Biological Outcomes of Hyporheic Zone Restoration in an Urban Floodplain

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City of Seattle Urban Creeks

**Thornton Watershed**

- Largest and most urbanized
- Water quality concerns
- Flooding problems
- B-IBI scores all “very poor”
- Cutthroat dominated
The Problem: Too Much Runoff and No Storage

Photo: Seattle Public Utilities
The Solution – Reconnect Stream to Floodplain

Before

- Floodplain
- Peak Flow Channel
- Low Flow Channel
- Bank Height

After

Photos: Seattle Public Utilities
Thornton Floodplain Reconnection Projects

Confluence

Knickerbocker

Lake Washington
Seattle Public Utilities Project Goals

• Maximize floodplain storage of stormwater
• Increase reach-scale habitat complexity
• Improve stream biological health
• Test new restoration approach - Hyporheic Zone
Hyporheic Zone

Mixing of surface and groundwater below and alongside channel

- Flood dampening
- Groundwater recharge
- Temperature regulation
- Biological production
- Nutrient cycling
NOAA Monitoring Objectives

- Evaluate biological response to hyporheic restoration
- Experiment with “assisted” recolonization
- Evaluate different hyporheic sampling techniques
Treatment reaches = Urban - restored
Control reaches = Urban - unrestored
Reference reaches = Forested - least disturbed
Monitoring Design – Response Variables

Biota

• Microbes
• Invertebrates

Co-variates

• Temperature (surface & hyporheic)
• Water chemistry
  • Total N & P
  • Dissolved nutrients
  • Dissolved organic carbon
  • Total organic and inorganic matter
Monitoring Design – Sample Methodologies

**Piezometers**
- To collect samples
- Pump samples
  - interstitial taxa
  - 15-25 cm below bed

**Colonization Baskets**
- To collect samples AND inoculate
- Substrate samples
  - clingers
  - 0-40 cm below bed
Monitoring Design – Sample Methodologies

Piezometer

Basket
Hyporheic Colonization Baskets
Sample Timeline

2014

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<th>Oct</th>
<th>Nov</th>
<th>Dec</th>
<th>Jan</th>
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- **Construction completed**

2015

- **Install piezometers & baskets**

- **Inoculate**

2016

- **Re-sample piezometers & baskets**

2017
NOAA Monitoring Objectives

- Evaluate biological response to hyporheic restoration
- Experiment with “assisted” recolonization
- Evaluate different hyporheic sampling techniques
Inoculation Response – Microbes

Image: Leaping Frog Films
Inoculation Response – Microbes

Pre = Fall 2014
1 = Winter 2015
2 = Spring 2015
3 = Summer 2015
Post = Fall 2015
Inoculation Response – Invertebrates

Image: Leaping Frog Films
Inoculation Response – Invertebrates

![Graph showing inoculation response of invertebrates]

- **Pre**
- **Post**

**Invert Taxa Richness**
- Reference
- Seeded
- Unseeded

Year: 2014

**Fall**
NOAA Monitoring Objectives

- Evaluate biological response to hyporheic restoration
- Experiment with “assisted” recolonization
- Evaluate different hyporheic sampling techniques
2-way ANOVA:

- Reach effect: T > C > R
- Reach x Year: Yes
Restoration Response – Invertebrates

Reach
- Reference
- Control
- Treatment

**Density (sqrt)**
- 2014: T, R > C
- 2015: T, R > C
- 2016: T > C, R

**Taxa Richness**
- 2014: T, R > C
- 2015: T, R > C
- 2016: T > C, R
Summary of Preliminary Results to Date

Response to experimental inoculation:
- Small transient changes in microbial taxonomic structure
- No significant changes in invertebrate density or structure
- Detection of four “new” invertebrate taxa at inoculated reach

Response to hyporheic restoration:
- Higher microbial metabolic activity
- Greater invertebrate density and taxa richness
- Changes in microbial and invertebrate taxonomic structure

Image Source: S. Iepure
Questions and Suggestions?
Restoration Response – Invertebrates

Density (sqrt) for 2014, 2015, and 2016:
- Treatment (T) > Control (C) and Reference (R)

Taxa Richness for 2014, 2015, and 2016:
- Treatment (T) and Reference (R) > Control (C)
Restoration Response – Invertebrates

### Density (sqrt)
- **T > C, R**
- **2014, 2015 > 2016**
- **No Interaction**

### Taxa Richness
- **T, R > C**
- **2014 > 2016**
- **Yes Interaction**