# Connecting Science and Policy Using the Stream Quantification Tool

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*Ecosystem Planning and Restoration*

*Asheville, NC* *August 16, 2018*

# Stream Function Pyramid Framework – SQT Example

- **Functional Categories & Statements**
  - **Hydrology: Transport of water from the watershed to the channel**
- **Function-Based Metrics** describes/supports the functional statement
  - **Flow Alteration**
- **Measurement Methods** quantifies function-based parameter
  - **Indices of Hydrologic Alteration (IHA)**
- **Performance Standards** compares condition to reference aquatic resources
  - **Presumptive Standard (Richter et al., 2011)**

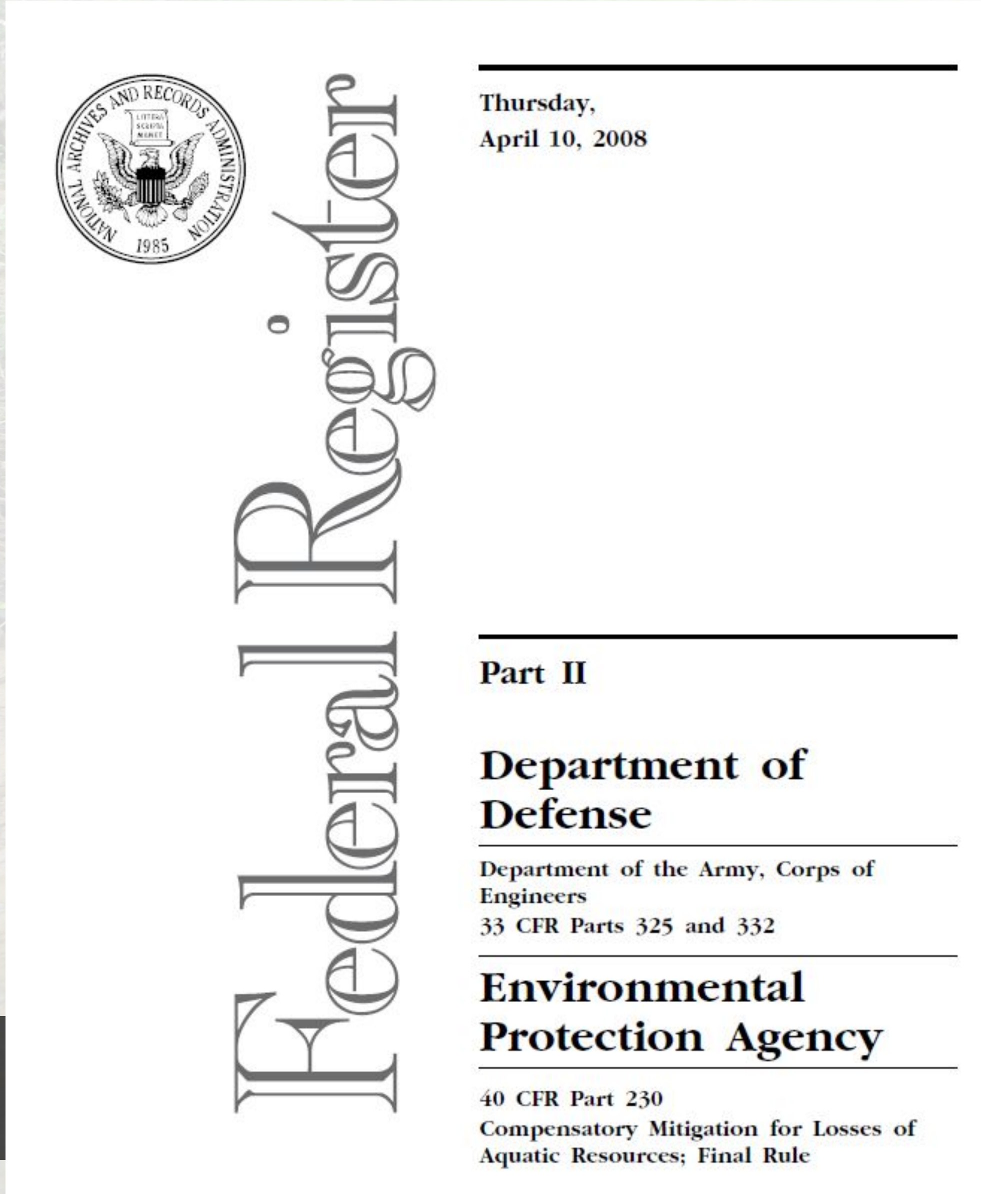
Richter, B. D., M. M. Davis, C. Apse, and C. Konrad. 2011. A presumptive standard for environmental flow protection. River Research and Applications DOI: 10.1002/rra.1511.

EPR

# Purposes of the SQT

1. Determine numerical differences between an existing stream condition and the proposed stream condition.
2. Link restoration activities to changes in stream functions (function-based parameters).
3. Link restoration goals to restoration potential.
4. Incentivize high-quality stream mitigation.
5. Assist with site selection.

# 2008 Mitigation Rule



Federal Register

Thursday,
April 10, 2008

Part II

Department of Defense

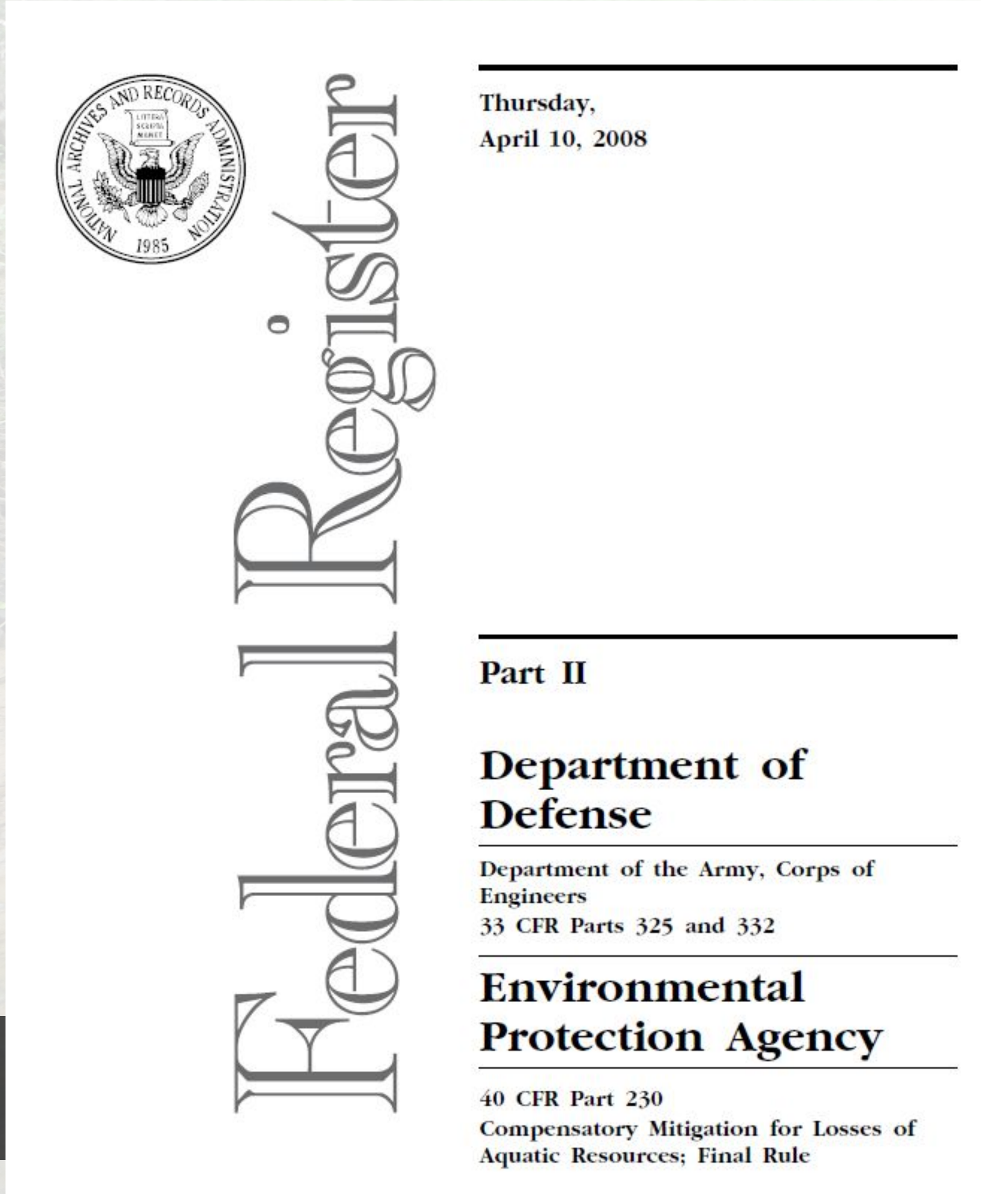
Department of the Army, Corps of Engineers
33 CFR Parts 325 and 332

Environmental Protection Agency

40 CFR Part 230
Compensatory Mitigation for Losses of Aquatic Resources; Final Rule

This rule improves the planning, implementation and management of compensatory mitigation projects by emphasizing a watershed approach in selecting compensatory mitigation project locations, requiring measurable, enforceable ecological performance standards and regular monitoring for all types of compensation and specifying the components of a complete compensatory mitigation plan, including assurances of long-term protection of compensation sites, financial assurances, and identification of the parties responsible for specific project tasks.

# Offset Unavoidable Impacts to waters of the U.S.



Federal Register

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Part II

**Department of Defense**

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**Environmental Protection Agency**

40 CFR Part 230
Compensatory Mitigation for Losses of Aquatic Resources; Final Rule

***Credit*** means a unit of measure (e.g., a functional or areal measure or other suitable metric) representing the accrual or attainment of aquatic functions at a compensatory mitigation site. The measure of aquatic functions is based on the resources restored, established, enhanced, or preserved.

***Debit*** means a unit of measure representing the loss of aquatic functions at an impact or project site.

"The number of credits must reflect the difference between pre- and post-compensatory mitigation project site conditions, as determined by a functional or condition assessment or other suitable metric."

# Dimension, Pattern, and Profile

- *Functions* means the physical, chemical, and biological processes that occur in ecosystems.

- Restoration means the manipulation of the physical, chemical, or biological characteristics of a site with the goal of returning natural/historic functions to a former or degraded aquatic resource."

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Biology

Physicochemical

Geomorphology

Hydraulics

Restoration Activities

Hydrology

# Quantifying Functional Lift and Loss

| Functional Category | Function-Based Parameters | Existing Parameter | Proposed Parameter |
|---|---|---|---|
| Hydrology | Catchment Hydrology | 0.50 | 0.50 |
| | Reach Runoff | 0.69 | 0.79 |
| Hydraulics | Floodplain Connectivity | 0.10 | 1.00 |
| Geomorphology | Large Woody Debris | 0.29 | 0.48 |
| | Lateral Stability | 0.20 | 0.67 |
| | Riparian Vegetation | 0.02 | 0.72 |
| | Bed Material | | |
| | Bed Form Diversity | 0.20 | 1.00 |
| | Plan Form | 0.30 | 1.00 |
| Physicochemical | Temperature | 0.37 | 0.48 |
| | Bacteria | | |
| | Organic Matter | 0.36 | 0.71 |
| | Nitrogen | | |
| | Phosphorus | | |
| Biology | Macros | 0.11 | 0.64 |
| | Fish | 0.00 | 0.36 |

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# Reference Condition

- Scores of 0.7 to 1.0 in the SQT.
- Culturally Unaltered, Minimal Disturbance

- *“Reference aquatic resources* are a set of aquatic resources that represent the full range of variability exhibited by a regional class of aquatic resources as a result of natural processes and anthropogenic disturbances.” 2008 Rule

# Ecological Performance Standards

- Ecological performance standards must be based on the best available science that can be measured or assessed in a practicable manner.

Criteria Used to Select Performance Standards in the SQT:

- Provided in peer-reviewed journals;
- Provided in government documents or monitoring databases;
- Provided in books or proceeding papers; and
- Best Professional Judgment.

# Purposes of the SQT

1. Determine numerical differences between an existing stream condition and the proposed stream condition.
    1. Focus on the delta rather than the proposed condition
2. Link restoration activities to changes in stream functions (function-based parameters).
3. Link restoration goals to restoration potential.
4. Incentivize high-quality stream mitigation.
    1. High-quality = maximum lift
5. Assist with site selection.

# The SQT is NOT

- A comprehensive stream condition assessment
  - We’ve left some things out.
- A design tool
  - Goal is to quantify functional results of restoration practices rather than dictate methods.

"The WSQT generates a condition score that is unitless, which is then multiplied by stream length to generate a "Functional Feet" score. This score is used to determine the initial credit obligation (described below). The WSQT spreadsheet calculates the change in condition at an impact site by comparing the difference between existing and proposed condition."

Omaha District

United States Army Corps of Engineers
Omaha District
Wyoming Regulatory Office

**WYOMING STREAM MITIGATION PROCEDURE**
**Version 2 (WSMP v2)**

# Evaluating the ecological function of restored streams in Piedmont, North Carolina using the SQT

Sara Donatich[1], Barbara Doll[1], & Jonathan Page[1]

[1] NC State University

August 16th 2018

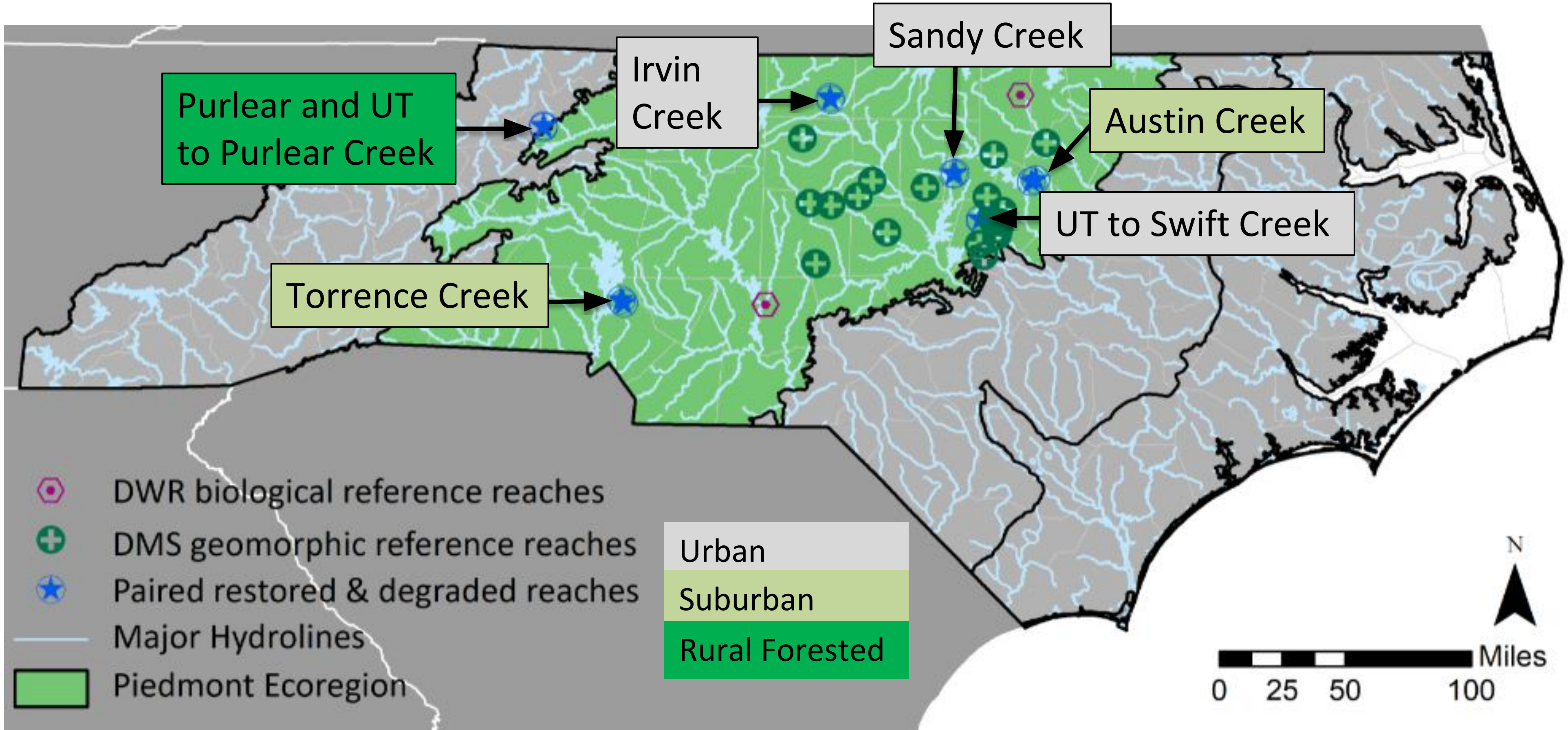
# Research questions

Does the NC SQT **accurately detect and quantify** ecological function?

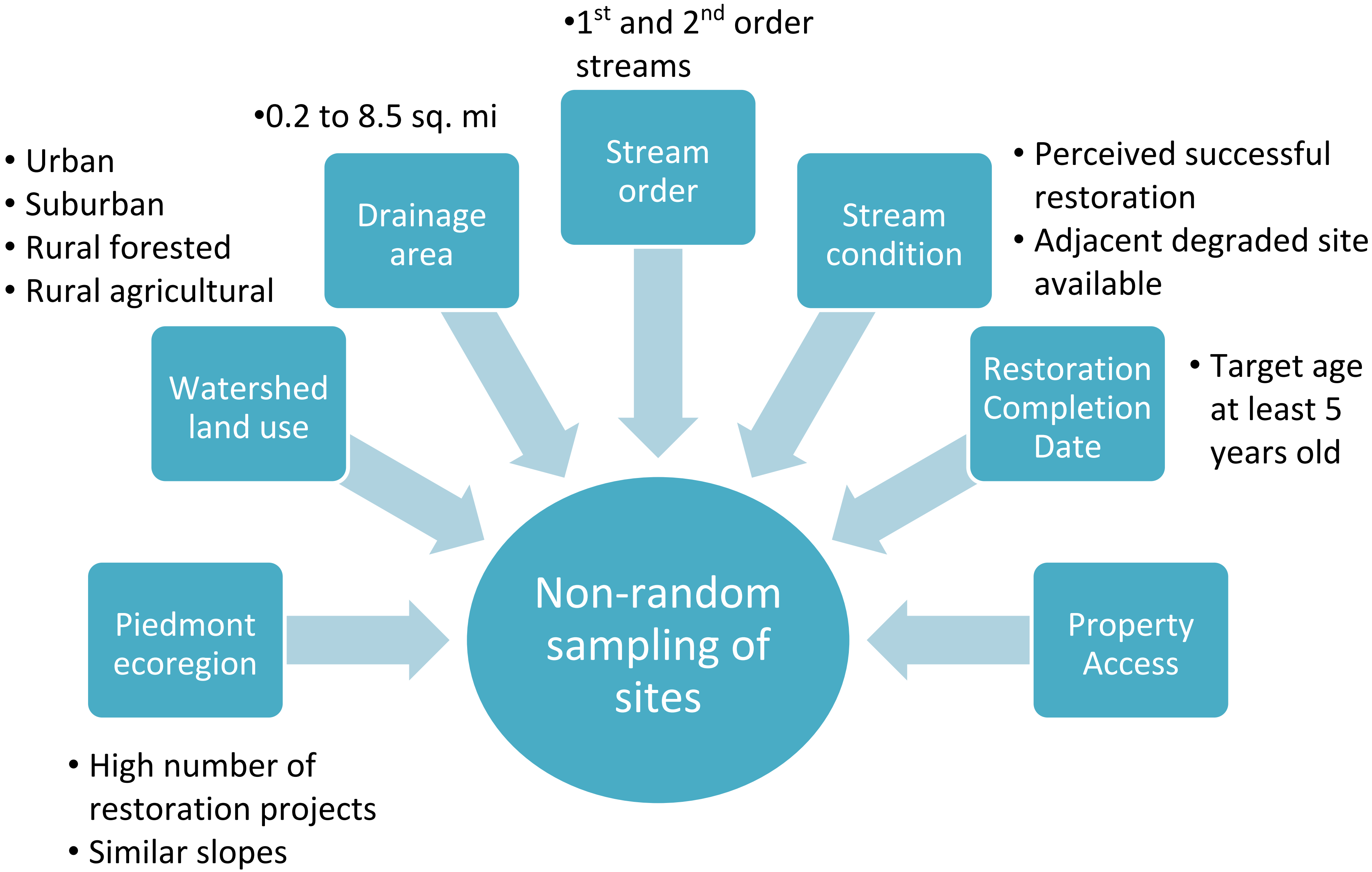
- What is the **natural performance range** for ecological function variables in Piedmont streams?
- Does the **stream functions pyramid framework** (embedded in SQT) apply to all **stream conditions?**
- Which ecological function variables **correlate** best with **good biological** condition?

# Site Location Map

- DEQ DMS geomorphic reference sites (*n=18*) [funded by NC DEQ DMS]
- DEQ DWR biological reference sites (*n=2*)
- Paired restored & degraded sites (*n=12; 6 pairs*) [funded by EDF]



# Site Selection Criteria



# Data Collection

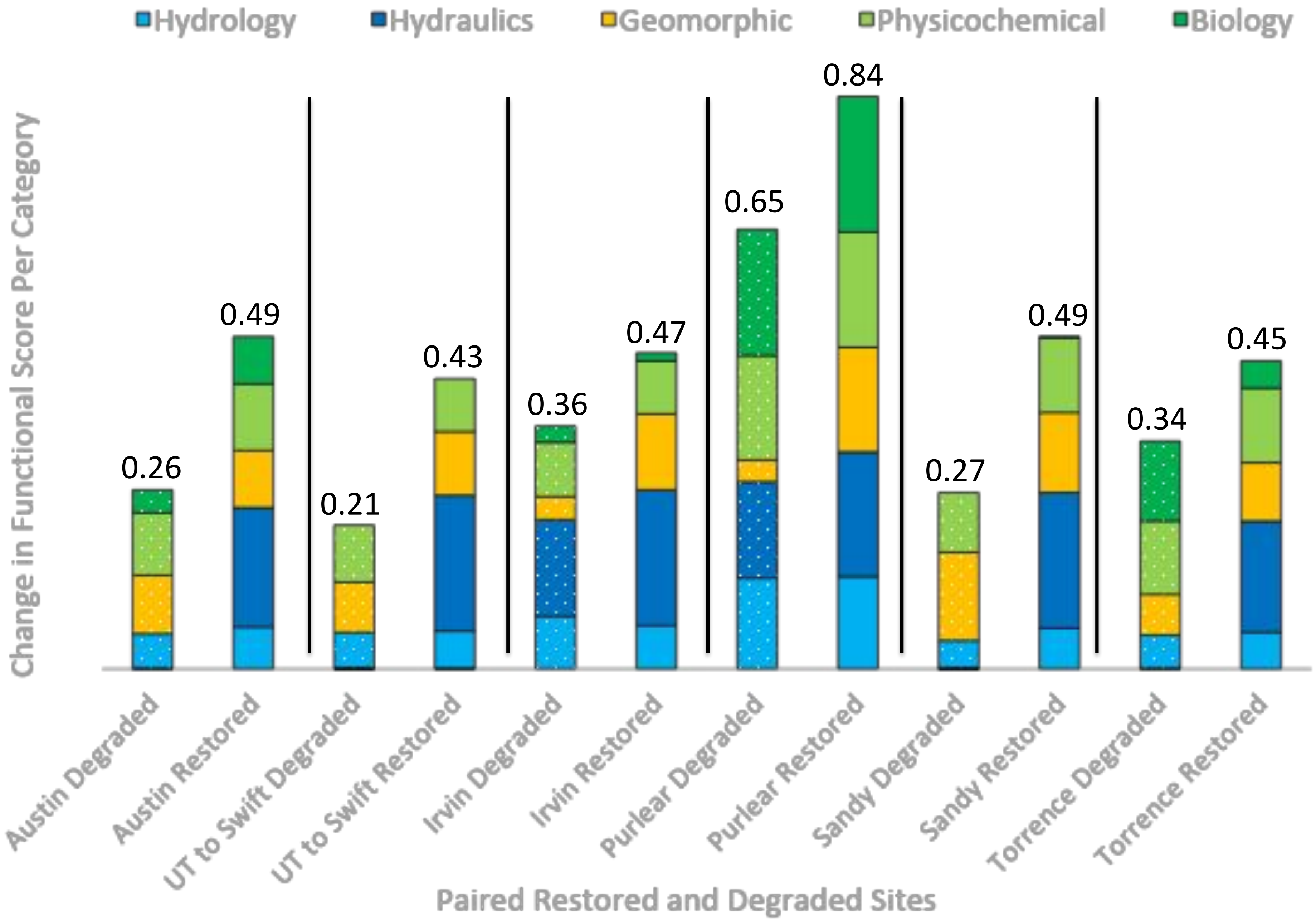
| Functional Category | Measurement Method |
|---|---|
| Hydrologic | Curve Number |
| | No. of Concentrated Flow Points |
| | Soil Compaction (Penetrometer) |
| | Soil Compaction (Bulk Density) |
| Hydraulic | Bank Height Ratio |
| | Entrenchment Ratio |
| Geomorphic | LWD Index |
| | LWD Piece Count |
| | Dominant BEHI/NBS |
| | Percent Streambank Erosion (%) |
| | Canopy Coverage (%) |
| | Buffer Width (ft) |
| | Basal Area (sq. ft/acre) |
| | Pool Spacing Ratio |
| | Pool Depth Ratio |
| | Percent Riffle |
| | Sinuosity |

| Functional Category | Measurement Method |
|---|---|
| Physico-chemical | Daily Maximum Summer Temperature (°F) |
| | Dissolved oxygen (mg/L) |
| | Specific Conductivity (mS/cm) |
| | pH |
| | Salinity (ppt) |
| | Total Nitrogen (mg/L) |
| | Total Phosphorus (mg/L) |
| | Fecal Coliform (Cfu/100 ml) |
| | % Shredders |
| Biological | NC Index of Biotic Integrity for Macroinvertebrates |
| | EPT Taxa Present |
| Restoration Potential | Watershed Catchment Assessment |

# Methods



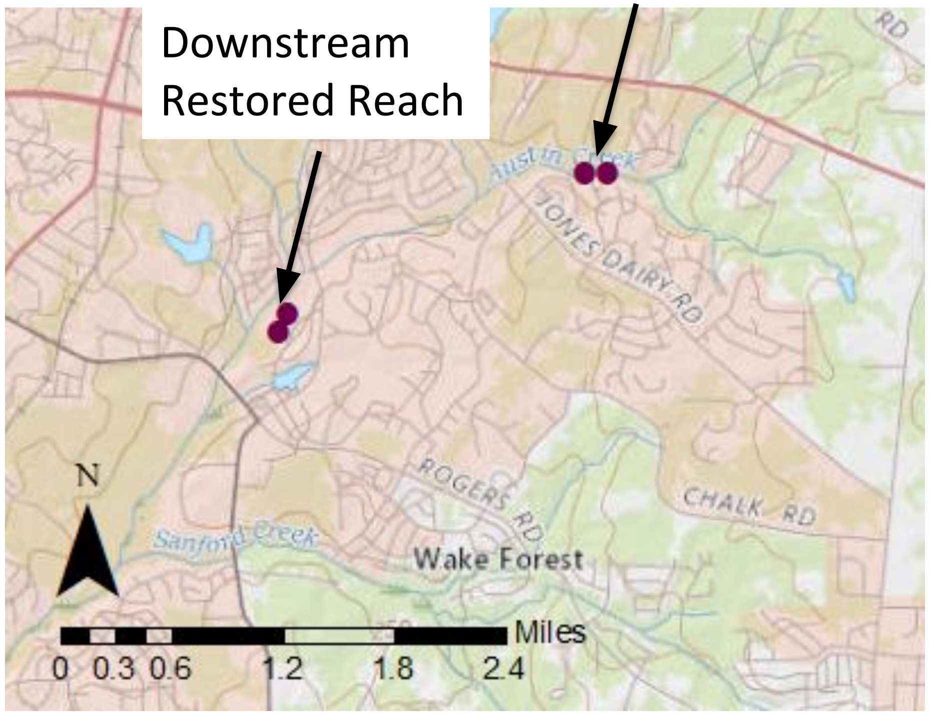




Hydrology
Hydraulics
Geomorphic
Physicochemical
Biology
Change in Functional Score Per Category
0.26
0.49
0.21
0.43
0.36
0.47
0.65
0.84
0.27
0.49
0.34
0.45
Austin Degraded
Austin Restored
UT to Swift Degraded
UT to Swift Restored
Irvin Degraded
Irvin Restored
Purlear Degraded
Purlear Restored
Sandy Degraded
Sandy Restored
Torrence Degraded
Torrence Restored
Paired Restored and Degraded Sites

# Site 1: Austin Creek

- Wake Forest, Wake County
- Suburban watershed
- Restoration completed in 2002
- Restoration objectives:
  - stabilize banks via channel reconfiguration
  - floodplain reconnection
  - establish native riparian vegetation
  - improve natural aesthetics [1]

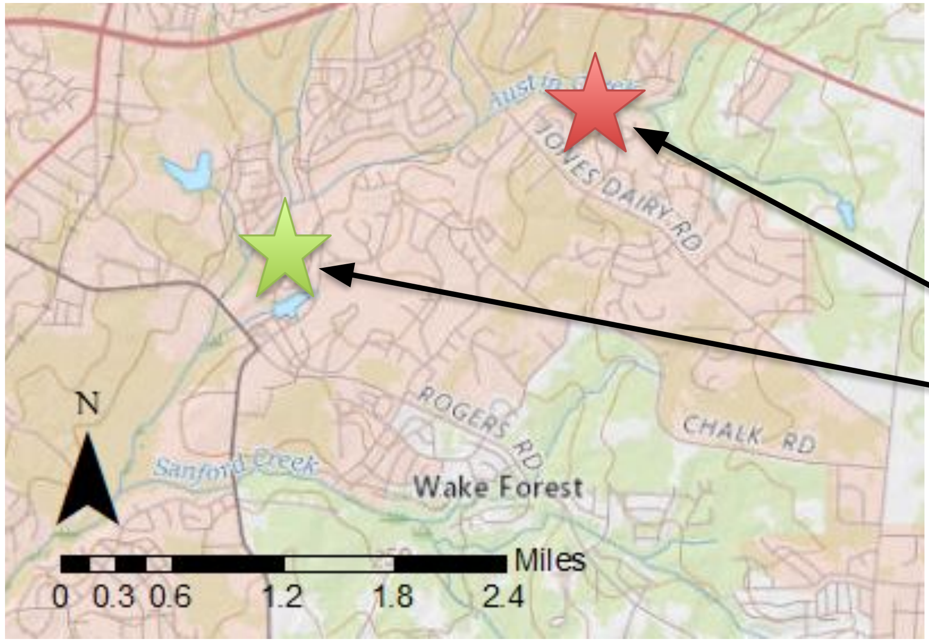
| | Degraded | Restored |
|---|---|---|
| Drainage Area (sq. mi) | 3.8 | 8.5 |




[1] Smith and Austin Creek Stream Mitigation Plan, 2003

# Site 1: Austin Creek

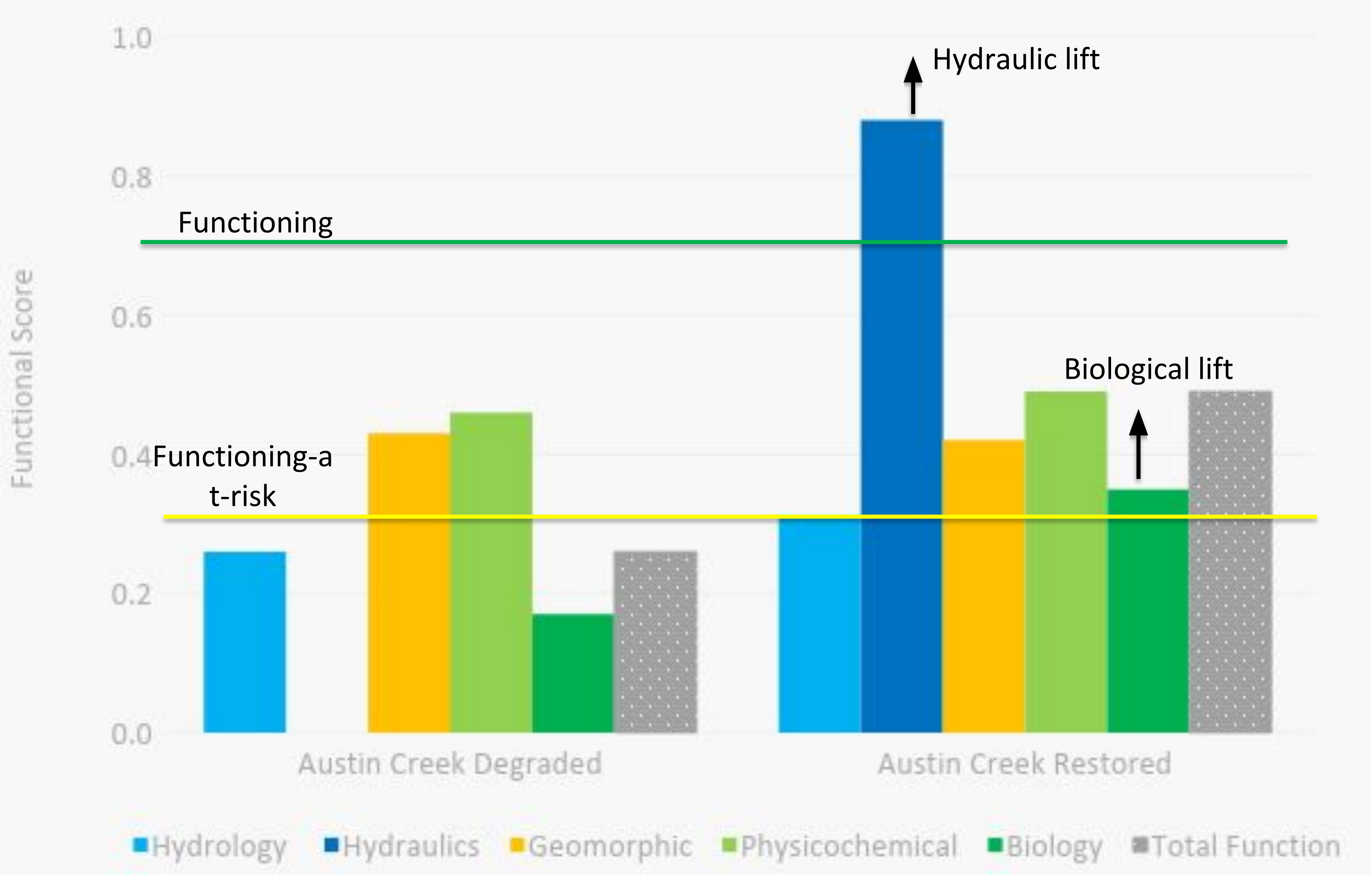
- Wake Forest, Wake County
- Suburban watershed




Downstream Restored Reach (2002)

| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 3.8 | 78 | Sand | 0.39 | G5c |
| 8.5 | 83 | Sand | 0.19 | C5 |

# Site 1: Austin Creek

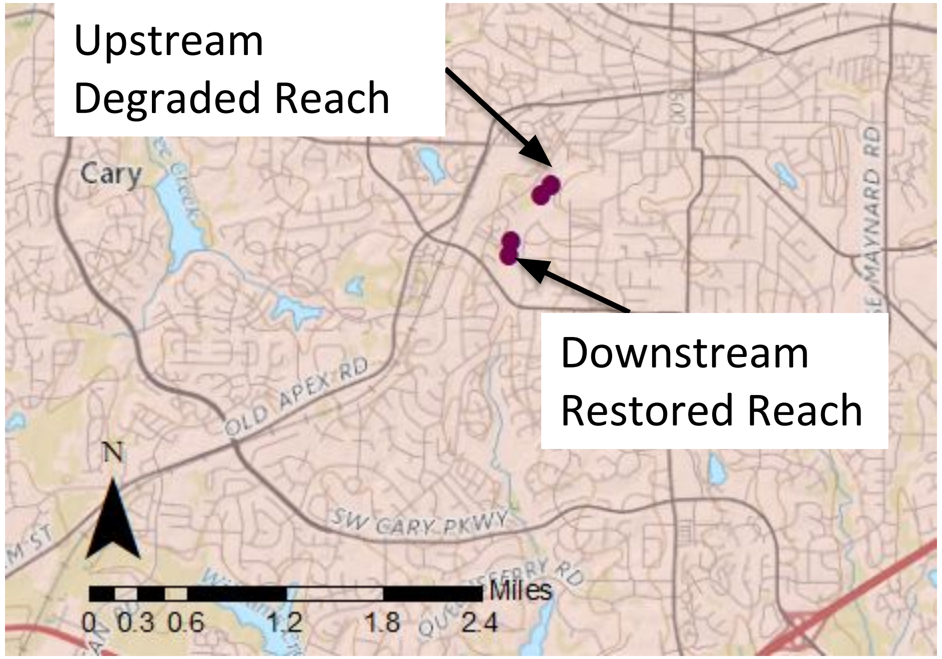


# Site 2: UT to Swift Creek

- Cary, Wake County
- Suburban watershed
- Restoration completed in 2012
- Restoration objectives:

  Improve water quality by:
  - establishing floodplain
  - riparian buffer planting
  - stabilizing banks
  - improving aquatic habitat [2]

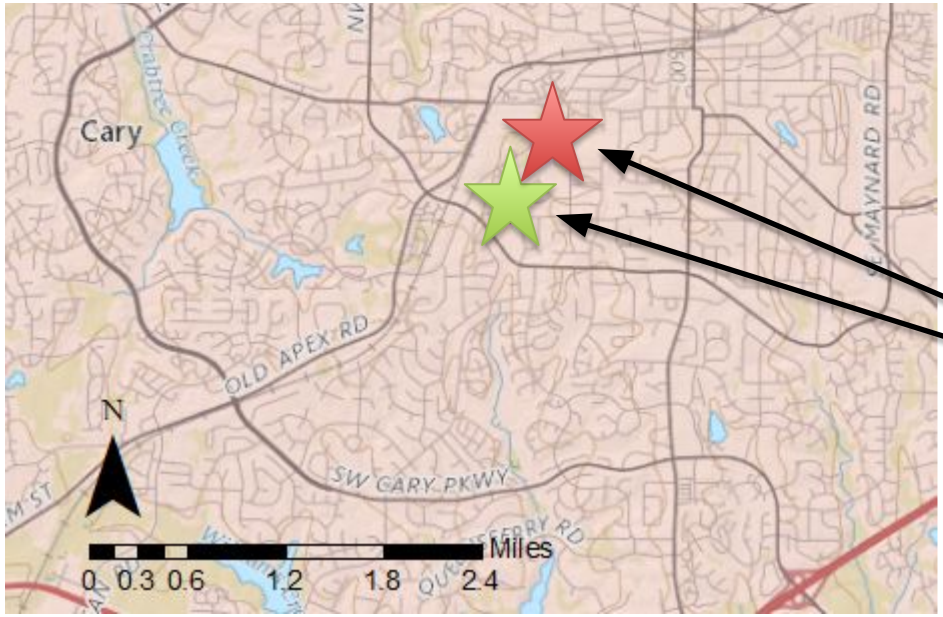
| | Degraded | Restored |
|---|---|---|
| Drainage Area (sq. mi) | 0.5 | 0.9 |




[2] UT to Swift Creek Restoration Monitoring Report Year 1, 2014

# Site 2: UT to Swift Creek

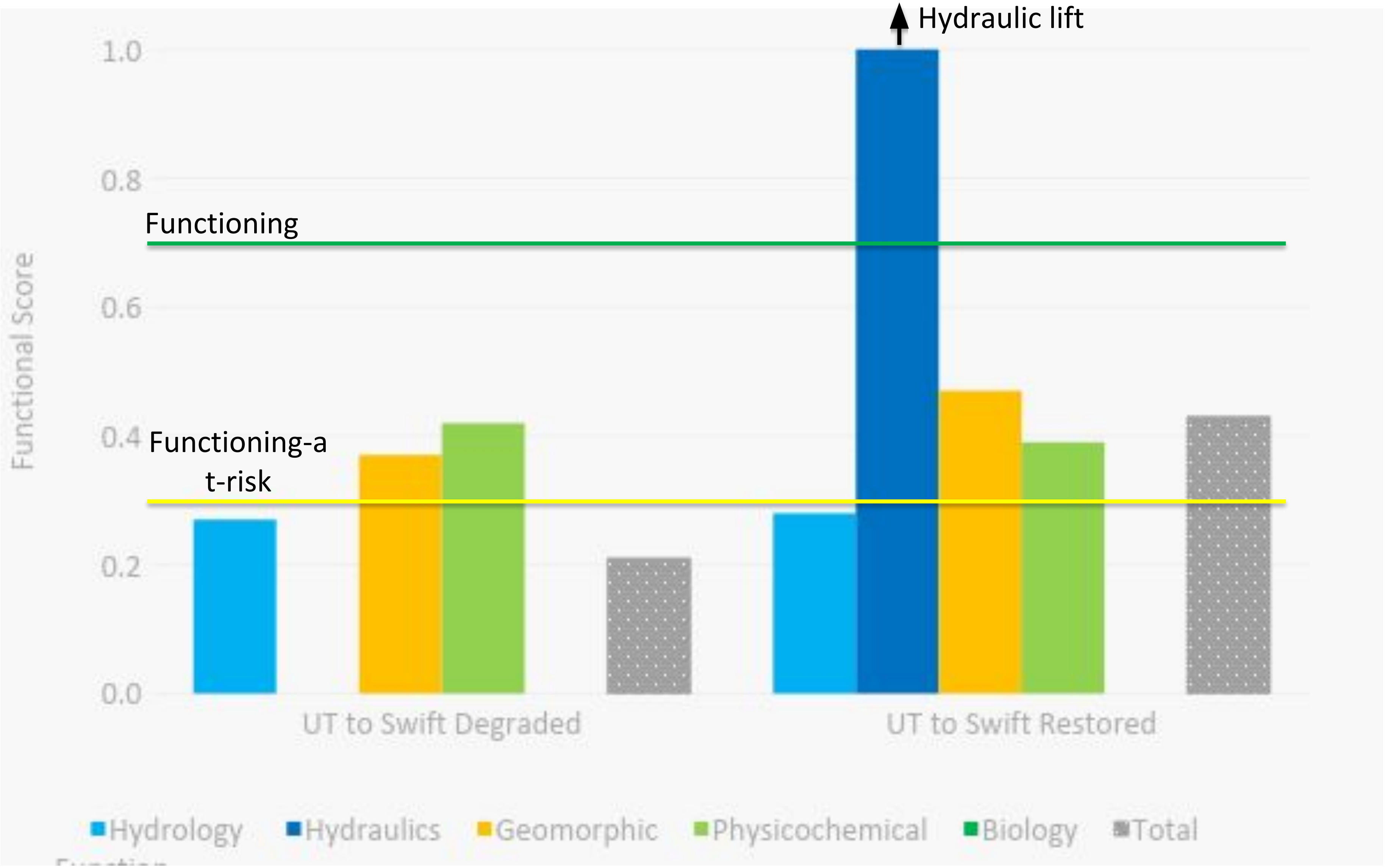
- Cary, Wake County
- Urban watershed





| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 0.5 | 82 | Gravel | 1.64 | G4c |
| 0.9 | 82 | Gravel | 0.30 | C4 |

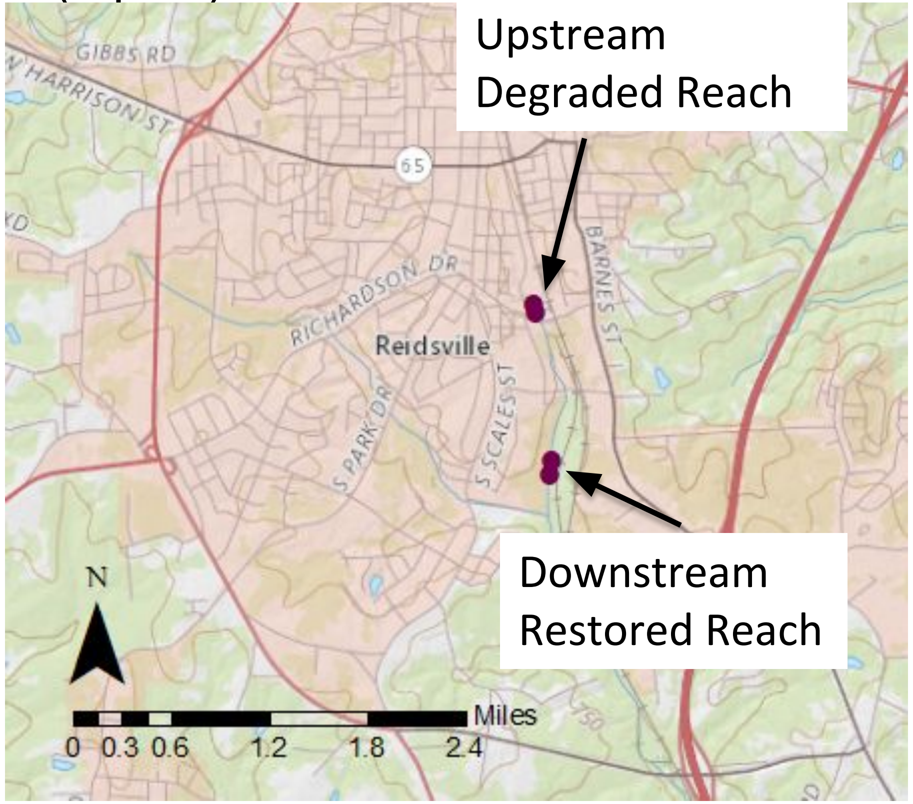
# Site 2: UT to Swift Creek



# Site 3: Irvin Creek

- Reidsville, Rockingham County
- Urban watershed
- Restoration completed in 2011
- Restoration objectives:
  - stabilize banks
  - floodplain reconnection
  - reduce nutrient levels, sediment input, and water temperature
  - increase dissolved oxygen
  - create in-stream habitat
  - decrease channel velocities[3]

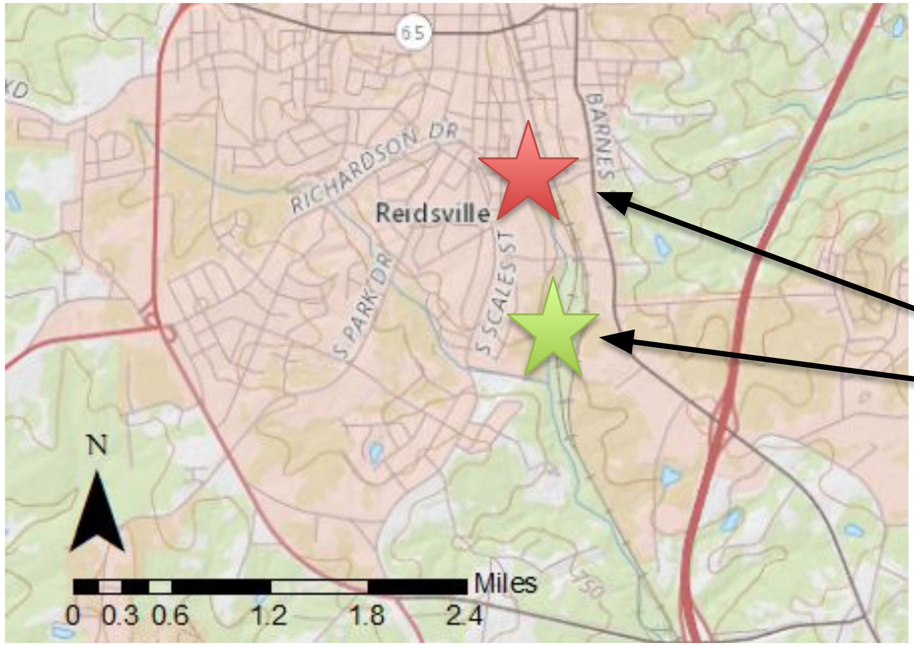
| | Degraded | Restored |
|---|---|---|
| Drainage Area (sq. mi) | 0.6 | 1.0 |




[3] Little Troublesome Creek Mitigation Plan Monitoring Year 1 Annual Report, 2013

# Site 3: Irvin Creek

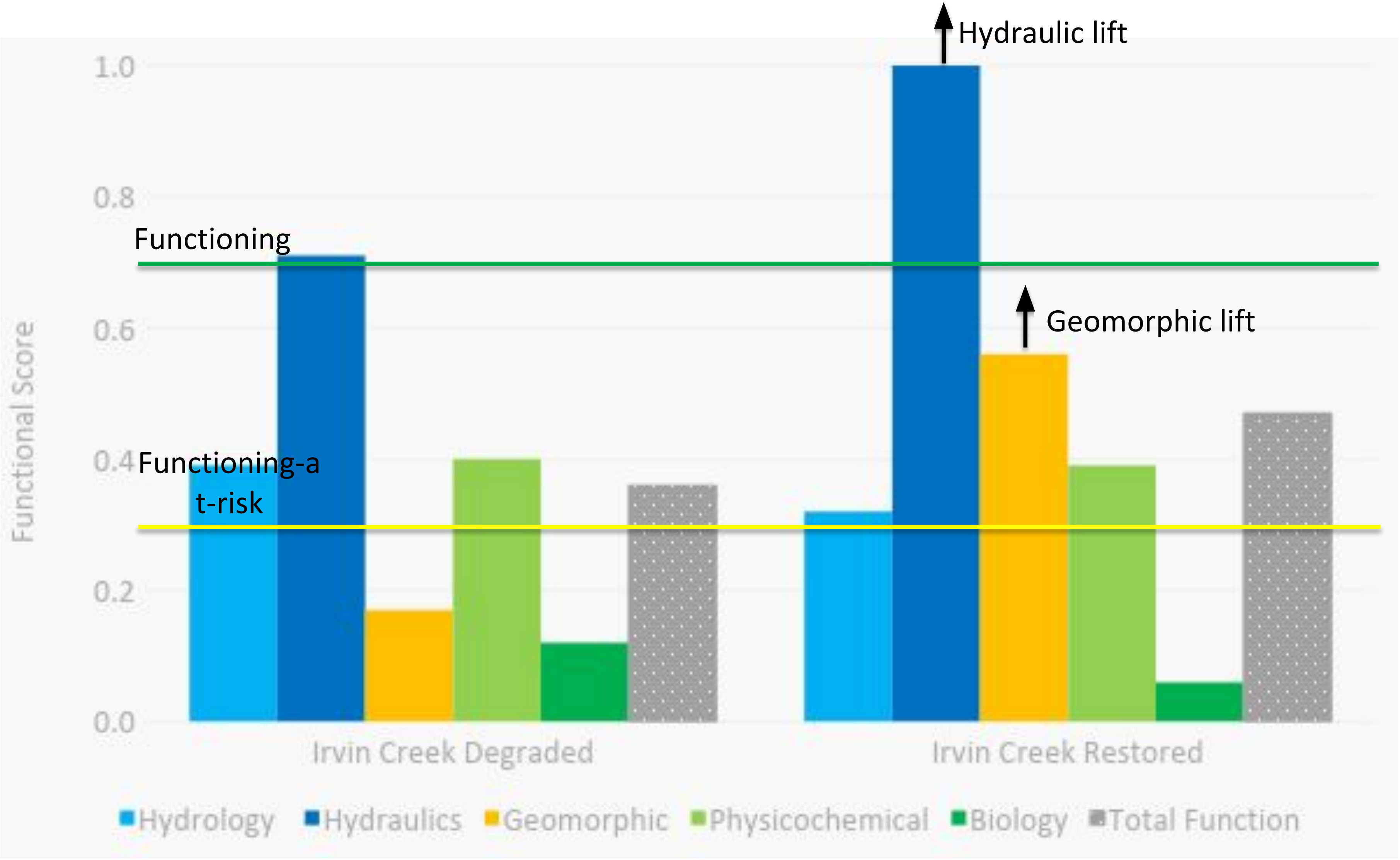
- Reidsville, Rockingham County
- Urban watershed




Downstream Restored Reach (2011)

| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 0.6 | 77 | Gravel | 0.53 | E4 |
| 1.0 | 77 | Sand | 0.57 | C5 |

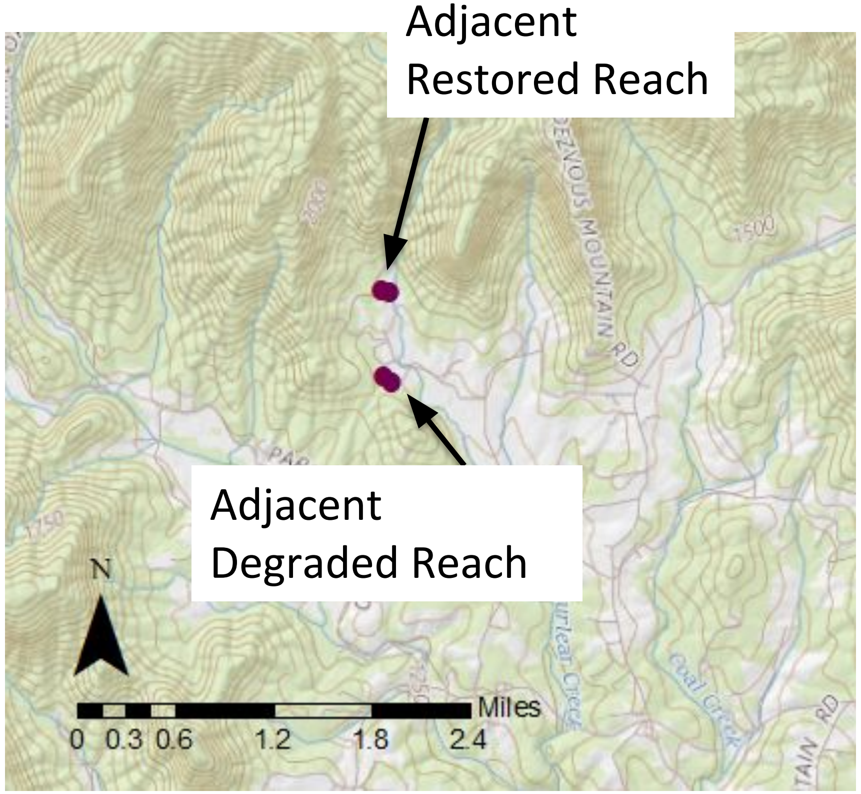
# Site 3: Irvin Creek



# Site 4: Purlear Creek and UT to Purlear Creek

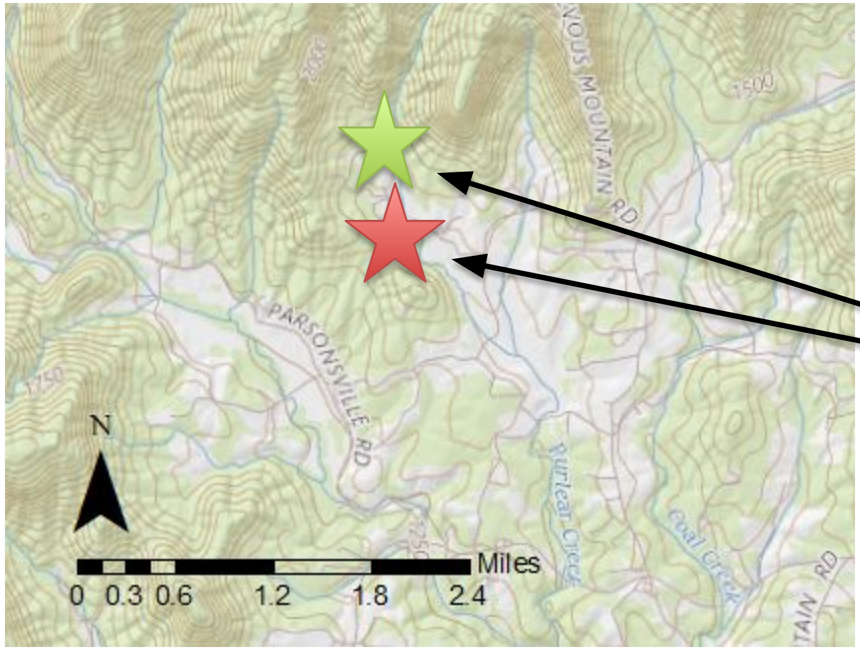
- Purlear, Wilkes County
- Rural Forested watershed
- Restoration completed in 2006
- Restoration objectives:
  - improve water quality by reducing sediment and nutrients
  - improve aquatic and terrestrial habitat for cold-water fish, mammals, birds
  - improve wetland functions to support bog turtle habitat

| | Degraded | Restored |
|---|---|---|
| Drainage Area (sq. mi) | 0.2 | 0.4 |



# Site 4: Purlear and UT to Purlear Creek

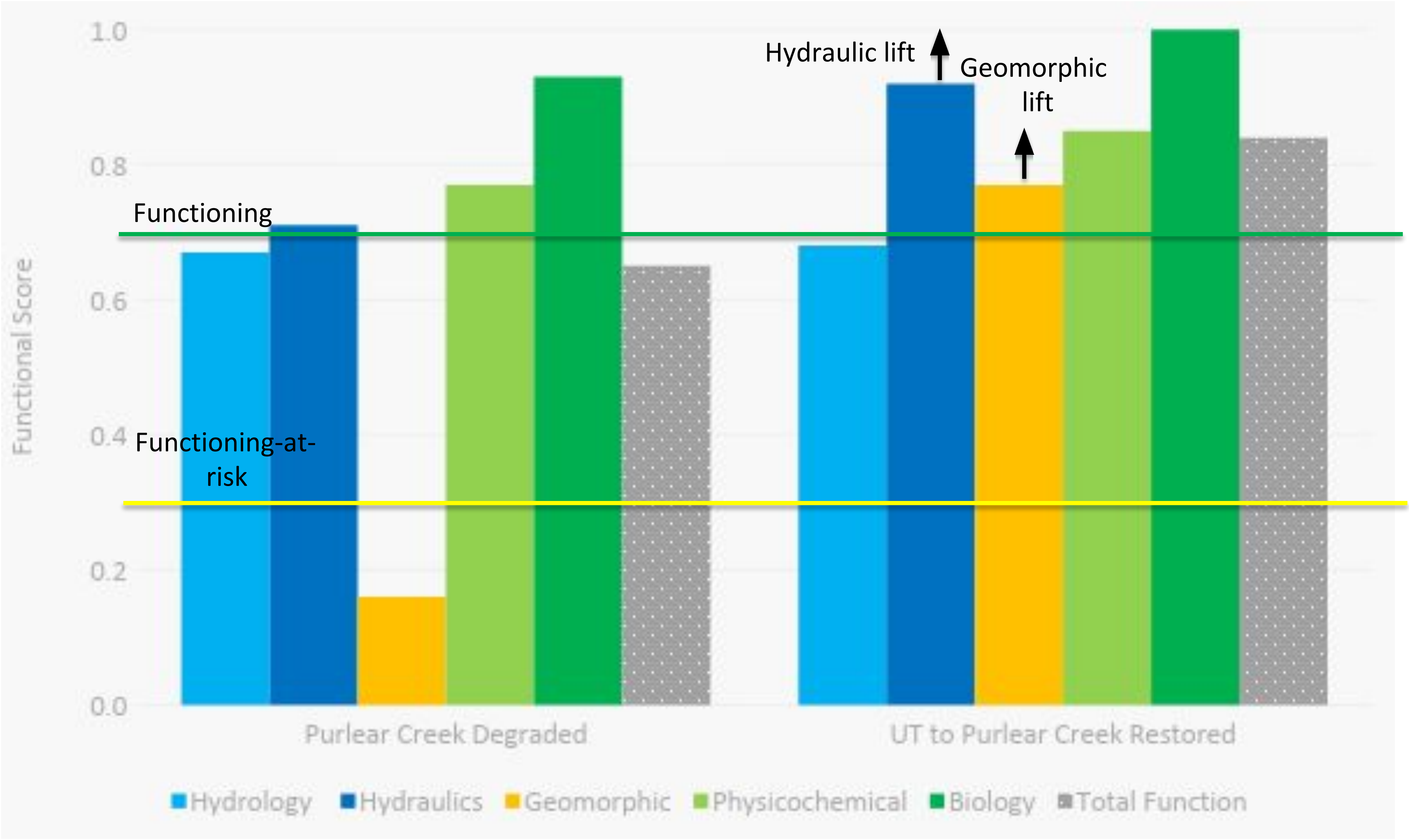
- Purlear, Wilkes County
- Rural forested watershed




Adjacent Restored Reach (2006)

| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 0.2 | 57 | Gravel | 2.10 | E4b |
| 0.4 | 58 | Gravel | 4.60 | C4b |

# Site 4: Purlear and UT to Purlear Creek

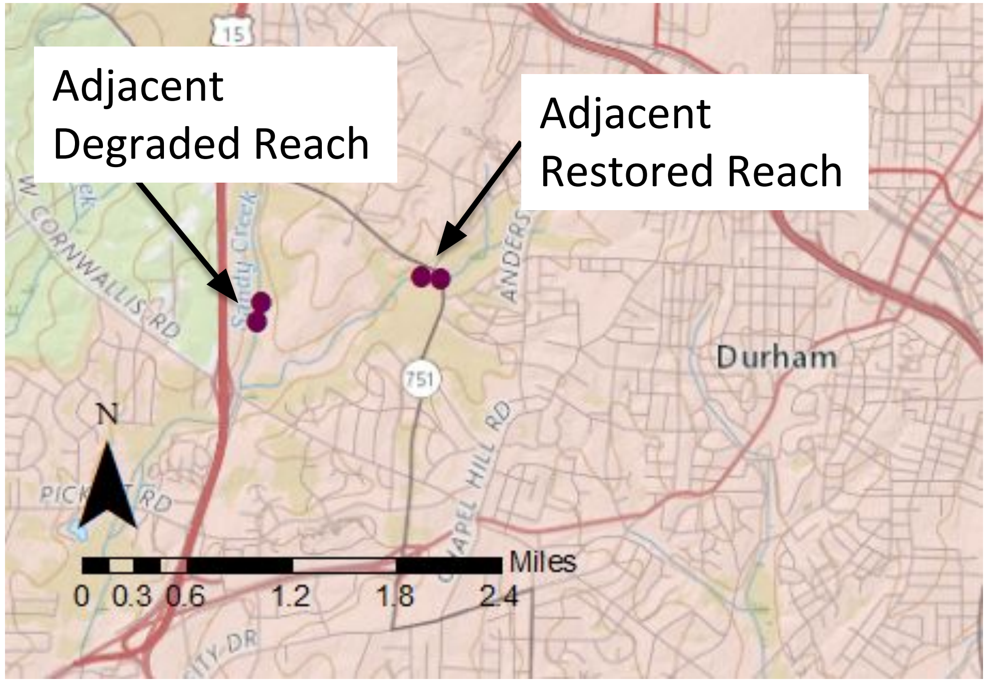


# Site 5: Sandy Creek

- Durham, Durham County
- Suburban watershed
- Restoration completed in 2005
- Restoration objectives:

  Improve water quality by:
  - floodplain reconnection
  - riparian vegetation replanting[4]

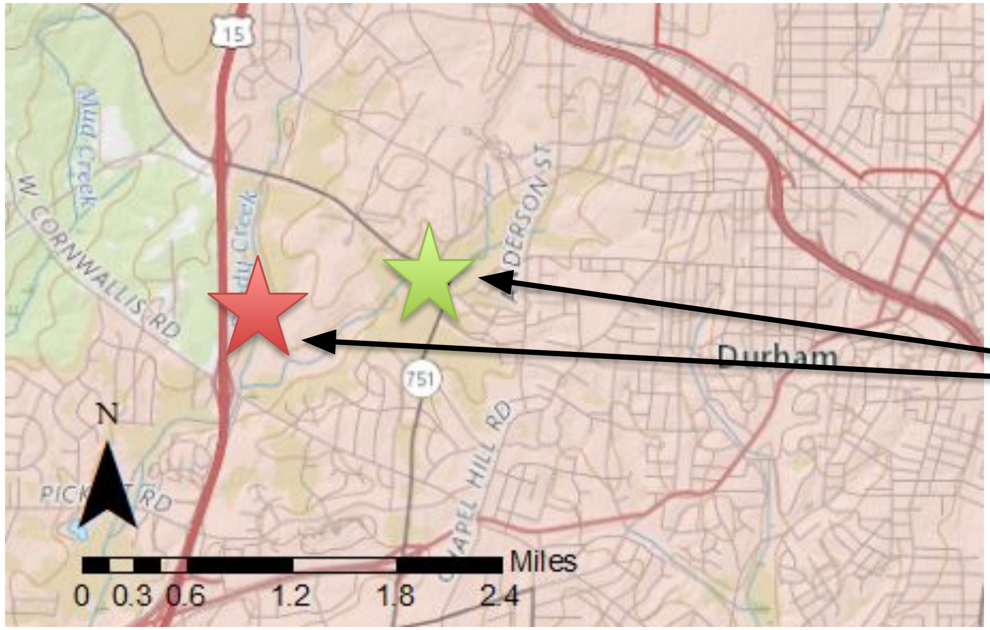
| | Degraded | Restored |
| --- | --- | --- |
| Drainage Area (sq. mi) | 2.0 | 1.8 |




[4] Final Report of Scientific Findings to NCDENR, 2008

# Site 5: Sandy Creek

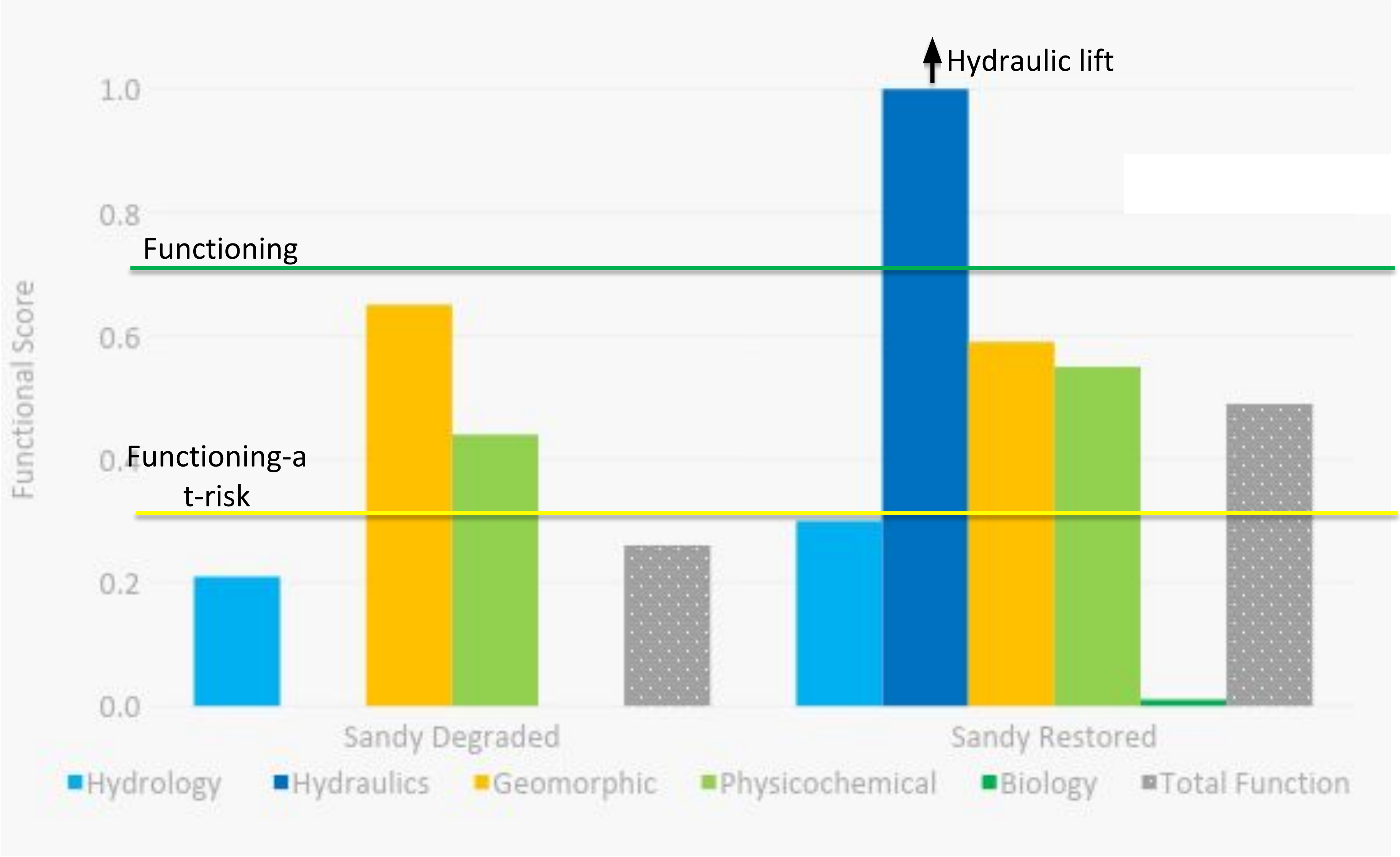
- Durham, Durham County
- Urban watershed




Adjacent Restored Reach (2005)

| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 2.0 | 87 | Sand | 0.27 | F5 |
| 1.8 | 87 | Sand | 0.23 | E5b |

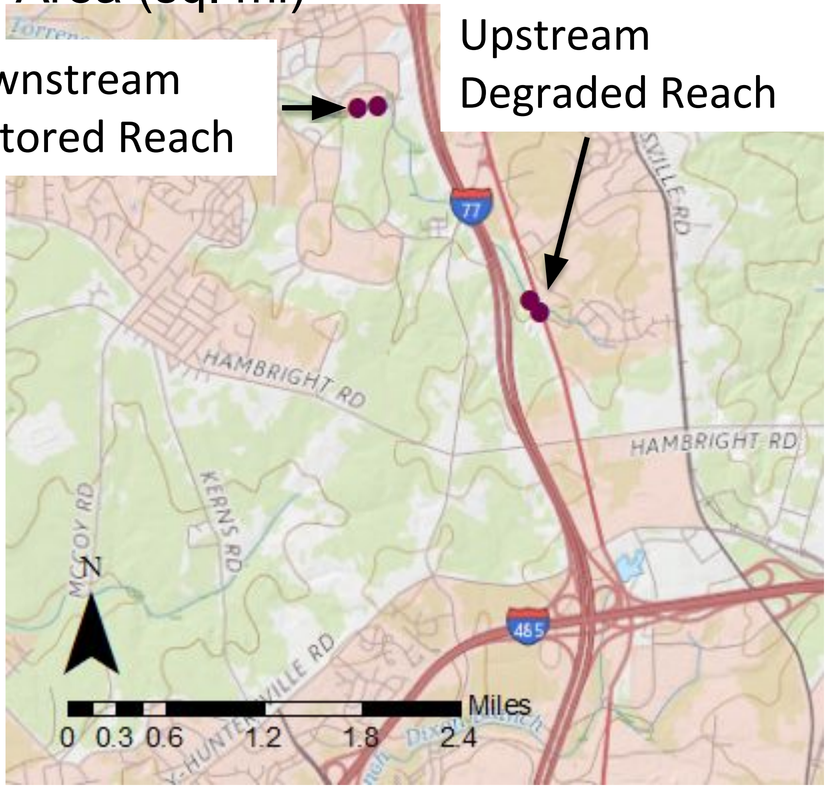
# Site 5: Sandy Creek



# Site 6: Torrence Creek

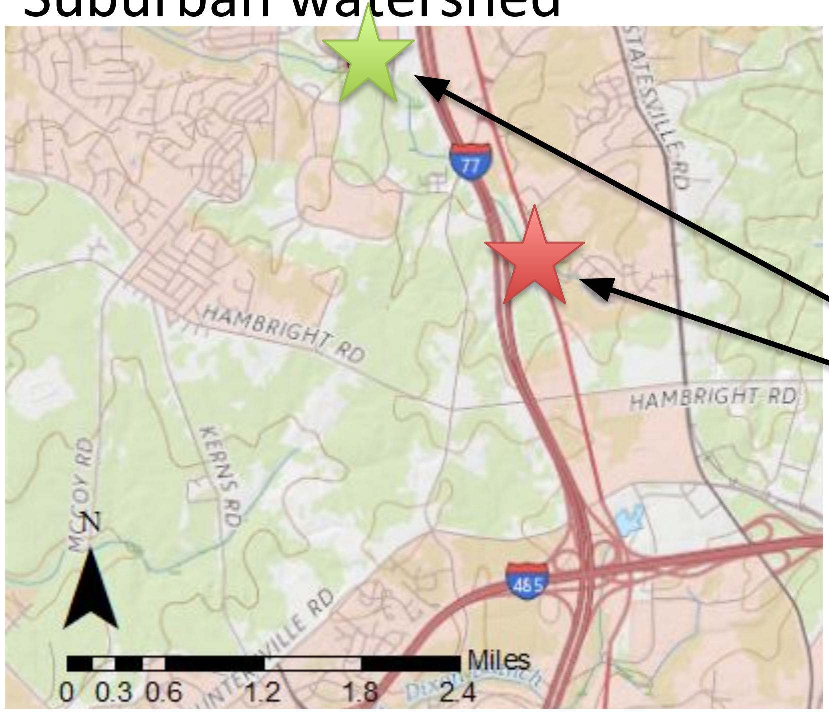
- Huntersville, Mecklenburg County
- Suburban watershed
- Restoration completed in 2013
- Restoration objectives:
  - Bank stabilization to reduce sediment loads from bank erosion

| | Degraded | Restored |
|---|---|---|
| Drainage Area (sq. mi) | 0.8 | 3.6 |

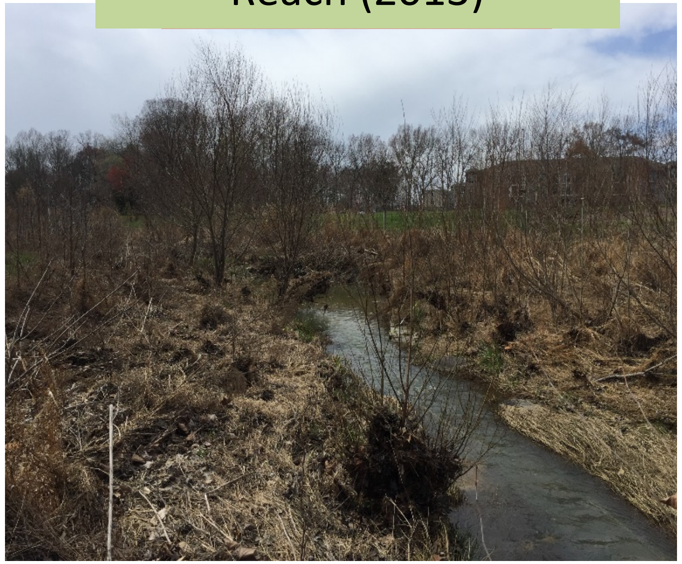


# Site 6: Torrence Creek

- Huntersville, Mecklenburg County
- Suburban watershed

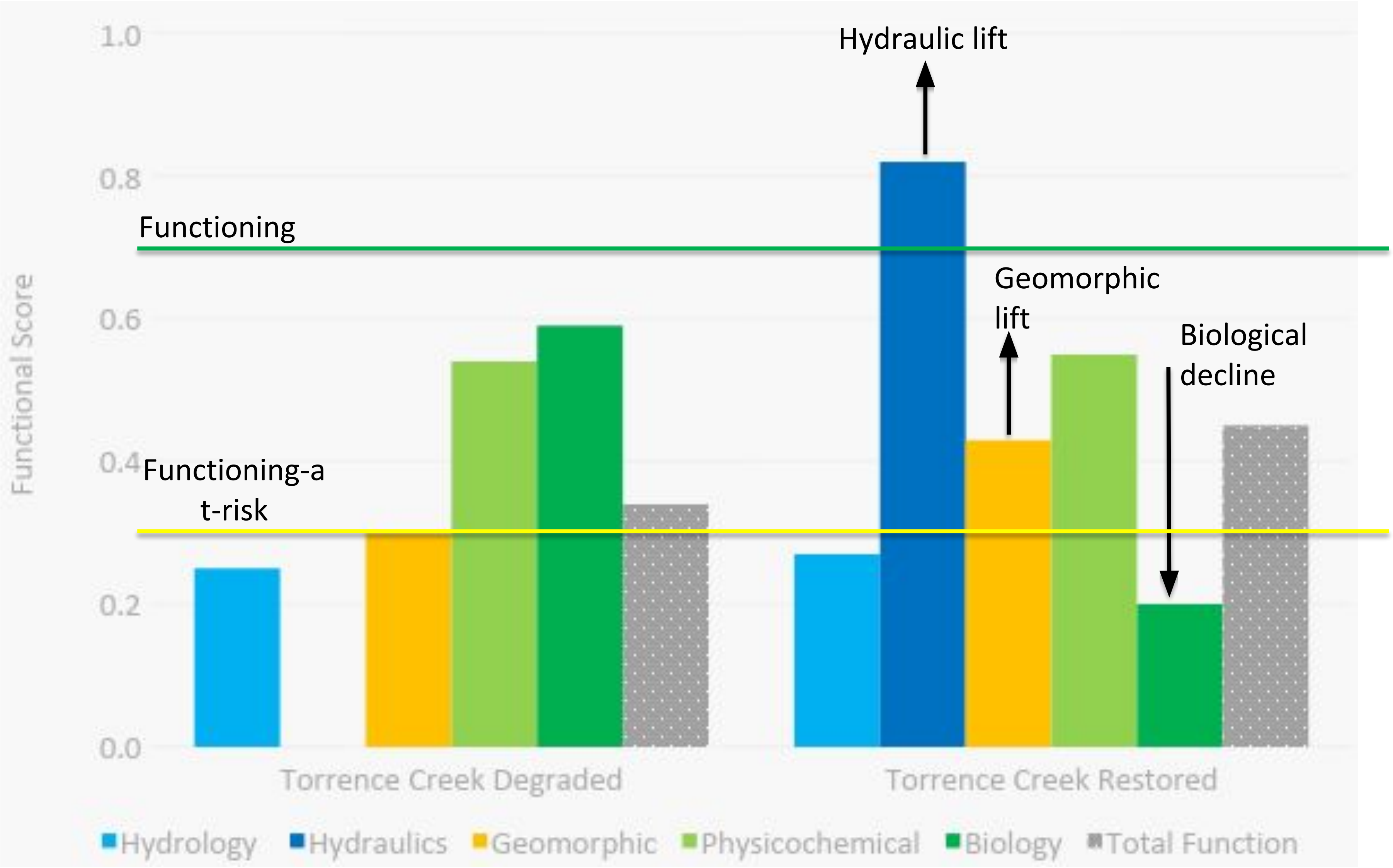



Downstream Restored Reach (2013)



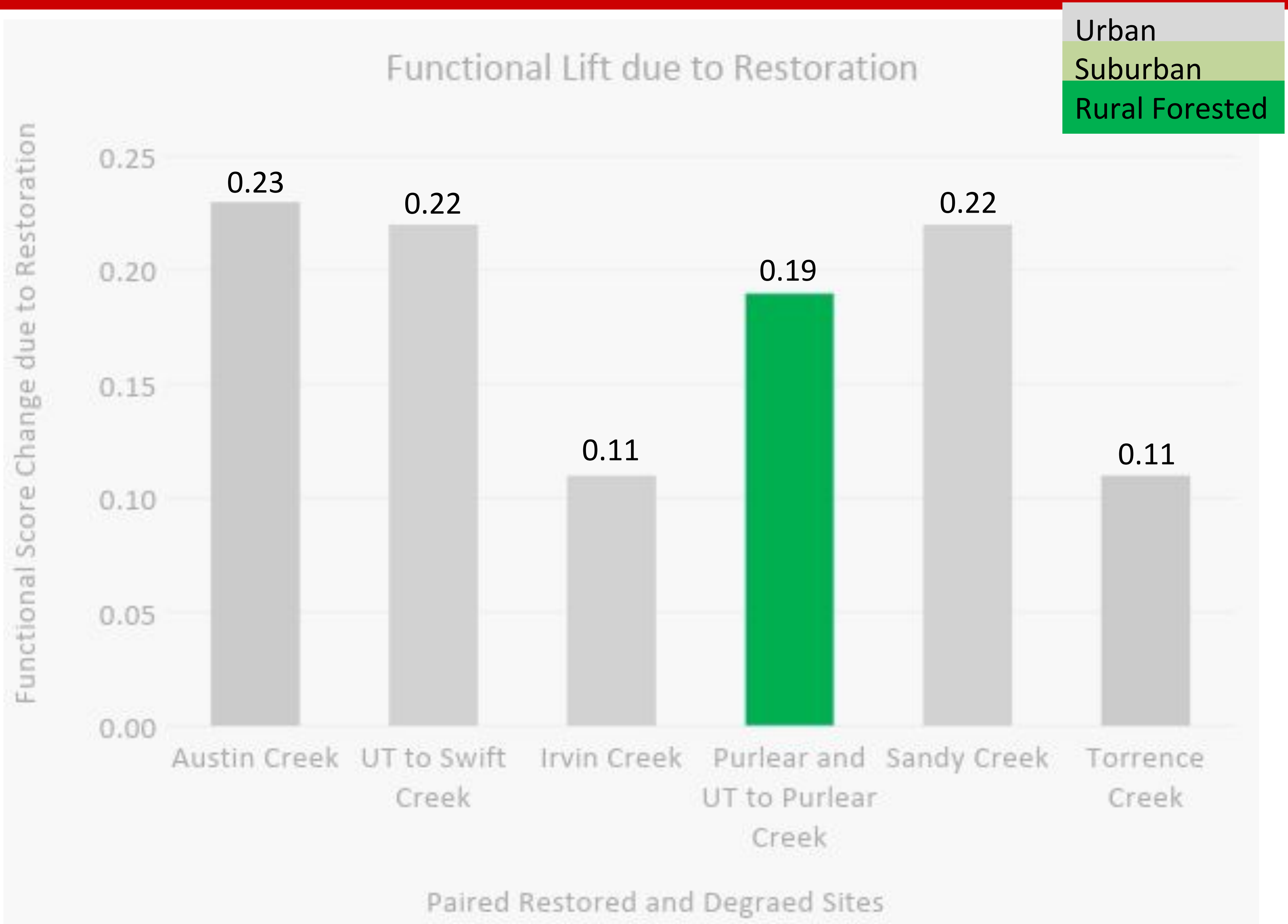
| Drainage Area (sq. mi) | Curve Number | Median Particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|
| 0.8 | 80 | Sand | 0.62 | G5c |
| 3.6 | 80 | Sand | 0.36 | C5 |

# Site 6: Torrence Creek



# Functional Change Summary

| Site | Overall Functional Change | | Functional Lift |
|---|---|---|---|
| Austin Creek | Not Functioning [0.26] | Functioning-At-Risk [0.49] | 0.23 |
| UT to Swift Creek | Not Functioning [0.21] | Functioning-At-Risk [0.43] | 0.22 |
| Irvin Creek | Functioning-At-Risk [0.36] | Functioning-At-Risk [0.47] | 0.11 |
| Purlear and UT to Purlear Creek | Functioning-At-Risk [0.65] | Functioning [0.84] | 0.19 |
| Sandy Creek | Not Functioning [0.27] | Functioning-At-Risk [0.49] | 0.22 |
| Torrence Creek | Functioning-At-Risk [0.34] | Functioning-At-Risk [0.45] | 0.11 |


Urban
Suburban
Rural Forested
Functional Lift due to Restoration
Functional Score Change due to Restoration
0.25
0.20
0.15
0.10
0.05
0.00
0.23
0.22
0.11
0.19
0.22
0.11
Austin Creek
UT to Swift Creek
Irvin Creek
Purlear and UT to Purlear Creek
Sandy Creek
Torrence Creek
Paired Restored and Degraed Sites

# General Insights

- **SQT functional scores** reflect **perceived** stream condition
- **Restored sites** exhibit **functional lift**
  - Lift largely due to improved **hydraulic and geomorphic function** addressed via restoration
- **Geomorphology** category may be **diluted**
  - Improvement in structural function is negated by low-scoring, post-restoration vegetation function
  - Incentivizes monitoring
- **Regionalization** is critical to capture diverse stream systems
  - **Sand-bedded systems** are ripple-dune-run systems; minimal riffles naturally
  - **Percent riffle** metric currently lumps run and riffle lengths together

# On-going Work

Data Collection & Analysis

- NC DEQ DMS **geomorphic reference** reaches (funded by DMS)
- NC DEQ DWR **biology reference** reaches
- Paired restored & degraded **rural agricultural** reaches

# Thank you

Sara Donatich
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EDF ENVIRONMENTAL DEFENSE FUND
Finding the ways that work

NC Environmental Quality

TN Department of Environment & Conservation

# Aligning Policy, Practice, and Agencies: Moving From Ratios to Function Lift

Vena Jones August 15, 2018


# 2004 TN Stream Mitigation Guidelines

- Ratio Based
  - Language focuses on projects that re-establish maximum **biological**, **chemical**, and **physical** integrity to resource
  - Describes **activity based crediting-pattern, profile, and dimension**
- Narrative Criteria
  - Does not require baseline information
  - Subjective
  - Creates **crediting drift**
  - TDEC uses to also inform on ratios for debits

# 2012 Draft Stream Mitigation Guidelines

Realized deficiencies in the 2004 mitigation guidelines; qualitative/subjective and crediting drift

- Wanted to be consistent with USACE requirements
- Wanted to align state guidelines with the 2008 Final Rule to the extent practical for TN
- Wanted to establish **functional lift**
- Move away from linear footage/ratio based system

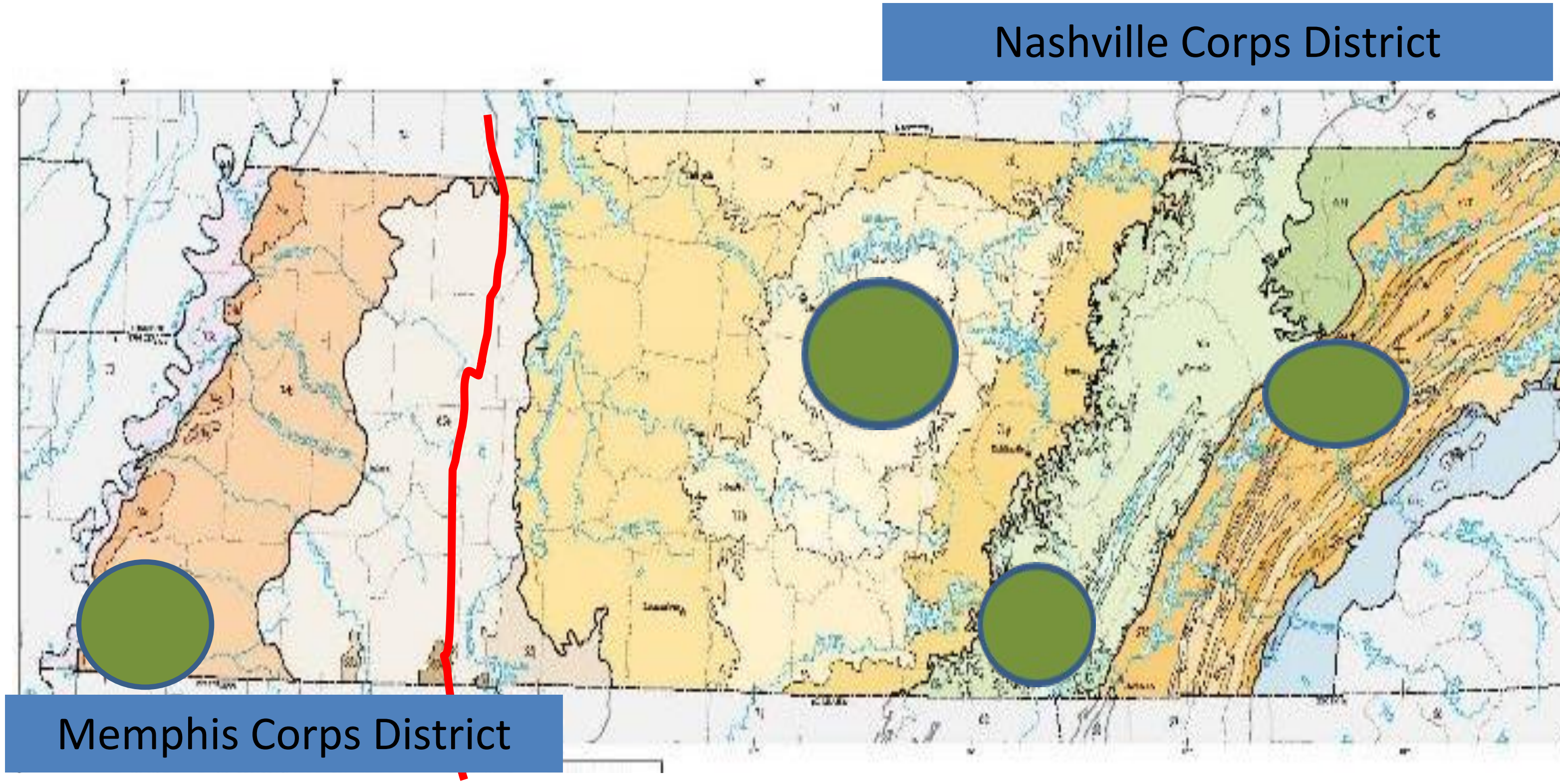
**Shortcomings**

- Received significant comment on efficacy of functional assessment parameters and methods
- Division lacked capacity to create a robust functional assessment

# TDEC Steps to Policy Change (2013)

- ID problem- uncertainty, credit drift, does not meet federal rule
- Engage our stakeholders
- Evaluate potential assessment methods
- Establish parallel pathways
  - Education and outreach
  - Incremental and iterative document development
  - Data gathering
  - Tool development
  - Tools to Policy

# Corps Districts in Tennessee



# Broad-based Collaboration 2014

- Stakeholdering
- Provide opportunity for wide ranging feedback
- NGOs
- Consultants
- All IRT agencies
- EPA
- Universities
- MS4s
- Citizens

- Important to have transparent, predictable, and repeatable processes for credits AND debits

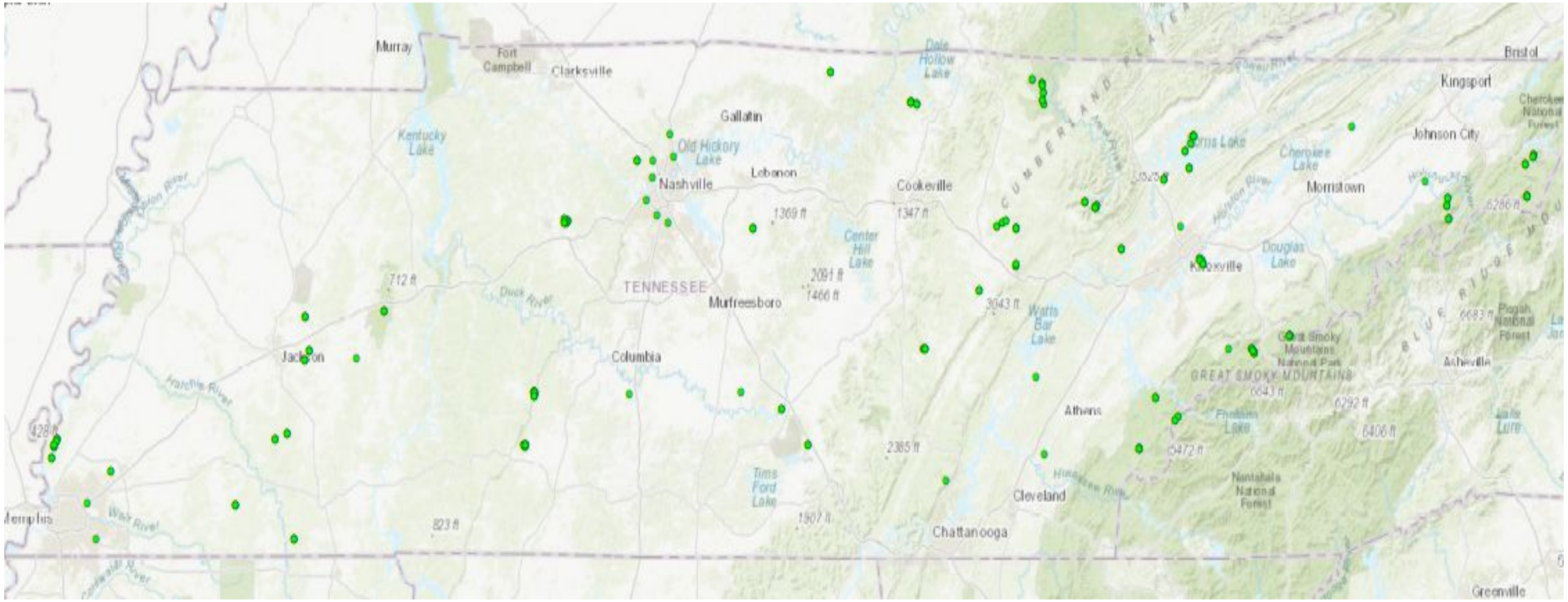
# Establishing Pathway (2014)

- *Measurable. Transparent. Predictable. Repeatable*
- Partner with USACE and IRT to develop/adopt functional assessment guidance tools
- Based on known stream functions
- Inherent relationships in stream channel metrics
- Incorporate TDEC biological and water quality data
- Regionalize as information becomes available

# Data gathering and analysis (2015)

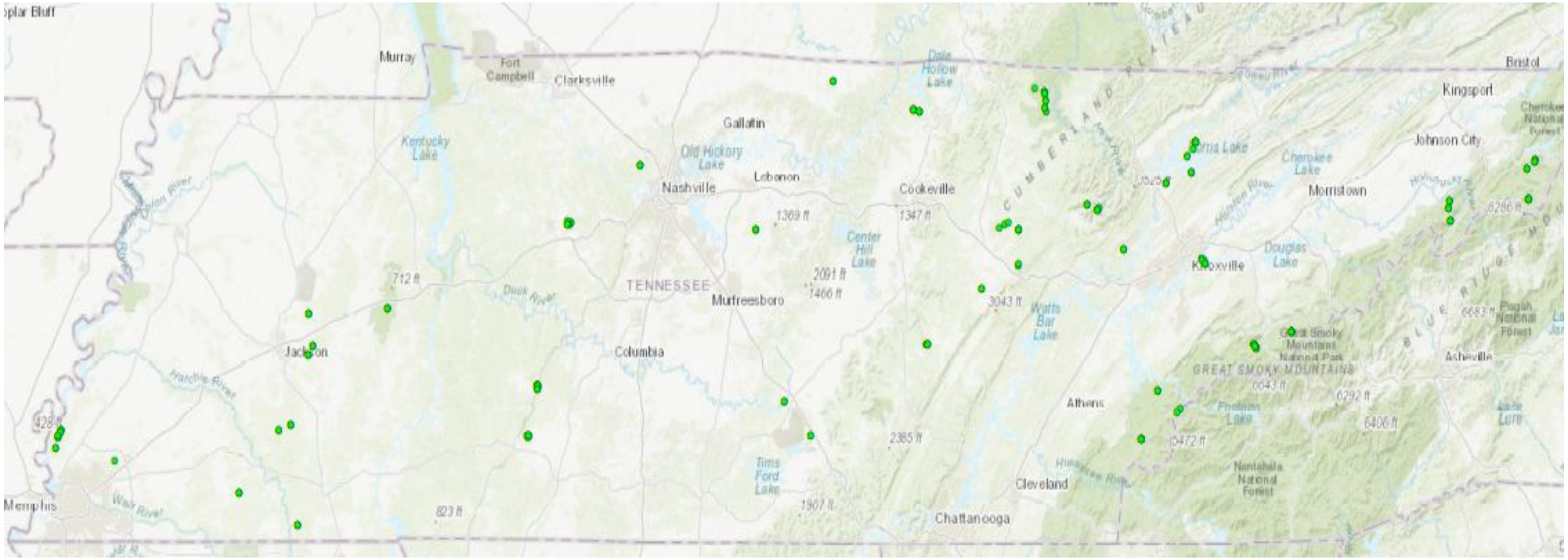
- Ecoregion based
- Regional Curves
- Bedform Diversity
- Large Woody Debris
- Riparian vegetation
- Biology
- Water Quality
- Ecogeomorphological Reference Sites
- Review 35 established compensatory mitigation sites with the TN SQT
- Riparian vegetation species composition

# All Sites (115)

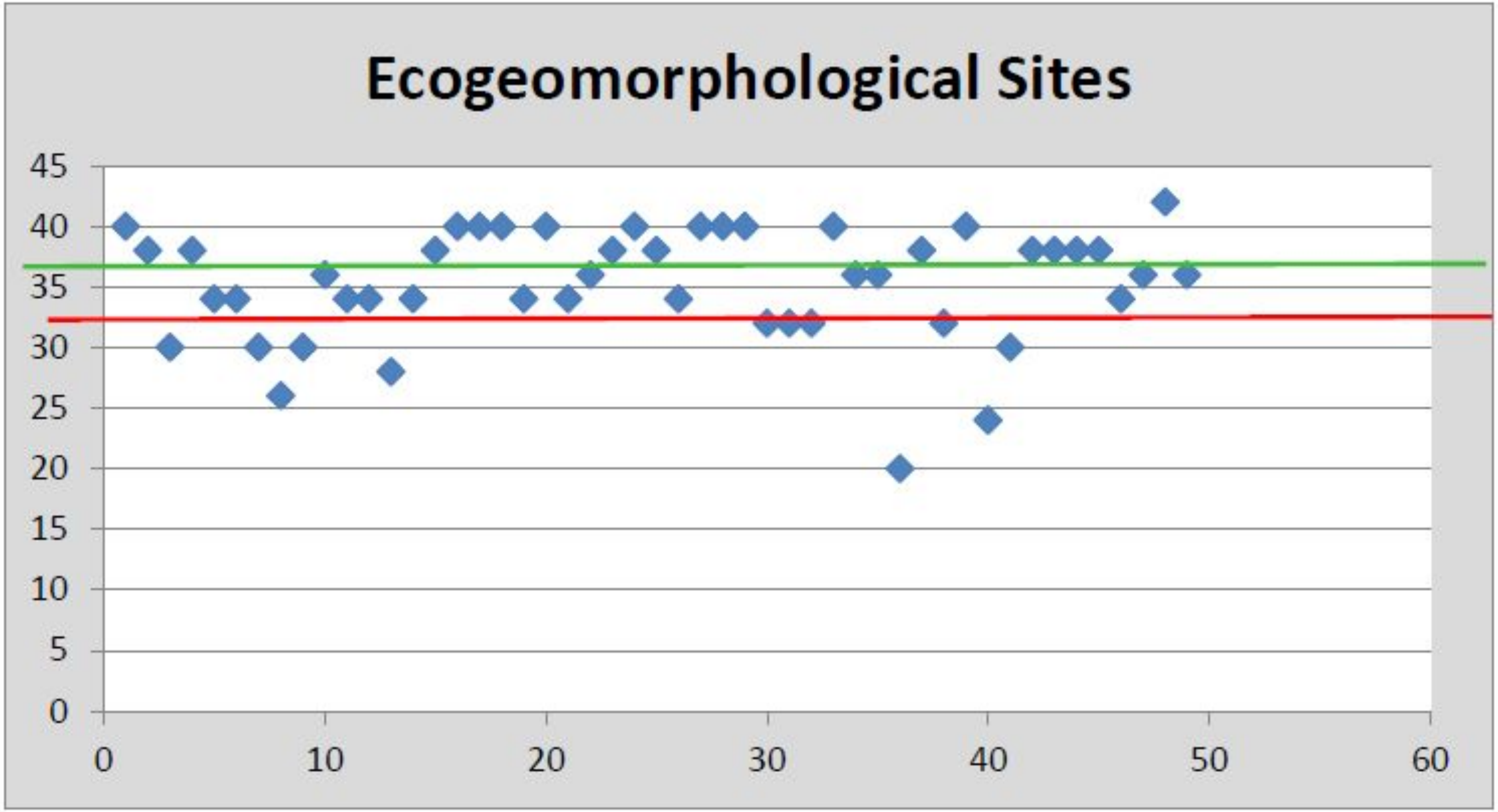



Department of
Environment &
Conservation

# GeoMorph Sites (92)



49 geomorph sites assessed for biology and WQ; 6 not supporting (FAR/NF) , 43 fully supporting; 11 ( high FAR) , 32 functioning are fully



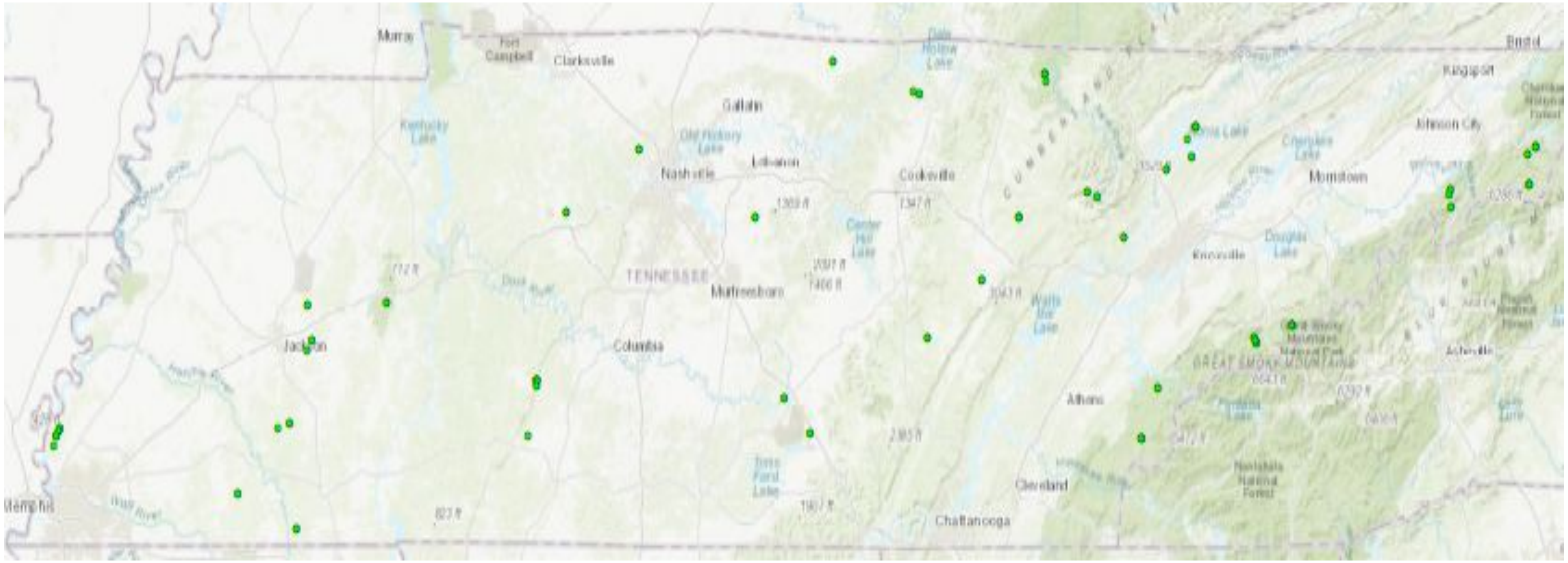
# Broad Based Collaboration

- Mitigation Assessment Team (MAT)
  - Internal working group of IRT
  - TDEC, USACE, & EPA
- MAT broken into parameter driven mini teams
  - Review  and analyze existing data
  - Research and gather new data
  - Incorporate TN specific data into performance curves from Stream Quantification Tool
- Stream Design Review Group
- All members of IRT

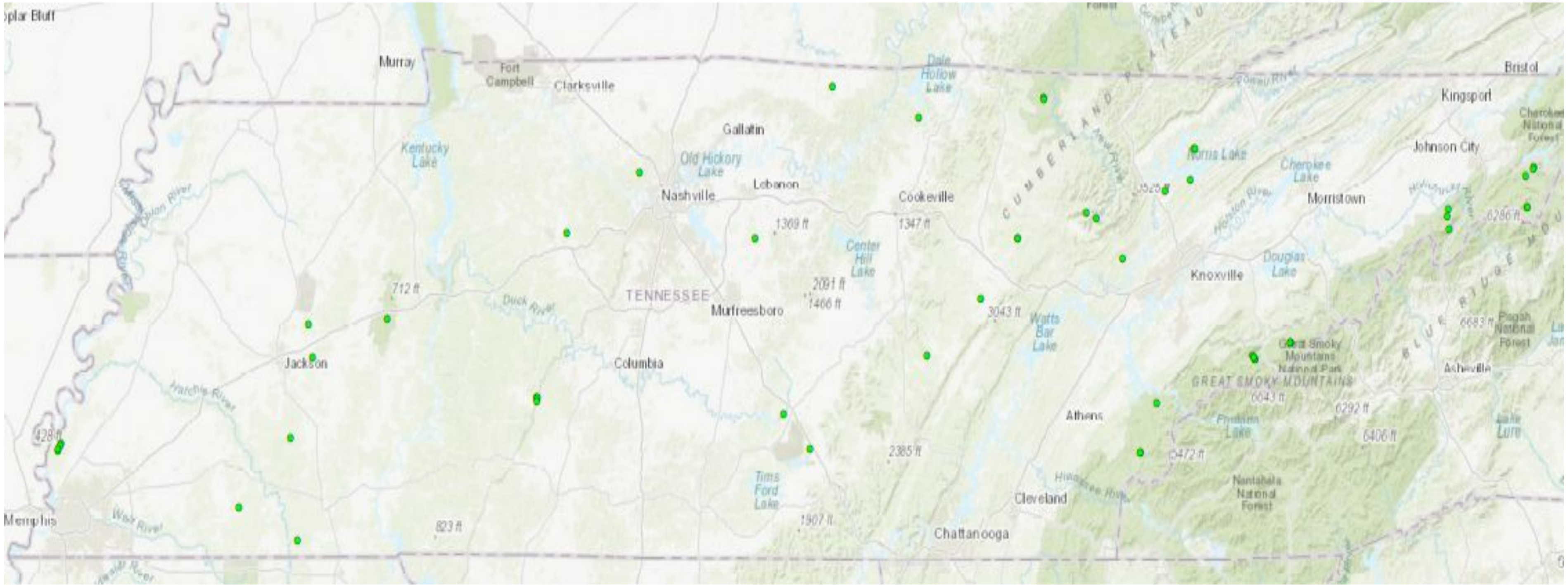
# TN SQT

| | | |
|---|---|---|
| Hydrology | Catchment Hydrology | Watershed Land Use Runoff Score |
| | Reach Runoff | Stormwater Infiltration |
| | | Concentrated Flow Points |
| Hydraulics | Floodplain Connectivity | Bank Height Ratio |
| | | Entrenchment Ratio |
| Geomorphology | Large Woody Debris | Large Woody Debris Index |
| | | # Pieces |
| | Lateral Migration | Erosion Rate (ft/yr) |
| | | Dominant BEHI/NBS |
| | | Percent Streambank Erosion (%) |
| | | Percent Armoring (%) |
| | Riparian Vegetation | Left - Average DBH |
| | | Right - Average DBH (in) |
| | | Left - Buffer Width (feet) |
| | | Right - Buffer Width (feet) |
| | | Left - Tree Density (#/acre) |
| | | Right - Tree Density (#/acre) |
| | | Left - Native Herbaceous Cover (%) |
| | | Right - Native Herbaceous Cover (%) |
| | | Left - Native Shrub Cover (%) |
| | | Right - Native Shrub Cover (%) |
| | Bed Material Characterization | Size Class Pebble Count Analyzer (p-value) |
| | Bed Form Diversity | Pool Spacing Ratio |
| | | Pool Depth Ratio |
| | | Percent Riffle (%) |
| | | Aggradation Ratio |
| | Plan Form | Sinuosity |
| Physicochemical | Bacteria | E. Coli (Cfu/100 mL) |
| | Organic Enrichment | Percent Nutrient Tolerant Macroinvertebrates (%) |
| | Nitrogen | Nitrate-Nitrite (mg/L) |
| | Phosphorus | Total Phosphorus (mg/L) |
| Biology | Macroinvertebrates | Tennessee Macroinvertebrate Index |
| | | Percent Clingers (%) |
| | | Percent EPT - Cheumatopsyche (%) |
| | | Percent Oligochaeta and Chironomidae (%) |
| | Fish | Native Fish Score Index |
| | | Catch per Unit Effort Score |

# Biology and WQ Sampling Sites (75)



# EcoMorph Sites (63)



# Bridging the Gap: tools into policy

- Crediting is easy-lift is lift
- Debits
- Transitioning
- Potential to change currency AND reduce mitigation requirement
- No net loss

# Projects in the Pipeline

GEORGIA ON MY MIND

| Reach | Existing Length | Proposed Length | Extra LF | Base Ratio | Ratio for Extra LF | Total Credits for Reach | Proposed FF - Existing FF | Functional Lift Score |
|---|---|---|---|---|---|---|---|---|
| AB | 1316 | 1713 | 397 | 1.5 | 1.1 | 1238.2 | 677 | 0.36 |
| BB | 1631 | 2220 | 589 | 1.5 | 1.1 | 1622.8 | 904 | 0.37 |
| EB | 1834 | 2598 | 764 | 1.5 | 1.1 | 1917.2 | 1032 | 0.35 |
| ARB | 1347 | 1866 | 519 | 1.5 | 1.1 | 1369.8 | 763 | 0.37 |
| CPC | 6272 | 7215 | 943 | 1.5 | 1.1 | 5038.6 | 3812 | 0.51 |
| FC | 986 | 1340 | 354 | 1.5 | 1.1 | 979.2 | 427 | 0.25 |
| | | | | | TOTALS | 12166 | 7615 | |
| | | | | | | | AVERAGE | 0.368333333 |

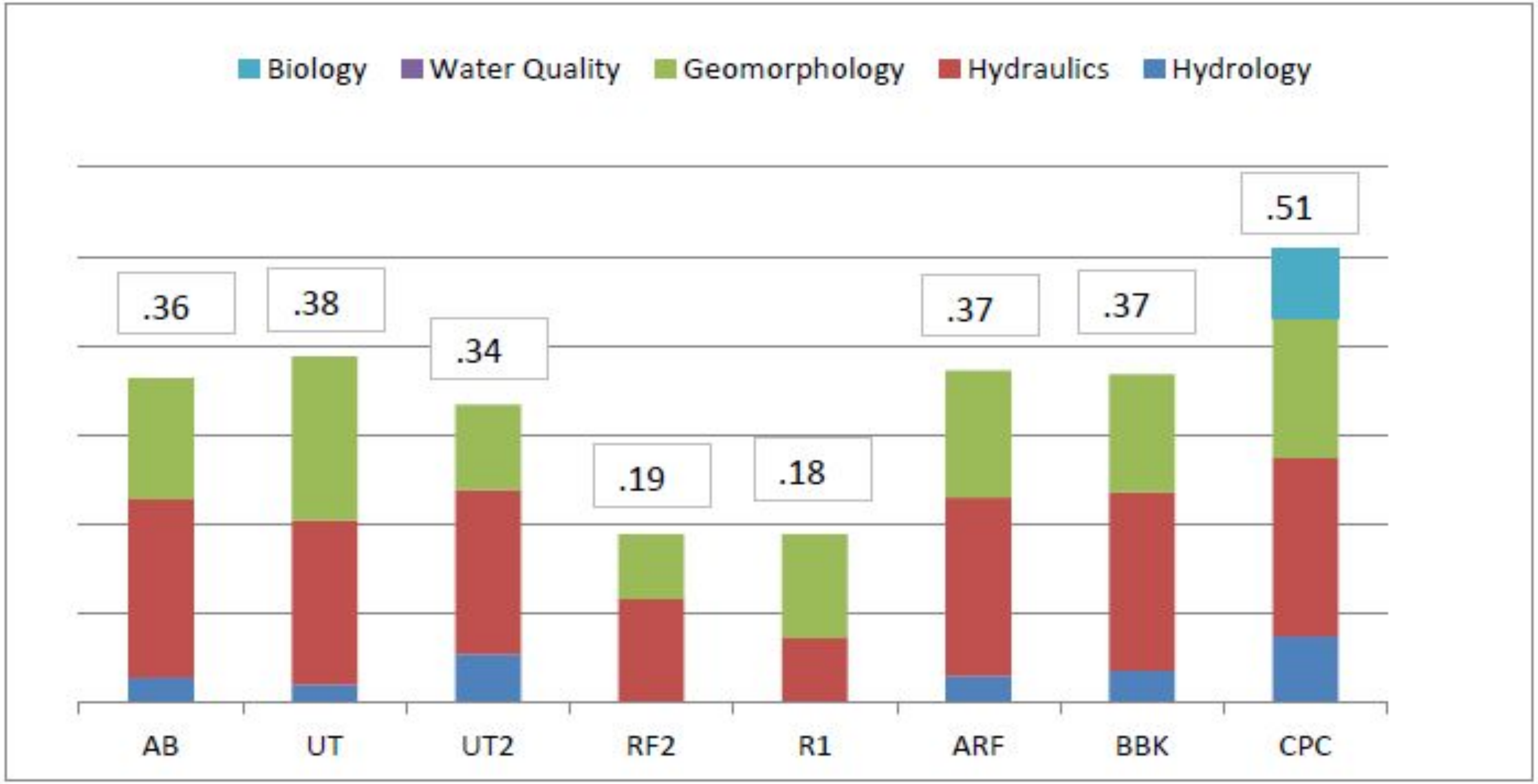
FORKS AND SPOONS

| Reach | Existing Length | Proposed Length | Extra LF | Base Ratio | Ratio for Extra LF | Total Credits for Reach | Proposed FF - Existing FF | Functional Lift Score |
|---|---|---|---|---|---|---|---|---|
| UT1 | 2509 | 3266 | 757 | 1.5 | 1.1 | 2360.8 | 1309 | 0.38 |
| UT2 | 492 | 841 | 349 | 1.5 | 1.1 | 645.3 | 321 | 0.34 |
| | | | | | TOTALS | 2361 | 1309 | |
| | | | | | | | AVERAGE | 0.36 |

RAY OF SUNSHINE

| Reach | Existing Length | Proposed Length | Extra LF | Base Ratio | Ratio for Extra LF | Total Credits for Reach | Proposed FF - Existing FF | Functional Lift Score |
|---|---|---|---|---|---|---|---|---|
| R1 | 5223 | 5223 | 0 | 3 | 1.1 | 1741.0 | 940 | ERRORS |
| R2 | 1887 | 1887 | 0 | 4 | 1.1 | 471.8 | 245 | ERRORS |
| R3 | 2666 | 2666 | 0 | 3 | 1.1 | 888.7 | 720 | 0.27 |
| R4 | 1025 | 1365 | 340 | 3 | 1.1 | 650.8 | 423 | 0.29 |
| R5 | 960 | 1260 | 300 | 3 | 1.1 | 592.7 | 256 | 0.38 |
| R6 | 2932 | 3628 | 696 | 3 | 1.1 | 1610.1 | 718 | ERRORS |
| | | | | | TOTALS | 5955 | 3302 | |
| | | | | | | | AVERAGE | 0.313333333 |

# Proposed Lift



# TN Debit Tool

- Debits will decrease
  - Proposed state rules establish existing condition
- Not all impacts are the same
- TDEC can't assess every impact site pre-impact
  - Standard Existing Condition Score (0.80)
  - Lower limit of ECS (0.40)
- Credits and debits need to be in the same currency
- Reporting and performance standards for all project types
- Biological assessments

**Tier 5 –This tier represents activities that result in a significant functional loss to most if not all stream resource values. Examples include but are not limited to:**

- **Pipe or 4-Sided Box Culvert:** These pipes encapsulate the stream for greater than 200 linear feet either cumulatively or individually. Includes wingwalls, any energy dissipation device, u-shaped endwalls. All components attached to the pipe structure itself. Does not include riprap. Riprap at the upstream or downstream section of a pipe is calculated using the bed and/or bank armoring descriptions by tier. These structures may affect the channel at the crossing approaches when the activity requires reshaping this zone making the stream wider and potentially deeper. This activity eliminate most stream resource values and functions including riparian vegetation, macroinvertebrates and fish communities, water quality, floodplain connectivity, natural bedforms and lateral migration and eliminates hydrologic contributions from reach runoff.

- **Channelization or Full Channel Armoring:** Affects both banks for a distance of 200 feet or greater. Channels are lined along the bed and banks with concrete, grouted riprap, or concrete articulated mats. These streams are incised and alterations most likely include channel bank and potentially bed reshaping. The bed material is not suitable substrate for aquatic colonization and these channels will most likely be maintained in their current state. Vegetation in the near buffer zone is restricted and routinely eliminated.

**Tier 6 – This tier represents 100% functional loss of a stream's resource value.**

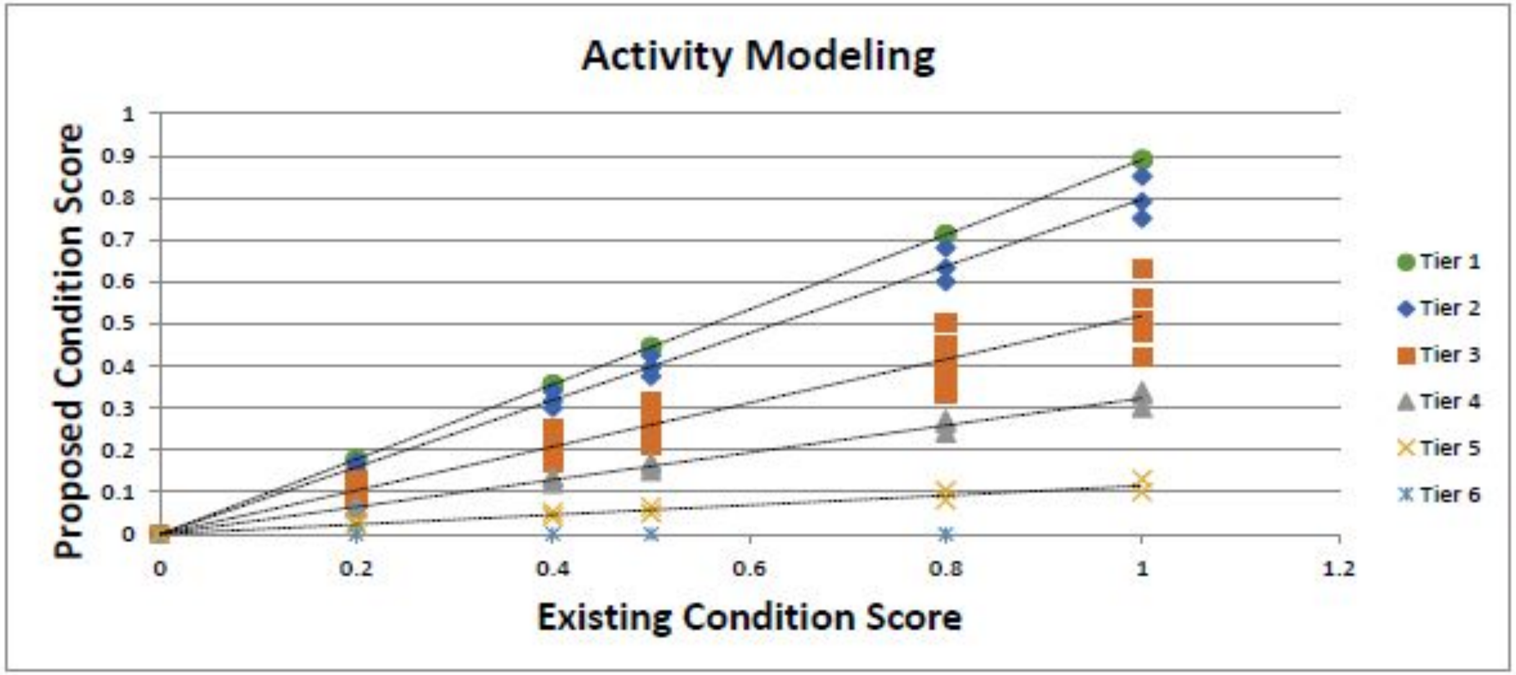
| Tier | Functional Loss Description |
| --- | --- |
| 0 | No appreciable permanent loss of resource value |
| 1 | Minimal loss of resource value (stream function). Impacts to reach runoff, lateral migration and/or riparian vegetation. No appreciable impact to water quality, and macroinvertebrate and fish communities. |
| 2 | Partial loss of resource value (stream function). Impacts to reach runoff, lateral migration, bed form diversity, and riparian vegetation. No appreciable impact to water quality, and macroinvertebrate and fish communities. |
| 3 | Permanent loss of some of resource value (stream function). Impacts to reach runoff, floodplain connectivity, lateral migration, riparian vegetation, and bed form diversity. May also include impacts to large woody debris. Minor impacts to water quality and moderate impacts to macroinvertebrate and fish communities. |
| 4 | Permanent loss of most of resource value (stream function). Impacts to reach runoff, floodplain connectivity, lateral migration, riparian vegetation, , and bed form diversity. May also include impacts to plan form and/or large woody debris. Significant impacts to water quality and macroinvertebrate and fish communities. |
| 5 | Permanent loss of most of resource value (stream function). Removal of all aquatic functions except for hydrology. |
| 6 | Total and permanent loss of all resource value (stream function). Complete elimination of all stream functions. Total loss of existing and potential function. |

## Proposed Impact Factors and Activity Modeling:

graph represents combined data from modeling individual activities and the impact these actions have on stream resources. Table establishes tier, functional loss and the impact factor used to determine debits.

| Impact Severity Tiers | Impact Factors | Percent Functional Loss |
|---|---|---|
| Tier 0 | 1.00 | 0% |
| Tier 1 | 0.89 | 11% |
| Tier 2 | 0.8 | 20% |
| Tier 3 | 0.52 | 48% |
| Tier 4 | 0.32 | 68% |
| Tier 5 | 0.12 | 80% |
| Tier 6 | 0.00 | 100% |

The Impact Factors were developed from linear regression equations of modeled impact scenarios using a simplified version of the SQT. Each impact type was described in detail and evaluated for stream resource values loss by the proposed activities. Using a simplified SQT, an individual impact factor was developed for each impact type. These types were grouped based on % functional loss (in clusters) and graphed in "tiers". A trendline was drawn and the slope of that line became the combined impact factor representing all activities within a given tier.



Name:
Date:

# TN SQT DEBIT TOOL v1.0

DRAFT DELIBERATIVE,
NOT TO BE RELEASED OUTSIDE THE AGENCY

**Project ID:**

| |
|---|
| Users Input Values |
| Users select values from a pull-down menu |

| Stream | Reach ID | Existing Length | ECS | Proposed Length | Impact Severity Tier | PCS | Change in FF |
|---|---|---|---|---|---|---|---|
| STR-1 | Box culvert | 26 | 0.8 | 26 | Tier 5 | 0.10 | -18.2 |
| | riprap | 65 | 0.8 | 65 | Tier 3 | 0.42 | -24.7 |
| STR-2 | Box culvert | 142 | 0.8 | 142 | Tier 5 | 0.10 | -99.4 |
| | riprap | 42 | 0.8 | 42 | Tier 3 | 0.42 | -16.0 |
| STR-3 | Fill | 221 | 0.8 | 221 | Tier 6 | 0.00 | -176.8 |
| | | | | | Tier 6 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |
| | | | | | Tier 3 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 6 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 3 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |

**Total Functional Loss: -335.1 FF**

Name:
Date:

# TN SQT DEBIT TOOL v1.0

DRAFT DELIBERATIVE,
NOT TO BE RELEASED OUTSIDE THE AGENCY

Project ID:

| Users Input Values |
| --- |
| Users select values from a pull-down menu |

| Stream | Reach ID | Existing Length | ECS | Proposed Length | Impact Severity Tier | PCS | Change in FF |
| --- | --- | --- | --- | --- | --- | --- | --- |
| STR-1 | Box culvert | 26 | 0.4 | 26 | Tier 5 | 0.05 | -9.1 |
| | riprap | 65 | 0.4 | 65 | Tier 3 | 0.21 | -12.4 |
| STR-2 | Box culvert | 142 | 0.4 | 142 | Tier 5 | 0.05 | -49.7 |
| | riprap | 42 | 0.4 | 42 | Tier 3 | 0.21 | -8.0 |
| STR-3 | Fill | 221 | 0.4 | 221 | Tier 6 | 0.00 | -88.4 |
| | | | | | Tier 6 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |
| | | | | | Tier 3 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 6 | 0.00 | 0.0 |
| | | | | | Tier 5 | 0.00 | 0.0 |
| | | | | | Tier 4 | 0.00 | 0.0 |
| | | | | | Tier 3 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 0 | 0.00 | 0.0 |
| | | | | | Tier 1 | 0.00 | 0.0 |
| | | | | | Tier 2 | 0.00 | 0.0 |

**Total Functional Loss: -167.5 FF**

# Comparison of Permitted to Proposed

| DEBITS | | | |
|---|---|---|---|
| 2004 Standard | Draft 2018 | | |
| | ECS 0.80 | ECS 0.50 | ECS 0.40 |
| 1140 | 588.64 | 367.98 | 293.32 |
| 461 | 325.8 | 204 | 162.9 |
| 2285 | 1643.3 | 1031.68 | 821.75 |
| 310 | 240 | 150 | 120 |
| 496 | 294.5 | 184.5 | 147.2 |

# Moving to a Draft TN Mitigation Guidelines

- Use TN SQT to assess established and proposed mitigation sites and compare to 2004 guidelines
- Use TN SQT to assess permitted impacts and compare debits
- MOU with USACE
- Draft Mitigation Guidelines- AUGUST 2018
  - TN Debit Tool
  - TN SQT
  - 3 User Manuals
- TRANSITION TRANSITION TRANSITION

**Vena Jones**
**DWR-Natural Resources Unit**
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# Development of an Interim Stream Quantification Tool for Georgia

Eric Somerville
Oceans, Wetlands & Streams Protection Branch
U.S. EPA Region 4

somerville.eric@epa.gov

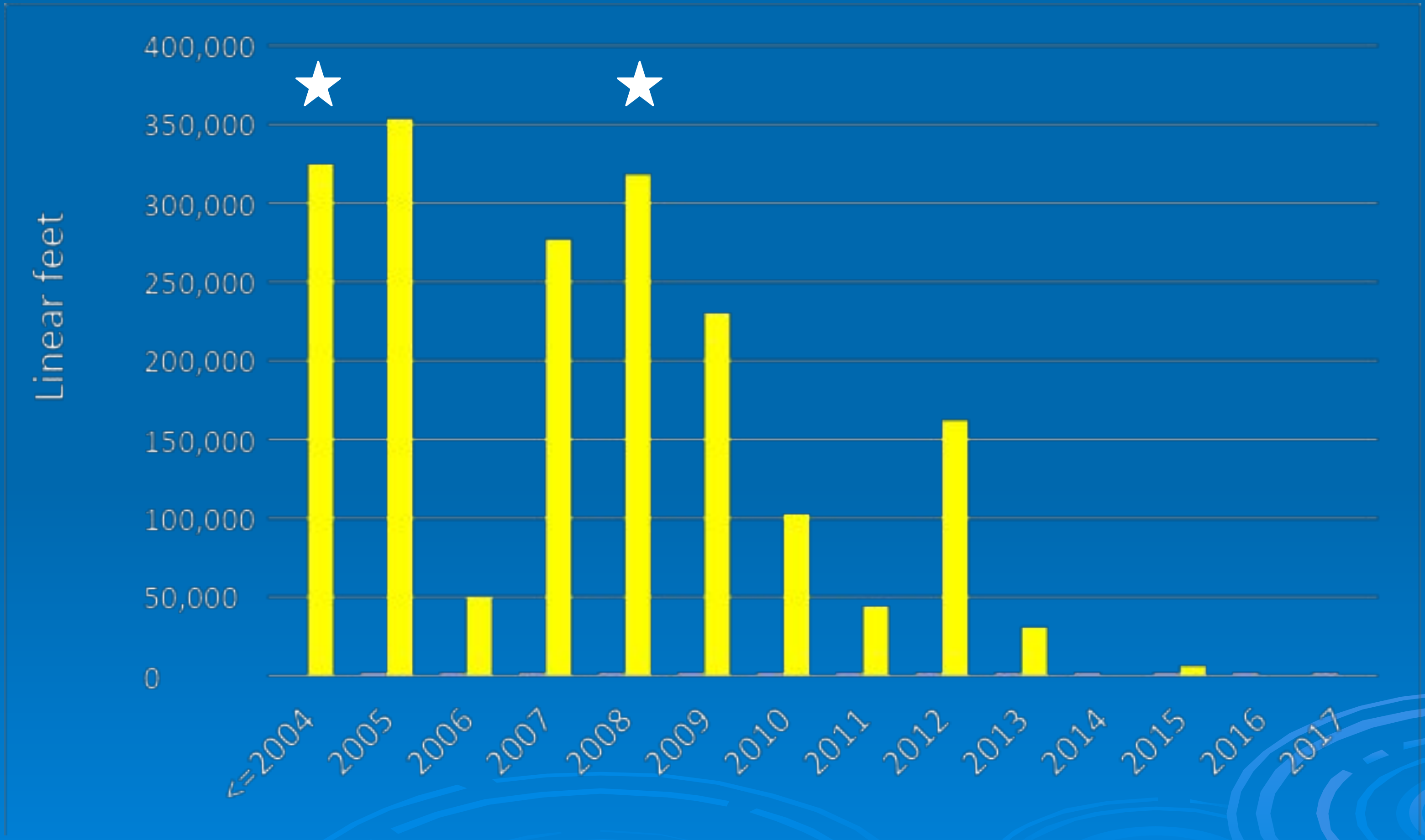
# Georgia Interim SQT, 2018

Not the "what," but the "why"

Photo: St. Mary's Fluvial Studies, https://sites.google.com/site/stmarysfluvialstudies/meanders-alice-emily

The following presentation is based solely on views of the author and is neither endorsed by, nor the official position of the U.S. Environmental Protection Agency.

# Annual Approved Stream Mitigation in Georgia




Source: RIBITS, accessed 7/6/2018

# Georgia Stream Mitigation Credits, 2004

| STREAM CHANNEL RESTORATION, STREAM RELOCATION AND STREAMBANK RESTORATION WORKSHEET | | | | | |
|---|---|---|---|---|---|
| **Net Benefit** | All proposals must include at least a 25’ riparian buffer on both banks<br>Buffers >50’ +2’/%slope also may generate riparian credit (use see buffer worksheet) | | | | |
| | Streambank Stabilization | Structure Removal | Stream Channel Restoration and Stream Relocation | | |
| | 2.0 | 4.0 to 8.0 | Priority 4<br>1.0 | Priority 3<br>4.0 | Priority 1 or 2<br>8.0 |
| **Monitoring/ Contingency** | Minimal<br>(Required)<br>0 | Moderate<br>0.3 | Substantial<br>0.4 | Excellent<br>1.0 | |
| **Priority Area** | Tertiary<br>0.05 | Secondary<br>0.2 | Primary<br>1.0 | | |
| **Control** | RC on restored channel and 25’ buffer (Required)<br>0.1 | Required RC + CE or GPP<br>0.3 | Required RC + CE + GPP<br>0.5 | | |
| **Mitigation Timing** | Schedule 3<br>0 | Schedule 2 (Use for all banks)<br>0.1 | Schedule 1<br>0.5 | | |

# 2008 Mitigation Rule:

## Mitigation objective

- Offset environmental losses resulting from unavoidable impacts to waters of the U.S.,
- Based on the lost aquatic resource functions,
  - ~must identify a target resource type & resource functions.

## Ecological Performance Standards

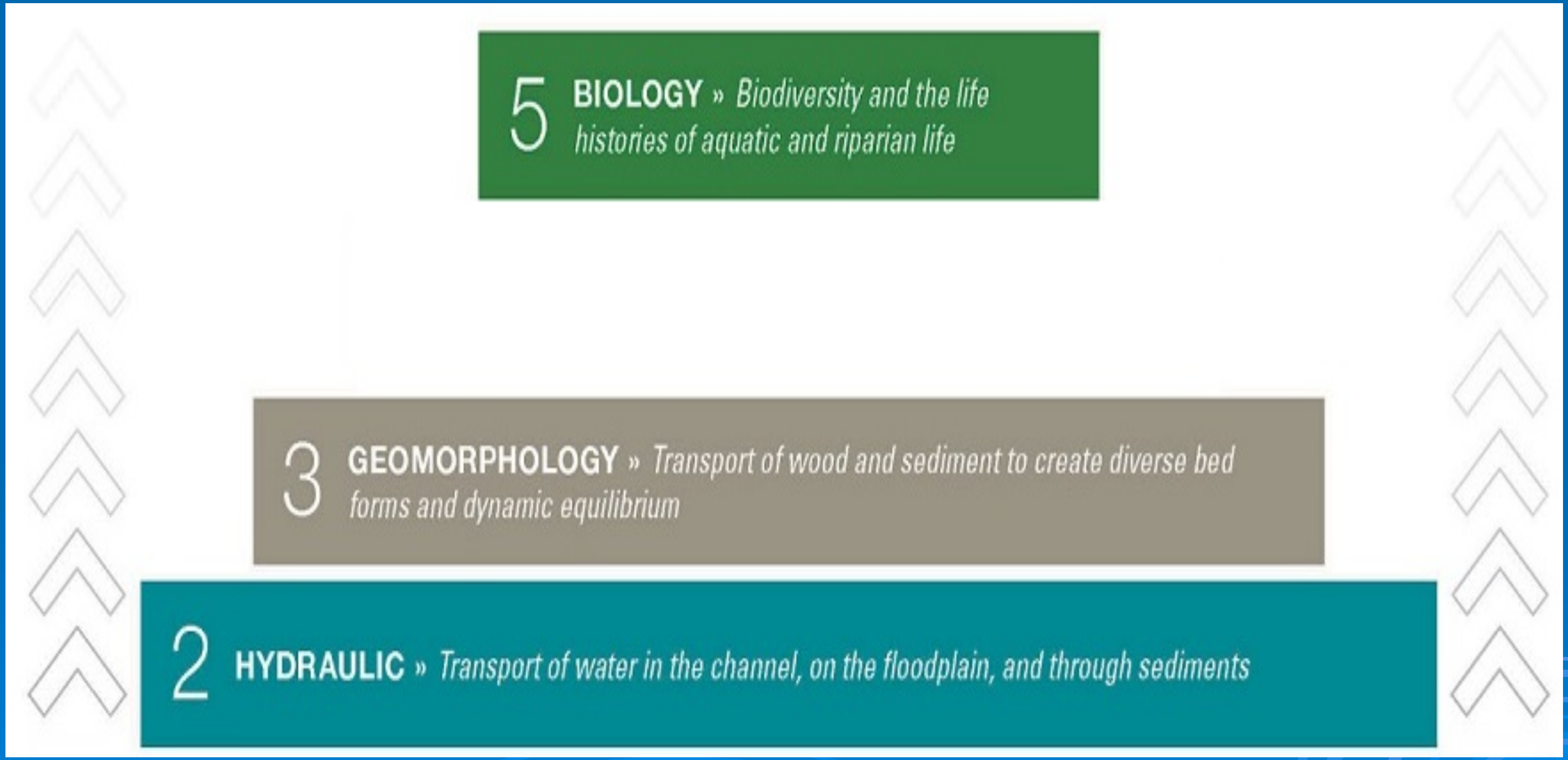
- Based on project objectives,
- Based on attributes that are objective and verifiable,
- Used to determine if the project is developing into the desired resource type & providing the expected functions.

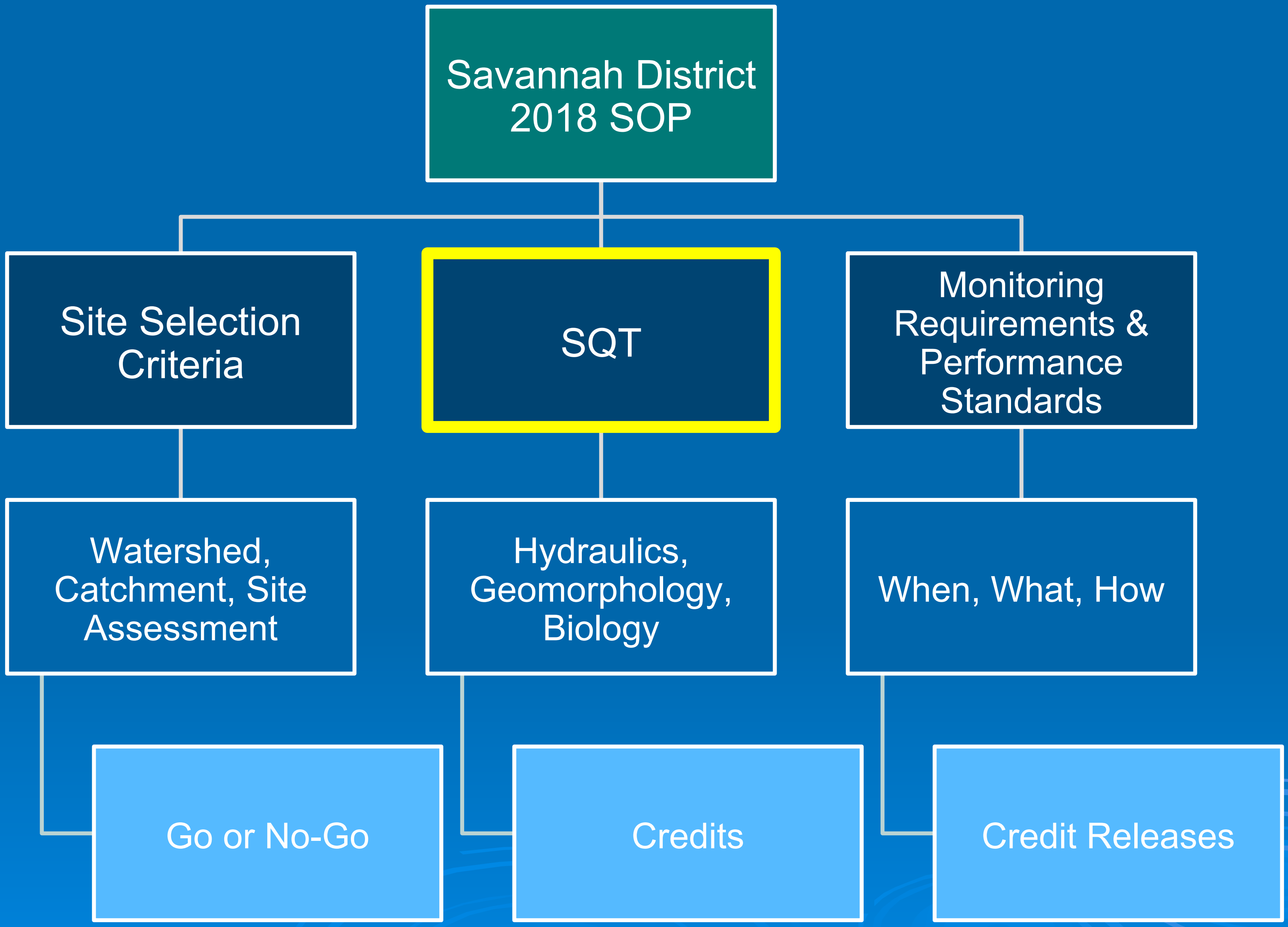
# The SQT is here!!

# The SQT is here!!

# Georgia Interim SQT

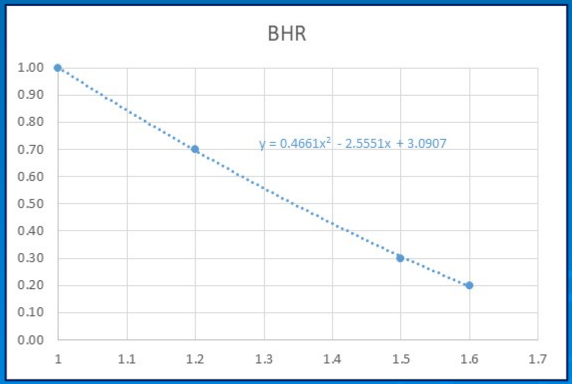
# SQT vs "SQT Light"

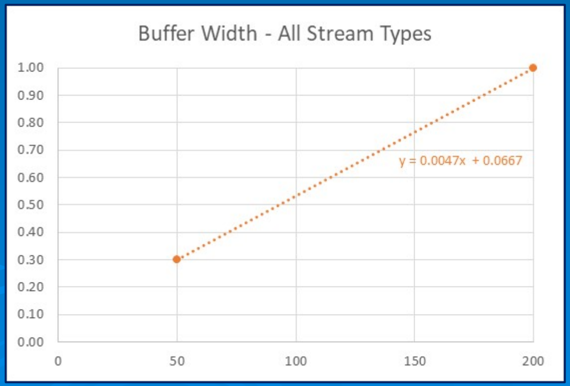


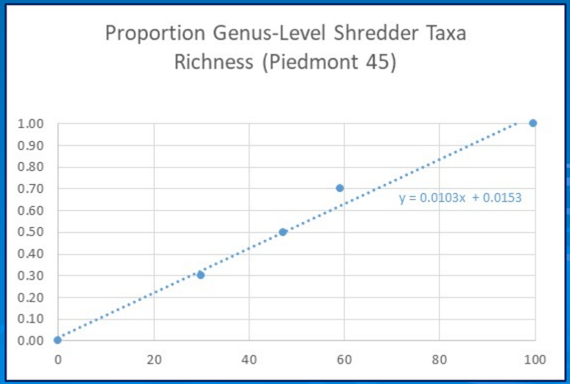

Savannah District 2018 SOP
Site Selection Criteria
SQT
Monitoring Requirements & Performance Standards
Watershed, Catchment, Site Assessment
Hydraulics, Geomorphology, Biology
When, What, How
Go or No-Go
Credits
Credit Releases

# "Georgia SQT Light"

| Functional Category | Function-Based Parameters | Measurement Method |
|---|---|---|
| Hydraulics | Floodplain Connectivity | Bank Height Ratio<br>Entrenchment Ratio |
| Geomorphology | Riparian Vegetation | Left Buffer Width (ft)<br>Right Buffer Width (ft) |
| | Bed Form Characterization | Pool Spacing Ratio<br>Percent Riffle<br>LWD Index |
| Biology | Macros | Proportion EPT Taxa Richness<br>Proportion Clinger Taxa Richness<br>Proportion Shredder Taxa Richness<br>Proportion Burrower Taxa Richness |



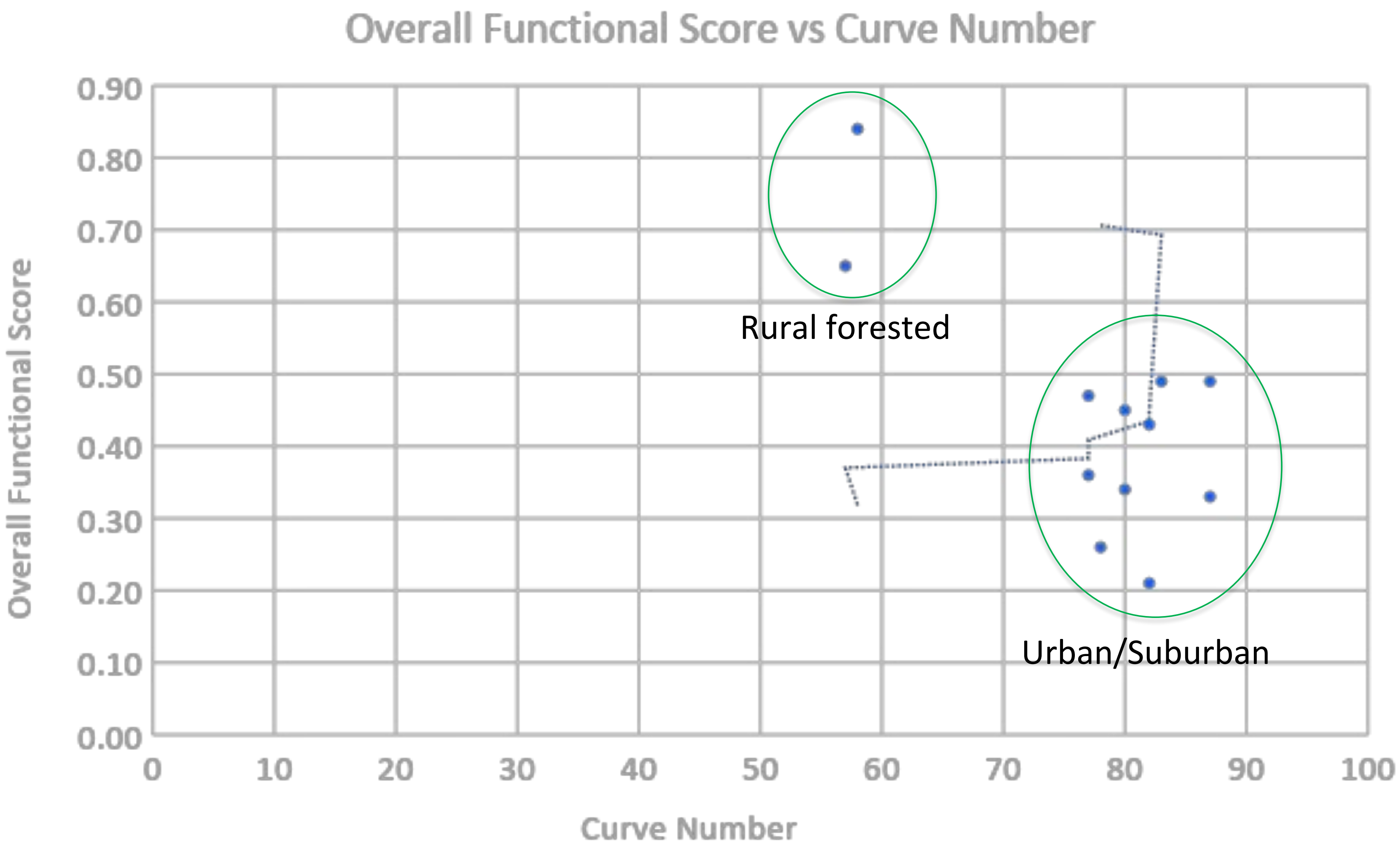
"As restoration science and practice develop, it is imperative that we examine and reexamine the assumptions and scientific evidence (or lack thereof) that underlie restoration efforts,"

-Margaret Palmer, 2009

end

| Site | Watershed Type | Drainage Area (sq. mi) | Curve Number | Median particle | Slope (%) | Rosgen Stream Type |
|---|---|---|---|---|---|---|
| Austin Degraded | Suburban | 3.8 | 78 | Sand | 0.39 | G5c |
| Austin Restored | Suburban | 8.5 | 83 | Sand | 0.19 | C5 |
| UT to Swift Degraded | Urban | 0.5 | 82 | Gravel | 1.64 | G4c |
| UT to Swift Restored | Urban | 0.9 | 82 | Gravel | 0.30 | C4 |
| Irvin Degraded | Urban | 0.6 | 77 | Gravel | 0.53 | E4 |
| Irvin Restored | Urban | 1.0 | 77 | Sand | 0.57 | C5 |
| Purlear Degraded | Forested Rural | 0.2 | 57 | Gravel | 2.10 | E4b |
| Purlear Restored | Forested Rural | 0.4 | 58 | Gravel | 4.60 | C4b |
| Sandy Degraded | Urban | 2.0 | 87 | Sand | 0.27 | F5 |
| Sandy Restored | Urban | 1.8 | 87 | Sand | 0.23 | E5b |
| Torrence Degraded | Suburban | 0.8 | 80 | Sand | 0.62 | G5c |
| Torrence Restored | Suburban | 3.6 | 80 | Sand | 0.36 | C5 |

| | Functional Scores | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Site Name** | **Total QT** | **Hydrology** | **Hydraulics** | **Geomorp-hic** | **Physico-chemical** | **Biology** | **% Shredders** | **IBI** | **EPT Richness** |
| Austin Degraded | 0.26 | 0.26 | 0.00 | 0.43 | 0.46 | 0.17 | 4.30 | 5.98 | 9 |
| Austin Restored | 0.49 | 0.31 | 0.88 | 0.42 | 0.49 | 0.35 | 3.10 | 5.48 | 11 |
| UT to Swift Creek Degraded | 0.21 | 0.27 | 0.00 | 0.38 | 0.42 | 0.00 | 0.00 | 8.17 | 8.43 |
| UT to Swift Creek Restored | 0.43 | 0.28 | 1.00 | 0.47 | 0.39 | 0.00 | 0.40 | 0 | 0 |
| Irvin Degraded | 0.36 | 0.39 | 0.71 | 0.17 | 0.40 | 0.12 | 0.02 | 6.05 | 2 |
| Irvin Restored | 0.47 | 0.32 | 1.00 | 0.56 | 0.39 | 0.06 | 0.03 | 6.49 | 4 |
| Purlear Degraded | 0.65 | 0.67 | 0.71 | 0.16 | 0.77 | 0.93 | 28.60 | 2.92 | 24 |
| UT to Purlear Restored | 0.84 | 0.68 | 0.92 | 0.77 | 0.85 | 1.00 | 27.10 | 2.03 | 32 |
| Sandy Degraded | 0.26 | 0.21 | 0.00 | 0.65 | 0.44 | 0.00 | 0.40 | 7.03 | 5 |
| Sandy Restored | 0.49 | 0.30 | 1.00 | 0.59 | 0.55 | 0.01 | 0.50 | 6.85 | 4 |
| Torrence Degraded | 0.34 | 0.25 | 0.00 | 0.30 | 0.54 | 0.59 | 0.00 | 4.58 | 13 |
| Torrence Restored | 0.45 | 0.27 | 0.82 | 0.43 | 0.55 | 0.20 | 0.01 | 5.78 | 8 |


Overall Functional Score vs Curve Number
Overall Functional Score
0.90
0.80
0.70
0.60
0.50
0.40
0.30
0.20
0.10
0.00
0
10
20
30
40
50
60
70
80
90
100
Curve Number
Rural forested
Urban/Suburban