

# Topics Fukushima

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JAEA staff collecting fallen leaves and soil from soil layer under deciduous trees (one of the works on environmental monitoring)

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## Elucidated the Cause of Cesium Concentration Changes in Freshwater Fish

～Three different routes were clarified～

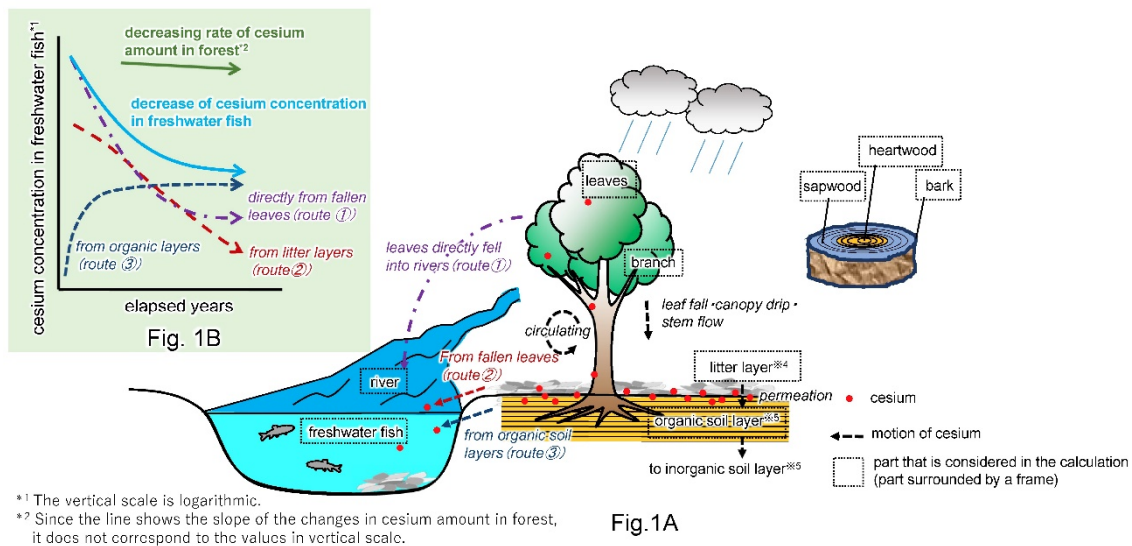
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Since the concentration of radioactive cesium (hereafter referred to “cesium”) in natural freshwater fish collected in Fukushima Prefecture is decreasing with time, shipment restrictions are gradually being cancelled<sup>(note)</sup>. However, for cesium incorporated into freshwater fish living in mountain stream (hereafter referred to simply “freshwater fish”), the routes of cesium supplied from forests had not yet been quantitatively evaluated. Therefore, it remained still unclear as to why the concentration of cesium in freshwater fish is rapidly decreasing. In order to obtain the prospect of resumption of inland fisheries in rivers and lakes, it was necessary to elucidate the mechanism by which cesium is incorporated into freshwater fish and to predict cesium concentration in the future.

The Fukushima Environmental Safety Center (Miharu Town and Minamisoma City, Fukushima Prefecture), Japan Atomic Energy Agency (JAEA), has been conducting the

project “Comprehensive Research”<sup>\*1</sup> on a series of cesium migration in environment from forests to rivers and ocean. As a part of this project, we have developed the Environmental Dynamics Models<sup>\*2</sup> and established/operated the Environmental Monitoring Database<sup>\*3</sup>. Utilizing the knowledge accumulated through these research and development, we have established the calculation models, by which we evaluated from what parts of forests cesium is migrating to freshwater fish. As a result, it was clarified that there are three routes for cesium migration into freshwater fish, and cesium is incorporated into fish by the combination of the three routes.

### ■ What route does cesium migrate?



Cesium released by the accident of the Fukushima Daiichi Nuclear Power Station (hereafter referred to “1F”) was transported in air, and fell on the ground such as forests. Cesium fallen in forests was first deposited in trees (leaves, branches and bark) and litter layers at the upper forest floors<sup>\*6</sup>. Over time, cesium has moved to the organic soil layer below the forest floor due to the defoliation, rainfall, decomposition of deciduous layers, etc. Depending on the migration behavior of cesium, the tendency of cesium concentration changes is different among the parts of forests. For example, cesium concentration in leaves, branches, bark and litter layers is decreasing with time, but accordingly it is increasing in organic soil layers.

As a result of the evaluation, it was clarified that there are three routes for the cesium migration from forests to rivers and freshwater fish, as follows (Fig. 1A),

Route ①・・・Leaves containing cesium directly fall into rivers, and cesium is eluded into river water.

Route ②・・・Cesium is eluded or outflowed from litter layers to rivers.

Route ③・・・Cesium is eluded from organic soil layers to river water through surface water or underground water.

Also, it was found that cesium supply to freshwater fish through the routes ① and ② is decreasing due to the rapid decrease of cesium concentration in leaves and litter layers with the time elapsed since the 1F accident (Fig. 1B). The result means that the amount of cesium outflow from forests is decreasing. On the other hand, since cesium is adsorbed on organic and inorganic soil layers, the cesium is hard to be outflowed from forests. Therefore, the decreasing rate of cesium concentration in freshwater fish is higher than that in the forests.

### ■ What is the future research?

As described above, it was found that the decrease of the cesium concentration in freshwater fish originates from the high decreasing rate of cesium concentration in leaves and litter layers in forests. Although cesium concentration will tend to decrease with time in future, the contribution from organic layers is considered to increase. It is presumed that cesium in organic soil layers will be adsorbed on inorganic soil layers while slowly moving to deeper region. By this process, cesium is known to be strongly adsorbed on inorganic soil layers such as clay minerals. Thus, we consider that such process will contribute to further decrease of cesium concentration in freshwater fish. From now on, we will further aim to elucidate the migration of cesium from organic to inorganic soil layers and the existence states of cesium, towards the future prediction of cesium concentration in freshwater fish.

(Note) As to the shipment restrictions, please refer to the following websites.

- Homepage of the Ministry of Health, Labor and Welfare  
<https://www.mhlw.go.jp/stf/kinkyu/2r9852000001dd6u.html>
- Homepage of Fisheries Agency  
<https://www.jfa.maff.go.jp/j/housyanou/kekka.html>
- Homepage of Fukushima Prefecture  
<https://www.pref.fukushima.lg.jp/site/portal/ps-suisanka-monita-top.html>

## 【Terminology】

### ※1 Comprehensive Research:

The results of the Comprehensive Research by JAEA are open in the report, JAEA-Research 2019-002 (<https://jopss.jaea.go.jp/search/servlet/search?5065250>) and Fukushima Comprehensive Environmental Information Site (<https://jopss.jaea.go.jp/search/servlet/search?5065250>).

### ※2 Environmental Dynamics Model:

A model in which the migration of cesium in environment is calculated on computer. The outline of the results obtained by this model is open in the “Analysis Examples Site” (<https://simu.jaea.go.jp/simulation/>).

### ※3 Environmental Monitoring Database:

A database developed and operated by JAEA. It is open in the “Database for Radioactive Substance Monitoring Data” (<https://emdb.jaea.go.jp/emdb/>).

### ※4 litter layer:

A layer of fallen leaves, fallen branches, and organic soil on the way to humus.

### ※5 organic soil layer・inorganic soil layer:

A Soil layer below litter layer containing a lot of swelling organic materials with advanced humus of fallen leaves and branches is called organic soil layer. A mineral soil layer below the organic soil layer with little humus is called inorganic soil layer. Cesium is known to be strongly adsorbed on inorganic soil layer such as clay minerals. Although organic soil layer has also a property to adsorb cesium, cesium in organic soil is assumed to be readily available to living organisms.

### ※6 forest floor:

Ground surface in forests.

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