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Arctic Grayling and Denil Fishways: A Study to Determine How Water Depth Affects Passage Success

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Denil in Field


Denil in Lab

- Erin Ryan, BFTC-USFWS
- Matt Blank, WTI-MSU
- Kevin Kappenman, BFTC-USFWS
- Owen Dudley, MSU

Arctic Grayling and Denil Fishways
Thanks to Funders, Partners and Key People

Ø Key Agencies and Partners

- AGRP
- USFWS
- BFTC
- MSU, Civil Engineering Department
- MSU, Ecology Department
- MSU, Western Transportation Institute
- Montana FWP
- Montana DNRC
- NRCS
- Private Landowners
- Others

Ø Key People

- Emma Cayer
- Jim Magee
- Mike Roberts
- Jacqueline Knutson
- Kale Gullet
- Steve Becker
- Bob Muth
- Bill Rice
- Matt Toner
- Jason Ilgen
- Buddy Drake

Study Purpose and Background

Arctic Grayling and Denil Fishways
Purpose


Denil in Field

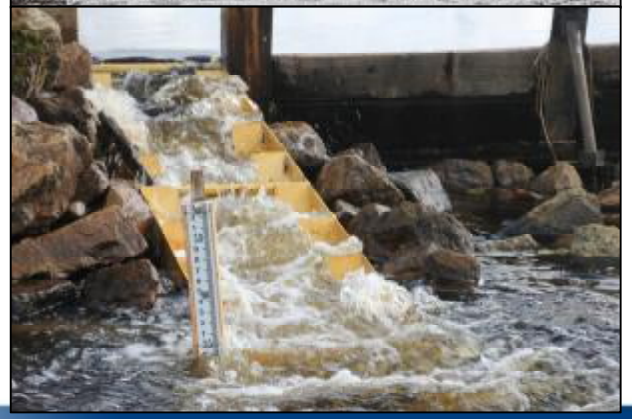

Denil in Lab

The purpose for this study was to determine the **optimum water depth or depth range** for passage of Arctic grayling through Denil fishways.

Knowing what depths provide the “best” passage will **help manage the operation** of the fishways - especially during water limited periods.

Arctic Grayling and Denil Fishways Background

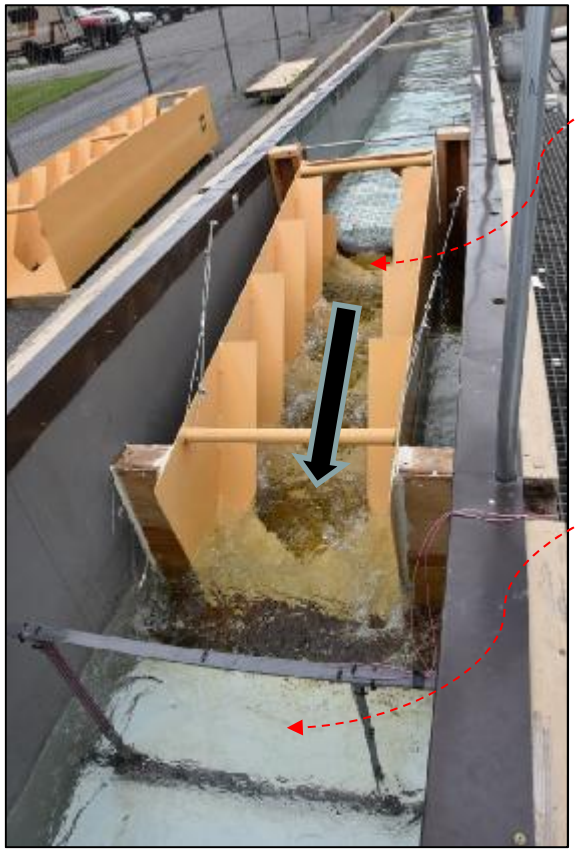
- Present field installations use either 6-foot or 12-foot long ladders set with a 1-foot vertical drop.
- There are 63 installed in Big Hole, with plans for more.
- The Denils are a type of “Simple” Denil.



Methods

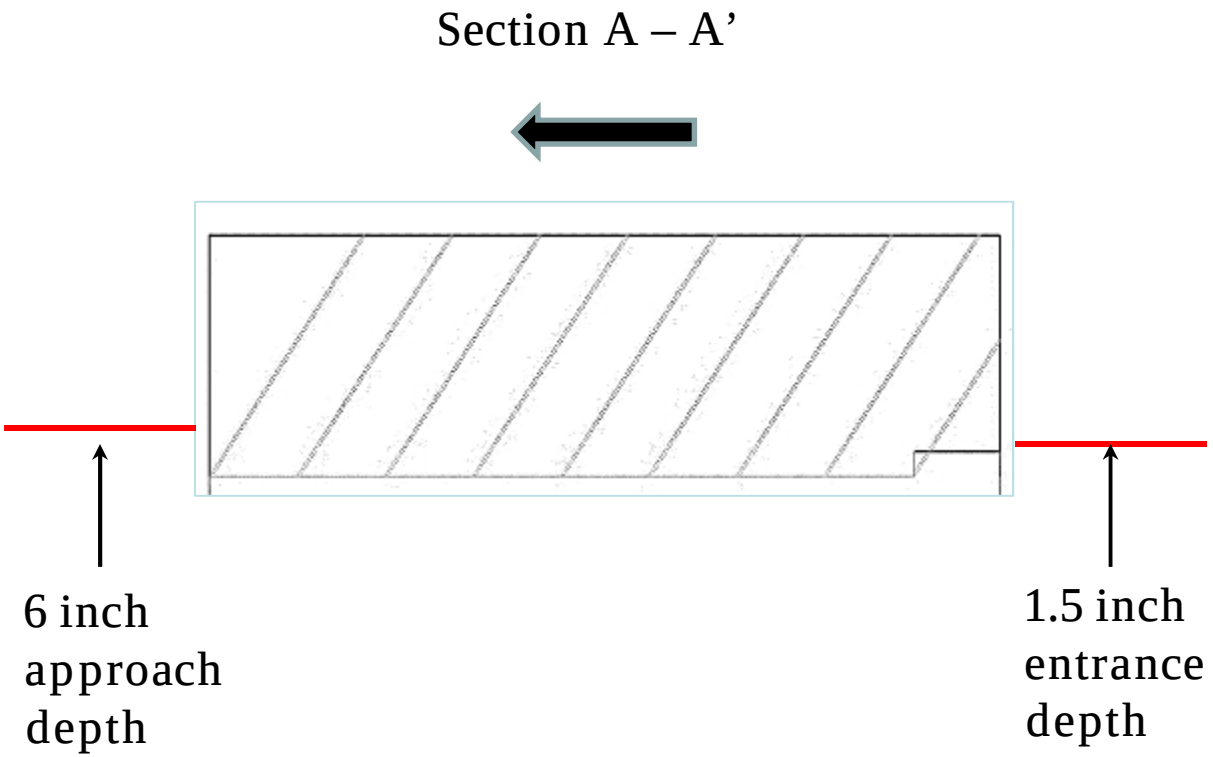
Arctic Grayling and Denil Fishways Methods

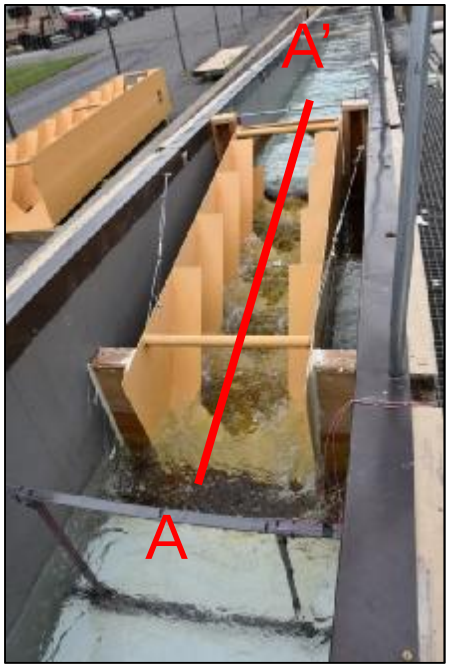
- Target for each length (6- and 12 foot):
  - 18 treatments per ladder
  - 3 different water depths at approach (6, 12, and 18 inches)
  - 6 depths at first notch for each approach depth (1.5, 2.5, 4, 6, 10 and 14 inches)
  - One control without ladder



*Arrow is flow direction.

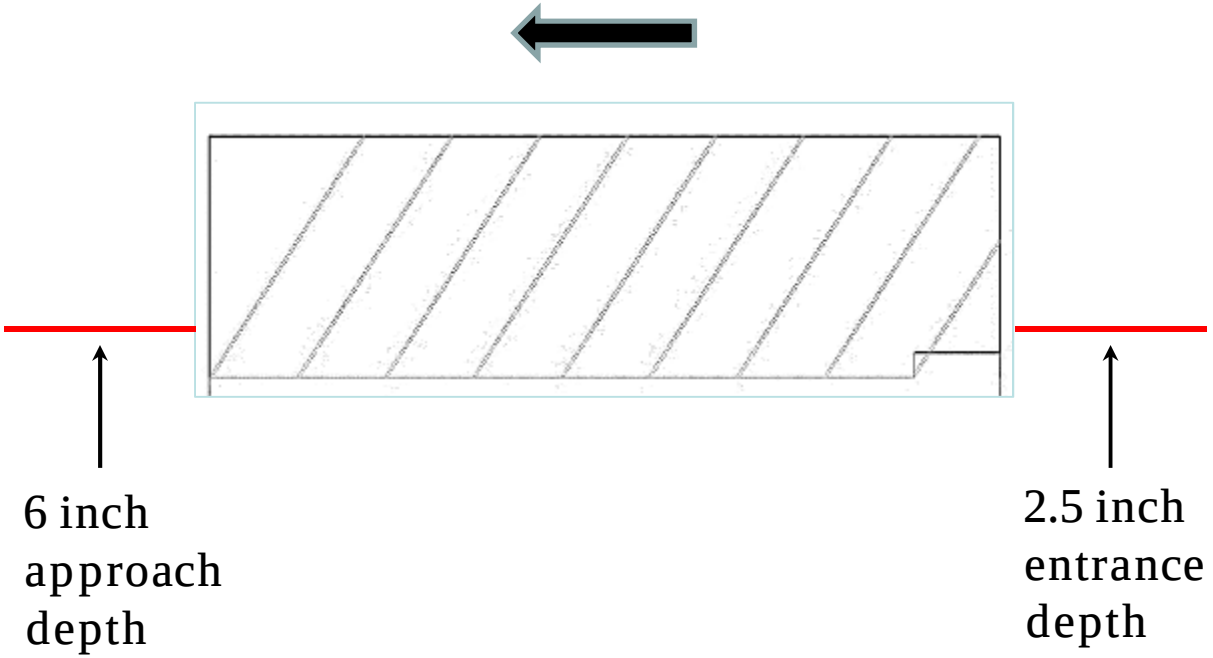
Arctic Grayling and Denil Fishways Methods

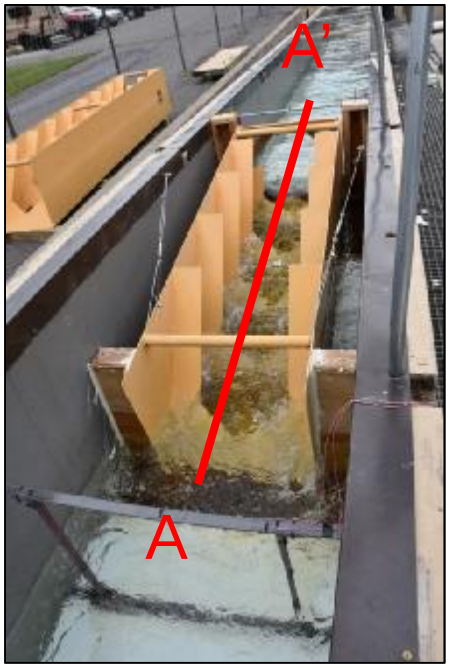




Arctic Grayling and Denil Fishways Methods

Section A – A’





Arctic Grayling and Denil Fishways Methods

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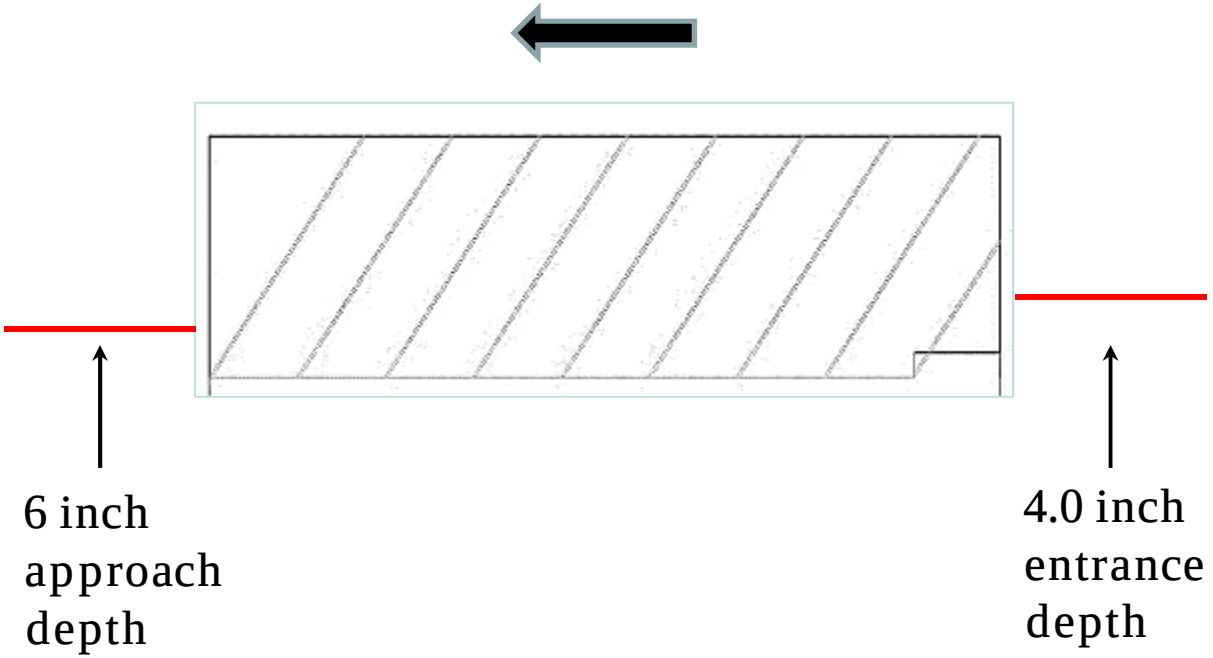

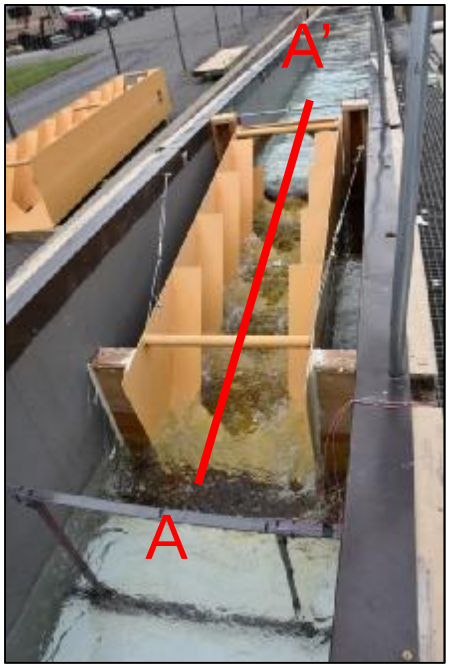

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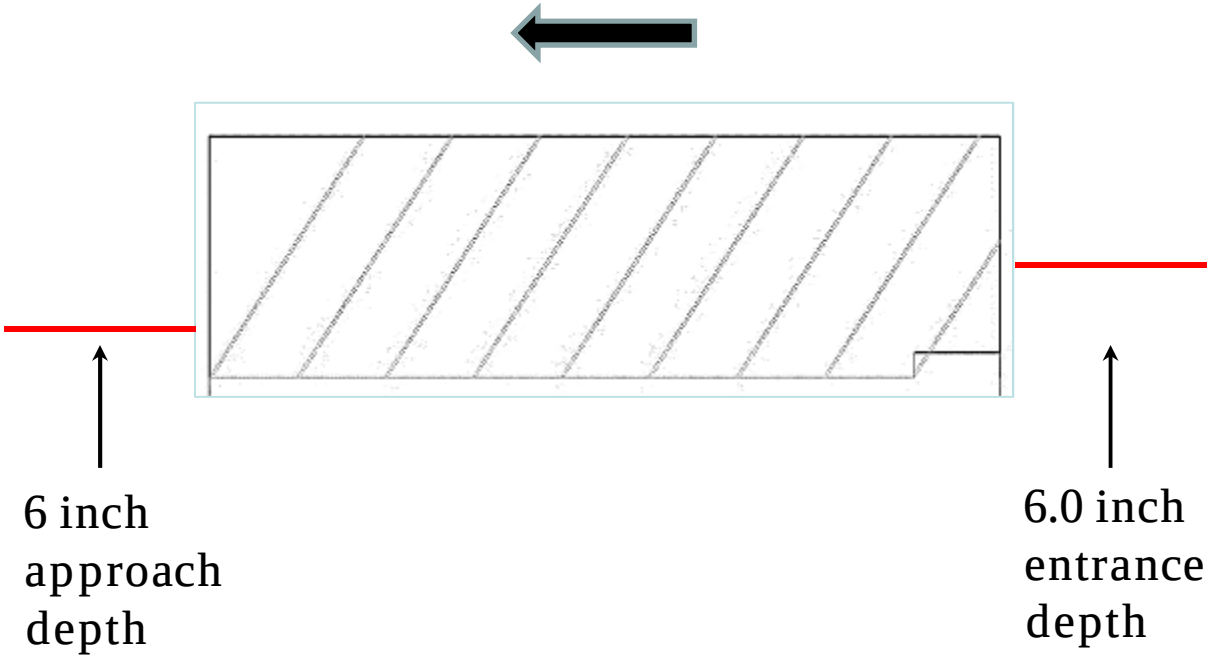

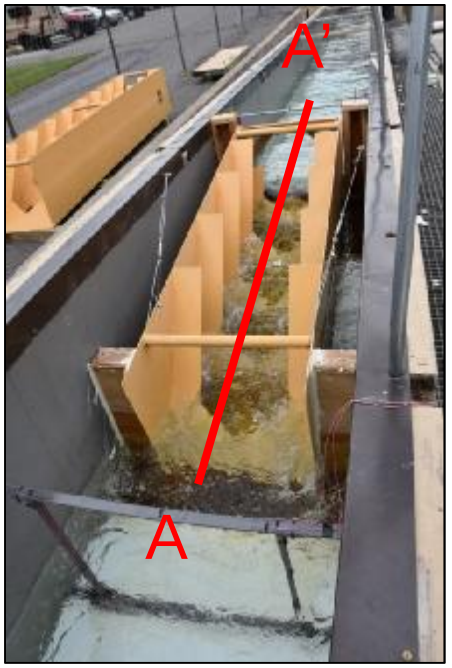

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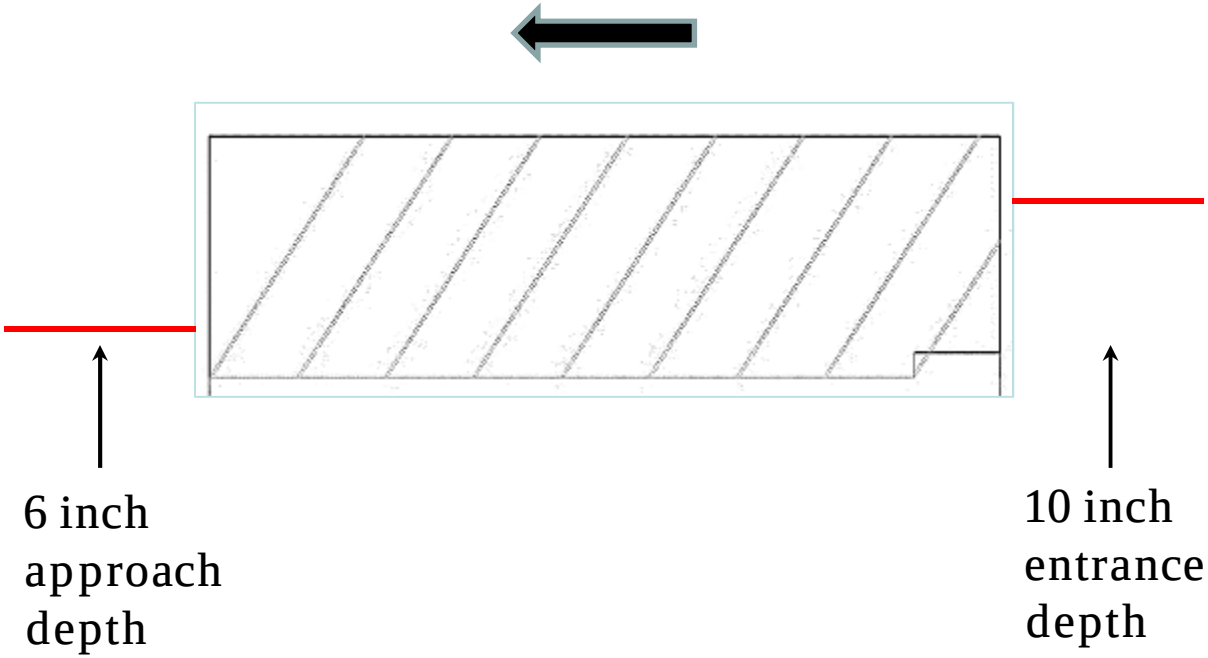

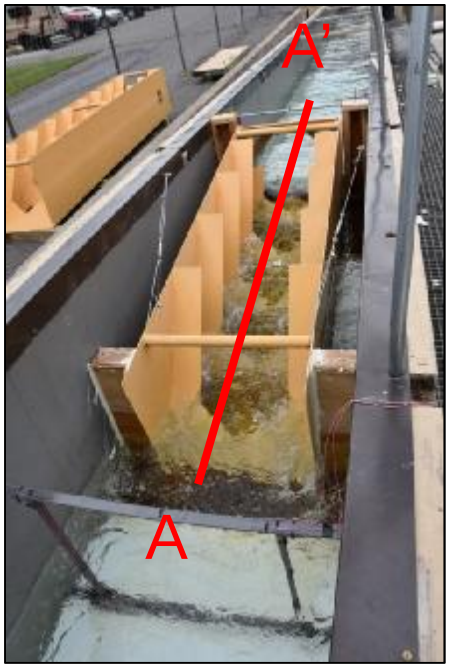

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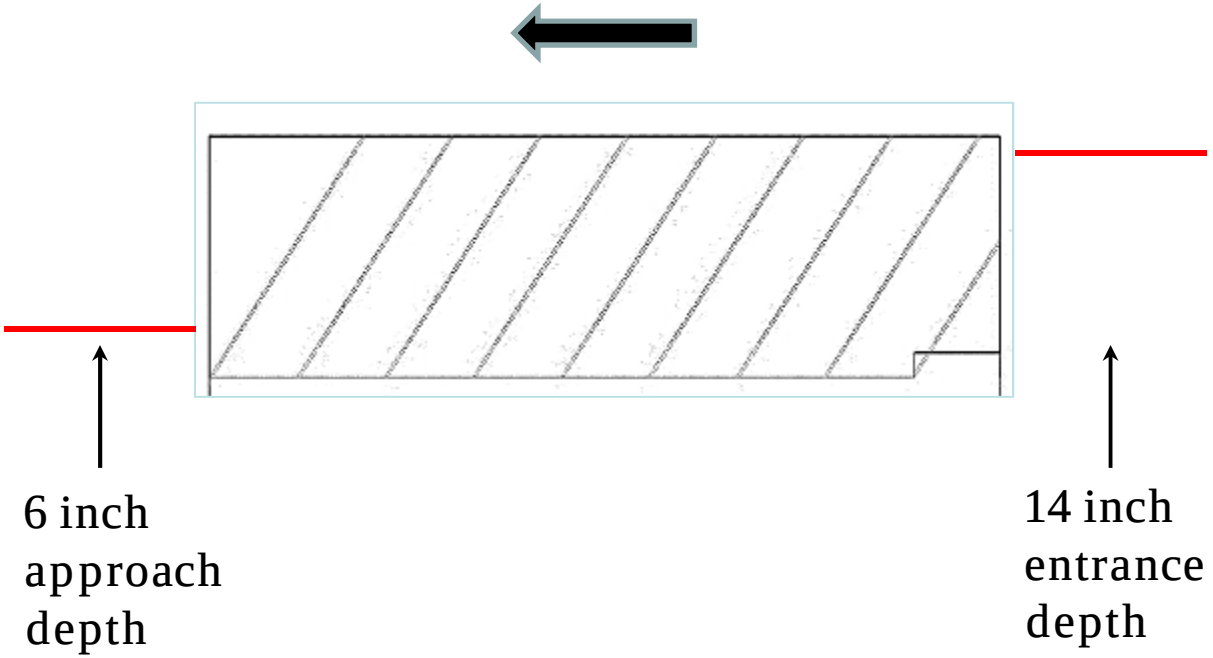
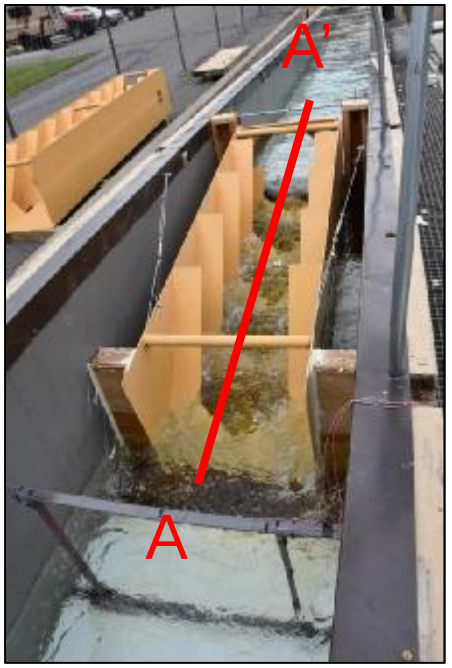


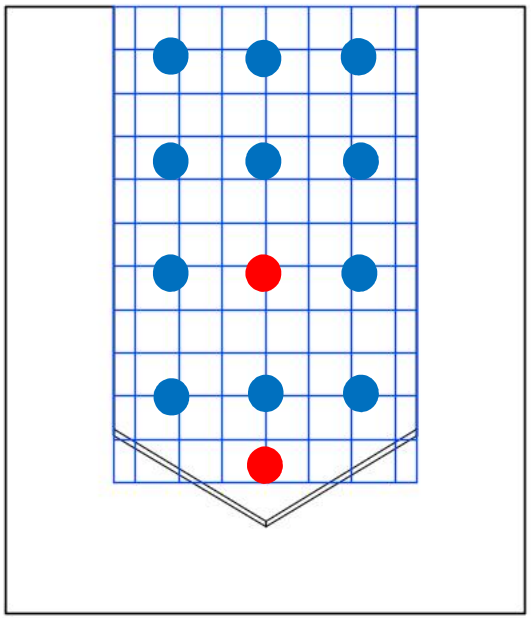


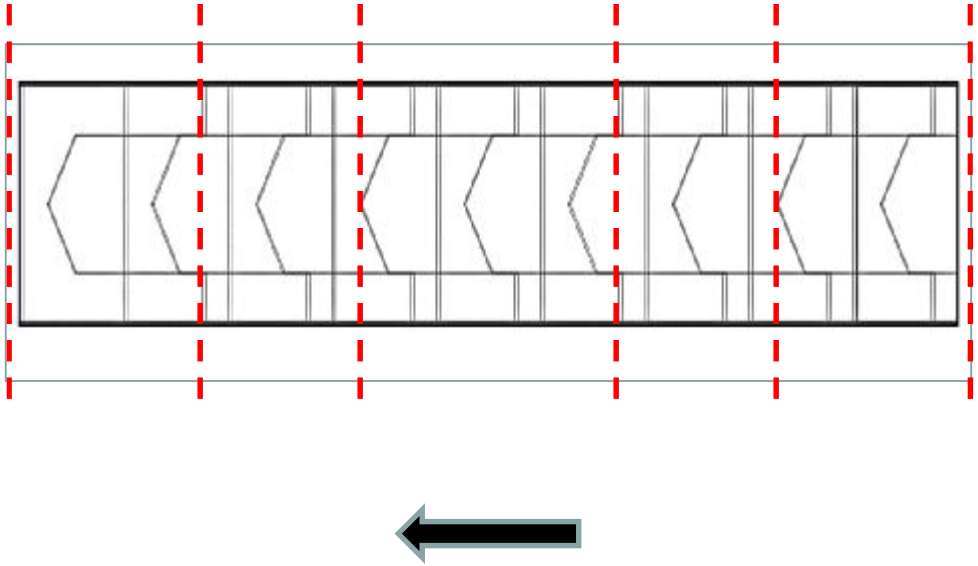
Arctic Grayling and Denil Fishways Methods

- Grayling were raised at BFTC. Fish were same size class, ~12 inches.
- Fish movements recorded by PIT array and video cameras. Ten fish per treatment.
- 2 hours per treatment. Time based on pilot studies and volitional study (2015).
- All treatments done at ~12 C (optimum temperature for grayling).

Arctic Grayling and Denil Fishways Methods

- Characterized hydraulic environment by collecting water depths, velocities, and stage heights. Monitored flow and temperature





*Arrow is flow direction.

Arctic Grayling and Denil Fishways Analysis

- Characterized flow environment using hydraulic computations and modeling
- Evaluated data using basic statistics
- Developed logistic regression models

Arctic Grayling and Denil Fishways Analysis

- Analysis focused on exploring relationships between passage success and:
  - Water depth
  - Water depth ratios
  - Velocities
  - Flow

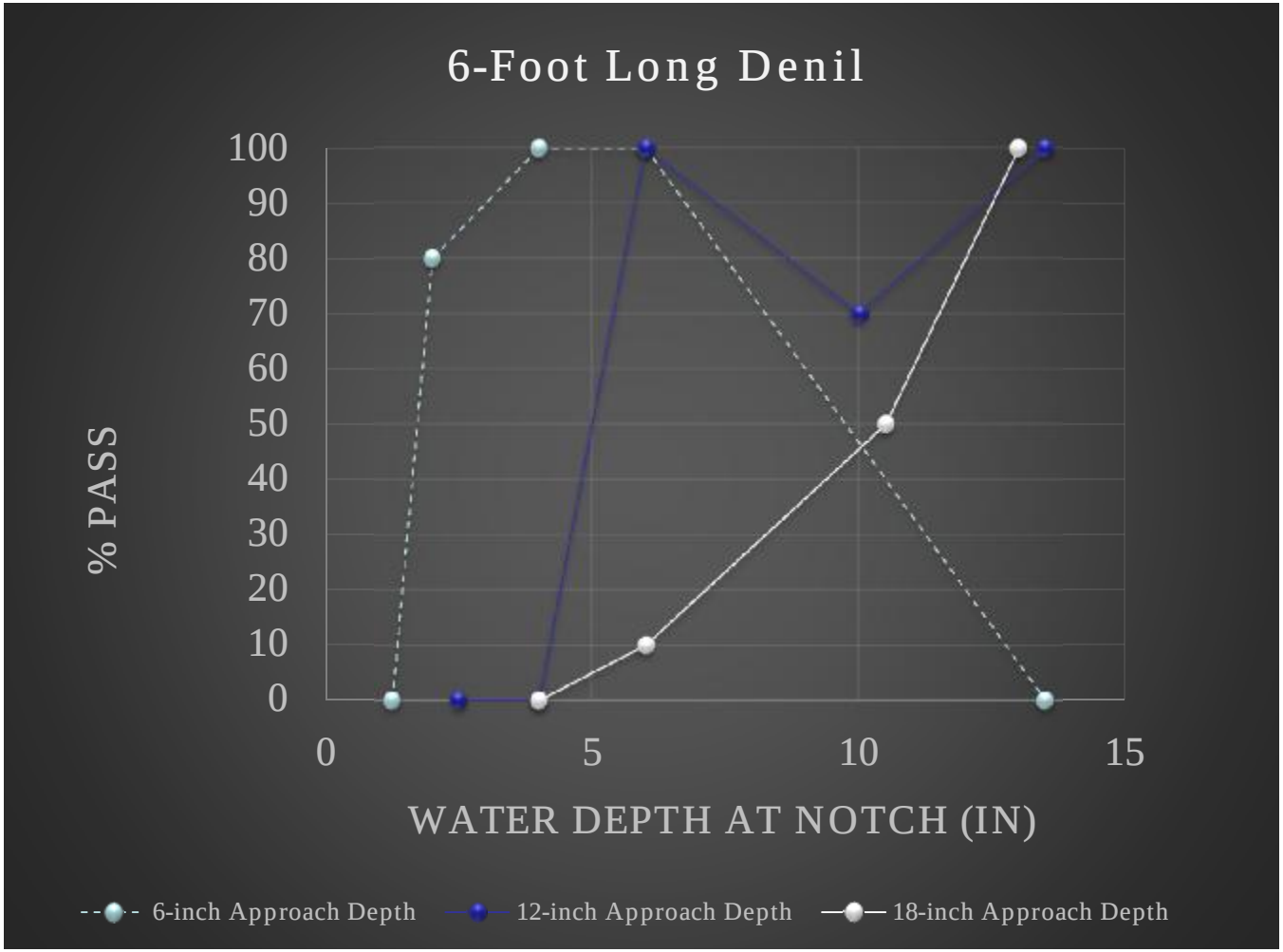
Results

Arctic Grayling and Denil Fishways Results

Ø In the 6-foot Denil

- § 130 grayling attempted passage
- § 71 passed (55%)
- § 59 failed (45%)

Arctic Grayling and Denil Fishways Results



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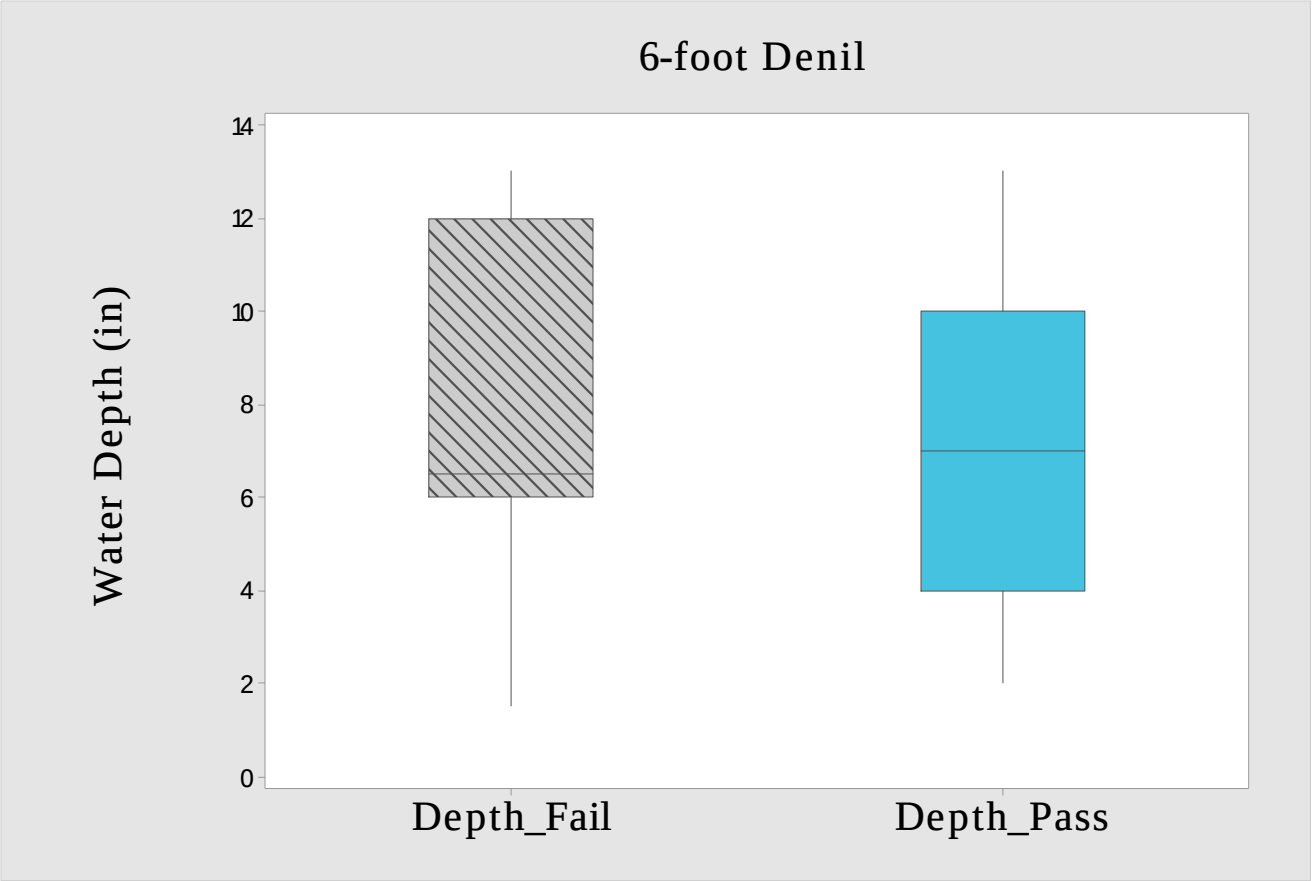

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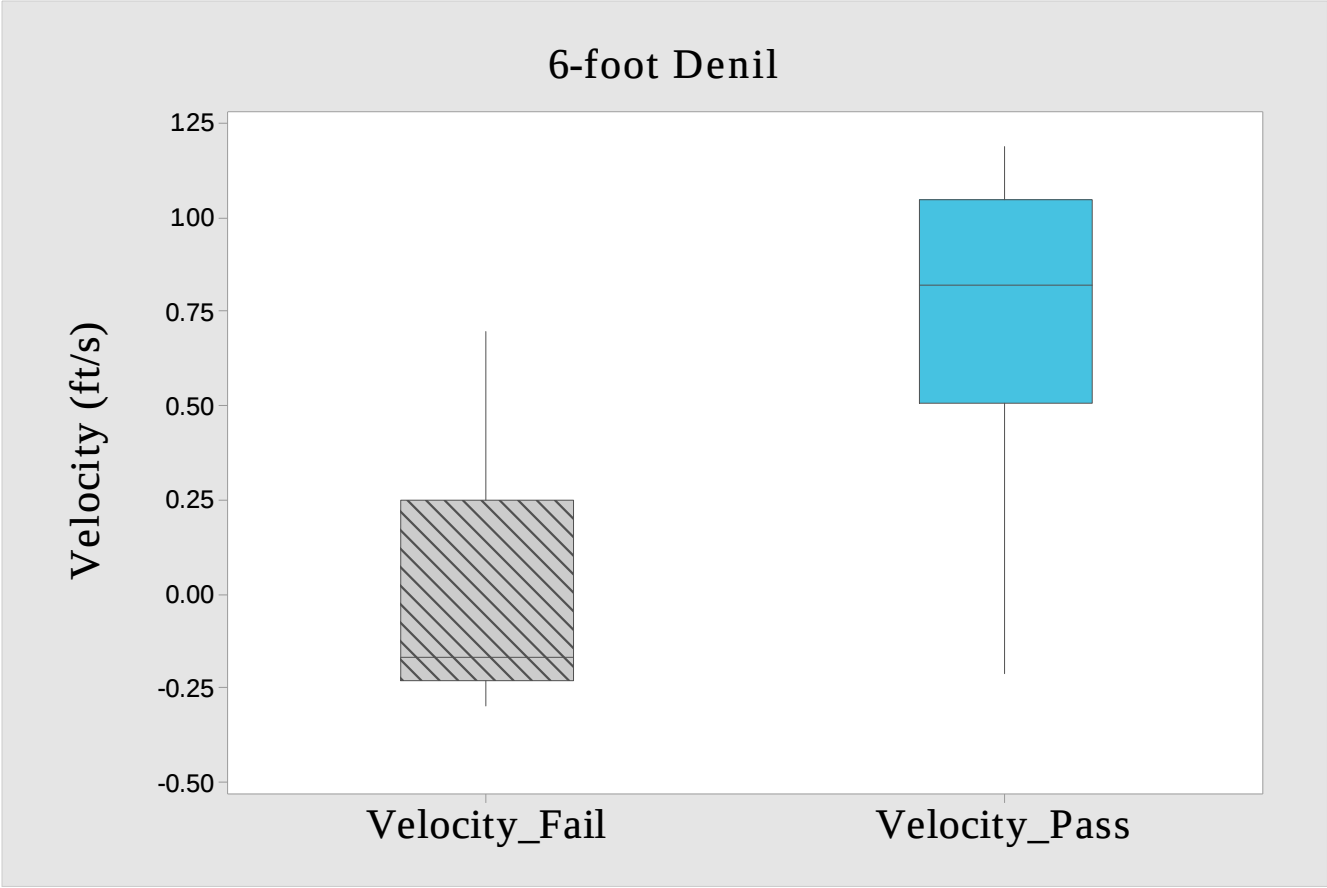
Arctic Grayling and Denil Fishways Results



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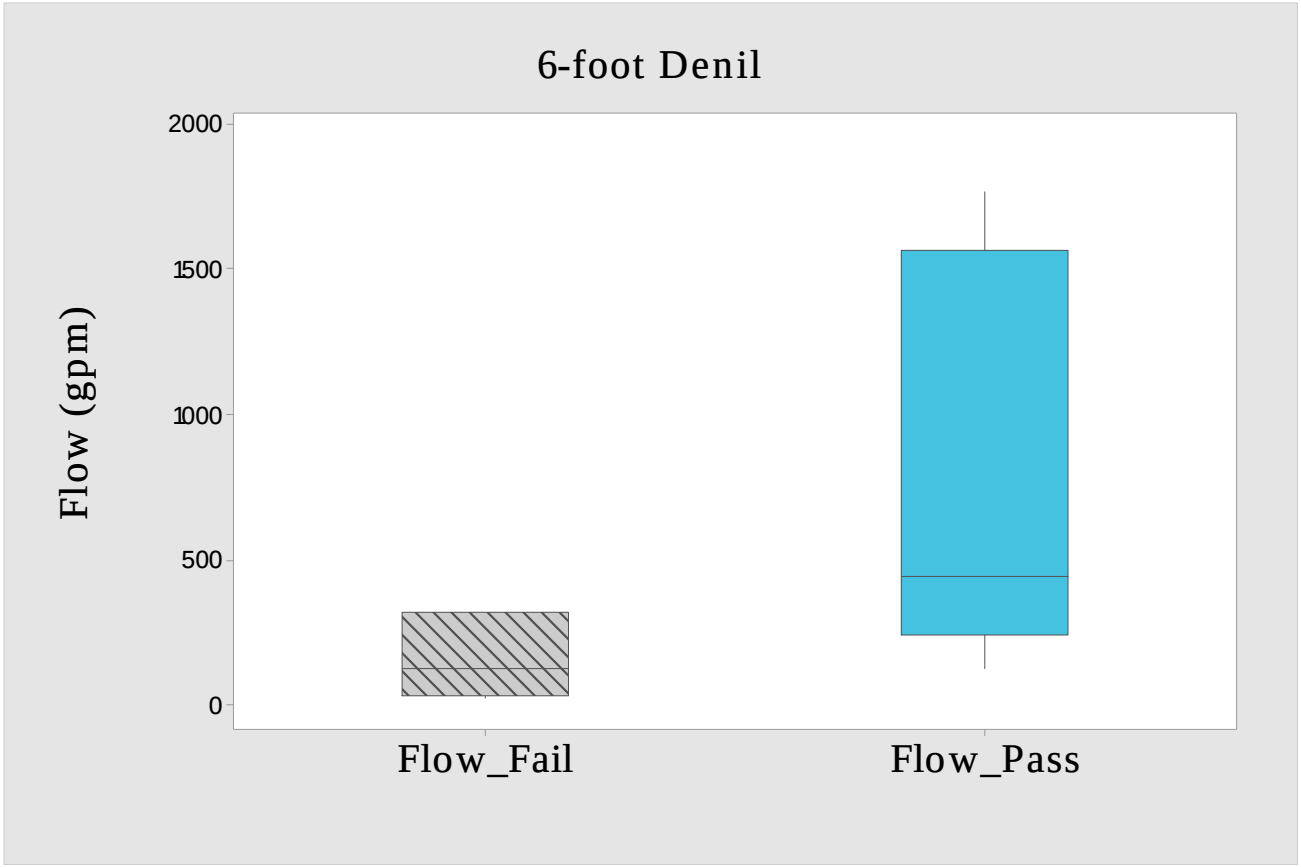
Arctic Grayling and Denil Fishways Results



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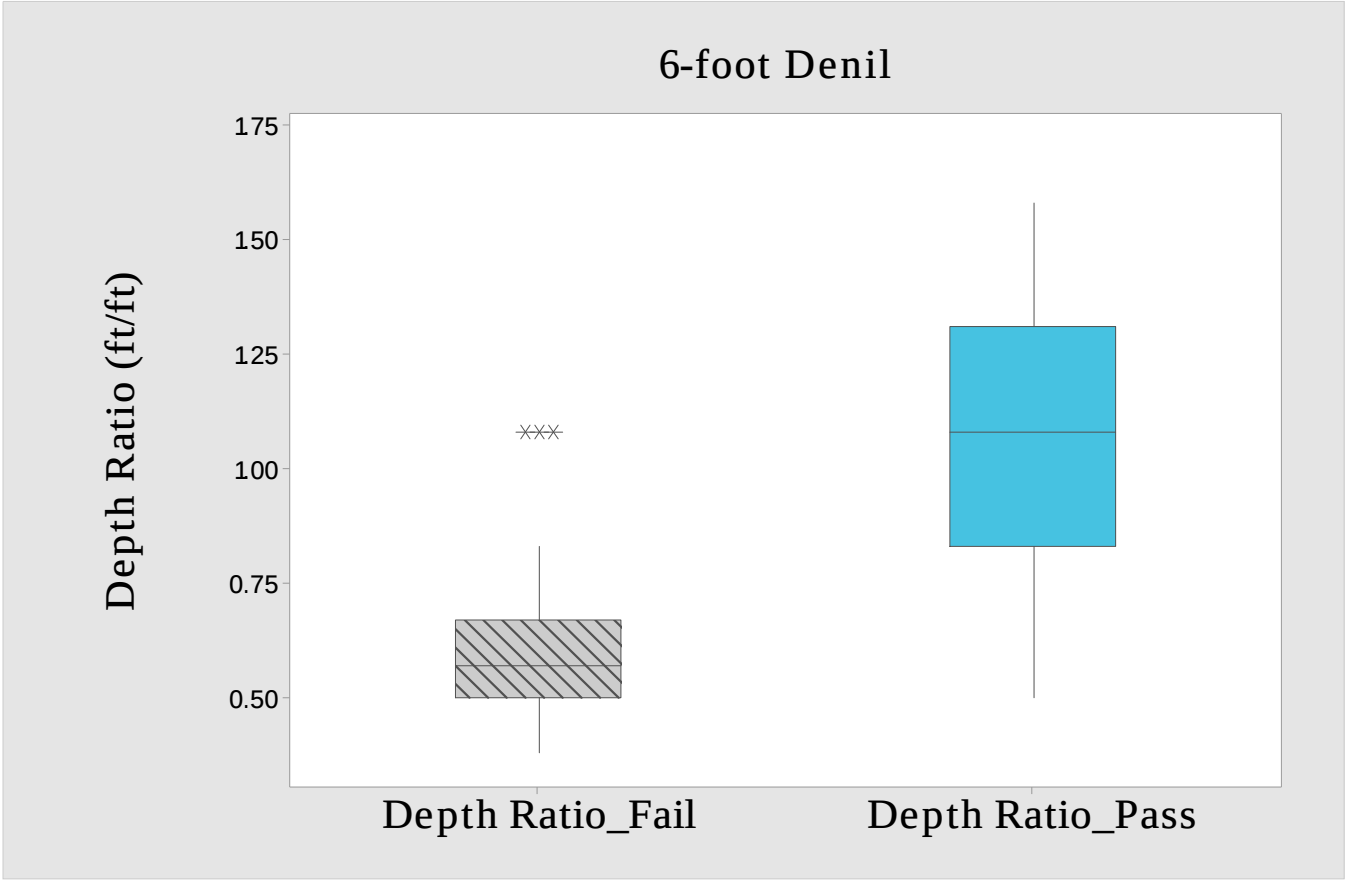

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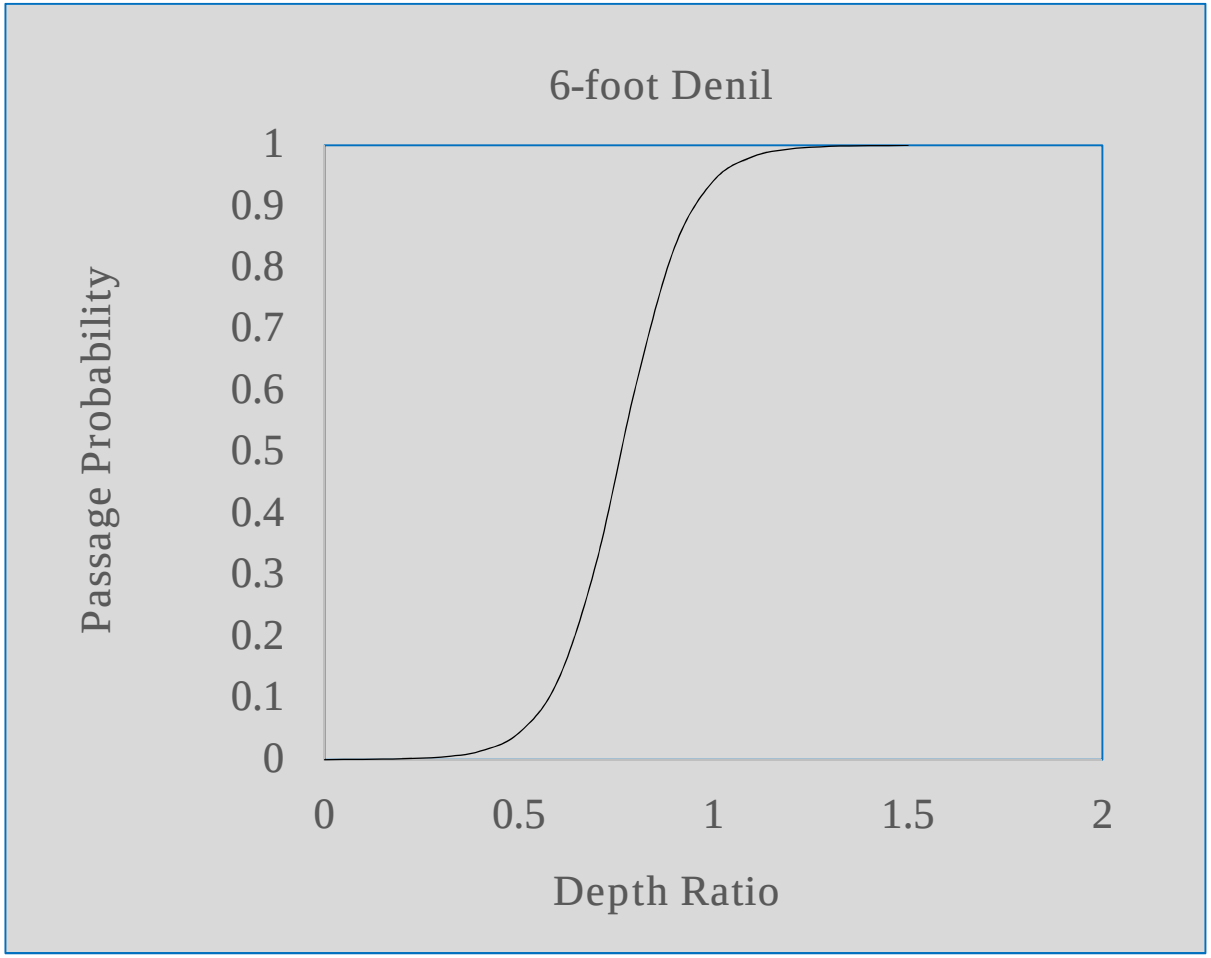


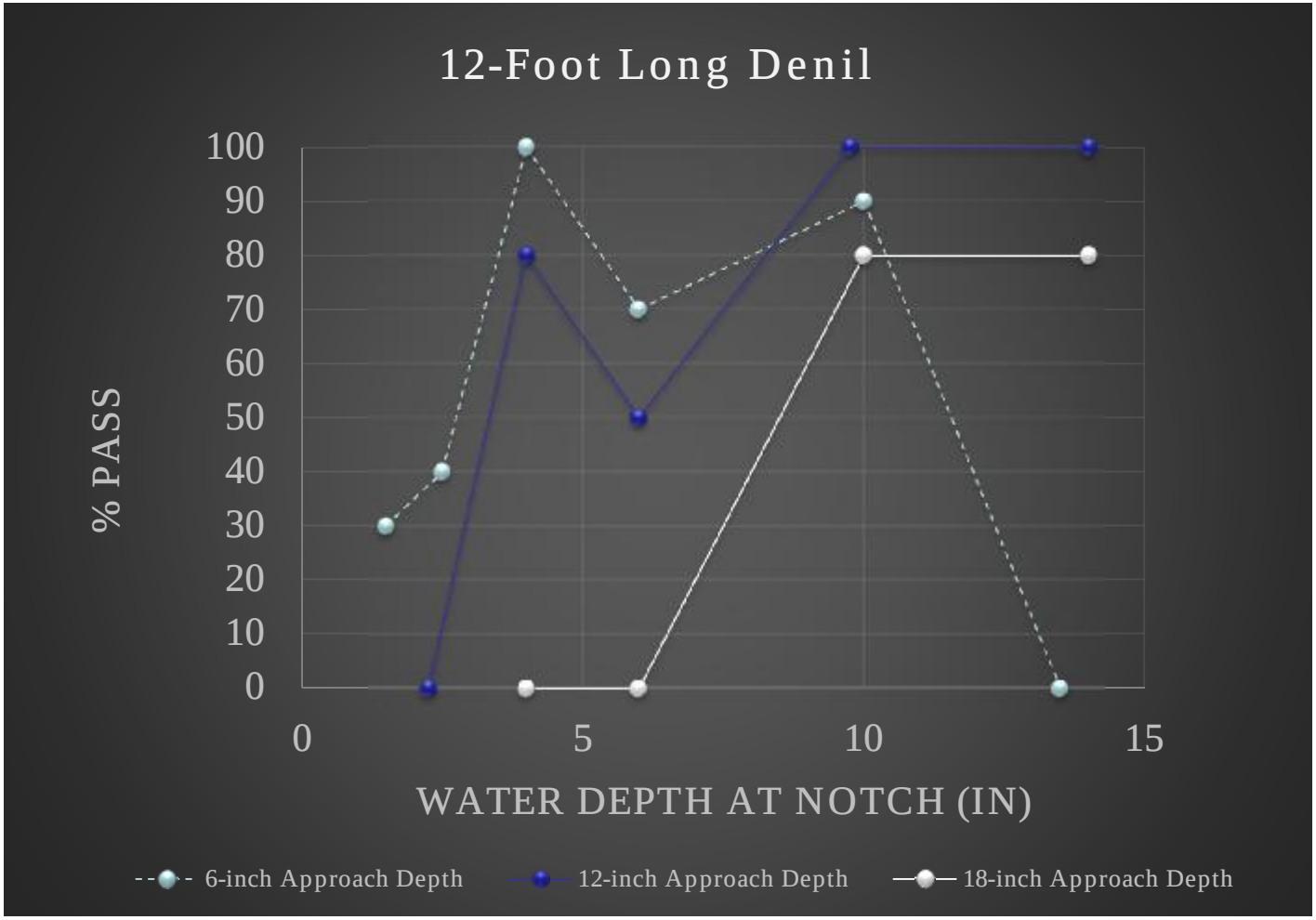
- Model correctly predicted passage success 95%
- Incorrectly predicted passage success 5%

Arctic Grayling and Denil Fishways Results

Ø In the 12-foot Denil

- 138 grayling attempted passage
- 82 passed (59%)
- 56 failed (41%)

Arctic Grayling and Denil Fishways Results



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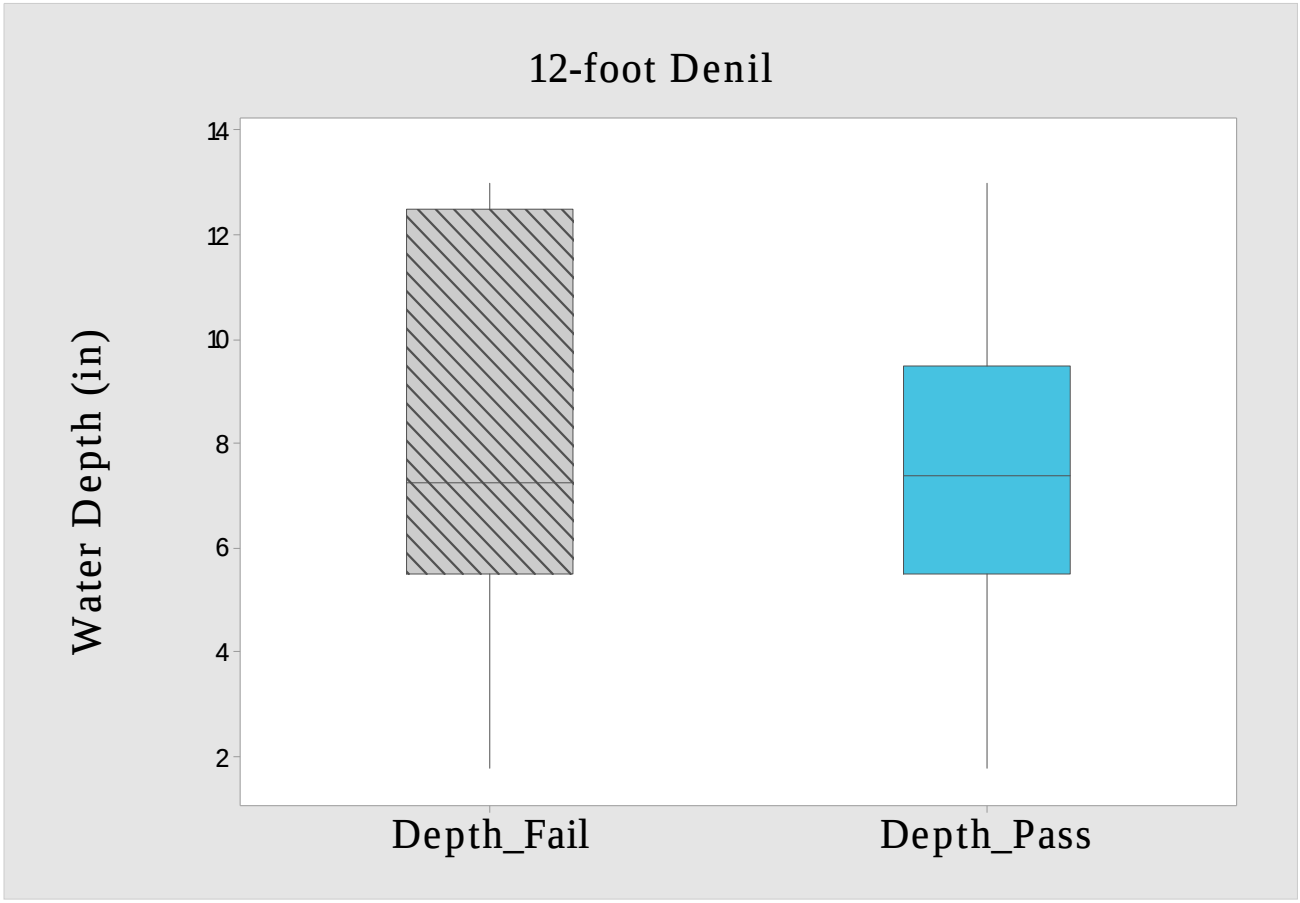

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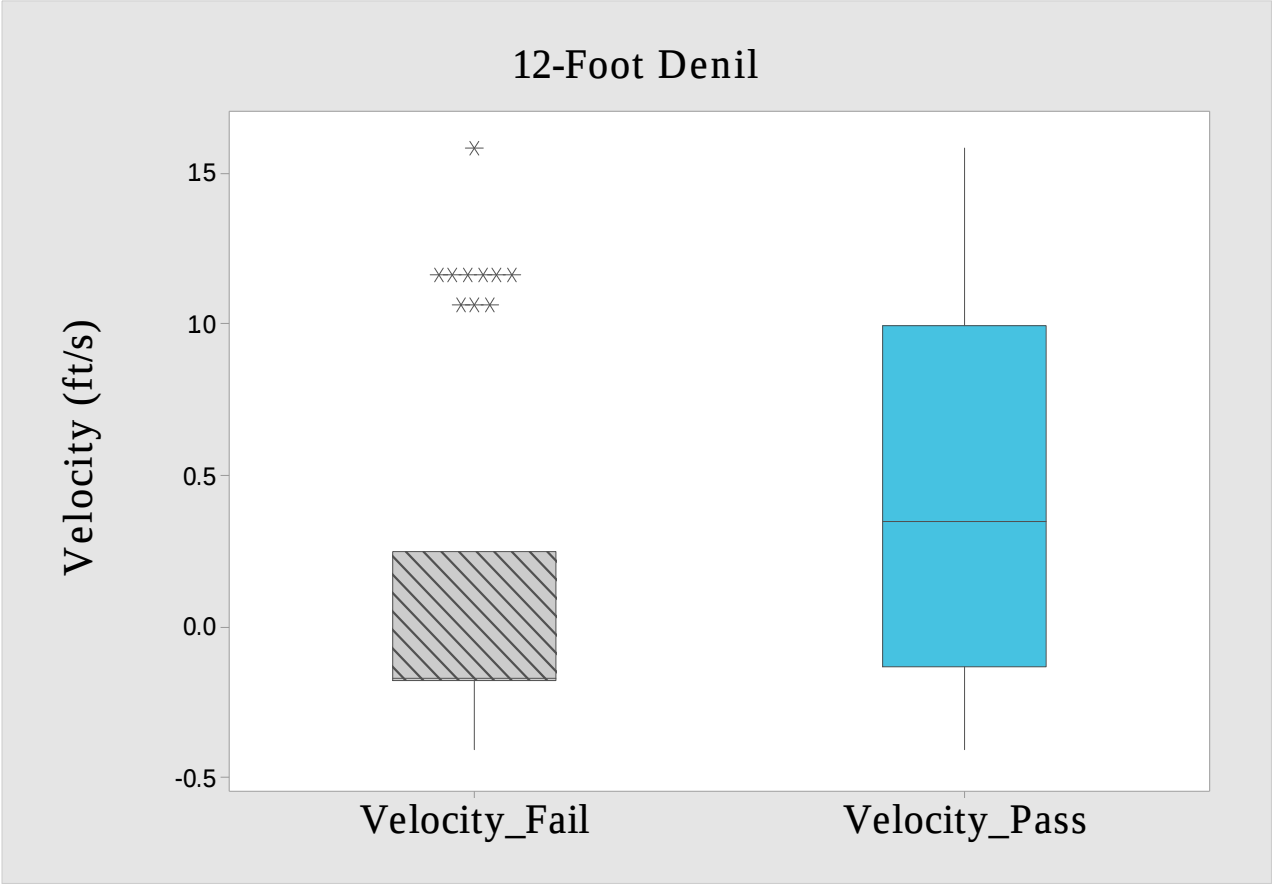

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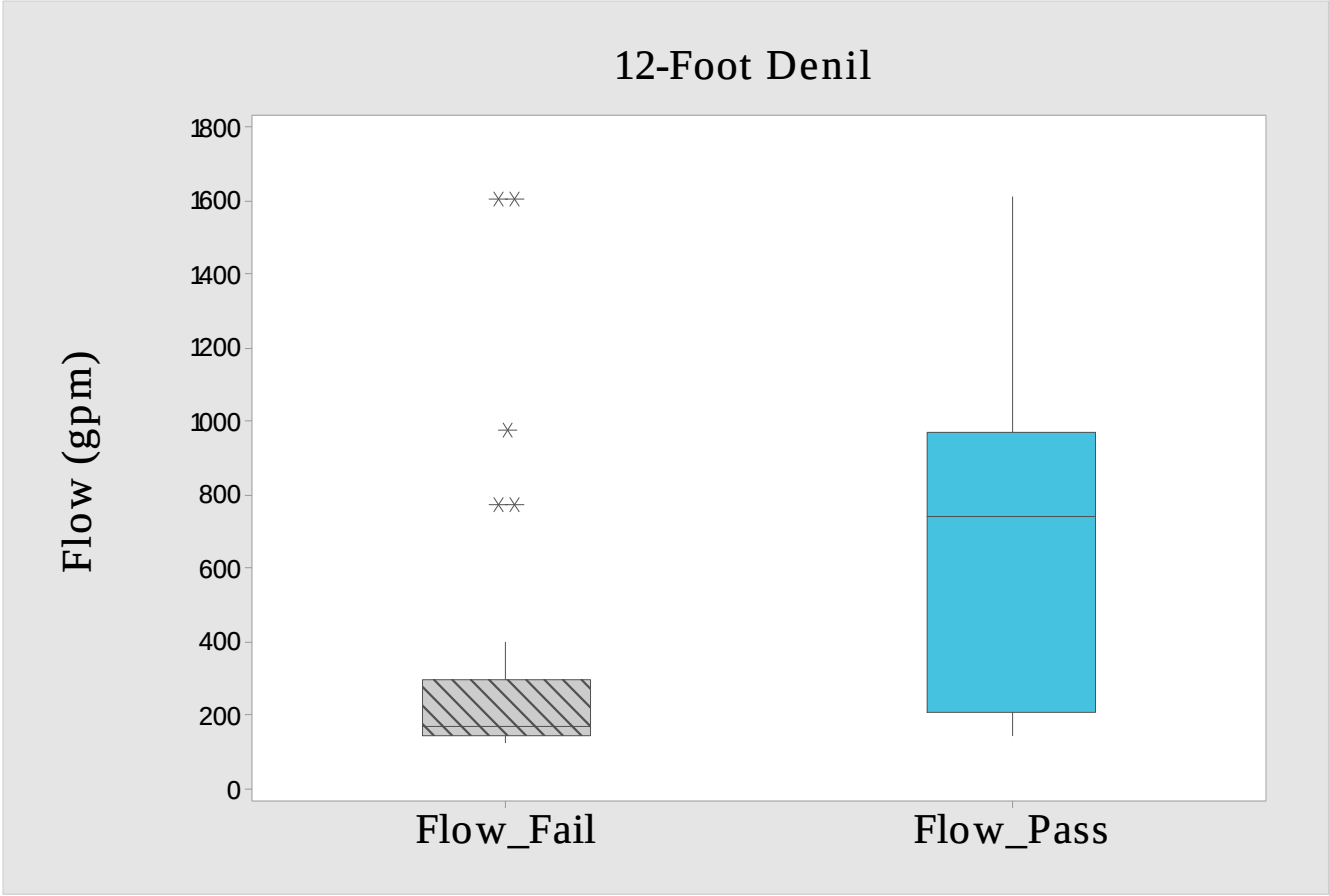

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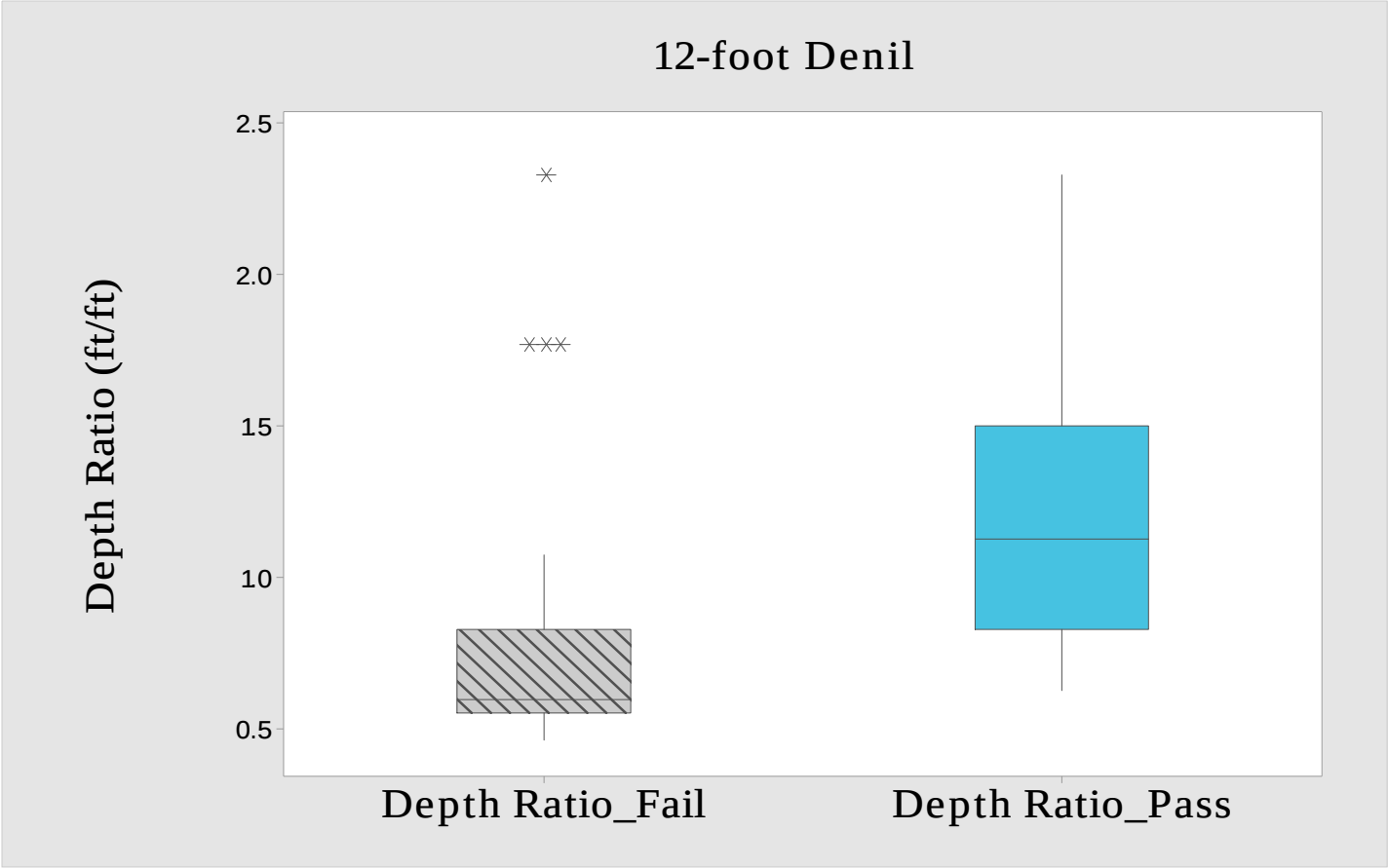

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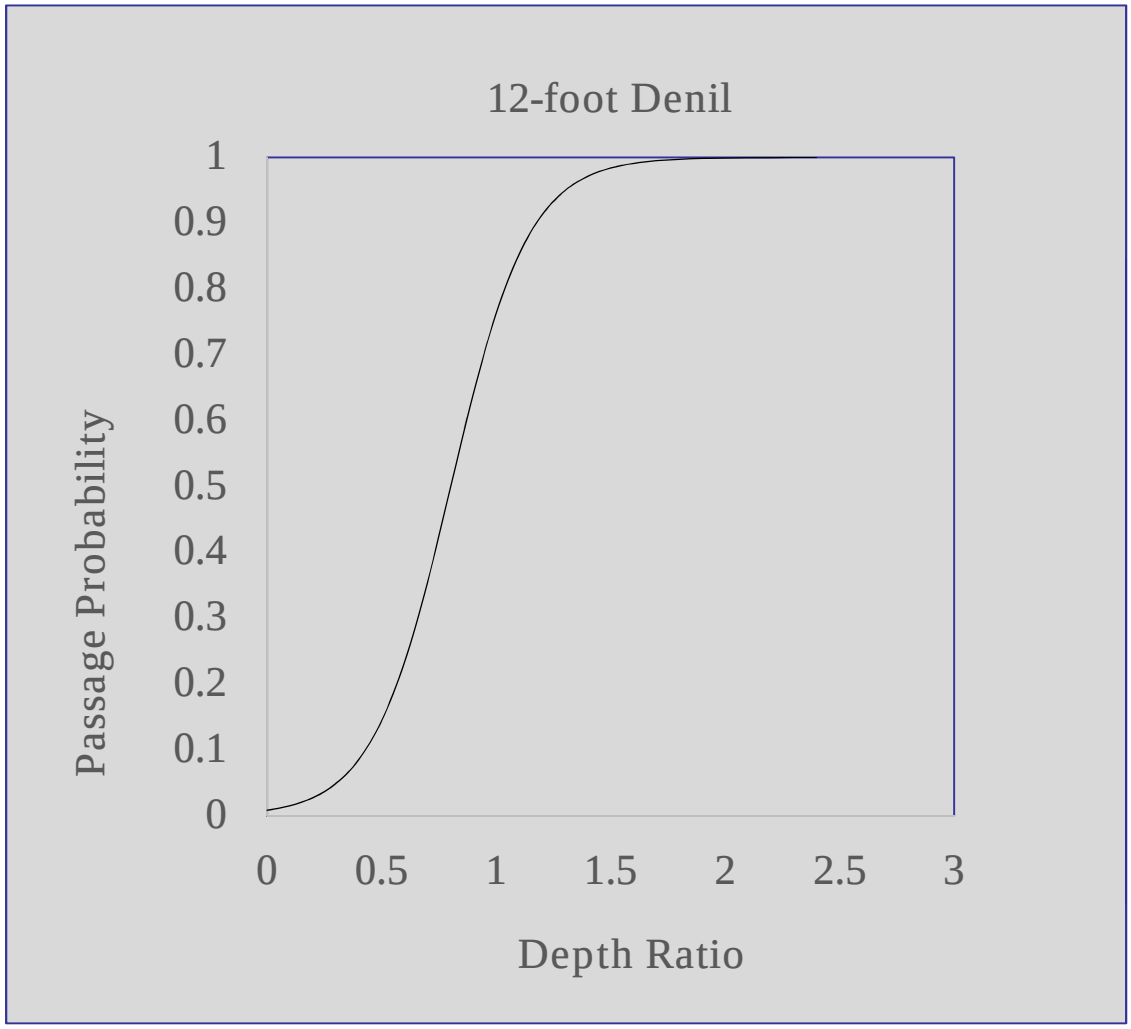
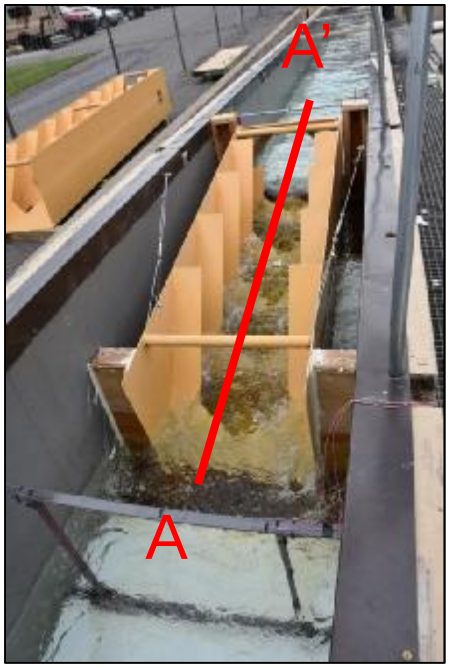


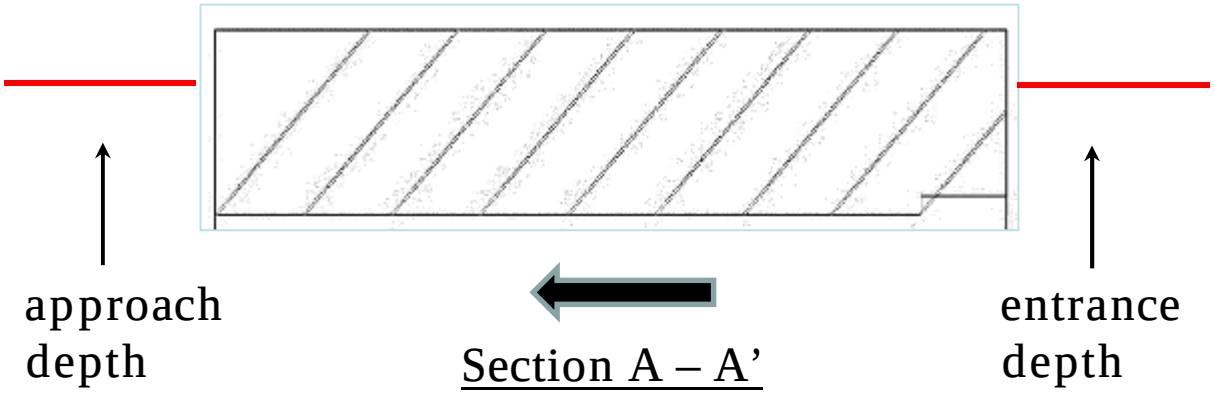
- Model correctly predicted passage success 86%
- Incorrectly predicted passage success 14%

Summary and Implications

Arctic Grayling and Denil Fishways Summary and Implications

- Velocity, flow and depth ratio were significantly different between pass and fail to pass for both size structures
- Best model for passage success was ratio of entrance depth and approach depth
- Plunging flows should be avoided, best passage was during streaming flows





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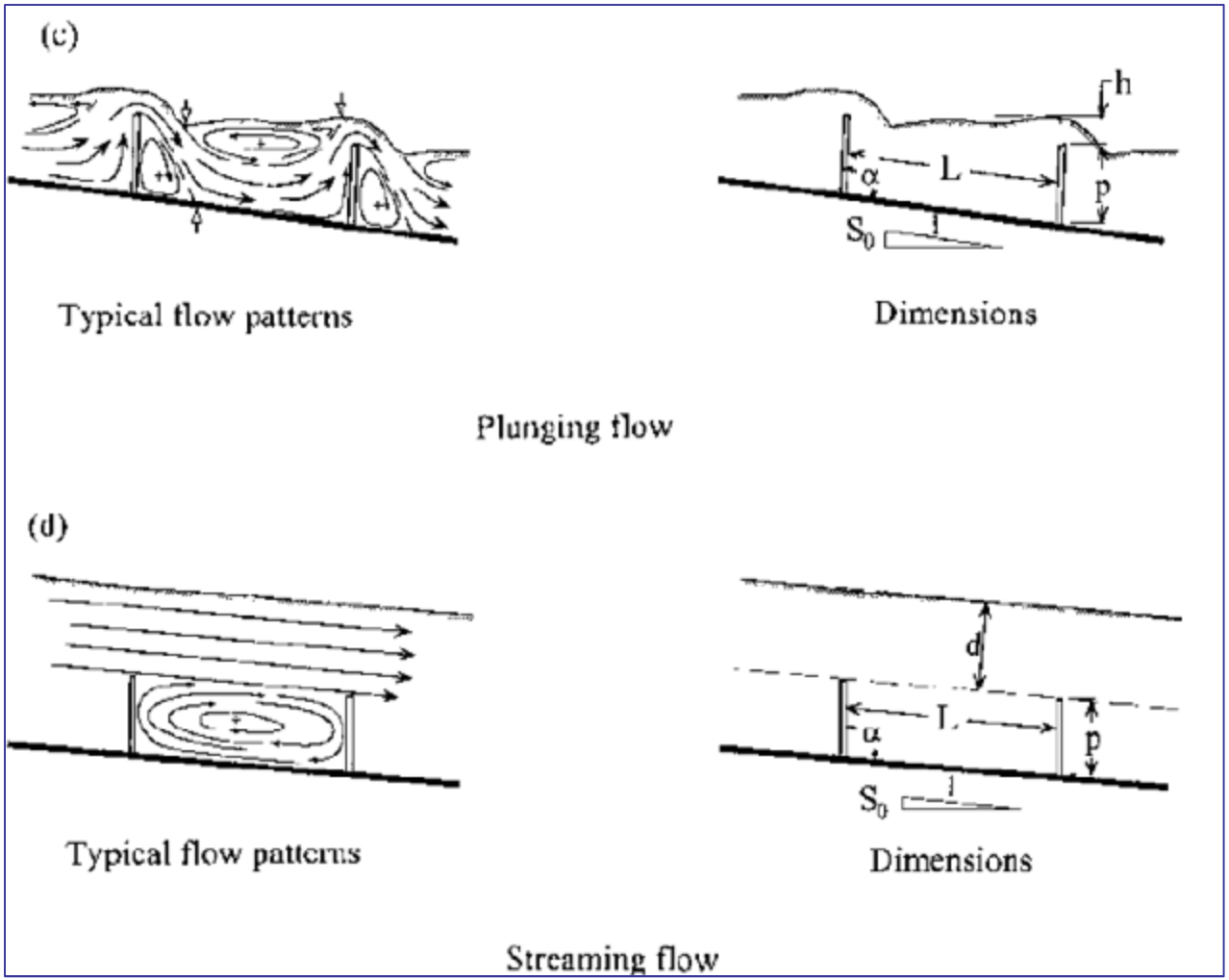

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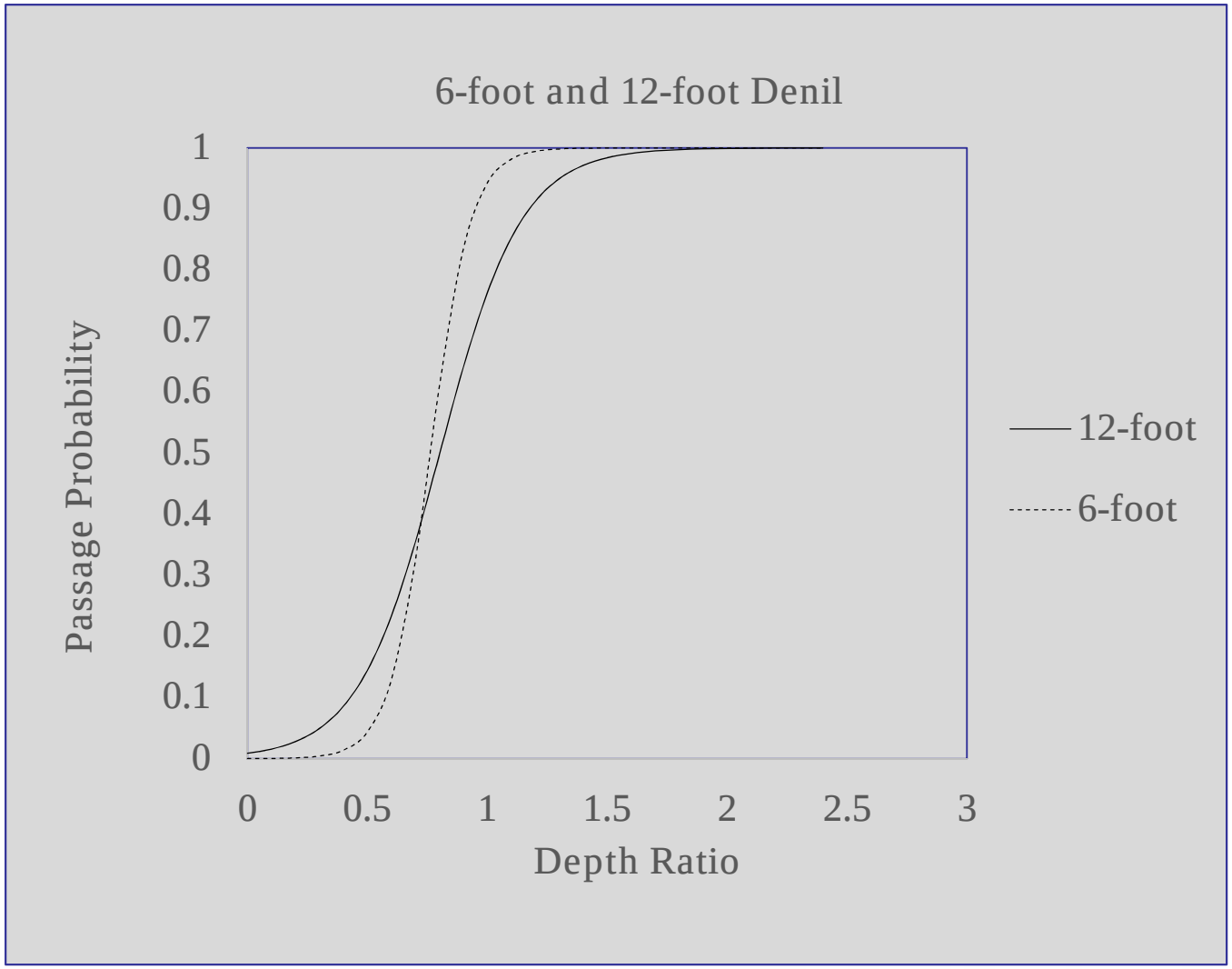

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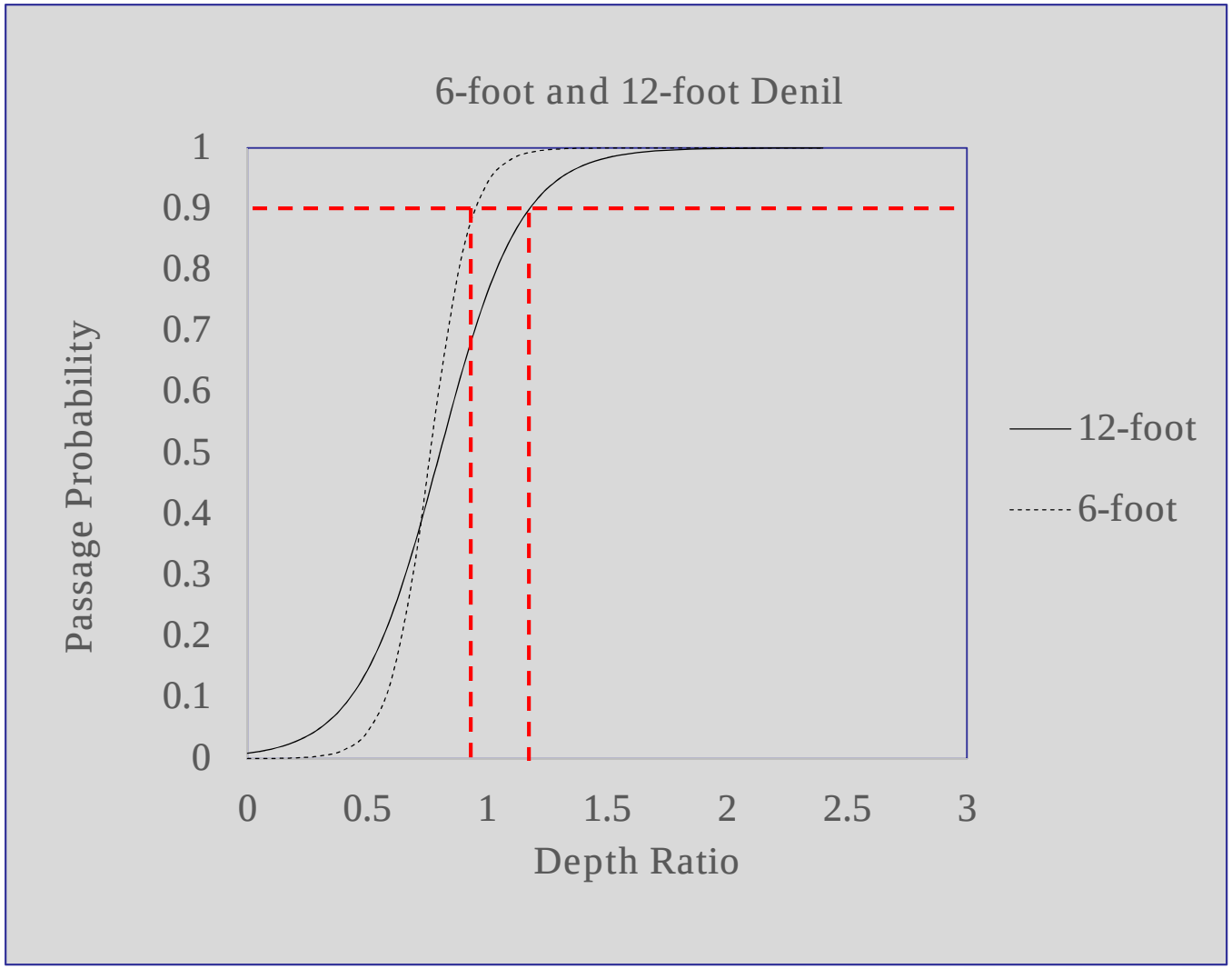


Future Research: Two New Studies

Denil Projects (2017-2018)
Flow Control Device Study

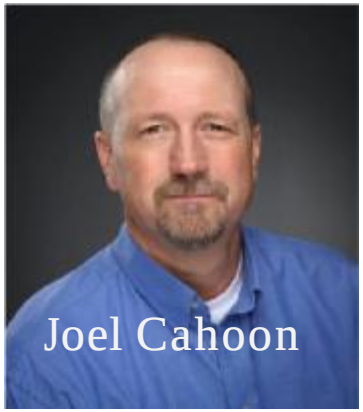
- **The Team:**
  - USFWS, MSU, MFWP
  - DNRC, NRCS, Land Owners
    - Katey Plymesser, PI
    - Tyler Blue, Grad Student
    - Matt Blank
    - Kevin Kappenman
    - Erin Ryan
    - Joel Cahoon

- **The Question**:
  - Do flow control devices affect passage success?

- **The Lab Study**:
  - Evaluate four different flow control devices

Flow Control Device in Field

Denil Projects (2017-2019)
Landscape Level Study of Denils: Big Hole Watershed



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Denil Projects (2017-2019)
Landscape Level Study of Denils: Big Hole Watershed

- This study will evaluate 63 Denil structures in the field to determine conditions that prevent, limit or allow passage.

Thanks!