

Mid-year Project Review for Research Theme Area #5: Environment Parents, pools and pike: ^{210}Po in the Canadian environment

D.J. Rowan (Environmental Sciences, Canadian Nuclear Laboratories)

In this study, I assembled a large global data set and augmented it with field data from the Serpent River watershed to test a set of basic, but untested hypotheses regarding ^{210}Po in freshwater ecosystems. These hypotheses involve the relationships between short-lived ^{210}Po ($t_{1/2}=138\text{d}$) its relatively long-lived parent ^{210}Pb ($t_{1/2}=20\text{y}$), the degree of disequilibrium in ecological pools and the consequences of ecological processes and rates for a short-lived but bioaccumulative radionuclide.

To what degree is ^{210}Po supported by ^{210}Pb in water and suspended sediment?

- Dissolved concentrations of ^{210}Po and ^{210}Pb in freshwater (12 lakes, 9 rivers/streams; $n=207$) lie around the 1:1 line, with a geometric mean $^{210}\text{Po}/^{210}\text{Pb}$ ratio of 0.99. Concentrations of ^{210}Po and ^{210}Pb rivers/streams are much greater than in lakes suggesting dominance of terrestrial sources.
- The ratio of ^{210}Po to ^{210}Pb suspended sediment in rivers is very close to 1:1 suggesting secular equilibrium and terrestrial source. The ratios of ^{210}Po to ^{210}Pb for suspended sediment in lakes are much lower than 1, suggesting disequilibrium between parent and daughter representative of rapid atmospheric processes. Secular equilibrium of lake sediment is observed and expected for this longterm pool.
- For rivers and streams, long-term terrestrial pools are sources and maintain secular equilibrium. Disequilibrium in lakes will be driven by the relationship between catchment and atmospheric contributions of ^{210}Pb .

To what degree is ^{210}Po supported by ^{210}Pb in biota of various trophic levels?

- The relationship between ^{210}Po and ^{210}Pb in macrophytes suggests that ^{210}Po is supported by the decay of its parent, ^{210}Pb . This 1:1 relationship may reflect the adherence of sediment particles to the macrophyte surface
- The relationship between ^{210}Po and ^{210}Pb in benthic invertebrates with a regression line derived from Canadian data showing that the Australian data are not driving the relationship.
- The ratio of ^{210}Po to ^{210}Pb shows a clear increase with trophic level, from 1:1 in primary producers to almost 8:1 in piscivores. This pattern is similar to the ratio of methyl Hg to total Hg in freshwater food webs.
- These results suggest preferential trophic transfer of ^{210}Po relative to ^{210}Pb , i.e. higher assimilation from

What are the relationships between ^{210}Po in fish and their prey? Are there differences in ^{210}Po bioaccumulation between exposure and reference lakes and rivers?

- The geometric mean of the ratio of ^{210}Po in the flesh of northern pike to lake whitefish is 1.68 suggesting biomagnification. Northern pike from exposure lakes are about 2-fold higher than pike from reference systems raising the possibility that uranium mine effluent may enhance

^{210}Po biomagnification although there is insufficient data to identify the mechanism responsible for this pattern.

Are there similarities in Hg and ^{210}Po biokinetics? What is the assimilation efficiency of ^{210}Po from fish prey?

- ^{210}Po levels in Lake Athabasca northern pike are predictable from Hg biokinetics parameters, suggesting an assimilation efficiency of 0.8, much higher than reported from laboratory studies.

What is the elimination rate of ^{210}Po from fish?

- Elimination of ^{210}Po from northern pike is very slow and similar to Hg, suggesting that the short physical half-life of ^{210}Po limits its biomagnification.