Proposed approach to develop a Biological-Environmental Classification (BEC) system and supporting flow – biology relationships in North Carolina

Funded by: *Environmental Defense Fund*

Conducted by: *RTI International*

Background:

- Biofidelity Analysis showed:
  - EFS and McManamay stream classifications systems could not be extrapolated beyond catchments with USGS gages
    - 49-64% match between classifications based on USGS gage versus WaterFALL modeled hydrologic data
    - ~ 270 USGS gages in NC
    - ~70,000 NHD+ catchments

Background:

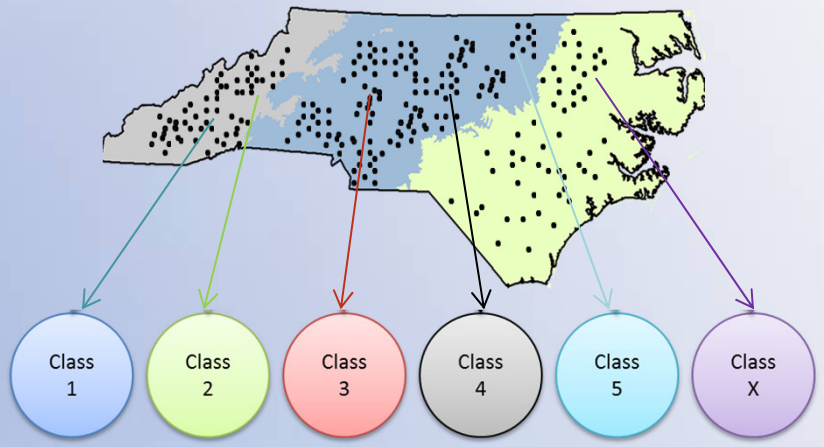
CONCLUSION:

- Need a classification system that is:
  - Not based on sensitive threshold values
  - Consistent and reproducible using USGS stream gage and modeled data
  - Easy to understand and implement
  - Can be applied throughout state
  - Captures the distribution of aquatic biota in North Carolina

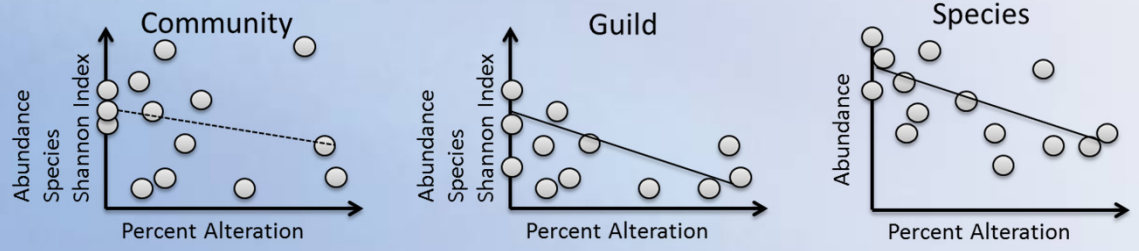
Objectives of Proposed Project:

1. Develop a classification system based on geographical assemblages of aquatic biota (fish) and associated environmental (physiographic and hydrologic) attributes – Biological-Environmental Classification (BEC) system
2. Determine flow–biology response relationships for each BEC class
3. Link significant flow metrics (and associated flow–biology relationships) to each BEC class to support ecological flow determinations

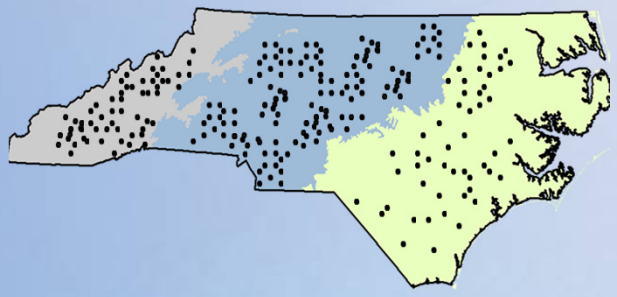
Step 1 – Determine BEC classes based on aquatic biota assemblages and environmental characteristics



Step 2 – Determine flow-biology relationships for each BEC class



Step 3 – Link significant flow metrics to each BEC class to support determination of ecological flows



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Step 1 – Determination of BEC class

- Iterative, cluster-classification approach using aquatic biota and environmental attribute data to develop BEC classes:
  - Aquatic biota:
    - NC fish (DWQ Fish community dataset) – 858 monitoring stations
  - Environmental attributes:
    - Regional classifications (6 classifications – ecological, physiographic, hydrologic)
    - Physiographic (watershed and stream channel) characteristics
    - Climatic variables
    - Hydrologic variables

Environmental attributes potentially used in BEC classes

Environmental Attributes	Variable
Climatic	Average precipitation
	Average temperature
Physiographic	Elevation
	Channel Width
	Channel Gradient
	Channel Sinuosity
	Local connectivity (stream fragmentation)
	Stream size/Drainage area
	Geology (catchment and local)
Hydrologic	Stream hydrologic regime (ground-water vs. surface water dominated)

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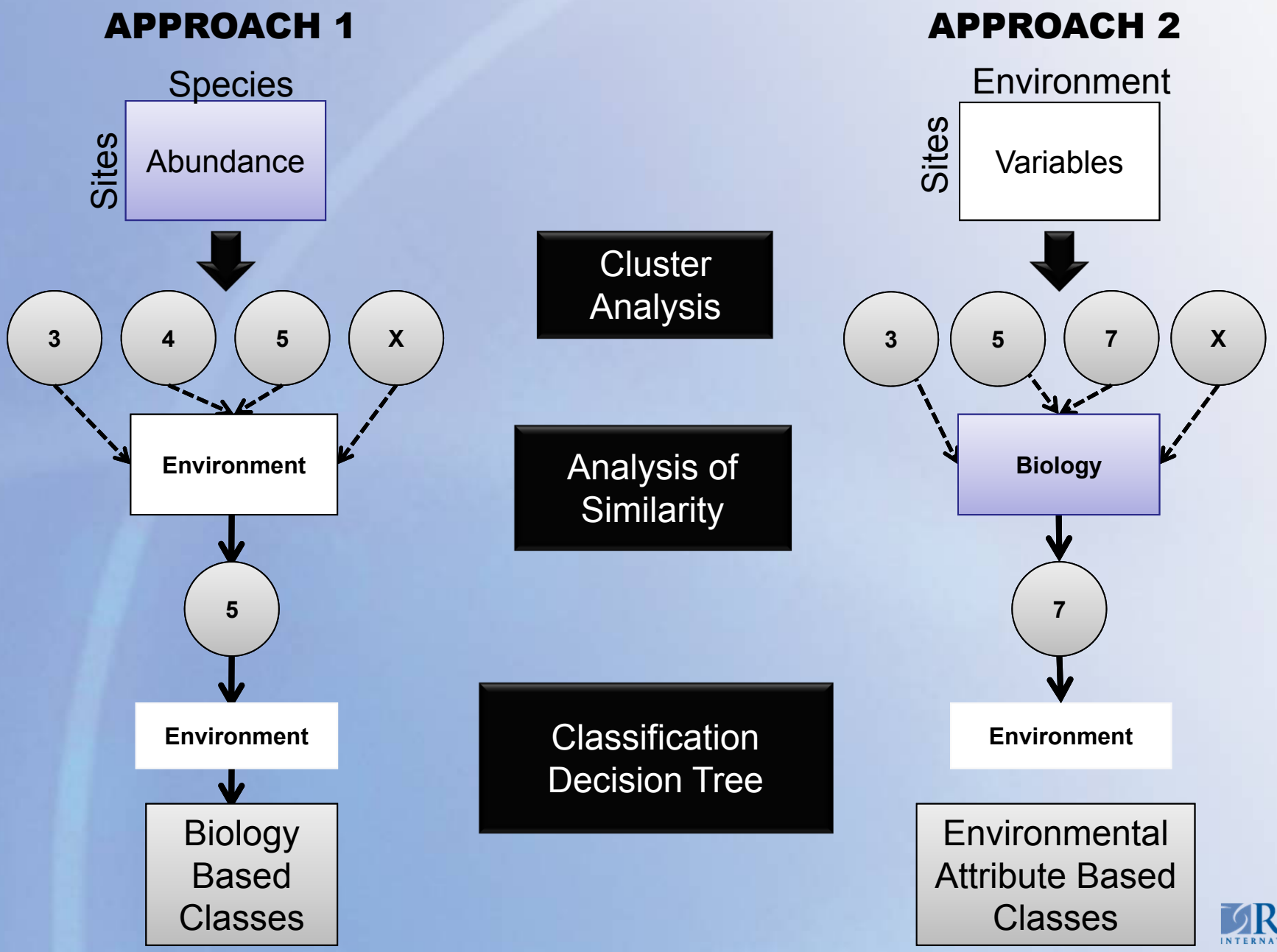
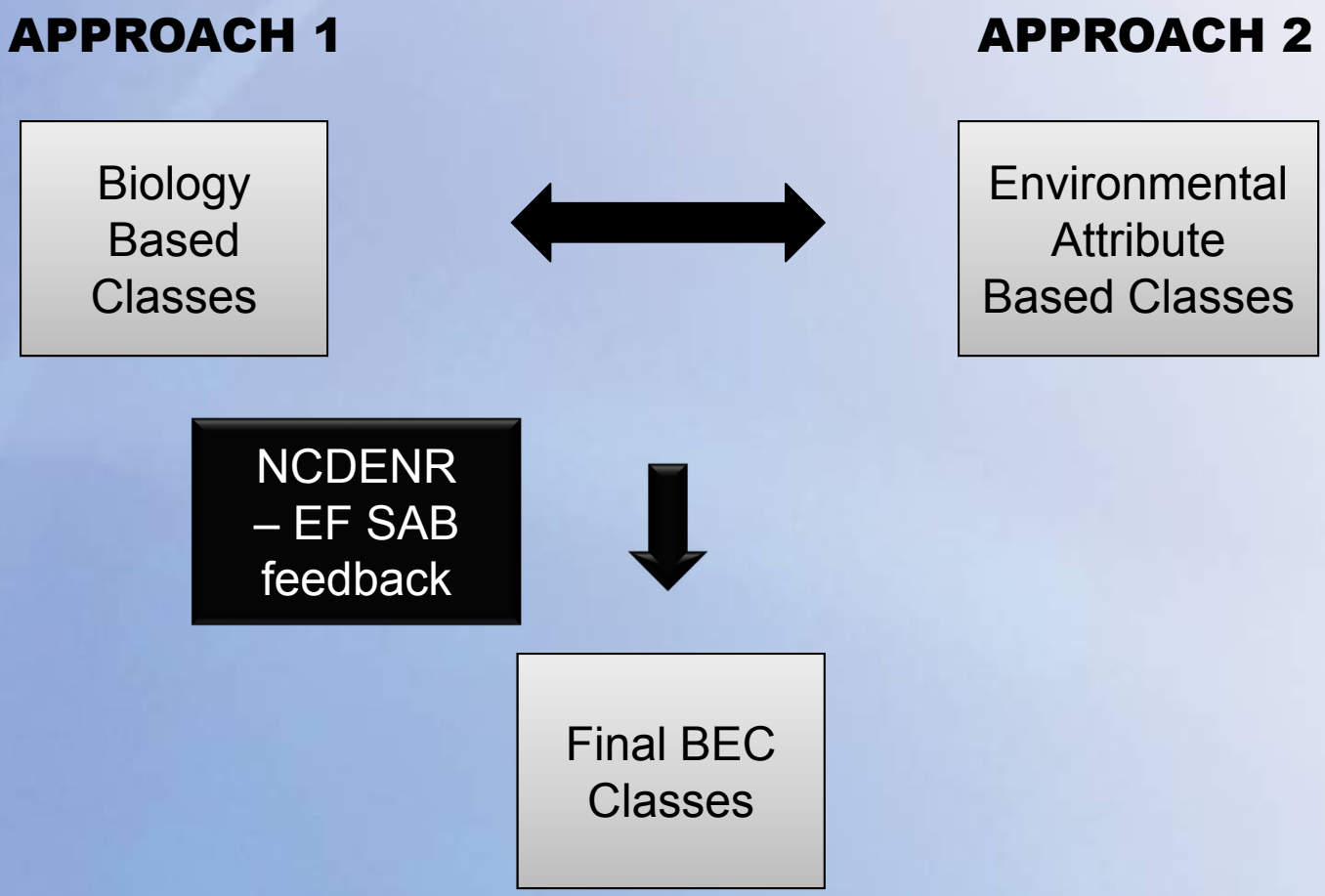
- Iterative, cluster-classification approach using aquatic biota and environmental attribute data to develop BEC classes

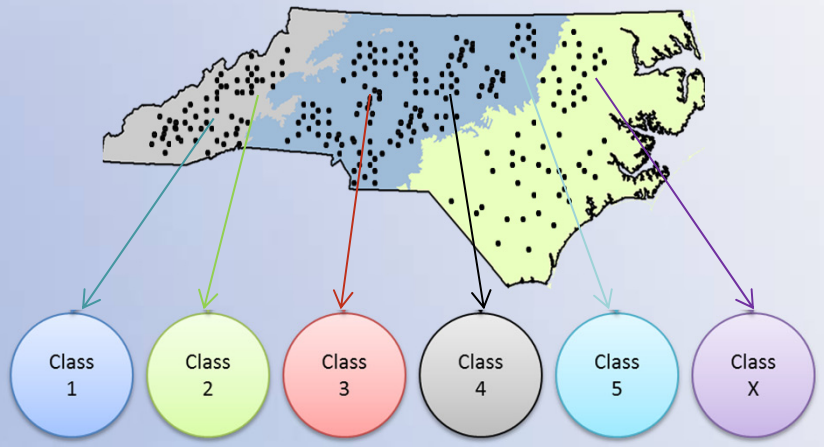

APPROACH 1
Species
Sites
Abundance
3
4
5
X
Environment
5
Environment
Biology Based Classes
Cluster Analysis
Analysis of Similarity
Classification Decision Tree
APPROACH 2
Environment
Sites
Variables
3
5
7
X
Biology
7
Environment
Environmental Attribute Based Classes

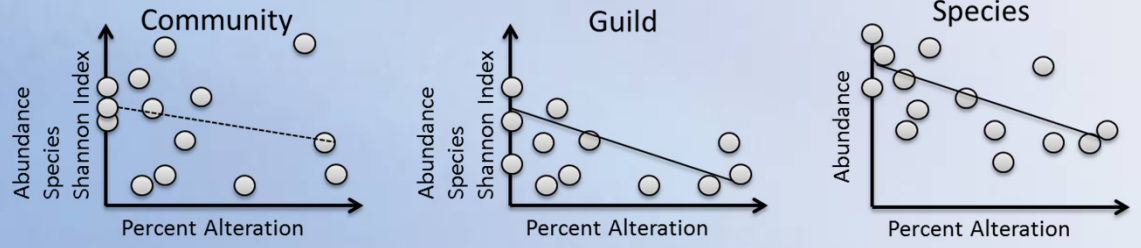

APPROACH 1
APPROACH 2
Biology Based Classes
Environmental Attribute Based Classes
NCDENR – EF SAB feedback
Final BEC Classes

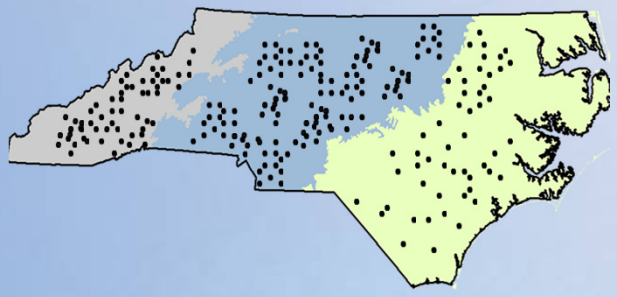
Step 1 – Determine BEC classes based on aquatic biota assemblages and environmental characteristics

Step 2 – Determine flow-biology relationships for each BEC class

Step 3 – Link significant flow metrics to each BEC class to support determination of ecological flows







Step 2. Determination of Flow-Biology Relationships

- Flow alteration – biological response relationships for each BEC class:
  - Flow alteration (% change):
    - Ecologically-relevant flow metrics
      - based on TNC Indicators of Hydrologic Alteration (IHA)
      - NC DENR management-focused
      - Generated using WaterFALL model

Flow Metrics

Time Step	Component	Threshold
Monthly	Extreme Low Flow	10th percentile
	Low Flow	25th percentile
	Median Flow	50th percentile
	High Flow	75th percentile
Annual Winter (10– 6) Summer (7–9)	Extreme Low Flow Threshold	10th percentile
	Extreme Low Flow Events	Number of events
	Extreme Low Flow Duration	Maximum

Expressed as % change:
-Historic = 1970's land-cover or Potential Natural Vegetation (PNV), no in-stream flow alterations
-Current = 2006 land-cover, with discharges, withdrawals, and impoundments

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Step 2. Determination of Flow-Biology Relationships

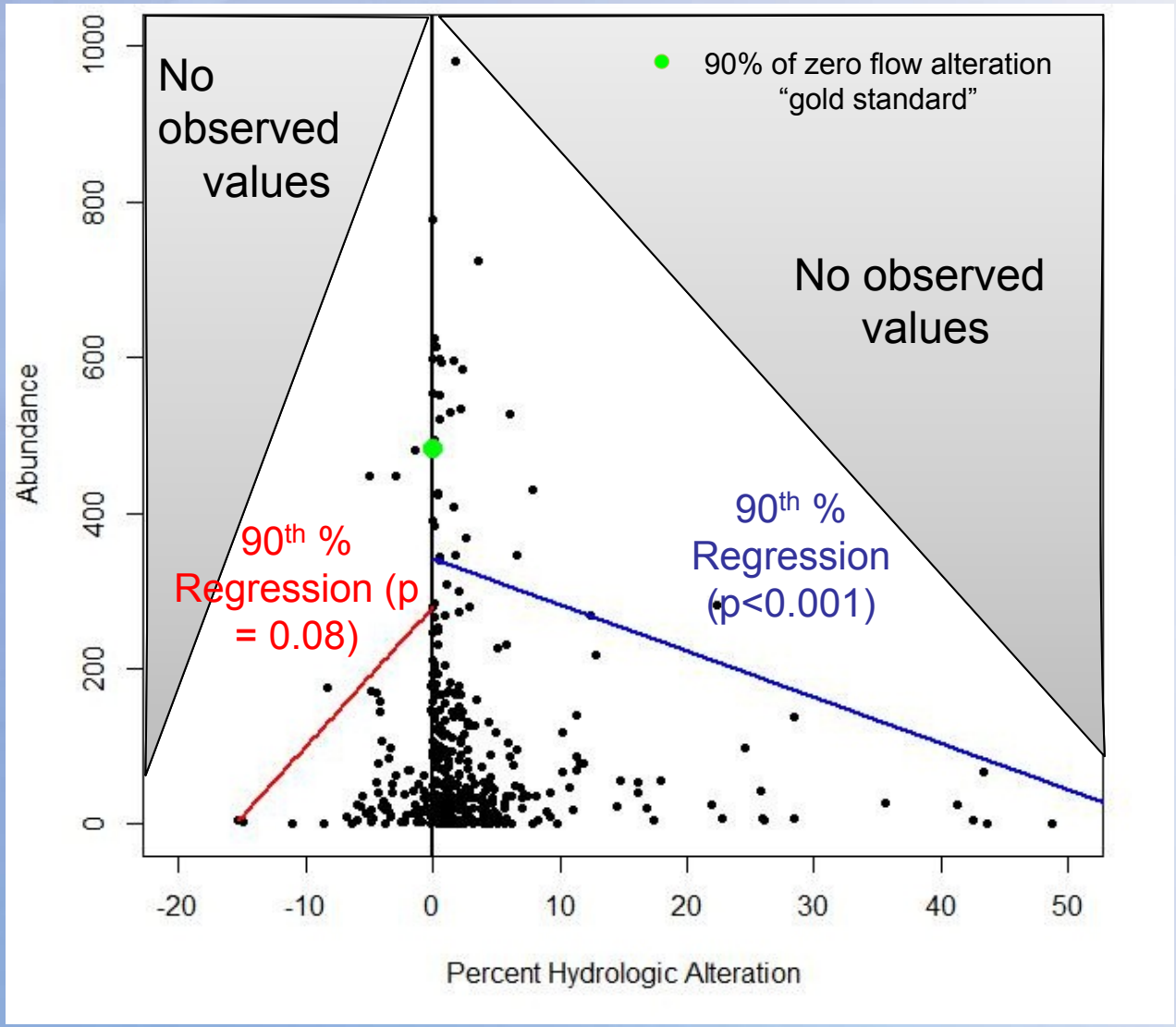
- Flow alteration – biological response relationships for each class:
  - Biological response:
    - NC Fish Community data (858 catchments with monitoring stations)

Level	Analysis metric
- Individual species	- Species abundance (count of individuals)
- Full community	- Number of species (diversity)
- Habitat guilds (6)	- Shannon Weaver Diversity Index

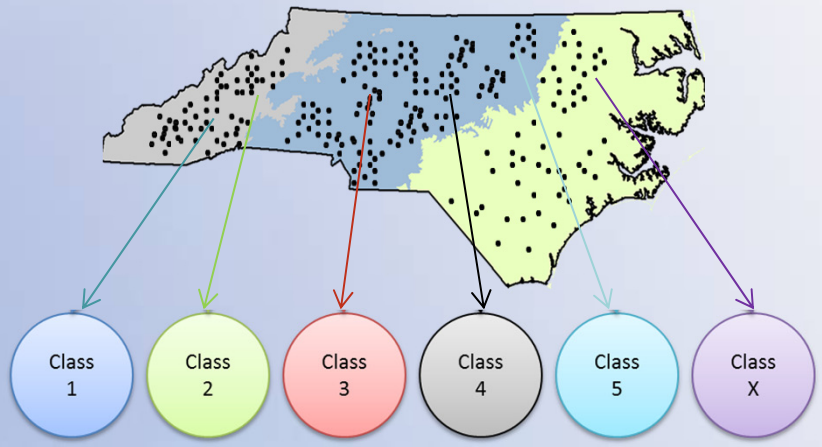
Step 2. Determination of Flow-Biology Relationships

- Flow alteration – biological response relationships for each class:
  - Analysis:
    - Space-for-time analysis
    - Quantile regression (90th percentile)

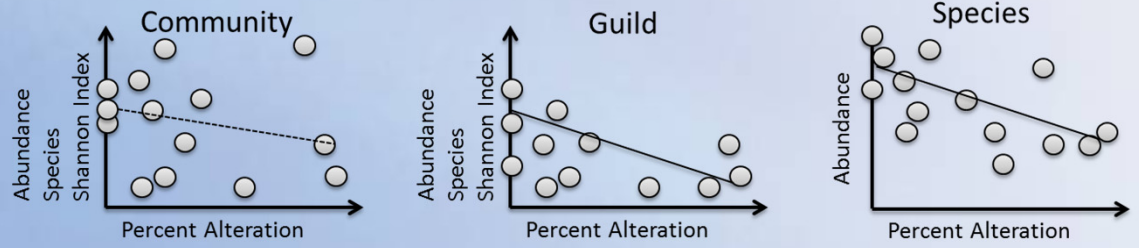
Example of Flow-Biology Relationship



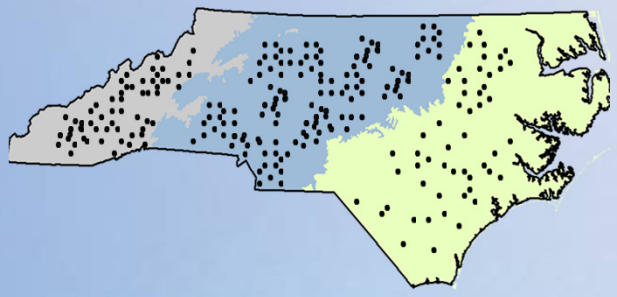
Step 1 – Determine BEC classes based on aquatic biota assemblages and environmental characteristics



Step 2 – Determine flow-biology relationships for each BEC class



Step 3 – Link significant flow metrics to each BEC class to support determination of ecological flows



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Step 3. Link flow metrics to each BEC class

- Link statistically significant flow metrics (from the flow-biology analyses) to each BEC class
- Some metrics (associated with individual species analyses) may be associated with more than one BEC class

Questions?