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Mercury Accumulation and Redistribution on Near-Channel Floodplains

Laura A. Hempel[a], Carl E. Renshaw[b], Brian P. Jackson[b]

[a]College of Earth, Ocean, and Atmospheric Sciences, Oregon State University, Corvallis OR; [b]Dept of Earth Sciences, Dartmouth College, Hanover NH

Introduction

•As much as half of a river's annual sediment load is deposited onto its floodplain [1,2,3,4,5]

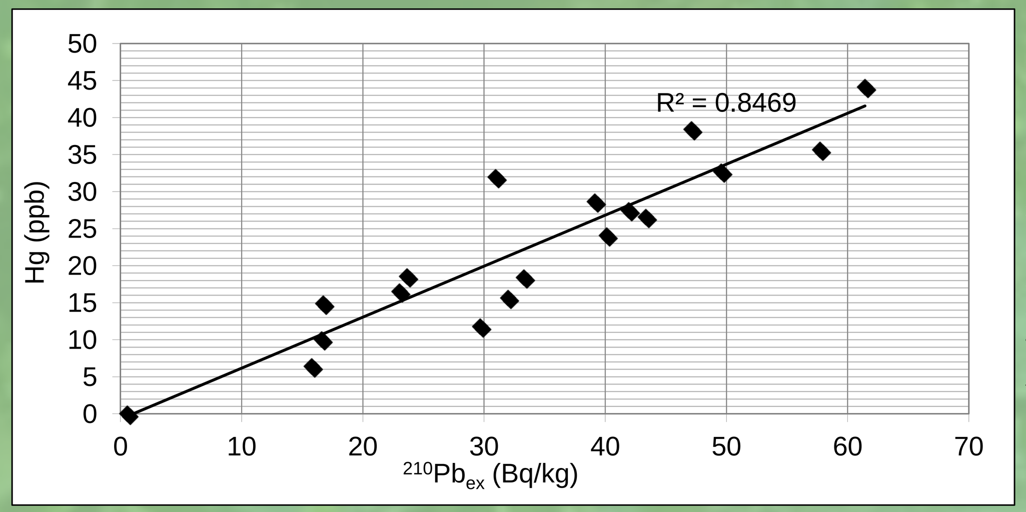
•Floodplain sediments can sequester significant amounts of pollutants[6]

•The spatial distribution of contaminants on floodplains is non-uniform and not well understood[7,8]

•A better understanding of contaminant storage and remobilization on floodplains is needed

Research Approach

- Atmospheric mercury and fallout radionuclides ($^{210}Pb_{ex}$ [$t_{1/2}$=22.3 yrs] and ^{7}Be [$t_{1/2}$=53 days]) interact similarly with sediment particles[9,10]
- This is demonstrated by the high correlation (r = 0.92) between $^{210}Pb_{ex}$ and Hg floodplain sediment concentrations[11]

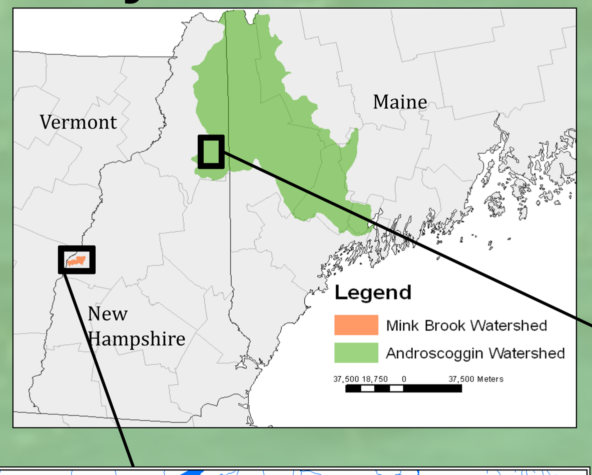


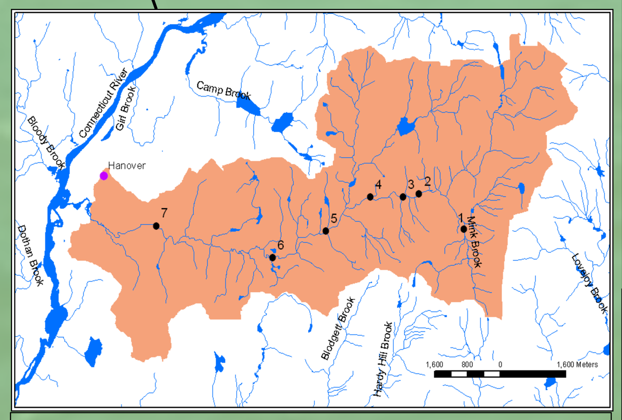
Graph of $^{210}Pb_{ex}$ activity vs Hg sediment concentration from the Ashuelot River [11]

- Hydrologic regime controls radionuclide floodplain inventory[12]

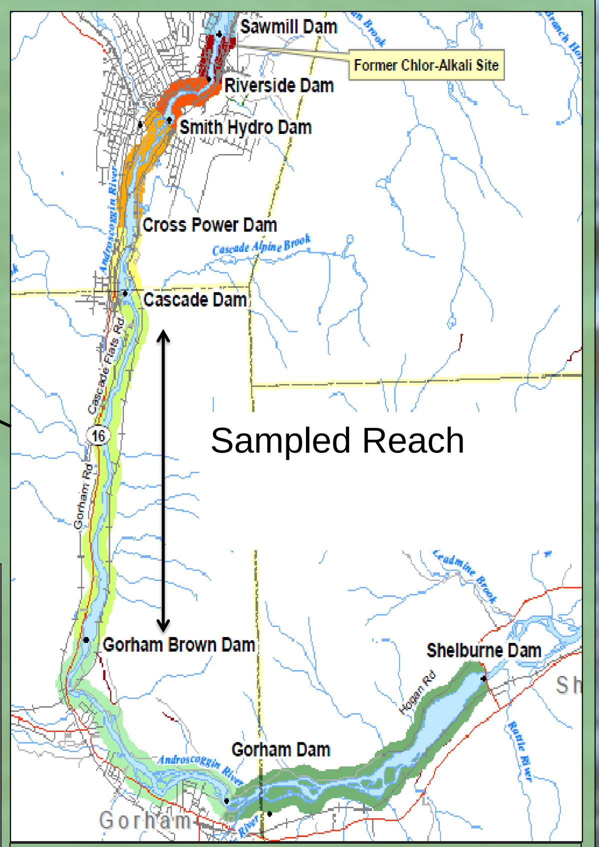
What controls Hg-bearing sediment dynamics on a floodplain?

Study Locations



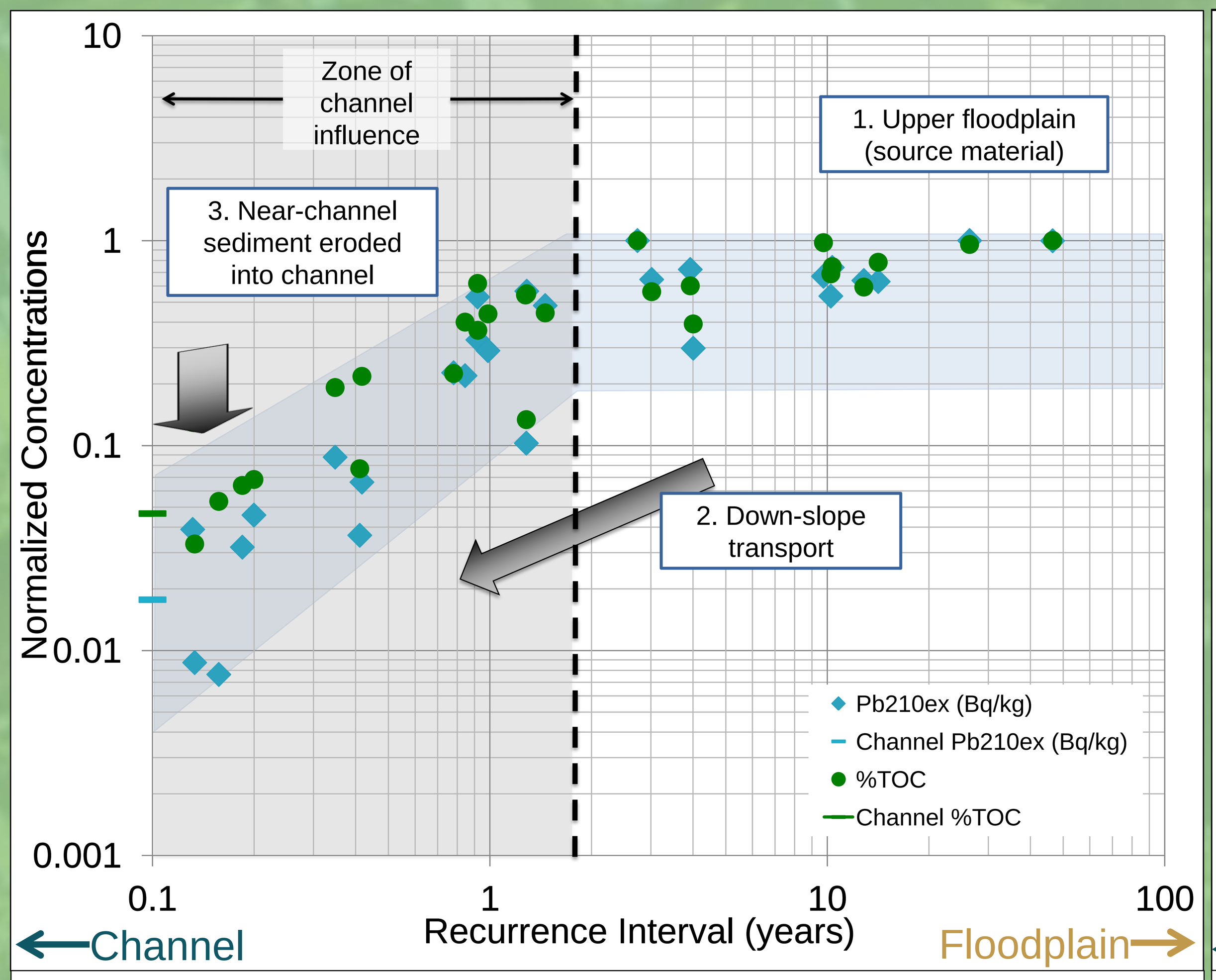


Mink Brook, NH(*drainage area*= 47km²)
- Free-flowing
- Atmospheric Hg source

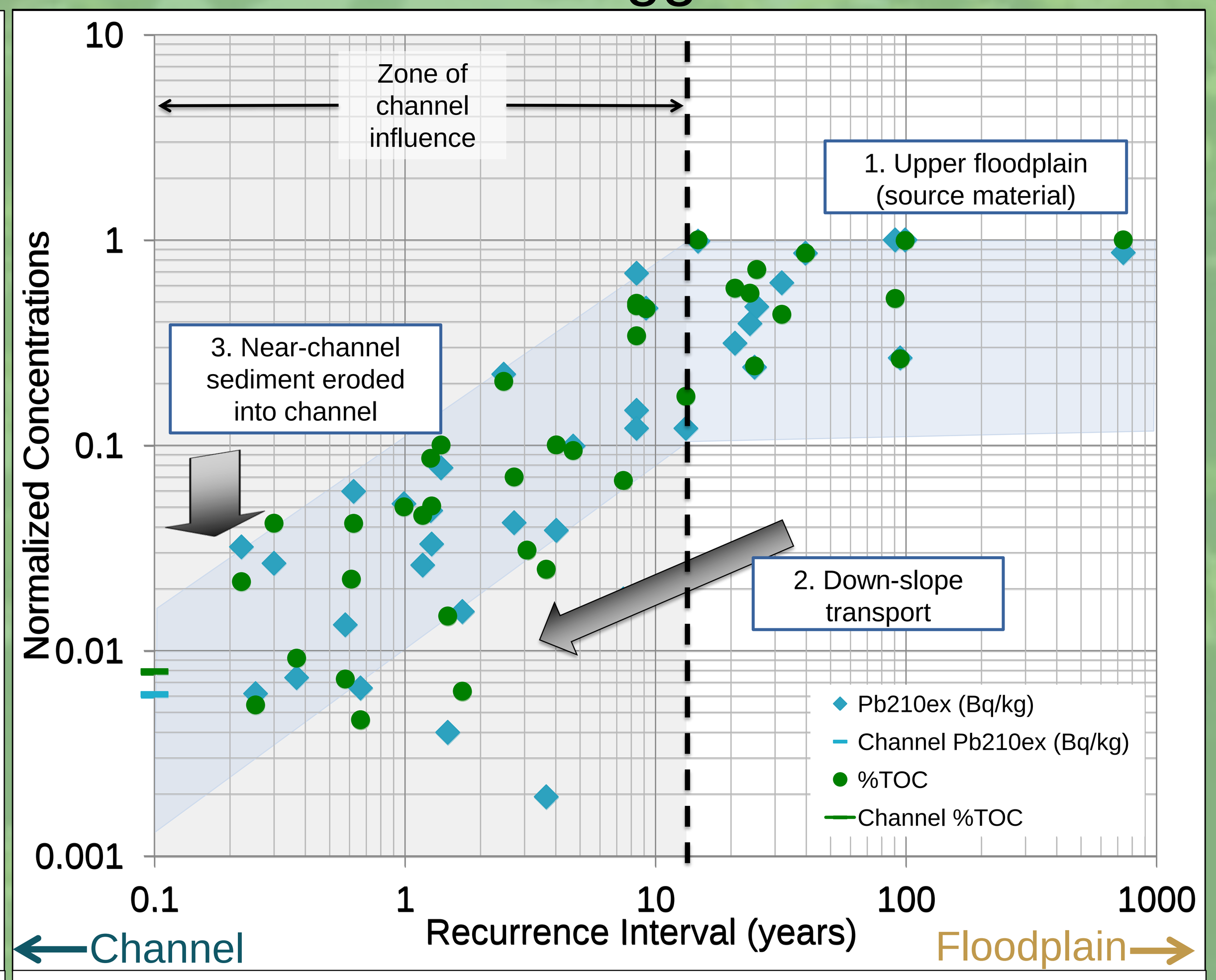


Androscoggin River, NH/ME
(drainage area = 9,127 km²)
- Highly regulated for hydropower
- Point-source, Hg-contaminated, EPA Superfund Site 4km upstream of sampled reach[13]

Results

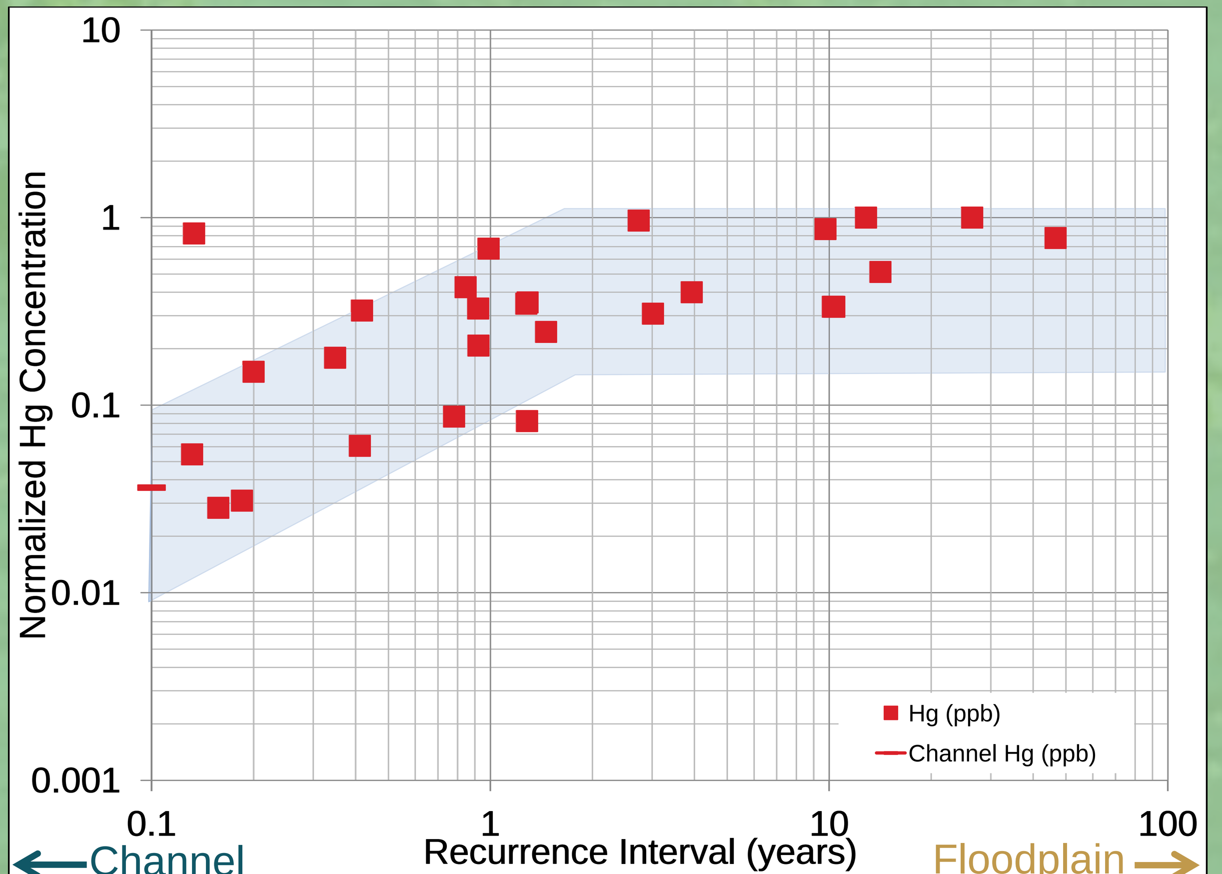


At the control site, both $^{210}Pb_{ex}$ and %TOC decrease near the channel

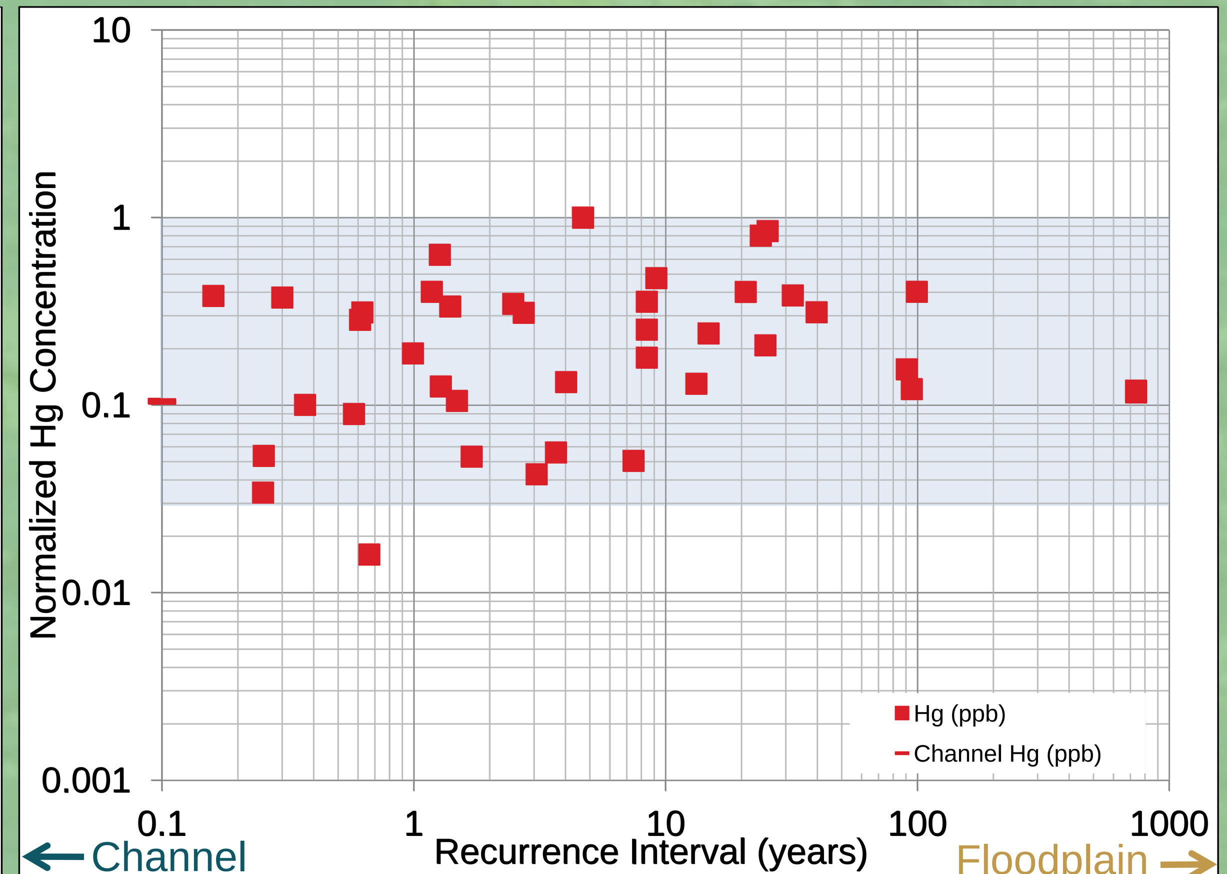


At the contaminated site, both $^{210}Pb_{ex}$ and %TOC decrease near the channel

- **Lead and organic carbon** follow same trend at both sites, therefore the processes that control floodplain re-working at Mink Brook (i.e. near-channel stripping) are likely the same mechanisms that control re-working at the Androscoggin



At Mink Brook, **Hg** concentrations decrease near the channel



At the Androscoggin River, **Hg** concentrations **do not** decrease near the channel

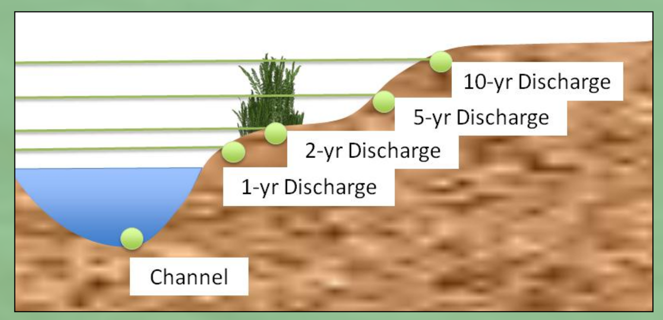
Mercury concentrations do **not** decrease near the channel at the Androscoggin, which implies either:

- Mercury is not mobilized like lead and organic carbon
  - *Not consistent with observed decrease in Hg near Mink Brook channel*

Or

- Mercury is rapidly redistributed across the floodplain at the Androscoggin
  - *May reflect photo-reduction and emission of Hg followed by re-deposition at high rates*

Sample Collection and Analysis

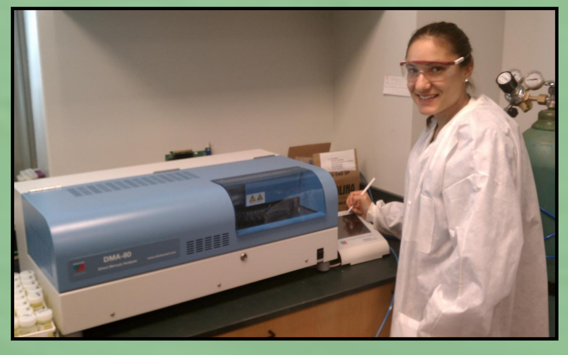


Field Sampling for Sediment

Collected approximately 4 sediment samples (from the top 2cm) per cross-section: one within the channel, and samples at the 1-, 2-, 5-, and 10-yr recurrence interval (RI) stages (indicated by green circles) during fall 2011

Radionuclide Analysis for ^{7}Be and $^{210}Pbex$

Used Canberra Intrinsic High Purity Germanium Detectors to analyze radionuclide activity for sediment size fraction <2mm

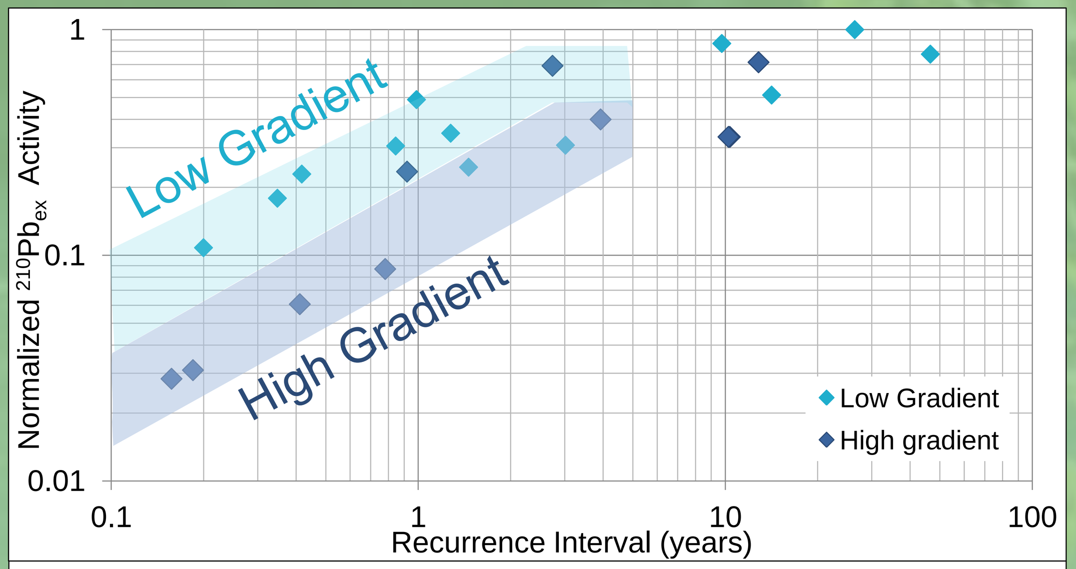


Analysis for Total Hg

Used Milestone DMA-80 Direct Mercury Analyzer to measure THg concentration for sediment size fraction <2mm following EPA QC standards

Discussion

- Similarity of near-channel and in-channel Hg concentrations at both sites suggests upland soil, ***not upstream Superfund site***, is direct source of Hg at Androscoggin River
- Higher Hg and $^{210}Pb_{ex}$ concentrations at the Androscoggin could be caused by higher (4.7 times) organic content of sediment, ***not by upstream Superfund site***
- The magnitude of channel and near-channel contaminant concentrations are controlled by hydraulic gradient



Graph of $^{210}Pb_{ex}$ activities as a function of RI for increasing (high) and decreasing (low) stream gradient at Mink Brook

Conclusion

- Metals and organics are mobilized (stripped) from the floodplain during low to moderate flows
- Mercury at the Androscoggin may be rapidly redistributed across the floodplain
- The major direct source of Hg to the channel may be the watershed, not the point source

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