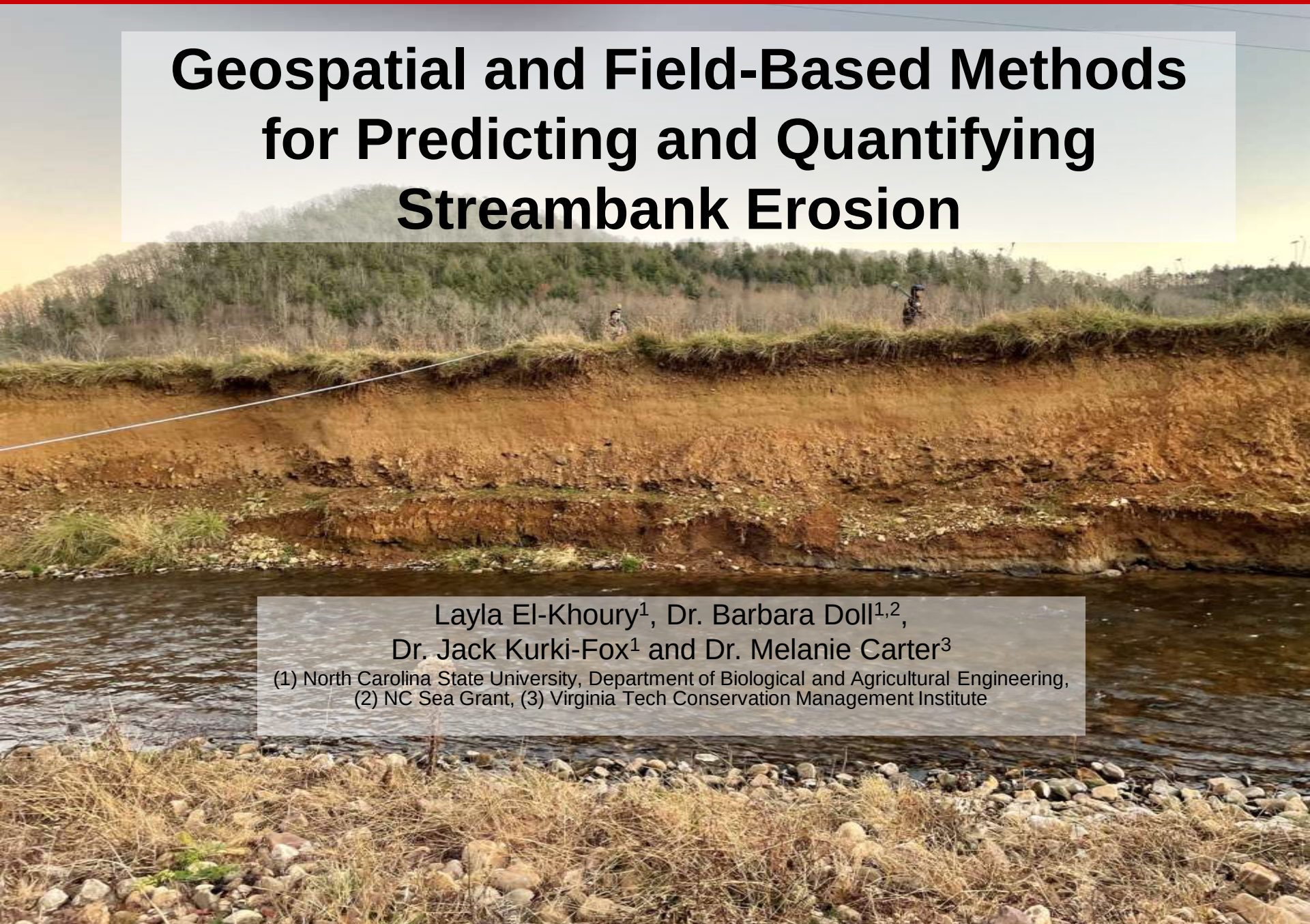
NC STATE UNIVERSITY

Geospatial and Field-Based Methods for Predicting and Quantifying Streambank Erosion



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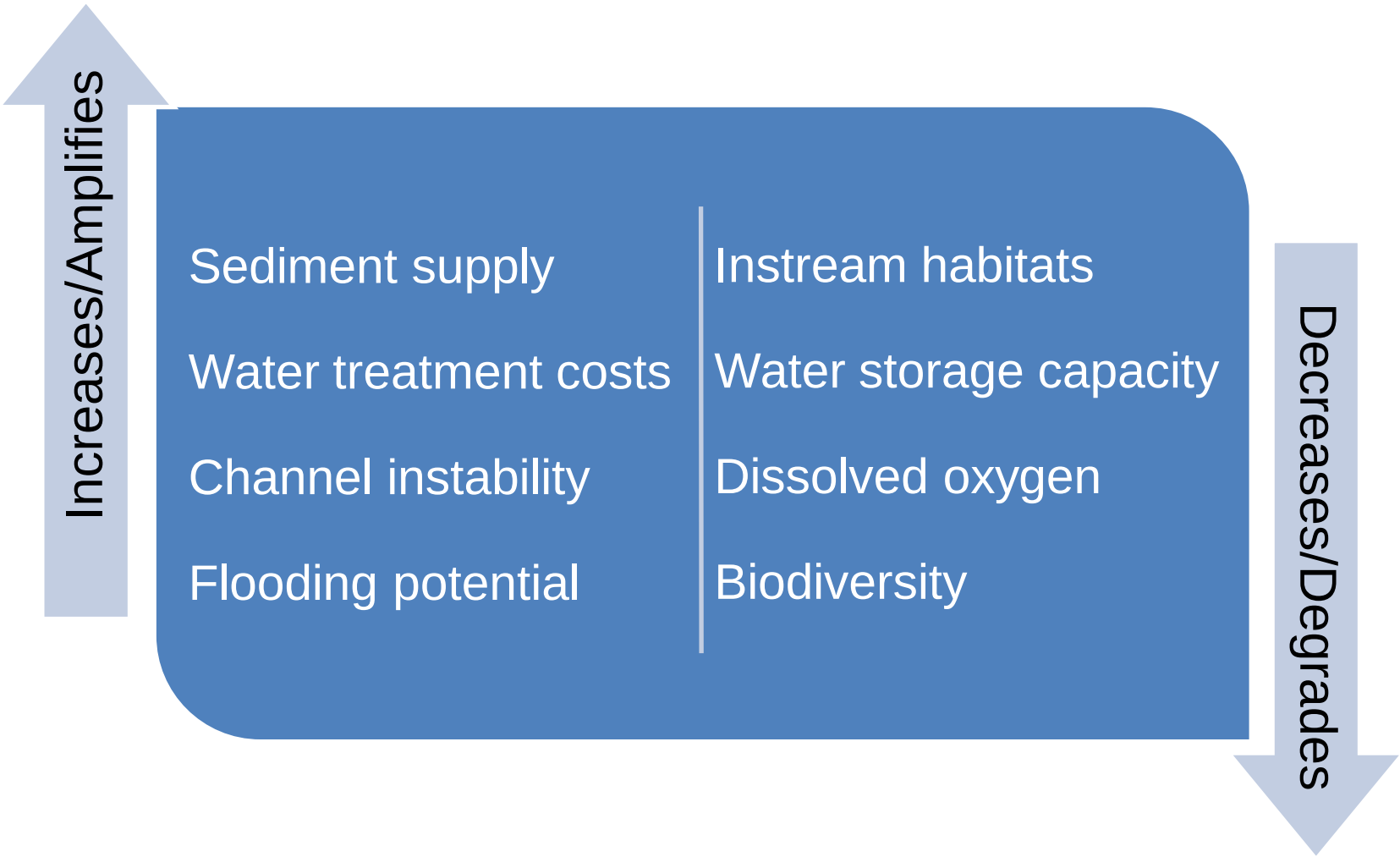
(1) North Carolina State University, Department of Biological and Agricultural Engineering,
(2) NC Sea Grant, (3) Virginia Tech Conservation Management Institute

Why do we care about streambank erosion?



How does identifying, measuring & predicting erosion rates help?

- Prioritize streams for restoration
  - Revitalize eastern hellbender population
  - Reduce downstream sediment

VT | CONSERVATION MANAGEMENT INSTITUTE

PHEASANTS forever The Habitat Organization

USDA Natural Resources Conservation Service

wrri NC WATER RESOURCES RESEARCH INSTITUTE

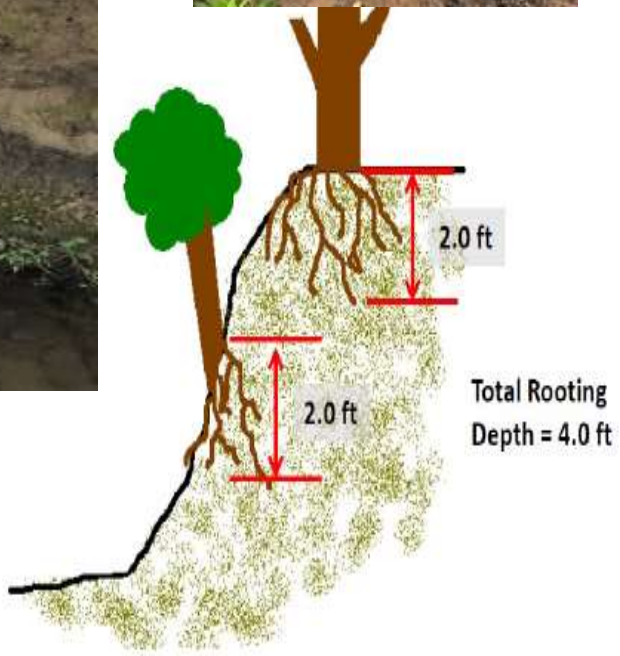
Raleigh

Research Goal: Improve methods for identifying, predicting and quantifying streambank erosion to better target restoration efforts

Identifying Erosion	• USGS Positive Openness Raster Dataset
Measuring Erosion Rates	• Physical Surveys • Aerial Imagery • LiDAR Surveys
Predicting Erosion Rates	• BANCS = Bank Assessment for Non-point source Consequences of Sediment

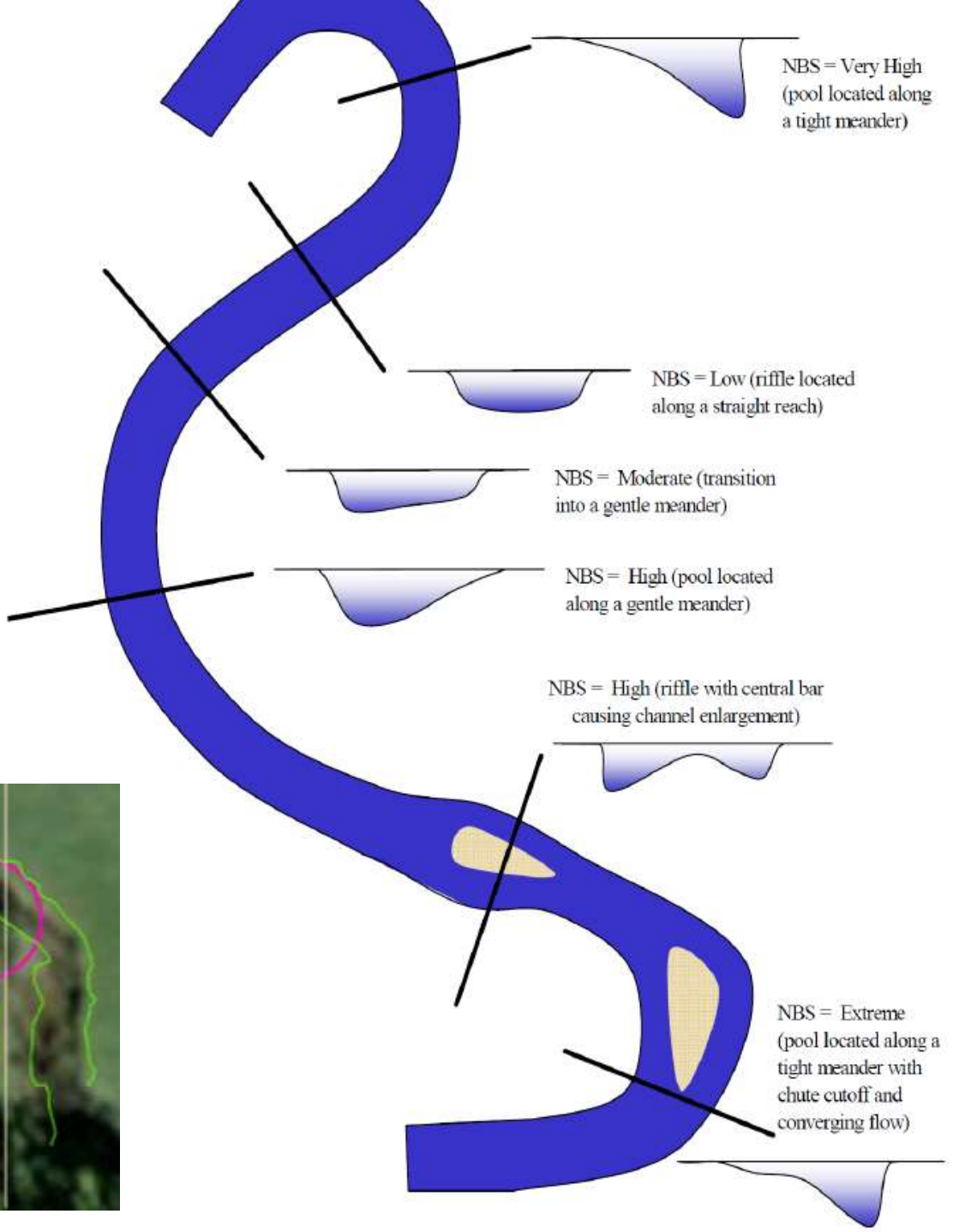
Bank Erosion Hazard Index (BEHI)

- Bank height to bankfull height ratio
- Root depth to bank height ratio
- Weighted root density
- Bank angle
- Surface protection
- Material adjustment
- Stratification adjustment

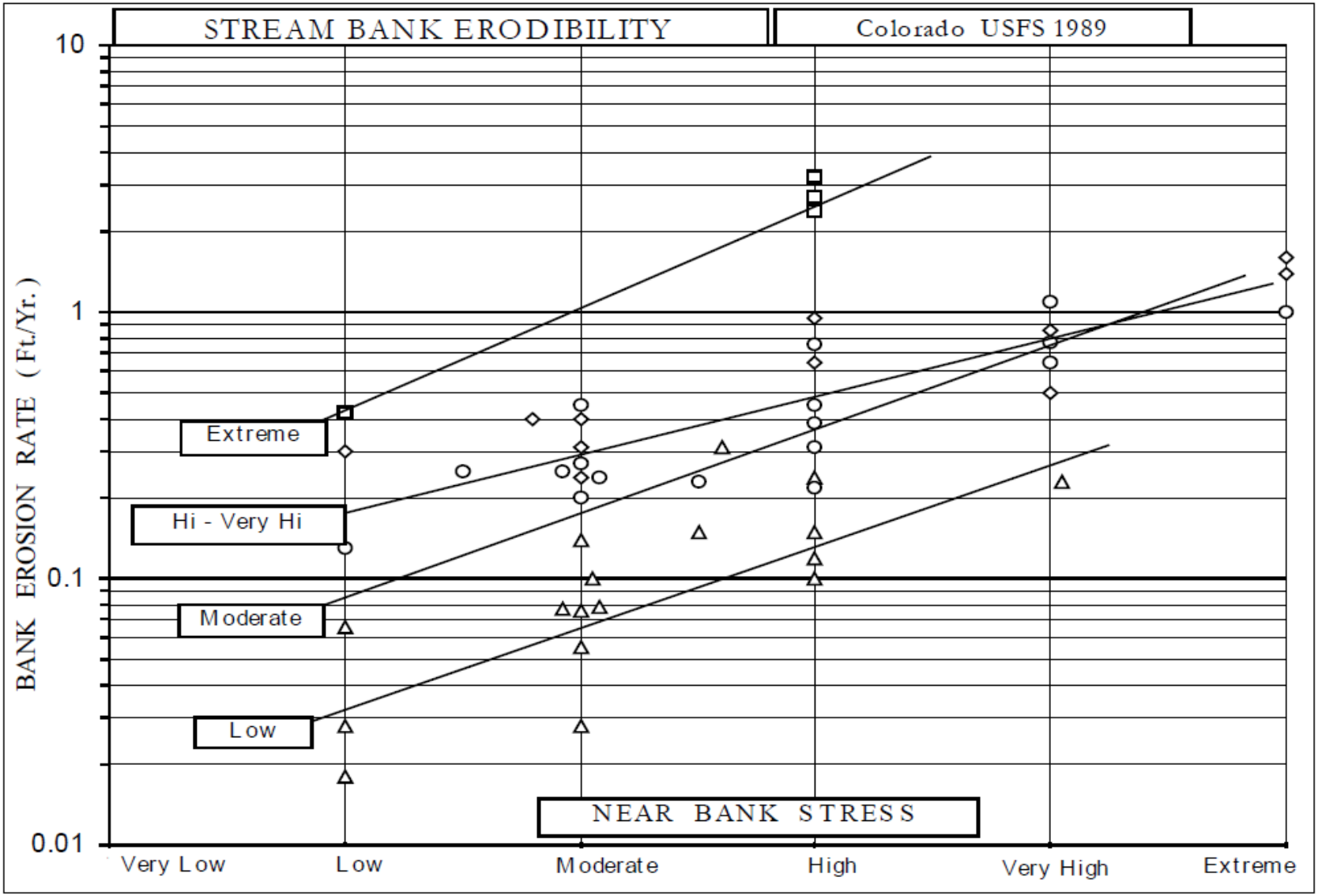


Near Bank Stress (NBS)

- Method 1: Visual
- Method 2: ratio of radius of curvature to bankfull width

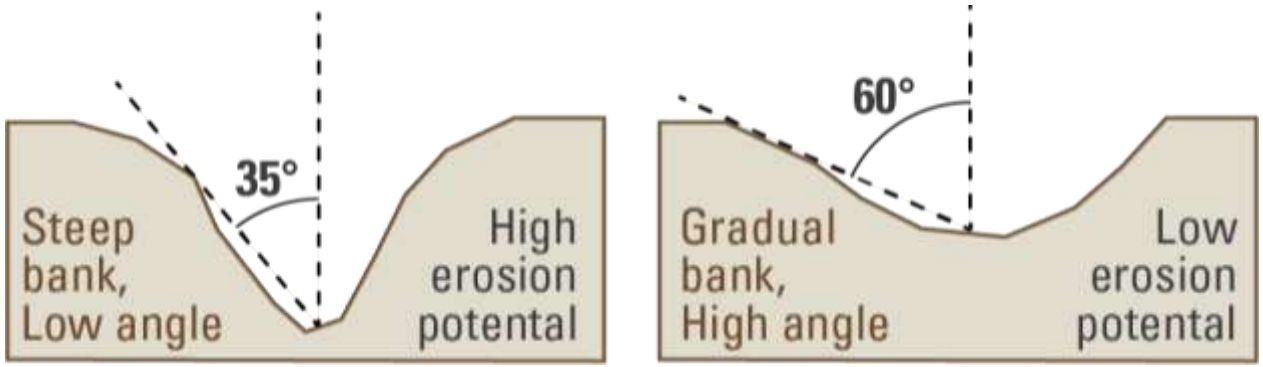


Predicting Erosion - BANCS



USGS Positive Openness

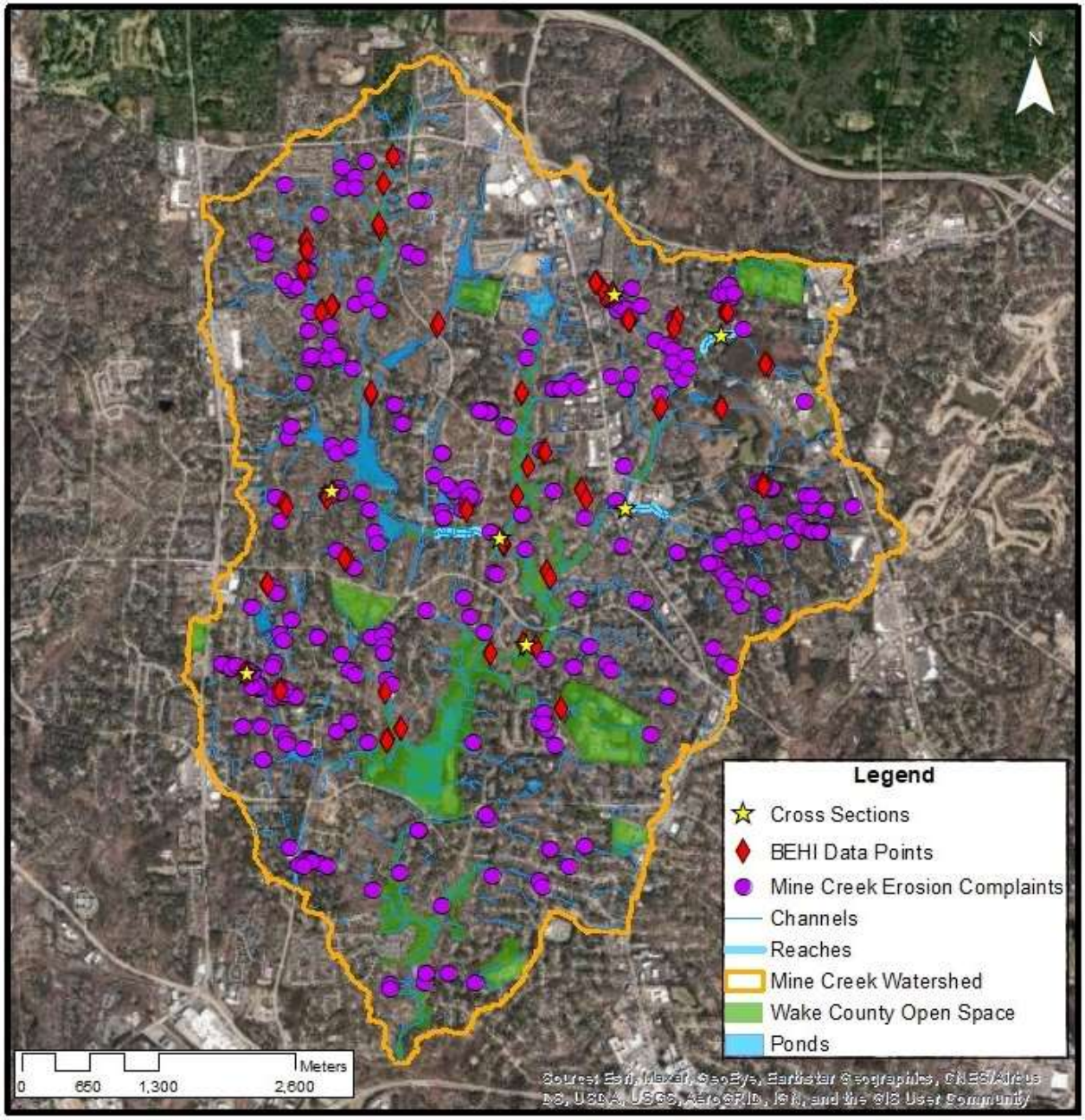
- Raster dataset developed from 2013 & 2015 lidar data
- Identifies locations of concave surfaces
  - Relief angles are less than 90º



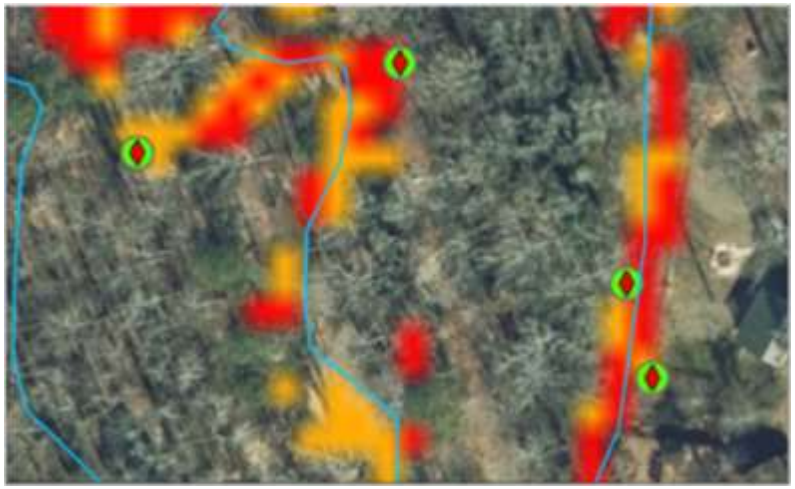
Mine Creek Study Sites, Raleigh, NC

- Mine Creek Watershed, North Raleigh, NC
  - 10 sq mi
  - 43 miles of streams
  - 32% impervious
- Drains to Shelley Lake
- Most erosion complaints

Funded by NC Urban Stormwater Consortium (WRRI) & City of Raleigh

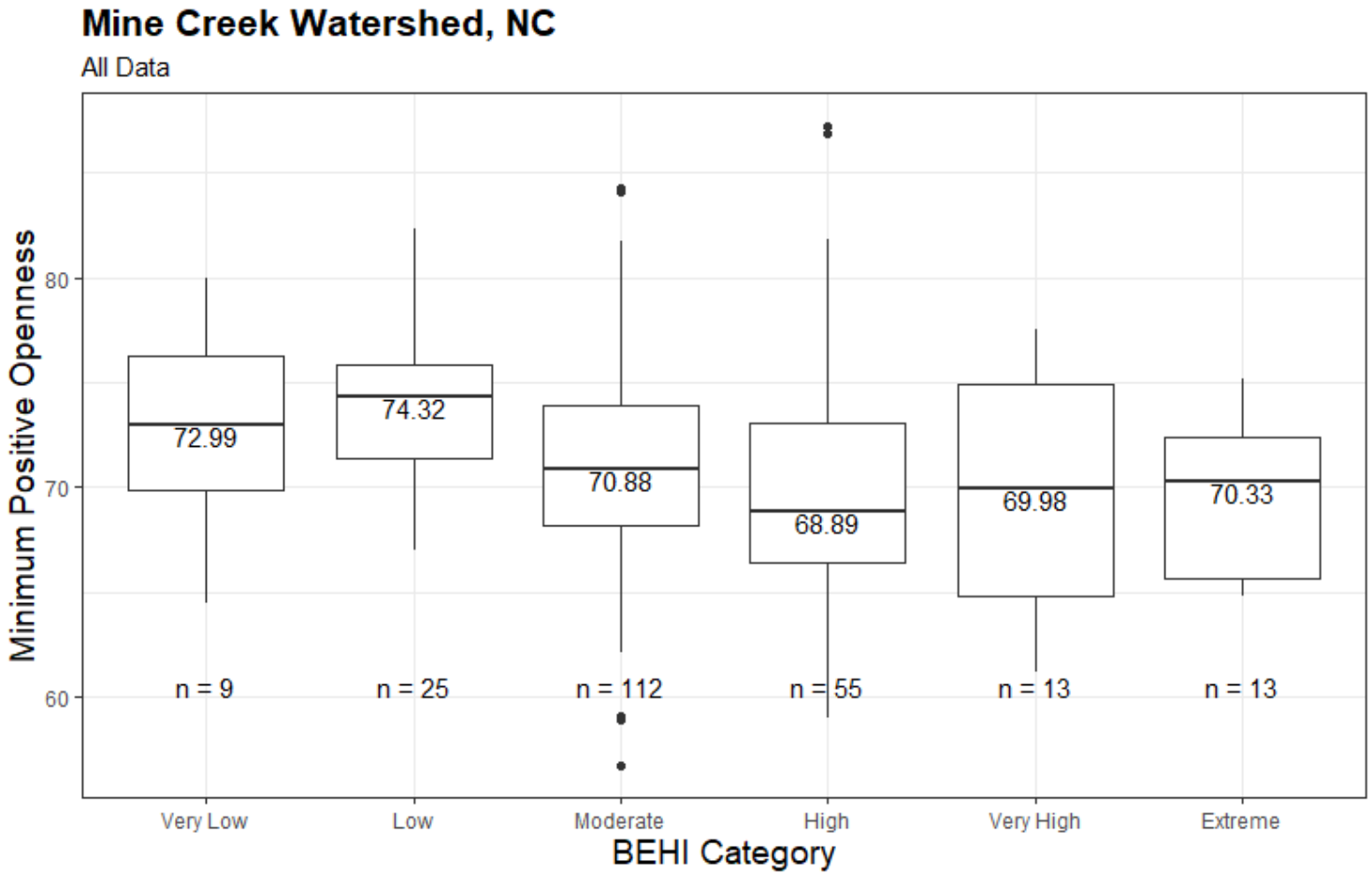


Erosion Categories & ArcGIS Analysis

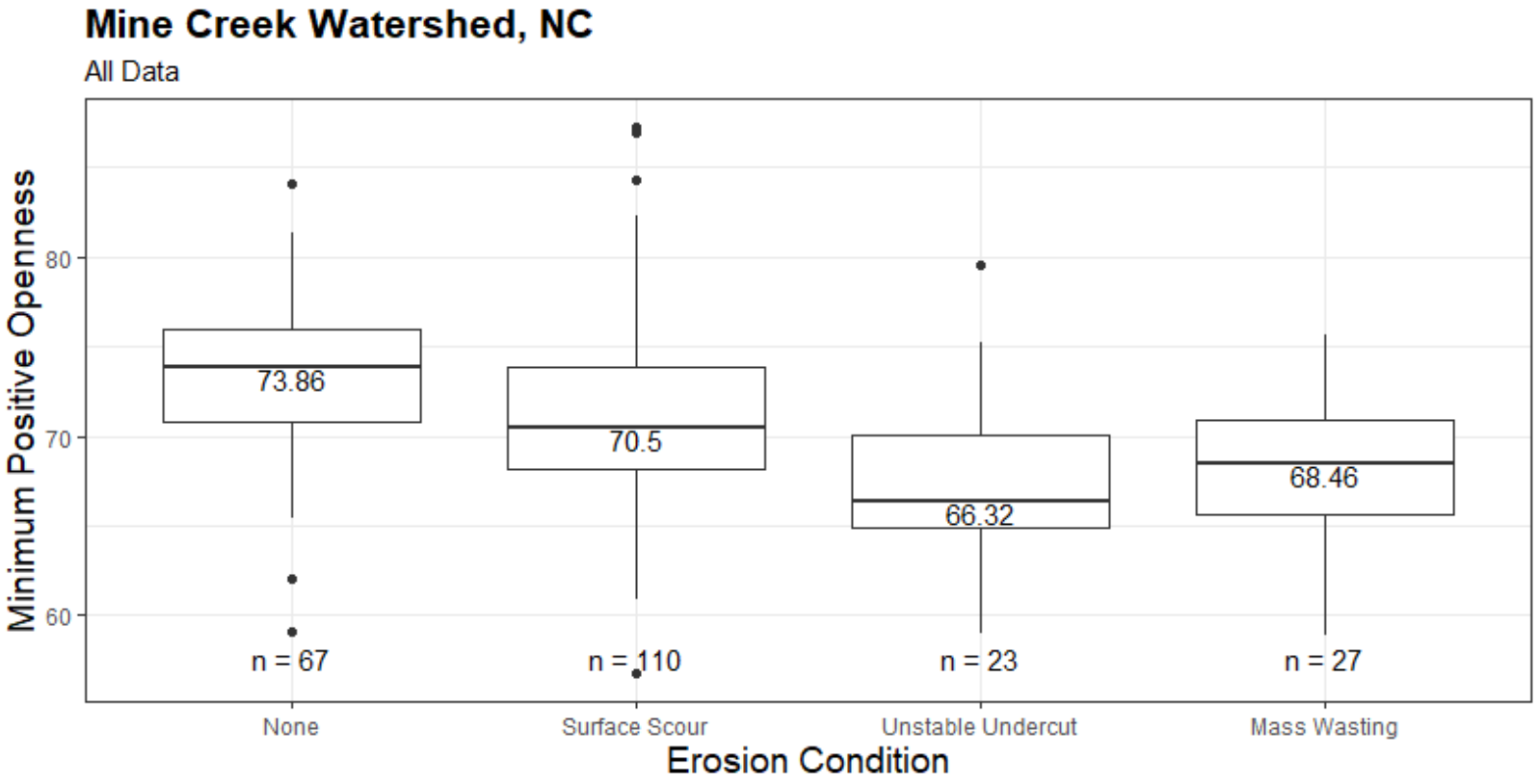


- Buffers at each data collection point
- Zonal Statistics as a Table to obtain PO

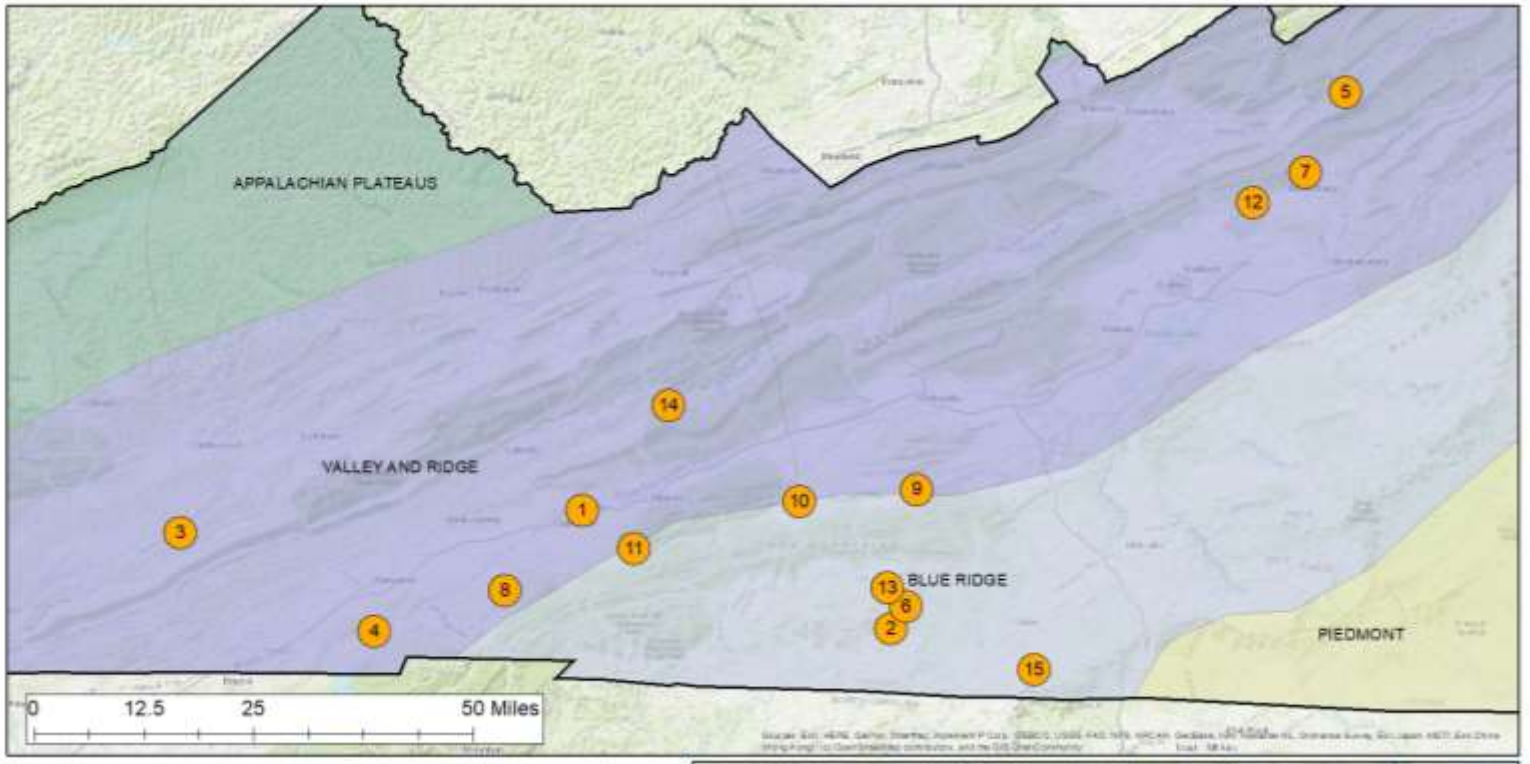
Positive Openness vs BEHI Category



Positive Openness vs Erosion Category



Virginia Erosion Study Sites



Site Locations

Quantifying and Predicting Streambank Erosion in the Ridge and Valley and Blue Ridge physiographic regions of Virginia to benefit Eastern Hellbender populations

Virginia Erosion Study Sites

Stream Site	BEHI/NBS	# of Cross-Sections	Aerial Imagery	LiDAR Survey
Copper Creek	x	7	x	
Elk Creek	x	4		
Middle Fork Holston River	x	5	x	
Rock Creek	x	6	x	x
Sinking Creek	x	5	x	x
UT Toms Creek - Bowman	x	6		
Toms Creek	x	6		
Wolf Creek	x	7		
Cripple Creek - Dunkley	x	6		
Cripple Creek - Maxwell	x	4		
South Fork Holston River - Rector	x	2	x	
South Fork Holston River - Wood	x	6		
Turkey Creek	x	5	x	x
Piney Creek	x	7		
North Fork Holston River - Emory	x	6		
Total # of Cross-Sections		**82**		

Erosion Categories

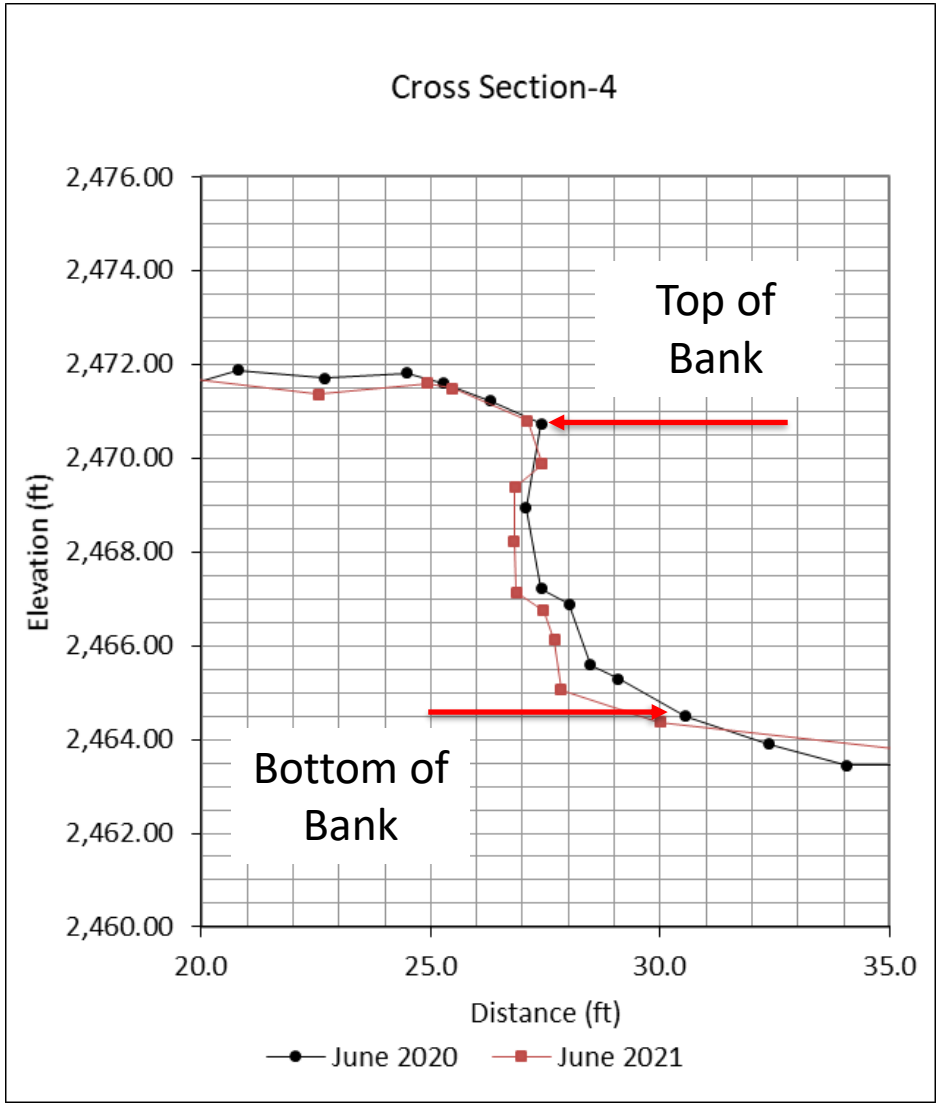
Permanent Cross-Sections & Soil Samples

Surveying Undercut Banks

Prism directly against bank

Measure offset & correct after

Bank Retreat Analysis – Excel

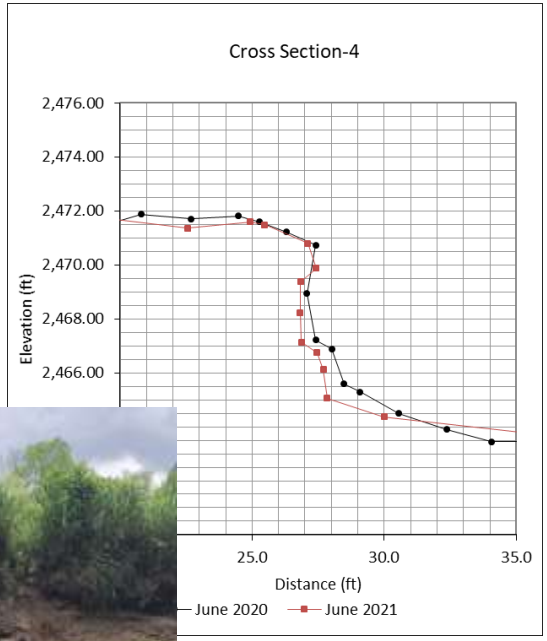


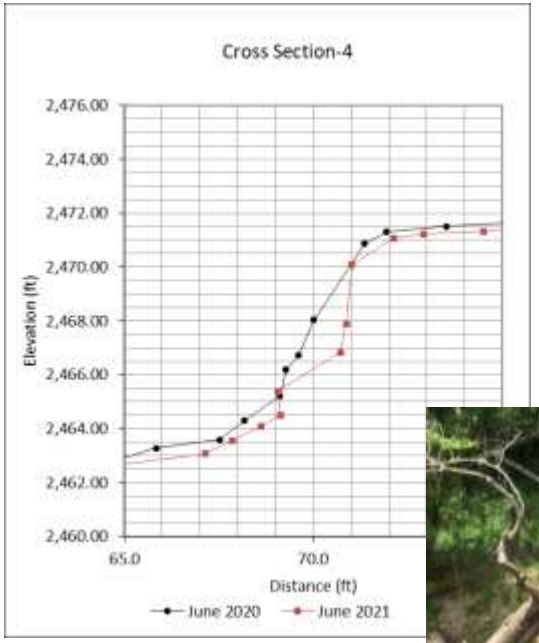
Elev (ft)	Station 2020 (ft)	Station 2021 (ft)	Difference (ft/yr)	Bank Retreat (ft/yr)
2471	26.81	26.62	-0.19	-0.19
2470.5	27.37	27.21	-0.15	-0.15
2470	27.28	27.39	0.11	0.00
2469.5	27.18	26.98	-0.20	-0.20
2469	27.09	26.83	-0.27	-0.27
2468.5	27.16	26.82	-0.34	-0.34
2468	27.26	26.83	-0.43	-0.43
2467.5	27.35	26.85	-0.50	-0.50
2467	27.80	27.08	-0.72	-0.72
2466.5	28.16	27.56	-0.60	-0.60
2466	28.33	27.72	-0.62	-0.62

- Right Bank Retreat = year 1 – year 2
- Left Bank Retreat = year 2 – year 1
- Erosion: negative
- Deposition: positive

Elk Creek – XS 4

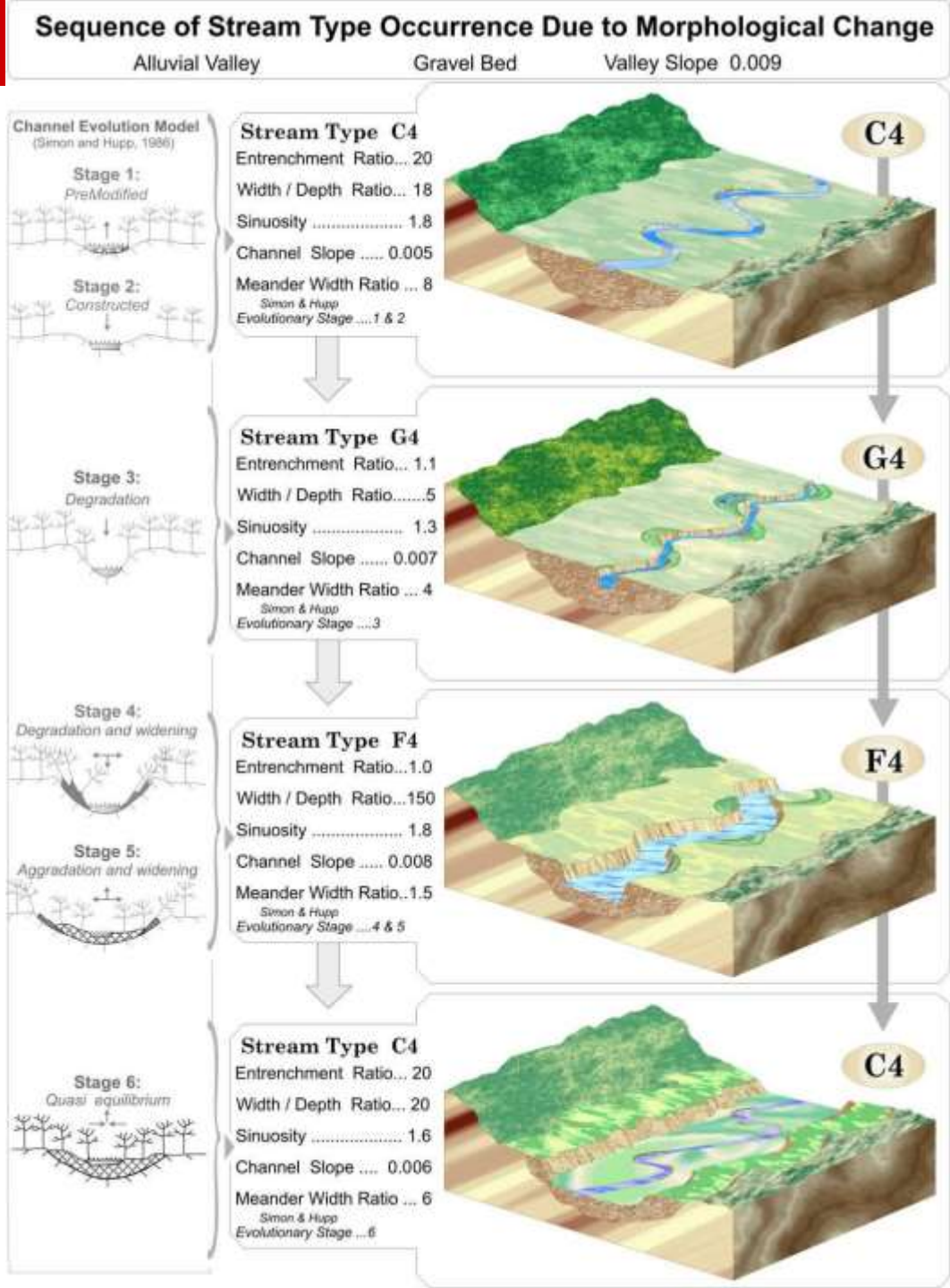
	Elevation (ft)		Bank Height (ft)		Bank Retreat (ft/yr)		
	Top of Bank	Toe of Bank	Analysis	Measured	Max	Average	Min
Left Bank	2471.5	2465.6	5.9	7	0.7	0.4	0.0
Right Bank	2471.1	2463.6	7.5	6.5	1.0	0.5	0.0





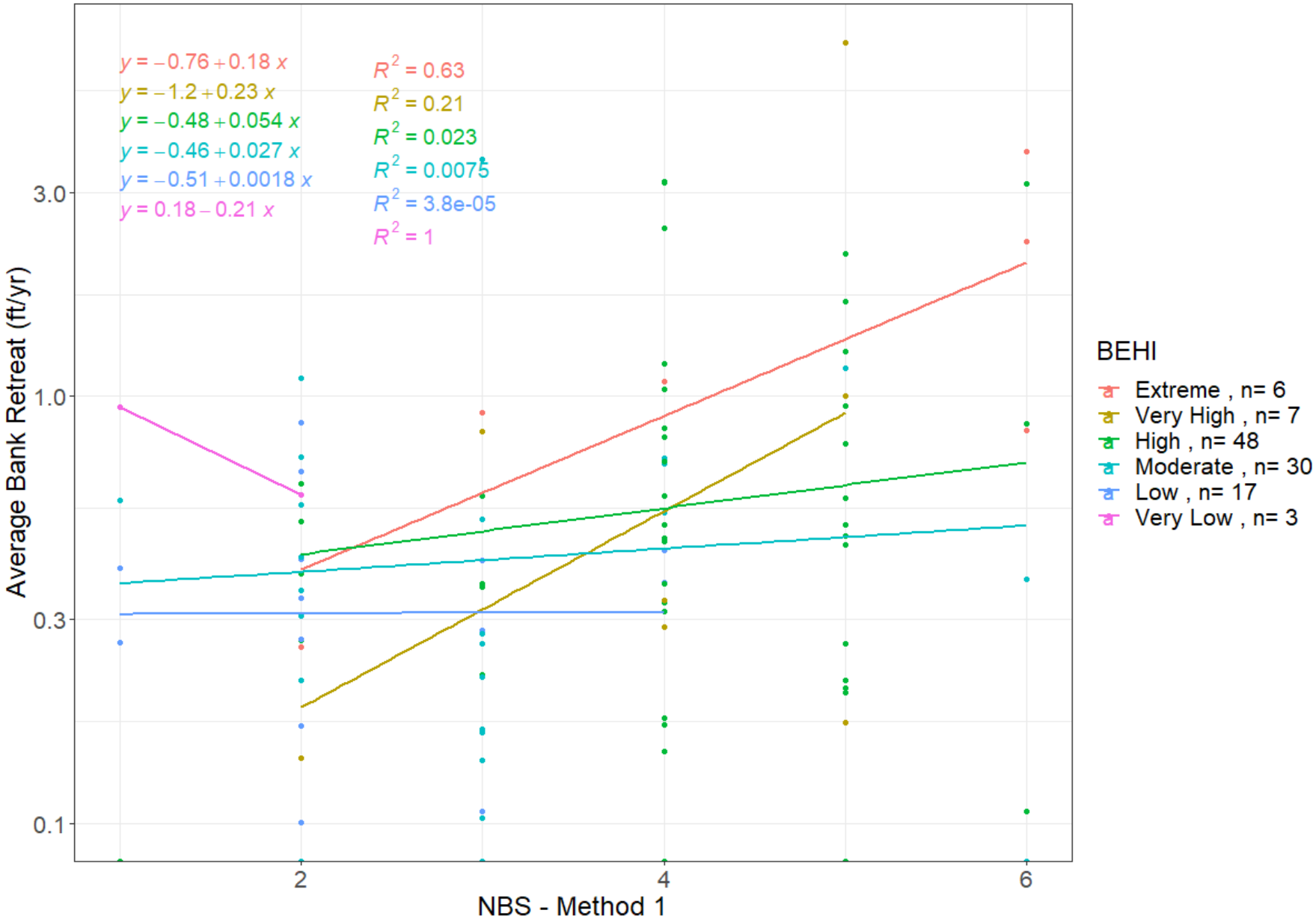
Statistical Analysis

- Develop erosion curves
- Statistically compare BANCS variables to streambank retreat
- Add additional explanatory variables to increase prediction:
  - Channel Evolution
  - Stream Dimension
  - Watershed Area
  - Watershed Condition
  - Soil Bulk Density
  - Slope

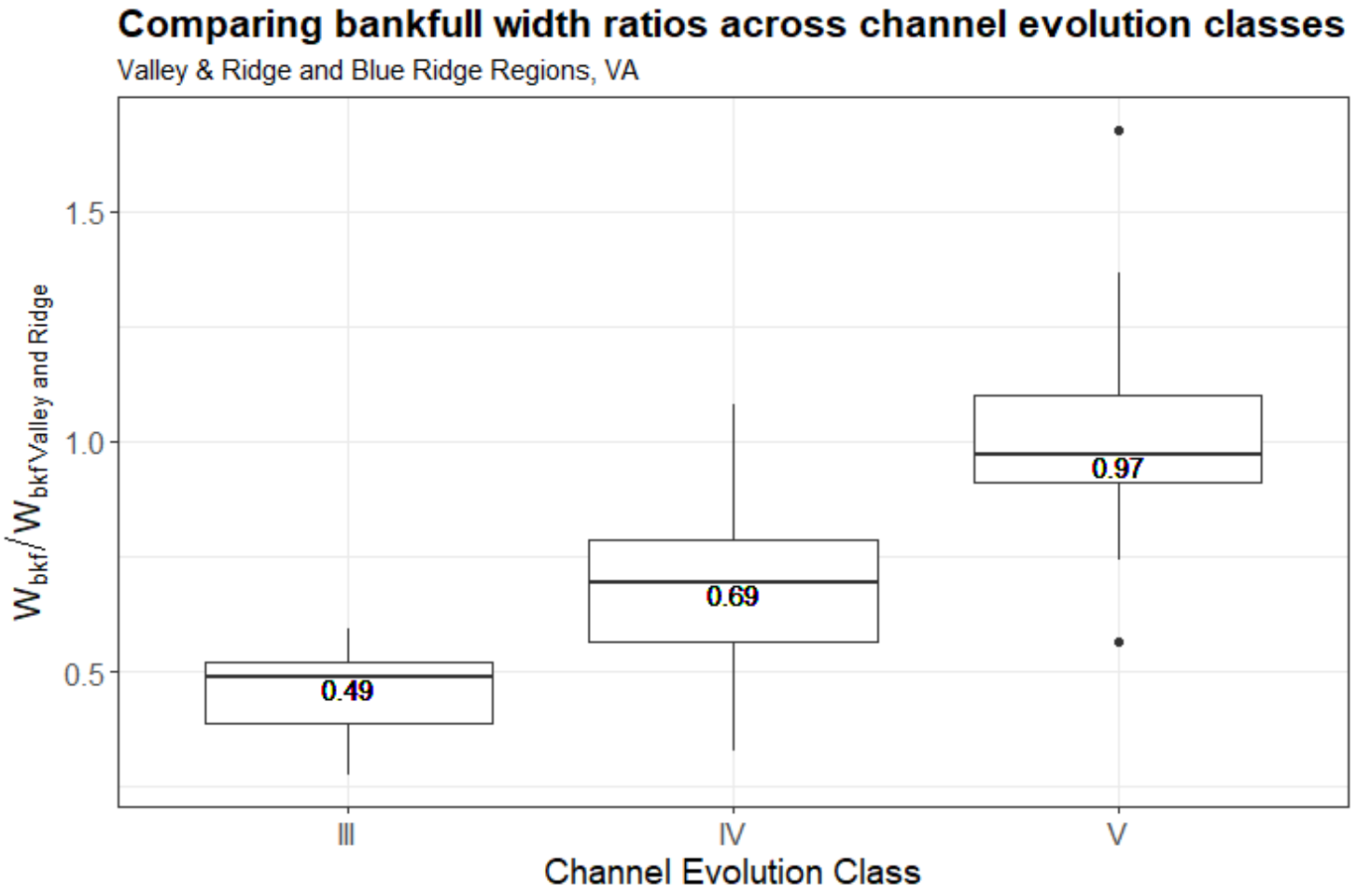


BEHI Erosion Curve

Blue Ridge and Valley & Ridge VA Regions



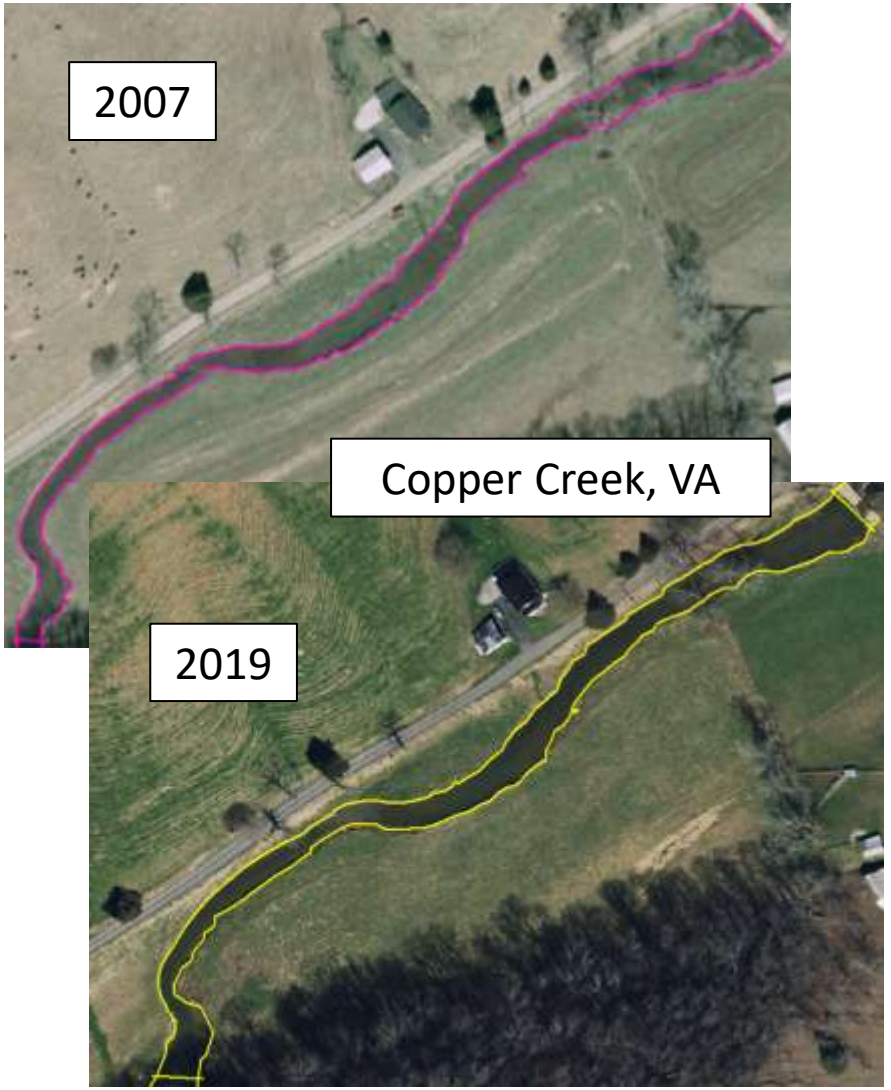
Channel Evolution Class Surrogate



Aerial Imagery Analysis - ArcMap

Methods: Purvis & Fox, 2016

1. Trace top of banks
2. Join bank lines
3. Convert polylines to polygon
4. Join polygons
5. Determine erosion & deposition
6. Calculate area & volume



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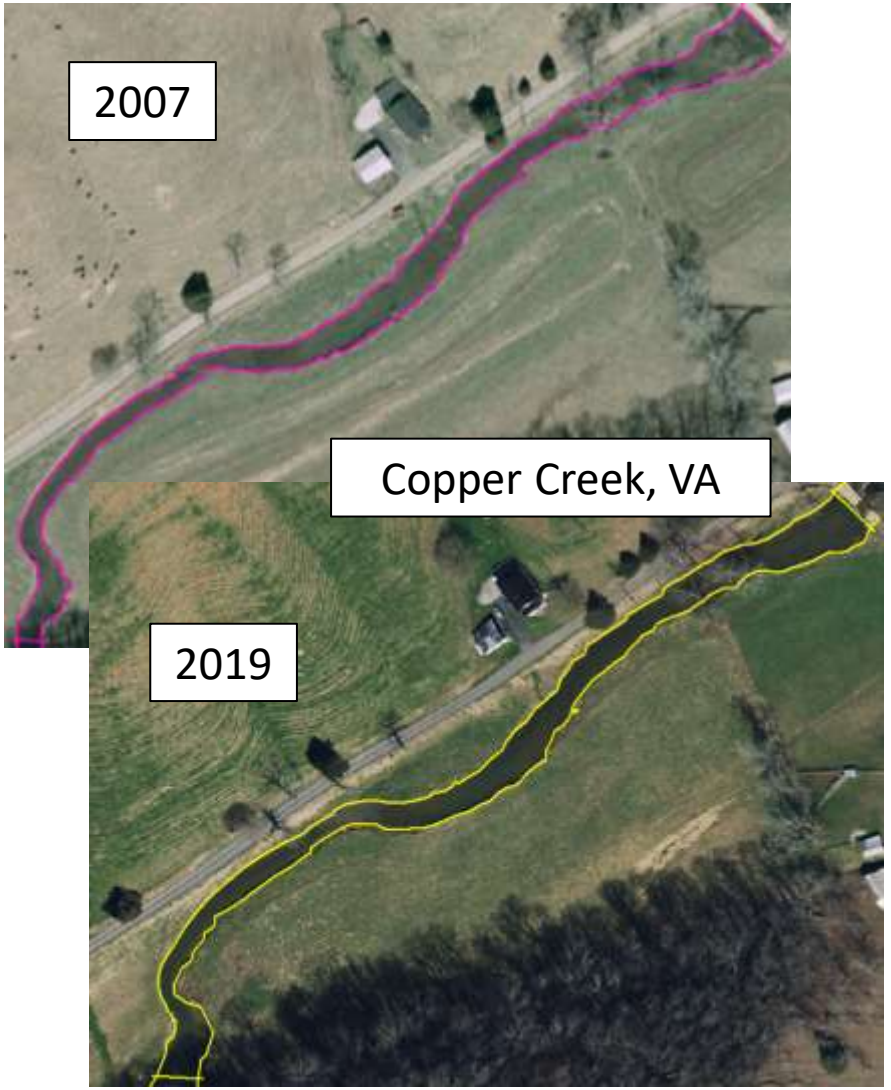

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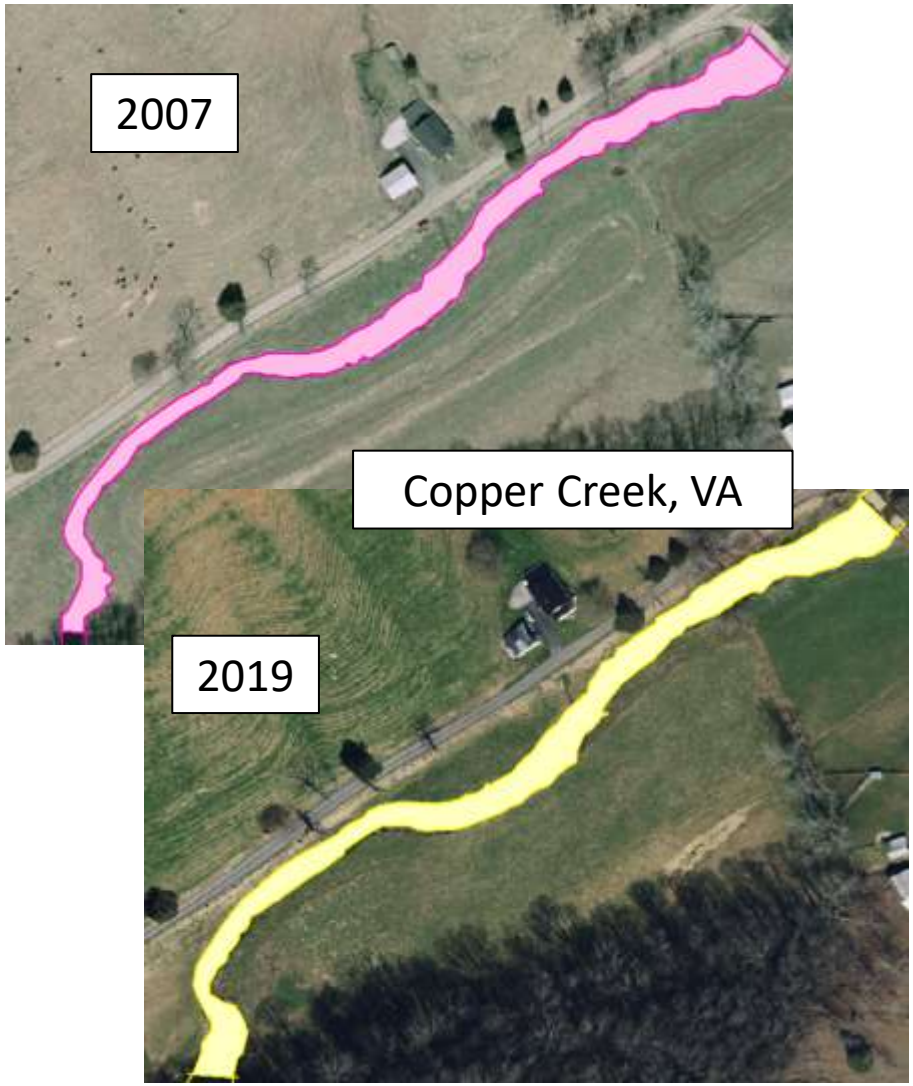

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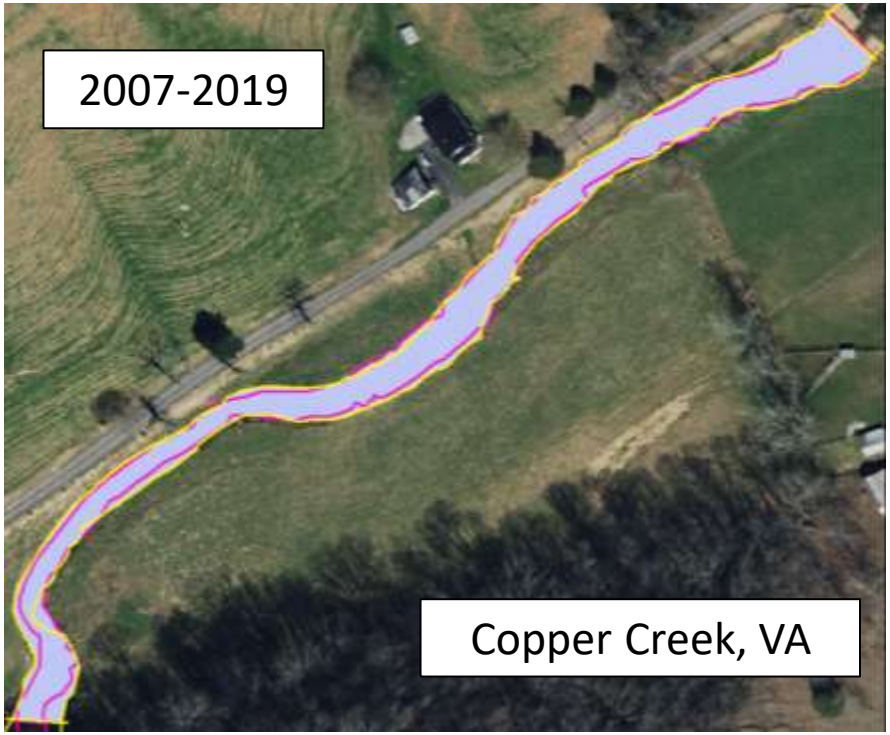

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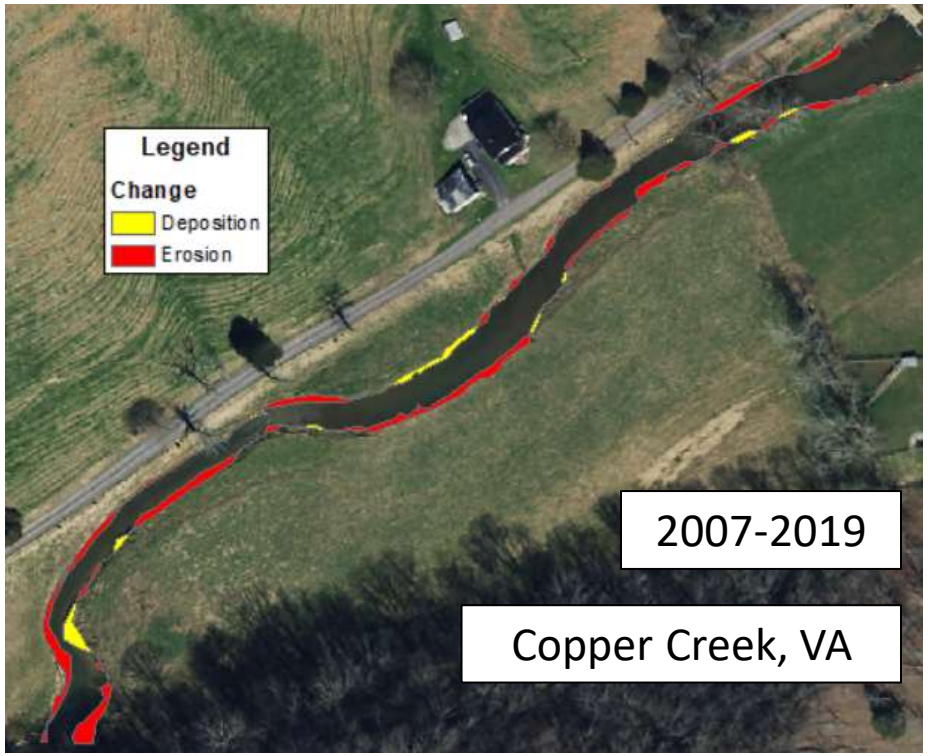

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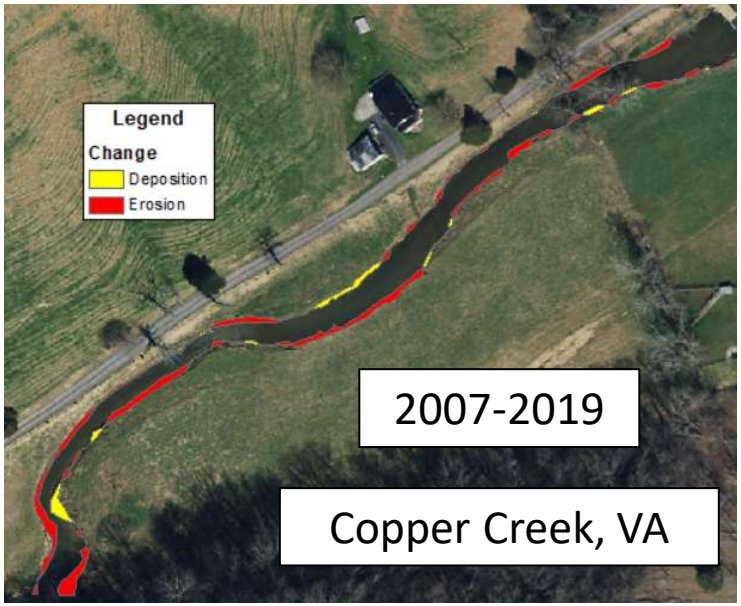
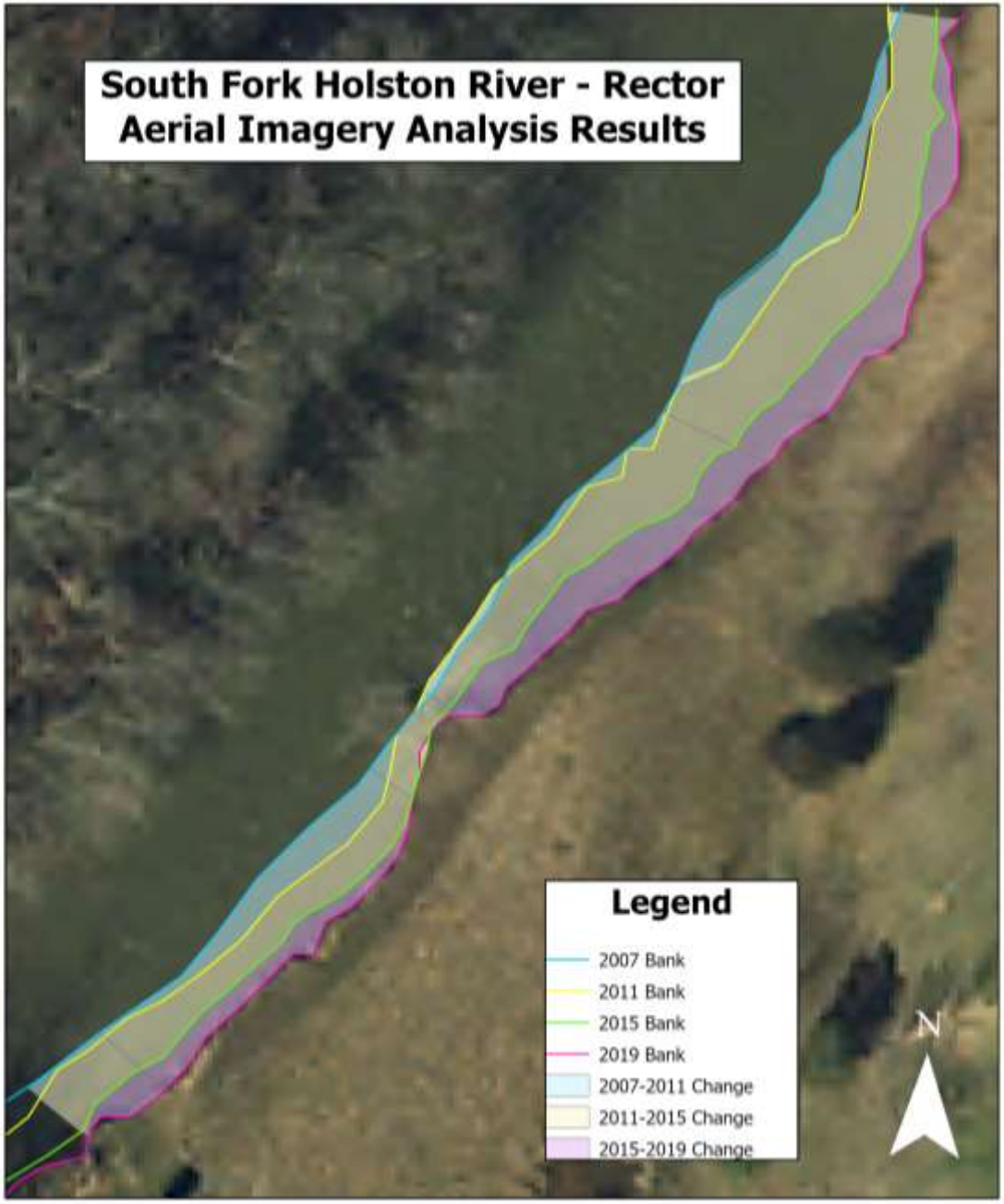
	Volume (ft^3)
Deposition	4,620
Erosion	24,417



Aerial Imagery Preliminary Results

Years	Erosion (ft^3)
2007-2011	6,875.8
2011-2015	19,480.9
2015-2019	10,515.9



LiDAR Analysis

WithersRavenel
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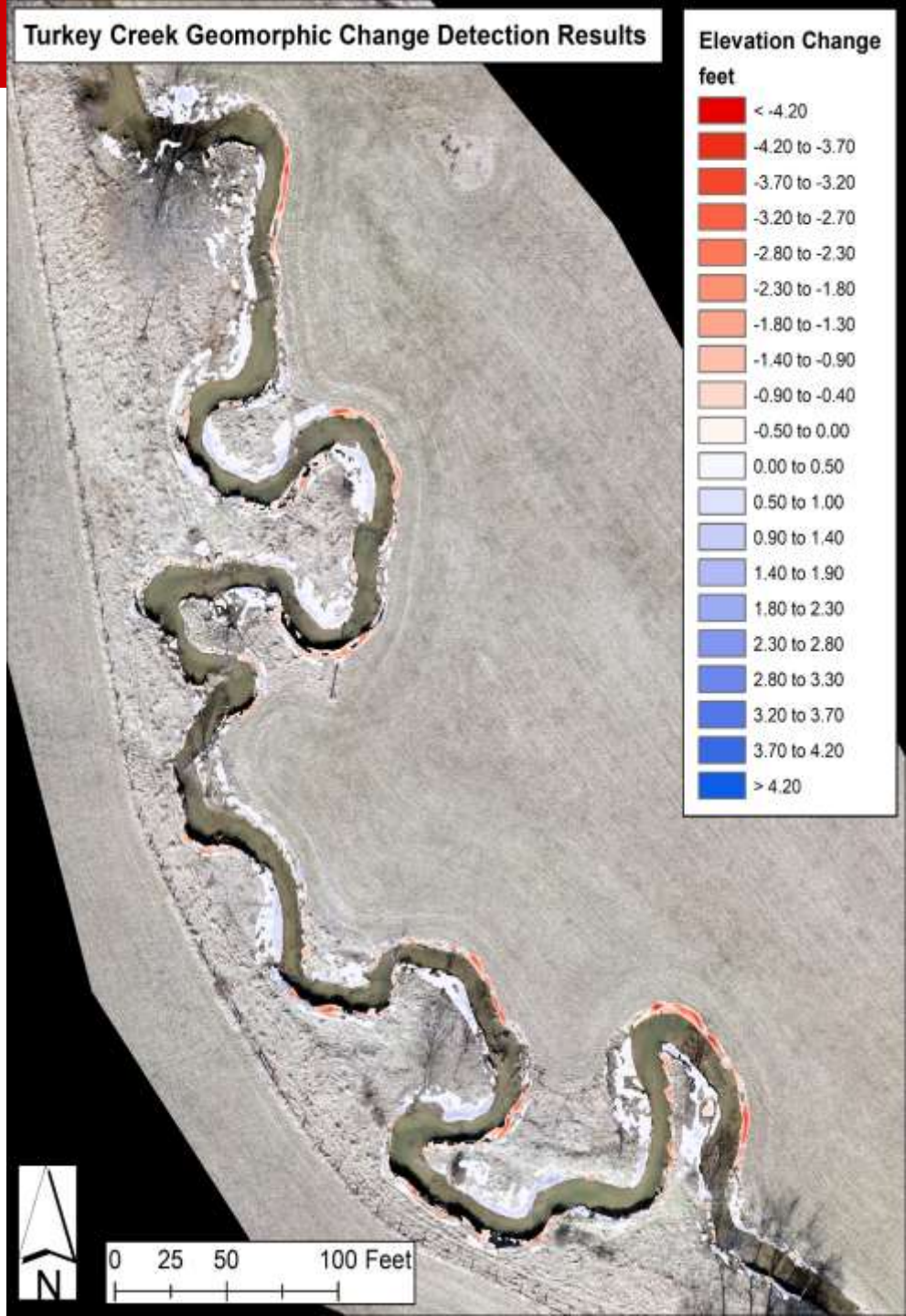
- Surveys completed:
  - March 2021
  - February 2022
- Error rates ranged from 25 to 44%

Site	Erosion (CY)
Rock Creek	-38.8 ± 10.4
Sinking Creek	-30.5 ± 13.3
Turkey Creek	-79.8 ± 19.8



Concluding Remarks

- Positive Openness can identify locations of erosion
- Traditional BANCS erosion curves are unable to capture the variability in erosion rates in this region
- Aerial imagery and LiDAR analyses limit the ability to capture different types of erosion

Next Steps

- Add additional explanatory variables to improve predictions
- Compare methods used to measure erosion rates

Questions?

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Layla El-Khoury: lcelkhou@ncsu.edu

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