Prioritizing Restorative Actions for a Threatened Species Using a Novel Spatial Approach

Joe Famularo

Agenda

I. Background

II. Purpose

III. Approach

IV. Preliminary results

V. Impact

Slide 2

K2 Should always have an agenda slide. italics are for you)
KPMG, 2/26/2018

My Background

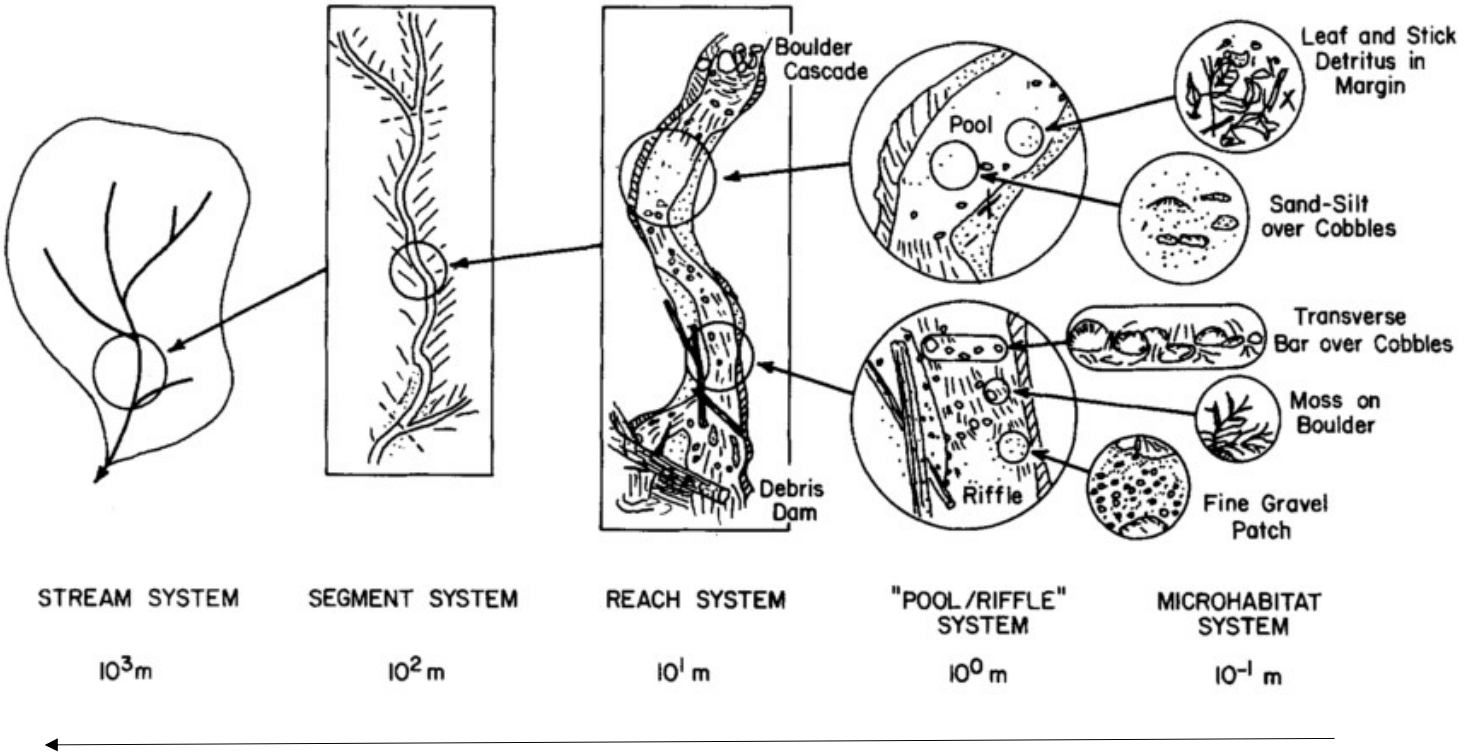
- Virginia Tech Graduate, Class of 2017
  - Bachelor of Science in Water: Resources, Policy, and Management
- Oak Ridge National Lab SULI Intern
- VCU Graduate Student

VIRGINIA TECH™

Justification: Maximizing Restoration Outcomes

- Efforts to characterize restoration successes and failures
- Need for prioritization of candidate sites
- Multispatial considerations
  - Watershed vs reach scale
  - Broad applicability

Spatial Scales in Stream Systems

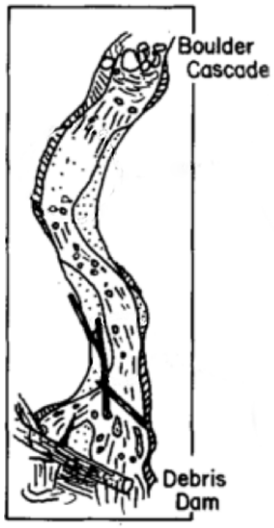


Frissel et al., 1986

Modeling for Prioritization of Restorative Actions

- Species Distribution Model
  - Watershed scale

- Microhabitat Suitability Model
  - Reach to Stream Segment Scale

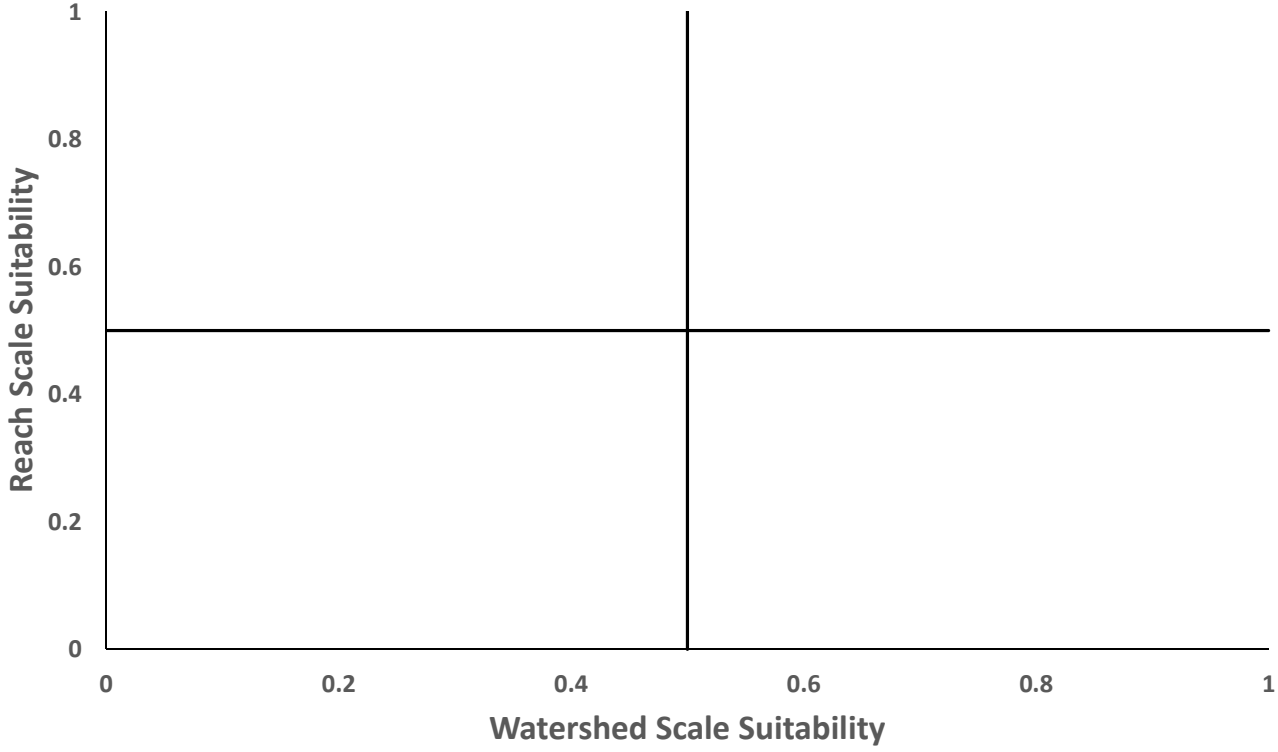


Frissel et al., 1986

Modeling for Prioritization of Restorative Actions

Frissel et al., 1986

Watershed Versus Reach Scale Suitability



Species Distribution Model

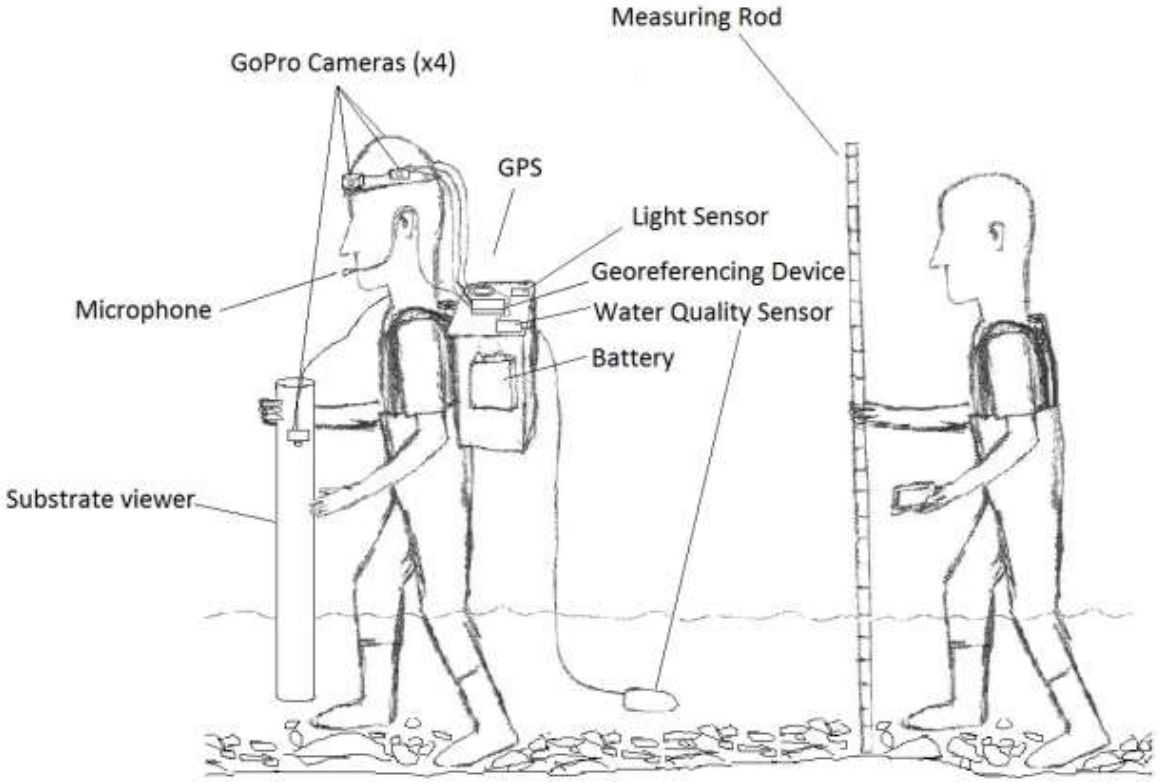
- Maximum Entropy Modeling (Phillips et al., 2004)

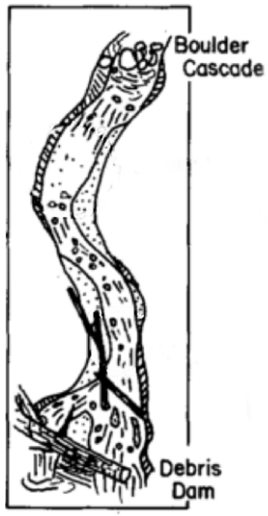
- Anthropogenic and Environmental Variables

Percent Contribution	Variables	Description
15.8	perm_avg	Average permeability
14.8	DCI	Measure of upstream length fragmented by dams
10.3	nid_storN	Percent of mean annual flow stored behind dams
8.6	rckdepl_avg	Average depth to bedrock
7.4	TEMP_CL	Temperature class

Frissel et al., 1986

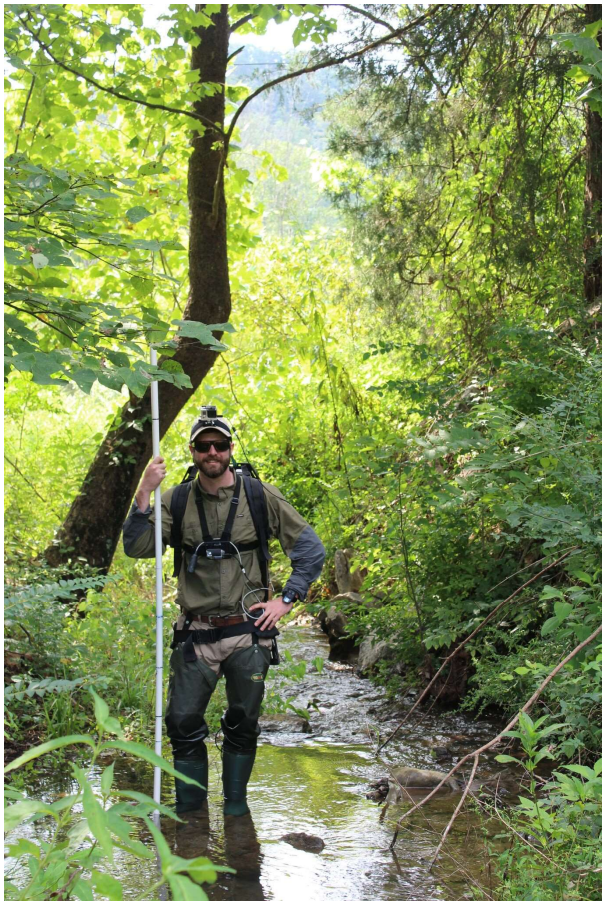
Backpack System Design





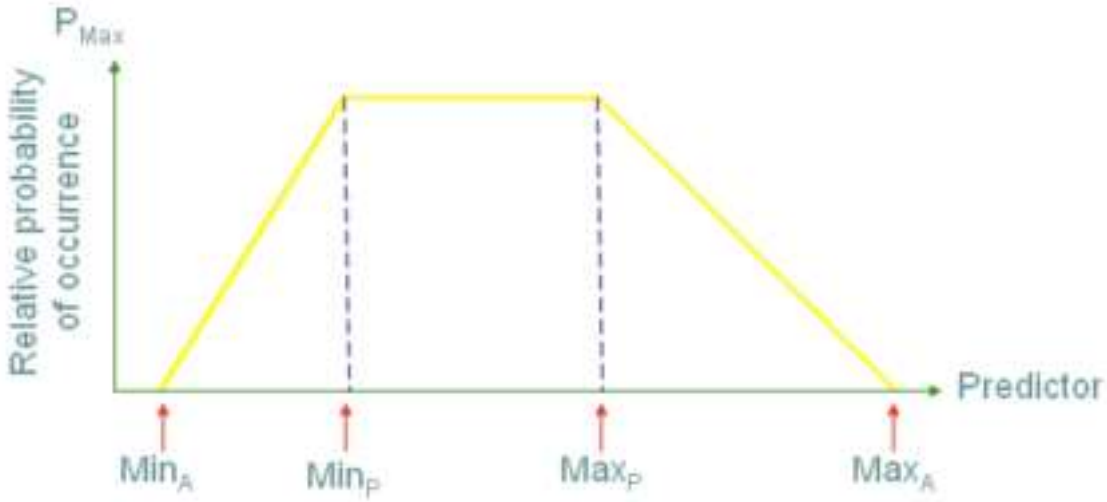
Frissel et al., 1986
McManamay & Eisinger, 2016

Backpack System Design

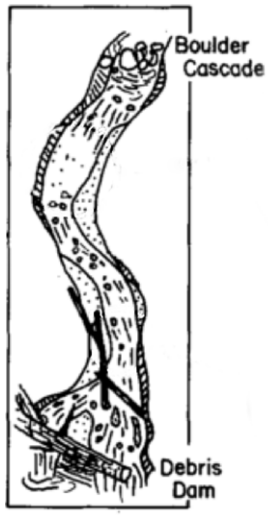


Microhabitat Suitability Model

- Species envelope method (Kesner-Reyes et al., 2004)



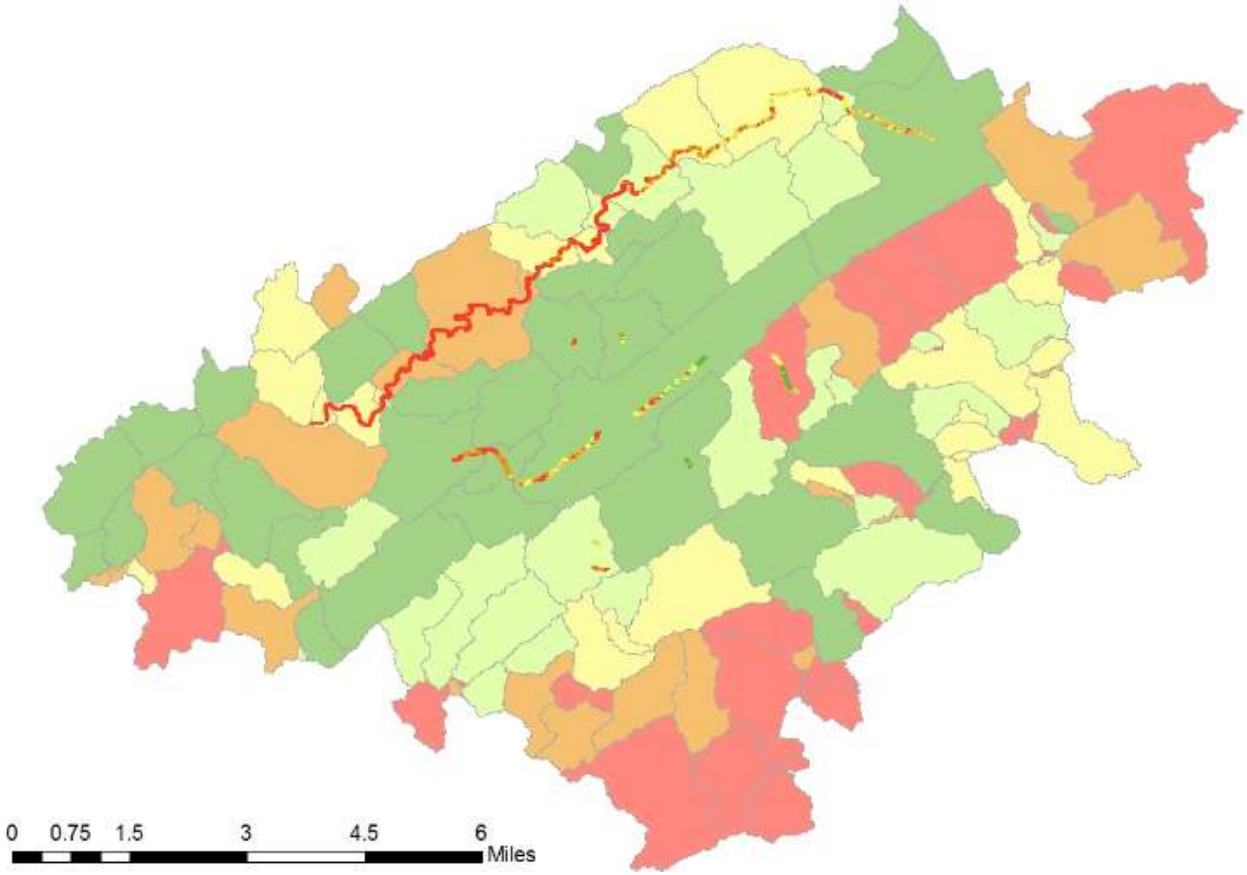
Pc= P1 x P2 x P3 x P4 x P5 x P6 x P7



Frissel et al., 1986

Kesner-Reyes et al., 2012

Preliminary Results



Species Distribution Model

Habitat Suitability Score

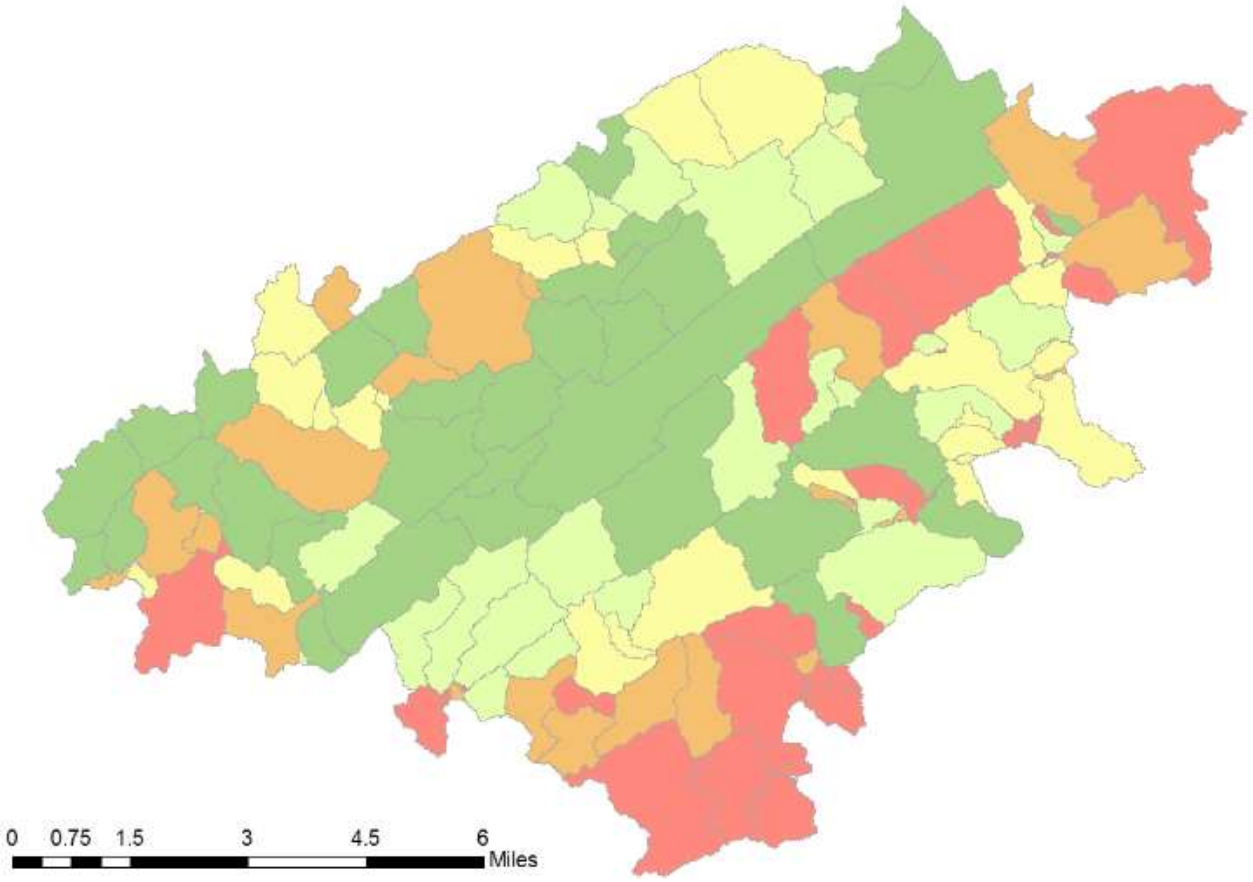
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Preliminary Results



Species Distribution Model

Habitat Suitability Score

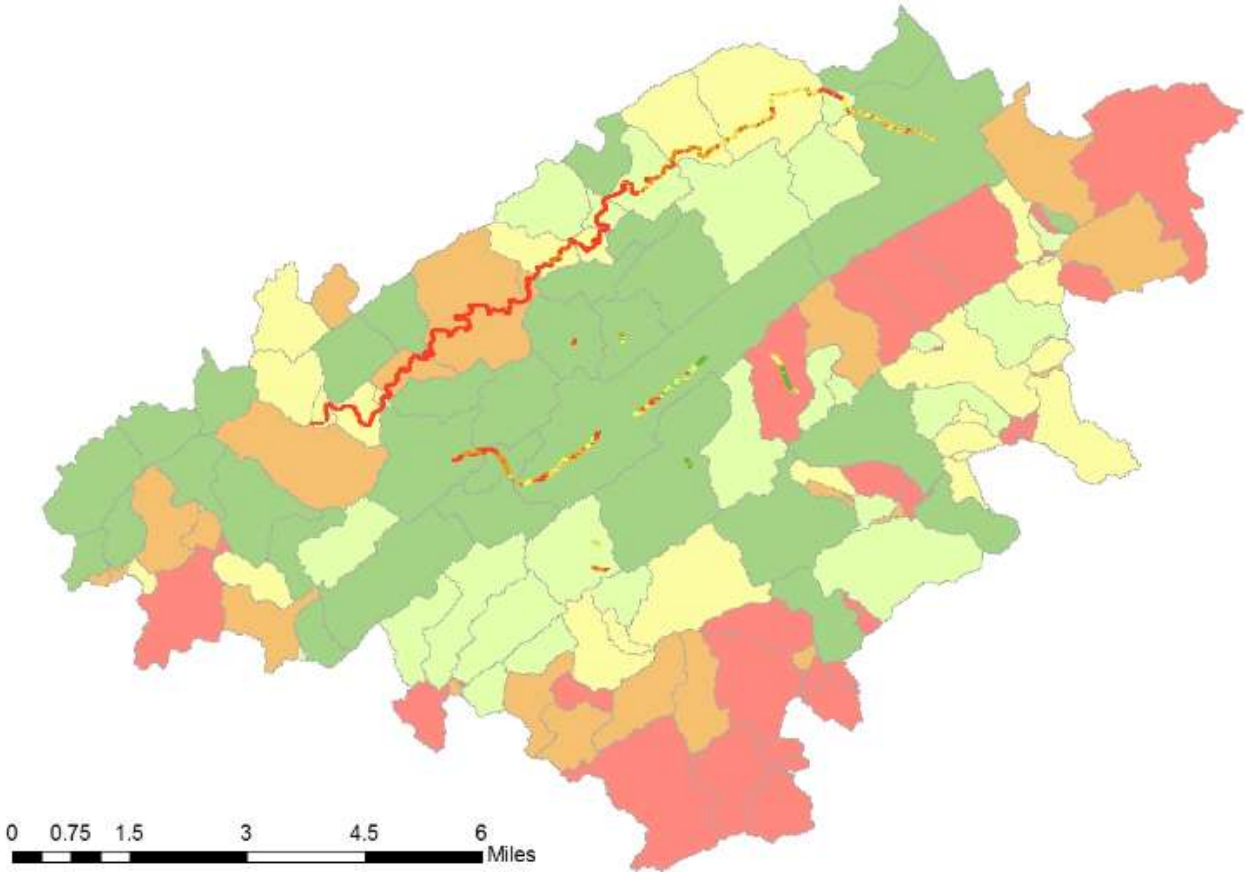
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Preliminary Results



Species Distribution Model

Habitat Suitability Score

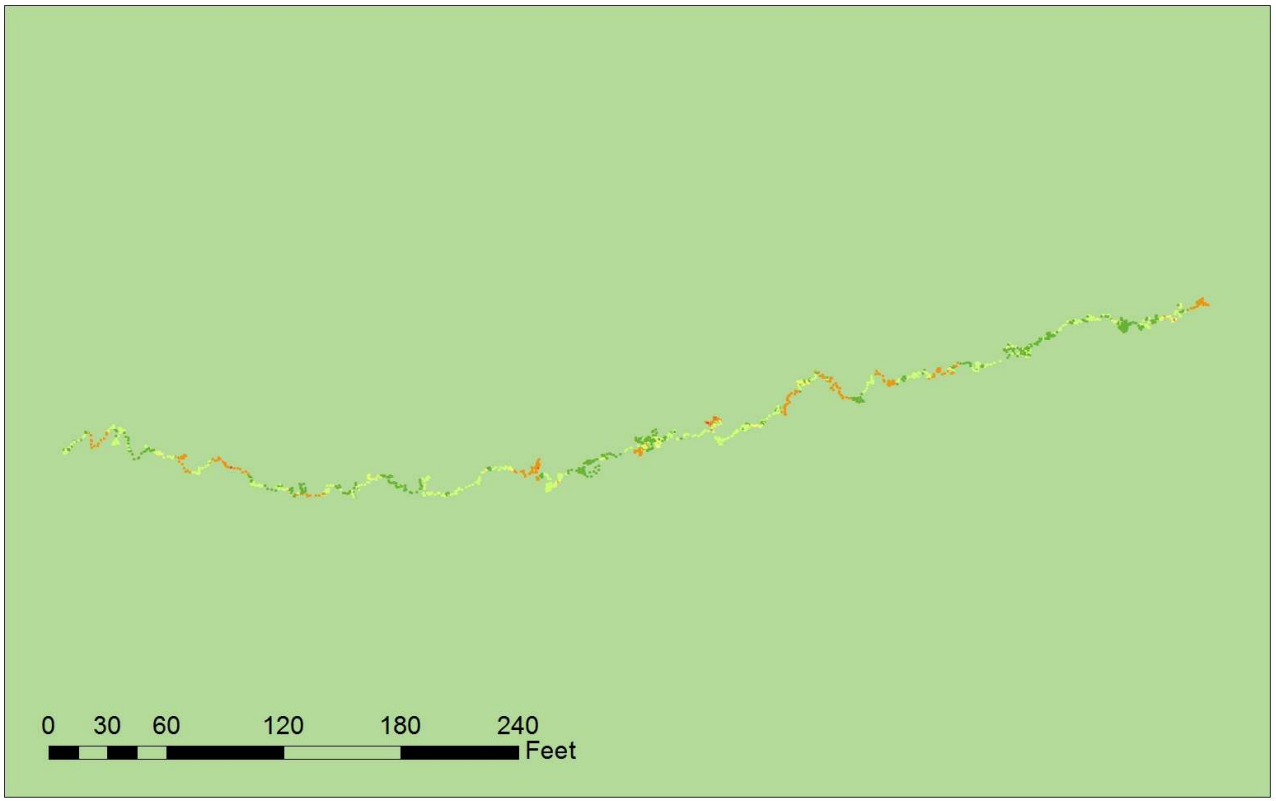
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

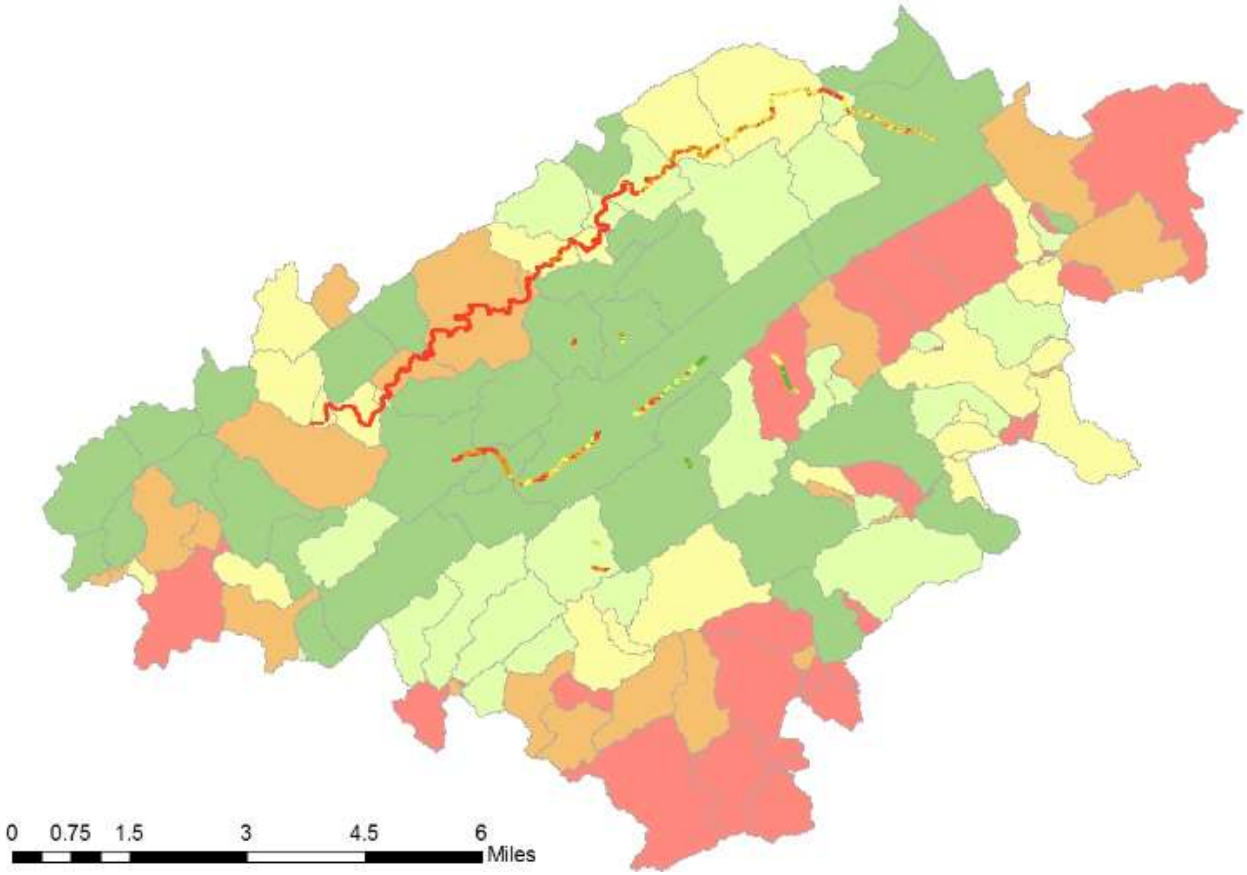
Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Pinhook Branch



Preliminary Results



Species Distribution Model

Habitat Suitability Score

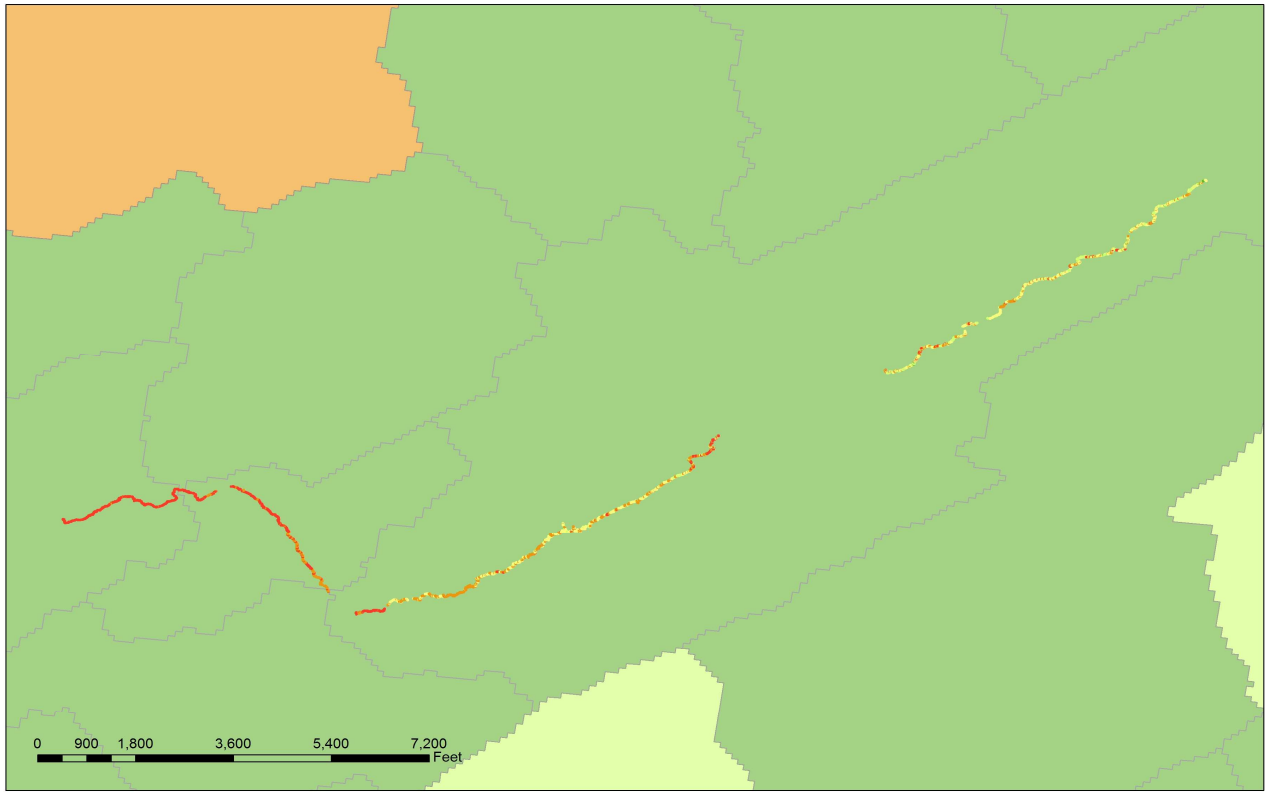
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Bear Creek



Species Distribution Model

Habitat Suitability Score

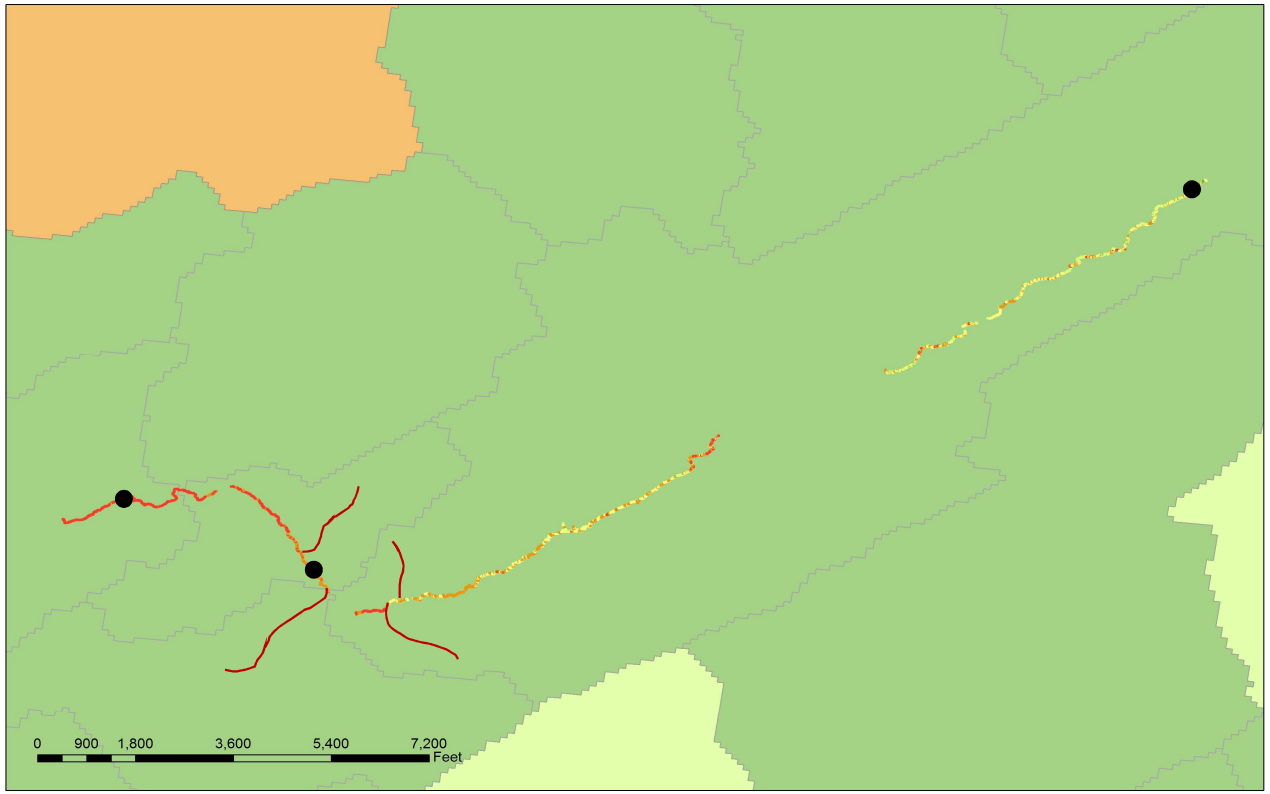
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Bear Creek



Species Distribution Model

Habitat Suitability Score

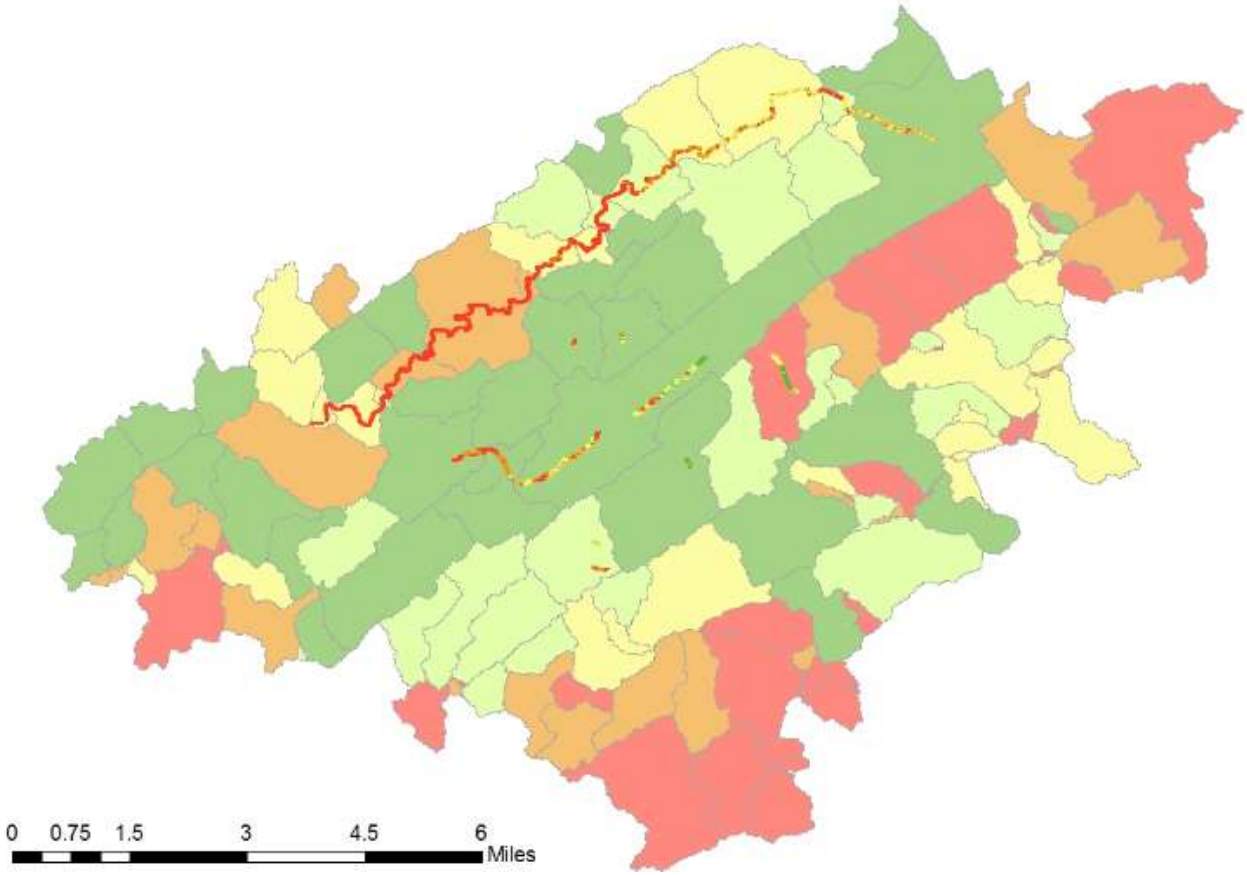
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Preliminary Results



Species Distribution Model

Habitat Suitability Score

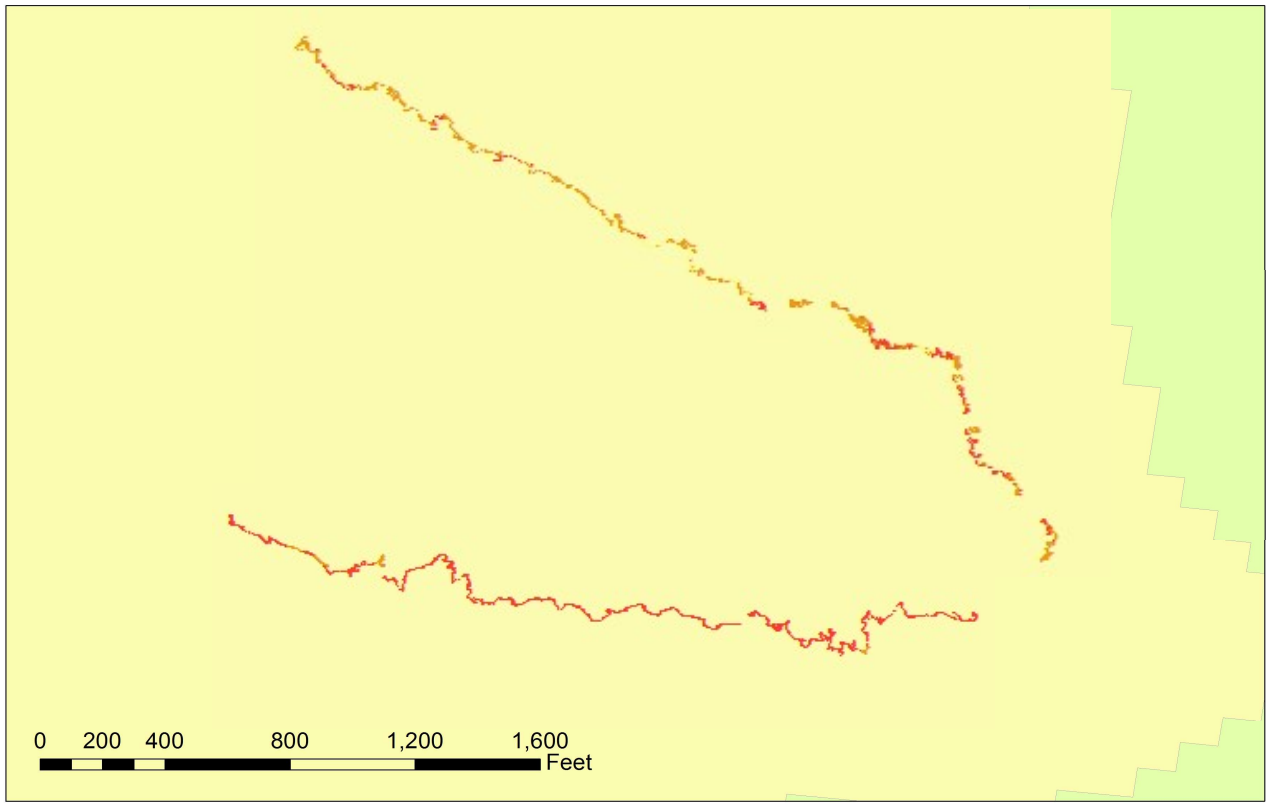
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

NW Trib & First Creek



Species Distribution Model

Habitat Suitability Score

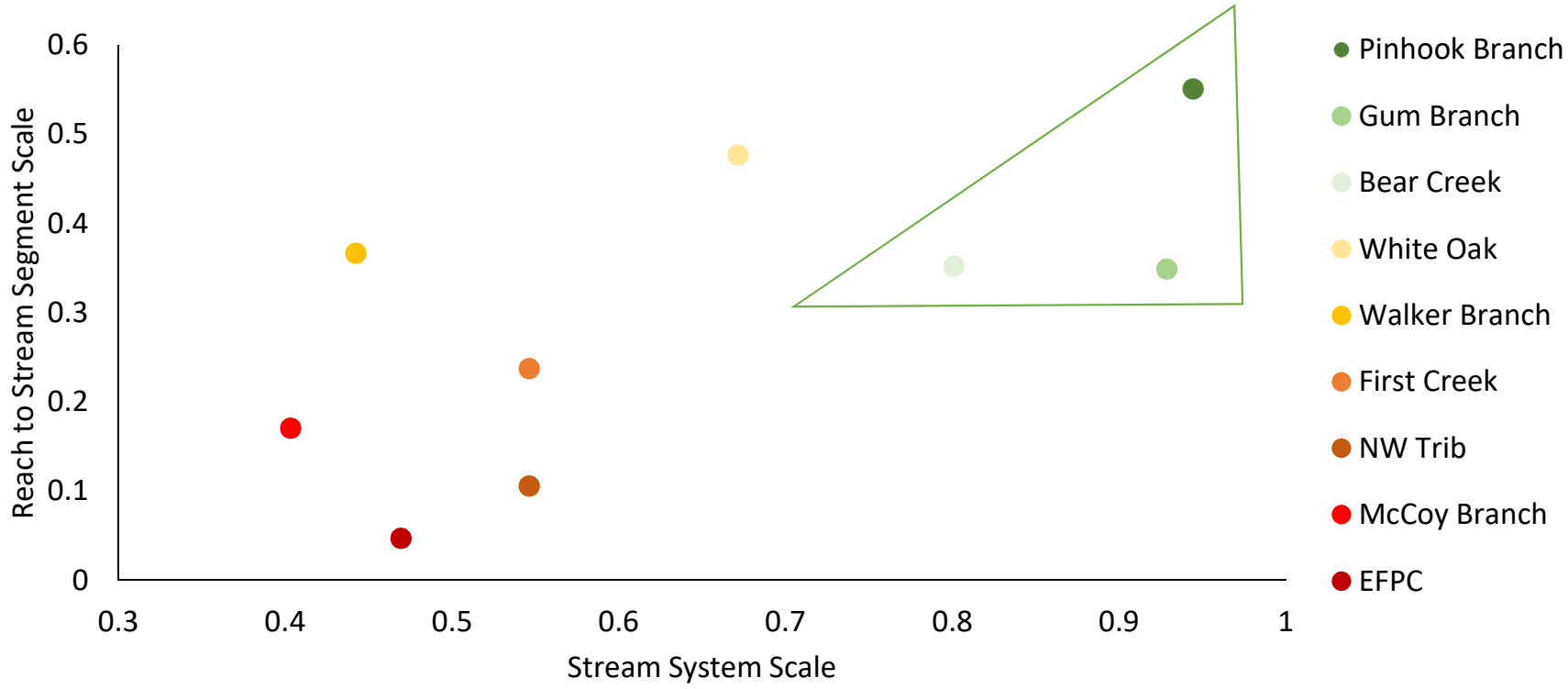
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Watershed vs. Reach Scale Habitat Suitability



White Oak Creek

Species Distribution Model

Habitat Suitability Score

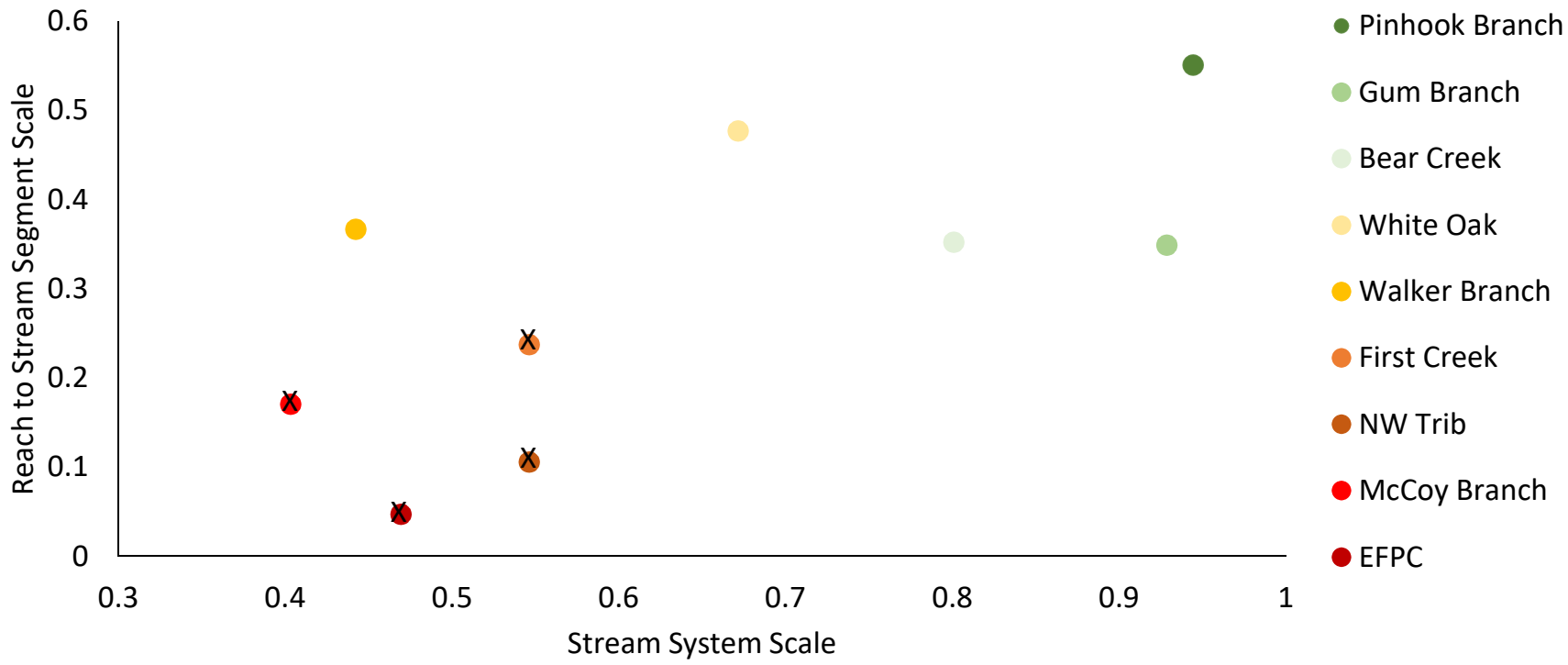
- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Watershed vs. Reach Scale Habitat Suitability



Walker Branch

Species Distribution Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Microhabitat Suitability Model

Habitat Suitability Score

- 0.00 - 0.20
- 0.21 - 0.40
- 0.41 - 0.60
- 0.61 - 0.80
- 0.81 - 1.00

Prioritization Table

Site	Microhabitat	Watershed	Priority & Action
Pinhook Branch	0.551	0.944	X – Existing population
White Oak	0.477	0.671	(1) Passable road crossing, (2) Weir removal
Walker Branch	0.366	0.442	(3) Passable road crossing, (4) Weir removal; (5) Riparian planting
Bear Creek	0.352	0.801	X – Existing population
Gum Branch	0.349	0.928	X – Existing population
First Creek	0.237	0.546	X - Altitude
McCoy Branch	0.170	0.403	X - Altitude
NWT	0.106	0.546	X - Altitude
EFPC	0.047	0.469	X - Altitude

Summary

- Potential to improve restoration outcomes
- Broad applicability
  - Not just single species
  - Monitor habitat quality
  - Post-restoration assessments

References

- Frissell, C. A., Liss, W. J., Warren, C. E., & Hurley, M. D. (1986). A hierarchical framework for stream habitat classification: Viewing streams in a watershed context. *Environmental Management*, *10*(2), 199–214.
- Kesner-Reyes, K., Kaschner, K., Kullander, S., Garilao, C., Baril, J., & Froese., R. (2012). AquaMaps: algorithm and data sources for aquatic organisms. *FishBase. World Wide Web Electronic Publication. Www.fishbase.org, Version (04/2012)*.
- Phillips, S. J., Dudík, M., & Schapire, R. E. (2004). A maximum entropy approach to species distribution modeling. *Twenty-First International Conference on Machine Learning - ICML '04*, 83.

This work was supported in part by the U.S. Department of Energy, Office of Science, Office of Workforce Development for Teachers and Scientists (WDTS) under the Science Undergraduate Laboratory Internship program.