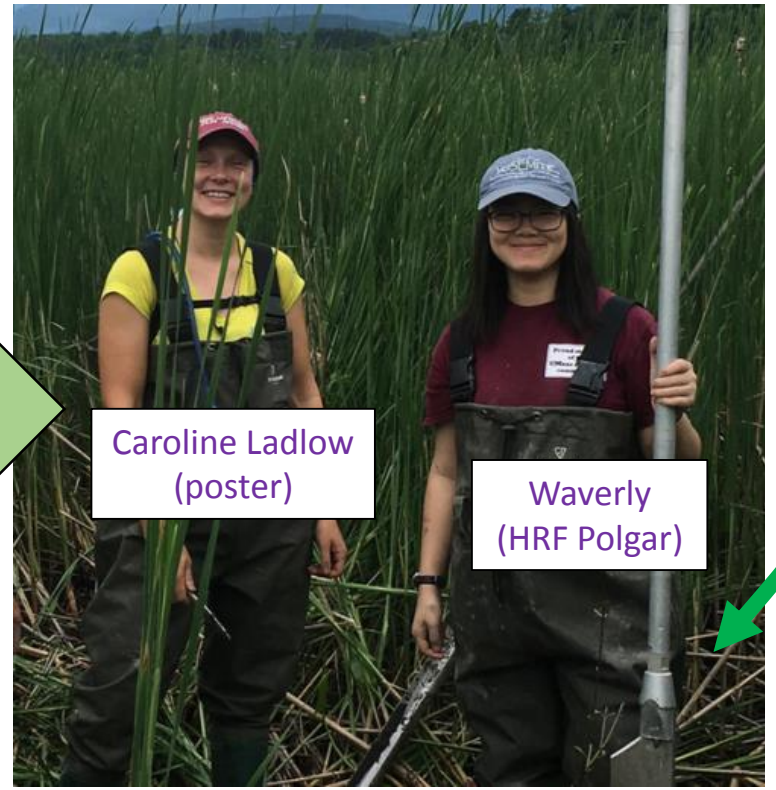
Rapid tidal marsh development on the Hudson during period of tributary damming and shoreline modification

Brian Yellen and Jon Woodruff
UMass Amherst, Dept of Geosciences



Open water ~1900

NATIONAL ESTUARINE RESEARCH RESERVE SYSTEM

NECASC Northeast Climate Adaptation Science Center

NOAA

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Dams and Sediment on the Hudson (DaSH) – Our Team

What effects will dam removal have on sediment dynamics in the Hudson Estuary?

Modeling studies

David Ralston, Associate Scientist
Woods Hole Oceanographic Institution

End user coordination

Sarah Fernald, Research Coordinator
Hudson River National Estuarine Research Reserve

Field studies

Brian Yellen, Research Professor
University of Massachusetts

Collaborative engagement

Ona Ferguson, Senior Mediator
Consensus Building Institute, Inc.

Jon Woodruff, Associate Professor
University of Massachusetts

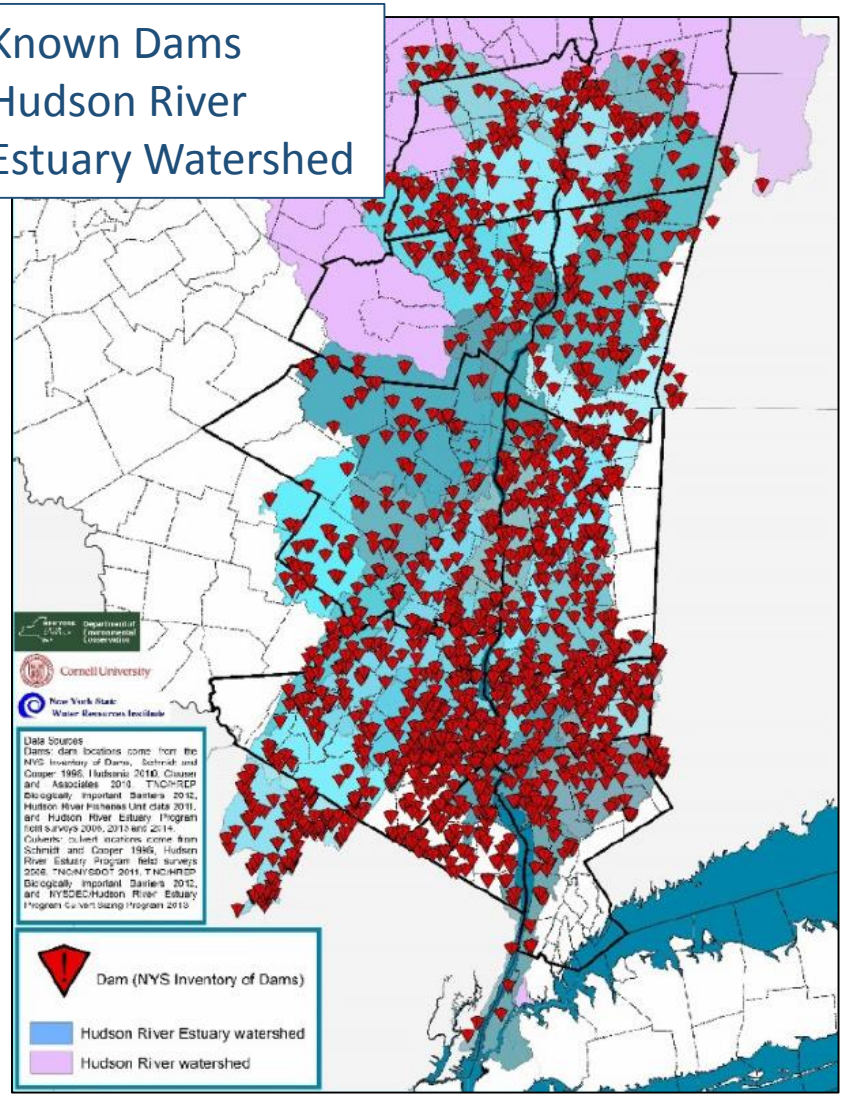
Elizabeth Cooper
Consensus Building Institute, Inc.

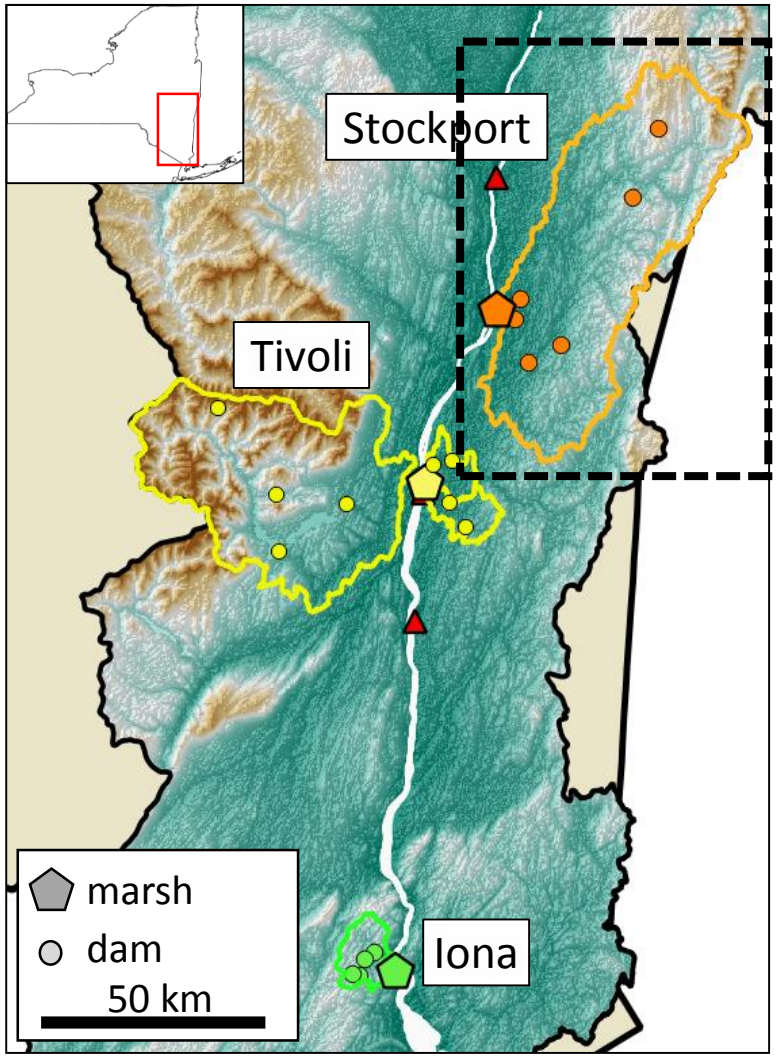
Advisory Committee

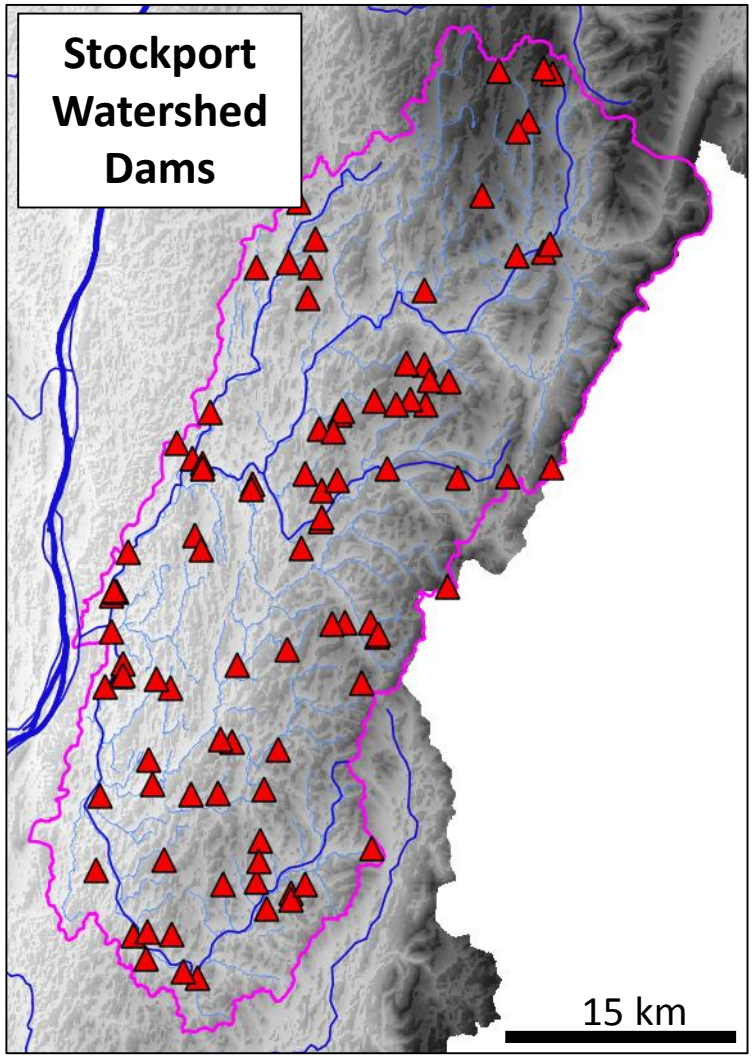
Elias Dueker
Jennifer Cavanaugh
Phil Moreschi
Scott Cuppett
Fran Dunwell
Dan Miller
Jim Lodge
Betsy Blair
Carl Alderson
Lisa Rosman
Megan Lung
Maria Tupper-Goebel
Alon Dominitz
Jennifer Ross
Karen Woodfield
Nava Tabak
Stuart Findlay
Barbara Beall
Russell Urban-Mead
Andy Peck

Project Background

Known Dams
Hudson River
Estuary Watershed







- Three tidal marsh – catchments
- Varying geology, land use, relief

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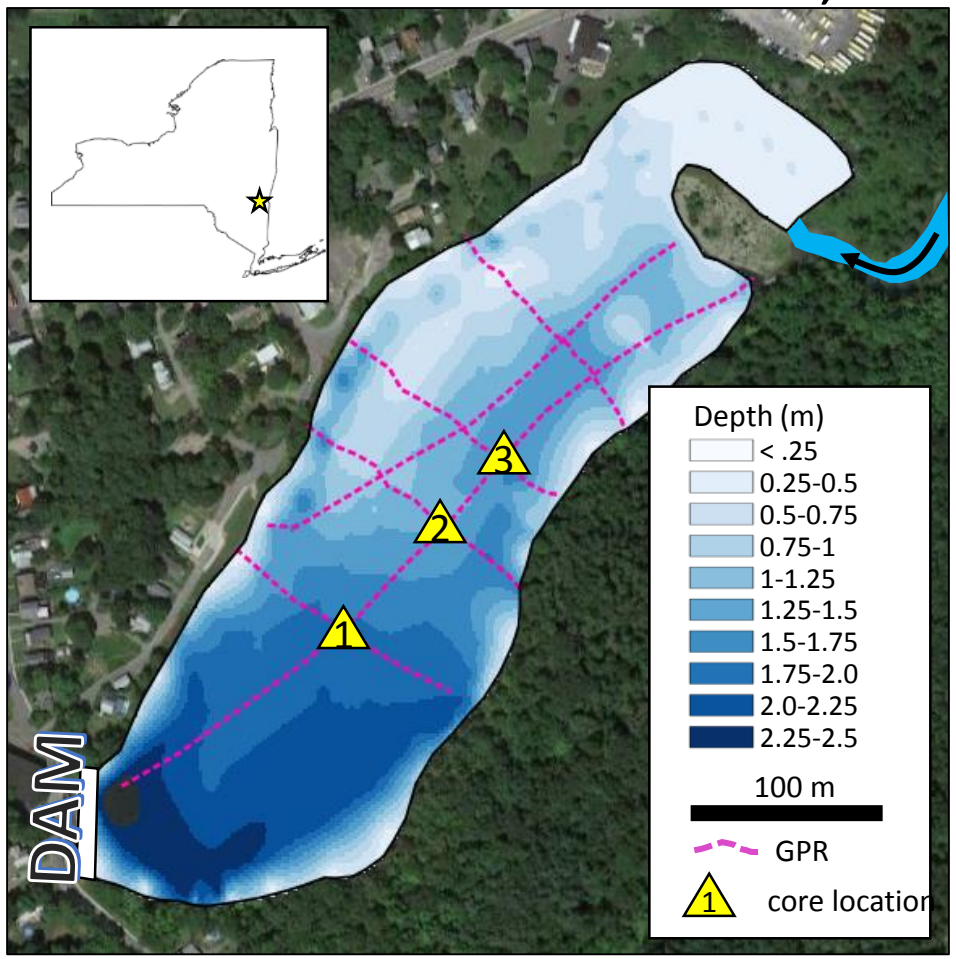
Impoundment Flavors: (1) Effective Sediment Trap

Summit Lake - Philmont, NY



total sediment **mass**

$$110,000\ Tons\ (1T = 1000\ kg)$$

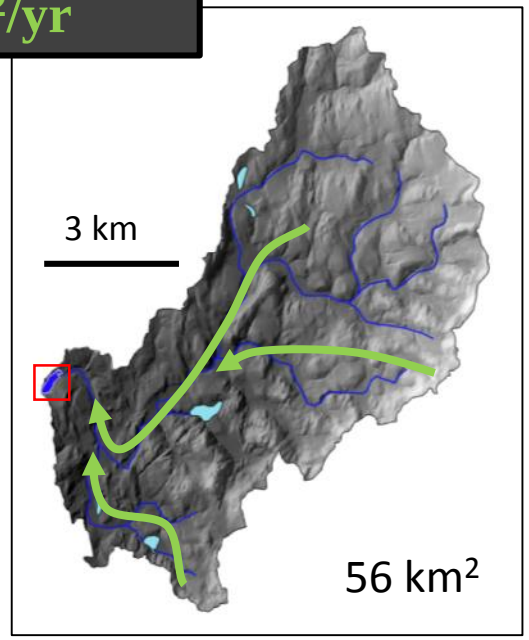
high flow residence time

$$0.5 - 1.5\ hour$$

silt settle = 1.4 hr

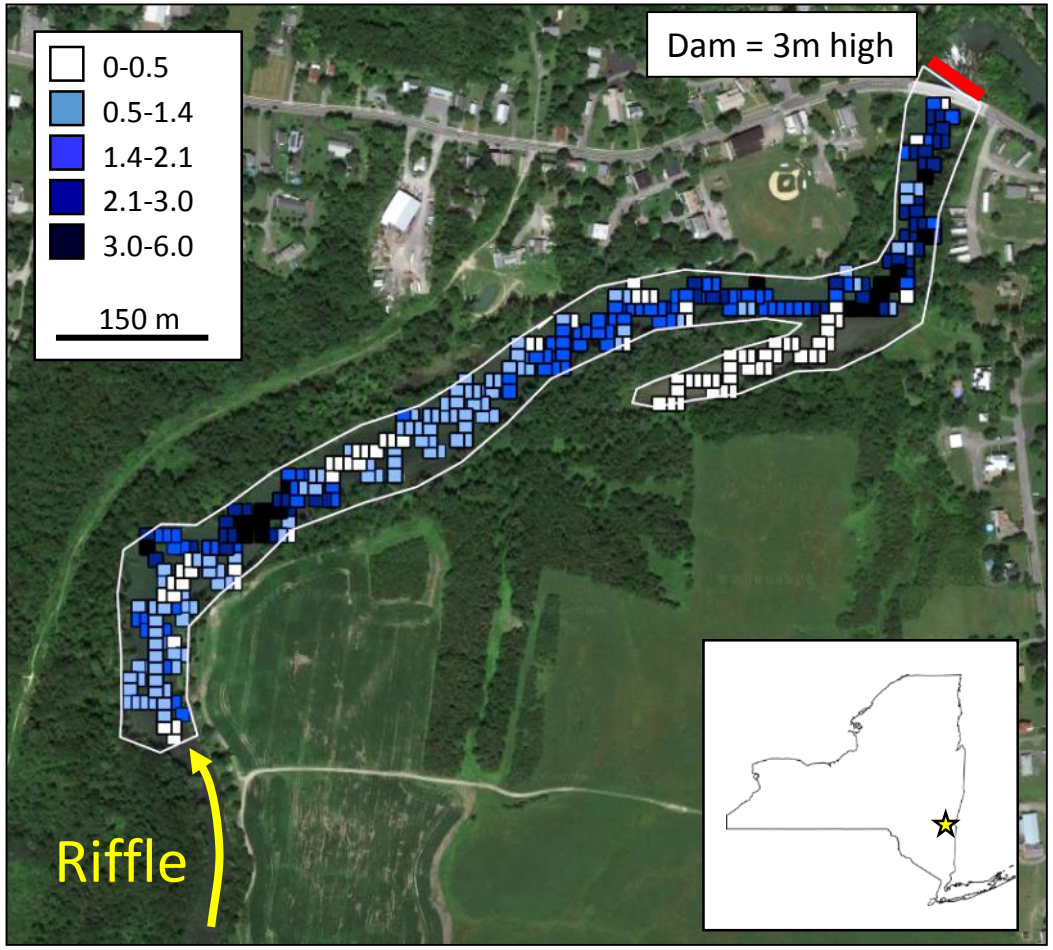
Sediment yield
13.5 T/km²/yr

minimum



Impoundment Flavors: (2) Run of River

Stottville Dam



total sediment mass

$45,000\ Tons$

high flow residence time

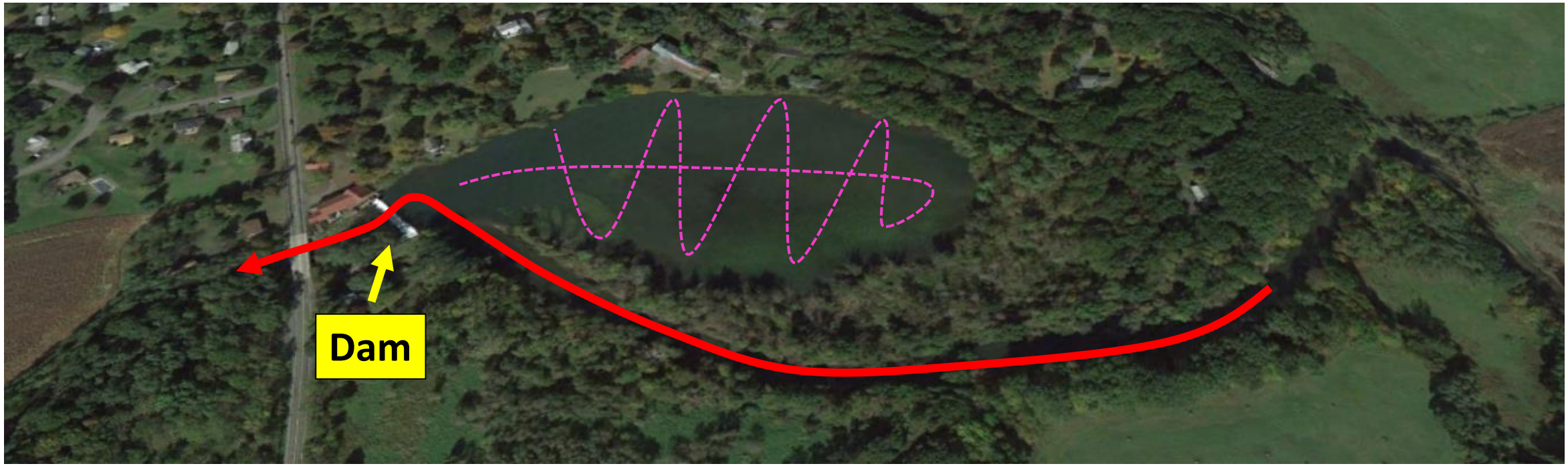
$4\ min$

time to settle silt

$1.2\ hours$

Watershed 438 km²
Yield < 1 T/km²/yr

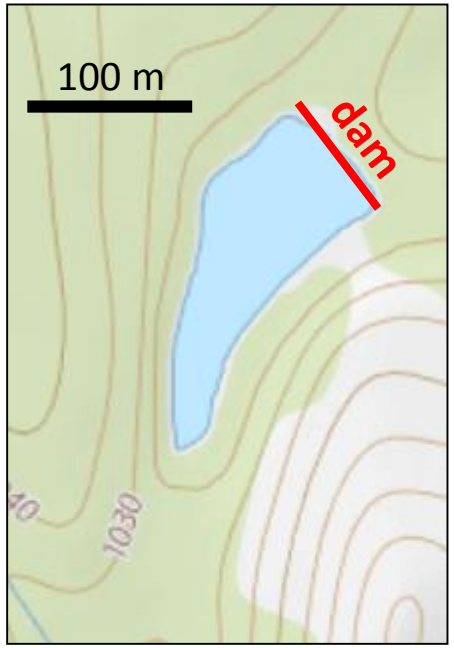
Impoundment Flavors: (2) Run of River



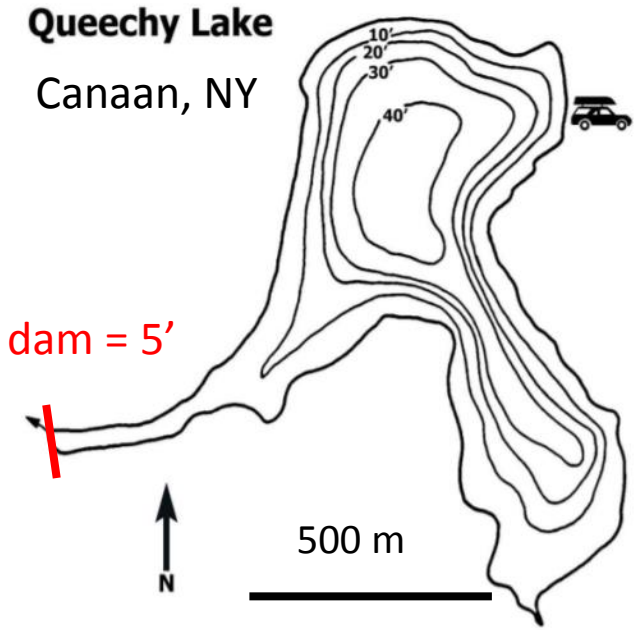
Impoundment Flavors: (3) Non-source

headwater ponds

Scafford Wildlife Marsh Dam
Chatham, NY

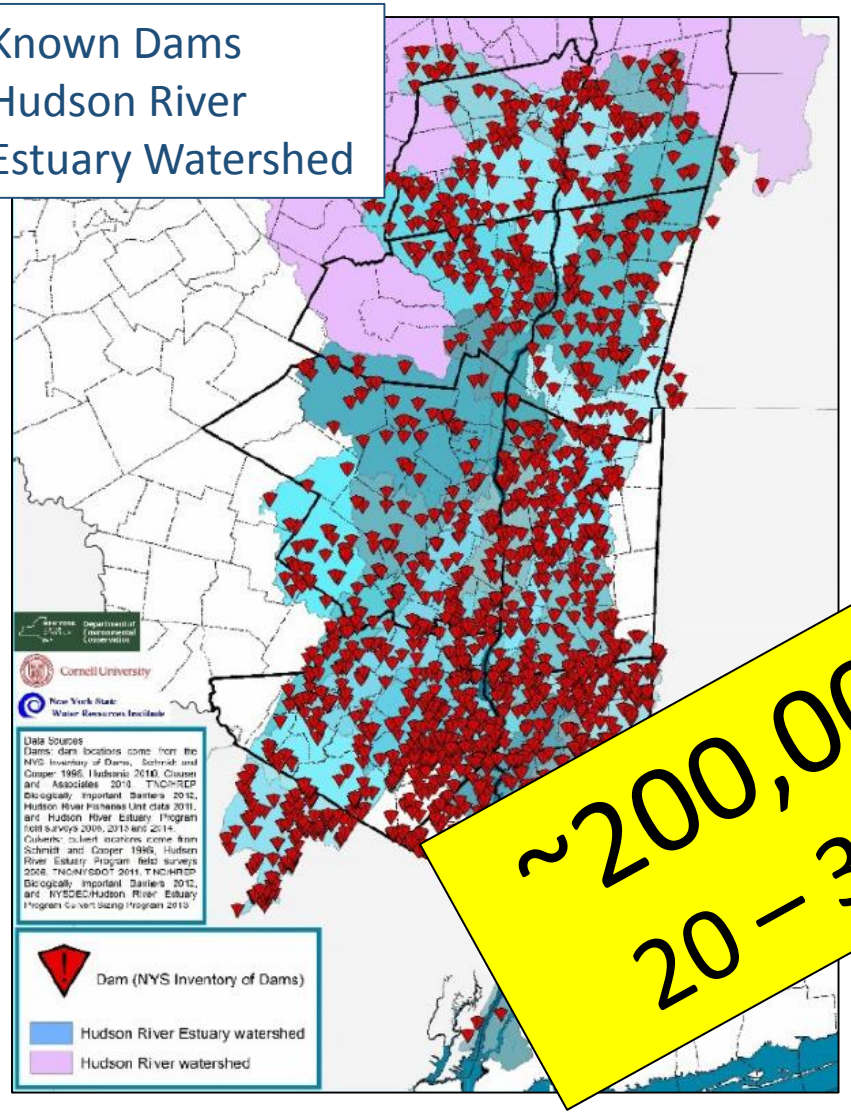


natural lakes

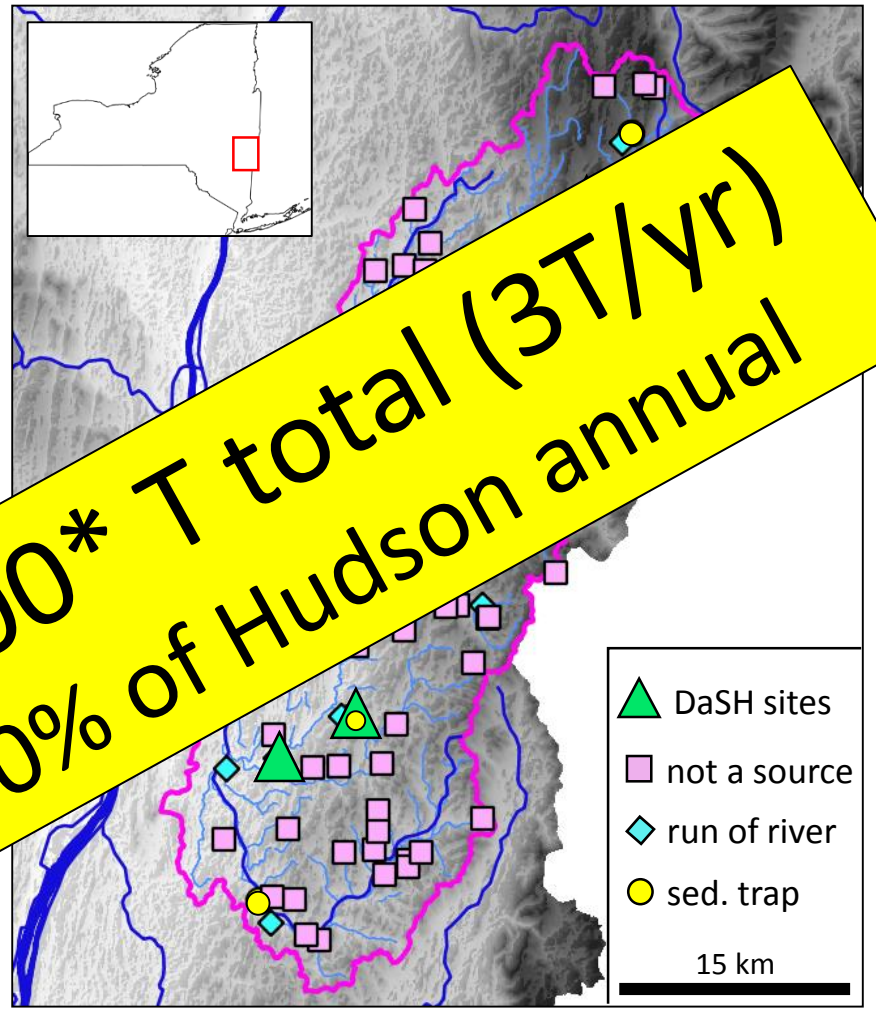


Overstated impacts of impoundments

Known Dams
Hudson River
Estuary Watershed



Stockport Creek Watershed Dams



~200,000* T total (3T/yr)
20 – 30% of Hudson annual

Non sources (n = 66)
stock ponds, impounded natural lakes

Run of river (n = 23)
filled, high energy, non-depositional

Sediment trap (n = 6)
impoundments with accommodation space

*Preliminary Estimate

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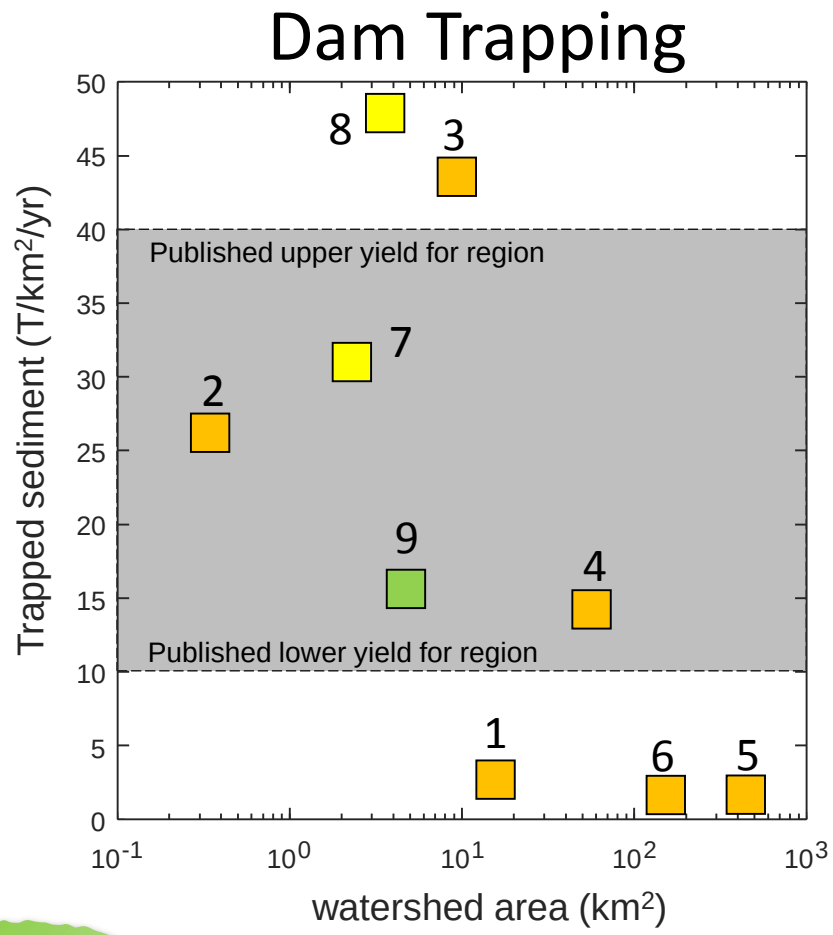
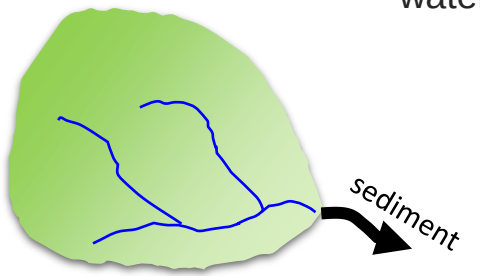
Sediment Yield* Estimates

	No.	Site	Wshed Area (km2)	% forest	Mass (T)	Res. Time (hr)	Yield T/km²/yr
Stockport	1	Black River Pond	15.5	98	2000	17	1.8
	2	Hand Hollow	0.34	99.6	350	7	28
	3	McCagg Pond	9.2	48.5	17000	2	38
	4	Summit Lake	56	76.2	110000	0.9	13
	5	Stottville	438	64.1	44000	0.07	1
	6	Red Mills Pond	150	67	24000	0.12	1
Tivoli	7	Timber Lake	2.4	99	8000		30
	8	Stone Ridge Pond	3.6	57	50000		47
Iona	9	Doodletown Reservoir	7.3	99	5500		17





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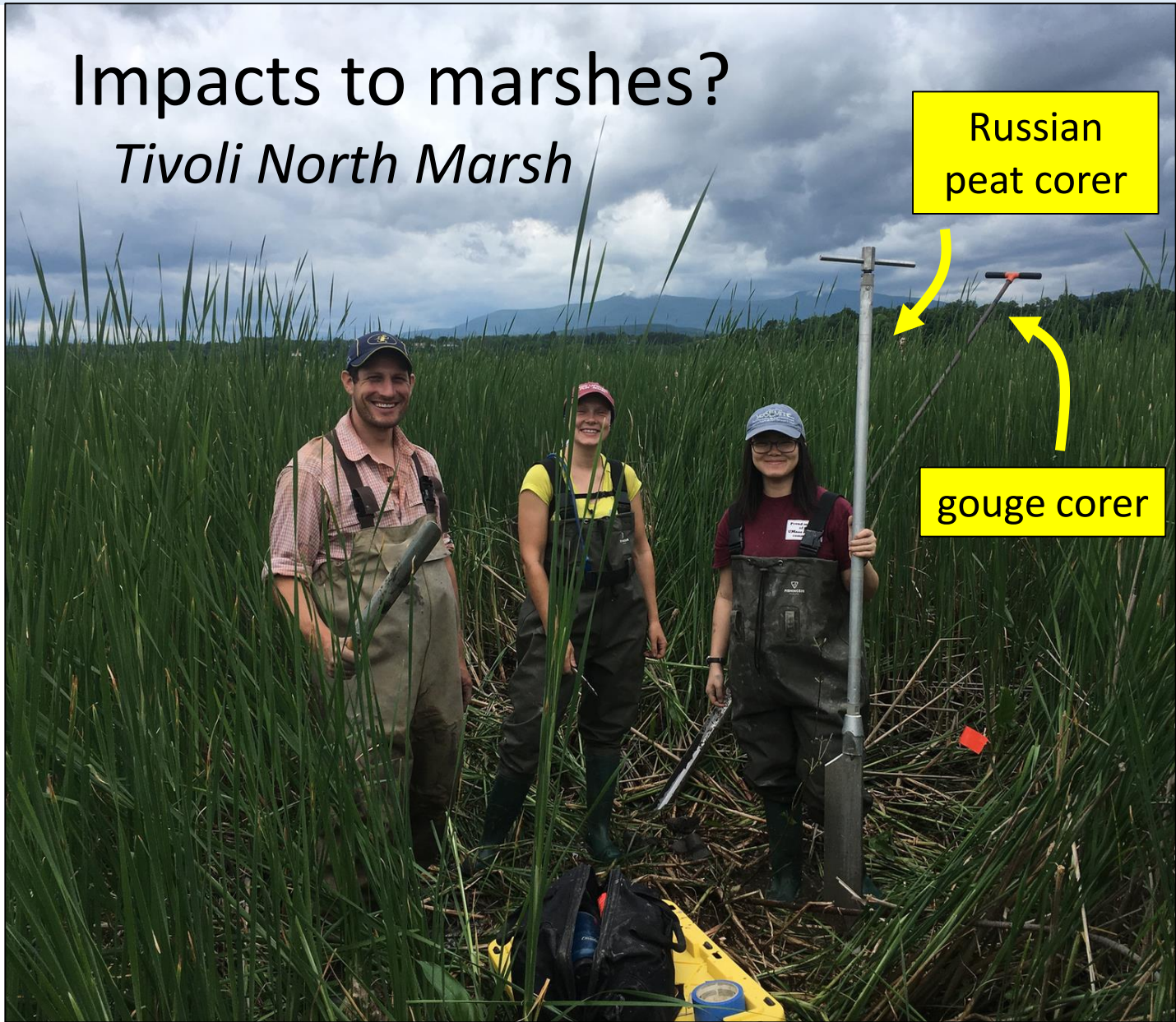
Main Points: Impoundment Surveys

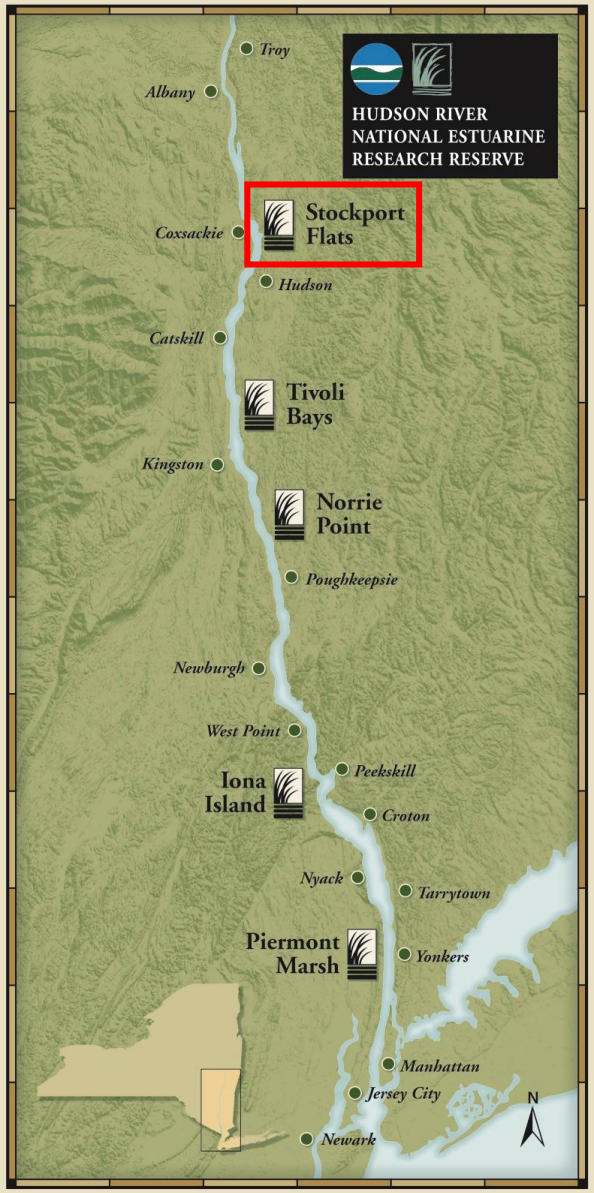
1. Dam-trapped sediment minimal relative to estuary sed budget

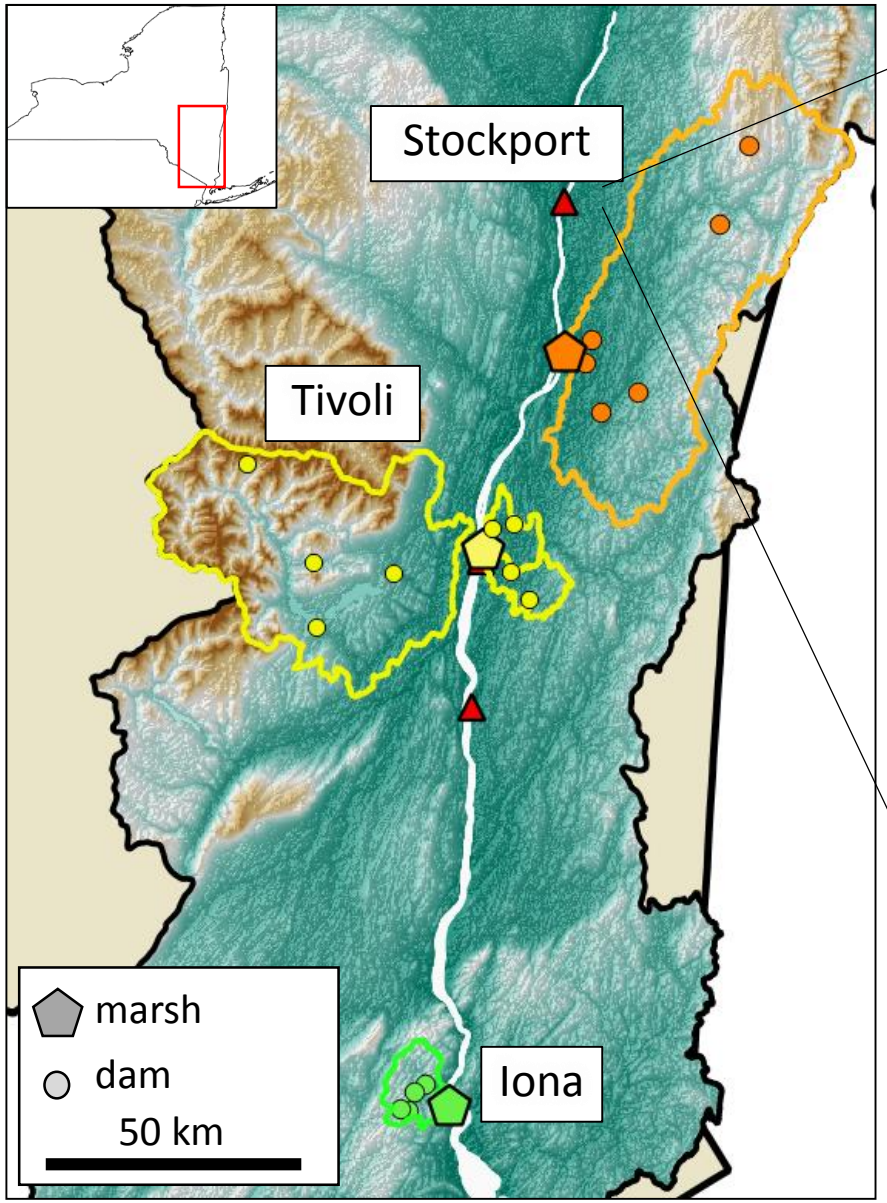
2. Most dams do not presently trap sediment

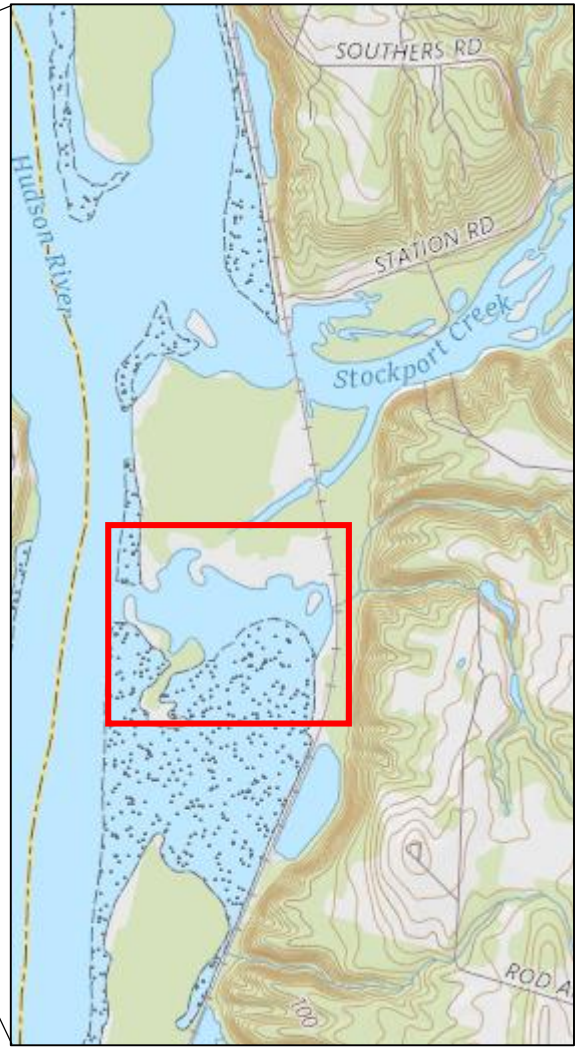
3. Geology and watershed area influence sediment yield



Stockport Marsh







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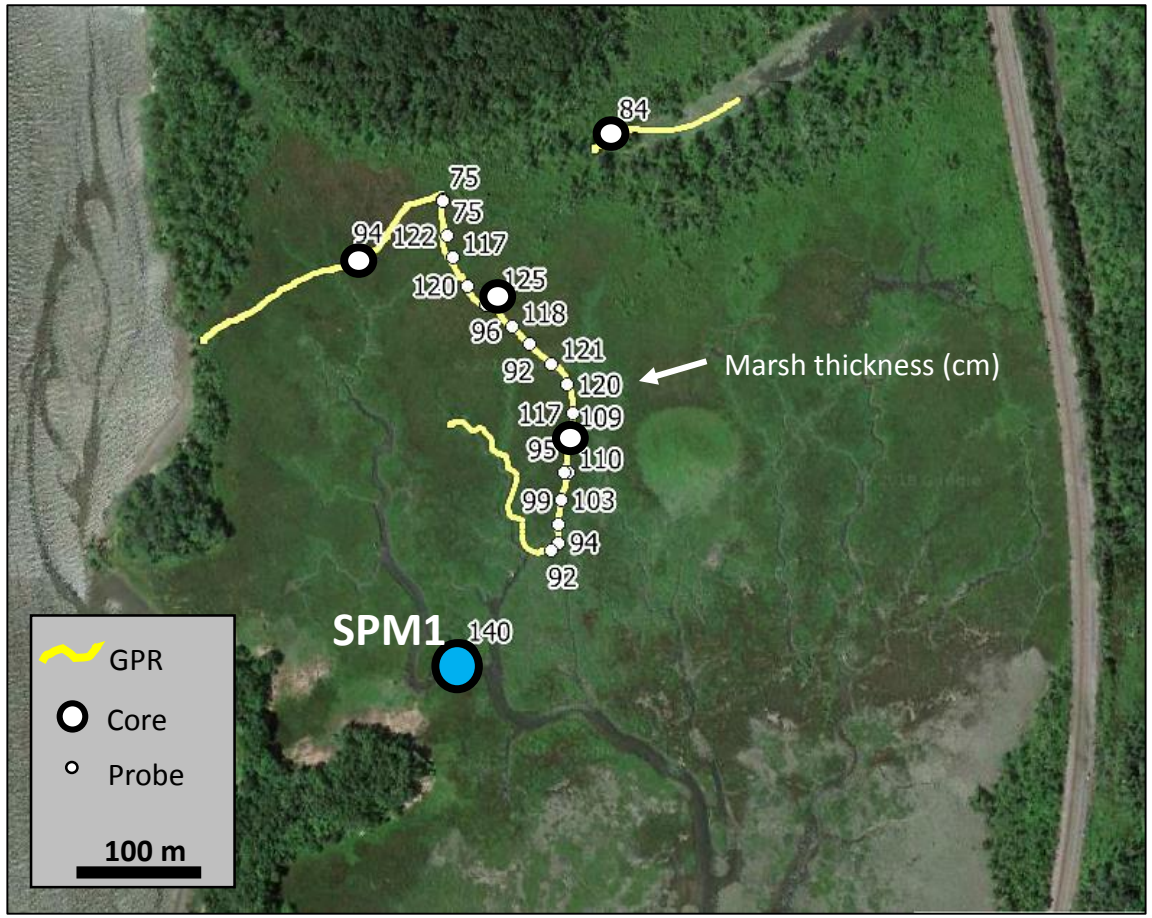
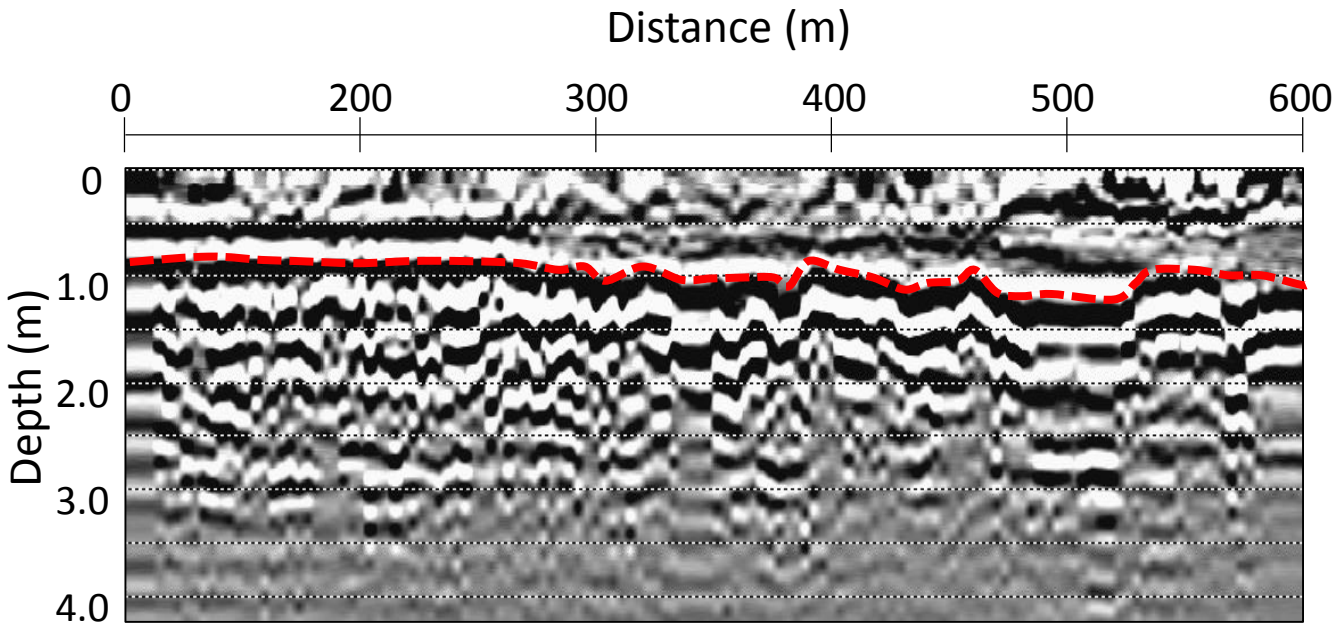
Stockport Marsh – Sediment Thickness





"Stockport Flats"

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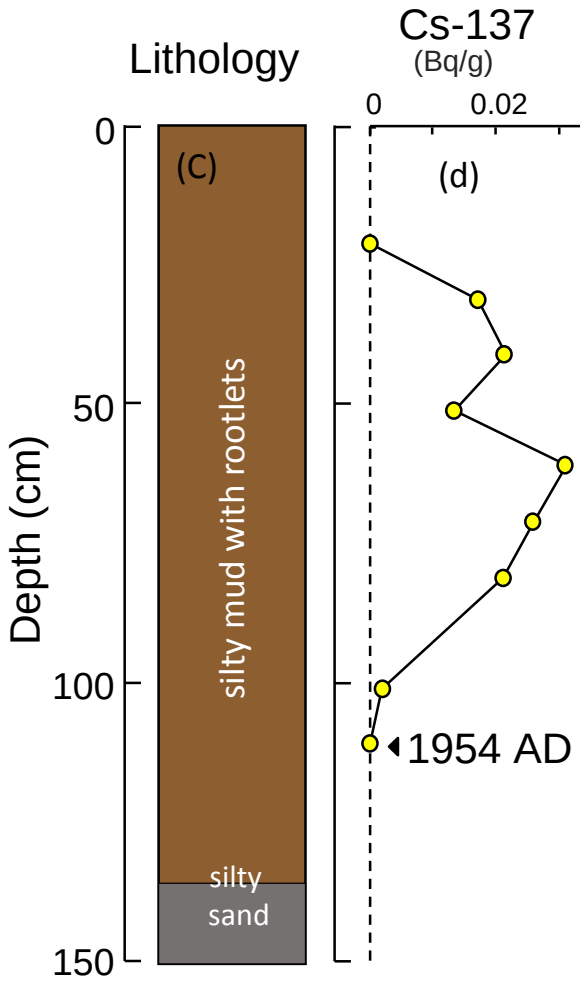
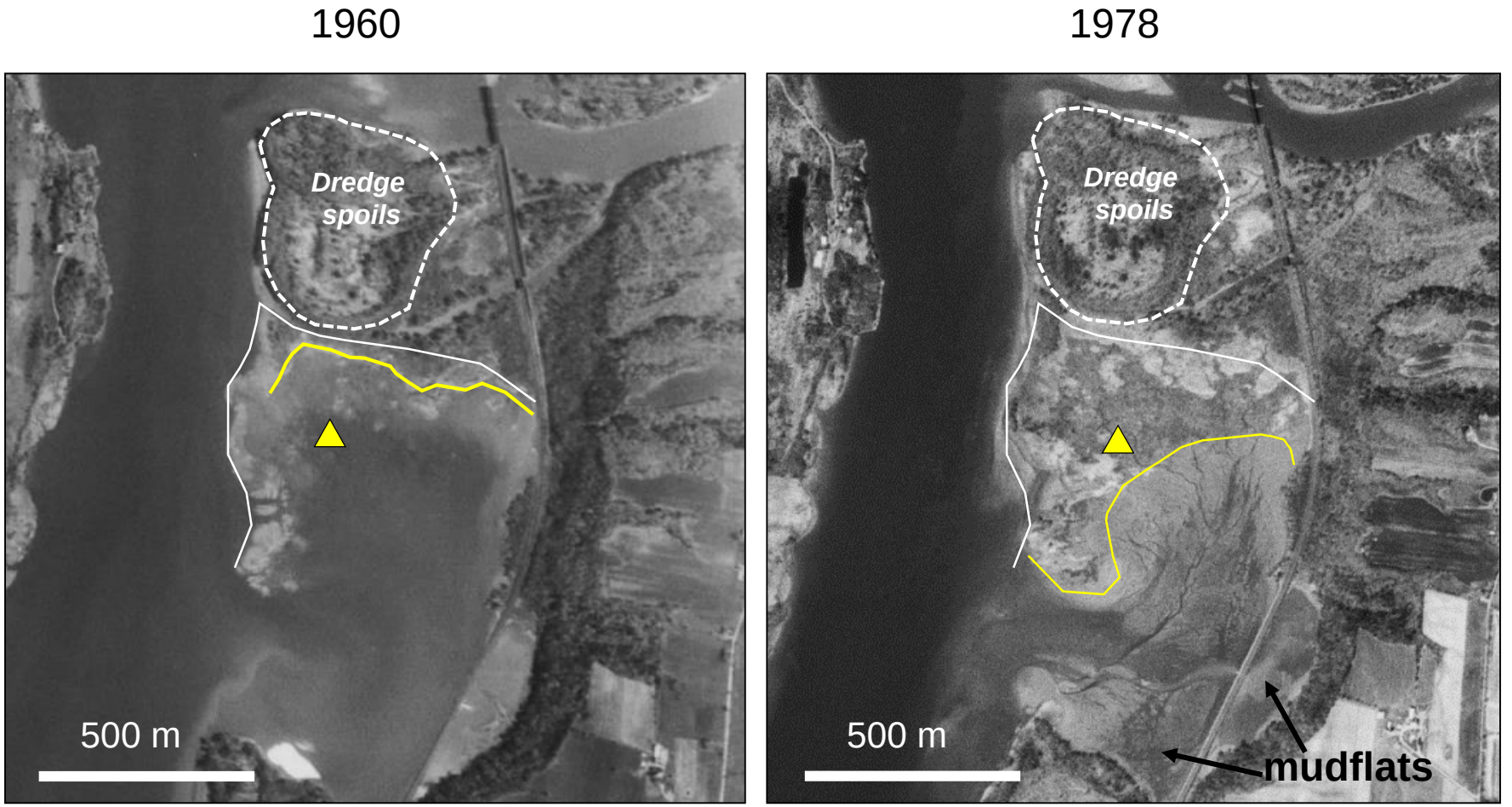
Stockport Marsh – Sediment Deposition



An inadvertent experiment in marsh seeding *…success!*



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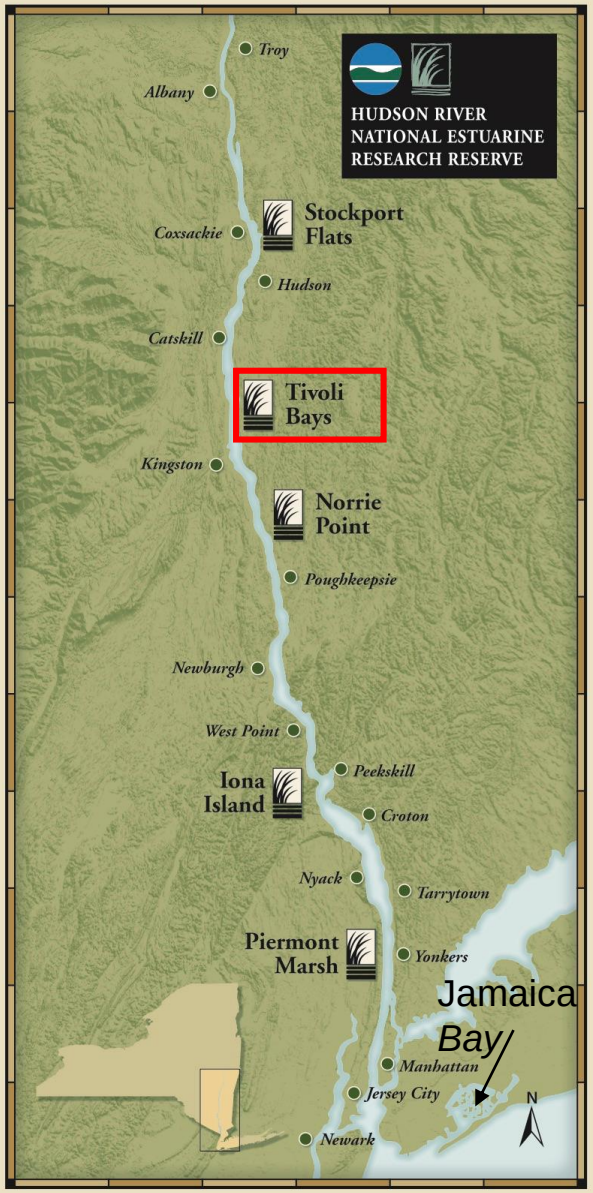
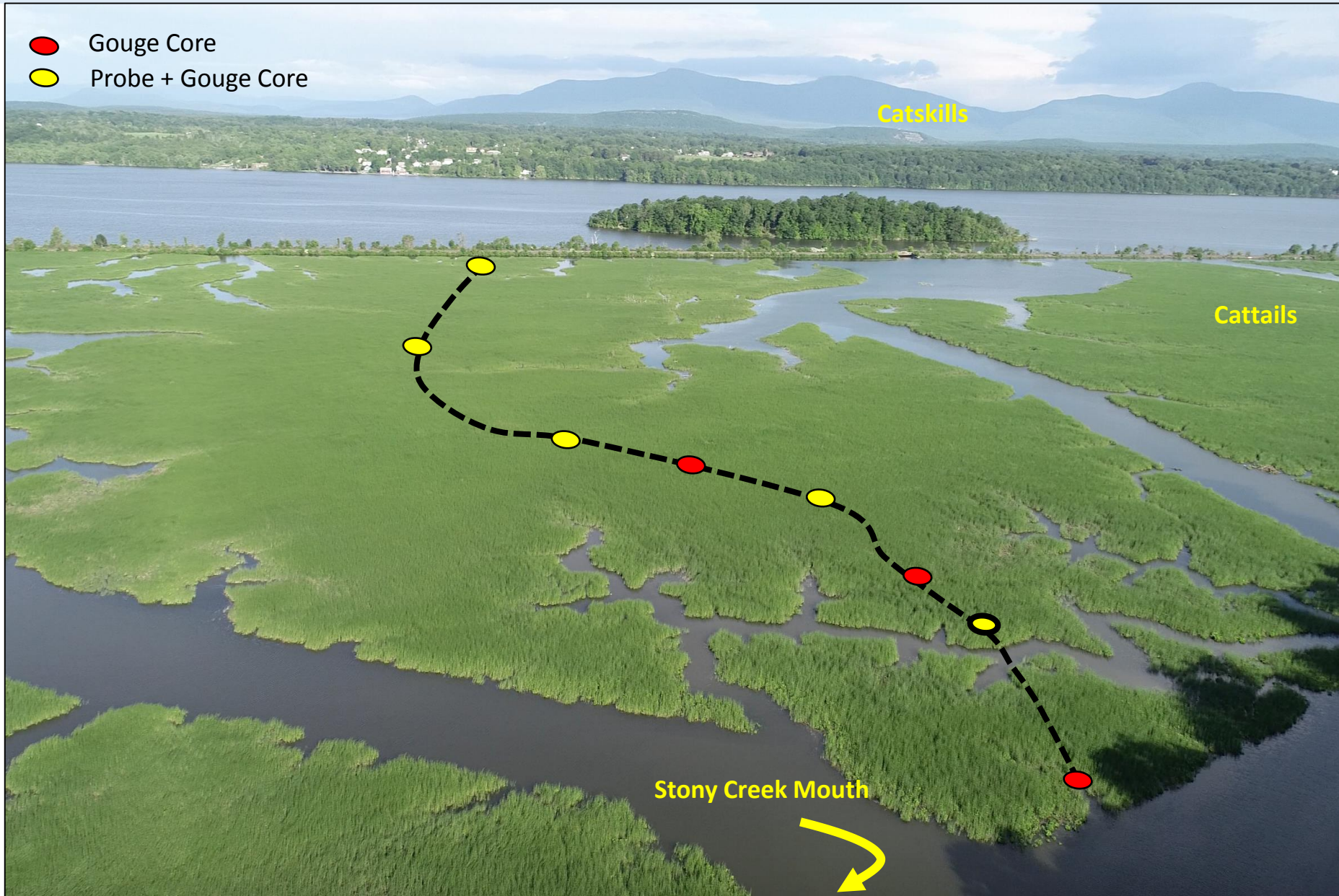
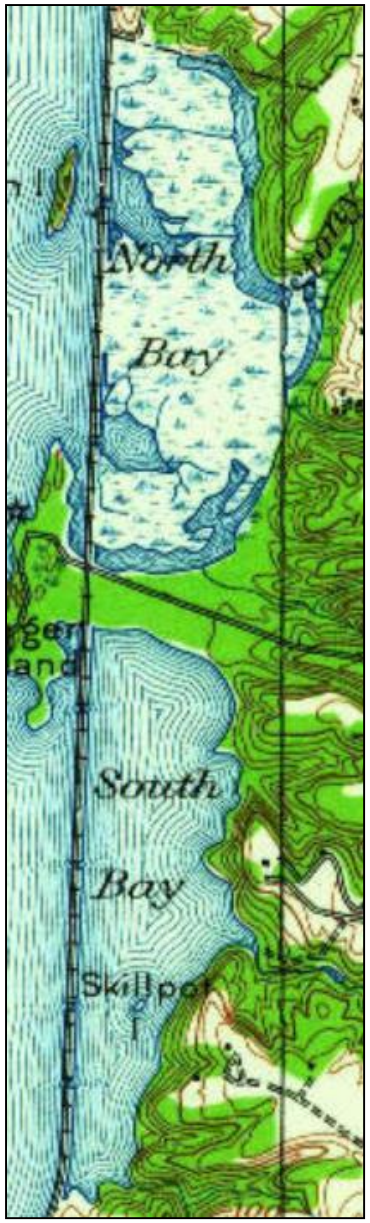
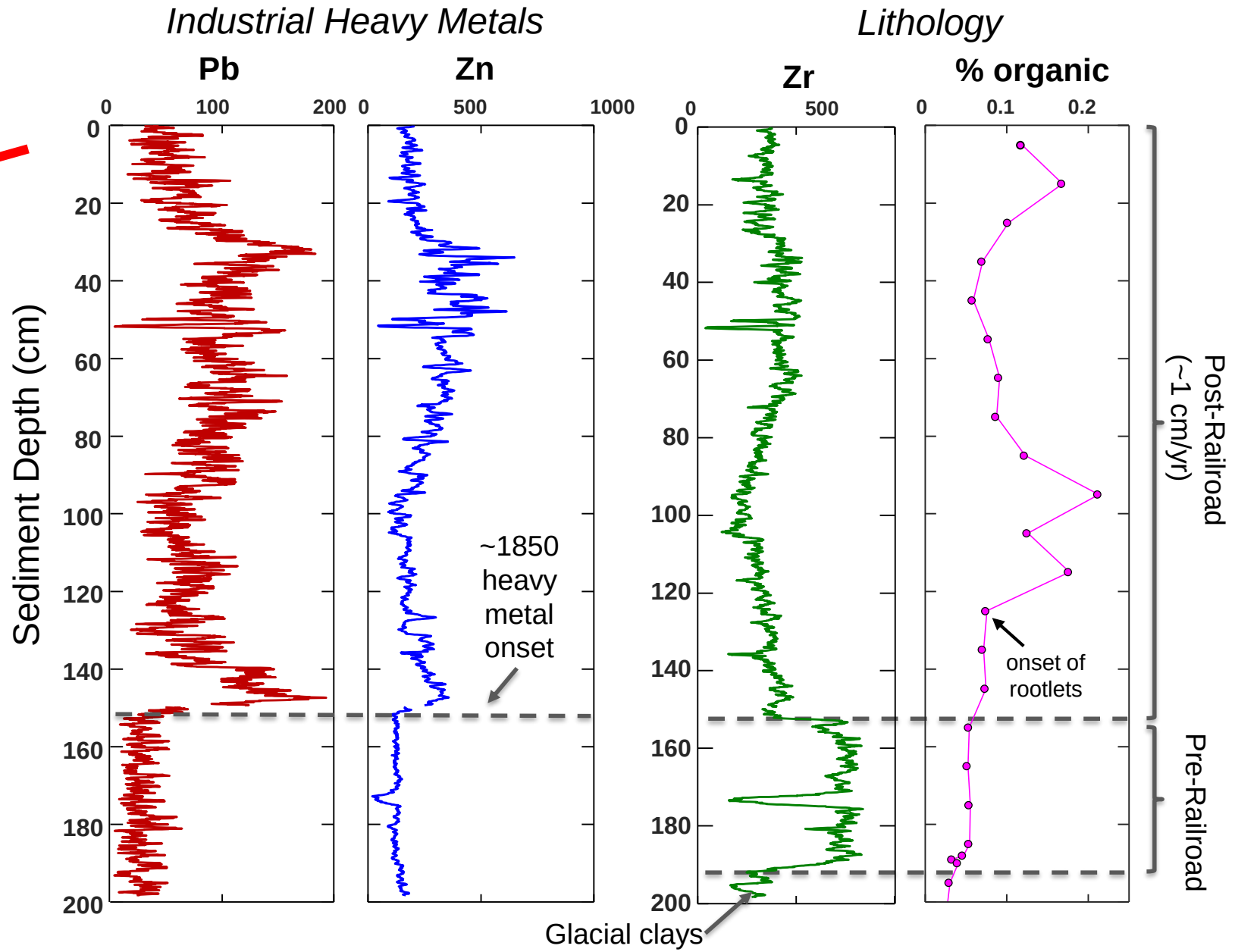
Tivoli North Bay

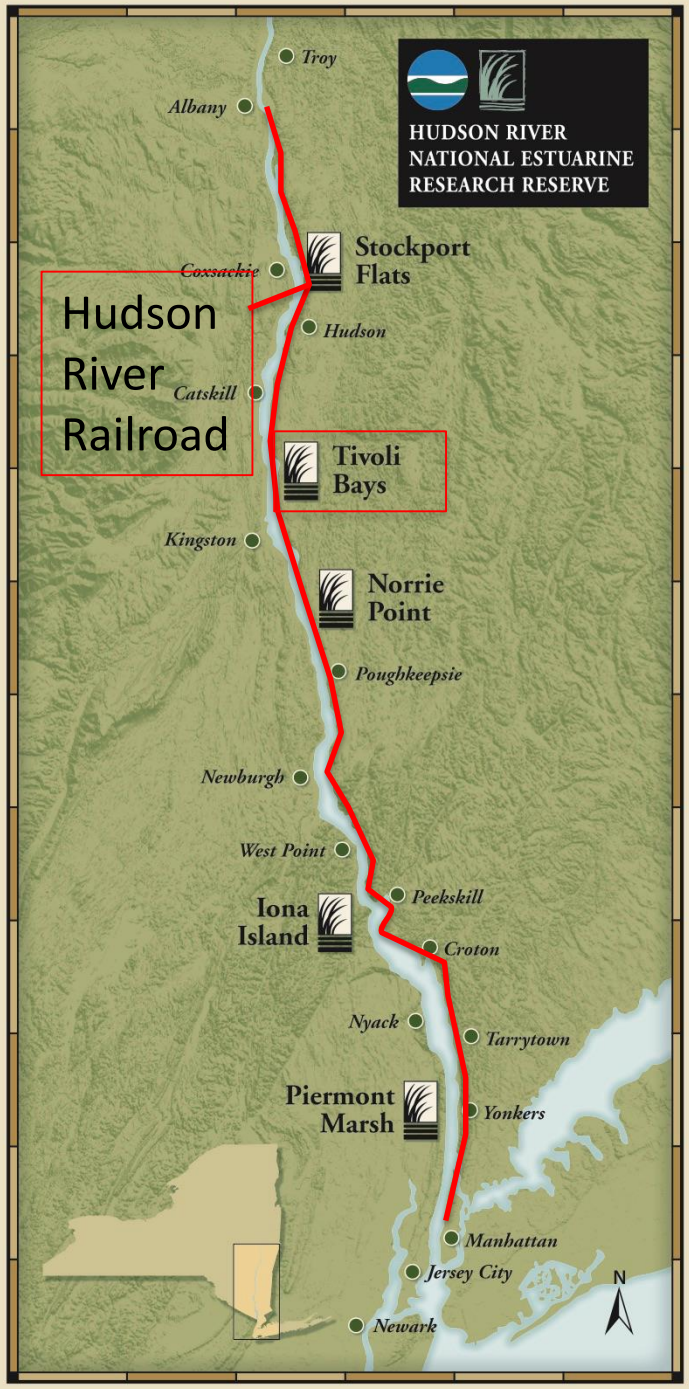




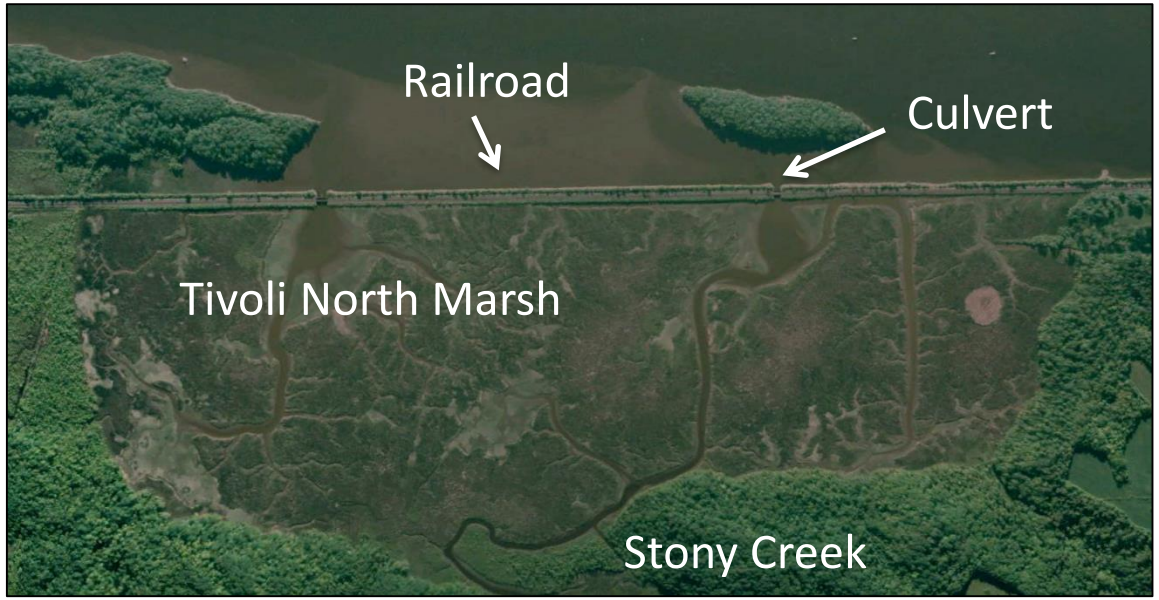
Tivoli North Sediments

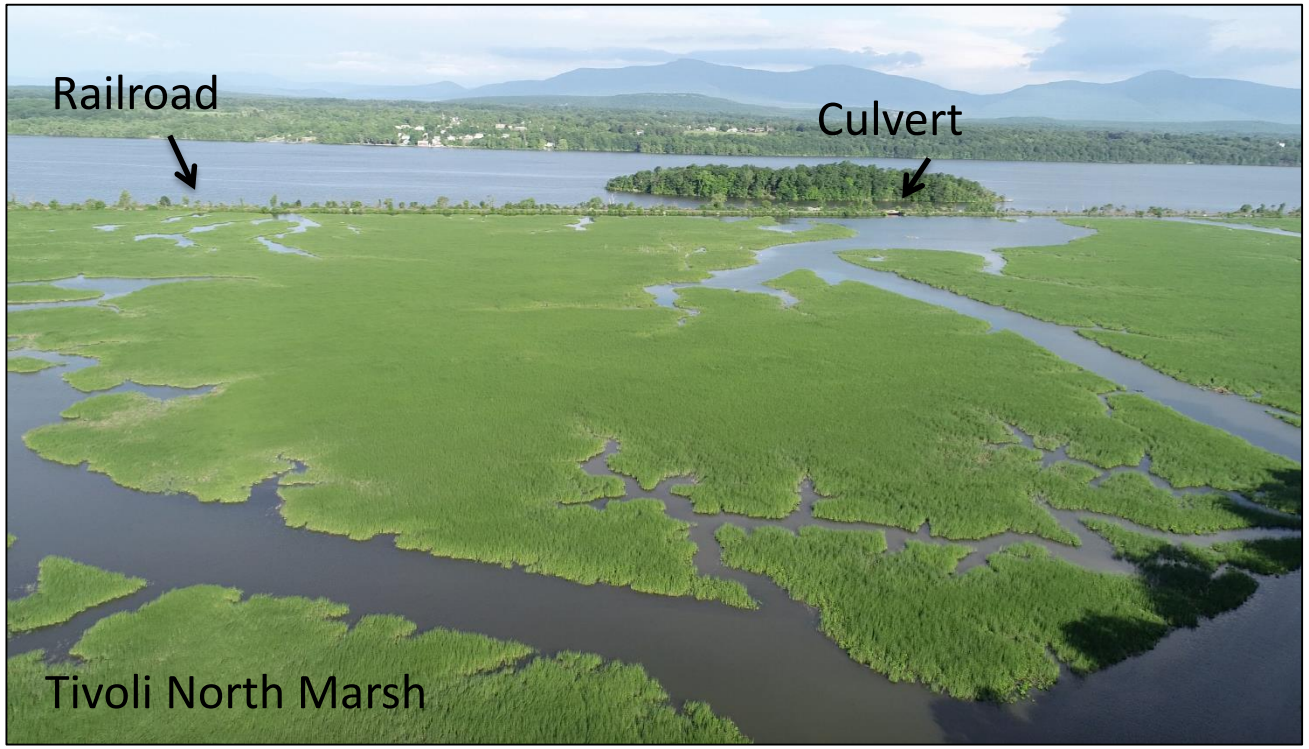




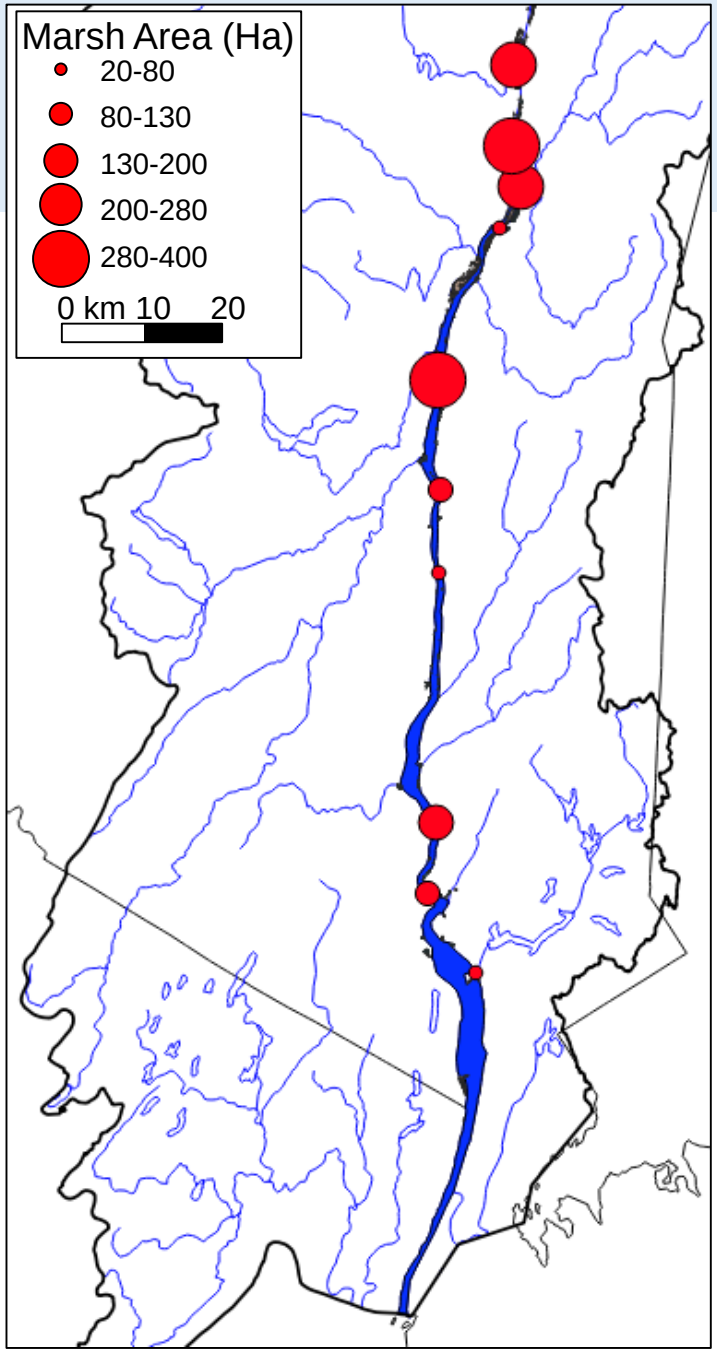


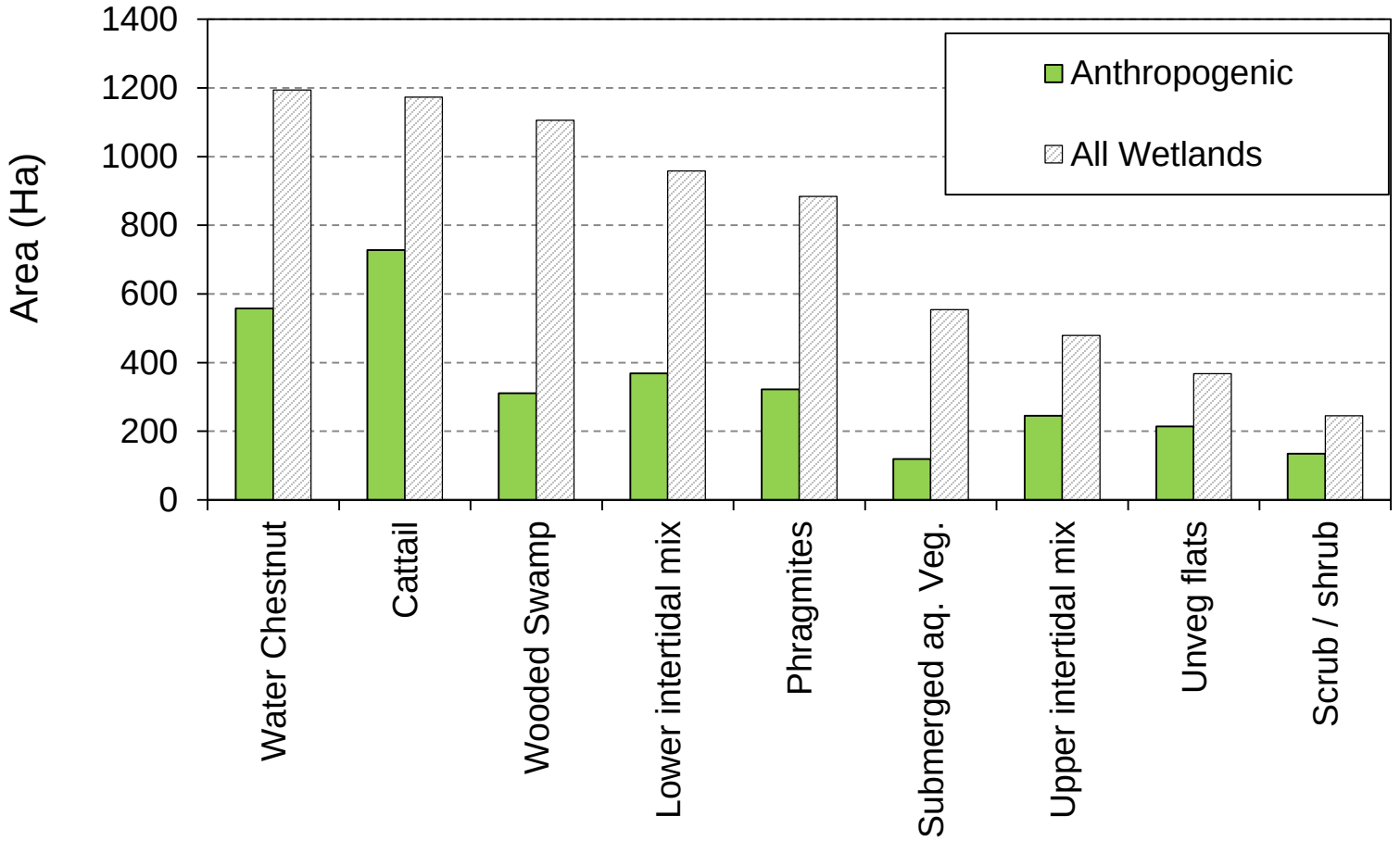
Why are deposition rates in Tivoli so high?





Aggregate Influence of Shoreline Changes on the Hudson





52% of wetlands are anthropogenic
2/3 cattail marshes

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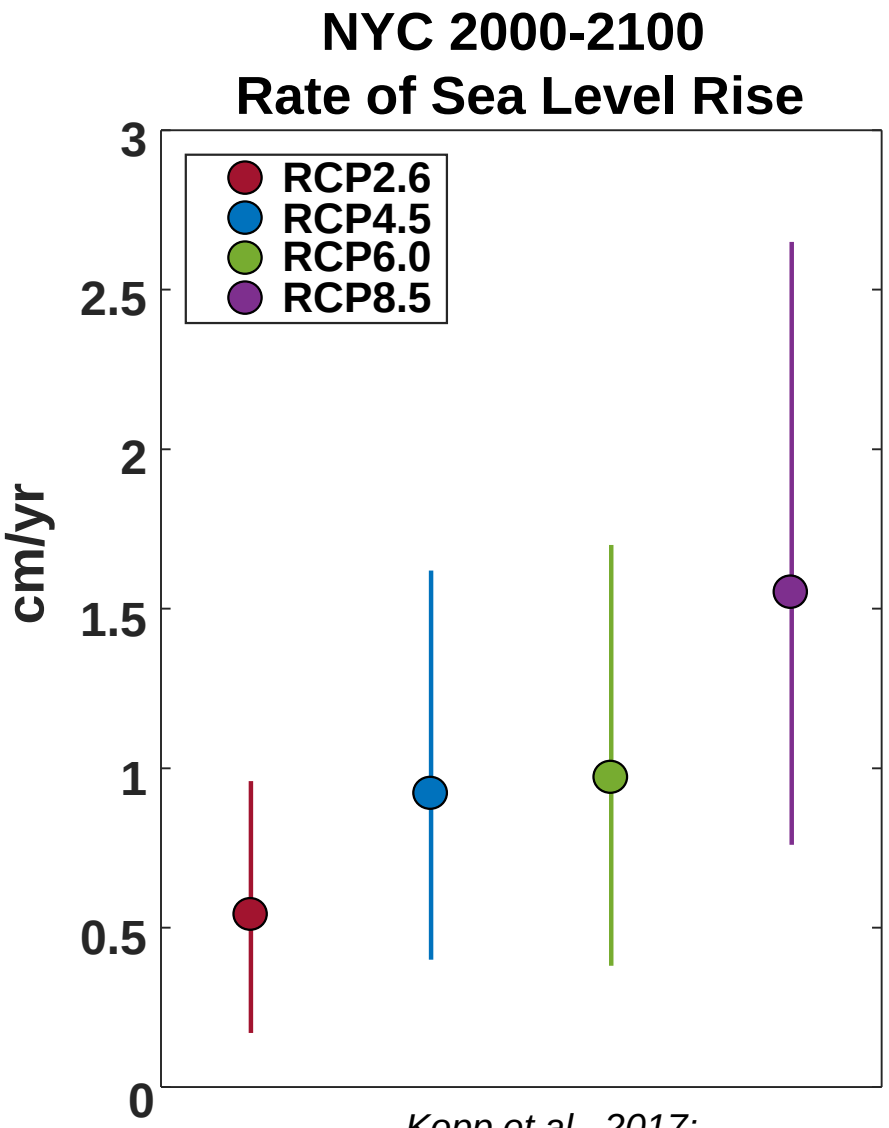
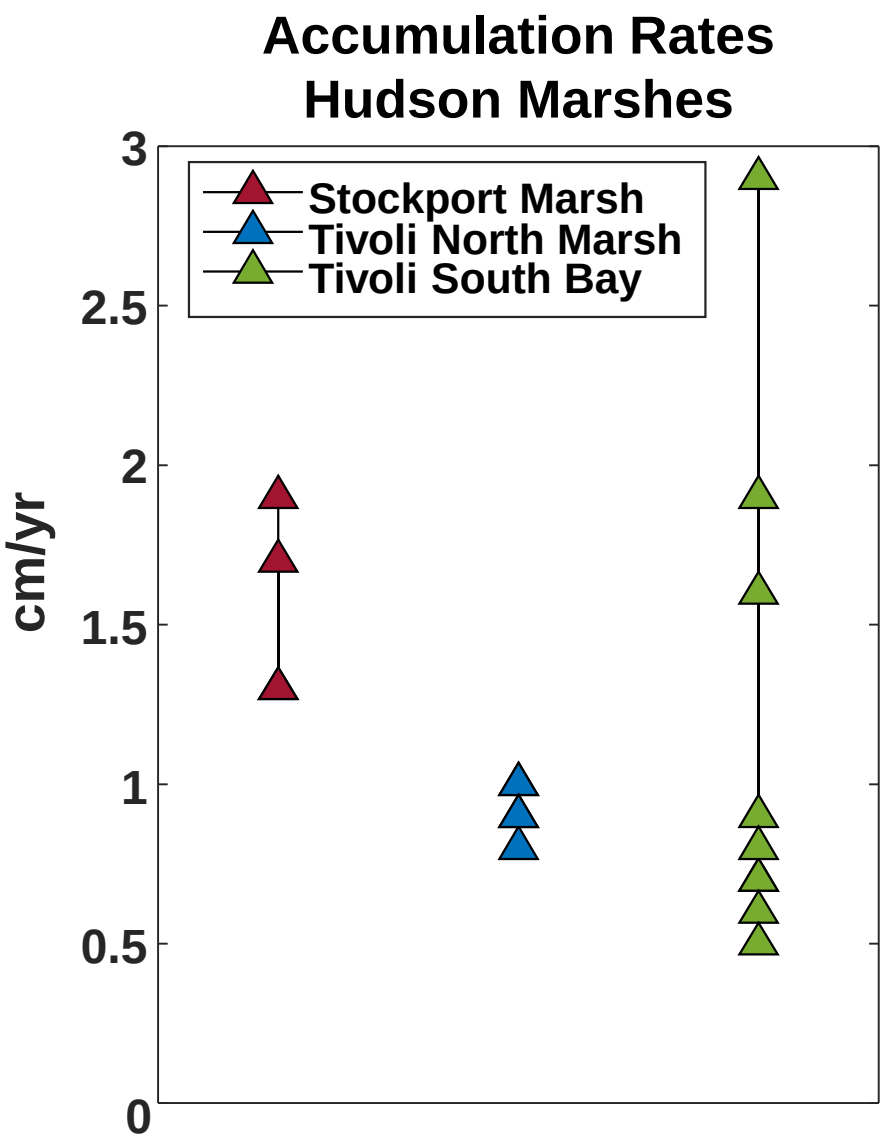
Hudson Marsh Accretion vs Sea Level Rise Projections



Kopp et al., 2017;
DeConto and Pollard, 2016



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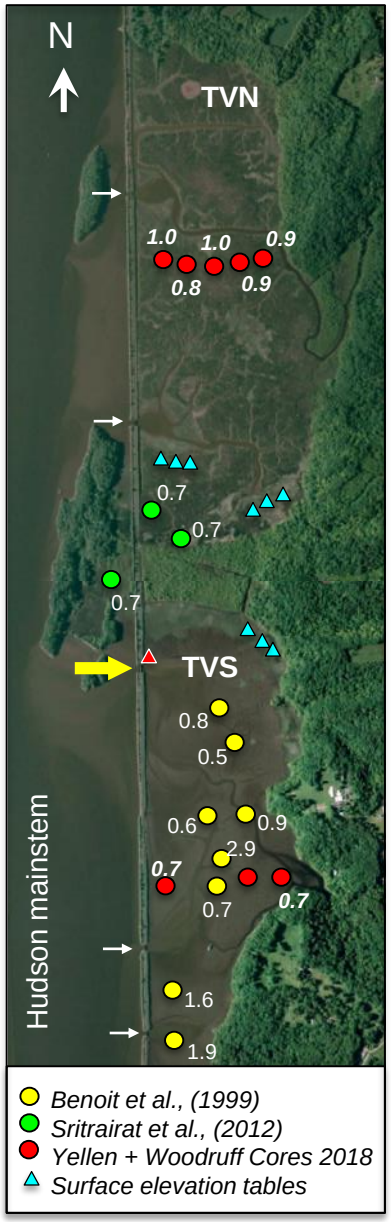
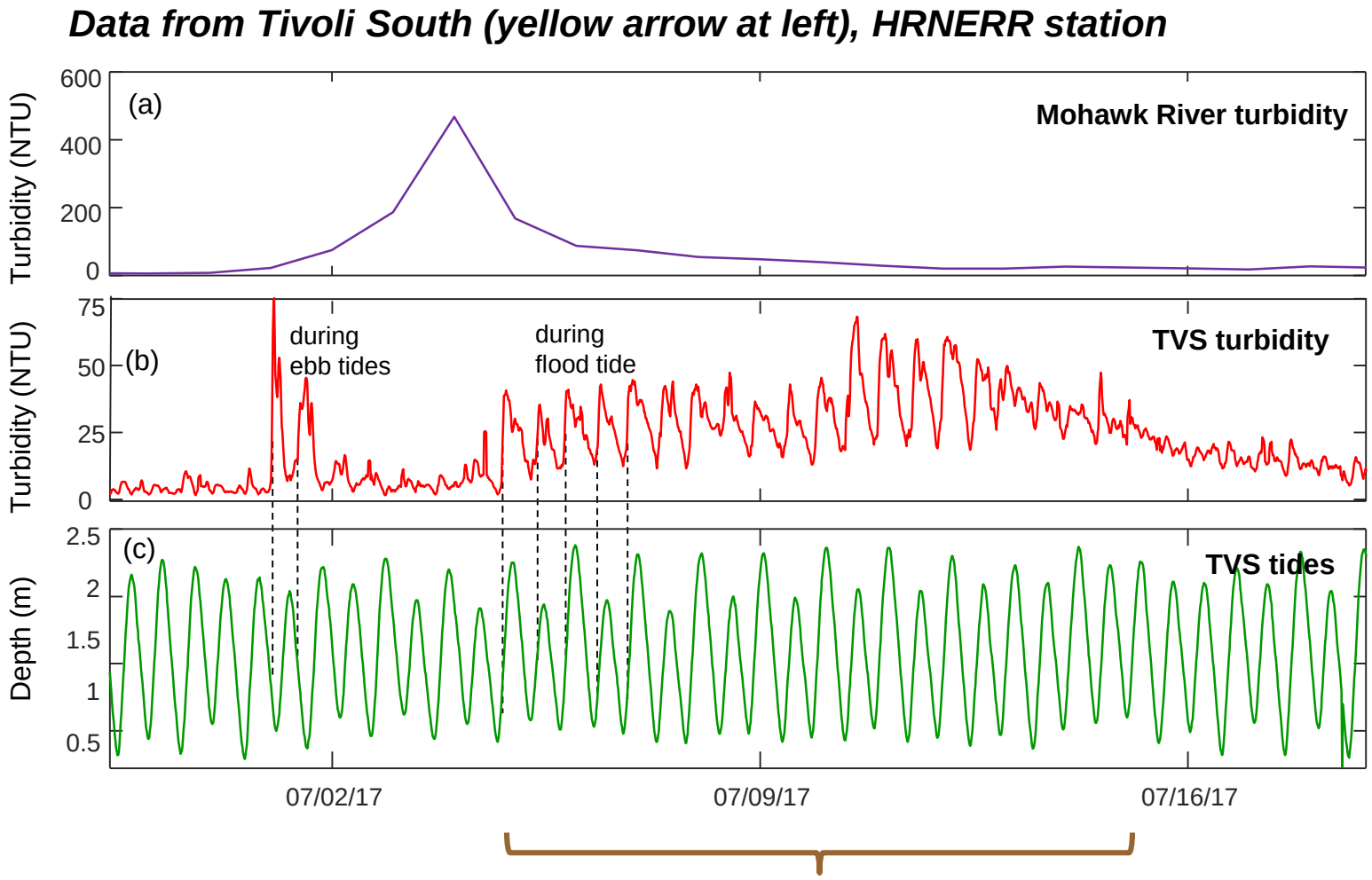
Where does the sediment come from?

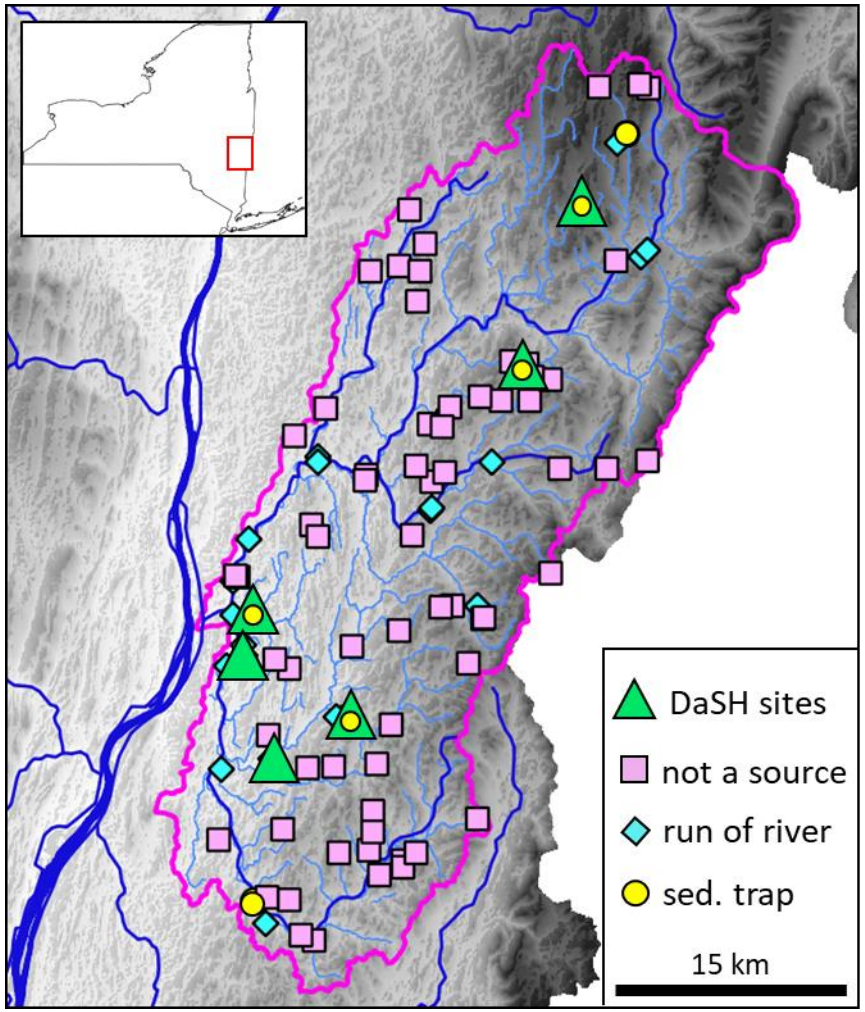




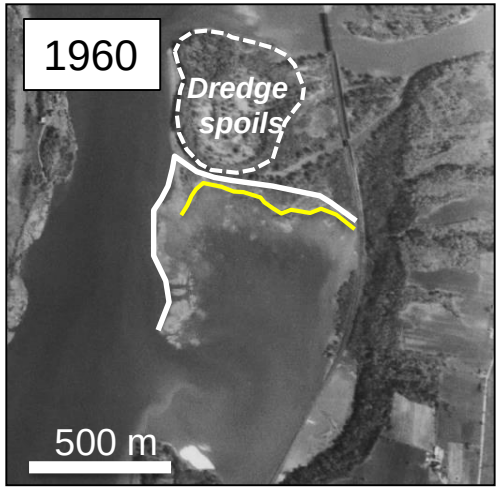
24% of flood sediment trapped

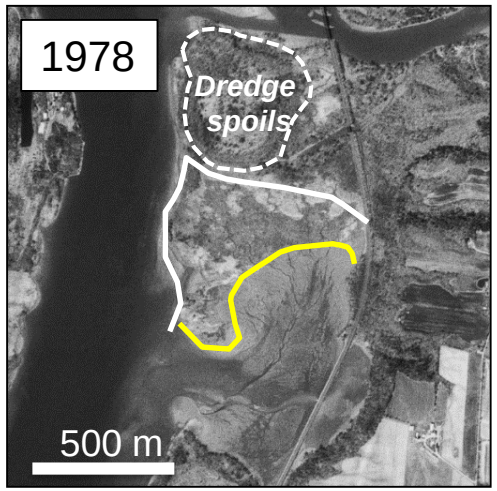
Conclusions

1. Most dams don't alter estuary sediment



2. Hudson tidal marsh limited by space, not sediment.





3. Roughly half of Hudson tidal marshes are anthropogenic.