

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



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# Research questions

Does the NC SQT accurately detect and quantify ecological function?

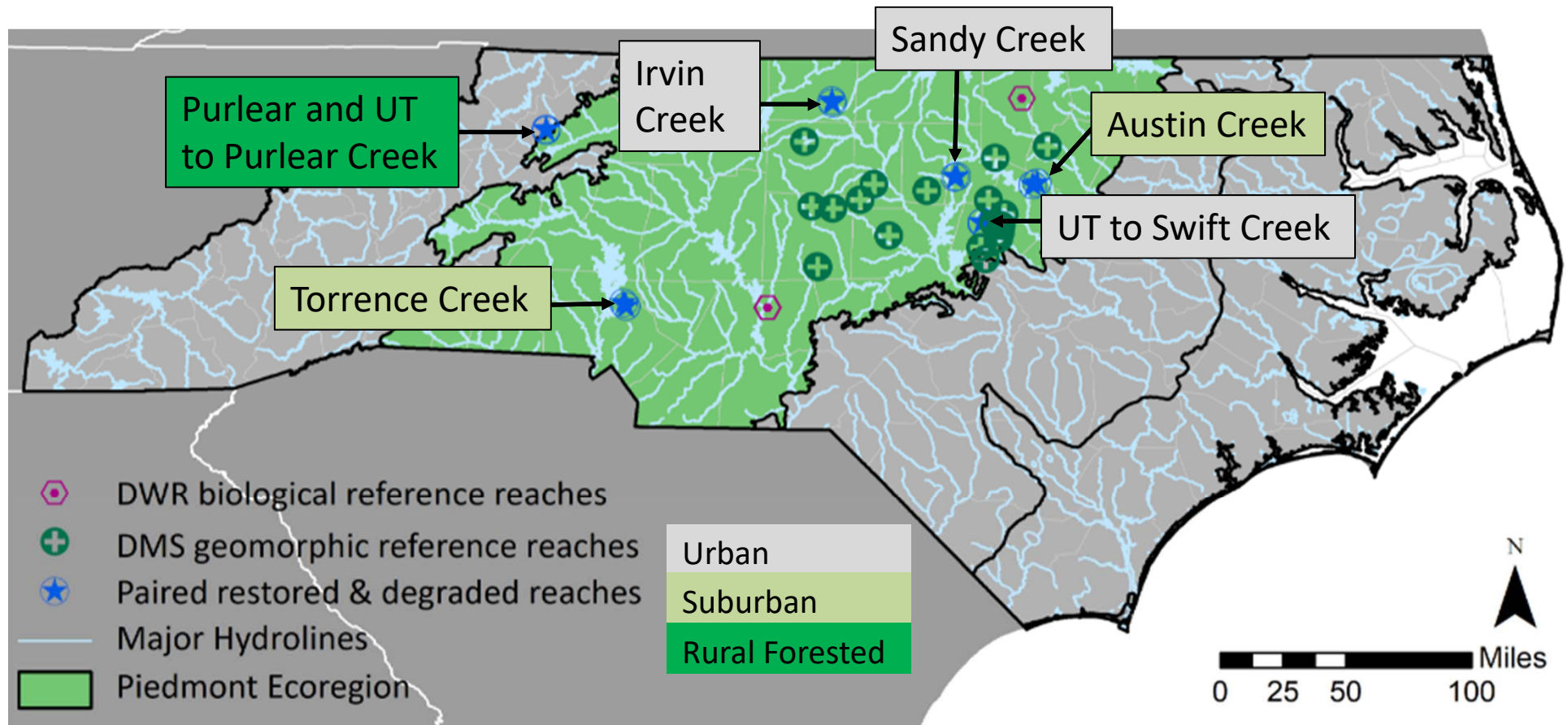
What is the **natural performance range** for ecological function variables in Piedmont streams?

Does the **stream functions pyramid framework** (embedded in SQT) apply to all **stream conditions**?

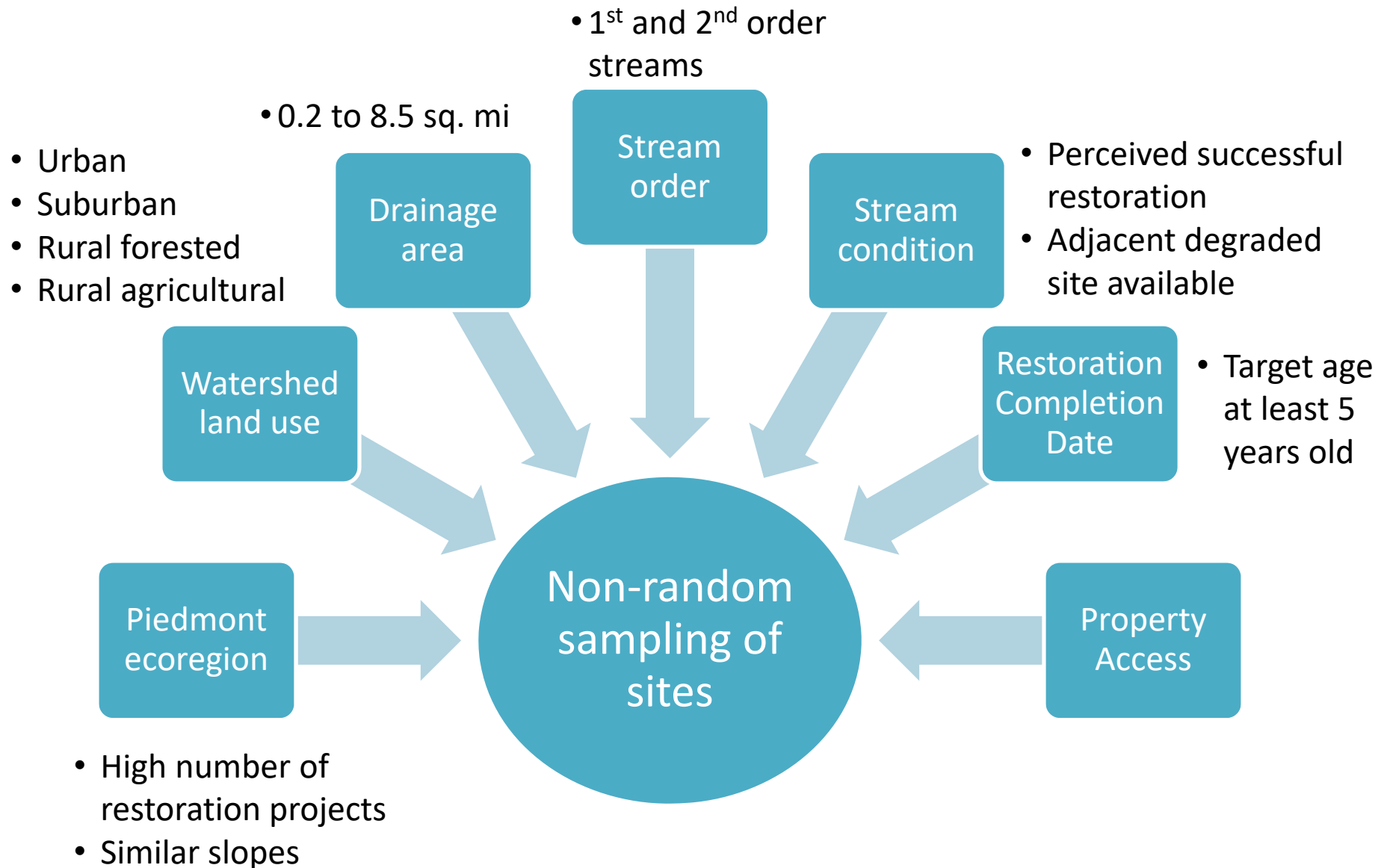
Which ecological function variables **correlate** best with **good biological** condition?

## 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]

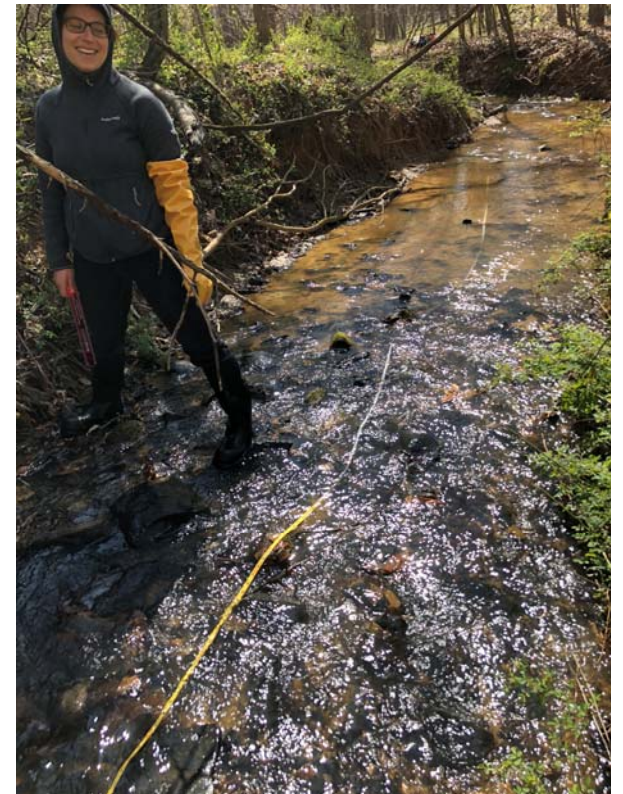


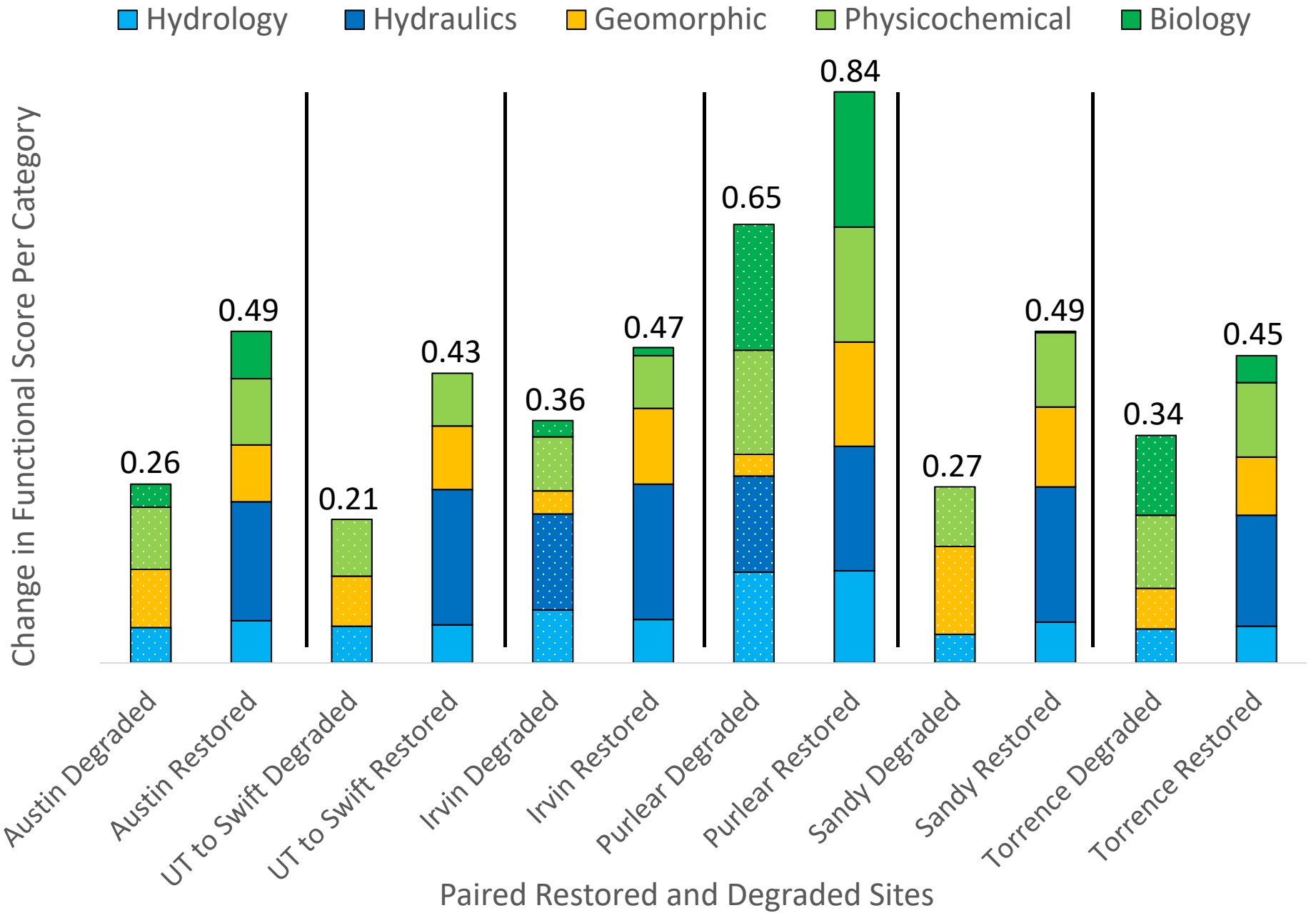
# Site Selection Criteria



# Data Collection

Functional Category	Measurement Method	Functional Category	Measurement Method
Hydrologic	Curve Number	Physico-chemical	Daily Maximum Summer Temperature (°F)
	No. of Concentrated Flow Points		Dissolved oxygen (mg/L)
	Soil Compaction (Penetrometer)		Specific Conductivity (mS/cm)
	Soil Compaction (Bulk Density)		pH
Hydraulic	Bank Height Ratio		Salinity (ppt)
	Entrenchment Ratio		Total Nitrogen (mg/L)
Geomorphic	LWD Index		Total Phosphorus (mg/L)
	LWD Piece Count		Fecal Coliform (Cfu/100 ml)
	Dominant BEHI/NBS		% Shredders
	Percent Streambank Erosion (%)		Biological
	Canopy Coverage (%)	EPT Taxa Present	
	Buffer Width (ft)	Restoration Potential	Watershed Catchment Assessment
	Basal Area (sq. ft/acre)		
	Pool Spacing Ratio		
	Pool Depth Ratio		
	Percent Riffle		
Sinuosity			

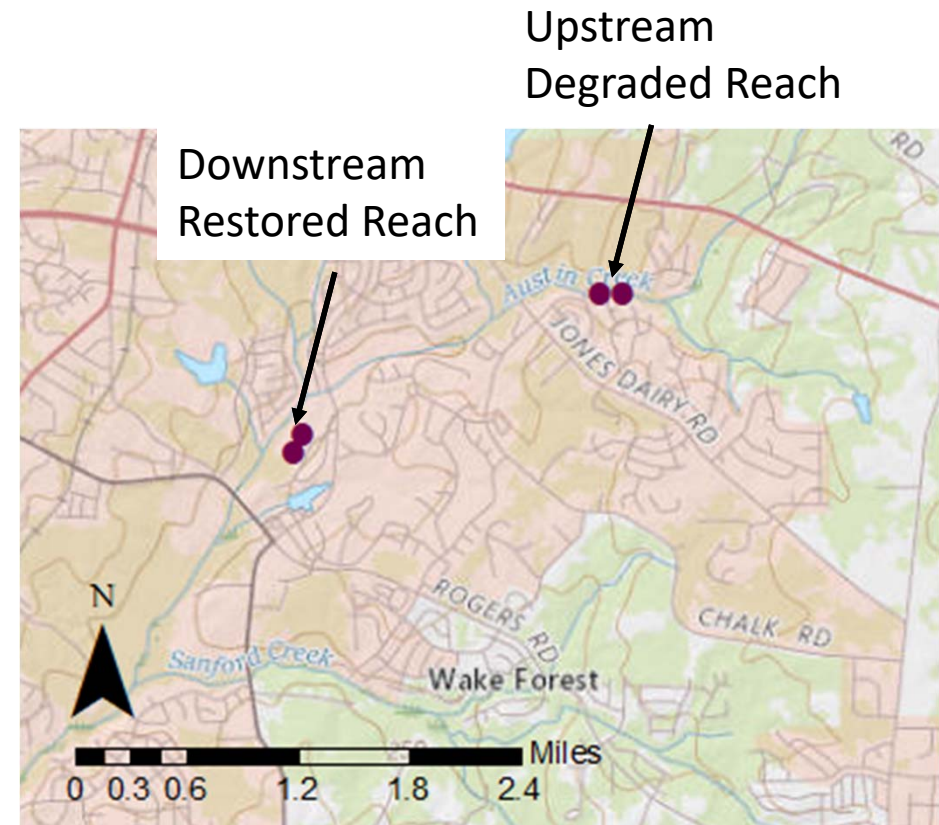




## Site 1: Austin Creek

- 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<sup>1</sup>

	Degraded	Restored
Drainage Area (sq. mi)	3.8	8.5

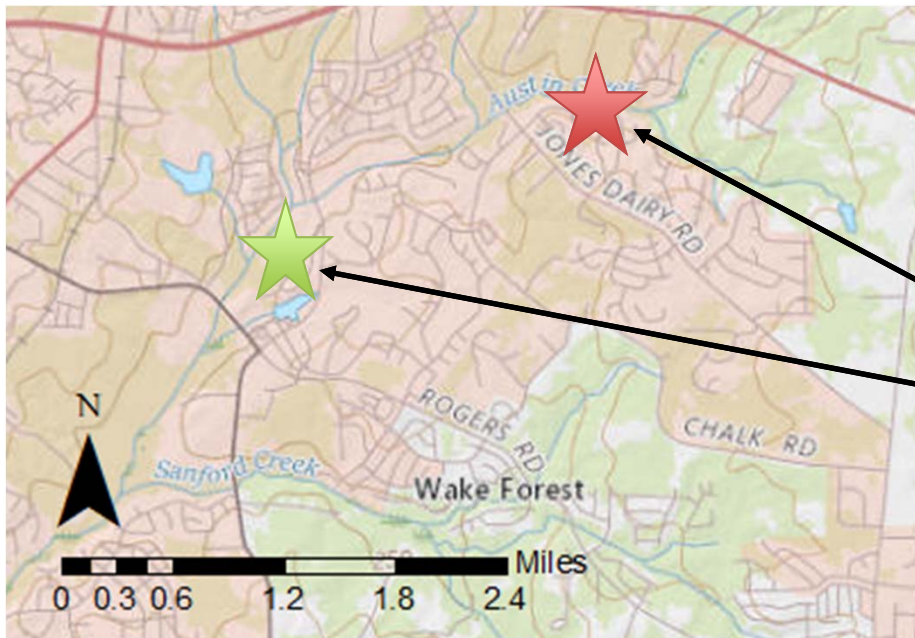


<sup>1</sup>Smith and Austin Creek Stream Mitigation Plan, 2003



# Site 1: Austin Creek

- Wake Forest, Wake County
- Suburban watershed

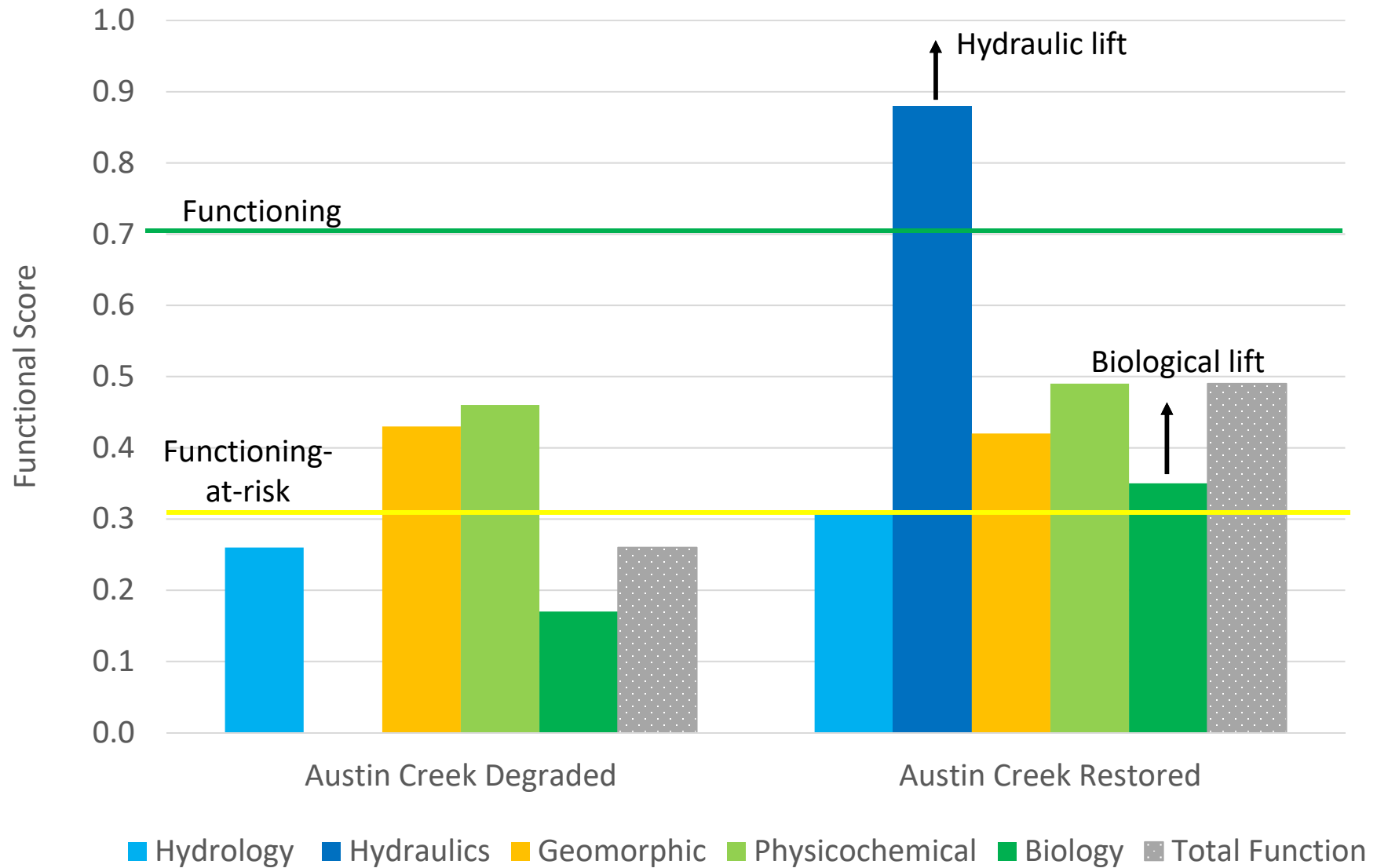


Downstream Restored Reach (2002)



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

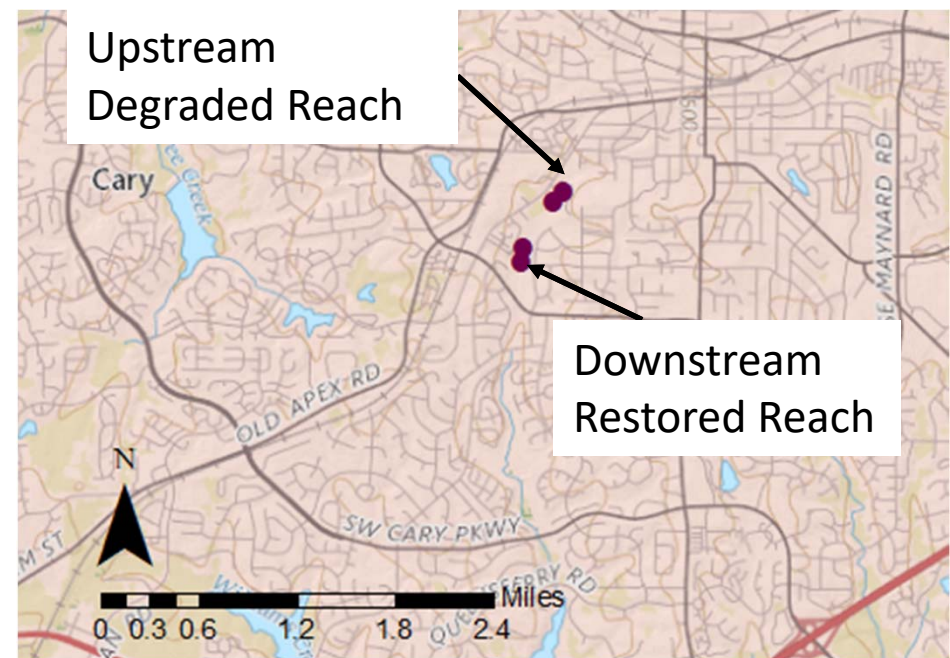
# Site 1: Austin Creek



## 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 <sup>2</sup>

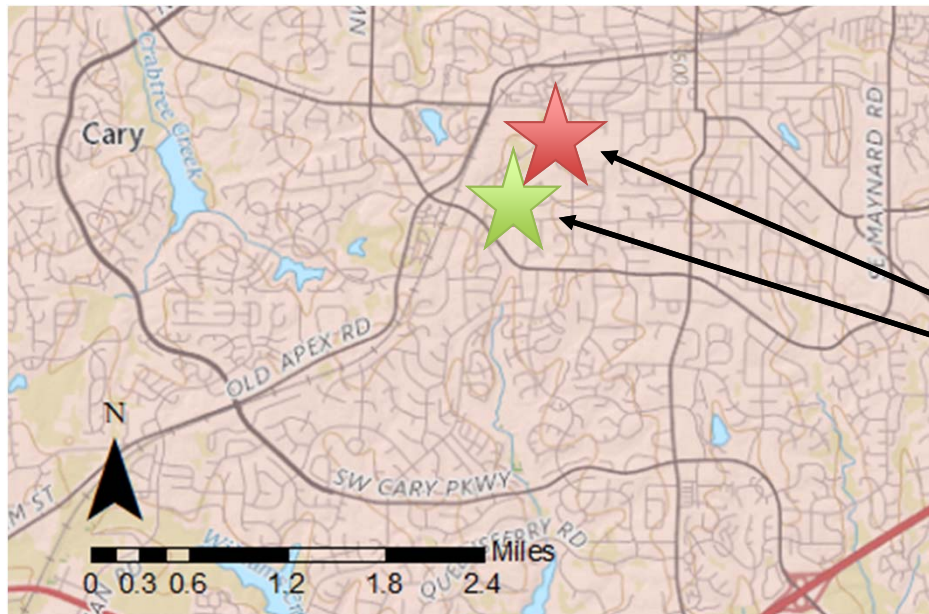
	Degraded	Restored
Drainage Area (sq. mi)	0.5	0.9



<sup>2</sup> UT to Swift Creek Restoration Monitoring Report Year 1, 2014

## Site 2: UT to Swift Creek

- Cary, Wake County
- Urban watershed

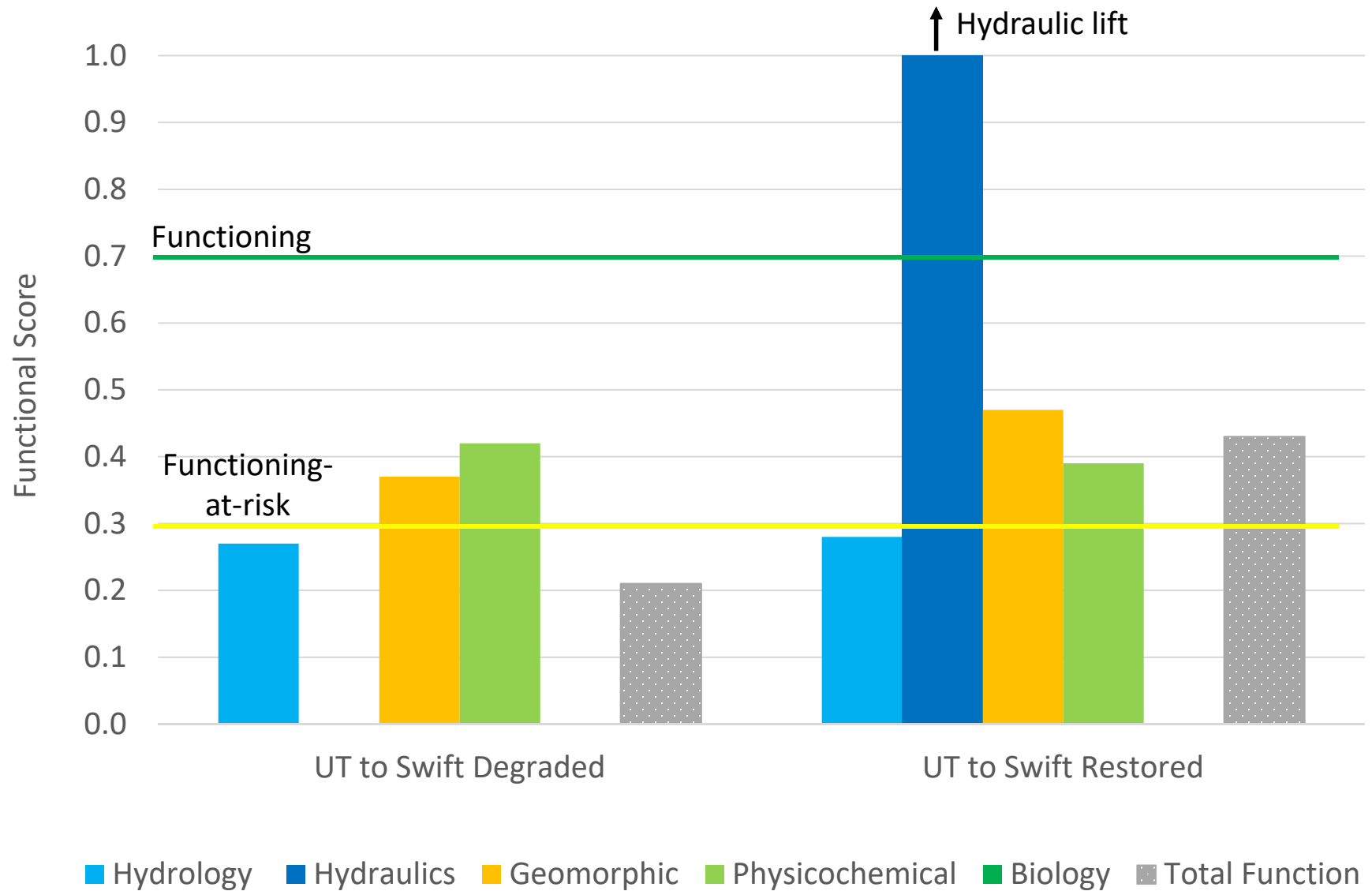


Downstream Restored Reach (2012)



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

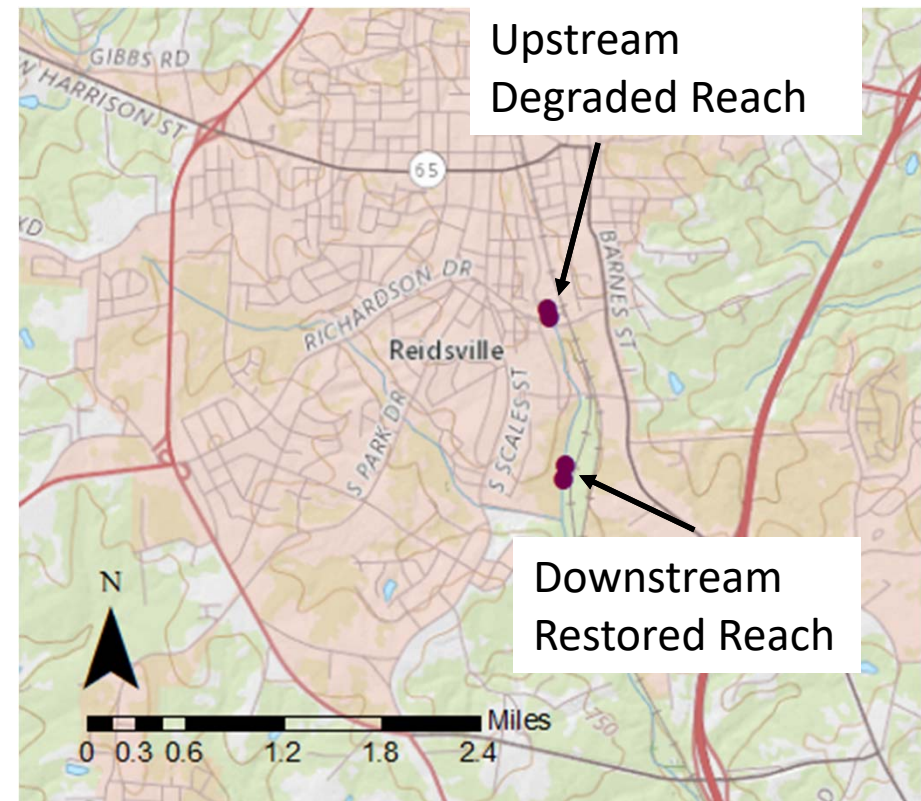
# Site 2: UT to Swift Creek



## 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<sup>3</sup>

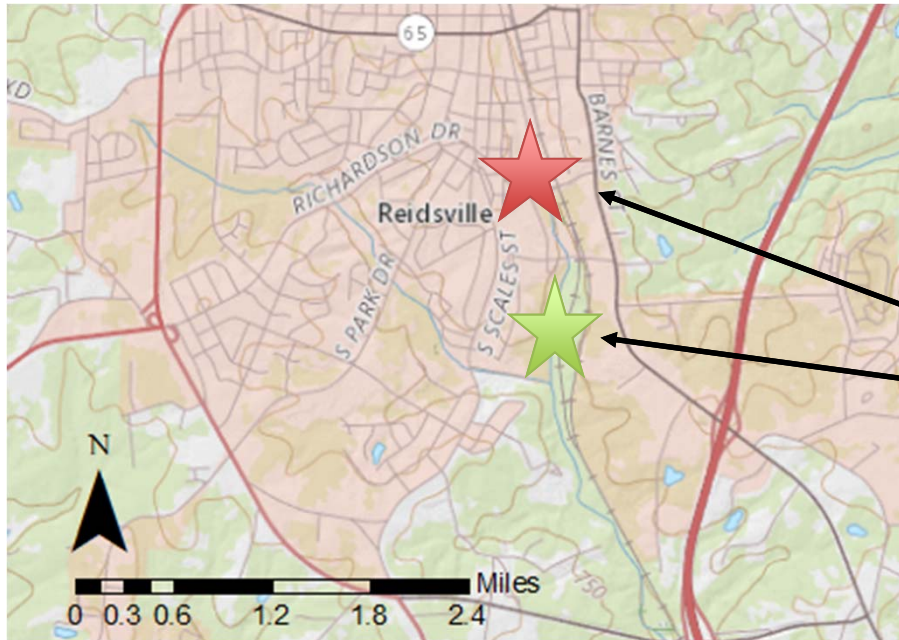
	Degraded	Restored
Drainage Area (sq. mi)	0.6	1.0



<sup>3</sup> Little Troublesome Creek Mitigation Plan Monitoring Year 1 Annual Report, 2013

# Site 3: Irvin Creek

- Reidsville, Rockingham County
- Urban watershed

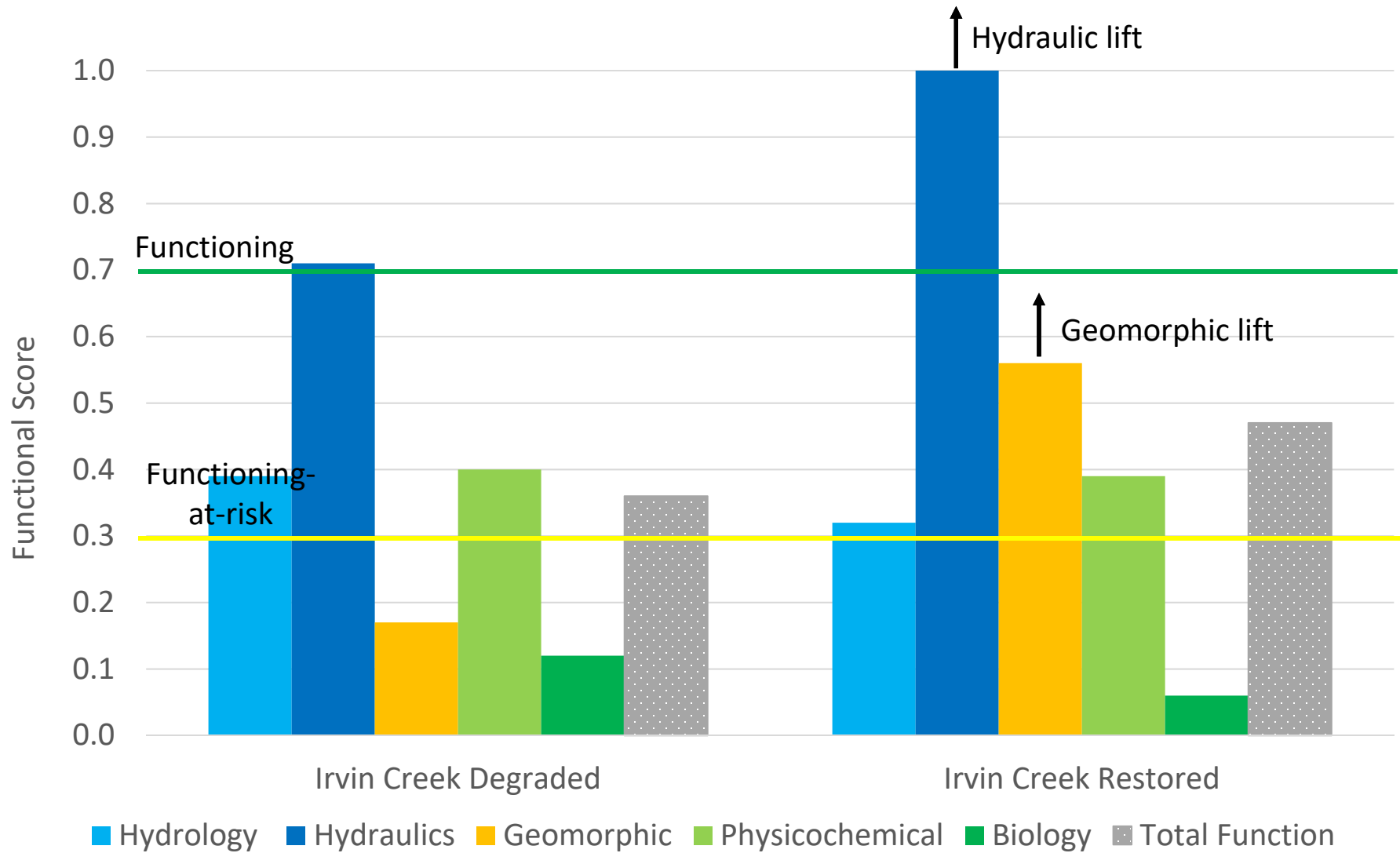


Downstream Restored Reach (2011)



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

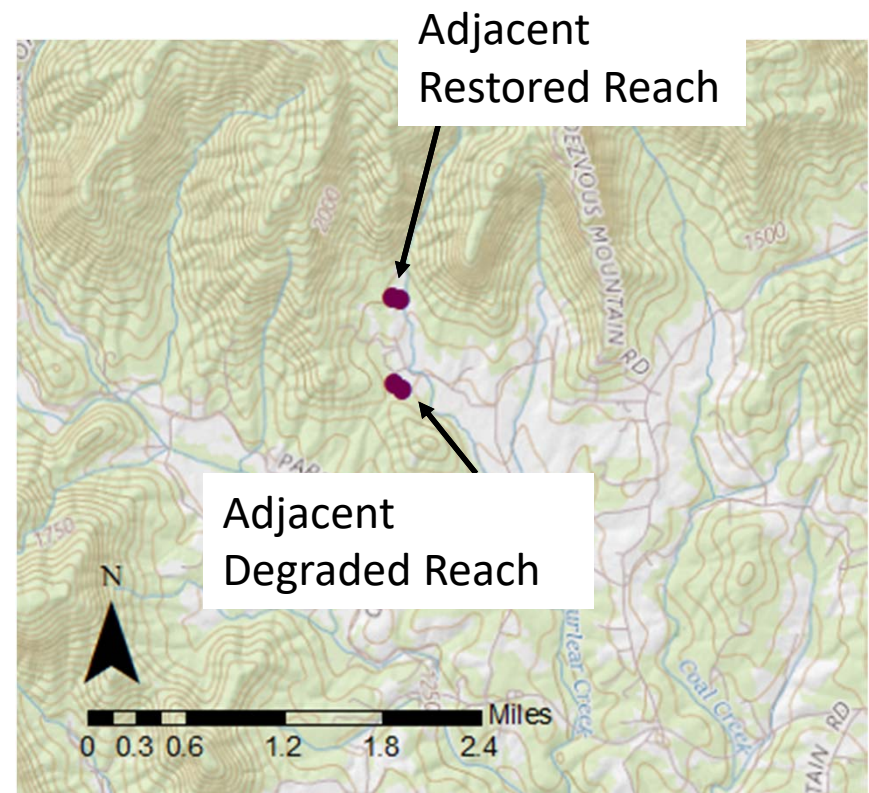




## Site 4: Purlear Creek and UT to Purlear Creek

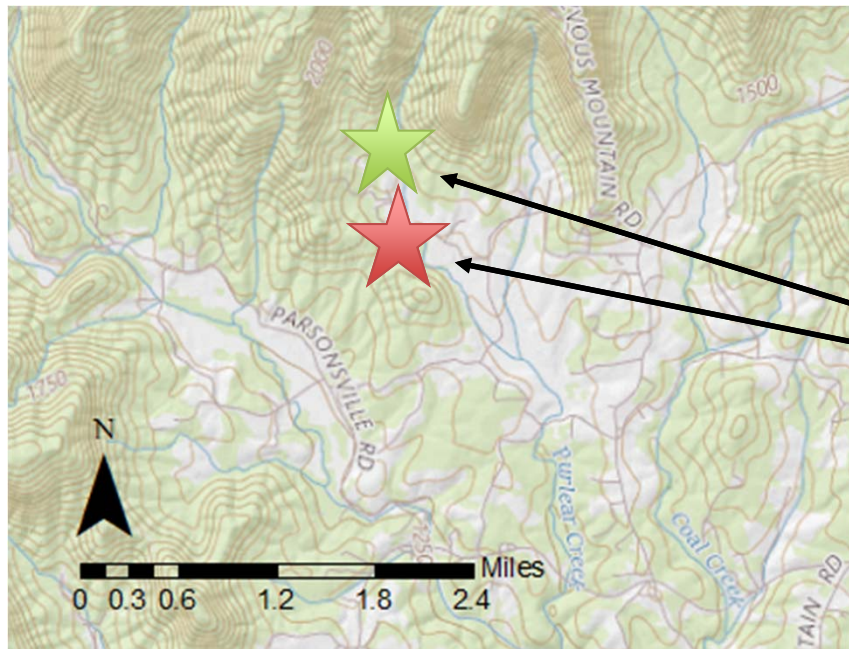
- Purlear, Wilkes County
- Rural Forested watershed
- Restoration completed in 2006
- Restoration objectives:
  - improve water quality by reducing sediment and nutrients
  - improve aquatic and terrestrial habitat for cold-water fish, mammals, birds
  - improve wetland functions to support bog turtle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

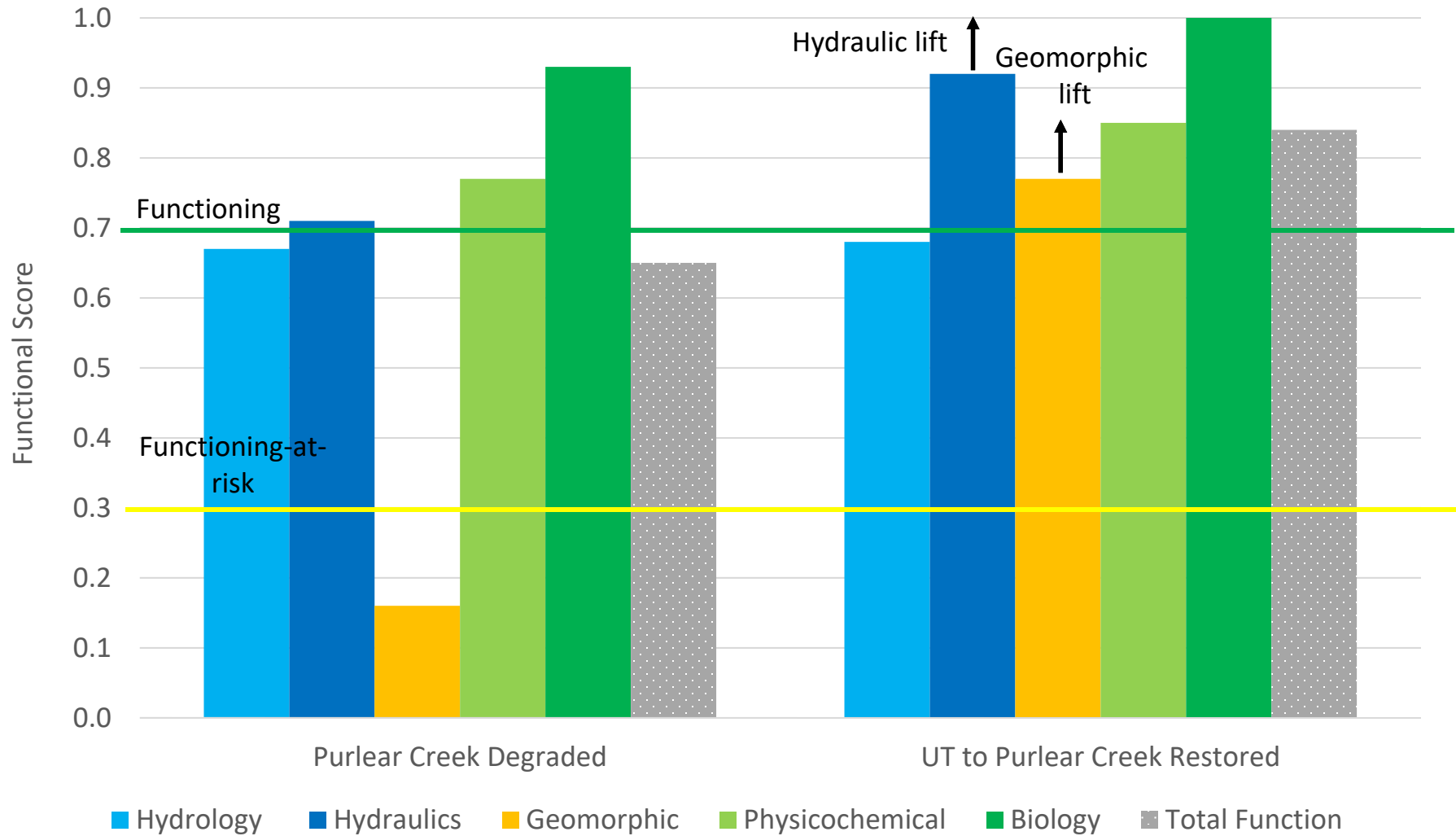


Adjacent Restored Reach (2006)



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

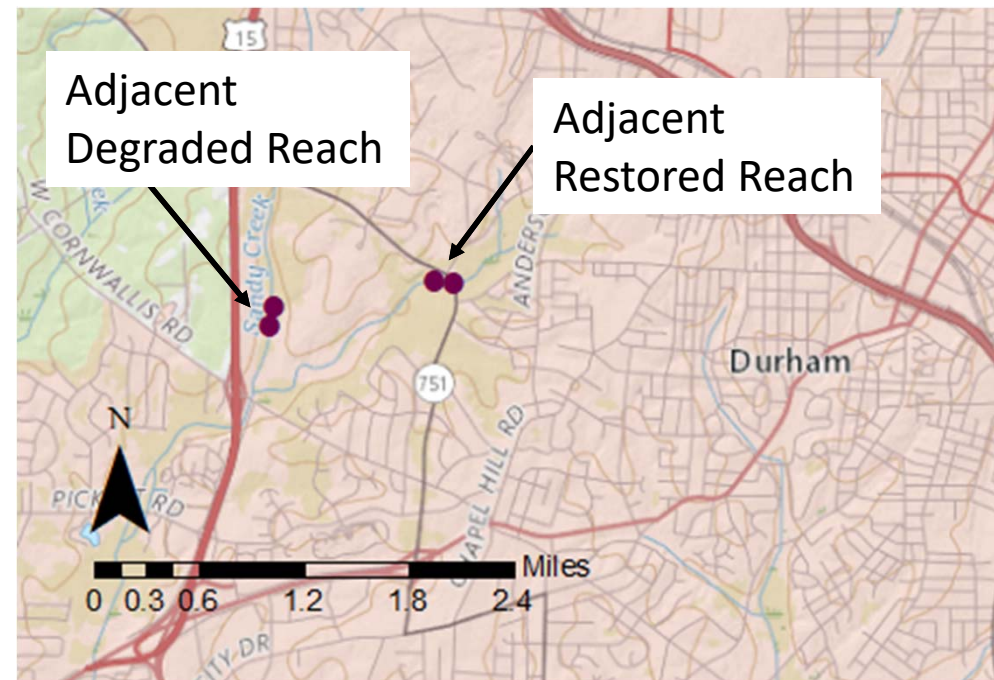
# Site 4: Purlear and UT to Purlear Creek



## Site 5: Sandy Creek

- Durham, Durham County
- Suburban watershed
- Restoration completed in 2005
- Restoration objectives:
  - Improve water quality by:
    - floodplain reconnection
    - riparian vegetation replanting<sup>4</sup>

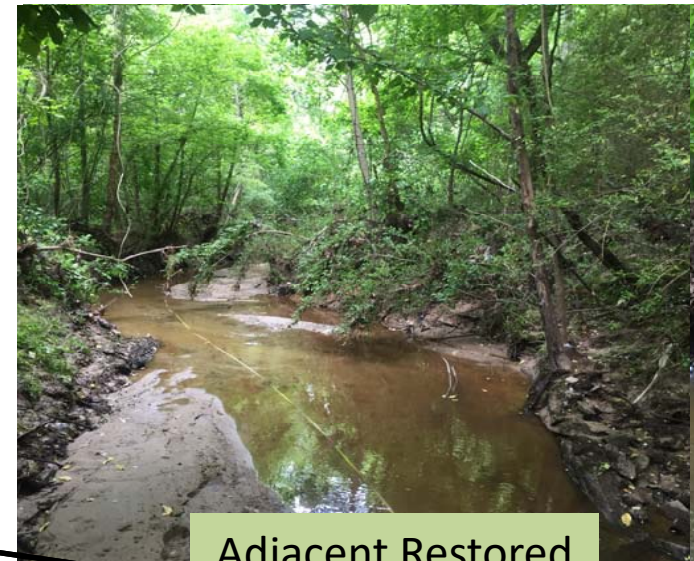
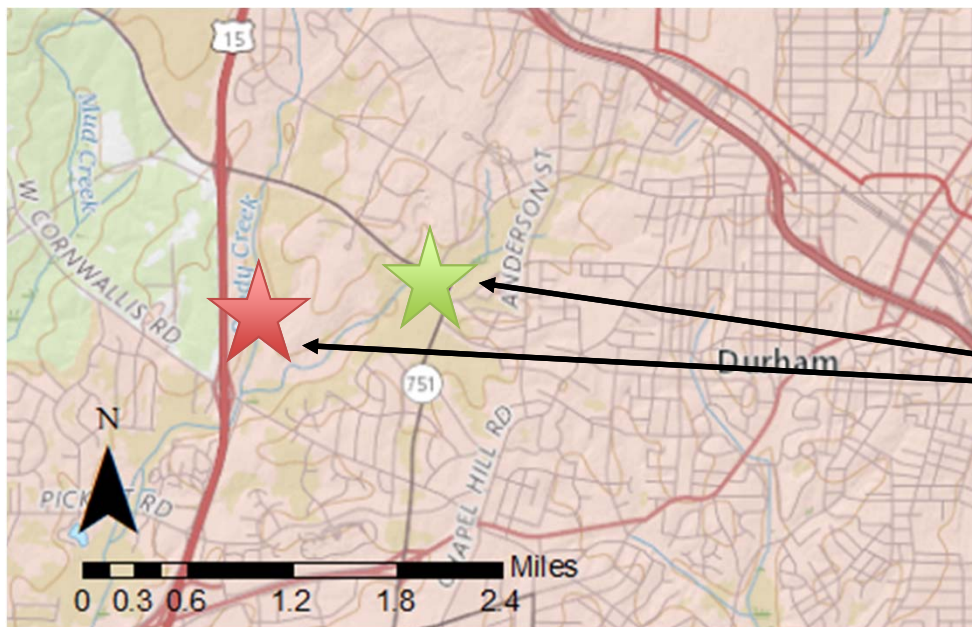
	Degraded	Restored
Drainage Area (sq. mi)	2.0	1.8



<sup>4</sup> Final Report of Scientific Findings to NCDENR, 2008

# Site 5: Sandy Creek

- Durham, Durham County
- Urban watershed

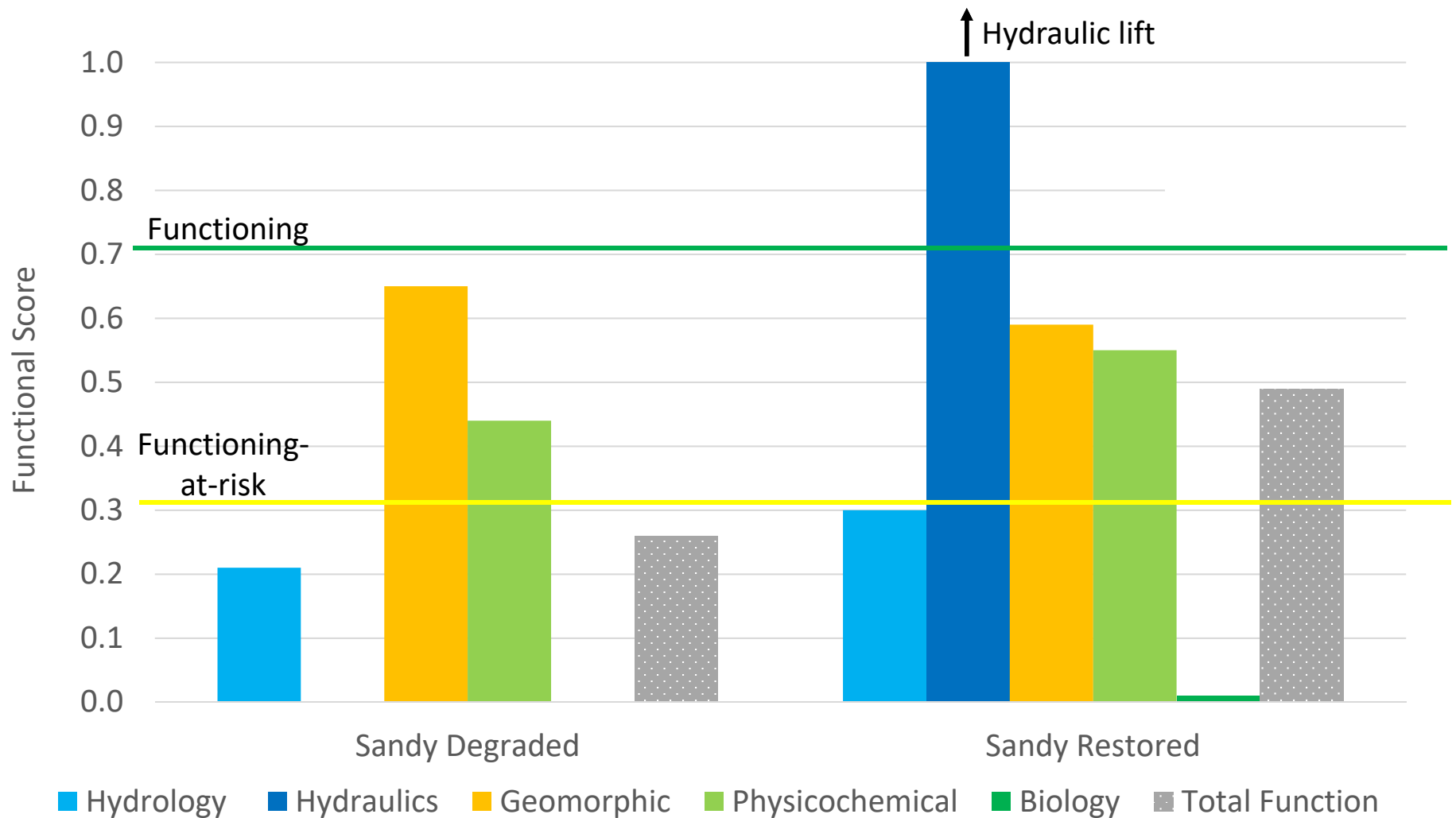


Adjacent Restored Reach (2005)



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

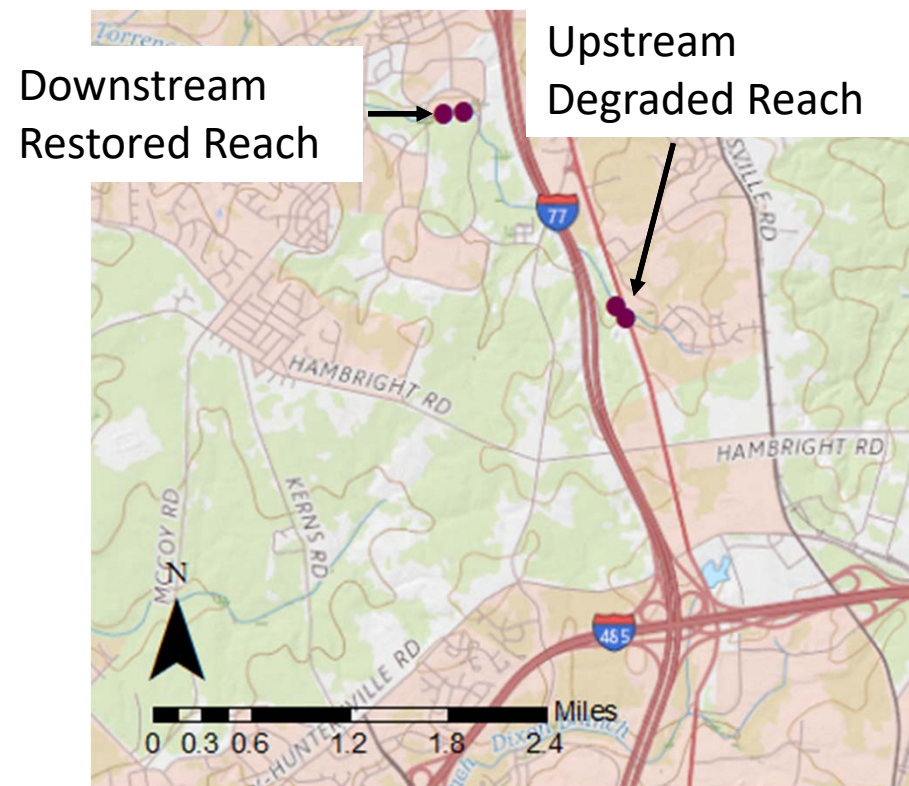
# Site 5: Sandy Creek



## Site 6: Torrence Creek

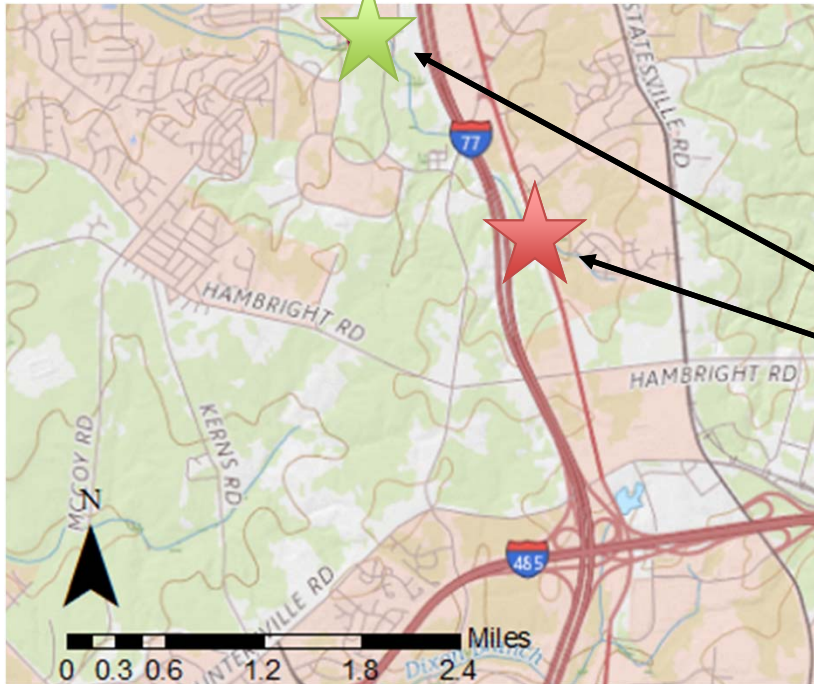
- Huntersville, Mecklenburg County
- Suburban watershed
- Restoration completed in 2013
- Restoration objectives:
  - Bank stabilization to reduce sediment loads from bank erosion

	Degraded	Restored
Drainage Area (sq. mi)	0.8	3.6

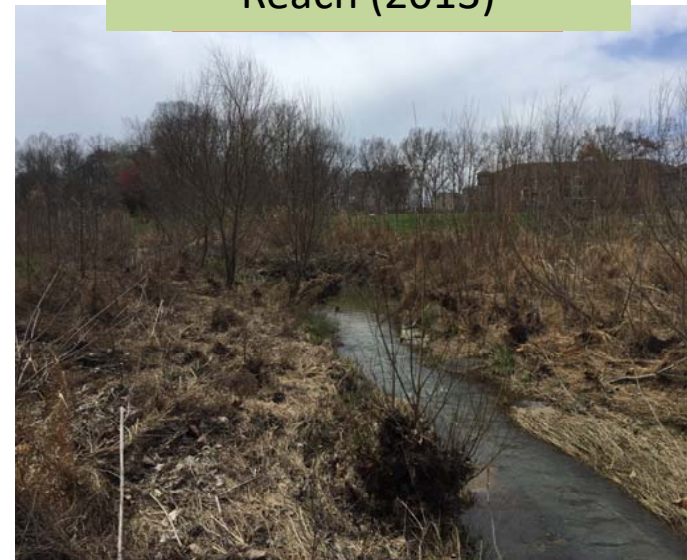


# Site 6: Torrence Creek

- Huntersville, Mecklenburg County
- Suburban watershed



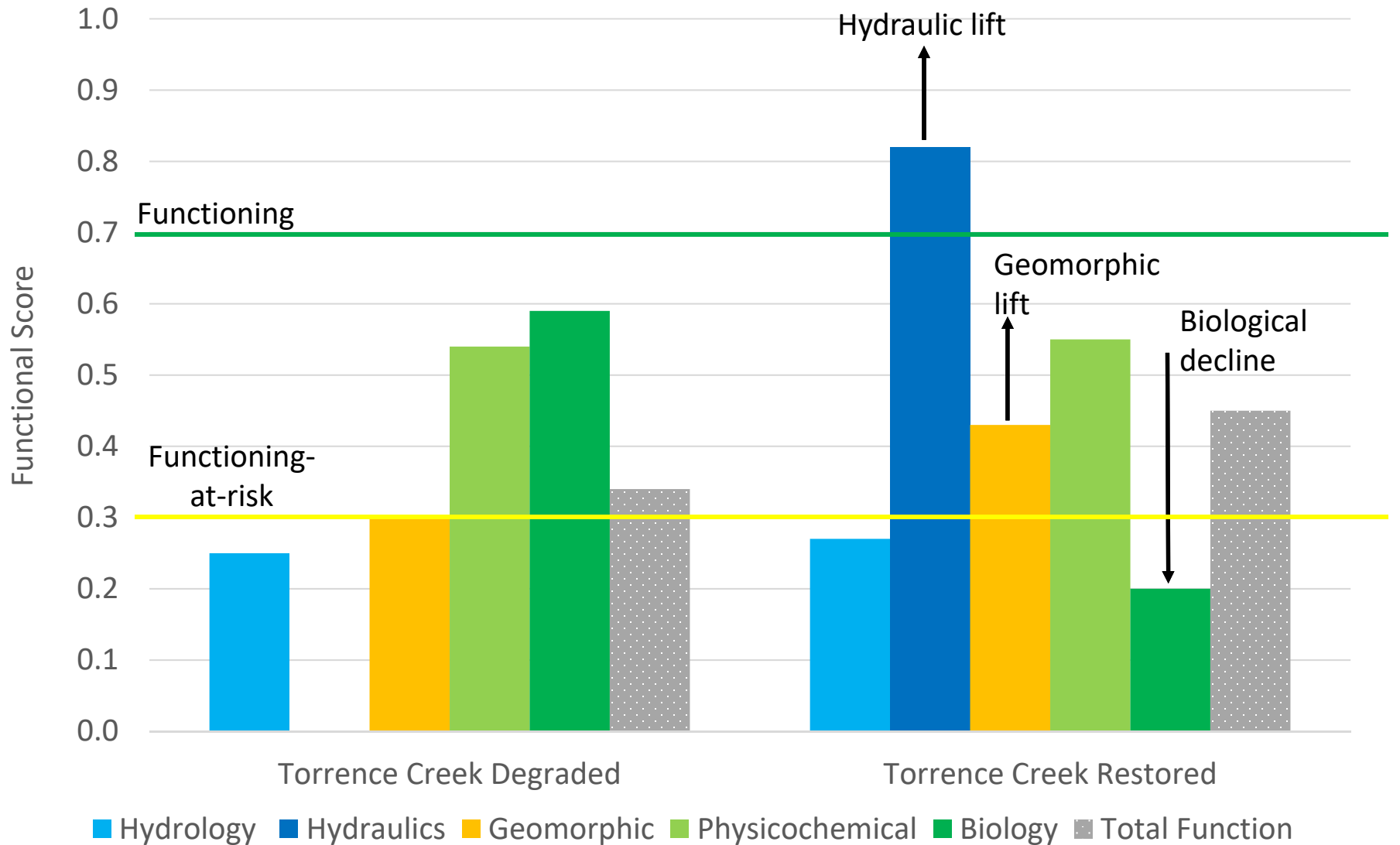
Downstream Restored Reach (2013)



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



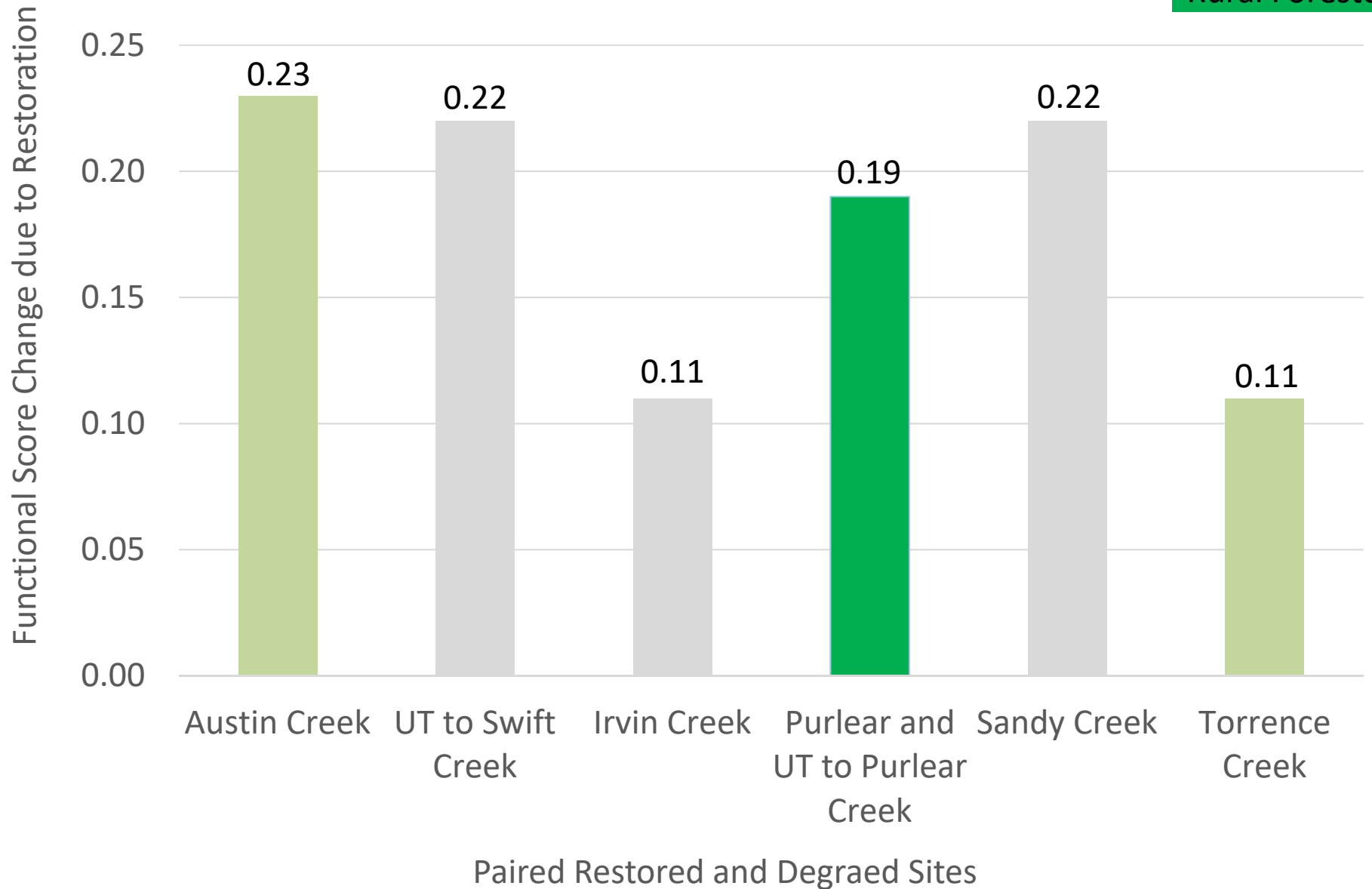
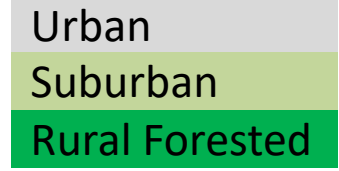
# Site 6: Torrence Creek



## 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

Functional Lift due to Restoration



## 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



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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

Site Name	Functional Scores						% Shredders	IBI	EPT Richness
	Total QT	Hydrology	Hydraulics	Geomorp- hic	Physico- chemical	Biology			
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

