Resident Fish Passage: Have we been asking the right questions?

N. Phil Peterson
West Fork Environmental, Inc.

Western Forestry and Conservation Association

The Effects of Forest Management on Fish Habitat

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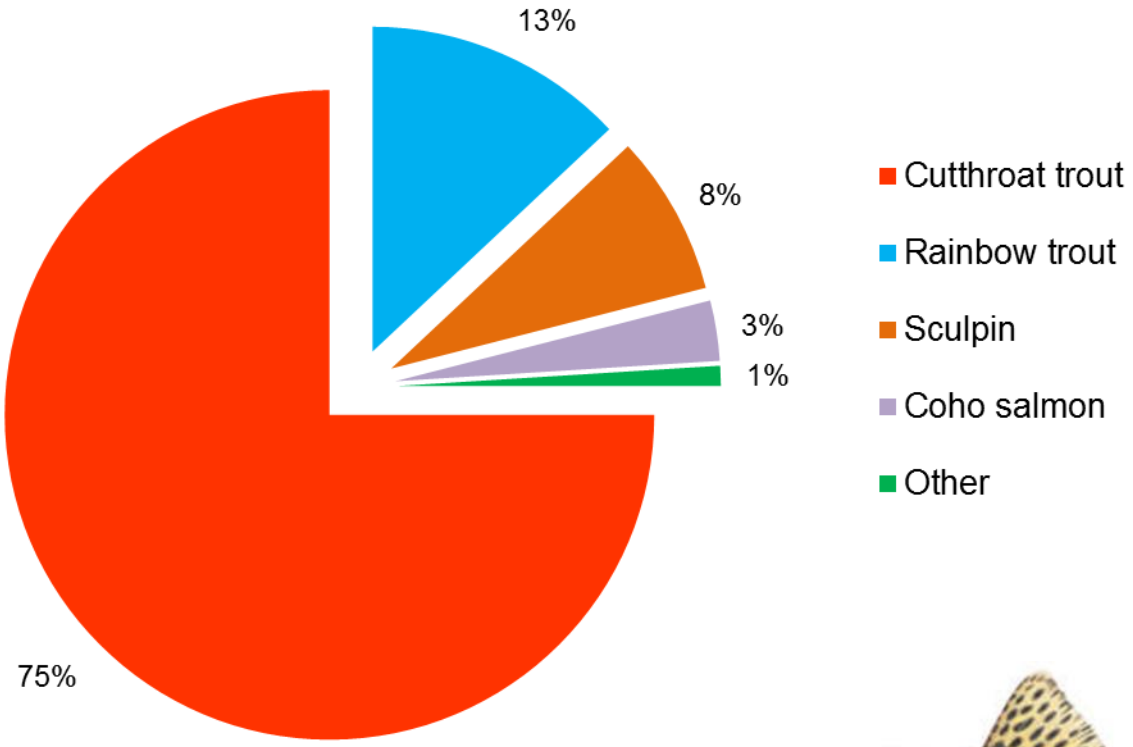
WEST FORK ENVIRONMENTAL

Uppermost species present in PNW headwater streams



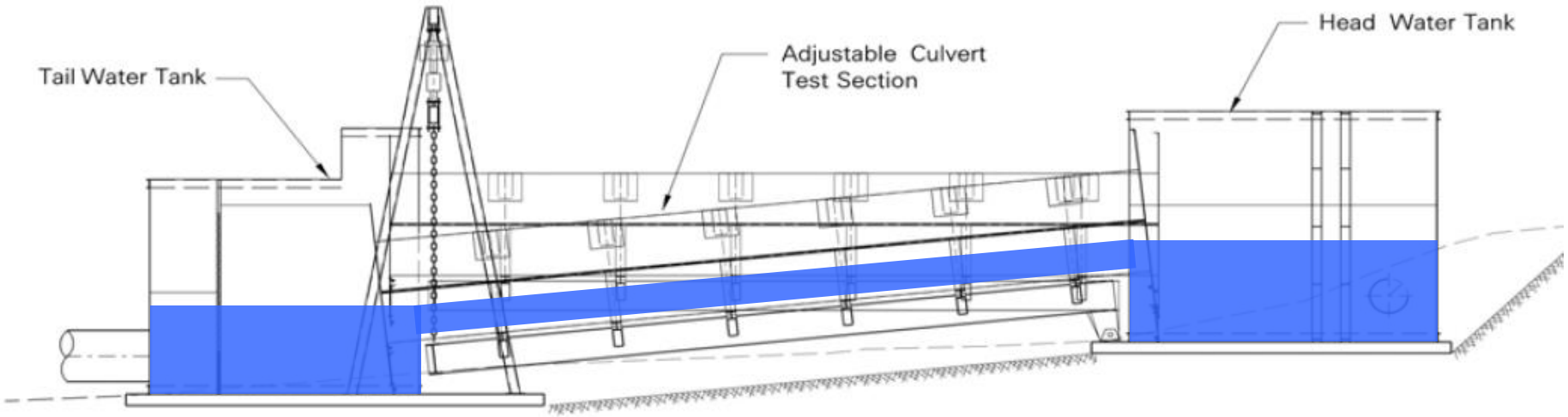
Potential culvert-related fish passage issues

- High velocities
- Drop at outlet
- No plunge pool
- Accumulation of debris
- Inadequate water depth
- Steep slope
- No substrate in pipe

Research Objectives

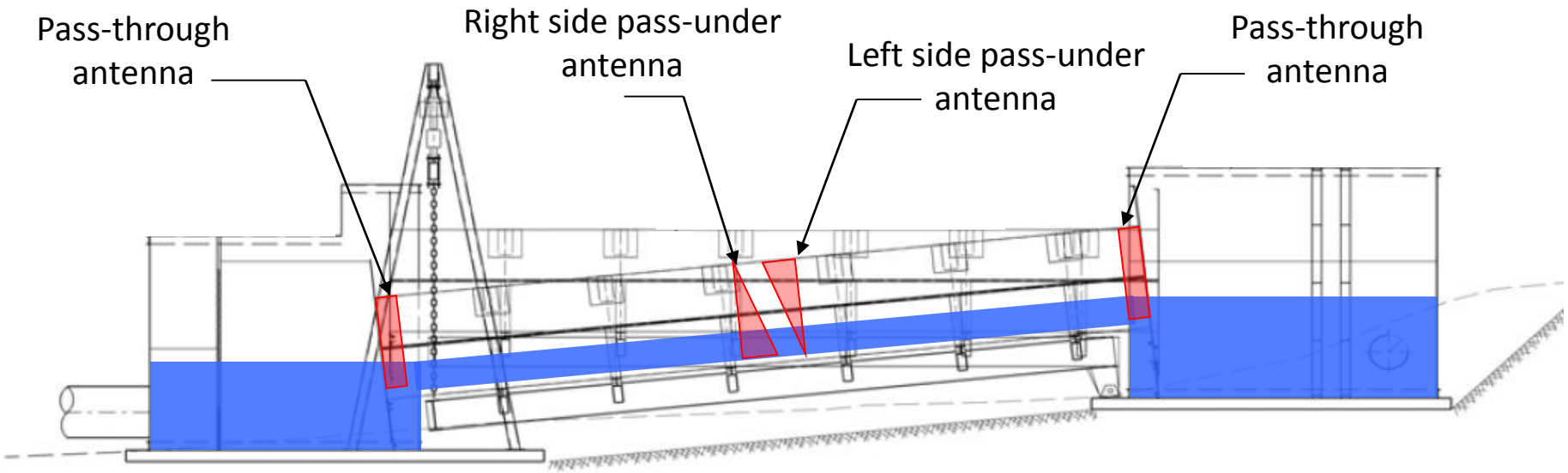
- Study 1: Test the ability for wild cutthroat trout to pass through a bare culvert over a range of velocities
- Study 2: Test culvert entry success and passage over a range of outfall drop heights and velocities
- Study 3: Test applicability of experimental data to operational settings

Culvert Test Bed Facility
(WDFW Skookumchuck Hatchery)

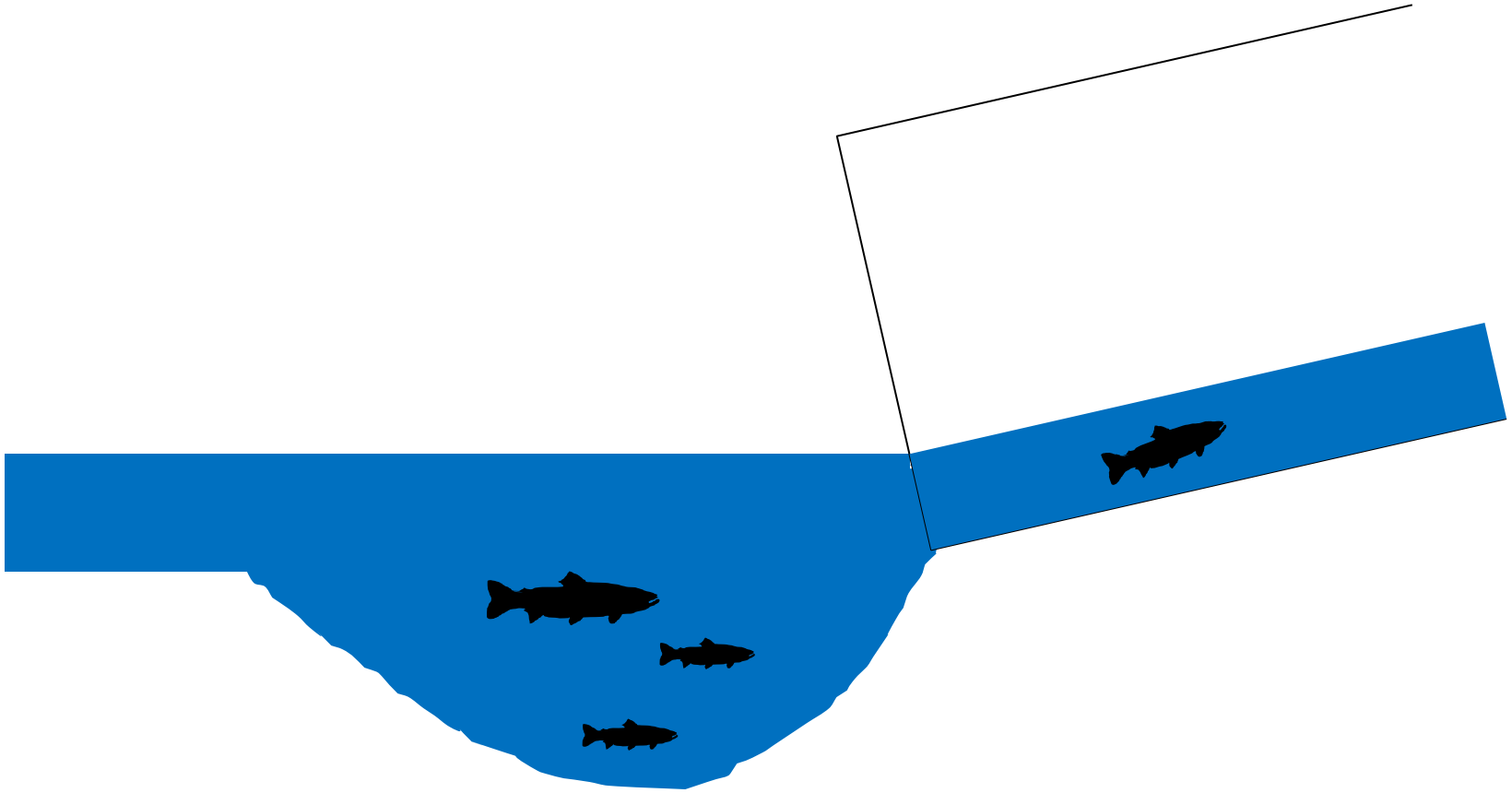


Study 1 & 2 used a 6’ diameter, 40’ long pipe

PIT antenna array



Study 1: Test the ability for wild cutthroat trout to pass through a bare culvert over a range of average velocities



Study 1: Trial conditions

Average Velocity	Flow	Slope
2	2.02	0.52
2.5	4.28	0.52
3	7.40	0.52
4.5	5.10	3.14
5	7.67	3.14
5.5	10.58	3.14
6	14.56	3.14
6	5.10	8.60
7	8.03	8.60
7.5	9.80	8.60
8	11.94	8.60

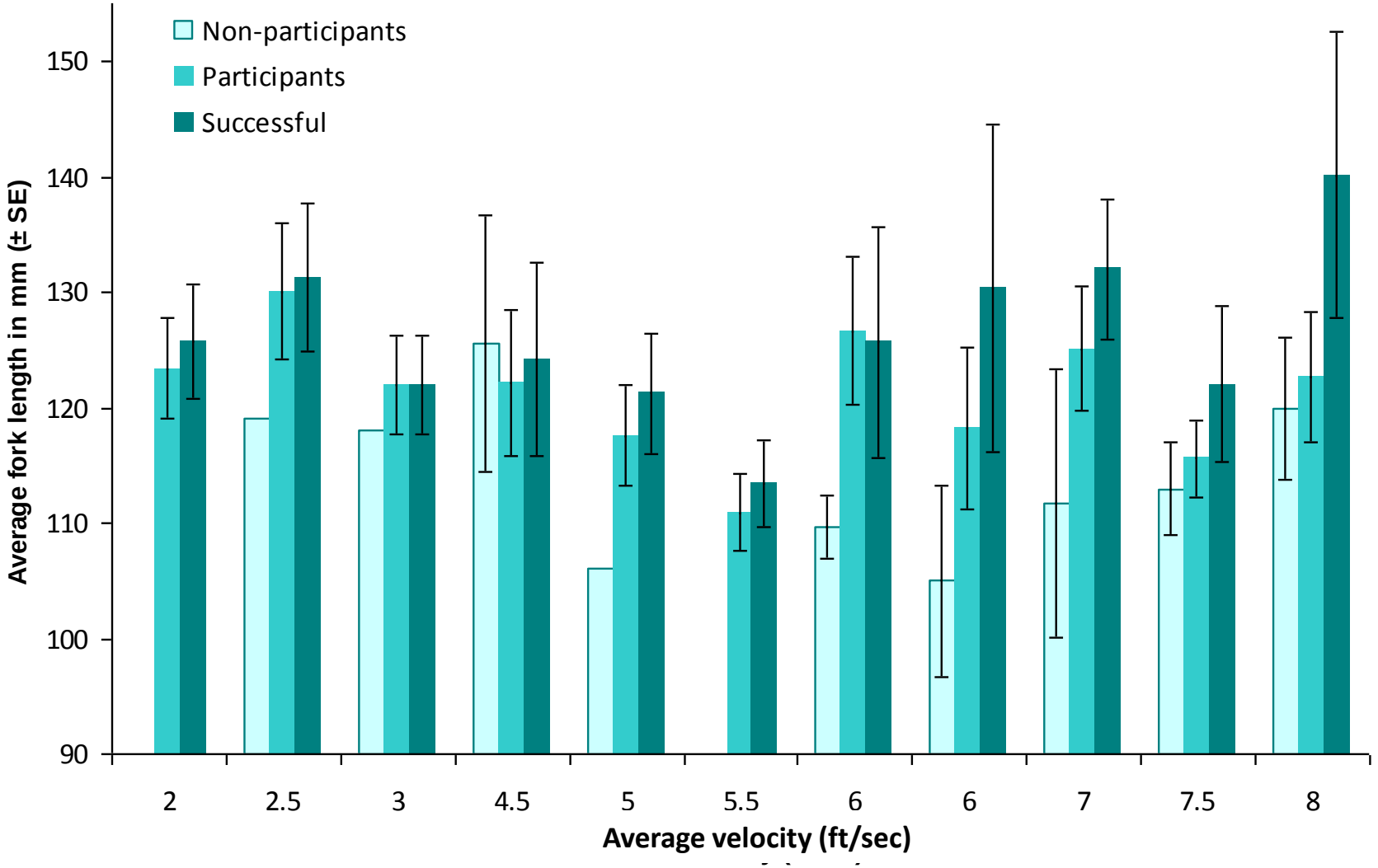
Test fish size

(*n* = 274)

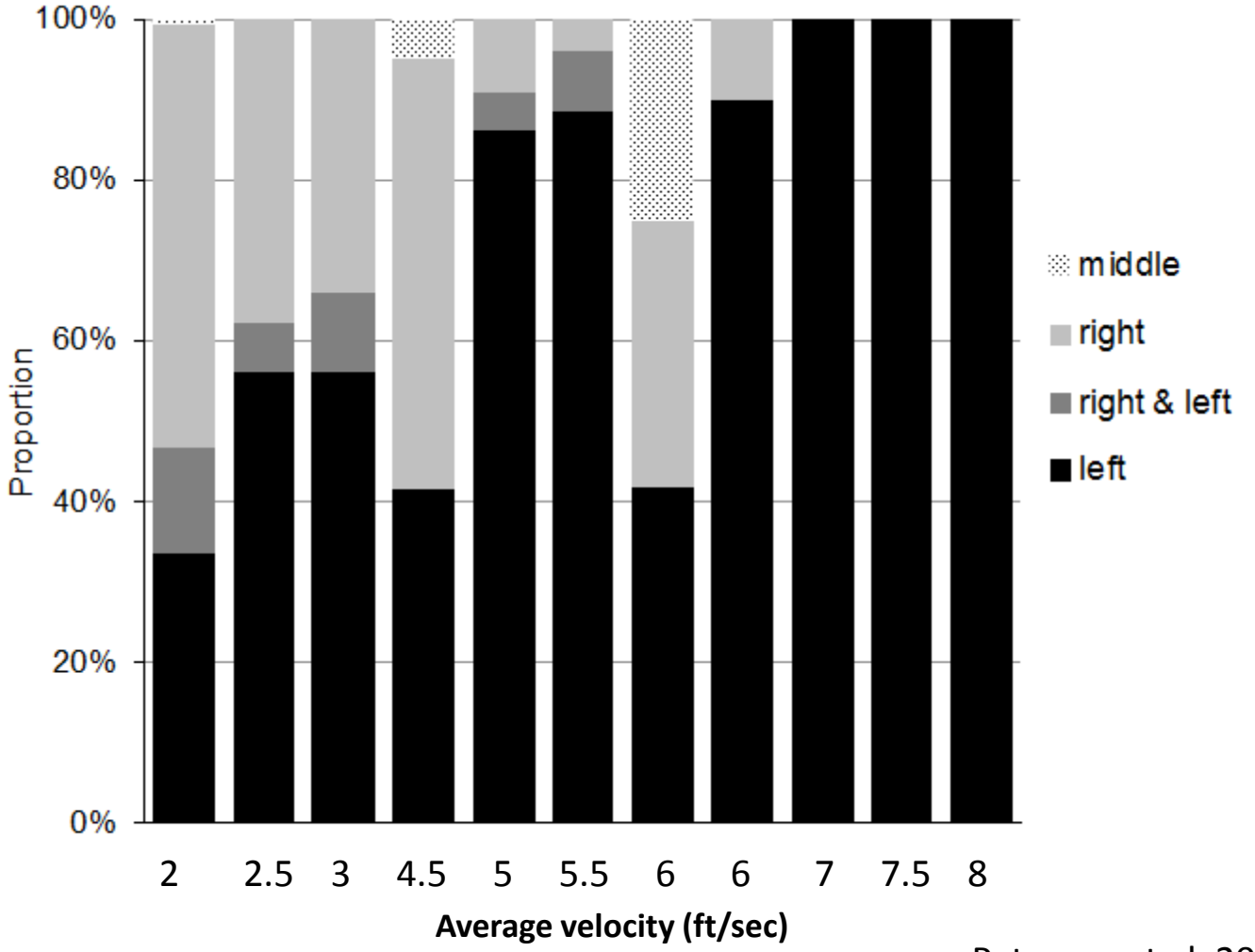
Participation

Average Velocity	*Fish (n)*	Avg. FL mm (SD)	Participation	Success	Trial No.
2	21	123 (20.2)	100% (21)	86% (18)	1
2.5	20	130 (20.1)	95% (19)	89% (17)	3
3	26	122 (25.8)	96% (25)	100% (25)	2
4.5	23	123 (25.8)	78% (18)	61% (11)	7
5	23	117 (19.9)	96% (22)	77% (17)	4
5.5	29	111 (18.0)	100% (29)	83% (24)	6
6	27	121 (24.0)	67% (18)	39% (7)	5
6	22	115 (28.1)	82% (18)	33% (6)	9
7	26	122 (25.2)	77% (20)	75% (15)	8
7.5	28	117 (16.6)	79% (22)	27% (6)	11
8	26	120 (21.5)	62% (16)	31% (5)	10

Fish size & passage success

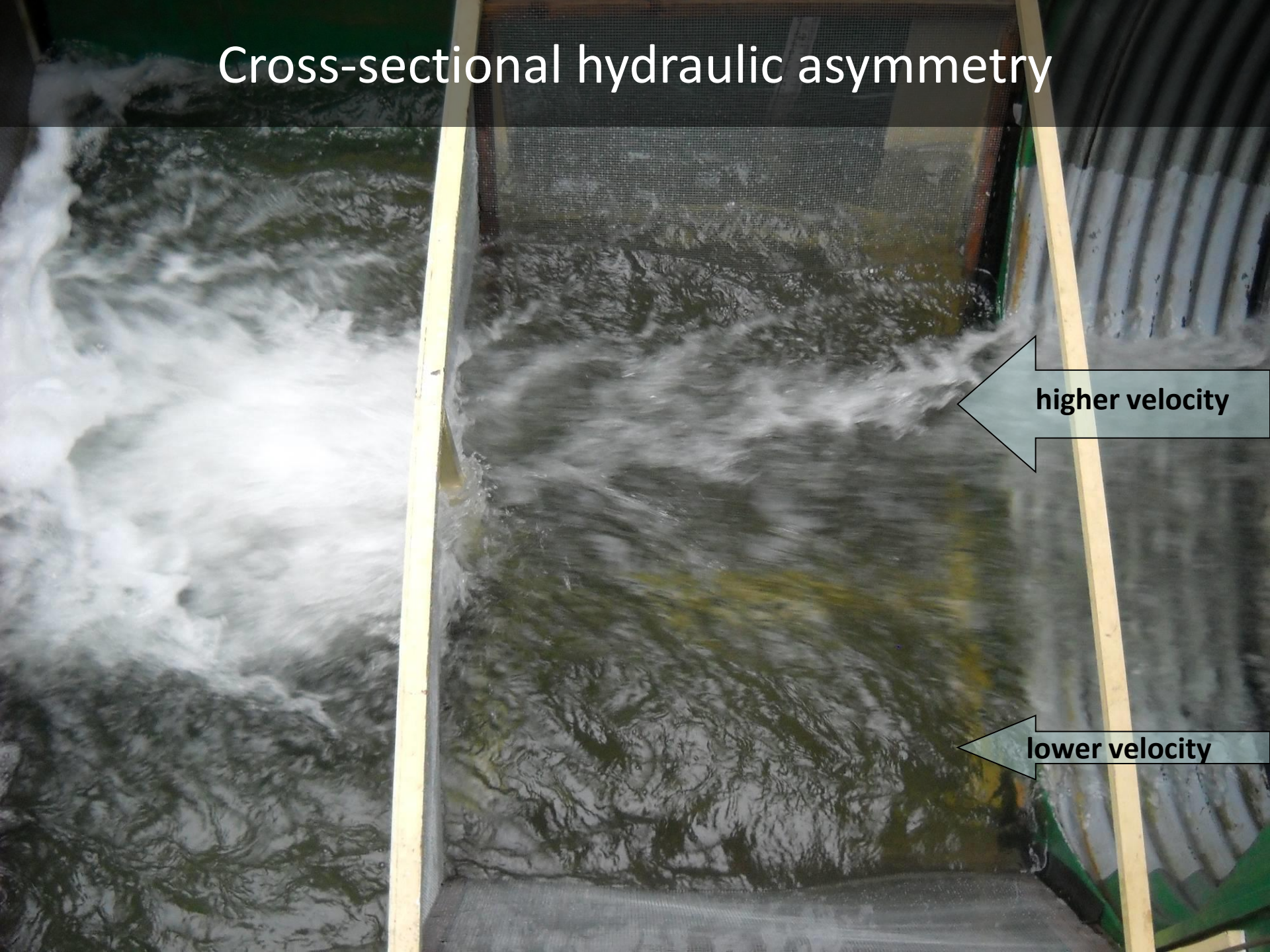


Culvert side and passage

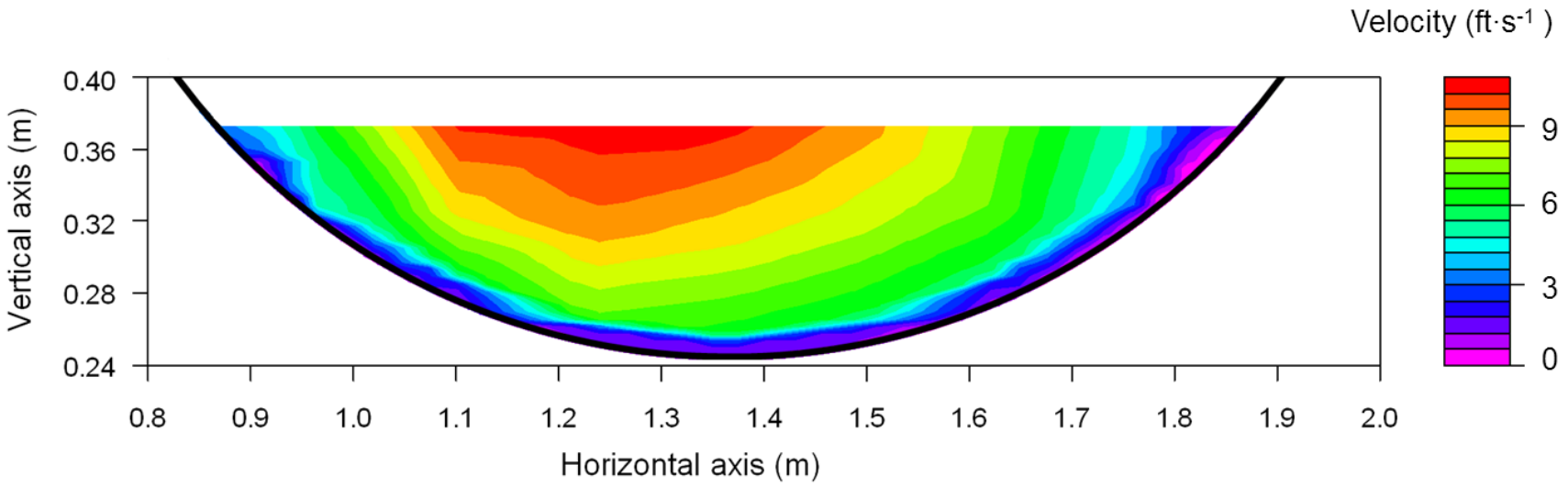


Peterson et al. 2013 NAJFM

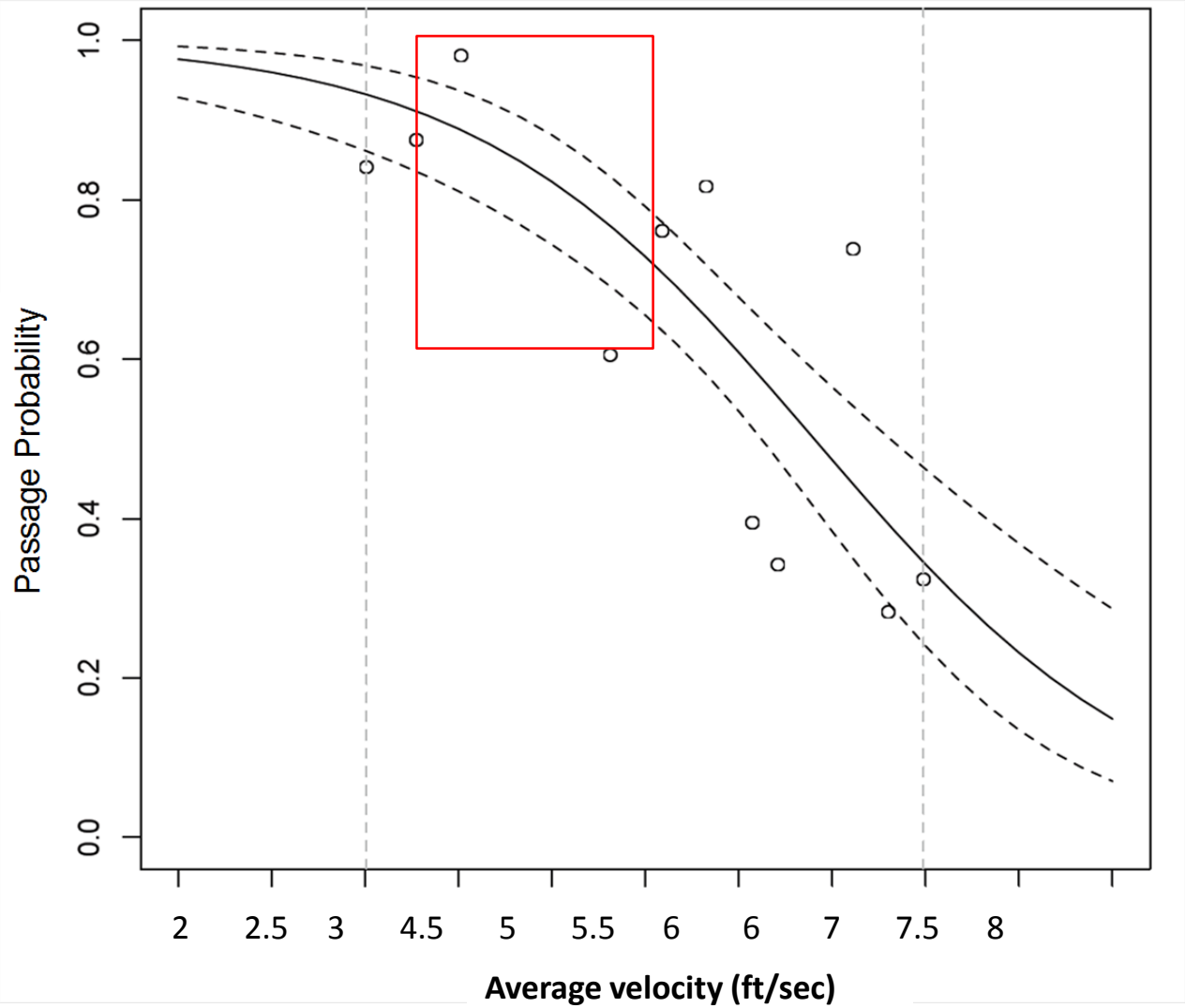
Cross-sectional hydraulic asymmetry

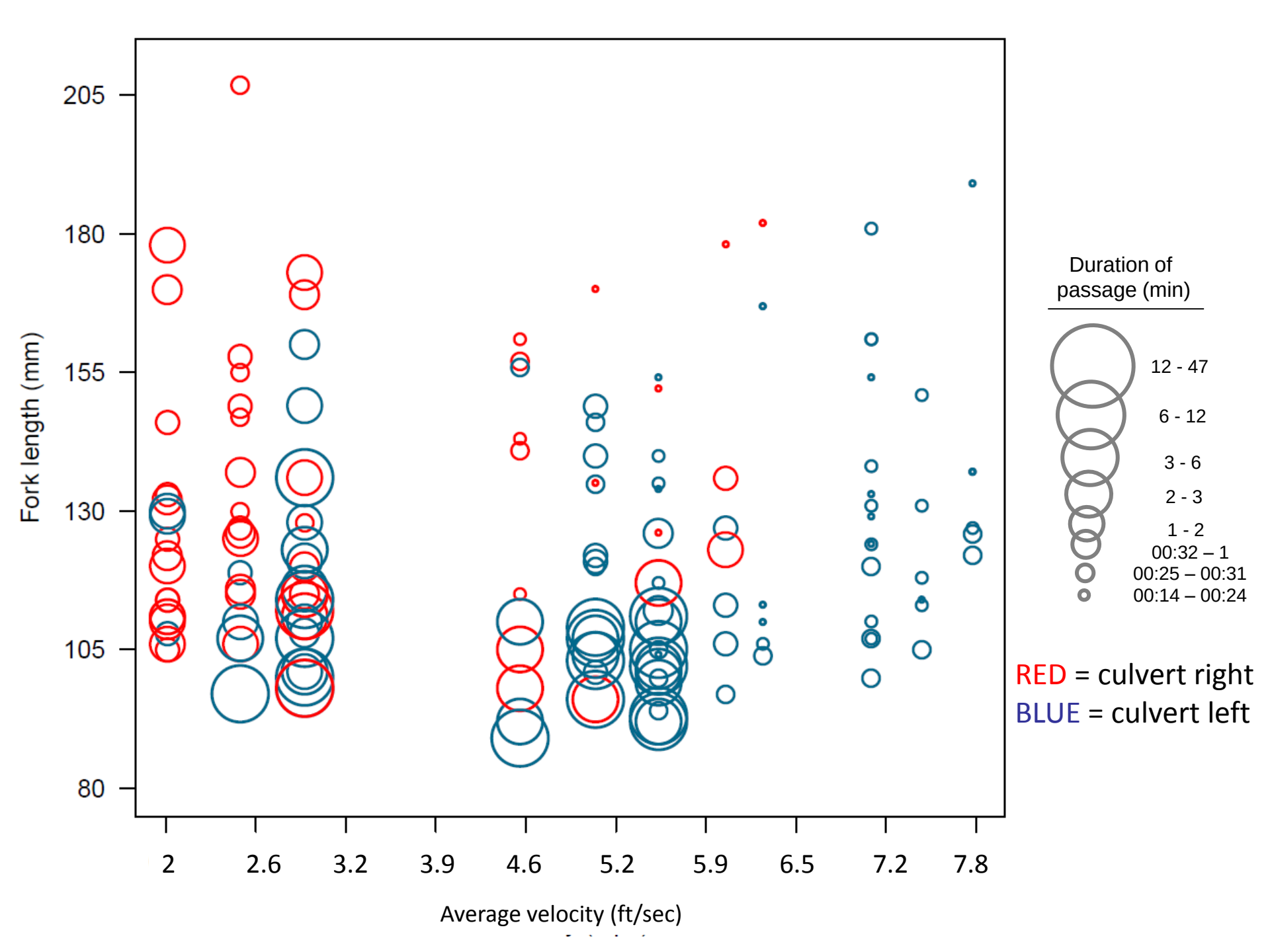


Cross sectional culvert velocities
(measured at a modeled 8 fps average velocity)

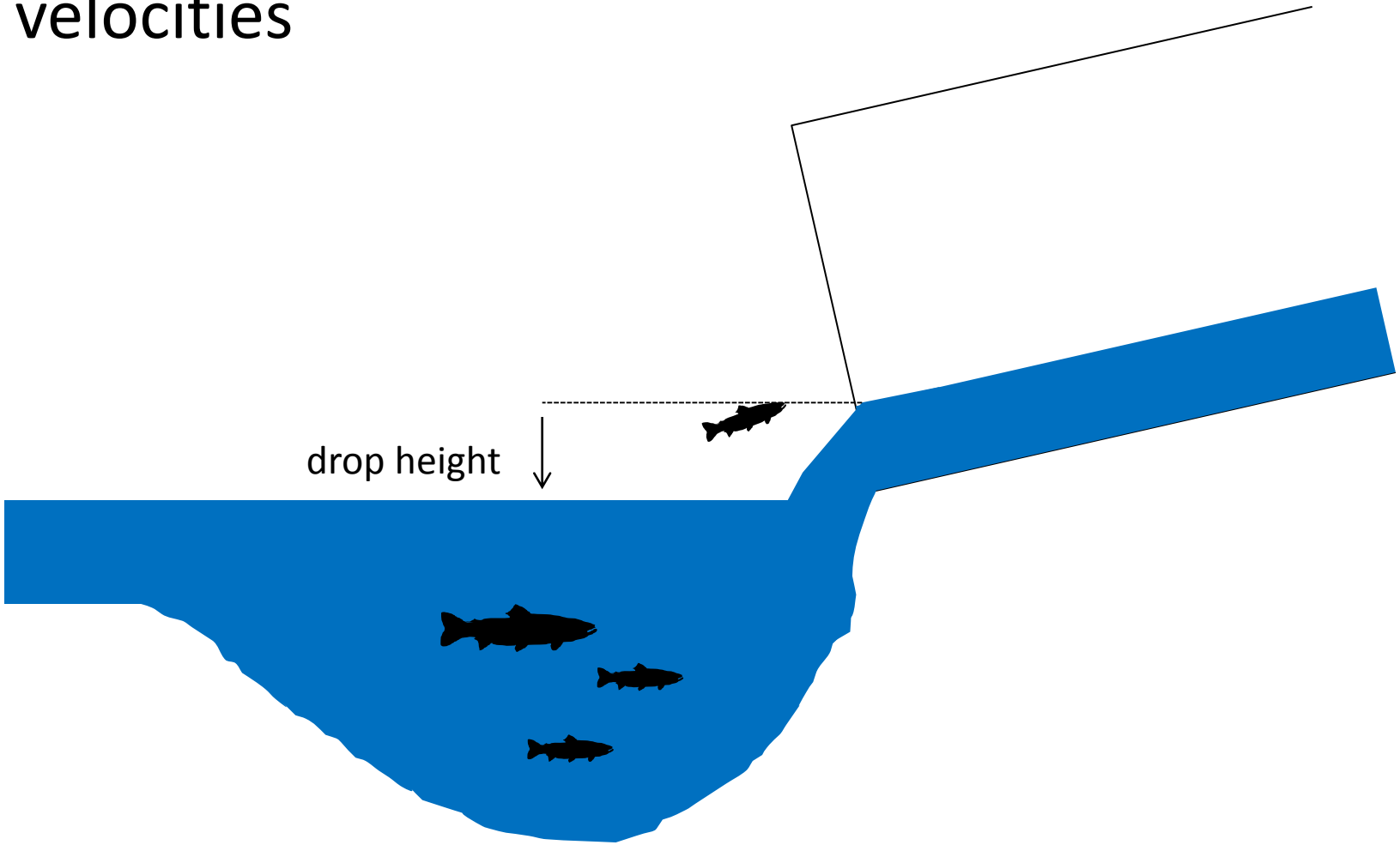


Passage probability using a logistic modeling approach

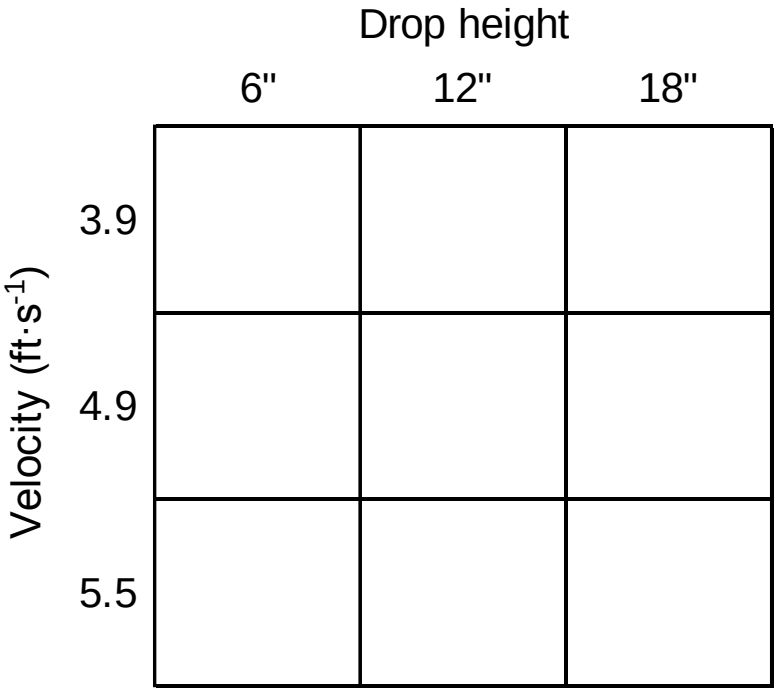



205
180
155
130
105
80
Fork length (mm)
2
2.6
3.2
3.9
4.6
5.2
5.9
6.5
7.2
7.8
Average velocity (ft/sec)
Duration of passage (min)
12 - 47
6 - 12
3 - 6
2 - 3
1 - 2
00:32 – 1
00:25 – 00:31
00:14 – 00:24
RED = culvert right
BLUE = culvert left

Study 2: Test culvert entry success and passage over a range of outfall drop heights and average velocities

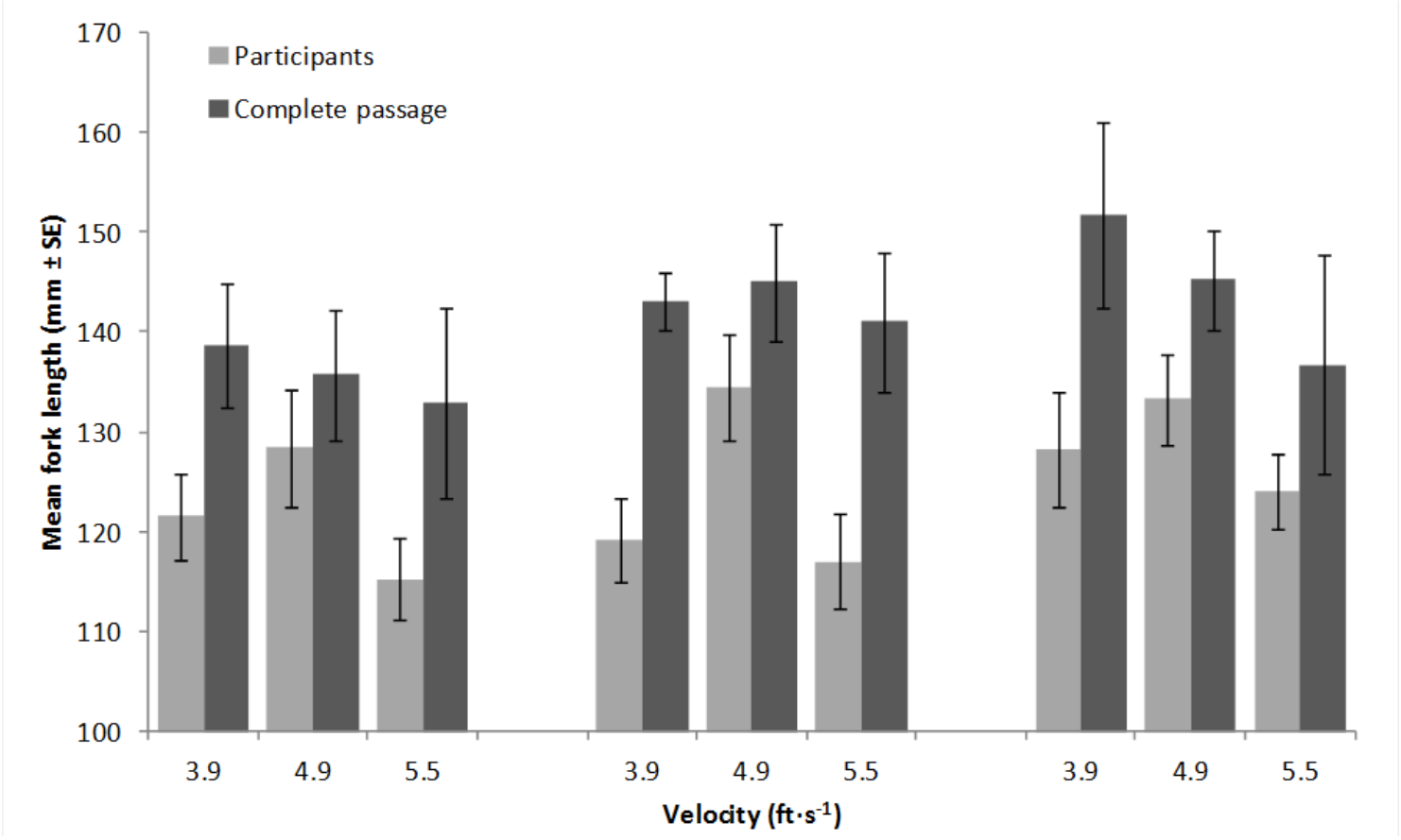


Study 2: Trial conditions



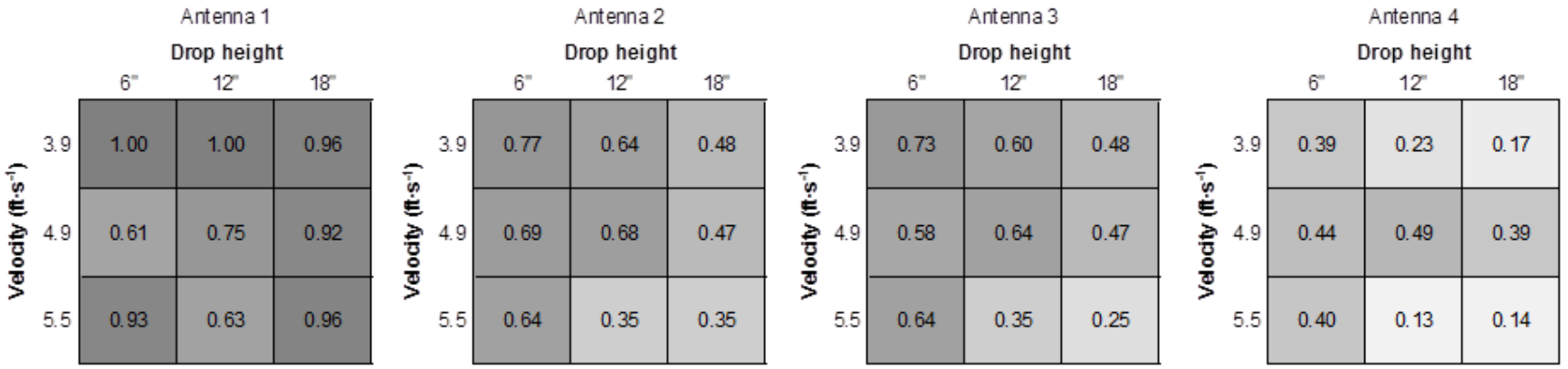
Each velocity and height combination was tested twice (18 total trials)

Participation and Passage by Velocity & Drop Height

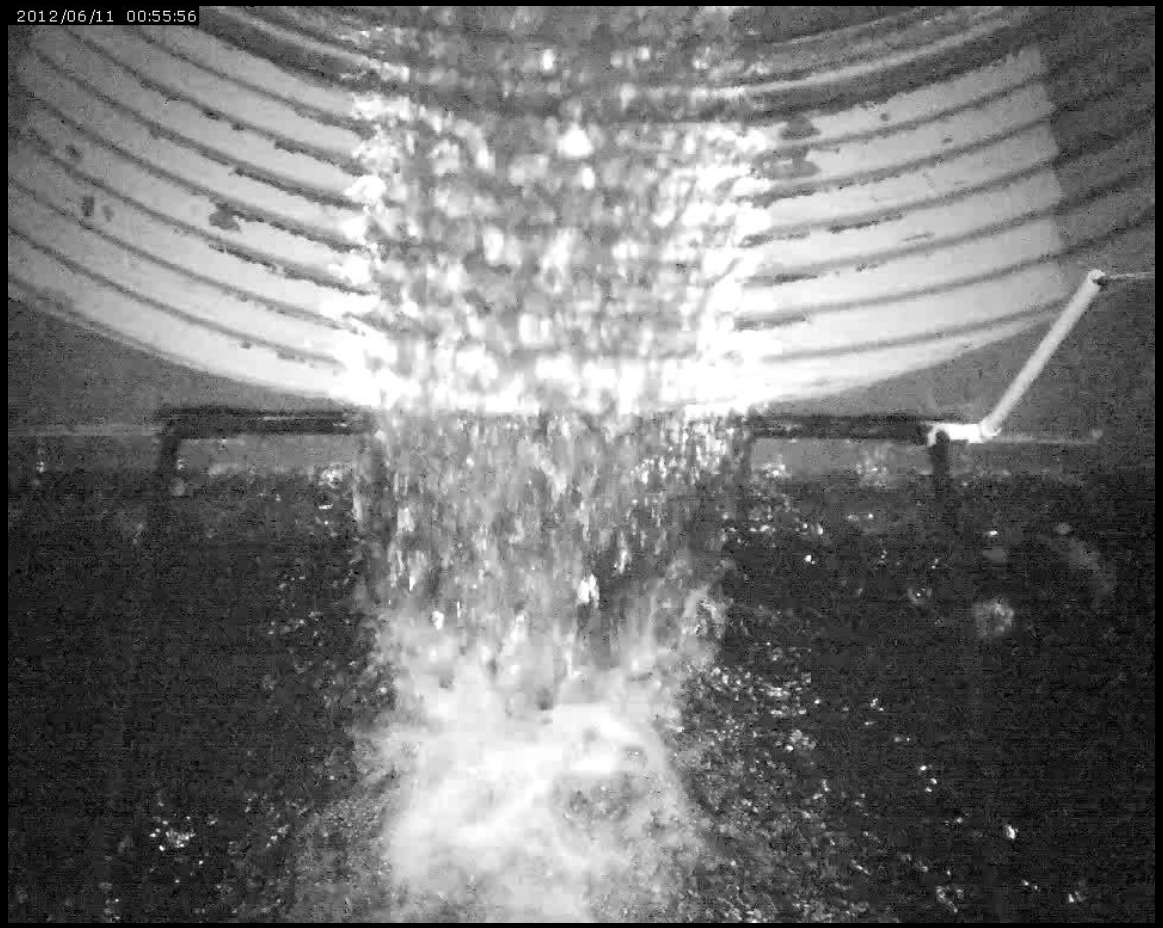


6” **12”** **18”**

Passage performance by distance through culvert



higher to lower passage success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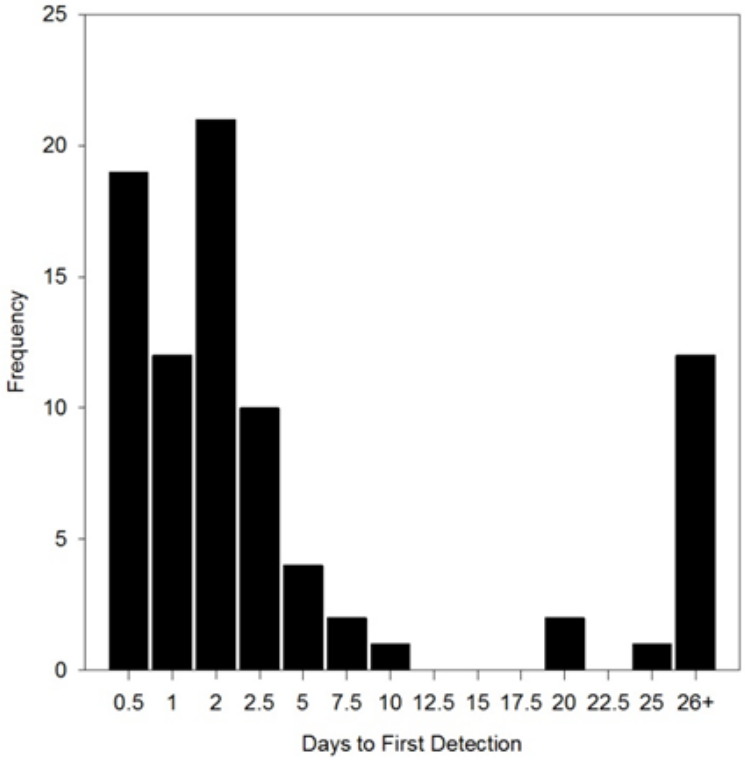
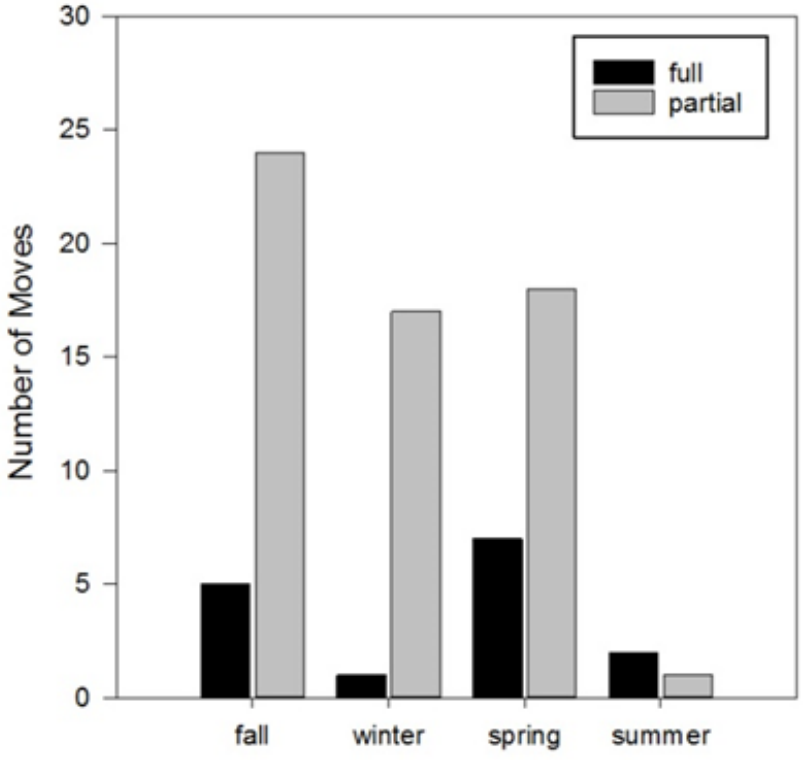
Study 3: Test applicability of experimental data to operational settings


barr
FROGTAPE
LOCTITE
KRYLON
Purdy
LEAKTITE
SHUR-LINE

Activity Patterns Post Release



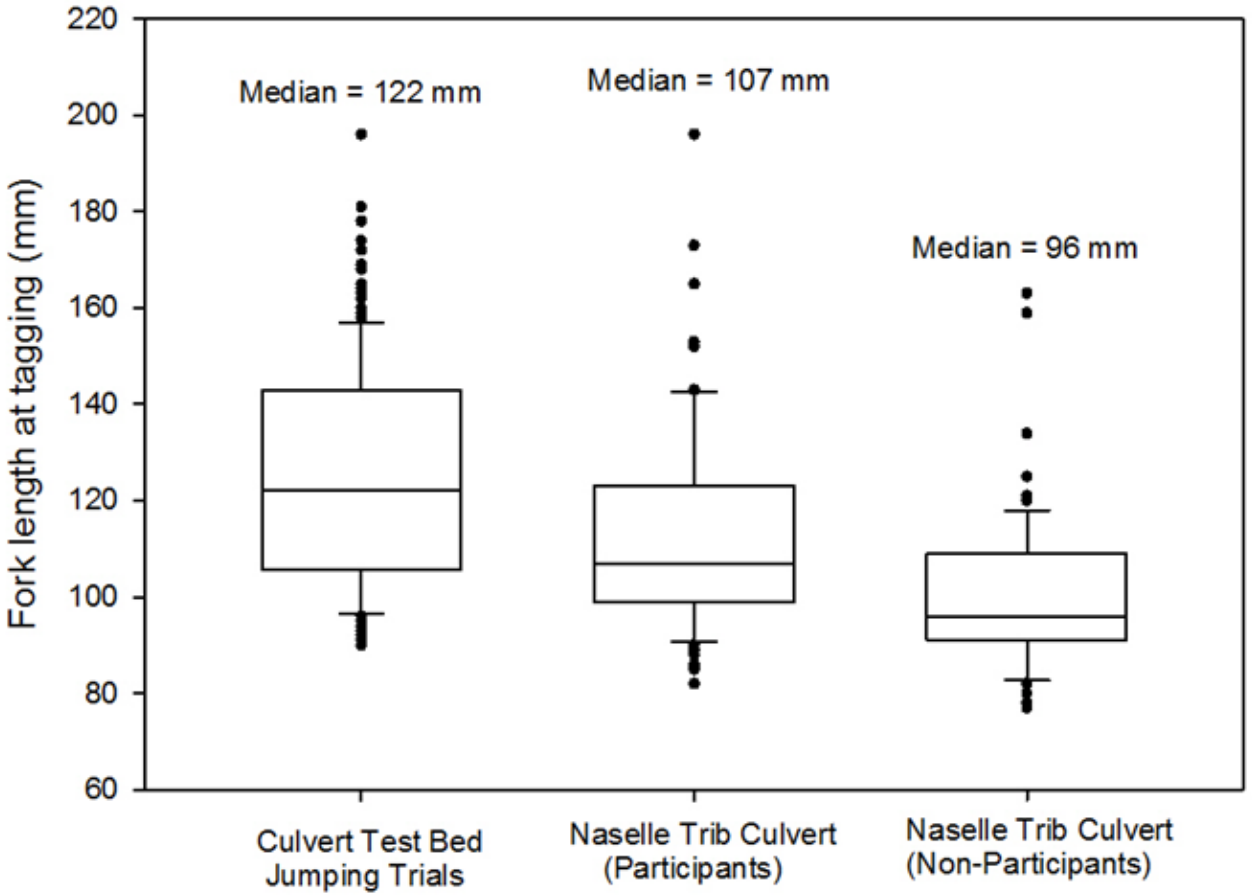
Days to first detect



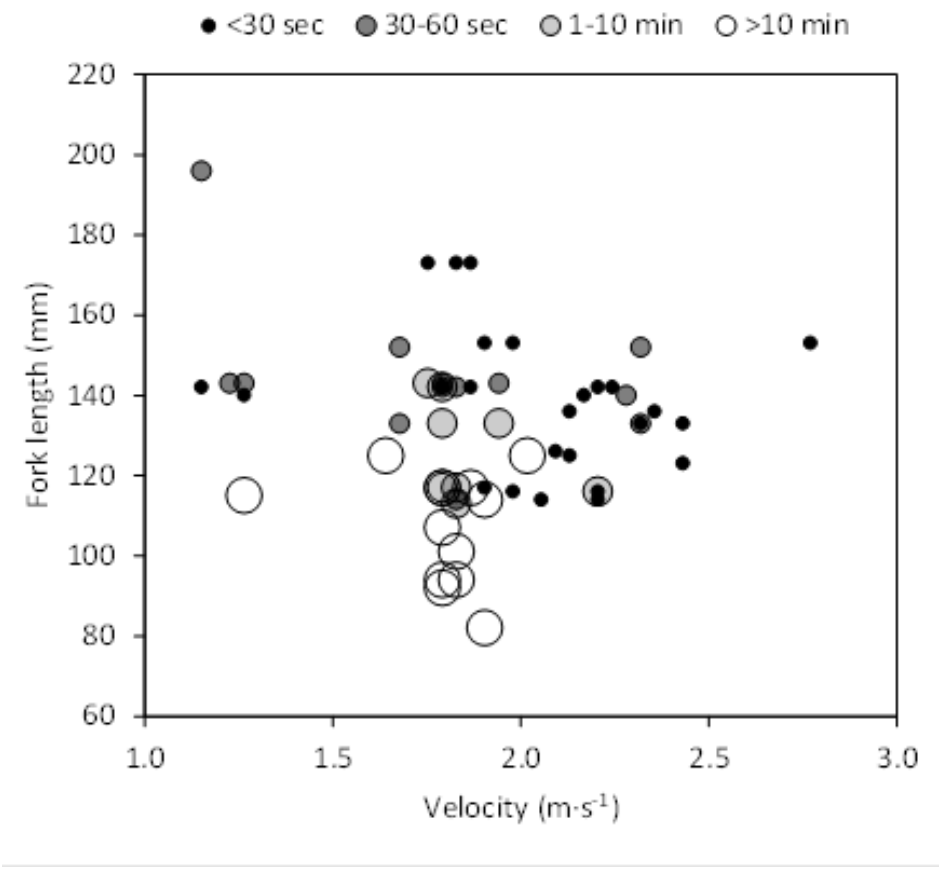
Seasonality

Fish Size Translation

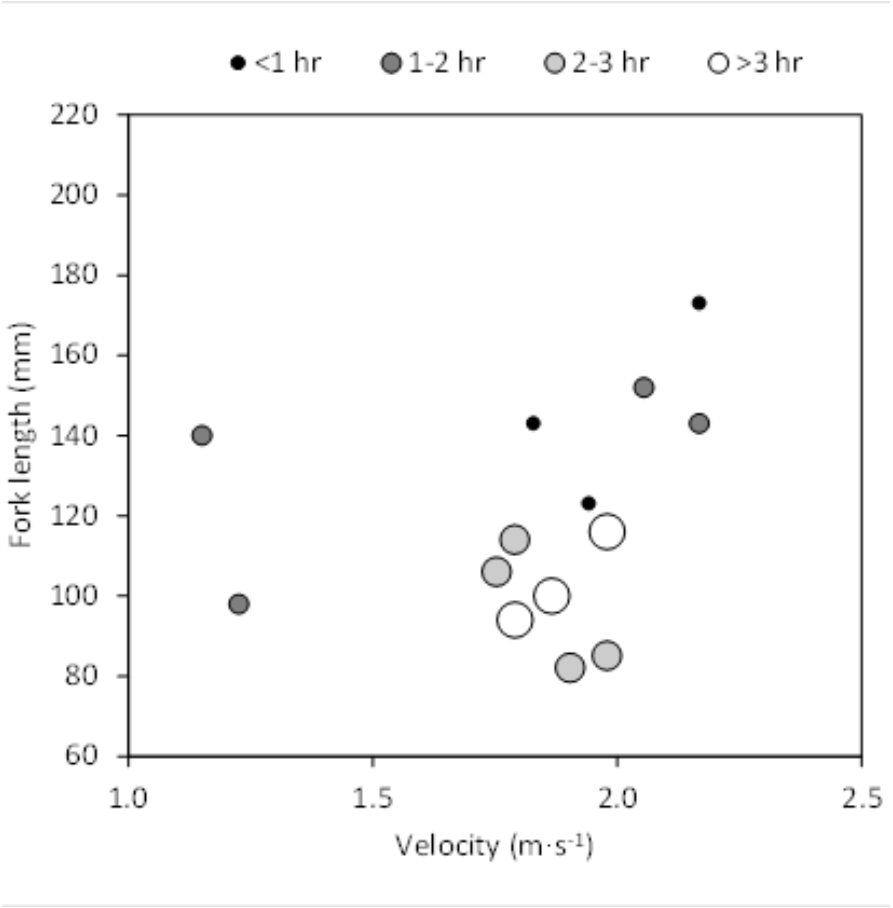
(Study 2 to Study 3)



Partial Passage (Ant 1 to Ant 2)



Complete Passage (Ant 1 to Ant 3)



Results summary

- Successful passage decreased with increased velocity, fish size was a minor factor
- Above 6 fps velocities, fish favored the reduced velocity side of pipe and traversed it more quickly
- Fish size was more important for successful passage when an outfall drop was introduced
- Combination of outfall drop and water velocity affected passage success with modest but obvious reductions over the ranges tested
- Experimental results translate to operational settings but results are modified by specific conditions

Conclusions

- Passage data was successfully used to fit a logistic model describing the probability of passage through corrugated metal culverts
- Empirical approach can aid in understanding how non-uniform flow conditions directly relate to fish passage
- Empirical studies testing fish passage could help inform culvert assessment protocols currently in use
- Understanding culverts in the context of partial passage should better identify their influence at the population level

Knowing what we do, what are the better questions?

What does partial passage mean to coastal cutthroat at the population level?

Is it really important for all species, all life stages to pass all the time?

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