Modeling Flow-Ecology Changes in South Carolina and Across the Region

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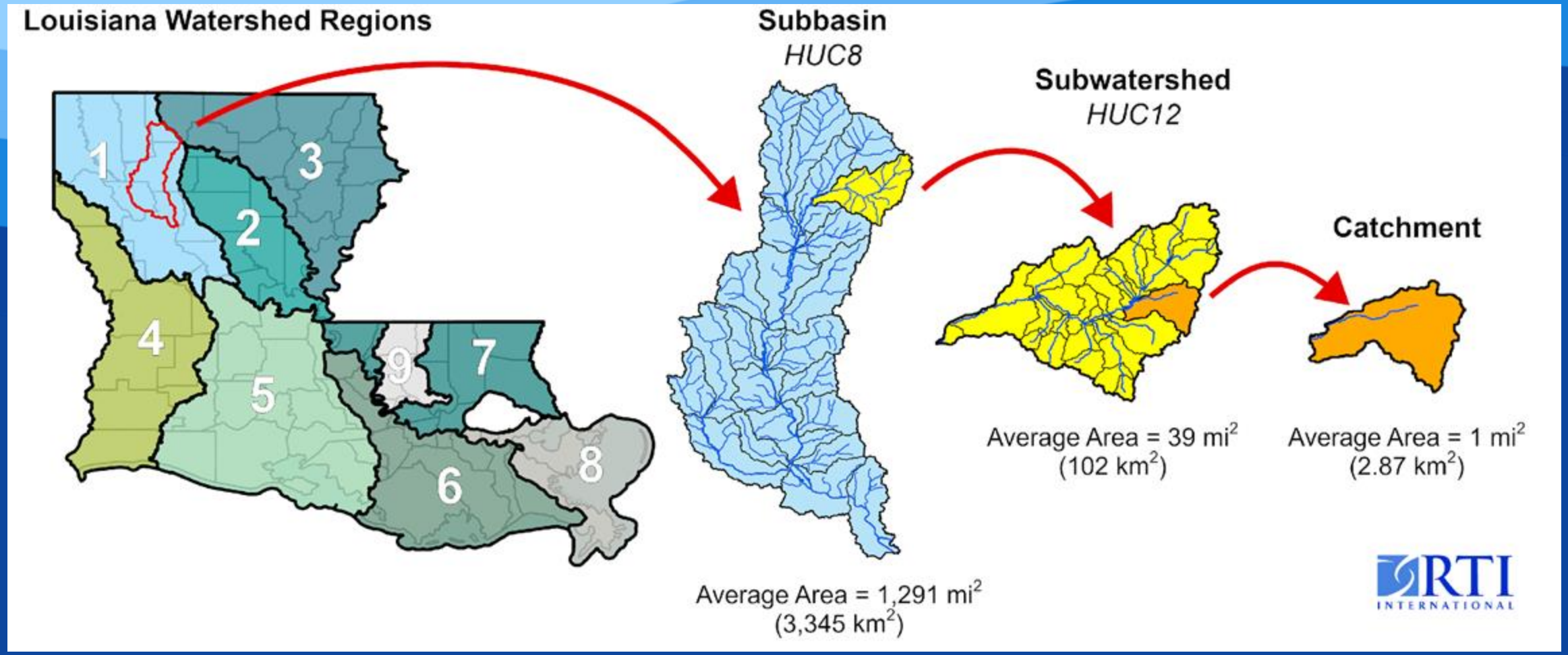
Scale of Assessment

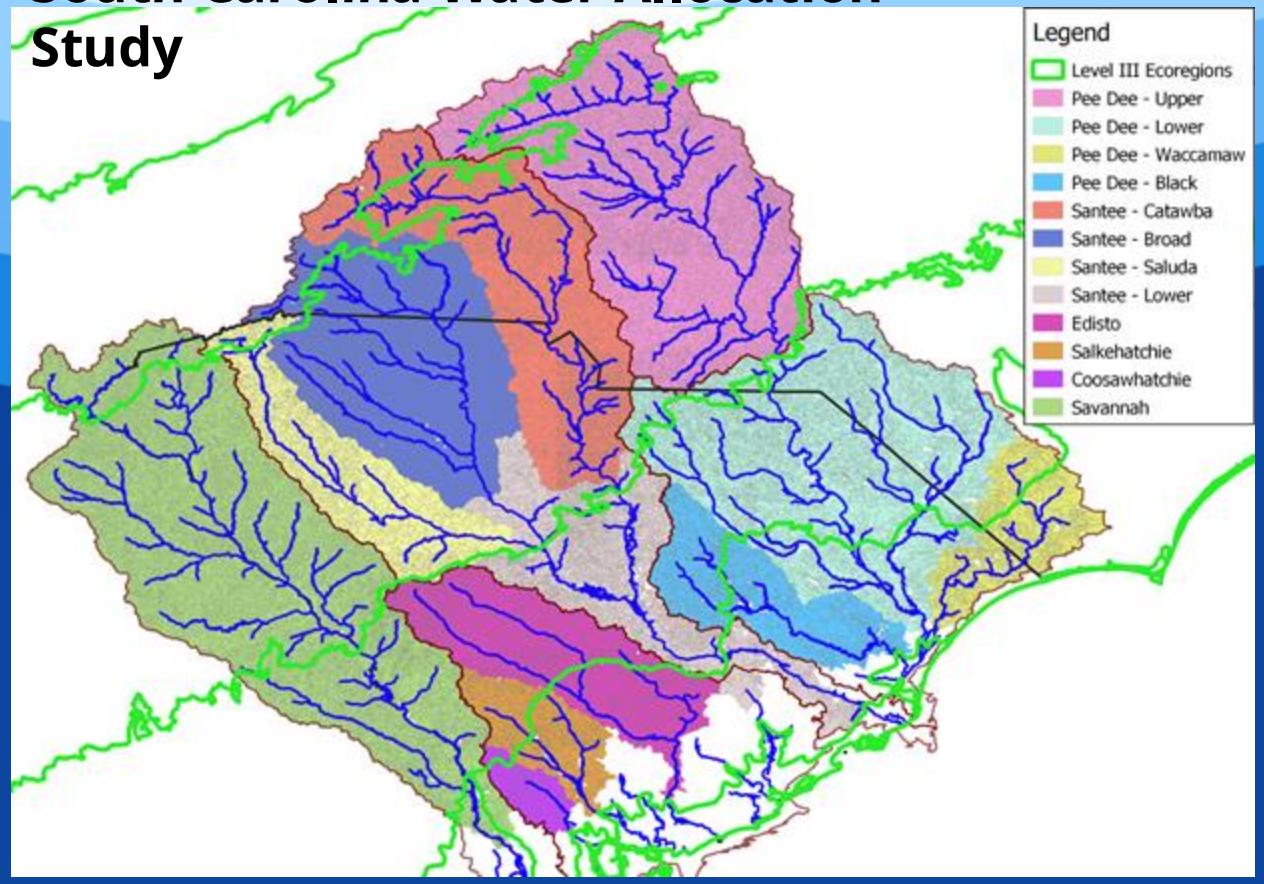


waterFALL

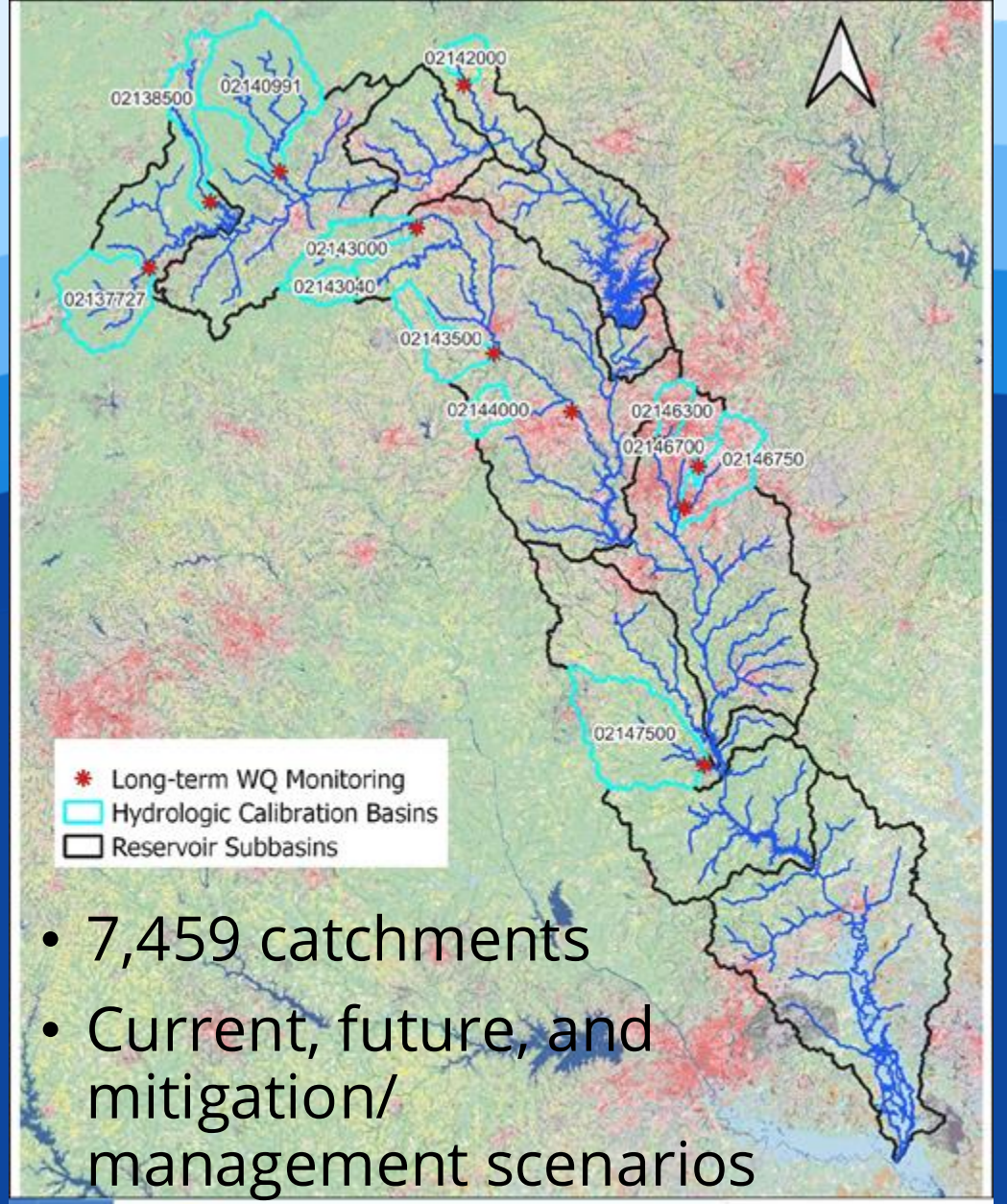
- Daily simulation
- Runoff, infiltration, baseflow, streamflow
- Open water and wetlands
- Sediment, total nitrogen, total phosphorus
- Local catchment with accumulation into full watershed
- Calibrated to observations

Watershed Modeling

South Carolina Water Allocation Study



- 65,484 catchments
- Current and future scenarios

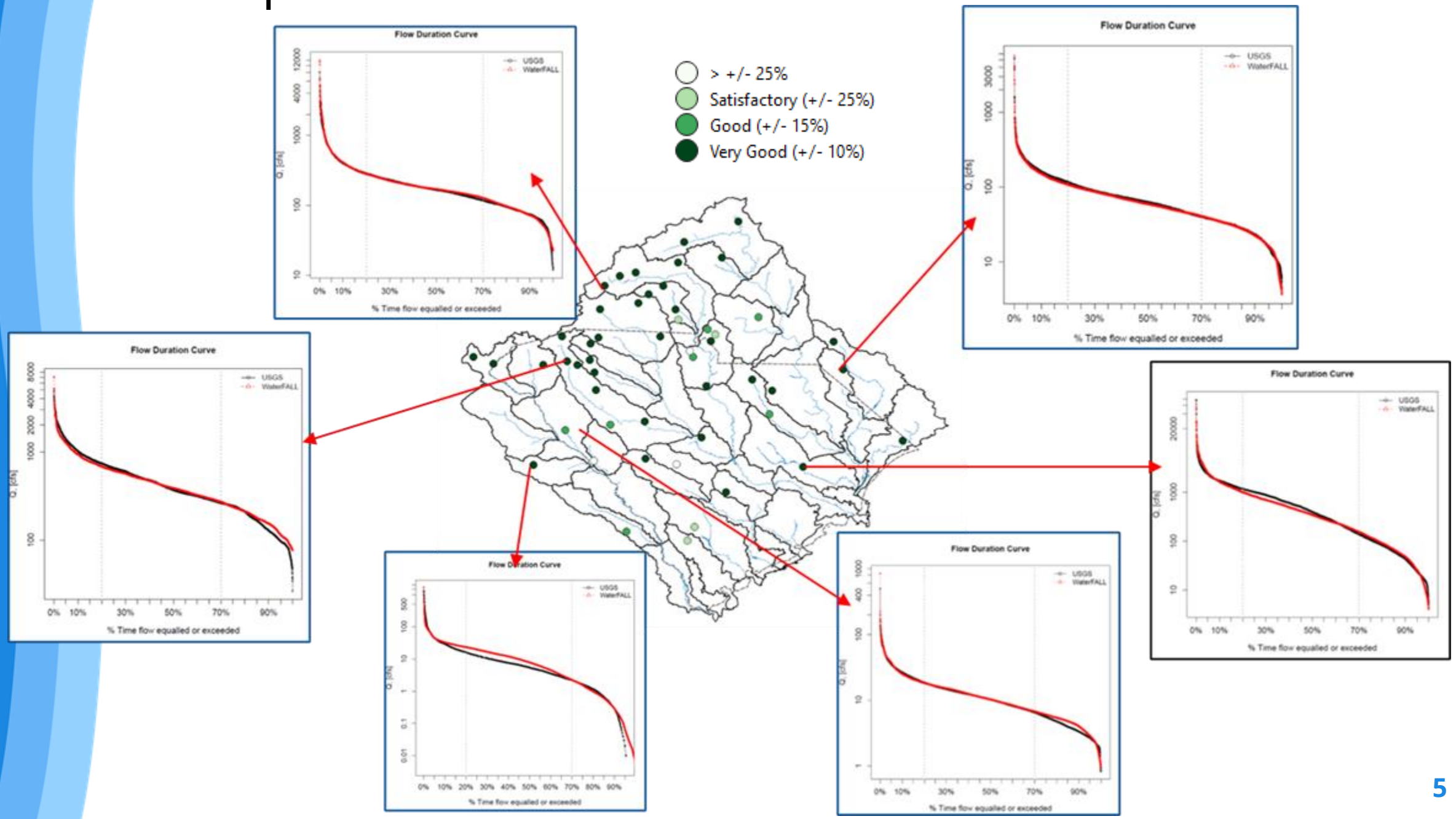


- 7,459 catchments
- Current, future, and mitigation/ management scenarios

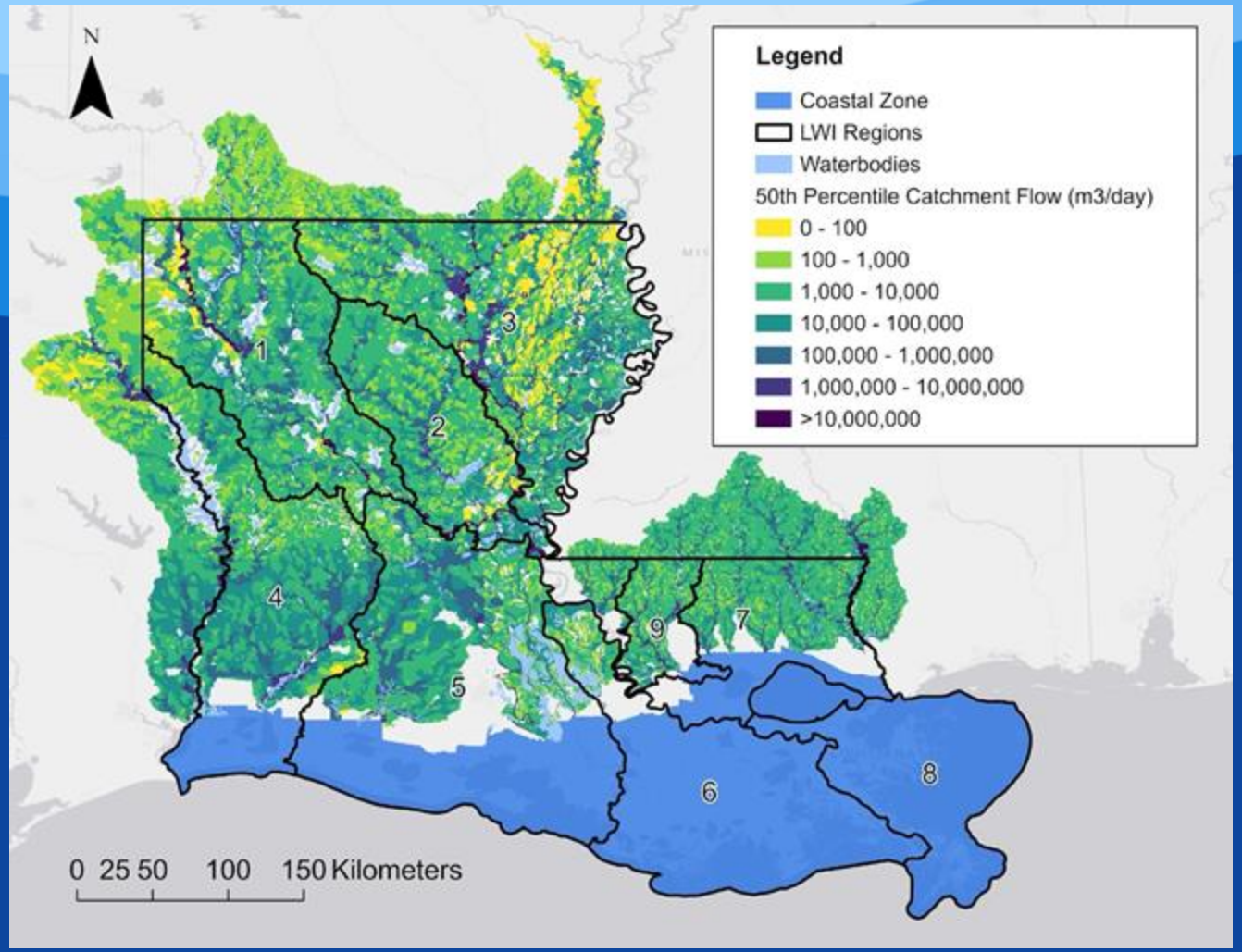
CALIBRATION LOCATIONS

INTEGRATED WATER RESOURCES PLAN

Example Calibration Results Across South Carolina



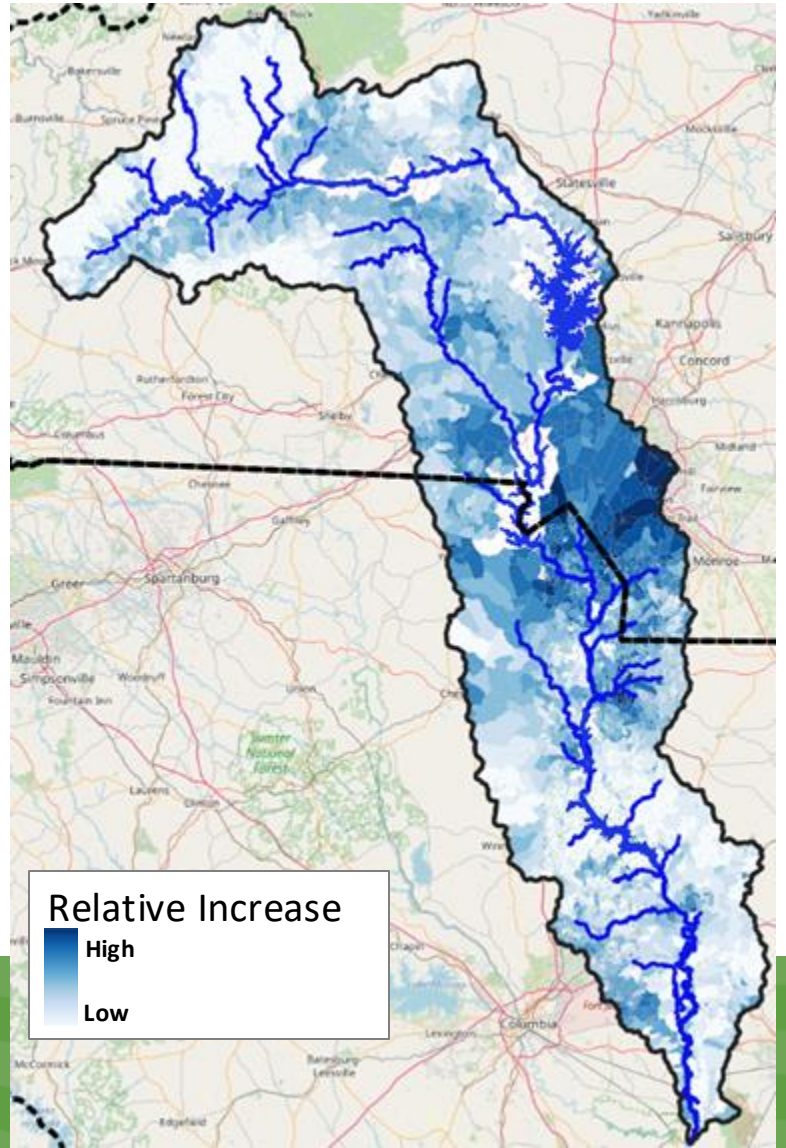
Catchment-Level Modeling



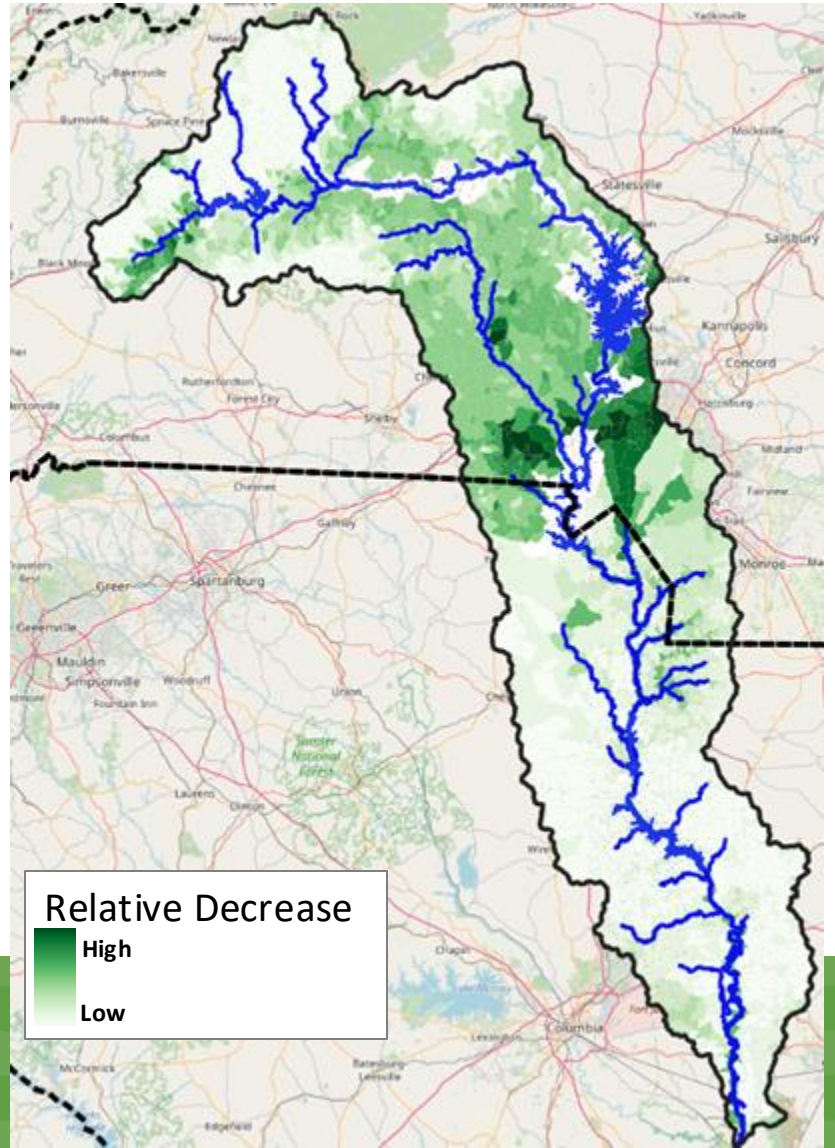
- Over 39,000 catchments upstream of coastal zone
- 8 state defined regions
- Creating publicly available Natured-Based Solutions Explorer web application to allow testing of NBS project implementation

Example Results:
Change in Metrics between 2020 and 2070

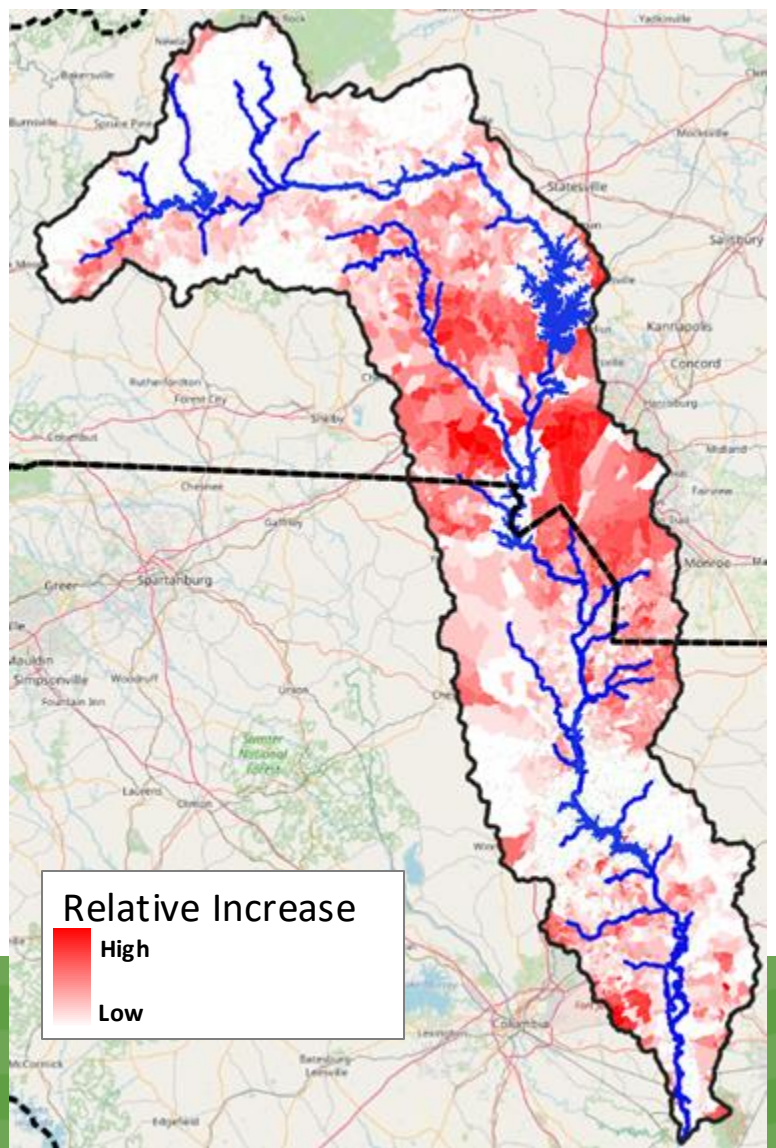
High Flow Pulse Count (FH1)



Baseflow (ML17)

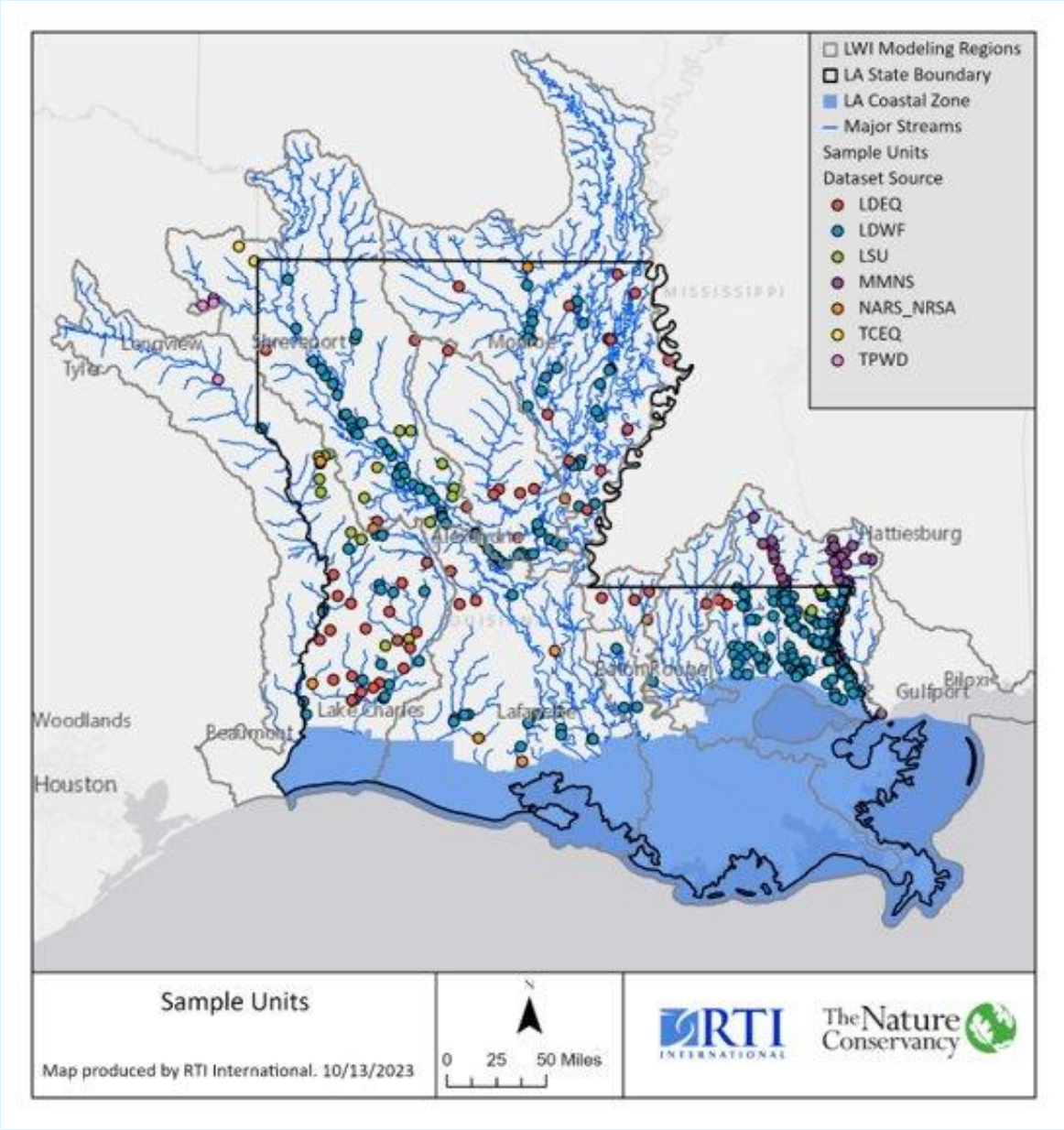


Flashiness (MA42)



LWI Ecological Flow Analysis

- Observed biological data at points within flowing network
  - Location observations to specific NHDPlus reaches
  - Classify observations into guilds and species (e.g., floodplain spawners)
- Technical Advisory Committee of state experts
- Determine ecological response hypotheses
- Calculate flow metrics (e.g., high flow pulse (75th and 90th percentile) counts) from WaterFALL simulations at catchment scale
- Test and select final relationships and metrics
- Apply findings to scenario analysis to determine impact on ecology



Aquatic Habitat: Hypothesis and Response

Guild	Flow component	Attribute	Hypothesis
Suckers (Guild and Indicator fish species)	Flows outside normal flow range	Magnitude	Reductions in flows lower than the normal range during the spring spawning season (February - June) reduces quality and availability of sucker spawning habitat.
			Increases in flows higher than the normal range during the spring season (February - June) reduces survival of fish and larva, due to energetic demands and displacement.
		Frequency	Reduced frequency of flows lower than the normal range during the spring spawning season (February - June) reduces quality and availability of sucker spawning habitat.
			Increased frequency of flows higher than the normal range during the spring season (February - June) reduces surival of fish and larva, due to energetic demands and displacement.

Fish	Catchments Included in Analysis	Total Modelled Catchments
Floodplain Spawner Guild	220	268
Largemouth Bass	146	191
Sucker Guild	165	196
Smallmouth Buffalo	37	42
Northern Hogsucker	66	68

Flow-Ecology Relationship: Sucker Guild

- Statewide finding
- Ecological relationship:
  - Habitat is improved when the average duration of higher than normal flows (> 75th percentile) are < 3 days during the spring season (February – June).
  - When the duration of higher than normal flows is > 3, habitat starts to decline.
- Ecological reasoning:
  - Extended (i.e., > 3 days) higher than normal flows in the spring season can reduce the survival of sucker fish and larva due to energetic demands and displacement

Key Points within Current Studies/Projects

Current Conditions

- Cumulative loads
- Source comparison
  - Reservoir
  - Basin
  - Natural vs. Impacted vs. Developed
- Peak and Drought loads
  - Event characteristics
- Natural riparian vs not
- Impairments/WQS comparison

Future Conditions

- Change in cumulative loads
- Natural vs. Impacted vs. Developed Contribution shifts
  - Relative
  - Total
- Peak and Drought
  - Event changes
  - Response
- Impairment/WQS increases

Mitigation Scenarios

- Conservation of natural lands
  - Reduction of future changes
  - Location focus
  - “Bang for buck”
- Riparian Buffers
  - Broad adoption vs. local adoption
  - Relative reductions achieved (local impacts)
- Agriculture Preservation
  - Impact by practice
  - Location focus
  - Broad adoption
- Specific NBS project implementation

RTI Completed Studies

- North Carolina
  - Statewide
  - Guild based
  - Featured Collection in February 2017. JAWRA: 53(1)
- South Carolina
  - Collaboration with Clemson, USGS, TNC, and SC DNR (SCDES)
  - Bower et al., 2022. Sci of Total Envir: 802 for relationships
  - Eddy et al., 2022 Ecohydrology for hydrologic metrics
- Louisiana
  - Collaboration with LWI, TNC, and state agencies
  - Studies upcoming (project report followed by journal article(s))

Questions and Discussion

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Sarah Bates
Adam Shelton
Eric Francisco
(Plus many other critical team members)

https://waterfall.rti.org

www.rti.org

For more information:

LWI NBS Program

NBS Explorer

waterFALL

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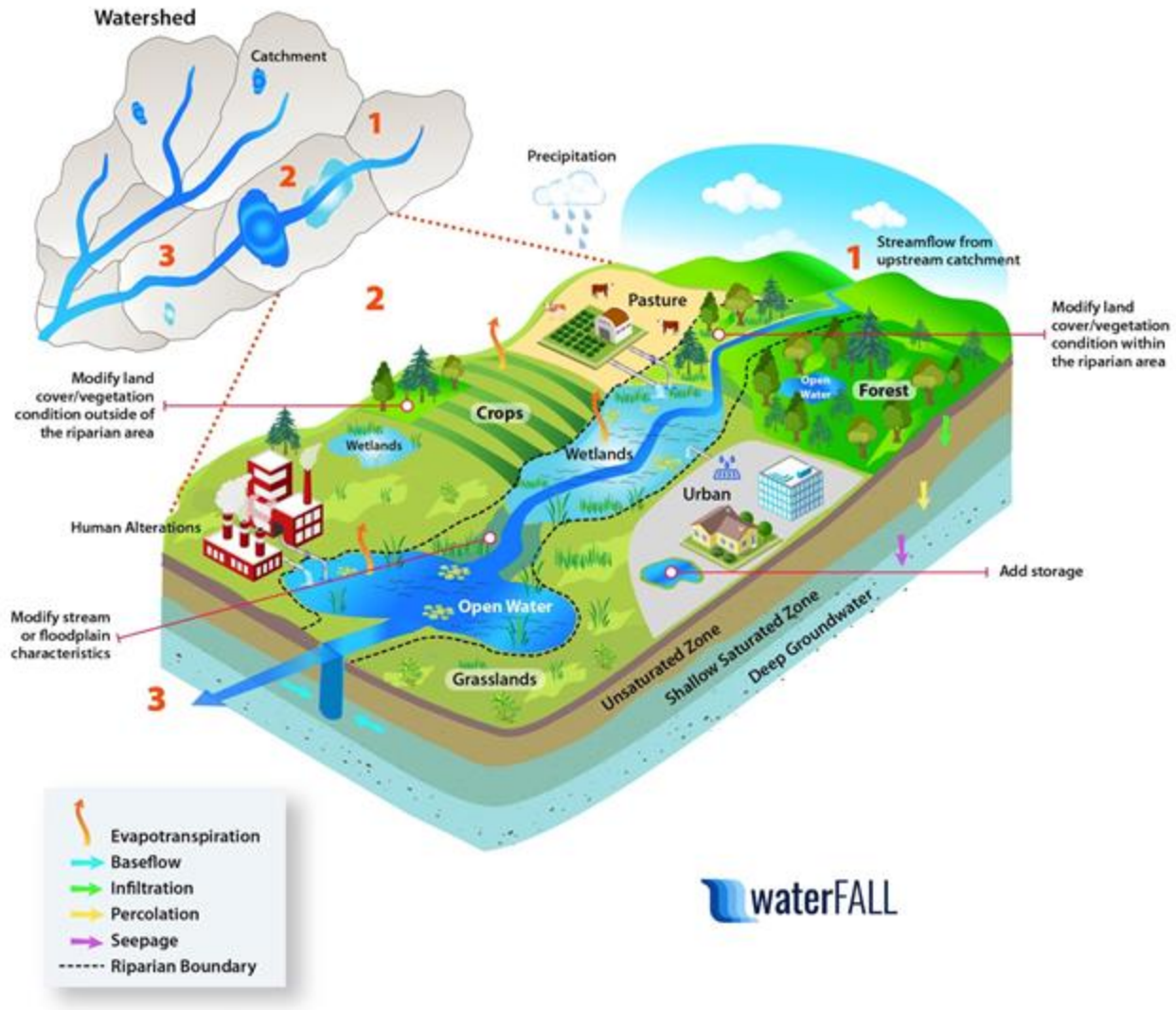
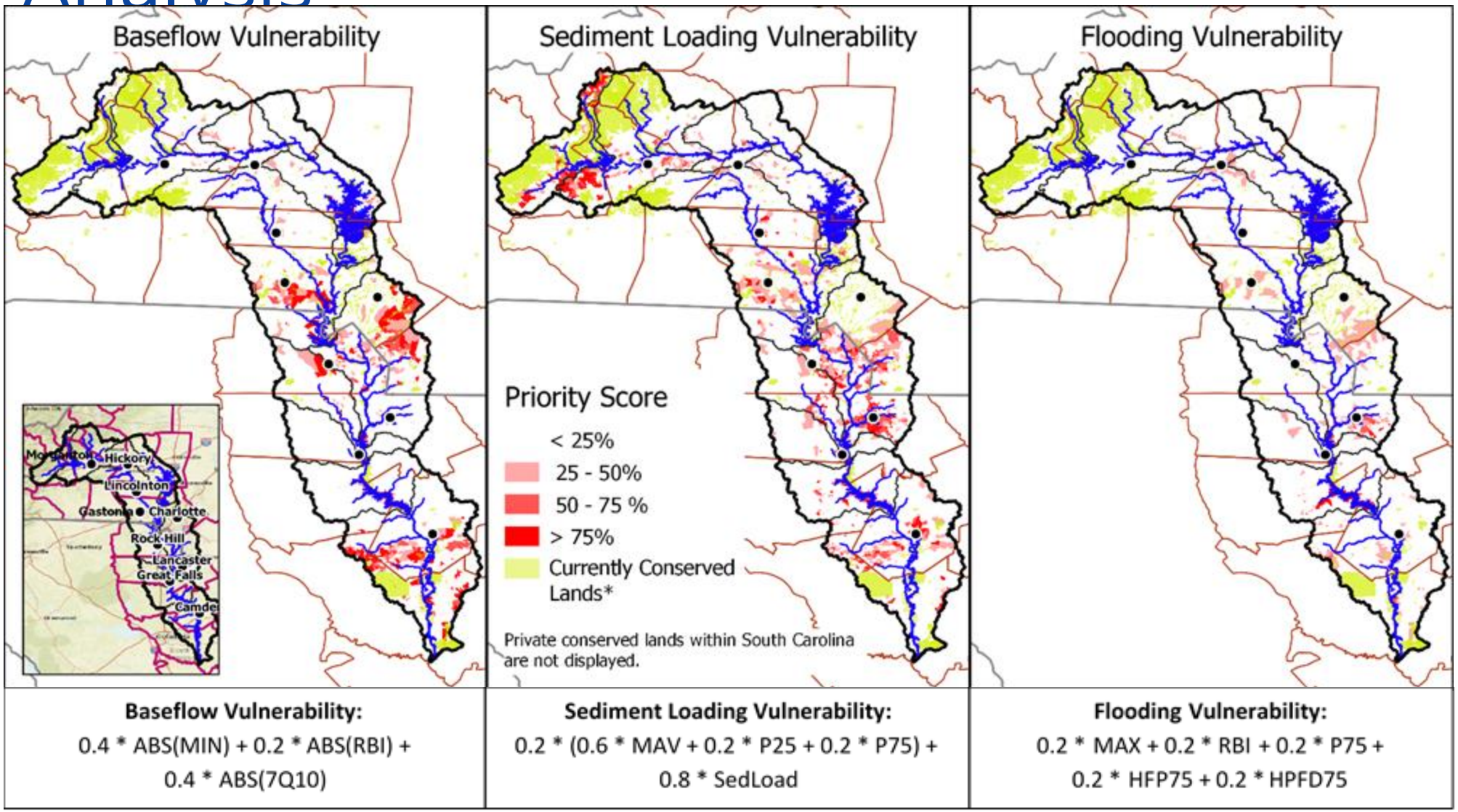


Prioritization Through Hot Spot Analysis



Baseflow Vulnerability:	Sediment Loading Vulnerability:	Flooding Vulnerability:
0.4 * ABS(MIN) + 0.2 * ABS(RBI) + 0.4 * ABS(7Q10)	0.2 * (0.6 * MAV + 0.2 * P25 + 0.2 * P75) + 0.8 * SedLoad	0.2 * MAX + 0.2 * RBI + 0.2 * P75 + 0.2 * HFP75 + 0.2 * HPFD75

[1]Metrics used in scenario definitions are defined as: 7Q10 = mean 7-day low flow occurring every 10 years on average; ABS = absolute value; HPF75 = high flow pulse count using the 75th percentile flow; HFPD75 = high flow pulse duration using the 75th percentile flow; MAV = mean annual average flow; MAX = mean annual maximum flow; MIN = mean annual minimum flow; P25 = 25th percentile flow; P75 = 75th percentile flow; RBI = flashiness index; SedLoad = sediment load