Restoration

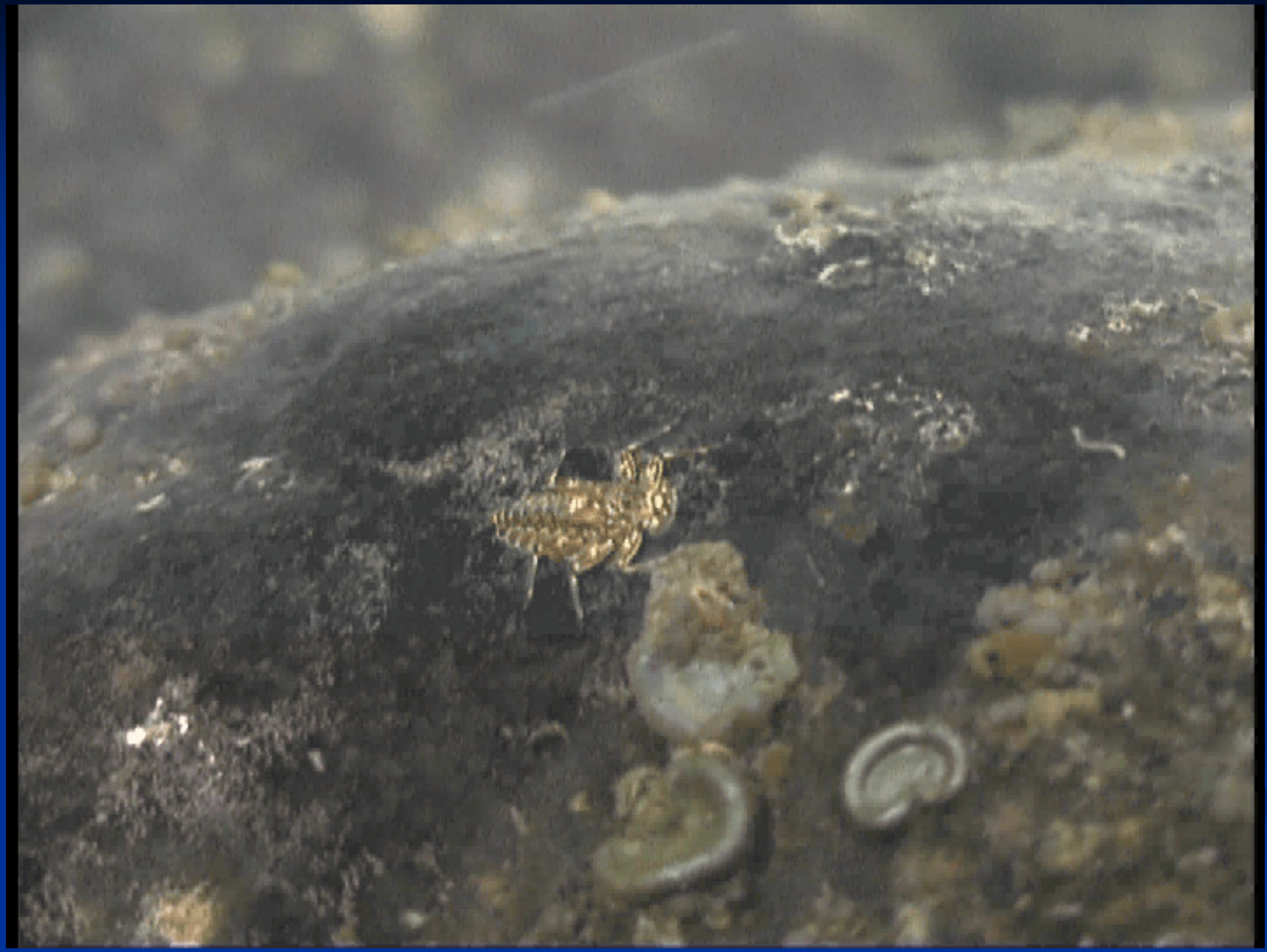
and Aquatic Insects

Presentation Outline

- A basic and brief introduction to aquatic insect ecology
- A short history of (bug) monitoring in NC
- What have we learned and where do we go from here?
- Research Needs

Why use Aquatic Insects?

- Found in all aquatic habitats
- Easily and inexpensively collected
- Most life cycles are about one year in length in temperate stream systems
- Integrate a wide array of potential pollutant types
- Important in the diets of fish



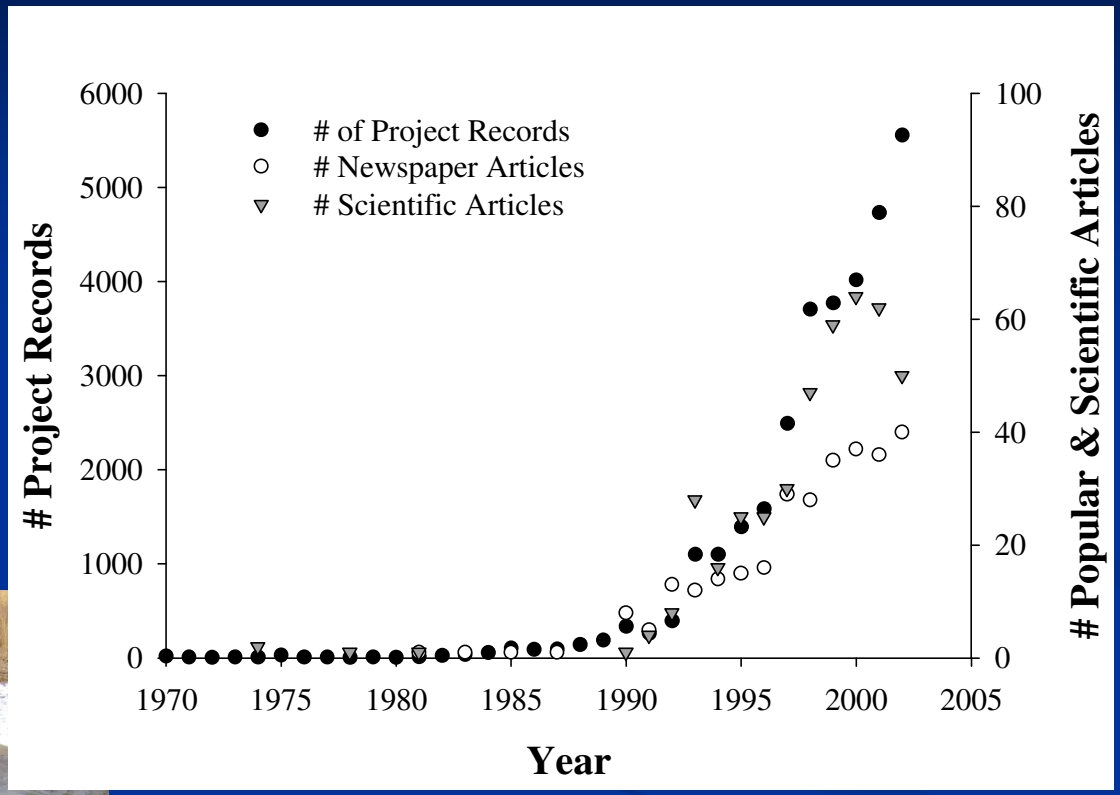

Sediment Tolerance value?

A Short History of Monitoring Projects

- Photographs were only documents needed?
- Natural Channel Design as a buzz word
- National River Restoration Science Synthesis
- NCSU bug monitoring
- The science of restoration has improved a great deal in 20 years.

National River Restoration Science Synthesis

37,099 project records

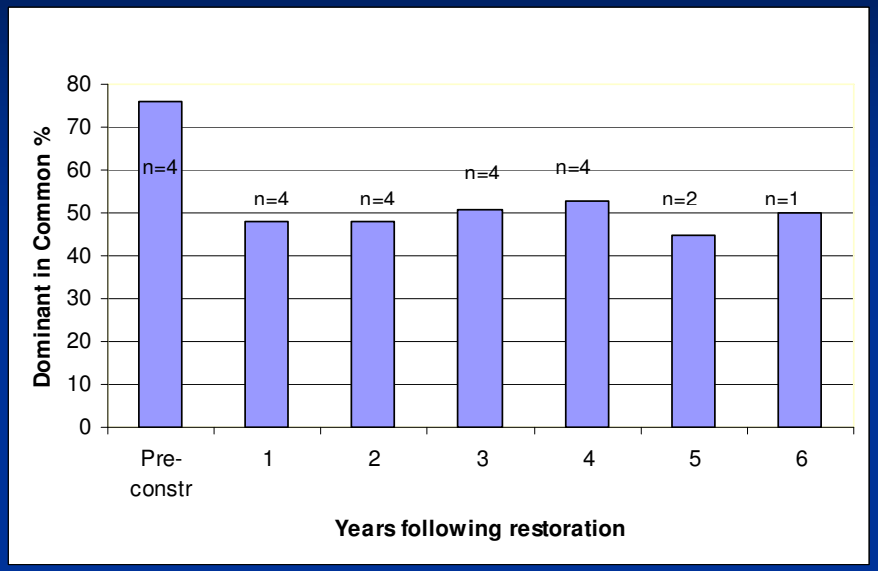


<10 % of all project records indicated monitoring

Case Studies and Data

North Carolina's in-lieu fee program will spend $36 - $45 million/year

Watershed Conditions!!



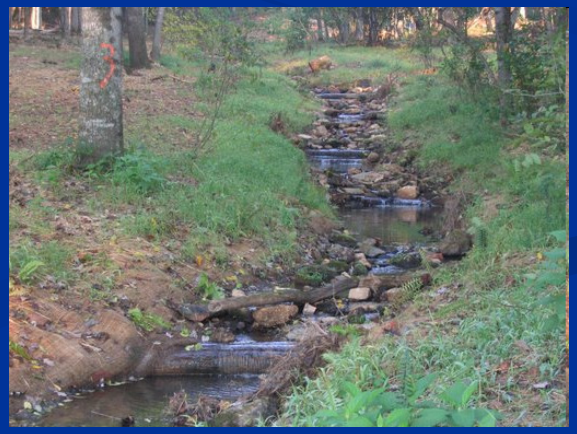
Preconstruction
DIC* > 50%

Preconstruction
DIC* < 50%

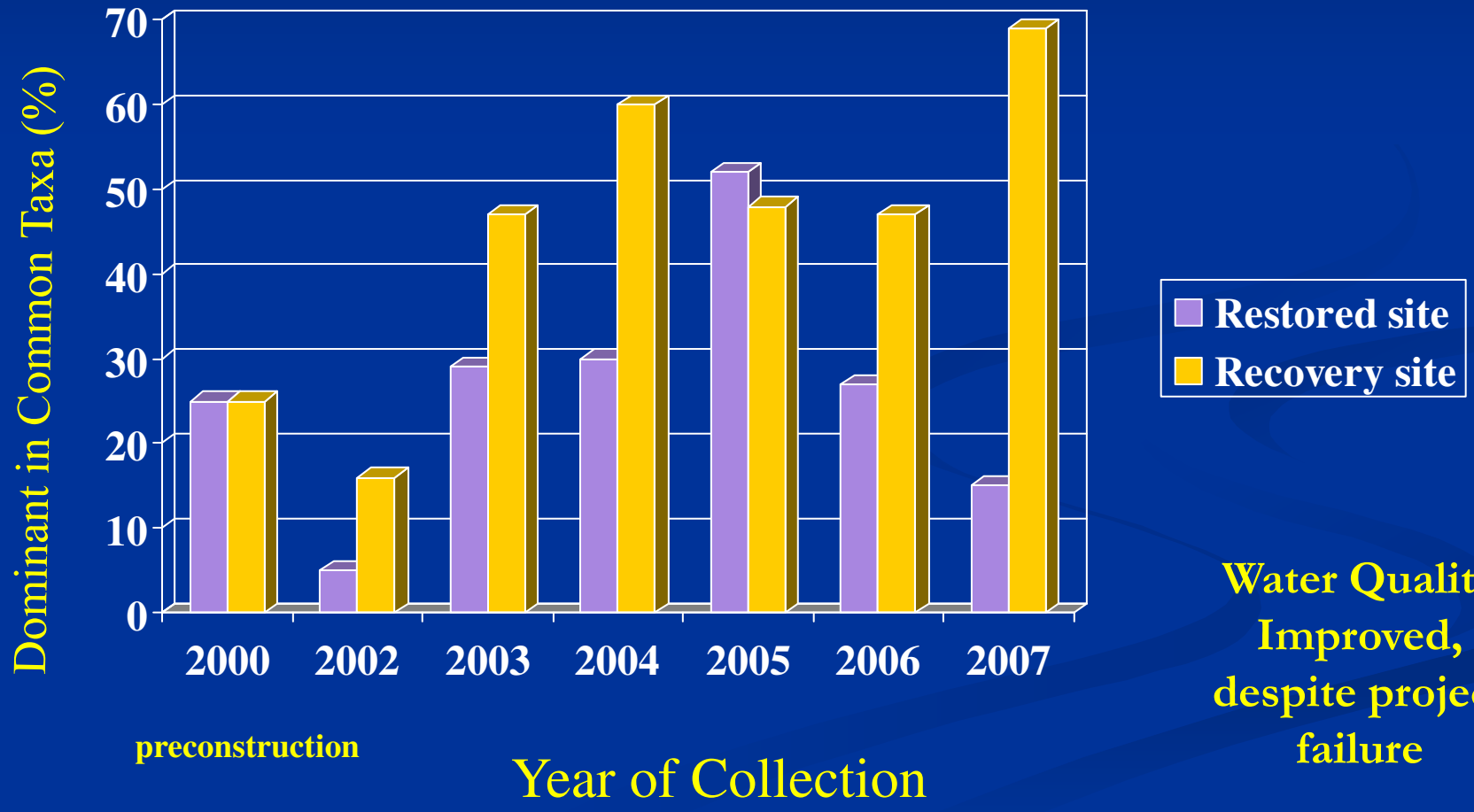
*DIC = Dominant Taxa in Common

DIC* from Small Streams (with good ref reaches)

Project Name	Pre Constr.	Pre Constr	Post Constr	Post Constr
Mickey Reach	50% (2003)	-	90% (2005)	90% (2007)
Rendezvous Mt.	59% (2005)	59% (2006)	51% (2007)	50% ** (2008)

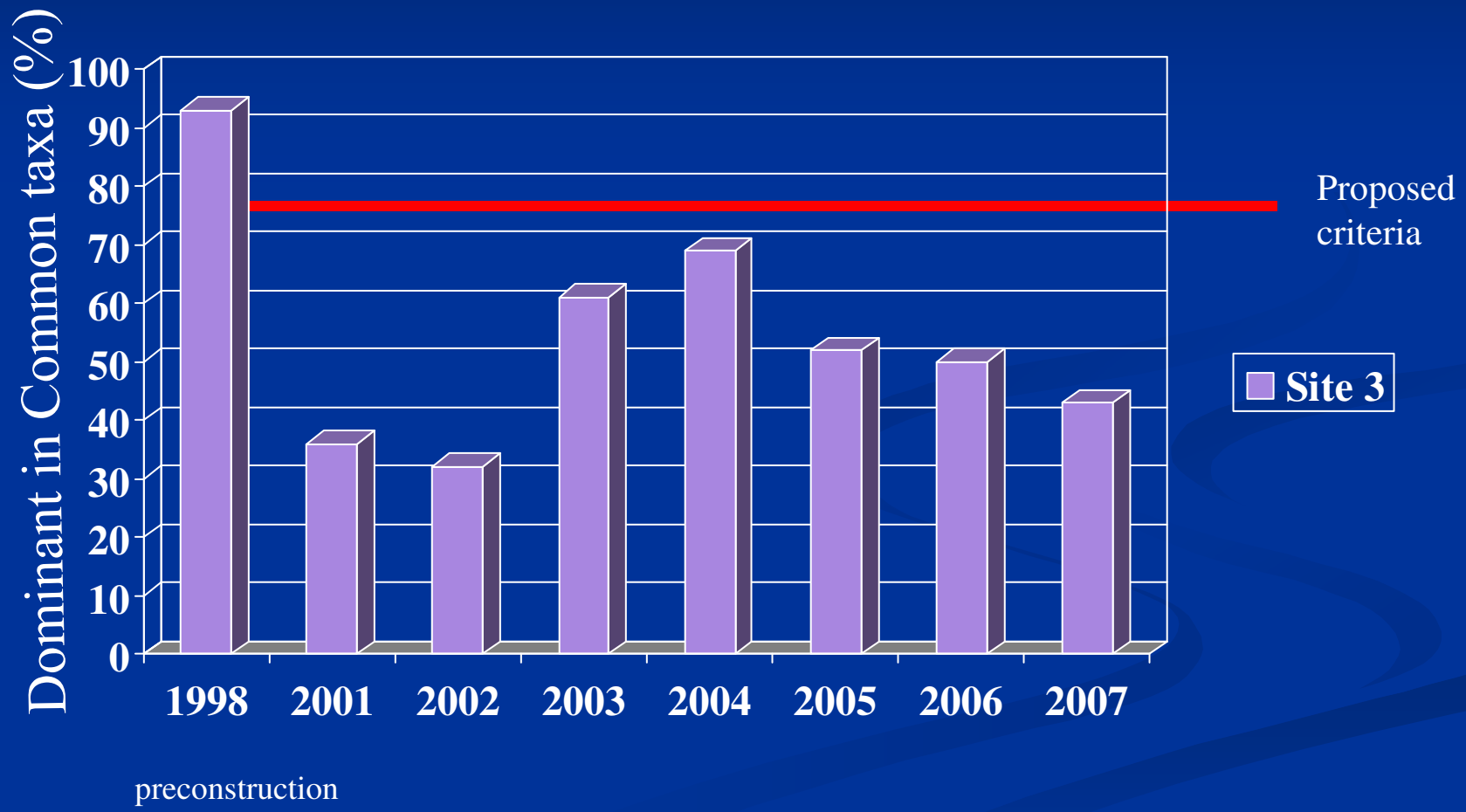


Dominant Taxa in Common, Payne Dairy



Water Quality Improved, despite project failure

Stone Mountain Benthos Data (Dominant Taxa in Common)



WNCSI "Before and After Studies" 2007 and 2016

Darnell Before

Darnell After

Kraft Before

Kraft After

WNCSI
South Fork Mitchell River

Are there long-term changes in insect fauna because of stream restoration projects?

Metric/Project	Darnell (Harmon)				Kraft			
Year of Collection	2007		2016		2007		2016	
Site Number	A*	C	1	2	A	C	1	2
EPT richness	18	12	**32**	**32**	18	18	**35**	**30**
EPT abundance	95	84	**137**	**151**	85	79	**128**	**104**
No. Stonefly taxa	5	3	**10**	**11**	7	4	**12**	**10**
Total richness	35	28	**57**	**51**	32	27	**59**	**51**

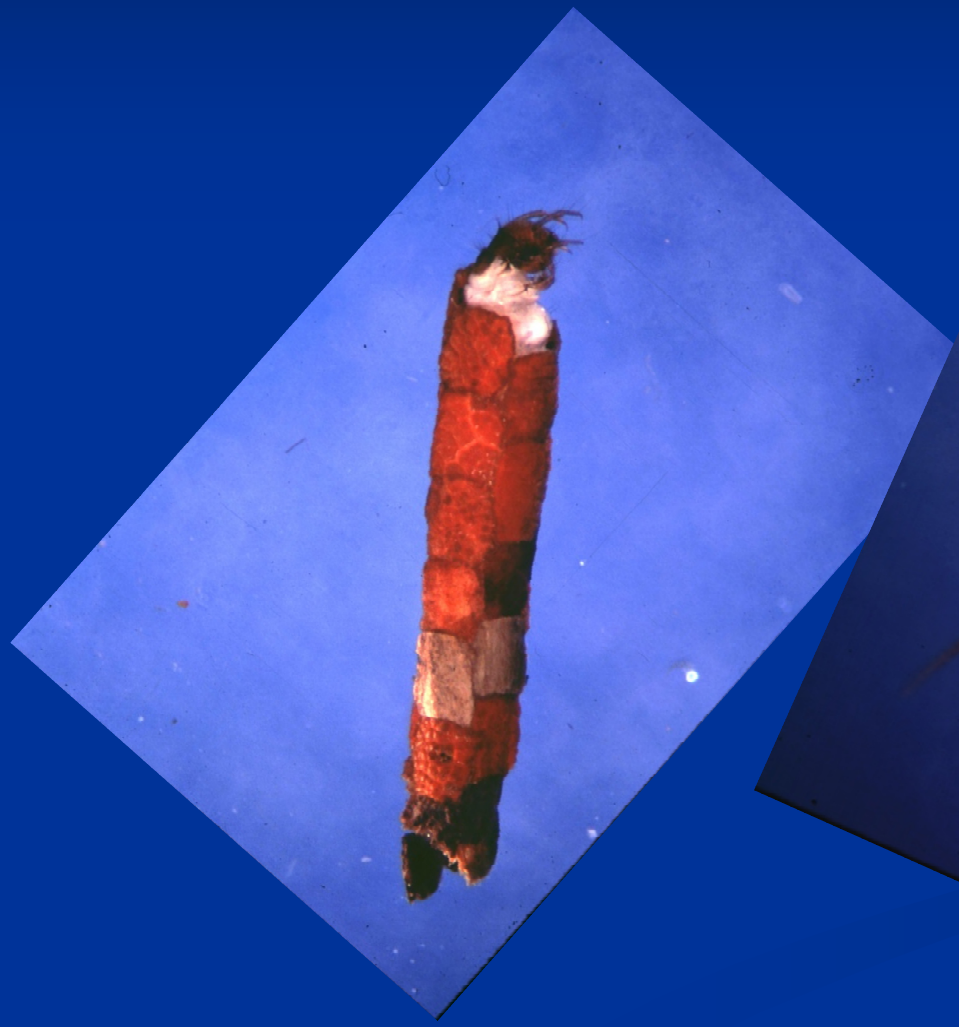
Significant Observations

- Much higher taxa richness and EPT abundance values in 2016 at all sites. (same methods).
- Stonefly taxa richness higher in 2016, samples collected same time of year.
- No difference between upstream and downstream sites at Darnell, minor differences at Kraft during the 2016 surveys.

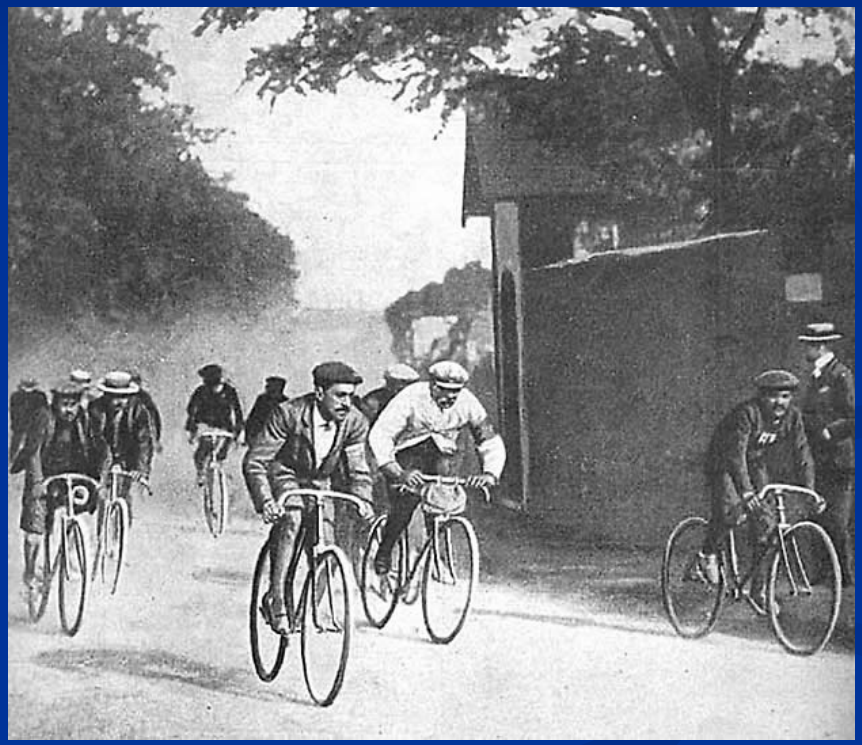
Functional Assessment

- Life History
  - Voltinism
  - Development
  - Synchronization of emergence
  - Adult ability to exit
  - Ability to survive desiccation
- Mobility
  - Female dispersal
  - Adult flying strength
  - Occurrence in drift
  - Maximum crawling rate
  - Swimming ability
- Morphology
  - Attachment
  - Armoring
  - Shape
  - Respiration
  - Size at maturity
- Ecology
  - Rheophily
  - Thermal preferance
  - Habit

% Shredders (Organic Material)

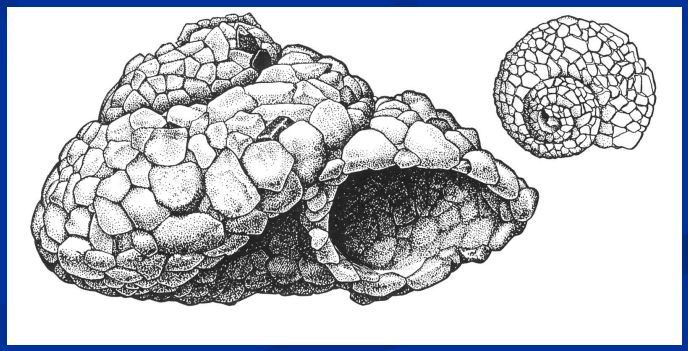


Where do we go from here (bug monitoring primarily)???



Bug Monitoring 101 – the basics

- Sources of Variability
- Sources of Recruitment
- Regulatory Responsibilities



Sources of Variability

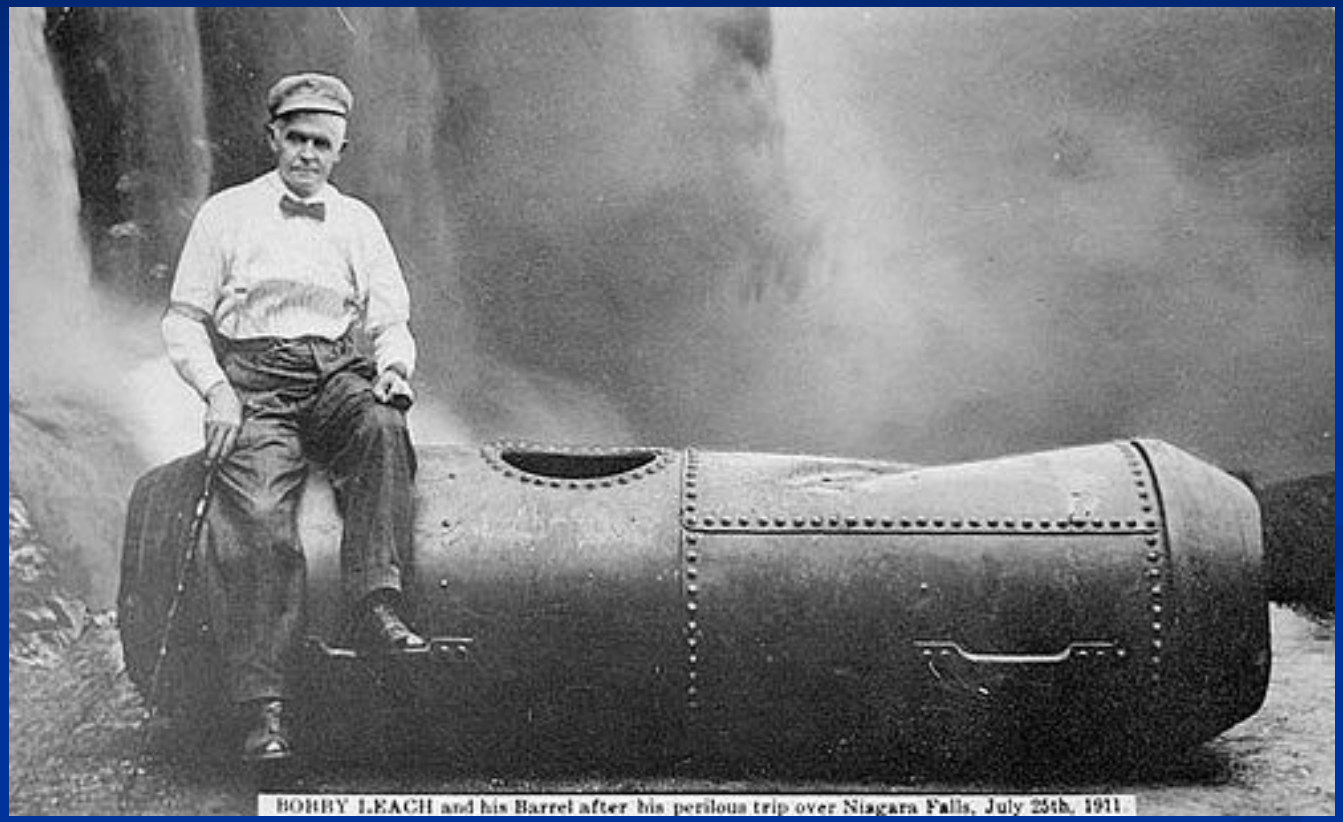
- Seasonality
- Effects of Stream Size (continuum)
- Effects of Flow
- Taxonomic Consistency

Sources of Recruitment

and how it will affect project success

- Drift from upstream tributaries
- Ariel from nearby catchments
- Upstream migration
- Oviposition?
- Others?

Lessons Learned?



In 1911, Bobby Leach survived a plunge over Niagara Falls in a steel barrel. Fourteen years later, in New Zealand, he slipped on an orange peel and died.

Measuring Success*

- The design should be based on a healthier river system
- The river's ecological condition must be measurably improved
- The river must be more self-sustaining and resilient to external perturbations so minimal maintenance is needed
- During construction phase, no lasting harm should be done to the ecosystem
- Both pre- and post-assessment must be completed and data made publically available

* Palmer, M.A. et al. 2005. Standards for Ecologically Successful River Restoration. Jo. of Applied Ecology. 42, 208-217.

Likelihood of Ecological Success

- Watershed condition – evaluation of catchment and the stream reach prior to restoration is important and should be used to develop effectiveness.
- Stream Size – smaller streams will recover/recolonize faster and should be given priority.
- Retention of Organic material will drive biological response
- Beavers happen
- Reattachment of the Hyporheic Zone.
- Specific and attainable project goals!

Research Needs

- What are the ecological and WQ benefits of various restoration practices (ecoregion, str. size).
- Evaluation of the current functional uplift tools for stream restoration relative to geomorphology, biology and chemical conditions.
- A critical evaluation of projects that have been built (biology could lag 10-15 years (Wohl, et. al. 2015). Have they worked or not?

Research Needs (Con't)

- An evaluation of specific restoration goals – mitigation credits and who should be involved in setting these goals.
- Hyporheic restorations was noted by Wohl in her paper for the CBP, have they worked?
- The gap betw society's expectations of rivers and scientific understanding of rivers (Wohl et. al.)
- Climate Change!

Questions?

Penrose Translation Slides

What does this mean for me?

- Watershed and water quality condition are important in determining the success of local habitat improvements if conducting stream restoration focused on benthic invertebrates.
- Retention of organic material (primarily leaves) may be important in determining the success of stream restoration focused on benthic invertebrates.
- Connecting surface waters with the hyporheic zone may be important for restoring benthic invertebrates.
- When setting goals for stream restoration, feasibility of attaining the goals should be considered.
- Determining the reasons why some projects are successful and others not is important in follow-up research.