

## Mid-year Project Review for Research Theme Area #5: Environment

### Environmental Perspectives on Historic Chalk River Radioactive Releases

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Assessing effects of legacy nuclear waste on plants: sensitive fern (*Onoclea sensibilis*) gametophyte viability at the Chalk River site

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We evaluated the effects of chronic exposure to environmental radiation on the reproductive fitness of sensitive fern by quantifying mutations in haploid gametophytes of spores from background and contaminated areas of the Chalk River site.

- Fern spores were irradiated from 1 to 1000 Gy to develop dose-response curves.
- Logistic curves fit to laboratory exposure data show that decreased spore viability begins at doses of about 10 Gy with complete reproductive failure at doses of 1000 Gy.
- In situ field dose rates ranged from 60 to 849  $\mu\text{Gy h}^{-1}$ , with effects possible  $>400 \mu\text{Gy h}^{-1}$ .
- We found no effects on gametophyte viability at the most contaminated areas of the Chalk River site, where we estimated growing season doses of 0.3 to 3.7 Gy.
- Fern spores were irradiated from 1 to 1000 Gy to develop dose-response curves, then exposed to more consistent light exposure.
- Germination was less variable, leading to much higher regression  $r^2$ . Unlike the initial experiment, with sufficient light, more spores successfully germinated and developed into viable gametophytes. The response to dose, however, was similar among experiments, with effects observed above 10 Gy.
- Hormetic curves fit to field composite laboratory exposure data for germinated spores show that spore viability increases up to doses of 10 Gy, with decreased spore viability above 10 Gy and complete reproductive failure at doses of 1000 Gy.
- Through chronic in situ field exposures and acute laboratory irradiations, we found that there was no evidence of reproductive impairment of sensitive fern at the most contaminated areas of the Chalk River site.
- Furthermore, there is evidence of hormesis for sensitive fern, with increasing gametophyte viability as doses approach 10 Gy.
- Field data, with doses of less than 10 Gy (60- 849  $\mu\text{Gy h}^{-1}$ ), fall along the dose-response curves and suggest that dose rates at waste management areas are too low to cause reproductive impairment in sensitive fern.

Assessing ecological effects of sediment contamination using burrowing mayfly (*Hexagenia limbata*) populations

D.J. Rowan, L. Brinkmann and J. Carr

- A population study of the burrowing mayfly (*Hexagenia limbata*) in the Ottawa River upstream and downstream of the Chalk River site was conducted to assess ecological effects of legacy contamination.

- Were population effects observed in burrowing mayflies in contaminated sediment downstream of Chalk River sources?
- No observed effect of legacy contamination on *Hexagenia limbata* abundance, biomass or body size and similar abundance pre-NRX accident (Rigler, 1952) and in upstream Lake Temiskaming (Sallenave and Barton 1990).
- Population level studies are rare in ecological effects assessments, and we will also discuss the utility using benthic invertebrate populations in ecological risk assessments.

#### Recovery of Ottawa River sediments following the NRX accident (1952) and shutdown (1992)

D.J. Rowan, M. Bond and R. Silke

Utilizing historical records and data, probable mix of key radionuclides and dated ( $^{210}\text{Pb}$ ) cores collected for the Ottawa River ecological risk assessment, doses to benthic organisms at the time of the NRX accident can be reconstructed. Recovery of the river following the accident and shutdown of NRX can also be reconstructed.

- $^{137}\text{Cs}$  and  $^{241}\text{Am}$  profiles in sediment at the process outfall clearly show NRX operations and recovery following its shutdown.
- Radionuclides with relatively short half-lives ( $^{60}\text{Co}$ , 5.2y;  $^{152}\text{Eu}$ , 8.5y) were still detectable in cores collected in 2011 downstream of the CRL process outfall.