Potential Sources and Rates of Natural Recovery in the South River

South River Science Team

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Outline

- Potential sources of natural recovery
- What are the potential rates of these processes in the South River?
- Key uncertainties

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Potential Sources of Natural Recovery

1. Dilution with low-IHg-concentration upstream sediment
2. Release of fine-grained particles by physical bed turnover
3. Reduced bioavailability of IHg associated with fine particles over time
4. Decrease in mercury methylation rates over time

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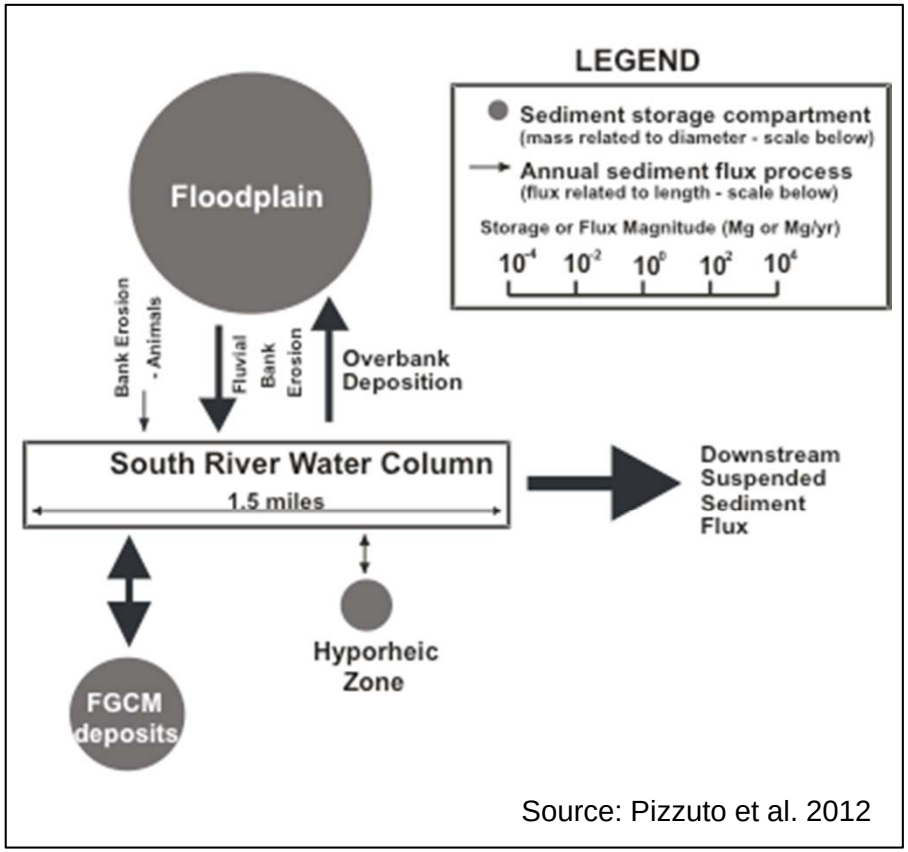
1. Dilution with Upstream Sediment

- Bank erosion, although a large source of THg, only accounts for a small amount of annual suspended sediment flux
- As THg loading from outfalls and river banks is reduced, THg concentrations on suspended solids should decline



Source: Pizzuto et al. 2012

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2. Bed Turnover

- Over time, high THg concentration sediment is mobilized and replaced with new sediment.
- This should decrease THg concentrations in the surface of the streambed.
- However, the rate of this is likely to be low:
  - Residence time of sediment in stream bed is ~30-50 years

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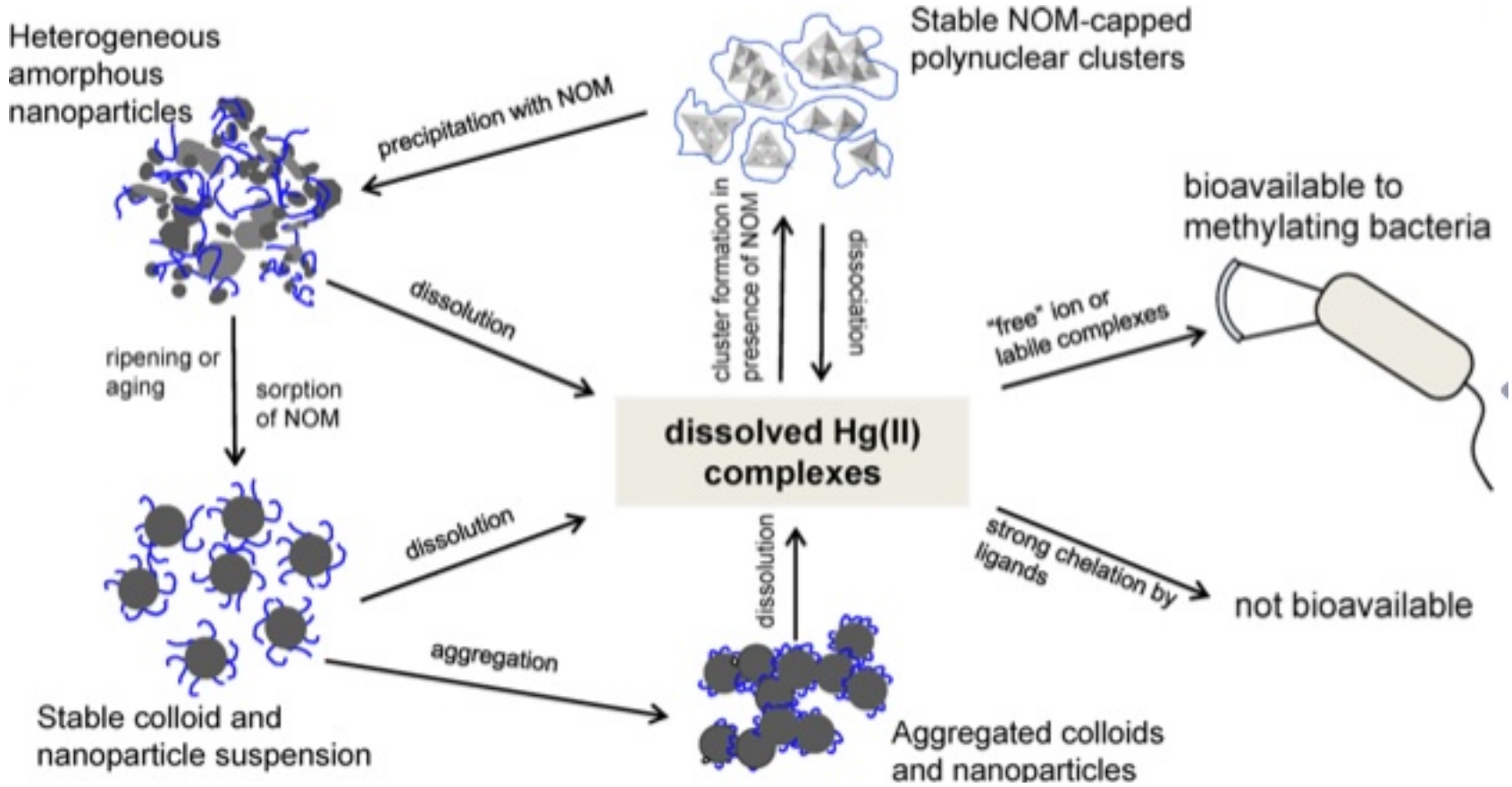
3. Mercury ‘Aging’ in Sediment

- Redox processes, including the precipitation and dissolution of iron and manganese oxides, changes the partitioning behavior of mercury.
- In anoxic zones, formation of sulfide complexes results in more strongly complexed IHg species.
- Over time, mercury-sulfur species aggregate into nanoparticles and increase in size over time, reducing the bioavailability to methylating bacteria.

3. Mercury ‘Aging’ in Sediment



Hsu-Kim et al. 2013

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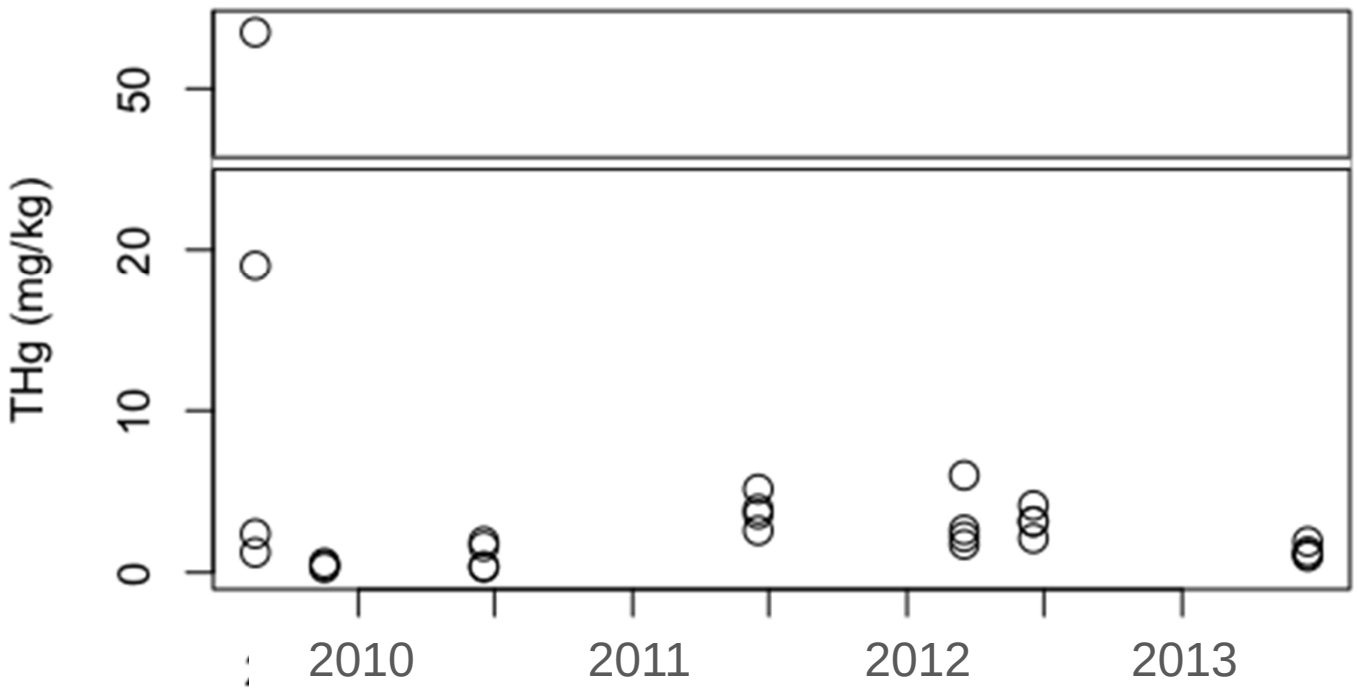
4. Sediment Aging

- Sediment particles in high-gradient streams are sites of the majority of bacterial activity.
- In other streams, the quantity and quality (as measured by particulate nitrogen) of organic matter were found to be the best predictors of microbial abundance.
- This suggests that as older sediment particles are replaced with newer particles, bacterial abundance will shift to the newer particles.

What are the Potential rates?

- Data from the pilot bank stabilization project may provide some information:
  - In some compartments, like near-bank sediment, concentration declines should be rapid.
  - Pore water may be showing signs of declining after three years post-stabilization.

Pilot Bank Stabilization Sediment



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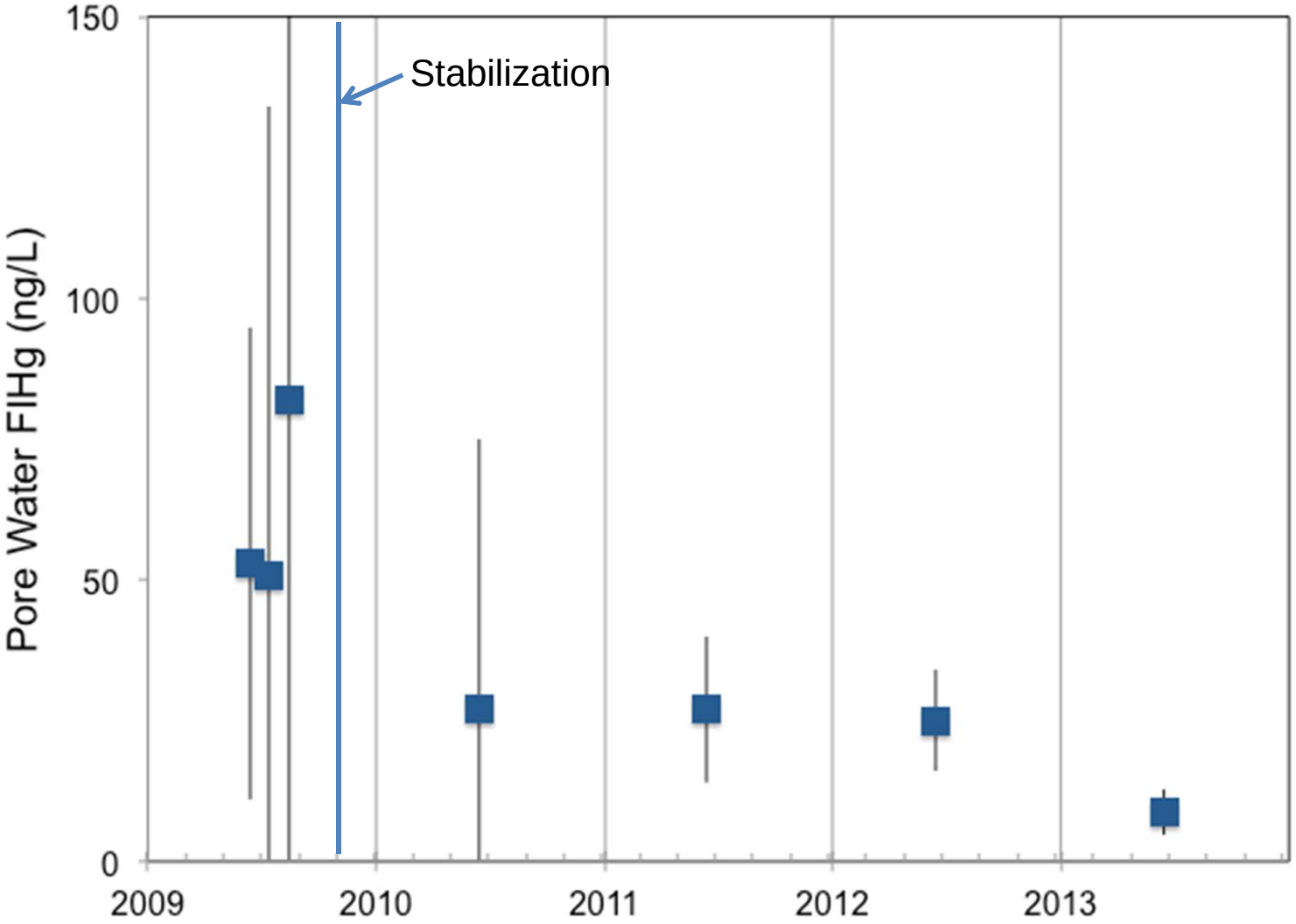
Pilot Bank Stabilization Pore Water



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Key Uncertainties

- Error terms in sediment budget estimates are high – 20 to 50%.
- Data concerning mercury aging may not be applicable to the South River.
- Pilot project data may not be applicable to downstream locations.