Are Restoration Goals and Timelines Consistent with Aquatic Invertebrate Life History Traits?

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Objectives

• Examine Restoration Goals and Timelines
• Discuss role of dispersal in stream restoration, possibility of using faunal reintroduction / *in-situ* bioassay
Restoration Project Goals - Problems

- Not defined *a priori* or tied directly to measurable monitoring goals
- Unrealistic or inappropriate scale of restoration
- Lack of or inadequate baseline data
Restoration Project Grant Timelines

- Short timelines, typically 2-3yrs, rarely 5yrs.
- May include one or more phases, e.g., concept design, final design, construction, or monitoring.
- Monitoring rarely falls within grant window.
Restoration Project Monitoring

- Monitoring effort inconsistent
- Projects included in NPDES permit have obligation to monitor
- Institutional “short term memory”
  - Partners cannot help past funding deadline
  - Push to implement new projects
Stream Restoration Project Goals

- Increase Habitat Heterogeneity
- Improve Biological Integrity
- Protect Sewer Infrastructure
- Urban BMP / Natural Stream Channel Design Demonstration Project
- Enhance Aesthetics of Park
Practical Goal – PA 303(d) list

• Urban Stream Restoration part of Watershed Management Plan

• Regulatory-based Goal

• 63% PADEP IBI for attaining aquatic life use

• Mechanism(s) for meeting goal not explicitly stated
“Field of Dreams” Hypothesis

- “If you build it, they will come.”
  - Some taxa already present at site (or nearby)
  - Some taxa locally extirpated and will need time to disperse to the site

1.) Palmer et al. 1997
Restoration Site Monitoring

- Macroinvertebrate, Habitat, Fish RBPs
- Cross-sectional and longitudinal profiles
- Bank pins, bar samples, sediment sampling
- 3D total station survey w/ velocity observations
Results to Date

- Construction disturbance impact
- Observed re-establishment of pre-existing macroinvertebrate community
  - Refugia within site
  - Drift from sites upstream
- Failure to achieve further improvement, likely due to additional abiotic stressors
  - Urban hydrology
  - Water quality impairment
Evaluate Ecological Success w/ Bioassessment

- Compare pre- and post- construction bioassessment results (metrics)
  - Only 2 samples: variability unaccounted for
  - Rapid protocols underestimate local species pool
- Monitoring timeframes
  - When (or how frequently) to monitor?
  - Rate of expected changes within community
- Biotic factors
Types of Dispersal²

- Passive dispersal
  - Phoresis – “Stowaways” Waterfowl, Anglers, Fish
  - Wind
- Active dispersal
  - Aerial dispersal by flying adults
- Dispersal through time
  - Diapause, resistant life stages

2.) Bilton, et al. 2001
Evidence for Dispersal of Stream Invertebrates

- Terrestrial collection of moving adults
  - Malaise$^{3,4,5}$, light$^{6,7}$, and sticky traps$^{8}$
- Mark-recapture
  - Stable isotopes$^{9,10,11}$
- Virgin, newly created habitats$^{12}$
- Recovery from disturbance$^{13}$
- Inferential evidence (i.e., gene flow) from molecular techniques$^{14,15}$

Abiotic Factors Affecting Dispersal

- Regional species pool and population status
- Biogeography – location & distance of colonists
  - upstream, downstream, in-basin, out of basin
- Geology, climate, land use in intervening space between site and sources of colonists
Abiotic Factors Affecting Dispersal

- Conditions very unfavorable for colonization of restored habitats in Philadelphia area

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PWD Macroinvertebrate sample results 2000-2010 $n=177$
Biotic Factors Affecting Dispersal

- Species-specific traits, some generalization is possible
- Flight ability and behavior
- Mating and oviposition behavior
  - Ovary development and length of pre-oviposition period
  - Feeding requirements
- Voltinism
- Some groups have traits unfavorable for dispersal and colonization
“Moving” Forward

- Based on present geographic distribution and poor dispersal ability factors, we should not assume that all taxa are prone to colonization of restored sites within 2-5yrs.

- Continue to implement stream restoration projects, collecting habitat and biological data

- Increase focus on headwaters (less susceptible to hydrology and water quality constraints)

- Consider faunal reintroduction and(or) in-situ bioassay at restoration sites
Faunal Reintroduction

- Release life stages of taxa not present at site, “wait and see” if they survive and reproduce
- No commercial sources
- If collected from wild
  - Risk of harm to natural populations
  - Undesired consequences, e.g., invasive species
- If data are collected to follow fate of released individuals, does not save much time relative to in-situ bioassay
In-situ bioassay

- Determine survivability under more controlled field conditions
- Collect accompanying water quality data
- May be useful in identification of other stressors
- One local example: Partnership for Delaware Estuary testing suitability of local streams (Brandywine R.) for reintroduction of freshwater mussels
Discussion

Any Questions?

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References