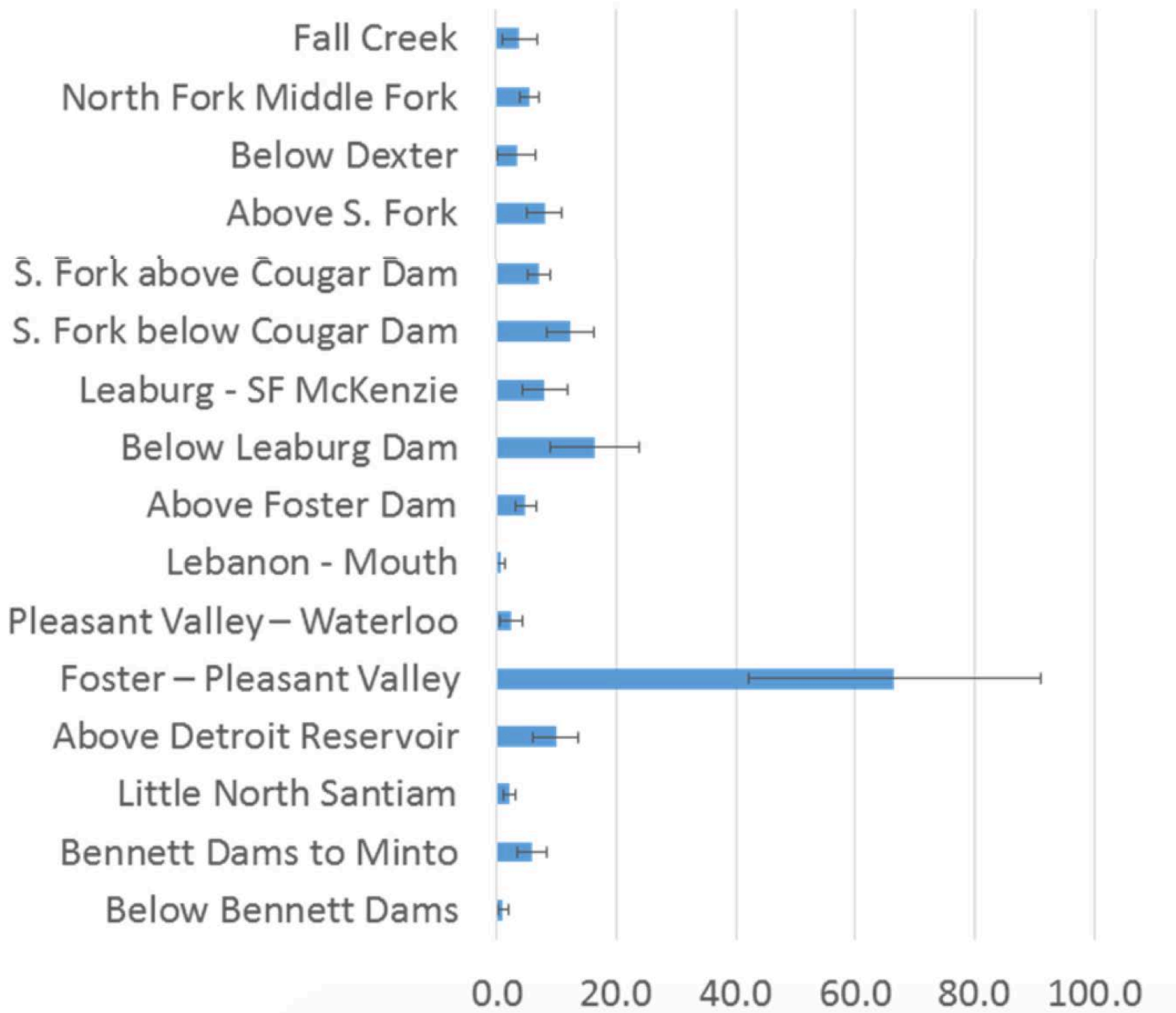


# Evaluation of Adult Chinook Salmon Behavior at the Foster Dam Adult Fish Facility on the South Santiam River, 2017

Christopher Caudill, George Naughton, Timothy Blubaugh, Tami Clabough,  
Matthew Keefer, Michael Jepson, Charles Boggs, & Grant Brink  
University of Idaho

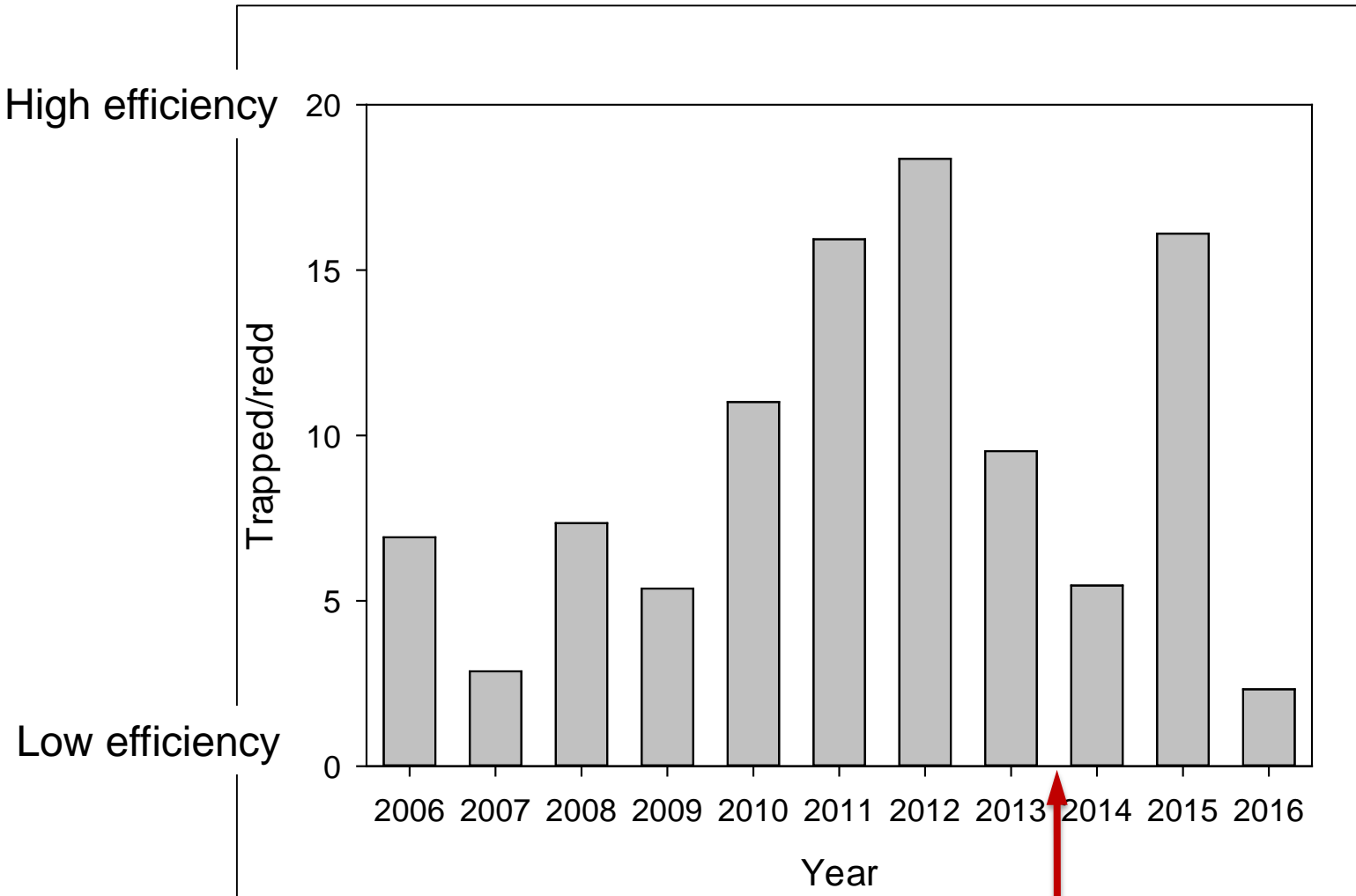


University of Idaho  
College of Natural Resources

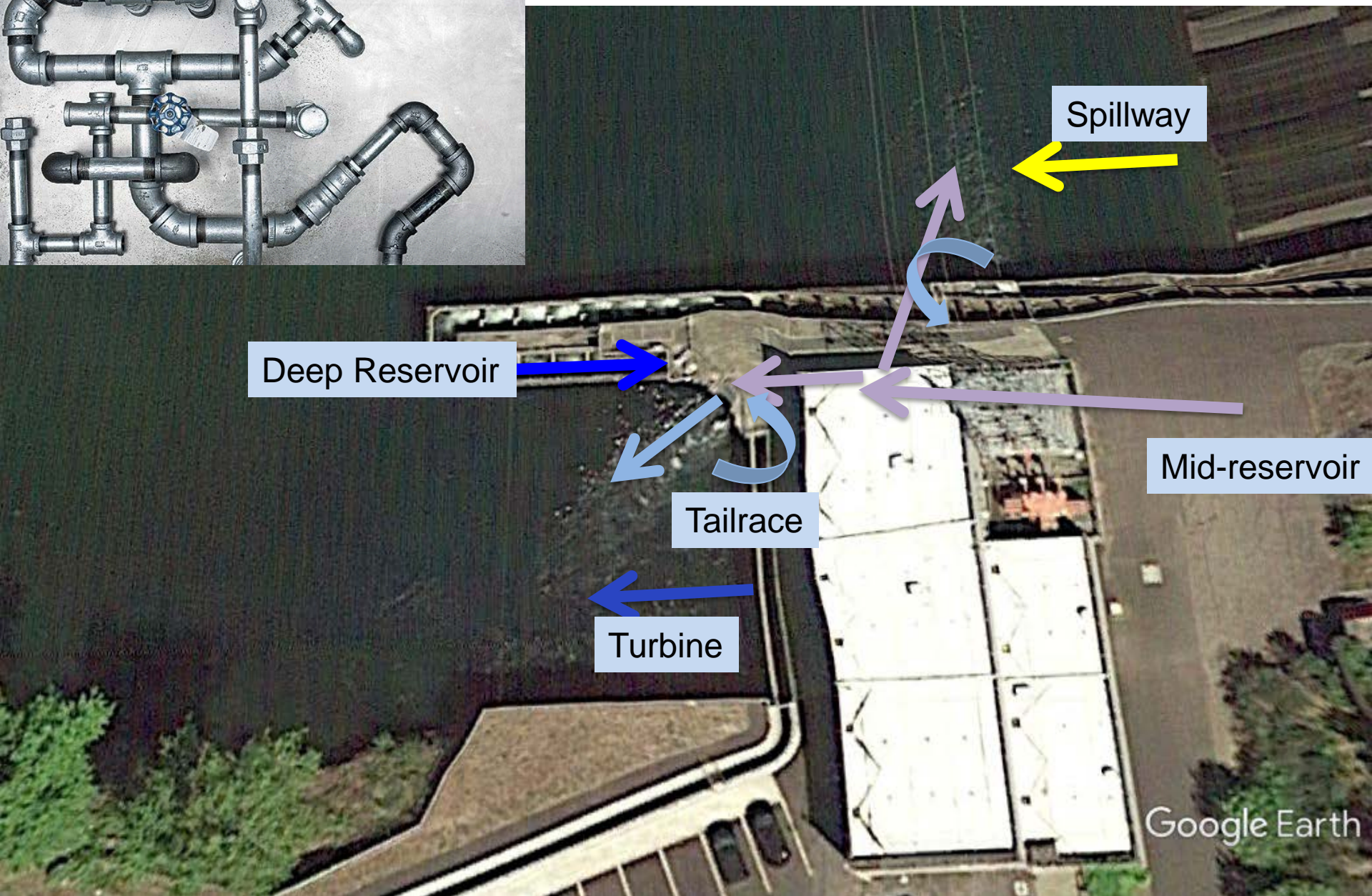


Average annual redds / km

# S. Santiam below FOS



**New Facility**



Deep Reservoir

Spillway

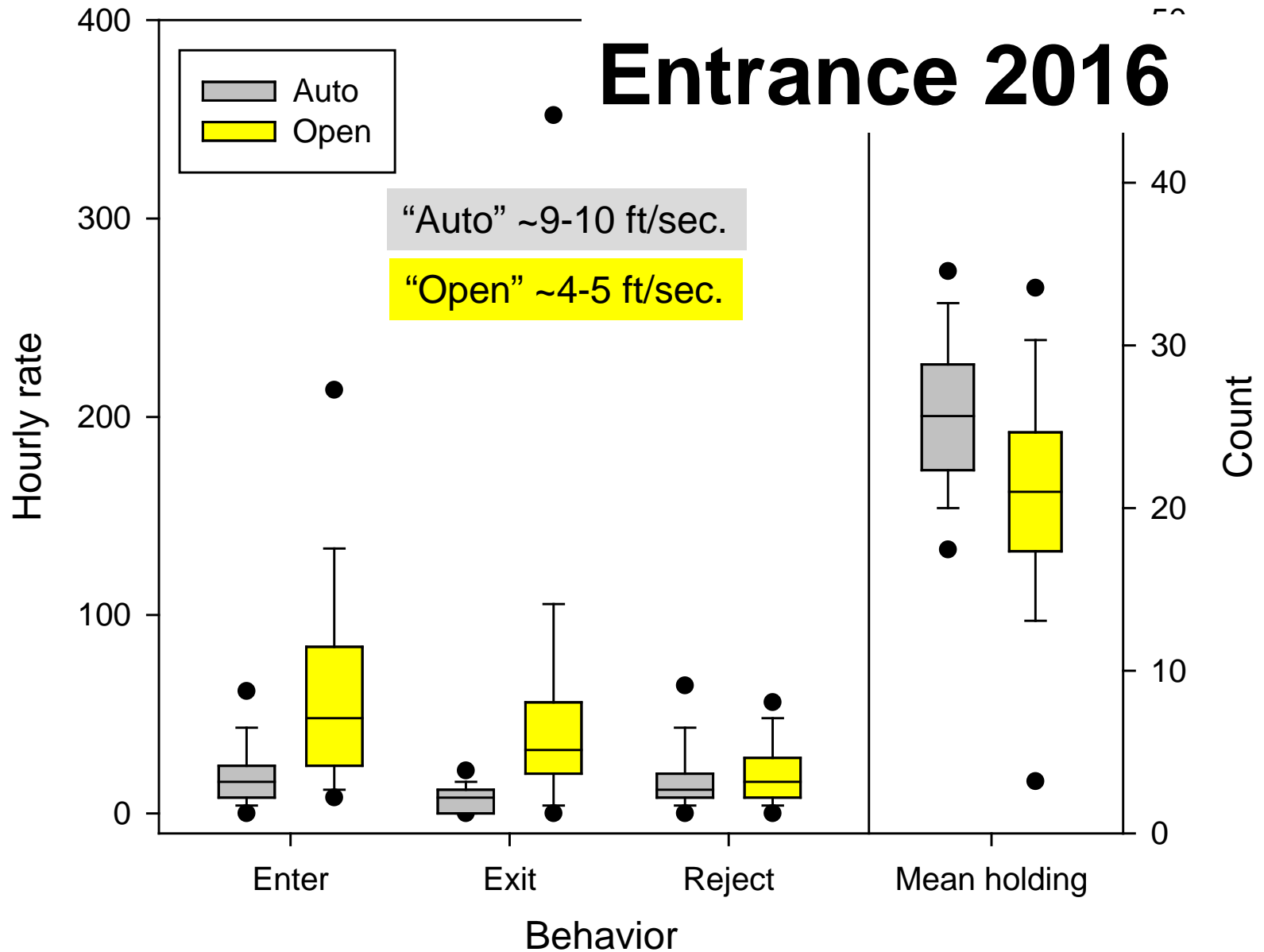
Mid-reservoir

Tailrace

Turbine

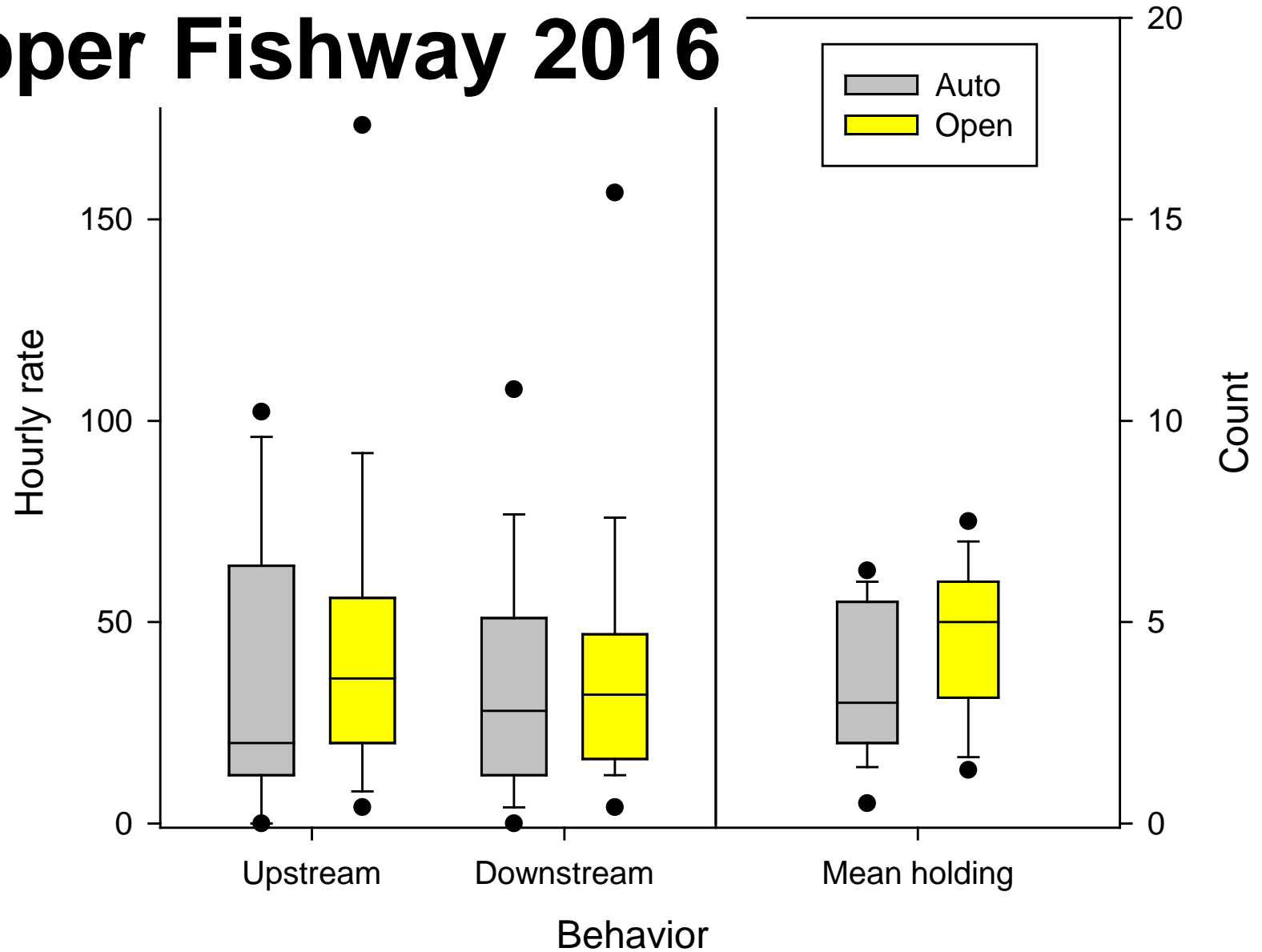
Google Earth

# Entrance 2016



**Decreased entrance velocity ~ increased activity at entrance**

# Upper Fishway 2016

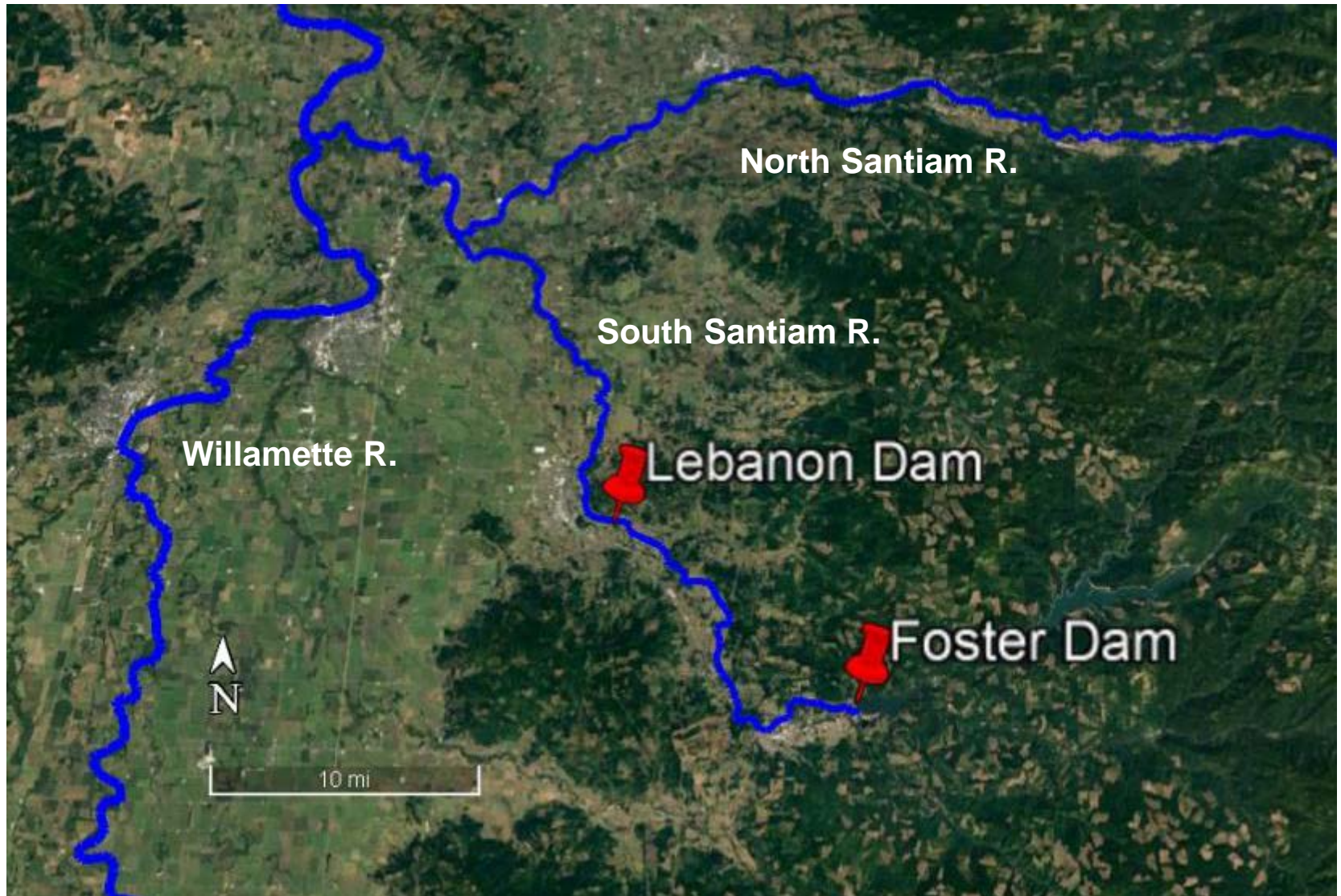


**Considerable activity at base of upper fishway, but no clear treatment effect**

# 2017 Objectives

- **Below FOS** Evaluate passage time, passage behavior, and estimate collection efficiency
  - Tailrace?
  - Fishway entrance and lower ladder (Velocity treatments)?
  - Upper fishway and trap entrance?
- **Monitor individual salmon:** Develop collection and tagging methods at Lebanon Dam
- Video monitoring of behavior and event rates at trap entrance
- **Above FOS** Reservoir releases, fallback, thermal experience and PSM

# Lebanon Trap Installation





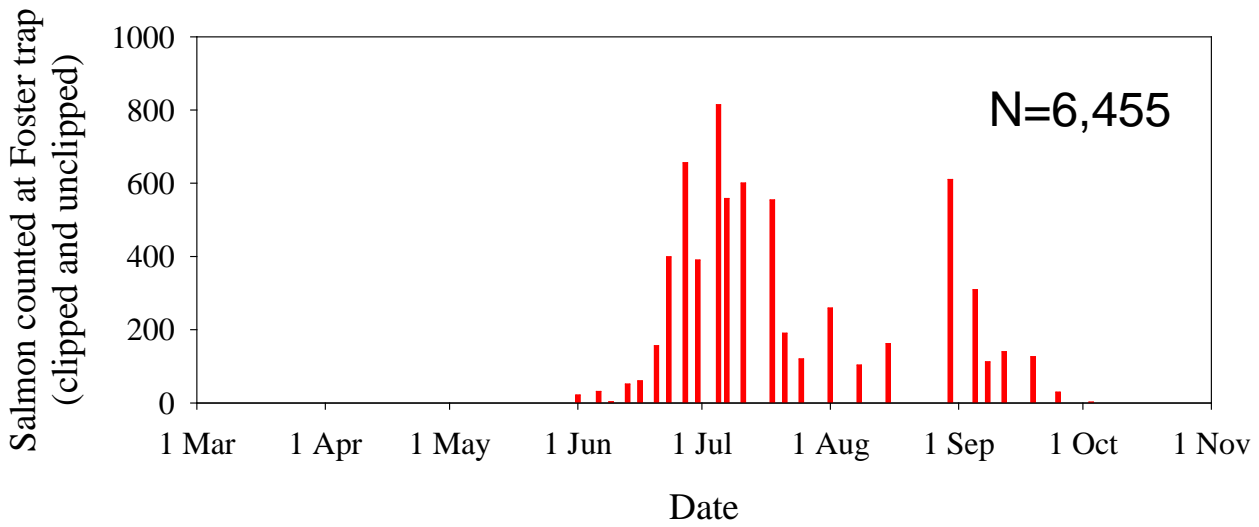
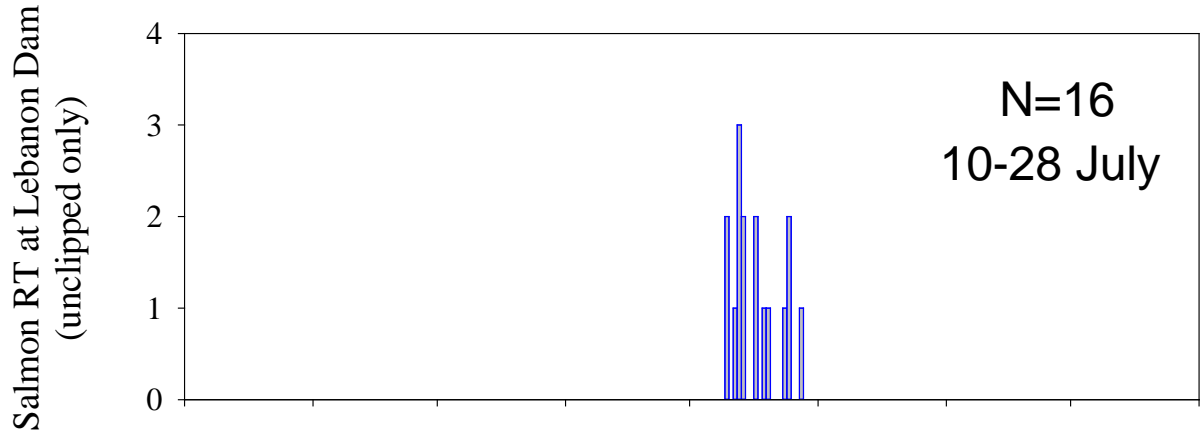
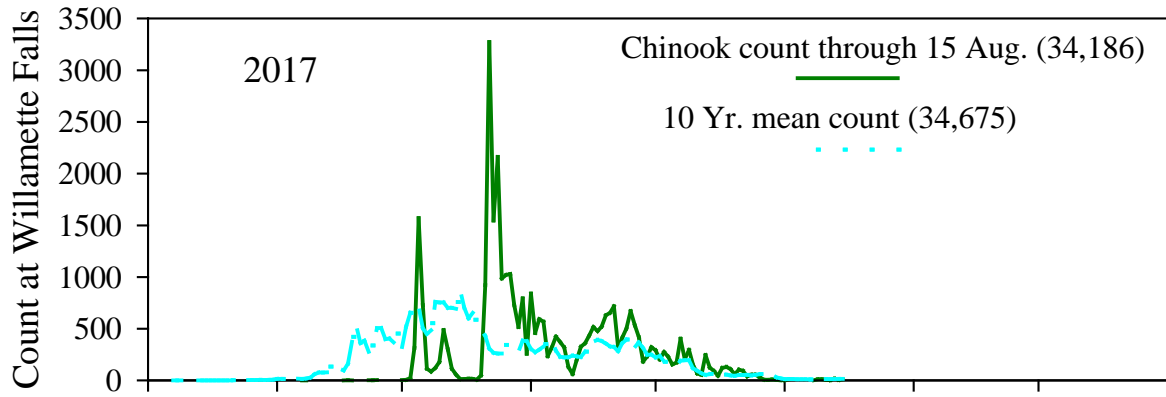
# Lebanon Trap Installation



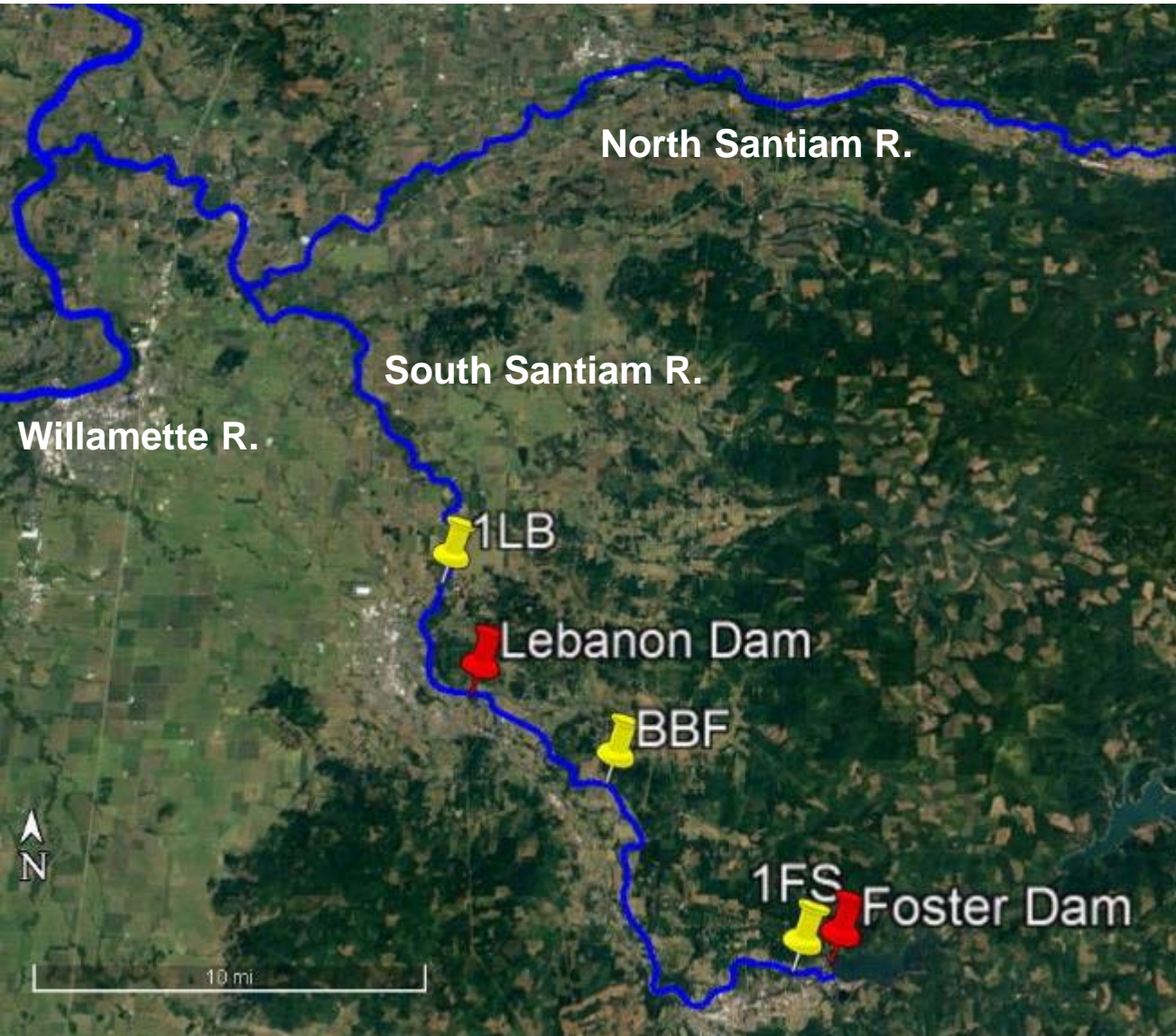






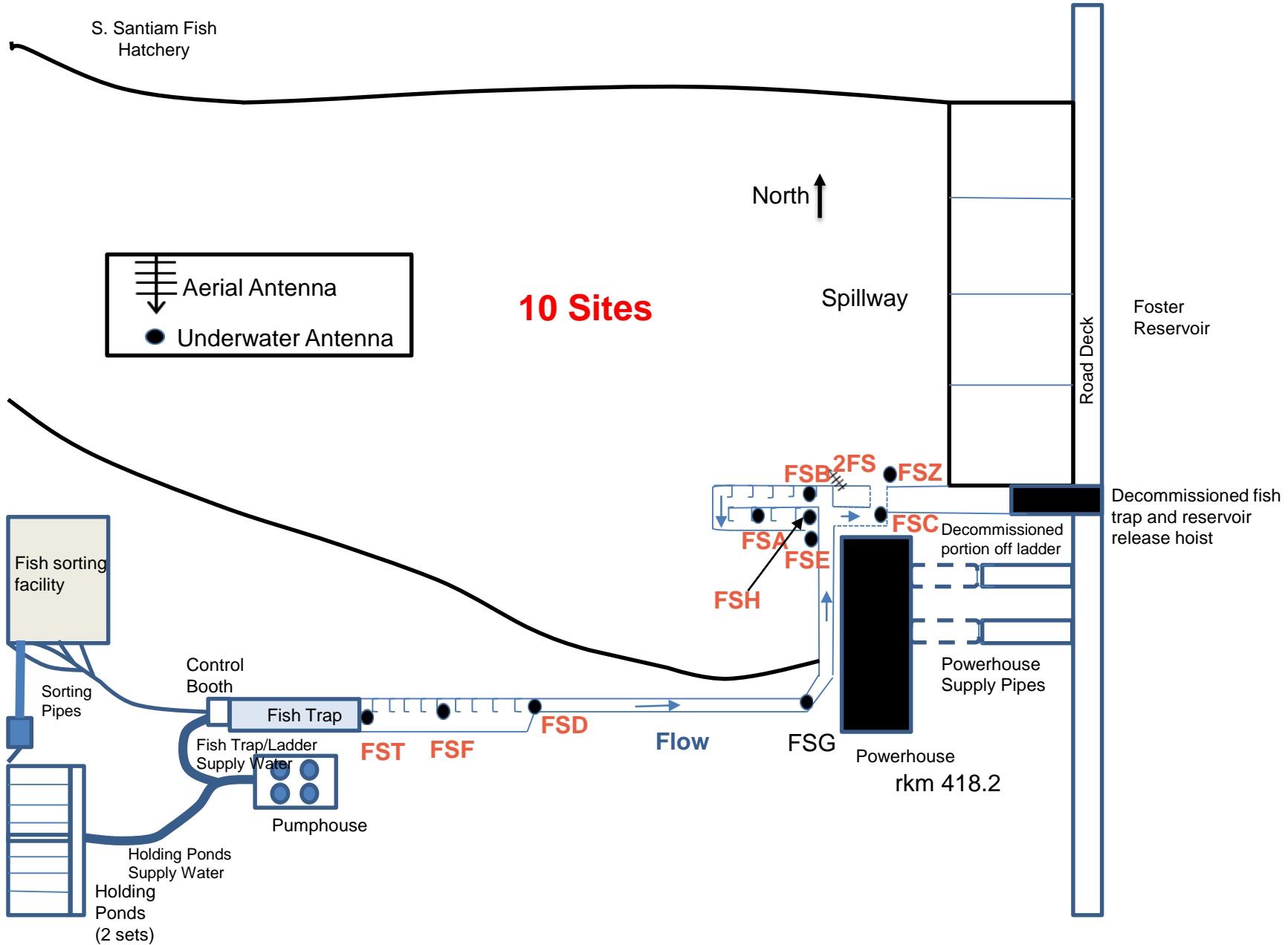


# Lebanon Telemetry Monitoring



- **1LB** ~6.4 RKM downstream of Lebanon Dam
- **BBF** ~10.1 RKM upstream of Lebanon Dam
- **1FS** ~1.6 RKM downstream of Foster Dam

# Foster Dam – Radio-telemetry Array



# Foster Dam – Temperature monitoring

S. Santiam Fish Hatchery

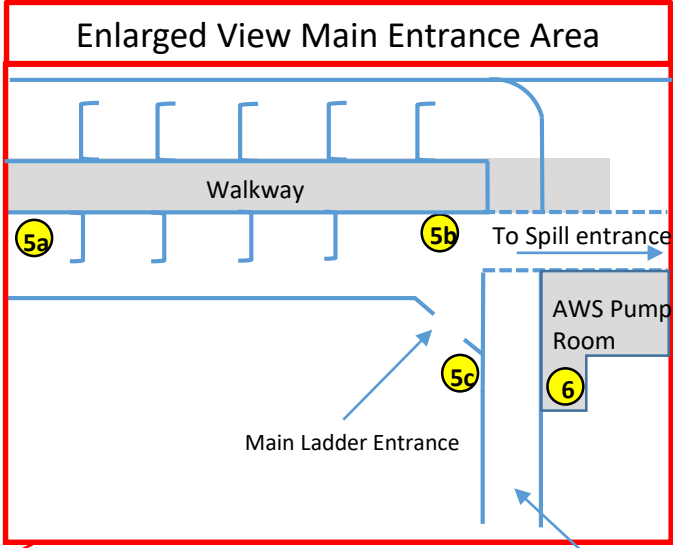
● Temperature loggers

11

North Bank

1

12 Sites



Spillways

Spillway Entrance

Road Deck

12

4

2

3b

Decommissioned ladder/trap/hopper

Powerhouse Supply Pipes

South Bank

New fish ladder channel

7

8

9

Upper Ladder

10

Powerhouse

Fish sorting facility

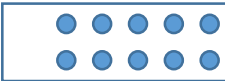
Anesthetic Tank

Trap Flume

Trap Controls

Trap False Weir

Fish Trap

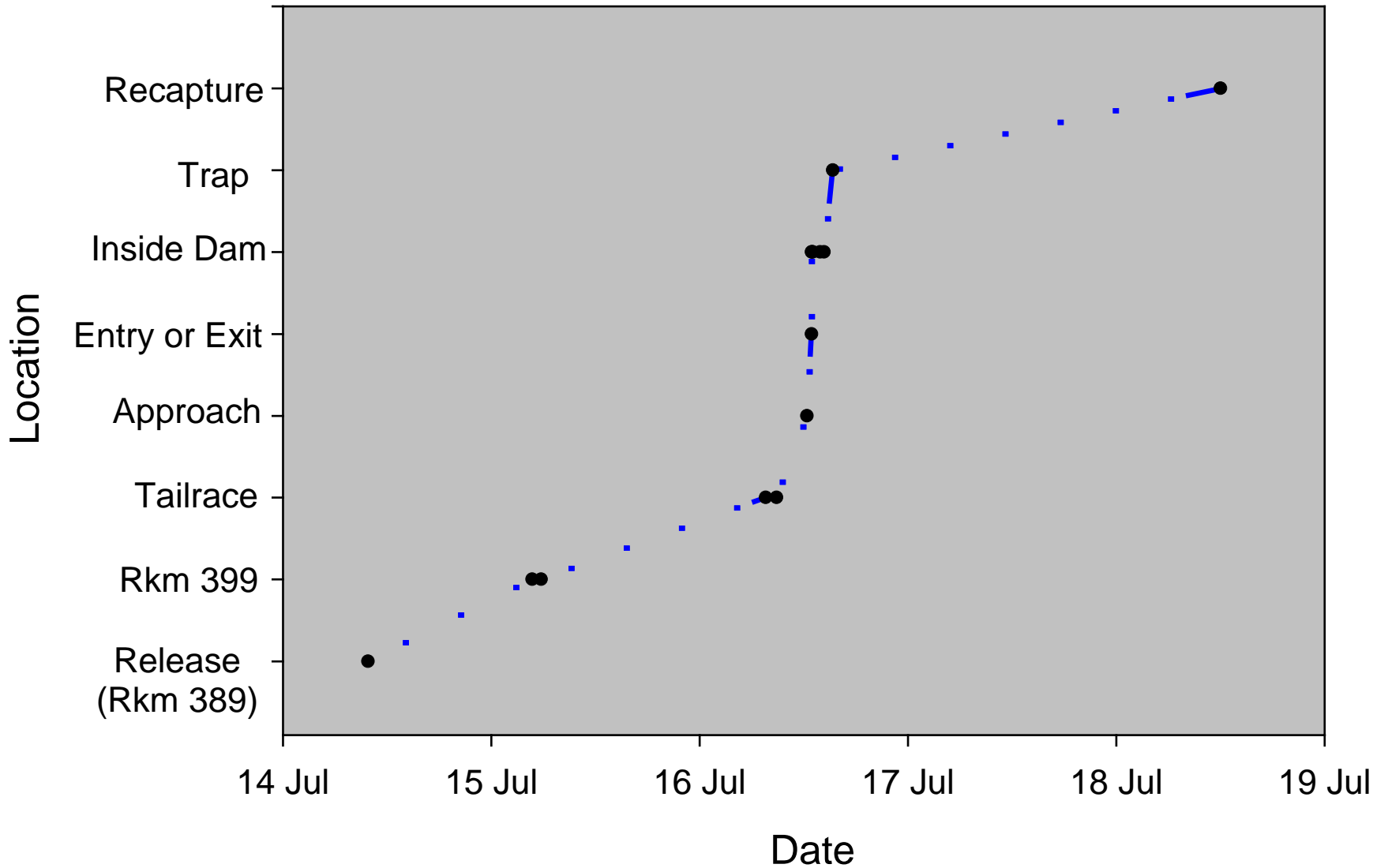


Holding Ponds

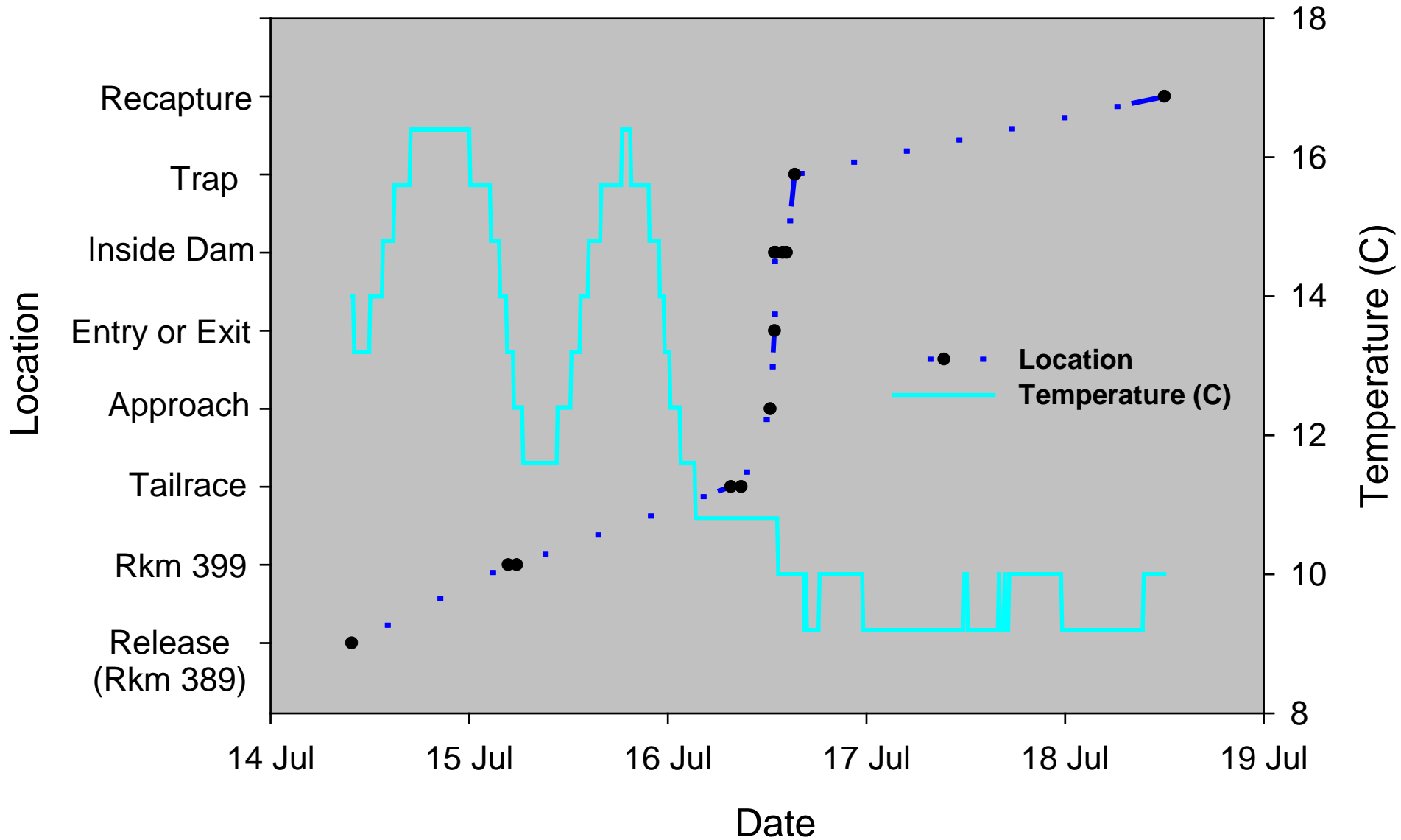
**FOS Forebay String**



# Spring Chinook 18/94



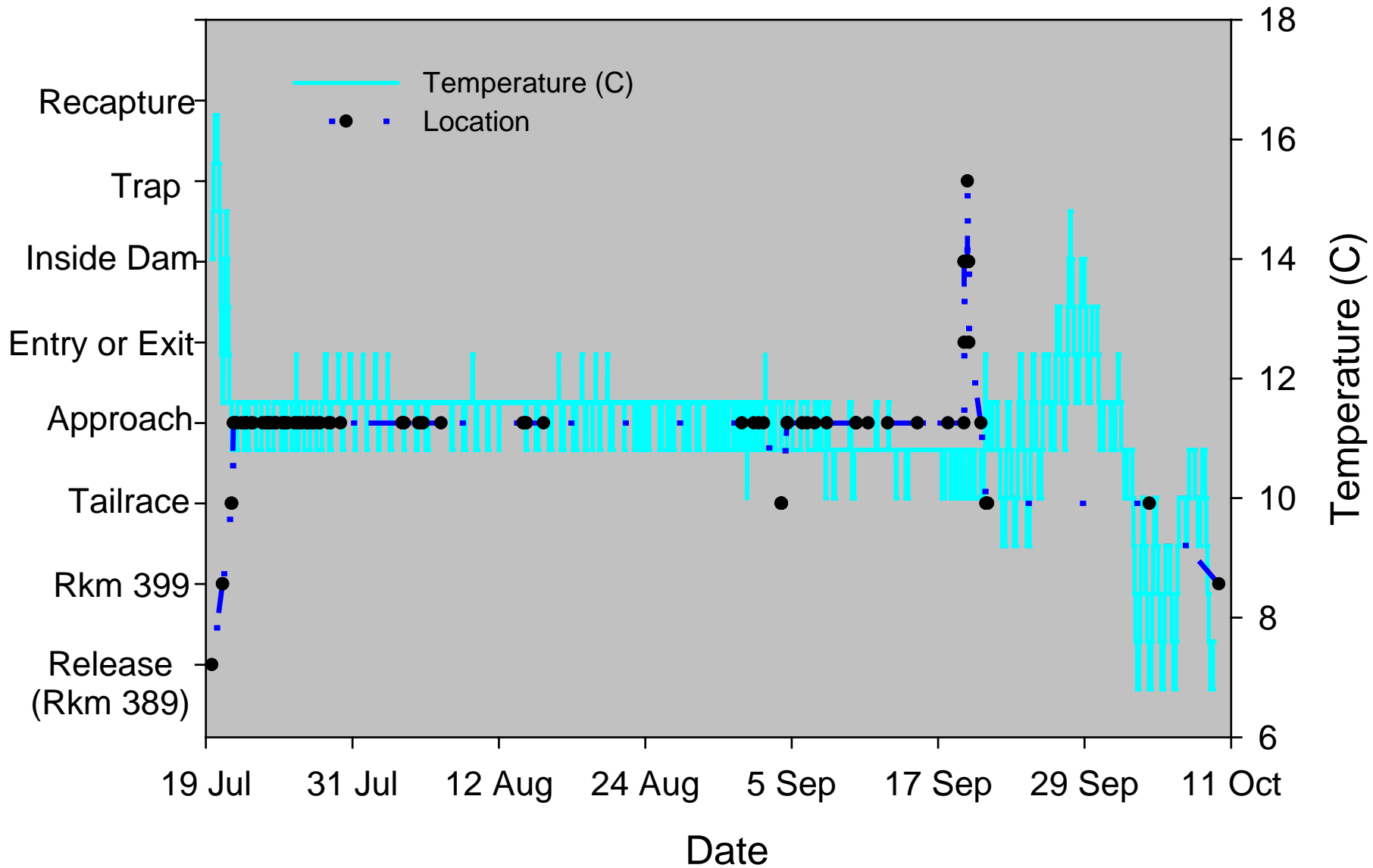
# Spring Chinook 18/94





# Spring Chinook 18/86

Recaptured in Little Wiley Creek on 9 October 2017



# Foster RT Passage Times

Fate	Passage segment	N	Min (d)	Max (d)	Median (d)	Mean (d)
To Foster trap	F1 to A1	7	0.1	0.3	0.2	0.2
	F1 to E1	7	0.2	19.4	2.5	6.3
	F1 to trap	7	0.3	35.6	2.7	14.1
	A1 to trap	7	0.1	35.4	2.5	13.9
	E1 to trap	7	0.1	30.4	0.2	7.7
Below Foster	F1 to A1	9	0.2	1.0	0.28	0.4
	F1 to E1	8	4.6	60.1	28.5	27.3
	F1 to trap	7	5.6	60.3	44.8	36.2
	A1 to trap	7	5.4	60.2	44.6	35.8
	E1 to trap	7	0.1	22.7	1.0	6.5

F1=First tailrace detection  
A1=First approach at dam

E1=First entrance at dam  
trap=detection below presort pool

# Foster RT Passage Times

Fate	Passage segment	N	Min (d)	Max (d)	Median (d)	Mean (d)
To Foster trap	F1 to A1	7	0.1	0.3	0.2	0.2
	F1 to E1	7	0.2	19.4	2.5	6.3
	F1 to trap	7	0.3	35.6	2.7	14.1
	A1 to trap	7	0.1	35.4	2.5	13.9
	E1 to trap	7	0.1	30.4	0.2	7.7
Below Foster	F1 to A1	9	0.2	1.0	0.28	0.4
	F1 to E1	8	4.6	60.1	28.5	27.3
	F1 to trap	7	5.6	60.3	44.8	36.2
	A1 to trap	7	5.4	60.2	44.6	35.8
	E1 to trap	7	0.1	22.7	1.0	6.5

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	F1 to E1	7	0.2	19.4	2.5	6.3
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	F1 to trap	7	5.6	60.3	44.8	36.2
	A1 to trap	7	5.4	60.2	44.6	35.8
	E1 to trap	7	0.1	22.7	1.0	6.5

F1=First tailrace detection  
A1=First approach at dam

E1=First entrance at dam  
trap=detection below presort pool

**Not  
Collected**

Code	Total # Apps	Total # Ents	Total # Exits
84	42	0	0
86	70	1	1
100	27	1	1
90	105	3	3
83	44	5	5
93	44	6	6
91	28	7	7
97	127	9	9
96	104	15	15

**One stray  
(~6%)**

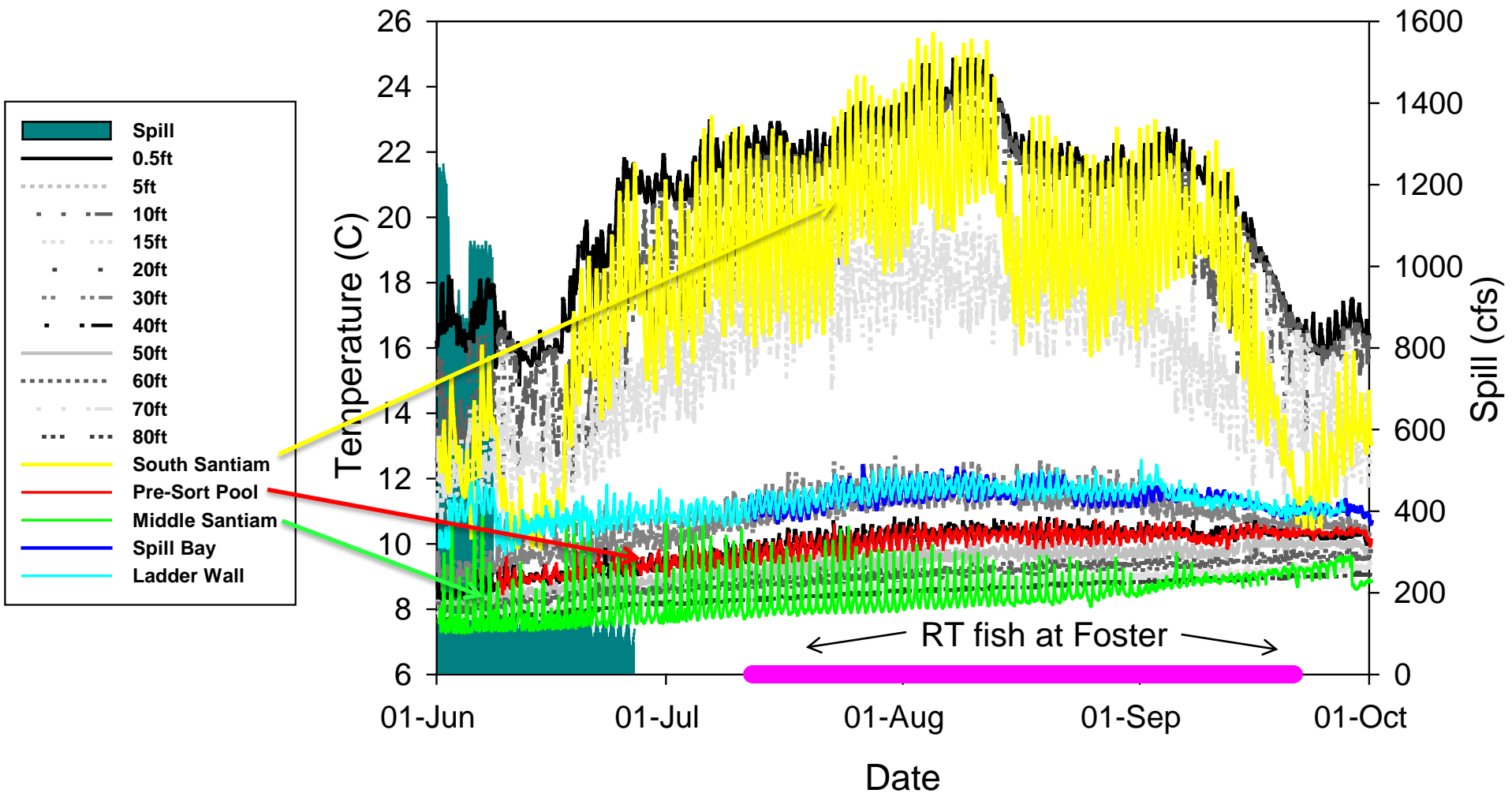
**One Reported  
Harvest: (~6%)**

**Overall  
Collection  
Ratio:  
46.7% (43.8-  
50.0%)**

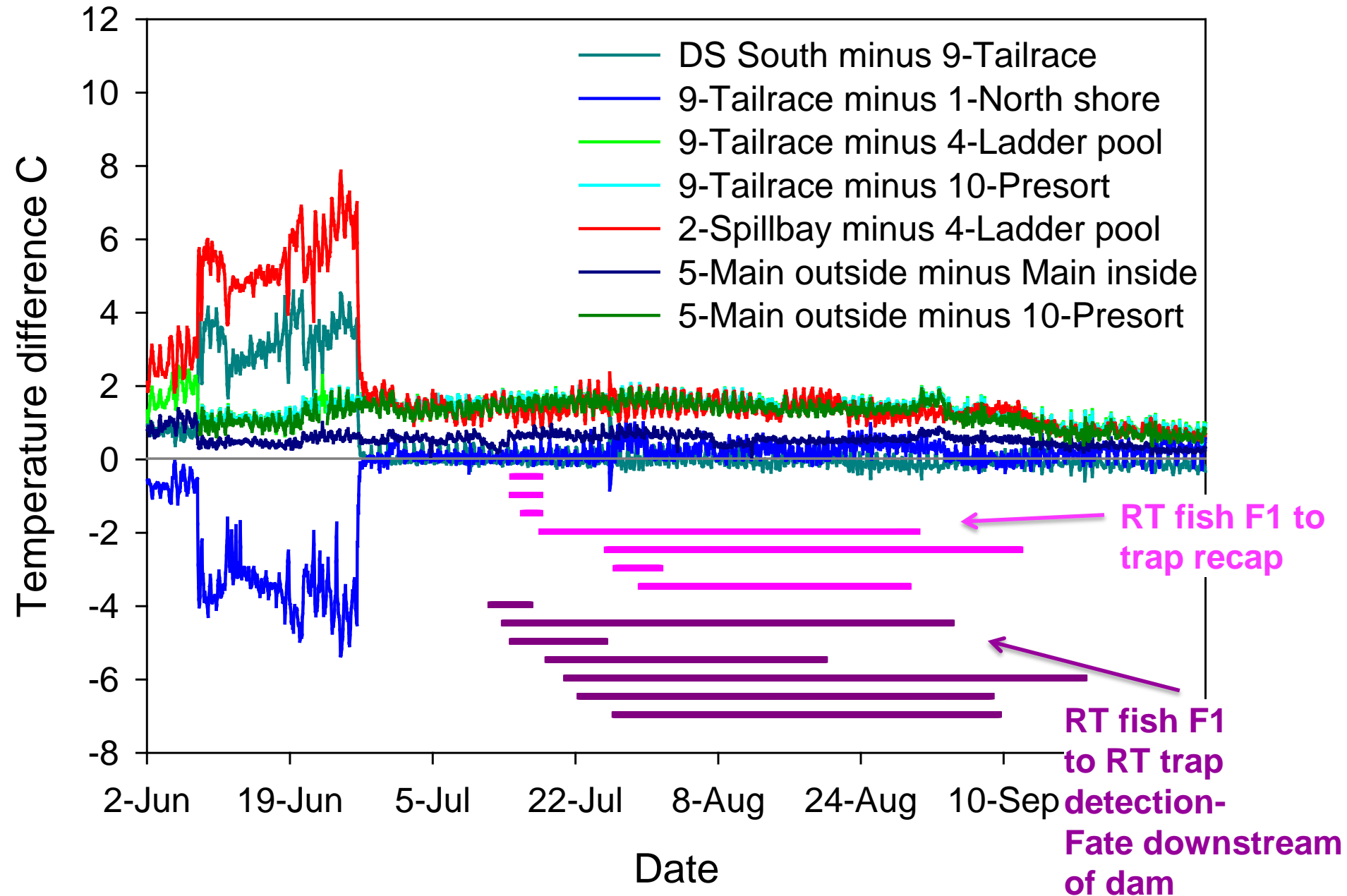
**Entered  
Trap**

82	22	1	0
92	8	1	0
94	1	1	0
95	25	1	0
85	80	3	2
79	107	10	9
87	183	28	27





# Temperature Gradients



# Foster Trap weir video

- Stratified random viewing of daytime files
  - 206 10-min files reviewed (~34 h)
- Scored behaviors:
  - Attempted ascent (visible jumps, surfing, etc.)
  - Successful ascent
  - Fallback from pool

# Foster Trap weir video

Weir jumping (attempts):

<https://youtu.be/T8fQpdvpHLE>

Fish Ascends:

[https://youtu.be/f-rM34Mlt\\_U](https://youtu.be/f-rM34Mlt_U)

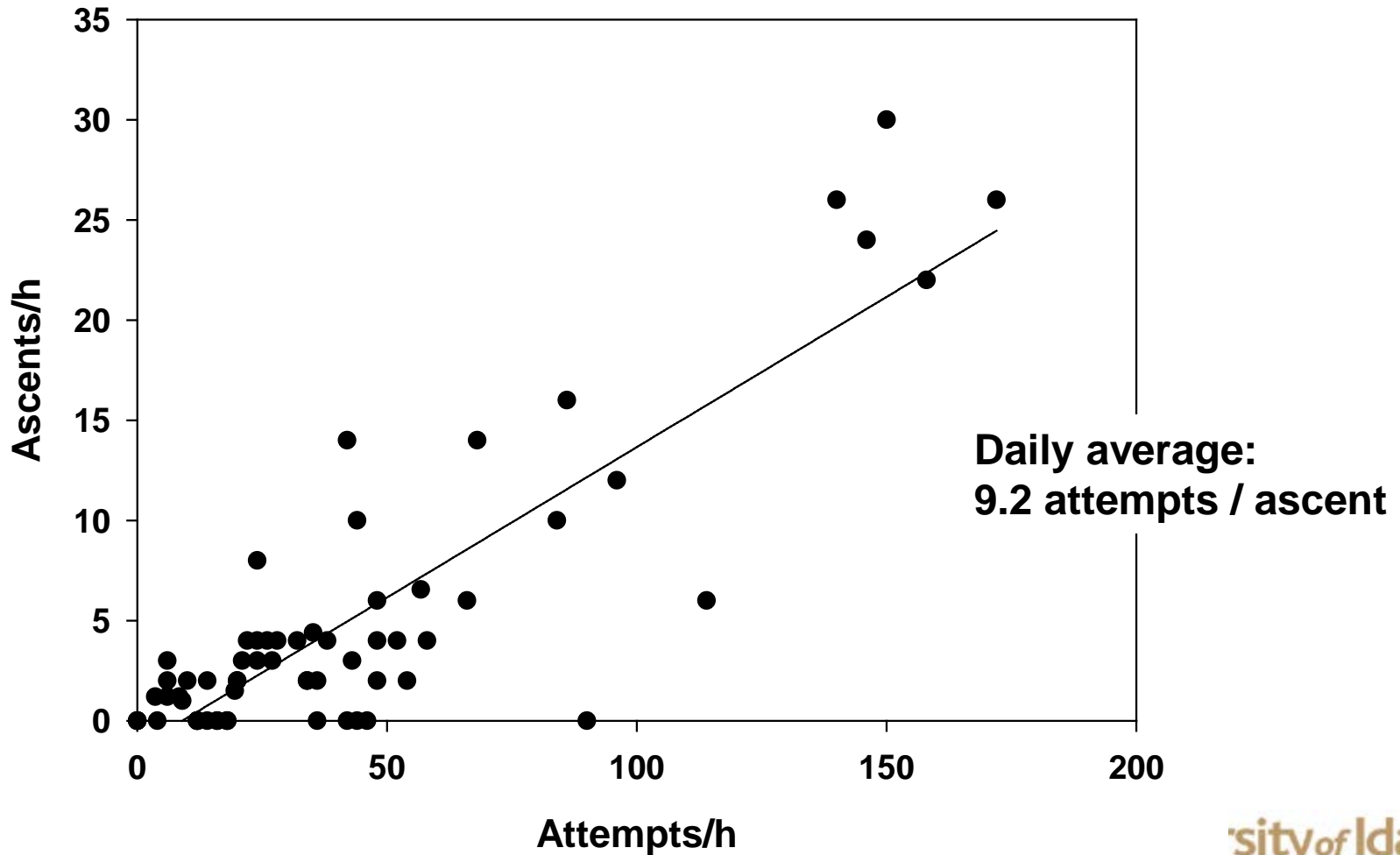
Fallback during high water:

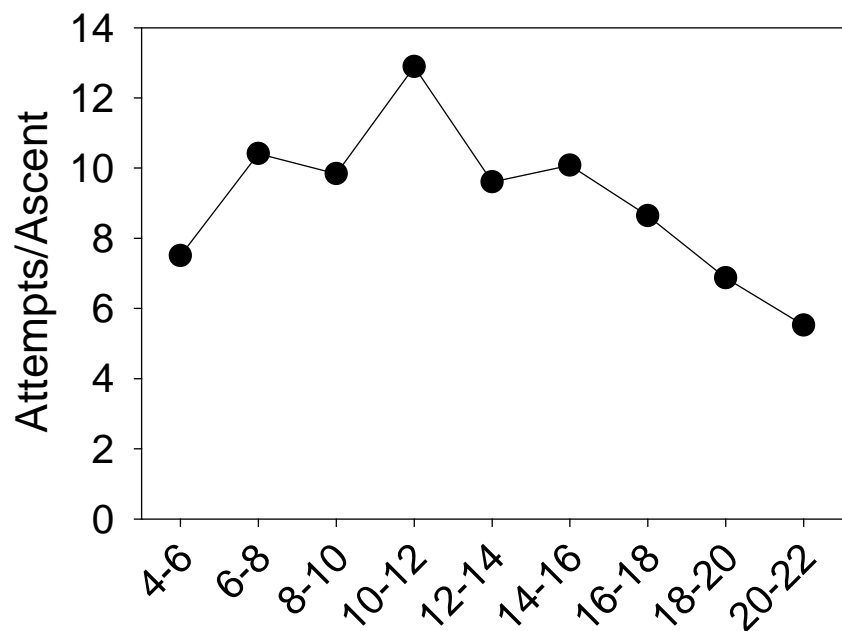
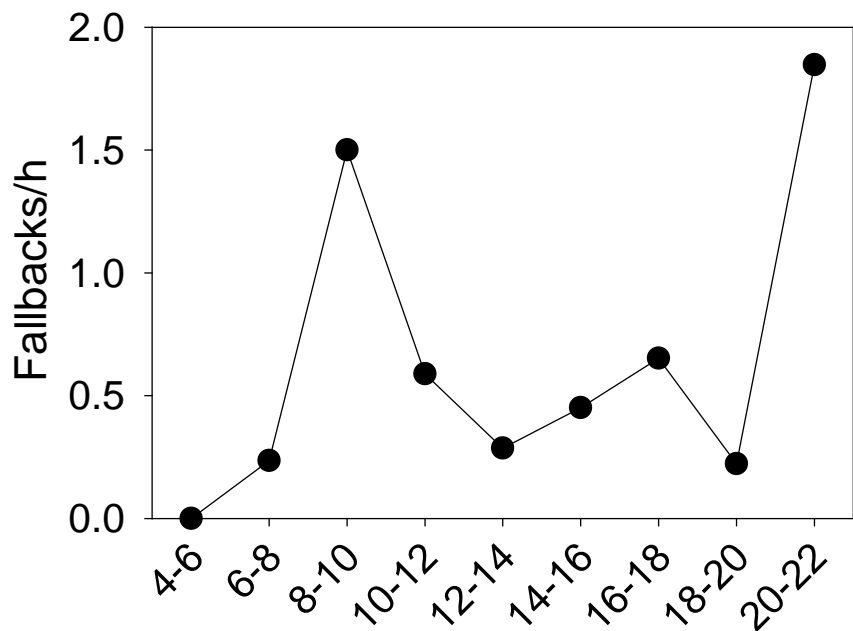
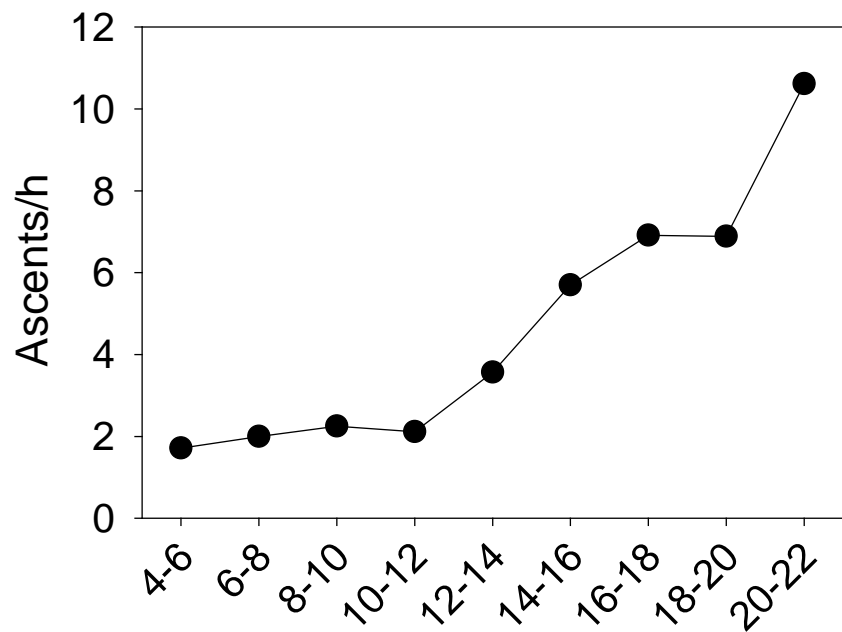
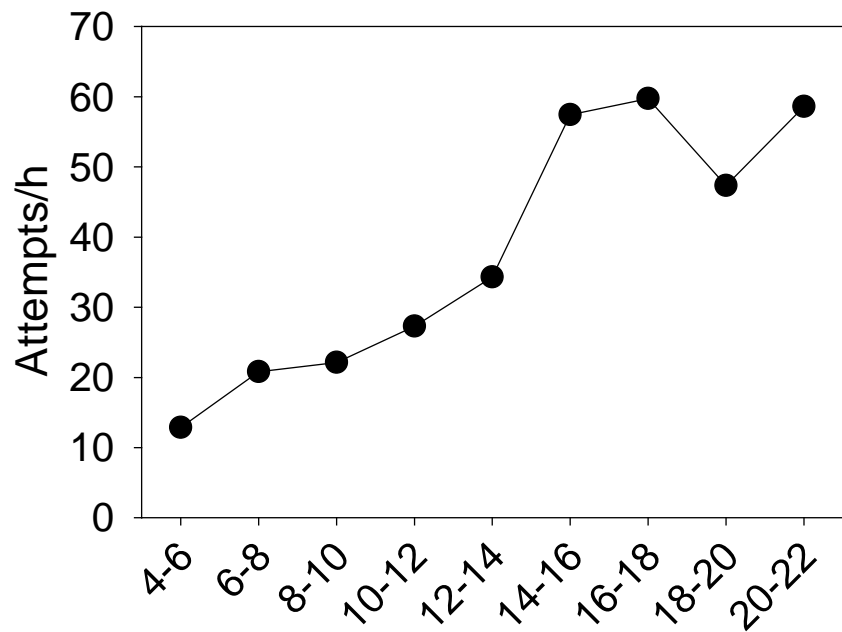
<https://youtu.be/VVCkOYzK1EA>

Fallback during normal or low water:

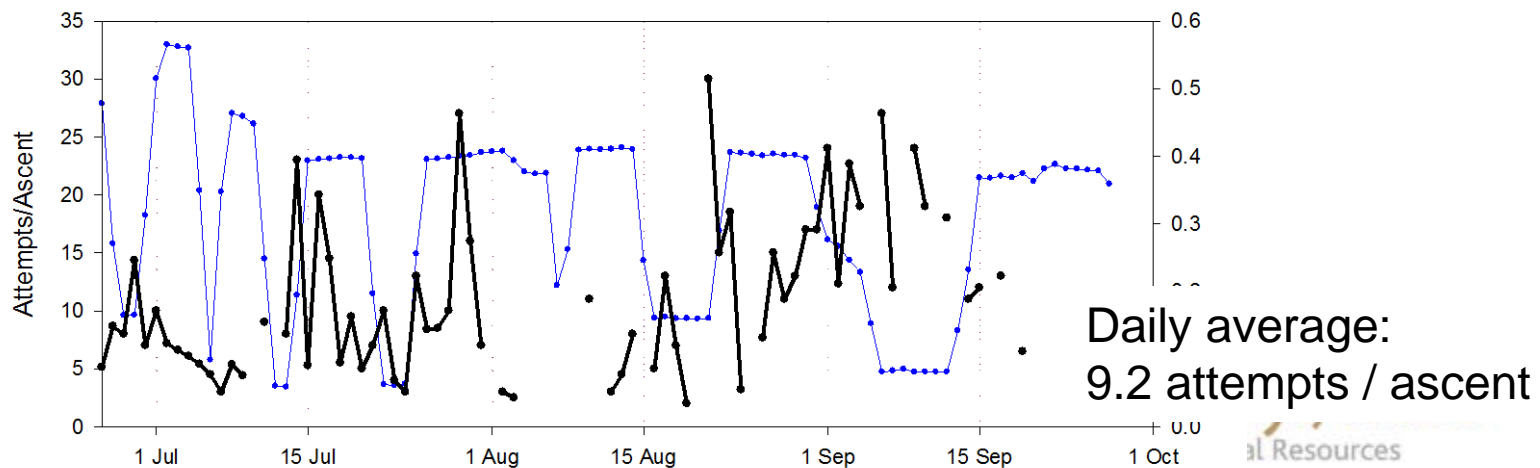
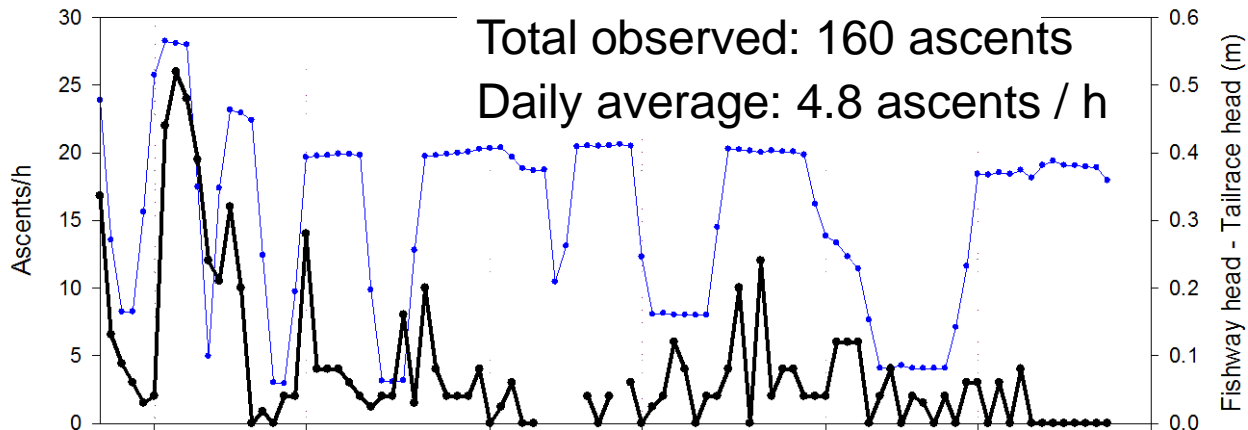
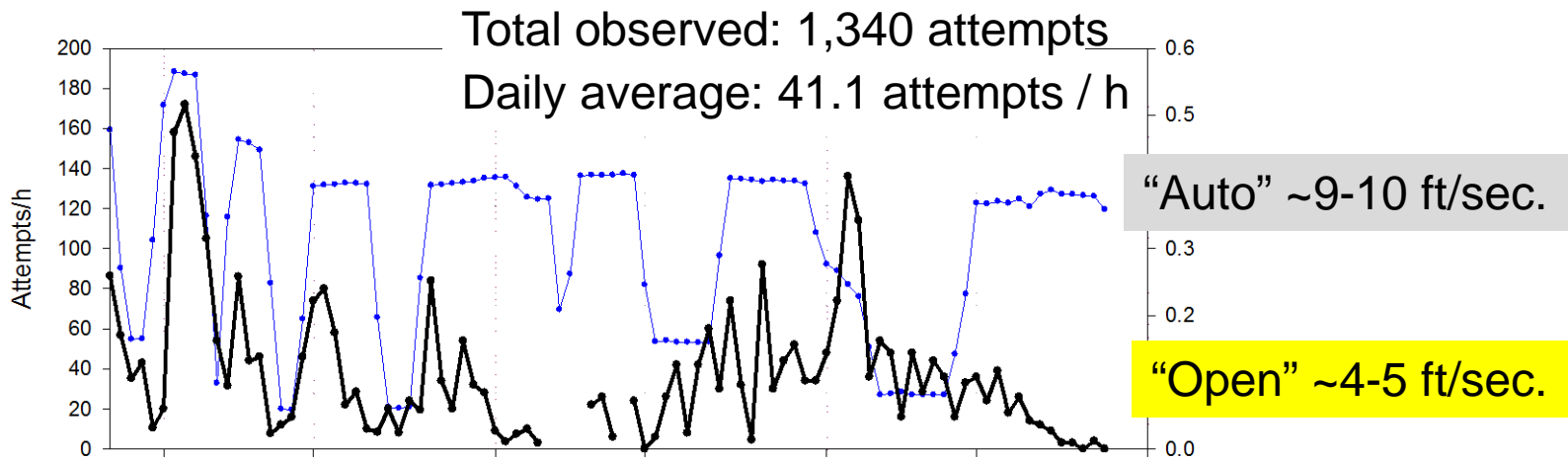
[https://youtu.be/zQ0u7\\_1-g-g](https://youtu.be/zQ0u7_1-g-g)

# Video results





Hour



# Video results: trap density /operations

	Attempts/h	Ascents/h	Fallbacks/h
Day Before	46.9	4.9	0.4
Trap Day	30.9	4.0	1.7
Day After	31.6	3.4	0.2



# Video results: trap density /operations

	Attempts/h	Ascents/h	Fallbacks/h
Day Before	46.9	4.9	0.4
Trap Day	30.9	4.0	1.7
Day After	31.6	3.4	0.2

# Video results: trap density /operations

	Attempts/h	Ascents/h	Fallbacks/h
Day Before	46.9	4.9	0.4
Trap Day	30.9	4.0	1.7
Day After	31.6	3.4	0.2

# Foster Trap weir video

'Normal' operations: pool water elevation  
below weir crest

'Working trap' operations (sometimes):  
pool water elevation above weir crest

Day of operation: Hydraulics? Alarm/social cues?

Social attraction cues?

(Density highest day before operation, lowest day after)

# Summary

- Successful collected and radio-tagged a small sample of hatchery Chinook salmon at Lebanon Dam
- All moved rapidly to tailrace
- High variance in behavior in tailrace:
  - Rapid movement to trap *or*
  - Tailrace and fishway milling and entry *or*
  - Tailrace and fishway milling without entry
- Collection efficiency  $\leq 50\%$

# Summary

- Activity at weir:
  - Many attempts / entry
  - Fallbacks
  - Complex associations with:
    - entrance velocity, season
    - time of day
    - trap density/operation
- Body temperature declines upon fishway & trap entry
- Overall role of temperature untested

# Foster Reservoir release study

- Do salmon use hypolimnetic refuge prior to tributary entry?



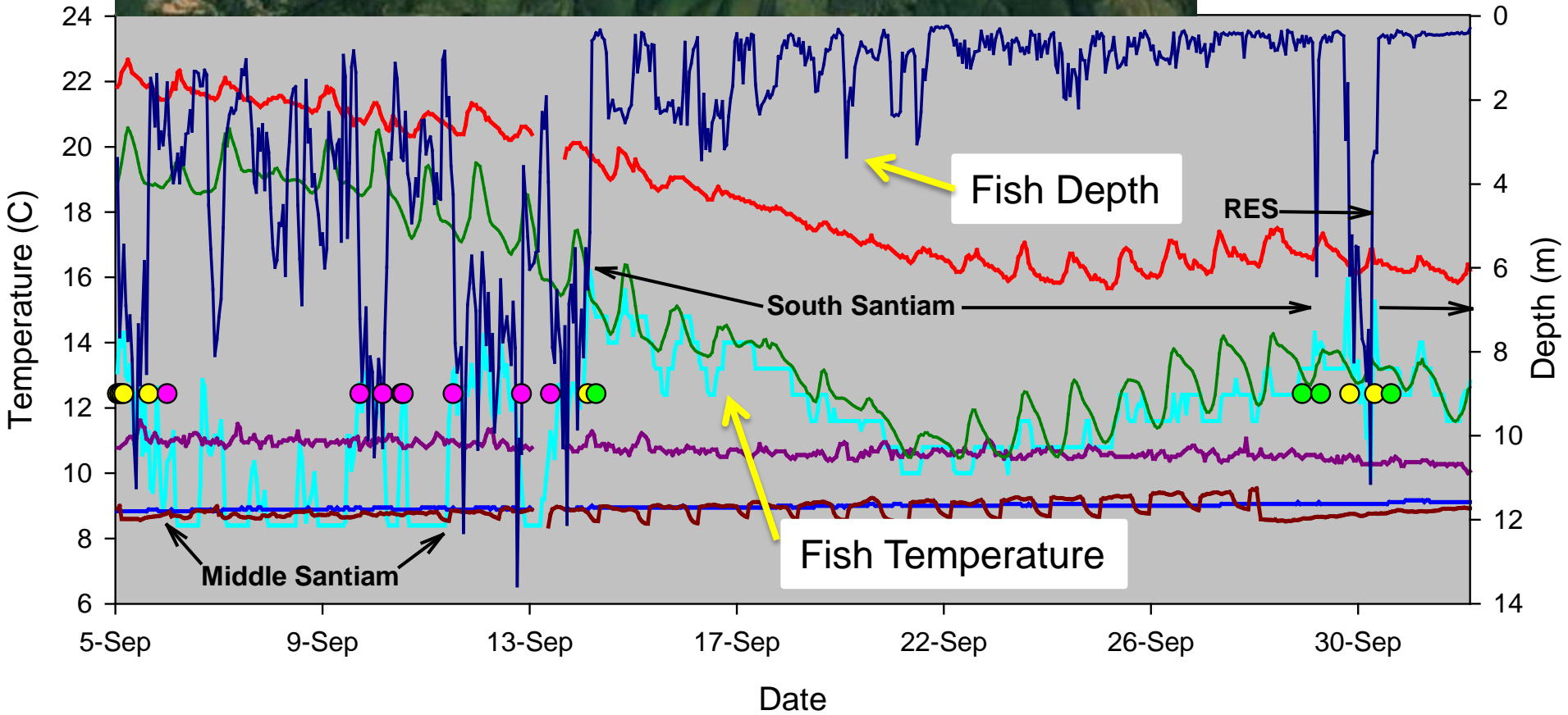
# Foster Reservoir Releases

Year	# released w/ Temp tag	# with data recovered	% with data recovered	# fallback	% fallback
2012	33	2	6.1	2	6.1
2013	50	3	6.0	6	12.0
2014	44	10	22.7	10	22.7
2015	14	4	28.6	2	14.3
2017	21	11	52.3	2	9.5





- Fish temp
- Res Surface 0.5 ft
- Res Middle 30ft
- Res Bottom 80ft
- Green Peter tailrace
- River Bend
- Fish Depth

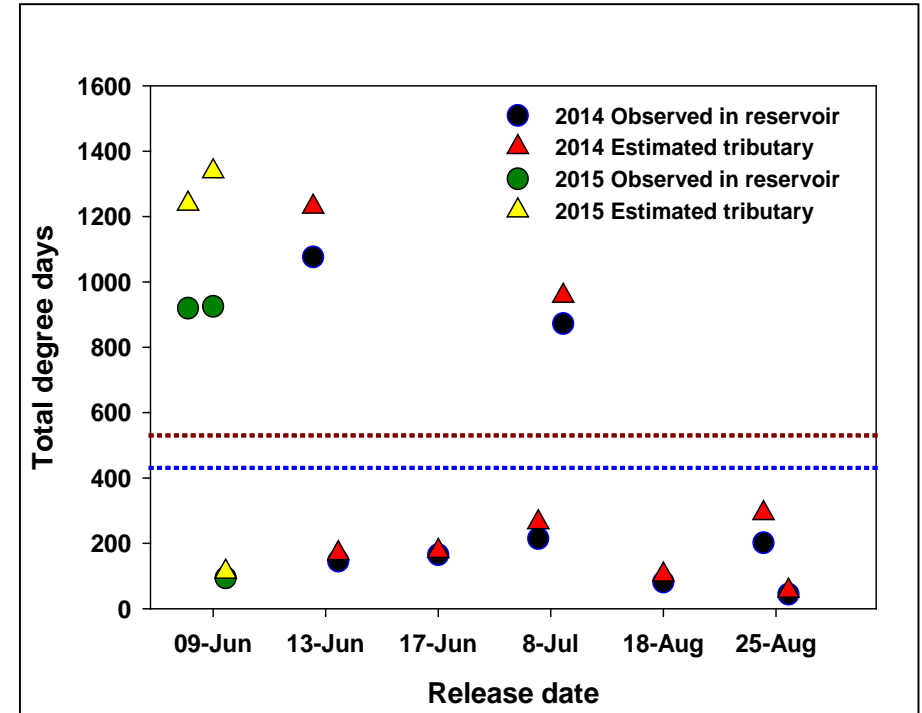
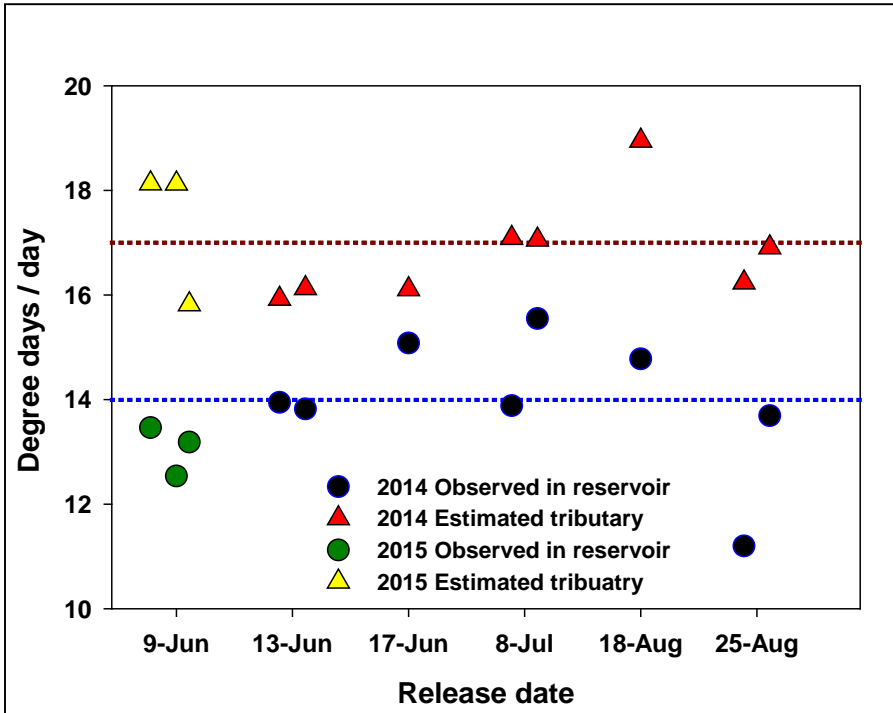




# Thermal benefit of reservoir release

Mean benefit = 3.3 degree days/d

Mean benefit = 99 Total degree days / fish



Reduction in the total accumulated degree days was **16%** (range = 14-23%) in 2014 and **39%** (range 20-45%) in 2015.

ODFW

Brett Boyd, Cam Sharpe

USACE

Fenton Kahn, Rich Piaskowski, Glenn Rhett,  
Steve Schlenker

UI

BJ Schenk, James Mader

NMFS

Ed Meyer

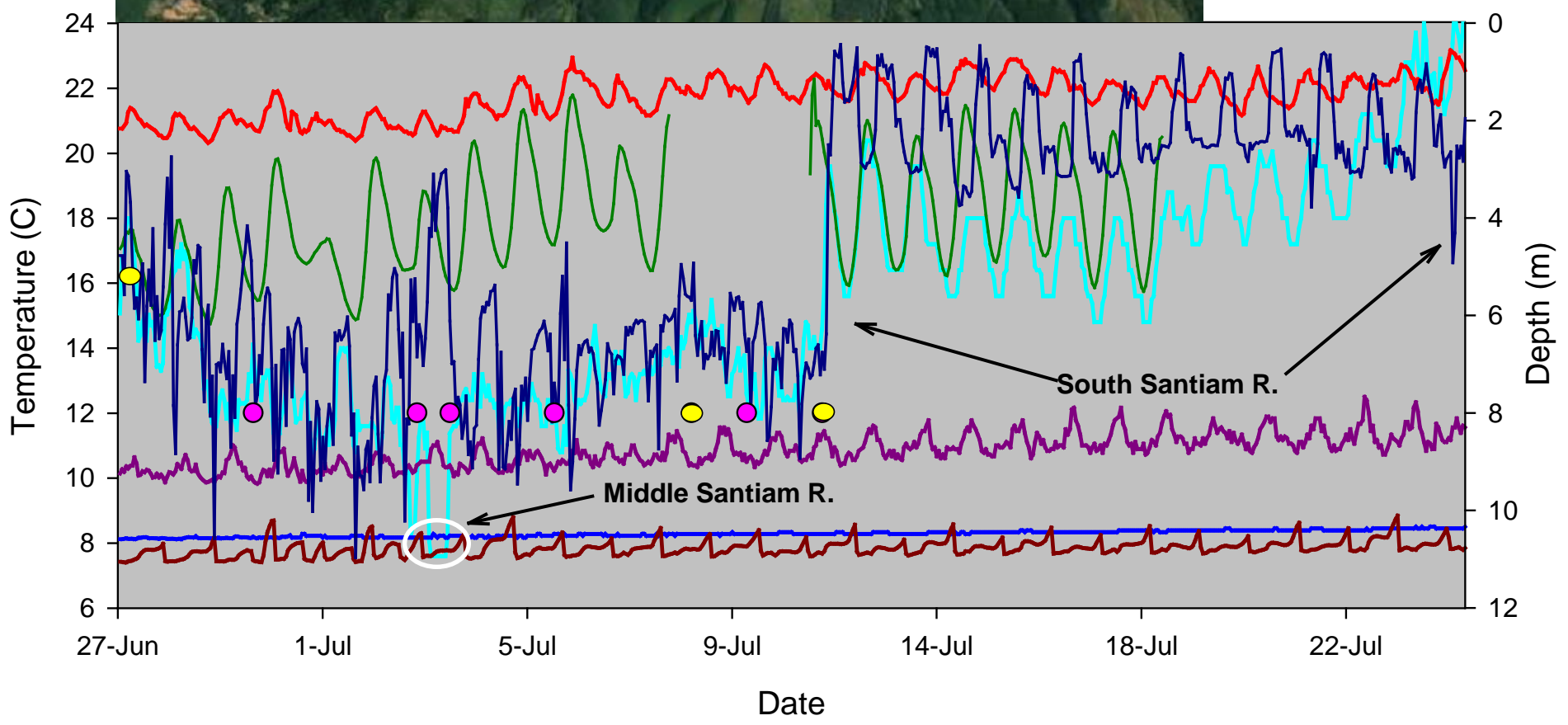
And many others!!

# Thanks!



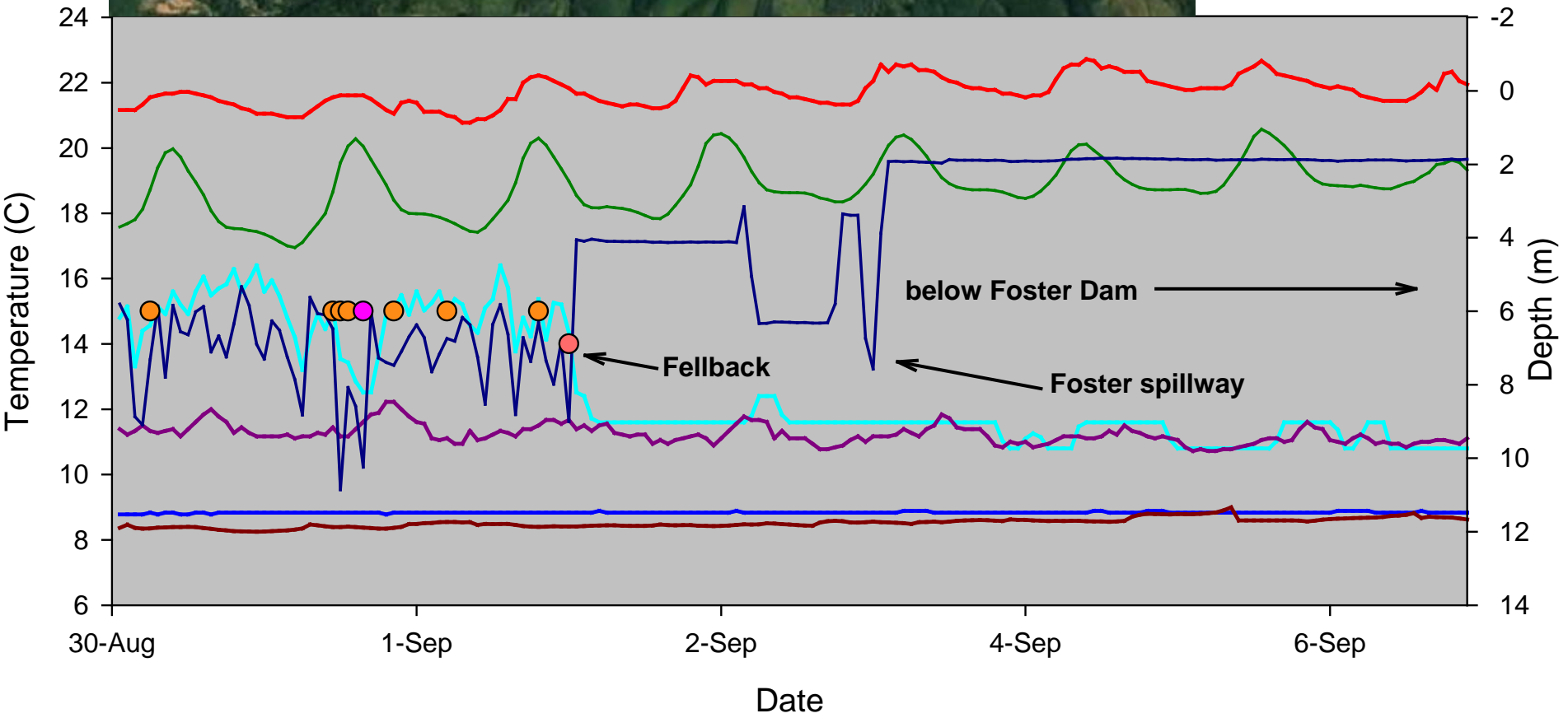


- Fish temp
- Res Surface 0.5 ft
- Res Middle 30ft
- Res Bottom 80ft
- Green Peter tailrace
- River Bend
- Fish Depth





- Fish temp
- Res Surface 0.5 ft
- Res Middle 30ft
- Res Bottom 80ft
- Green Peter tailrace
- River Bend
- Fish Depth



# 2017 Temperature Monitoring



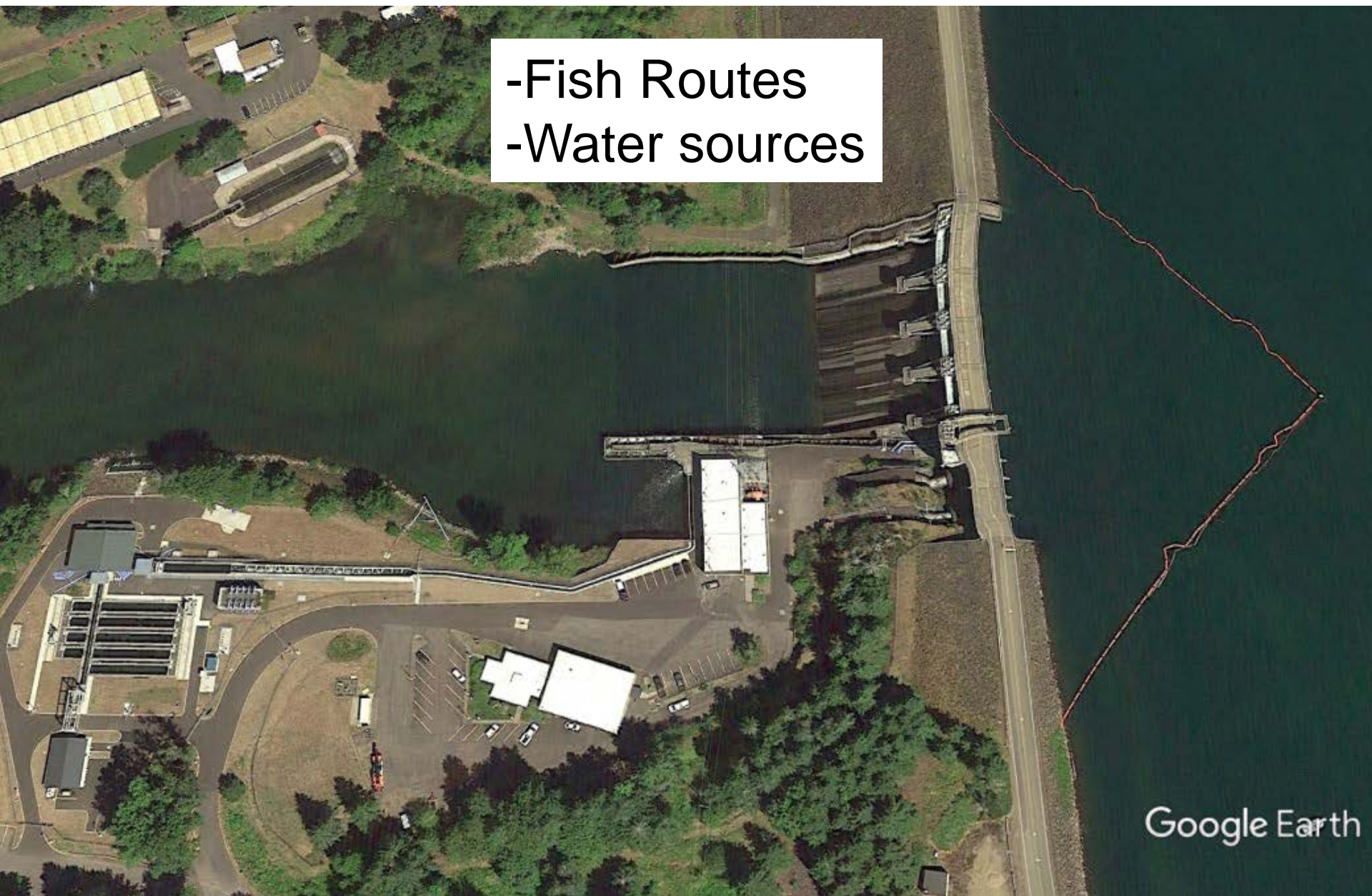
July 2012



Google Earth

University of Idaho  
College of Natural Resources

-Fish Routes  
-Water sources



Google Earth



Google Earth

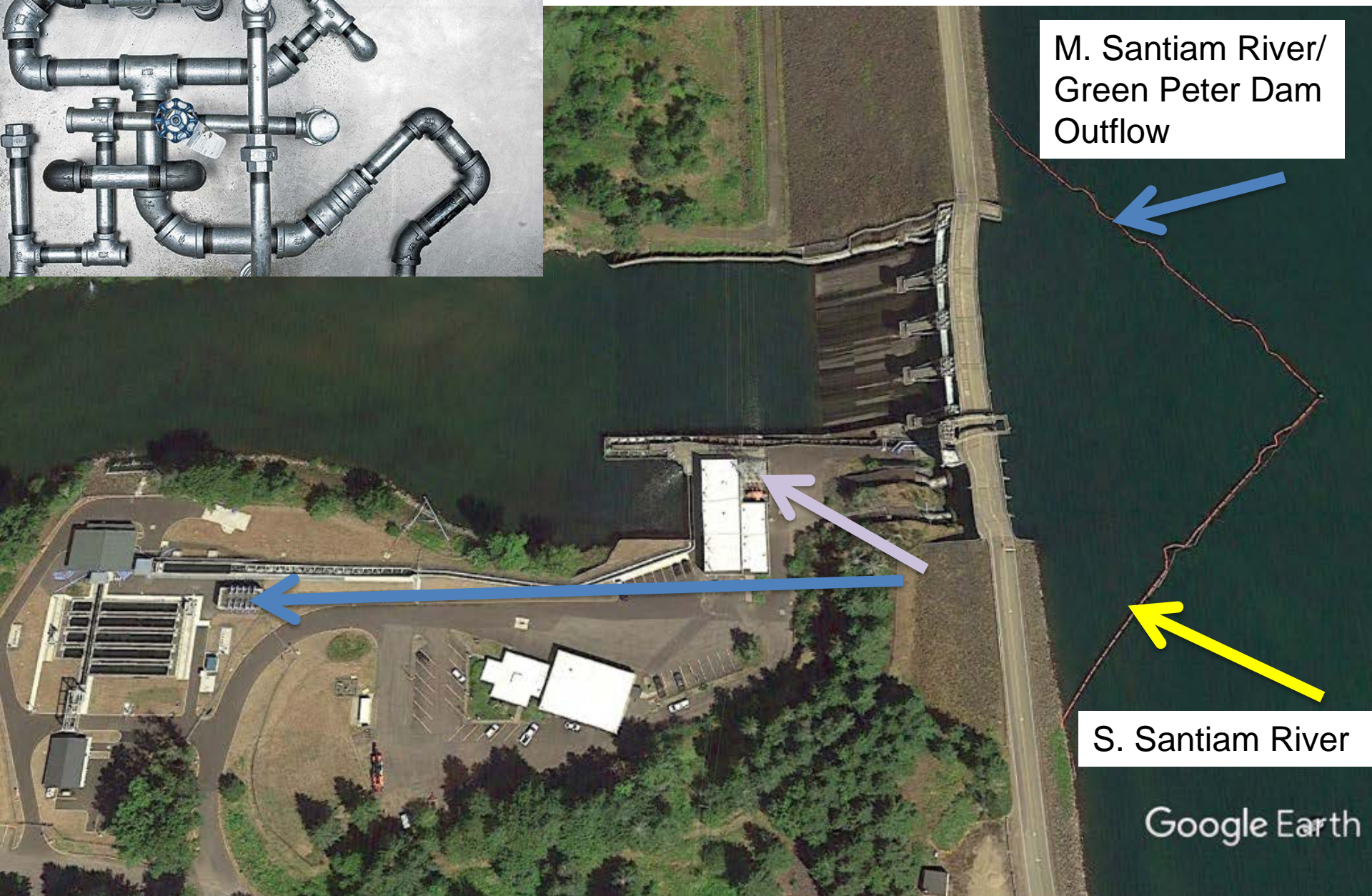


July 2016

M. Santiam River/  
Green Peter Dam  
Outflow

S. Santiam River

Google Earth





Presort Pool

Deep Reservoir

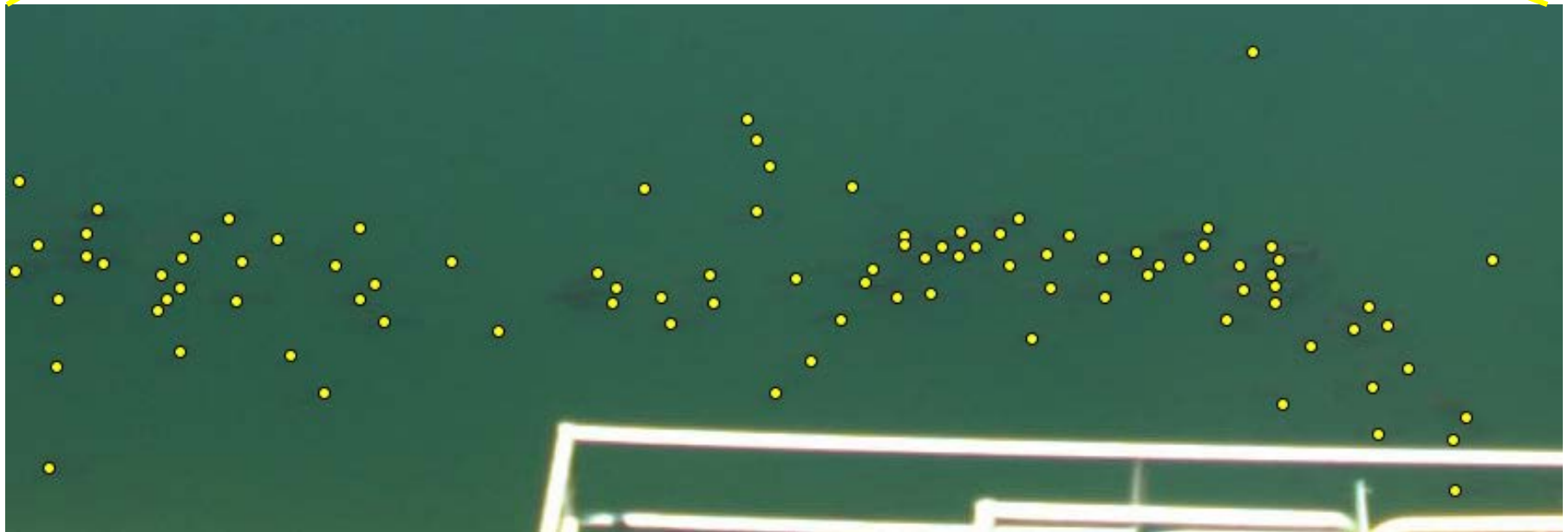


Google Earth

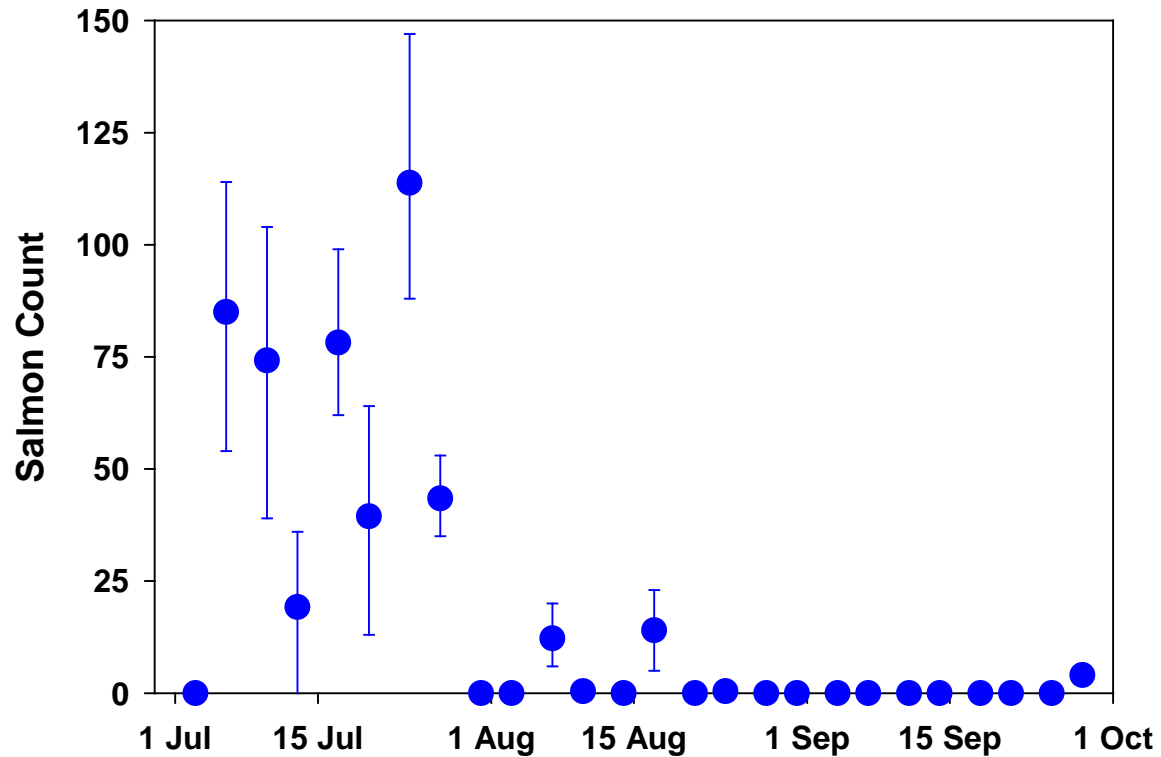
# Foster tailrace photos: 'holding index'

- Obj 1: Enumerate salmon holding in tailrace
- Obj 2: Describe spatial distribution
- *Methods*
  - Optical cameras above spill basin & Powerhouse
  - Systematic review of photos from mid-day
  - ImageJ (software) used to count visible fish

# Foster tailrace photos



# Foster tailrace photos: Spillway



# Foster tailrace photos: Powerhouse

**Grant is still working on Powerhouse photos, but in general these are of lower consistency and quality. Also very limited temporal overlap with the spillway Reconyx photoset.**

August 28, 12:15: 25 Fish observed



**Basic story here is that there is a lot of glare and surface turbulence at PH, certainly fish holding.**

# Foster tailrace photos: Spillway



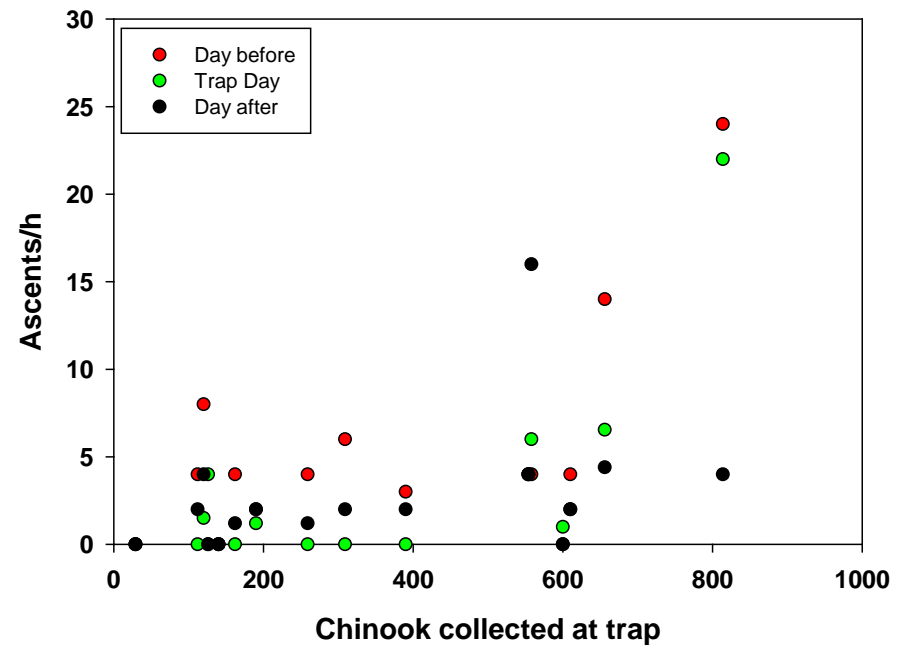
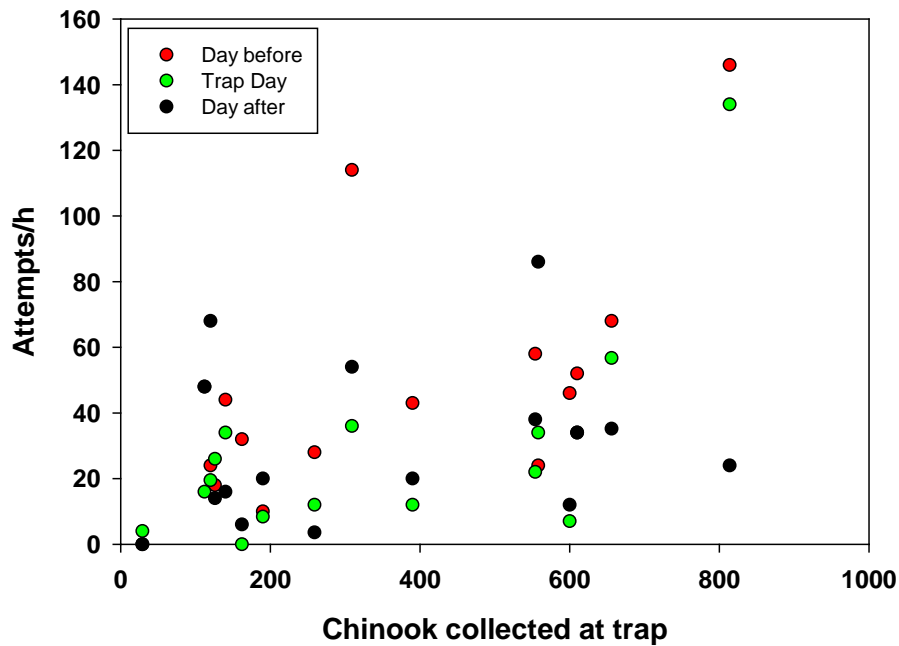
July 17, 12:00: 91 Fish observed

**Could make these dots bigger?**

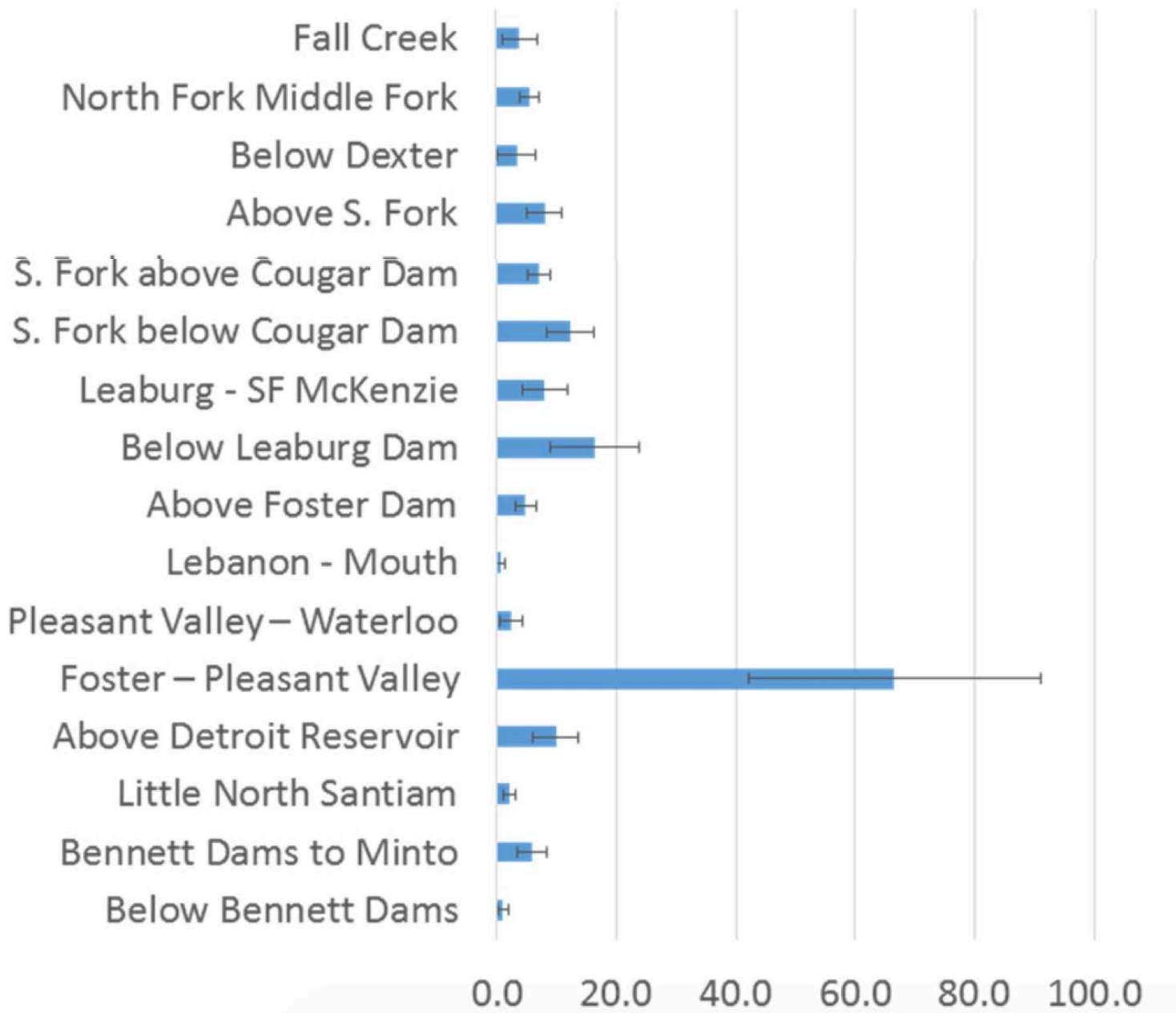
July 24, 1:00: 147 Fish observed



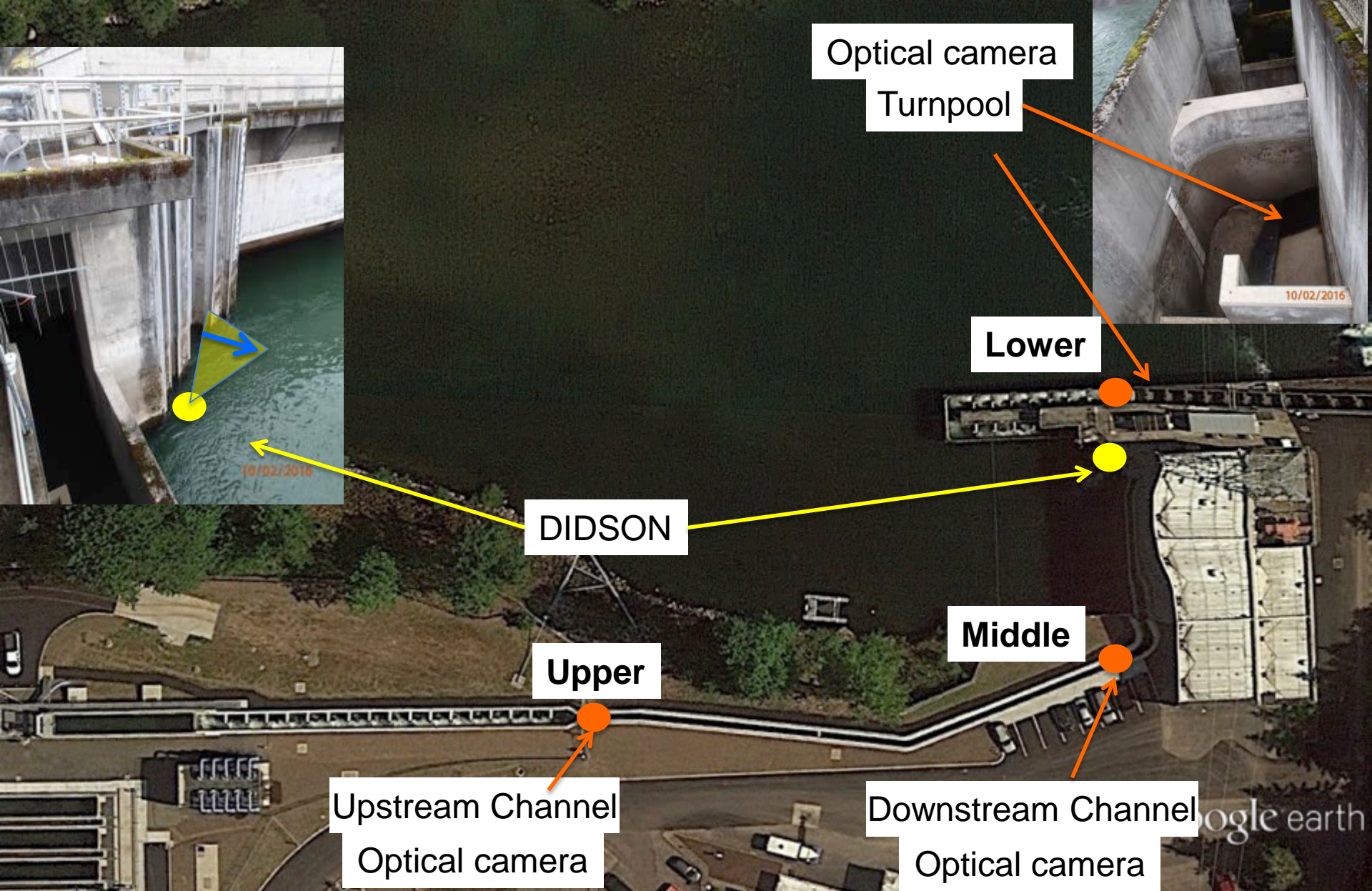
# Video results: trap density effects







Average annual redds / km



# Entrance Velocity Treatments

