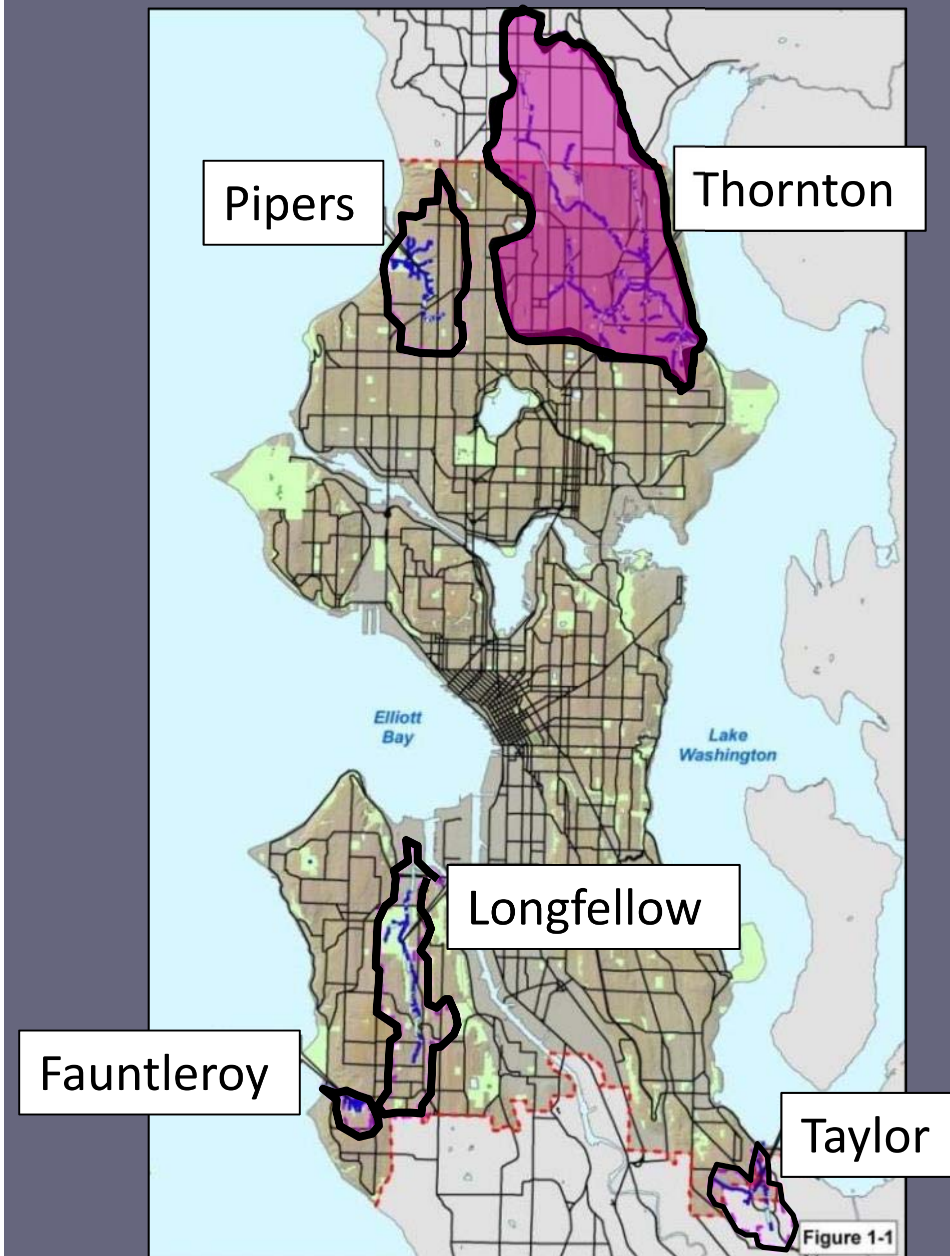
# Biological Outcomes of Hyporheic Zone Restoration in an Urban Floodplain

S. Morley, L. Rhodes, A. Baxter, G. Goetz
NOAA Fisheries

K. Lynch
S. Damm
SPU

Thank You! P. Bakke, R. Hrachovec, P. Hoppe, K. Hanson, W. Nilsson, C. Pierre, D. Paige, A. LaBarge, K. Macneale, J. Wilhelm, S. Solomon

# City of Seattle Urban Creeks




## Thornton Watershed

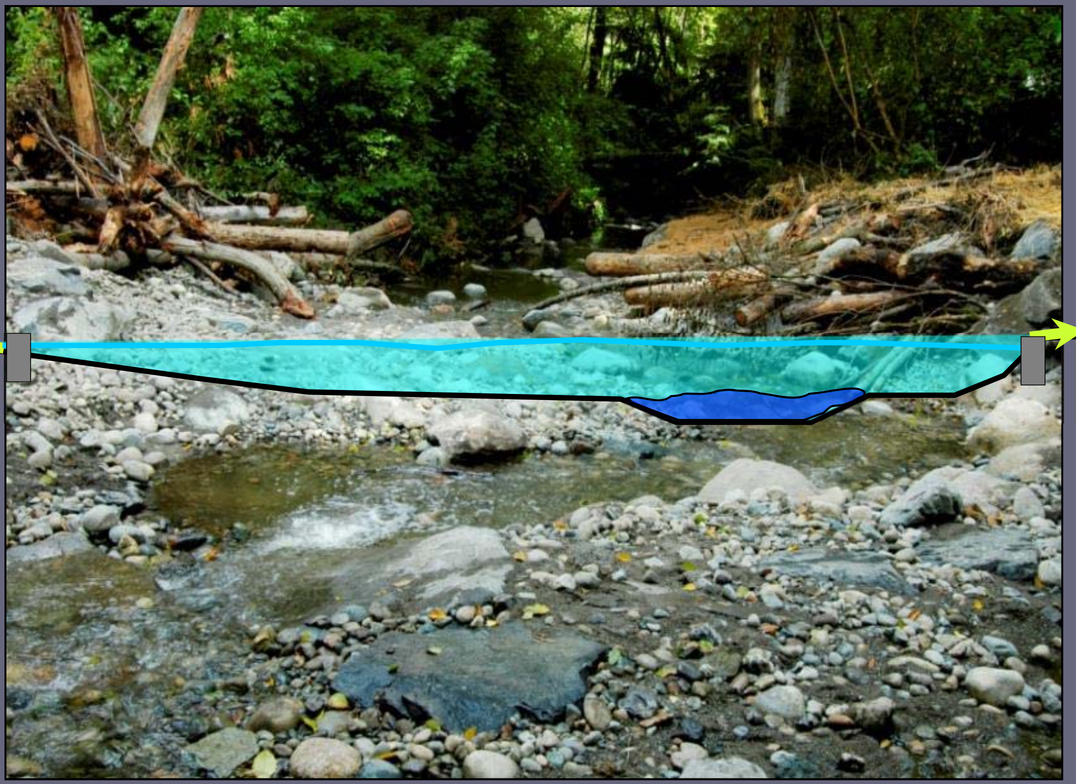
- Largest and most urbanized
- Water quality concerns
- Flooding problems
- B-IBI scores all “very poor”
- Cutthroat dominated

# The Problem: Too Much Runoff and No Storage

Photo: Seattle Public Utilities

# The Solution – Reconnect Stream to Floodplain

Before

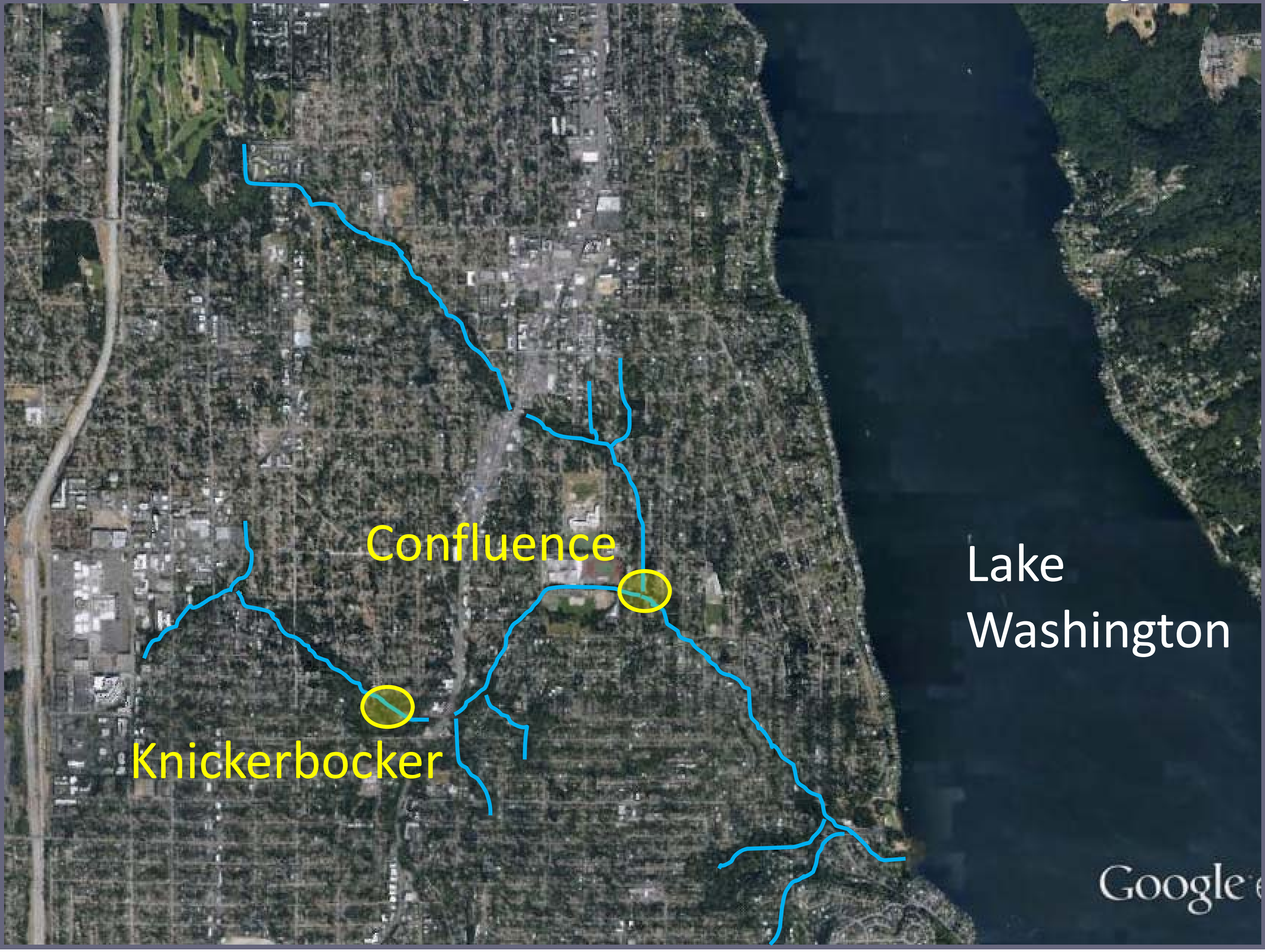


After

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

Photos: Seattle Public Utilities

# Thornton Floodplain Reconnection Projects

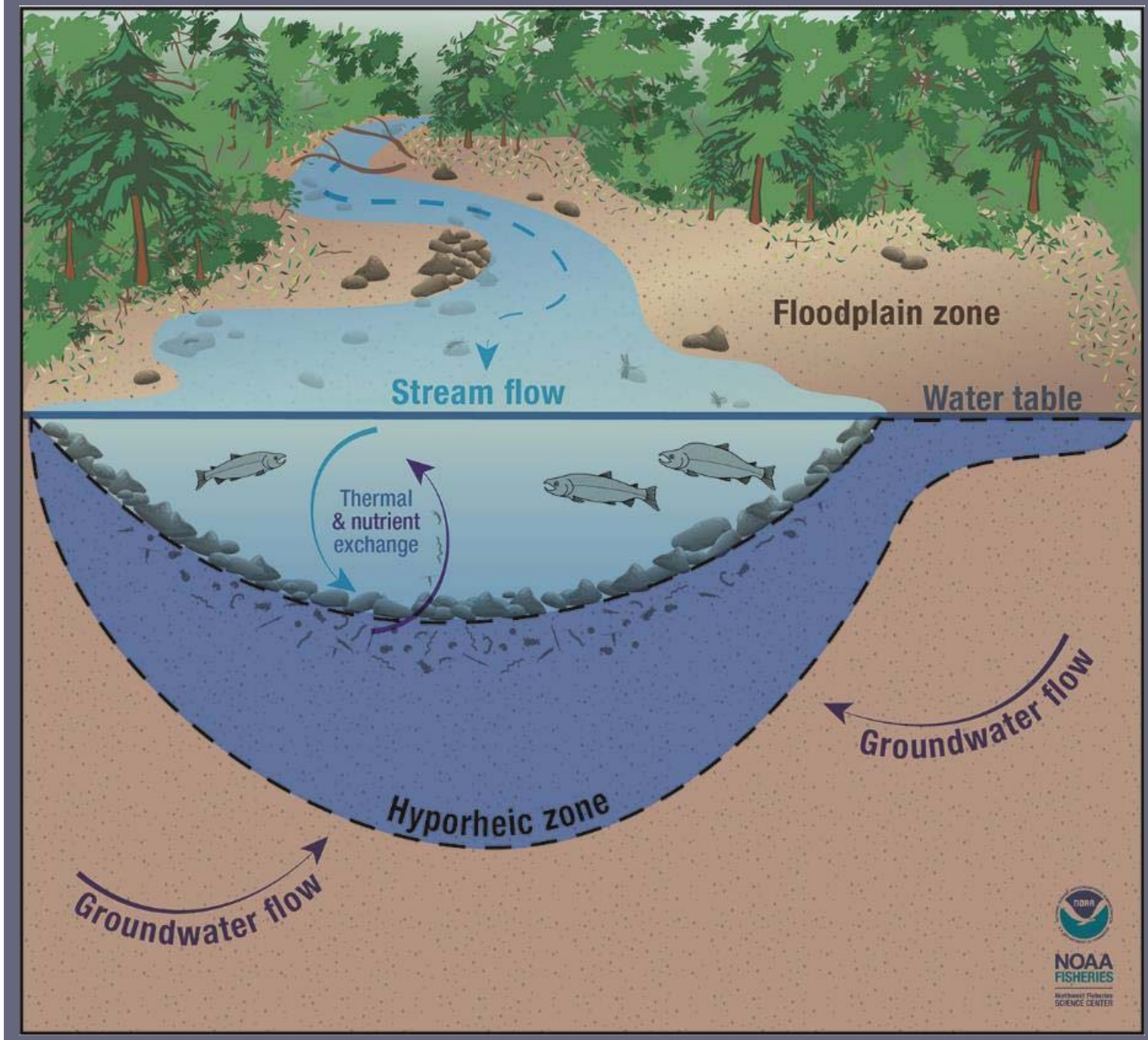


# Seattle Public Utilities Project Goals

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

# Hyporheic Zone

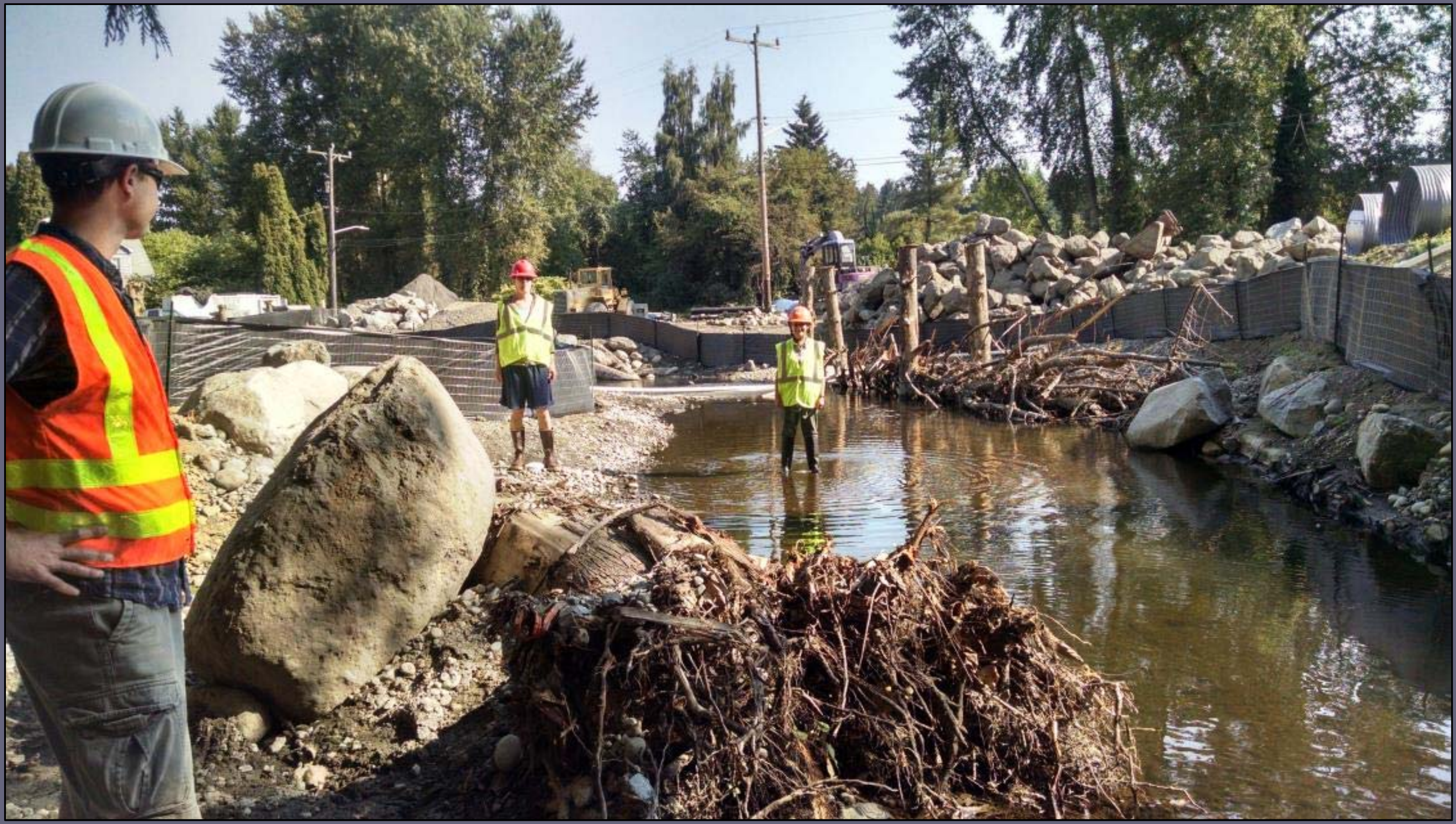
## Mixing of surface and groundwater below and alongside channel



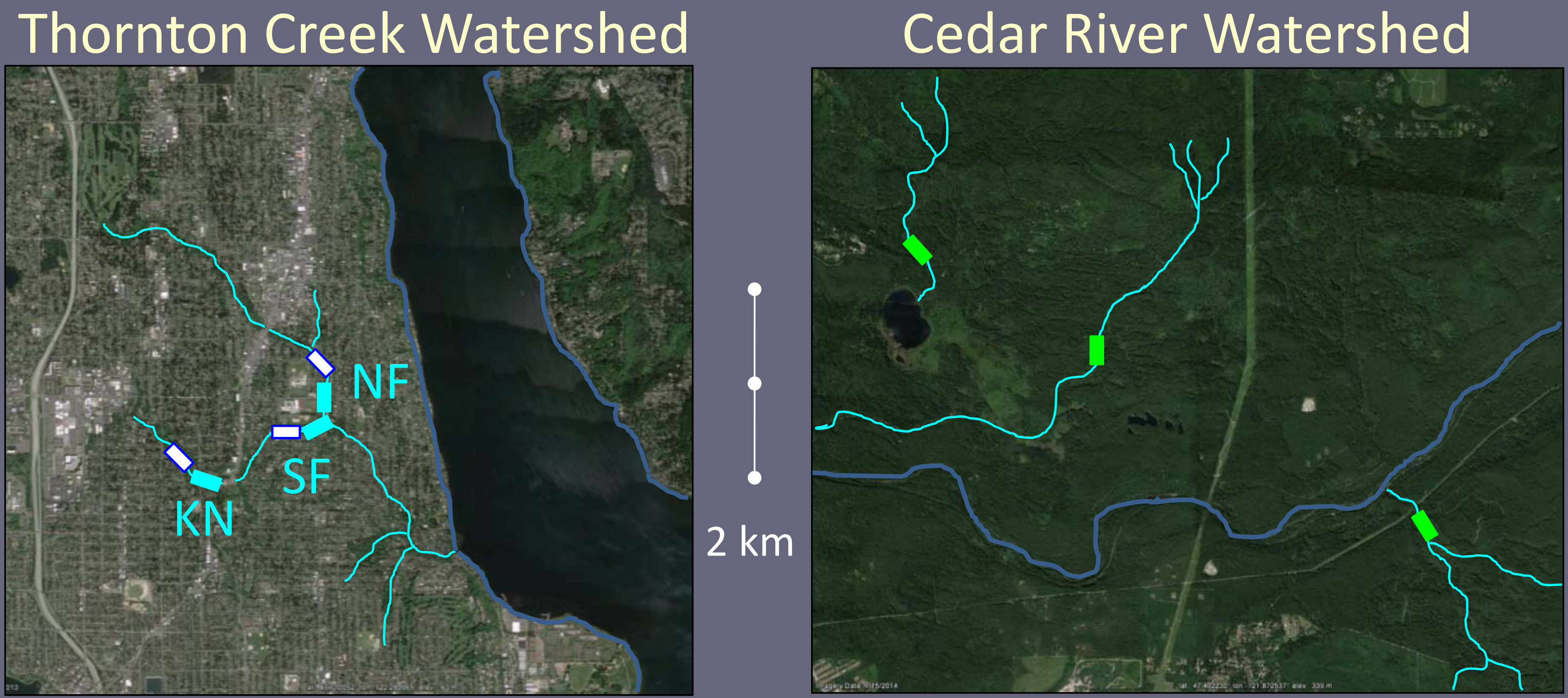

- Flood dampening
- Groundwater recharge
- Temperature regulation
- Biological production
- Nutrient cycling

# NOAA Monitoring Objectives

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



# Monitoring Design – Study Reach Locations




Treatment reaches = Urban - restored

Control reaches = Urban - unrestored

Reference reaches = Forested - least disturbed

# Monitoring Design – Response Variables

## Biota

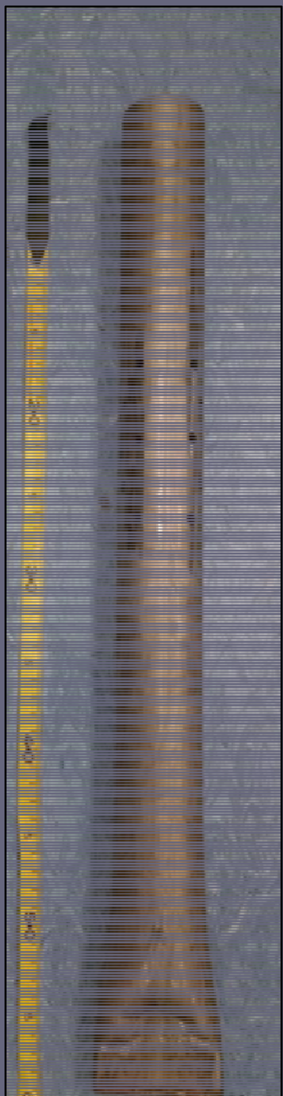
- Microbes
- Invertebrates


Photo: G. Carter

## Co-variates

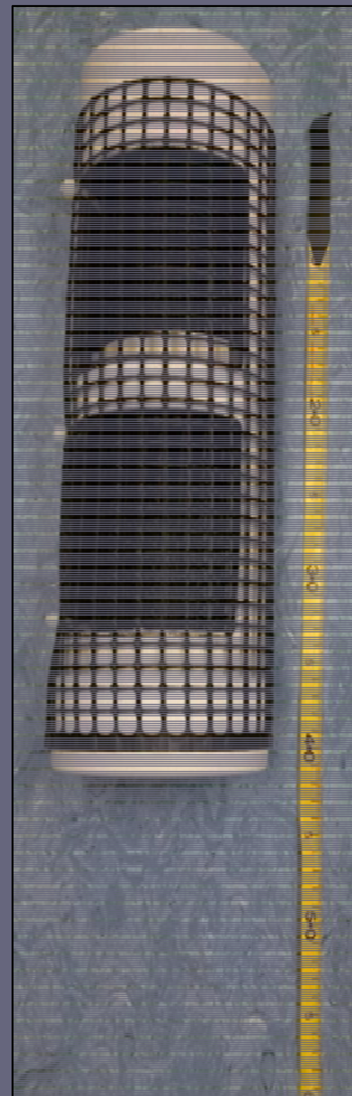
- Temperature (surface & hyporheic)
- Water chemistry
  - Total N & P
  - Dissolved nutrients
  - Dissolved organic carbon
  - Total organic and inorganic matter

# Monitoring Design – Sample Methodologies



## Piezometers

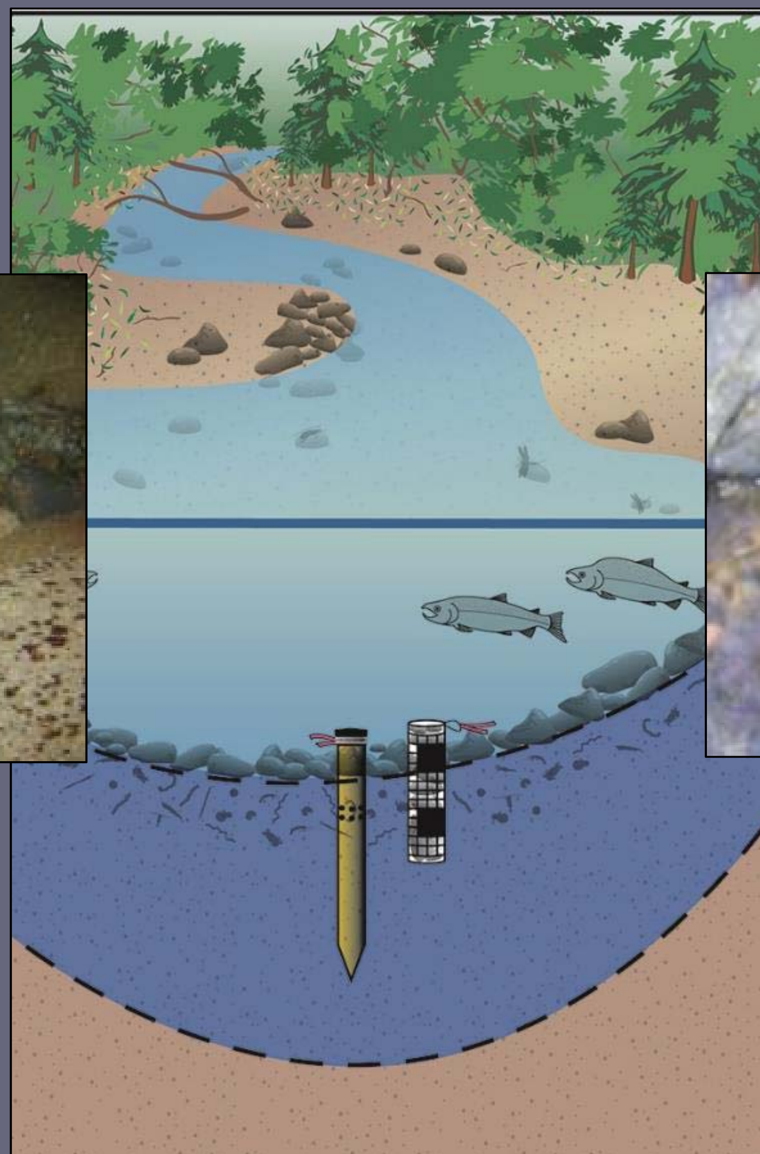
- To collect samples
- Pump samples
  - interstitial taxa
  - 15-25 cm below bed



## 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 2015

| Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|

Construction completed

2016

2017

Re-sample piezometers & baskets

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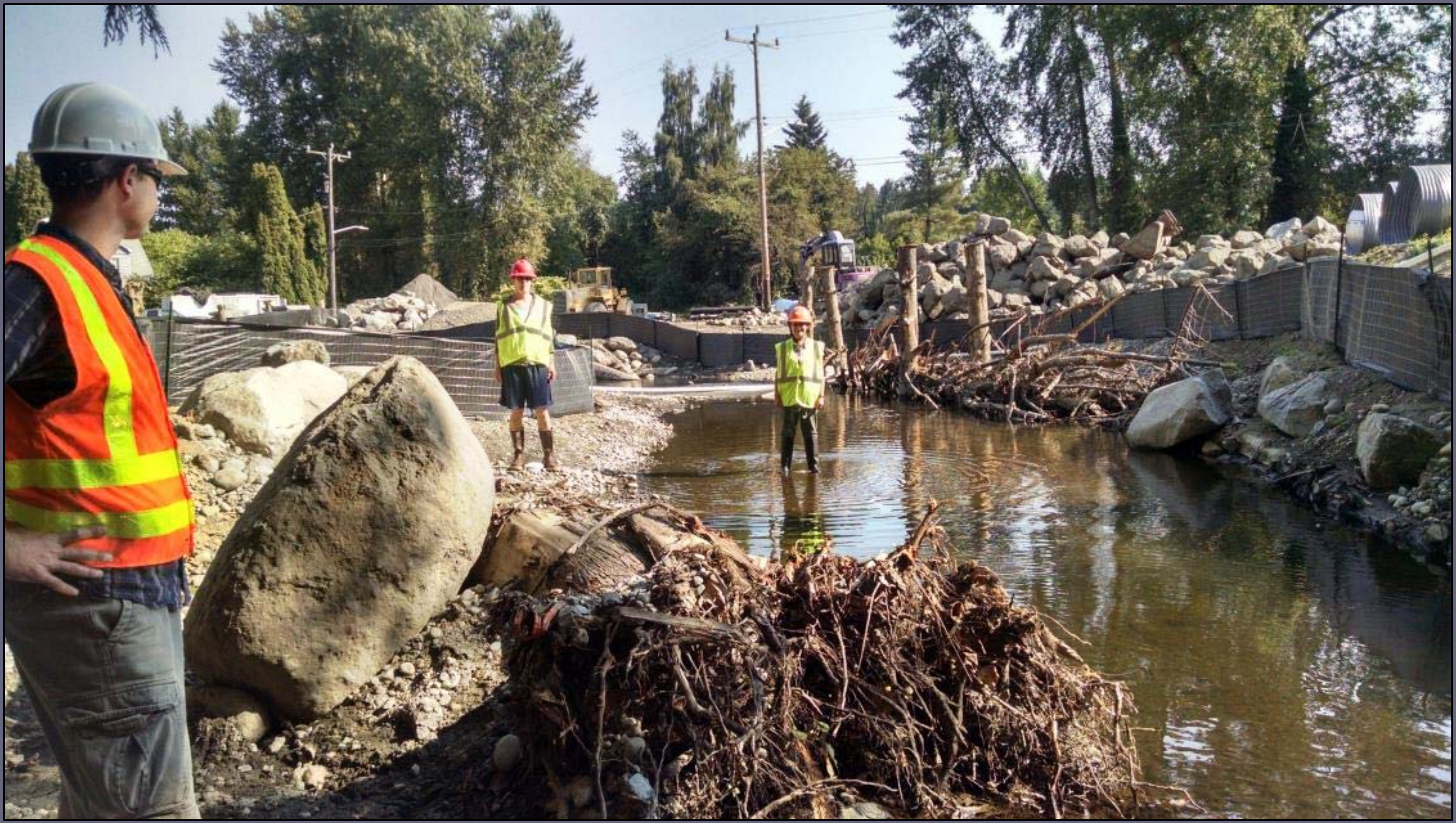

# Inoculation Response – Microbes

Image: Leaping Frog Films

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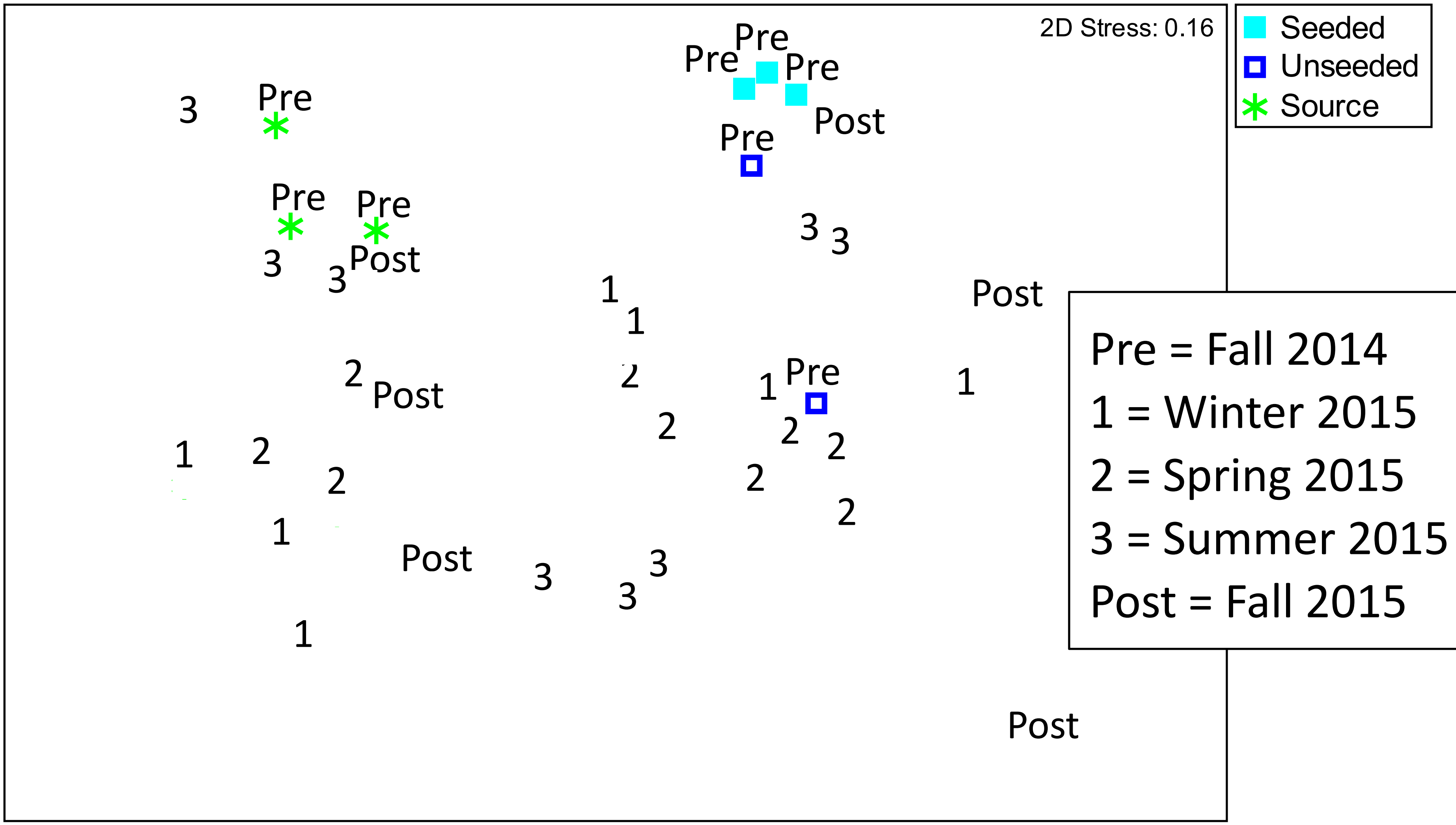
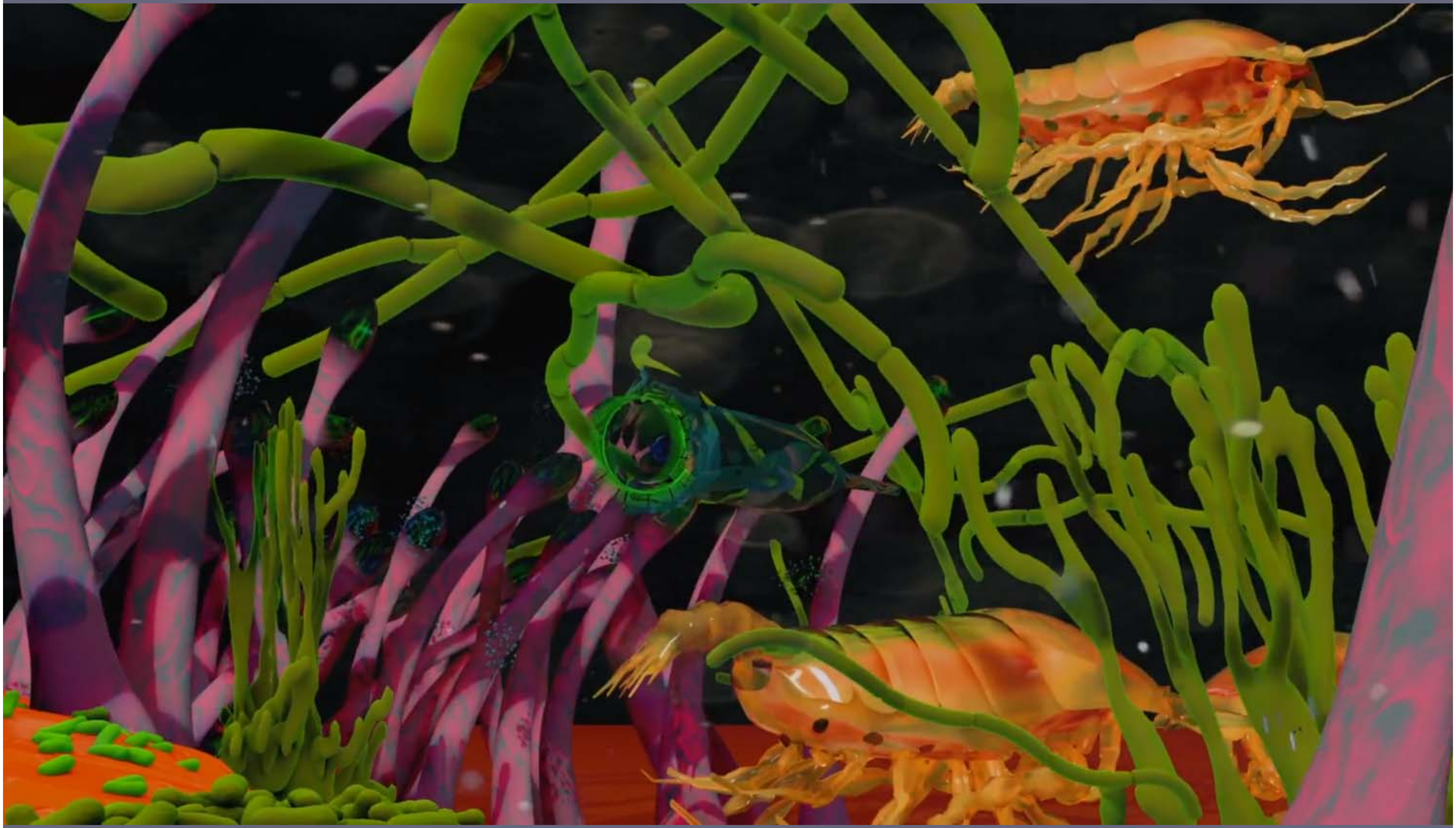


# Inoculation Response – Invertebrates



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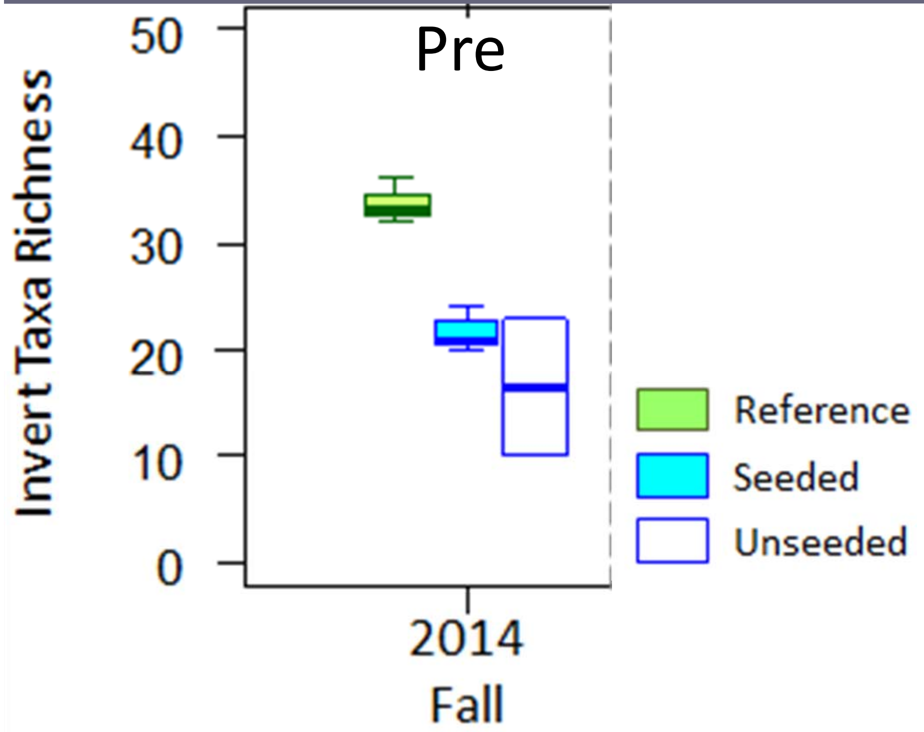


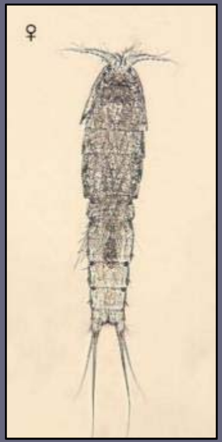

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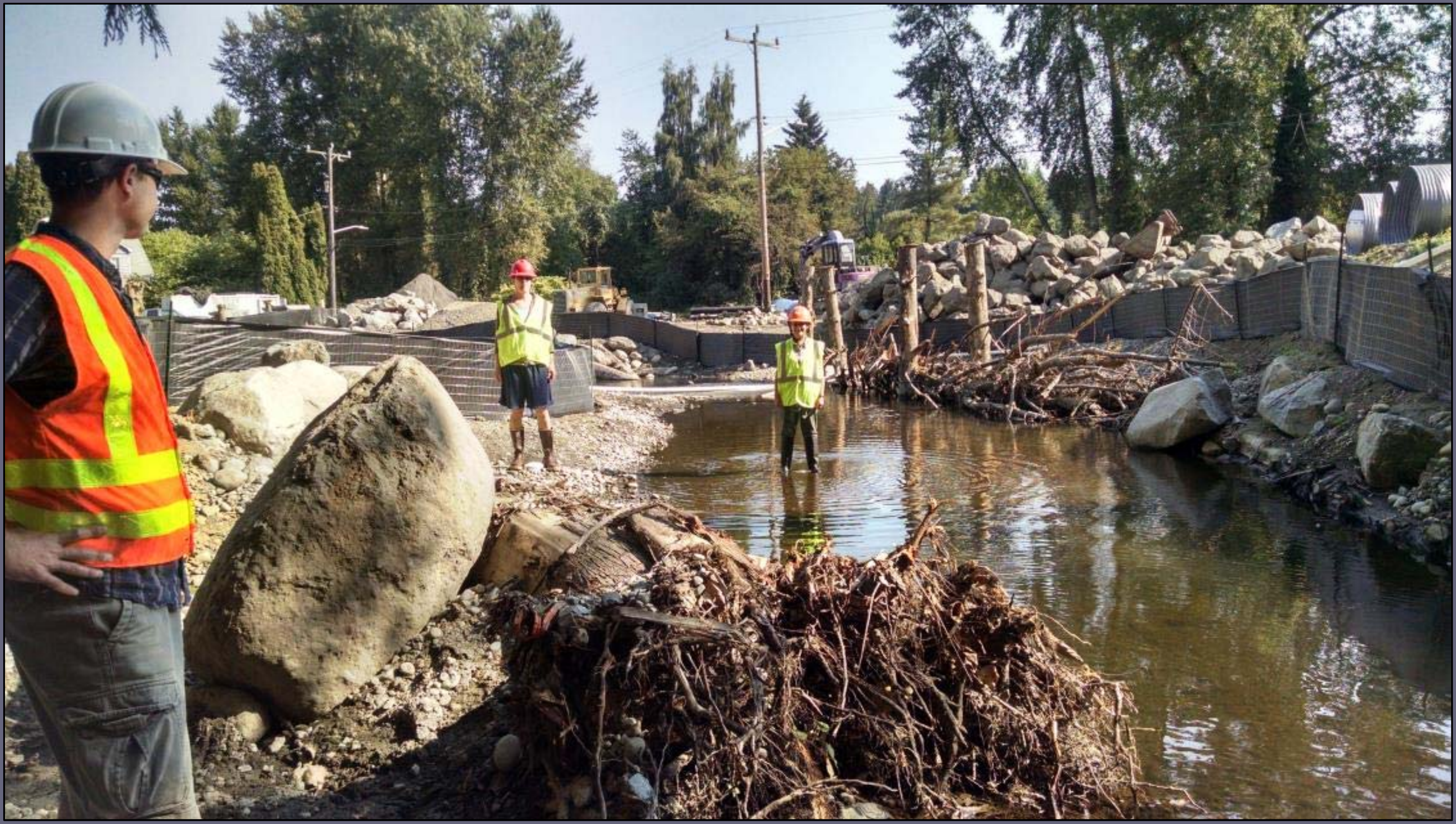
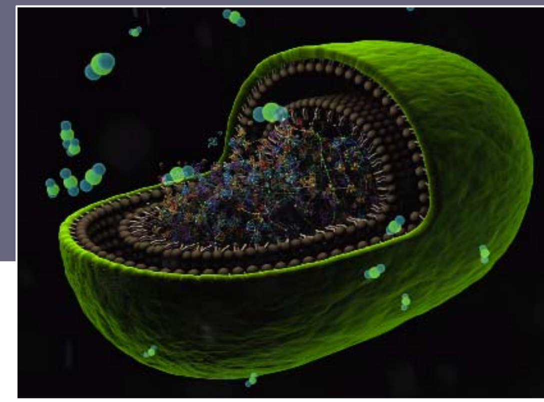
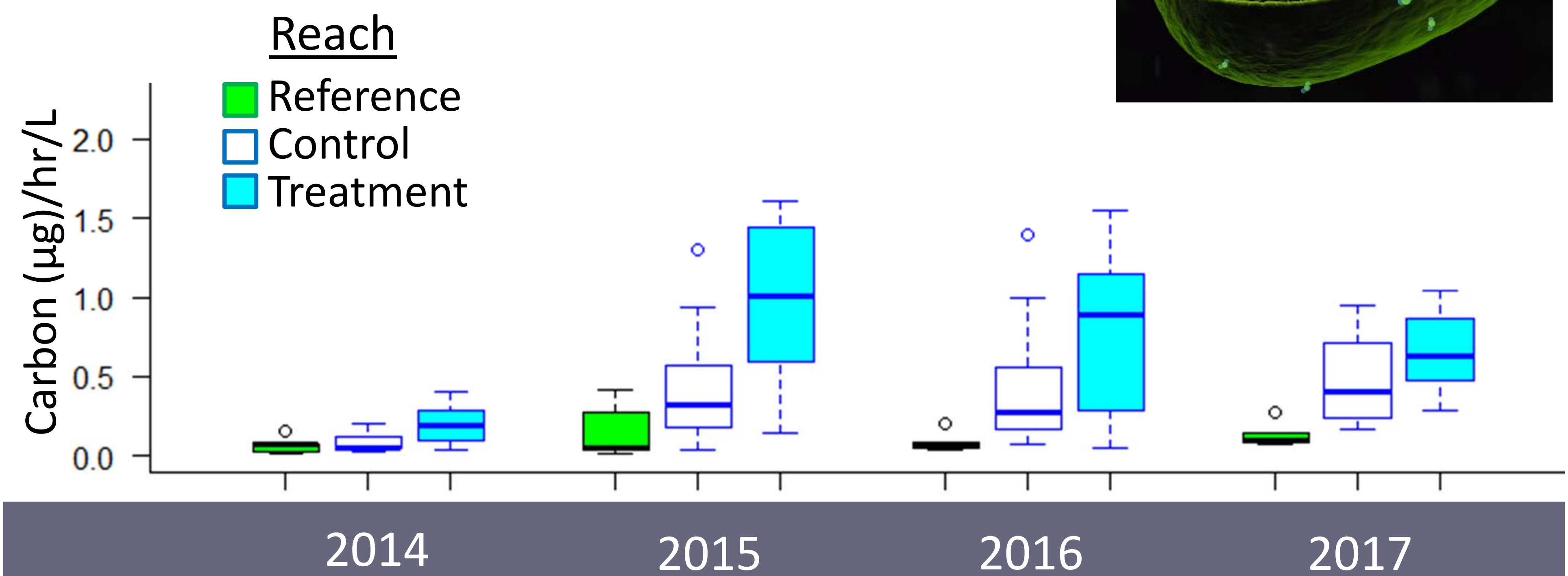


# Restoration Response – Microbes



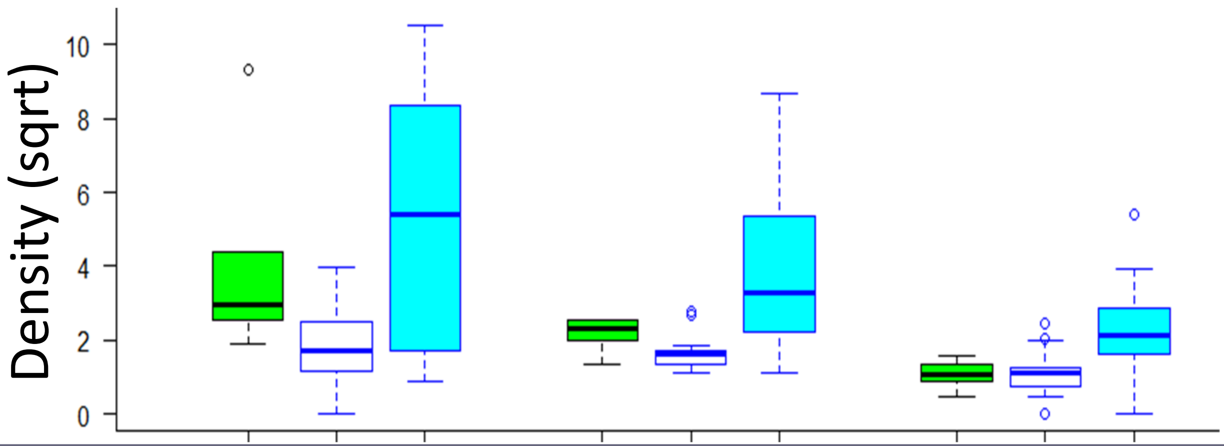


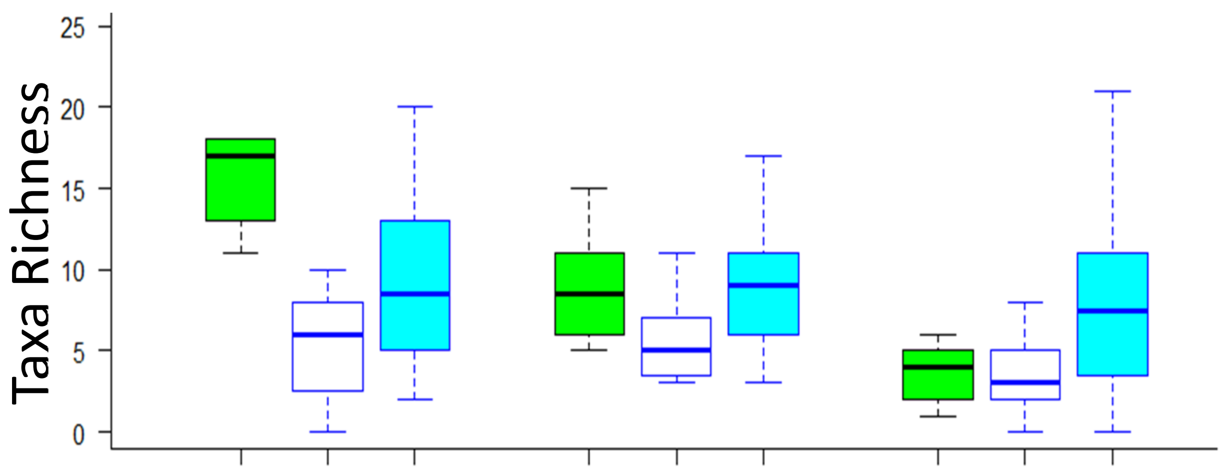

2-way ANOVA: Reach effect: T > C > R

Year effect: 2014 > 2015, 2016, 2017

Reach x Year: Yes

# Restoration Response – Invertebrates



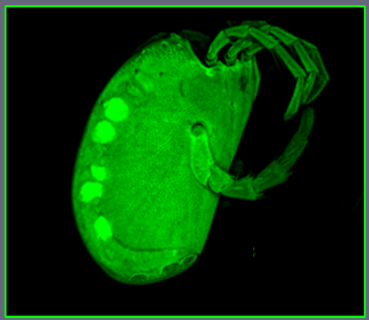
# Summary of Preliminary Results to Date

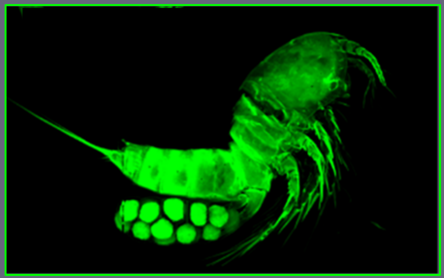
## Response to experimental inoculation:

- 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





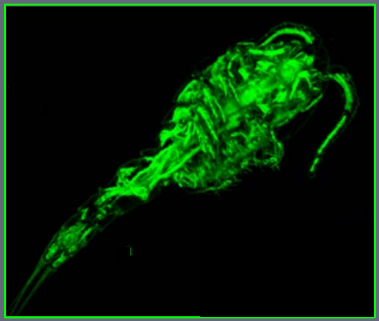
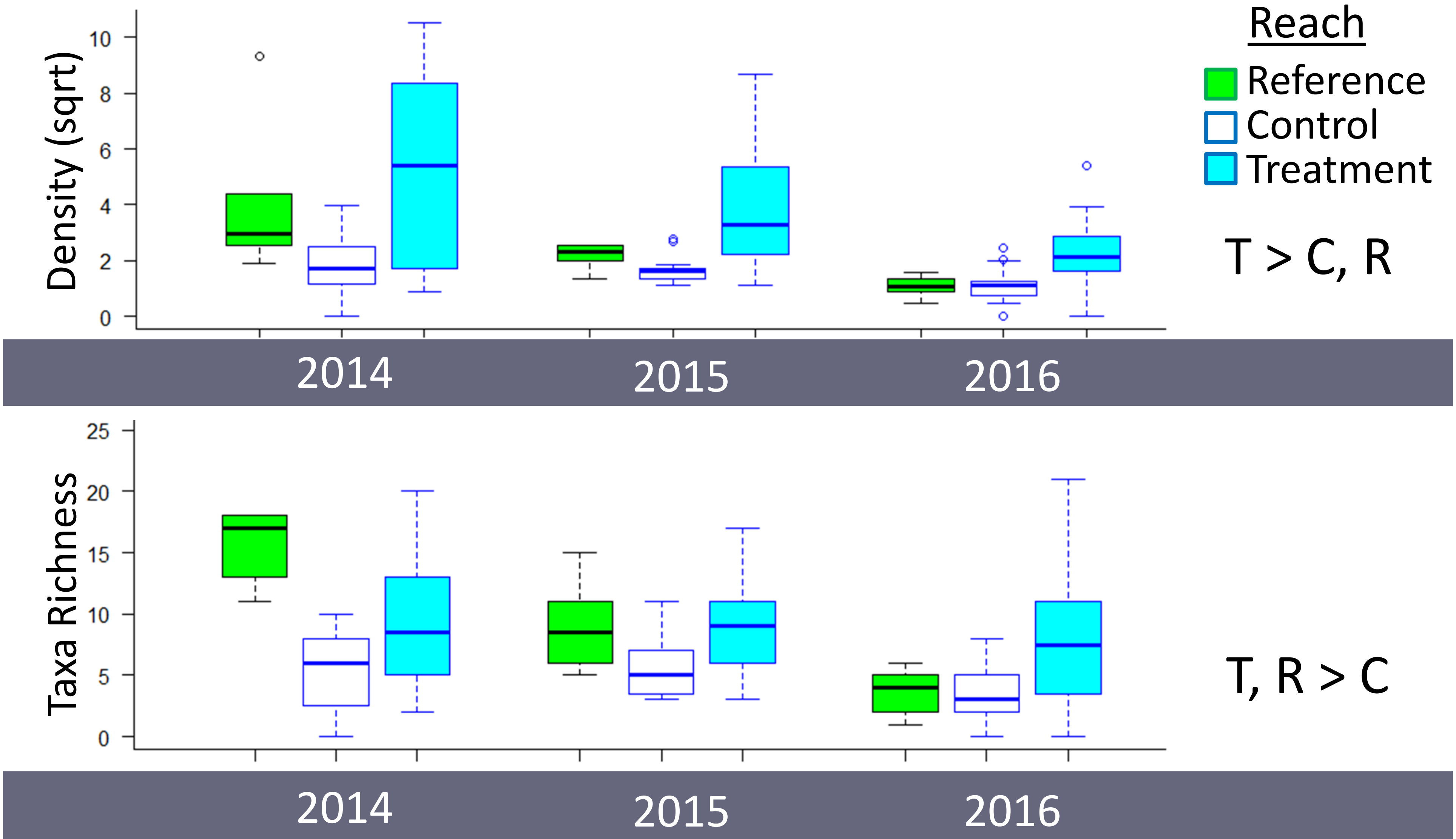


Image Source: S. Iepure

# Questions and Suggestions?


# Restoration Response – Invertebrates



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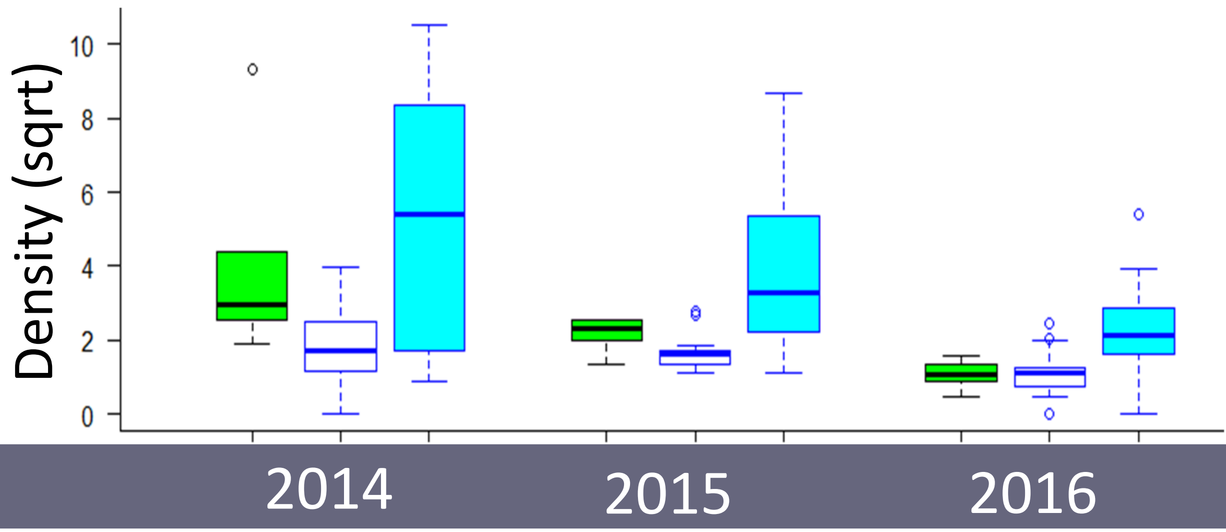
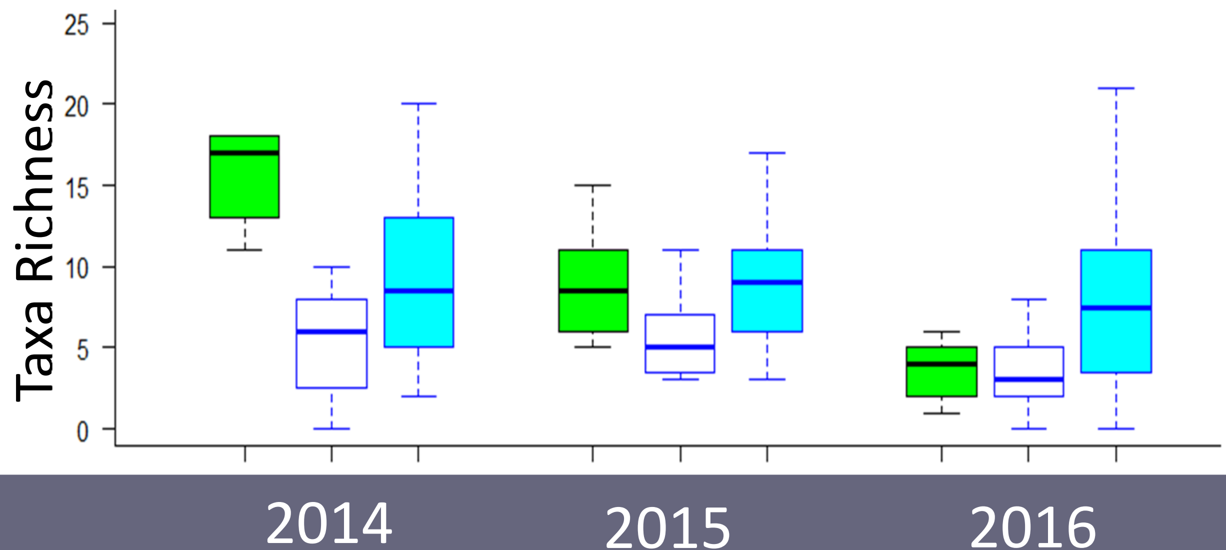



Reach

Reference
Control
Treatment

T > C, R
2014,2015 > 2016
No Interaction




T, R > C
2014 > 2016
Yes Interaction