Velocity Distributions and Fish Use of Engineered Log Jams

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Overview

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Background

- Large woody debris increase habitat complexity and are important for
  - Creating Habitat
  - Spawning migrations
  - Predatory cover for adults and juveniles
  - Feeding habits

- ELJ construction is popular, but limited research has been done on understand their effects on flow and fish behavior
History

- Logging Effects
  - Since 1800s
  - Decreasing quantity of natural woodings falling into streams
  - Splash damming for log transportation
    - Widened channels
    - Eliminated natural log jams
    - Scoured and washed away gravel and sediments, exposing bedrock
  - Reduced Natural habitat

Splash dam at Mill Creek, Oregon, 1905
History

- Removal of woody debris
  - 1950s to 1980s
    - Wood was thought to prevent passage of salmon spawning migrations
- Realization of importance of large wood
  - Endangered Species Act (1973)
    - 5 salmonids eventually placed on endangered list
    - 1980’s, People began to bring wood back into streams
    - Development of Engineered Log Jams (ELJ’s)
Study Purpose

- Gain an understanding of how different ELJ structures effect:
  - Stream Hydraulics (Velocity & Turbulence)
    - Pool and Channel velocities and turbulence
    - Bathymetry
  - Fish Behavior
- To contribute information on how to better construct engineered log jams for fish use, modifying channel hydraulics, and stabilizing stream banks
Objectives

- Survey study sites for future laboratory model reconstructions and 3-dimensional mapping

- Take bathymetry measurements of stream beds

- Observe Fish Focal Points (FFP’s) and orientation (10am to 3:30pm)

- Take velocity measurements throughout stream; specifically near FFP’s

- Combine bathymetry measurements, fish data, and velocity measurements to determine placement and fish velocity preferences

- Sediment sampling for characterization of roughness
Questions

- How do ELJ’s affect stream flow?
- How do ELJ’s influence bathymetry?
- What flow velocities do fish prefer?
- How do ELJ’s influence fish behavior?
Hypotheses of ELJ’s affects

- Stream Hydraulics
  - Increase flow complexity
  - Increase water mixing
- Channel Morphology
  - Increase organic and sediment deposition near jams
- Fish Behavior
  - Use log Jams as shelter/cover
  - Prefer slower flow conditions with easy access to fast flow for feeding
Site Locations

- Crooked Creek, Meander Jam
- Canal Creek, Full Channel Jam
Crooked Creek

- 6 Logs embedded into the bank
- Root wads at stream center
- 1 Submerged log spanning under others
- 4 Separate pools created
- Main channel section
- River left gravel bar
Site Description

- 7 Key logs
- River left is a sand bar
- Flow mainly constricted when crossing logs 3&4
- Lots of silt and sand deposition upstream and river-left downstream
Methods and Instruments

Total Station with Reflector Rod

Acoustic Doppler Current Profiler (ADCP)
Methods and Instruments

- Tom and Sarah’s eyes & brains for snorkeling.

- Measuring utensils, rocks, and sticks
Results

Bathymetry of Crooked Creek
Results
Bathymetry of Canal Creek
Canal Creek Velocity Contour Maps
Canal Creek Velocity Contour Maps
Results, Crooked Ck.
Fish Velocity Utilization

Legend

Species
- CHNK
- COHO
- RBTT

Edge of wetted channel

Direction of flow

0  1.5  3  6 Meters
Results, Crooked Ck.
Fish Velocity Utilization

- Horizontal Stream Demographics
  - Max Velocity: 74.29 cm/s
  - Mean Velocity: 33.55 cm/s
  - Minimum Velocity: 5.16 cm/s

- Vertical Stream Demographics
  - Max Velocity: 23.40 cm/s
  - Mean Velocity: 0.04 cm/s
  - Minimum Velocity: -22.60 cm/s
Fish velocity preferences versus total measured velocities at Crooked Creek

![Graph showing fish velocity preferences versus total measured velocities](image)
Results, Canal Ck.

Velocity Utilization

- Horizontal Magnitude Velocity Values in Centimeters Per Second
  - Number of Fish n=139
  - Max Velocity: 200.70 cm/s
  - Mean Velocity: 34.12 cm/s
  - Minimum Velocity: 1.73 cm/s

- Vertical Velocity Values in Centimeters Per Second
  - Number of Fish n=140
  - Max Velocity: 71.60 cm/s
  - Mean Velocity: -0.13 cm/s
  - Minimum Velocity: -38.50 cm/s

- Horizontal Stream Demographics
  - Max Velocity: 200.70 cm/s
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- Vertical Stream Demographics
  - Max Velocity: 71.60 cm/s
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Fish velocity preferences versus total measured velocities at Canal Creek

![Graph showing fish velocity preferences versus total measured velocities at Canal Creek. The graph plots the percent of total velocity values against the total velocity magnitude in cm/s. Two curves are shown: one for fish focal point velocities and another for total measurable velocities. The distribution peaks at a velocity magnitude of approximately 45 cm/s, with a standard deviation of around 30 cm/s.]
Sources of Error

- ADCP bottom track was often lost
  - Manual translating and rotating transect points necessary
    - Possible errors in translations or rotation values
      - Nearest velocity vector and orientation to fish could be off by a few degrees.

- Velocity histograms assume FFP’s are associated with surrounding water velocity vectors
  - Velocity vector and FFP sometimes separated by about 1 meter
- Pyramid structure of beam data collection makes deeper “bins” less accurate than upper measurements
Conclusion

- How do ELJ’s affect stream flow?
  - Create
    - Pools of low flow
    - Creates hydraulic complexity

- How do ELJ’s influence bathymetry?
  - Areas of sediments deposition
  - Areas of scouring

- What flow velocities do fish prefer?
  - Vertical velocities near zero
  - Horizontal magnitude velocity near 34cm/s

- How do ELJ’s influence fish behavior?
  - Fish utilize flow fields created by ELJ’s
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For Your Contributions
Questions?