The Spatial Distribution of Sediment Characteristics and Mercury Content within Local Impoundments

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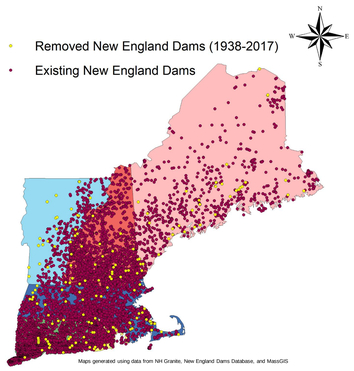
Motivation



Dam preservation considerations
- Navigation
- Irrigation
- Flood Control
- Hydropower
- Recreation
- Reservoirs for drinking water
- Historical monuments & aesthetics
- Contaminated sediment mobilization

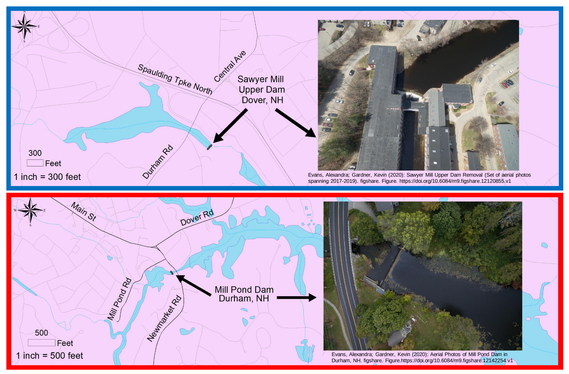
Dam removal considerations
- Expensive maintenance, inspection, and repairs
- Hazardous aging infrastructure
- Fish passage impedance
- Natural river flow alteration
- Nutrient transport reduction
- Environmental contaminant accumulation

Research Objectives

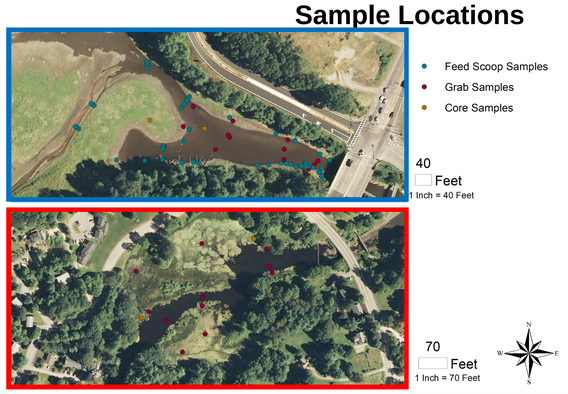
- Contribute to the developing field of dam removal science, as over 1200 dams have been removed in the United States, yet fewer than 10% of those have been scientifically studied (Bellmore et al., 2017).
- Characterize conditions at two local impoundments and explore implications of dam removal to inform local communities considering dam removal
- Determine strength of relationships between sediment grain size, mercury content, organic matter fraction, and spatial distribution to assess applicability in other impoundments

Site Locations

- Sawyer Mill Upper Dam on the Bellamy River in Dover, New Hampshire. Dam removal in process
- Mill Pond Dam on the Oyster River in Durham, New Hampshire. Dam removal being considered



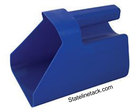
Sample Locations



- Sample locations were chosen in spatially varying areas: upper, mid, and lower impoundment, on both berms and in main channels
- Locations were also chosen as spots which would complement previous studies and current studies

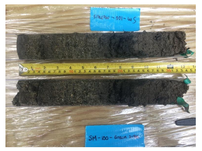
Sampling Methods

3-Quart Feed Scoop Sampler
- Used to sample exposed surficial sediment



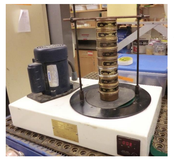
Van Veen Grab Sampler
- Used to sample submerged surficial sediment
- Deployed from side of Jon boat

Sediment Hand Corer
- Used to sample submerged buried sediment
- 2 cores collected at each site
- Collected cores ranged from 25 to 71 centimeters long



Core Processing
- Grain size samples were collected by slicing one core half approximately every 5 cm or at visually distinct strata
- Mercury analysis samples were collected using acid-washed plastic scoops in mirrored locations along the other core half

Laboratory Procedures



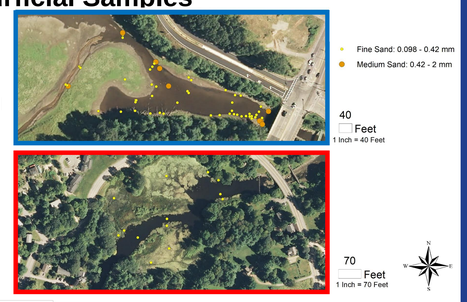
Grain Size Distribution
- ~200 grams of each dried sample was sieved on a shaker table through US sieve numbers: #10, #35, #50, #80, #100, #140, #170, and #230
- The fraction of mass retained on each sieve indicated the fraction of sediment within each size class

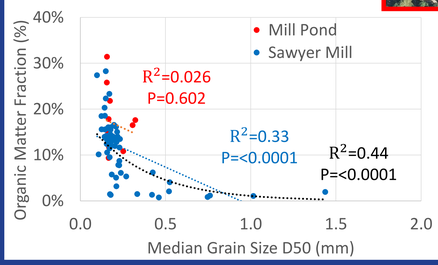
Organic Matter Fraction
- 2 to 5 grams of dry sample were placed into porcelain crucibles
- Heated to 550 degrees Celsius for 3 hours then reweighed
- Weight loss assumed to be due to ignition of organic matter

Mercury Content
- Approximately 0.05 grams of dry sediment from each designated core sample were loaded into the DMA-80 *Direct Mercury Analyzer* to assess mercury content

Results: Surficial Samples

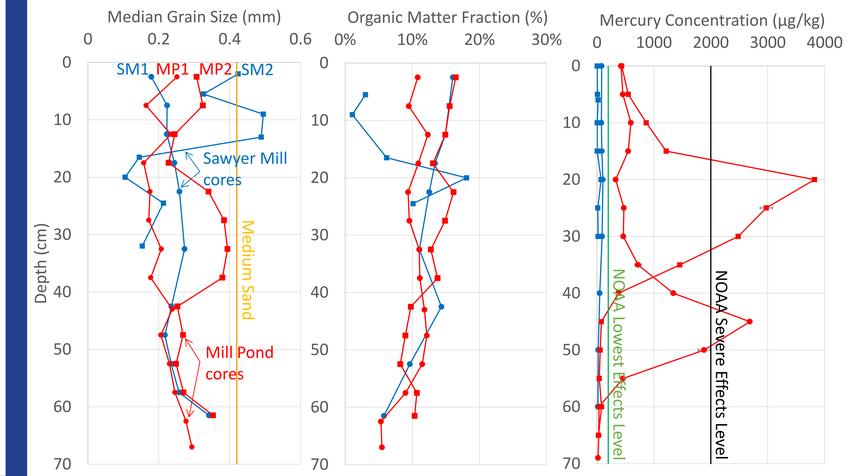
- Sawyer Mill samples ranged from medium to fine sand, with the coarsest samples located in the main channel and the finest samples accumulating on adjacent berms
- 100% of Mill Pond samples were classified as poorly graded fine sand samples, with little spatial variability in grain sizes





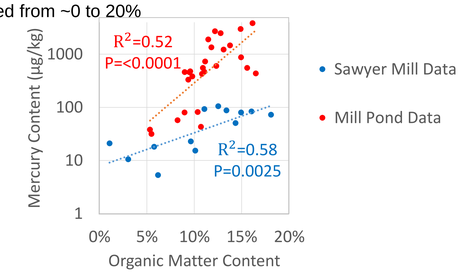
- Organic matter content ranged from 9-31% in Mill Pond and 0.7-21% in Sawyer Mill
- A general trend of decreasing organic matter fraction with increasing grain size can be observed, with stronger correlation in Sawyer Mill sediments

Results: Core Samples



- The median grain size across all cores varied from 0.15 to 0.5 mm. Cores SM1 and MP1 contained relatively homogenous sediment grain sizes over depth, while SM2 and MP2 contained sharp discontinuities
- Top 5 cm of all core samples consistent with observations of surficial organic matter content at each impoundment
- MP1, MP2, and SM1 exhibited gradual decreases in organic matter fraction with depth, suggesting slow consumption, while SM2 varied from ~0 to 20%
- All Sawyer Mill samples contained mercury levels lower than the NOAA Lowest Effects Level
- Four Mill Pond samples contained mercury levels above the NOAA Severe Effects Level

- A general trend of increasing mercury content with increasing organic matter fraction was observed, with stronger statistical significance in Sawyer Mill sediments



Conclusions

- Elevated mercury contents, at levels high enough to cause pronounced disturbance to freshwater organisms, were found at depths greater than 15 cm within Mill Pond. These peak levels were discovered amidst low mercury content within surficial and deeper Mill Pond sediment, highlighting the importance of thorough spatial sampling to delineate the extent of contamination in potentially mobile sediments
- Only weak relationships were observed between organic matter content (and, to a lesser extent, fine grain sizes) and mercury content, suggesting that the observed mercury contamination may have arisen from transient local sources
- Scientific investigations can provide useful information for dam removal decisions. Further work is needed to research potential historical sources of contamination, explore historical rates and patterns of sediment deposition, and constrain the heavy metal burden in these impoundments and others

Acknowledgements

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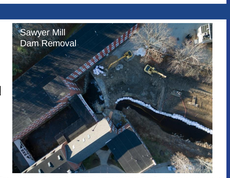

Reference
Bellmore, R. J., et al.(2017). *WIREs Water*, 4: e1164. doi:10.1002/wat2.1164.