Reference SON: *2020-1593*

Riparian model development for mitigation requirements and ecosystem restoration actions

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Other Partners:

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Riparian Model Development for Impact and Benefit Assessment

Research Need

USACE actions often affect riparian ecosystem structure and function in both positive and negative ways (e.g., benefits of ecosystem restoration and impacts associated with flood damage reduction). While some regional tools exist, no nationwide models or modeling frameworks adequately capture the effects of USACE actions on riparian outcomes.

Project Purpose & Objectives

This project seeks to provide a structured, consistent approach for riparian modeling that provides continuity from early project planning to long-term operations. A preliminary model and riparian screening tool will be developed based on existing knowledge, largely by combining current USACE methods into a certified model. A rigorous riparian modeling framework will be developed in collaboration with external resource agencies and partners. This more detailed modeling approach will be evaluated relative to empirical field data for multiple taxa and outcomes.

Value of Research and Development (Payoff)

USACE practitioners currently lack broadly applicable techniques for assessing impacts and benefits to riparian zones, and existing models are currently regionally specific, inconsistent in approach, and ultimately do not meet project planning needs. This project will provide a consistent framework for accounting for the impacts and benefits of USACE in riparian ecosystems. This approach will facilitate communication nationwide, provide a mechanism for easier "roll-up" of environmental metrics, and align approaches across USACE business lines.

Products and Deliverables

Journal Articles (JAs)

Ayala-Torres, R., L.H. Dietterich, S. Wiest and S.K. McKay. (2025). Developing predictive models of riparian buffer

efficacy with meta-analysis. Environmental Challenges, 20, 101258. https://doi.org/10.1016/j.envc.2025.101258

Technical Reports (TRs)

Wiest, S., G. Menichino and S.K. McKay. Submitted. Riparian Ecological Function Index (REFI). ERDC/TR. Vicksburg, MS: US Army Engineer Research and Development Center.

Technical Notes (TNs)

Wiest, S., D.D. Hernandez-Abrams and S.K. McKay. 2023. Review of Riparian Models for Assessing Ecological Impacts and Benefits. ERDC/TN EMRRP-ER-26. Vicksburg, MS: US Army Engineer Research and Development Center. http://dx.doi.org/10.21079/11681/47706

McKay S.K., S. Wiest, S. McFadden and J. Hawkins. Submitted. Riparian Model Evaluation in Beargrass Creek, Kentucky. ERDC TN-EMRRP-xx. U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Shaw, C. and S.R. Wiest. Submitted. A Web Application for Riparian Models (WARM). ERDC/TN. Vicksburg, MS: US Army Engineer Research and Development Center.

Other Reports/Models/Tools/Datasets

Ayala-Torres, R., S.R. Wiest, E. Dorfmueller and S.K. McKay. 2022. Ecological riparian zones width by instream process. White Paper. University of Puerto Rico, Mayaguez.

Shaw, C. and S.R. Wiest. 2023. Increasing accessibility of riparian assessment tools through web applications. Conference Proceedings Paper. ASCE Inspire Conference.

Wiest, S., G. Menichino and S.K. McKay. Pending Certification. Riparian Ecological Function Index (REFI). Model. Vicksburg, MS: US Army Engineer Research and Development Center.

Shaw, C. and S.R. Wiest. Pending Certification. A Web Application for Riparian Models (WARM). Web Application. Vicksburg, MS: US Army Engineer Research and Development Center.

Conference Presentations/Webinars/Workshops

Wiest, S.R. 2022. Riparian Ecological Function Index (REFI). Poster. EWRI World Water Resources Congress. Atlanta.

Wiest, S.R. 2022. Riparian Ecological Function Index (REFI). Poster. AWRA Annual Conference. Seattle.

Wiest, S.R., G. Menichino and S.K. McKay. 2023. Riparian Ecological Function Index (REFI). EL Homecoming. Vicksburg, MS: US Army Engineer Research and Development Center.

McKay, S.K. Riparian Ecological Function Index (REFI). 2023. ASLO Annual Meeting. Spain.

McKay, S.K. 2023. Riparian Ecological Function Index (REFI). Symposium on Urbanization and Stream Ecology (SUSE). Australia.

Shaw, C. and S.R. Wiest. 2023. Increasing accessibility of riparian assessment tools through web applications. Oral Presentation. ASCE Inspire Conference. Washington D.C., Virginia.

Wiest, S.R., G. Menichino and S.K. McKay. 2024. Riparian Ecological Function Index (REFI). EMRRP Virtual Webinar.

Ayala-Torres, R. and S.K. McKay. 2024. Developing predictive models of riparian buffer efficacy with meta-analysis. EMRRP Virtual Webinar.

Shaw, C. and S.R. Wiest. 2024. Web Application for Riparian Models (WARM). EMRRP Virtual Webinar.

Wiest, S.R. 2024. Riparian Ecological Function Index (REFI). Poster. National Conference on Ecosystem Restoration. Albuquerque, New Mexico.

Wiest, S.R. 2024. Riparian Ecological Function Index (REFI). Oral Presentation. America Ecological Engineering Society. Blacksburg, Virginia.

Wiest, S.R. 2024. Riparian Ecological Function Index (REFI). Oral Presentation. National Stream Restoration Conference. New Orleans, Louisiana.

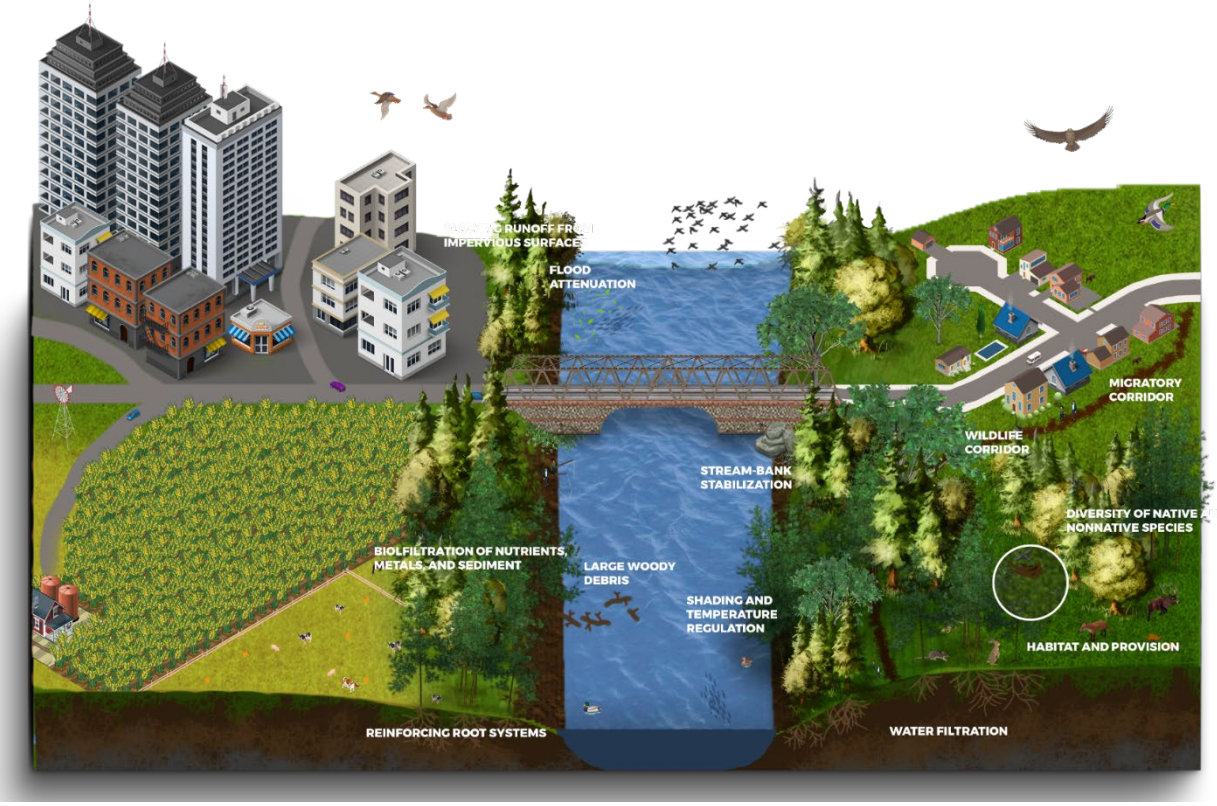
Wiest, S.R. 2024. Riparian Ecological Function Index (REFI). Oral Presentation. WRAP Stream Restoration Course. Missouri.

Wiest, S.R. 2025. Riparian Model Evaluation in Beargrass Creek, Kentucky. Poster. River Restoration Northwest. Skamania, Washington.

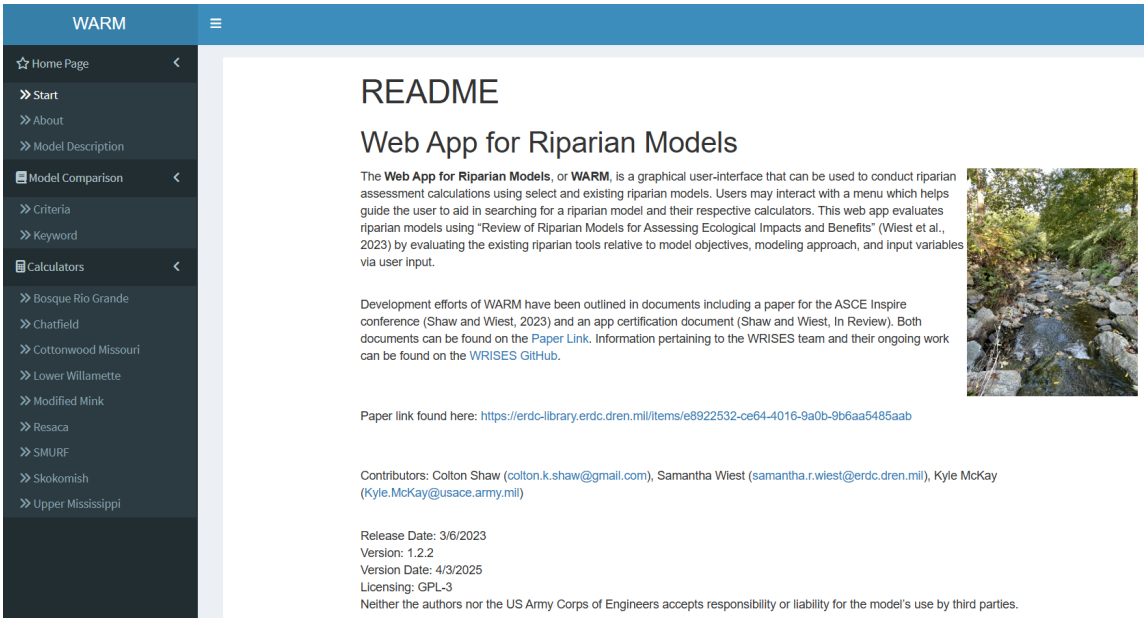
Wiest, S.R. 2025. Riparian Ecological Function Index (REFI). Oral Presentation. ECO-PCX Certification Meeting.

Communication (Social Media, Videos, Podcasts, Photos, etc.)

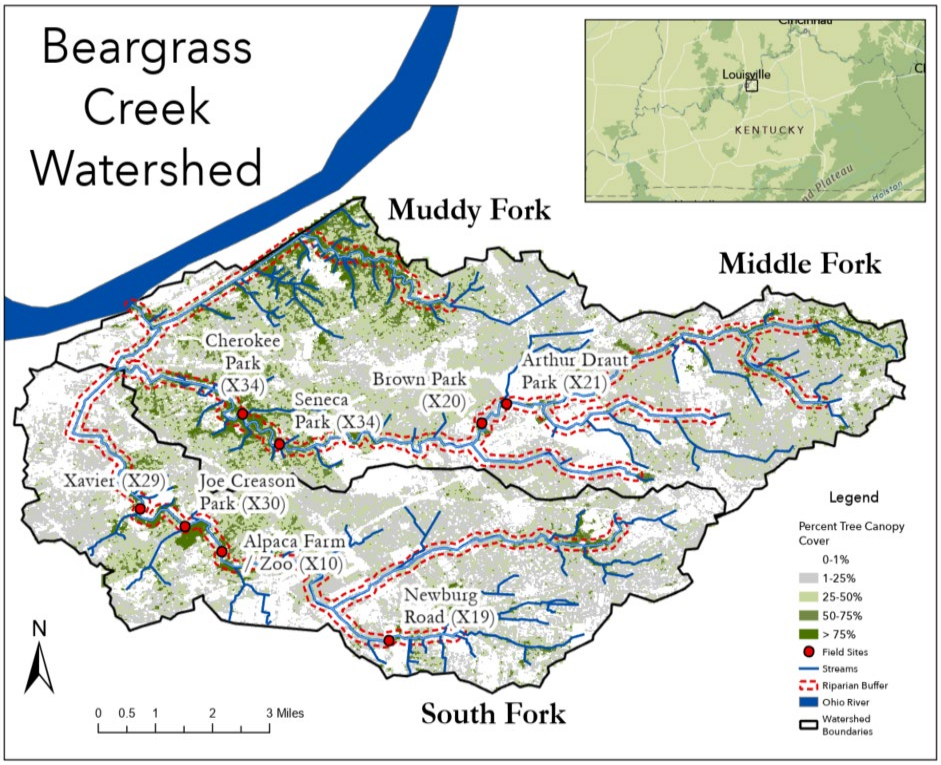
Images



Overarching conceptual model depicting different riparian functions and stressors.



Web application for increasing model accessibility and service (https://wrises.shinyapps.io/warm/).



Map of Beargrass Creek Watershed with sampling sites used or model verification and validation.

Riparian Ecological Function Index (REFI) Field Worksheet

Reach/ID		River Bank	Left / & / Right
Lat/Long		Reach Length (ft)	
Date		Min Buffer Width (ft)	0-30 / 30-100 / 100+
Assessor (s)		Avg Buffer Width (ft)	0-30 / 30-100 / 100+

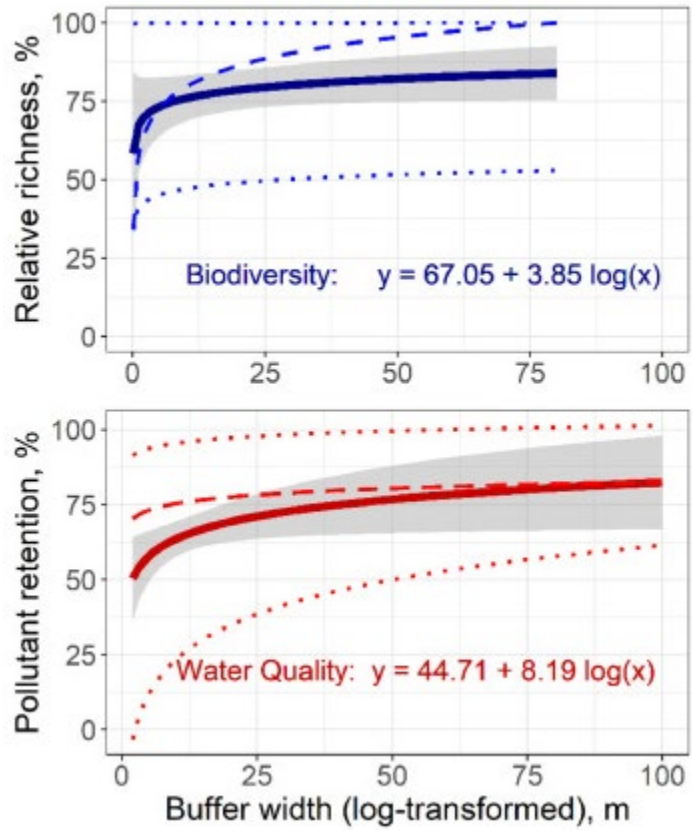
SCORING INTRUCTIONS

Variables are judgment-based scores reflecting the condition of the riparian zone relative to this physical or ecological function. **Indicators** record the logic embedded in the variable and can be used to calculate a variable score. Each indicator has a specific context: WAT = Watershed, BAN = Bank area, CHA = Channel, or RIP = riparian zone. Indicators may be omitted by selecting "NA", or indicators may be added under "Other Indicators". A minimum of three indicators is recommended for each variable.
REFI assessment involves two primary steps:
1) Assess **indicators** based on your agreement with their *functional statement* at the site. Strongly Agree (SA), Agree (A), Neutral (N), Disagree (D), Strongly Disagree (SD), Not Applicable (NA)
2) Score **variable** condition using its *functional statement* and **indicators** based on the following scale:
Functioning (15 to 11), Functioning At-Risk (10 to 6), or Non-Functioning (5 to 1).

Variable	Indicators	Score
	INSTREAM FUNCTIONS	
Watershed Runoff *RZ reduces upland runoff and associated pollution load to the stream and supports interflow processes*	**Direct Runoff** WAT: Runoff velocities and volumes are reduced by riparian zone roughness (e.g., vegetation) and extent, encouraging infiltration and interflow processes.	
	Bypassing Flows WAT: Bypass elements are not present (e.g., pipes, tile drains, ditches) and runoff sources move through the riparian system as overland flow or as interflow.	
	Floodplain Slope RIP: Interflow processes (i.e., shallow groundwater flow) are not limited by steep ground slope in riparian zone and floodplain.	
	Runoff Pollution WAT: Potential point/non-point pollutant sources are intercepted and adequately mitigated by the RZ.	
Score: ___	**Notes/Other Indicators:**	
Hydrologic Connection *RZ is hydrologically connected and provides flood storage, which reduces channel erosion and provides aquatic refugia in the floodplain*	**Floodplain Connectivity** CHA: Stormflows have the ability to access and spread out into the floodplain consistent with the natural geomorphic condition (e.g. limited channel incision).	
	Floodplain Roughness RIP: Hydraulic roughness slows floodplain velocities consistent with expectations for the stream valley and landscape. Features indicative of these processes include vegetation density and presence of large wood.	
	Flood Storage RIP: Floodplain topography and features slow or store water consistent with expectations for the stream valley and landscape. Features indicative of this outcome include floodplain wetlands and topographic depressions.	
	In-stream Hydrology CHA: Flow controls (e.g., dams) in the watershed or stream do not constrain the hydrologic connection between the stream and riparian zone.	
Score: ___	**Notes/Other Indicators:**	
Streambank Processes *RZ vegetation and fluvial geomorphic processes are in sync such that the stream is in dynamic equilibrium.*	**Erosion Potential** BAN: There is little potential for bank erosion based on protection provided by bank rooting depth, bank cover, or bank slope. (Note: rely on dominating feature for scoring).	
	Reach Erosion BAN: The channel in this reach is not experiencing excessive erosion or deposition.	
	Channel Evolution CHA: Stream is relatively stable and not experiencing morphological changes or major shifts that could negatively impact riparian zone structure or function.	
	Sediment Supply CHA: There is not excessive sediment supply, from watershed sources or legacy sediment, and sediment imbalance due to in-stream flow controls that trap sediment.	
Score: ___	**Notes/Other Indicators:**	
Energy, Nutrients, and Sediment *RZ provides energy sources to stream, buffers nutrients, and pollutants from runoff and in groundwater.*	**Carbon Sources** CHA: Riparian zone provides energy sources (e.g. FPOM, CPOM) to stream consistent with River Continuum Concept. Organic material are from diverse and quality sources (e.g. leaves, branches, large wood).	
	Root Zone RIP: Riparian zone roots are deep enough to likely intercept groundwater during baseflow and stormflow.	
	Soil Suitability RIP: There is no evidence of disturbance or compaction from unnatural processes. Surface layer of soil allows uninhibited plant growth and infiltration.	
	Mobilizing Flows CHA: Sediment, wood, and organic material is freely transported to the stream, consistent with expectations stream valley and landscape.	
Score: ___	**Notes/Other Indicators:**	
Riparian Filtering *RZ filters out suspended sediment from upland runoff and in-stream flooding.*	**Buffer Width** RIP: The vegetated buffer has an objectively wider width to support filtering processes. (Note: a "wider" width is classified as at least 30 feet (10 meters), but preferably greater than 90 feet (30 meters)).	
	Buffer Density RIP: The vegetated buffer is dense enough in vegetation to slow overland flow velocity to filter sediment/pollution before reaching the stream.	
	Ground Cover RIP: The vegetated buffer floor is covered by vegetation or organic material.	
Score: ___	**Notes/Other Indicators:**	

Draft of Riparian Ecological Function Index (REFI) field assessment sheet.

Calculator/spreadsheet to roll-up scores for Riparian Ecological Function Index (REFI).



Final results of buffer width meta-analysis.