Fukushima Daiichi Nuclear Power Station
Status of Progress of the Marine Organisms Rearing Tests

December 22, 2022

Tokyo Electric Power Company Holdings, Inc

1. Report on the marine organism rearing test (as of December 2022) (1/5)

State of marine organisms

- No flounder have died or have experience abnormalities since October 21, in both series of tanks of the normal seawater and tanks of ALPS treated water diluted with seawater (as of December 16).
- 2 abalone have died in normal seawater and 8 abalone have died in ALPS treated water diluted with seawater since the test started on October 25 (as of December 16).
  - According to experts, the abalone died due to injuries sustained during transport or daily cleaning, not from disease as the internal organs were not bloated and the mantle was bruised.
  - Because the injuries to the abalone seems to be from the high stocking density and contact during tank cleaning, improvements will be made on those fronts.

・The tritium concentration was adjusted to approx. 30 Bq/L by adding an appropriate amount of ALPS treated water, and additional test was started on November 30.

  - The additional rearing test is being conducted because it is beneficial to conduct tests in tritium concentrations observed when the water is actually being discharged (tritium concentration around the discharge tunnel outlet in the radiological environmental impact assessment results) to achieve the objective of the rearing test.

Size of flounder at the start of the test: Weight 36±12g; length: 15.9±1.8cm

Size of abalone at the start of the test: Weight 27±4g; shell length: 5.8±0.3cm

Tank series	Classification	Number of marine organisms in each tank (as of December 16, 2022)		
		Flounder	Abalone	Seaweed
Series 1	Normal seawater（around 0.1～1 Bq/L）	130	154	-
Series 2	Normal seawater（around 0.1～1 Bq/L）	146	154	-
Series 3	Less than 1500Bq/L※1	186	186	-
Series 4	Less than 1500Bq/L※1	183	198	-
Series 5	Around 30Bq/L※2	32	-	-

※1 Measurement as of the end of November: approx. 1250Bq/L（no large change from the last measurement taken)
※2 Measurement as of the end of November: approx. 36Bq/L

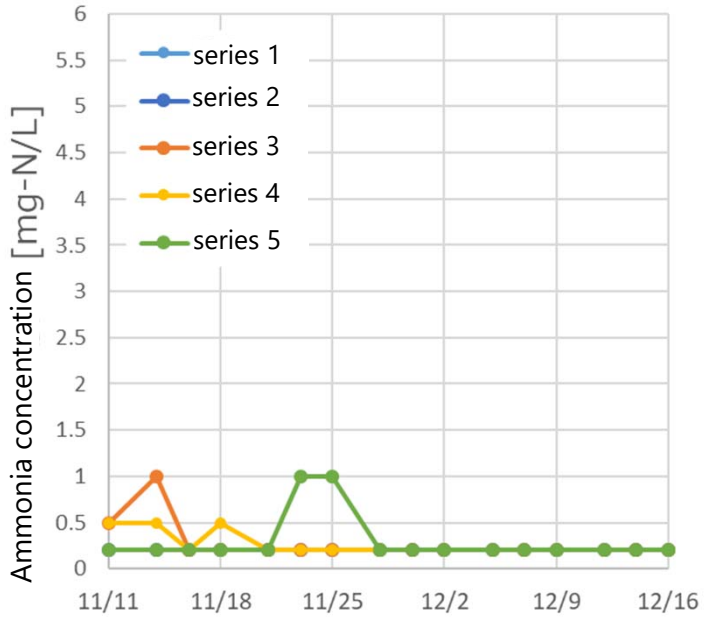
1. Report on the marine organism rearing test (as of December 2022) (2/5)

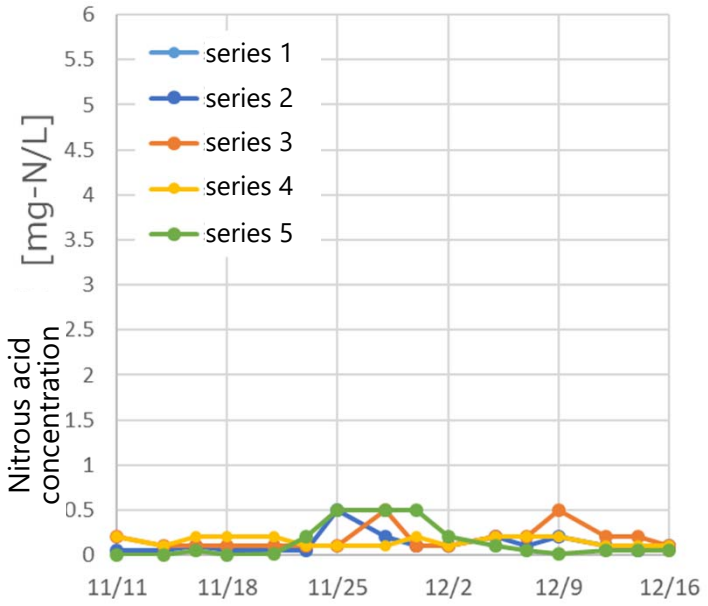
Water quality in the rearing tanks

- While there have been some fluctuations in figures, water quality has been kept generally in the range suited to rearing marine organisms.

Item	Minimum to maximum in series 1 through 5 (November 11, 2022 to December 16, 2022)	Explanation for the measurement values
Water temperature (℃)	17.4～18.6	Kept within a range of 18.0℃±0.6℃.
Ammonia (mg-N/L)	0.2～1.0 ※	Generally kept below 0.5mg-N/L, in a range that doesn't impact most marine organisms
Nitrous acid (mg-N/L)	0.005～0.500	Generally kept below 0.5mg-N/L, in a range that doesn't impact most marine organisms
Nitric acid (mg-N/L)	3～81	Decreasing as the denitrification tank has been introduced and nitric acid is discharged as N2 gas.

※Temporarily increased when the stock and the amount of feed increased

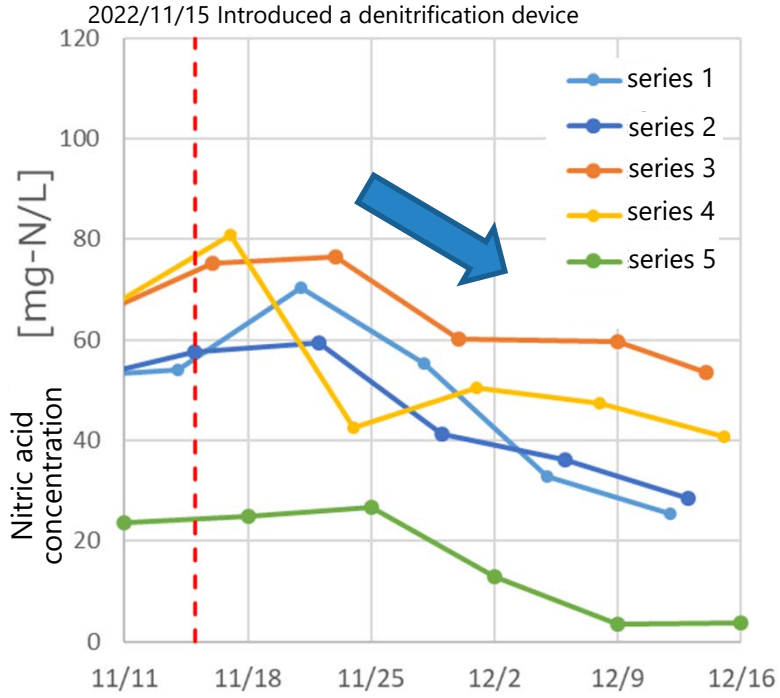




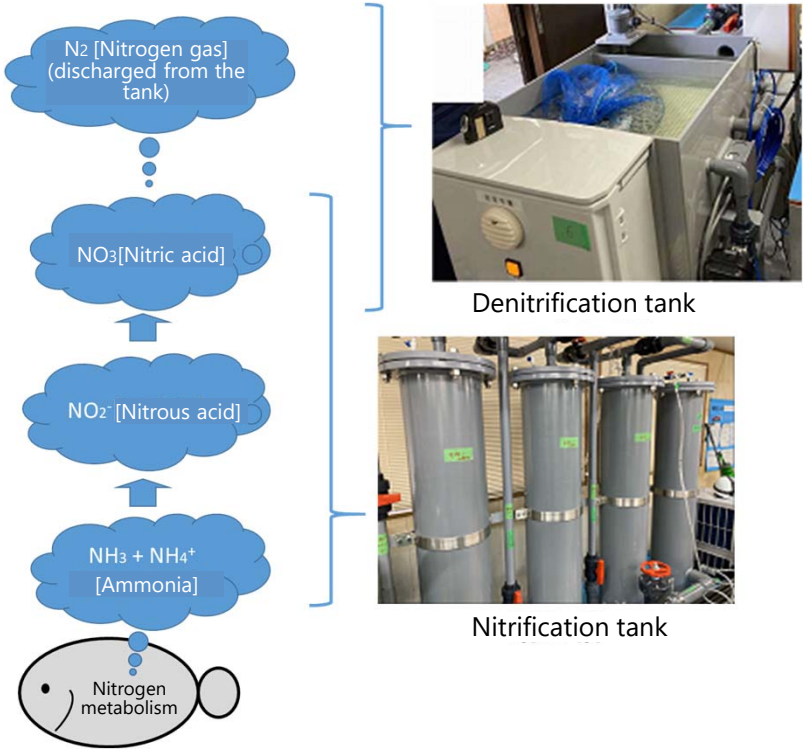
1. Report on the marine organism rearing test (as of December 2022) (3/5)

Additional measures for nitric acid

- The ammonia excreted from the flounder is oxidized into nitric acid via nitrous acid through bacteria decomposition and accumulates in the water. While the toxicity of nitric acid is lower than that of ammonia or nitrous acid, if the water is not replaced, it can accumulate to concentrations that could affect organisms. Therefore, a denitrification device※1has been introduced to reduce the nitric acid concentration.



Confirmed that the nitric acid concentration has been on a decreasing trend since November 15 when the denitrification device was introduced.

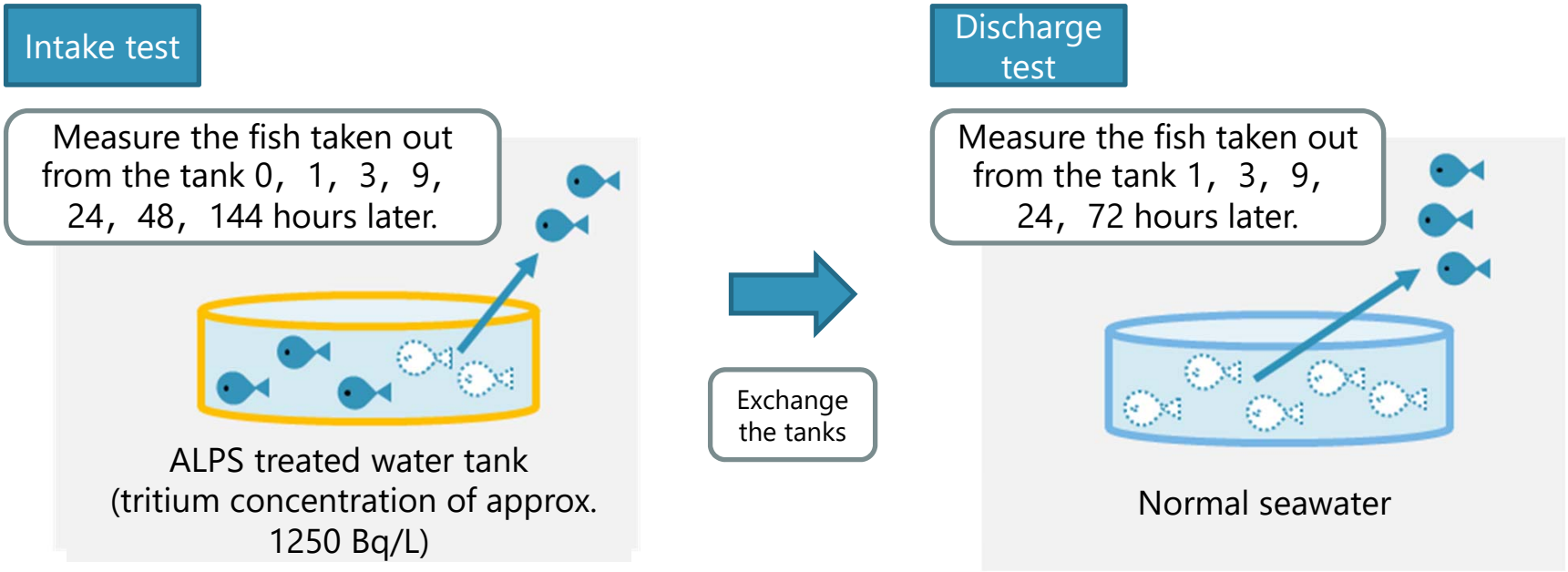


※1 Device that reduces nitric acid to nitrogen gas and discharges outside of the tank

1. Report on the marine organism rearing test (as of December 2022) (4/5)

Measuring the tritium concentration in flounder (tritium concentration of less than 1500Bq/L)

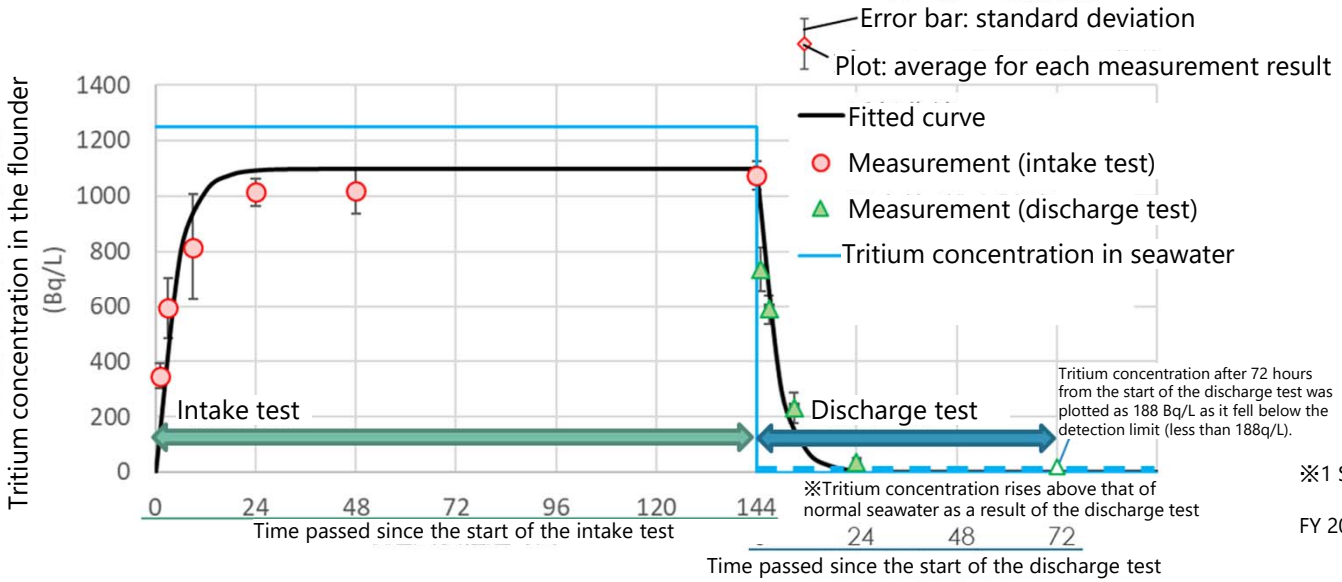
- The result of tritium concentration measurements taken on October 2022 from flounder reared in diluted ALPS treated water (less than 1500Bq/L) was disclosed (the part analyzed by TEPCO).
  - Number of flounder measured
    - 33 flounder for the intake test
    - 25 flounder for the discharge test
- To verify that after a certain period of time the tritium in flounder reaches equilibrium at a lower concentration than the rearing environment, an *intake test* was conducted measuring tritium concentrations in flounder at 0, 1, 3, 9, 24, 48 and 144 hours after the flounder is brought into the ALPS treated water.
- Afterward, to verify that the tritium concentration in the flounder will be reduced by discharging the tritium from the flounder that had been moved from ALPS treated water tanks to normal seawater tanks, a *discharge test* was conducted measuring tritium concentrations in flounder at 0 hours (the 144-hour point in the intake test) after the flounder is placed in the normal seawater tank, and 1, 3, 9, 24, 72 hours afterward.



1. Report on the marine organism rearing test (as of December 2022) (5/5)

Results of tritium concentrations in flounder (tritium concentration of less than 1500Bq/L) and insights

- Tritium concentrations changed with time in both intake and discharge tests. The relationship between the measurement values and the fitted curve for the data drawn based on the approach to fitted curve developed based on past data is as follows.



※ In graphing the measurements, points below the detection limit and suspected adulteration were removed

（Reference）On the fitted curve:
Based on previous findings, the changes in tritium concentration within marine organisms were represented by the following formula.

$$dC_A(t) = A\{-C_A(t) + C_B(t)\}$$

A : constant t : time
$C_A(t)$: tritium concentration within the marine organism
$C_B(t)$: tritium concentration in seawater

※1 Similar analysis results have been reported in the following literature in the past.
FY 2009 Experimental Study on Carbon Transfer in Land and Aquatic Ecosystems, Research Institute of Environmental Science and Technology

・Referring the data from graph above, the following results are confirmed same as previous findings. ※1

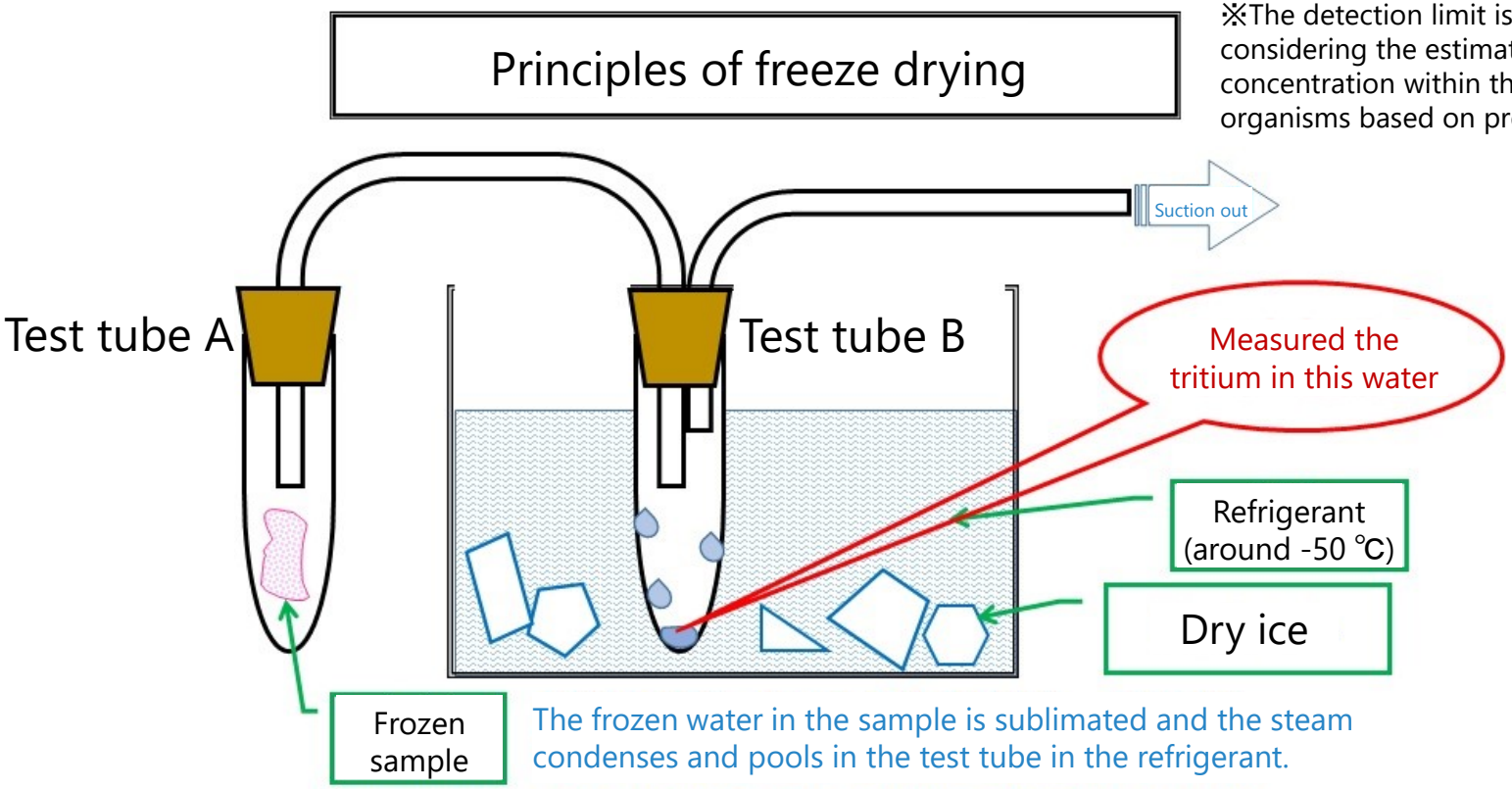
【Intake test】
- The tritium concentration in living bodies does not exceed that of the environment which it was reared in (i.e., does not exceed the tritium concentration in ALPS treated water diluted with seawater in this test).
- The tritium concentration reaches an equilibrium after a certain period of time.

【Discharge test】
- The tritium concentration in the flounder will be reduced as time passes after the flounder, which has reached equilibrium in higher tritium concentrations than that of normal seawater, is returned to normal seawater.

【Reference】Method for measuring tritium in rearing tests

1. Fillet the sampled marine organisms and freeze them.
2. Place the frozen sample in test tube A as shown below.
3. Place test tube B in refrigerant that has been cooled to around -50℃ with dry ice. Connect the test tubes as shown and suction out the air in test tubes A and B to create a vacuum.
4. In the vacuum, the water in the frozen samples sublimates and the steam condenses within the test tube that is in the refrigerant. This condensed steam (now water) is collected within a stipulated period.
5. The condensed water is analyzed※ and its tritium concentration is measured.

※The detection limit is set considering the estimated tritium concentration within the marine organisms based on previous findings



2．Schedule going forward

Rearing schedule

- Seaweed: The date of starting the rearing test will be announced as soon as it is determined.

Schedule going forward

- Measurements of tritium concentration in abalone reared in ALPS treated water diluted with seawater (less than 1500Bq/L) from October to November 2022
- Measurements of tritium concentration in flounder reared in ALPS treated water diluted with seawater (30Bq/L) from November to December 2022【additional rearing test】

【Reference】

What We Hope to Prove with the Rearing Test (1/2)

Fukushima Daiichi Nuclear Power Station Start of Marine Organisms Rearing Tests
(September 29, 2022 Excerpts from documents)

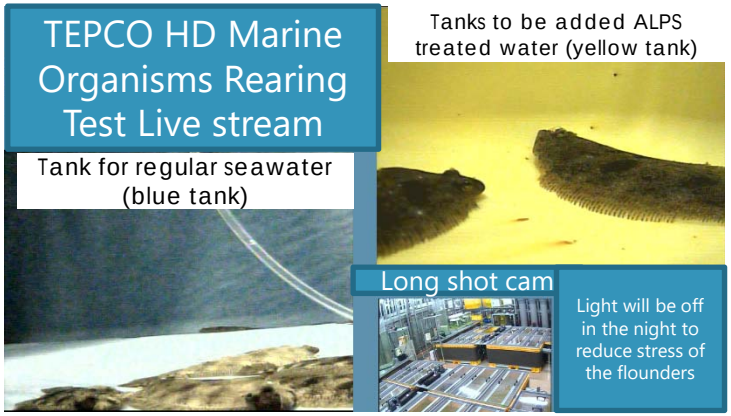
① In order to alleviate people's concerns and to cultivate peace of mind, we will rear marine organisms in tanks of seawater containing ALPS treated water and compare them with organism reared in normal seawater and report the results carefully in an easy-to-understand manner.

To be confirmed in the test

- Marine organisms rearing tests will be conducted both in seawater and in ALPS treated water diluted with seawater. The marine organisms in these two environments will be compared via rearing data to confirm there are no significant differences between the two populations.

Information disclosure policy

- For ①, we will provide a live stream of the rearing tank and write about how the rearing test is going on in the observation diary on our website and on Japanese Twitter. The rearing environment (e.g., water quality, temperature of the water), state of organisms (e.g., changes in the number of organisms), analysis results (e.g., comparisons of the tritium concentration in the live organisms and in seawater) of the marine organisms reared in ALPS treated water diluted with seawater and organisms reared in normal seawater will be summarized and disclosed every month.
- In addition to having people from the local community and parties concerned visit the test site, we will also have biology experts check on the test as it is ongoing.



◀ Live stream of the seawater rearing test (for illustration purposes only)

- The normal seawater is in the blue tanks and the ALPS treated water diluted with sweater is in the yellow tanks.
- The layout of the tanks will be changed as needed based on feedback from relevant parties to ensure optimal visibility.

【Reference】

What We Hope to Prove with the Rearing Test (2/2)

Fukushima Daiichi Nuclear Power Station Start of Marine Organisms Rearing Tests
(September 29, 2022 Excerpts from documents)

② Based on the results of many studies domestic and abroad on the behavior of tritium, data for this test will first be gathered for 6 months to show that "tritium is not concentrated in the living bodies and that the concentration of tritium in living bodies does not exceed that of the rearing environment" as demonstrated in past tests results.

Results of experiments domestic and abroad

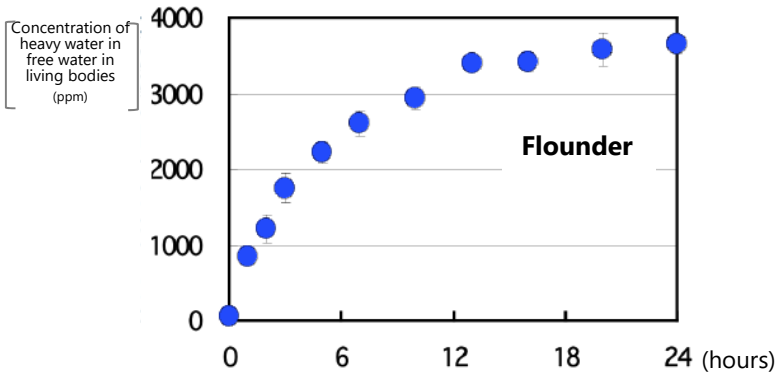
- The tritium concentration in a living bodies does not exceed that of the environment which it was reared in.
- The tritium concentration reached an equilibrium after a certain period of time.

※1 Tritium in living bodies is either free water tritium (FWT) or organically bound tritium (OBT). Studies have been conducted domestically and abroad for both.

※2 This experiment was conducted using heavy hydrogen (H-2) which has the same properties as tritium (H3) (The heavy hydrogen concentration in seawater is about 4000 ppm.)

- Free water tritium (FWT): Tritium that exists in the form of water in living bodies
- Organically bound tritium (OBT): Tritium that is organically bound with carbon and other molecules in living bodies

■ Experiment on flounder in heavy water※2



Excerpt from "FY2009 Report on a Study of Carbon Transfer in Terrestrial and Aquatic Ecosystems" by the Institute for Environmental Sciences

To be confirmed in the rearing test

- The tritium levels in the flounder, abalone and seaweed reared in the ALPS treated water diluted with seawater (tritium concentration of approx. 1500 Bq/L) will be analyzed and assessed* to confirm that tritium levels will reach equilibrium after a certain amount of time, and that the tritium concentration at equilibrium doesn't exceed that of the rearing environment.
  - It will also be confirmed that the tritium levels of marine organisms that have reached the tritium equilibrium will fall once they are moved to seawater only tanks .

※3 OBT data will be collected over 6 months and assessed for conformity with past data to confirm that OBT levels do not exceed that of the rearing environment.