Benthic Fauna of Restored Streams

The real voyage of discovery consists not in seeking new landscapes, but in having new eyes.

Marcel Proust

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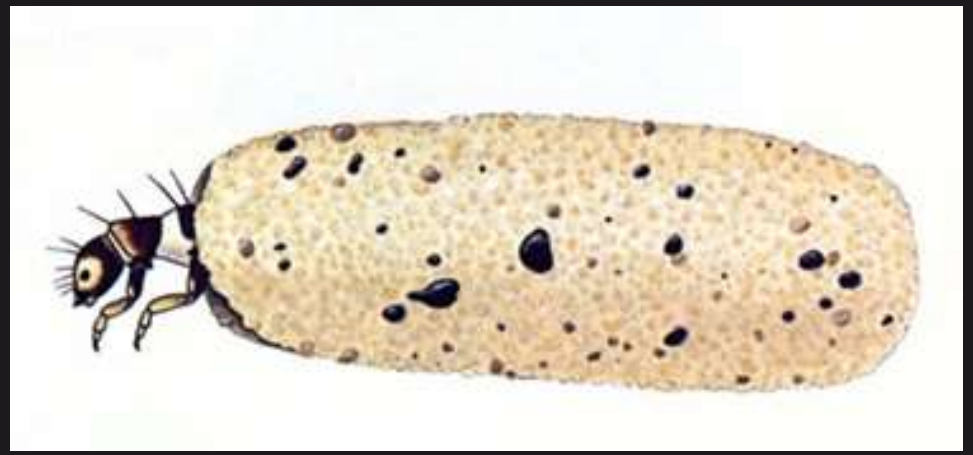
Perceived Impediments to the use of Biological Data



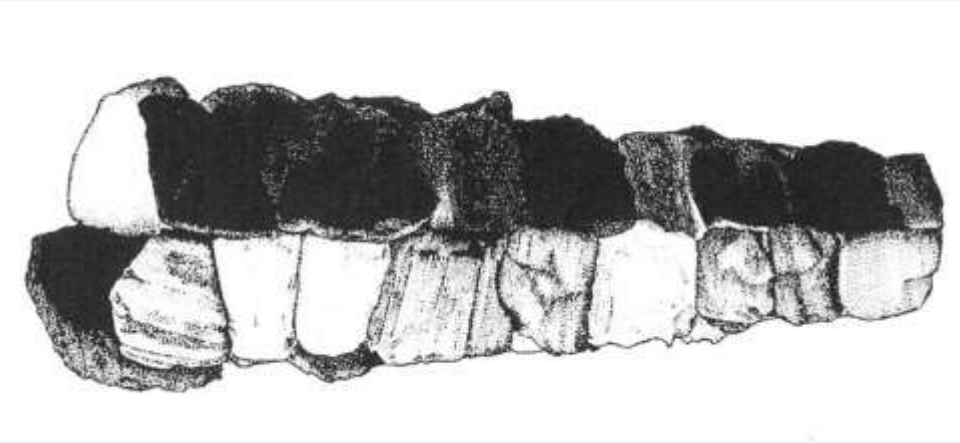
- **Watershed Expectations**
- **Lack of Regulatory Drivers**
- **Long-term Recovery or no Recovery**
- **Normalization of Metrics**
- **Training, taxonomy too difficult**
- **Cost of doing investigations**
- **Data are too complicated, variable**

Why do scientists use aquatic insects?

- They're found in all stream types; ubiquitous
- Large number of species (i.e. Chironomidae = 10,000 species worldwide), spectrum of environmental responses.
- Sedentary nature to allow spatial analyses
- Propensity of some species to enter the water column and drift
- Long life cycles, about 1 year in length
- Easily and inexpensive to collect
- Taxonomy is relatively well described (family and genus)
- Integrate a wide array of potential pollutants
- Important in the diets of fish and other organisms

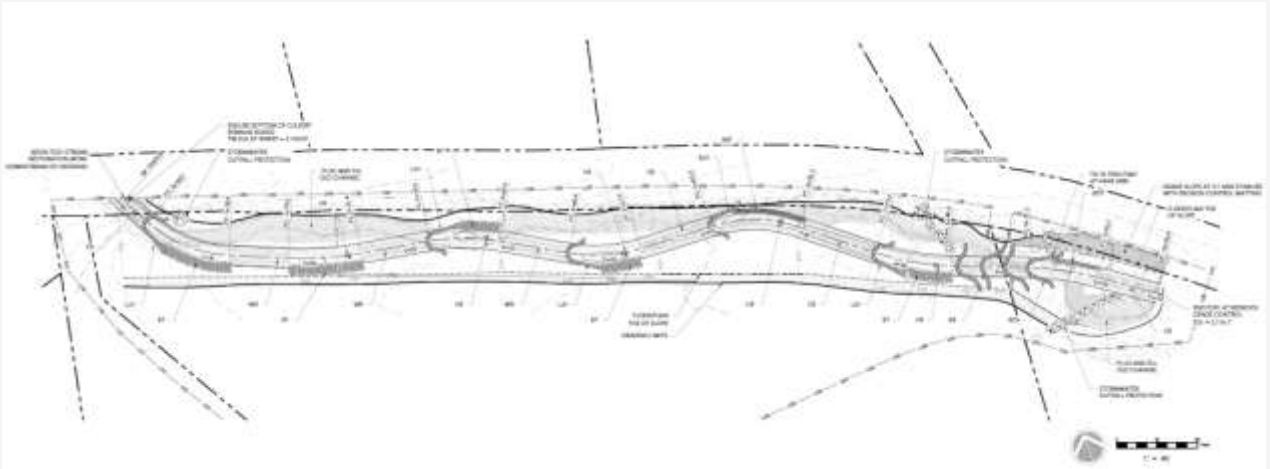
Basic Information Needed to Define Ecological Uplift

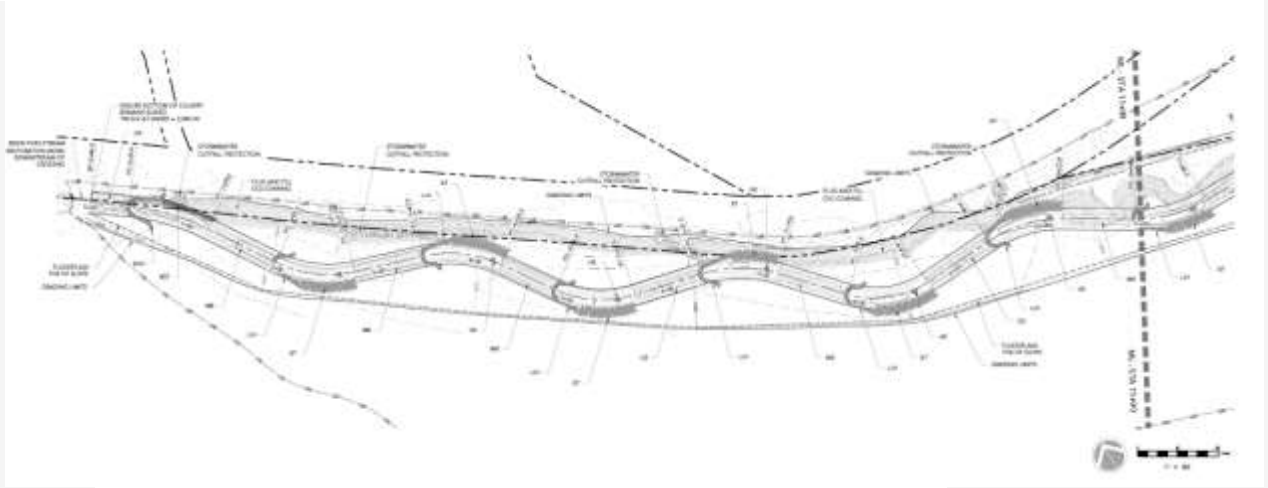
- **Nearby Reference Condition**
- **Pre-construction Data**
- **Basic Taxonomic Skills (Family level doesn't cut it in most cases)**

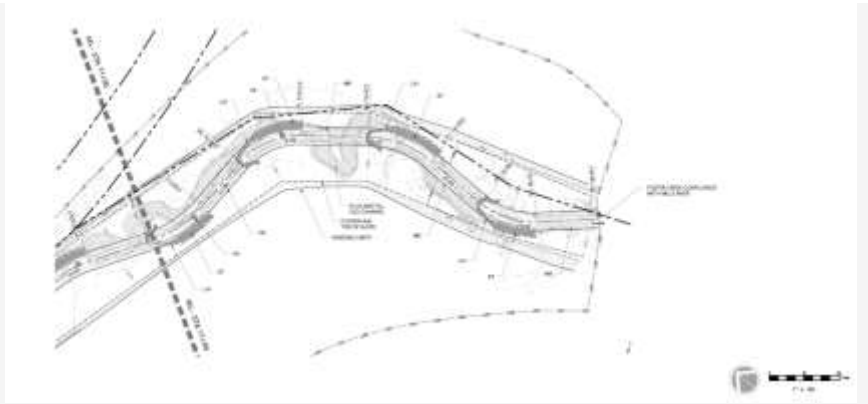


Foster's Creek (Henderson Co., NC)

Photos and drawings by Jennings Environmental

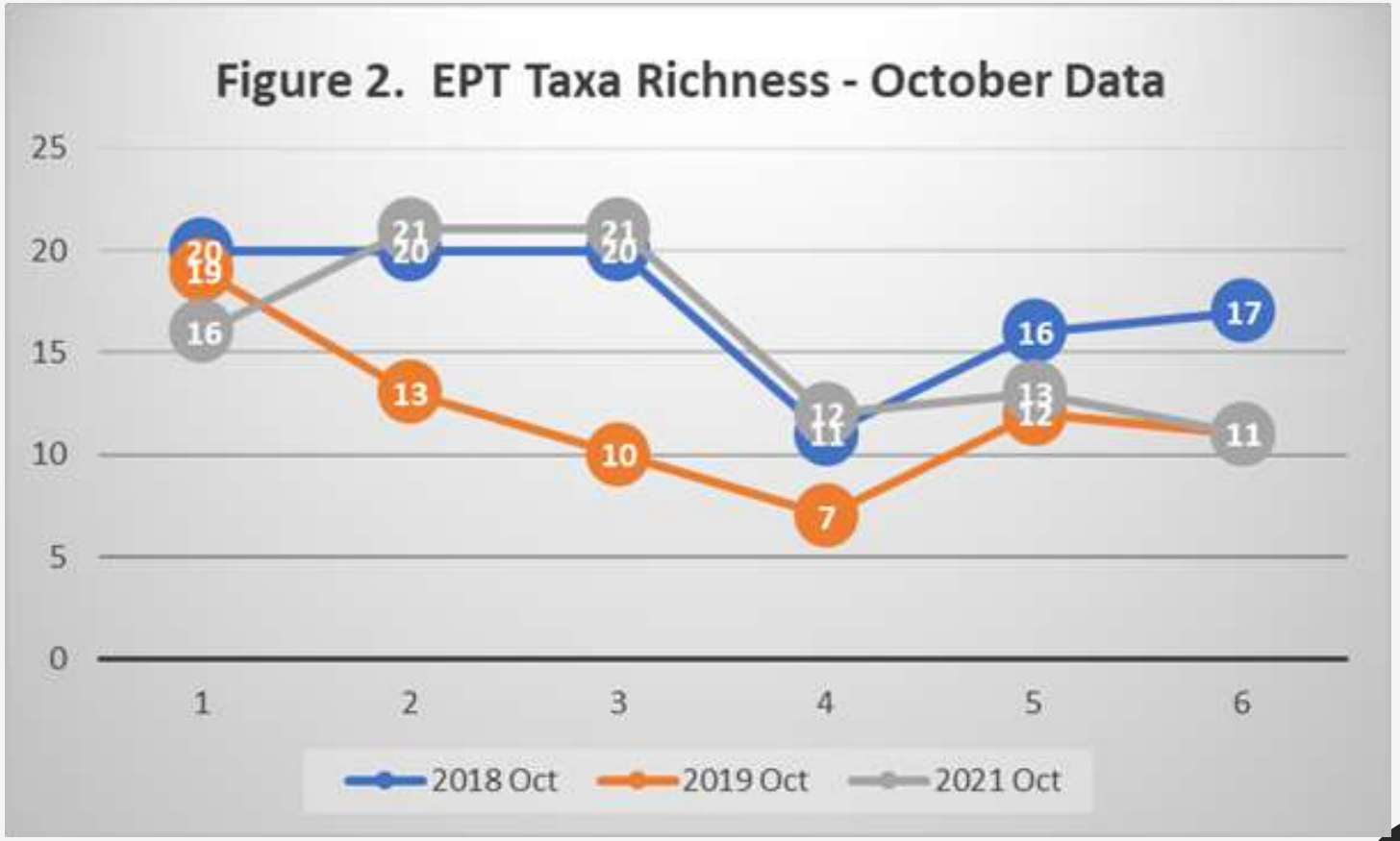






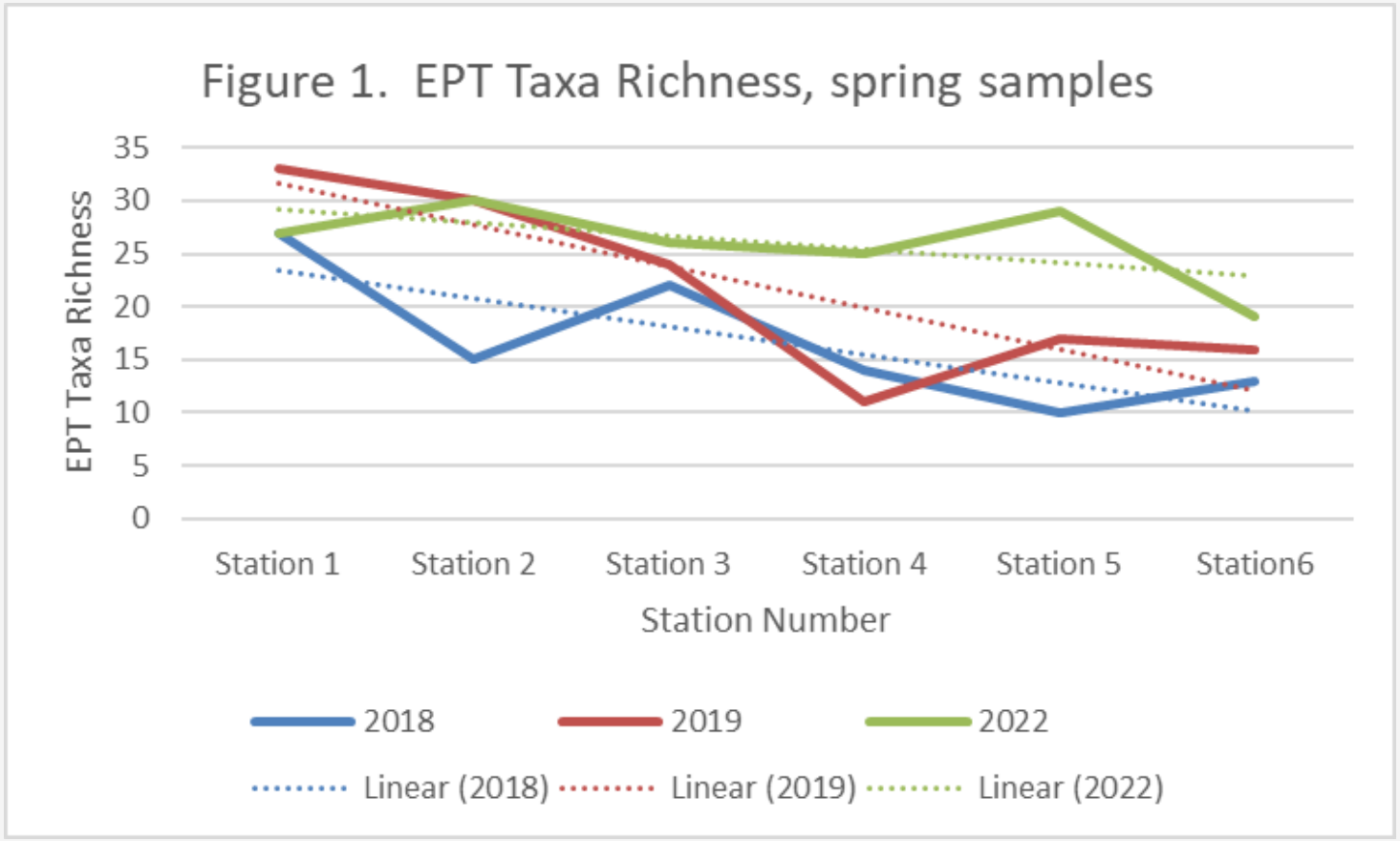
Value of Seasonal Pre-construction Data

Very low EPT taxa richness data were noted in October 2019 due to unstable habitat conditions, sedimentation and high flows because of Hurricanes Florence and Michael.



First Year of Post-Construction Data - Spring Samples.

Is this Ecological Uplift?



Abundance of Lepidostoma spp (Trichoptera)

Is this Ecological Uplift?

Other Taxa following Restoration in Foster's Creek – year 1!

- *Eurylophella verisimilis* (mayfly)
- *Eccoptura xanthenes* (stonefly)
- Many other numerically rare taxa
  - *Tallaperla* spp (stonefly) at Site 5
  - *Baetis pluto (mayfly)* (fall species)
  - *Drunella tuberculata (mayfly)* at Site 3

Carolina Bison Project

"The health of our waters is the principle measure of how we live on the land".

- *Luna Leopold*

Photos by Brad Breslow

Restoration and Wetland Construction

Lifting the channel a few inches, reconnecting the floodplain and raising the water table created a riparian wetland.

Carolina Bison Project

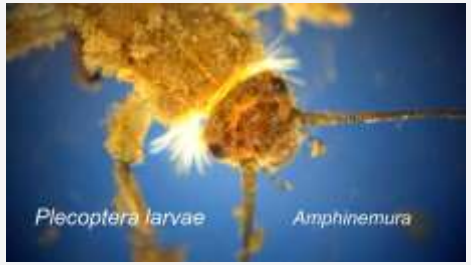

Photo by Jason York

	Carolina Bison #1		Carolina Bison #2	
Collection Date	Apr 2019	Apr 2022	Apr 2019	Apr 2022
Total Taxa Richness	11	33	19	31
EPT Taxa Richness	3	17	5	10
EPT Abundance	5	75	16	59
No. Intolerant Taxa	1	6	3	4
Dominant in Common	**12.5%**	**36.8%**	25.0%	26.0%

Dominant in Common Taxa or Expected/Observed (E/O)

Taxa collected 1 year following wetland creation

- *Diphector hageni* (mayfly)
- *Teloganopsis deficiens* (mayfly)
- *Maccaffertium modestum* (mayfly)
- *Paraleptophlebia* spp (mayfly)
- *Amphinemura* spp (stonefly)
- Hydropsyche (H.) betteni (caddisfly)
- Polypedilum aviceps (Chironomidae)
- *Calopteryx (damselfly)*
- *Ophiogomphus spp (dragonfly)*



Dodson Branch, (Heywood Co. NC.)

The health of our waters is the principle measure of how we live on the land.
-Luna Leopold

Stream Biodiversity: The ghost of land use past. Harding, J.S. et.al 1998.

"...past land-use activity, particularly agriculture, may result in long-term modifications to and reduction in aquatic diversity, regardless of reforestation of riparian zones."

Reed Canary Grass

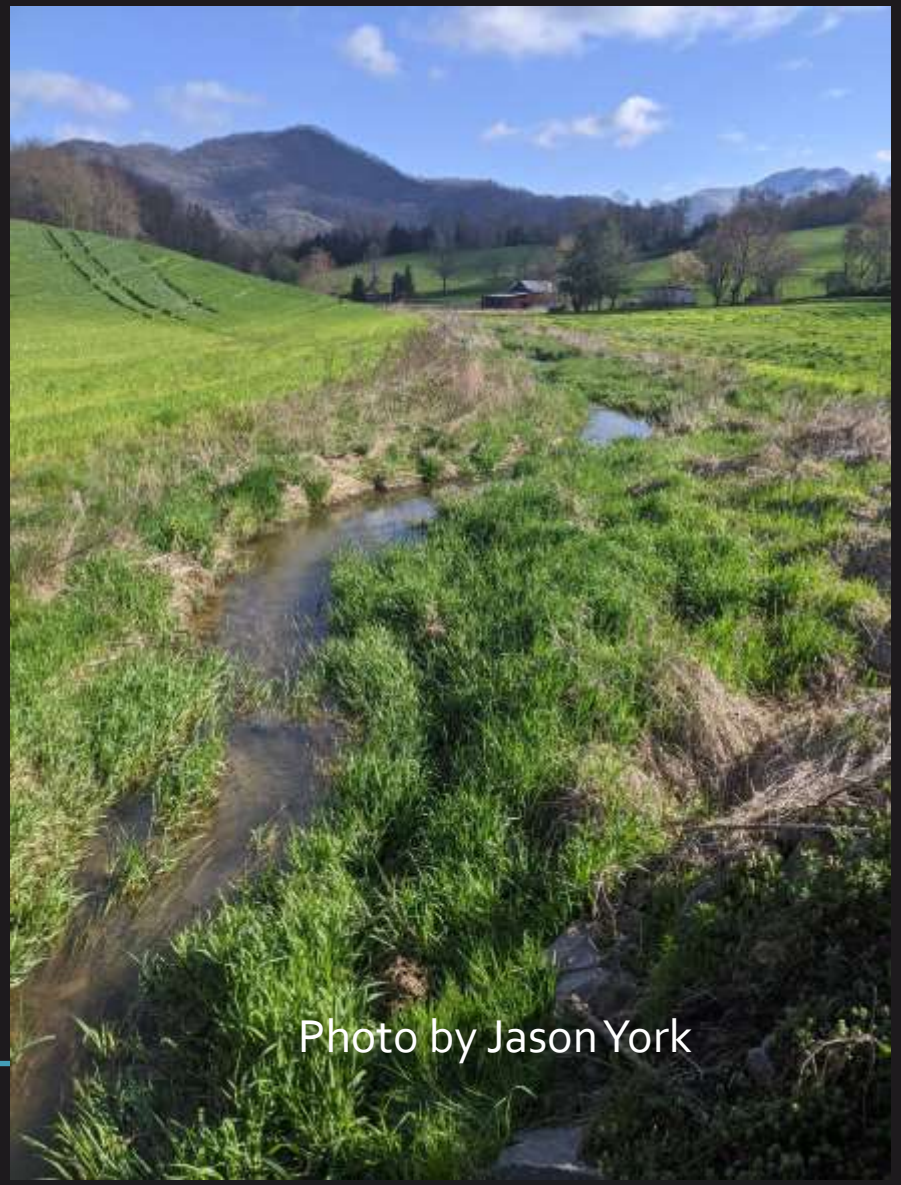


Photo by Jason York

	Dotson Branch Station #4			
	14-Apr-16	13-Apr-18	2-Apr-19	14-Apr-20
Total Taxa Richness	22	27	22	41
EPT Taxa Richness	4	9	8	16
Seasonal Correction	4	9	8	15
EPT Abundance	17	40	28	77
Biotic Index	5.74	5.11	5.62	4.65
Seasonal Correction	6.24	5.61	6.12	4.70
# Taxa ≤ 2.5	1	4	3	7
Bioclassification*	Fair	Good/Fair	Fair	Good

"In every aspect, the valley rules the stream" - Hynes, 1975

Taxa added following infestation of Canary Grass

- *Baetis pluto* and *B. tricaudatus* (mayflies)
- *Isoperla holochlora* (stonefly)
- *Glossosoma* spp. (caddisfly)
- *Leucotrichia pictipes* (caddisfly)
- *Neophylax consimilis* (caddisfly)

Value of Small Streams

- *75 – 80 % of all stream lengths. First and second order*
- *More bang for the buck*
- *Mitigation Credits and management options??*

Photos by Grant Ginn

Value of Small Streams

- Faunal habitat and sources of recolonization
- Biogeochemical processes; retention and breakdown of carbon, nutrient cycling and sediment transport
- Closely connected to adjacent terrestrial processes

LA Barmuta, A Watson, A Clarke and JE Clapcott 2009, The importance of headwater streams, Waterlines report, National Water Commission, Canbarra.

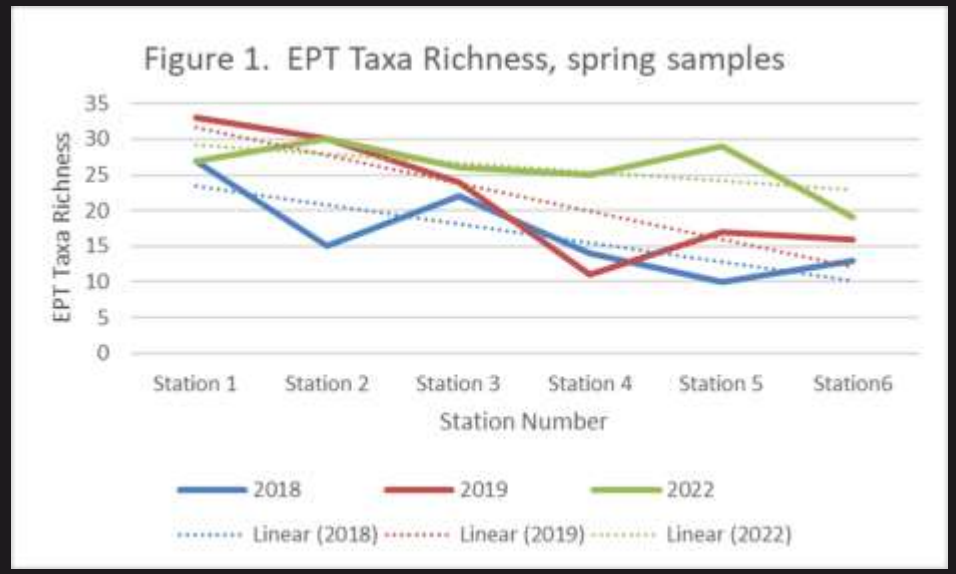
Perceived Impediments to the use of Biological Data

- Watershed Expectations
- Lack of Regulatory Drivers
- Long-term Recovery or no Recovery
- Normalization of Metrics
- Training, taxonomy too difficult
- Cost of doing investigations
- Data are too complicated, variable

Watershed Expectations

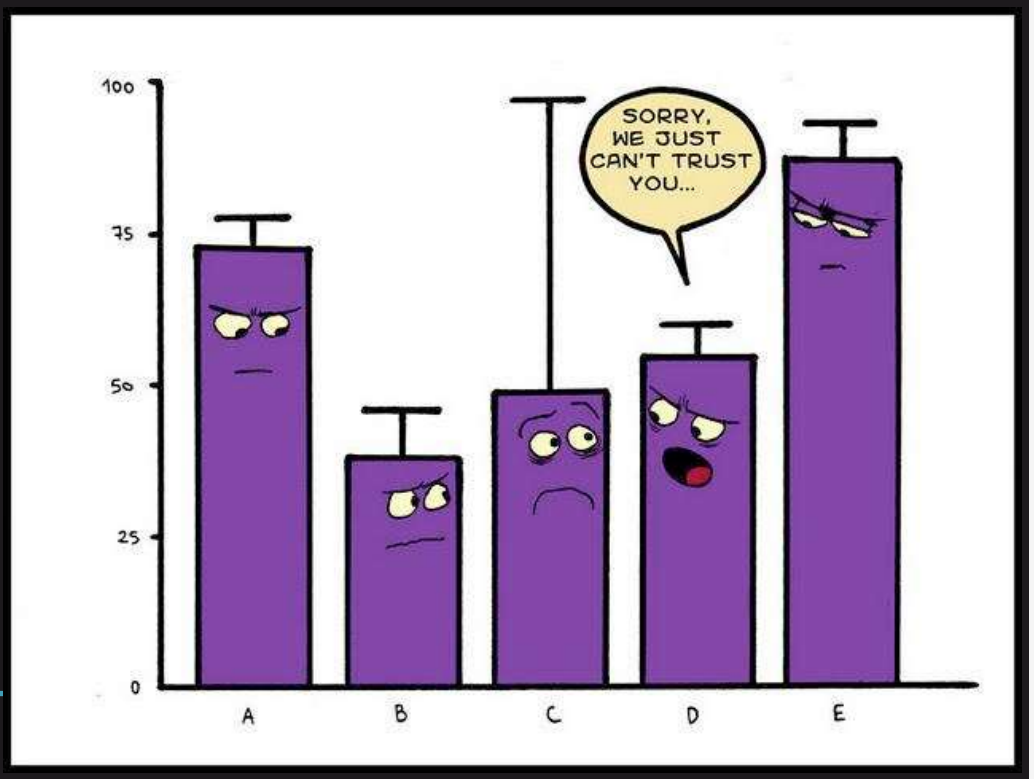
- Concern #1. Unexpected watershed perturbations can affect Ecological Uplift and thus project success or risk.
  - ❑ Perturbations should be accounted for with data from reference locations within the watershed.
  - ❑ Low risk, very rare condition and if they occur watershed managers need to know – value of having good data.
  - ❑ Restoration contract firms should not be accountable for these events.
- Concern #2. The ghosts of land use past.
  - ❑ Way more 'frightening' to me. But it's information we need to know.
- Concern #3. Risk/speed of recolonization.
  - ❑ It depends of sources of repopulation; upstream references, drift or aerial migration.

Recovery of the benthos takes too long



- <u>Concern #1</u>. Several prominent scientists are noted for their skepticism of ecological uplift at all, but certainly that it will take too long.
  - ❑ Data presented here dispels this concept, but it depends on the proximity of reference conditions. I've noted uplift in many projects in less than 3 years.
  - ❑ Uplift is much more likely in small streams.
- <u>Concern #2</u>. Recovery should be predictable for regulators to make the use of benthos practical.
  - ❑ Biological monitoring is variable, accounting for variability is critical.
    - Rural vs. Urban streams
    - Watershed Size
    - Season
    - Taxonomy

Normalization of Metrics

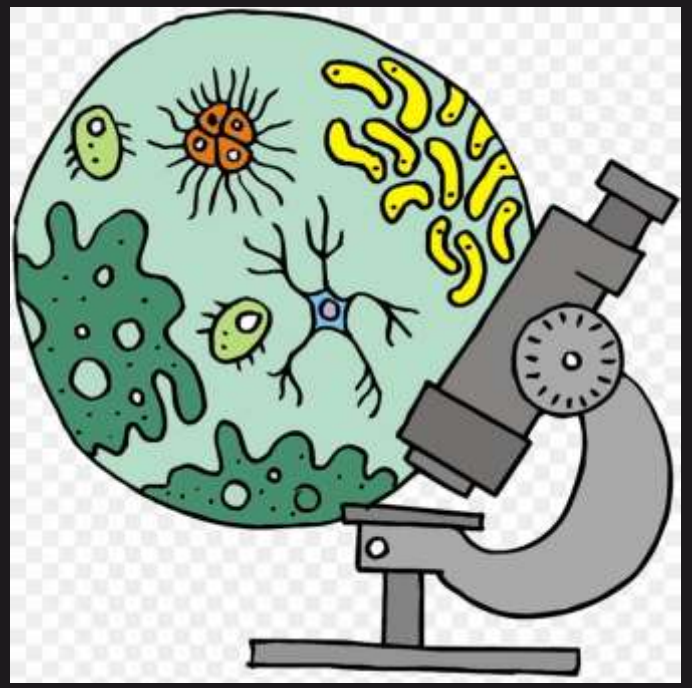


- Concern #1. Can we agree on the definition of Ecological Uplift? Should it be left to ecological regions? Should Interagency Review Teams decide?

EPT taxa richness
EPT abundance
Biotic Indices
Observed Expected Ratios
Presence of Keystone Species
Riparian obligates
Multimetrics

Hope you caught Jason York's talk in Session H this morning

Training, taxonomy too difficult



- Question #1. Is the identification of benthic insects too difficult?
  - ❑ No, but what did you expect me to say?
  - ❑ It does take work and our Universities are not teaching taxonomy.
  - ❑ Workshops
- Question #2. Taxonomic Precision. Is Genus/Species levels of Identification Necessary?
  - ❑ Yes – family levels of ID can not be used to determine trends in data. Although remember the example at Foster's Creek with *Lepidostoma spp.*
- Question #3. Can DNA sequencing be used to determine trends?
  - ❑ No, it only gives presence/absence data

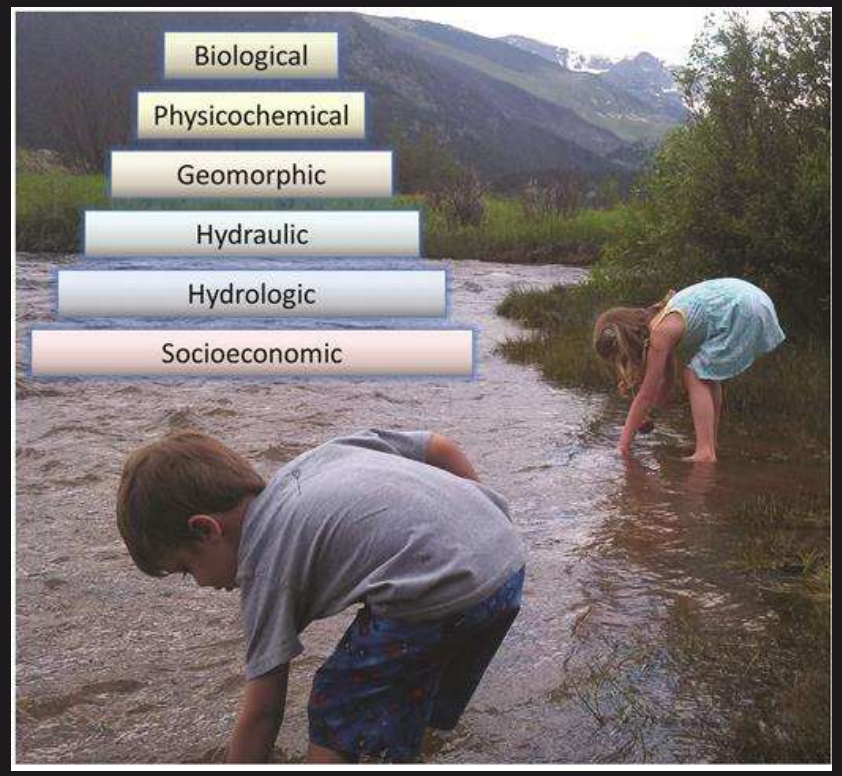
Cost for doing a biological survey

- Foster's Creek - $3,325.00
- Carolina Bison Project - $2,650.00
- Dotson Branch – $2,775.00
- Ivy River Survey - $2,450.00
- Linville Creek Study - $2,150.00
- Beeson Creek Study - $1,412.50
- Mainspring Conservation - $1,500.00
- NCSU Stormwater survey - $1,500.00
- New Bern Stormwater - $2,321.00
- Lower Pigeon River Study - $2,362.50

- Average Cost - $2,244.60 NOT THE VALUE

(Costs depend mostly on collection type and how long it'll take to do the IDs and summary.)

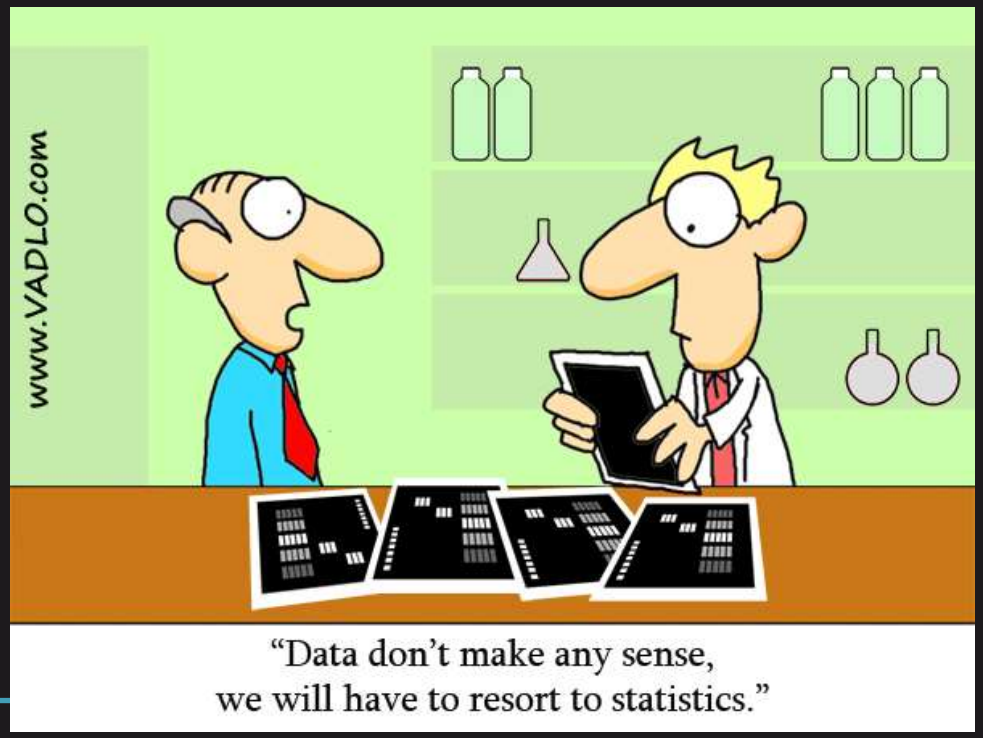
Regulatory Drivers?



Robert J Hawley, Making Stream Restoration More Sustainable: A Geomorphically, Ecologically, and Socioeconomically Principled Approach to Bridge the Practice with the Science, BioScience, Volume 68, Issue 7, July 2018, Pages 517–528, https://doi.org/10.1093/biosci/biy048

- In many cases restoration projects are approved by regulatory agencies based on the fact that the project will improve ecologic function.
- Ecological functions are typically the goal of restoration. Objectives need to be specific, realistic, achievable and measurable (NRCS 2007, Ch. 2).
- Biologists need to account for variability in the data!!
- Should we consider a field worksheet similar to NCSAM or NCWAM? Topic for discussion during our panel.
- Biological data are required in Georgia and Virginia – other states?

Data are too variable



ALL DATA ARE VARIABLE

ACCOUNTING FOR VARIABILITY IS NEEDED.

- Seasonality
- Stream size or Order
- Taxonomic
- Watershed condition