Impact of Water Fluctuations and Intermittency on Stream Biota Community Structure

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Intermittent Streams

- Dry when groundwater table drops below the elevation of the stream bed
- Often seasonally
Isolated Pools
Streambed Desiccation
Why Intermittent Streams?

- Dynamic systems
- Naturally occurring
- Majority of stream network
- Unsustainable groundwater extractions
- Perennial → Intermittent

https://md.water.usgs.gov/posters/flowGIS/
Hypothesis

- How are stream biota impacted by dynamic fluctuations
- If colonization of certain organisms is inhibited by drying
- Decrease in species richness and diversity in areas prone to drying
- Community structure will shift / increased species richness and diversity with prolonged reconnection
Objectives

• Observe community structure changes - fish, invertebrates, microbes across three seasons
• Immediately post-reconnection, four months post-reconnection, pre-disconnection
Reaches determined when dry
Six sites per reach (n=18)
Second order
Karstic geology
Continuous flow upstream
Seasonal drying downstream

Study Site- Little Creek, TN
Fish Assemblage Analysis

- Triple pass depletion electroshocking
- Field ID to species
- Habitat delineation at each site
Immediately Post-Reconnection Fish Analysis

Stress=0.12

Legend
- Upstream
- Intermediate
- Downstream
Immediately Post-Reconnection Fish Analysis

Stress = 0.12

PERMANOVA
Reach: pseudo $F_{2,15} = 9.35, P < 0.01, R^2 = 0.55$
Immediately Post-Reconnection: Summary

- Low species richness in downstream reach
- Expected- dry for 2 months prior to sampling
- Does the community shift after 4 months of reconnection?
Four months Post- Reconnection Fish Analysis

Legend
- Upstream
- Intermediate
- Downstream

Stress=0.10
Four months Post-Reconnection Fish Analysis

Stress = 0.10

PERMANOVA
Reach: pseudo $F_{2, 15} = 1.28$, $P = .23$, $R^2 = 0.15$
Immediately Post-Re-connection and Four months Post-Re-connection Fish Analysis

Legend
- Immediately Post RC
- Four months Post RC

Stress=0.12
Immediately Post-Reconnection and Four months Post-Reconnection Fish Analysis

PERMANOVA
Reach: pseudo $F_{2,30} = 5.68, P <0.01, R^2 = 0.19$
Season: pseudo $F_{1,30} = 10.62, P <0.01, R^2 = 0.18$
Species-Discharge Relationship

Log$_{10}$ richness vs. Log$_{10}$ discharge (m$^3$s$^{-1}$)

$r^2 = 0.22$, $p < 0.01$
Invertebrate Community Structure

- Do organisms from different assemblages follow similar structural patterns as fish?
Immediately Post-Reconnection Invertebrate Analysis

Legend
- **Blue**: Upstream
- **Green**: Intermediate
- **Red**: Downstream

Stress = 0.06
Immediately Post-Reconnection
Invertebrate Analysis

Legend
- Upstream
- Intermediate
- Downstream

PERMANOVA
Reach: pseudo $F_{2, 8} = 6.47, P < 0.01, R^2 = 0.68$
Fish Cutaneous Microbiome

- Unique mucosal surface - community of microbes → microbiome
- Symbiotic relationship - protect against pathogens
- Microscale structure of microbial community on fish using the same model
Fish Cutaneous Microbiome

- Microbial communities in three fish species found ubiquitously
- Non-lethal skin swabbing
- Metabarcoding and high-throughput DNA sequencing
Immedialey Post- Reconnection Microbiome Analysis

**PERMANOVA**
Reach: pseudo $F_{2, 85} = 3.47$, $P < 0.01$, $R^2 = 0.07$
Species: pseudo $F_{2, 85} = 1.43$, $P = 0.01$, $R^2 = 0.03$

Stress=0.15
Take-Home

- Drying events cause unique community structures in all assemblages immediately post-reconnection.
- Fish reaches that are prone to drying have unique community compositions even after 4 months of continuous reconnection.
- Increased discharge may be an environmental variable responsible for community structure shifts.
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