



Great Lakes Bank Erosion Study Michigan Stream Team

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The Big Questions

- What are bank erosion rates in Great Lakes rivers?
- How significant is the bank component in Great Lakes sediment budgets?
- Is there a simple assessment that can be correlated to bank erosion rates?

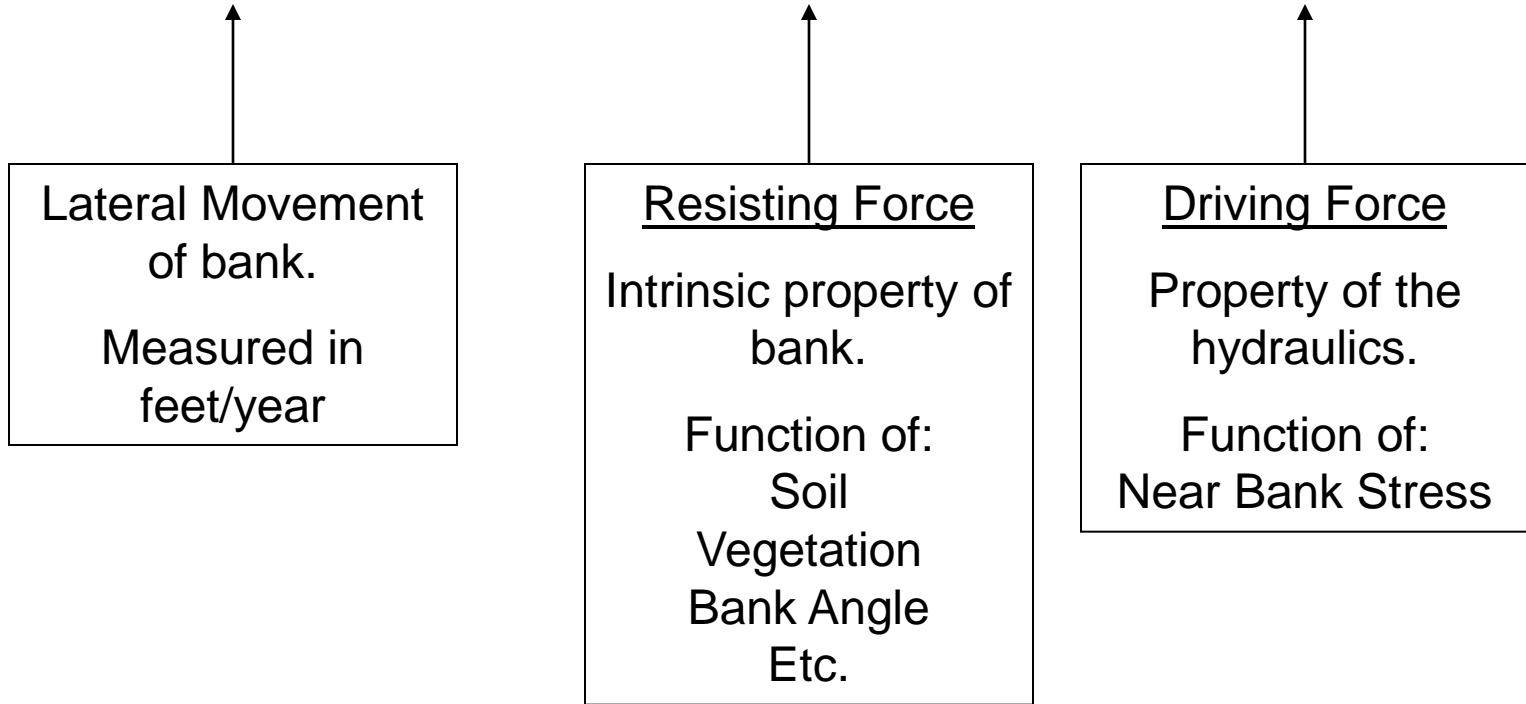


Project Background

- Funded under Water Resources Development Act (WRDA), Section 516(e)
 - Develop tools/models to reduce sediment loadings to Federal Harbors & Areas of Concern
- Bank Erosion is often a large component of sediment budgets
- Bank Erosion is difficult to estimate



$$\textit{Bank Erosion} \propto \textit{Erodability} \times \textit{Erosivity}$$





Proposed Scope

- Apply Rosgen's *Bank Assessment for Non-point sources Consequences of Sediment* (BANCS) model
 - Bank Erosion Hazard Index (BEHI): erodability
 - Near Bank Stress (NBS): erosivity
- Bank Pins
 - Measures bank erosion rates
- Develop Bank Erosion Regional Curves

BEHI

- Study Bank Height / Bankfull Height Ratio
- Root Depth / Study Bank Height Ratio
- Weighted Root Density
- Bank Angle
- Surface Protection
- **Bank Material**
- **Stratification**

↖ Adjustment Factors

Stream:			Location:		
Station:			Observers:		
Date:		Stream Type:		Valley Type:	

BEHI Score (Fig. 3-7)					
Study Bank Height (ft) =	(A)	Bankfull Height (ft) =	(B)	(A) / (B) =	(C)
Root Depth (ft) =	(D)	Study Bank Height (ft) =	(A)	(D) / (A) =	(E)
Root Density as % =	(F)	(F) × (E) =		(G)	
Bank Angle (H)		Bank Angle as Degrees =		(H)	
Surface Protection (I)		Surface Protection as % =		(I)	

Bank Material Adjustment:		Bank Material Adjustment
Bedrock (Overall Very Low BEHI)	➔	Bank Material Adjustment
Boulders (Overall Low BEHI)		Stratification Adjustment
Cobble (Subtract 10 points if uniform med. to large cobble)		Add 5-10 points, depending on position of unstable layers in relation to bankfull stage
Gravel or Composite Matrix (Add 5-10 points depending on percentage of bank material that is composed of sand)		
Sand (Add 10 points)		
Silt/Clay (No adjustment)		

Very Low	Low	Moderate	High	Very High	Extreme	Adjective Rating and Total Score
5 - 9.5	10 - 19.5	20 - 29.5	30 - 39.5	40 - 45	46 - 50	Total Score

Bank Sketch

Surface Protection

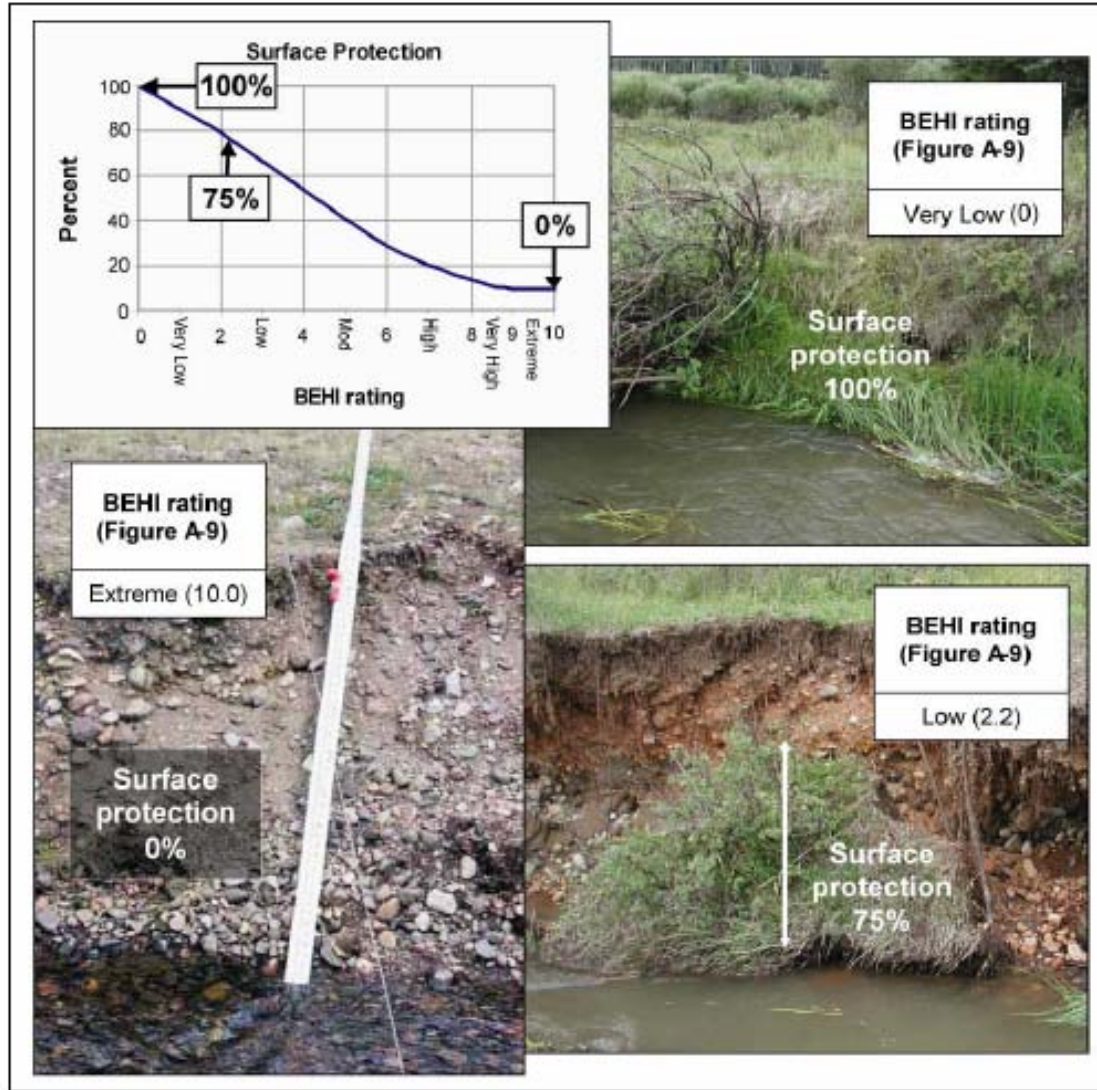
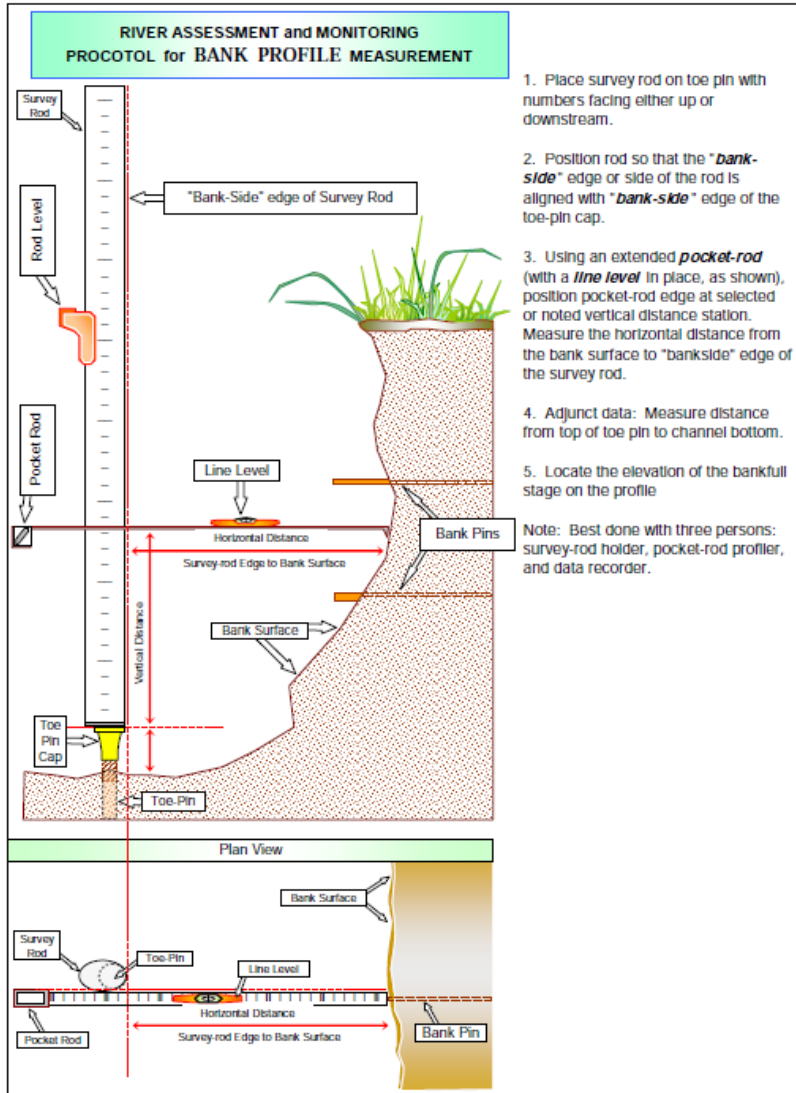


Figure A-14. Examples of surface protection values converted to BEHI ratings.

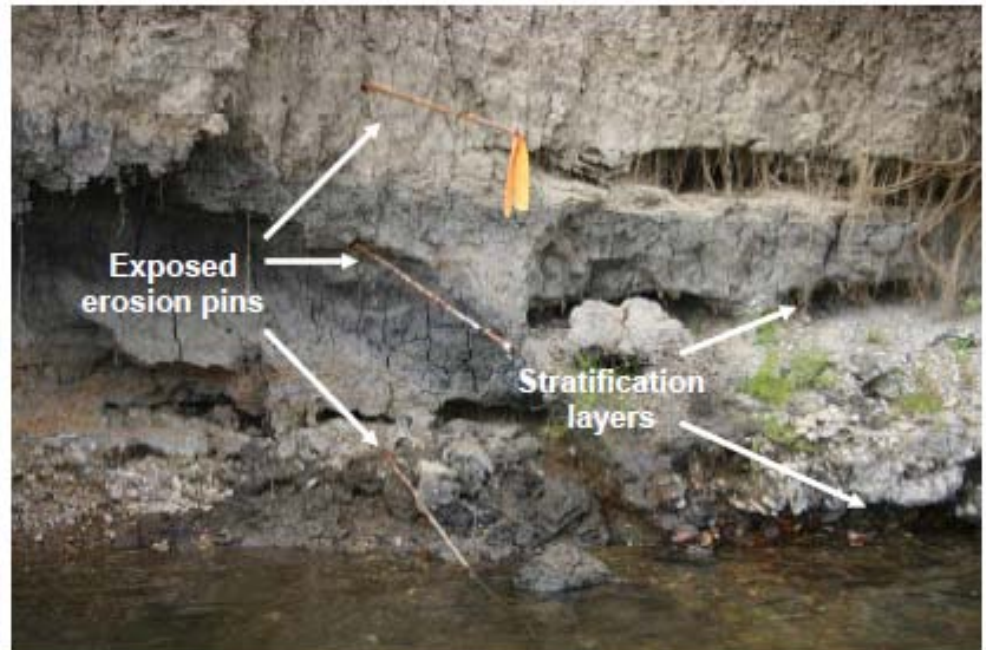
Near Bank Stress

1. Channel pattern
2. Ratio of radius of curvature to bankfull width
3. Ratio of pool slope to average water surface slope
4. Ratio of pool slope to riffle slope
5. Ratio of near-bank maximum depth to bankfull mean depth
6. Ratio of near-bank shear stress to bankfull shear stress
7. Velocity profiles

Estimating Near-Bank Stress (NBS)									
Stream:					Location:				
Station:					Stream Type:			Valley Type:	
Observers:					Date:				
Methods for Estimating Near-Bank Stress (NBS)									
(1)	Channel pattern, transverse bar or split channel/central bar creating NBS.....				Level I	Reconnaissance			
(2)	Ratio of radius of curvature to bankfull width (R_c / W_{bkt}).....				Level II	General Prediction			
(3)	Ratio of pool slope to average water surface slope (S_p / S).....				Level II	General Prediction			
(4)	Ratio of pool slope to riffle slope (S_p / S_{rf}).....				Level II	General Prediction			
(5)	Ratio of near-bank maximum depth to bankfull mean depth (d_{nb} / d_{bkt}).....				Level III	Detailed Prediction			
(6)	Ratio of near-bank shear stress to bankfull shear stress (τ_{nb} / τ_{bkt}).....				Level III	Detailed Prediction			
(7)	Velocity profiles / Isovels / Velocity gradient.....				Level IV	Validation			
Level I	(1)	Transverse and/or central bars-short and/or discontinuous.....NBS = High / Very High							
		Extensive deposition (continuous, cross-channel).....NBS = Extreme							
Level II	(2)	Radius of Curvature R_c (ft)	Bankfull Width W_{bkt} (ft)	Ratio R_c / W_{bkt}	Near-Bank Stress (NBS)				
	(3)	Pool Slope S_p	Average Slope S	Ratio S_p / S	Near-Bank Stress (NBS)				
	(4)	Pool Slope S_p	Riffle Slope S_{rf}	Ratio S_p / S_{rf}	Near-Bank Stress (NBS)				
Level III	(5)	Near-Bank Max Depth d_{nb} (ft)	Mean Depth d_{bkt} (ft)	Ratio d_{nb} / d_{bkt}	Near-Bank Stress (NBS)				
	(6)	Near-Bank Max Depth d_{nb} (ft)	Near-Bank Slope S_{nb}	Near-Bank Shear Stress τ_{nb} (lb/ft ²)	Mean Depth d_{bkt} (ft)	Average Slope S	Bankfull Shear Stress τ_{bkt} (lb/ft ²)	Ratio τ_{nb} / τ_{bkt}	Near-Bank Stress (NBS)
Level IV	(7)	Velocity Gradient (ft / sec/ ft)		Near-Bank Stress (NBS)					
Dominant Near-Bank Stress									
Converting Values to a Near-Bank Stress (NBS) Rating									
Near-Bank Stress (NBS) Ratings	Method Number								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)		
Very Low	N / A	> 3.00	< 0.20	< 0.40	< 1.00	< 0.80	< 0.50		
Low	N / A	2.21 – 3.00	0.20 – 0.40	0.41 – 0.60	1.00 – 1.50	0.80 – 1.05	0.50 – 1.00		
Moderate	N / A	2.01 – 2.20	0.41 – 0.60	0.61 – 0.80	1.51 – 1.80	1.06 – 1.14	1.01 – 1.60		
High	See (1)	1.81 – 2.00	0.61 – 0.80	0.81 – 1.00	1.81 – 2.50	1.15 – 1.19	1.61 – 2.00		
Very High	(1)	1.50 – 1.80	0.81 – 1.00	1.01 – 1.20	2.51 – 3.00	1.20 – 1.60	2.01 – 2.40		
Extreme	Above	< 1.50	> 1.00	> 1.20	> 3.00	> 1.60	> 2.40		
Overall Near-Bank Stress (NBS) Rating									



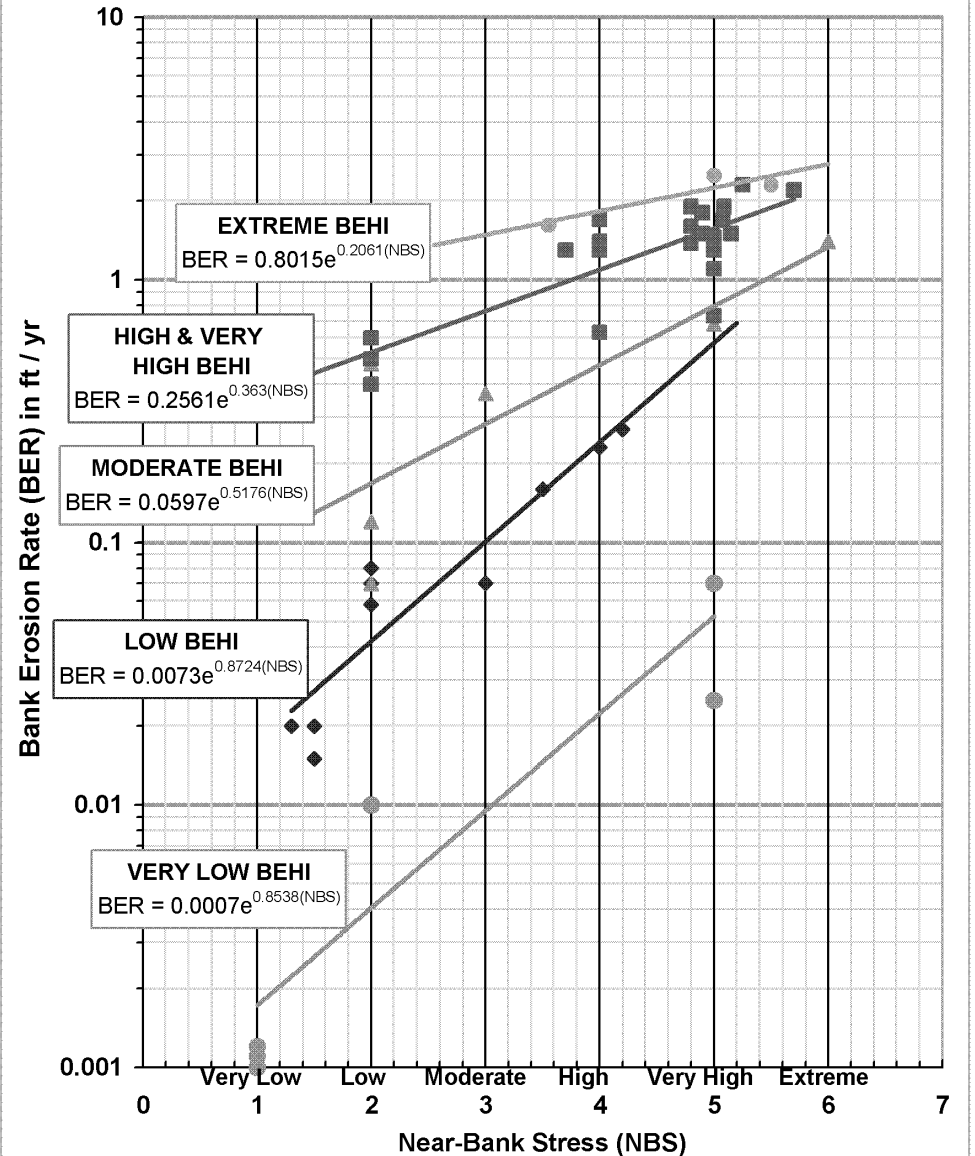
Bank Pins



Bring it all together

- Regional Bank Erosion Rate Curve

Prediction of Annual Streambank Erosion Rates
using Yellowstone National Park (1989) data for streams
found in alpine glaciation and/or volcanism areas





Regional Curves

- Great Lakes Wide
- Valley Types (Rosgen VIII, IX, X, etc.)
- Natural Streams vs. Agricultural Ditches
- Landuse
- Eco-regions



Other Assessments

- Pfankuch (erodability)
- FHWA Stability Indicator (erodability)
- Near-Bank Velocity Perturbation (erosivity)
- Historical Aerial Photography (erosion)



Scope, Schedule, Costs

- Geographically, throughout Great Lakes
 - Chicago and Buffalo USACE Districts
- Schedule:
 - April 2010: Training for partner agencies/districts
 - June 2010: Begin installation of bank pins
 - June 2011: Begin second visits to sites to measure erosion
 - October 2012: Complete field visits
 - December 2012: Project Complete
- Costs: ~\$180K



Questions?

BUILDING STRONG