South River Watershed Relative Risk Model

South River Science Team
Quarterly Meeting
June 13, 2012

Agenda

- Relative Risk Model (RRM)
  - Not duplicative or in lieu of Western Washington University RRM
- Overview of the RRM for Smallmouth Bass (*Micropterus dolomieu)*
- Next Steps
  - Stakeholder engagement
  - Finalization of models for remaining endpoints
  - Development of the watershed planning/assessment tool

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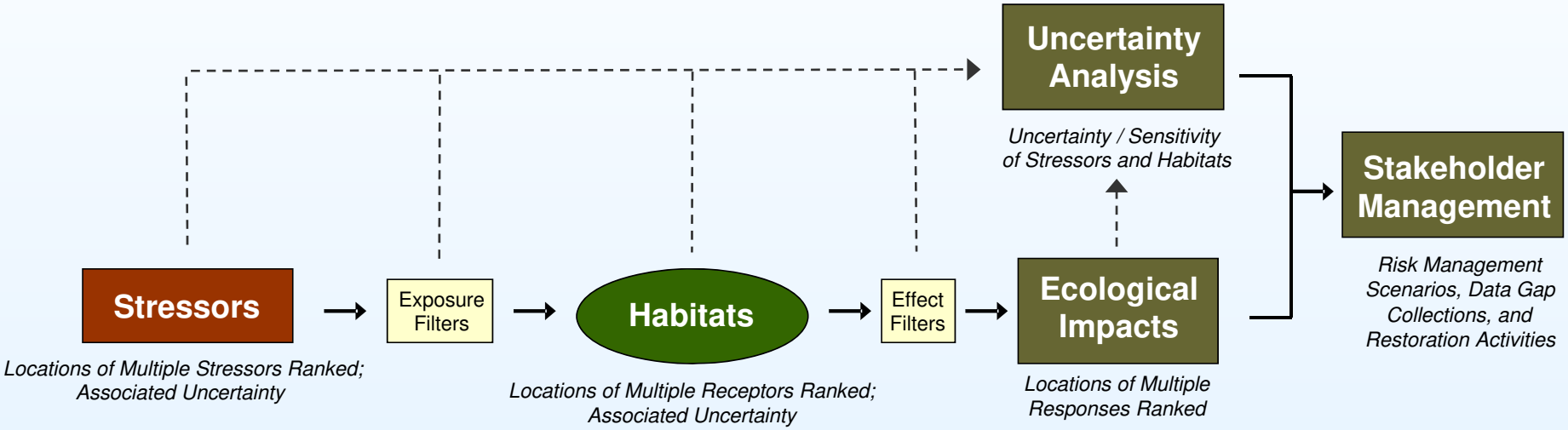
Traditional Relative Risk Model



Notes:
Adapted from Landis and Wiegers (2005)

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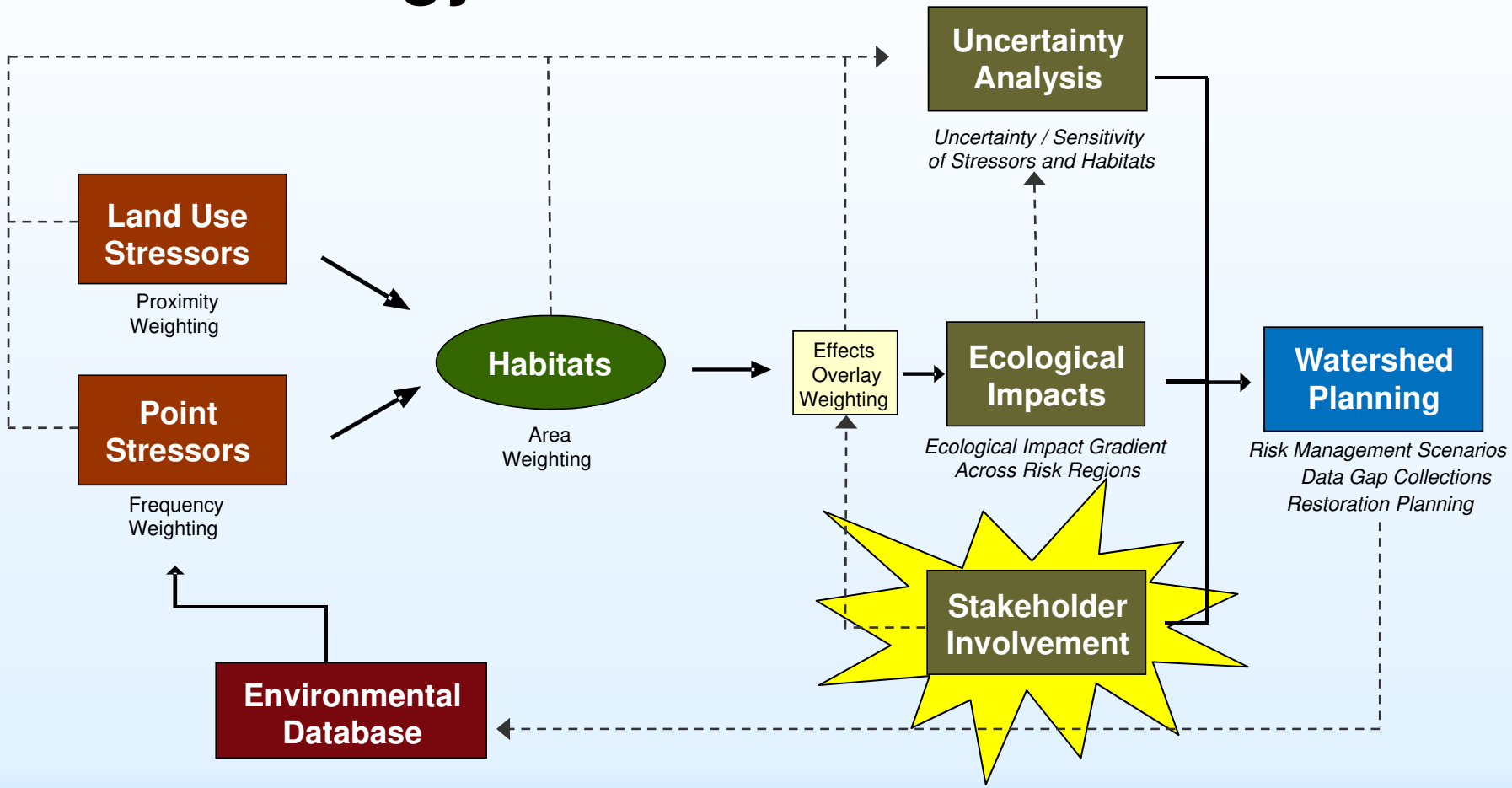
South River RRM Assessment Methodology



Notes:
Adapted from Landis and Wiegers (2005)

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Conceptual Model Overview

Stressors → Habitats → Endpoint Species

Aquatic Stressors

- Water Temperature
- Dissolved Oxygen
- Suspended Solids / Sedimentation
- Nutrients

Aquatic and Terrestrial Stressors

- Aquatic Habitat Loss / Alteration
- Pathogens
- Chemicals (Hg)
- Non-Native / Invasive Species
- Species Removal / Biodiversity Loss

Terrestrial Stressors

- Terrestrial Habitat Loss / Alteration

Aquatic Habitats

- Lotic and Lentic Benthic
- Riverine Open Water
- Lacustrine Open Water
- Wetlands and Marshes

Terrestrial Habitats

- Riparian Corridor
- Interior Forest
- Interior Shrubland
- Open Space

Warmwater and Coldwater Fish

- Smallmouth Bass
- Brook Trout

Herptiles

- Northern Painted Turtle
- American Toad

Benthic Invertebrates

- Mayflies

Piscivorous and Insectivorous Avifauna

- Belted Kingfisher
- Carolina Wren

Insectivorous Mammal

- Little Brown Bat

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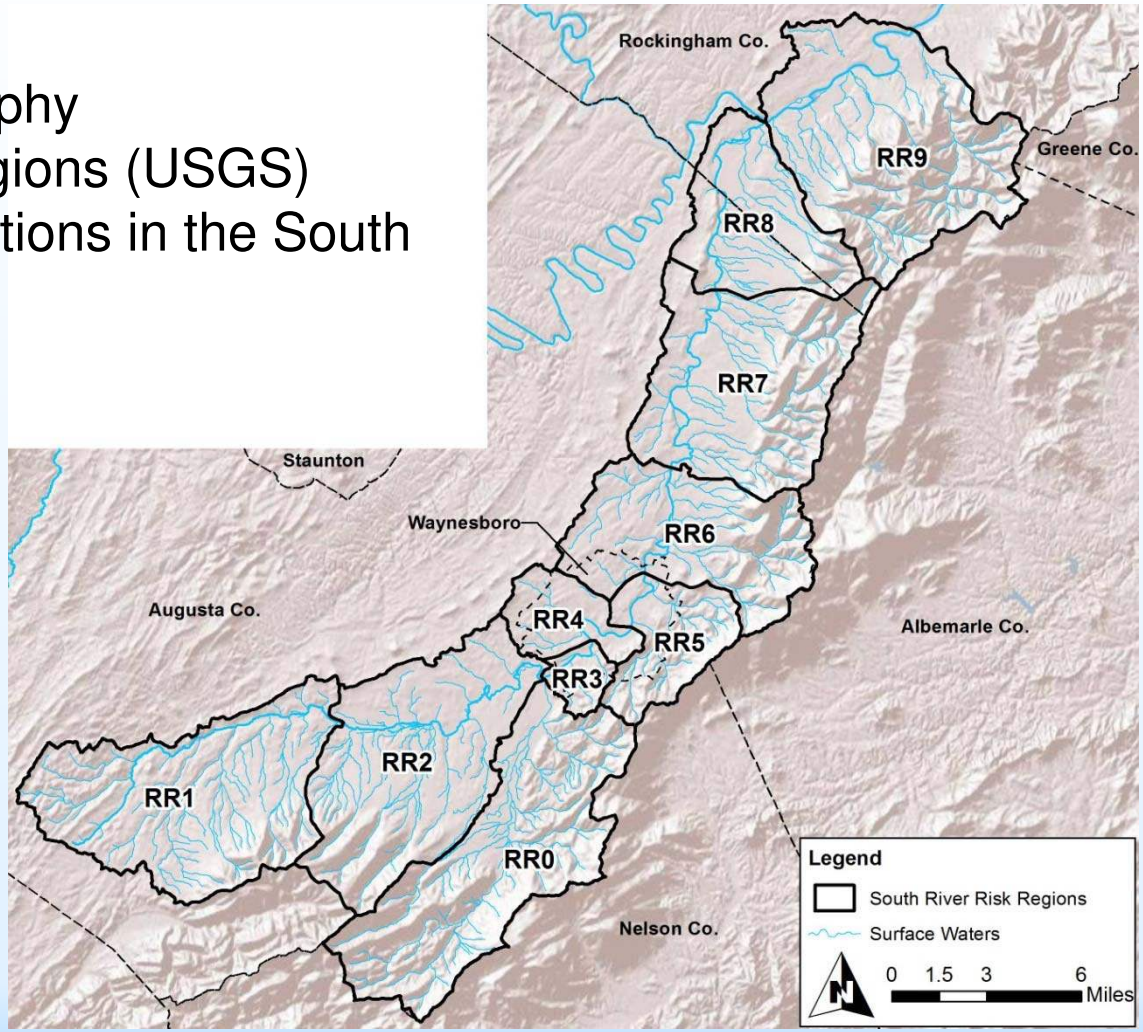
Risk Regions

Delineated by:

- Hydrology and topography
- Previously modeled regions (USGS)
- Existing land use conditions in the South River watershed

	Risk Region	Drainage Area (Mi^2)
Upper Risk Regions	RR-0	41.57
	RR-1	41.96
	RR-2	39.95
	RR-3	3.49
	RR-4	8.44
Lower Risk Regions	RR-5	12.66
	RR-6	27.90
	RR-7	37.18
	RR-8	21.07
	RR-9	44.98



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Assessment Methodology

Modeling framework utilizes separate weighting criteria for polygon-derived land cover stressors and point-derived stressors:

- Individual polygon stressors weighted by proximity corridors
- Individual point stressors weighted by frequency of occurrence
- Combined effects determined through a weighted overlay approach

Smallmouth Bass – Stressor Overview

Point Data Stressors

Aquatic Stressors

- Water Temperature
- Dissolved Oxygen
- Suspended Solids (Turbidity)

Aquatic and Terrestrial Stressors

- Chemicals (Hg)

Stressor data weighted by frequency of occurrence

Category	Risk Rank	Value Range
Temperature (ºC)		
Low	2	0.0 - 27.0
Moderate	4	27.0 - 32.3
High	6	> 32.3
No Data	0	
Dissolved Oxygen (%)		
Low	2	> 6.0
Moderate	4	1.0 - 6
High	6	0.0 - 1.0
No Data	0	
Turbidity (Nephelometric Units)		
Low	2	0.0 - 25.0
Moderate	4	25.0 - 40.0
High	6	> 40.0
No Data	0	
Tissue Total Mercury Concentration (ppm)		
Low	2	0.0 - 0.5
Moderate	4	0.5 - 3.0
High	6	> 3.0
No Data	0	

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Smallmouth Bass – Stressor Overview

Polygon Data Stressors

Aquatic Stressors

- Water Temperature
- Dissolved Oxygen
- Suspended Solids / Sedimentation

Aquatic and Terrestrial Stressors

- Pathogens

Stressor data weighted by land use proximity to surface water

LAND USE/LAND COVER CLASS	Risk Rank By Category		
	D.O.	Temp	Turbidity
Forested Lands			
Coniferous Forest	2	2	2
Deciduous Forest	2	2	2
Mixed Forest	2	2	2
Scrub/Shrub	2	2	2
Developed/Urban Lands			
Road/Railroad	4	4	4
Developed, High Intensity	6	6	6
Developed, Medium Intensity	6	6	6
Developed, Low Intensity	4	4	4
Developed, Open Space	2	2	4
Dams	6	6	2
Agricultural Lands			
Pasture/Hay	6	2	6
Row Crops and Horticulture	6	4	6
Aquatic/Wetlands			
Emergent Wetland	2	2	2
Forested/Shrub Wetland	2	2	2
Pond/Lake	2	2	2
Stream/River	2	2	2

*Risk to smallmouth bass from pathogens such as *Aeromonas salmonicida* was estimated based on VDGIF fish-kill observations

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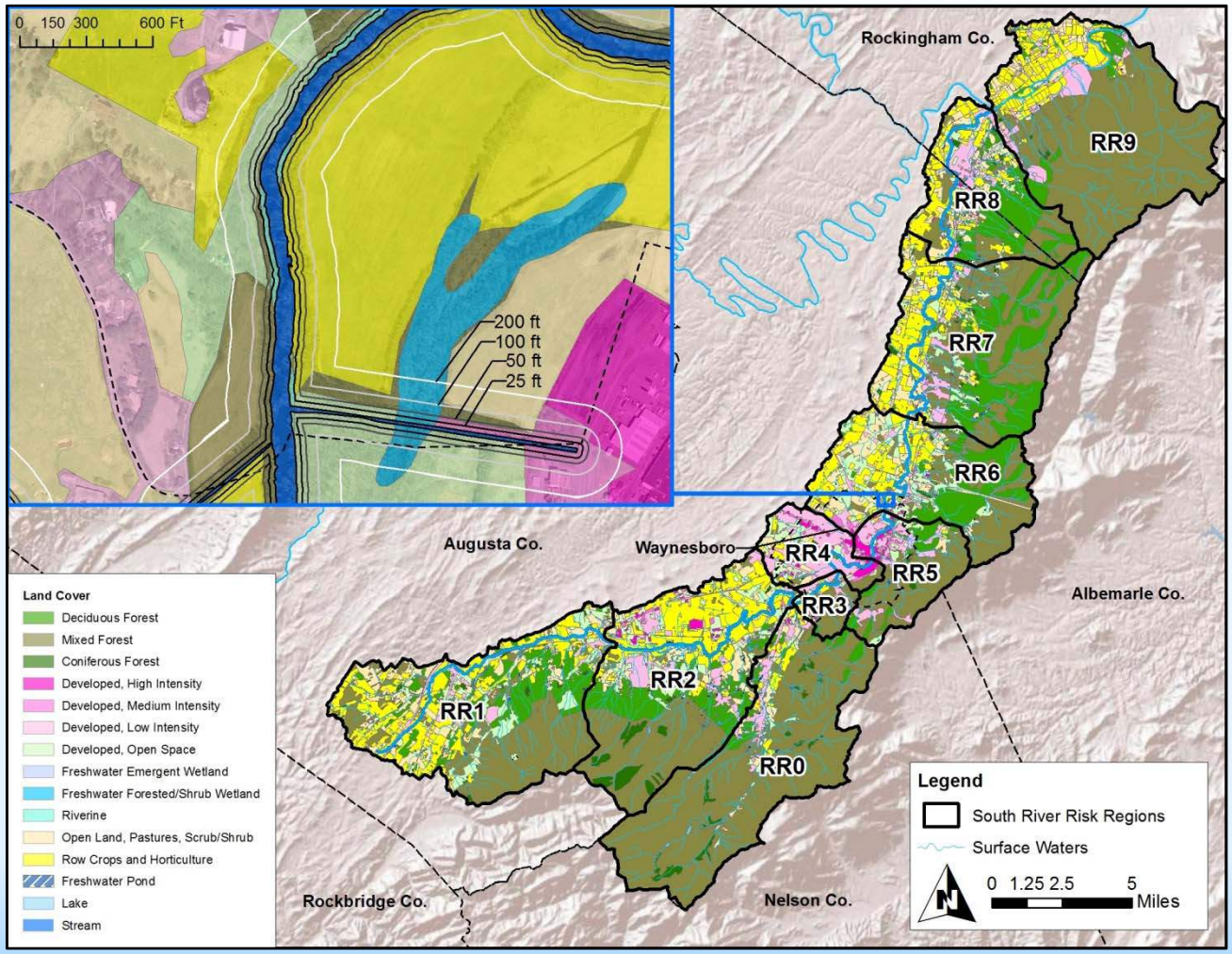
Smallmouth Bass – Stressor Weighting

Stressor data weighted based on proximity to receiving waters

Buffer Corridor Width	Proximity Weighting Factor
0 - 25 feet	40 %
25 - 50 feet	30 %
50 - 100 feet	20 %
100 - 200 feet	10 %



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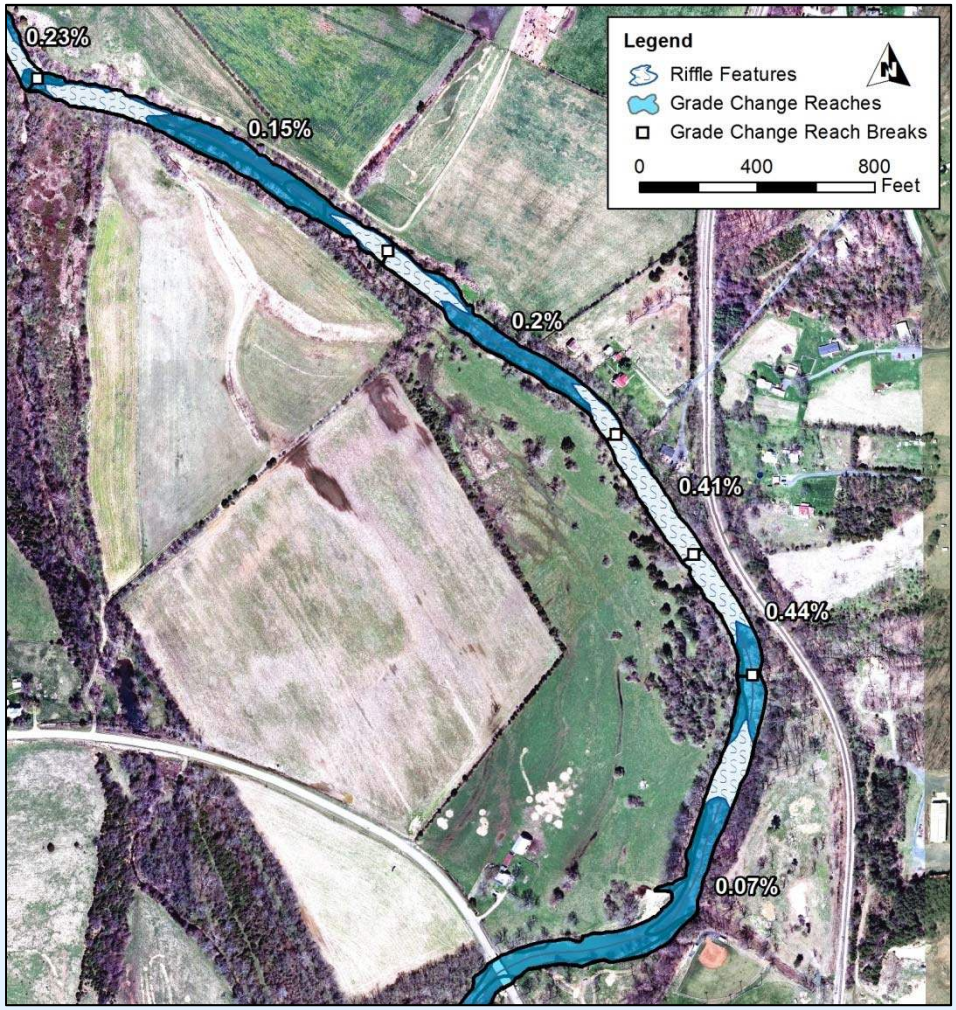
Smallmouth Bass – Habitat Overview

Habitat Layer

- Habitat gradients established using HSI suitability models
- Lotic surface waters > 30 feet wide considered viable habitats
- Riffles delineated in GIS

Risk Category	Risk Rank	Value Range(s)
Non-Riffle Area (%)		
Optimal	2	35.0 - 85.0
Sub-Optimal	4	20.0 - 35.0 & 85.0 - 95.0
Marginal	6	0.0 - 20.0 & >95.0
No Data	0	
Channel Gradient (%)		
Optimal	2	0.08 - 0.40
Sub-Optimal	4	0.05 - 0.08 & 0.40 - 0.80
Marginal	6	<0.05 & >0.8
No Data	0	



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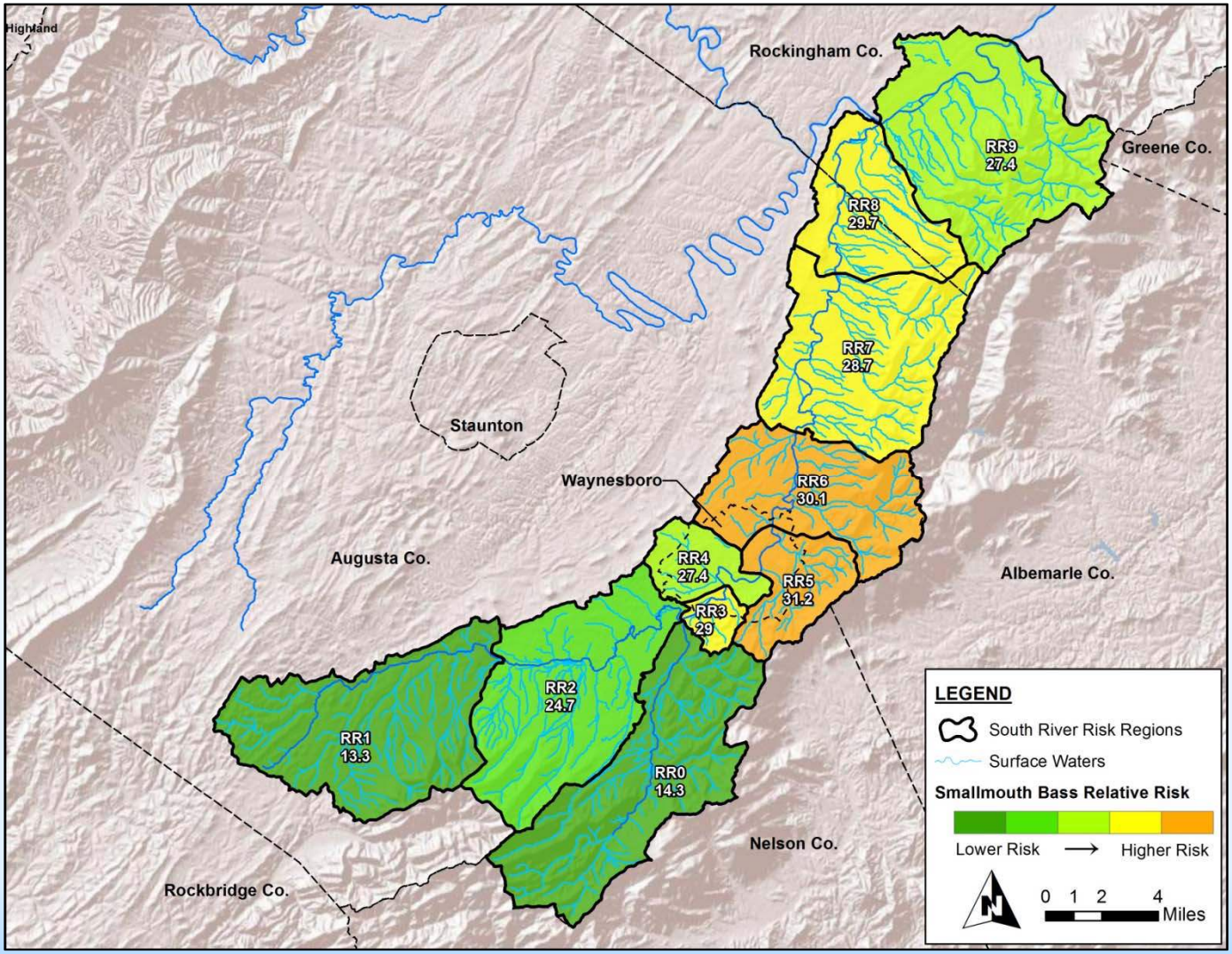
Smallmouth Bass – Preliminary Results

- Relative risk highest in Risk Regions 5 & 6
- Back Creek (RR0) and upper South River (RR1) have lowest risk



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Smallmouth Bass – Risk Region 6 Results

Risk Region 6 Scoring Overview

- Scores combined in weighted overlay and risk values assessed
- Total relative risk is 30.1
- Overlay weight is adjustable

Model Input	Region Rank	Overlay Weighting	Risk Value
Main Stem Polygon Land Use Stressors			
Dissolved Oxygen	45	~9%	4.1
Temperature	25	~9%	2.3
Turbidity	45	~9%	4.1
Tributary Polygon Land Use Stressors			
Dissolved Oxygen	35	~9%	3.2
Temperature	25	~9%	2.3
Turbidity	35	~9%	3.2
Point Data Stressors			
Chemicals (Hg)	35	~9%	3.2
Dissolved Oxygen	25	~9%	2.3
Temperature	20	~9%	1.8
Turbidity	20	~9%	1.8
Overlay Stressors			
Pathogens	20	~9%	1.8
		Total Relative Risk =	**30.1**

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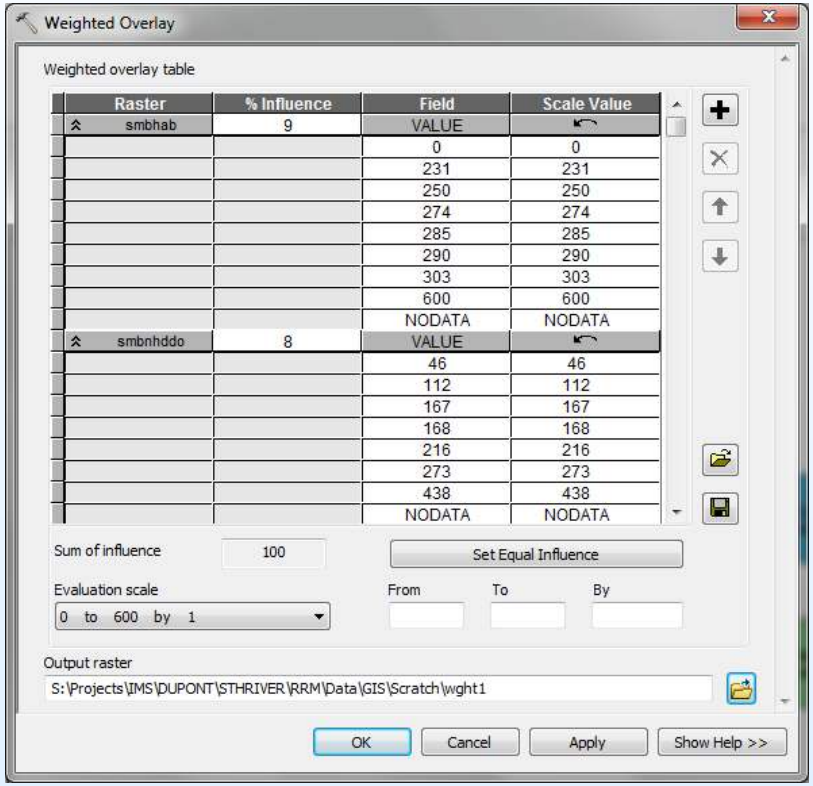
Smallmouth Bass – Effects Overlay

Effects overlay weights stressor and habitat influence based on a proportion of total risk

- Scales the model and allows calibration across multiple spatial and temporal inputs
- Proportion of total risk can be easily modified to accommodate varying stakeholder values
- For this assessment equal scaling was used



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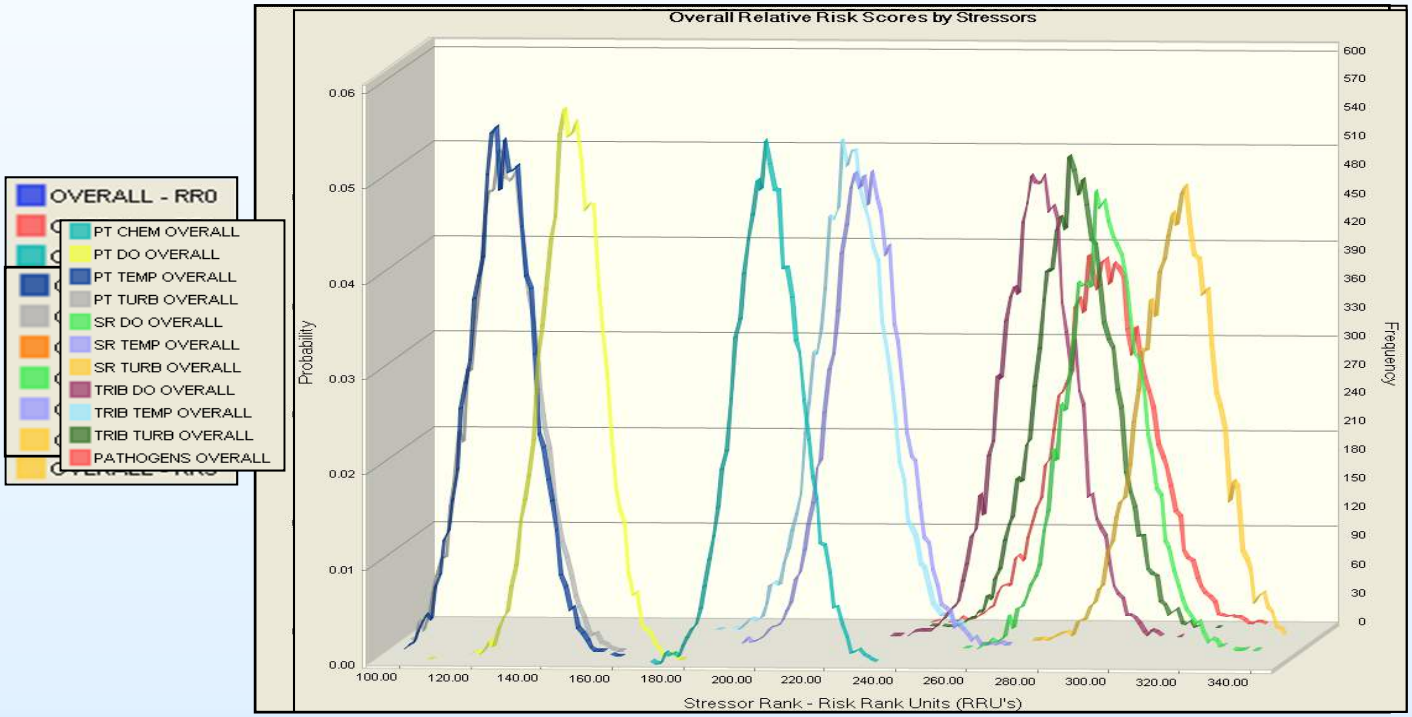
Smallmouth Bass – Uncertainty

The RRM quantifies associated ecological risk across multiple spatial and temporal scales using Monte Carlo simulation



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Future Direction…

The existing framework of the model allows for comparative assessments of the multiple risk regions with modified stressor or habitat conditions.

- Stakeholder Involvement
- Finalization of additional endpoint evaluations
- Watershed planning tool development

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