Development of an Environmental Degradation Index for Potential Hazardous Material Releases using Berkeley, Charleston, and Dorchester Counties, South Carolina

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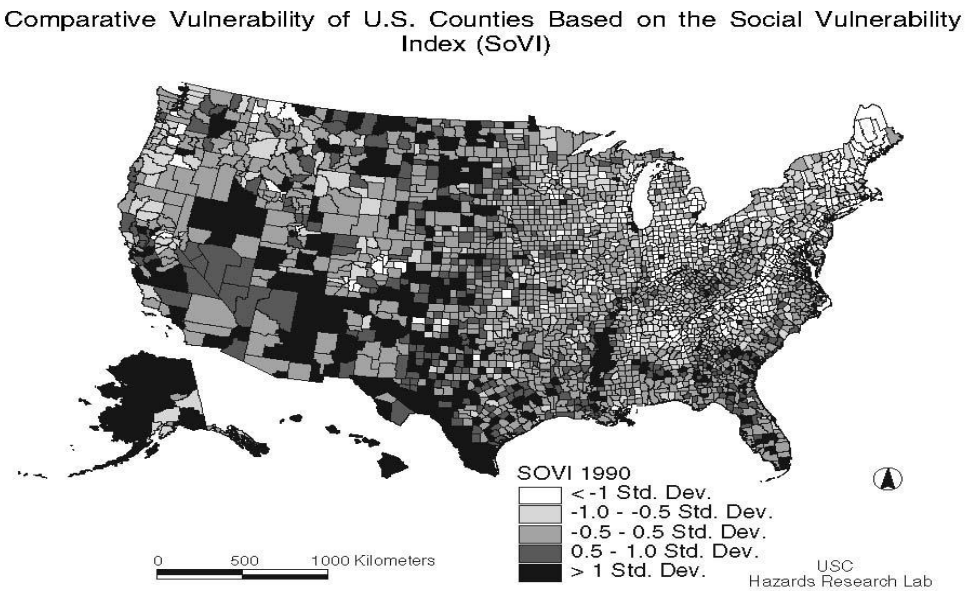
Introduction

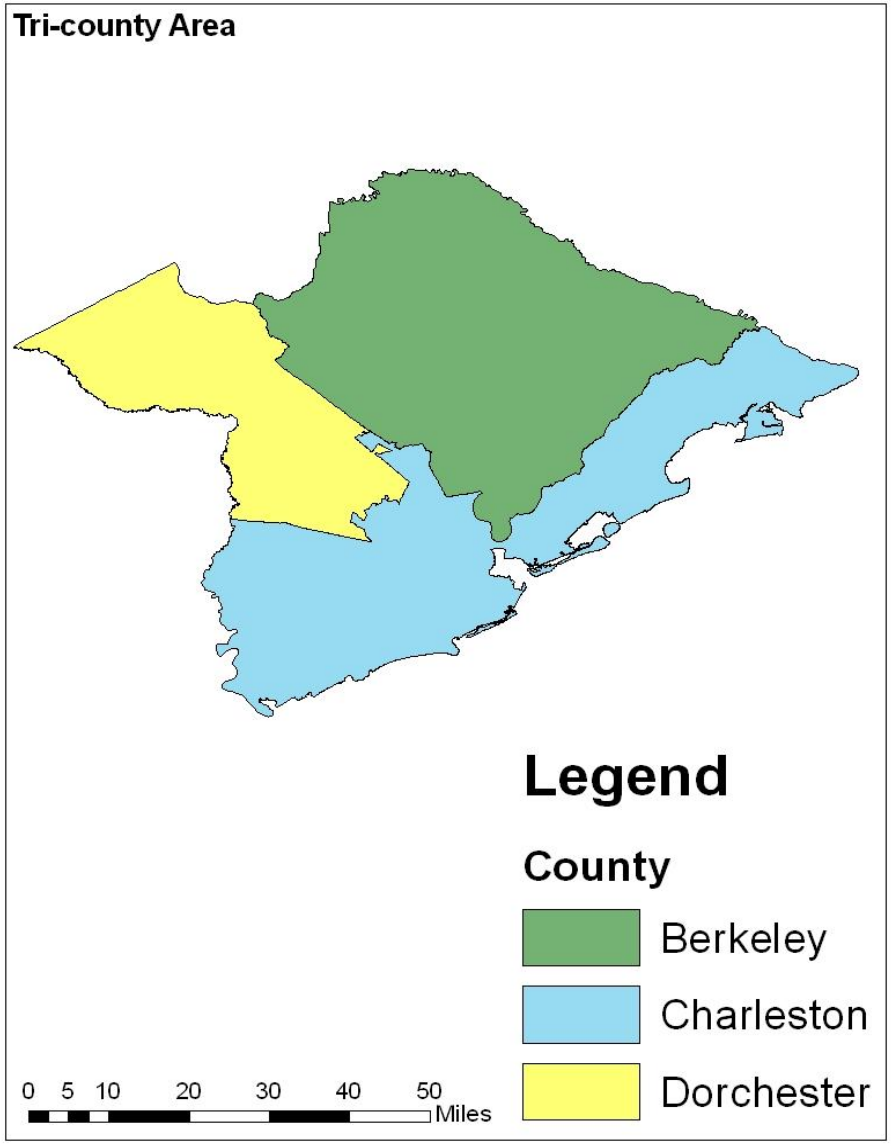
- Hazardous materials found throughout our developed infrastructure
- Natural hazards, accidents, and incidents can release these contaminants
- Need to know how contaminants will:
  - Disperse through environment
  - Affect environment
    - Humans and society
    - Natural environment and biota

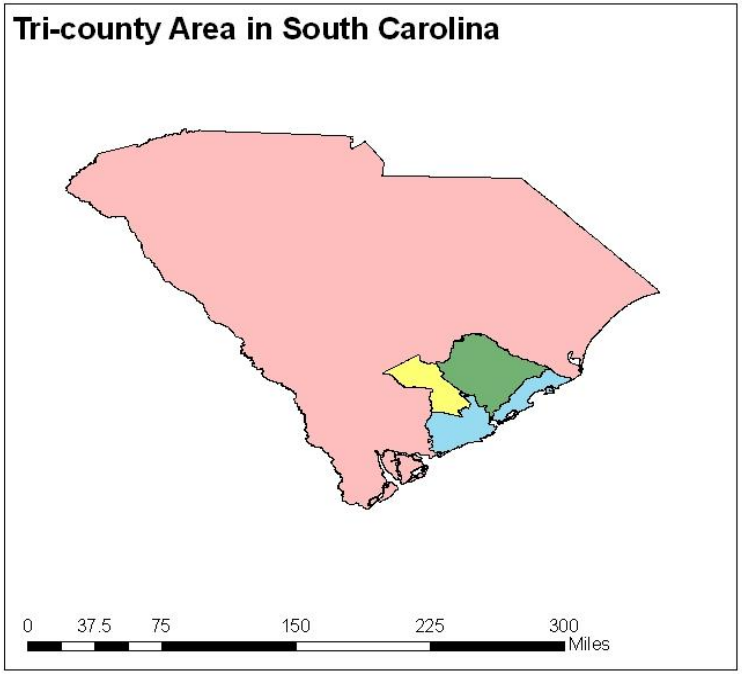
Significance

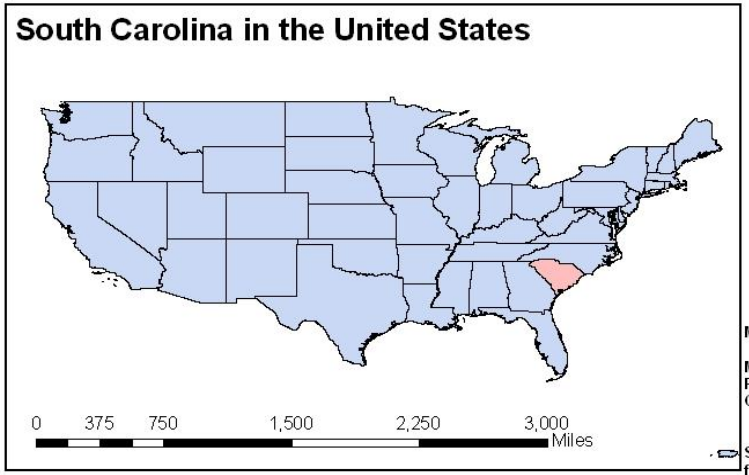
- All previous work of this type has been done AFTER a release has occurred
  - This study is taking a proactive approach to management of hazards
- No expert based index of environmental degradation
  - Human health
  - Society
    - Cutter 2003



Study Area







Map Information:

Map Units GCS
Projection NAD 1983
Created by: Kathleen Clancy
5 January 2011

State, and County data
from ESRI

Project Basics

- This project is built off of a BCD COG funded study
  - BCD COG study is designed to look at the potential impacts of hazardous material releases on human societies and infrastructures
- Base information and models that have been created for the BCD COG study are being adapted for this project

Objectives

- Can we quantify the potential effects of hazardous material releases on the natural environment?
- The answer involves 4 objectives:
  - Identification of hazardous materials within the study region
  - Modeling of hazardous material release impact footprints
  - Develop expert opinion based index of “chemo-environmental” risk due to hazardous material releases
  - Design first responder/land manager informational materials

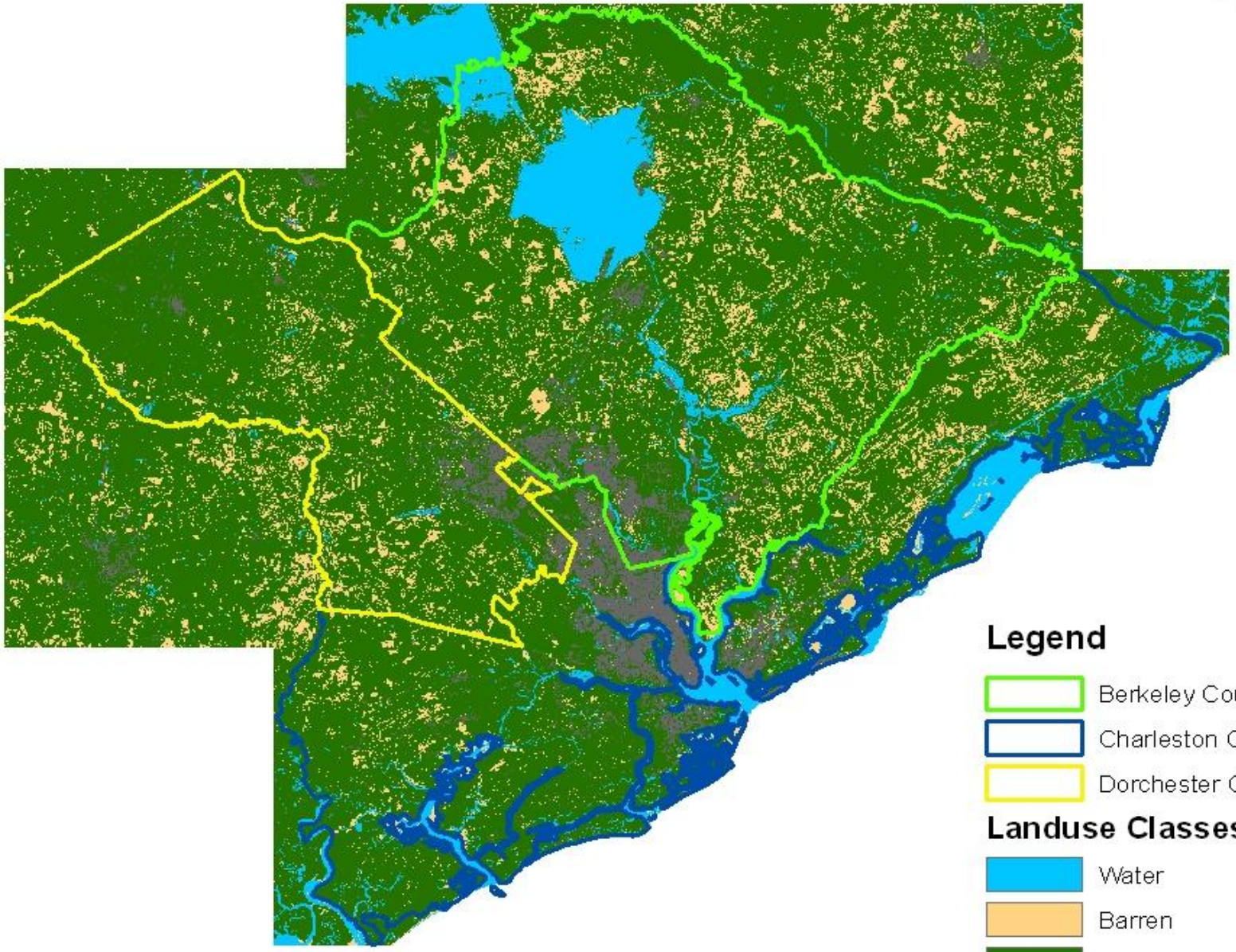
Hazmat ICER

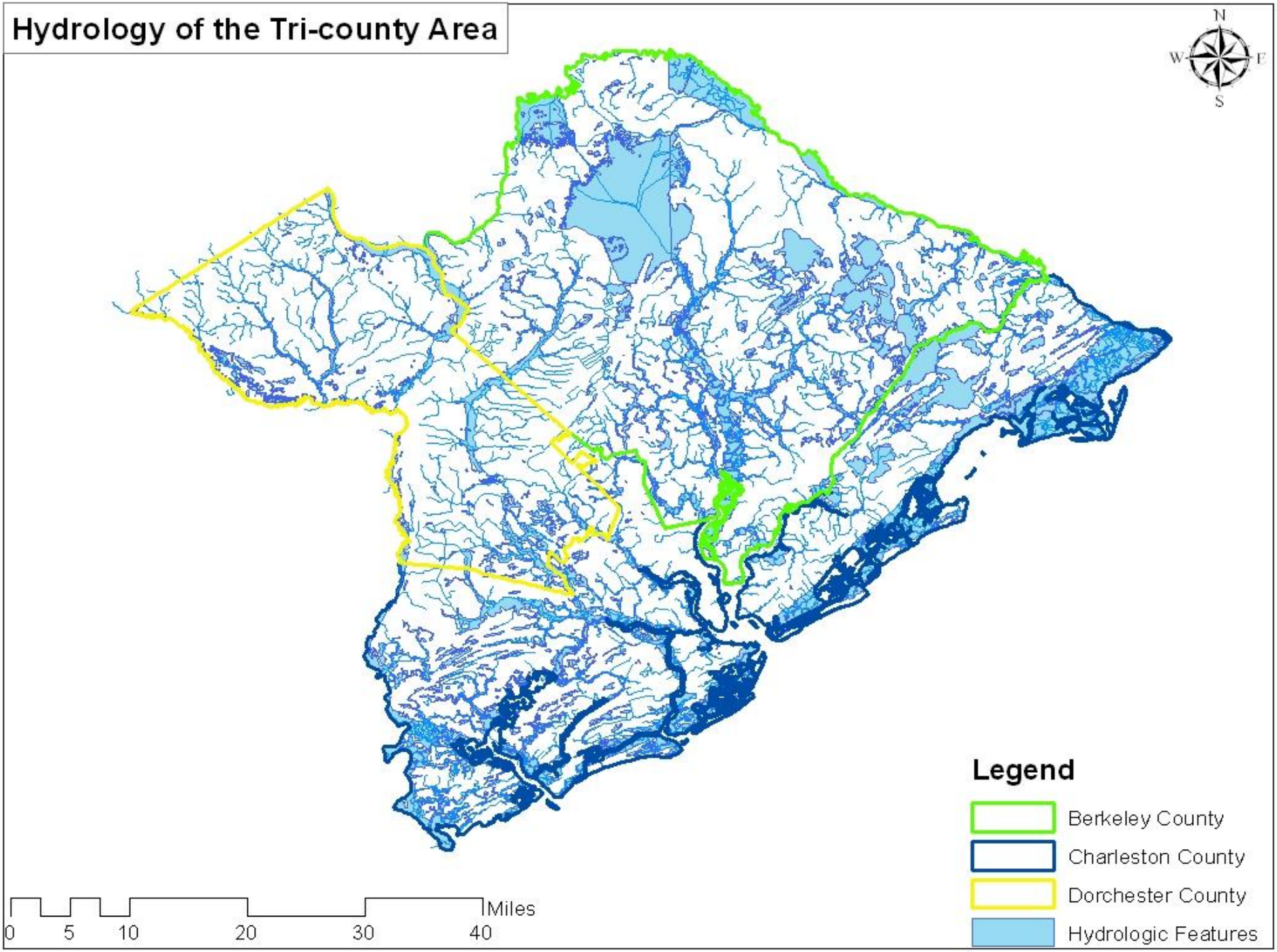
- Hazardous Materials Index of Chemo-Environmental Risk
  - Scaled Index: 1 = low to 5 = high
- Made up of multiple Risk Potentials (RPs)
  - Environmental
  - Hydrologic
  - Biotic
  - Conservation Lands
  - Chemical

Environmental RP

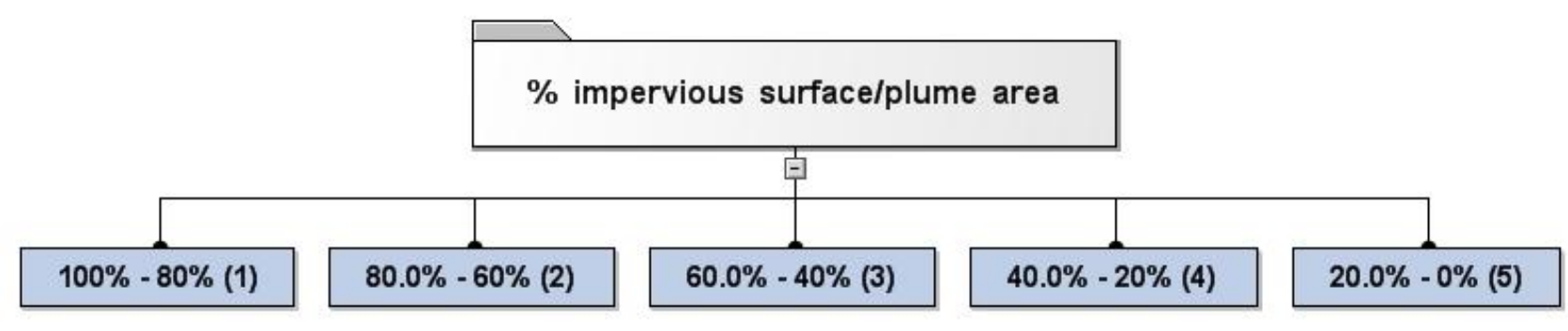
- Based on Urban vs. Non-Urban Area
- Urban
  - Impervious Surface
  - Population
- Non-Urban
  - Water
    - Lakes and Rivers/Streams
  - Vegetated
  - Barren

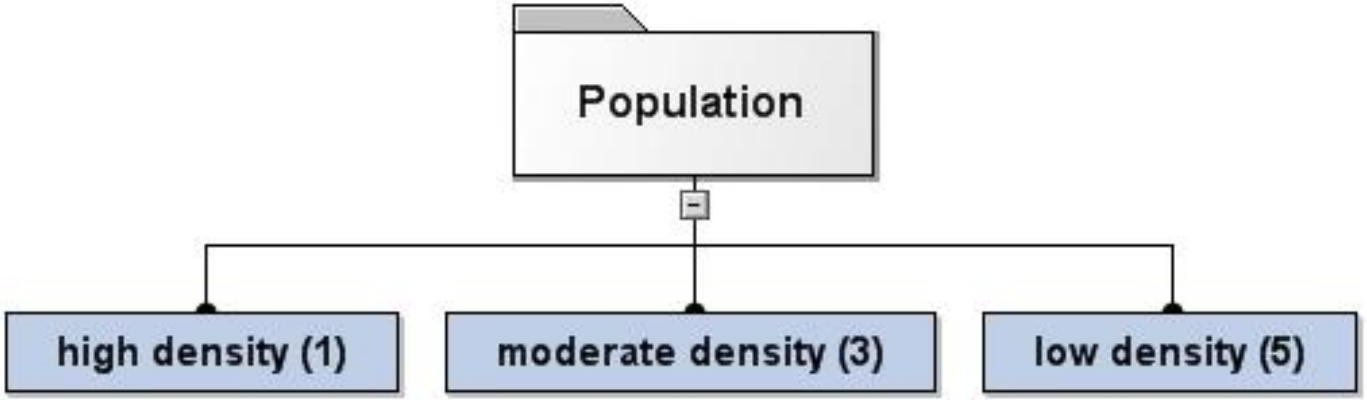
Landuse Classification of the Tri-county Area



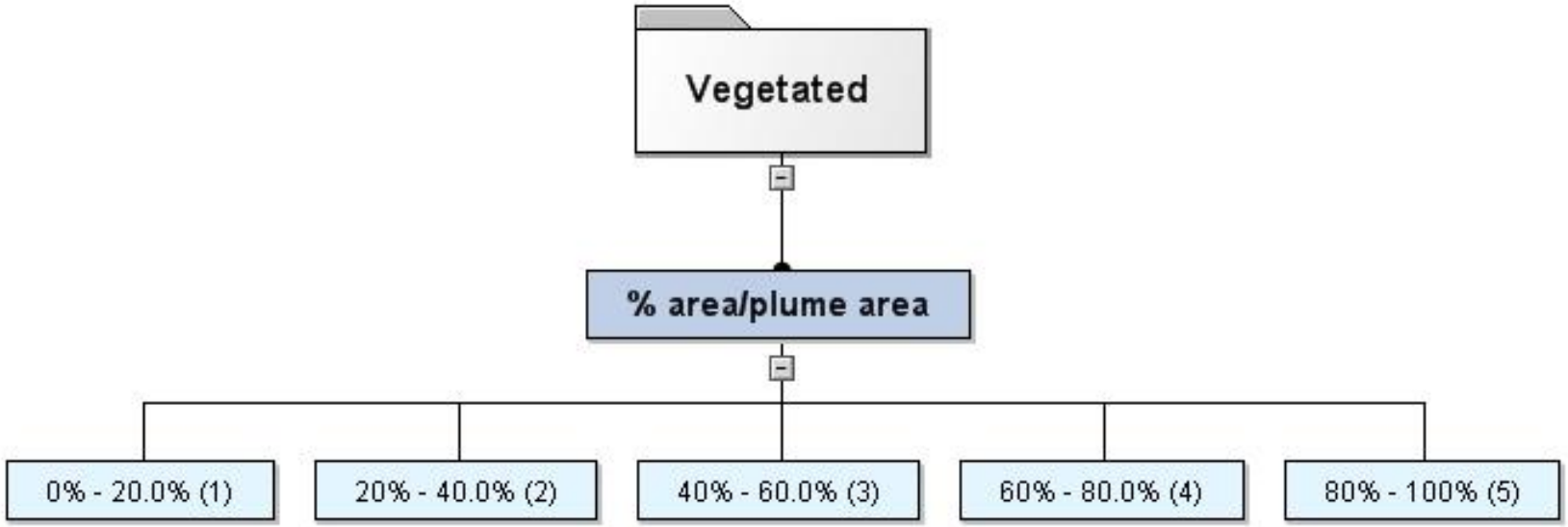

Hydrology of the Tri-county Area
N
W
E
S
Legend
Berkeley County
Charleston County
Dorchester County
Hydrologic Features
Miles
0
5
10
20
30
40

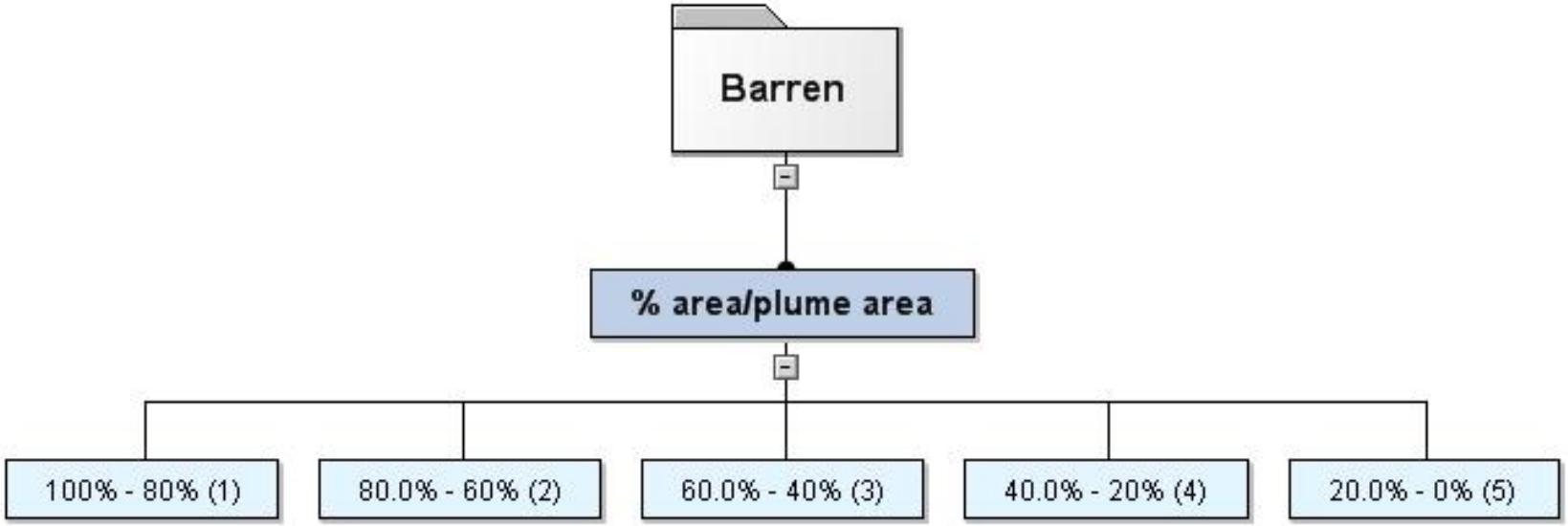
Environmental RP



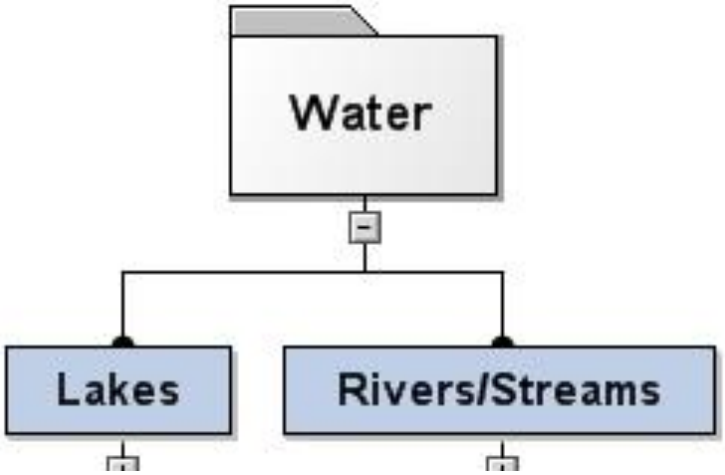


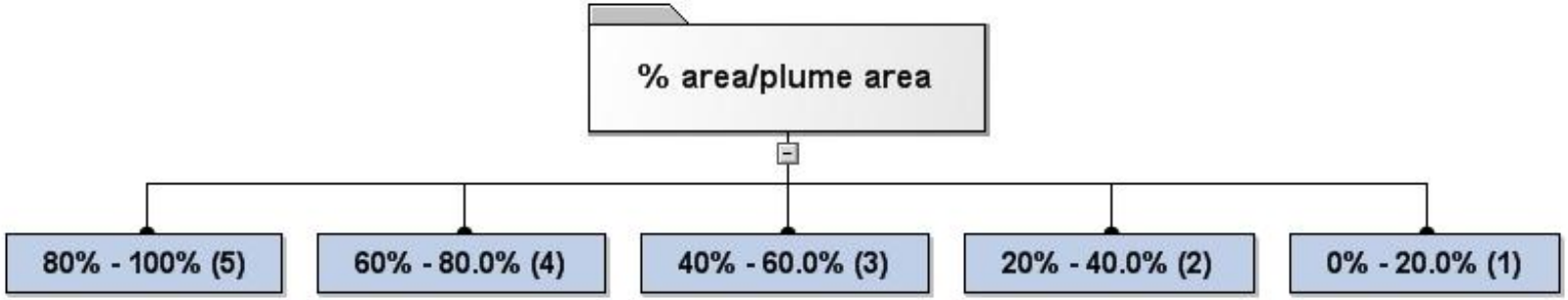
Environmental RP





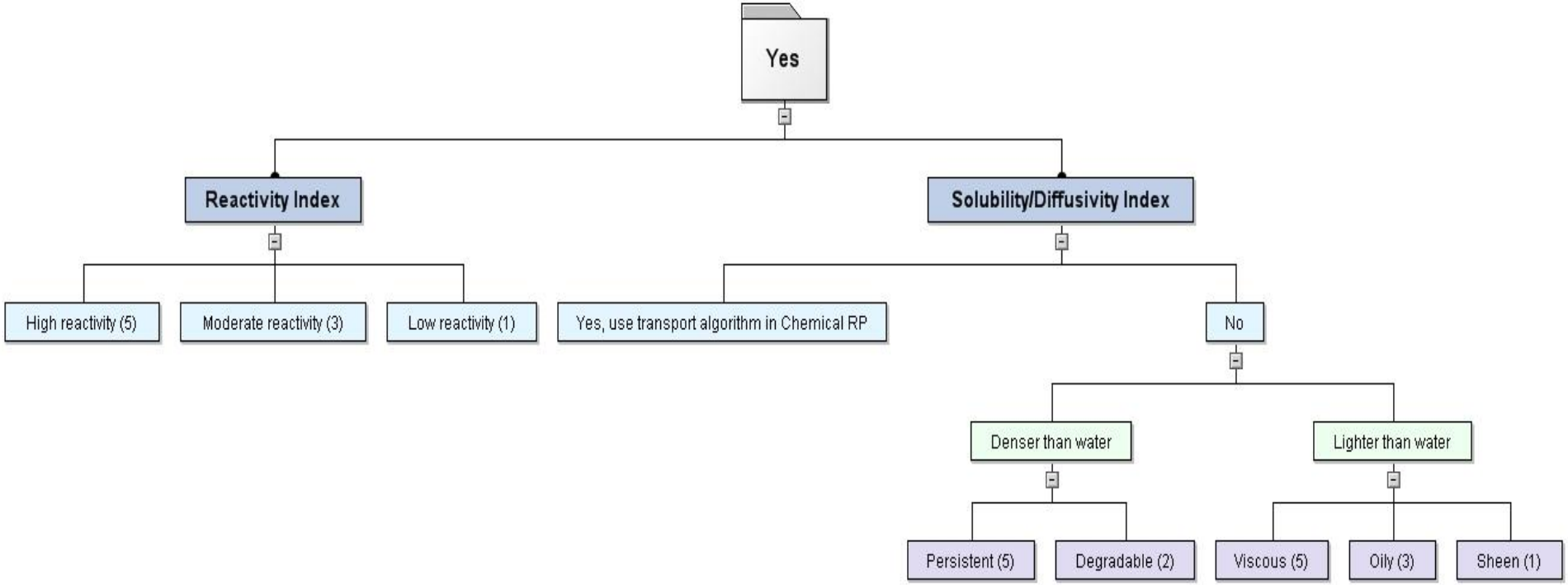
Environmental RP





Hydrologic RP

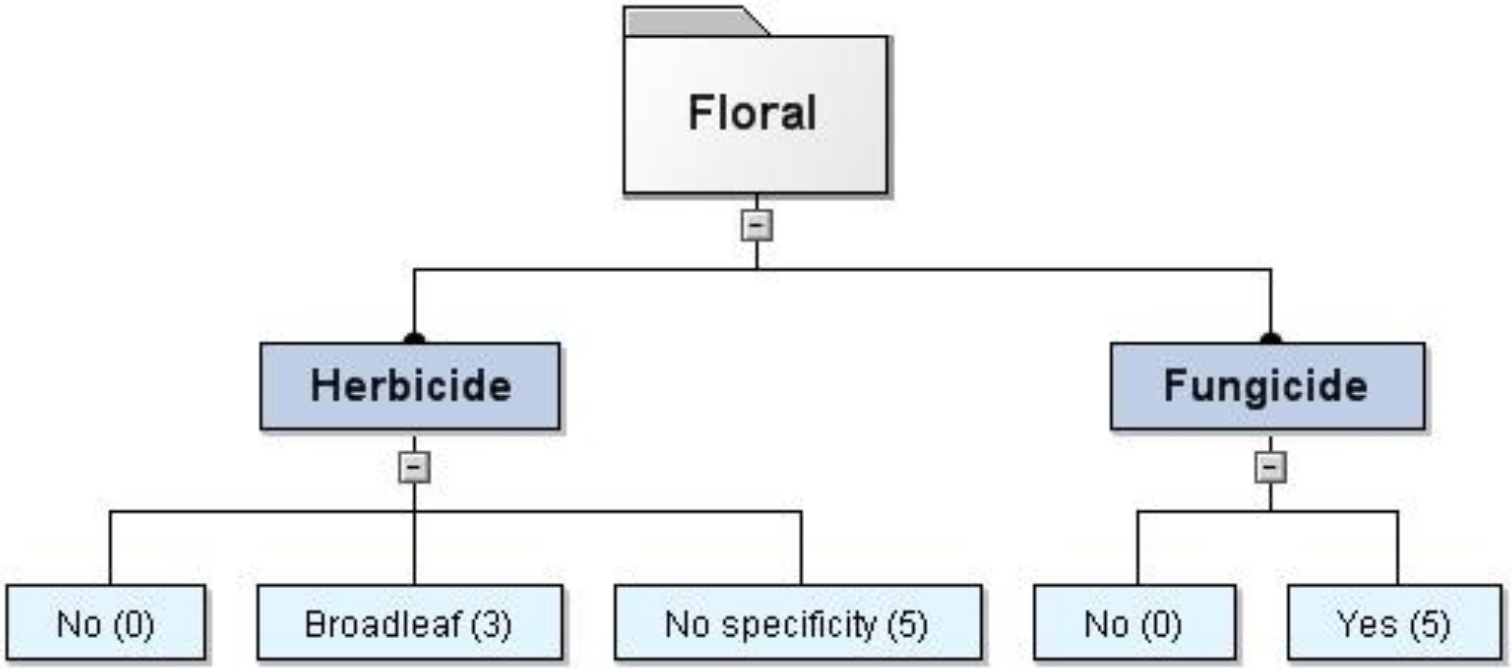
- Is the chemical reactive with or soluble in water?
  - No = 1



Biotic RP

- Floral and Faunal
- Floral
  - Herbicide
  - Fungicide
- Faunal
  - Health Effects
  - Species Richness
  - Threatened and Endangered
    - Do not have this data yet, but in process of acquisition

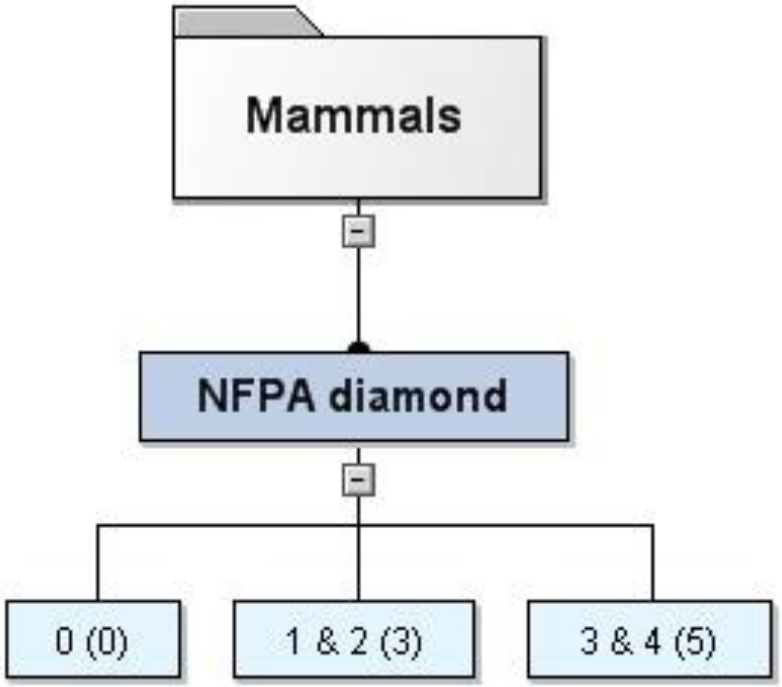
Biotic RP


Floral
Herbicide
Fungicide
No (0)
Broadleaf (3)
No specificity (5)
No (0)
Yes (5)

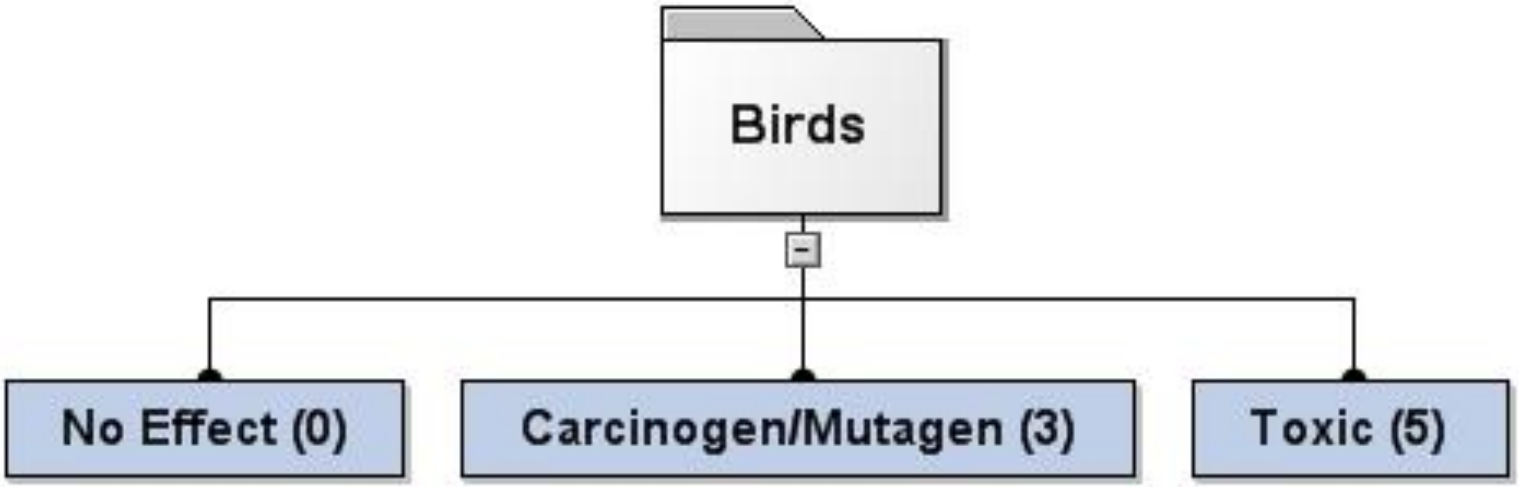
Biotic RP

- Health Effects for:
  - Mammals
  - Birds
  - Reptiles
  - Amphibians
  - Fish
  - Insects
- Broken down into categories of 0, 3, or 5

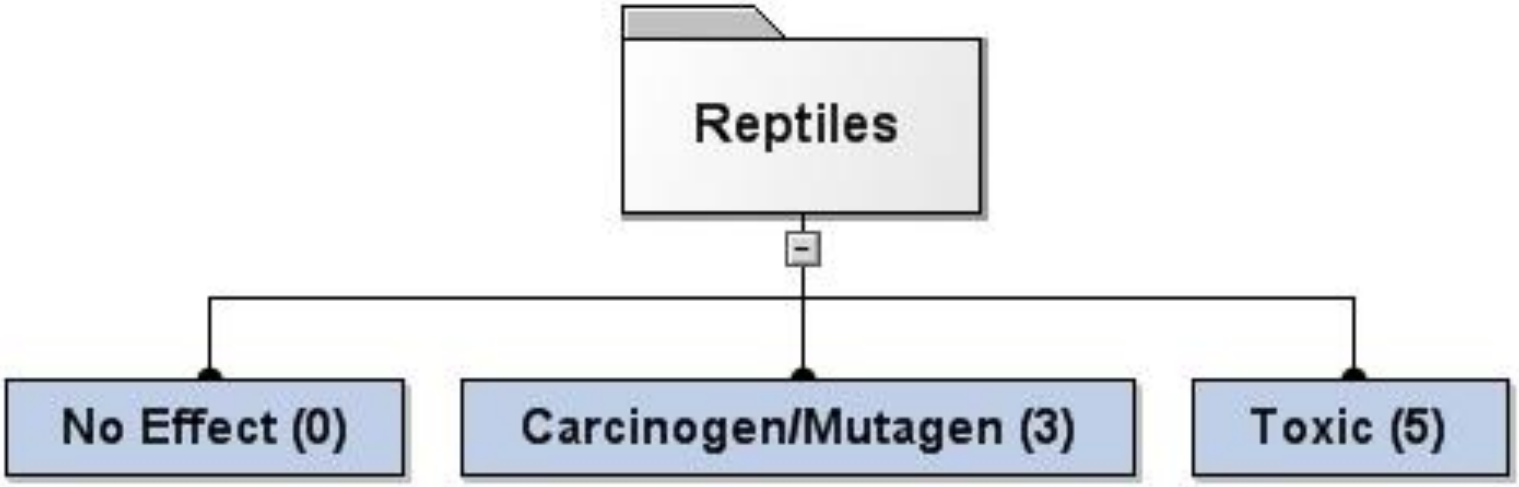
Biotic RP



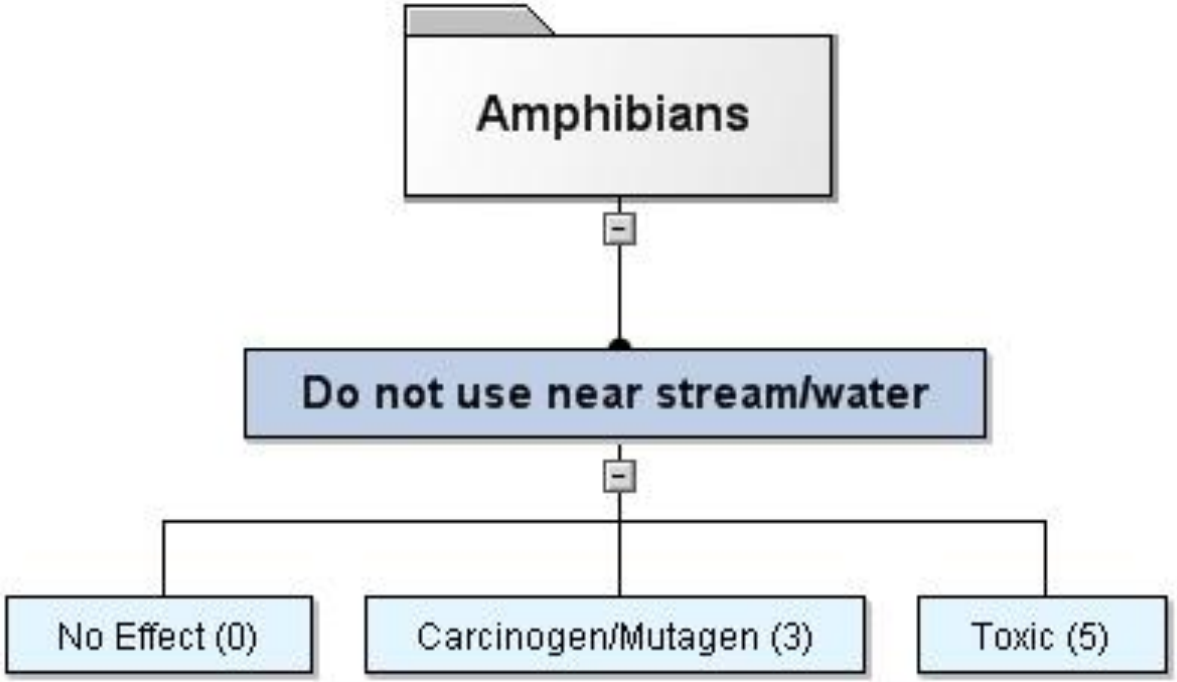
Biotic RP



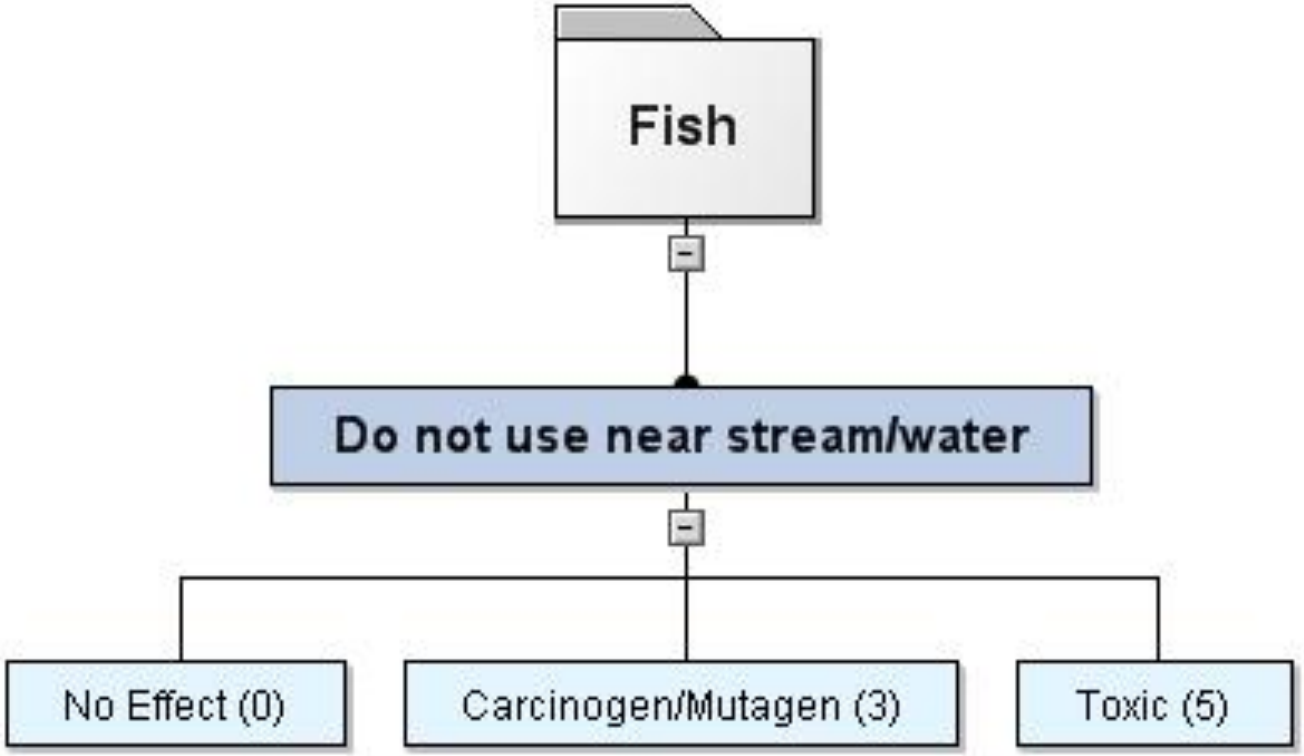
Biotic RP



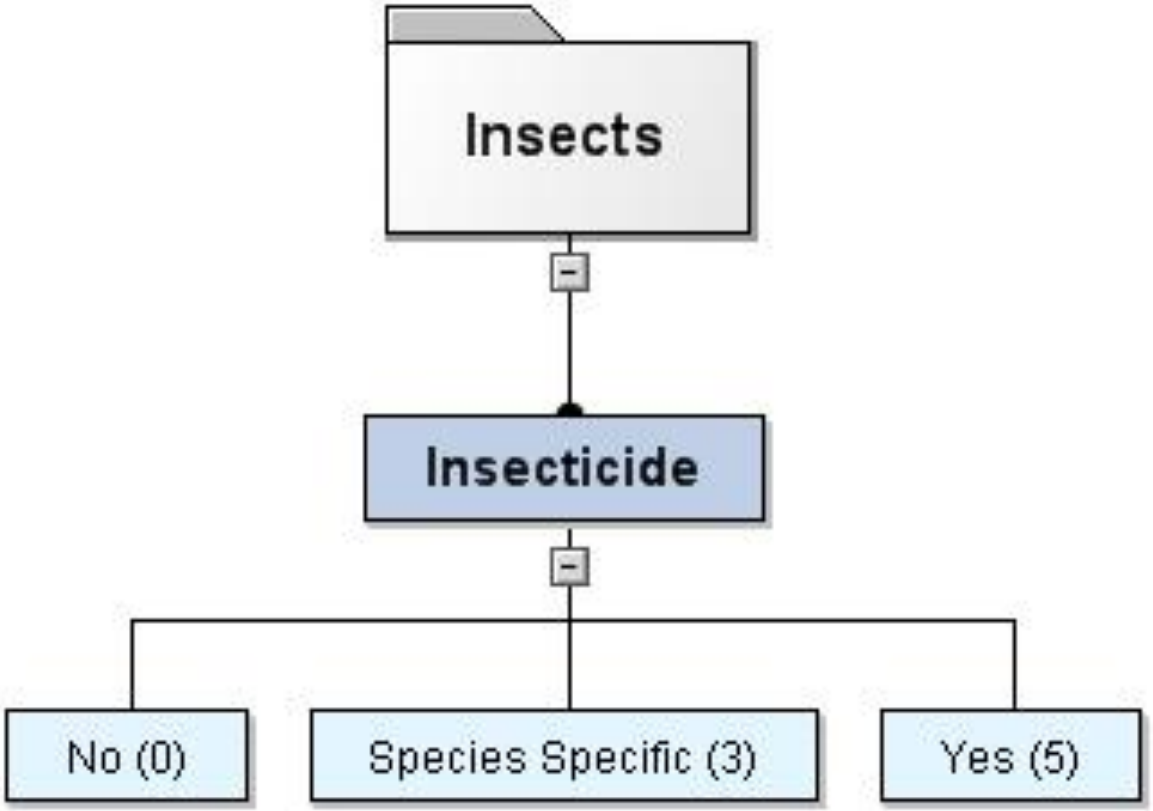
Biotic RP


Amphibians
Do not use near stream/water
No Effect (0)
Carcinogen/Mutagen (3)
Toxic (5)

Biotic RP

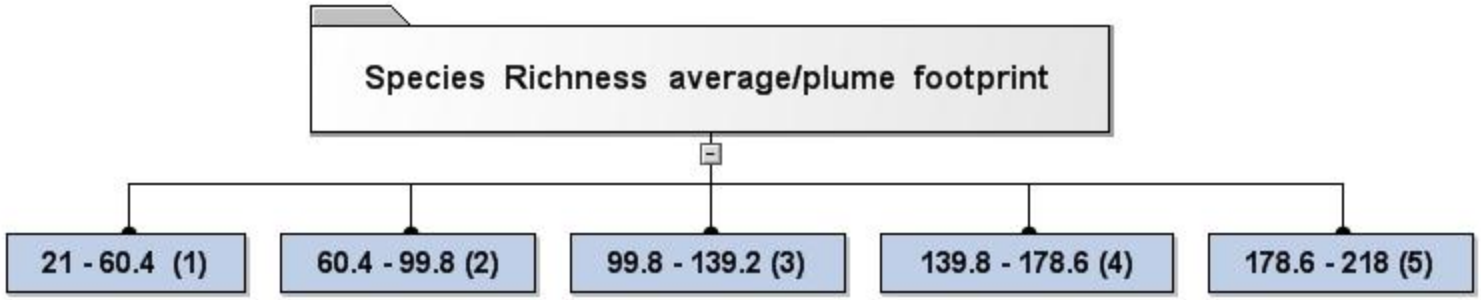

Fish
Do not use near stream/water
No Effect (0)
Carcinogen/Mutagen (3)
Toxic (5)

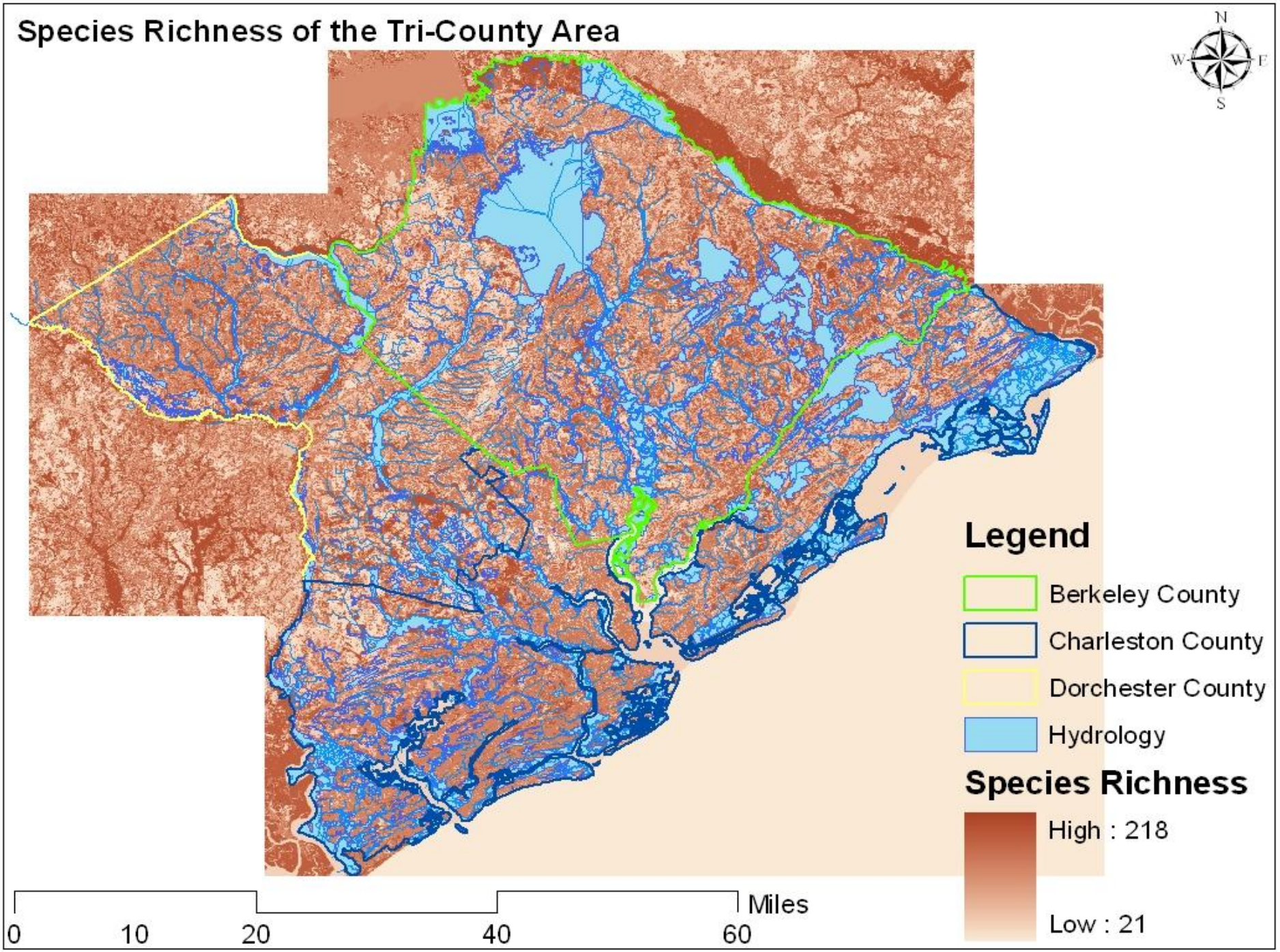
Biotic RP



Biotic RP

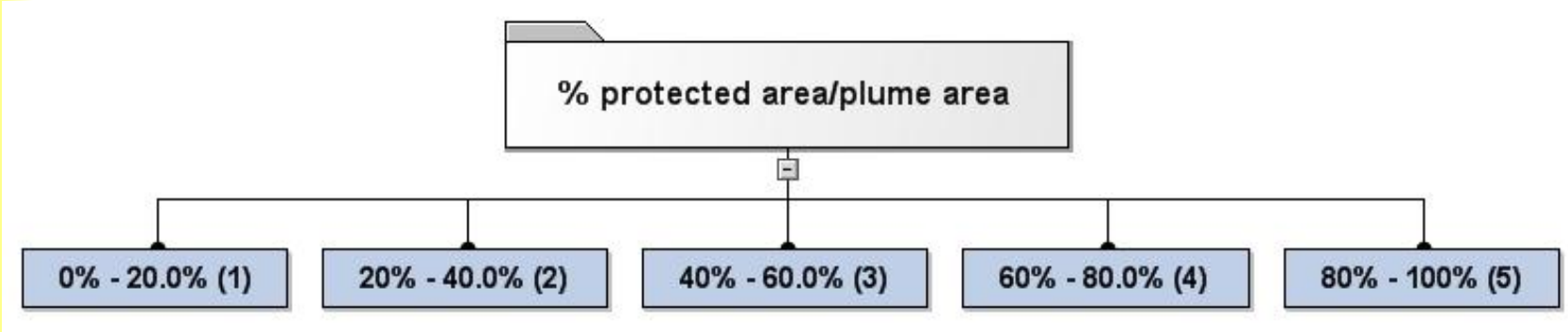
- Species Richness is the number of species in a given area
  - Collected as part of the SC GAP data, based on suitable habitat
  - Values range from 21 to 218 within the study area



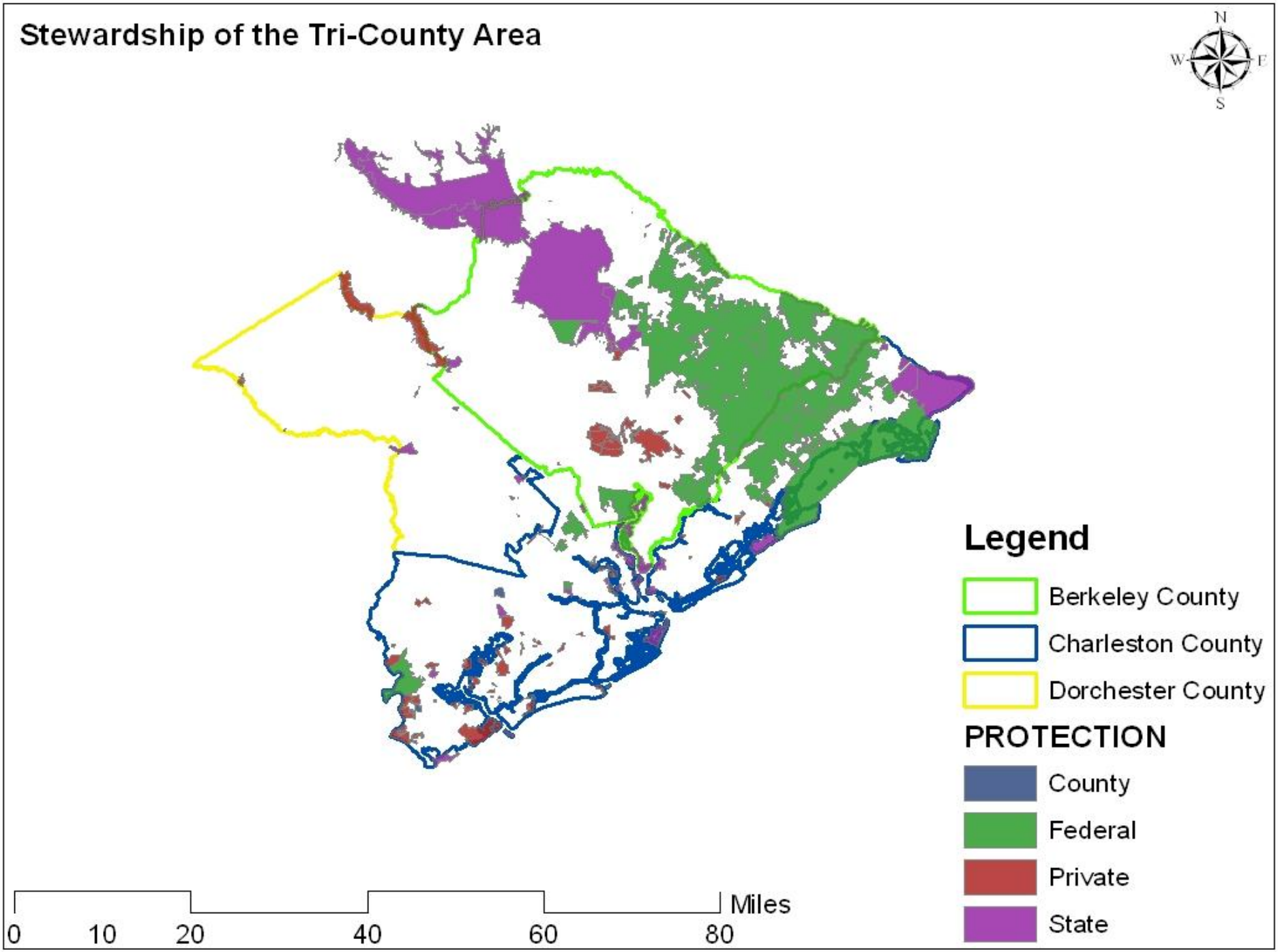

Species Richness of the Tri-County Area
N
W
E
S
Legend
Berkeley County
Charleston County
Dorchester County
Hydrology
Species Richness
High : 218
Low : 21
Miles
0
10
20
40
60

Conservation Lands RP

- Based on stewardship of the area



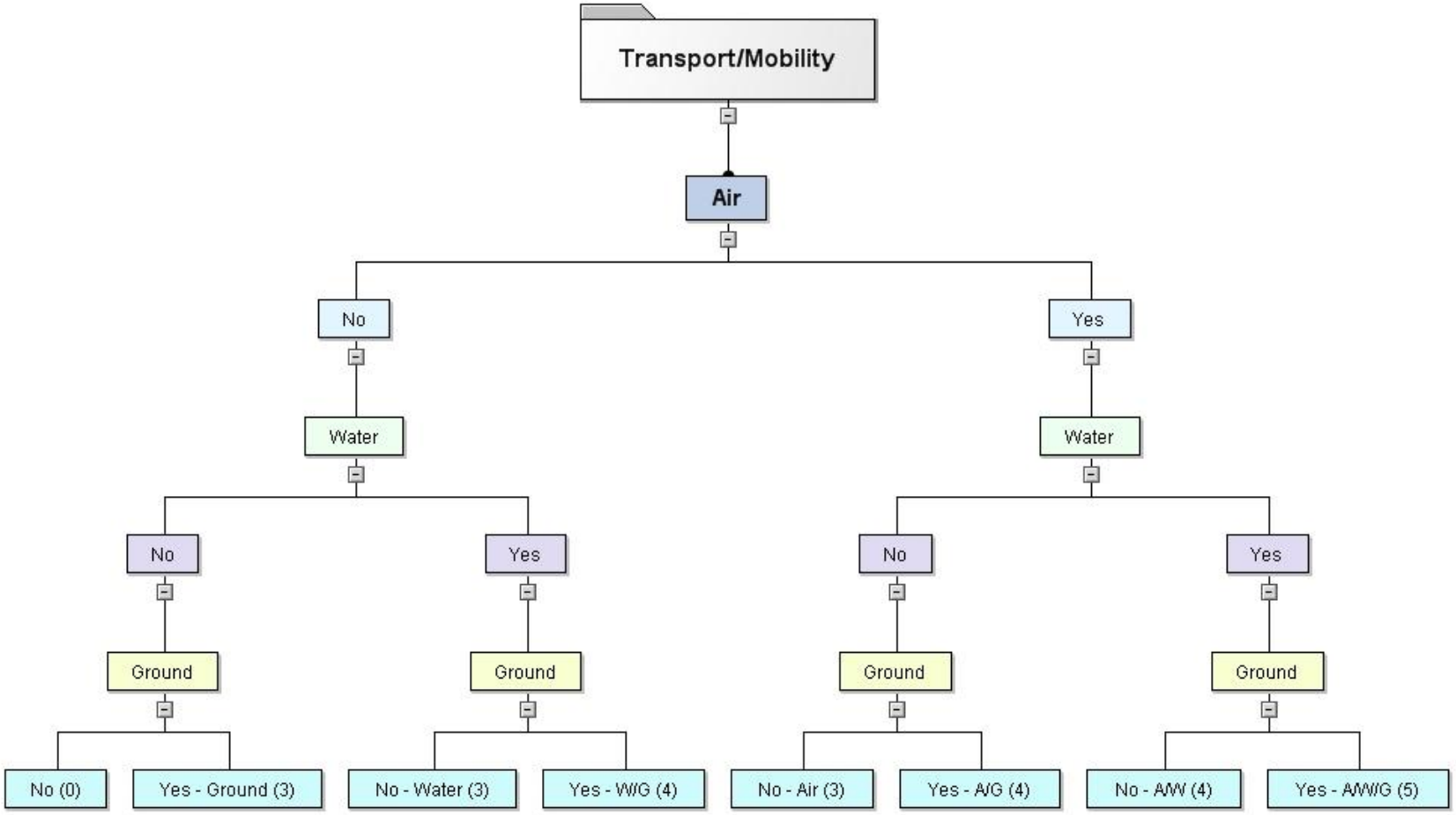
Stewardship of the Tri-County Area



Chemical RP

- **Transport/Mobility**
- Quantity of chemicals on site
- Number of chemicals on site
- NFPA Reactivity/Instability
- NFPA Flammability

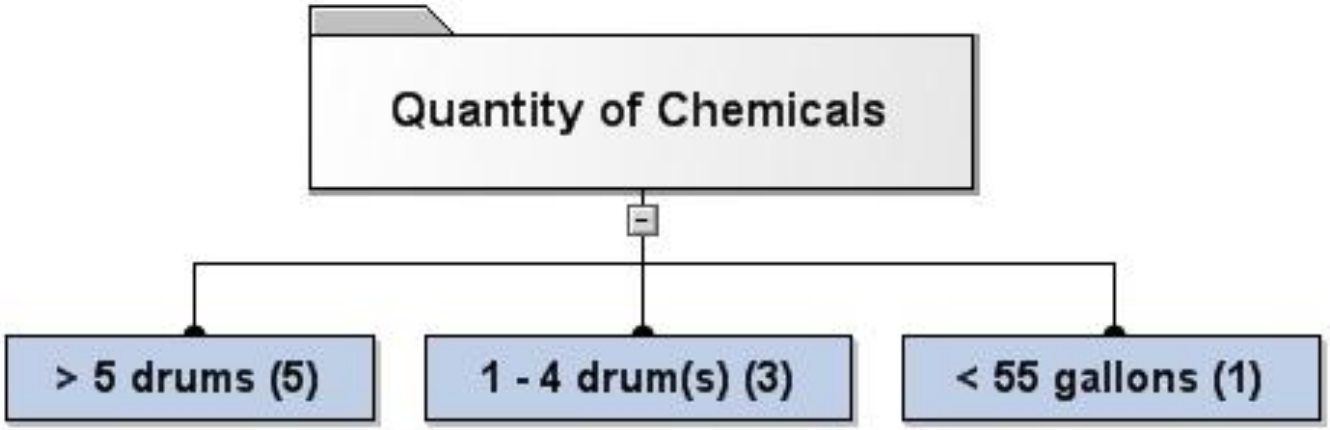
Chemical RP


Transport/Mobility
Air
No
Yes
Water
Water
No
Yes
No
Yes
Ground
Ground
Ground
Ground
No (0)
Yes - Ground (3)
No - Water (3)
Yes - W/G (4)
No - Air (3)
Yes - A/G (4)
No - A/W (4)
Yes - A/W/G (5)

Chemical RP

- Transport/Mobility
- **Quantity of chemicals on site**
- Number of chemicals on site
- NFPA Reactivity/Instability
- NFPA Flammability

Chemical RP

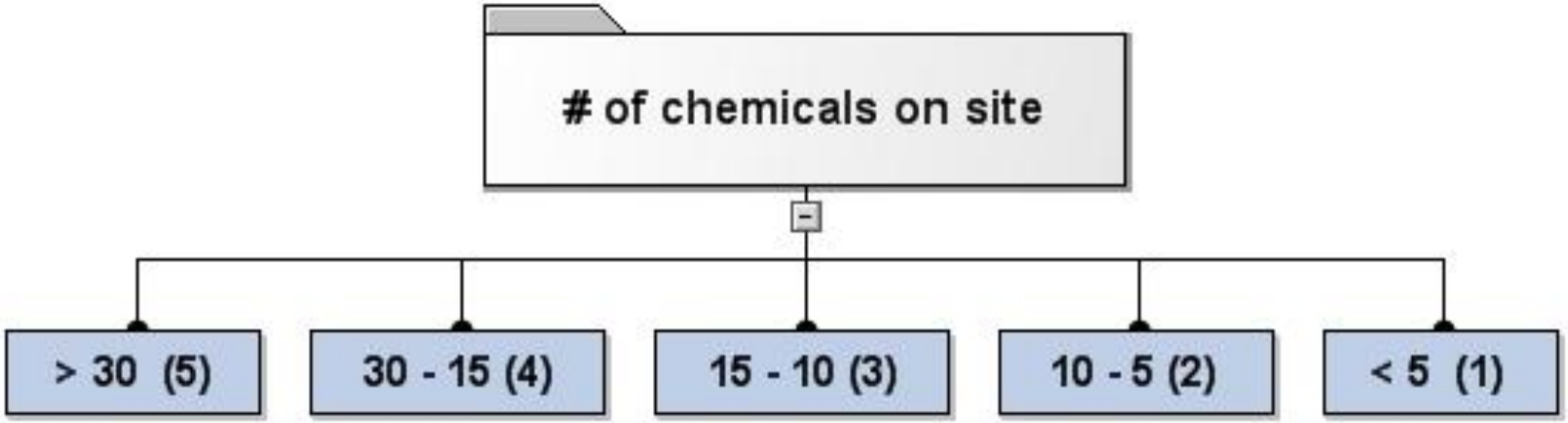


- Data that is currently unavailable
  - Determined through:
    - Permits
    - Uses

Chemical RP

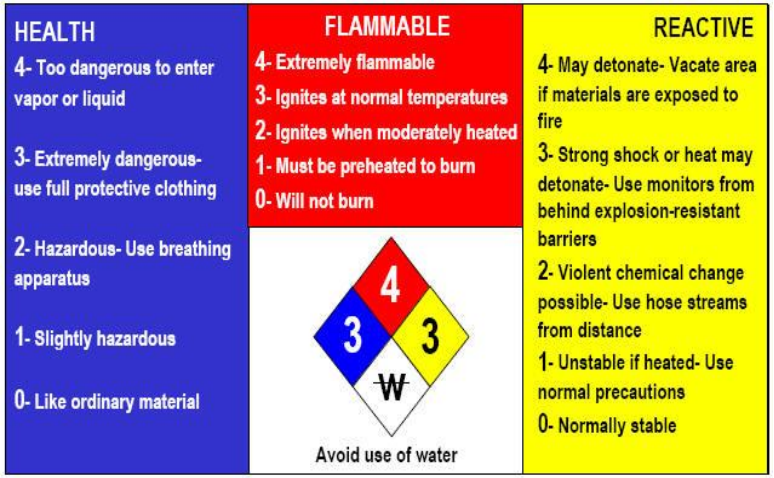
- Transport/Mobility
- Quantity of chemicals on site
- **Number of chemicals on site**
- NFPA Reactivity/Instability
- NFPA Flammability

Chemical RP



Chemical RP

- Transport/Mobility
- Quantity of chemicals on site
- Number of chemicals on site
- **NFPA Reactivity/Instability**
- **NFPA Flammability**
  - NFPA 0 = 0
  - NFPA 1 = 2
  - NFPA 2 = 3
  - NFPA 3 = 4
  - NFPA 4 = 5



Index Use

- Data sheets are being created for BCD COG for use by:
  - Land and resource managers
  - First responders
  - Remediators

- Hazmat ICER value and affected areas will be included on these data sheets

Example Use – BellSouth 91759

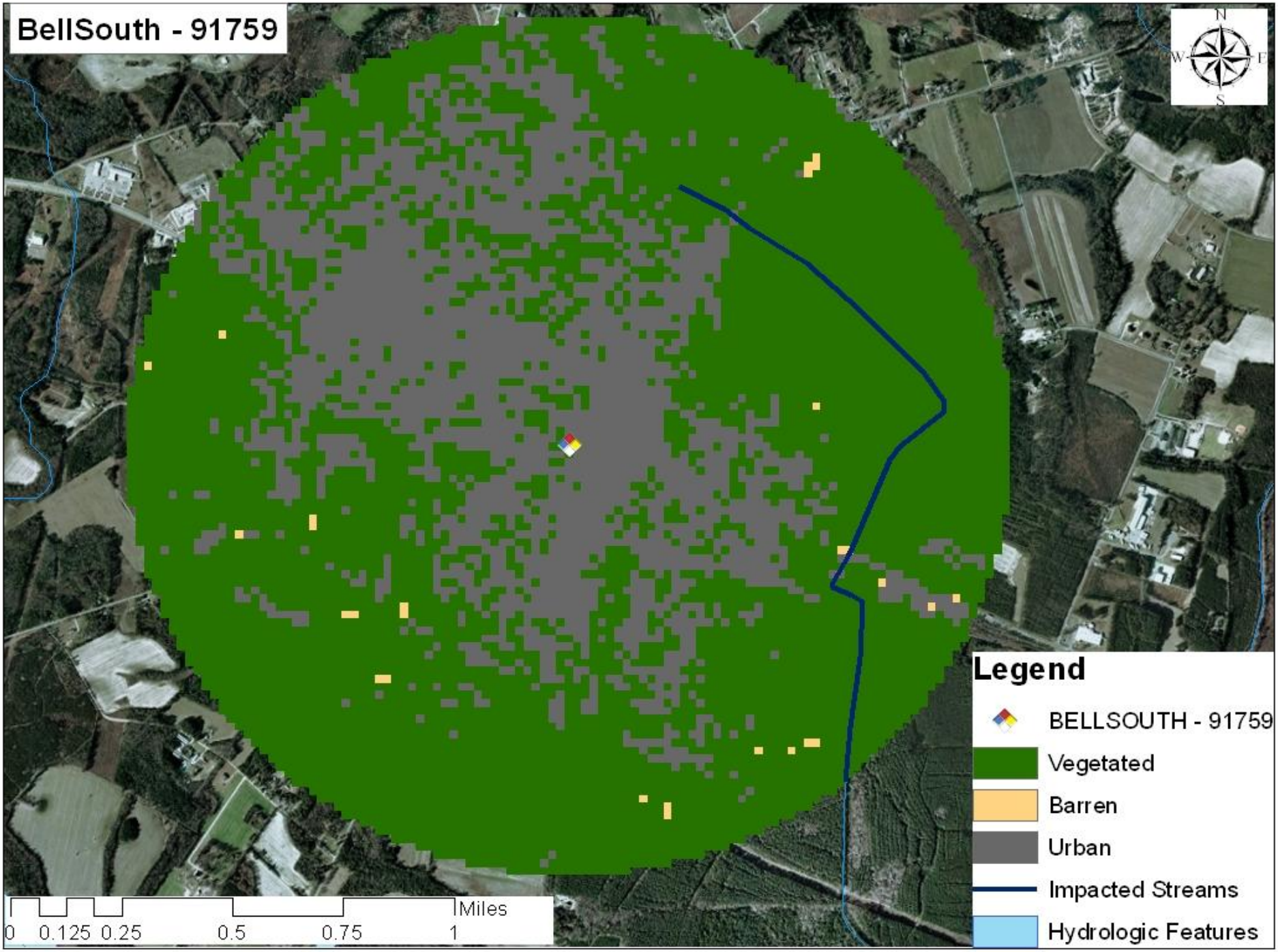
Incident Date:

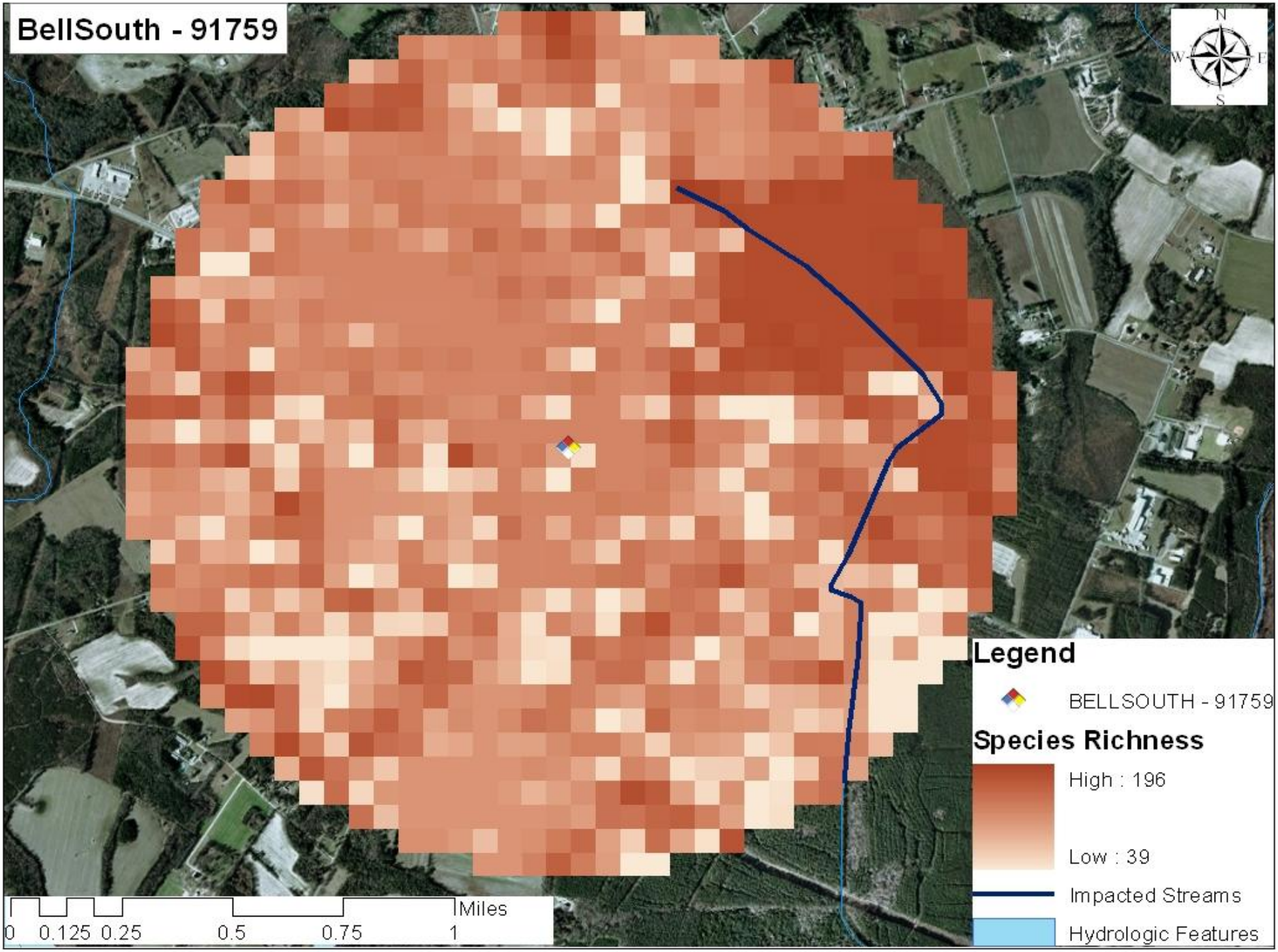
Responder:

Chemicals on Site	CAS #	Blue	Red	Yellow	White
LEAD	7439-92-1	1	0	0	
SULFURIC ACID	7664-93-9	3	0	2	Reactive with Water, Do Not Use Water

Notes:


BellSouth - 91759
N
W
E
S
Legend
BELLSOUTH - 91759
Mile Buffer
Impacted Streams
Hydrologic Features
Miles
0
0.125
0.25
0.5
0.75
1


BellSouth - 91759
N
W
E
S
Legend
BELLSOUTH - 91759
Vegetated
Barren
Urban
Impacted Streams
Hydrologic Features
Miles
0
0.125
0.25
0.5
0.75
1


BellSouth - 91759
N
W
E
S
Legend
BELLSOUTH - 91759
Species Richness
High : 196
Low : 39
Impacted Streams
Hydrologic Features
Miles
0
0.125
0.25
0.5
0.75
1

BellSouth - 91759

Chemical	Environ RP	Hydro RP	Biotic RP	Conserv Lands RP	Chemical RP	Chemical Index Value	Hazmat ICER Value
Lead	3	1	2	1	1	2	**2**
Sulfuric acid	3	5	5	1	2	3	

- This example done with equal averaging of the various factors
  - Within RPs
  - To get Hazmat ICER Value

Index Improvements

- Rankings/weightings will be assigned through consultation with experts in academia, industry, and government.
- Missing data
  - Chemical quantities
  - Threatened and Endangered Species
- Creation of tool within ArcGIS to automate index process

Methodology - Validation

- Index will be validated:
  - Past, well described spills where environmental impact studies were performed after the event will be used
  - Information on the contaminants involved and area of release will be input into the rubrics and the index determined for comparison to actual environmental impacts
- Once validated, the index can be used nationally in different areas other than the tri-county area

Project Outcomes

- Nationally transferable index and tool
- Creation of effective communication materials for first responders, land managers, other users
  - Data sheets
  - Numerical scale of potential environmental degradation

Acknowledgements

Thesis Advisor:

Dr. Norm Levine

Thesis Committee:

Dr. Eric Anderson

Dr. Andrew Felts

Dr. Vijay Vulava

Charlie Kaufman

Funding: SCEMD Grant

https://sites.google.com/site/kclancythesis/

Questions?