Status of Sea Area Monitoring for the Handling of ALPS Treated Water

December 22, 2022

TEPCO

Tokyo Electric Power Company Holdings, Inc.

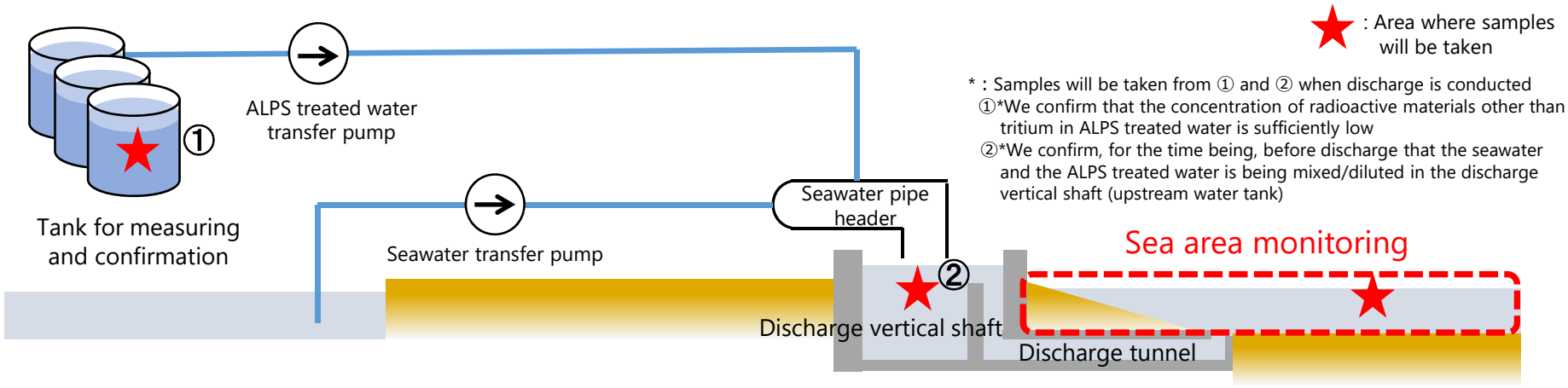
Sea area monitoring plan （1/2）

【Formulating and starting sea area monitoring plan】

○TEPCO as the organization responsible for ALPS water discharge, formulated and revised the sea area monitoring plan focusing on the area near the outlet. The plan includes an increase of sampling locations of seawater and fish for tritium near the station and at the shore of Fukushima Prefecture, and an additional measuring of seaweed for tritium and iodine 129.

(Published on March 24,2022)

○Sample gathering was started on April 20, 2022 to ascertain normal tritium concentrations and the normal state of marine organisms according to this sea area monitoring plan.



Confirming before discharge and sea area monitoring

Sea area monitoring plan （2/2）

TEPCO

【Objective of the sea area monitoring results assessment】

＜Currently＞

○ Since April 22, we have been gathering monitoring data to **ascertain the normal range for tritium concentrations** (fluctuations in concentrations of tritium in subdrain/groundwater drain treated water, groundwater bypass water, site discharge channels).

＜When treated water is discharged＞

○ We will ascertain how the seawater dispersed and the impact on marine organisms.

○ We will compare the results against sea dispersion simulation results and concentrations used in radiation impact assessments to confirm that seawater dispersion behavior and material concentrations are within the expected range.

○ If measurements exceed the normal range, we will check our measurements with other monitoring organizations and identify the cause.

○ If measurements grossly exceed the normal range *, then sea discharge will be stopped. Measurements will be taken again from the relevant location and the state of scope and frequency of monitoring will be temporarily expanded to ascertain the state of the surrounding sea area.

*：To be set based on data collected in preparation for the discharge

Sea area monitoring plan　Sampling locations（1/2）

・TEPCO increased the number of samples taken, targets to be measured, frequency of measurement for seawater, fish, and seaweed and set the detectable limit to be in line with government.

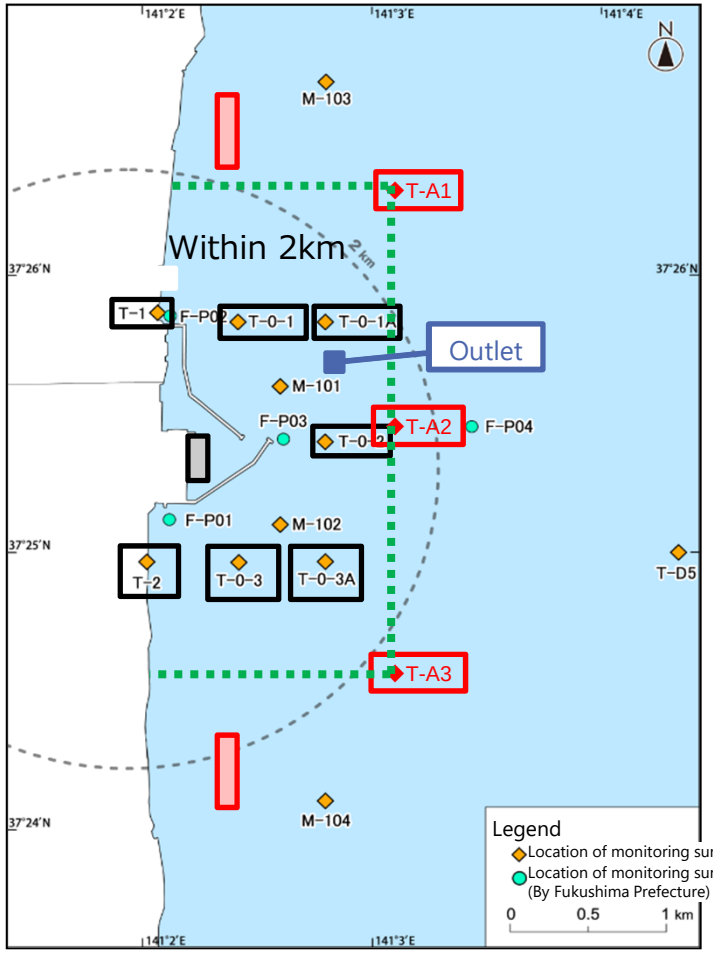


Diagram 1. Near the station (Within 2km outside the port)

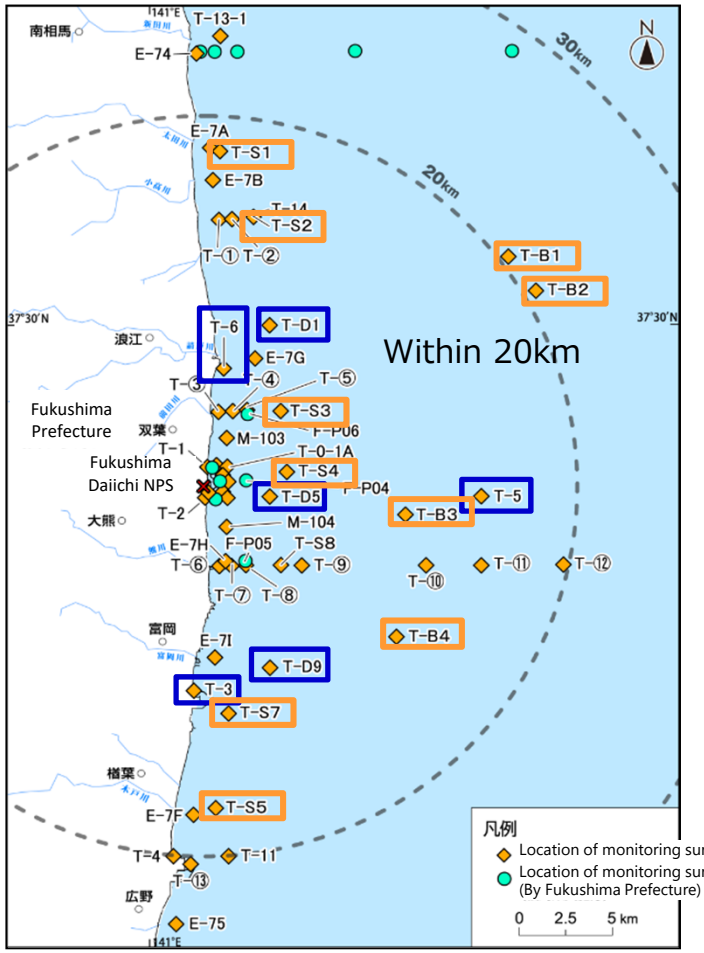


Diagram 2. Within 20km off the coast of Fukushima Prefecture

【TEPCO's sampling locations】

- : Locations where the detectable limit is being revised (seawater)
- : New sampling locations (seawater)
- : Locations at which sampling frequency will be increased (seawater)
- : Locations at which tritium will be measured in addition to cesium (fish, seaweed)
- : Locations with no change (Seaweed)
- : New sampling locations (Seaweed)
- : Areas where no fishing is being conducted on a daily basis ※
  1.5km (East to West), 3.5 km (South to North)

※：Area where common fishery rights are not set

※On Diagram 1, notation and location of T-A1, T-A2 and T-3 was revised from the sea area monitoring plan published on March 24,2022 to be consistent with the Comprehensive Monitoring Plan

Sea area monitoring plan　Sampling locations（2/2）

・TEPCO increased the number of samples taken for tritium in regards to seawater.

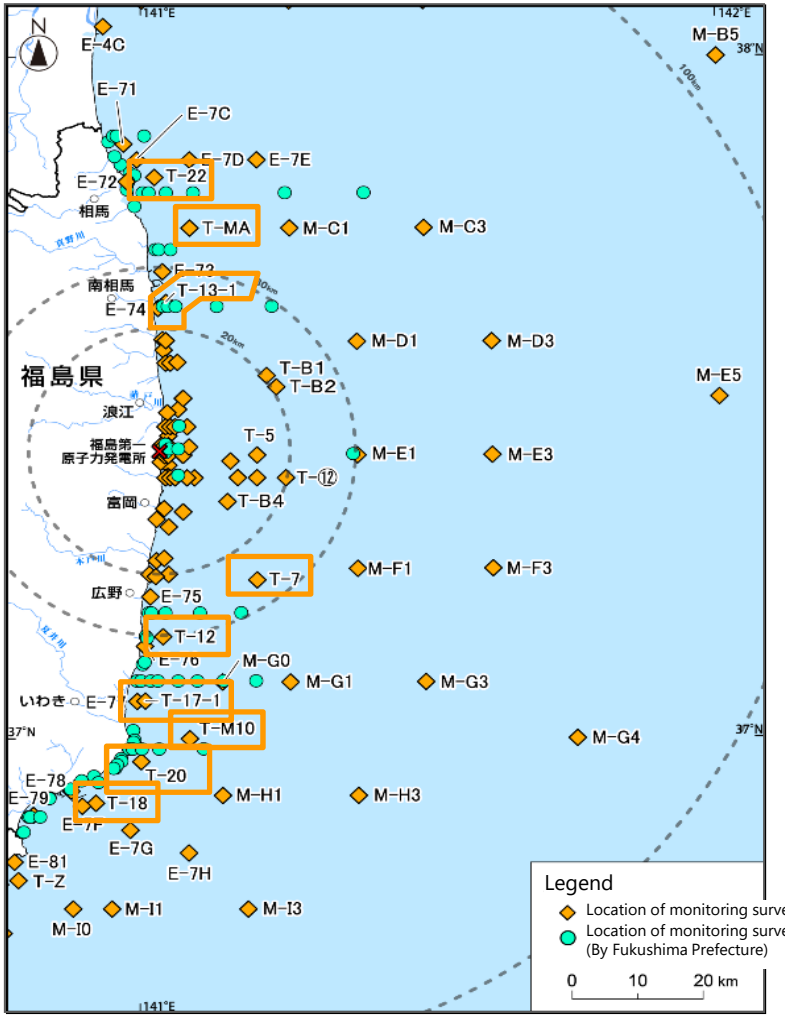


Diagram 3. Outside 20km off the coast of Fukushima Prefecture

【 TEPCO's sampling locations 】

：Locations at which tritium will be measured in addition to cesium (seawater)

State of sea area monitoring results (1/2)

【State of seawater】

＜Within 2 km outside the port＞

◯ Tritium concentrations have remained constant for the past year. Values for new measurement points have also been at low levels of the normal range* for seawater across Japan.

◯ While there were temporary increases in cesium 137 concentrations presumably due to rainfall which has been the cause of the fluctuations in concentrations around the Fukushima Daiichi NPS in the past as well, concentrations have remained constant in the past year. Values for new measurement points have also been at low levels of the normal range* for seawater across Japan.

◯ Since April 18, tritium has been monitored using a lower detection threshold.

＜Within 20 km off the coast＞

◯ Tritium and Cesium 137 concentrations have remained constant for the past year, and values have been at low levels of the normal range* for seawater across Japan.

＜Outside 20 km off the coast＞

◯ Tritium concentrations observed at the new measurement point have also been at low levels within the normal fluctuation range* for seawater across Japan. Cesium 137 concentrations have remained constant for the past year, and values have also been at low levels of the normal range* for seawater across Japan.

＊：Range of values recorded for April 2019 to March 2021 in the following database.

Across Japan (including the sea off the coast of Fukushima Prefecture)

Tritium concentration： 0.043 Bq/L ～ 20 Bq/L

Cesium 137 concentration ： 0.0010 Bq/L ～ 0.45 Bq/L

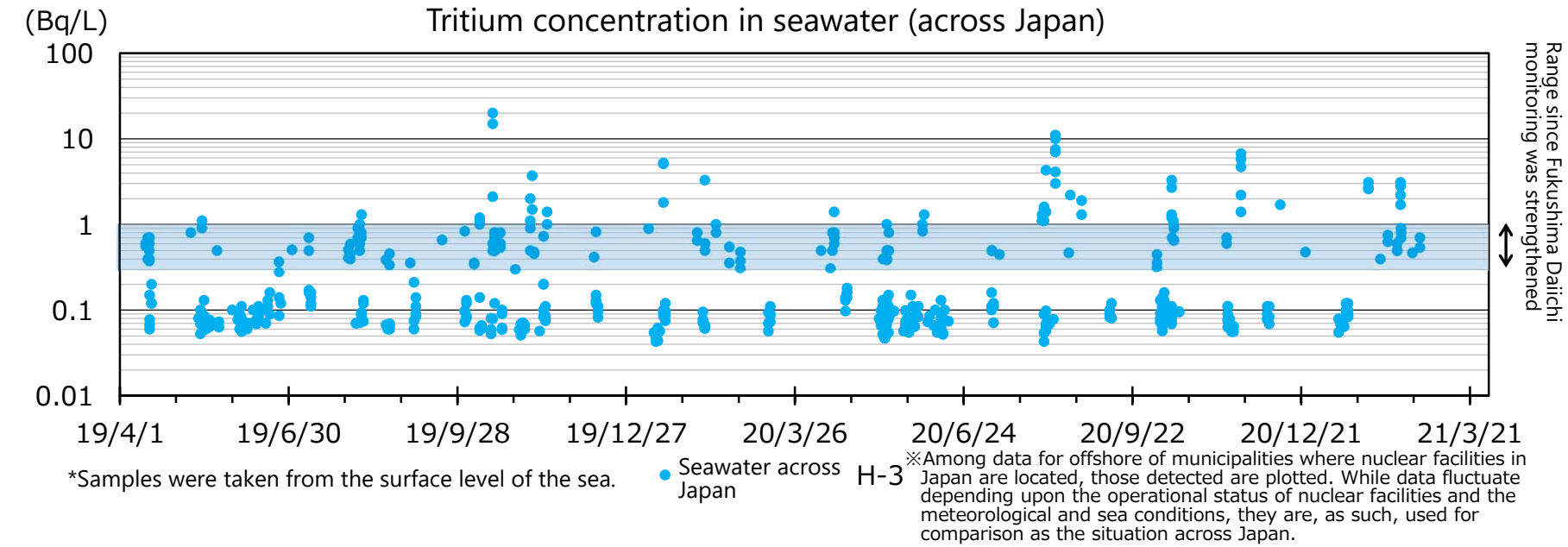
Sea off the coast of Fukushima Prefecture

Tritium concentration： 0.043 Bq/L ～ 2.2 Bq/L

Cesium 137 concentration ： 0.0010 Bq/L ～ 0.45 Bq/L

Source: Environmental Radiation Database, Environmental Radioactivity and Radiation in Japan
https://www.kankyo-hoshano.go.jp/data/database/ (only in Japanese)

Range of tritium and cesium 137 concentrations in seawater across Japan

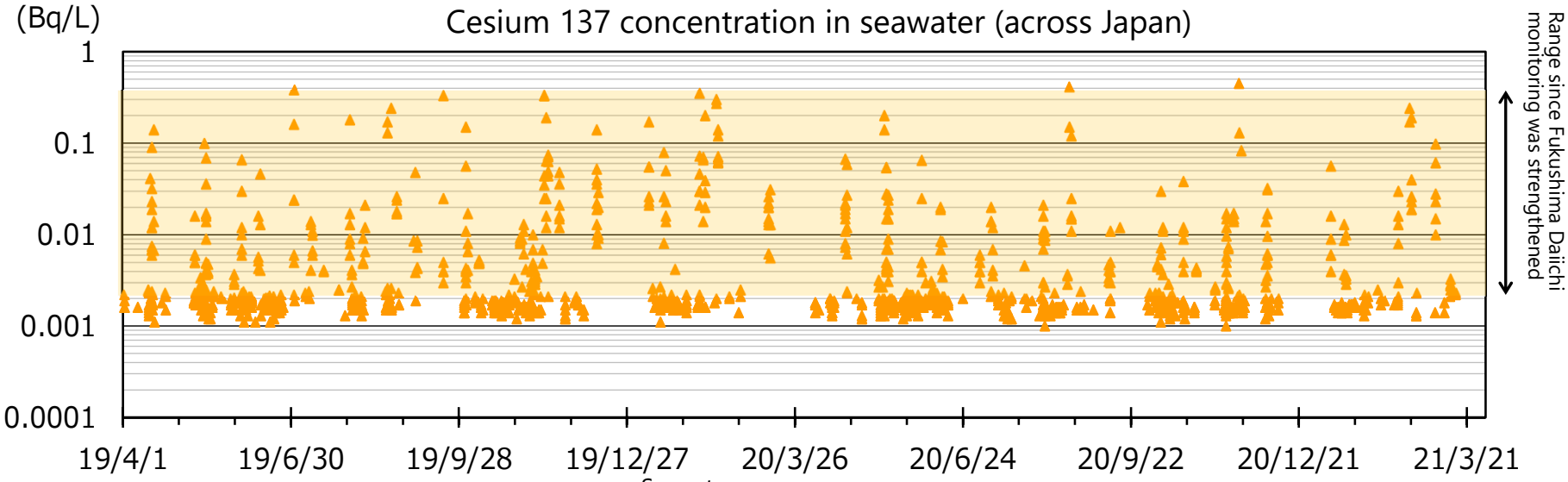


*Samples were taken from the surface level of the sea.

● Seawater across Japan

H-3

※Among data for offshore of municipalities where nuclear facilities in Japan are located, those detected are plotted. While data fluctuate depending upon the operational status of nuclear facilities and the meteorological and sea conditions, they are, as such, used for comparison as the situation across Japan.



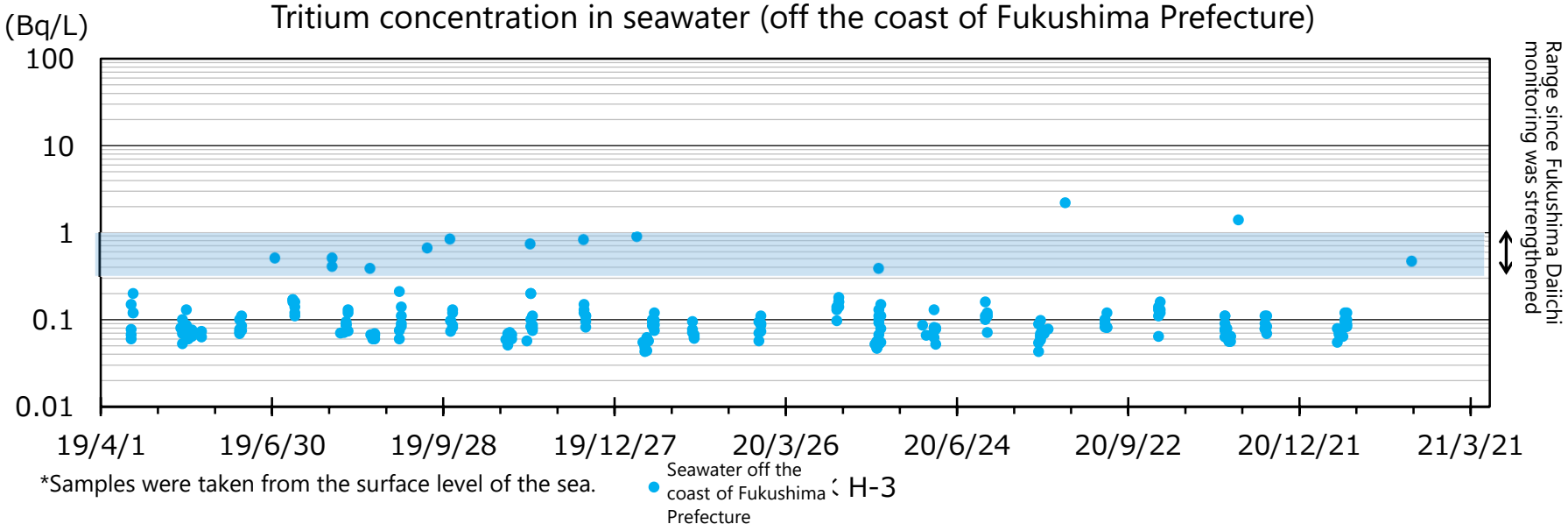
*Samples were taken from the surface level of the sea.

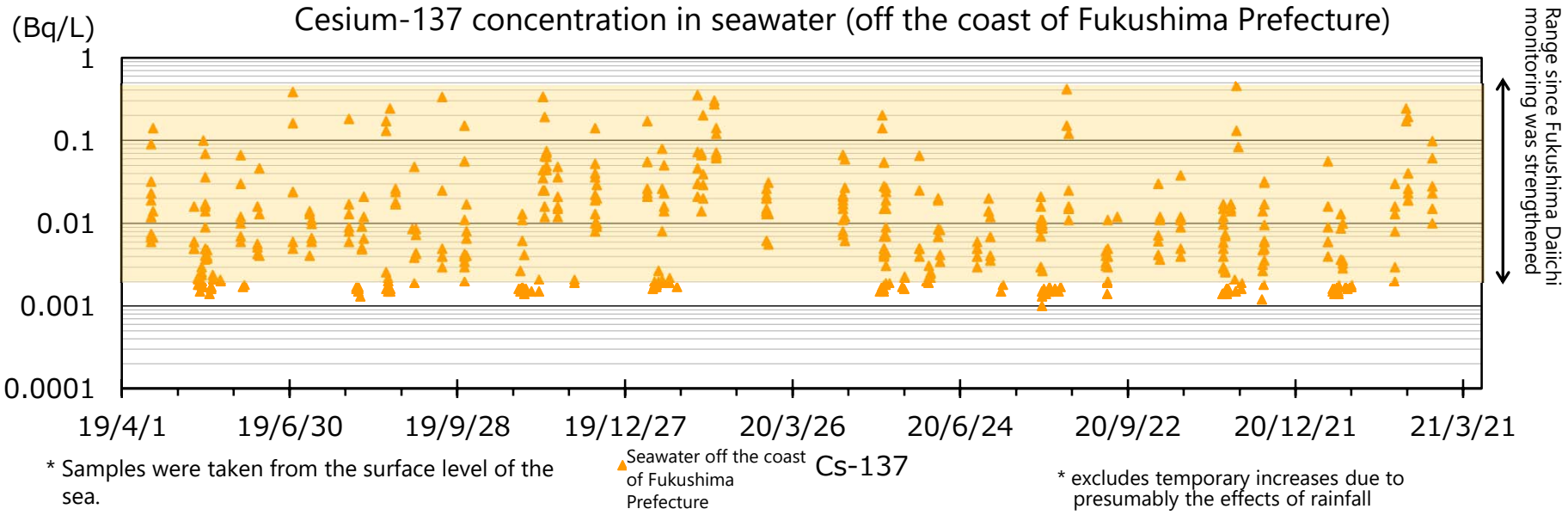
▲ Seawater across Japan

Cs-137

* excludes temporary increases due to presumably the effects of rainfall

Range of tritium and cesium 137 concentrations in seawater off the coast of Fukushima Prefecture





State of sea area monitoring results (2/2)

【State of fish and seaweed】

The concentration of tritium observed in fish sampled at sampling point T-S8 has not changed in the past year. Overall, the tritium concentration in fish sampled at sampling points including those taken at new points whose analysis values have been verified, are fairly stable at such a level as low as the range observed in fish across Japan*. The remaining data for fish is being confirmed, as well as data for seaweed.

＊：Range of values recorded for April 2019 to March 2021 in the following database.

Across Japan（including off the coast of Fukushima Prefecture)

Tritium concentration (tissue free water) ： 0.064 Bq/L ～ 0.12 Bq/L

Source: Environmental radiation database, Environmental radioactivity and radiation for Japan, https://www.kankyo-hoshano.go.jp/data/database/

(Reference) Verification of fish tritium analysis values

The tritium analysis value for fish sampled from the new sampling point was found to be higher than the tritium concentration of the surrounding seawater. To identify the cause of the phenomenon, analysis was suspended in August and the differences in analysis methods employed by each analysis institution were investigated. Measurement devices, impurities (organic material) and chemical reactions were identified and verified as potential causes that could have affected analysis values. Analysis procedures in the analysis institution outside the plant were reviewed and analysis restarted in October.

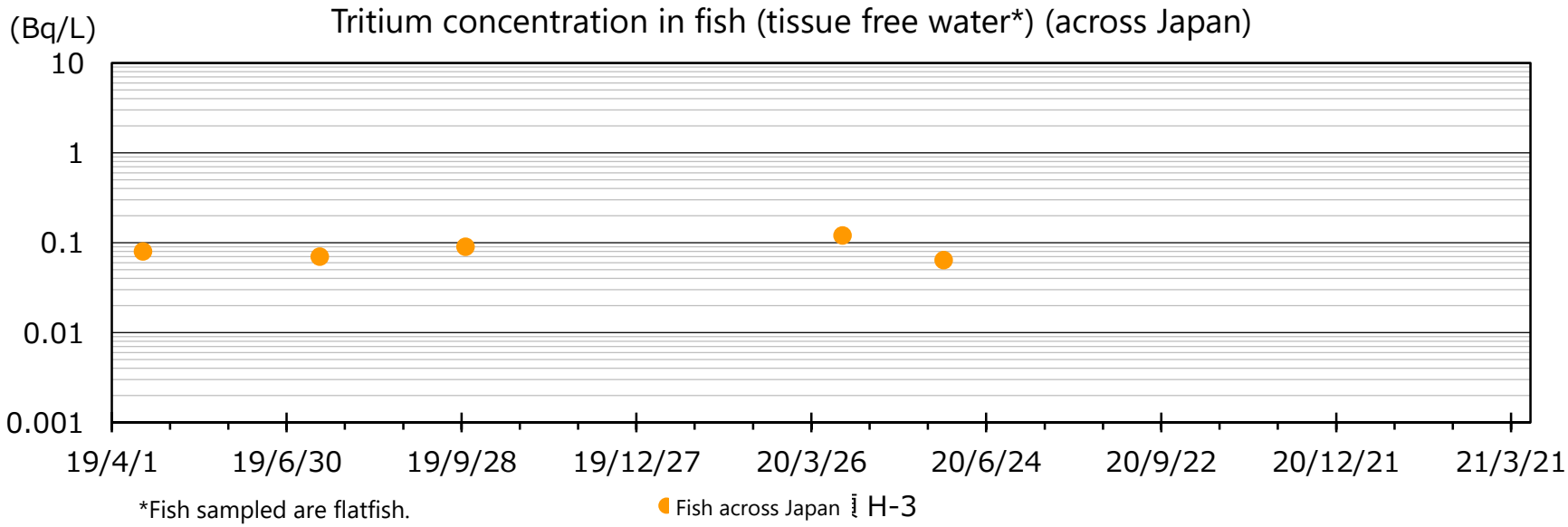
＜Potential causes that could have affected analysis results, and results of the verification of the potential causes＞

- Verified that the difference in measurement devices had not affected analysis results
- Verified that the chemical reaction to remove impurities was not sufficient
- Verified that the resting time to remove the chemical reaction may have not been sufficient

The impurity removal method used in in-plant analysis will continue to be reviewed, and any possibility that the higher tritium levels are coming from tritium in the ambient NPS environment mixing into the sampled fish will be examined as well. Until the investigation is complete, the samples that were to be analyzed on station premises are being analyzed in institutions outside of the plant.

※Excerpt from Document 3-1 at the 104th meeting of Supervision and Evaluation Committee for Specified Nuclear Facilities

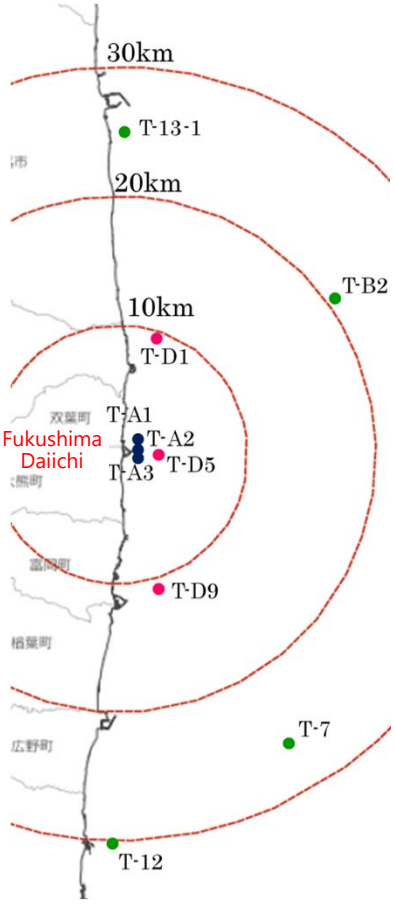
Range of tritium concentration in fish across Japan



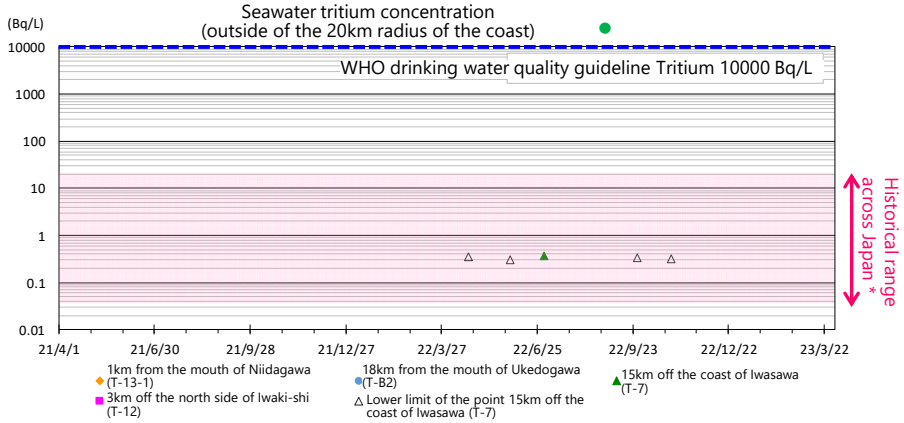
* : Tissue-free water tritium is tritium that exists in the tissue of animals and plants as water and is excreted from the tissue as water.

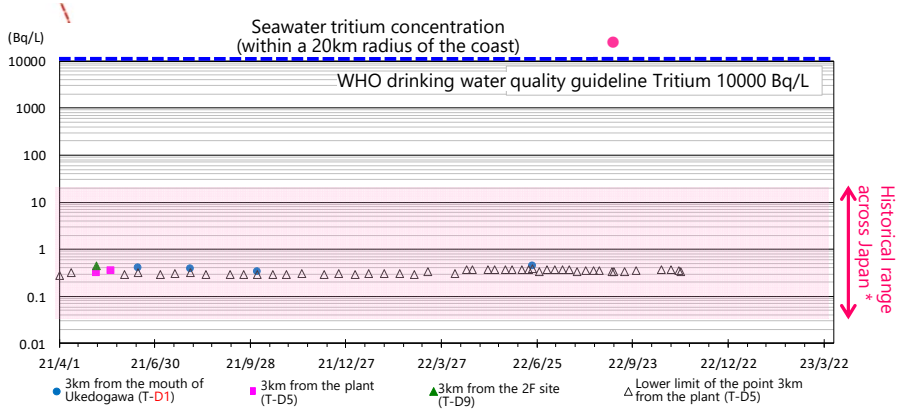
Source: Environmental radiation database, Environmental radioactivity and radiation for Japan

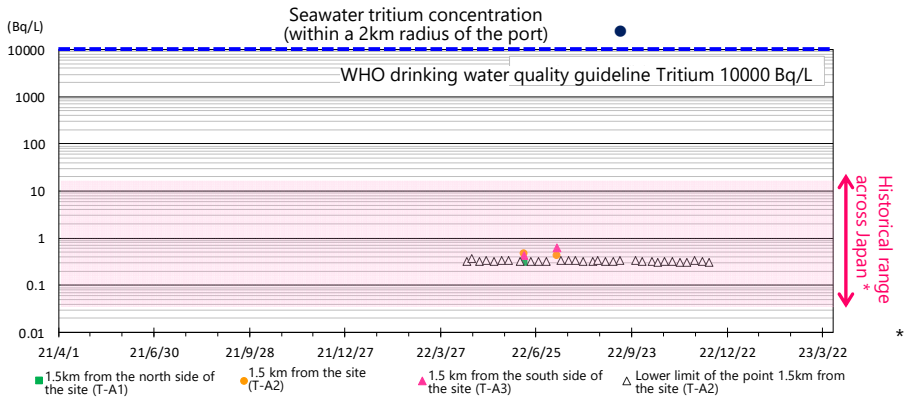
Trends in tritium concentration in seawater (1/4)



※Created based on the maps from Geospatial Information Authority of Japan







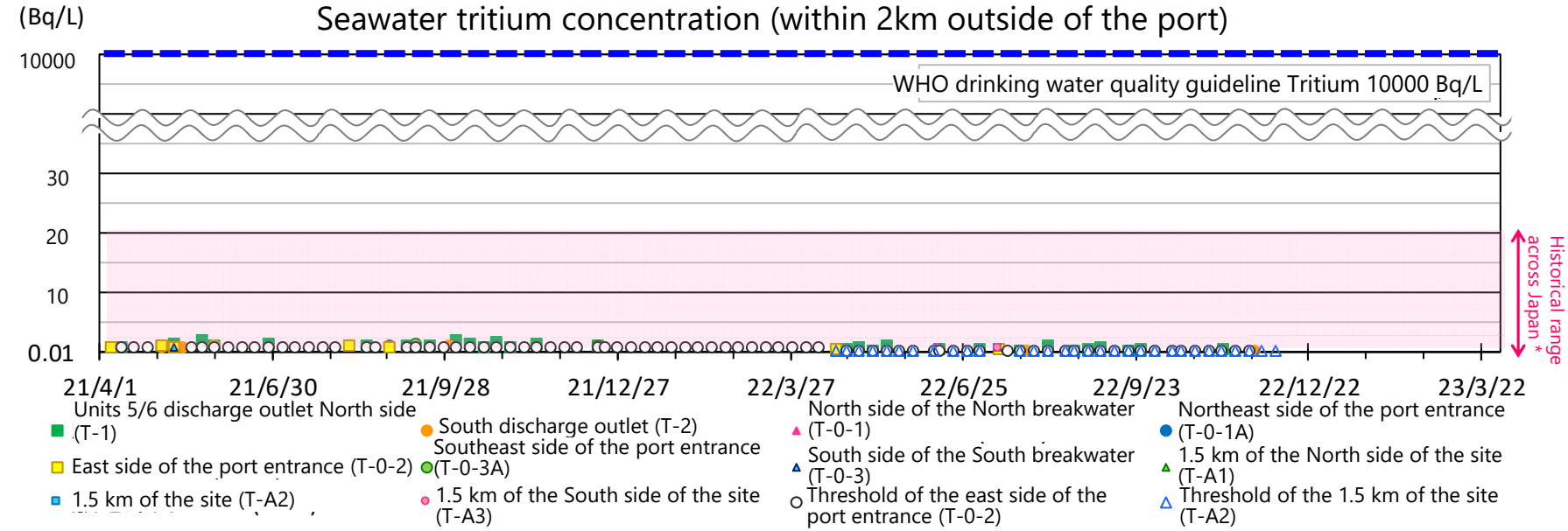
○ There is a sea current running in the South to North direction off the coast from the station. As such, three to four sampling points were chosen to be symmetrical on the East-West axis with the plant as the center and Tritium concentration is plotted.

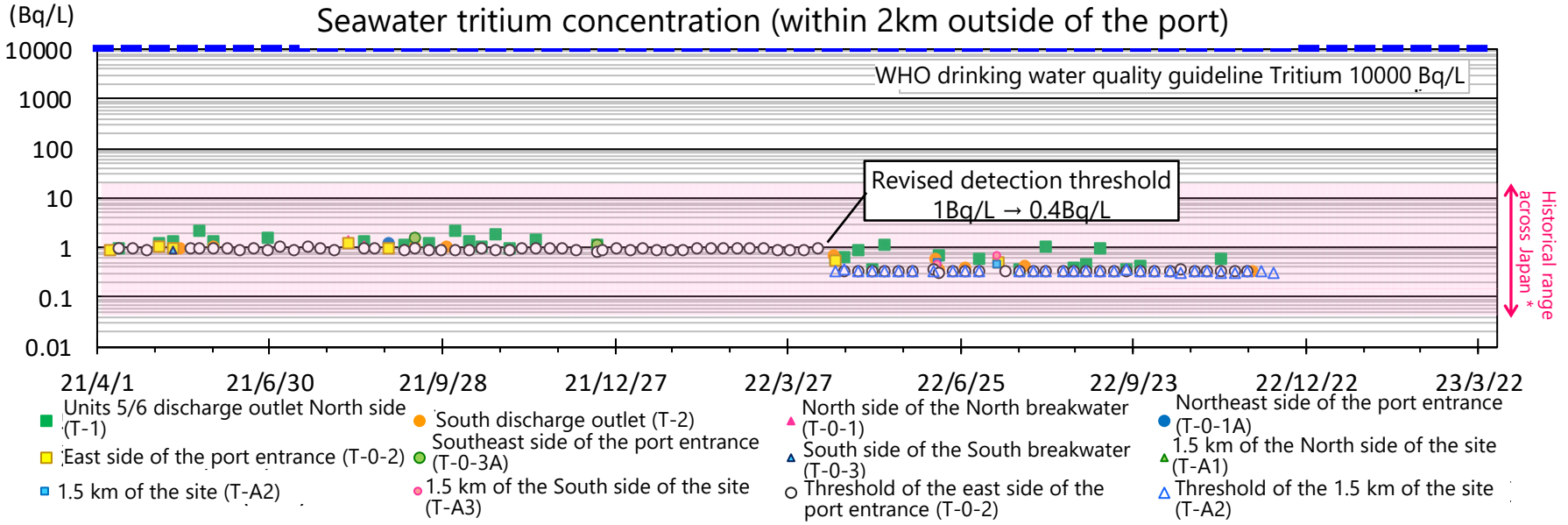
○ Measurement values have remained stable in the last year and the tritium concentrations observed at the new measurement points have been fairly stable at low levels within the normal fluctuation range* for seawater across Japan.

○ See the graphs on the next slide onwards for trends for each sampling point.

*：Range of values recorded for April 2019 to March 2021
Tritium concentration: 0.043 Bq/L ～ 20 Bq/L

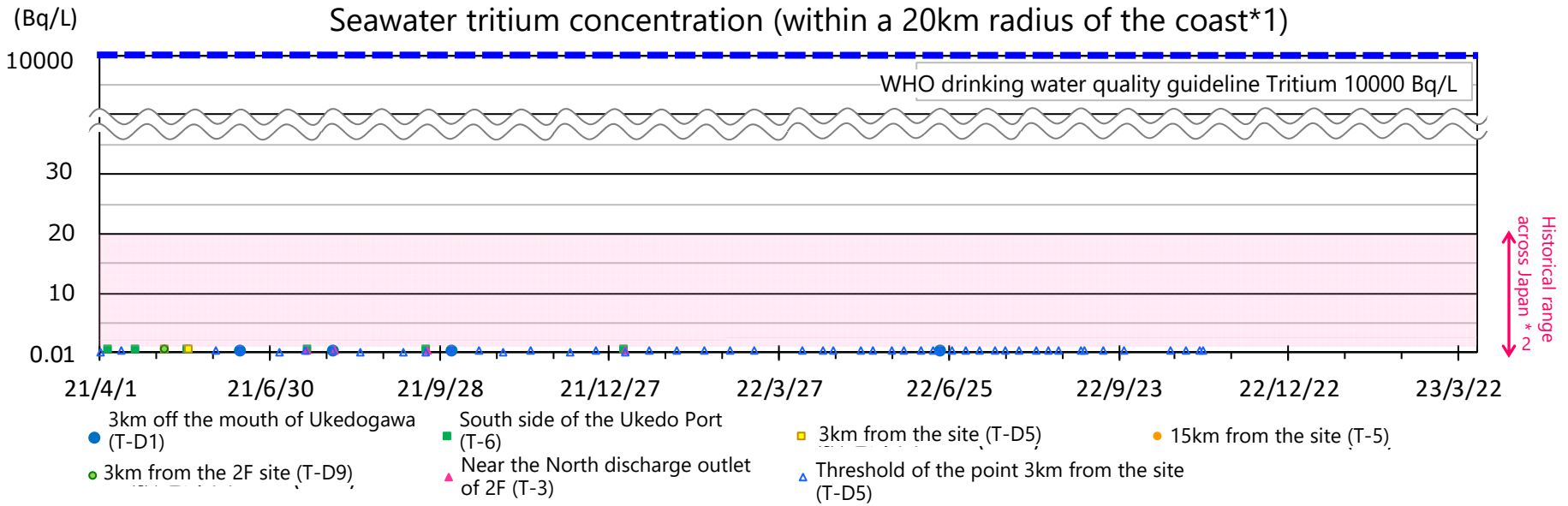
Trends in tritium concentration in seawater (2/4)

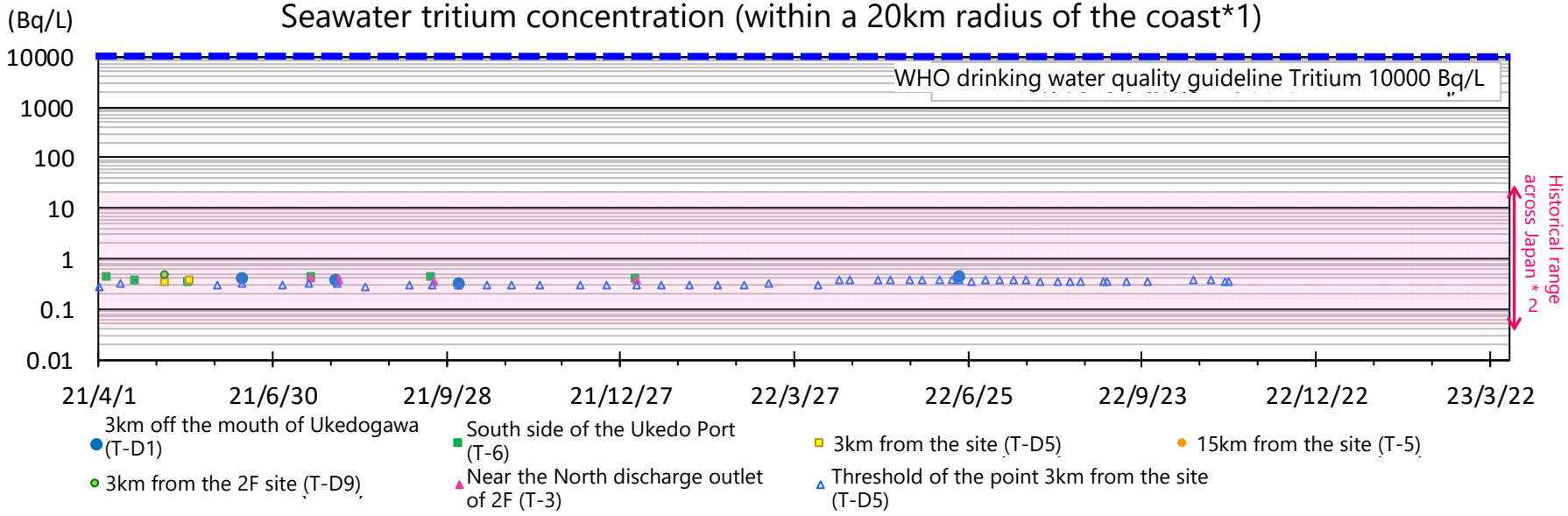




* : Range of values recorded for April 2019 to March 2021 Tritium concentration 0.043 Bq/L ～ 20 Bq/L

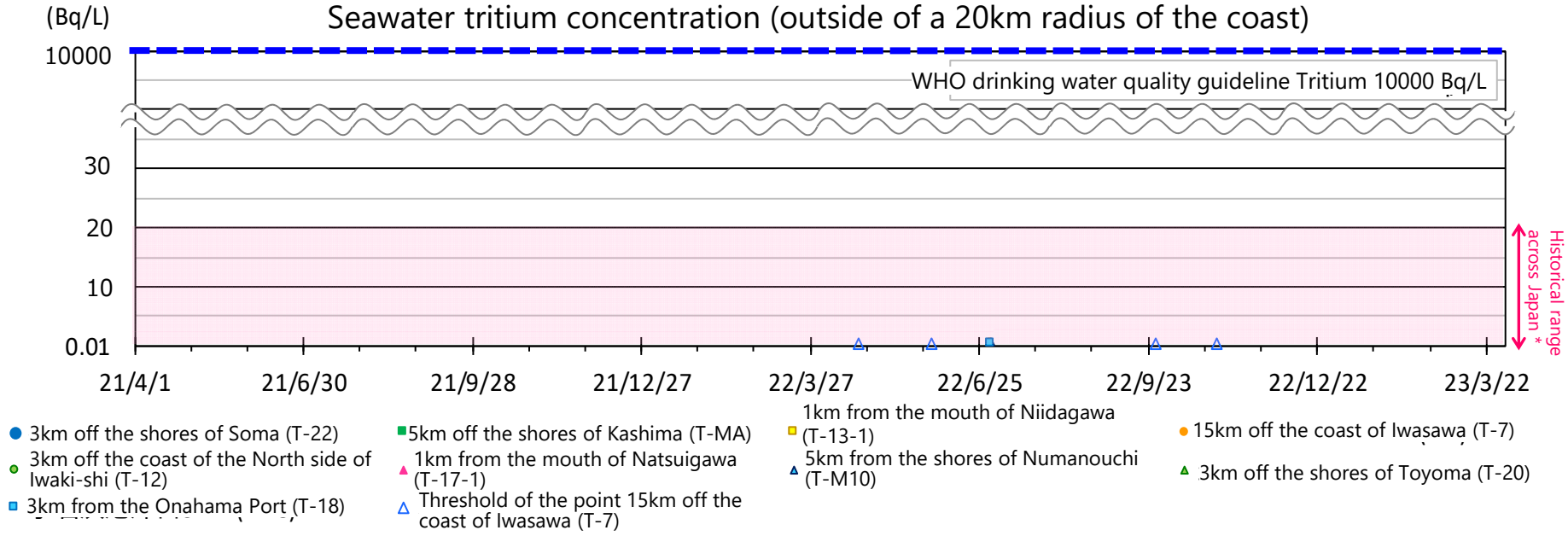
Trends in tritium concentration in seawater (3/4)

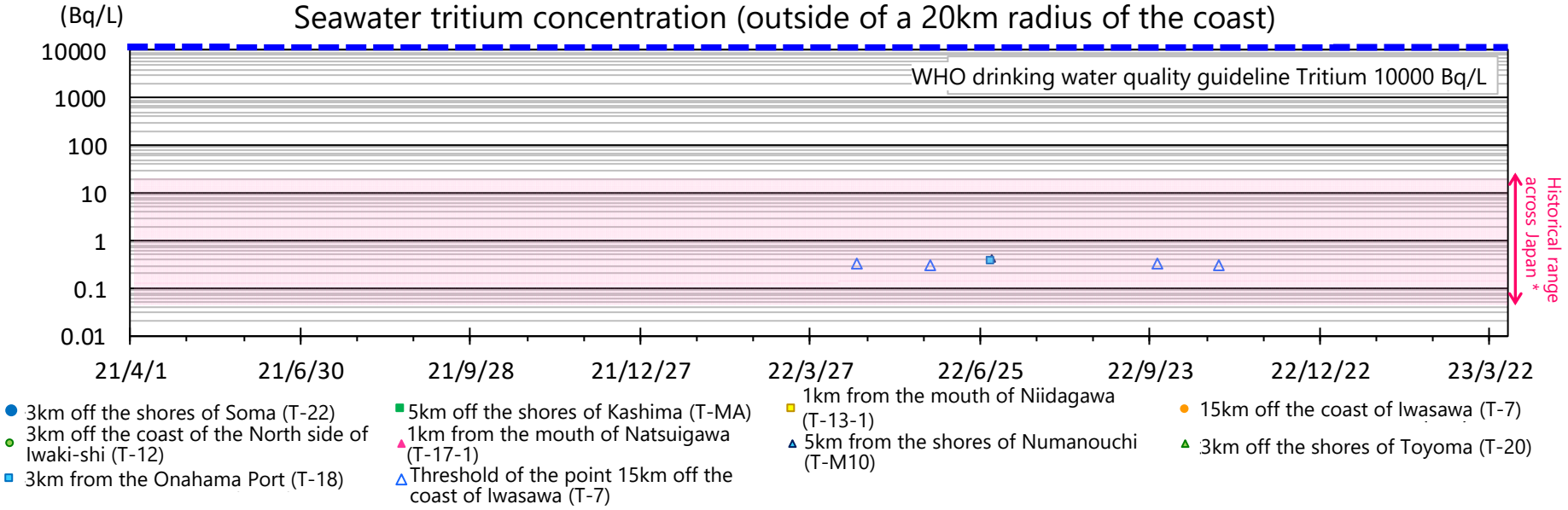




*1 : The seawater tritium concentration for the fish sampling points within a 20km radius of the coast is shown in p.21
*2 : Range of values recorded for April 2019 to March 2021 Tritium concentration 0.043 Bq/L ～ 20 Bq/L

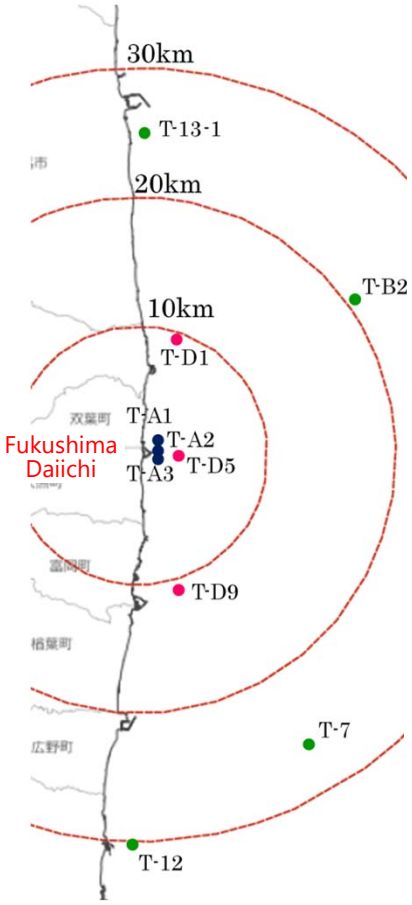
Trends in tritium concentration in seawater (4/4)



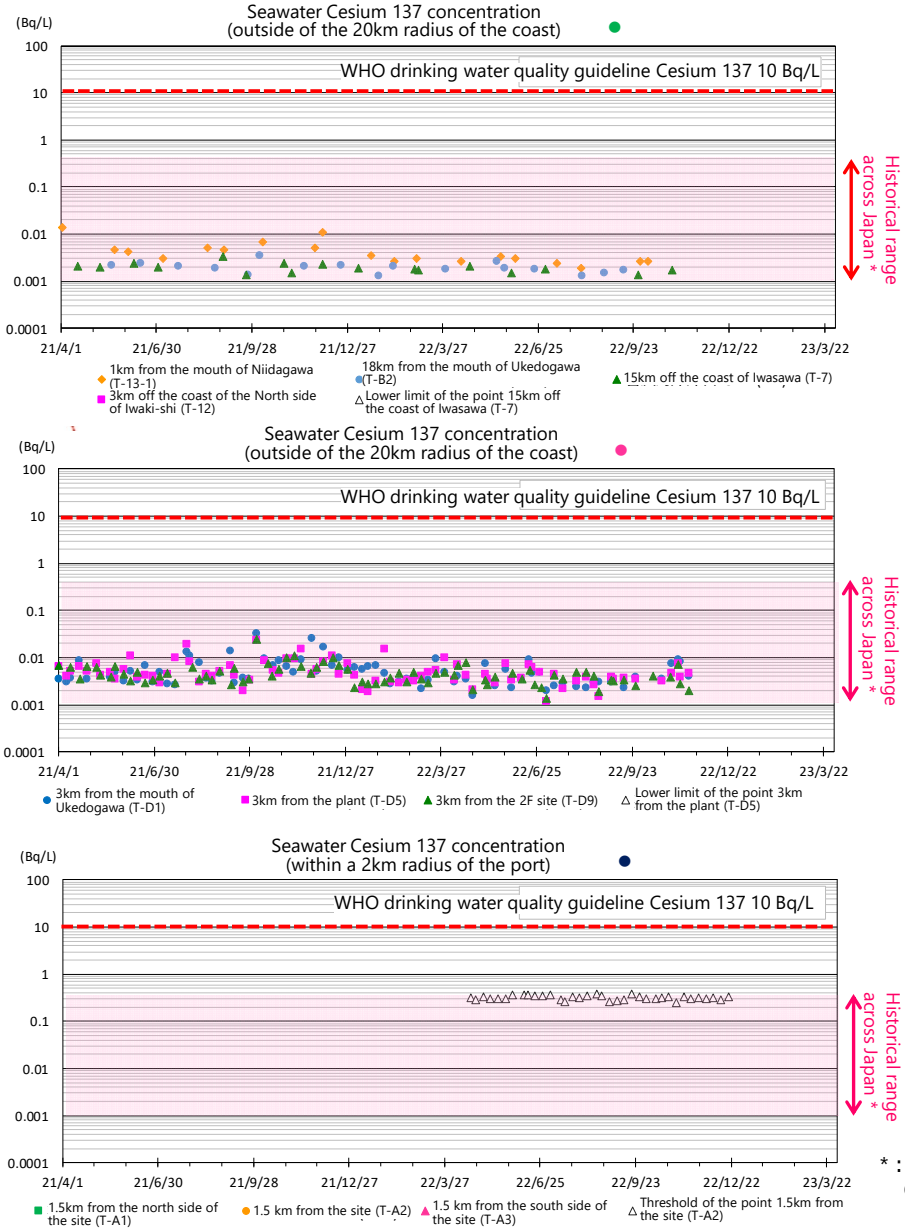


*：Range of values recorded for April 2019 to March 2021　Tritium concentration 0.043 Bq/L ～ 20 Bq/L

Trends in Cesium 137 concentration in seawater (1/4)



※ Created based on the maps from Geospatial Information Authority of Japan



○ There is a sea current running in the South to North direction off the coast from the station. As such, three to four sampling points were chosen to be symmetrical on the East-West axis with the plant as the center and Cesium 137 concentration is plotted.

○ Measurement values have remained stable in the last year and the concentrations observed at the new measurement points have been fairly stable at low levels within the normal fluctuation range* for seawater across Japan.

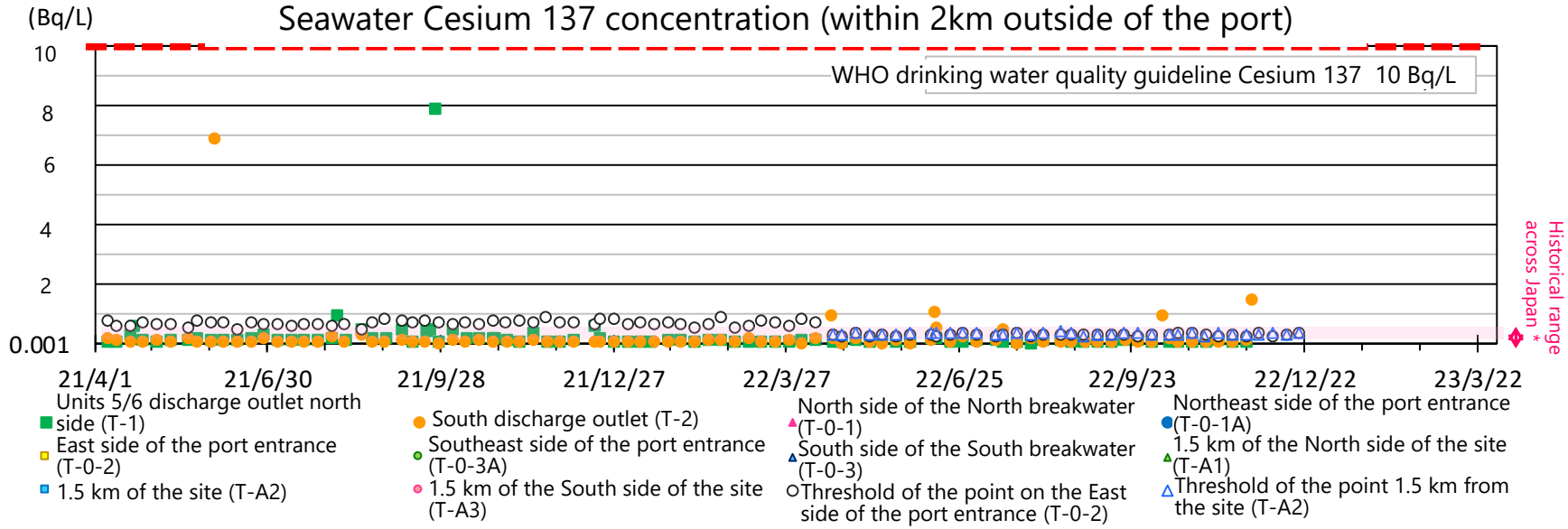
○ The Cesium 137 concentration tends to be lower the further the sampling point is from the plant.

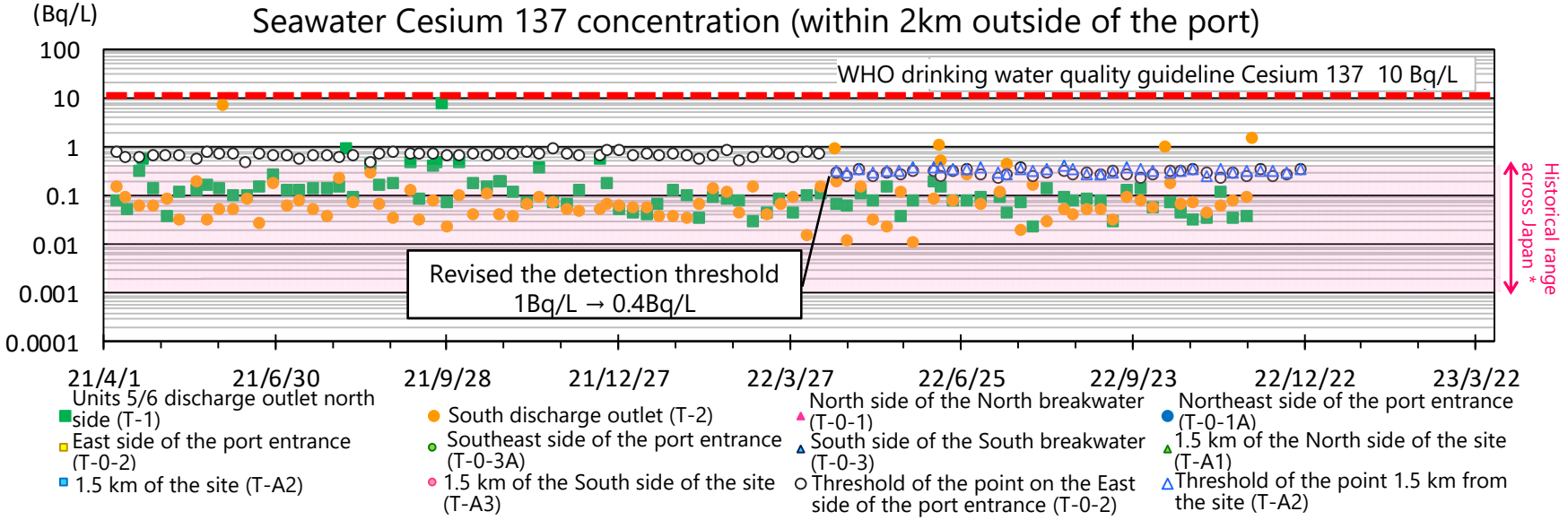
○ See the graphs on the next page and onwards for trends for each sampling point

*： Range of values recorded for April 2019 to March 2021
Cesium 137 concentration 0.0010 Bq/L ～ 0.45 Bq/L

Trends in Cesium 137 concentration in seawater (2/4)

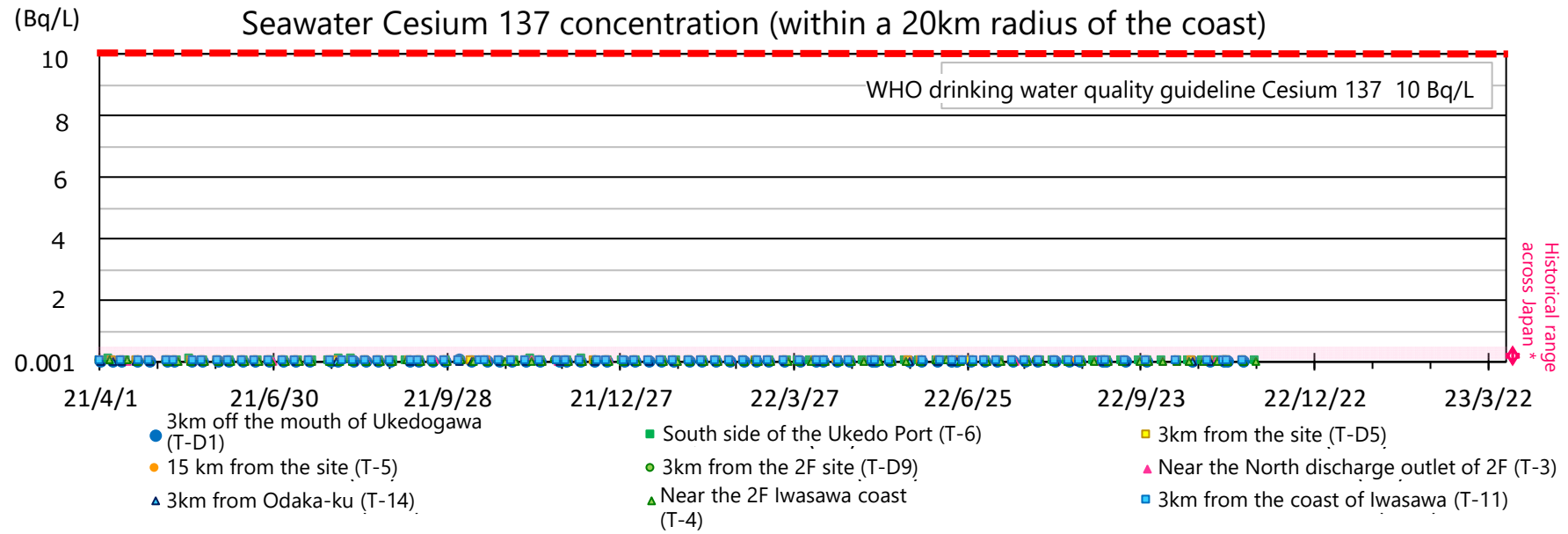
○There were temporary increases in cesium 137 concentrations presumably due to rainfall which has been the cause of the fluctuations in concentrations around the Fukushima Daiichi NPS in the past as well.

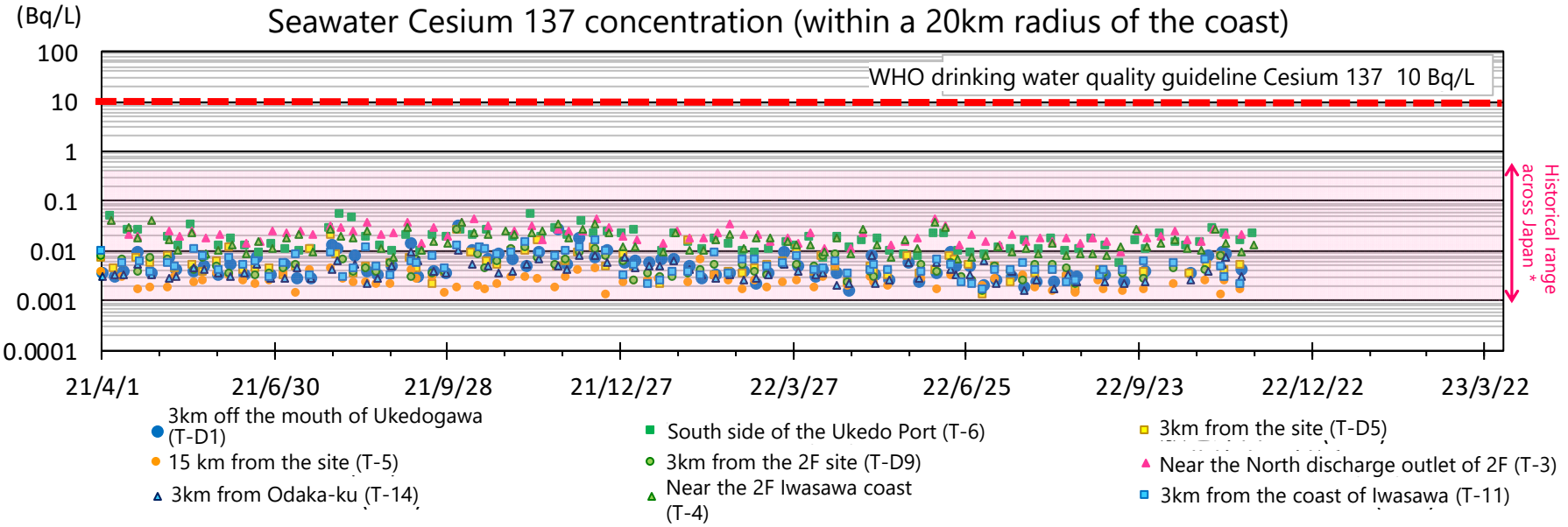




* : Range of values recorded for April 2019 to March 2021 Cesium 137 concentration 0.0010 Bq/L ～ 0.45 Bq/L

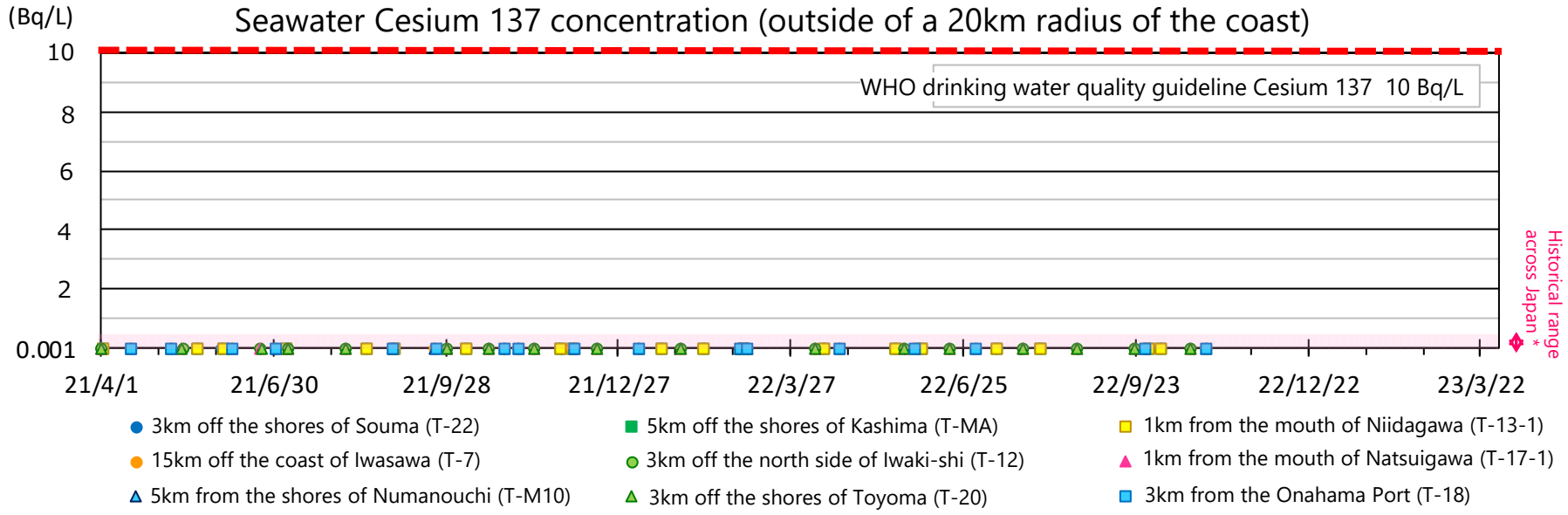
Trends in Cesium 137 concentration in seawater (3/4)

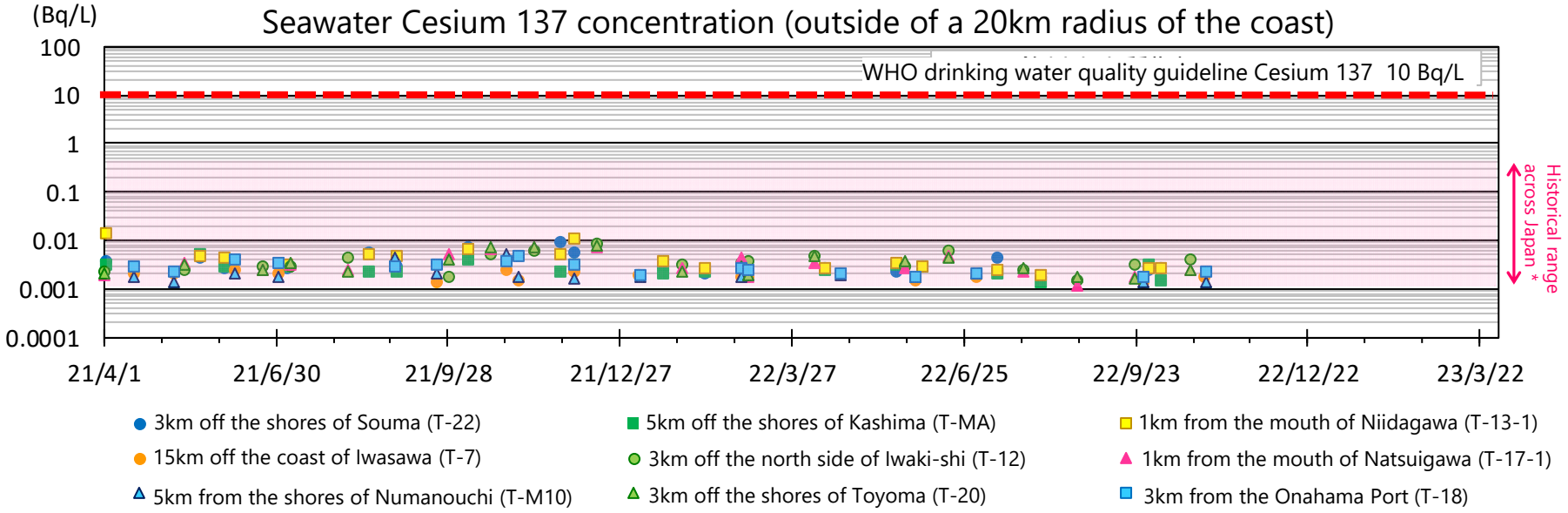




* : Range of values recorded for April 2019 to March 2021 Cesium 137 concentration 0.0010 Bq/L ～ 0.45 Bq/L

Trends in Cesium 137 concentration in seawater (4/4)



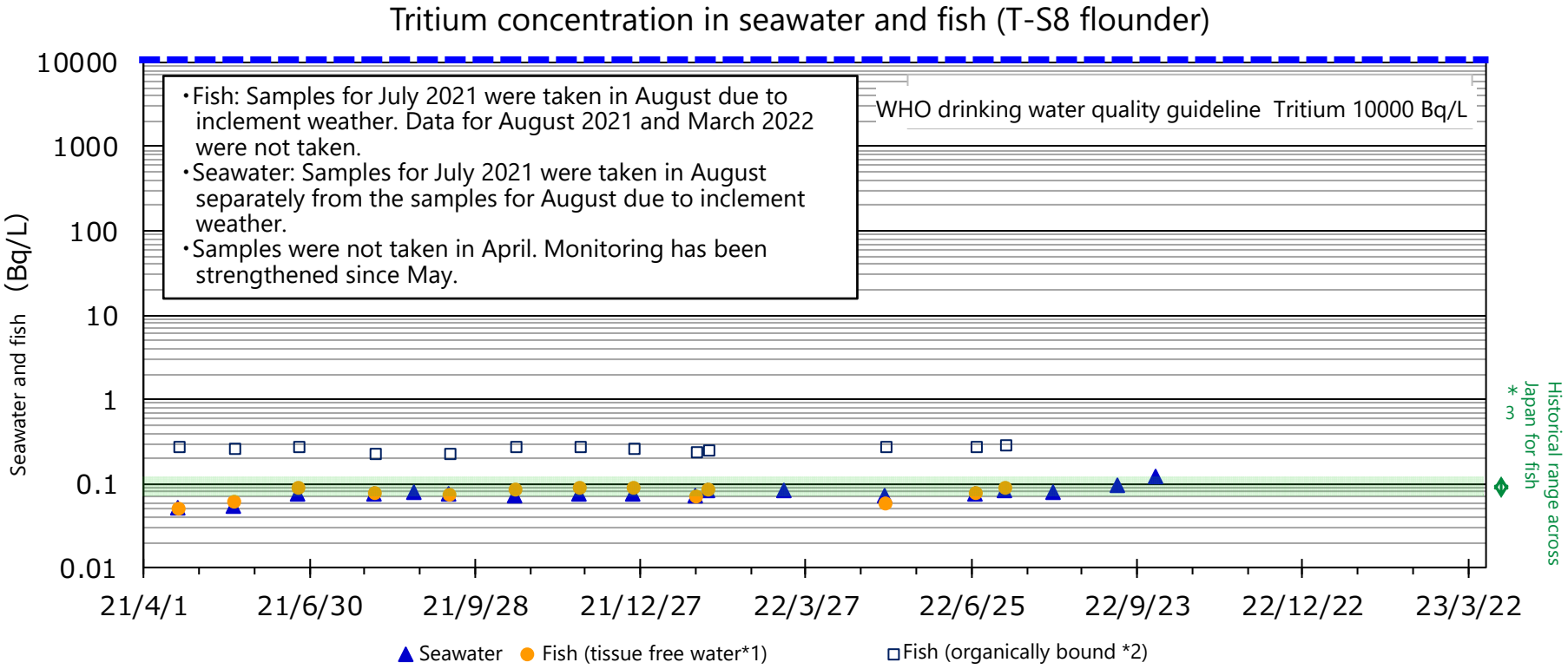


* : Range of values recorded for April 2019 to March 2021 Cesium 137 concentration 0.0010 Bq/L ～ 0.45 Bq/L

Trends in tritium concentration in seawater and fish

○ Measurement values have been stable for the past year.

○ The tissue free water tritium levels in fish have been on par with the concentration in seawater.



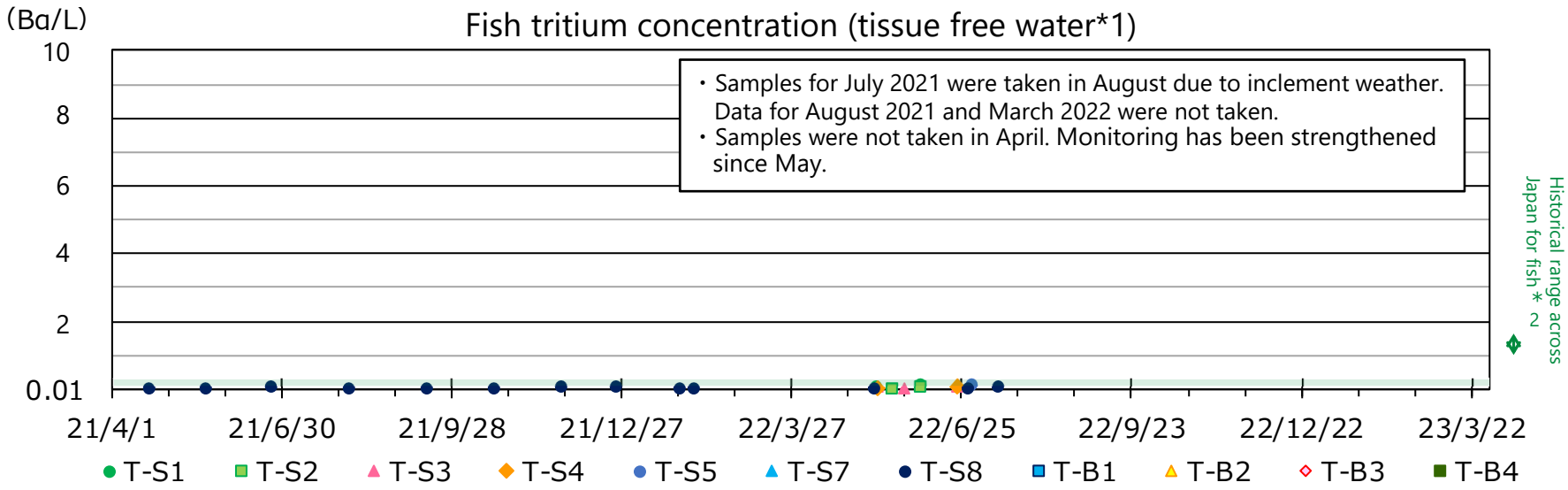
※Organically bound tritium was only detected below the detection threshold and as such, each point indicates the detection threshold. The detection threshold for organically bound tritium according to the Comprehensive Monitoring Plan is 0.5 Bq/L.

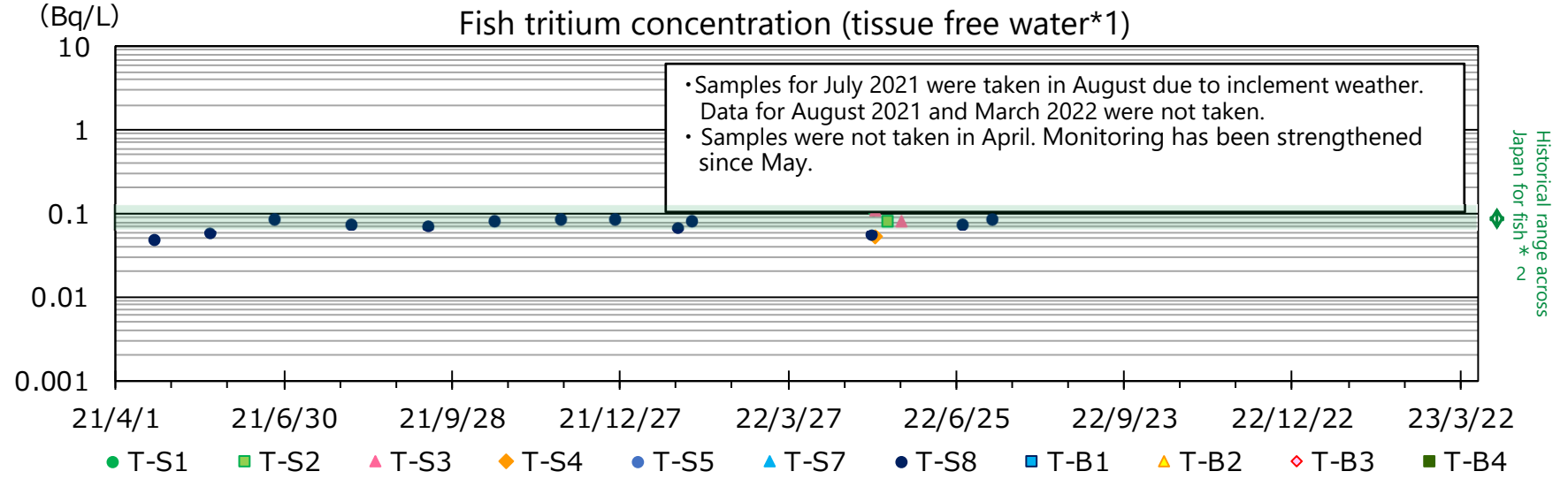
*1：Tissue free water tritium exists in the tissue of animals and plants as water and is excreted outside of the tissue similar to water.

*2：Organically bound tritium is taken into tissue as it organically binds to the protein in the tissue in animals and plants, and is excreted from the tissue through cell metabolism.

*3： Range of values recorded for April 2019 to March 2021 Fish tritium concentration (tissue free water) 0.064 Bq/L ～ 0.12 Bq/L

Trends in fish tritium concentration (1/2)



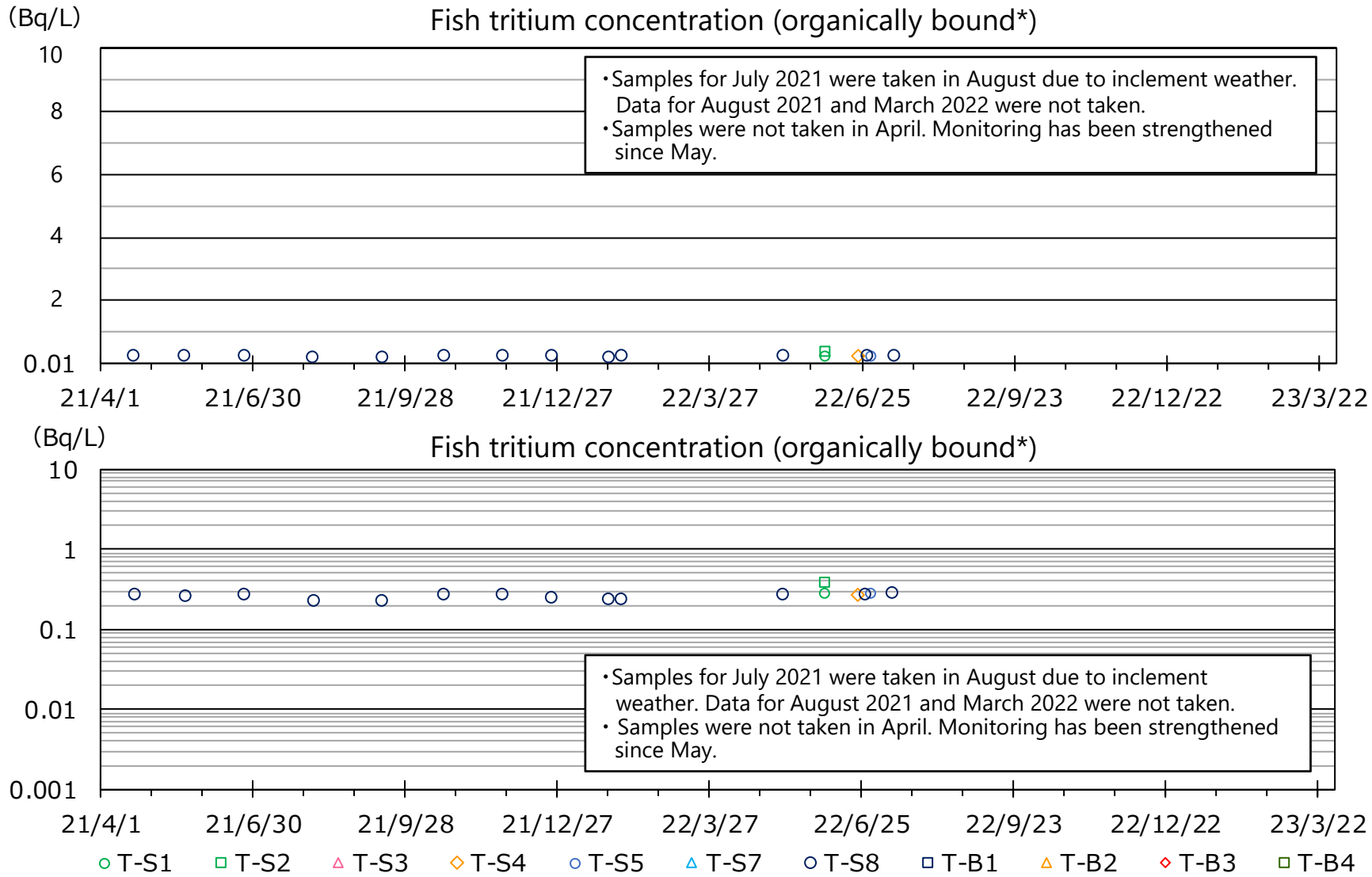


※Flounder was used as the fish.

*1： Tissue free water tritium exists in the tissue of animals and plants as water and is excreted outside of the tissue similar to water.

*2： Range of values recorded for April 2019 to March 2021 Fish tritium concentration (tissue free water) 0.064 Bq/L ～ 0.12 Bq/L

Trends in fish tritium concentration (2/2)

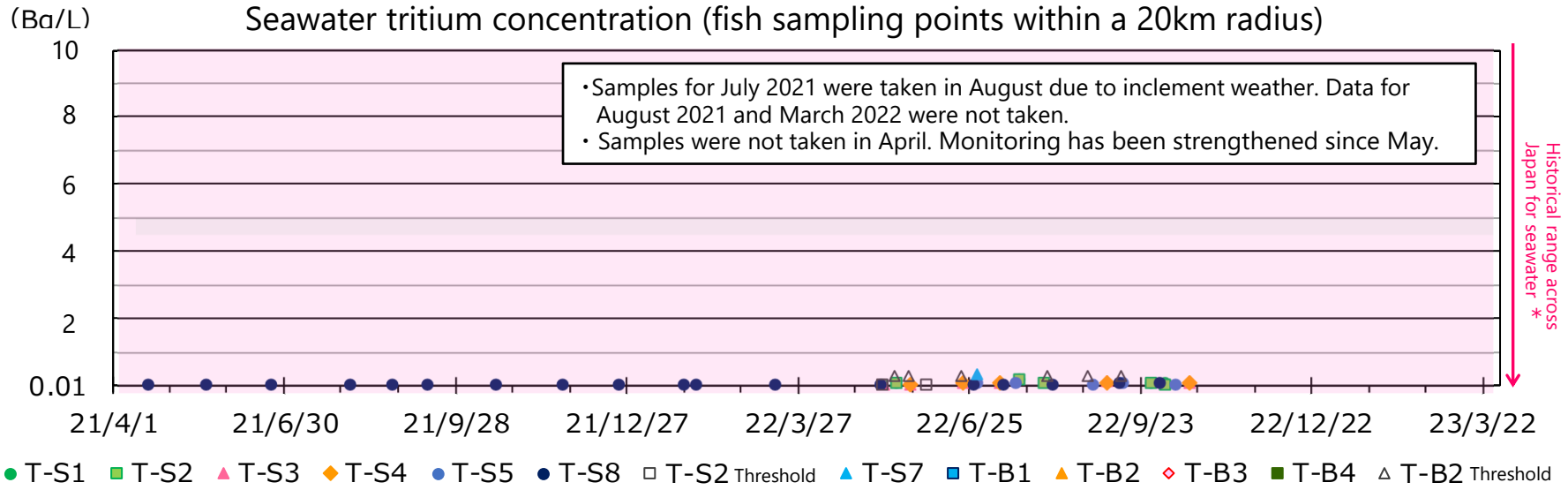


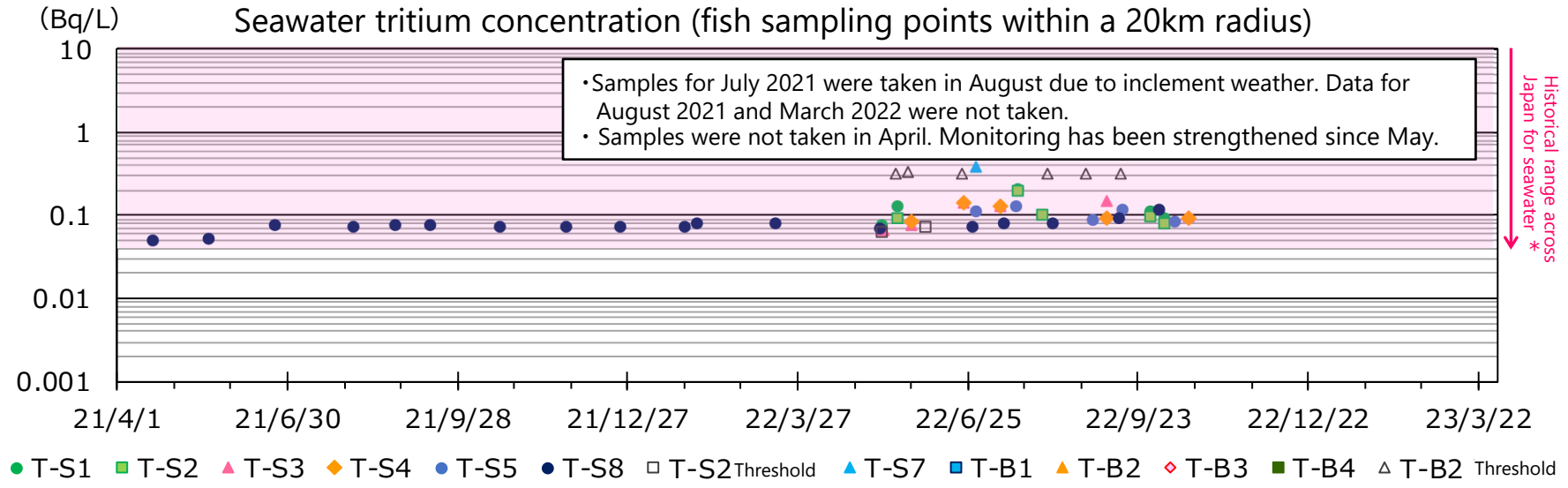
※ Flounder was used as the fish.

※Organically bound tritium was only detected below the detection threshold and as such, each point indicates the detection threshold. The detection threshold for organically bound tritium according to the Comprehensive Monitoring Plan is 0.5 Bq/L.

* : Organically bound tritium is taken into tissue as it organically binds to the protein in the tissue of animals and plants, and is excreted from the tissue through cell metabolism.

Trends in tritium concentration in seawater (fish sampling points)





※Samples taken from the surface layer
Detection threshold T-S1～T-S8 (except for T-S7) : 0.1Bq/L
T-S7, T-B1～T-B4 : 0.4Bq/L

* : Range of values recorded for April 2019 to March 2021
Seawater tritium concentration 0.043 Bq/L ～ 20 Bq/L

<Reference> Sea area monitoring plan (1/2)

【seawater】

・TEPCO increased the number of samples taken, frequency of measurement for tritium and set the detectable limit to be in line with government targets.

Red：Strengthened compared to the current plan

Target	Sampling location (See 2-3. Diagram 1,2,3)	Number of samples taken	Subject of measurement	Frequency	Detectable limit
Sea water	Inside the port	10	Cesium-134,137	Daily	0.4 Bq/L
			Tritium	Weekly	3 Bq/L
	Outside the port, within a 2km radius of the station	2	Cesium-134,137	Weekly	0.001 Bq/L
				Daily	1 Bq/L
		5 → 8	Cesium-134,137	Weekly	1 Bq/L
		7 → 10	Tritium	Weekly	1 → 0.4 Bq/L*1
	Within 20 km of the coast	6	Cesium-134,137	Weekly	0.001 Bq/L
			Tritium	Twice a month → Weekly*2	0.4 → 0.1 Bq/L*3
	Within 20 km of the coast (Fish sampling location)	1	Tritium	Monthly	0.1 Bq/L
		0 → 10	Tritium	None → Monthly	0.1 Bq/L*3
	20 km+ off the coast of Fukushima Prefecture	9	Cesium-134,137	Monthly	0.001 Bq/L
		0 → 9	Tritium	None → Monthly	0.1 Bq/L*3

※：All samples are taken from the surface level of the sea

1：Values will be measured using the electrolytic concentration method as needed.

*2：To be measured monthly when the detectable limit is at 0.1Bq/L

*3：To be set at 0.4 Bq/L until the electrolytic concentration device is installed.

*：Concentration method that uses the fact that tritium water is less easily electrolyzed.

<Reference> Sea area monitoring plan (2/2)

TEPCO

【Fish and seaweed】

・TEPCO increased the number of samples taken, subject and frequency of measurement and set the detectable limit to be in line with government targets.

Red：Strengthened compared to the current plan

Target	Sampling location (See 2-3. Diagram 1,2)	Number of samples taken	Subject of measurement	Frequency	Detectable limit
Fish	Within 20 km of the coast	11	Cesium134,137	Monthly	10 Bq/kg (live)
			Strontium 90 (5 samples with the highest concentrations of cesium)	Quarterly	0.02 Bq/kg (live)
		1	Tritium (tritiated water)	Monthly	0.1 Bq/L
			Tritium (organically bound)		0.5 Bq/L
		0 → 10	Tritium (tritiated water) *1	None → Monthly	0.1 Bq/L*3
			Tritium (organically bound) *2		0.5 Bq/L
Seaweed	Inside the port	1	Cesium134,137	Annually → Three times a year	0.2 Bq/kg (live)
	Outside the port, within a 2km radius of the station	0 → 2	Cesium134,137	None → Three times a year	0.2 Bq/kg (live)
			Iodine 129	None → Three times a year	0 .1 Bq/kg (live)
			tritium (tritiated water)*1	None → Three times a year	0.1 Bq/L*3
			tritium (organically bound) *2		0.5 Bq/L

*1：Tritium that exists as water form in the tissue of animals and plants and is excreted similarly to water.
*2：Tritium that is taken into tissue of animals and plants as it organically binds to the protein of the tissue, and is excreted from the tissue through cell metabolism.
*3： Set at 0.4 Bq/L until the electrolytic concentration device is installed

<Reference> Overview of facilities for securing safety

Secondary treatment facility（newly installed reverse osmosis membrane facility）

Secondary treatment of treated water to be re-purified (sum of the ratios of nuclides, excluding tritium, is between 1 and 10)

Secondary treatment facility（ALPS）

Secondary treatment of Treated water to be re-purified (sum of the ratios of nuclides, excluding tritium, is 1 or higher)

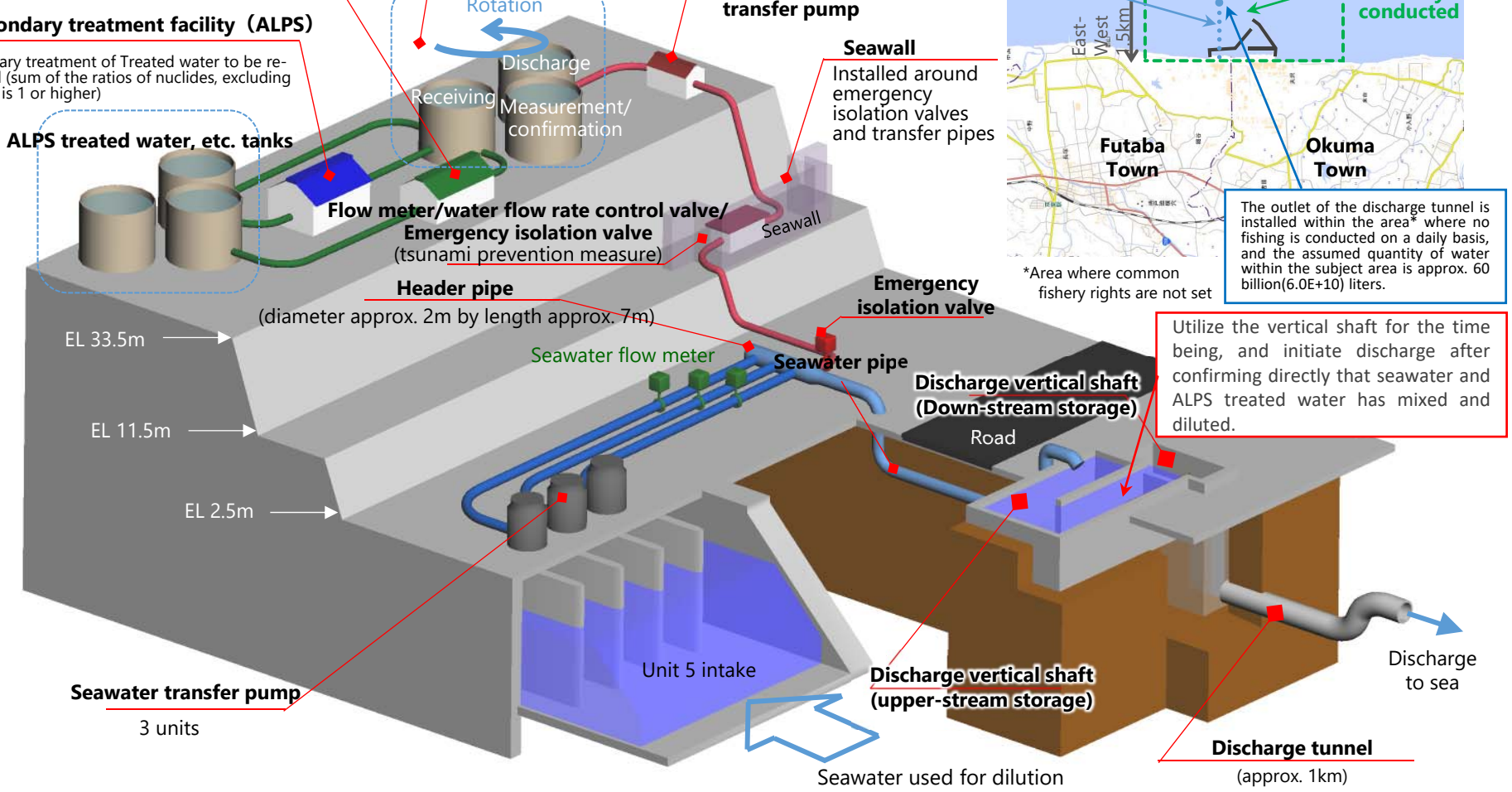
Measurement/confirmation facility (K4 tank group)

Comprised of three sets of tank groups each with the role of receiving, measurement/confirmation, and discharge. In the measurement/confirmation stage, water that has been made homogenized through circulation and agitating is sampled and analyzed (approx. 10,000m³ × 3 groups)

ALPS treated water transfer pump

Seawall

Installed around emergency isolation valves and transfer pipes



Source: Developed by Tokyo Electric Power Company Holdings, Inc. based on the map developed by the Geospatial Information Authority of Japan (electronic territory web)
https://maps.gsi.go.jp/#13/37.422730/141.044970/&base=std&ls=std&disp=1&vs=c1j0h0k0l0u0t0z0r0s0m0f1

*Area where common fishery rights are not set

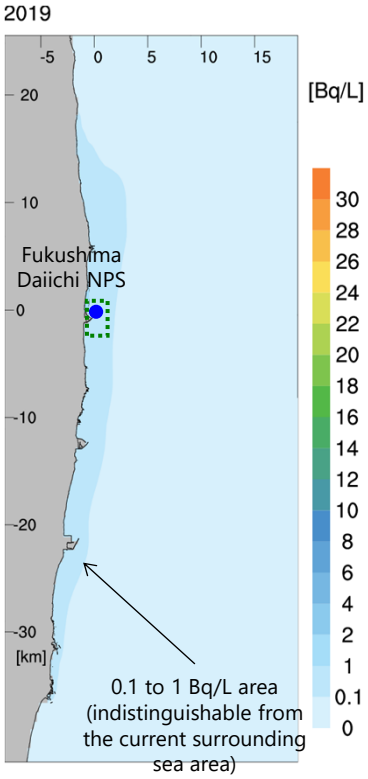
The outlet of the discharge tunnel is installed within the area* where no fishing is conducted on a daily basis, and the assumed quantity of water within the subject area is approx. 60 billion(6.0E+10) liters.

Utilize the vertical shaft for the time being, and initiate discharge after confirming directly that seawater and ALPS treated water has mixed and diluted.

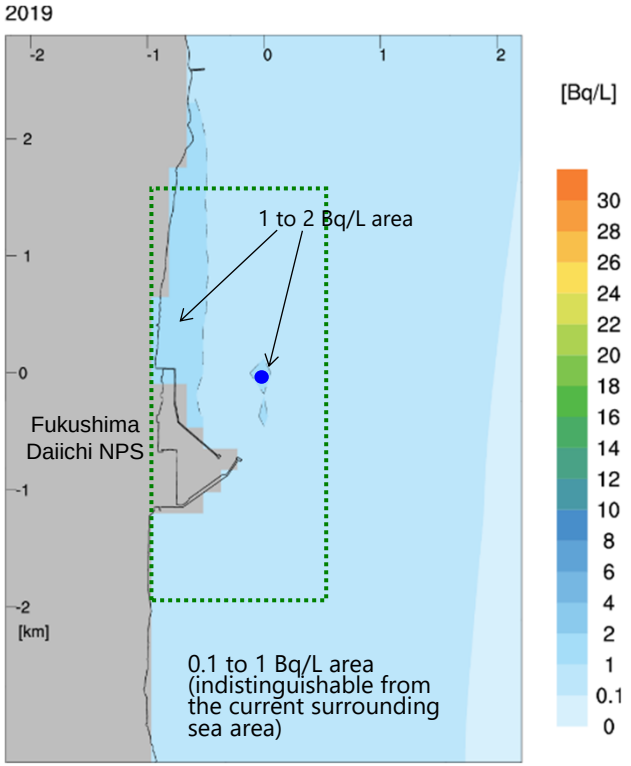
<Reference> Results of dispersion simulation at sea

○ Assessment using the meteorological and sea conditions data from 2019 found that the area with higher tritium concentrations than the current surrounding area (0.1-1 Bq/L) (the area inside the dotted line) will be <u>the area 2 to 3 km from the station as 1 to 2 Bq/L which is 1/100 thousandth to 1/10 thousandth of the WHO Guidelines for drinking-water quality (10,000 Bq/L)</u> .

⇒ Monitoring will be strengthened to confirm the status of dispersion.



Enlarge the scale by approx. 10 times



※：The simulation was conducted using a program based on sea scattering model (ROMS) originally developed by a US university and widely used by universities and research institutes, and further improved by CRIEPI

Enlarged view of the area off the coast of Fukushima Prefecture
(Largest value in scale at 30 Bq/L)

Enlarged view of the area around the station
(Largest value in scale at 30 Bq/L)