

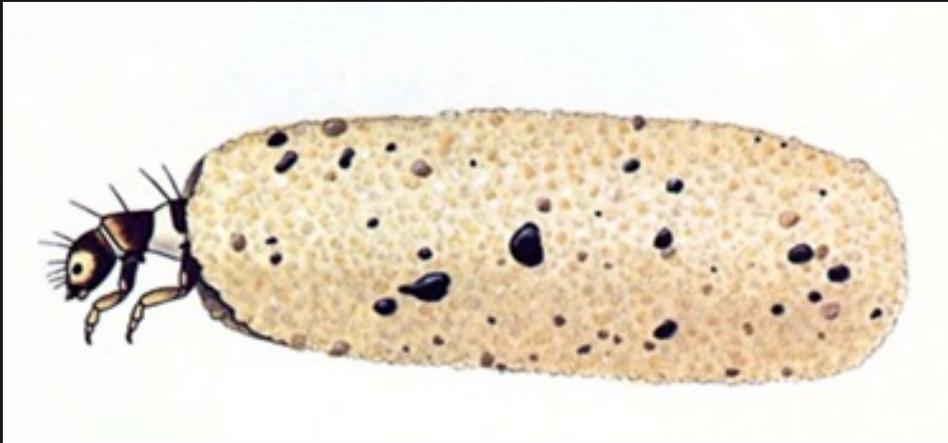


*The real voyage of discovery consists
not in seeking new landscapes, but in
having new eyes.*

Marcel Proust

Benthic Fauna of Restored Streams

*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**

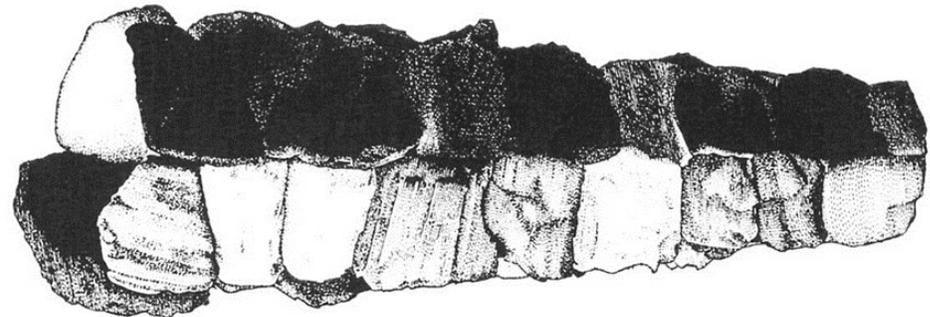


Why do scientists use aquatic insects?

- 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

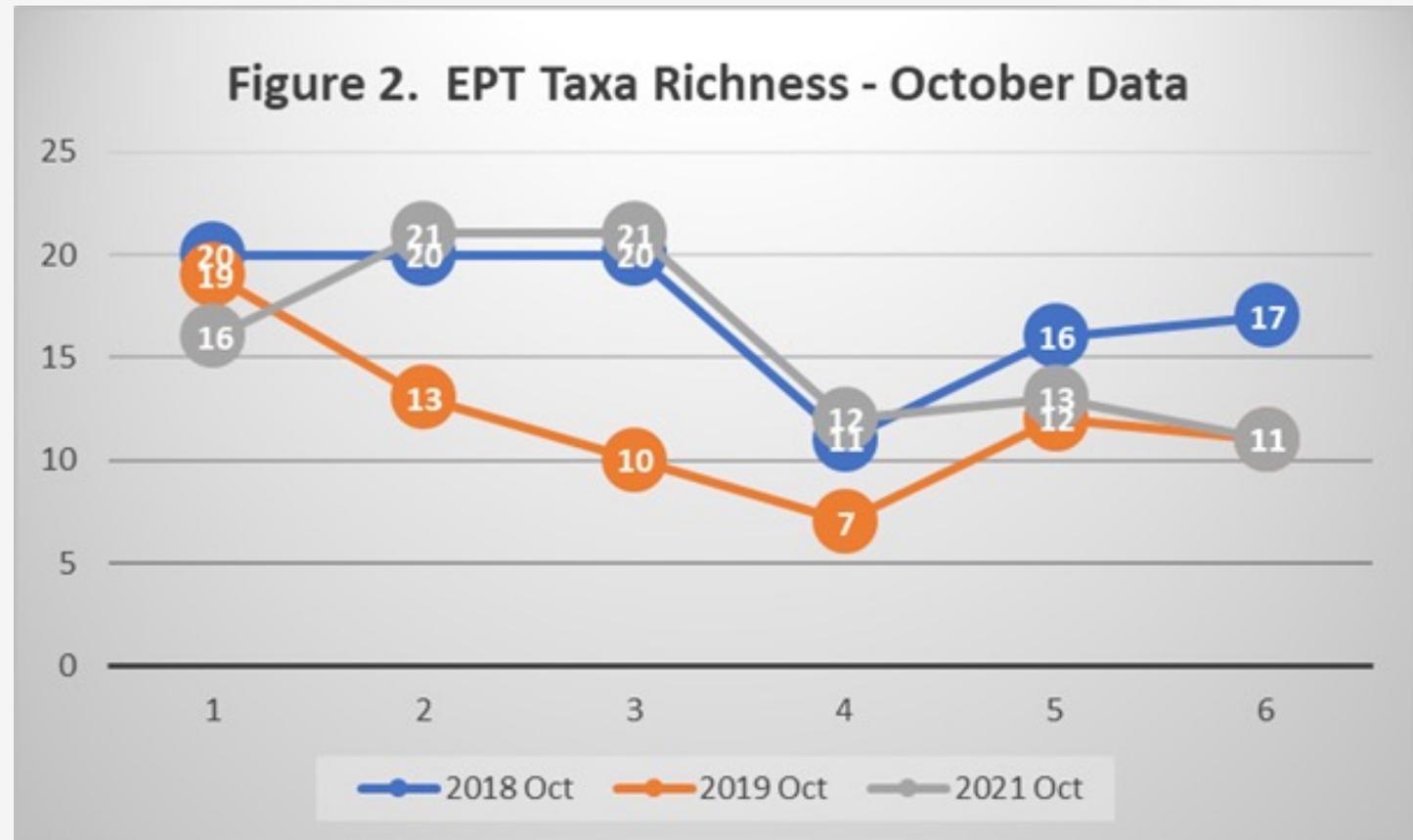
*Basic
Information
Needed to
Define
Ecological
Uplift*

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



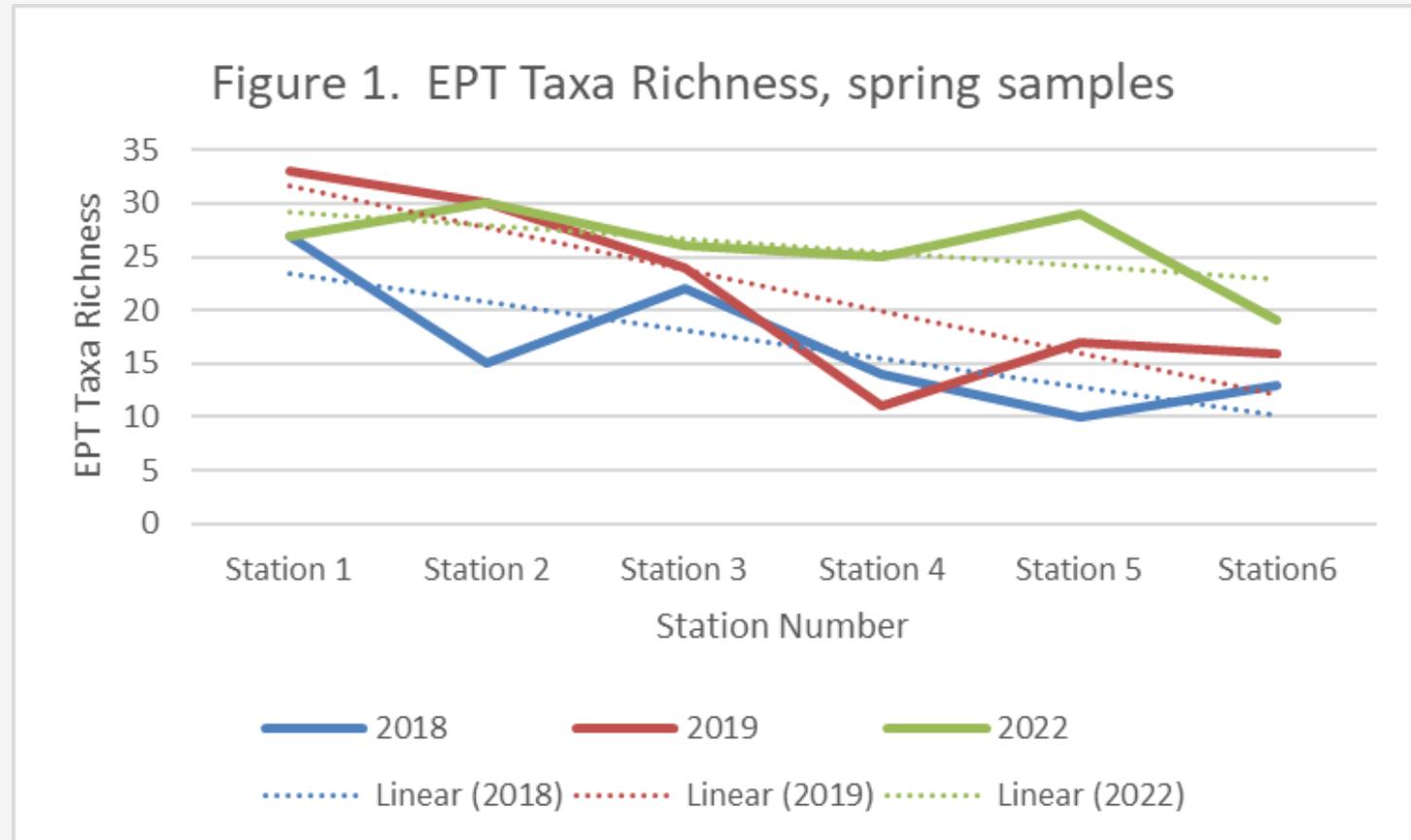
Value of Seasonal Pre-construction Data

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

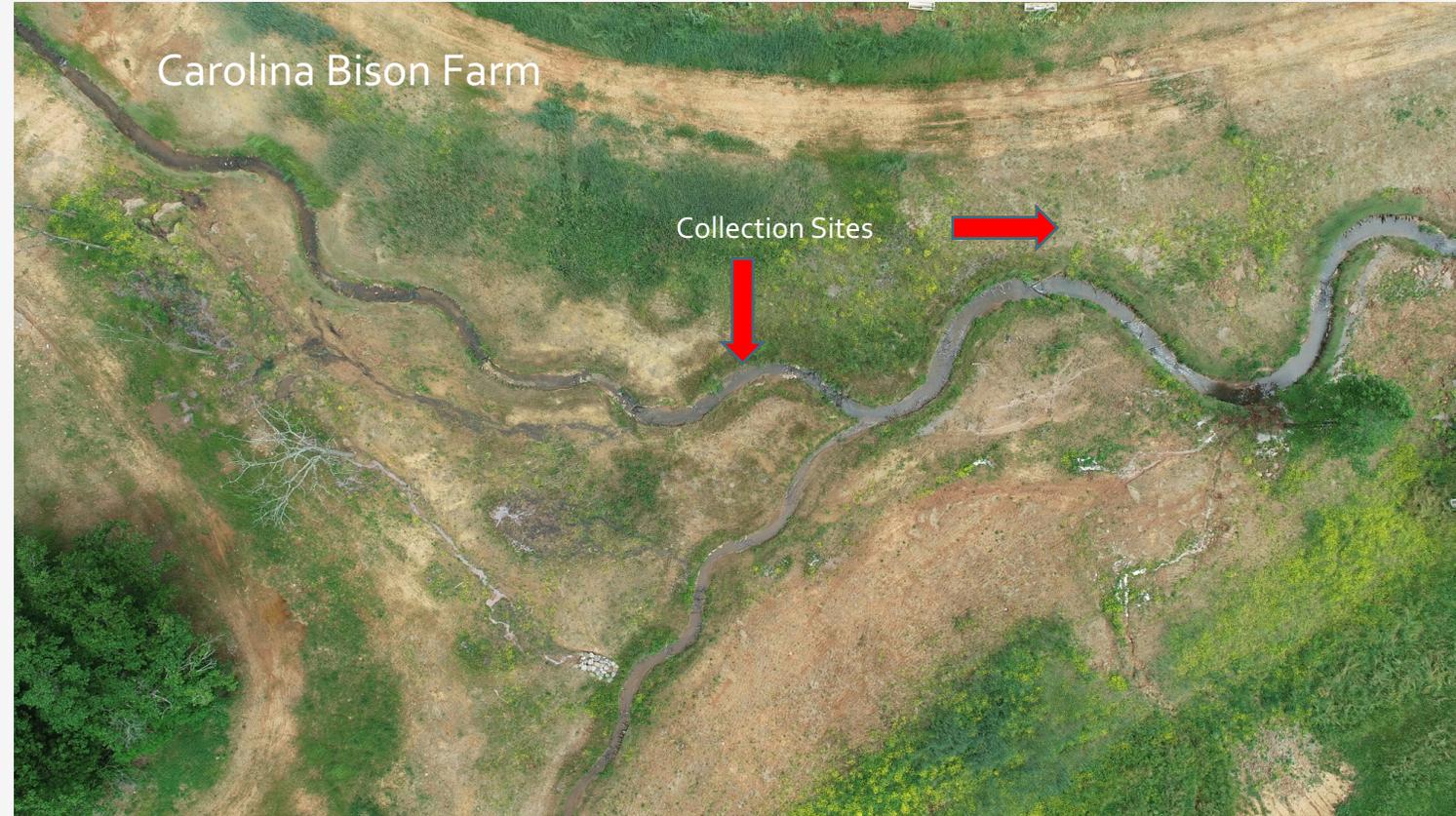
“The health of our waters is the principle measure of how we live on the land”.

- *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

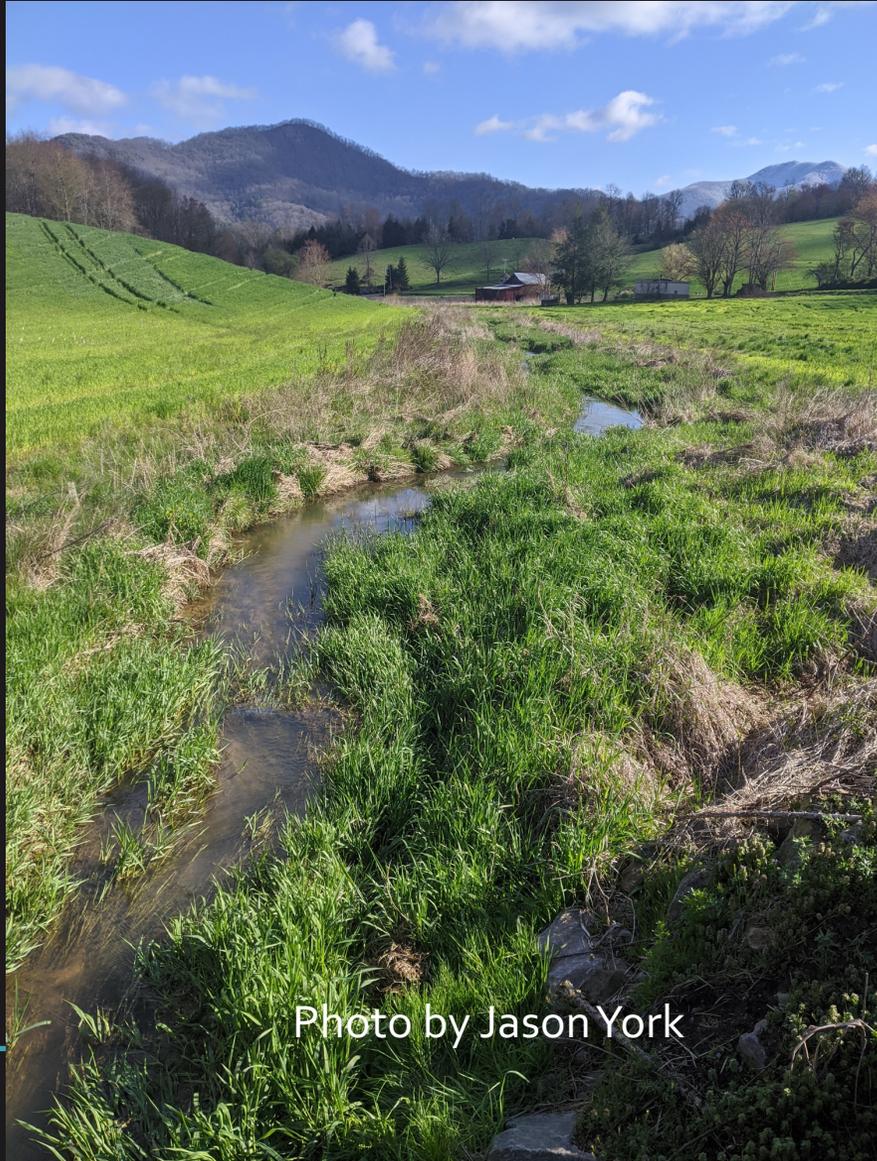


Photo by Jason York

	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 \leq 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



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Watershed Expectations



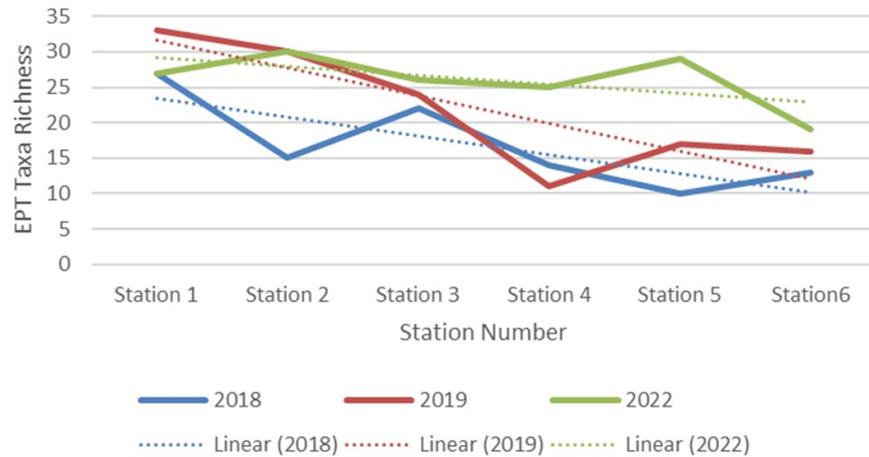
- Concern #1. Unexpected watershed perturbations can affect Ecological Uplift and thus project success or risk.
 - Perturbations should be accounted for with data from reference locations within the watershed.
 - Low risk, very rare condition and if they occur watershed managers need to know – value 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.

So the question is – do we adhere to a protocol that doesn't always work (woody stems per acre) or ignore ecological uplift that does work?



Recovery of the benthos takes too long

Figure 1. EPT Taxa Richness, spring samples



- Concern #1. 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.
- Concern #2. 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

*How do the
insects
Recolonize
Restored
features?*

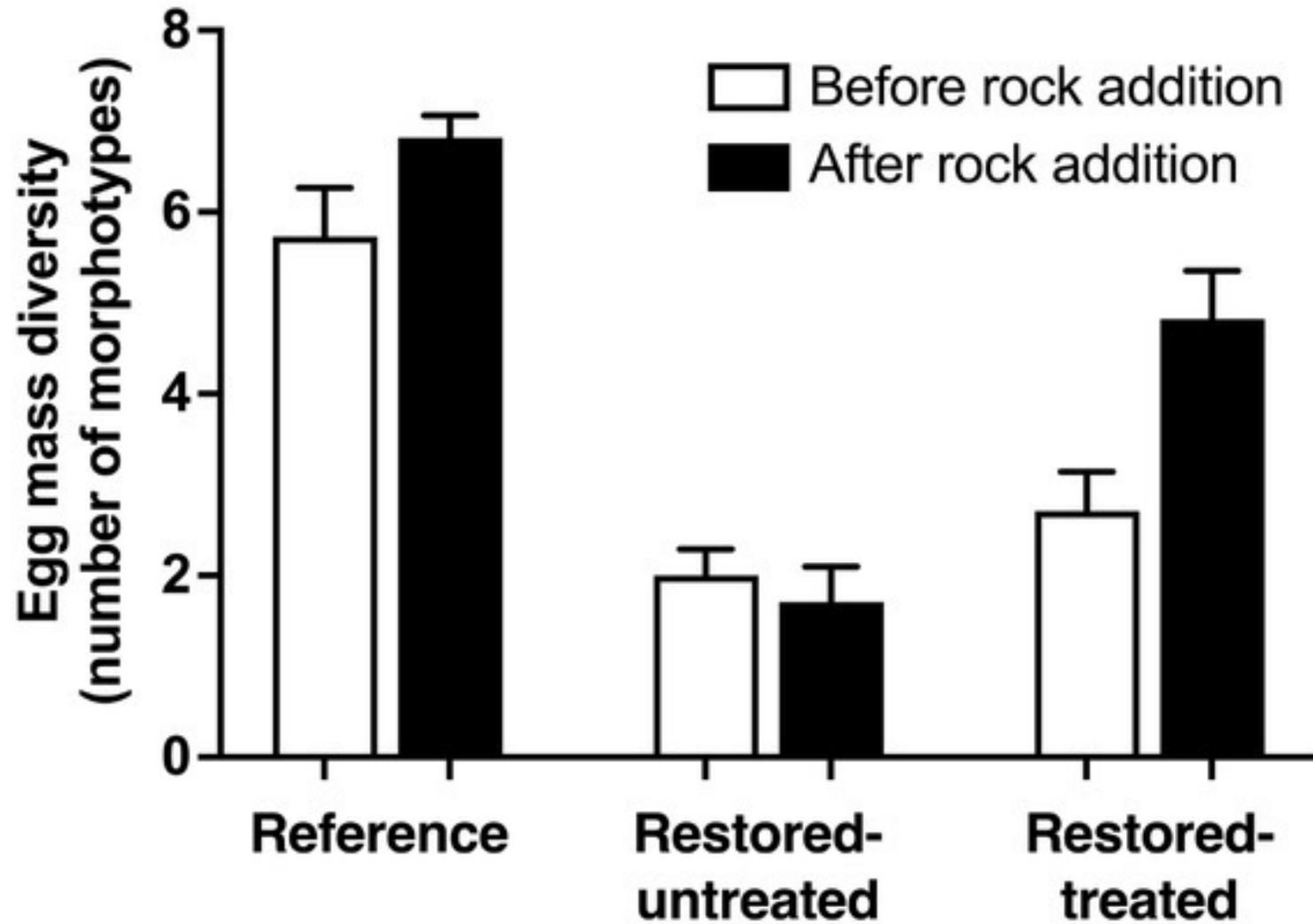
- Drift from upstream refugia, tributary streams
- Aerial oviposition of adult insects
- Upstream migration of larvae





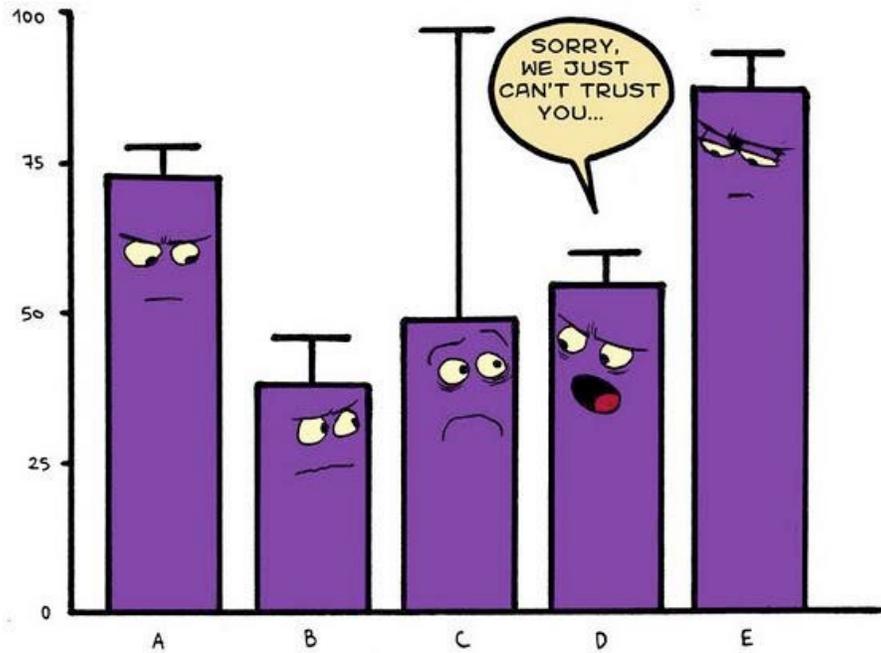
Photo 3: The underside of a small (~6 cm in length) emergent rock in a restored stream with three egg masses (white-colored areas) representing multiple taxa. Photo credit: Samantha Jordt.

Research on Oviposition



Source: Samantha Jordt and Brad Taylor submitted manuscript

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

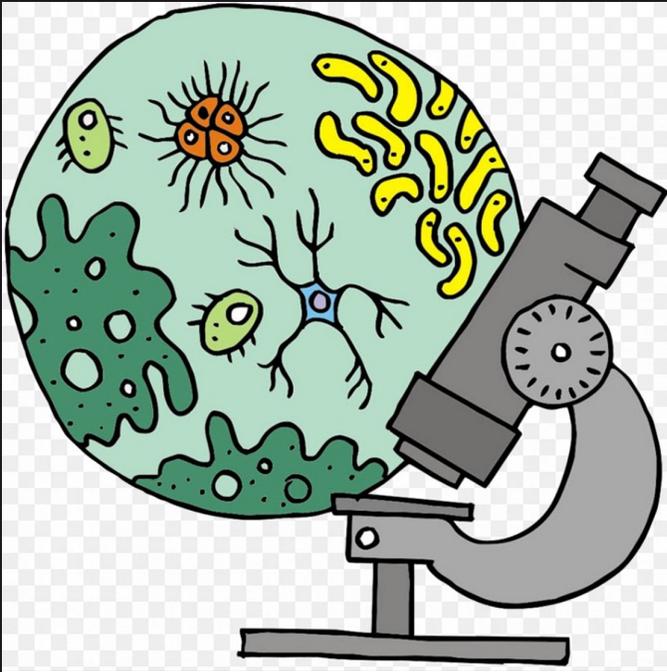
Presence of Keystone Species

Riparian obligates

Multimetrics

Jason's presentation will address this topic

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.
- Question #3. Can DNA sequencing be used to determine trends?
 - No, it only gives presence/absence data

Cost for doing a biological survey

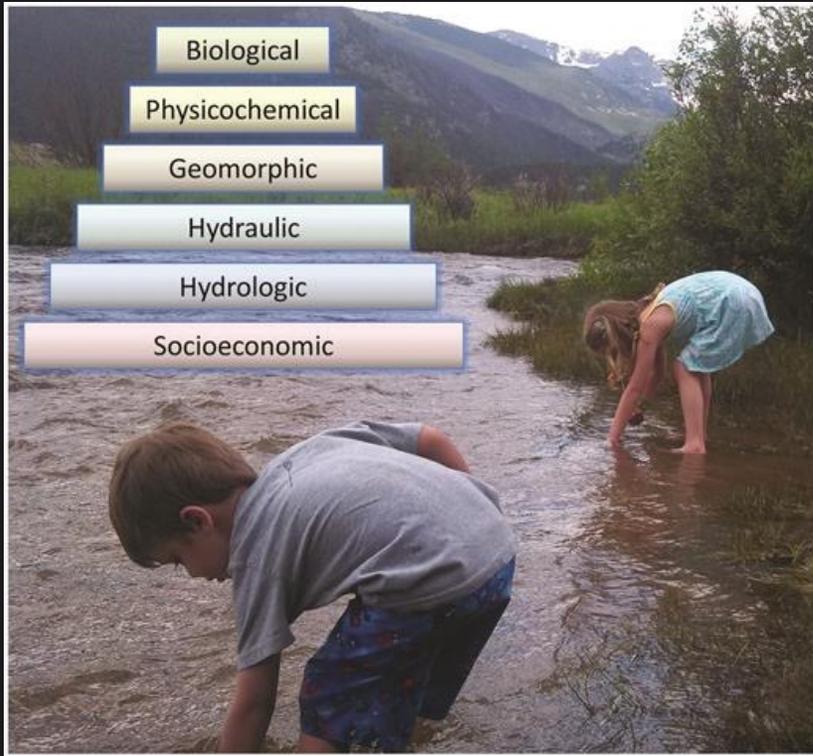


- Foster's Creek - \$3,325.00
- Carolina Bison Project - \$2,650.00
- Dotson Branch – \$2,775.00
- Ivy River Survey - \$2,450.00
- Linville Creek Study - \$2,150.00
- Beeson Creek Study - \$1,412.50
- Mainspring Conservation - \$1,500.00
- NCSU Stormwater survey - \$1,500.00
- New Bern Stormwater - \$2,321.00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



- 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



“Data don’t make any sense,
we will have to resort to statistics.”