Passage of Native Cutthroat Trout Through Small Culverts On Steep Slopes: What Are The Limits?

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WEST FORK ENVIRONMENTAL

Plum Creek

Fish Passage: What's the big deal?

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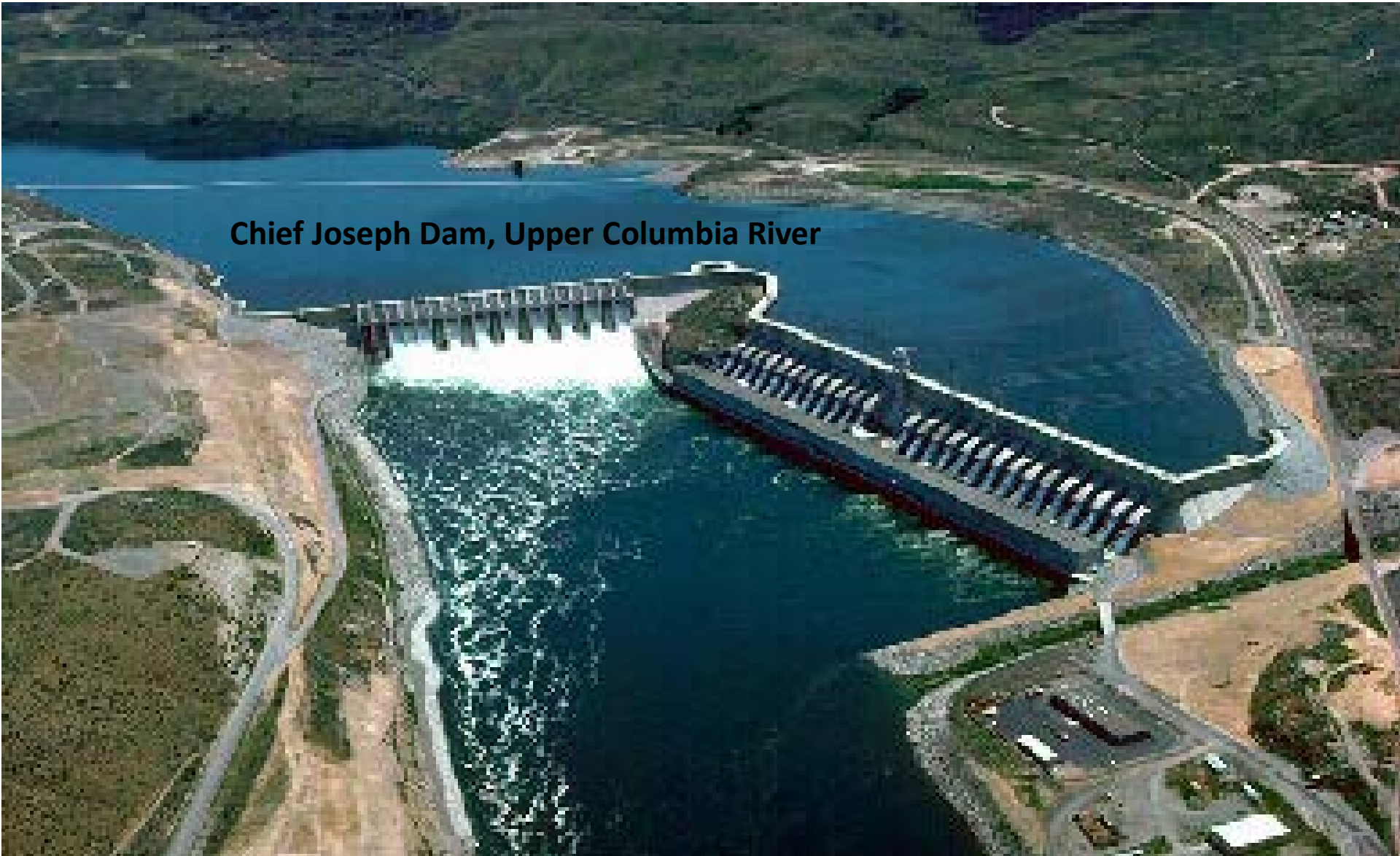


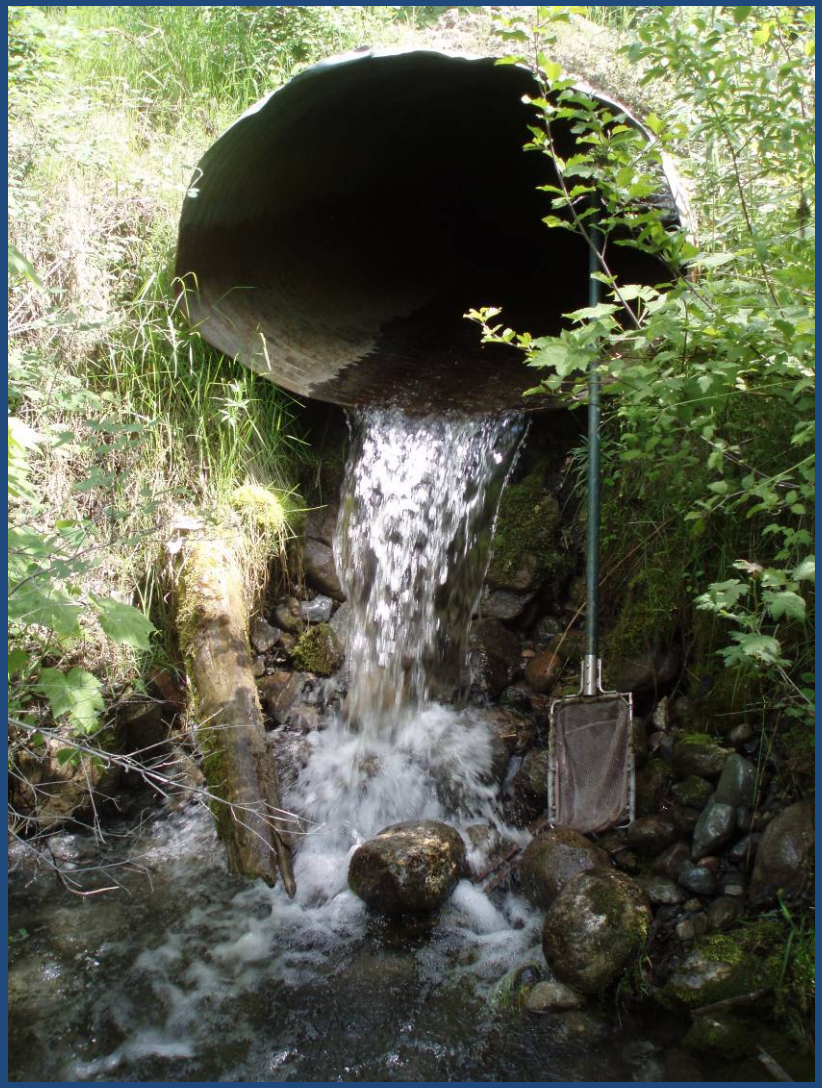
Fish Passage: What's the big deal?

Glen Canyon Dam
Colorado River

Fish Passage: Our Northwest Context

- **Washington State private forest lands**
  - 6,505 barriers identified in 1997
  - 50% have been replaced to date (total cost $100-200M)
- **Washington State DOT**
  - 1,904 barriers identified at a cost of $900M
  - 75% of blocked streams contain significant habitat upstream
- **US Forest Service lands in WA and OR**
  - 4,800 barriers at a cost of 331M, estimated to take 100 years to complete
- **Oregon DOT**
  - 733 barriers identified in W. Oregon (total cost >$100M)
- **British Columbia**
  - 44,000 culverts pose a moderate to high risk for passage problems

Culvert Passability



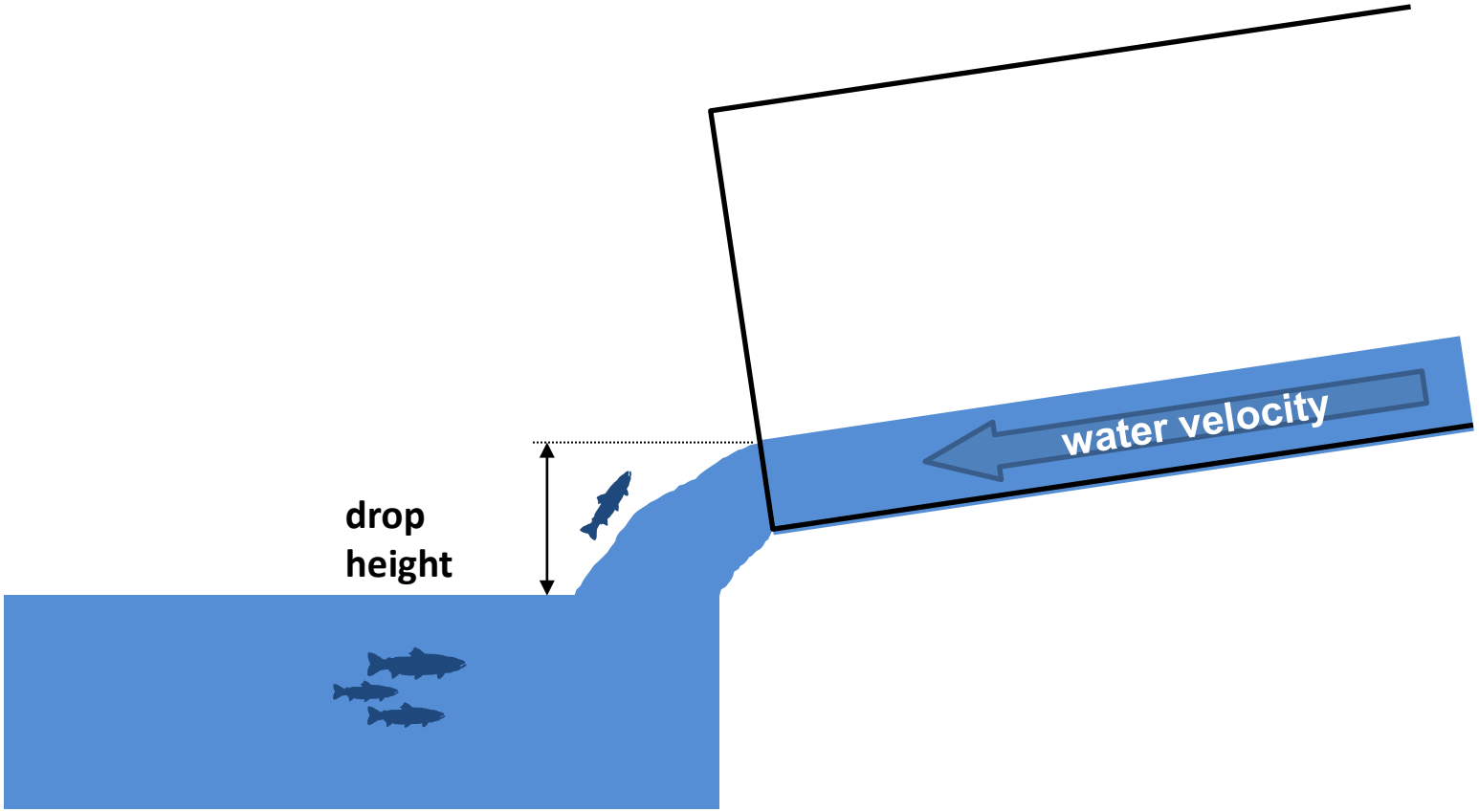
Coastal Cutthroat Trout

- Life history: both sea-run and resident forms
- Resident populations represent the most common fish species found in small headwater streams
- Resident populations often thrive above migration barriers

Study Objectives

•Assess the passability of wild coastal cutthroat trout through a culvert over a range of slopes and flows;

•Assess the influence of culvert outlet conditions (drop height and water velocity) on passability




Culvert Test Bed Facility
near Tenino, Washington

Passage Detection System

PIT = passive integrated transponder

½ duplex

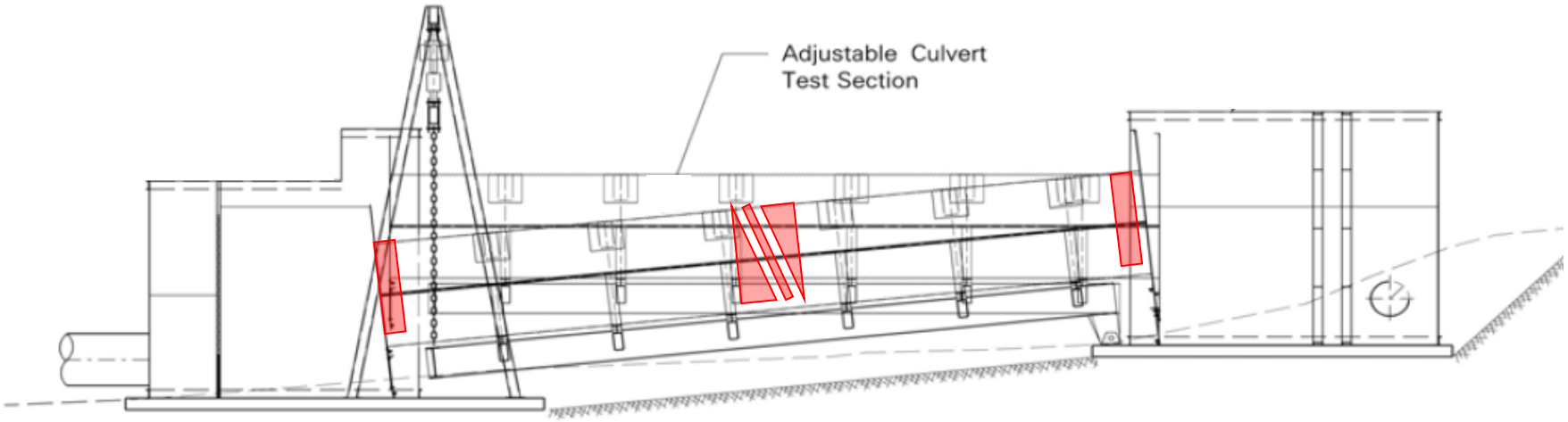
Unique ID for individual fish

How many try?

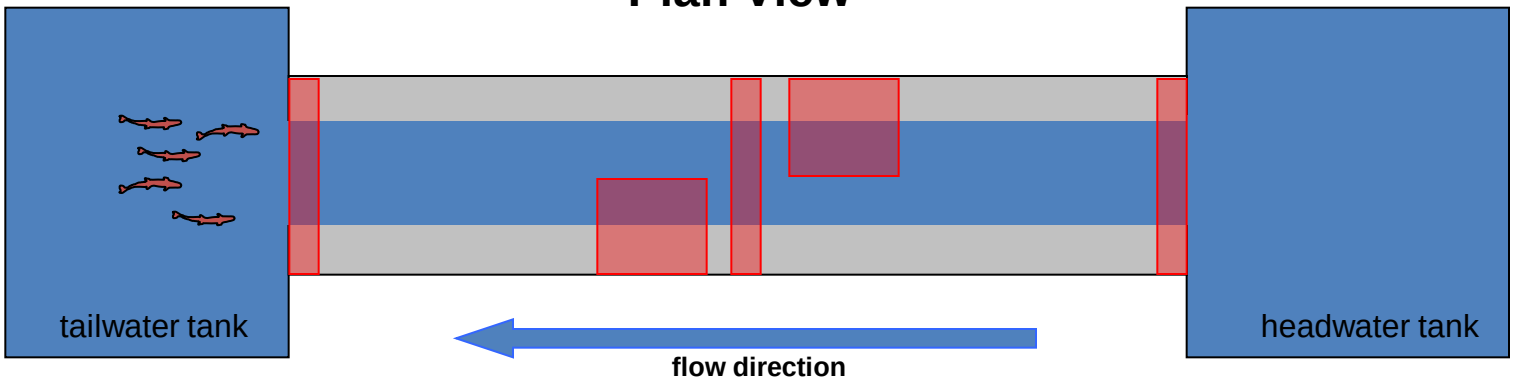
How many make it?

Passage Detection System

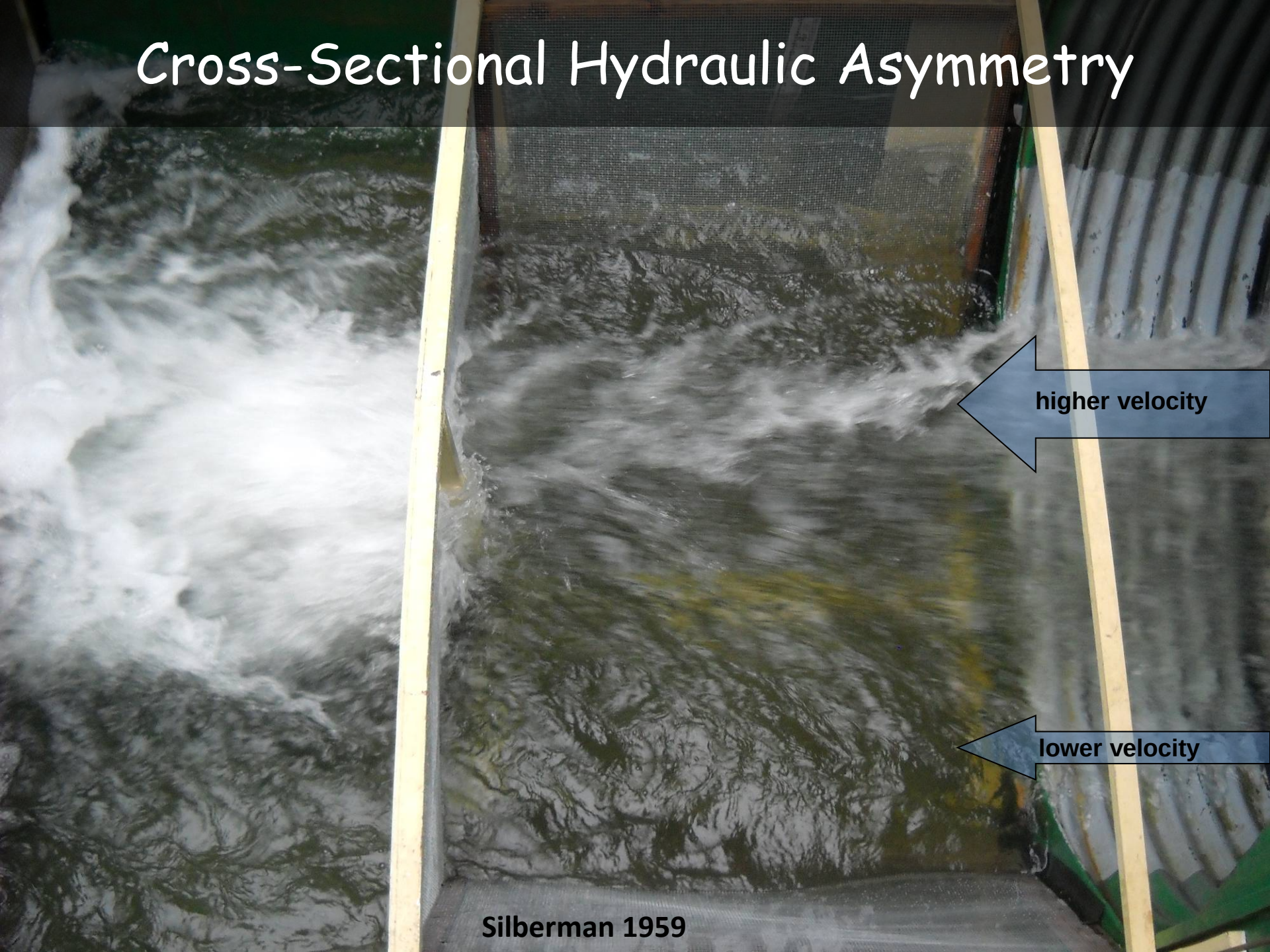
PIT Tag Antennae



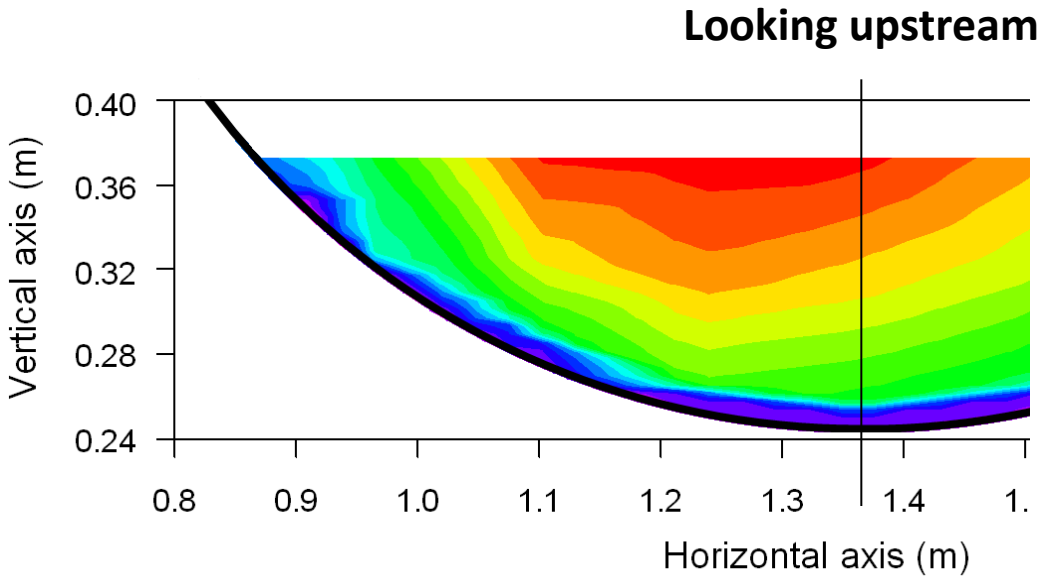
Plan View



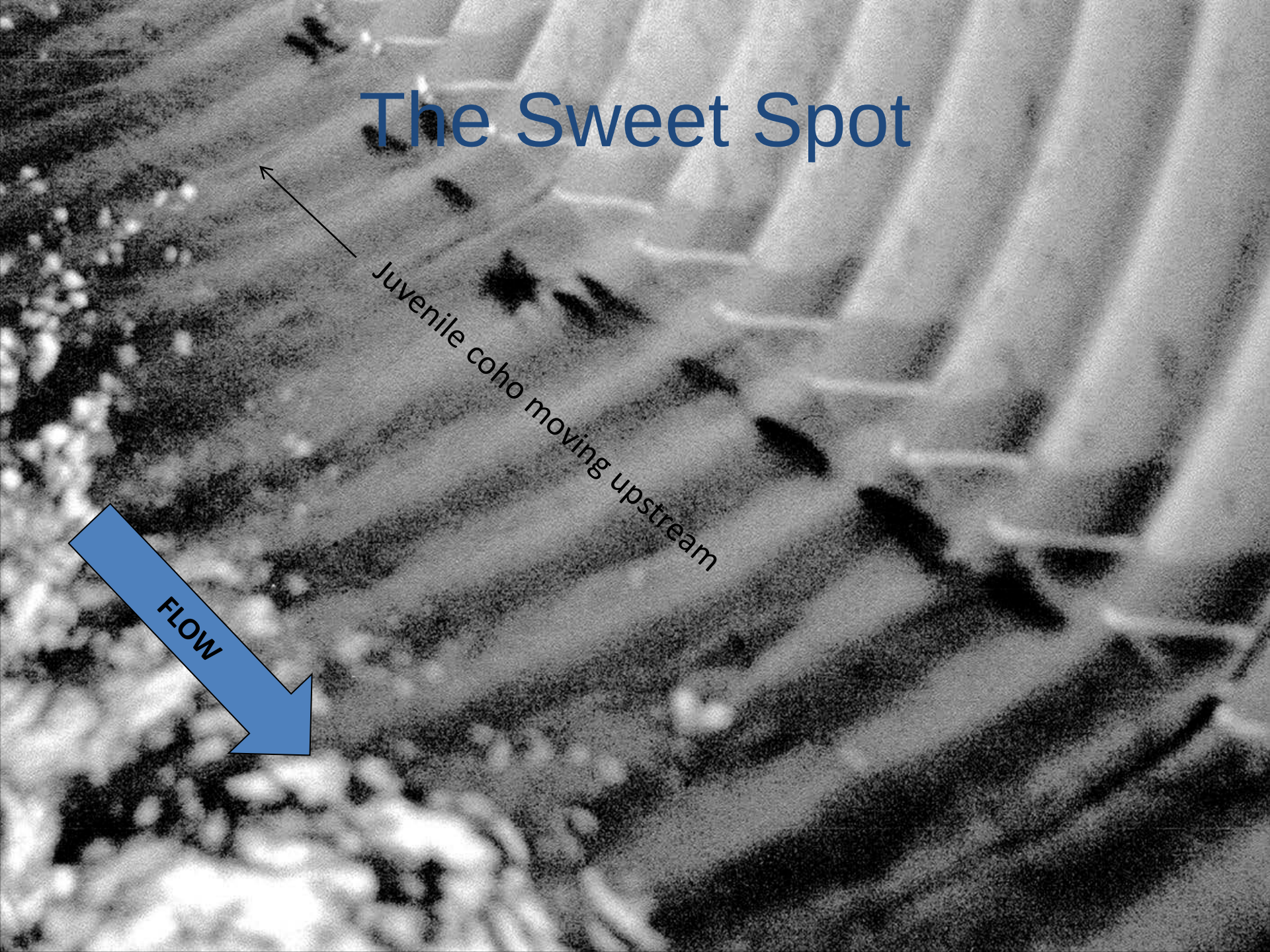
Cross-Sectional Hydraulic Asymmetry



Cross Sectional Velocity Profile



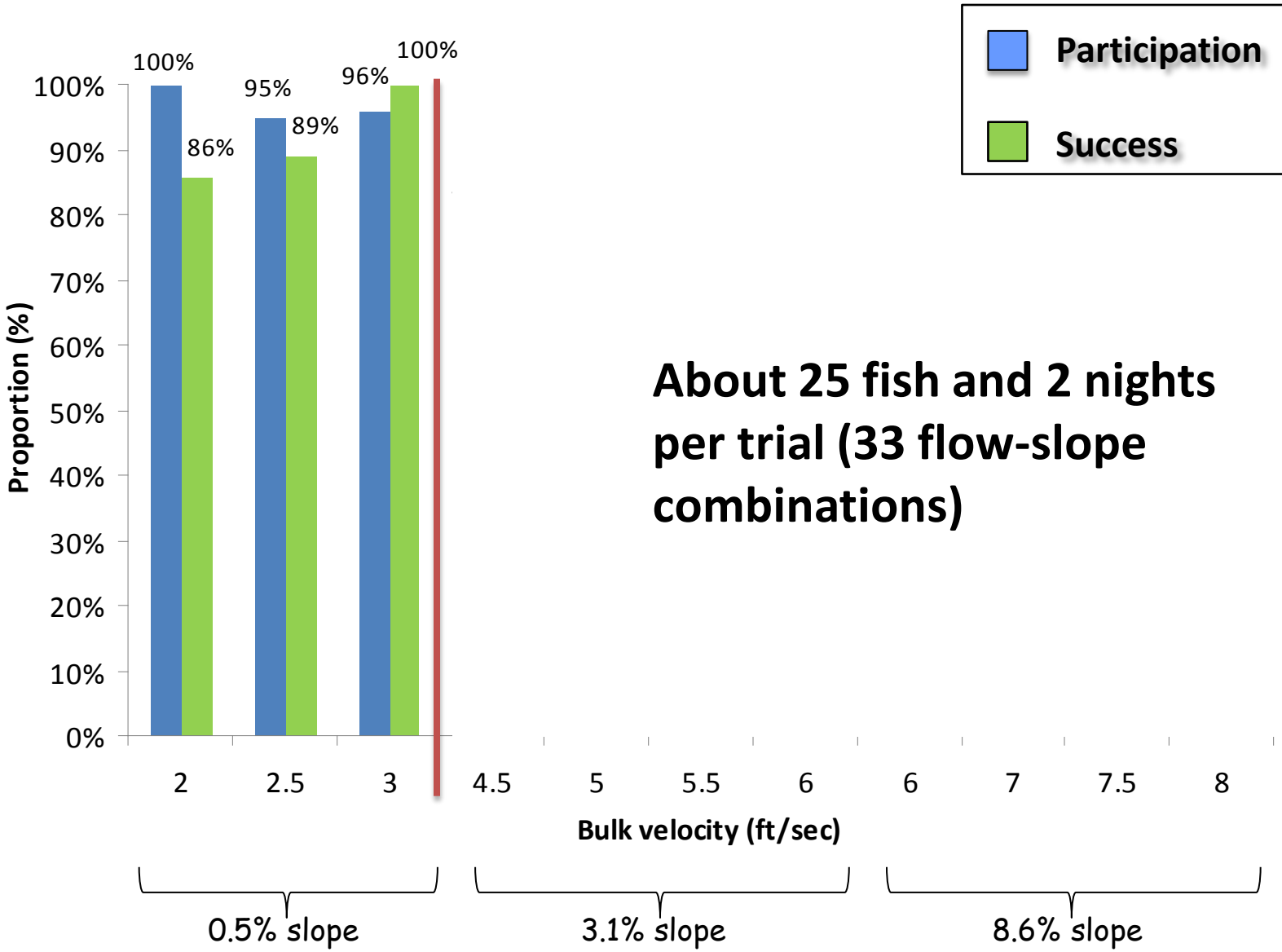
The "Sweet Spot"


The Sweet Spot
Juvenile coho moving upstream
FLOW

Size Distribution of Tested Cutthroat Trout

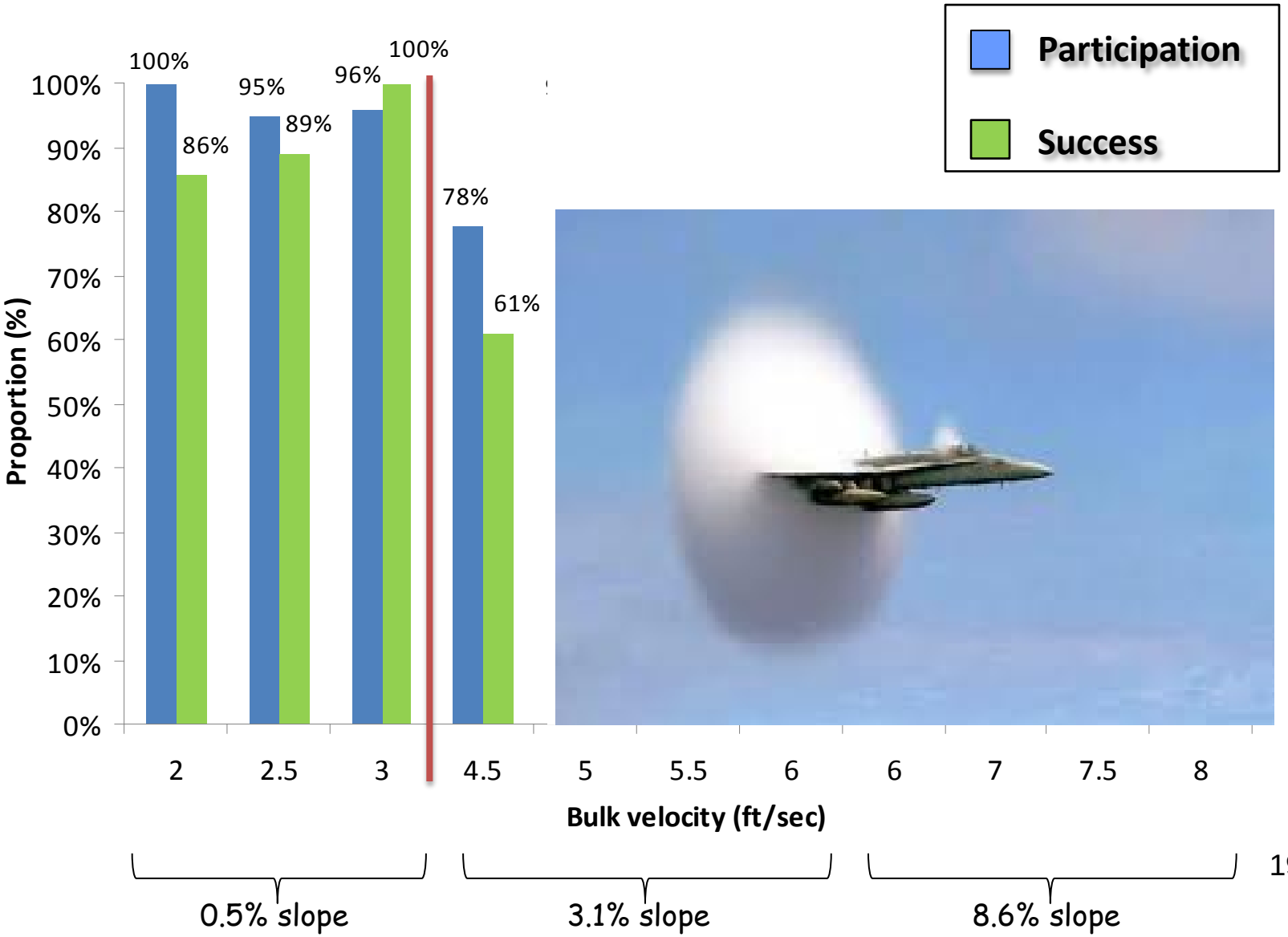
(*n* = 274)

Results

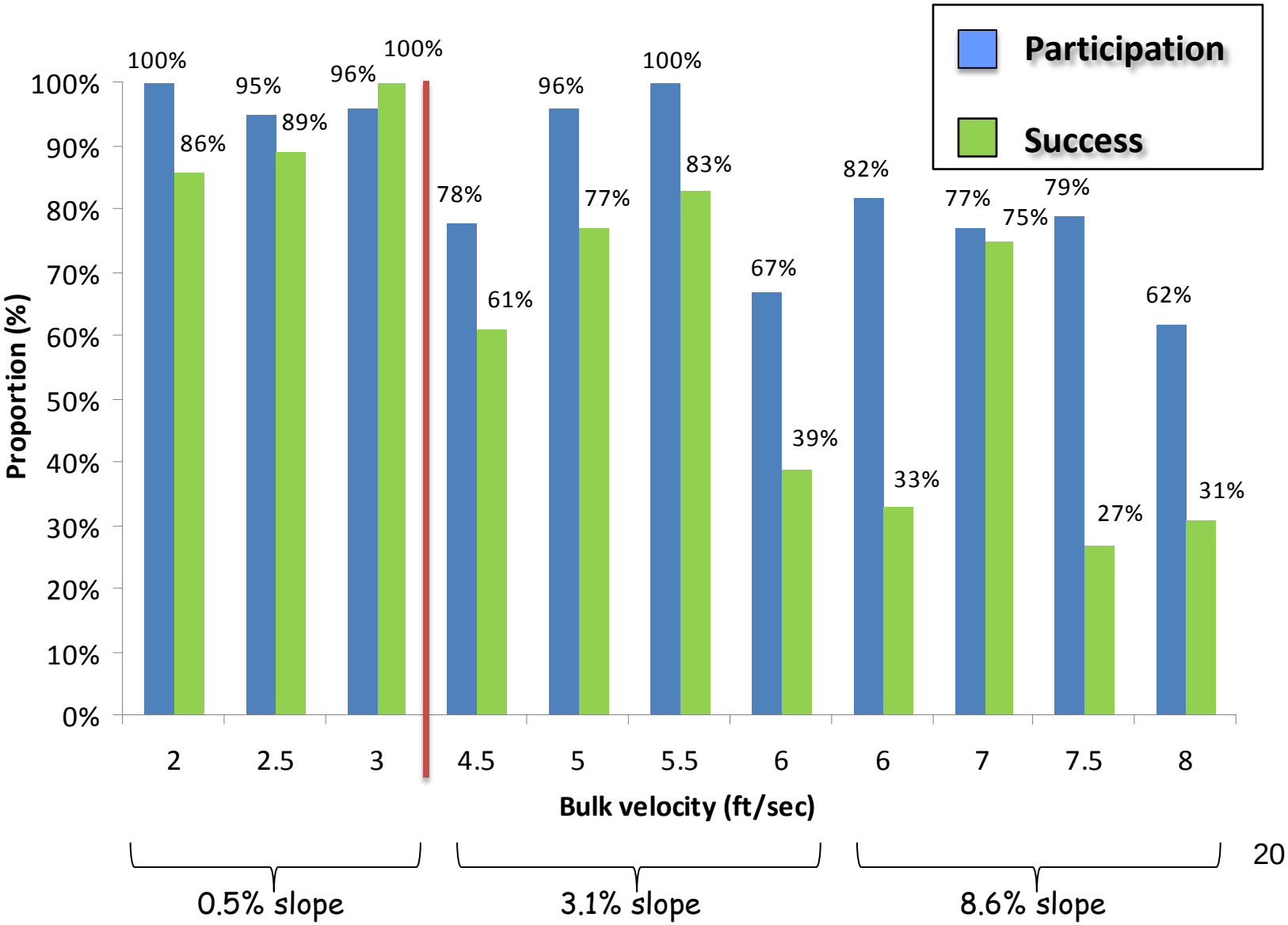


About 25 fish and 2 nights per trial (33 flow-slope combinations)

Results

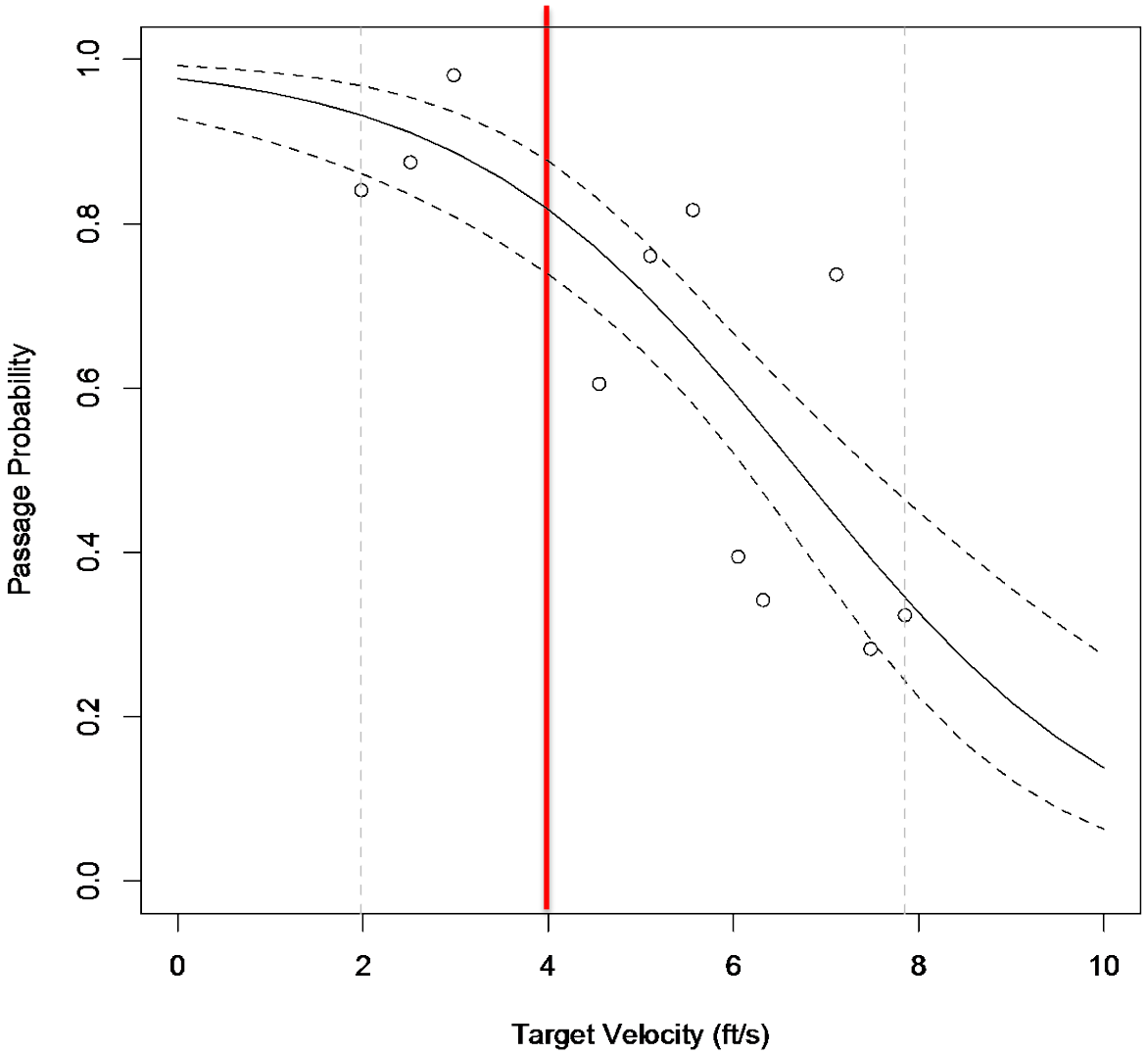

Participation
Success
100%
86%
95%
89%
96%
100%
78%
61%
Proportion (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2
2.5
3
4.5
5
5.5
6
6
7
7.5
8
Bulk velocity (ft/sec)
0.5% slope
3.1% slope
8.6% slope

Results


Participation
Success
Proportion (%)
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
100%
86%
95%
89%
96%
100%
78%
61%
96%
77%
100%
83%
67%
39%
82%
33%
77%
75%
79%
27%
62%
31%
2
2.5
3
4.5
5
5.5
6
6
7
7.5
8
Bulk velocity (ft/sec)
0.5% slope
3.1% slope
8.6% slope

Flow: 8 cubic feet/sec Pipe Slope: 8.6% Velocity: 7 ft/sec

Probability of Passage

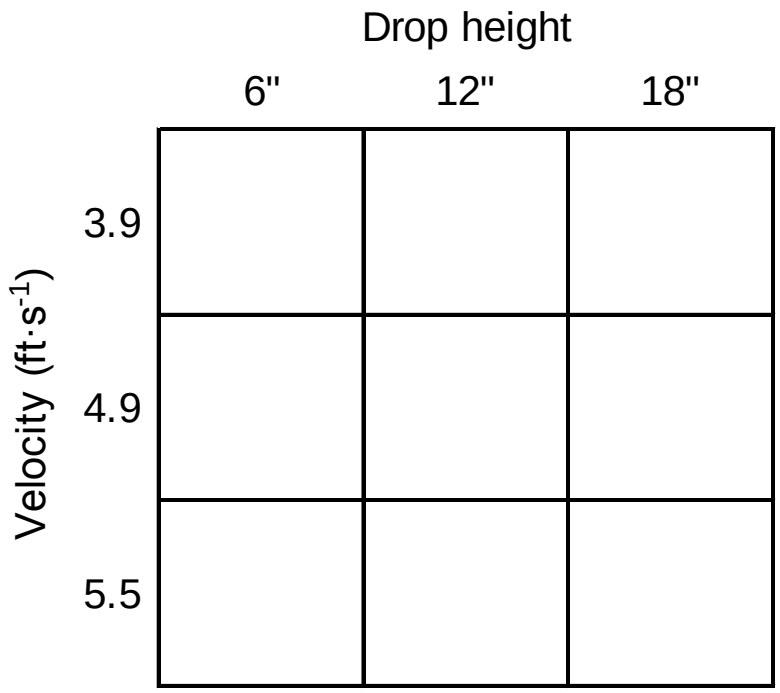


Bottom Line

- Wild cutthroat were successful in average passage conditions well beyond those predicted by most passage criteria
  - No perch at outlet

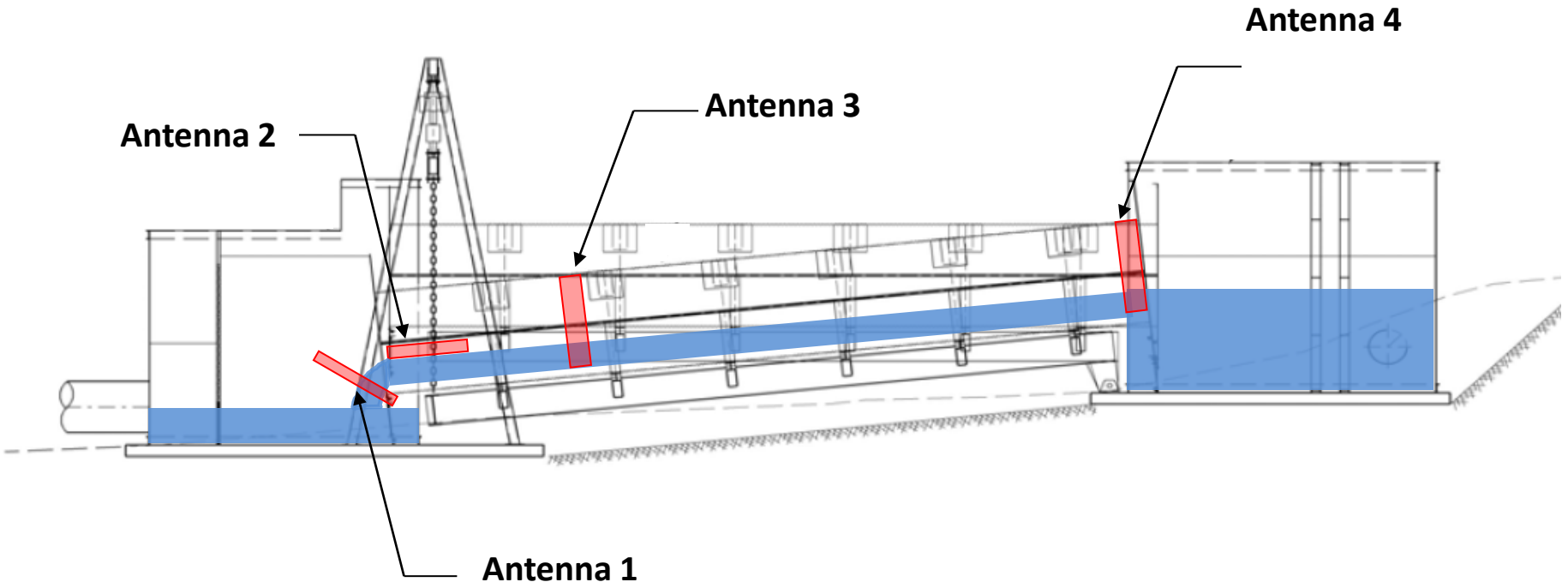

Outlet Drop Height

Study design
Passage conditions matrix

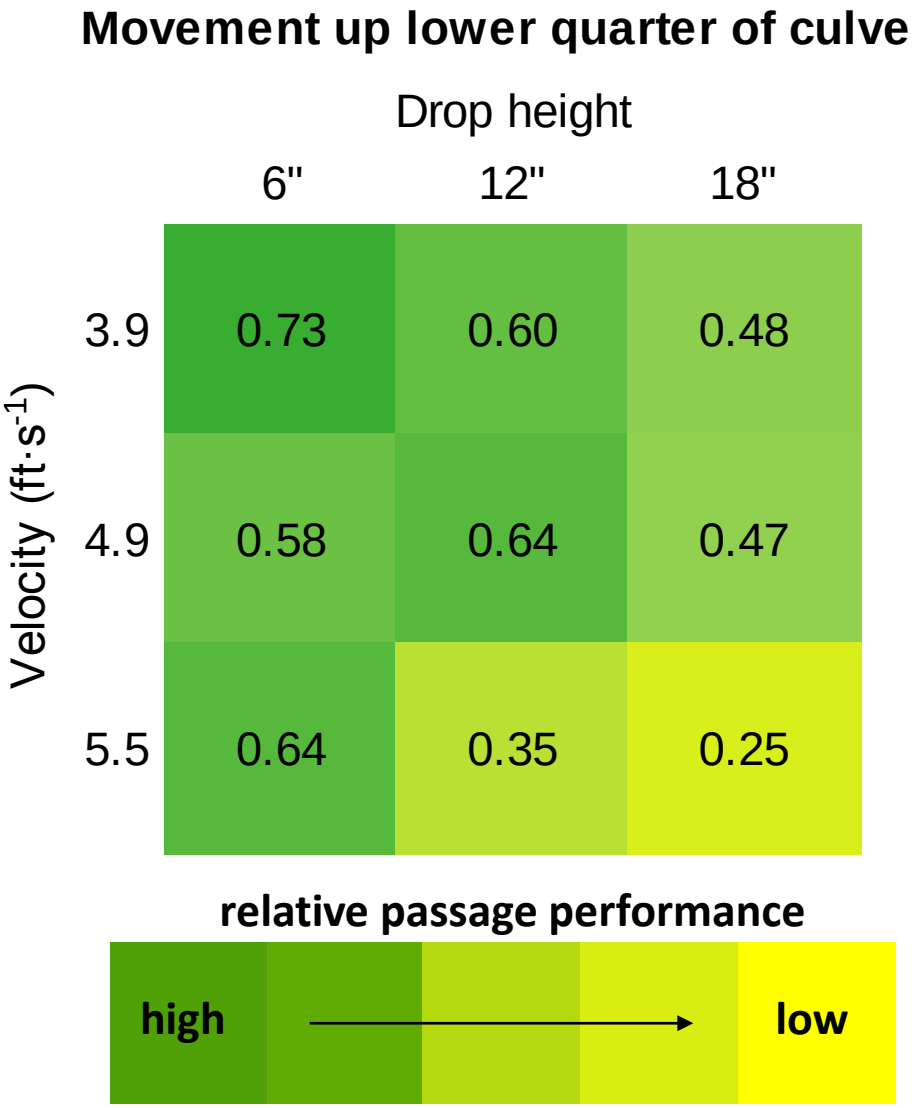


Each velocity and height combination was tested twice (18 total trials)

Passage Detection System



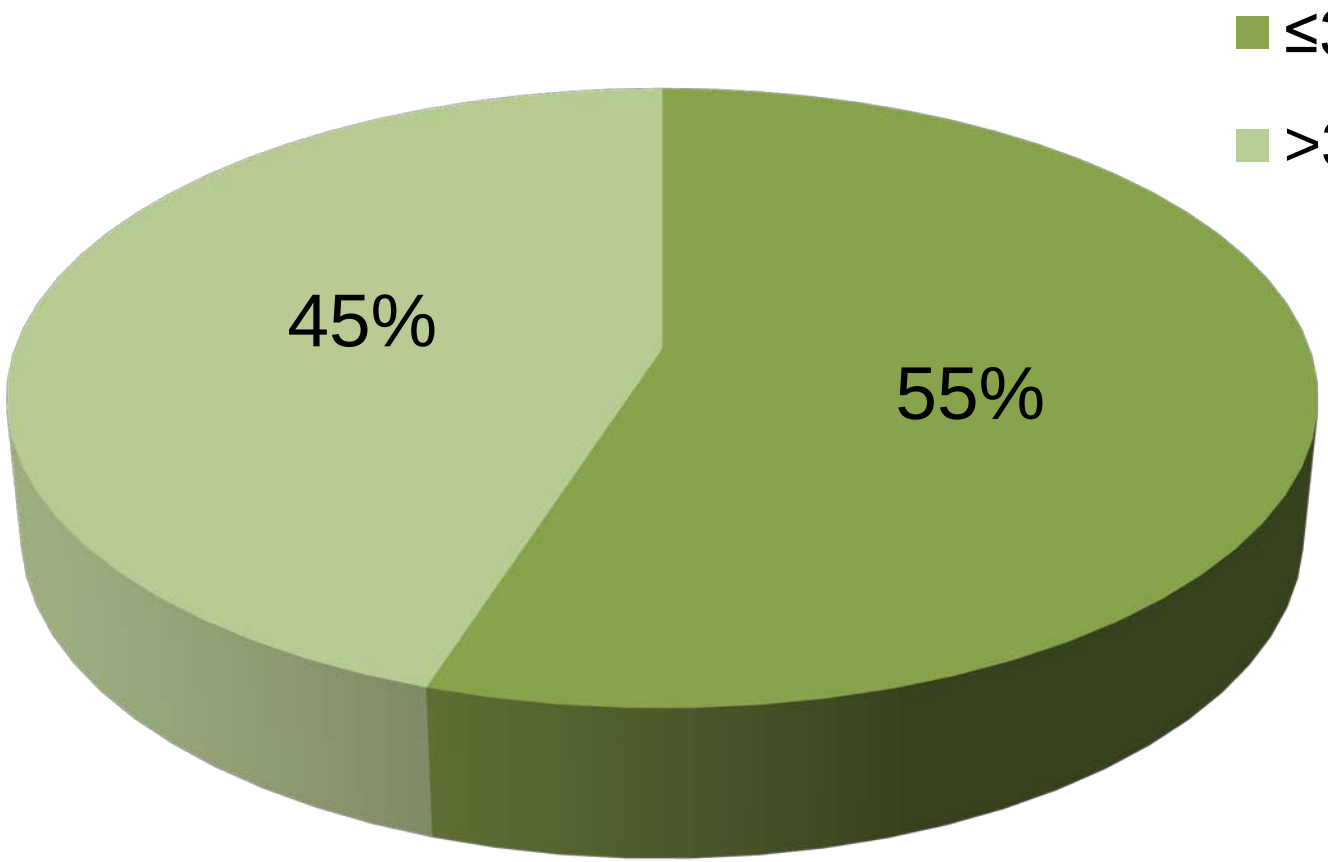
Passage performance by distance through culvert



What Next?

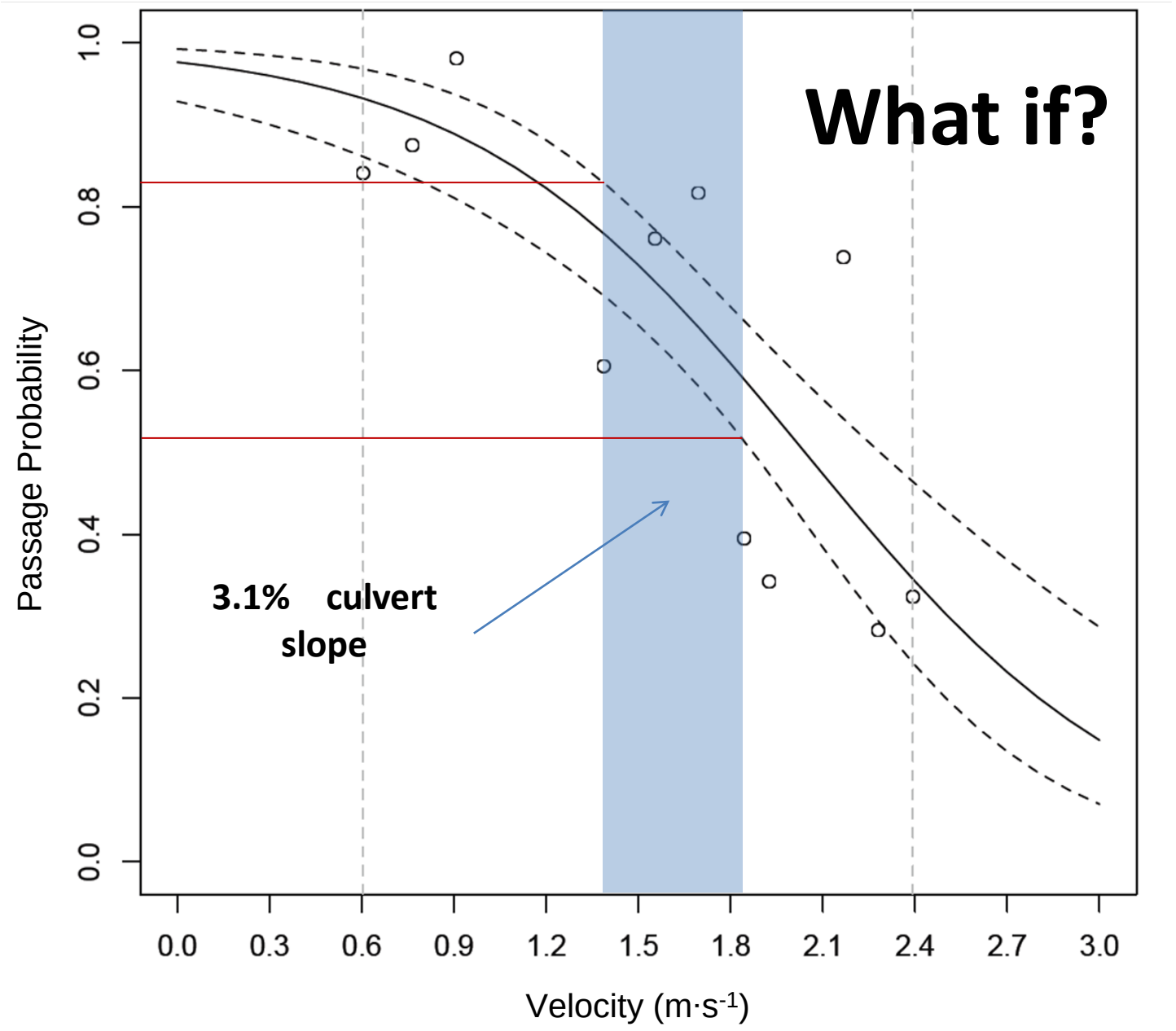
- Policy
  - Improve passage criteria
    - Account for partial passage
  - Broaden the decision space
  - True 'worst first' prioritization

Culvert Slope Categories for Inventoried Fish Passage Barriers in Alaska & British Columbia



N = 909

Sources: British Columbia Forest Practices Board (2009), Flanders and Cariello (2000)


What if?
3.1% culvert slope
Passage Probability
0.0
0.2
0.4
0.6
0.8
1.0
0.0
0.3
0.6
0.9
1.2
1.5
1.8
2.1
2.4
2.7
3.0
Velocity (m·s-1)

Acknowledgments

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- Washington Dept. of Transportation
- Washington Forest Protection Association
- Individual Timber Companies