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Effects of Scaling on Turbulence in a Denil Fishway

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Effects of Scaling on Turbulence in a Denil Fishway



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Fish Passage and Ecohydraulics Research Group

www.montana.edu/ecohydraulics

Montana State University

- Matt Blank, PhD, PE, Assistant Research Professor, Civil Engineering Department and Research Scientist, Western Transportation Institute
- Joel Cahoon, PhD, PE, Professor, Civil Engineering Department
- Tom McMahon, PhD, Professor, Department of Ecology
- Katey Plymesser, PhD, PE, Assistant Professor, Civil Engineering Department

US Fish and Wildlife Service

- Kevin Kappenman, Research Biologist, Bozeman Fish Technology Center
- Bill Rice, Fish Passage Coordinator, Regional Office, Lakewood, CO
- Erin Ryan, Engineering Technician, Bozeman Fish Technology Center



College of
ENGINEERING

Western Transportation Institute

Current and Recent Projects

Improving Conservation Status of Arctic Grayling; Assessing and Increasing Landscape Connectivity Benefits of Denil Fishways in the Big Hole River Watershed

The purpose of this study is to evaluate the use and effectiveness of Denil structures installed in existing irrigation diversions throughout the Big Hole watershed.

Modifying Denil Fishways to Optimize Arctic Grayling Passage

The purpose of this project is to evaluate four different flow management structures to determine which are the most effective at passing Arctic grayling through Denil fishways.

Evaluating the Efficacy of Denil Fishways in Irrigation Structures for Passage of Arctic Grayling

The purpose of this project is to evaluate how water depth affects passage success for Arctic grayling through both a 6-foot and a 12-foot Denil.

Volitional Swimming Performance of Arctic Grayling in an Open-Channel Flume: A Baseline Study

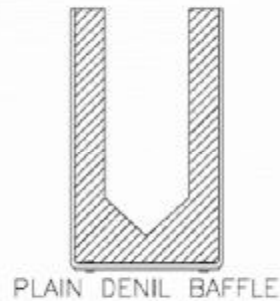
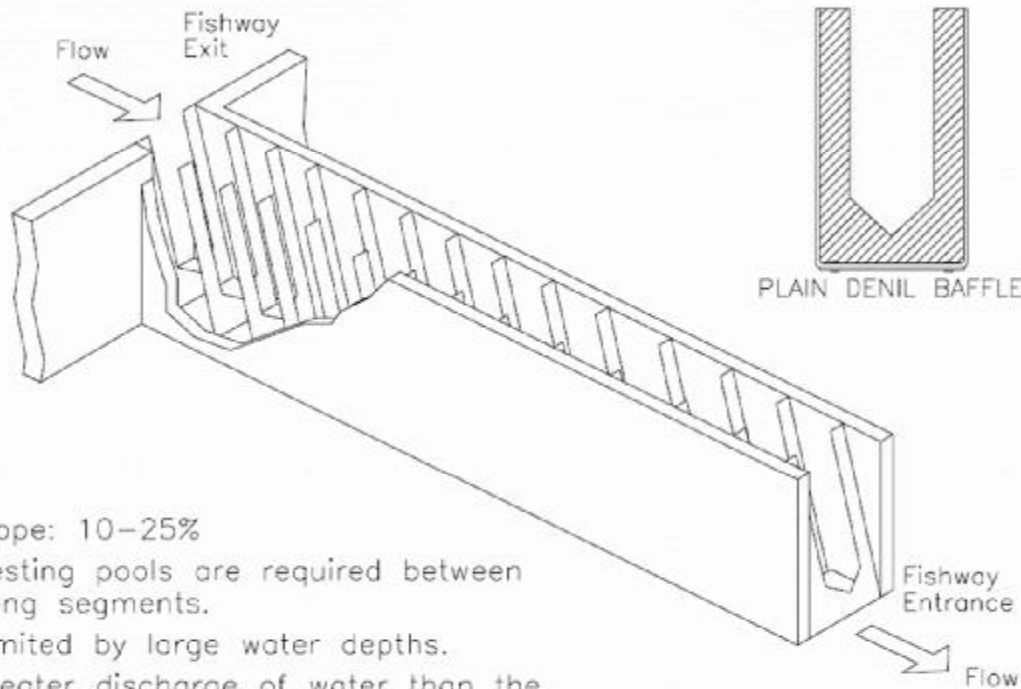
We are characterizing the swimming performance of Arctic grayling, a species of special concern, for fish passage assessment and design.



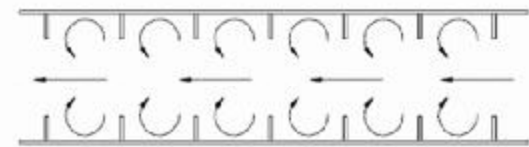




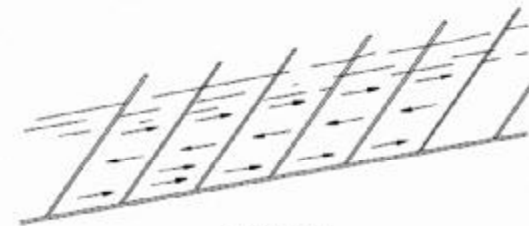
Plain Denil Fishway



FLOW PATTERN

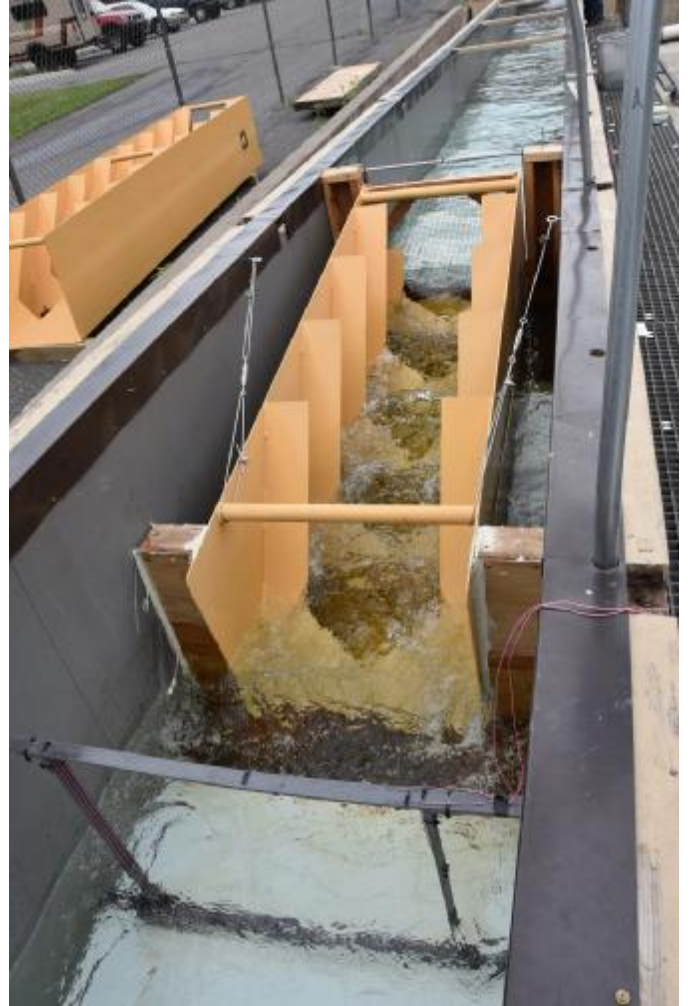


PLAN VIEW

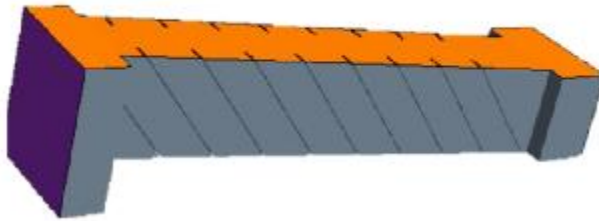


PROFILE

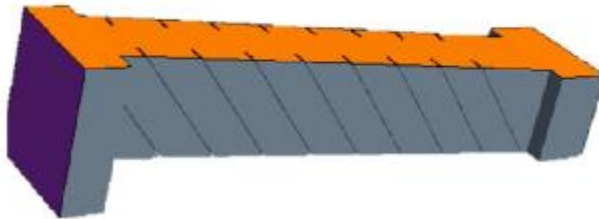
- Slope: 10-25%
- Resting pools are required between long segments.
- Limited by large water depths.
- Greater discharge of water than the other fishways and, therefore, a greater attraction capability.



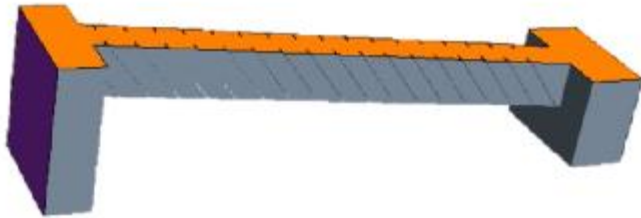




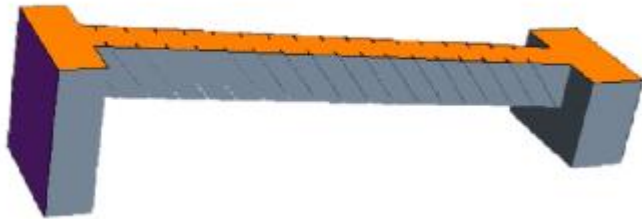
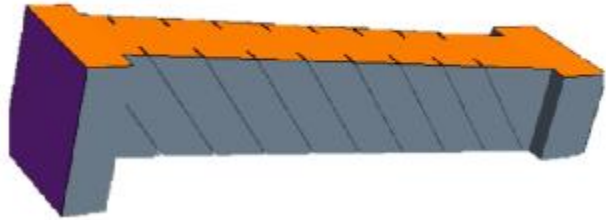
- Create CFD model of Denil fishway at Bozeman Fish Technology Center (BFTC)



- Create CFD model of Denil fishway at Bozeman Fish Technology Center (BFTC)
- Use data from BFTC Denil to verify model



- Create CFD model of Denil fishway at Bozeman Fish Technology Center (BFTC)
- Use data from BFTC Denil to verify model
- Run CFD model with a half-size scaled model

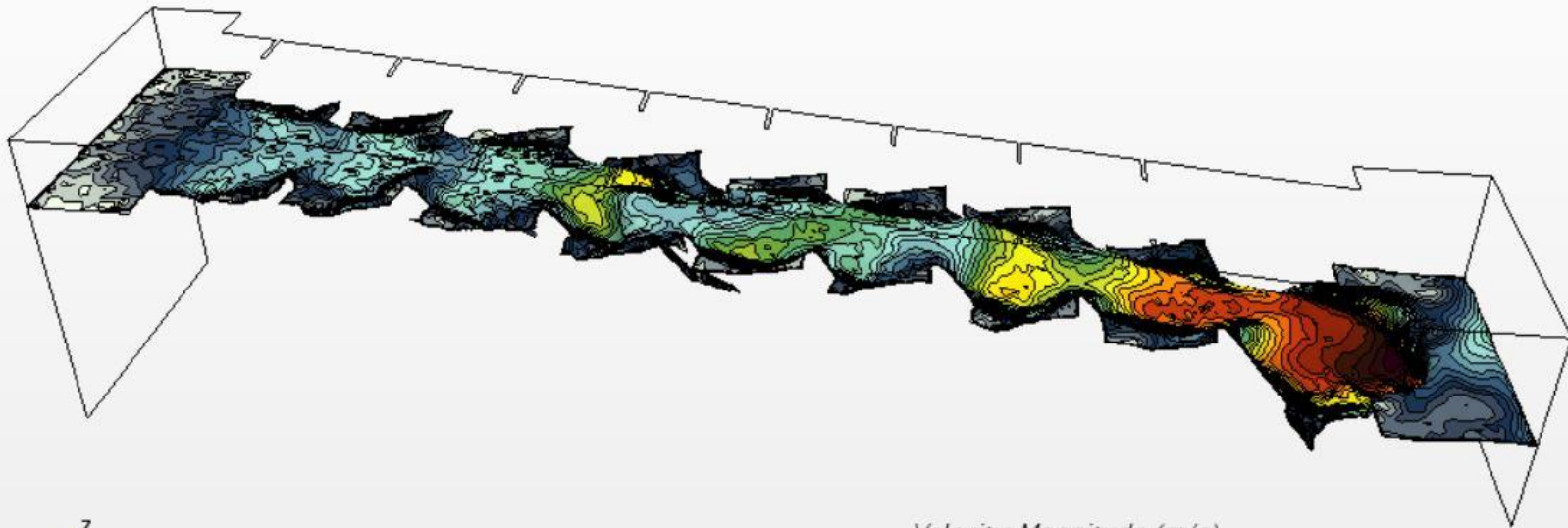


- Create CFD model of Denil fishway at Bozeman Fish Technology Center
- Use data from BFTC Denil to verify model
- Run CFD model with a half-size scaled model
- Compare turbulence in full-size and scaled model

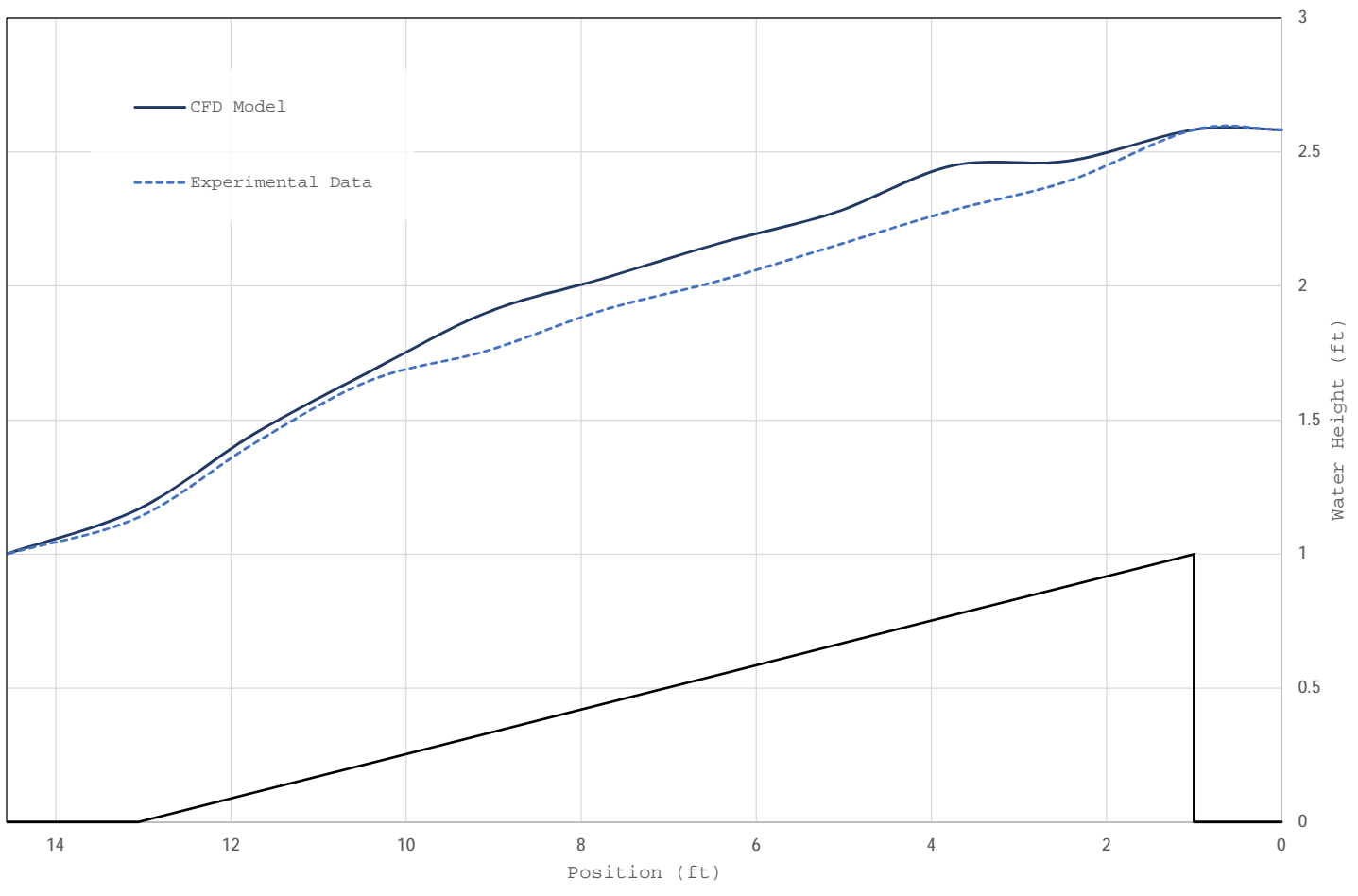
CFD Model Details

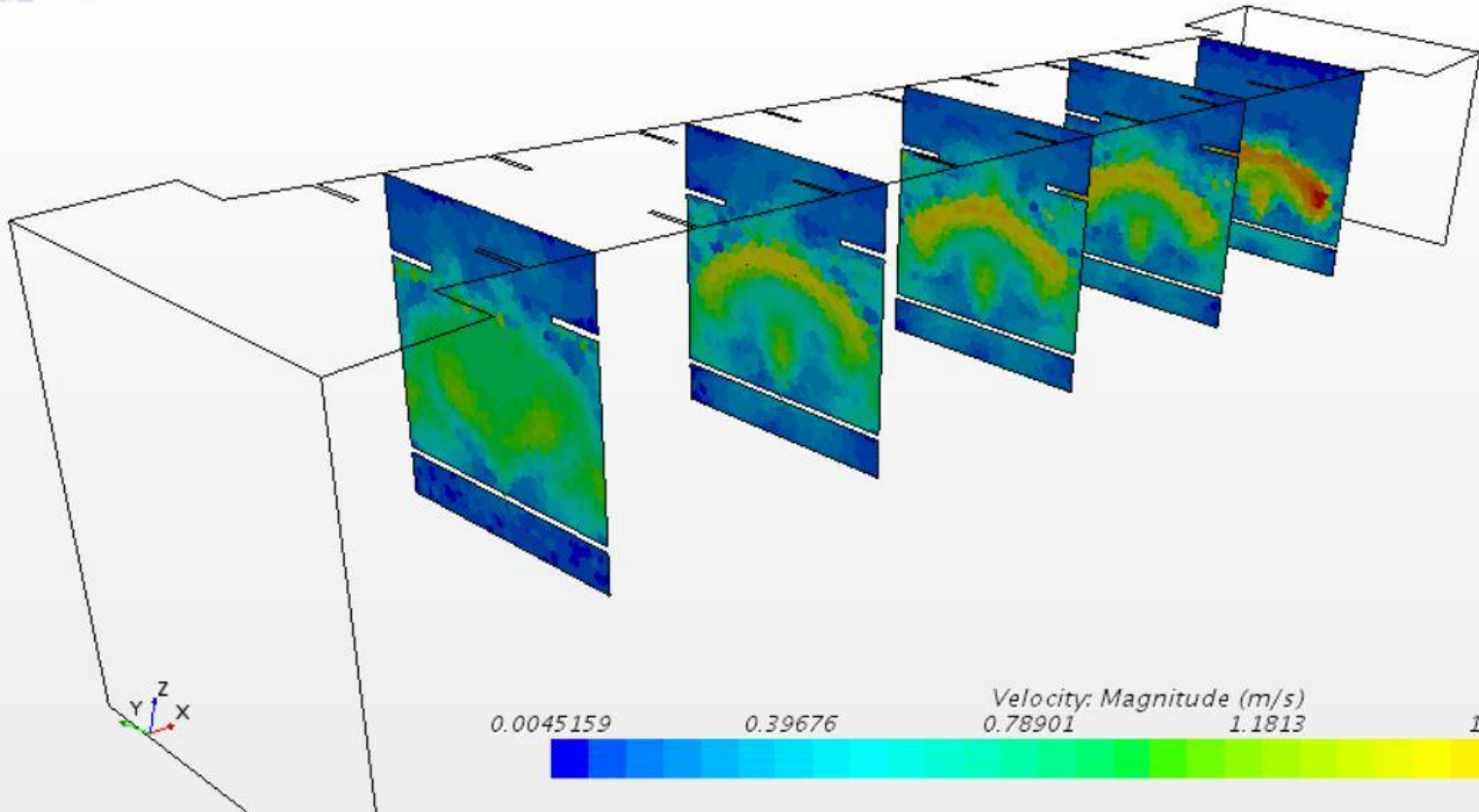
- 3D Geometry created in AutoCAD and imported to STAR-CCM+
- Boundary conditions
 - Stagnation inlet with constant water surface elevation
 - Pressure outlet at water exit and top of domain
 - Smooth no-slip walls
- Polyhedral mesh, base size 0.025 m
- Multiphase VOF, transient solution using STAR-CCM+
- Mesh dependency conducted
- Solution verified with field measurements

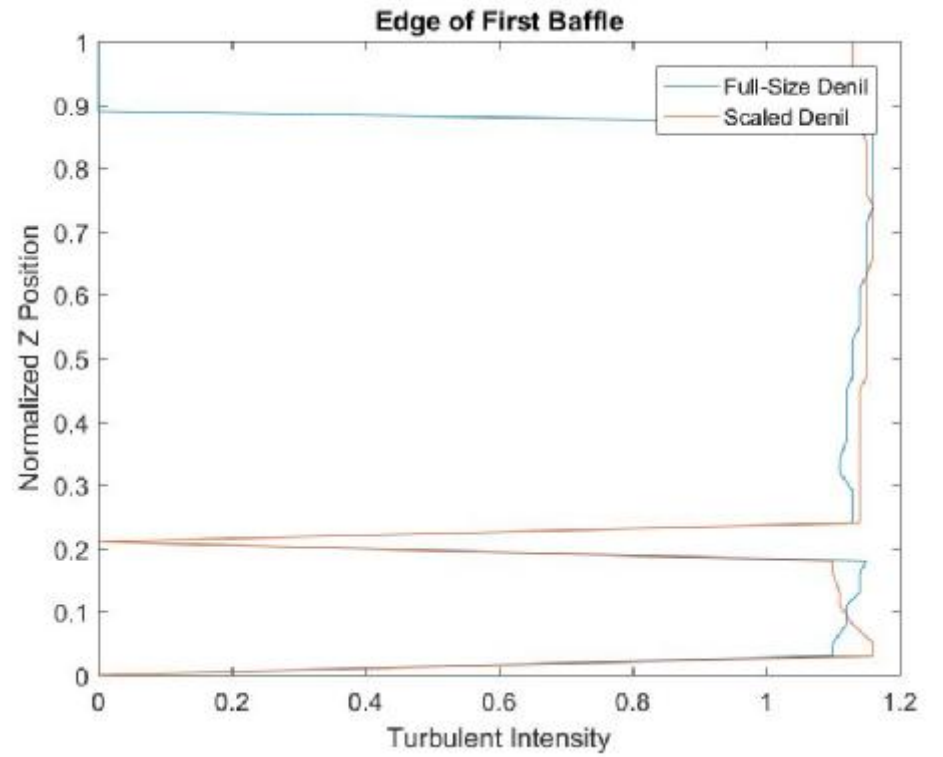
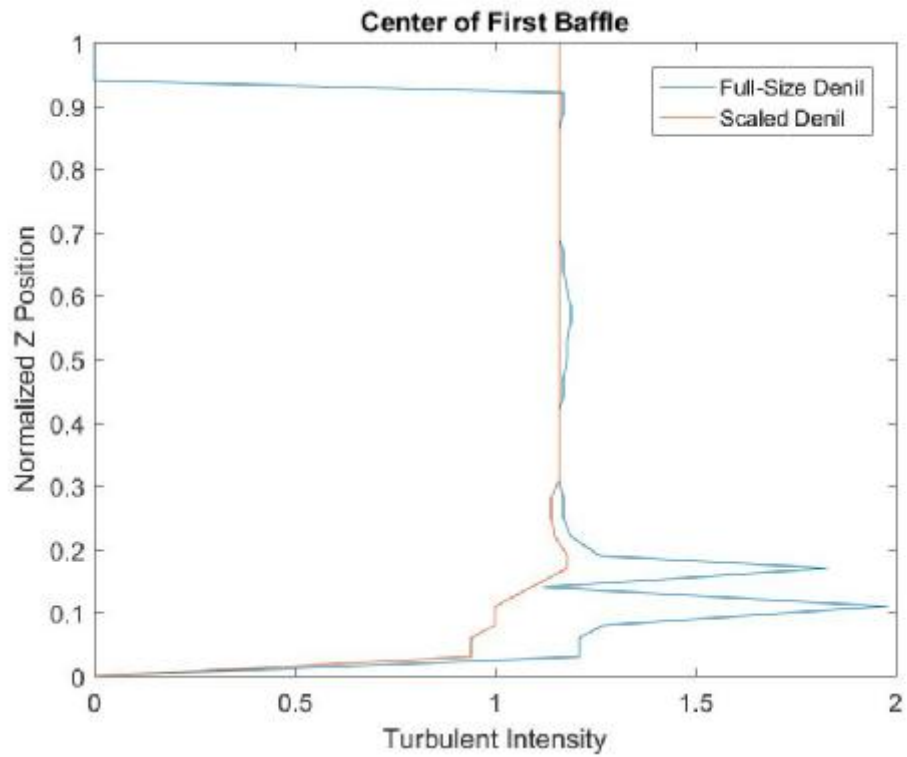


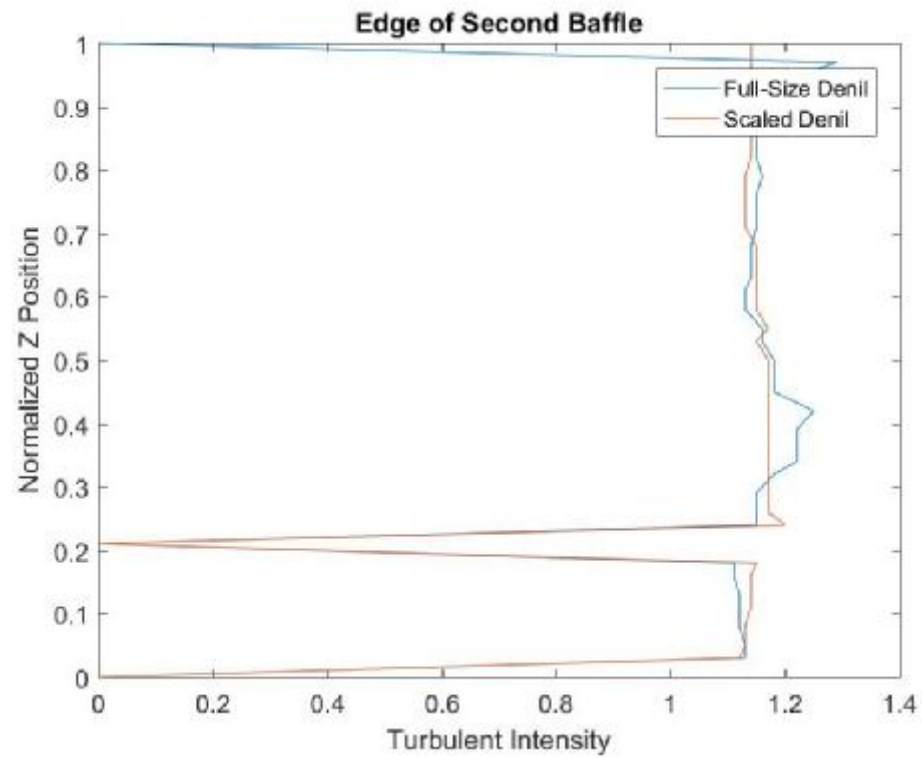
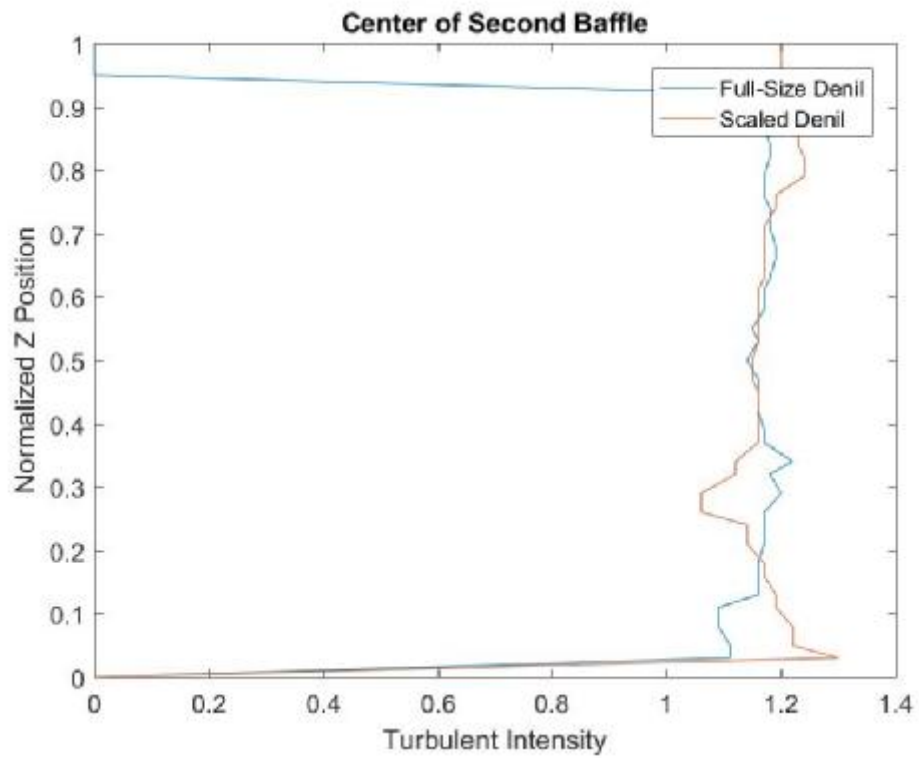


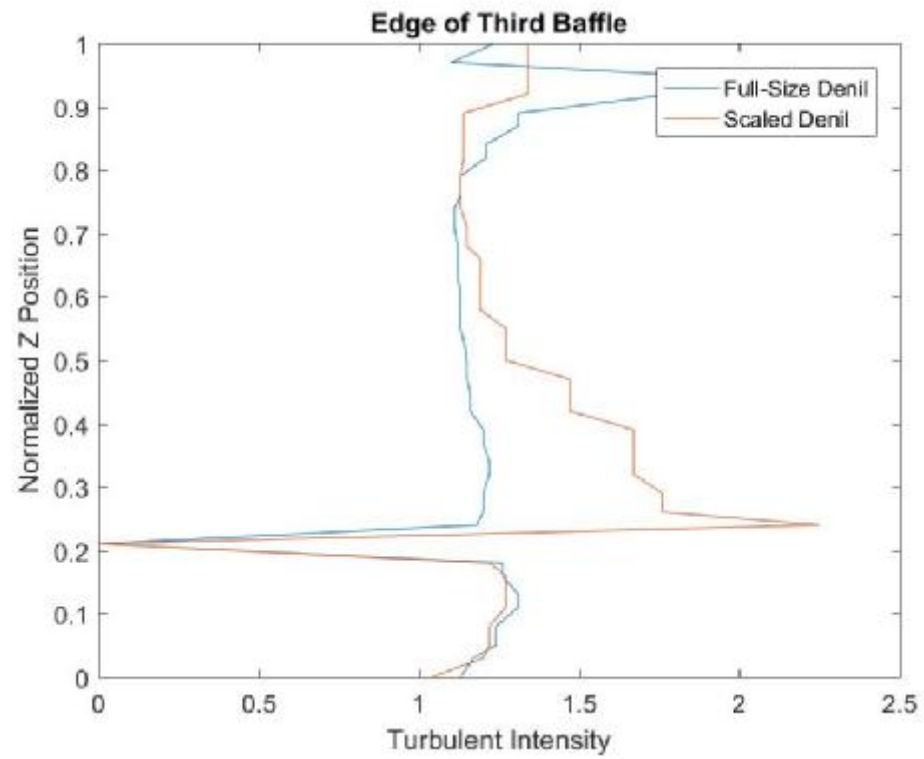
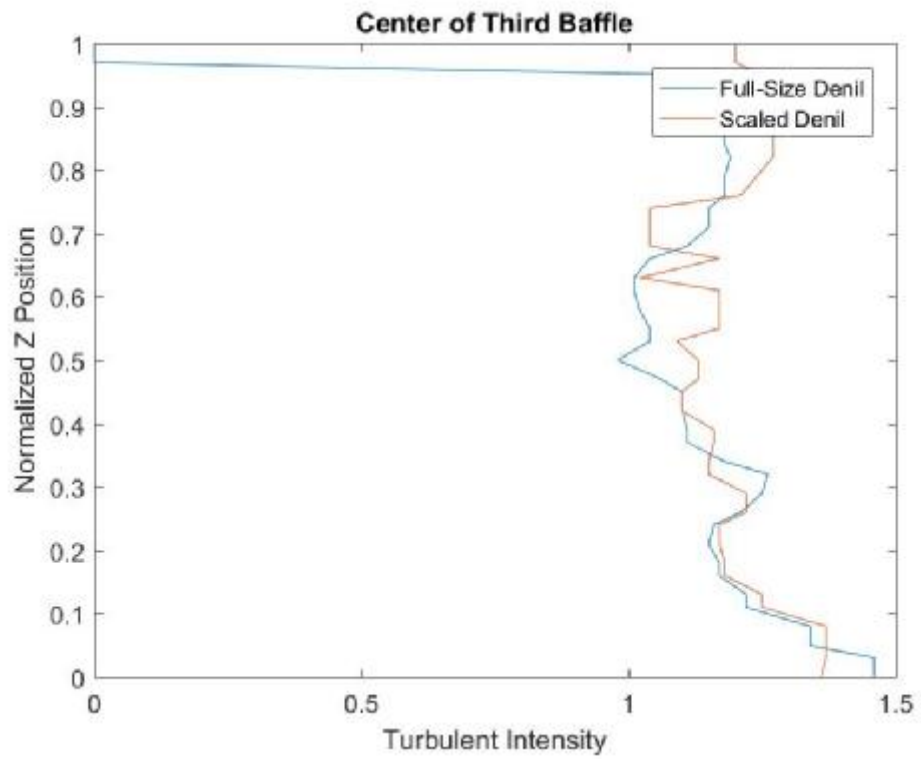
Solution Time 14.97 (s)

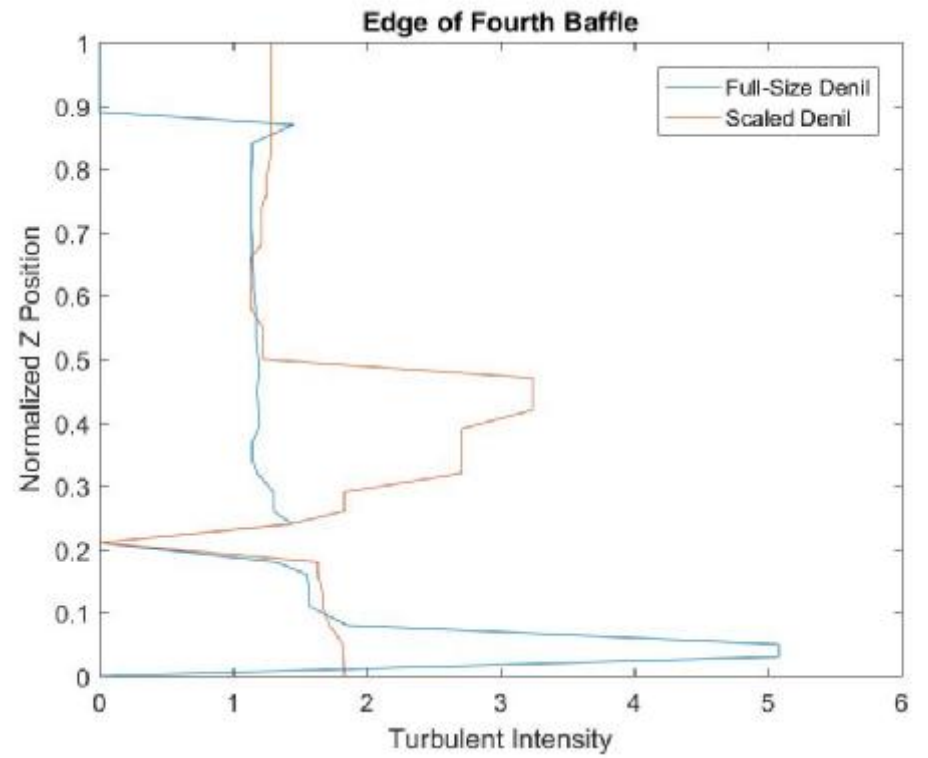
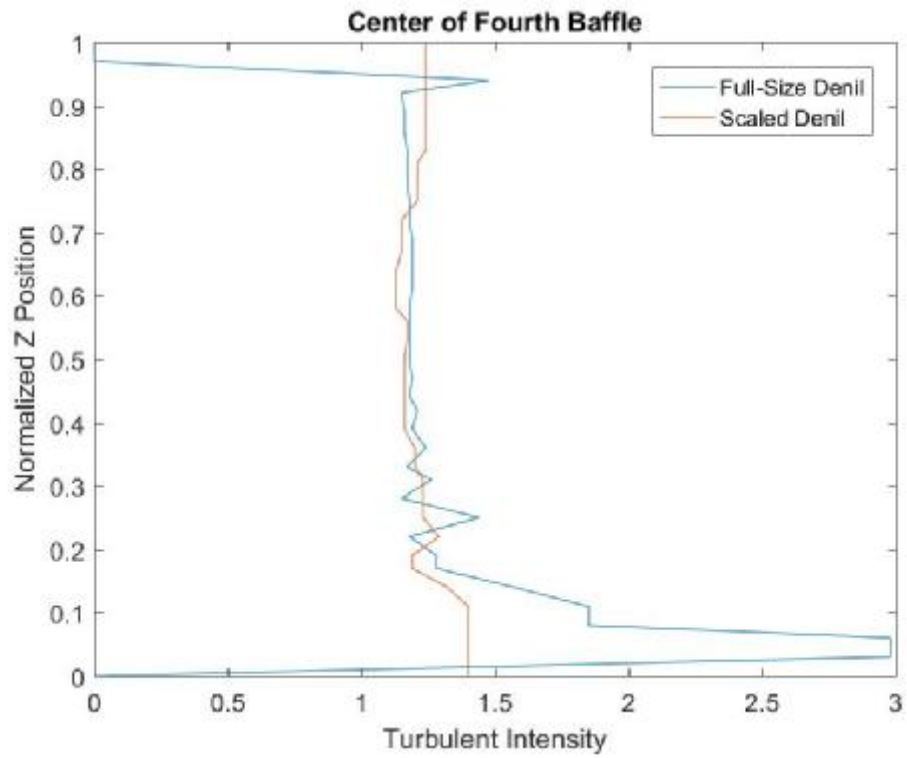












Conclusions and Future Work

- Turbulence Intensity does scale reasonable well
- Need further verification of model
- Refine mesh near walls if information about near wall is required
- Run simulations for all up/down head combinations for behavioral study

Partners and Funders

- Plains and Prairie Potholes LLC of the United States Fish and Wildlife Service
- Western Transportation Institute at Montana State University
- Bozeman Fish Technology Center of the United States Fish and Wildlife Service
- Ecology Department at Montana State University
- Department of Civil Engineering at Montana State University
- Montana Fish, Wildlife and Parks
- Turner Enterprises Incorporated
- Trout Unlimited
- Gallatin National Forest of the United States Forest Service
- Montana Chapter of the American Fisheries Society
- Montana Department of Transportation
- USFWS Region 6 Fish Passage Program



MONTANA
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College of
ENGINEERING

Western Transportation Institute

Please contact me if you are interested in collaborating or studying with our group.

I'm currently seeking an additional MS (thesis option) or PhD student.....

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