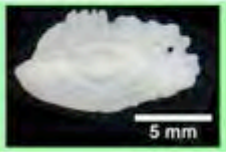
North PacificMarine Science Organization
24th Annual Meeting, 2015, Qingdao, China

# Use of otoliths to estimate the concentration of radioactive strontium


**Fish Samples from this harbor**


***Japanese rockfish***
**$^{134}$Cs + $^{137}$ Cs was > 100 kBq/kg-wet**




**Otolith removed from fish**
beta ray of $^{90}$Sr would be a biomarker to show that fish had lived in the harbor

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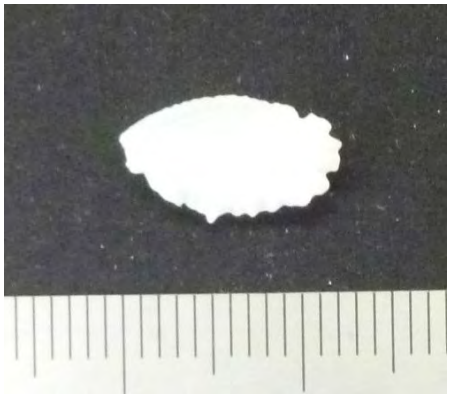
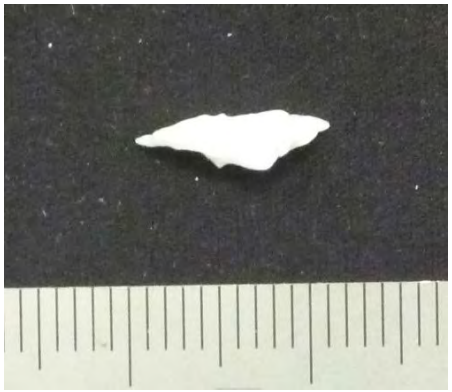
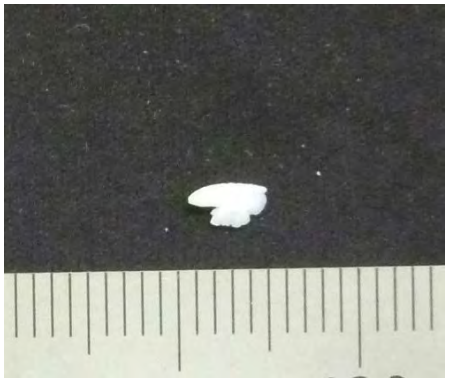
# What is otolith?



*Japanese rockfish*
（*Sebastes cheni*）



*brown hakeling*
（*Physiculus maximowiczi)*



*fat greenling*
（*Hexagrammos otakii*）

Otolith (ear-stone) is a structure to control fish body balance.
Calcium carbonate is the main component of otolith.
Radioactive strontium would be accumulate in otolith.
Otolith remains metabolically unchanged once formed,
fish experienced highly $^{90}Sr$ environment would have measureable quantity of $^{90}Sr$ in otolith.
Otolith can removed easily form skull in high purity.

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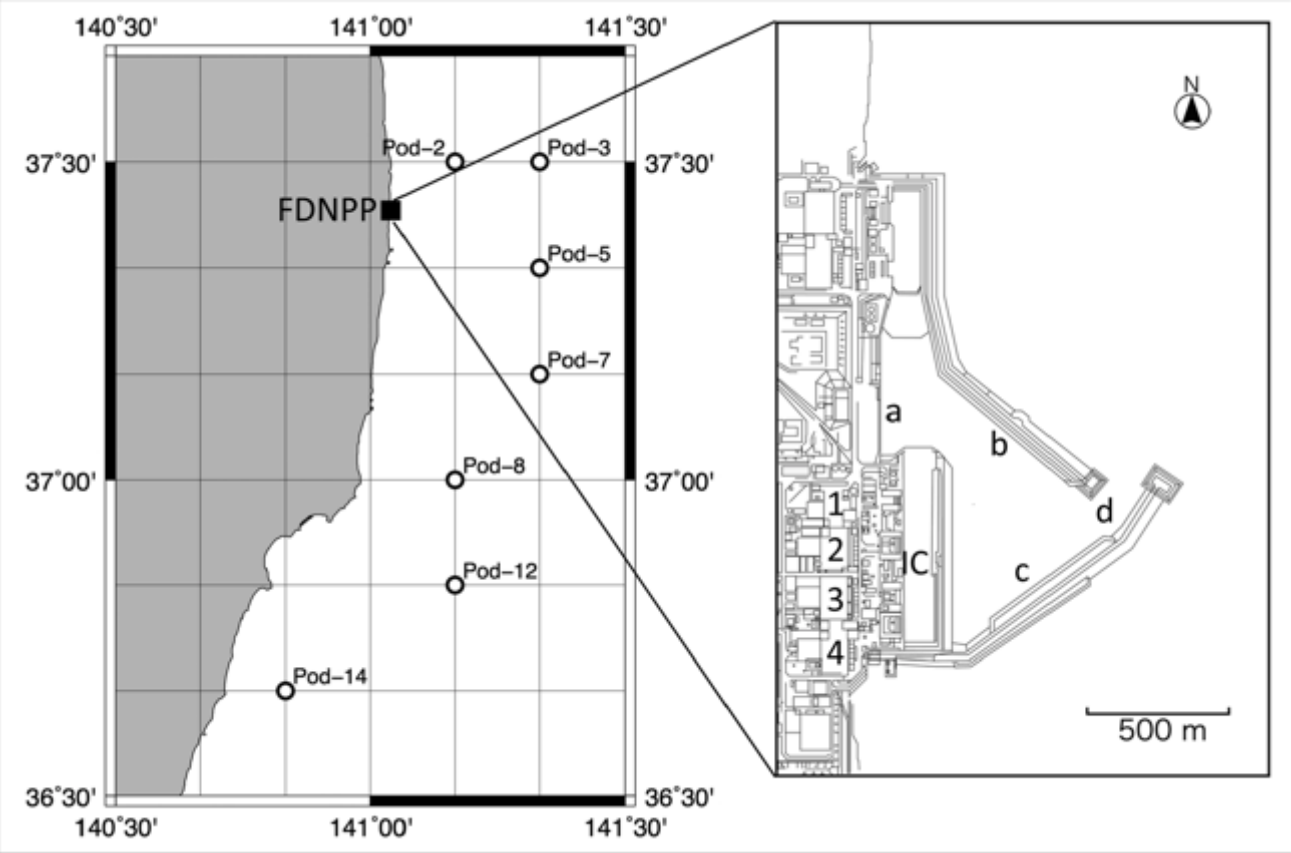
# Sampling points of fish in/around the main port of FDNPP




R/V SOYO-maru 892 tons

Sampling date

In the port; January 18 to February 12, 2013 by TEPCO

Around the port; December 14 to 19, 2012 by R/V SOYO-maru

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# Fish samples used this study

*Japanese rockfish*
（*Sebastes cheni*）

*brown hakeling*
（*Physiculus maximowiczi)*

*fat greenling*
（*Hexagrammos otakii*）

Table 1. The information of sampling for fish caught in the port of FDNPP.

| date of sampling | station | gear | number of fish | | |
|---|---|---|---|---|---|
| | | | *Japanese rockfish* | *brown hakeling* | *fat greenling* |
| 18. January. 2013 | ULD | cage | 0 | 9 | 5 |
| | south jetty | cage | 0 | 4 | 1 |
| | north jetty | cage | 0 | 13 | 0 |
| 30. January. 2013 | ULD | cage | 0 | 3 | 0 |
| | south jetty | cage | 0 | 10 | 1 |
| | north jetty | cage | 0 | 3 | 2 |
| 12. February. 2013 | entrance | gill net | 84 | 0 | 5 |

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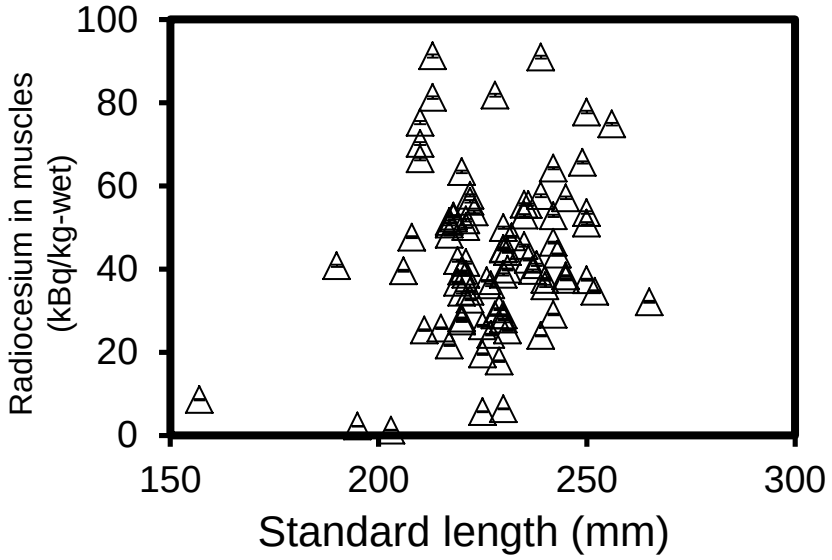
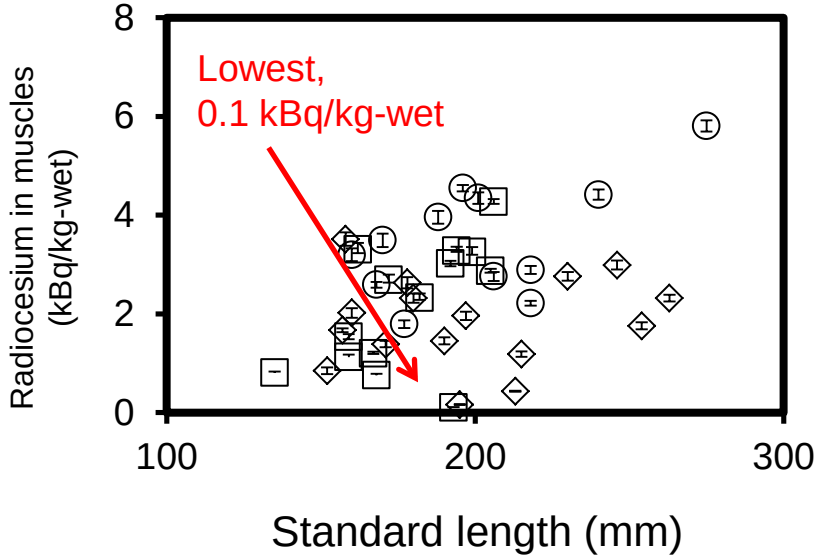
# Concentrations of radiocesium in fish obtained in the port of FDNPP

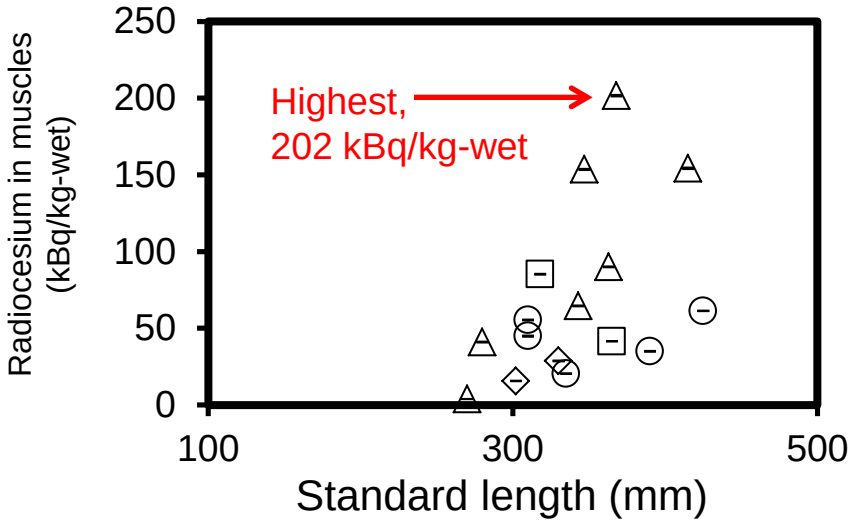
*Japanese rockfish*




*brown hakeling*




*fat greenling*




Slight correlations between standard length and concentrations of radiocesium in muscles was observed in Japanese rockfish ($r = 0.217$, $p < 0.05$), brown hakeling ($r = 0.363$, $p < 0.05$), and fat greenling ($r = 0.476$, $p < 0.05$).
Concentrations of radiocesium differed even among individuals of similar size of fish.

△ ; Entrance of port
◇ ; North jetty
□ ; Sorth jetty
○ ; Unloading deck

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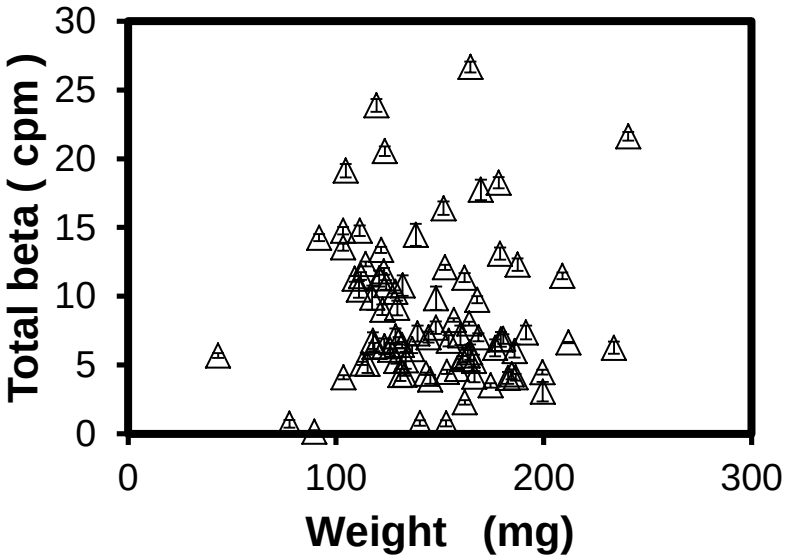
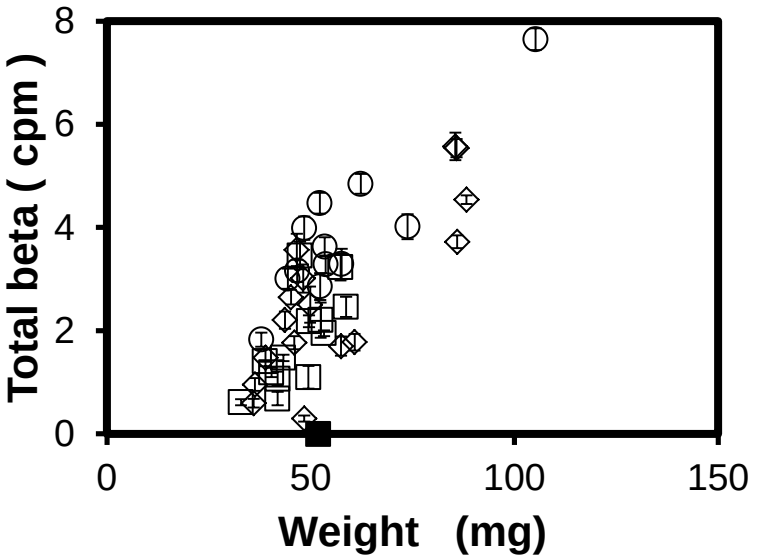
# Beta-rays were detected in all otoliths isolated from the fishes

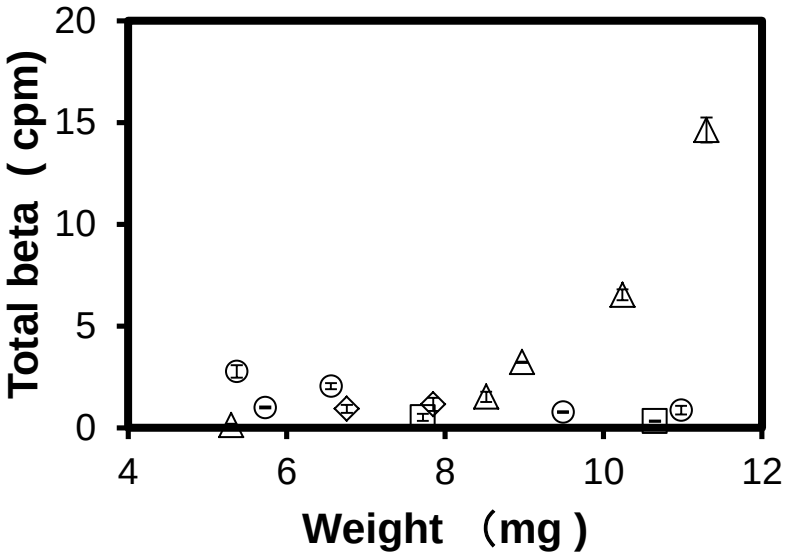
*Japanese rockfish*




*brown hakeling*




*fat greenling*




The beta-ray count rates from otoliths differed even among fish of similar weight from the same species.
There was good correlation between beta-ray count rates from otolith and the weight of otolith in brown hakeling ($r$ = 0.782, $p$ < 0.001).

△ ; Entrance of port
◇ ; North jetty
□ ; Sorth jetty
○ ; Unloading deck

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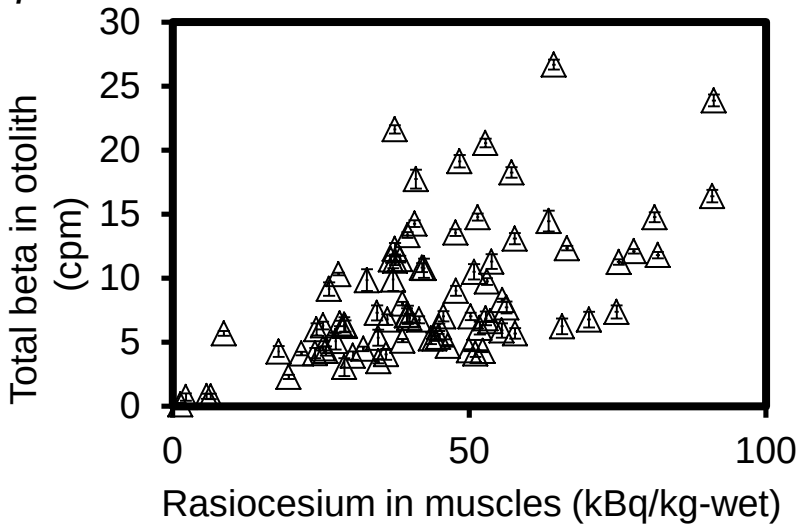
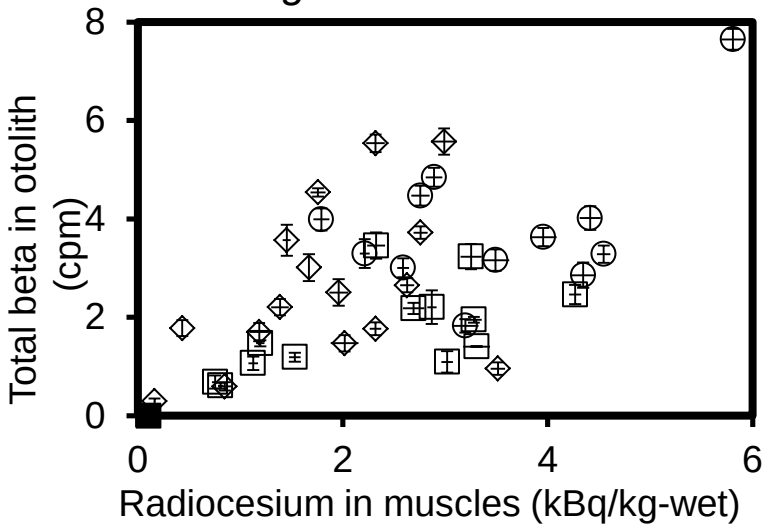
# Relationship between radiocesium concentrations in muscles of fish and total beta-ray counts of otoliths

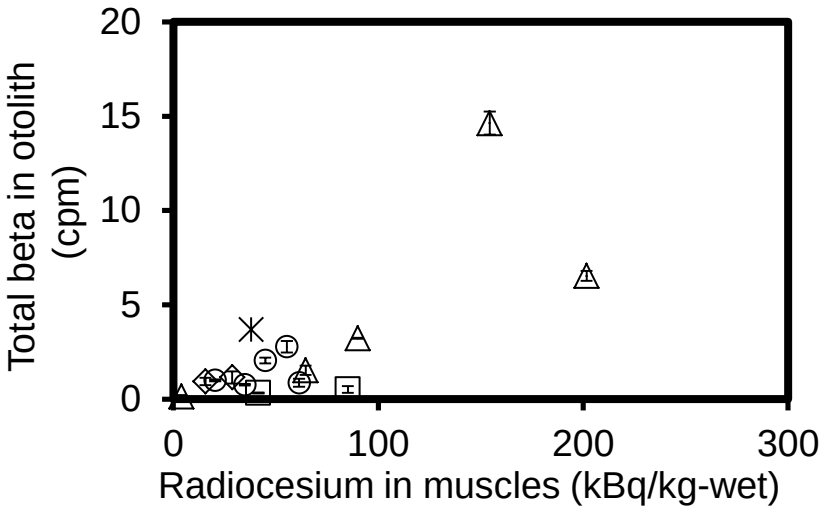
*Japanese rockfish*




*brown hakeling*




*fat greenling*




Correlation coefficients for Japanese rockfish, brown hakeling, and fat greenling were 0.567 ($p < 0.001$), 0.569 ($p < 0.001$), and 0.755 ($p < 0.005$), respectively.

△ ; Entrance of port
◇ ; North jetty
□ ; Sorth jetty
○ ; Unloading deck

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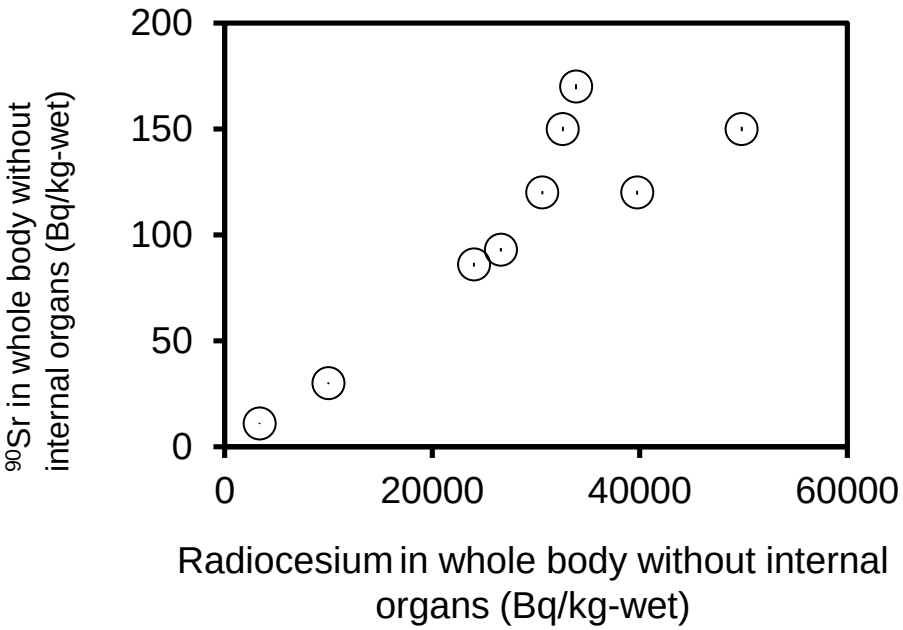
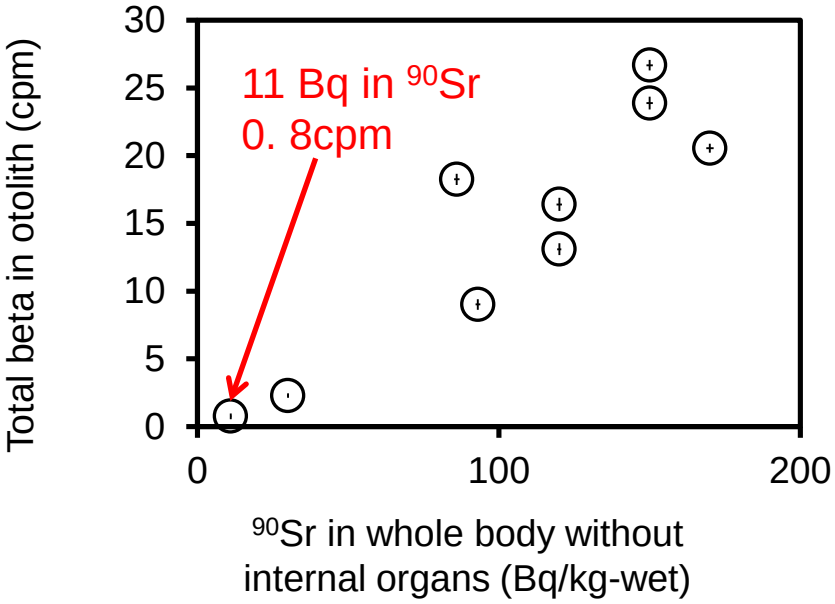
# Beta-ray emitted from the fish otoliths was originating from $^{90}$Sr

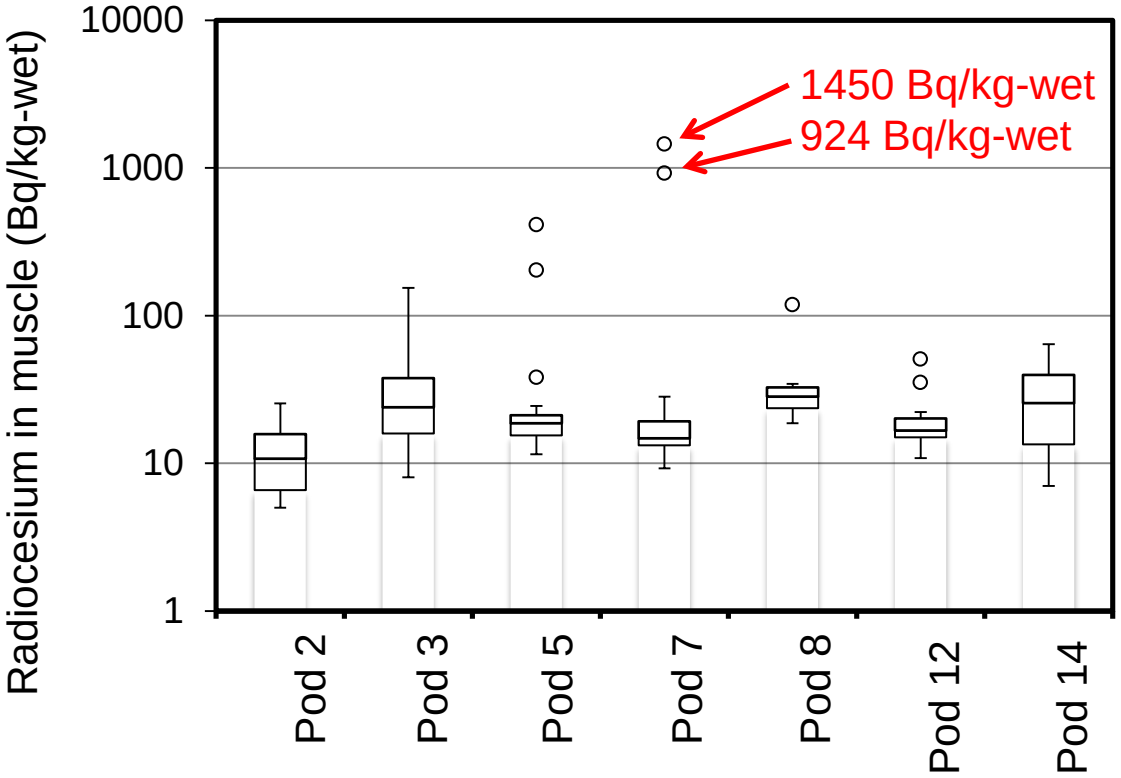


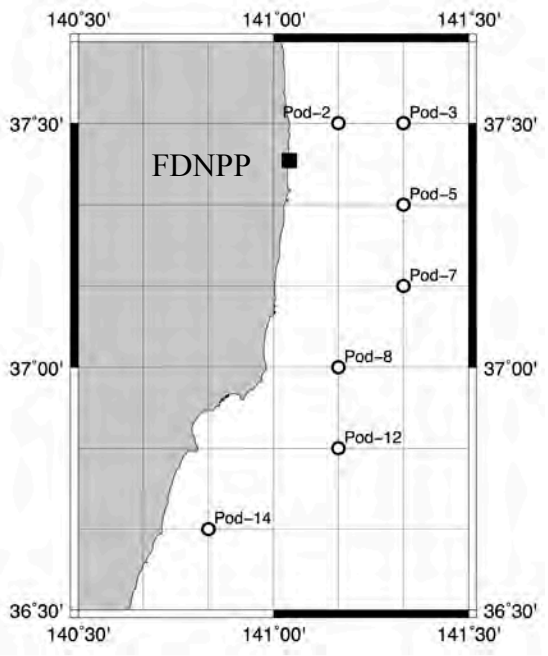




The concentration of $^{90}$Sr was directly proportional to that of radiocesium in the whole body without internal organs of Japanese rockfish (Left panel, $r = 0.893$, $p < 0.005$)
The concentration of $^{90}$Sr in Japanese rockfish was correlated with the counts of beta-rays emitted from the otoliths (Right panel, $r = 0.904$, $p < 0.005$).

Fig. 5

# Results of survey for brown hakeling by R/V Soyo-maru




In this surver, beta-rays were not detected in otoliths from any samples, including fish samples with radiocesium concentrations greater than 500 Bq/kg-wet.

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# Take home messages

✓The beta-rays were emitted from otoliths of fishes caught in the port of FDNPP.

✓Beta-ray intensities were correlated with the concentrations of radiocesium in muscles of the three fish species.

✓The beta-ray count rates from otoliths showed good correlation with the concentration of $^{90}$Sr in whole body without internal organs of Japanese rockfish.

✓No beta-rays were detected from brown hakeling samples collected around FDNPP. We suggest, the detection of beta-rays from otoliths may indicate that the fish had ever lived in the main port of FDNPP.

✓Use of otoliths to estimate the concentration of $^{90}$Sr is simple and convenient. This method can be applied to only high dose sample (more than 10 Bq/kg-wet as $^{90}$Sr).

References

Fujimoto et al. (2015) Environ Sci Technol, 49, 7294−7301

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