Flood stratigraphy at the margin of a delta front in a modern reservoir: Morris Pond, NY

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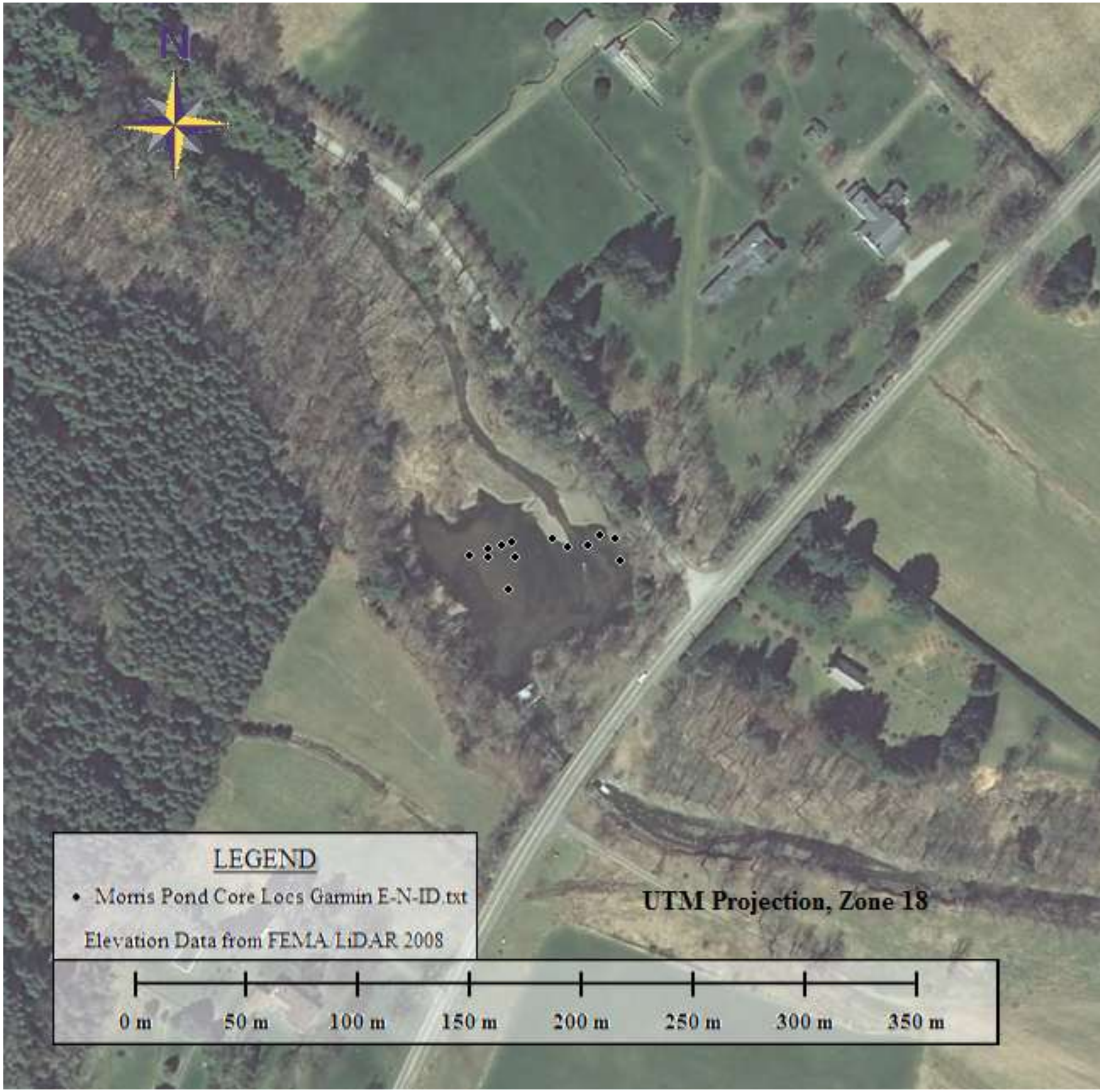
Muds and Floods

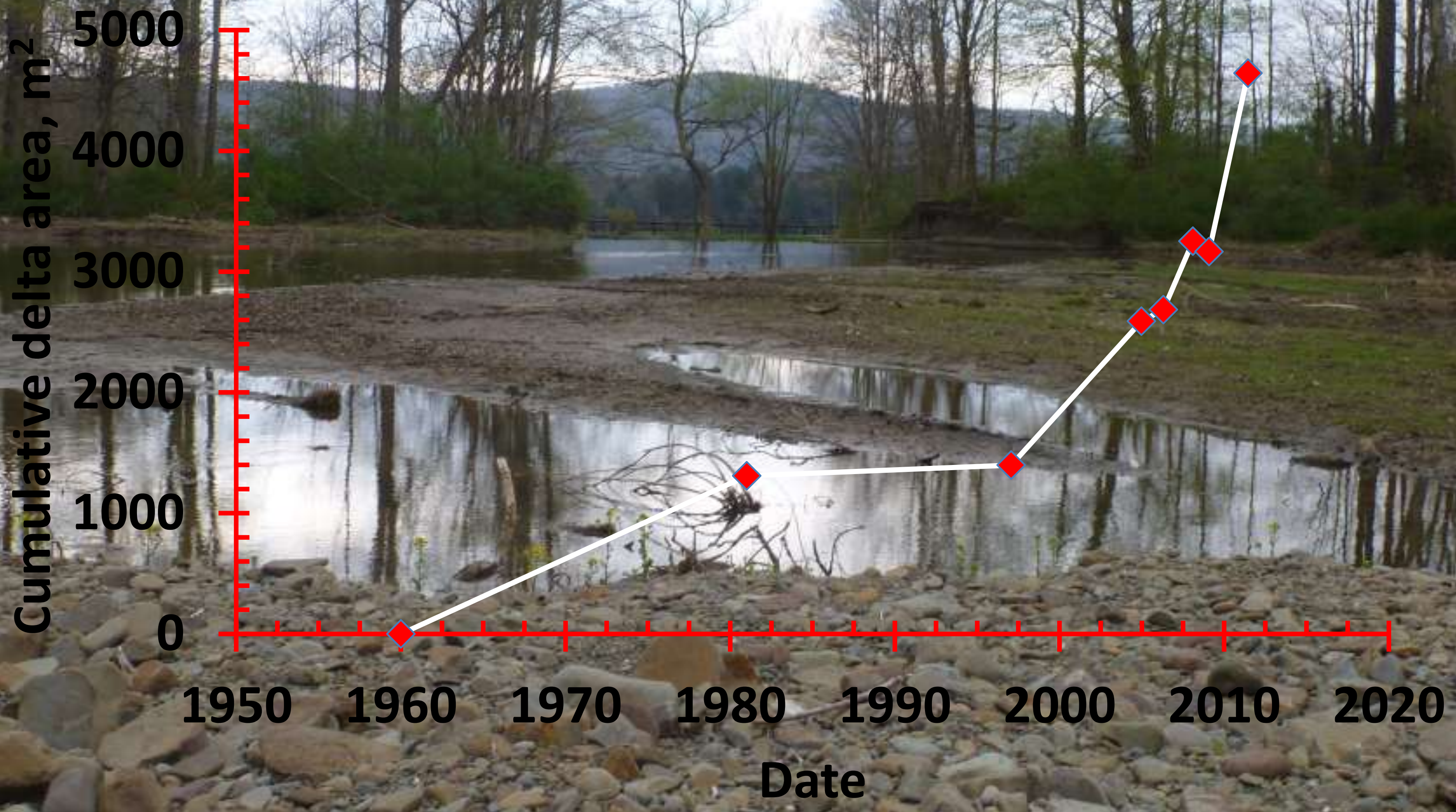
- **Goal**: Use grain size in muddy lake and reservoir deposits to reconstruct flood records
- **Goal**: Characterize historic sediment flux into reservoirs
- This Project presents:
  - At a glance, size variation on local deltas is huge
  - At a glance, deposition across the delta is stochastic
  - Not so clear: moving farther from the delta, do muds change in grain size?
  - Is there a meaningful, relatively simple way to measure 1 to 100μm size particles?



Morris Pond with sediment core locations (at current delta front). Advance of delta front occurred in Sept. 2011.

Morris Pond, Morris, NY: runoff from Lee Sept. 2011

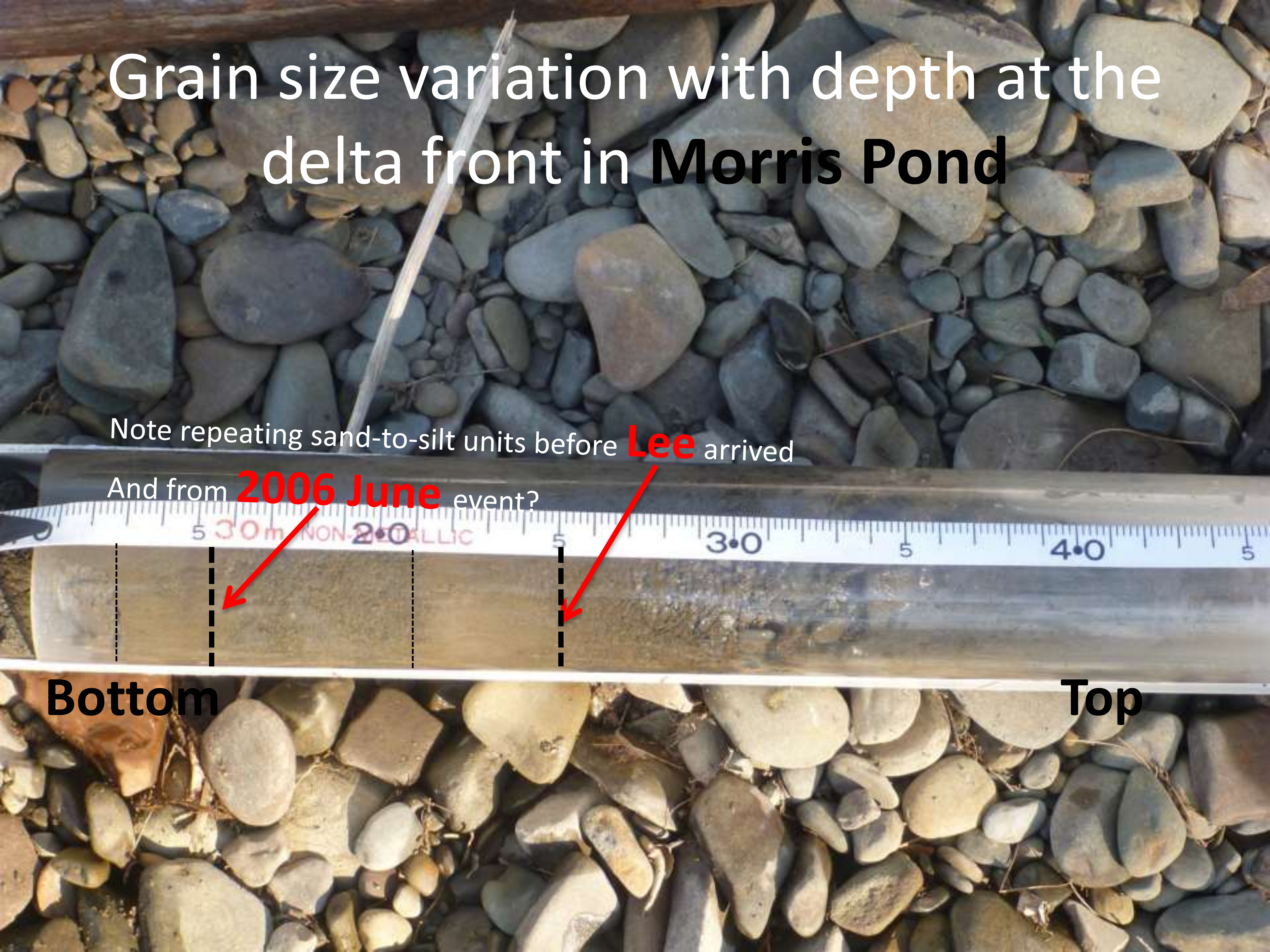
Cumulative Delta Growth since 1960



Data derived from water surface area in aerial imagery

Delta Front, Morris Pond, March 2012

Grain size variation with depth at the delta front in **Morris Pond**



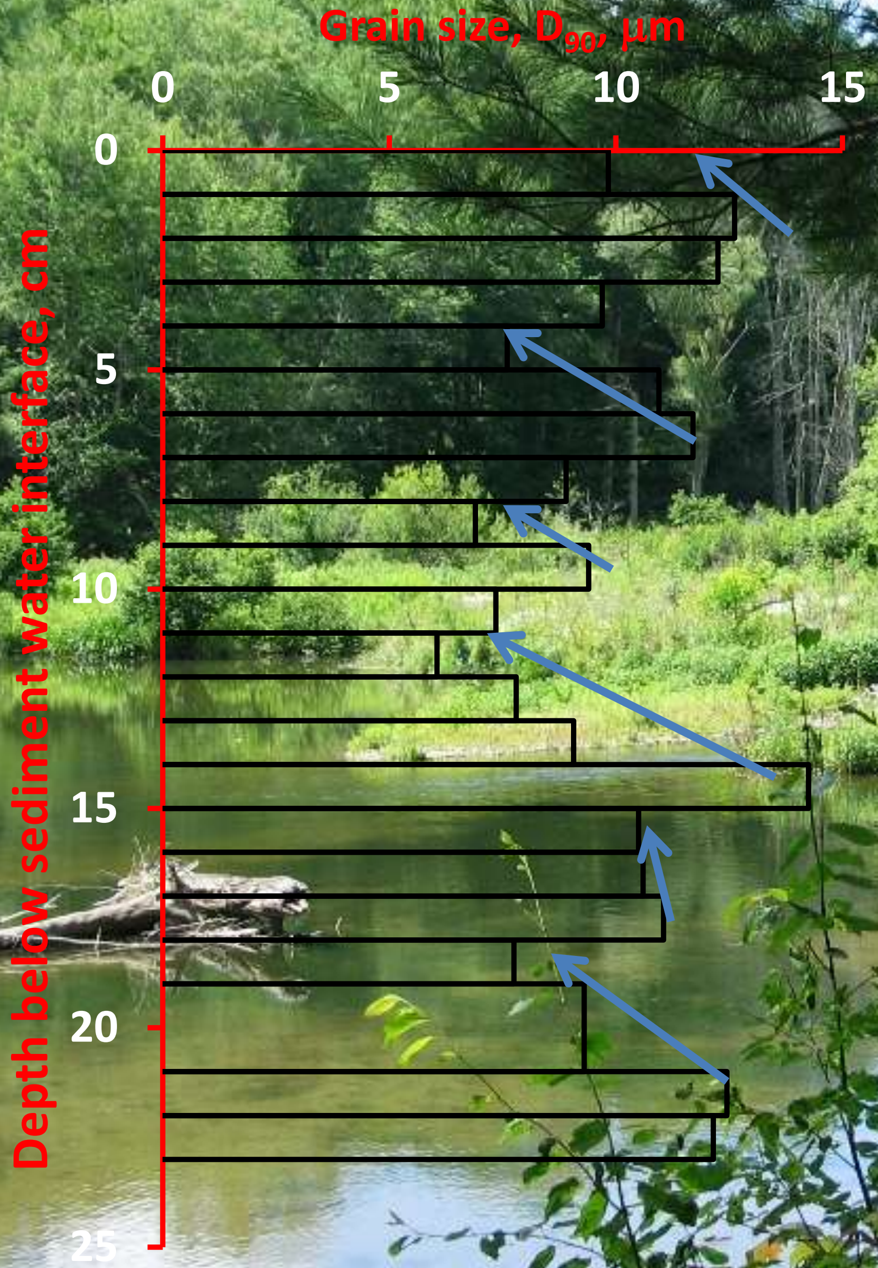
Grain size measurement methods

- Visual with a scale—ok for gravel
- Photomicrographs offer distributions for mud
- Automated particle characterization
- Grain size distributions
  - Sample size considerations
  - Power law distributions

Sampling Procedure

- Small sample by toothpick from core to glass slide, glue cover slip, and label slide
- Photomicrograph at 2-10X magnification
  - Collect a dozen photos (more is better) of each slide
- Run particle size macro in ImageJ (scale, threshold, identify shapes, measure…)
- Extract statistics on shape
  - Use Minimum Feret diameter as intermediate grain diameter

Core at Edge of Delta Front

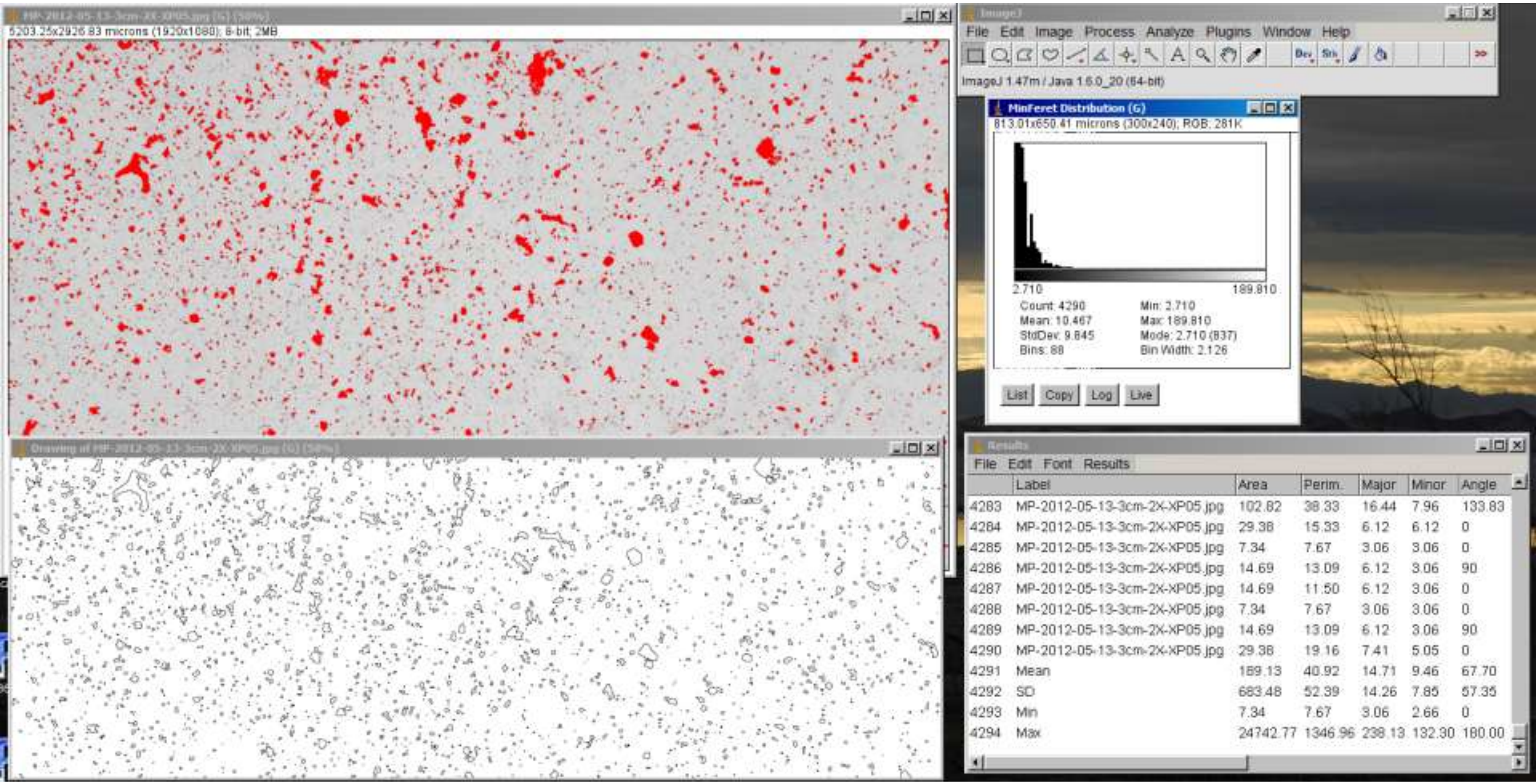


Grain size variations in Morris Pond, just off the delta front, single core: 6 fining sequences

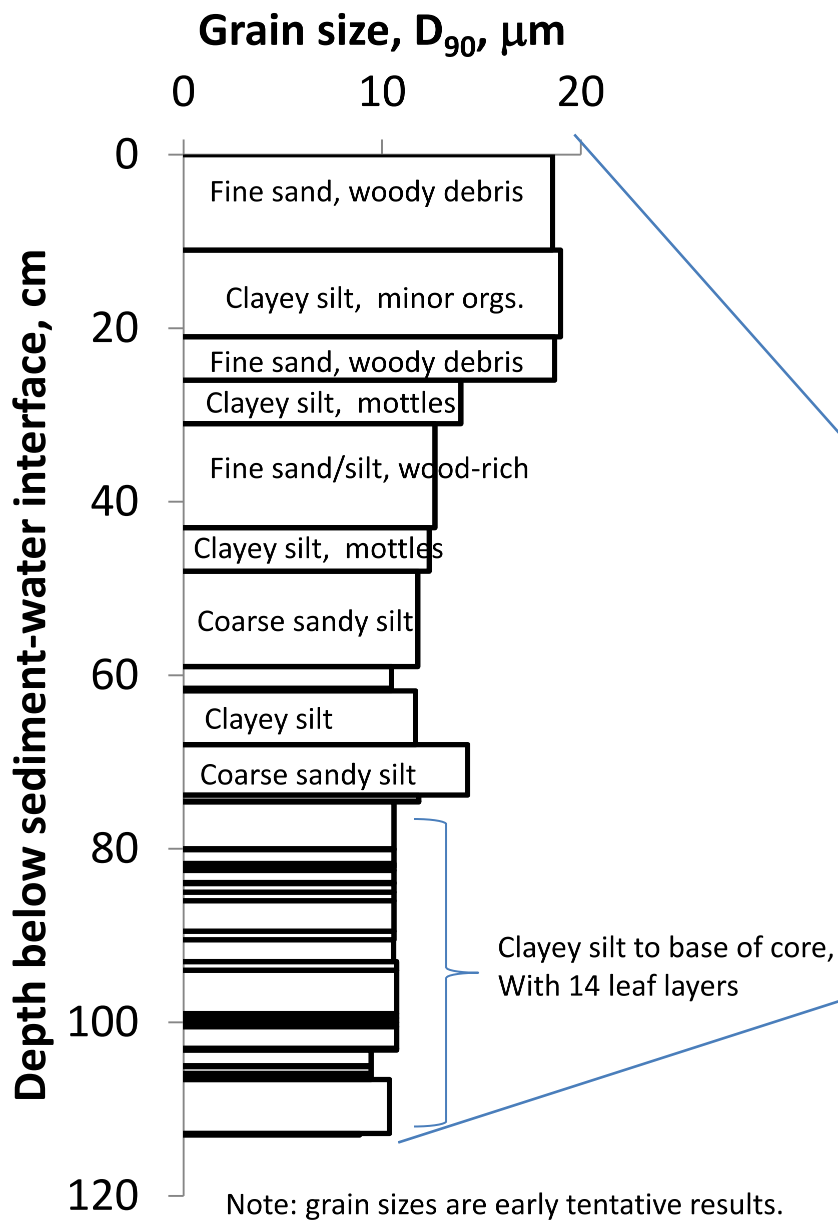
“Distal” portion of the delta

Distal delta cores show repetitive grain size variations, with leaf layers (white arrows) Morris Pond

ImageJ: Particle Characterization



Morris Pond
Core Log

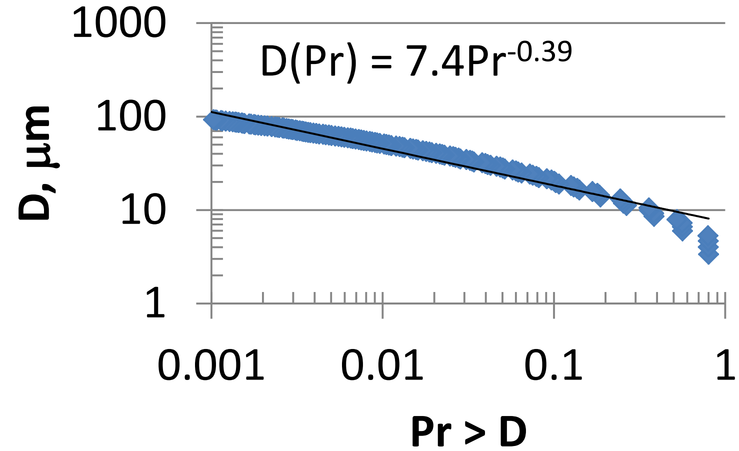


Note: grain sizes are early tentative results.

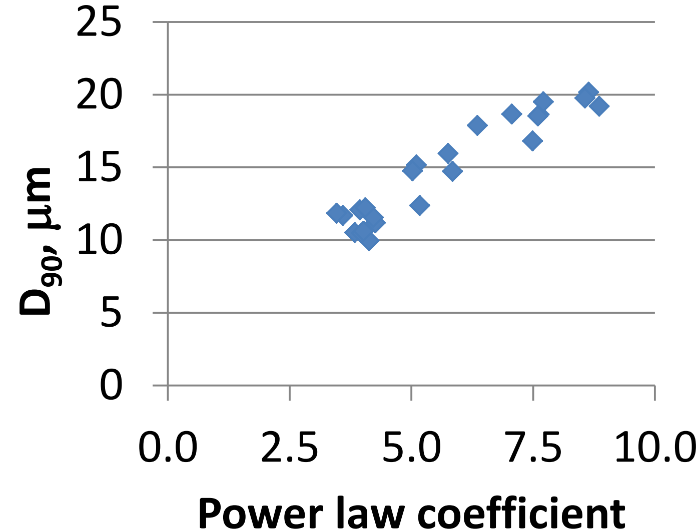
Is the delta growth recorded in the distal portion of the delta?

Some Statistical Results

- With enough particles, cumulative distributions approach power laws
- Coefficients covary with D_{90} and D_{ave}, but not $D_{99.9}$
  - Large particles decoupled from population transport dynamics
- Standard deviation increases with D_{90}—floods carry broader range of particles
- Smear slides and ImageJ: as a particle analyzer works ok, but grain size distributions are a troublesome measure…



Pr = probability of a grain size



In Summary

- There are clear layers in reservoirs with “fining upward sequences”
- Higher deposition rates in last 10 years: about 6 cm/yr, and lower part of core is ~ 2 cm/yr maximum rate, based on leaf layers
- Power law cumulative distributions: coefficients vary from 3 to 7 and exponents vary from 0.39 to 0.51
- **Mud** particle size decreases with distance from delta fronts

Questions?

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ABSTRACT (Original, as submitted in December 2012)

We hypothesize that for rivers debouching into standing bodies of water, grain size should vary directly with discharge, and thus, grain size variations in sedimentary cores could serve as a proxy flood record. To test this hypothesis, we investigate a small historic reservoir on Morris Brook in upstate New York (42.5096° N, 75.2899° W). The reservoir has existed at least since the 1940s. Morris Brook drains an area of about 20 km^2, where land use consists of a mix of agricultural pastures and forests. The stream is predominantly alluvial, but cuts a bedrock (Devonian sandstone) gorge a few hundred meters above the reservoir. A 4-5 m masonry dam impounds the reservoir, and an active delta has prograded into the reservoir. Sediments trapped in the reservoir comprise muddy bottomsets with gravel foresets and topsets. Aerial photographs dating to 1960 permit a reconstruction of the delta front over time, and indicate a significant increase in the growth rate of the delta since 2000, from roughly 0.2 m^2/day to 1.7 m^2/day. Floods in 2006 and 2011 contributed substantially to this increase.

We delve into the sedimentary record using sediment cores to identify horizons associated with the recent floods, and to extend the record into the past. We have sampled the bottomsets just offshore of the delta front, and we have moved into a more distal portion of the delta as well to document spatial variability of grain size in the cores. In addition to fining upward sequences which we interpret as flood events, we find packets bounded by leaf layers in the distal delta, which we interpret as annual(?) markers. Given the large number of reservoirs and lakes in central New York, the effort could open up a significant library of flood records for the Anthropocene and beyond. Delta fronts, however, are challenging to core, and the record is always in danger of being reworked as thalwegs wander.

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T111. Lake Systems Through Space and Time