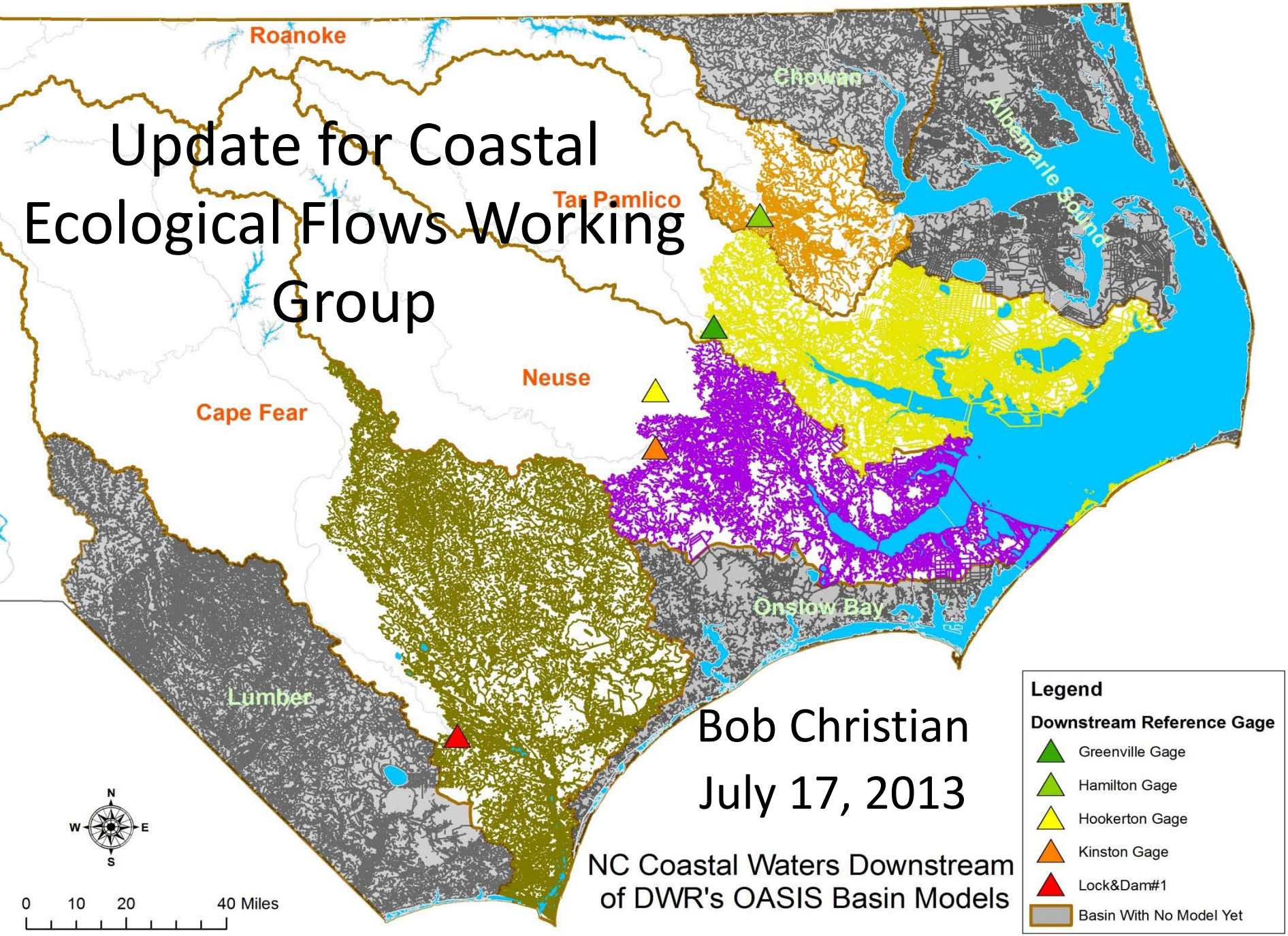
Update for Coastal Ecological Flows Working Group



Bob Christian

July 17, 2013

NC Coastal Waters Downstream of DWR's OASIS Basin Models

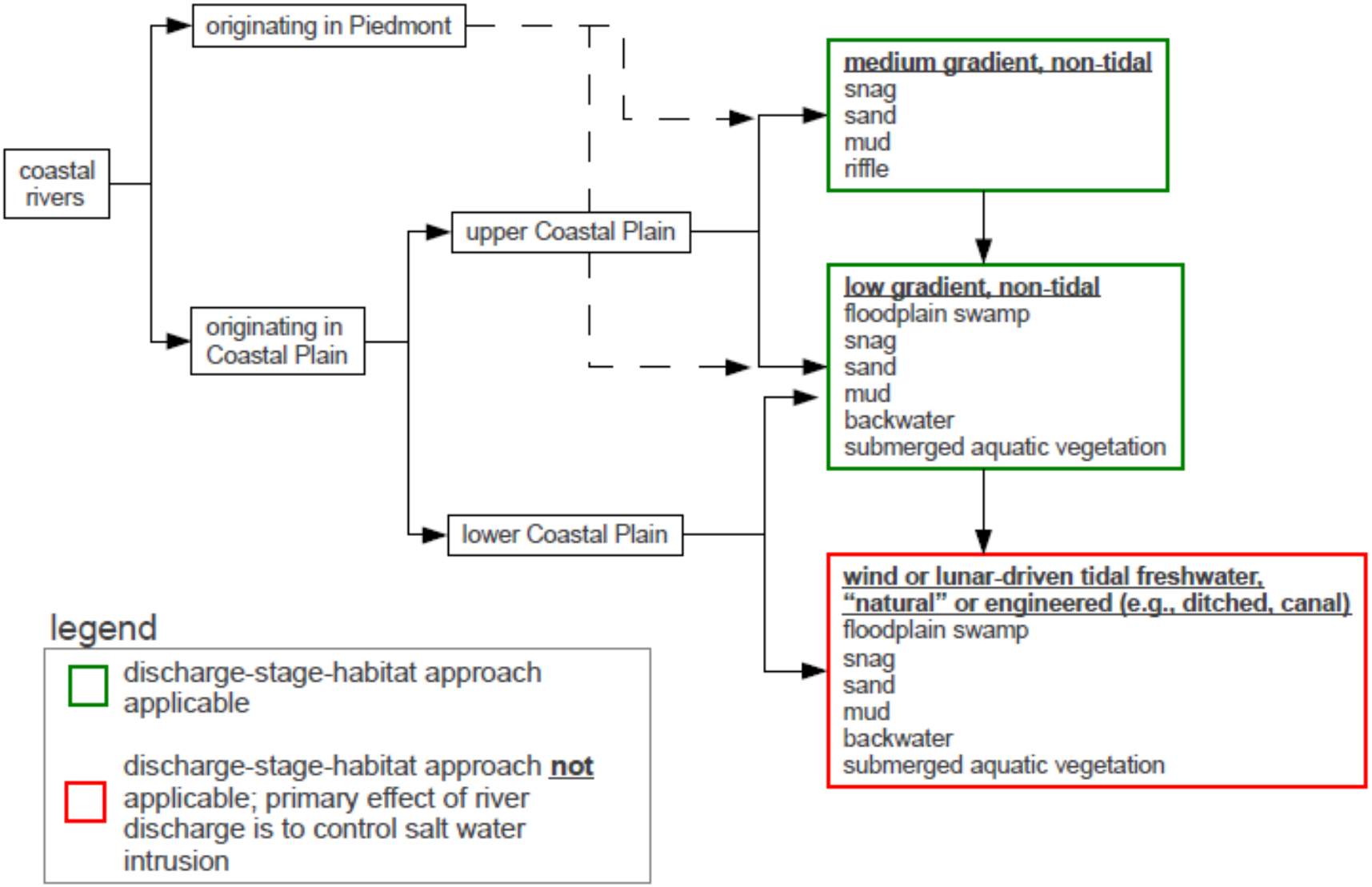
Working Group Membership

- Bob Christian ECU
- Eban Bean ECU
- Dean Carpenter APNEP
- Scott Ensign Consulting
- Mike Griffin ECU
- Kevin Hart NC DMF
- Mike O'Driscoll ECU
- Mike Piehler UNC IMS
- Judy Ratcliffe Natural Heritage
- Fritz Rhode NOAA
- Bennett Wynne NC Wildlife Resources

Overall Objectives

- Assess applicability of previous coastal work
  - Other states
  - Greenville
- Develop stream typology
- Advance spatial modeling and mapping
- Establish relevant ecological and biological dependencies on flow
- Develop frameworks for potential coastal EF criteria and protocols if possible
- Identify factors limiting EF protocols and needed research within coastal systems

GEOMORPHIC TYPOLOGY AND ASSOCIATED IN-STREAM HABITATS

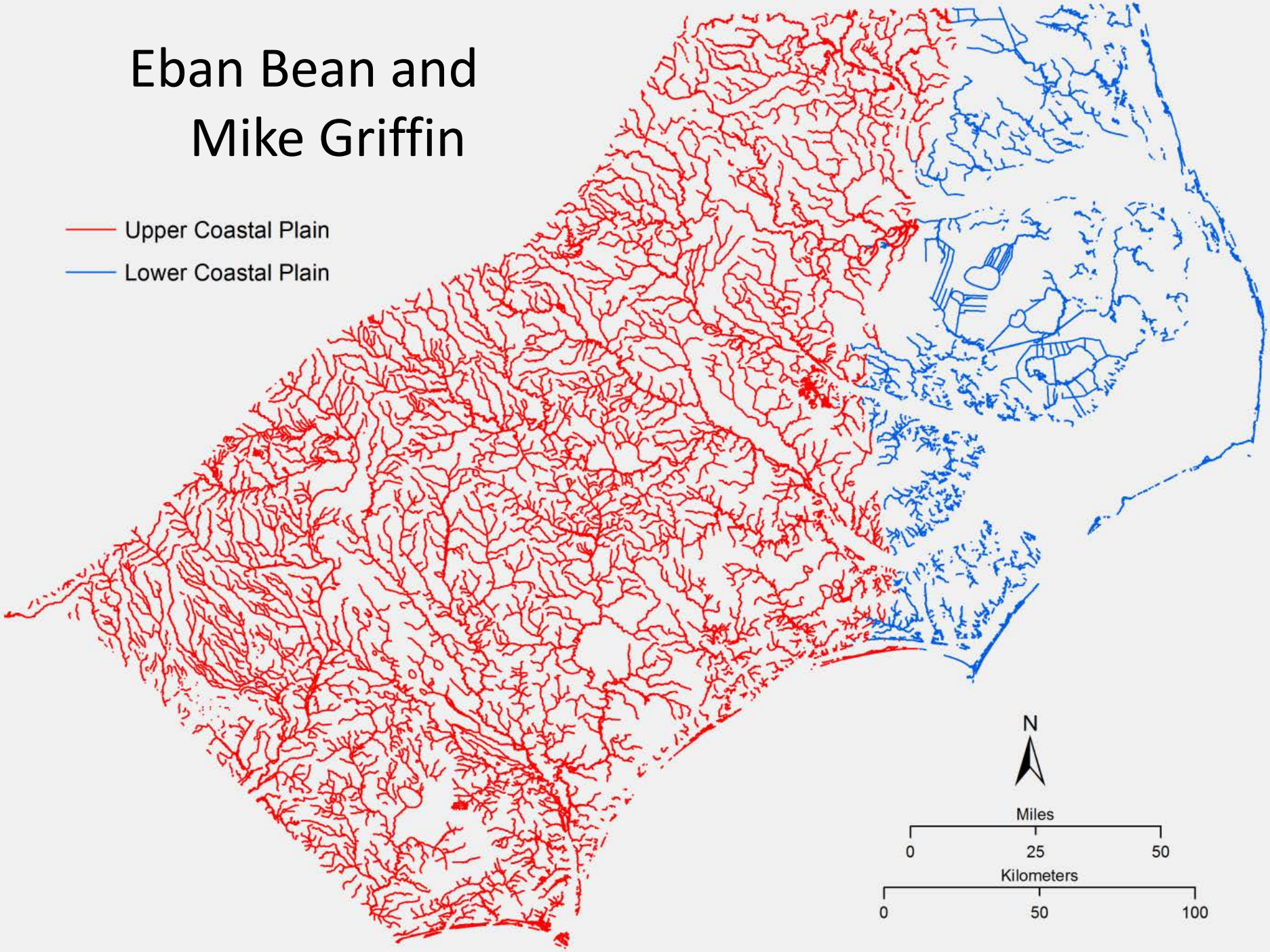


by Scott Ensign

Link of Stream Typology & Potential EF Determination

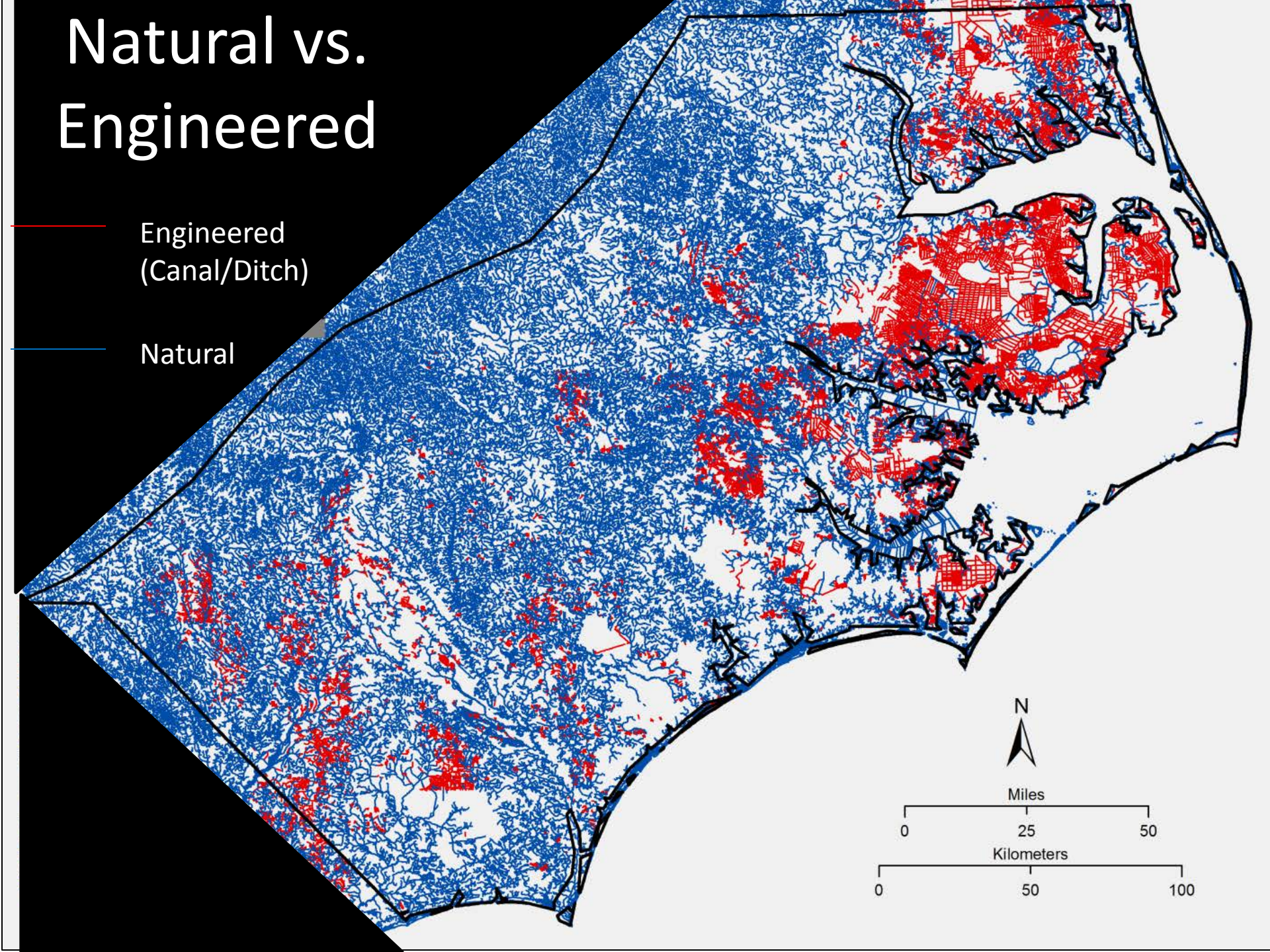
Origin	Slope	EF determinant		
		Discharge & Habitat	Downstream Salinity	Overbank Flow
Piedmont	Medium gradient	X	X	
Upper Coastal Plain	Medium gradient	X	X	
Upper Coastal Plain	Low gradient	X	X	X
Lower Coastal Plain	Low gradient	X	X	X
Lower Coastal Plain	Wind or tidal driven flow		X	X

Eban Bean and Mike Griffin



CP Origin, Non Tidal
Peidmont Origin, Non Tital
CP Origin, Salt Water Tidal
N
Miles
0
25
50
Kilometers
0
50
100

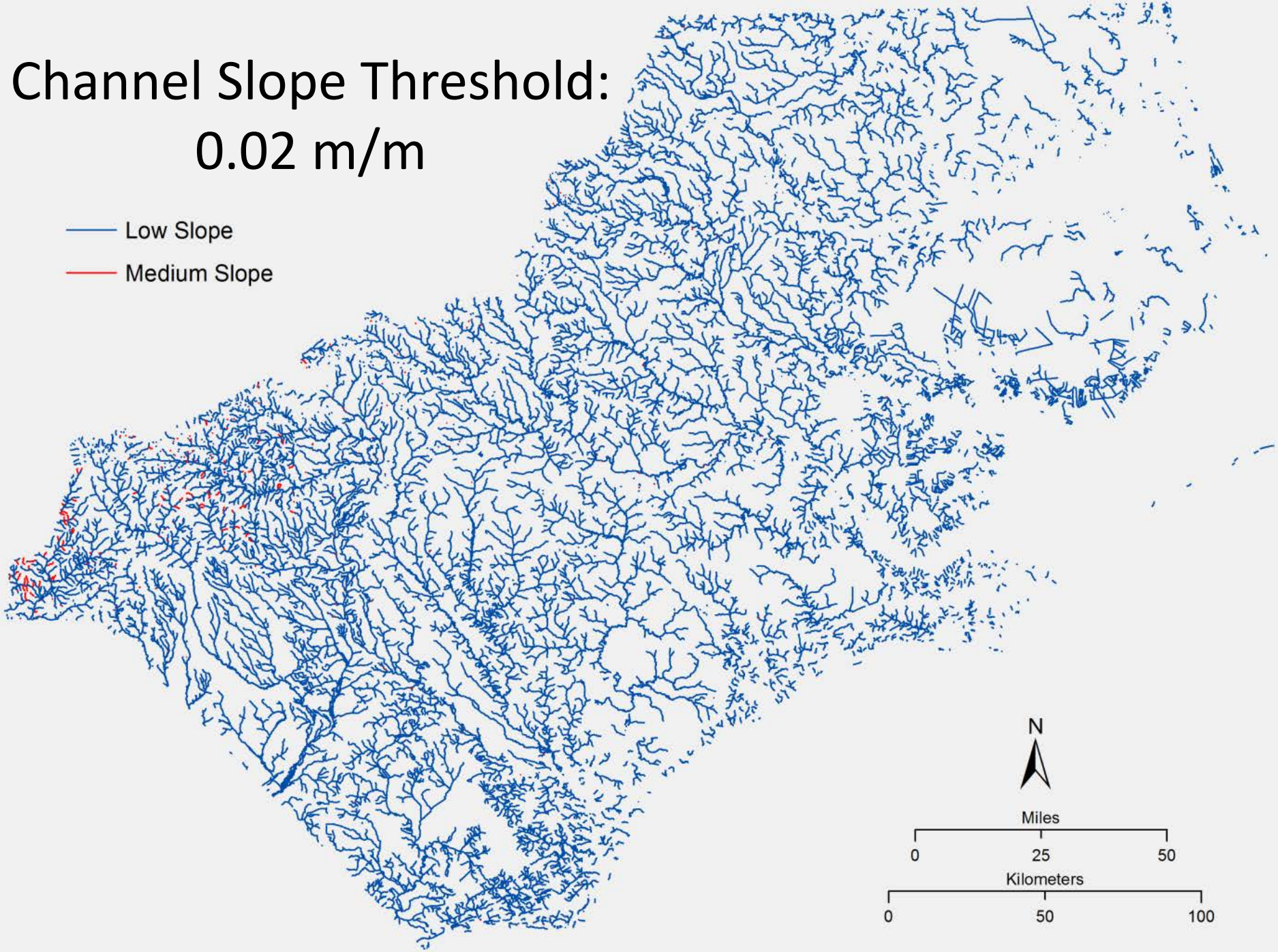
Natural vs. Engineered



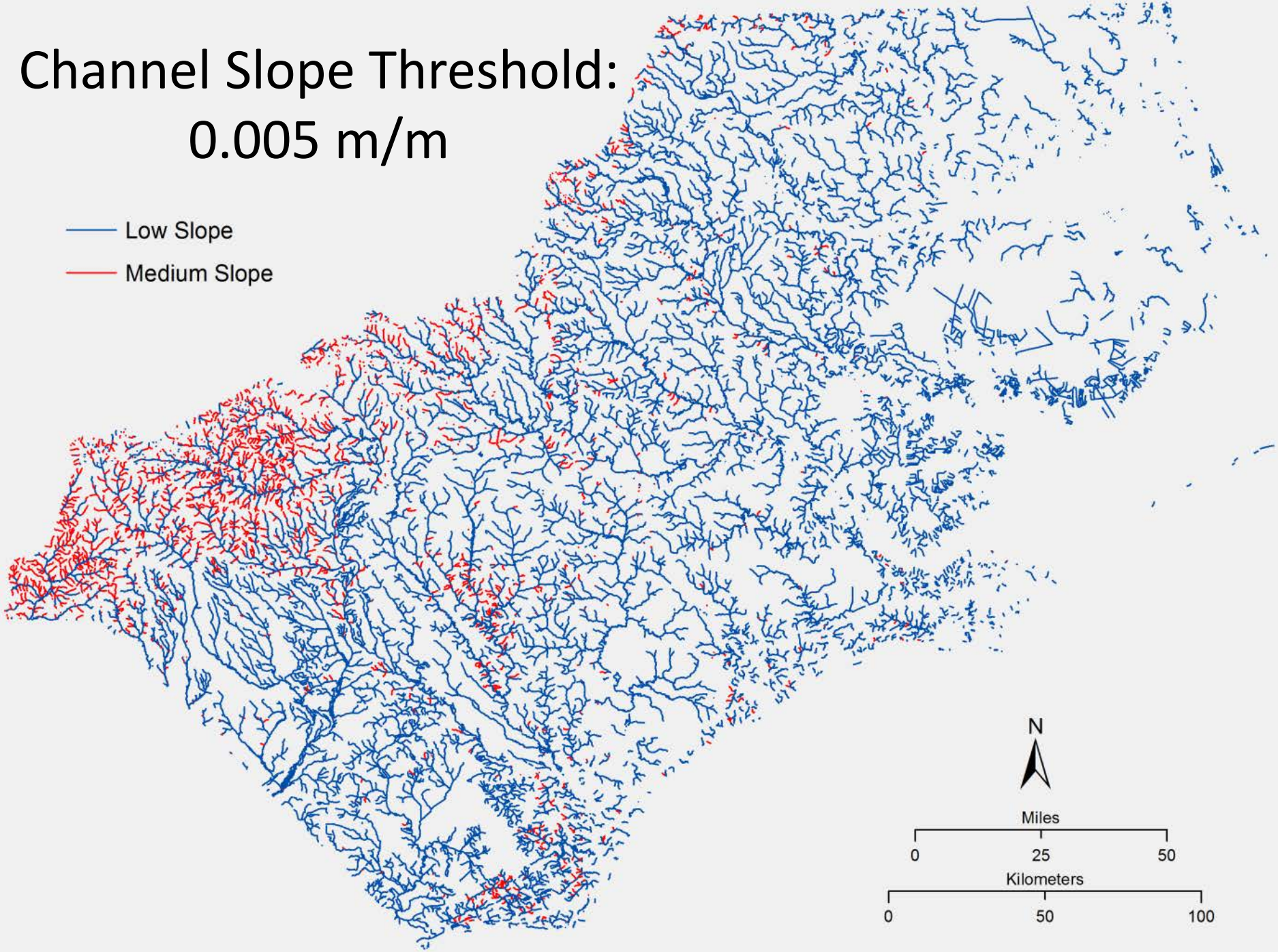
Channel Slopes
(with aid from Kimberly Meitzen)

- Elevation change over reach length
  - average reach slope
- Range:
  - TNC: 0.00001% – 2.9%
- Distribution:
  - TNC: Most 0.00001% -- 2%

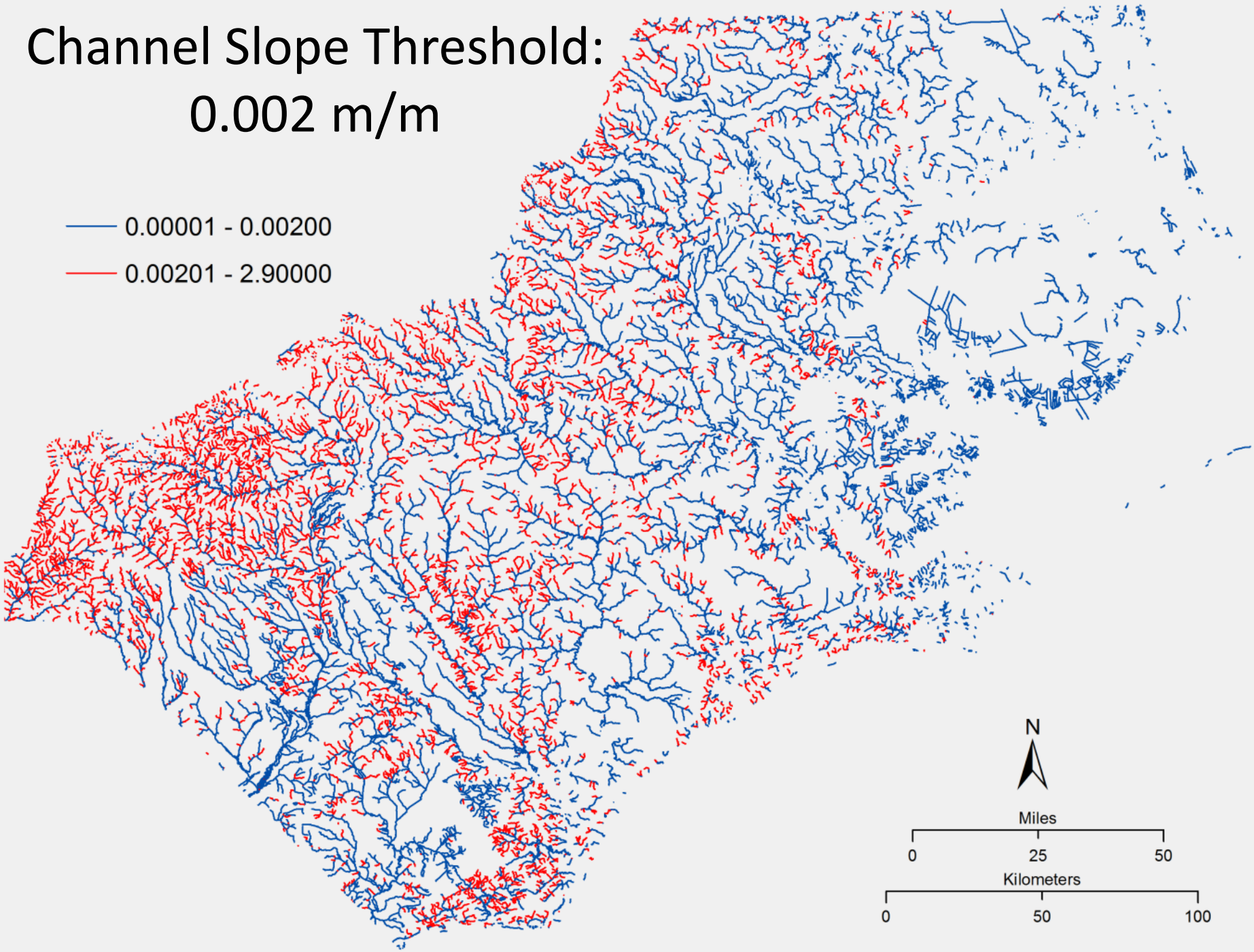
Channel Slope Threshold: 0.02 m/m



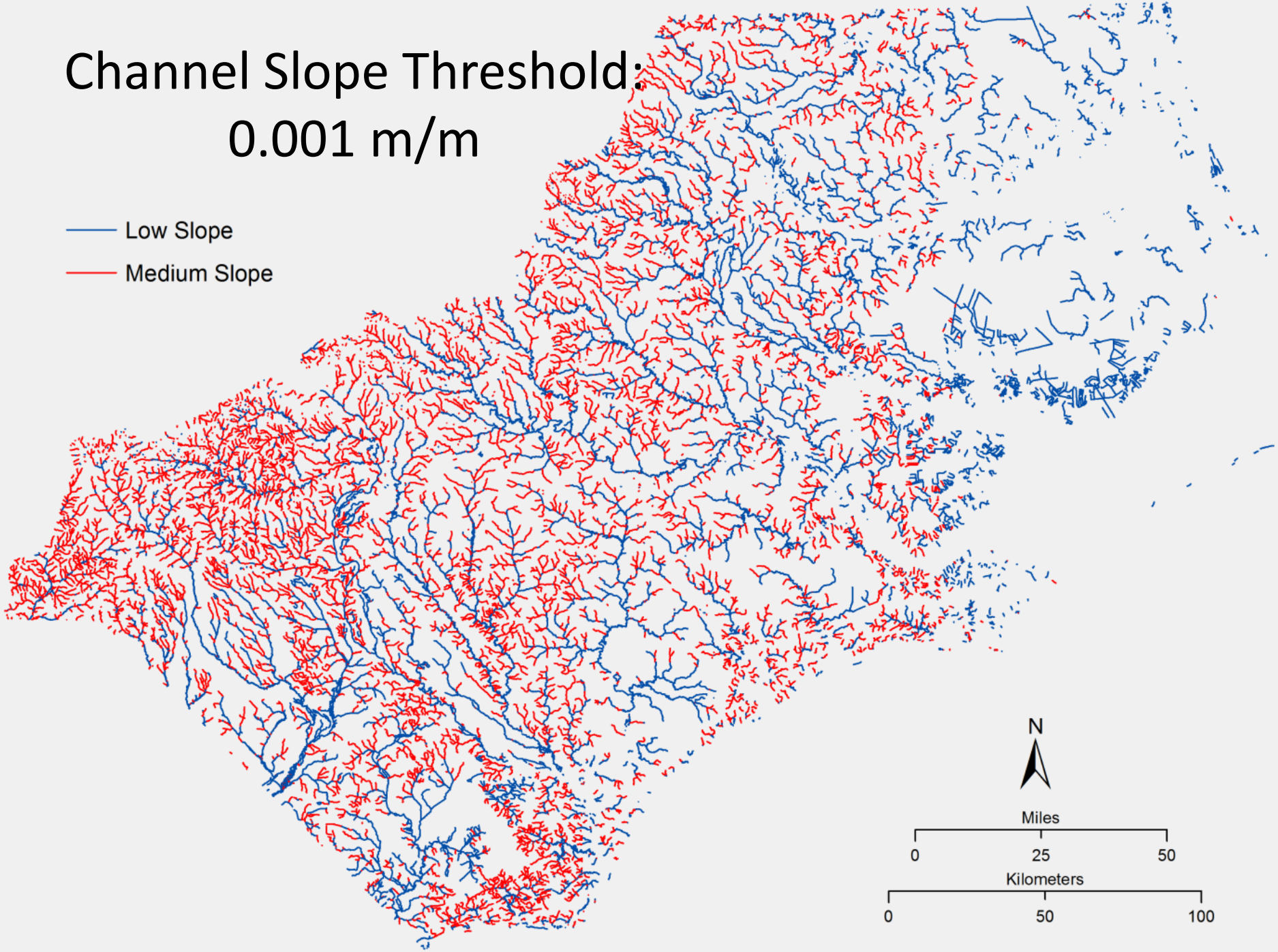
Channel Slope Threshold: 0.005 m/m



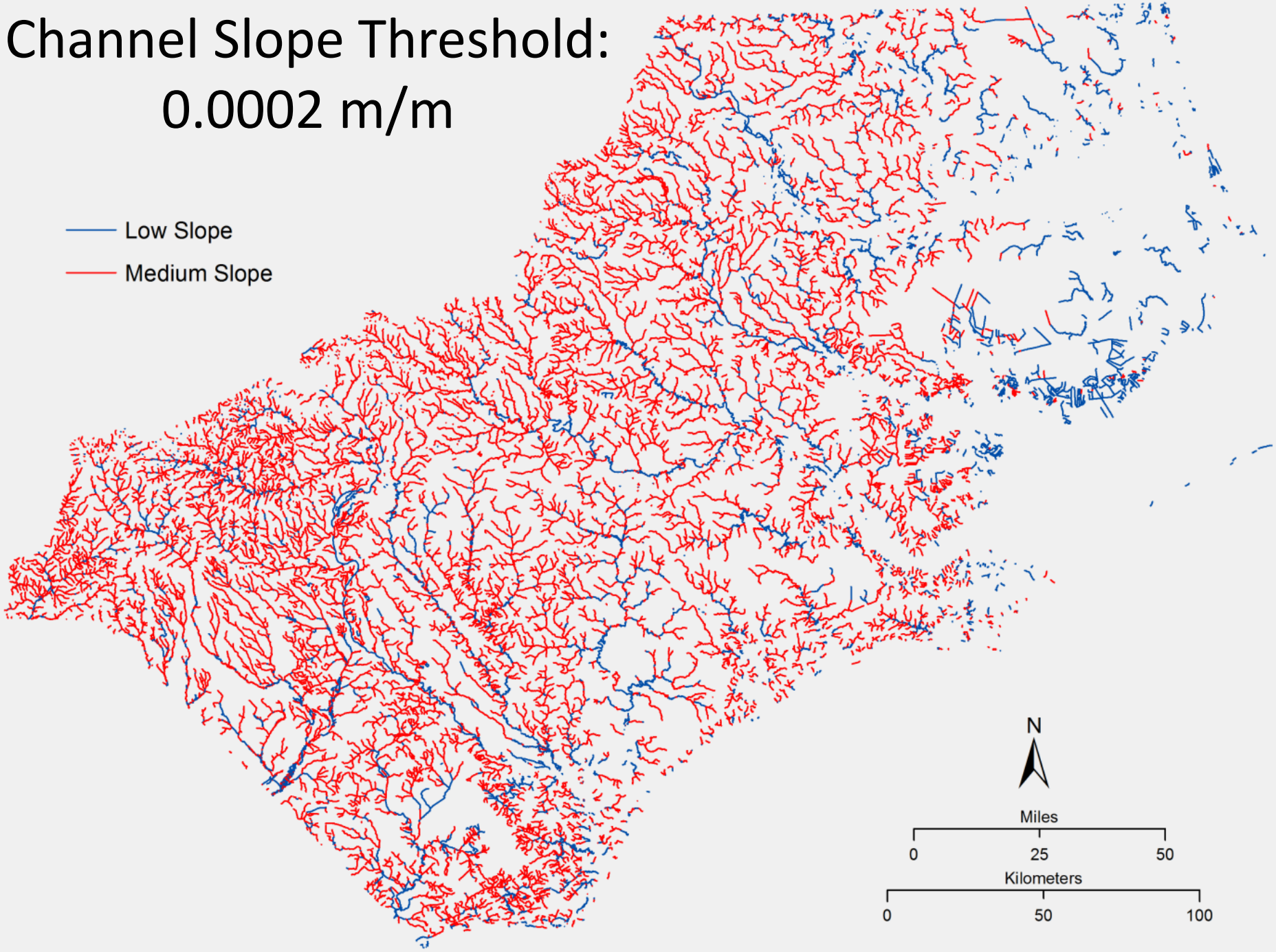
Channel Slope Threshold: 0.002 m/m



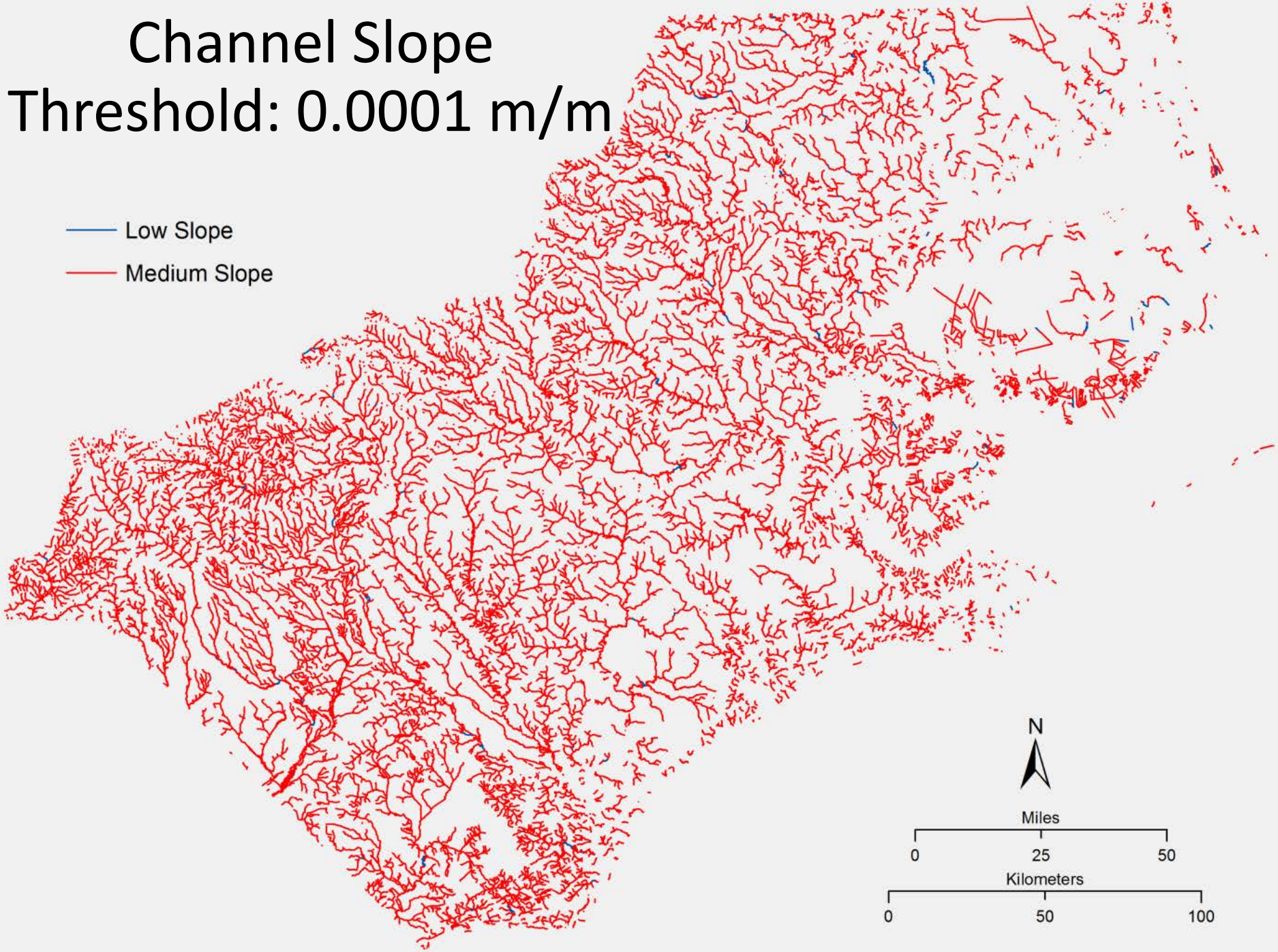
Channel Slope Threshold: 0.001 m/m



Channel Slope Threshold: 0.0002 m/m



Channel Slope
Threshold: 0.0001 m/m

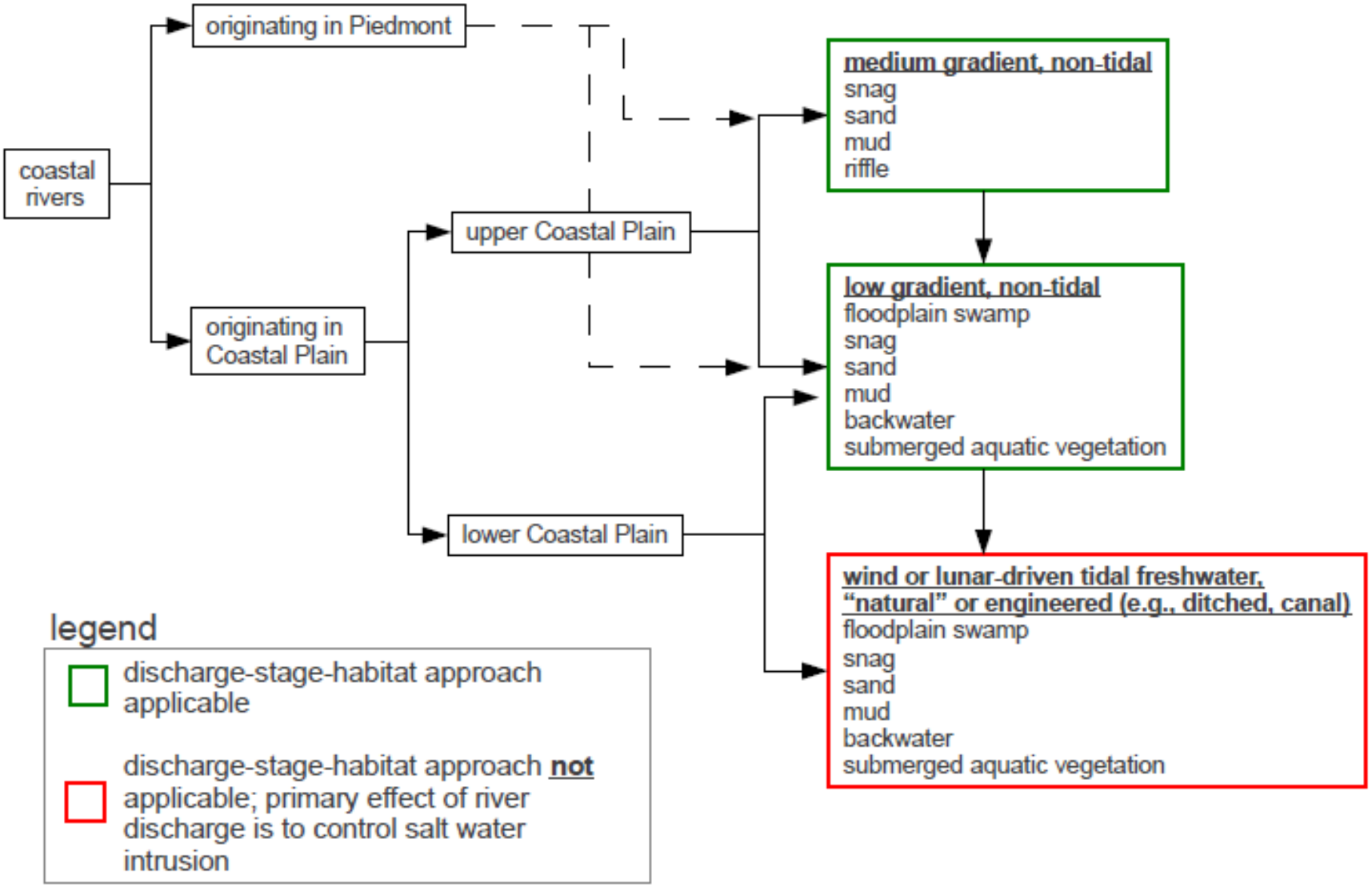


Slope threshold for typology

- Low slope = $\leq$0.001 m/m
- Medium slope = >0.001m/m to 0.005 m/m

- Appears to relate to stream order, catchment size

GEOMORPHIC TYPOLOGY AND ASSOCIATED IN-STREAM HABITATS



by Scott Ensign

Objectives for July 15

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Lower Coastal Plain	Low gradient	X	X	X
Lower Coastal Plain	Wind or tidal driven flow		X	X

Special Coastal Plain Considerations

- Because of flatness, low elevation and proximity to the sea
  - Ground water and surface water are closely linked
    - Ground water withdraw can be important to surface water flow
    - Ground water withdraw may alter inundation patterns of low order streams
    - Ground water may be shunted into surface water for agriculture
  - Flow is closely linked to water quality
    - Salinity
    - Dissolved oxygen
  - Stage is not necessarily well defined by freshwater flow

Key nekton

- Species are often different than those found in inland waters or having different ecology from that inland.
  - Examples (Some require Fisheries Management Plans involving flows)
    - Anadromous fish (upstream spawning)
      - Blueback herring and alewife (under consideration for endangered status)
      - American shad
      - Atlantic sturgeon (endangered)
      - Shortnose sturgeon (endangered)
      - Striped bass (stock status – concern)
    - Catadromous fish (marine spawning)- eel – (stock status - depleted)
    - Estuarine species – some of the common low-salinity species that occur in river systems: southern flounder, Atlantic croaker, spot, menhaden, bay anchovy, blue crab, white shrimp, striped mullet

Anadromous fish

- Ecologically and economically important
- Large database for State
- Spawning flows important
- Flows during larval and juvenile growth and development equally important
  - not simply spawning season
  - position of salt “wedge” important
- Habitat suitability models available

Physical factors and flow influence select species and life history stages

Table 2.4. Physical spawning (adult) and egg development requirements for resident freshwater and anadromous fishes inhabiting coastal North Carolina.

	Salinity (ppt)		Temperature (C)		Dissolved oxygen (mg/l)		Flow (cm/s)	Other parameters
Species	**Adult**	**Spawn/ Egg**	**Adult**	**Spawn/ Egg**	**Adult**	**Spawn/ Egg**	**Spawning**	**Spawn/ Egg**
Alewife	[S] 0-5	[S] 0-5 [O] 0-2		[S] 11-28 [O] 17-21	[S] >3.6	[S] >4	**[O] slow current**	[S] Suspended solids <1000 mg/l
American shad	[S] 0-18	[S] 0-18	[S] 10-30	[S] 13.0-26.0	[S] >5		**[S] 30-90**	
Blueback herring	[S] 0-5	[S] 0-22 [O] 0-2		[S] 14-26 [O] 20-24	[S] >5		**[O] strong current**	[S] Suspended solids <1000 mg/l
Striped bass	[S] 0-5	[S] 0.5-10	[S] 20-22	[S] 12-24, [O] ~18-22	[S] >5		**[S] 30.5-500, [O] 100-200**	
Yellow perch	[S] 0-13	[S] 0-2	[S] 6-30		[S] >5			[S] Suspended solids <1000 mg/l
White perch	[S] 5-18	[S] 0-2	[S] 10-30	[S] 12-20	[S] >5			[S] Suspended solids <100 mg/l
Sturgeon, Atlantic	[S] 0 to >30	[S] 0-5	[S] 0 to >30	[S] 11-20				
Sturgeon, Shortnose	[S] 0 to >30	[S] 0-5	[S] 0 to >30	[S] 5-15				

[S] = Suitable, and [O] = Optimum

Vegetation (foundation species)

- Riparian swamp trees
  - Important flow conditions:
    - Overbank flow frequency, timing and duration
    - Salinity
    - DO
- Submerged aquatic vegetation
  - Important flow conditions:
    - Salinity
    - DO

Link of Stream Typology & Potentially Key Assemblages

Origin	Slope	Assemblage		
		Anadromous Fish	Resident fish	Vegetation (Foundation species)
Piedmont	Medium gradient	X		
Upper Coastal Plain	Medium gradient	X		
Upper Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Low gradient	X		X
Lower Coastal Plain	Wind or tidal driven flow		X	X

Research Needs

1. Juvenile abundance indices vs. flow and salinity/conductivity
2. Salinity distribution across coastal plain
3. Quantification of stream typology classes
4. Roanoke slabshell mussel distribution and abundance as representative of benthos
5. Hydrologic metrics and characteristics of coastal streams
6. Determine reference flow regimes for each river basin
7. Balance of withdraws from and discharges to coasta; streams

Where are we?

- Not far enough for a “Trial balloon.”
- There is a need for a coastal plain approach at least for coastal plain originating, low gradient and tidally dominated streams
- Stage may be the tracking hydrologic property rather than flow
- Flow and water quality cannot be separated
- Different key assemblages may be needed for different stream classes