Lake Erie Regional Sediment Management and Sediment Budget

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RSM

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Outline

1. Background and purpose
2. Phase I. Overview of sediments and transport processes
3. Phase II. Sediment budget (in progress NY, PA, and OH)
4. Future work (MI, data sharing, implement RSM principles)

Problem Statement

- Great Lakes navigation projects in past were managed as isolated entities
- Need data and fundamental background science on what is happening in the entire system
- Need tools to inform decisions on sediment management affecting whole system, not just individual projects
- Potential changes from climate change (less ice? greater storminess?)
- Limited capacity in existing CDFs and high cost and environmental limitations for new CDFs

Phase I

- Overview analysis:
  - Sediment sources and sinks
  - Physical processes (waves, water levels, ice)
  - Lake Erie geology
  - Jetties, harbors, man-made obstructions
  - Transport directions

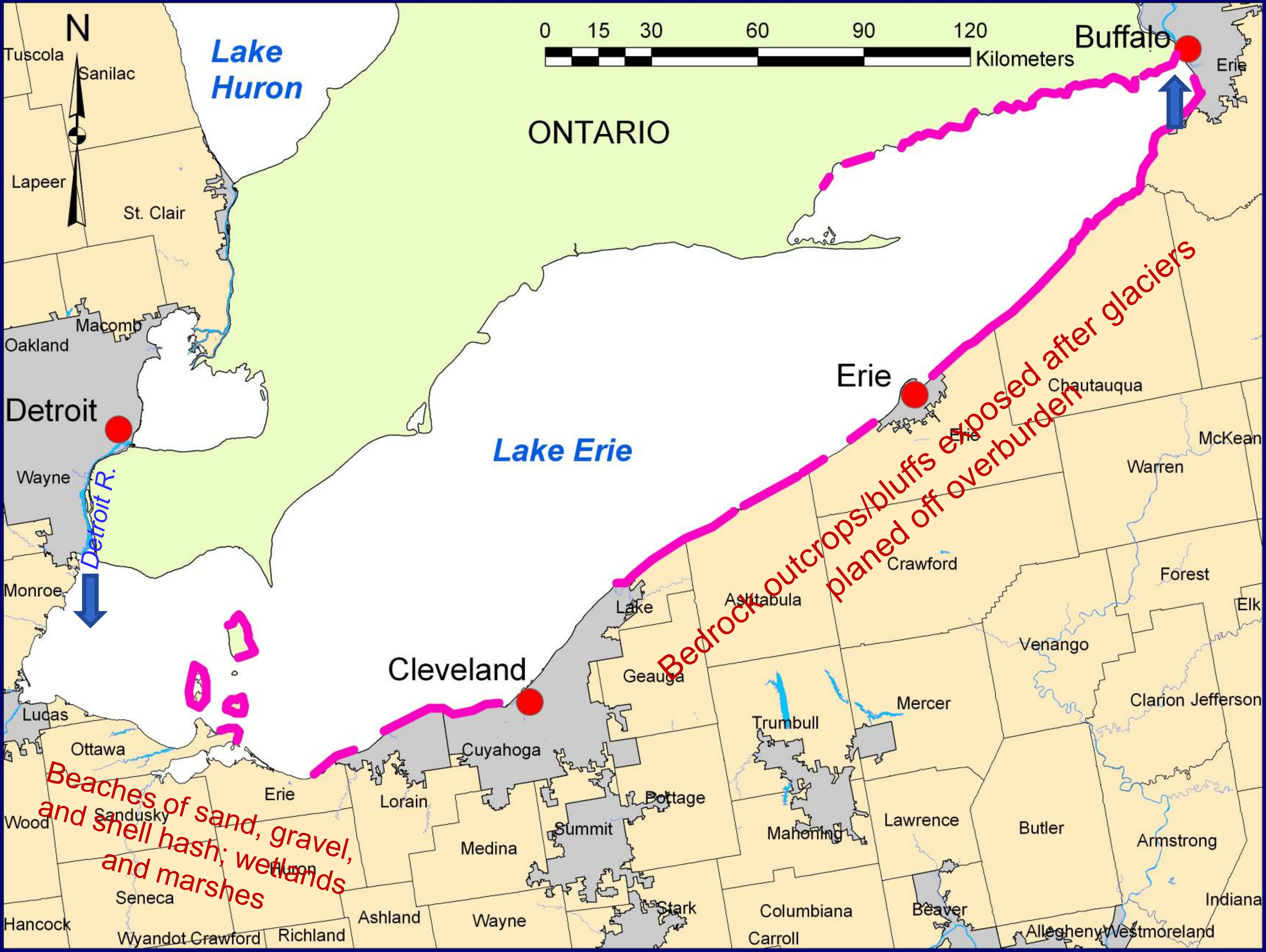
- Cooperative effort between ERDC, Buffalo District, PA DNR, and Ohio Geological Survey
- Compiled information from widely scattered technical literature, USACE unpub. data, USGS, expertise from Ohio Geol. Survey

Lake Erie Framework

Surface: 25,670 km^2, 4th largest Lake

95 % total inflow from upper lakes via Detroit R.

Shallowest lake, vul-nerable to fluctuating water level and seiching



West Lake Erie

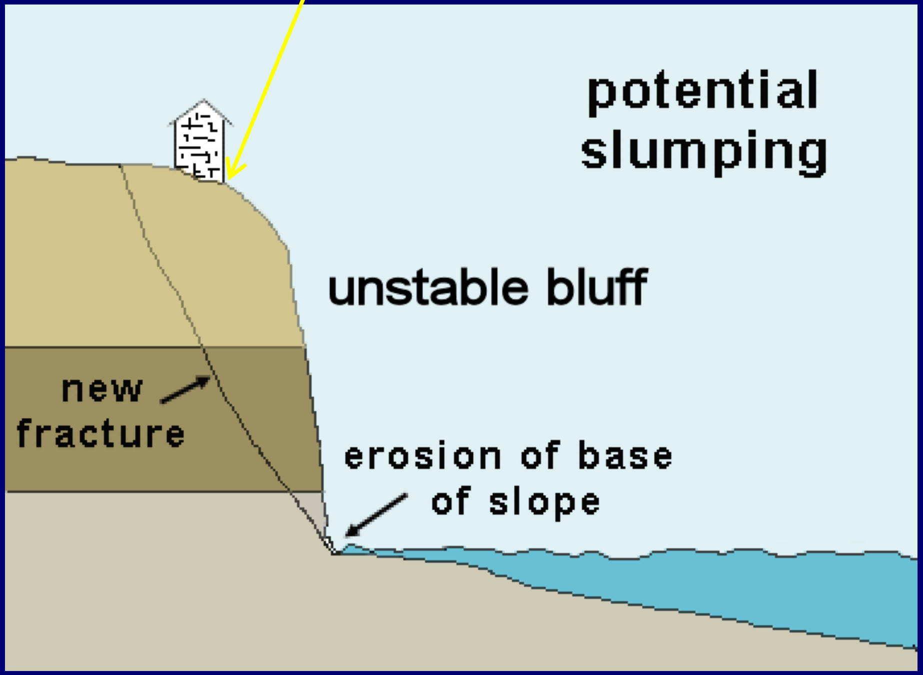
Barrier spit at Sheldon Marsh State Nature Preserve, April 2005. One of the few remaining unarmored beaches in western Ohio - example of terrain that would have been common here 150 years ago.

Sandusky Bay, Aug 1999. Marshy shores consist of low clay banks with minor fine sand.

East Lake Erie

Showse Park, east of Vermillion, OH, August 1999. Low-grade, friable shale weathers from wave impact, groundwater percolation, and freeze-thaw cycles.

Bluff edge



East L. Erie, cont.

Shale bluffs near Evans, NY, 1995. Fragments weather into beach sand

Shale slabs in shallow water, North East, PA, 1994. Waves move some sediment to beaches

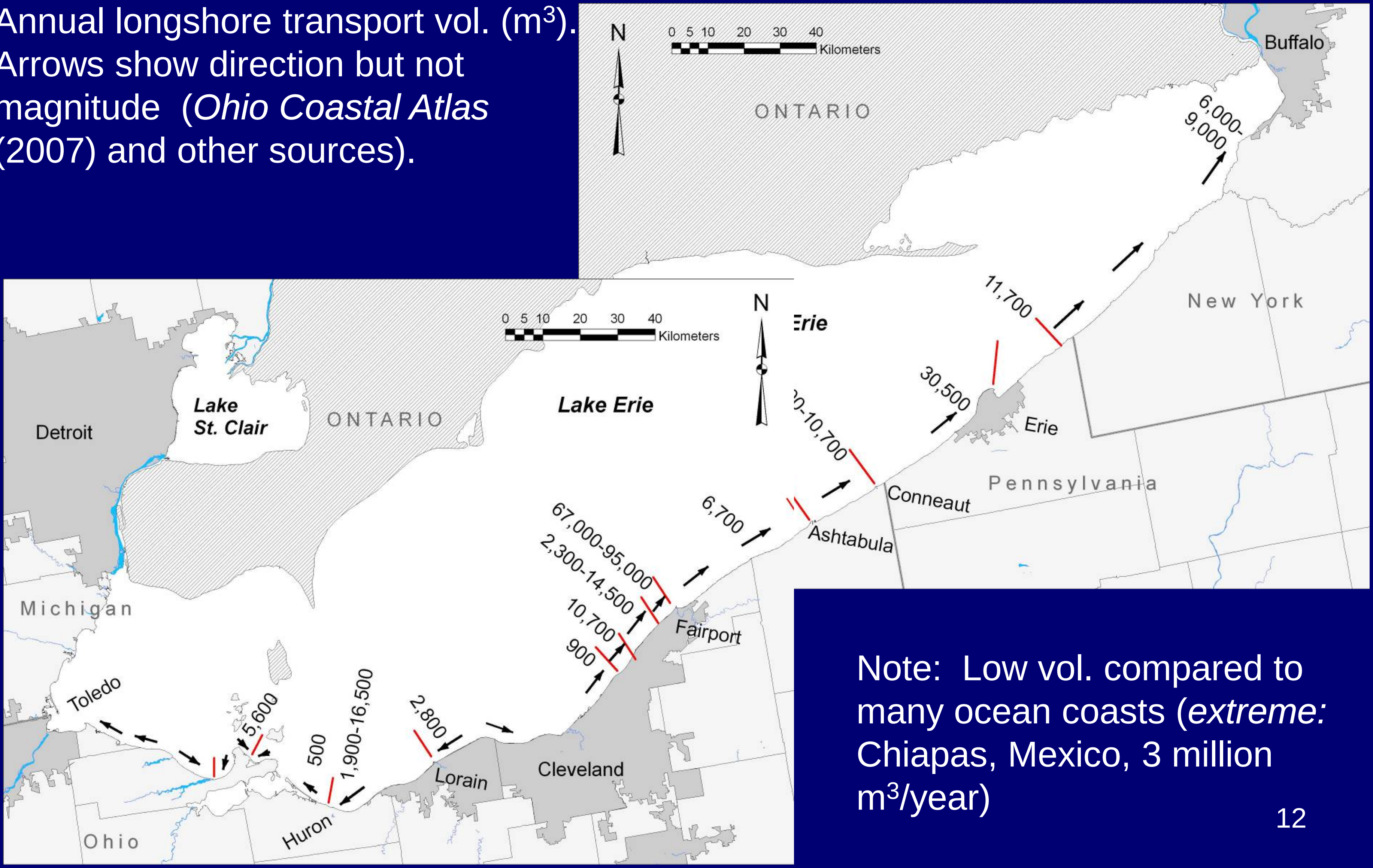
Sediment Sources - Losses

- **Sediment sources:**
  - Material brought down rivers (mostly fine-grained)
  - Industrial dumping and runoff from sewers
  - Gravel, sand, and clay eroded from glacial till bluffs and clay banks
  - Sediment created in situ from bedrock bluff weathering
  - Limited supply from lake bed lowering and offshore outcrops

- **Sediment losses:**
  - Wave- and ice-induced transport into deep water
  - Material trapped in fillets at harbor jetties
  - Material dredging from harbor entrance channel and placed in confined disposal facilities or placed in deep water
  - Bluff armoring
  - Beach mining (no longer a factor)

Longshore Sediment Transport

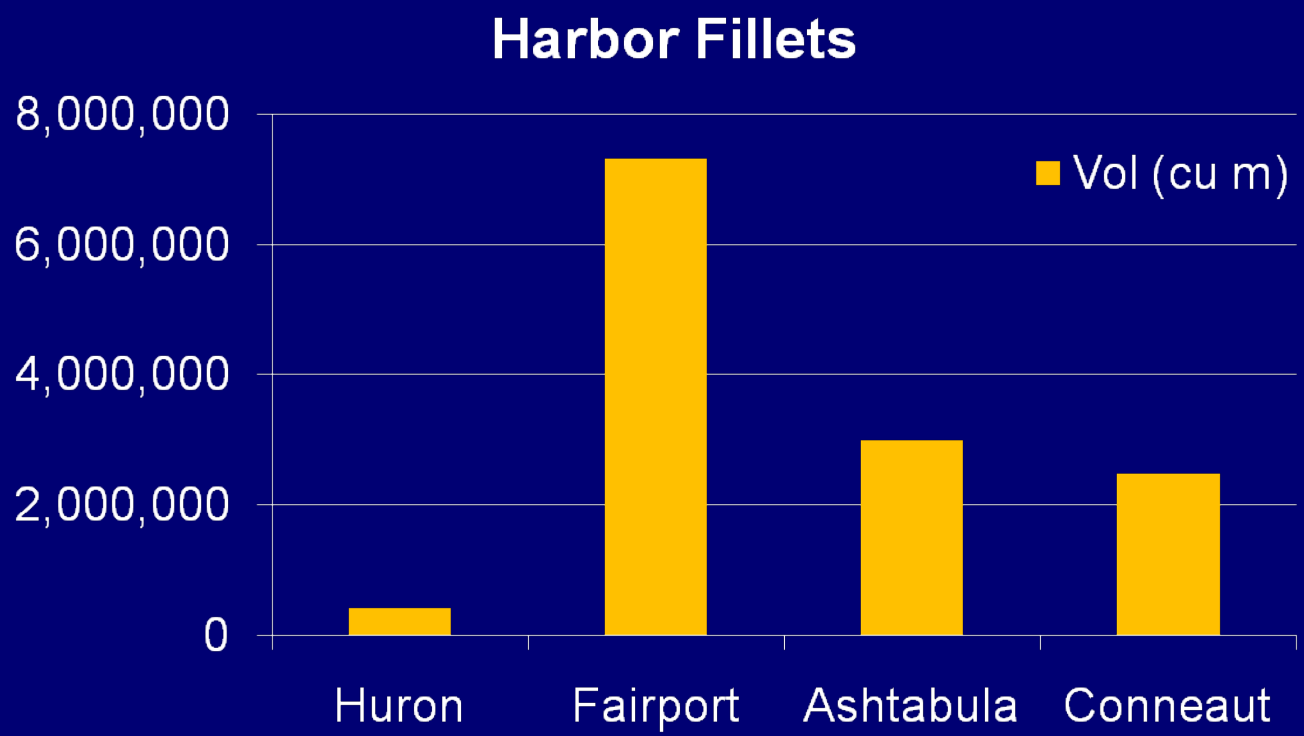
Annual longshore transport vol. (m^3). Arrows show direction but not magnitude (*Ohio Coastal Atlas* (2007) and other sources).



Note: Low vol. compared to many ocean coasts (*extreme:* Chiapas, Mexico, 3 million m^3/year)

Trapping at Harbor Mouths

- Greatest loss of sed. from littoral system over 150 years
- 27 harbors, power plants with structures



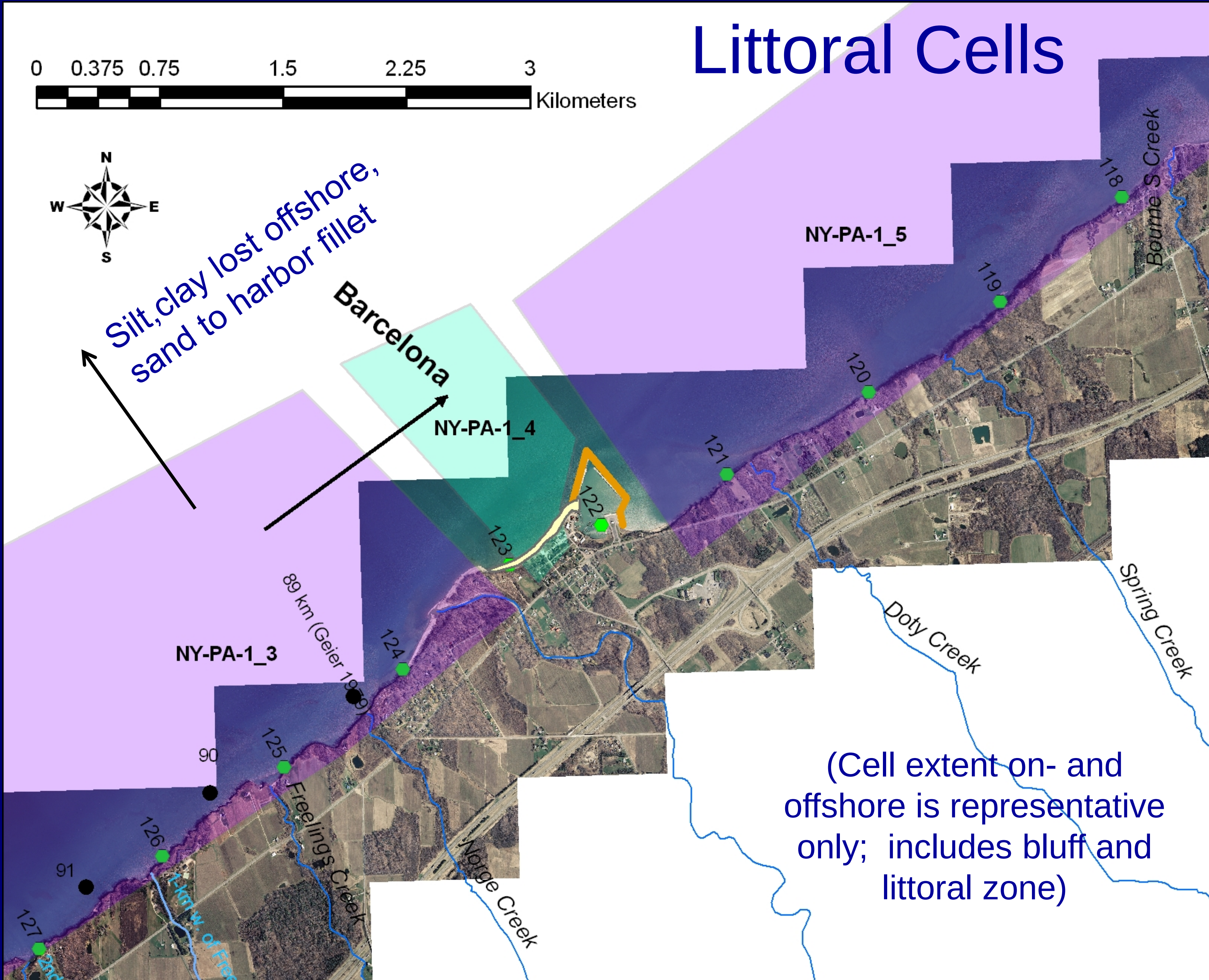
Volumes computed by LRB (Weston Cross, Anna Jessen and Ryan Patterson) from historical charts

FEDERAL HARBOR AS LITTORAL BARRIER

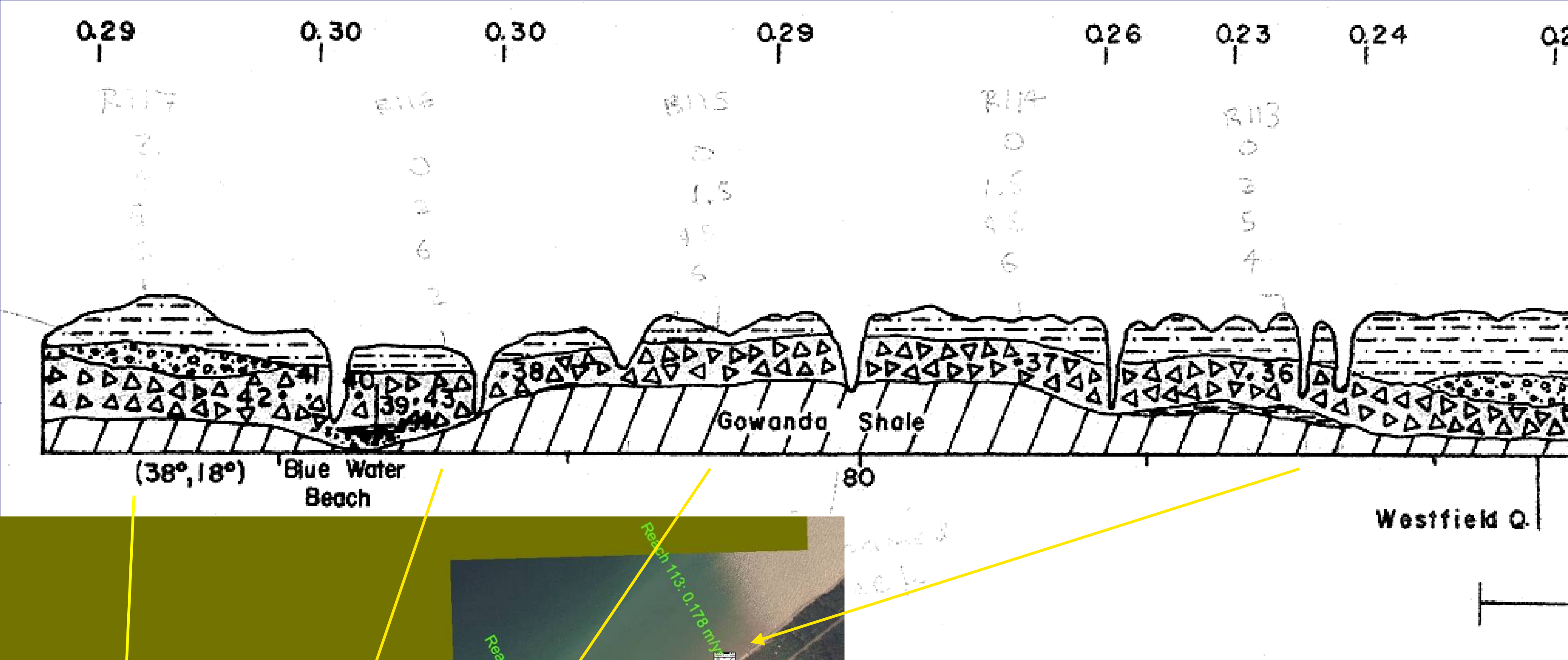
Phase II: Sediment Budget

- Define littoral cells based on geologic or morphologic characteristics
- Evaluate bluff recession (ERDC)
- Calculate volumes at jetty fillets (LRB)
- Tabulate dredge volumes from Fed. navigation channels (LRB)
- Sediment Budget Analysis System (SBAS) extension within ArcMap™ GIS software

Littoral Cells



(Cell extent on- and offshore is representative only; includes bluff and littoral zone)



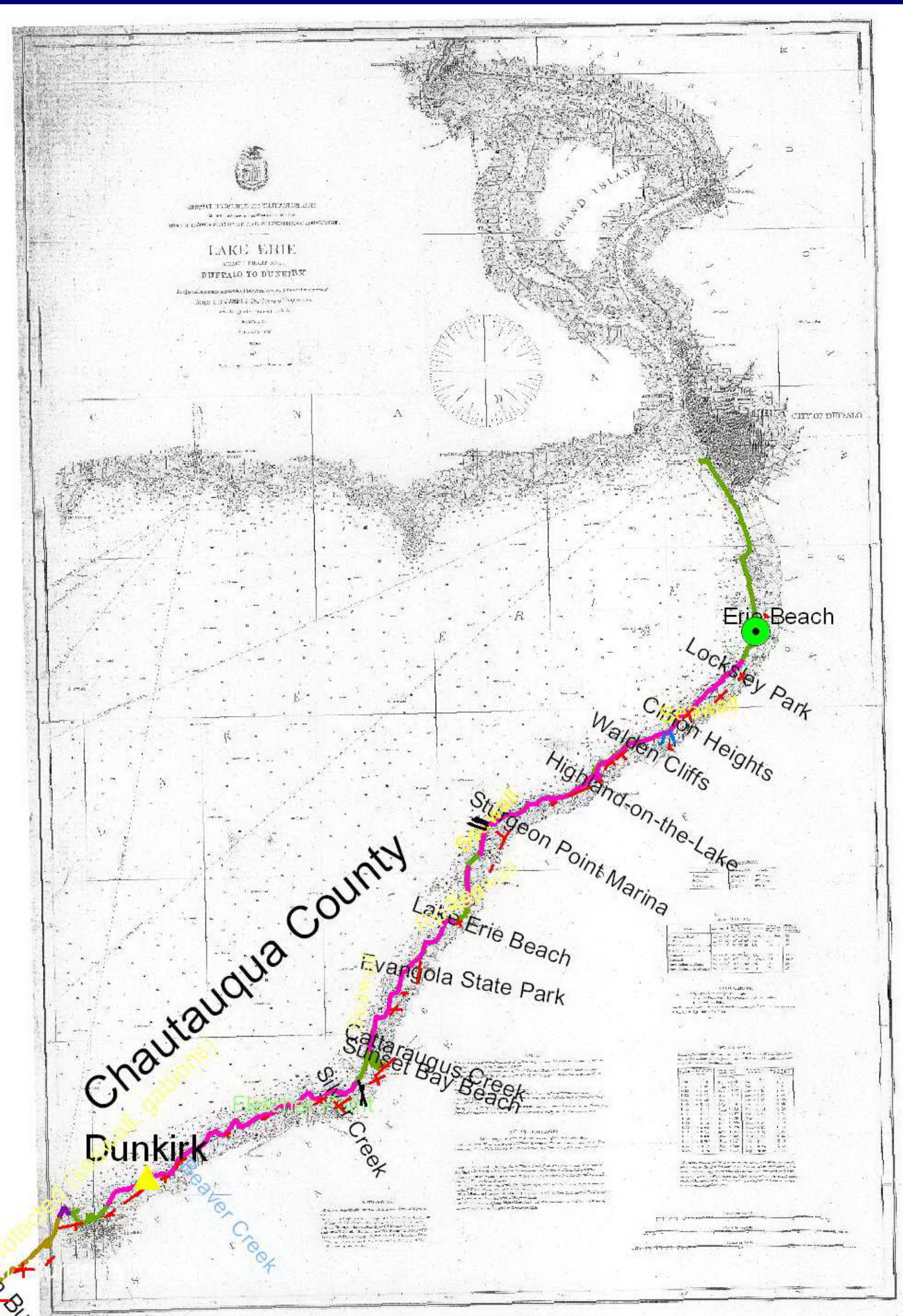
Bluff Stratigraphy

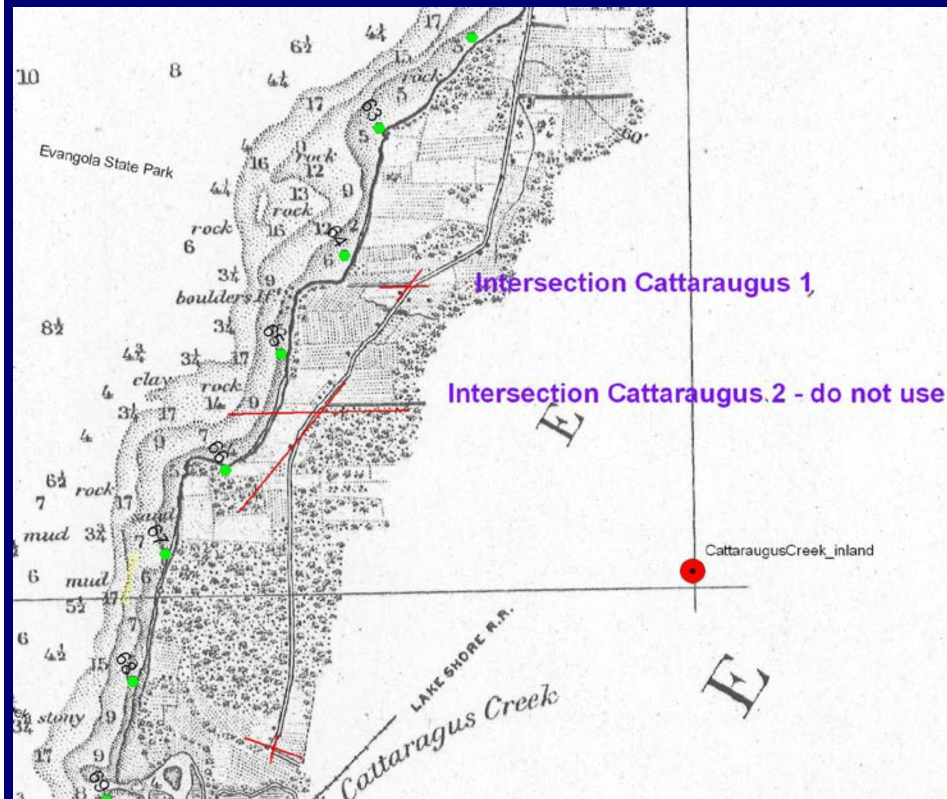
Tot. sed. vol. = bluff height reach width retreat distance

<u>Beach</u> sed. vol. = tot. vol. coarse content

Historical Data

1870s USACE Lake Survey charts

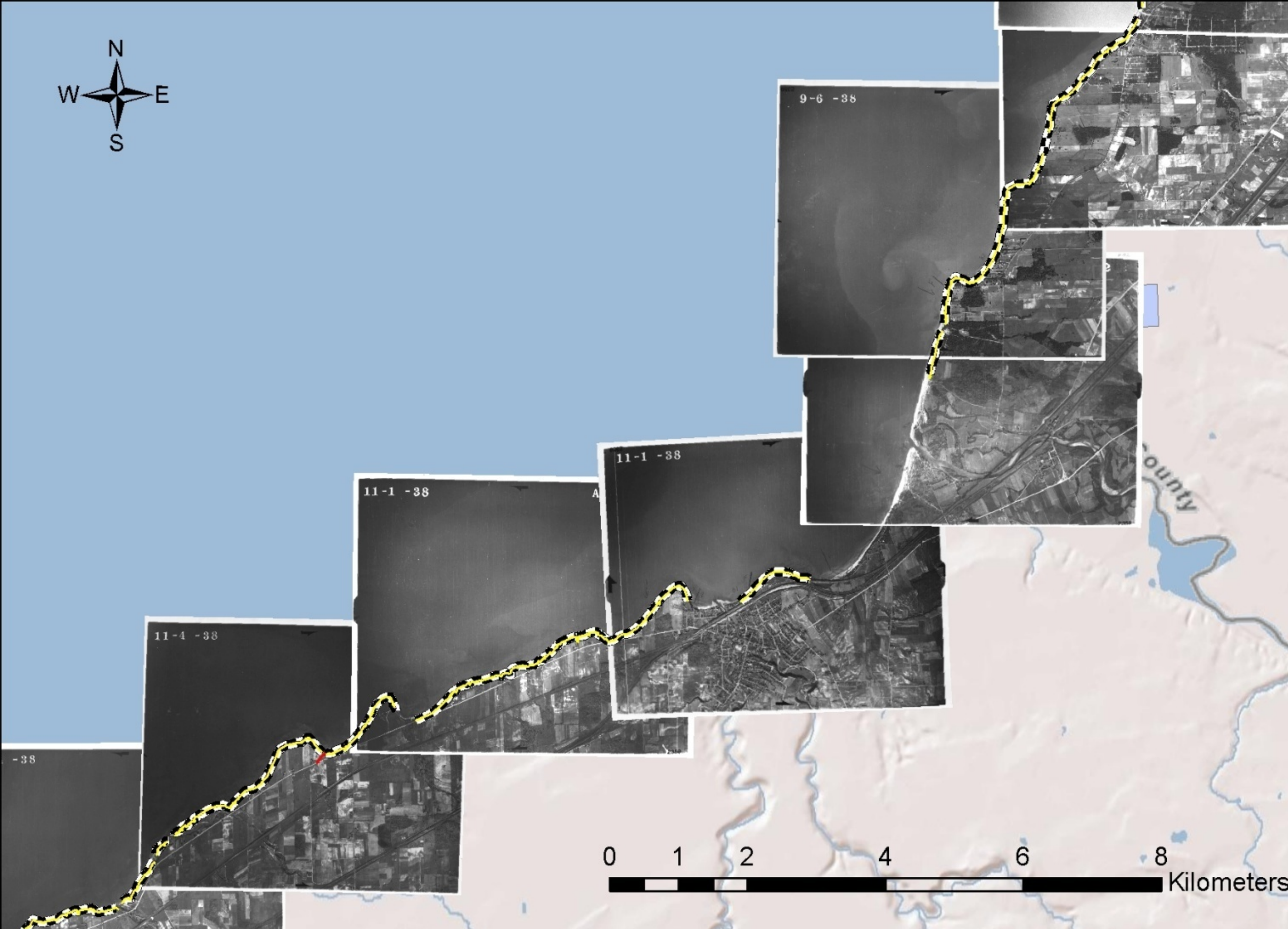




Georeferencing based on matching old with contemporary roads, buildings in 2006, 2008 photography

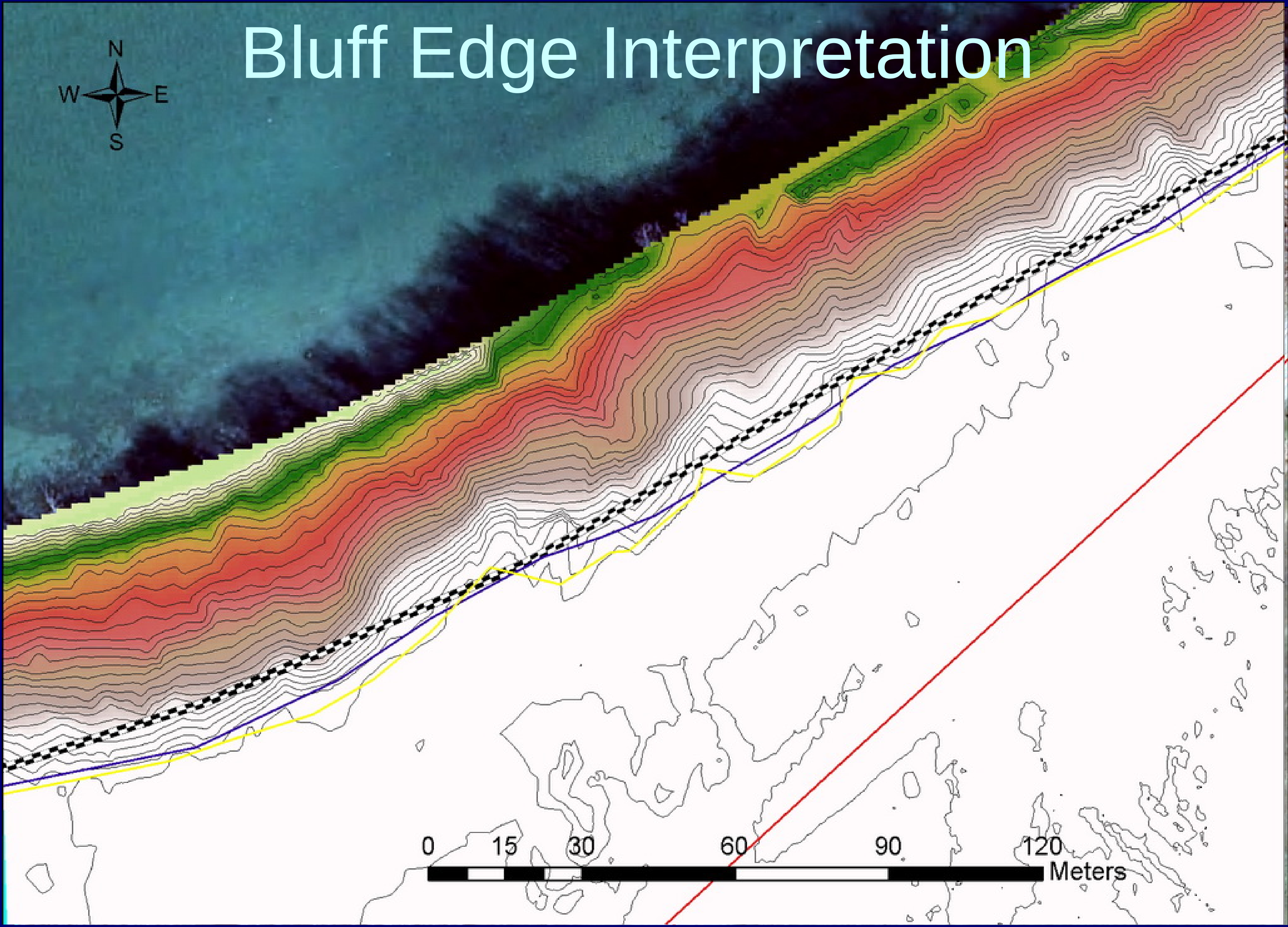
Historical Photography

1938 Agricultural Adjustment Administration

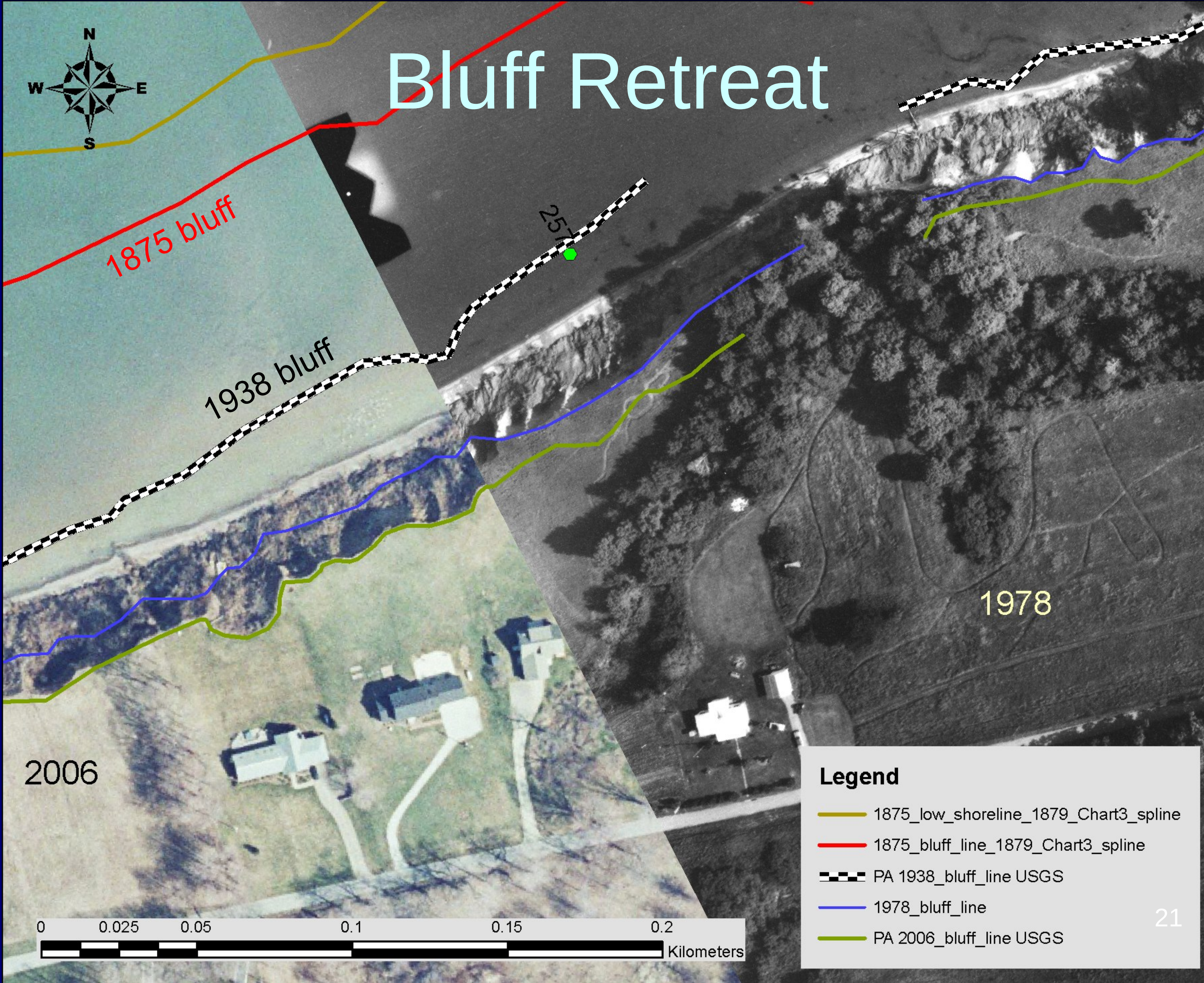


1978 USACE archives

Bluff Edge Interpretation

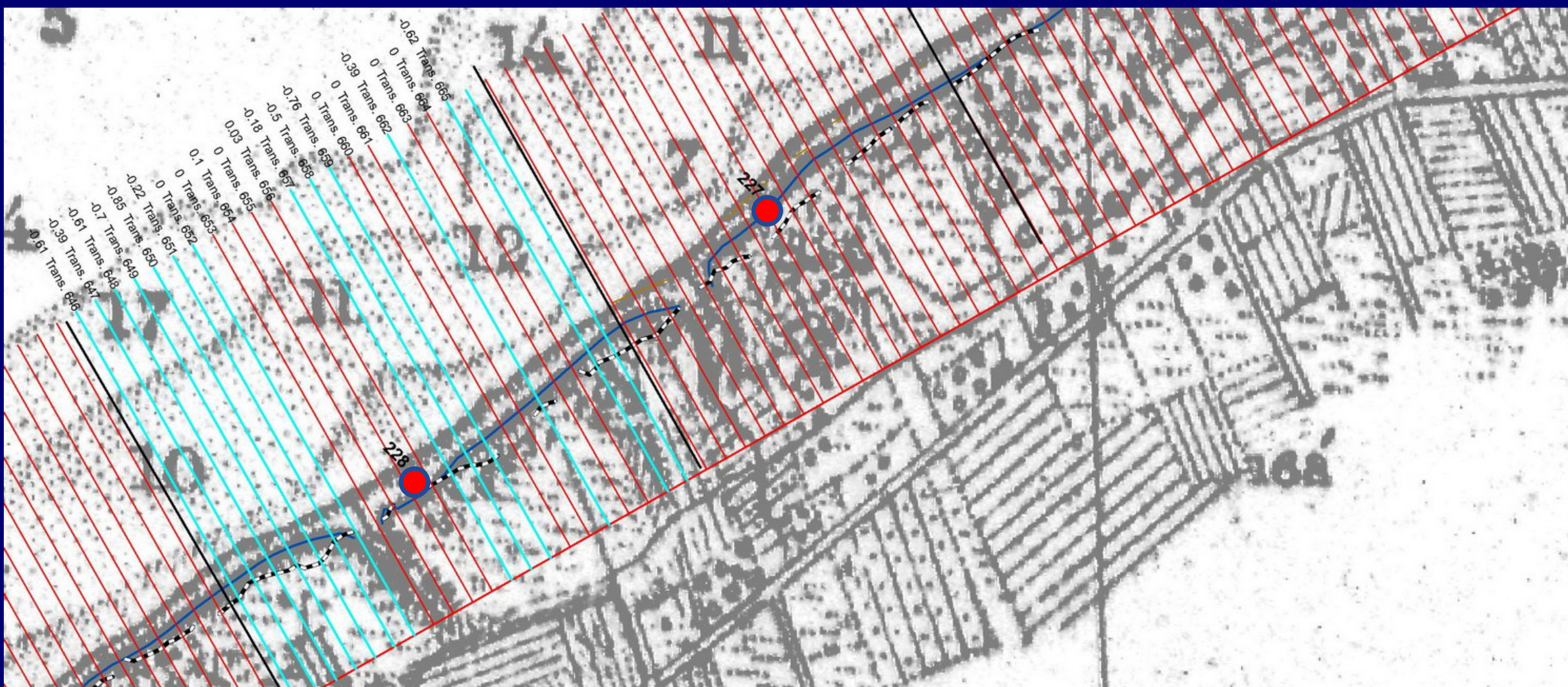


Bluff Retreat

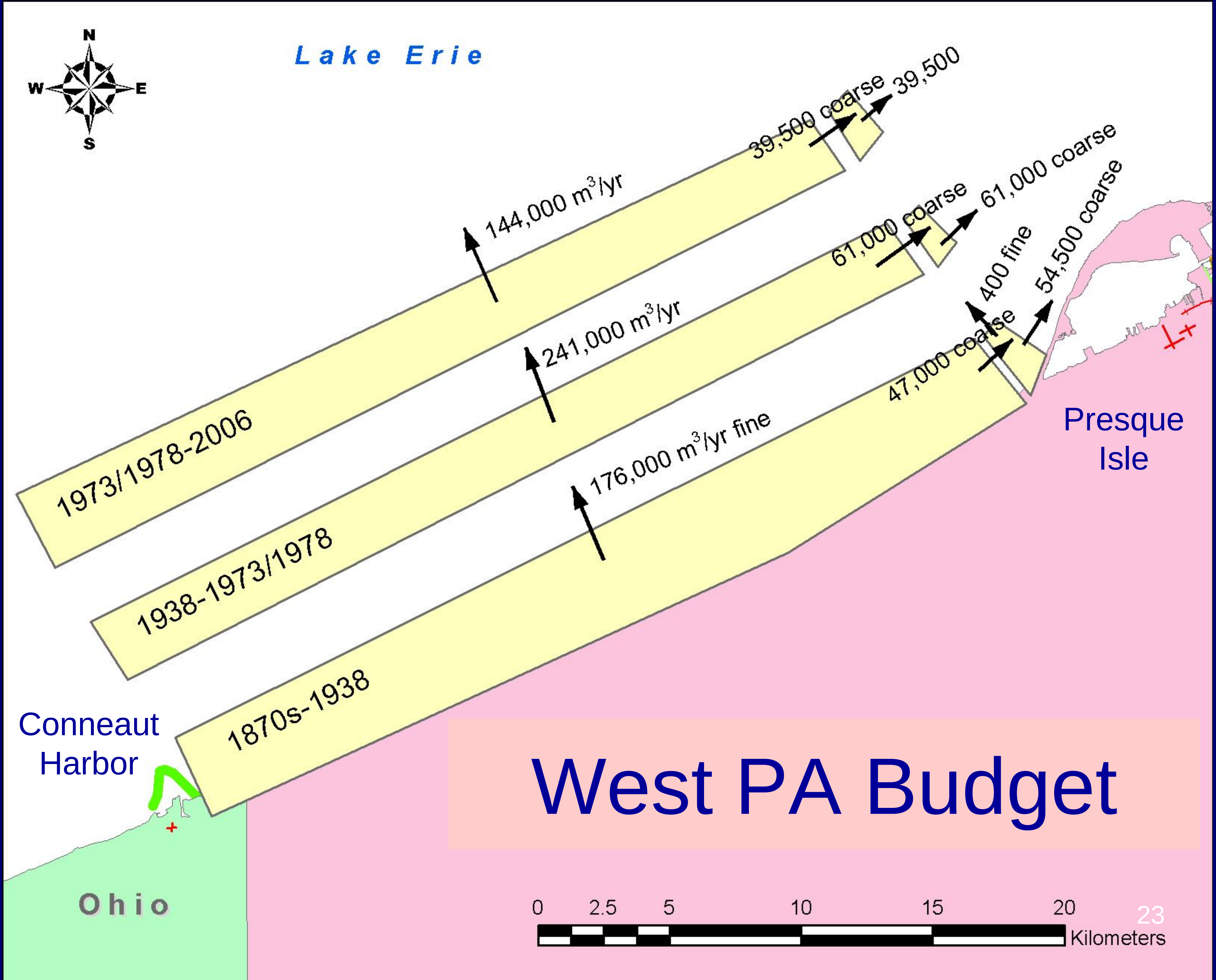


Bluff Retreat Rates

1. Create baseline
2. Set up transects at 50-m intervals using USGS DSAS software
3. Compute retreat (no bluff advance possible)
4. Average for 1-km reaches
5. Enter 1-km values in master spreadsheet

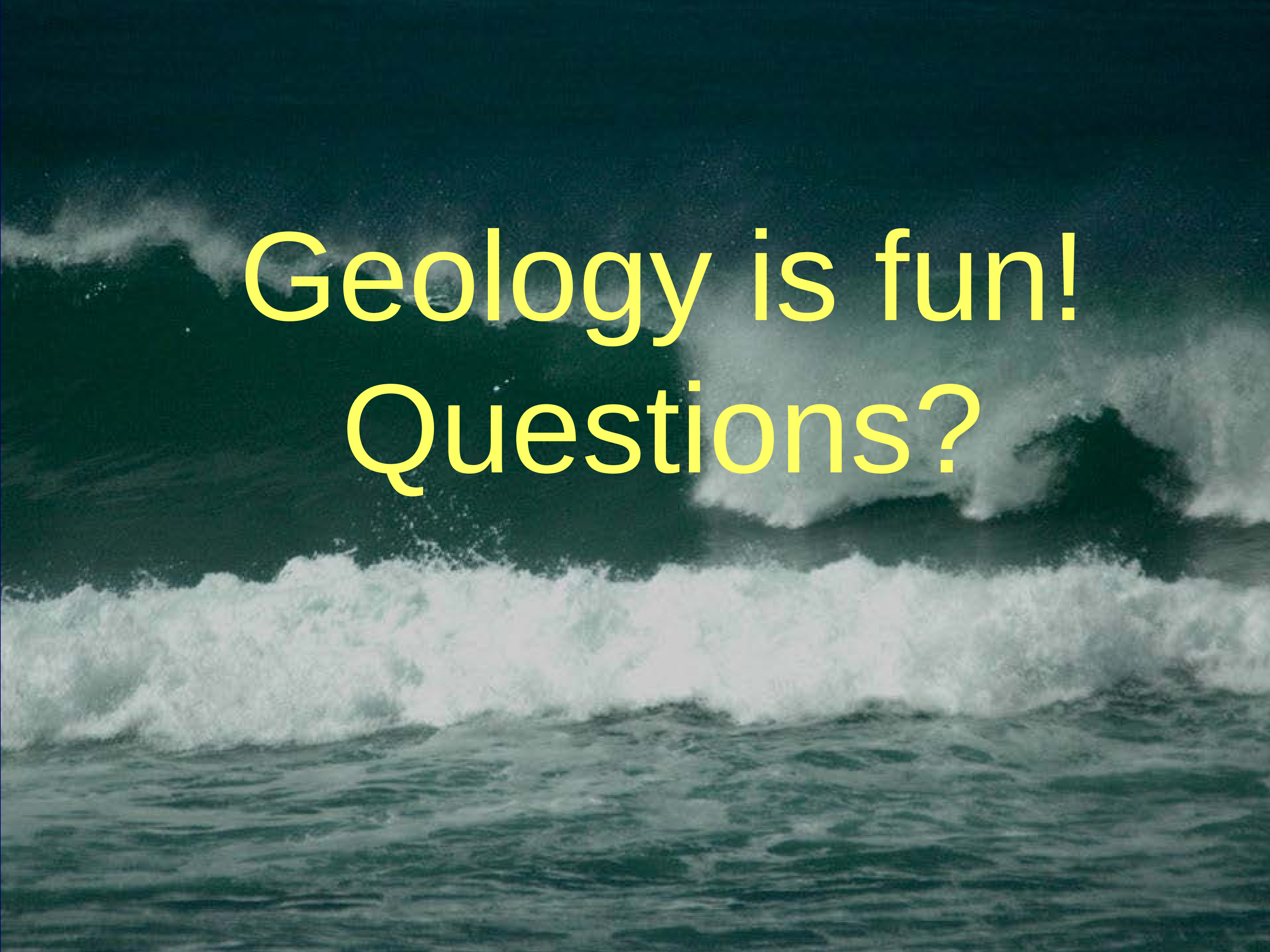


West PA Budget



Future Work

- R&D on shale/siltstone contribution to budget
- Journal publications
- Dev. online interactive display tool
- Apply findings to variety of section 204 beneficial use projects for ecosystem restoration
- Model projected climate change effects on ice cover, water levels, storminess, sediment transport
- Need to develop an approach to risk-based principles on a regional scale to inform project decision-making.
- Improve efficiency from using systems approach to managing multiple projects in the Lake


Geology is fun!
Questions?