



Biological Fidelity Analysis of Stream Classes - UPDATE

Funded by: *Environmental Defense Fund*

Conducted by: *RTI International*

Outline of Presentation

- Background
- Current Status:
 - Site selection
 - Aquatic biota
 - Stream classification
 - Preliminary statistical analysis results
 - Individual species
 - Community assemblage

Project Objectives:

- To adopt a stream classification system that represents the distribution of aquatic biota in North Carolina
 - evaluate the 7 stream classes of the Environmental Flow Specialist (EFS) hydrological stream classification system:
 - A. Coastal Streams
 - B. Small Stable Streams
 - F. Medium Stable Streams
 - C. Large Stable Streams
 - E. Large Piedmont Rivers
 - D. Small Flashy Streams
 - G. Small Seasonal

Project Objectives:

- To adopt a stream classification system that represents the distribution of aquatic biota in North Carolina
 - Compare fidelities of aquatic biota to different stream classification systems
 - If necessary, modify the EFS stream classes to more accurately describe the distribution of biota

Study Methods:

- Aquatic Biota and Datasets:
 - Fish
 - Benthos
 - Aquatic species in Natural Heritage Program database

Aquatic Biota and Datasets

Aquatic Biota	Database
Benthos	NCDENR DWQ Benthic Macroinvertebrate
Fish	NCDENR DWQ Fish Community, USGS NAQWA, WRC Trout, WRC Diversity (Gameland Surveys)
Natural Heritage Inventory	NCDENR Natural Heritage Program

Study Methods:

- Aquatic Biota and Datasets:
 - Fish
 - Benthos
 - Aquatic species in Natural Heritage Program database
- Sites:
 - 185 NHD+ catchments with USGS gages (used to develop EFS stream classes)
 - ~600 NHD+ catchments with stream classes based on WaterFALL hydrologic data
- Aquatic biota data within each NHD+ catchment will be paired with the assigned stream class

Study Methods:

- Stream Classifications Systems:
 - EFS
 - McManamay et al. (2011)
 - Konrad (*in review*)
- Statistical Analyses:
 - Random Forest (individual species)
 - Similarity Analyses (communities)

Current Status:

- Site Selection
- Aquatic Biota
- Stream Classifications
- Preliminary Statistical Analyses

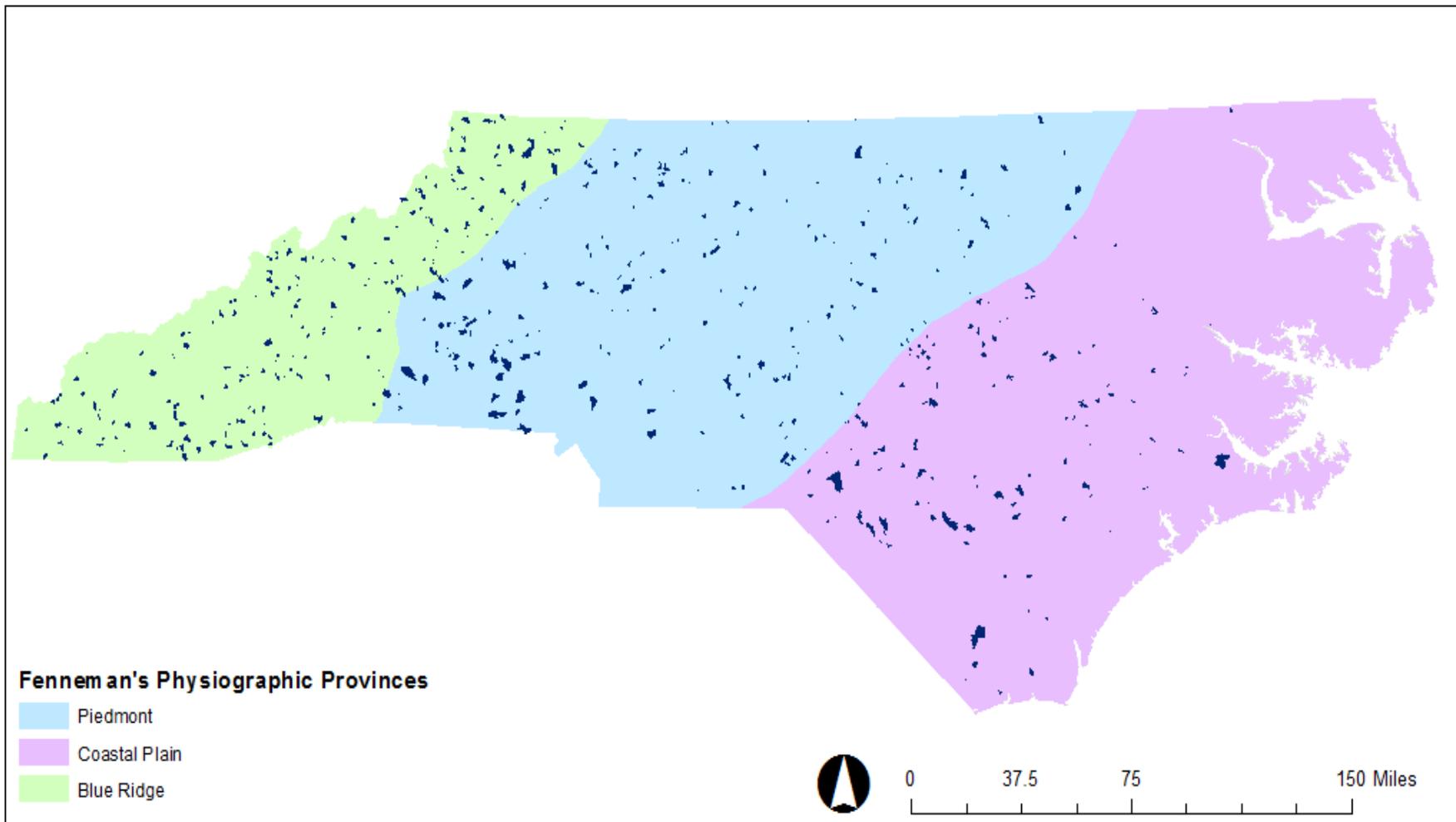
1. Site Selection

- 185 NHD+ catchments with EFS stream classes
- 527 NHD+ catchments:
 - equal representation of 3 physiographic regions
 - “minimally impaired” condition:
 - Water quality: Excellent, Good or Good-Fair Benthos site condition
 - Water quantity (instream flow alteration): total drainage area of monitoring station is at least twice the size of the total drainage area of the closest upstream flow alteration
 - Within each physiographic region, proportional representation of streams with and without upstream flow alterations
 - Random selection of qualifying sites

1. Site Selection

- Final number of sites (criteria applied to 185 NHD+ catchments + new sites):
 - 578:
 - 217 mountains
 - 231 piedmont
 - 130 coastal plain

1. Site Selection



2. Aquatic Biota

- All monitoring sites within 578 NHD+ catchments:
 - Fish, benthos, NHP aquatic species
 - 30 years of data (1981-2010) assuming stream classes based on ~ 2010 condition

Aquatic Biota	Number of Monitoring Sites
Benthos	636
Fish	238
Natural Heritage Inventory	656

3. Stream Classification

- Stream classes based on WaterFALL hydrologic data:
 - Generate for all 578 NHD+ catchments:
 - 2006 NLCD
 - 40 years of climate data (1967-2006)
 - Instream flow alterations (dams, withdrawals and discharges – 1995-2012)
 - Plan to generate these stream classes within the next couple of months
 - Calibrate and QAQC stream classes with a comparison against classes determined by USGS gage data

3. Stream Classification

- Stream classification systems:
 - EFS (7 classes), McManamay et al. (2011) (8 classes)
 - ~~Konrad (*in review*) (8 classes)~~

4. Preliminary Statistical Analyses

- Analyses:
 - Random Forest (individual species)
 - Presence/absence
 - Similarity Analysis (communities)
 - Presence/absence
 - Abundance
- Dataset:
 - Benthos (106 out of 185 NHD+ catchments with EFS stream classes)
 - Taxonomic ambiguity resolved
 - Remove Parent – Keep Child (resolved to Genus level)
dataset used in both sets of analyses

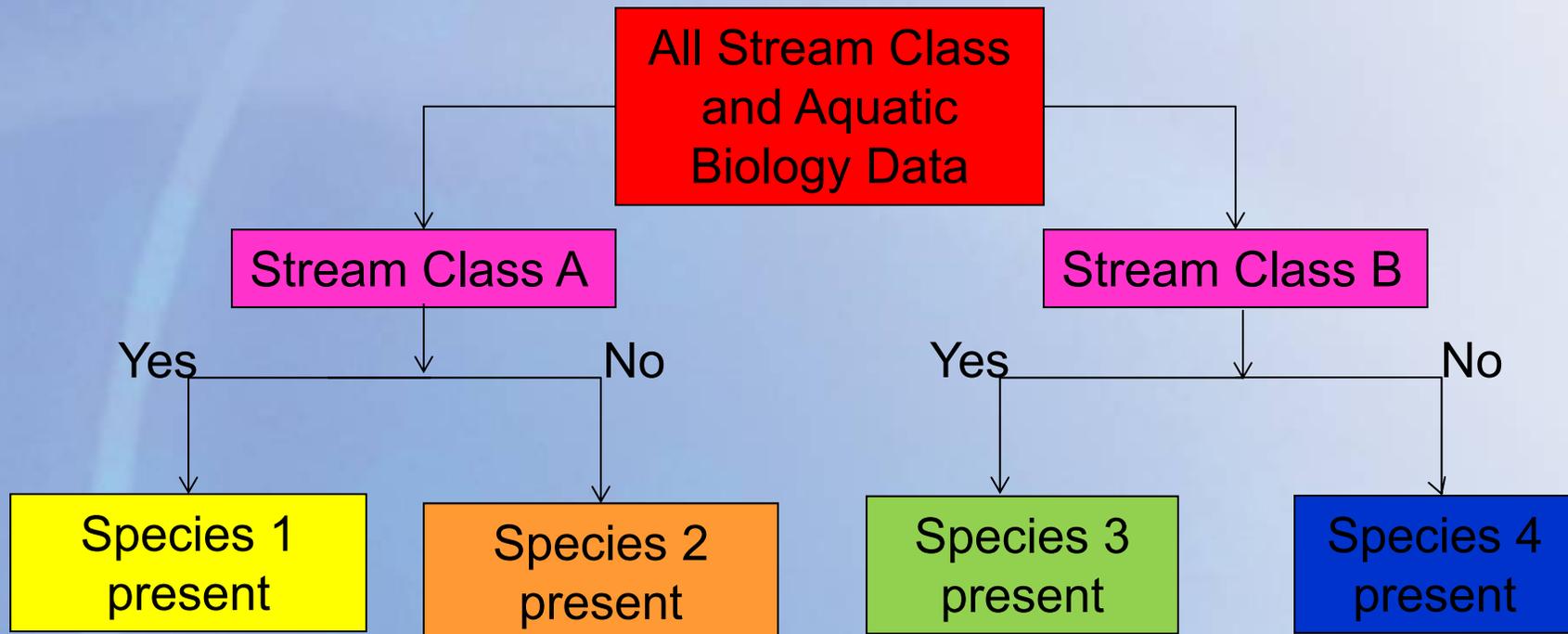
4. Preliminary Statistical Analyses

- Number of NHD catchments for each stream class

Stream Class	Number of NHD+ Catchments
A	14
B	41
C	6
D	30
E	1
F	8
G	6

Random Forest Approach

- Random Forest is a decision-tree modeling and classification approach (Cutler et al., 2007)
- A decision tree is a predictive model that uses a set of binary rules (yes/no) to split the data based on the predictor variable



Random Forest Analysis - *Biological fidelity to stream class*

Aquatic species	Stream Class						
	A	B	C	D	E	F	G
1		High	High	Low	Low		
2						High	
3	Low			High	High		
4		Low	Medium			High	
5	Medium	Medium	Medium	Medium	Medium	High	Medium
6					High	High	
7		Low	Low		High		
8					Low		High
9	High				Low		
10			High	High			

 = high probability
 = medium probability
 = low probability
 = absent

Random Forest Analysis – *NO Biological fidelity to stream class*

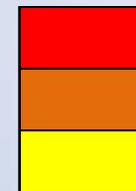
Aquatic species	Stream Class						
	A	B	C	D	E	F	G
1	High	High	High	High	High	High	Low
2	Low	Medium	Medium	Medium	Medium	Medium	Medium
3	Medium	Medium	Medium	Medium	Medium	Low	Low
4	Low	Low	Low	Low	Low	Low	Low
5	Medium	High	High	High	High	High	Medium
6	Low	Low	Low	Low	Low	Low	Low
7	Absent	Low	Low	Medium	Medium	Medium	Medium
8	High	High	High	High	High	High	High
9	High	High	High	Low	High	High	Low
10	Low	Low	Low	Low	Low	Low	Low

 = high probability
 = medium probability
 = low probability
 = absent

4. Preliminary Statistical Analyses

Taxa	Stream Class						
	A	B	C	D	E	F	G
Ceratopsyche	0.032	0.034	0.005	0.076	0.000	0.012	0.032
Serratella	0.031	0.008	-0.003	0.071	0.000	0.000	-0.010
Heptagenia	0.013	-0.003	0.034	0.025	0.000	0.001	0.010
Pycnopsyche	-0.012	0.011	-0.006	0.019	0.000	0.004	0.027
Phylocentropus	0.038	0.001	0.001	0.002	0.000	0.000	0.005
Cardiocladius	0.000	-0.004	-0.004	0.001	0.000	0.016	0.001
Pteronarcys	0.007	0.000	0.013	0.019	0.000	0.004	0.004
Neophylax	0.014	0.008	0.011	0.013	0.000	-0.006	-0.015
Paragnetina	0.004	0.005	0.008	0.013	0.000	0.000	0.007
Brachycentrus	-0.006	0.000	-0.001	0.013	0.000	-0.005	0.004
Promoresia	0.007	0.000	-0.003	0.012	0.000	0.004	0.008
Epeorus	0.008	0.005	0.008	0.011	0.000	-0.005	0.009
Microtendipes	-0.010	0.006	0.010	0.011	0.000	-0.008	0.010

Importance:



High
Medium
Low

4. Preliminary Statistical Analyses

- Only ~10% of taxa (41 out of 408) showed a higher fidelity to one stream class over another
- Probability of general occurring in each stream class are probably low
- Some of the results may be an artifact of the low numbers of NHD+ catchments for each stream class (1-41)
- Minimum number of NHD+ catchments for more robust analyses is ~ 40.
- 36% of taxa had ≤ 3 records
- Fidelities could be further confounded by including all benthos sites in the analysis

Questions?