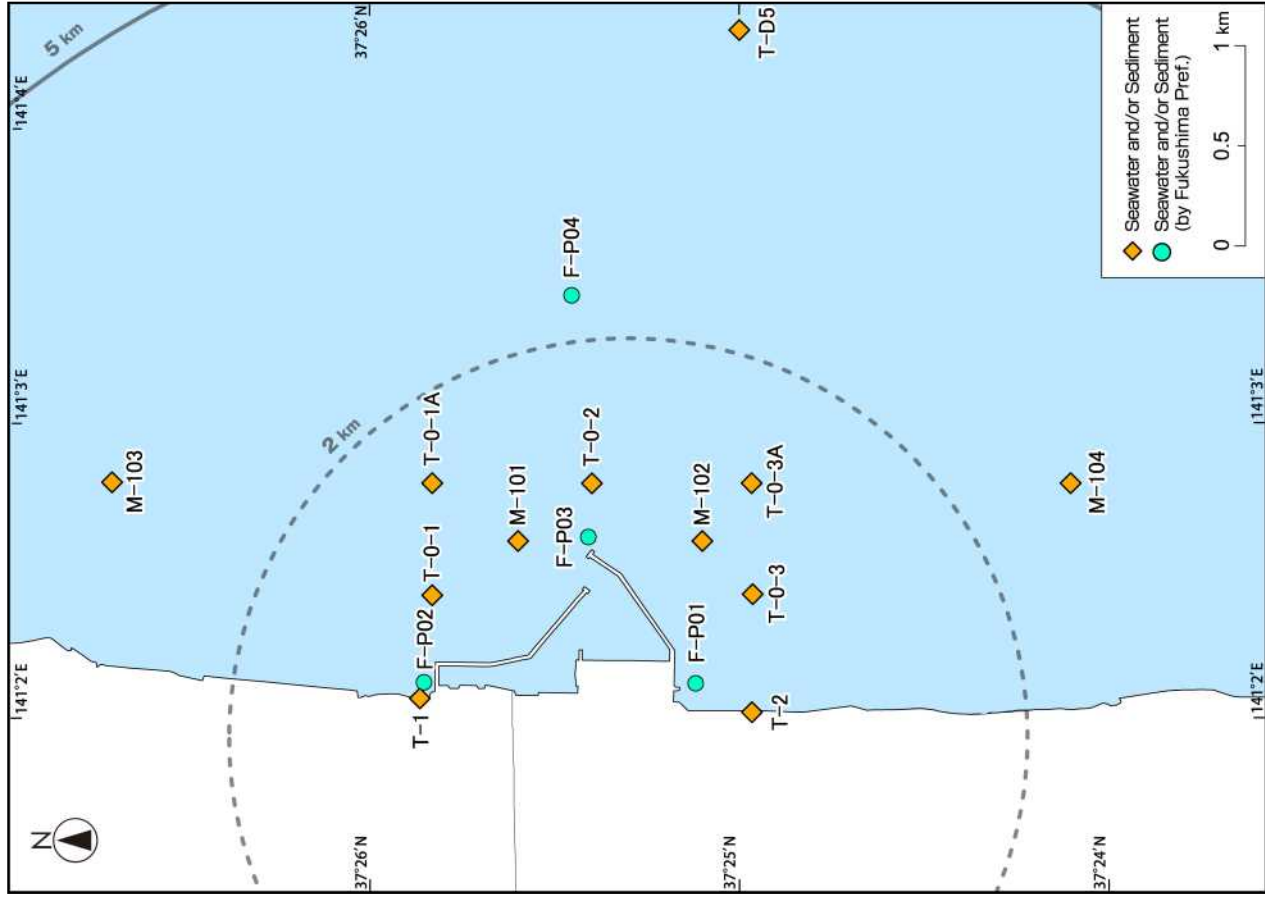


Fig.3

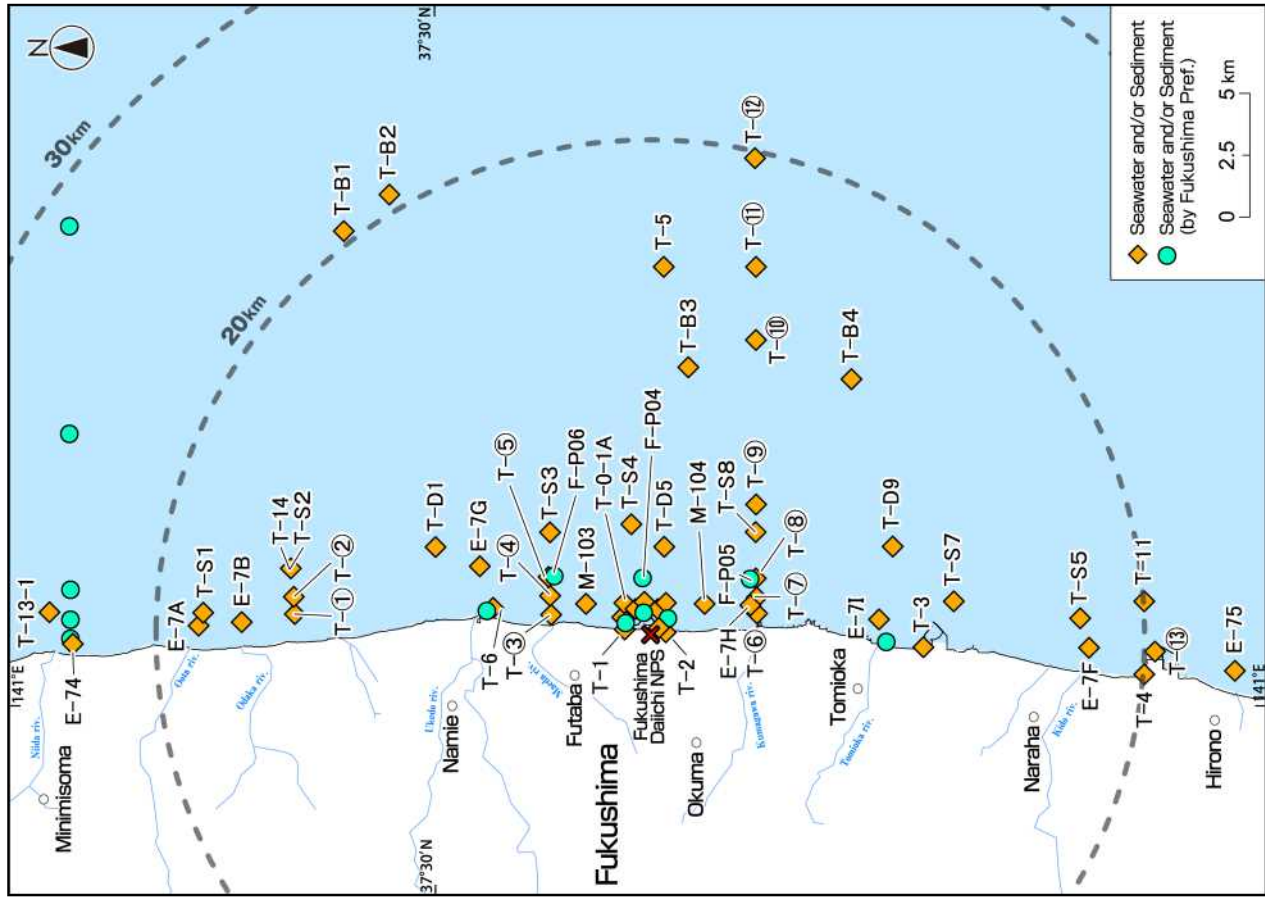


Fig.4

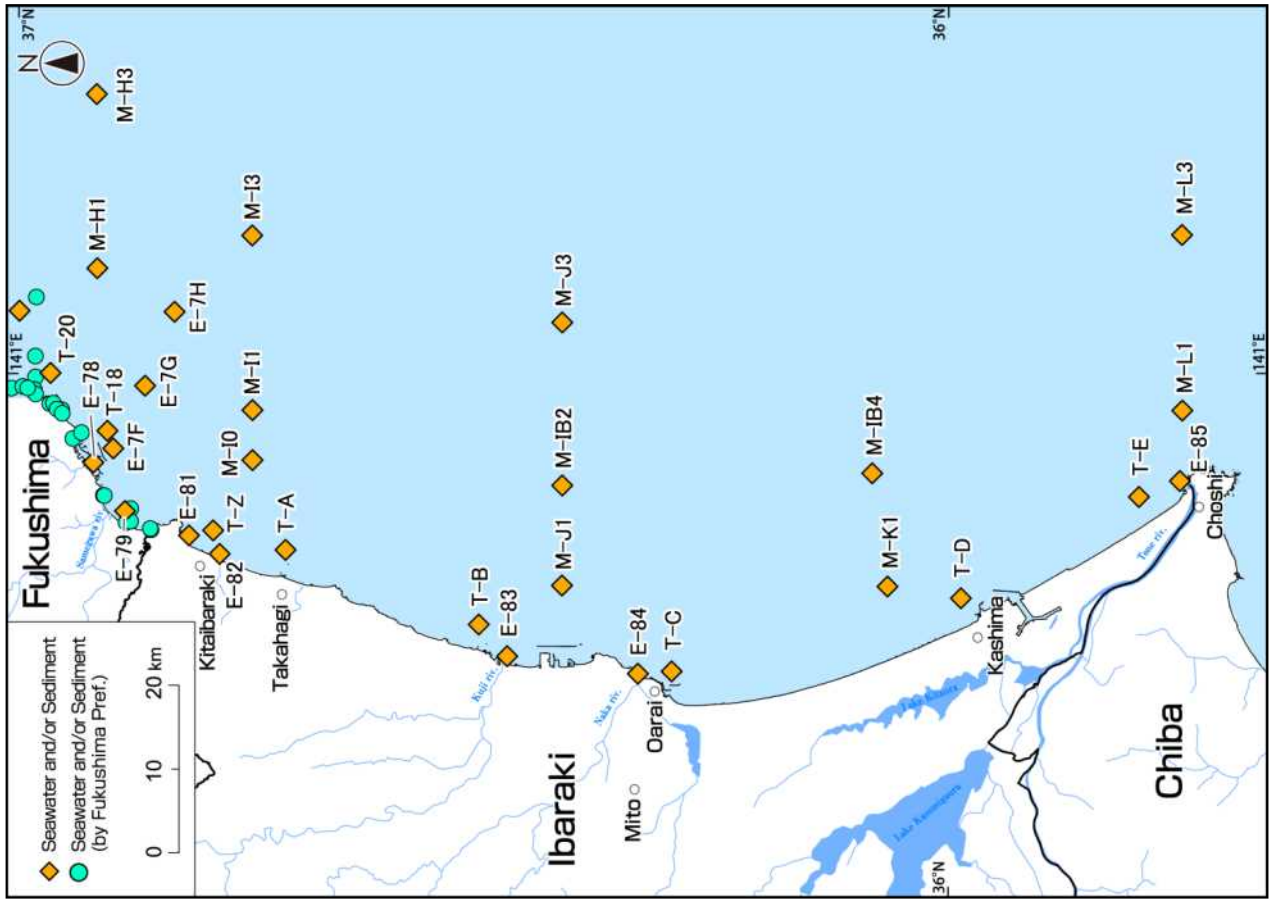


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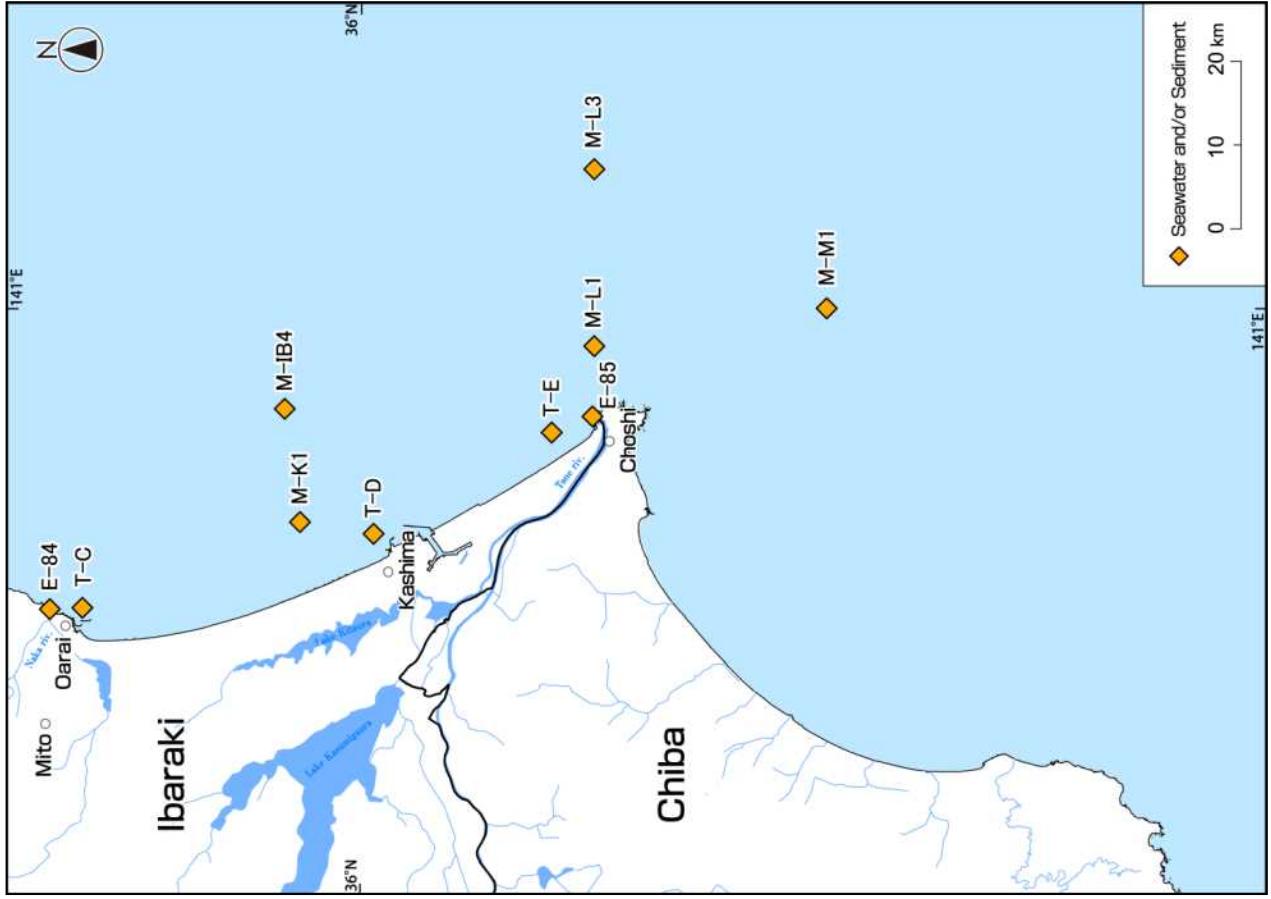


Fig.6

Outer sea area

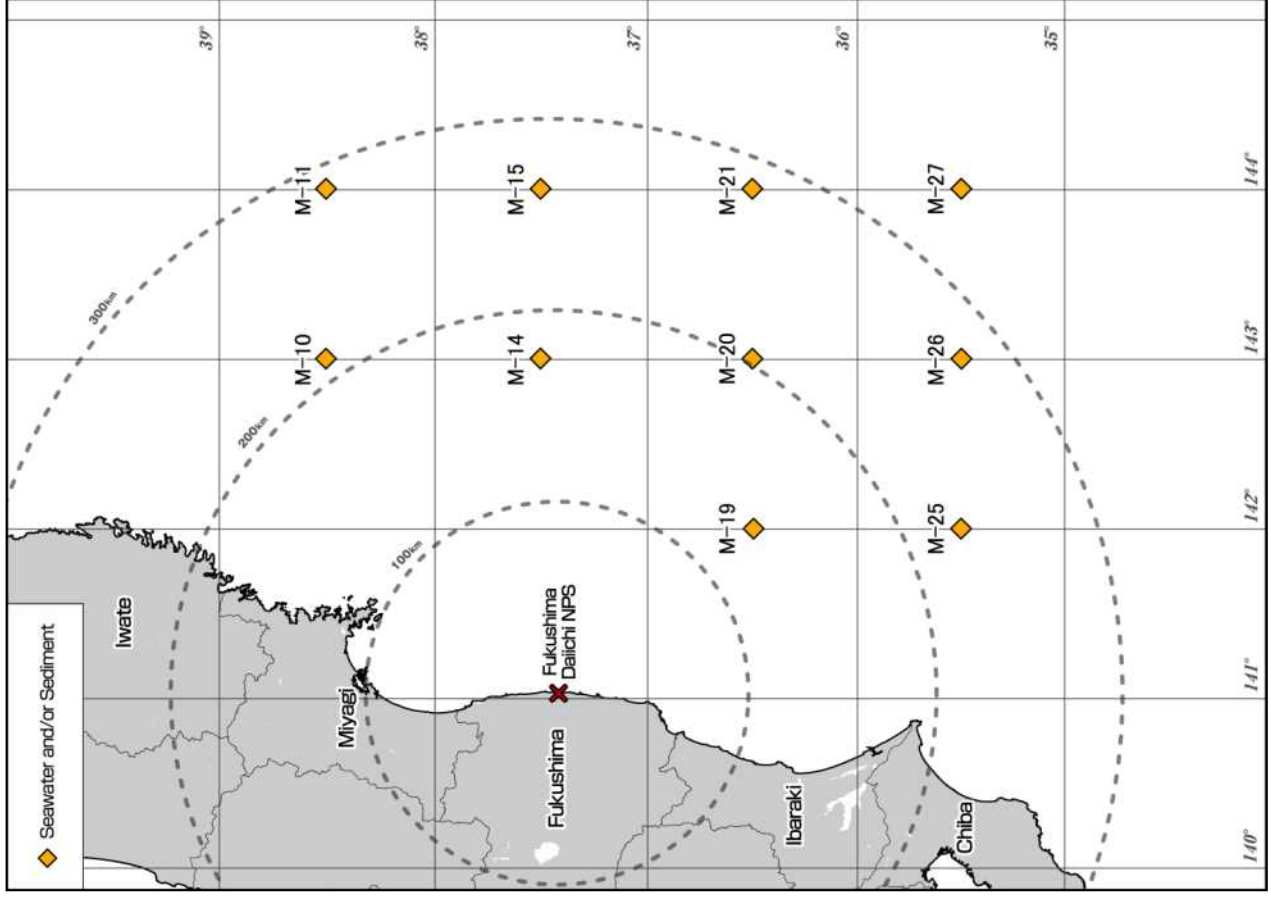


Fig. 7

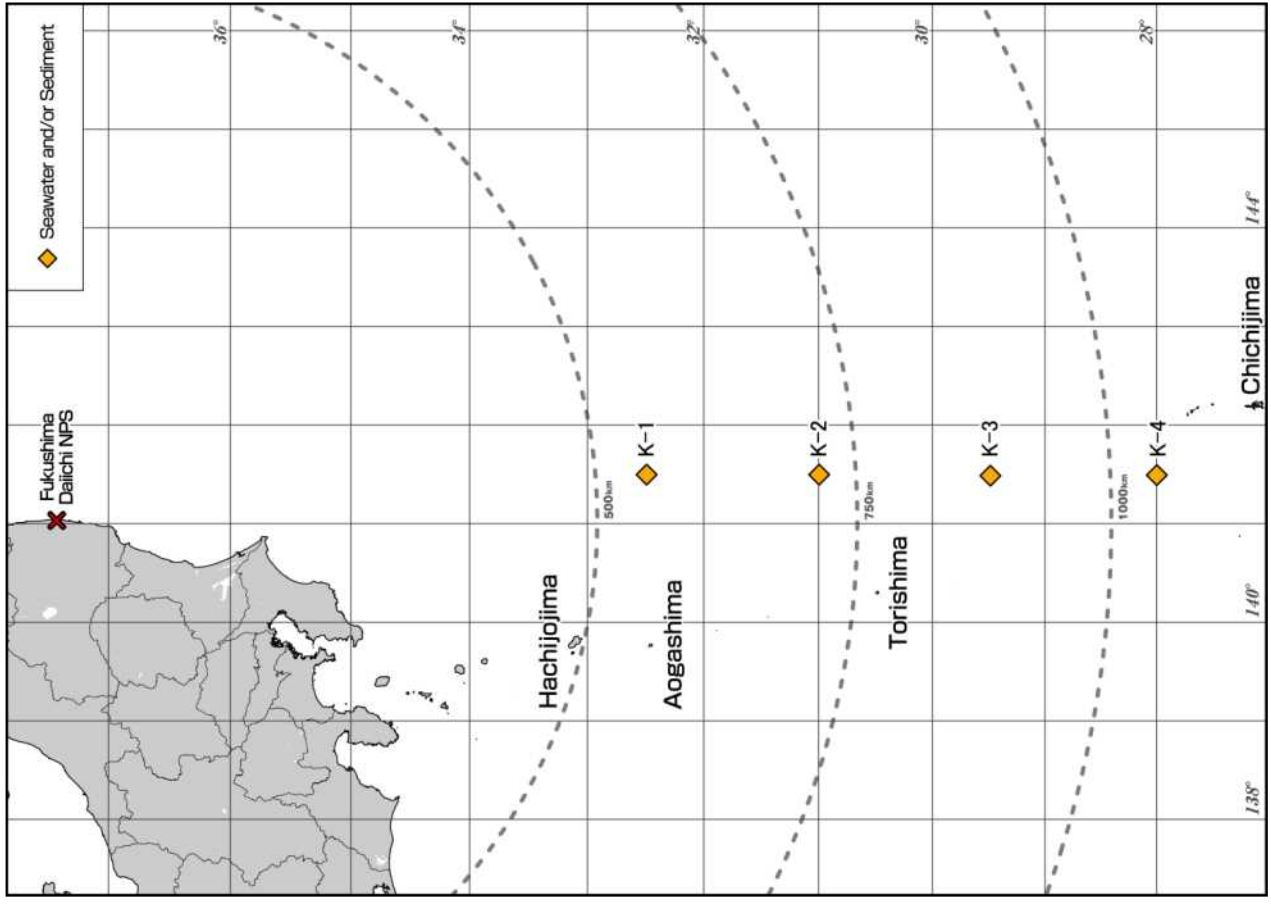


Fig. 8

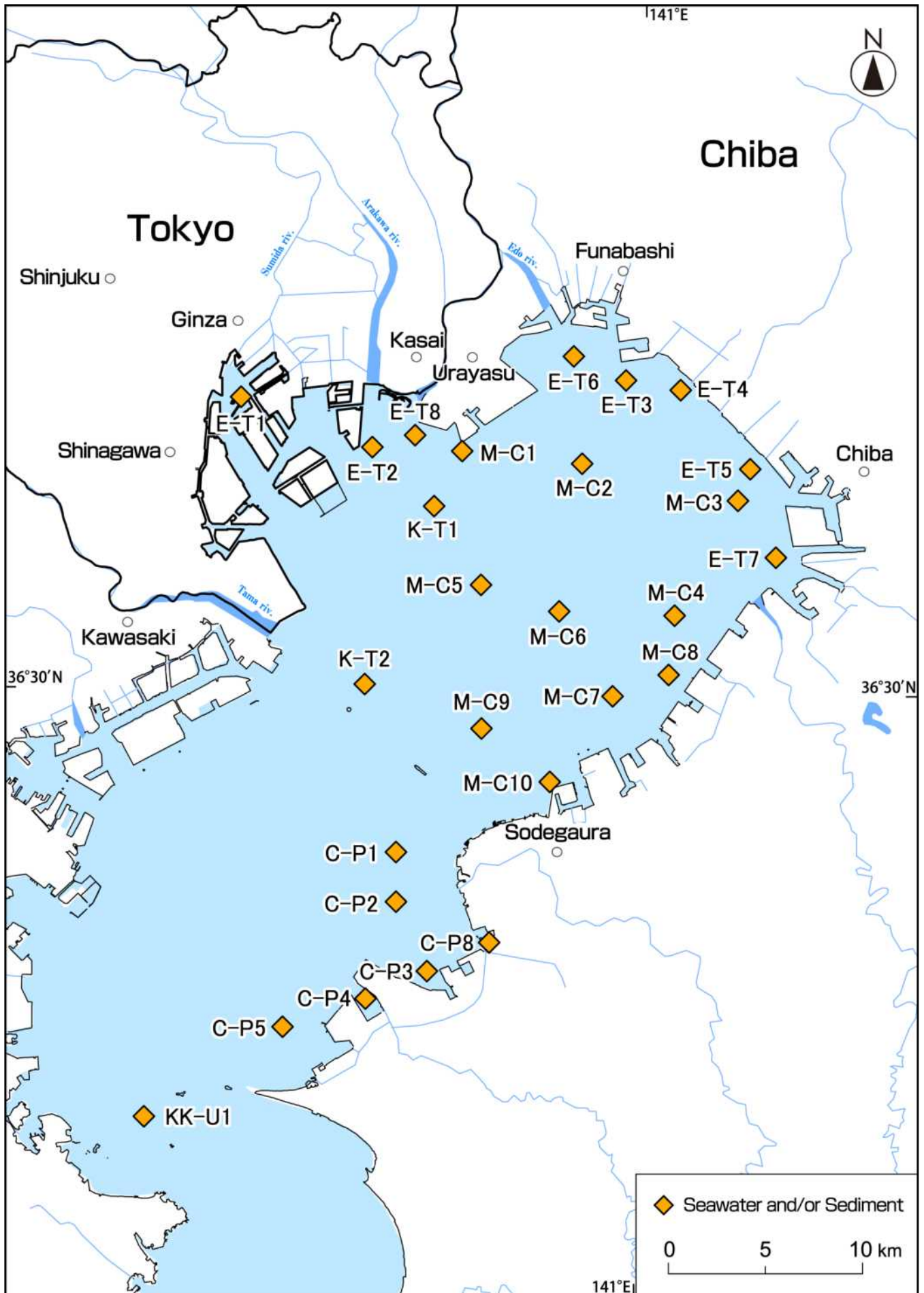


Fig.9

Sampling Points for Sea area Monitoring

