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

_Tanya. H. Hevroy, PhD_
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

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

The future of Radioecology
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
How to study an ecosystem?

Size / organisational / ecological level

- Genome
- Proteins
- Tissues
- Organism
- Population
- Community
- Ecosystem

Molecular Assays
One-species experiments
Few species
Many sp’s
Field investigations

Ecological relevance / nature-like
Interpretability / replicates

Figure: Hallvard Haanes
Microcosms and mesocosms...

**Multispecie experimental units.**

1. **Contain abiotic and biotic components**
2. **Can show ecological processes**
B; Radioecology and environmental assessments.

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


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...

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<tr>
<th>Plants: photosynthetic parameters - different sensitivity</th>
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<tr>
<th></th>
<th>Lemna minor</th>
<th>Lysemachia nummularia</th>
<th>Egeria densa</th>
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<td>I b) Log ETR</td>
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Grazers and production

![Graphs and images related to grazers and production.](image-url)
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 higher level effects…
• Ecosystem buffering

• Restricted by time
• Restricted by radiation field
NORCO II
Radionuclides in our ocean

<table>
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<tr>
<th>Radionuclide</th>
<th>Rate of release</th>
<th>Produced water</th>
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<tr>
<td>210Pb</td>
<td>1.1 GBq/år</td>
<td>34.88 Bq/s</td>
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<tr>
<td>226Ra</td>
<td>20.4 GBq/år</td>
<td>646.88 Bq/s</td>
</tr>
<tr>
<td>228Ra</td>
<td>19.3 GBq/år</td>
<td>612.00 Bq/s</td>
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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 radionuclides through a benthic Baltic sea community consisting of algae and grazers.
Fucus – approx 70 Bq/g – no obvious variation among 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