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Modeling of radionuclide transfer to biota in the Fukushima area

The French AMORAD* project (2013-2022)

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INTRODUCTION

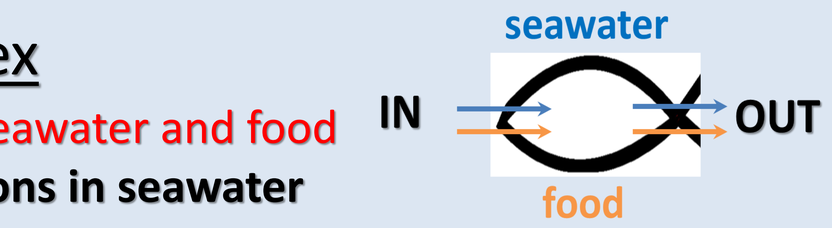
In 2013, the AMORAD project was launched to **improve the modeling of the dispersion of radionuclides in the environment and the assessment of their impacts on different ecosystems**.

Here, we present the results of the modeling efforts carried out to study the ^{137}Cs contamination of marine biota following the accident at the Fukushima Daichi Nuclear Power Plant **(hereafter = FDNPP1).**

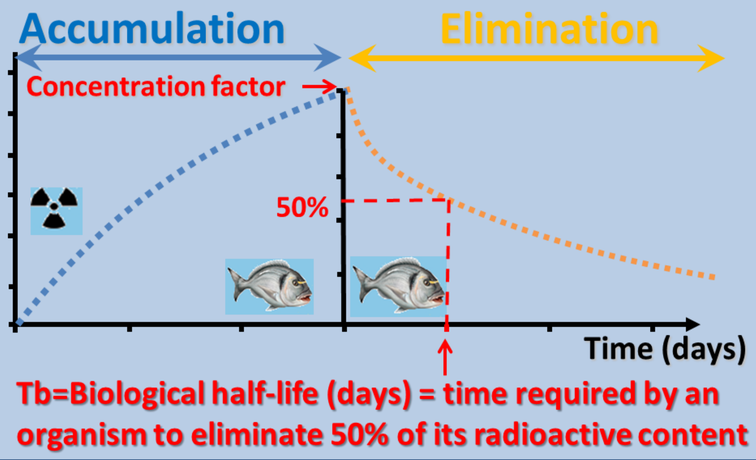
RESULTS

From the simplest to the most complex

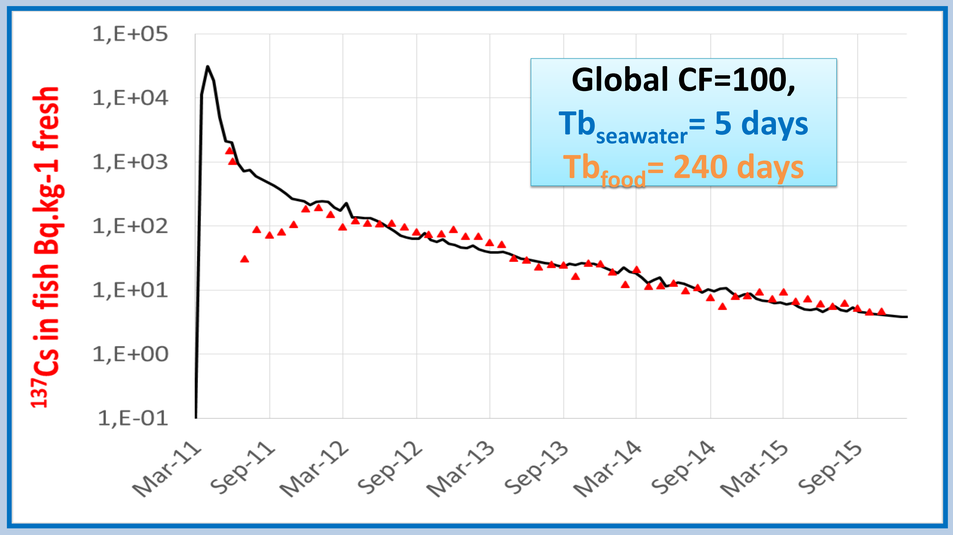
4 approaches taking into account cesium accumulation both by seawater and food and **requiring a coupling with a model giving ^{137}Cs concentrations in seawater**



1. Biokinetic models



Tb=Biological half-life (days) = time required by an organism to eliminate 50% of its radioactive content



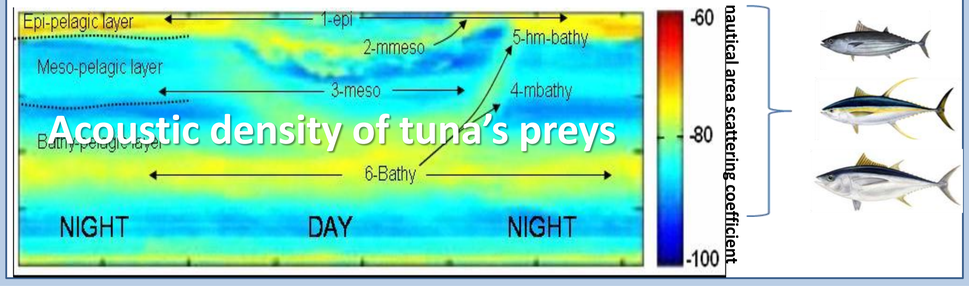
^{137}Cs in fish living close to the bottom in the area 2-30km from the **FDNPP1** showing good agreement between model results (-) and field data (Δ).
Fish = group of all fishes living close to the bottom – no indication of species

Fiévet et al., 2017, PlosOne

2. From Zooplankton to Tunas

Coupling model SEAPODYM with ^{137}Cs transfer equations to simulate the dynamics of zooplankton and 6 functional groups of tuna's prey living in the water column (0-1000m) and their contamination after the accident

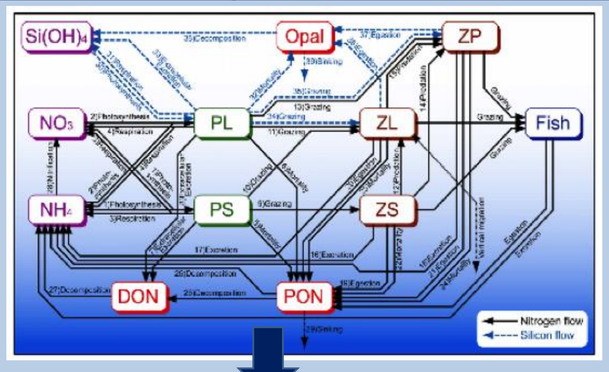
See poster #43 for details



Outputs are used to compute contamination risk index for 3 tuna species in the North Pacific Ocean with skipjack having the highest indexes. These indexes can be used for fisheries management.

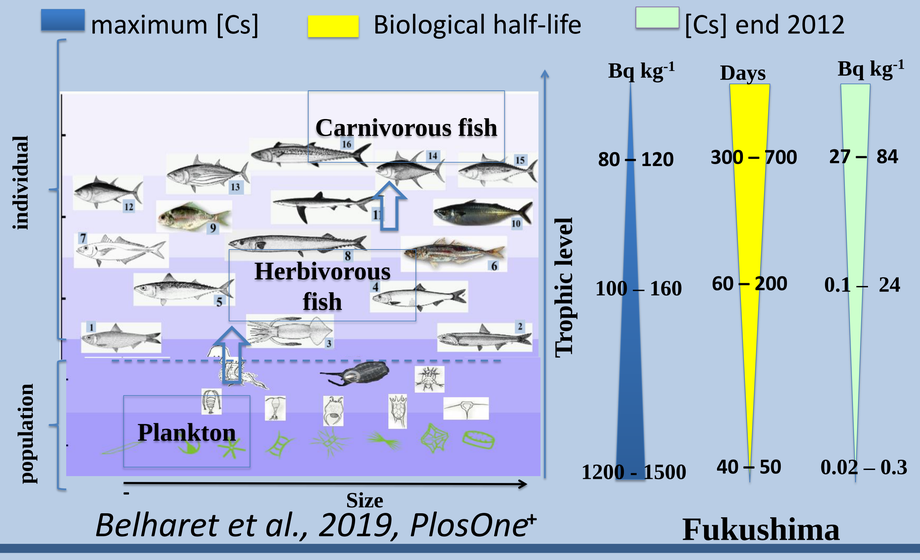
3. From Phytoplankton to fish living in the water column

Modelling the ^{137}Cs transfer to plankton populations and to 16 fish species living in the water column using ecosystem model and radioecological model



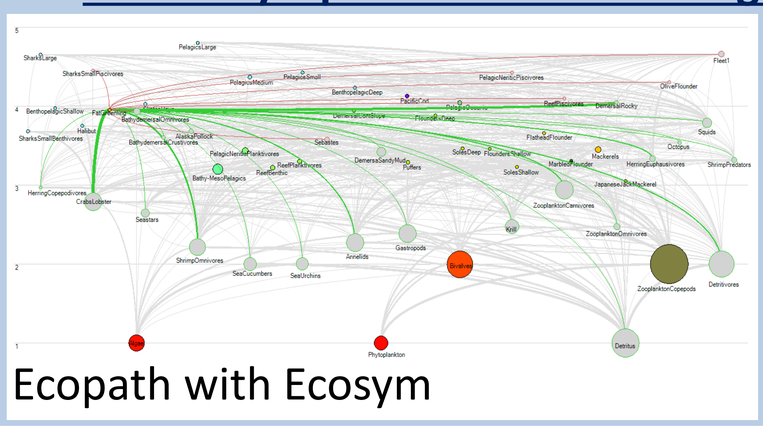
^{137}Cs transfer model to biota

Model Ouput => plankton populations accumulate more ^{137}Cs but eliminate it more rapidly and it is the opposite for fish



Belharet et al., 2019, PlosOne+

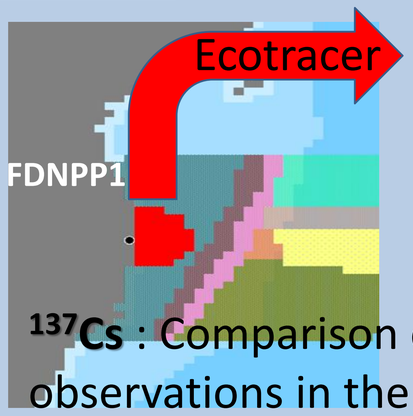
4. From Phytoplankton to fish living in the water column and on bottom sediment

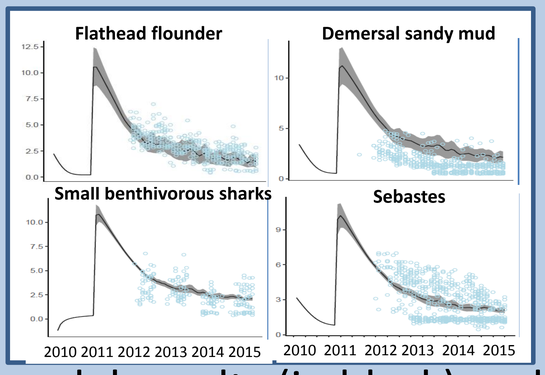


Ecopath with Ecosym

A comprehensive foodweb model comprising 56 groups
Example: in green the groups on which the fat greenling feeds and in red the groups which feed on this species including the fisheries

Booth et al., 2020, Ecological Modelling





^{137}Cs : Comparison of model results (in black) and observations in the field (O) in the 20km area

TAKE-AWAY MESSAGE

Biokinetic models (1) are particularly suited to the accident phase, that is to say the acute phase of the accident which is mainly dealt with in crisis centers since they are easy to handle, whereas the implementation of more complete and complex models based on ecosystem approaches (2, 3 and 4) require more time and are well adapted both to the post-accident phase which can last several years and to the important problem of fisheries management in mid and long terms.