South River Watershed Relative Risk Model
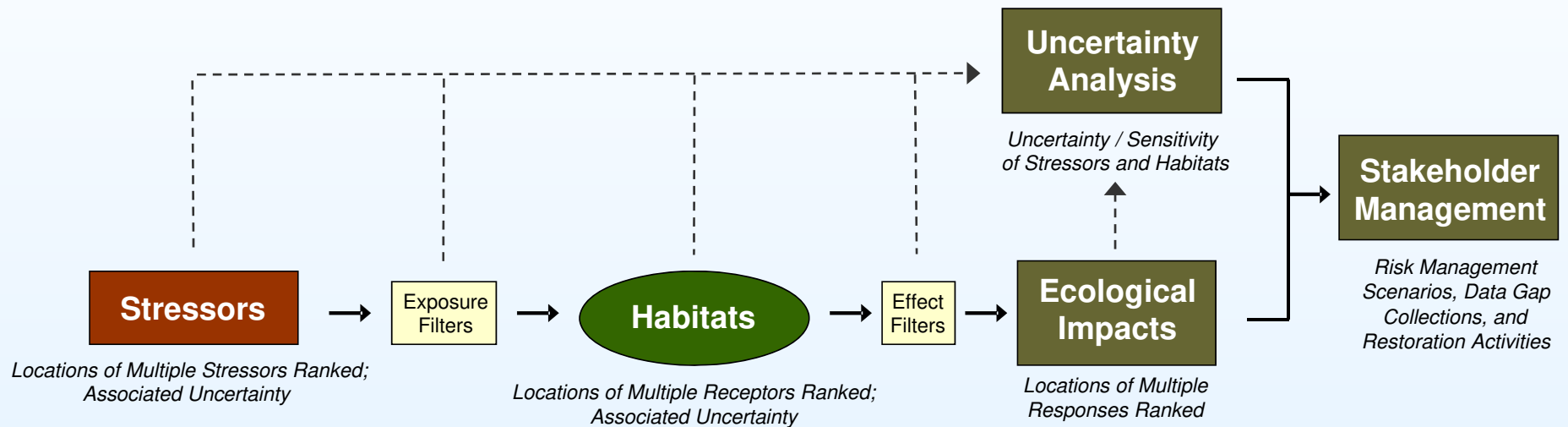

South River Science Team
Quarterly Meeting
June 13, 2012

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
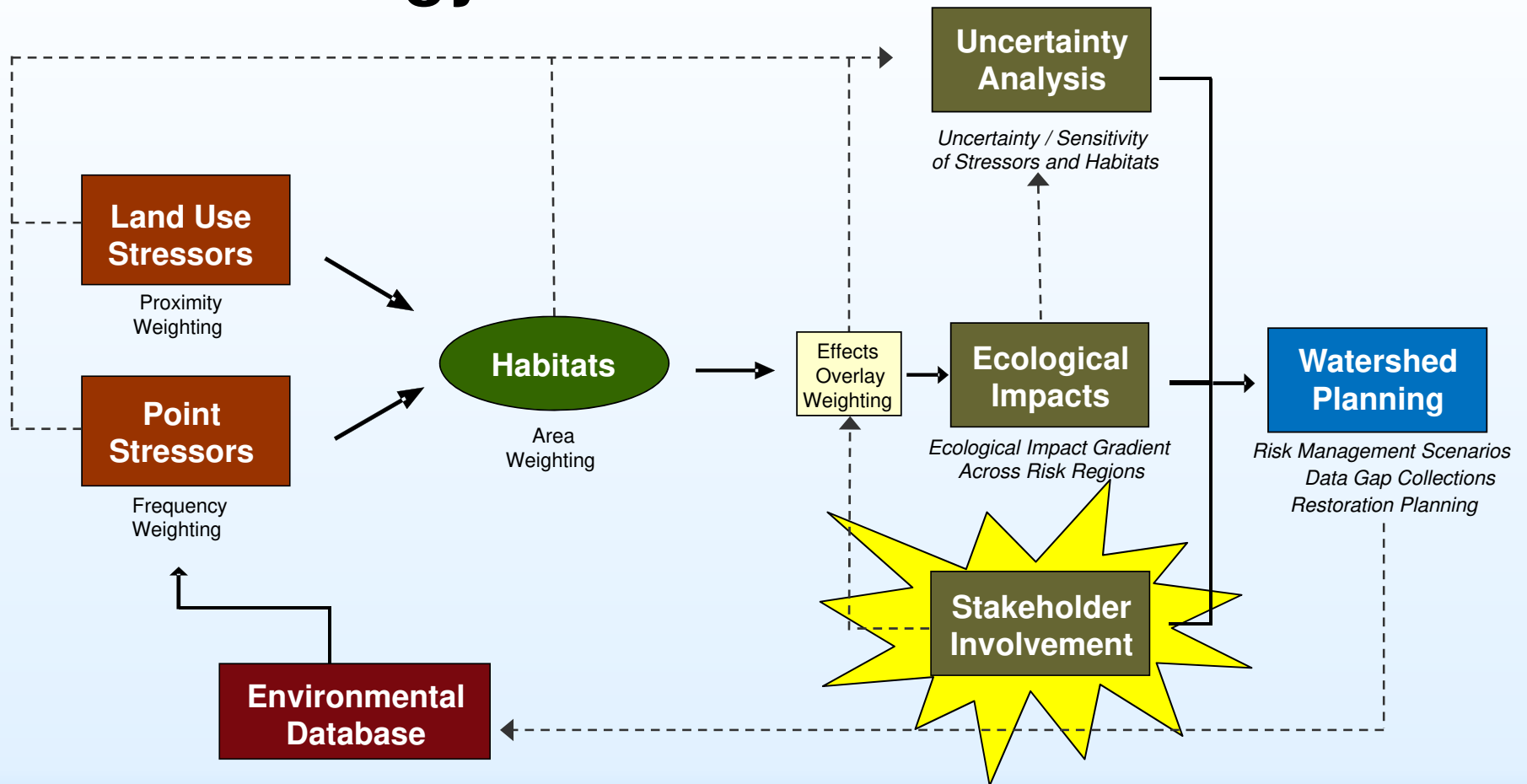 - Development of the watershed planning/assessment tool

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Traditional Relative Risk Model

Uncertainty Analysis

Uncertainty / Sensitivity of Stressors and Habitats

Stakeholder Management

Risk Management Scenarios, Data Gap Collections, and Restoration Activities

Stressors

Locations of Multiple Stressors Ranked; Associated Uncertainty

Exposure Filters

Habitats

Locations of Multiple Receptors Ranked; Associated Uncertainty

Effect Filters

Ecological Impacts

Locations of Multiple Responses Ranked

Notes:
Adapted from Landis and Wiegers (2005)

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South River RRM Assessment Methodology

Land Use Stressors
Proximity Weighting

Point Stressors
Frequency Weighting

Habitats
Area Weighting

Effects Overlay Weighting

Ecological Impacts
Ecological Impact Gradient Across Risk Regions

Uncertainty Analysis
Uncertainty / Sensitivity of Stressors and Habitats

Watershed Planning
Risk Management Scenarios
Data Gap Collections
Restoration Planning

Stakeholder Involvement

Environmental Database

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
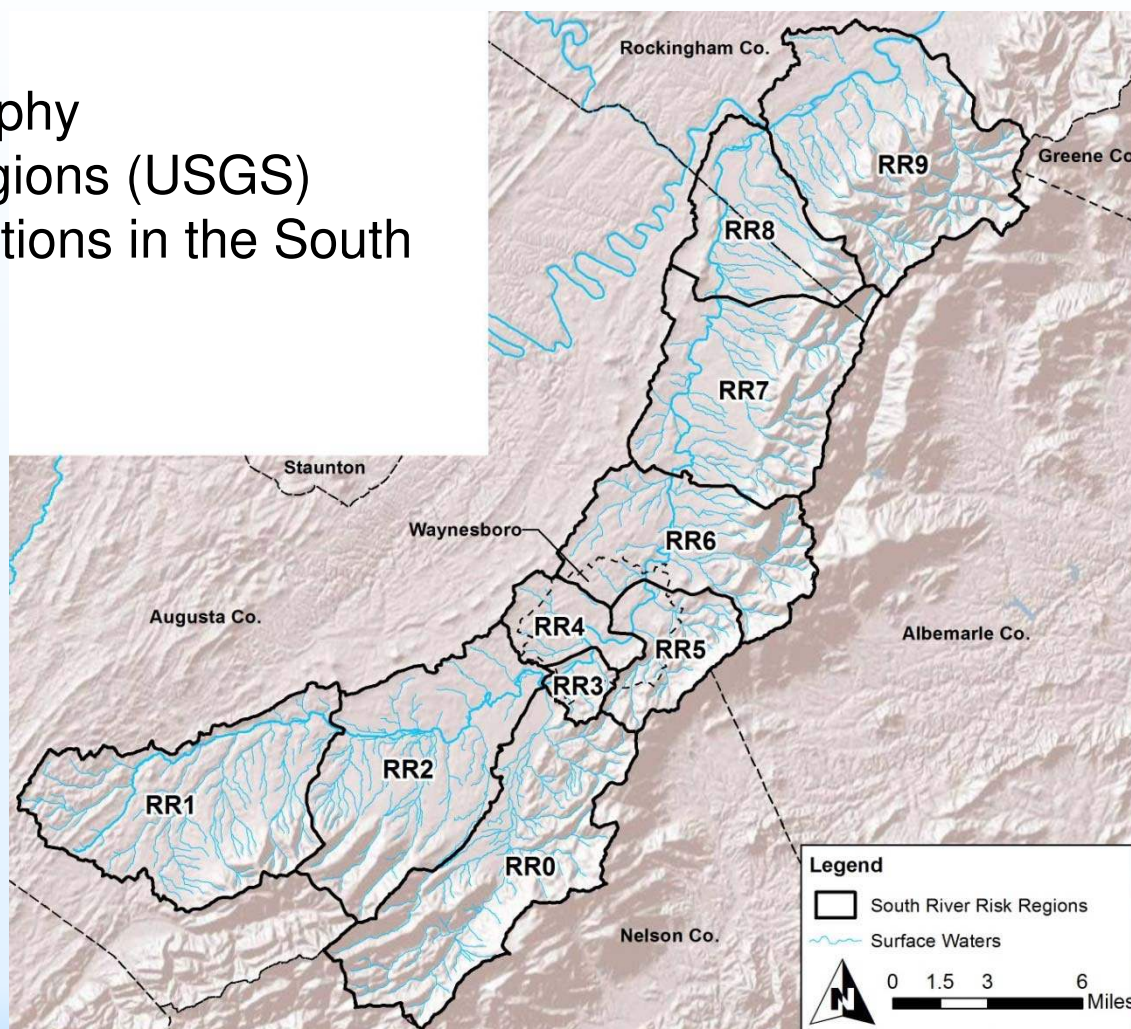
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Risk Regions

Delineated by:

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

Upper Risk Regions

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

Lower Risk Regions

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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

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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 (^{o}C)		
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 %
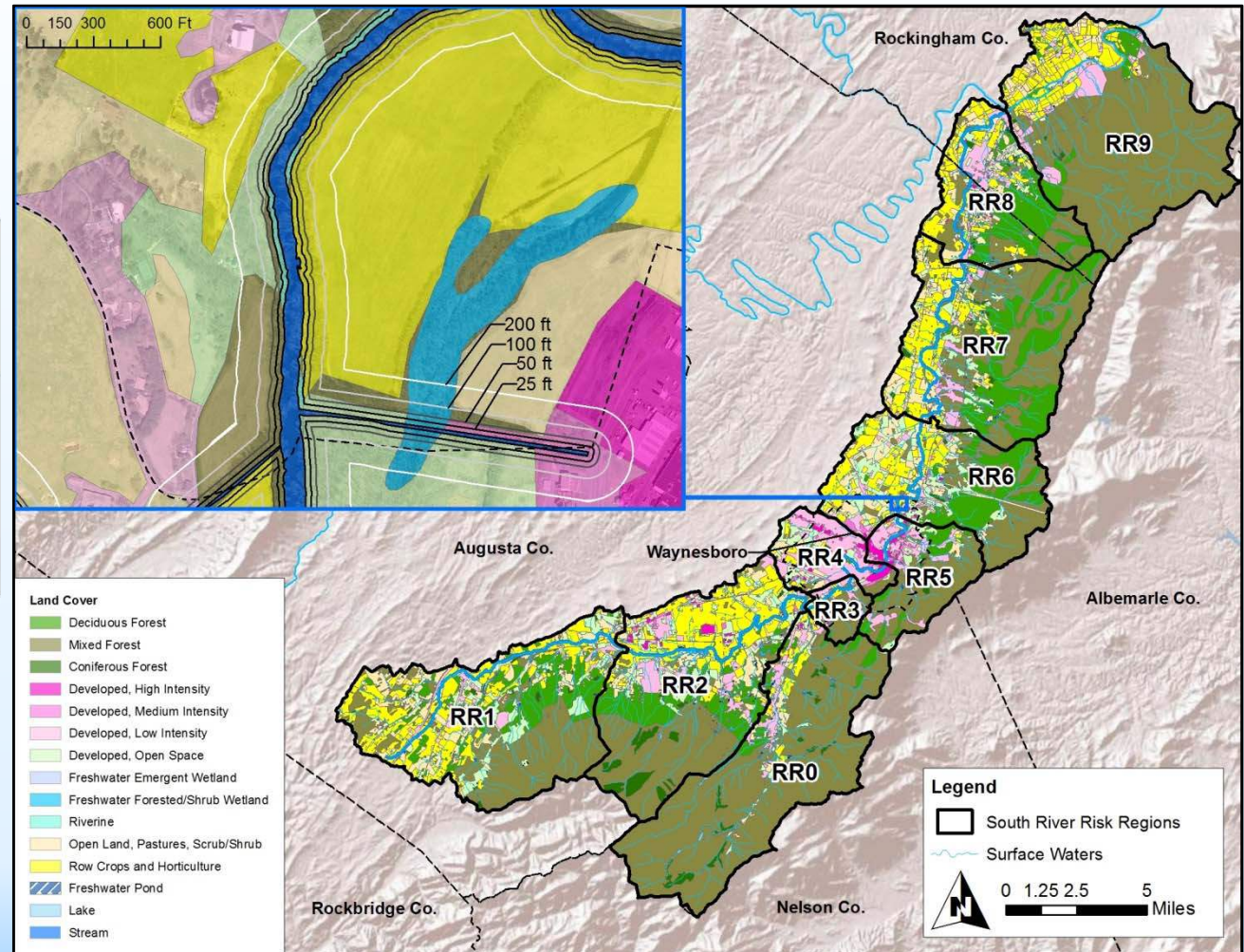
Smallmouth Bass – Habitat Overview

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	
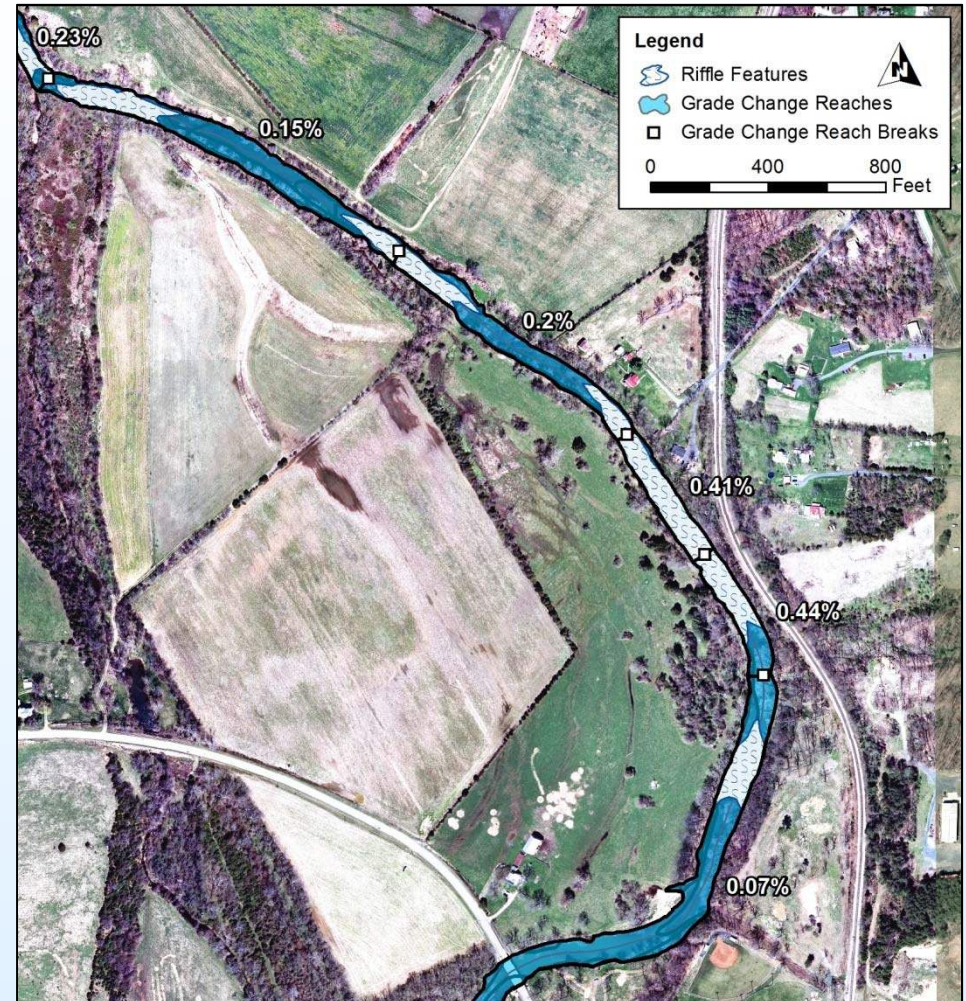
Smallmouth Bass – Preliminary Results

- Relative risk highest in Risk Regions 5 & 6

- Back Creek (RR0) and upper South River (RR1) have lowest risk
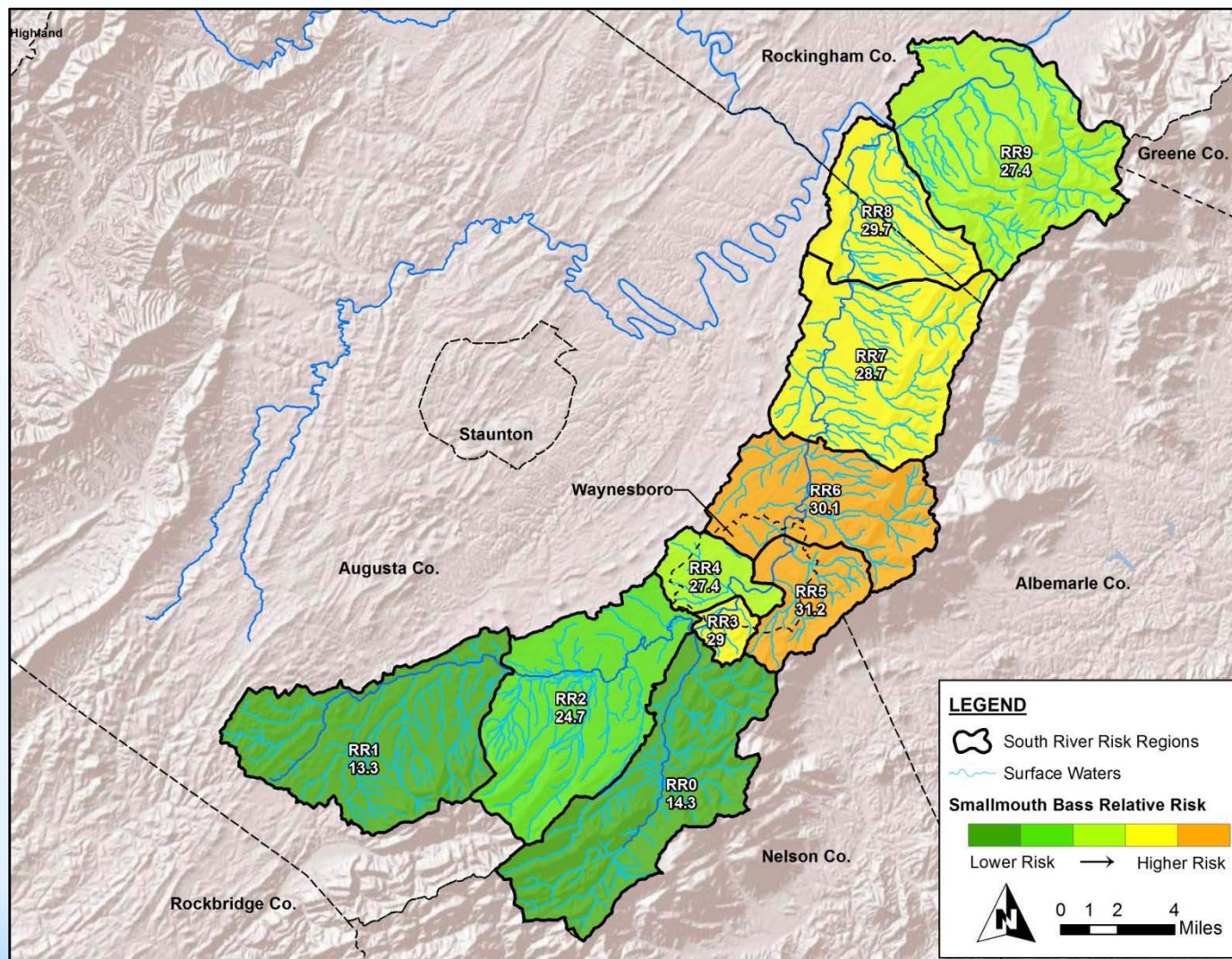
Smallmouth Bass – Risk Region 6 Results

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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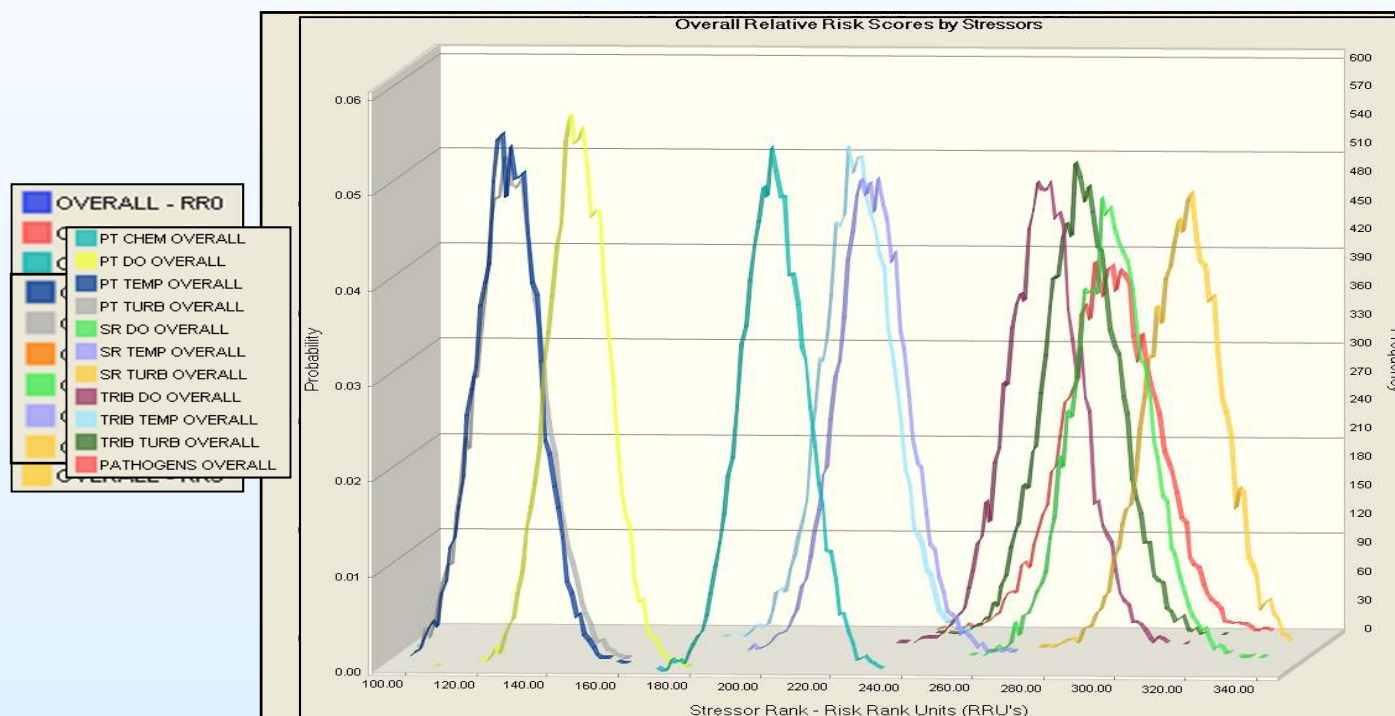
Future Direction…

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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