NOW WE KNOW WHY THERE ARE SO FEW EXAMPLES OF MICROCOSM STUDIES IN RADIOECOLOGY.

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DSA Norwegian Radiation and Nuclear Safety Authority

The future of Radioecology

INTERNATIONAL COMMISSION ON RADIOLOGICAL PROTECTION

International Atomic Energy Agency

…aim to have negligible impact on
- biological diversity,
- conservation of species,
- health and status of natural habitats / communities

International Union of Radioecology

Mismatch between environmental protection goals and the endpoints measured

Ecosystem approaches are needed to support protection goals

Lack of good experimental data to evaluate ecosystem-level effects of radiation

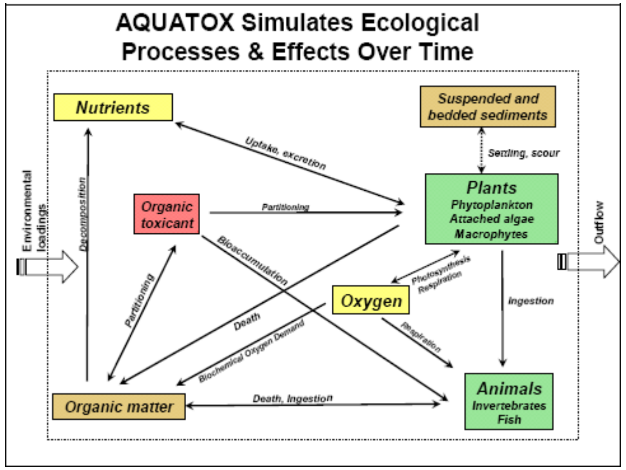
Radioecology studies thus far…

RAPS approach:

- Single species endpoints:
  - Mortality, reproduction, chromosome damage
- Models

Ecosystems approach:

- Population endpoints
  - growth, size, density, age, net reproduction, rates
- Community endpoints
  - Structure (biodiversity, food web)
  - Functional (primary production, biomass, energy)
  - Indirect effects



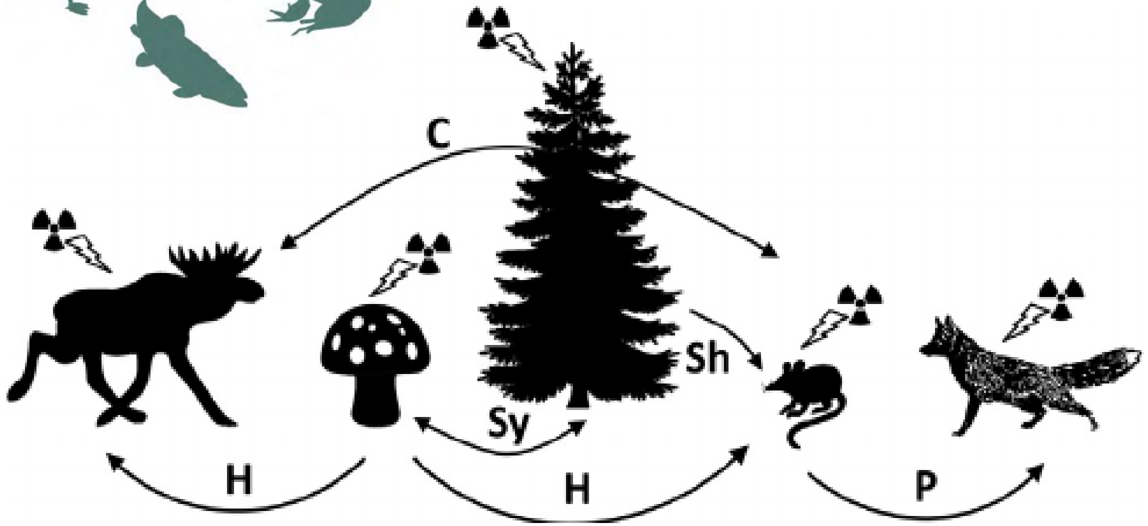


Figure: Clare Bradshaw

How to study an ecosystem?

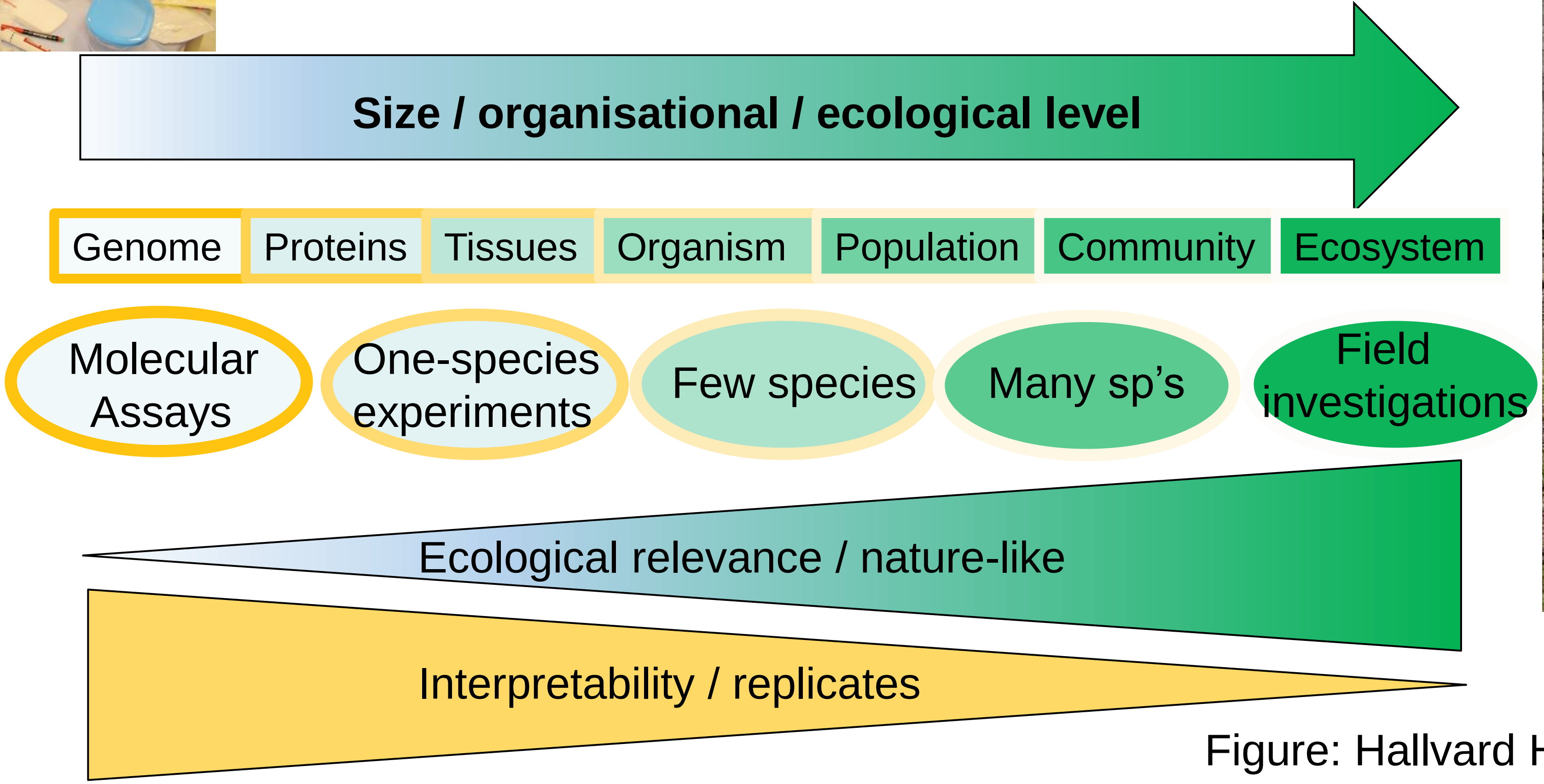


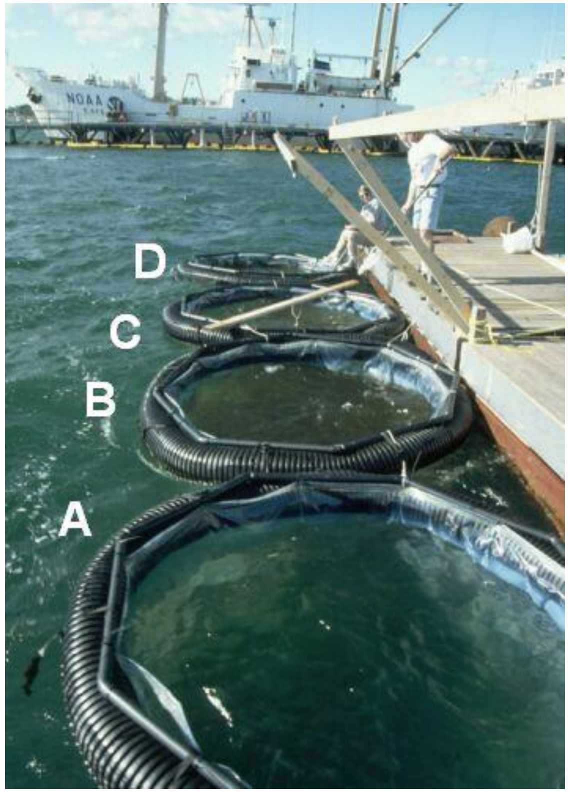
Figure: Hallvard Haanes

Microcosms and mesocosms…

Multispiecies experimental units.

1. *Contain abiotic and biotic components*

2. Can show ecological processes



Bilder: Googleimages

Bilder: Clare Bradshaw, Stockholm University

nks
Nordic nuclear safety research

B; Radioecology and environmental assessments.

NORCO I & NORCO II

UNIVERSITY OF EASTERN FINLAND

NMBU

Stockholm University

DSA Norwegian Radiation and Nuclear Safety Authority

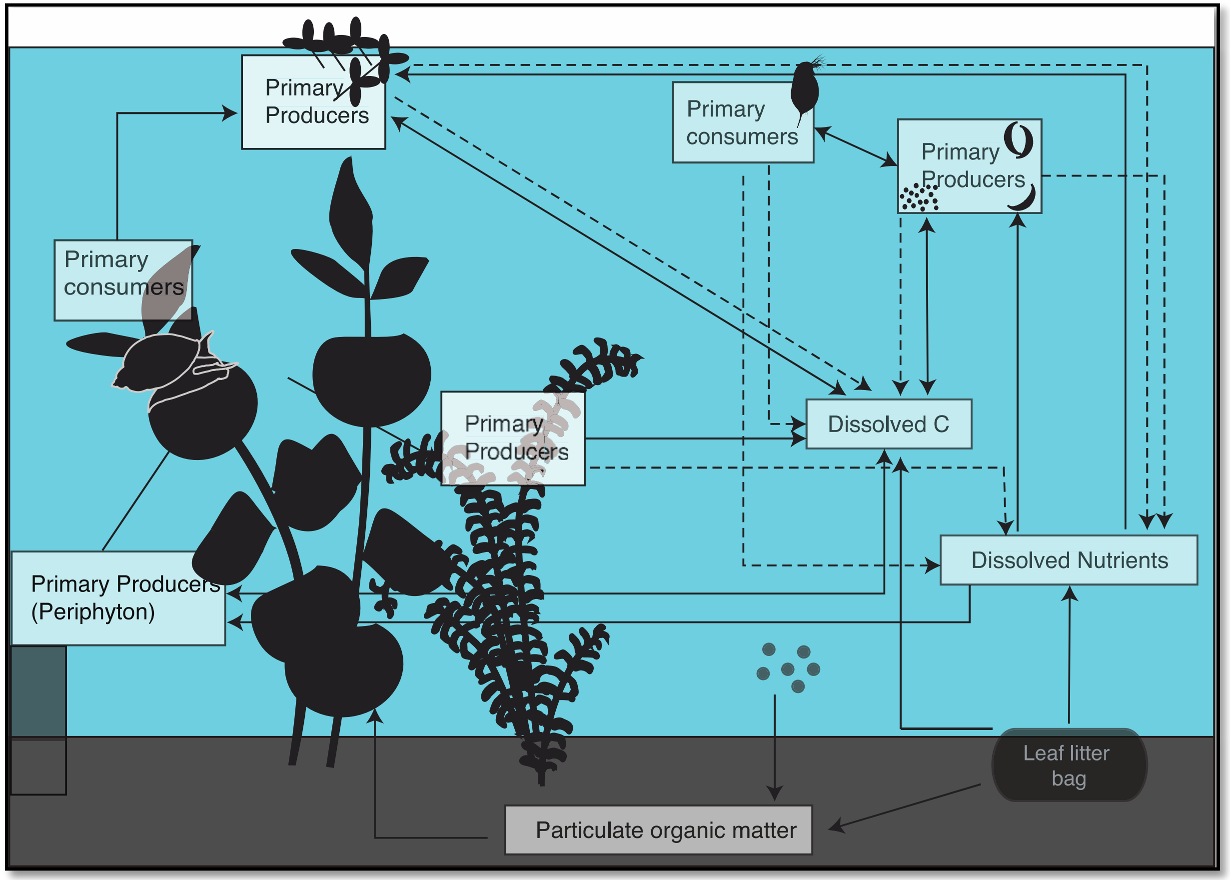
CERAD
CENTRE FOR ENVIRONMENTAL RADIOACTIVITY

NIVA
Norsk institutt for vannforskning

IUR International Union of Radioecology

NORCO I:
Radiation effects and ecological processes in a freshwater microcosm.

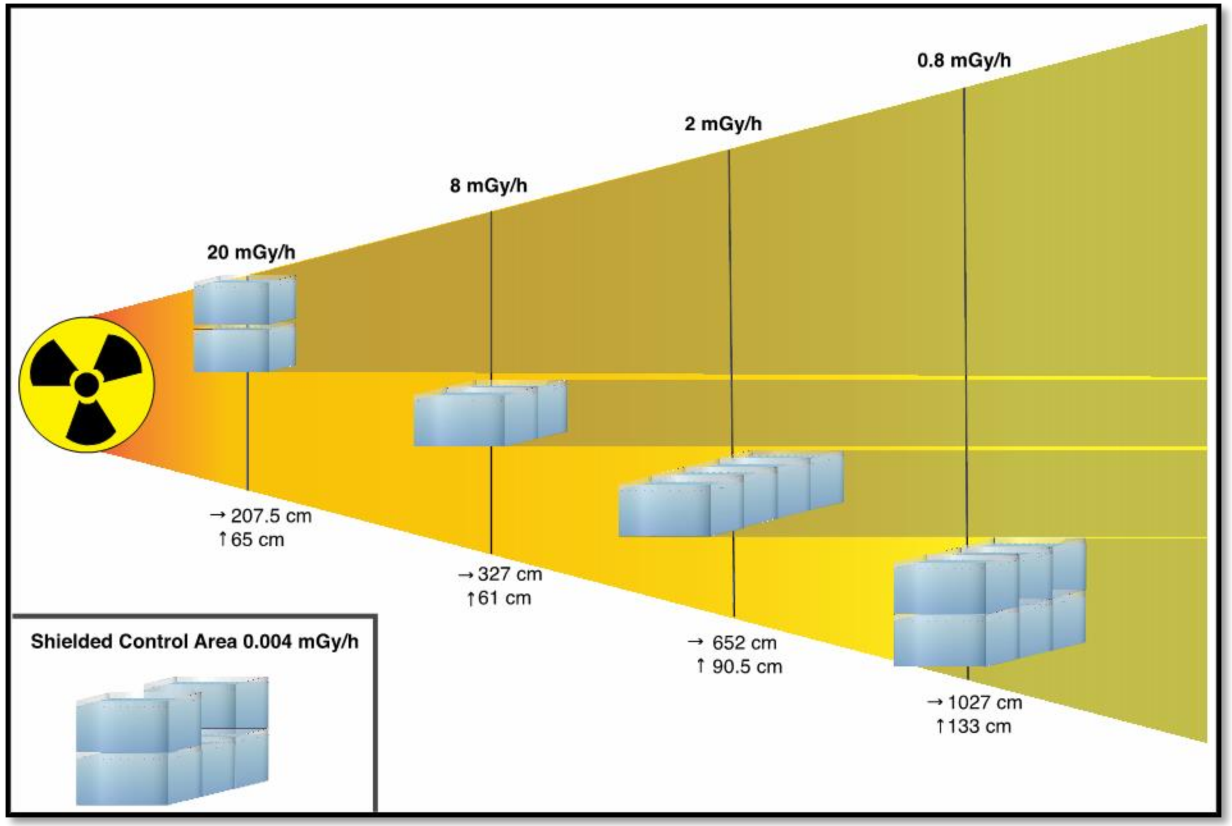
Hevrøy. TH & Golz. A-L, Xie.L, Hansen. EL and Bradshaw. C. Submitted JER 2018.



Ecosystems approach:

- Population endpoints
  - growth, size, density, age, net reproduction, rates
- Community endpoints
  - Structure (biodiversity, taxonomi, food web)
  - Functional (primary/NEP production, biomass, energy
  - Indirect effects

Cosms exposed to ionizing radiation from Co-60 source for 21 days

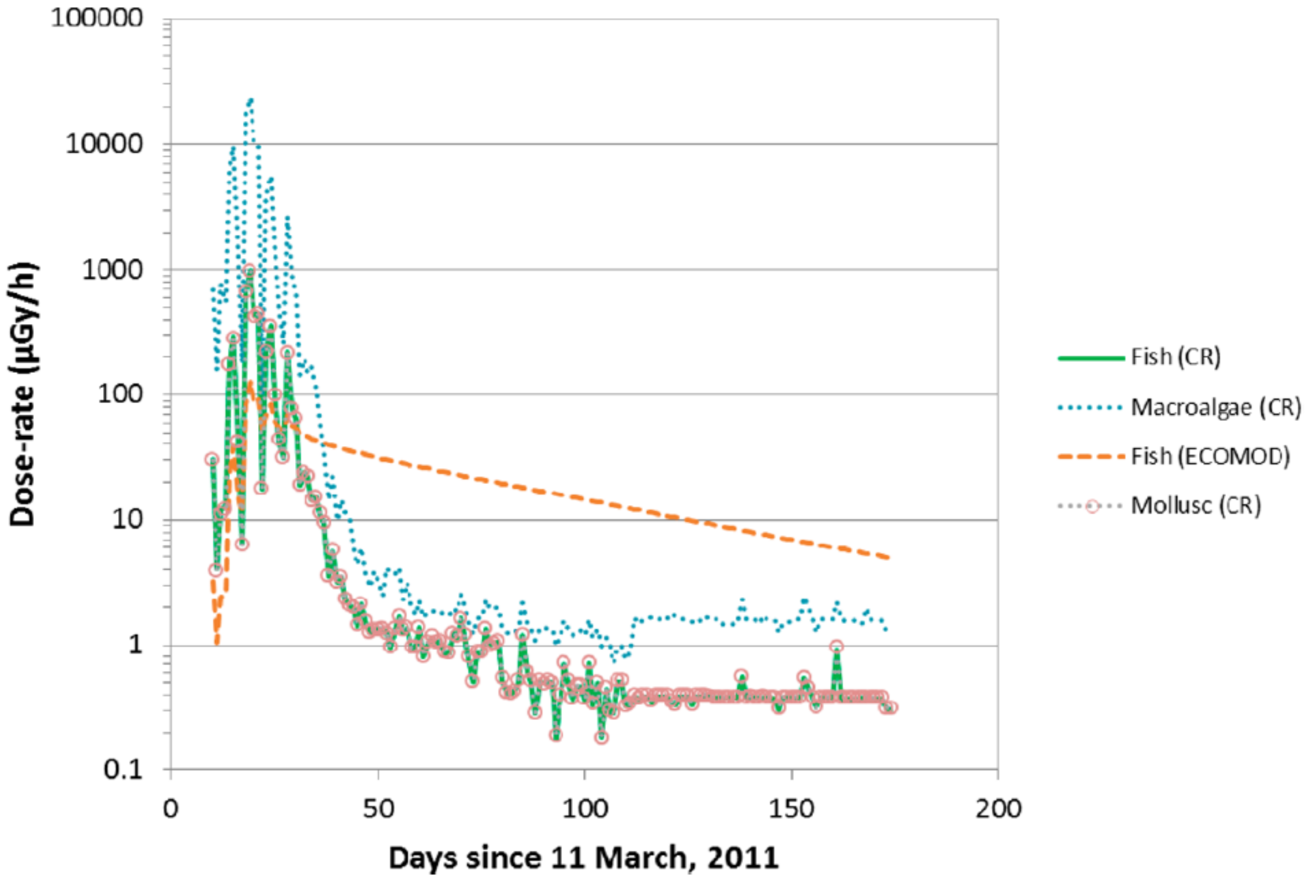


Dose comparisons

Chernobyl Lakes – 0.1 – 30 mGy/hr

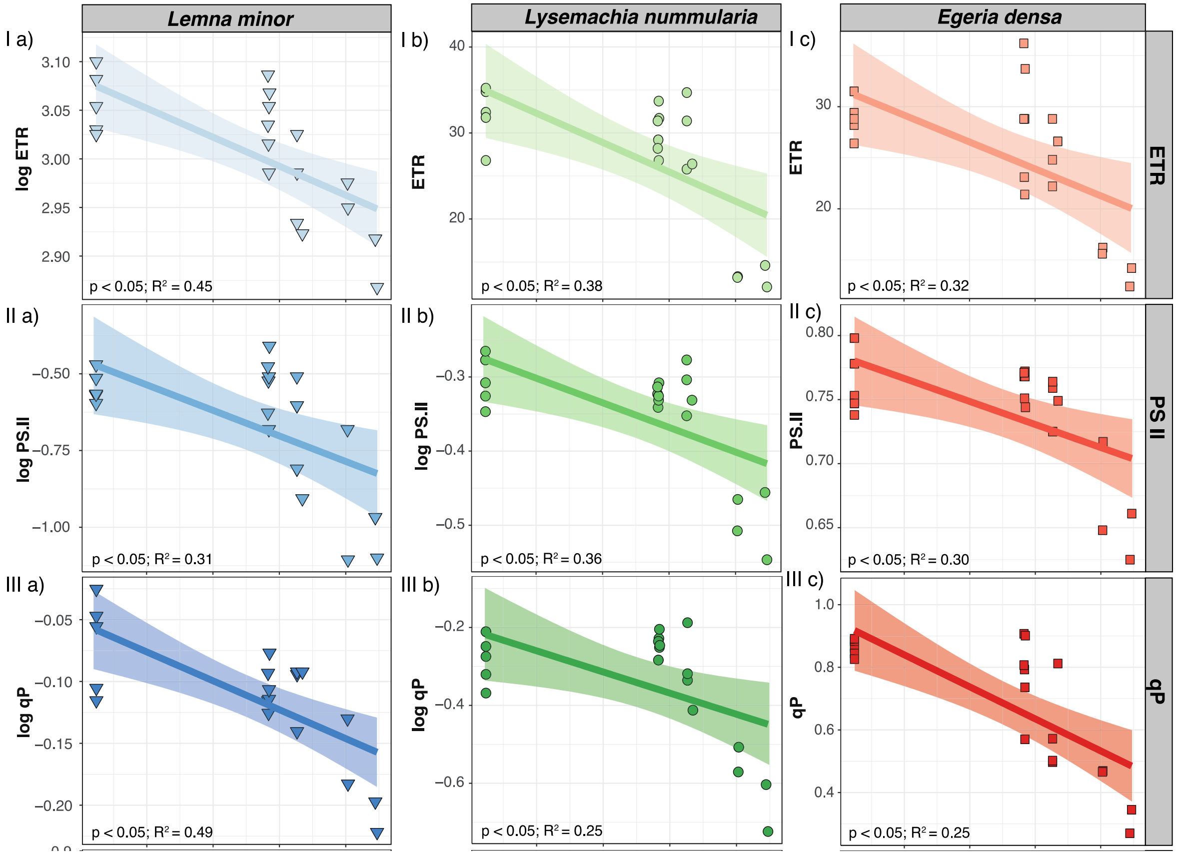
Chernobyl acute phase – estimated absorbed dose up to 20 Gy/d for pine trees (UNSCEAR 2008)

Fukushima – Strand et al 2014

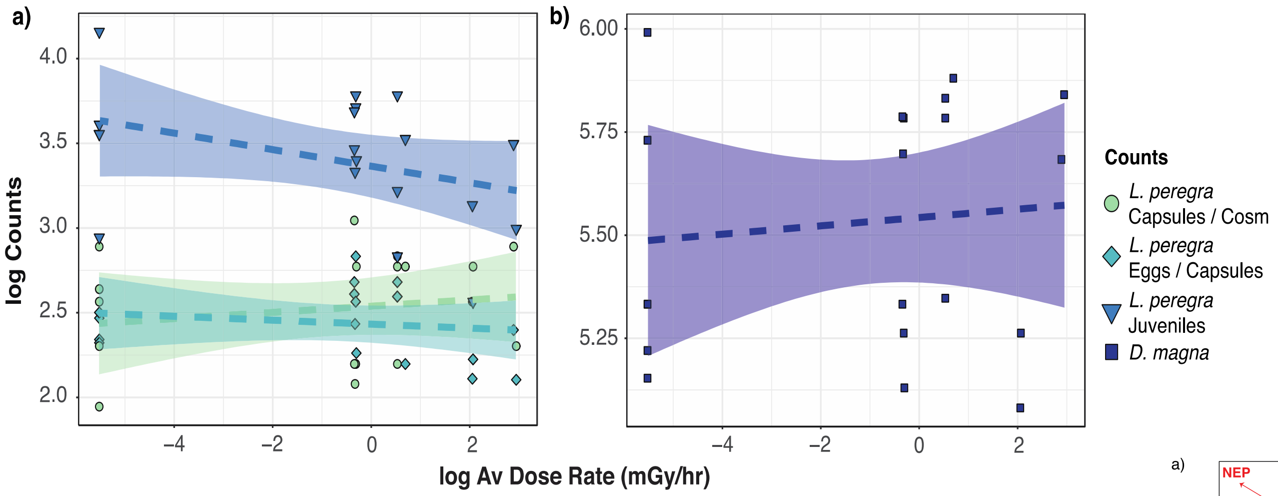


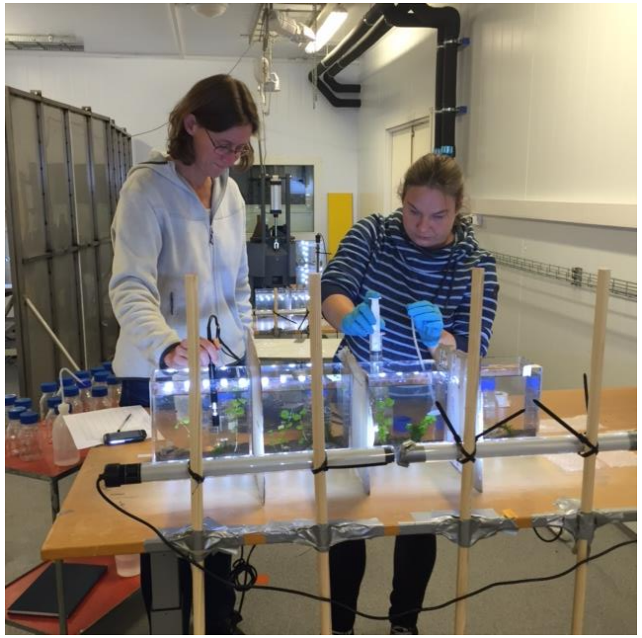
Some results…

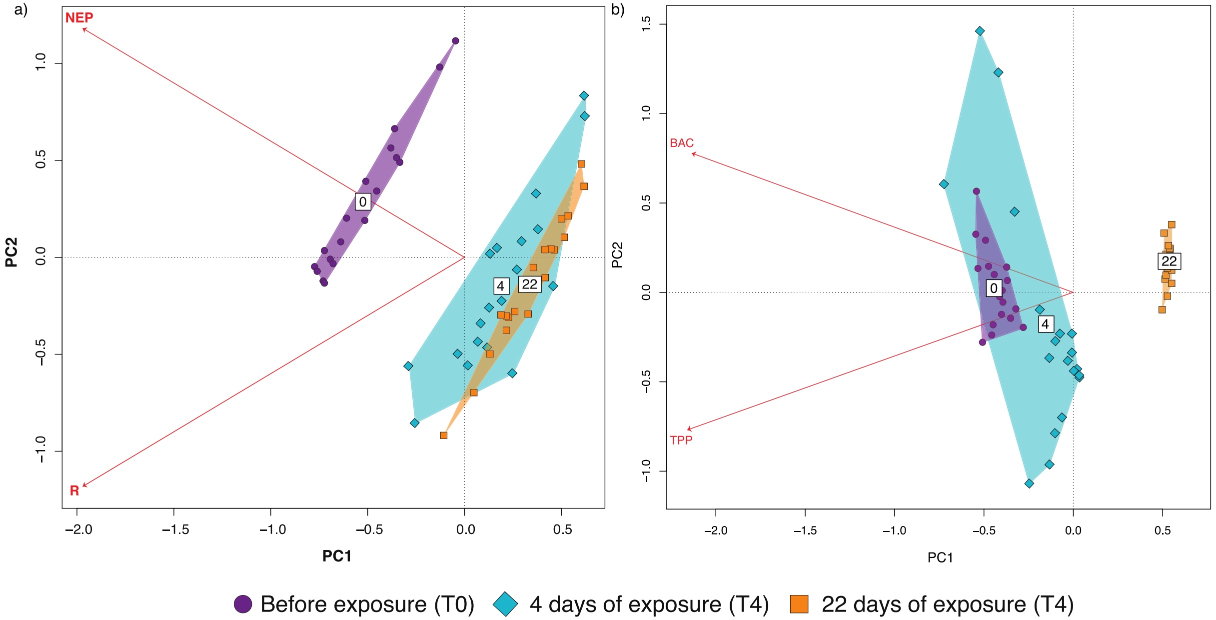
Plants:
photosynthetic parameters
- different sensitivity



Grazers and production

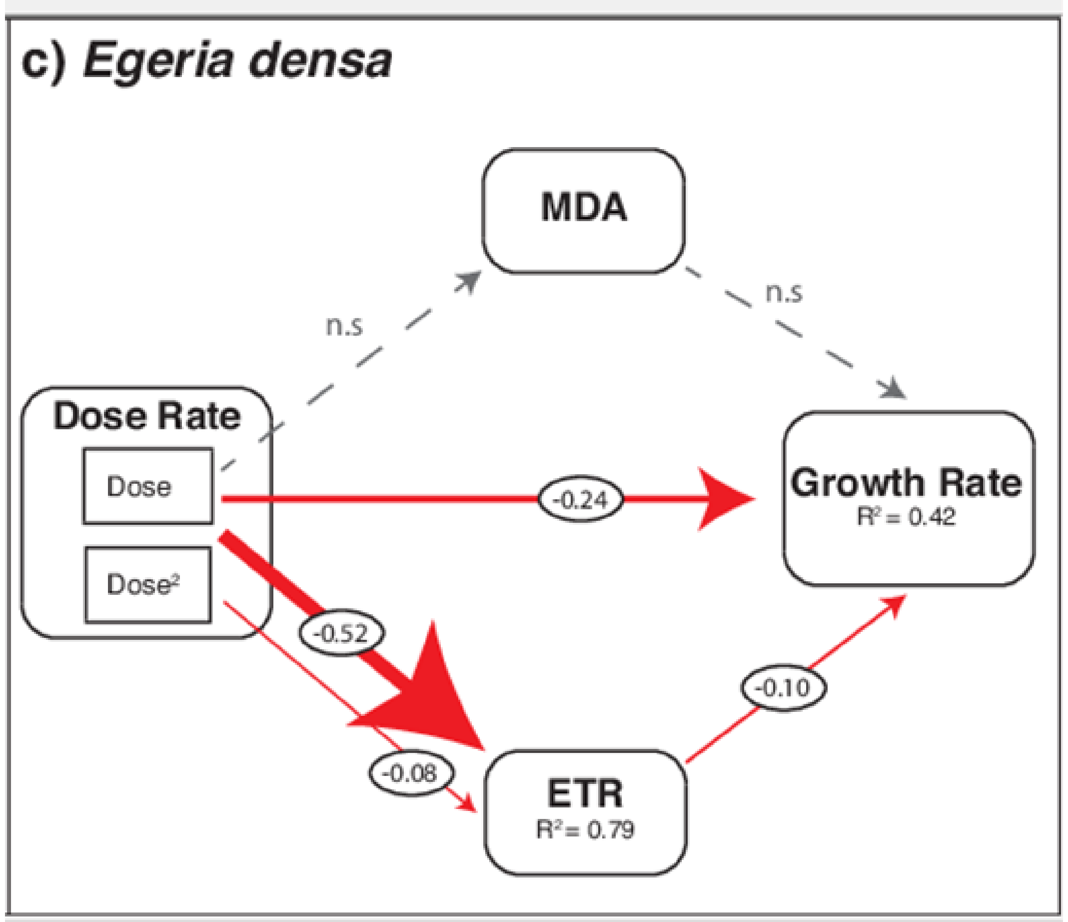






Structural equation Modelling (SEM)

- Networks to estimate **Indirect effects.**
- Hypothetical or defined pathways



Summary of NORCO I

- Few significant effects of dose rate at endpoints measured
- Individual effects -> could lead to highler level effects…
- Ecosystem buffering

- Restricted by time
- Restricted by radiation field

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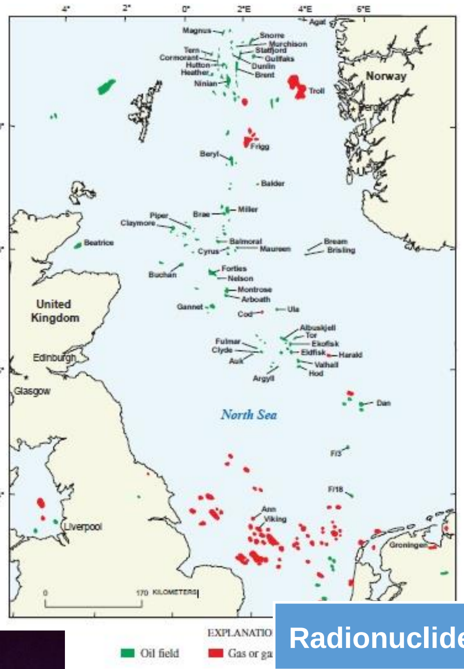
NORCO II
Radionuclides in our ocean

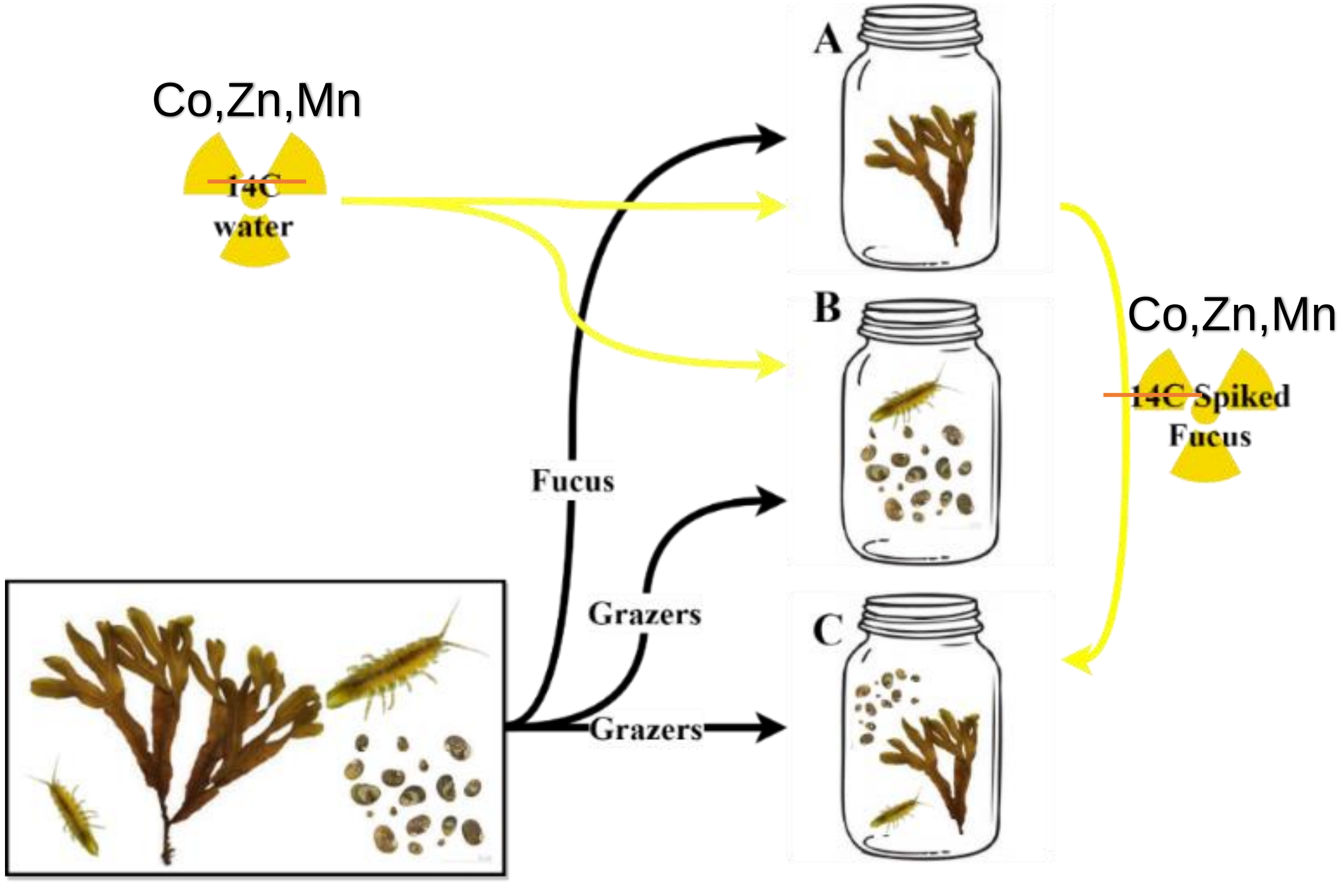


Radionuclide	Rate of release		Produced water
	GBq/år	Bq/s	Bq/L
210Pb	1,1	34.88	0.2
226Ra	20.4	646.88	3.7
228Ra	19,3	612.00	3.5

NORCO II- Trophic transfer of radioisotopes of the micronutrients Mn-54, Zn-65 and Co-57 in the Baltic sea.

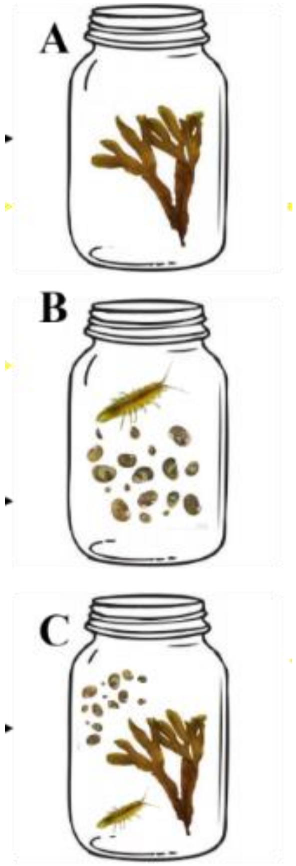
(Holmerin I, Bradshaw C, Hevrøy T, Jensen LK)

Aim: assess transfer and uptake of radionluclides through a bentic Baltic sea community consisting of aglae and grazers.



3RN Treatment: Cosm treatment:	A: Fucus + 3RN spiked water:	B: Grazers + 3RN spiked water:	C: Grazers + Fucus spiked with 3RN:
Control	5 jars	-	-
Eutrophied	5 jars	-	-
Eutrophied + Grazer	5 jars	5 jars	5 jars
Grazer	5 jars	5 jars	5 jars

Prelim results!

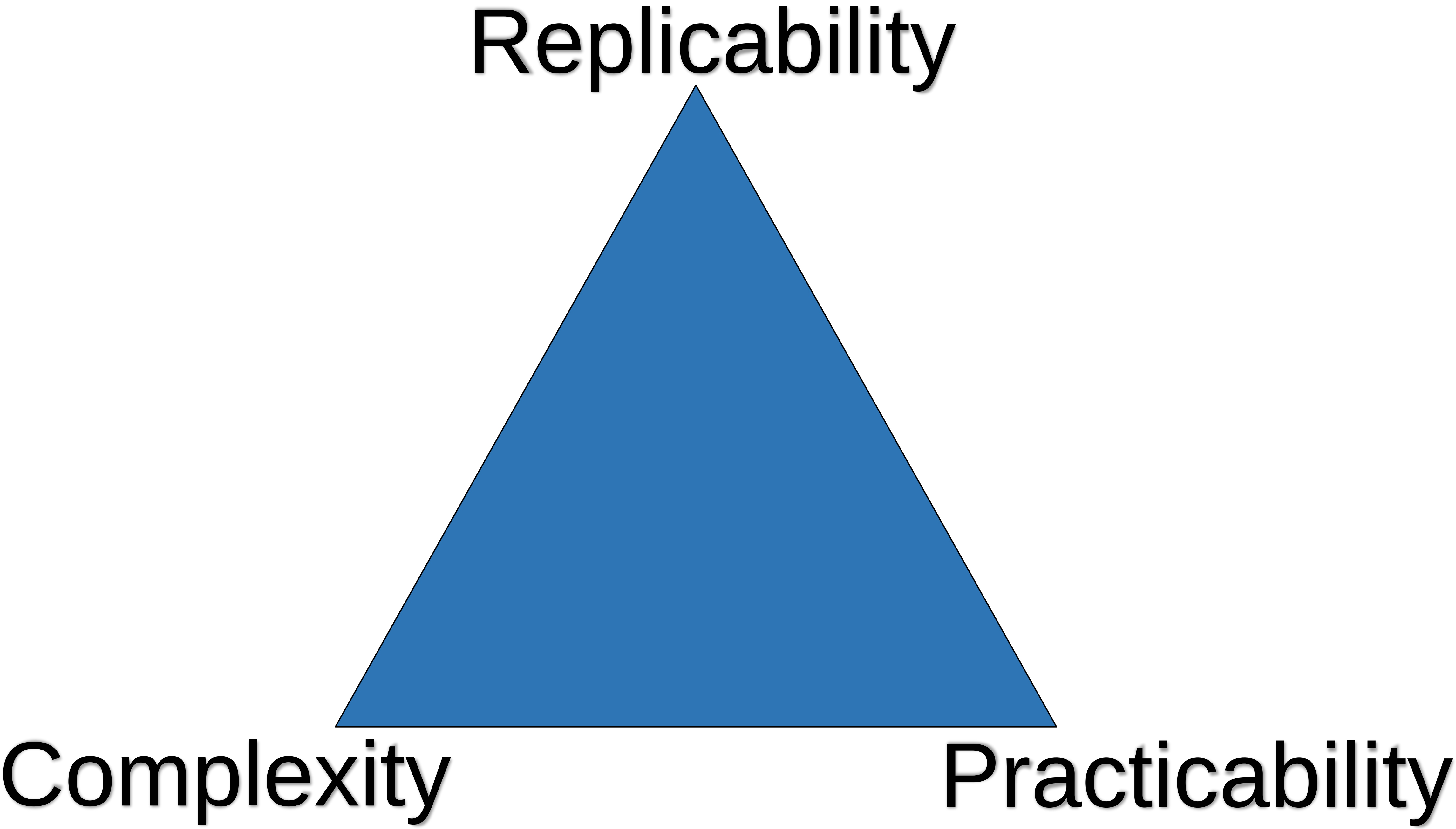


Fucus – approx 70 Bq/g – no obvious variation amoung radionuclides

Idotea - B (Co = 150, Mn = 150 Zn = 240)
C (Co = 5, Mn = 5 Zn = 13)

Theodoxus – B(Co = 45, Mn = 50 Zn = 200)
C (Co = 4, Mn = 2 Zn = 14)

- ***Restricted by waste management, toxicity, half-lives***


Replicability
Complexity
Practicability