# Evaluation of Adult Chinook Salmon Behavior at the Foster Dam Adult Fish Facility on the South Santiam River, 2016

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Foster Dam and Lake – 1968

Redds and Trap count

New Facility

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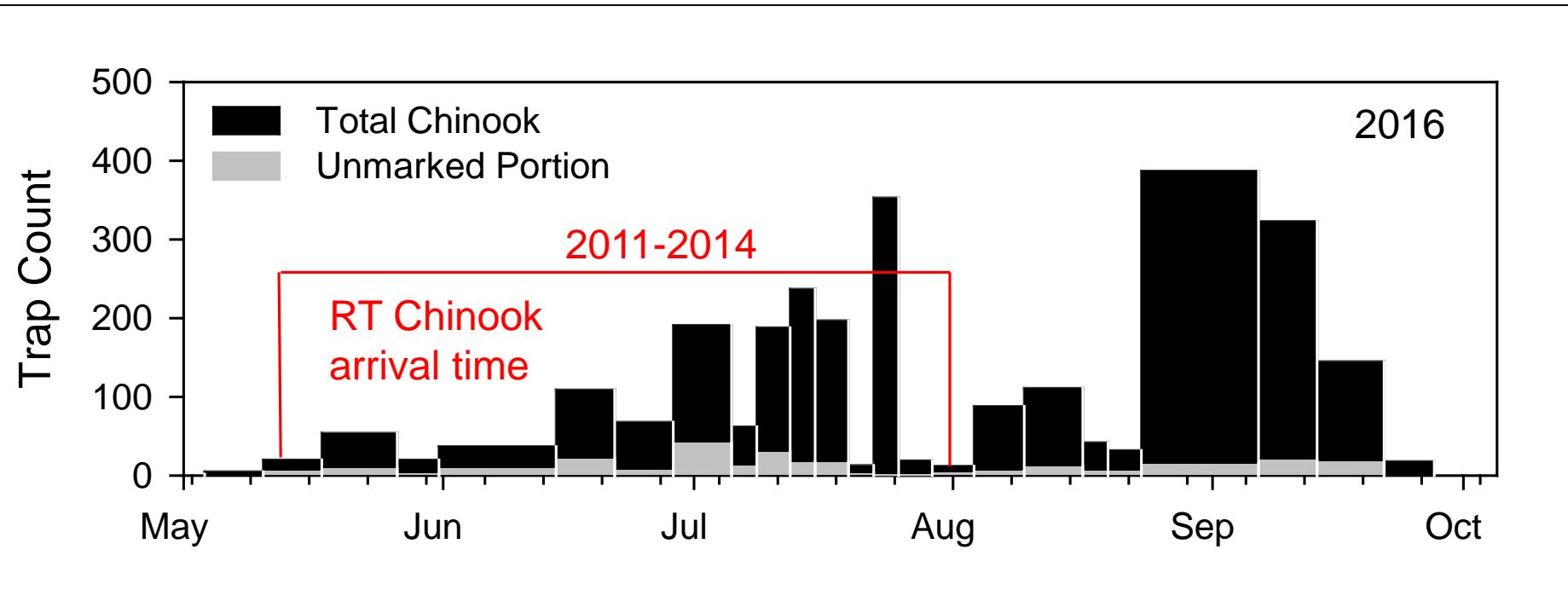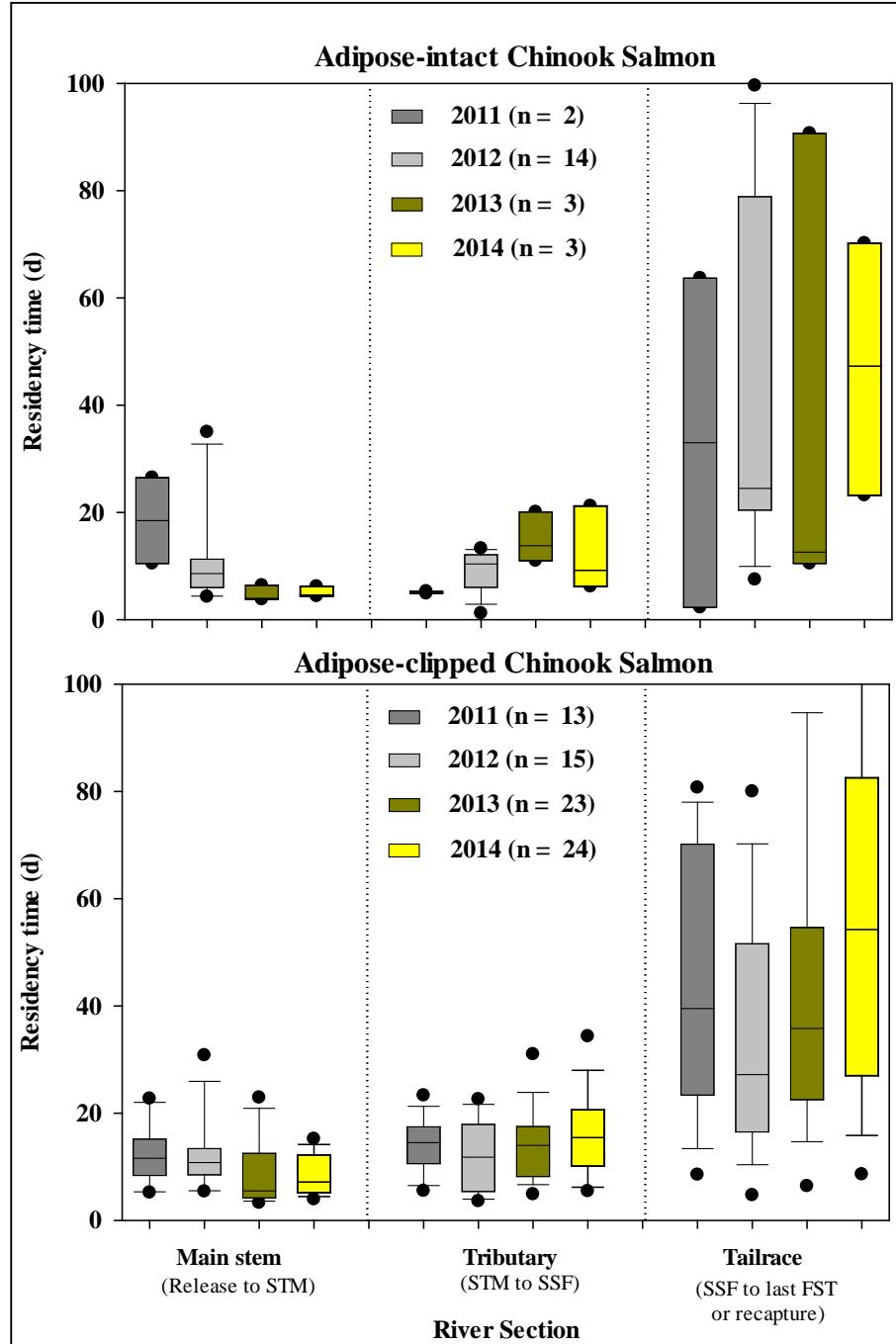
Trap Counts vs. Arrival
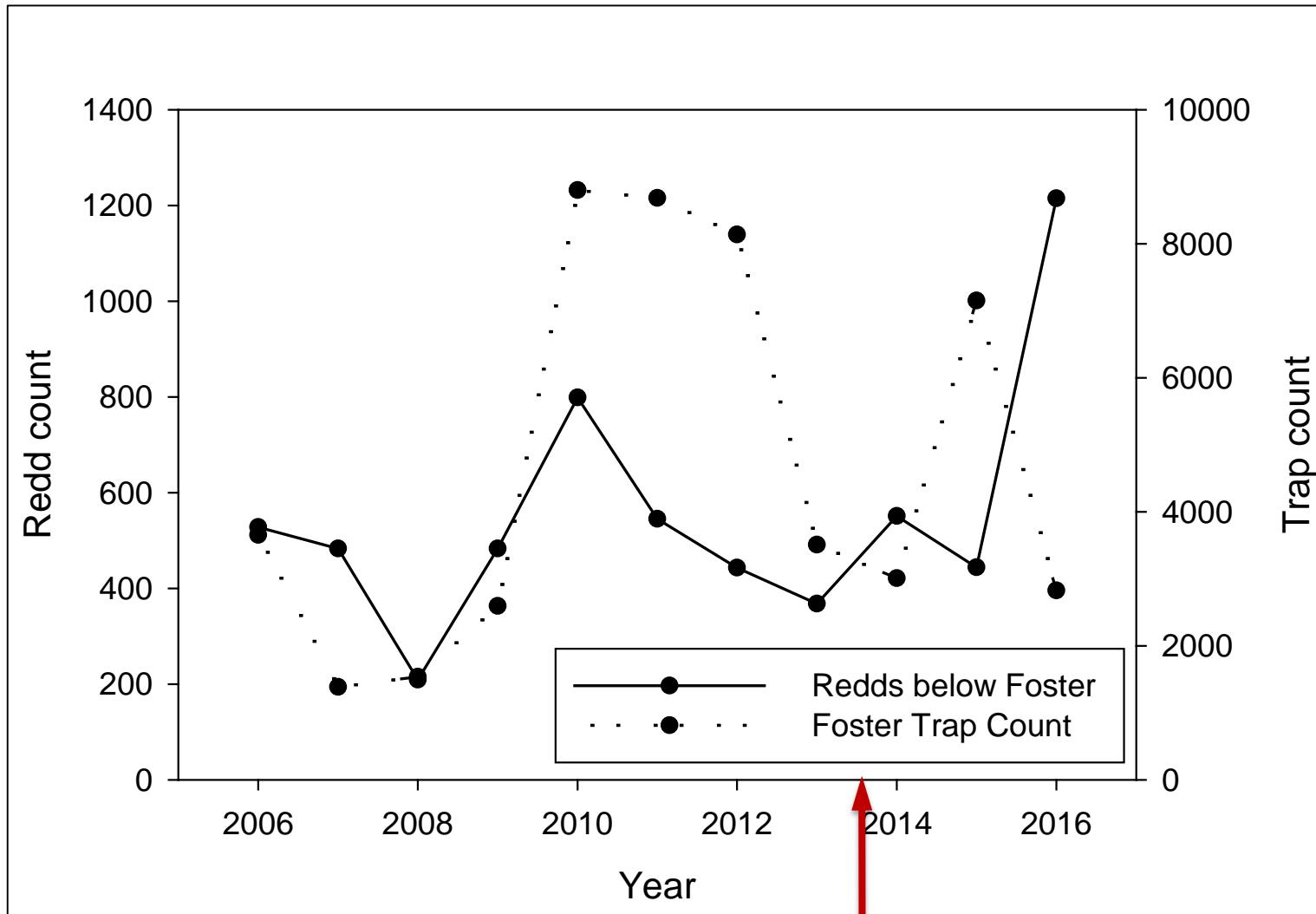
-Why slow movement into new facility?
  -Bottleneck(s)?
  -Causes?

-Overall facility collection efficiency?

2016 Objectives
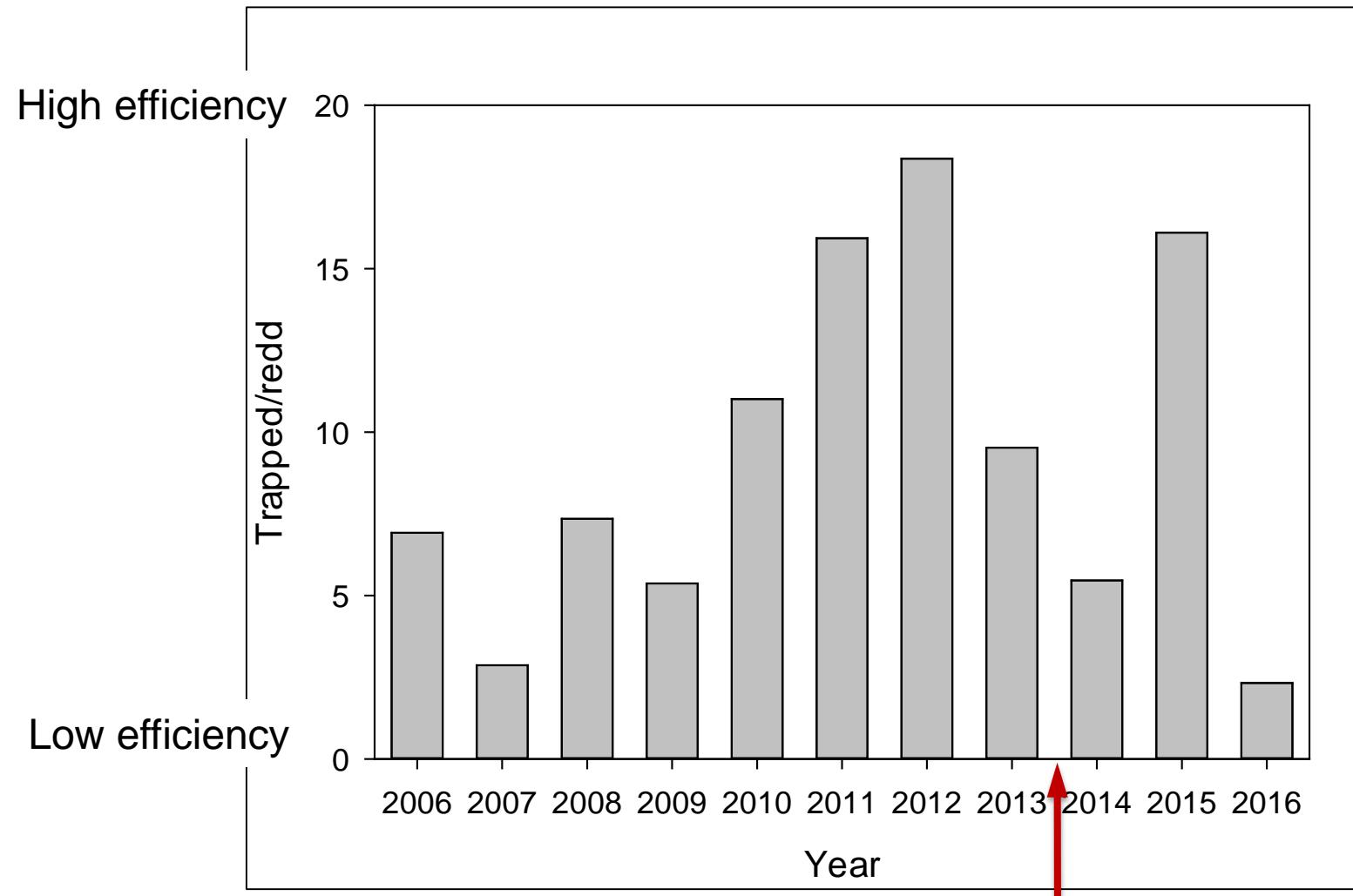
- Impediments to collection?
  - Review 2006-2016 trap data for associations between trap rate and conditions

  - Evaluate environmental conditions in the fishway and tailrace to ID potential bottlenecks
  - Manipulate main entrance velocity
  - Monitor behavior at the main entrance (DIDSON) and within the fishway (optical video)

Results: Redds and Trap count
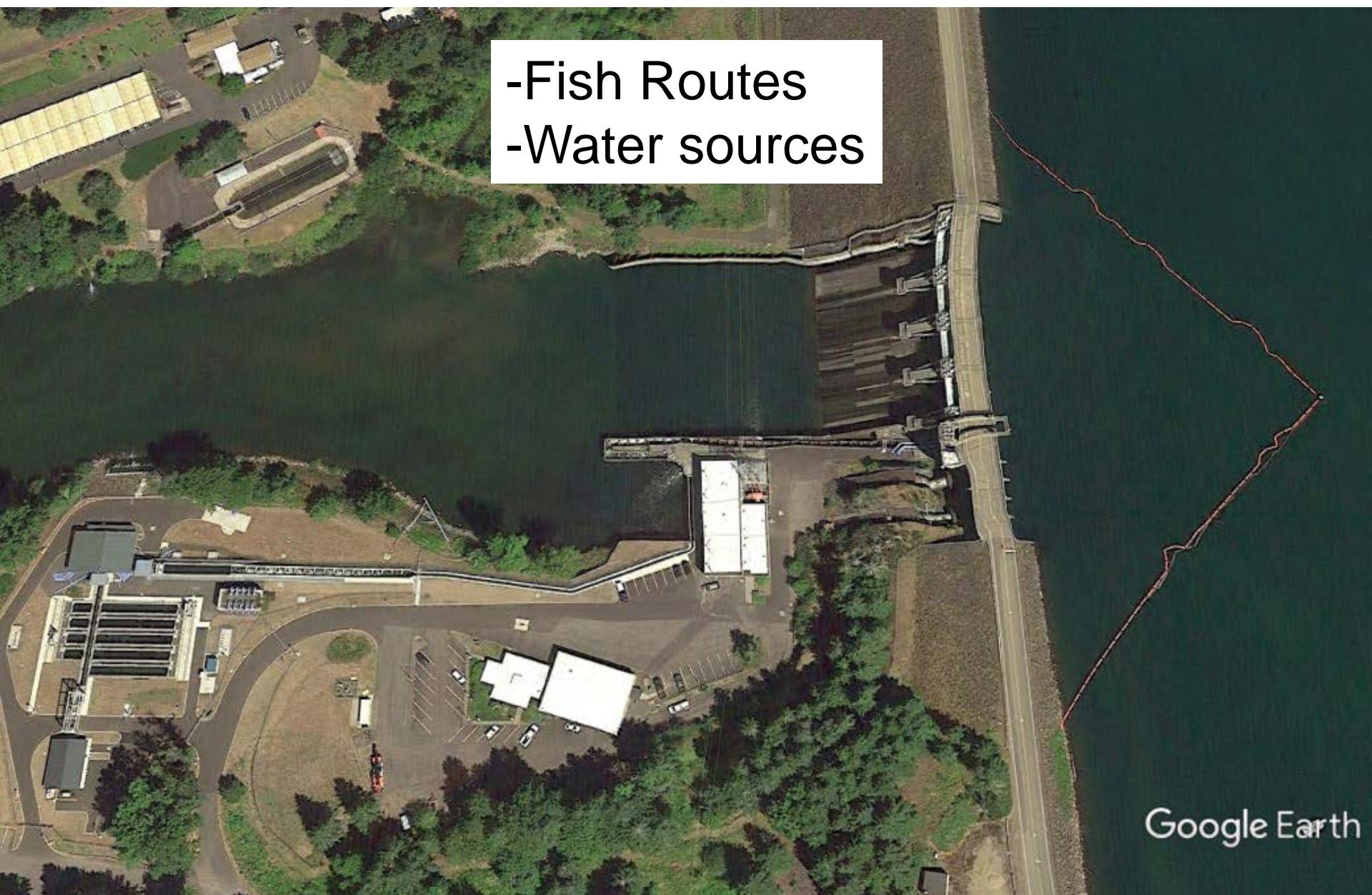
New Facility

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Results: Trap:Redd

July 2012

Google Earth
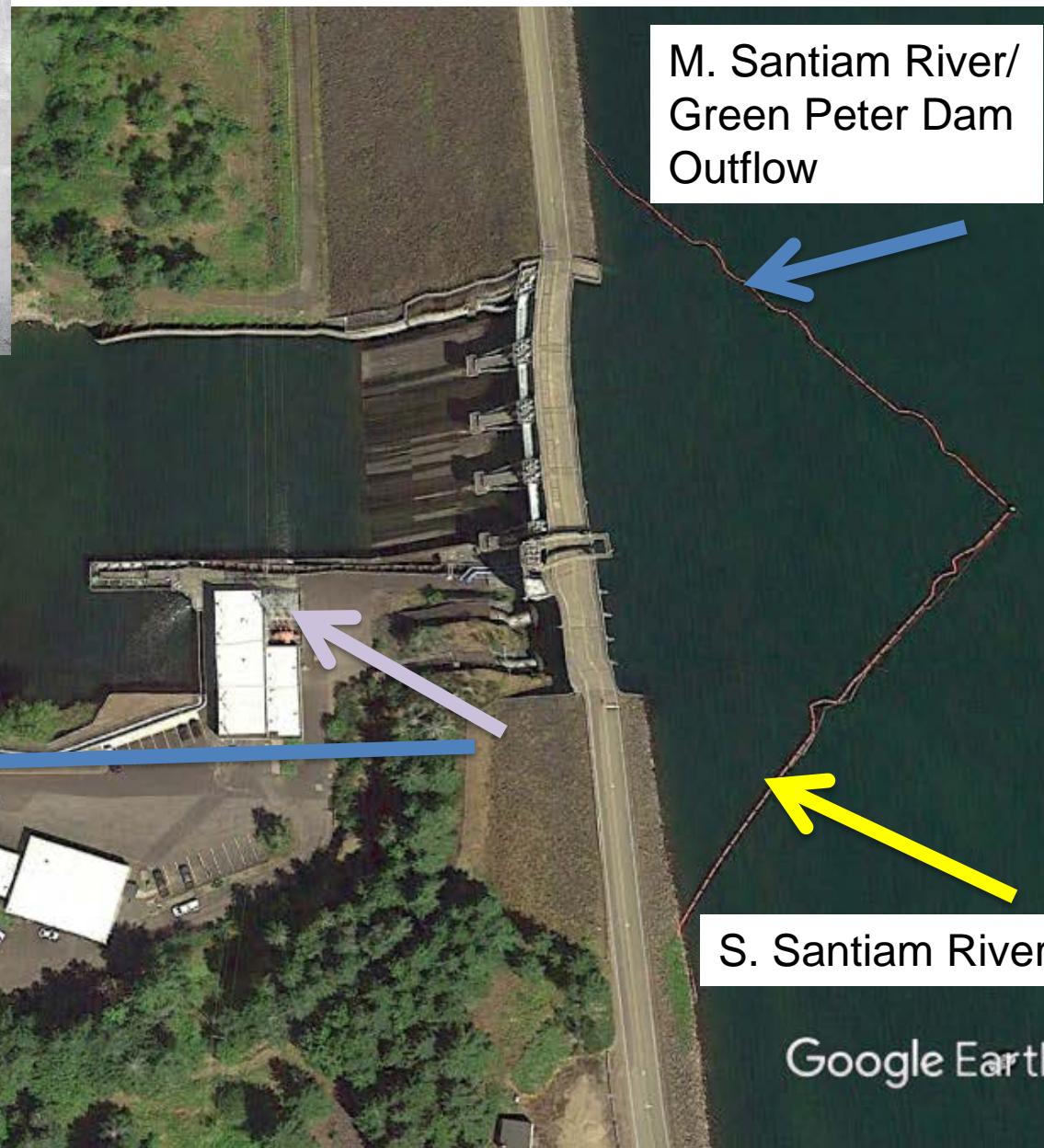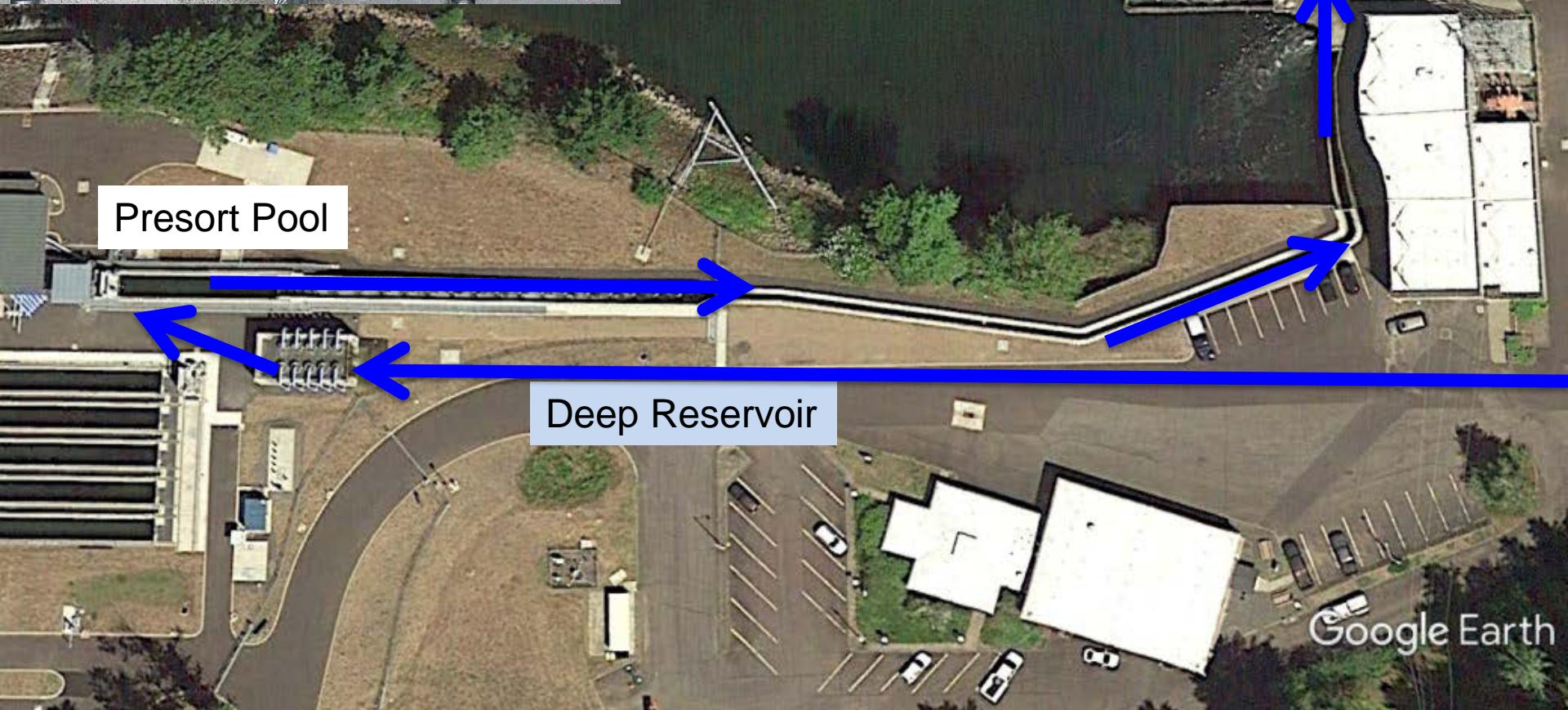
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-Fish Routes
-Water sources

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Promised Land

Side

Main

Presort Pool

Upper Fishway

Google Earth

July 2016

M. Santiam River/
Green Peter Dam
Outflow

S. Santiam River

Google Earth

Presort Pool

Deep Reservoir

Google Earth

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Spillway

Deep Reservoir

Mid-reservoir

Tailrace

Turbine

Google Earth

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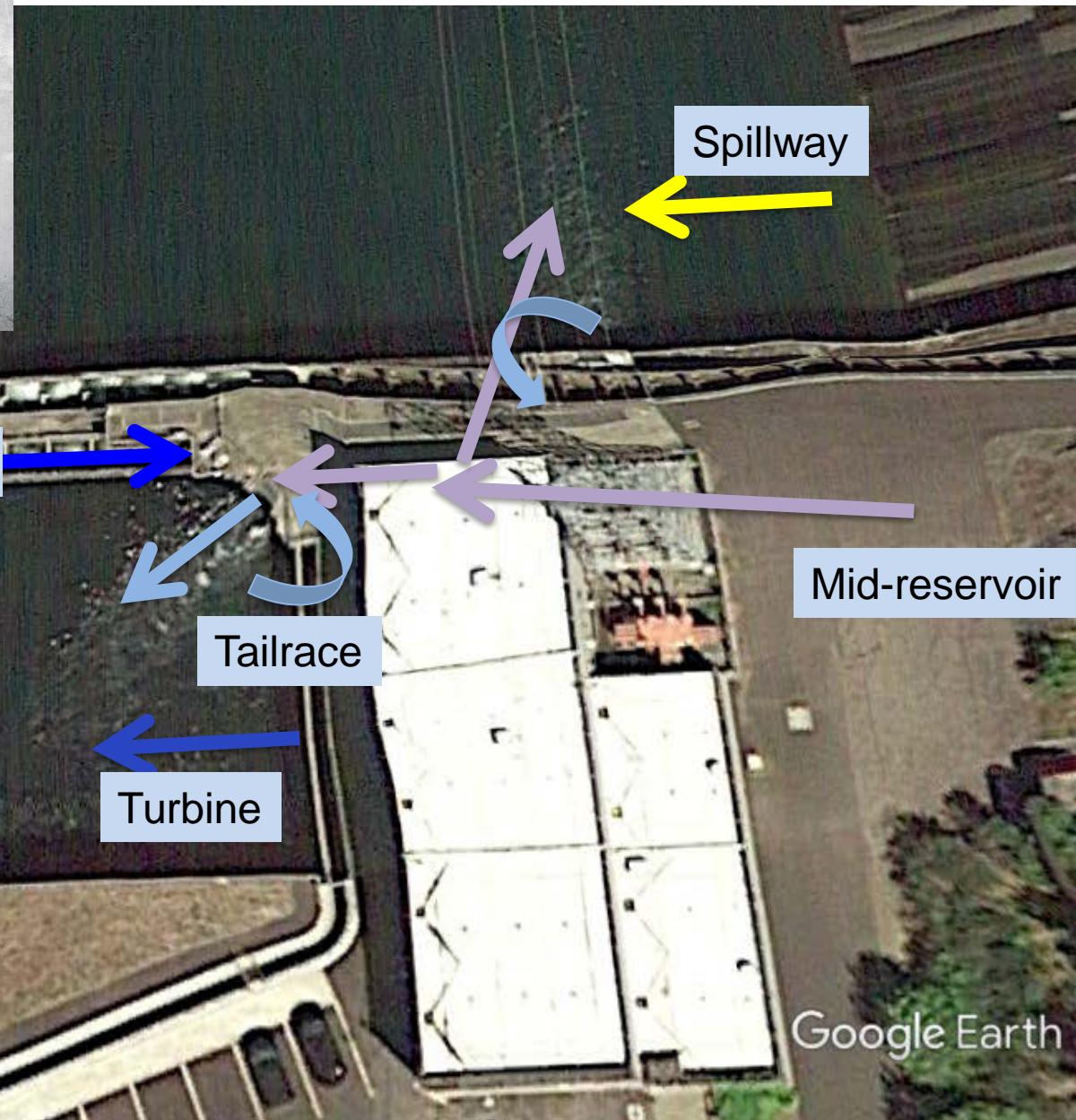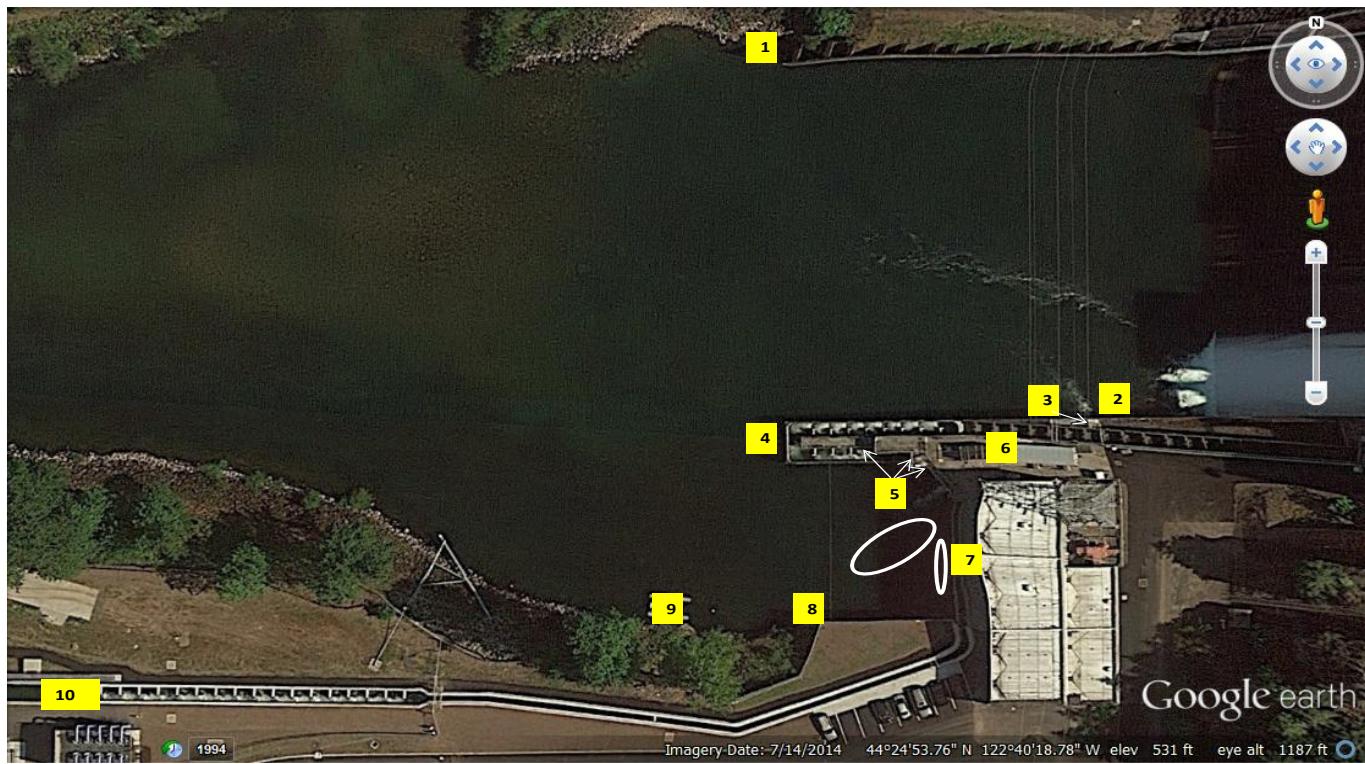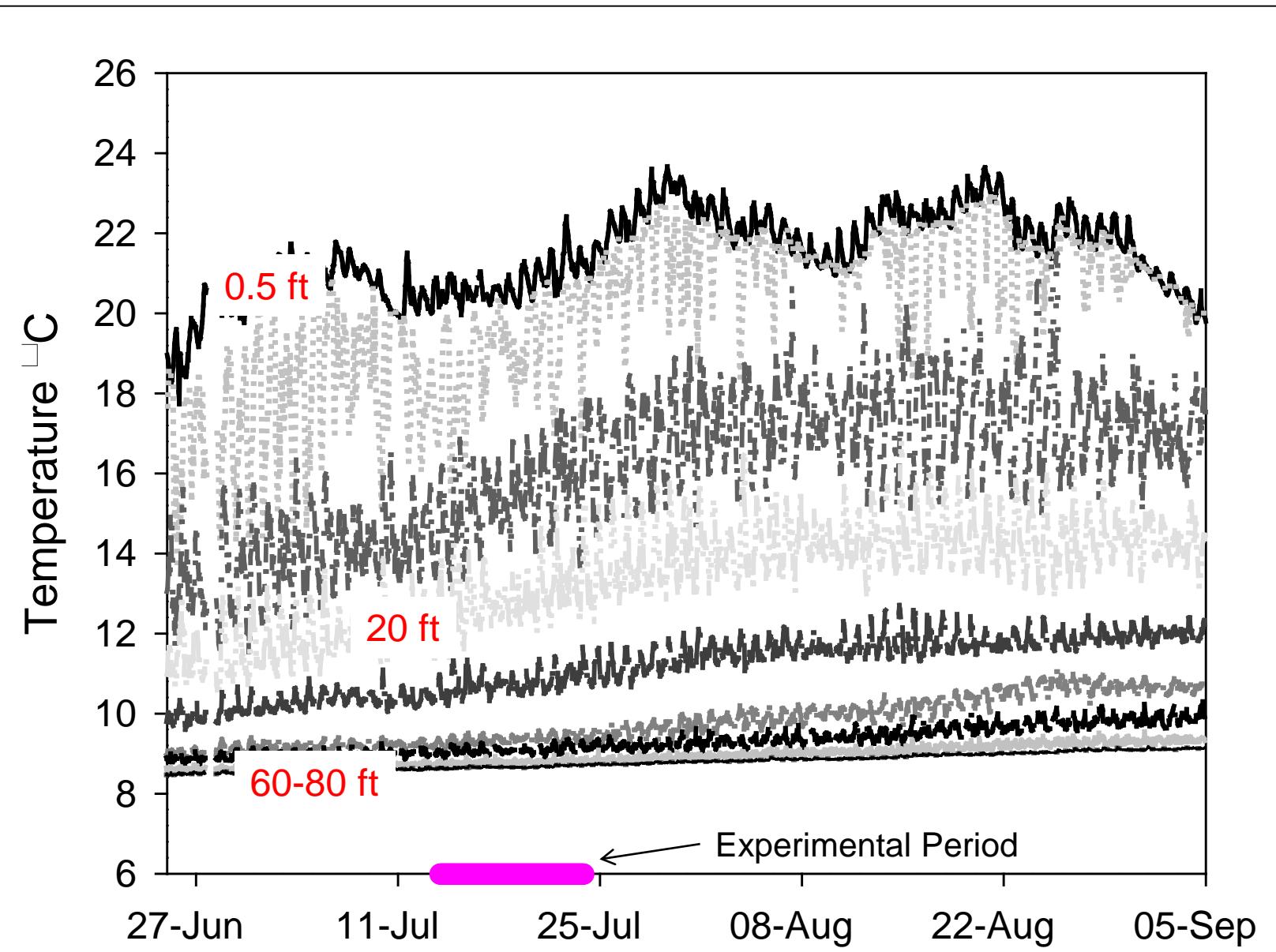
# 2016 Foster Monitoring Objectives
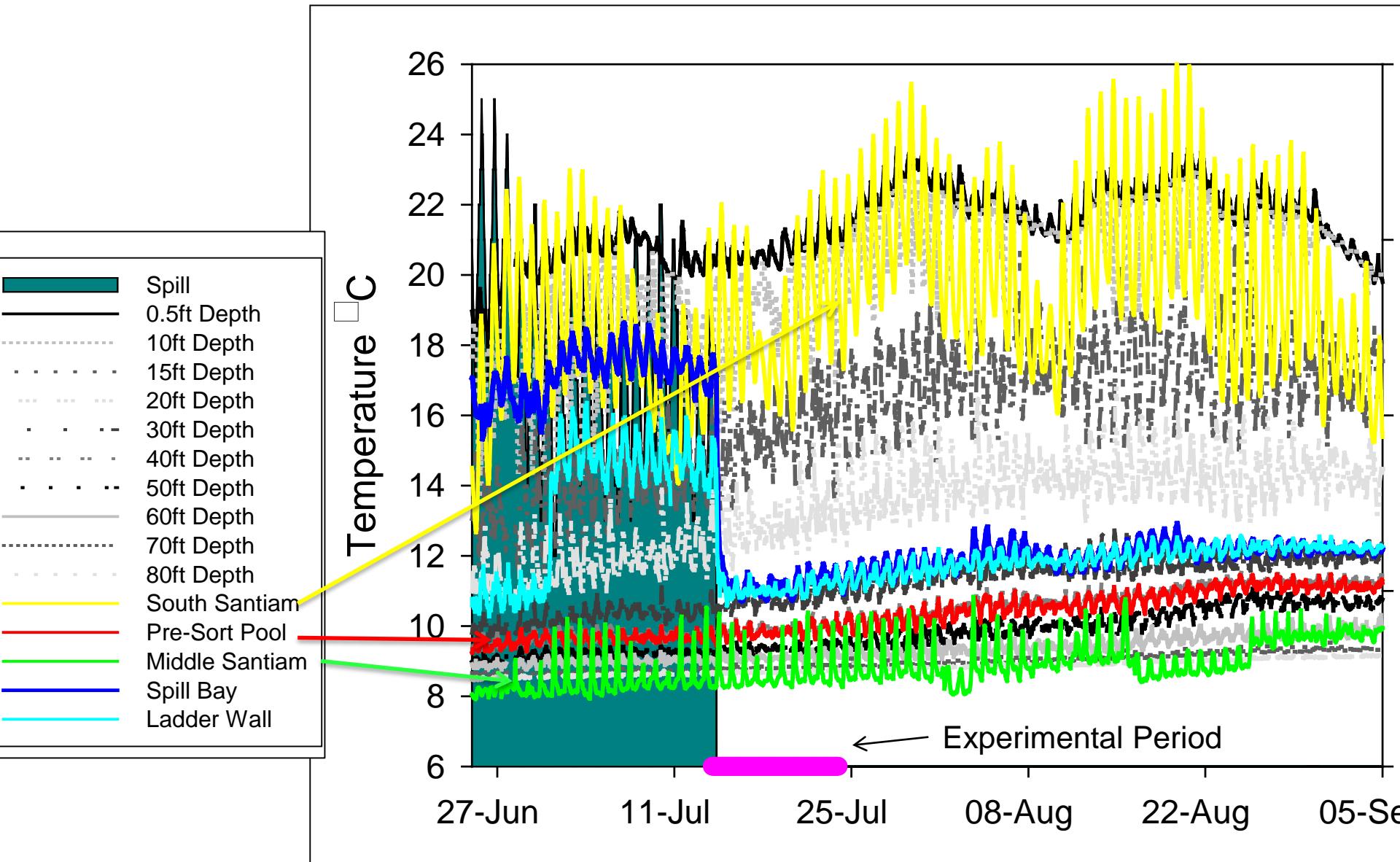
- **Temperature**
  - Green Peter tailrace, South Santiam
  - Forebay string
  - Foster ladder
  - Foster tailrace

FOS Reservoir Temperature String

Legend:
- Spill
- 0.5ft Depth
- 10ft Depth
- 15ft Depth
- 20ft Depth
- 30ft Depth
- 40ft Depth
- 50ft Depth
- 60ft Depth
- 70ft Depth
- 80ft Depth
- South Santiam
- Pre-Sort Pool
- Middle Santiam
- Spill Bay
- Ladder Wall

Temperature °C

27-Jun   11-Jul   25-Jul   08-Aug   22-Aug   05-Se

Experimental Period

Temperature Gradients

Spillbay >> Presort

Legend:
- DS South minus 9-Tailrace
- 9-Tailrace minus 1-North shore
- 9-Tailrace minus 4-Ladder pool
- 9-Tailrace minus 10-Presort
- 2-Spillbay minus 4-Ladder pool
- 5-Main outside minus Main inside
- 5-Main outside minus 10-Presort

Tailrace *warmer* than fishway but still much cooler than S. Sanitam

Tailrace Lateral Gradients

Temperature difference C

Date

Segment	Water supply	Potential Issue(s)
Tailrace	Spillway (Surface) Turbine (Deep) Fishway (Mix)	
Main entrance	Ladder + Upper Reservoir Tailrace	Temperature Temperature gradient Natal cues, Velocity
Side entrance	Ladder + Mid Reservoir + Tailrace	Temperature Temperature Gradient Natal Cues, Velocity
Transition Area	Ladder	Temperature Temperature gradient Natal cues
Lower Ladder Channel Upper Ladder Presort Pool	Deep Reservoir	Temperature Natal cues Upper ladder hydraulics Presort entrance

Entrance Velocity Treatments
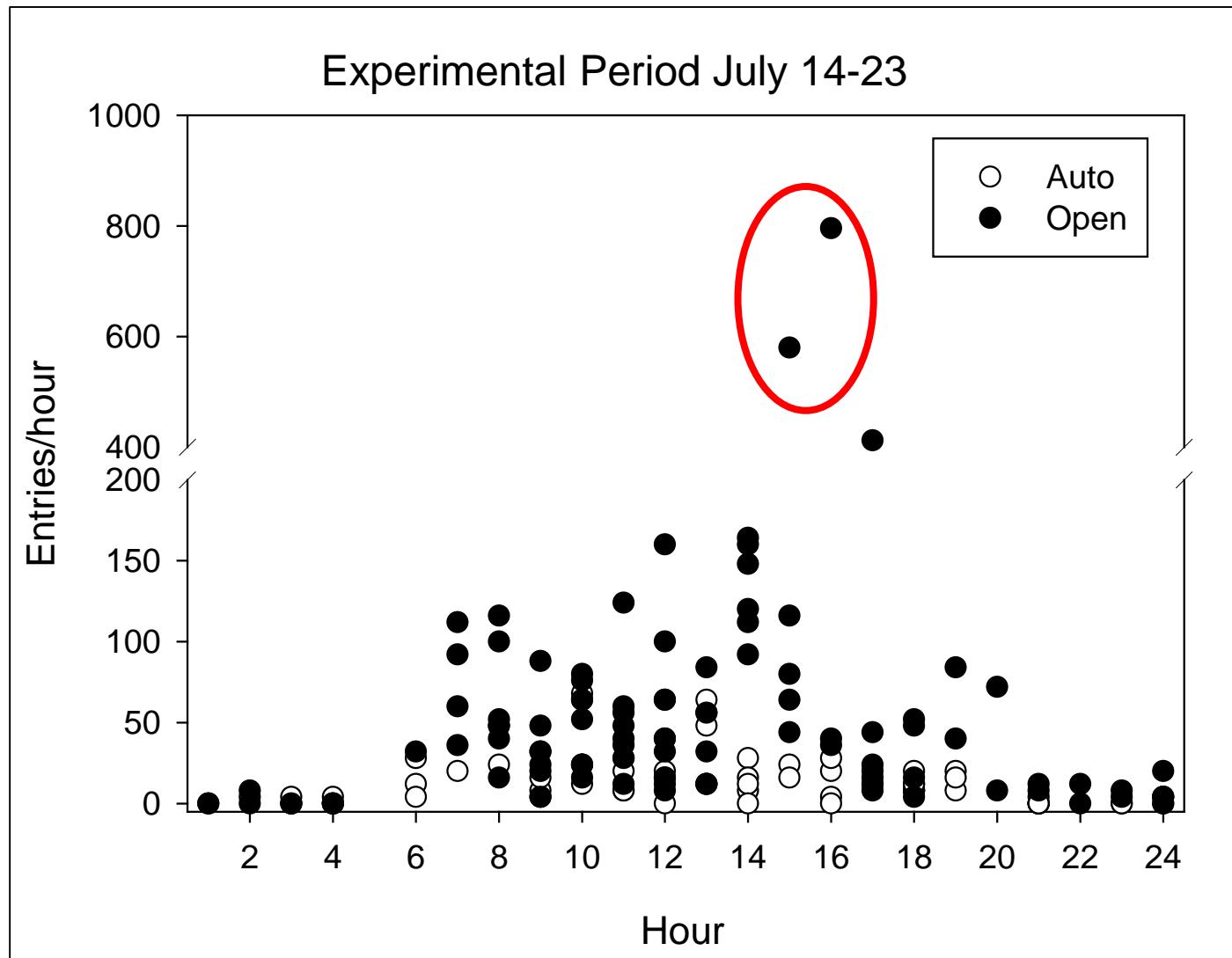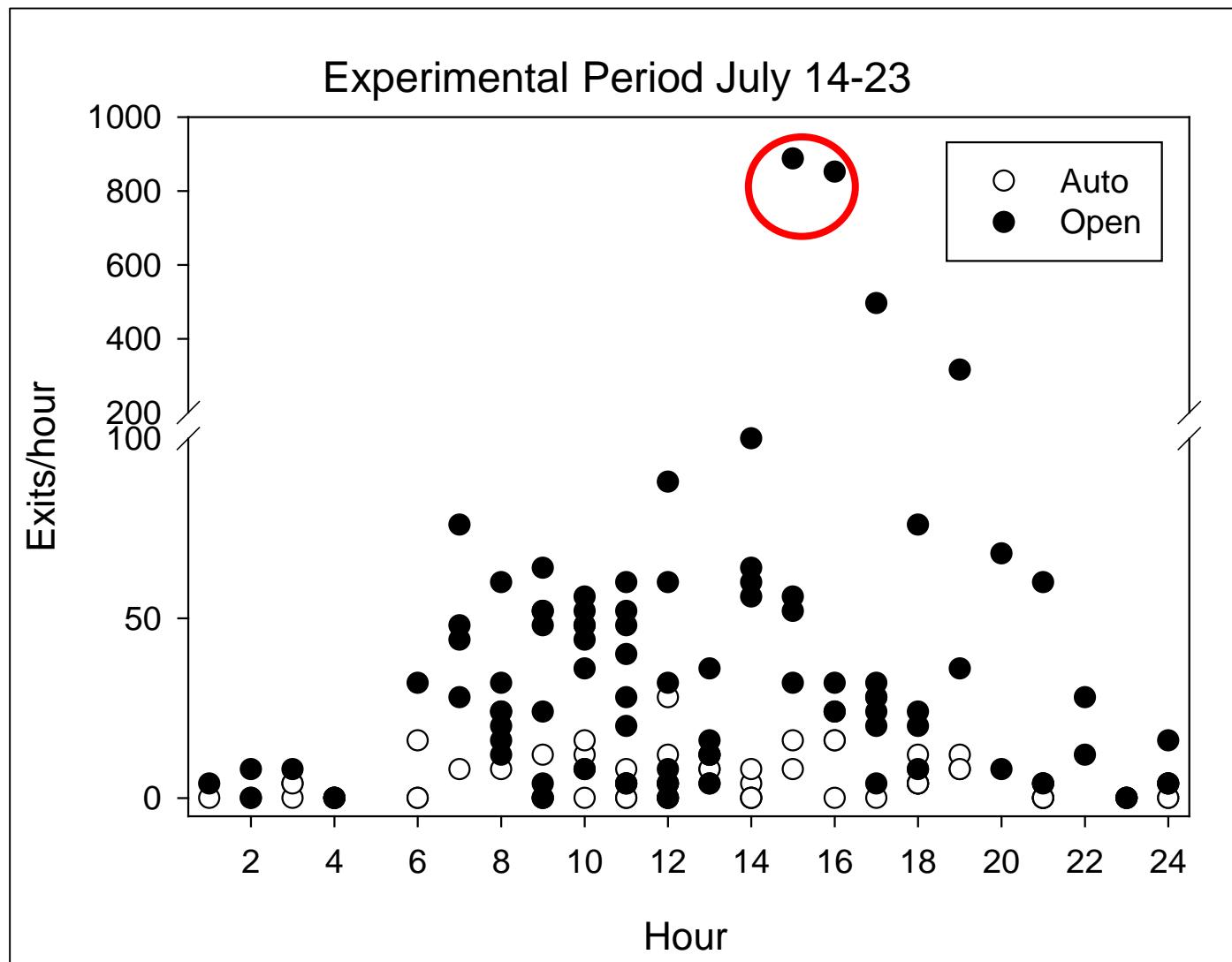
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2016 Objectives

- Impediments to collection?
  - Review 2006-2016 trap data for associations between trap rate and conditions

  - Monitor environmental conditions in the fishway and tailrace
  - Manipulate main entrance velocity
  - Monitor behavior at the main entrance (DIDSON) and within the fishway (optical video)

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Optical camera
Turnpool

Lower

DIDSON

Middle

Presort Pool

Upper

Upstream Channel
Optical camera

Downstream Channel
Optical camera

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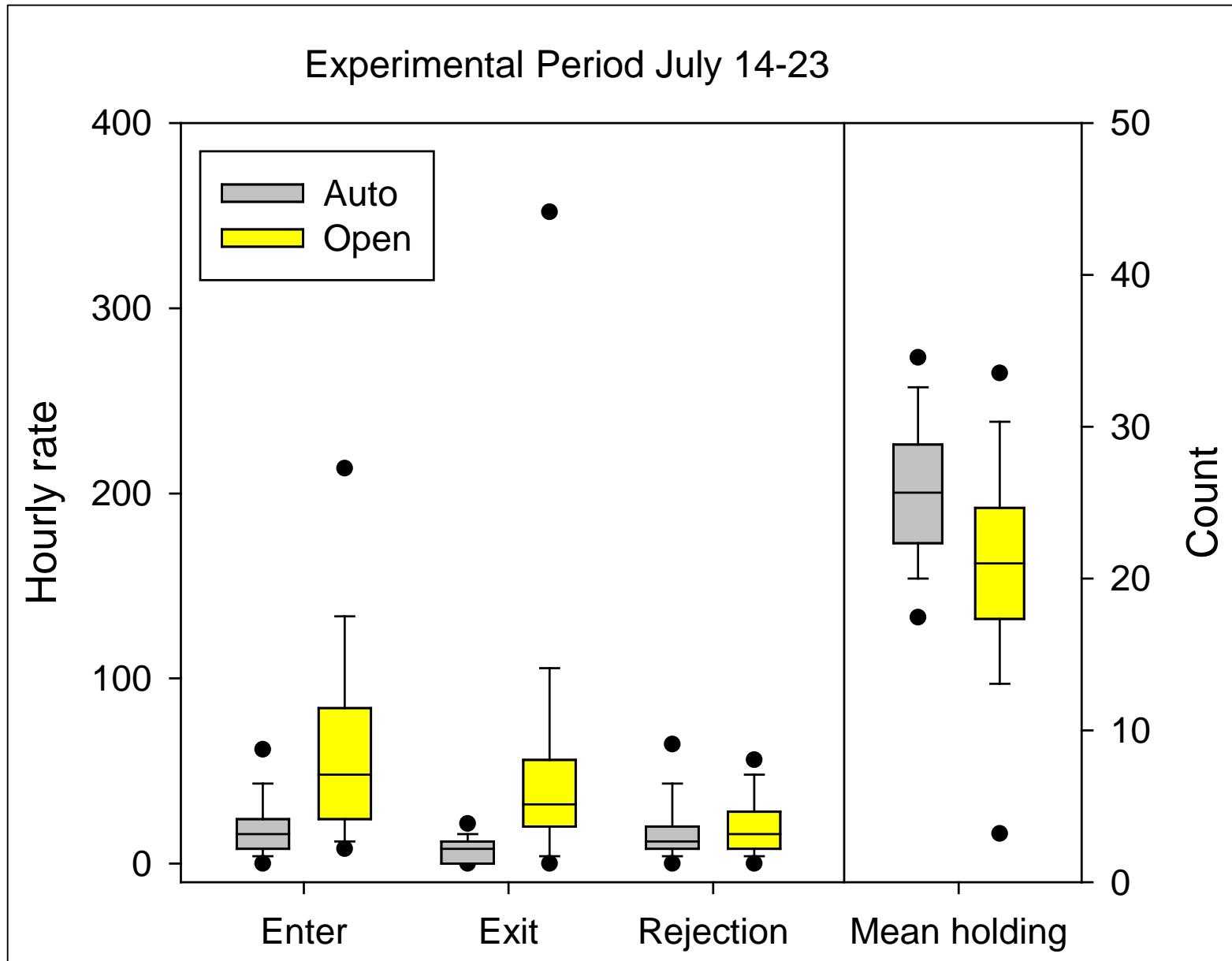
Entrance: DIDSON Entries/Hour
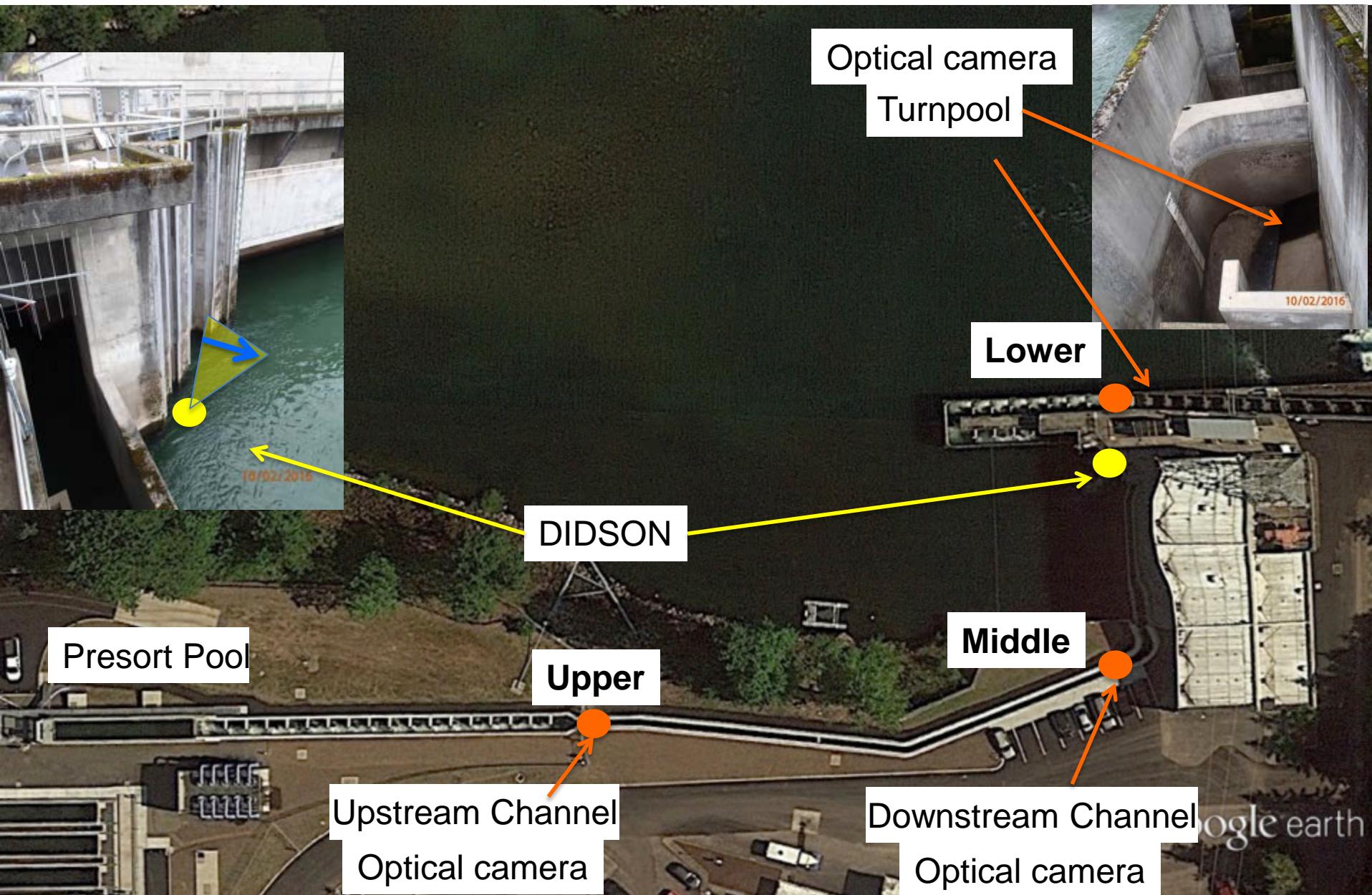
Entrance: DIDSON Exits/Hour
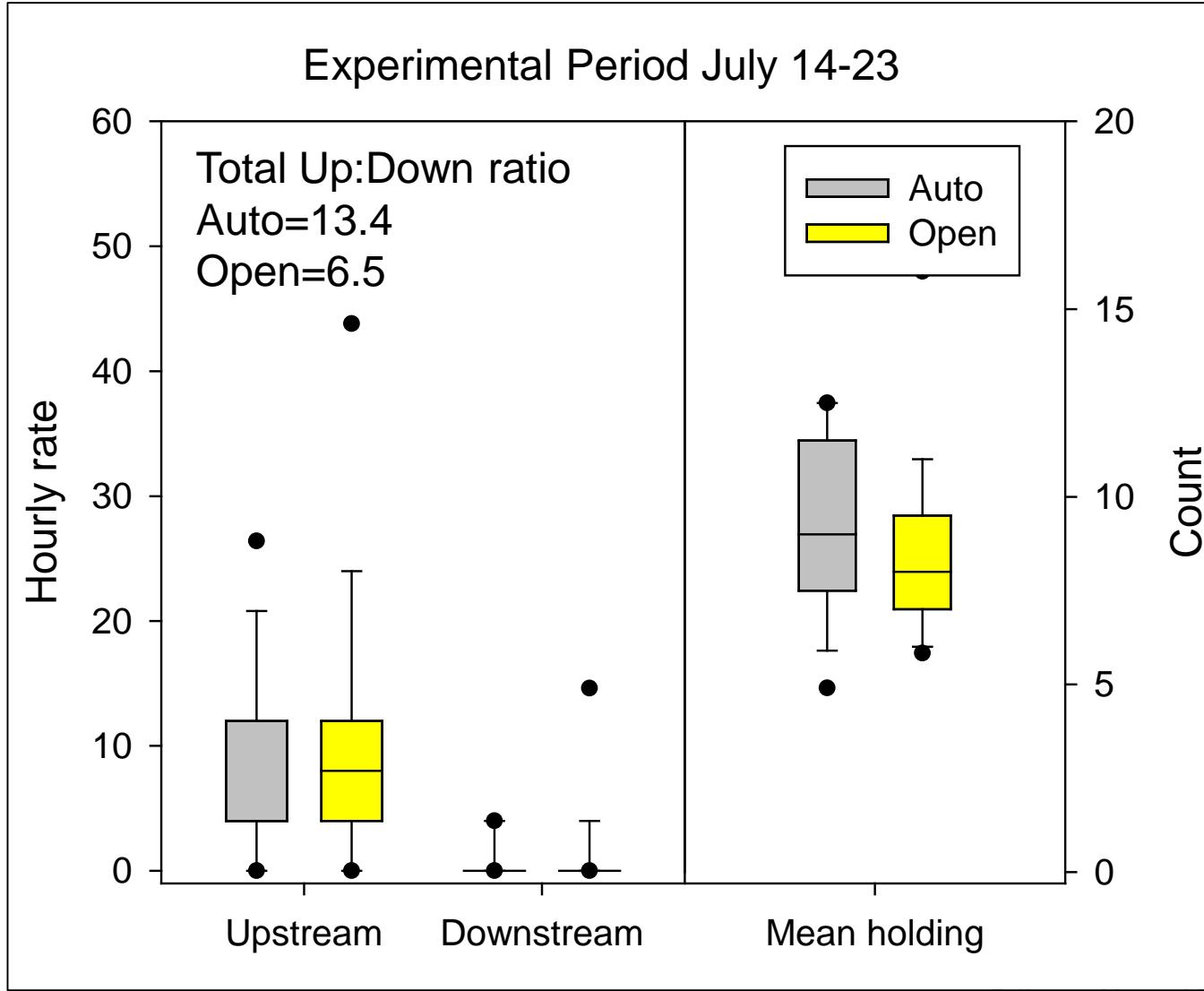
Entrance Behavior: DIDSON

Experimental Period July 14-23

Optical camera
Turnpool

Lower

DIDSON

Presort Pool

Middle

Upper

Upstream Channel
Optical camera

Downstream Channel
Optical camera

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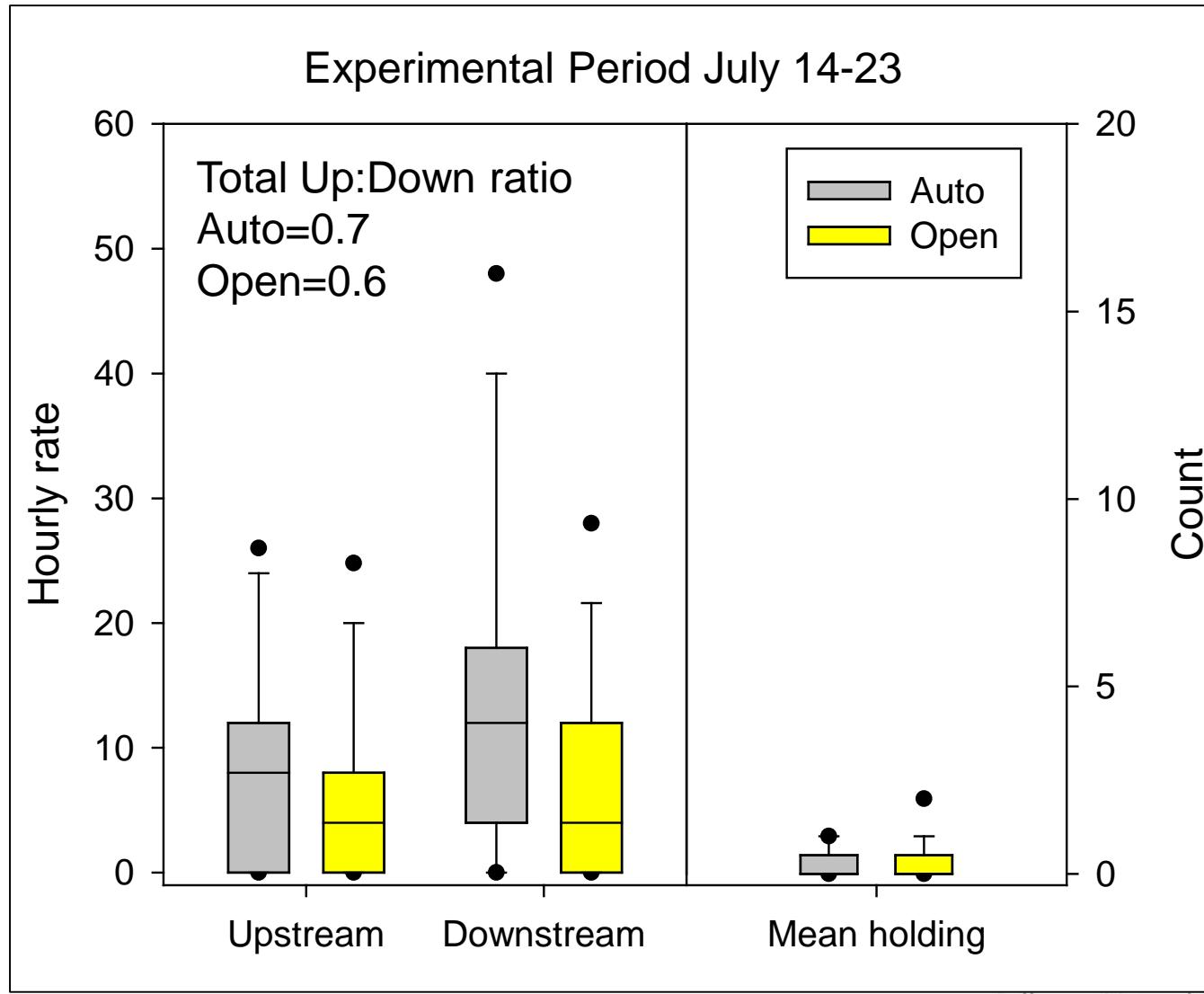
Lower Optical Camera
Weir/turnpool

Experimental Period July 14-23

Total Up:Down ratio
Auto=13.4
Open=6.5
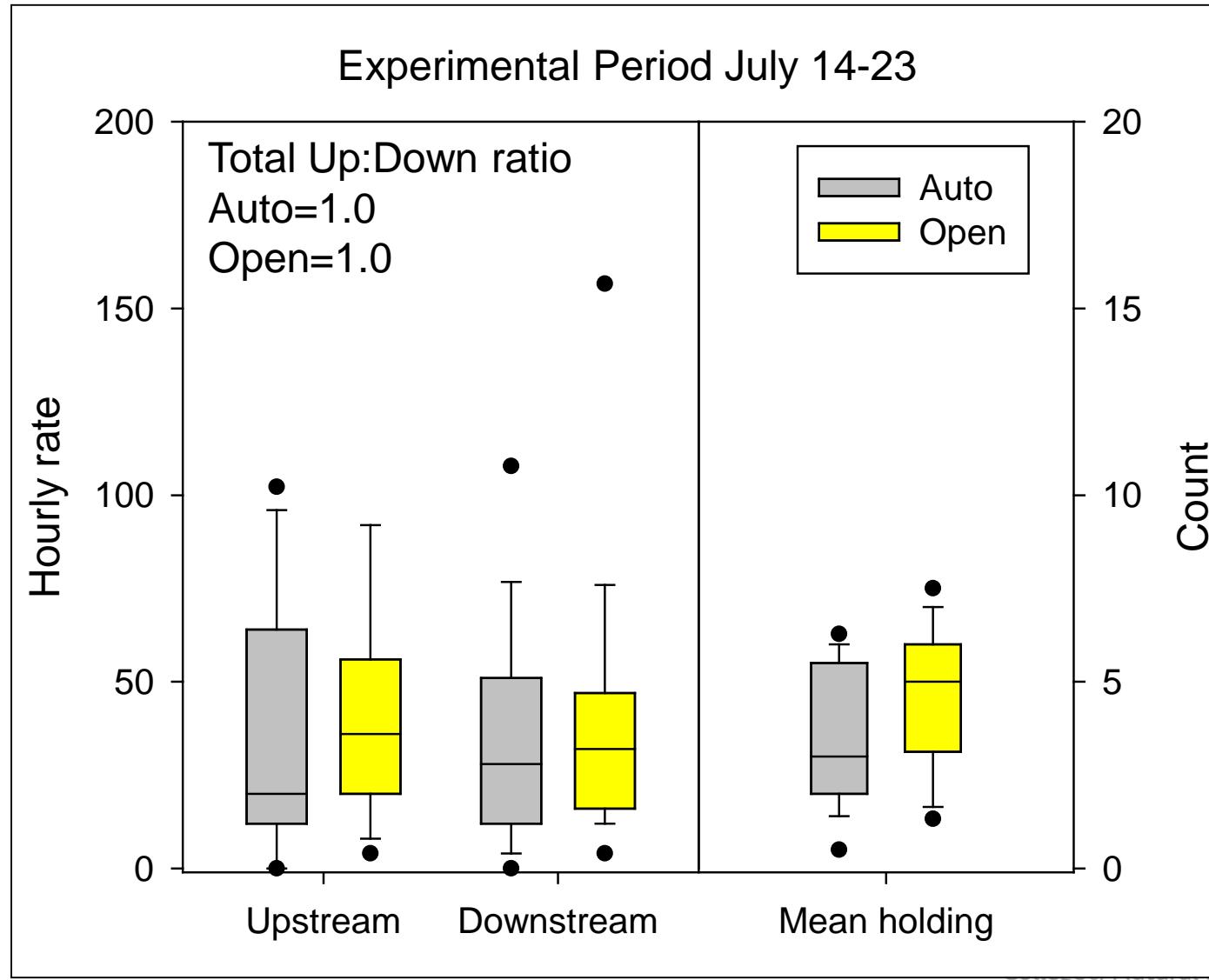
Middle Optical Camera
Downstream Channel

Experimental Period July 14-23

Total Up:Down ratio
Auto=0.7
Open=0.6
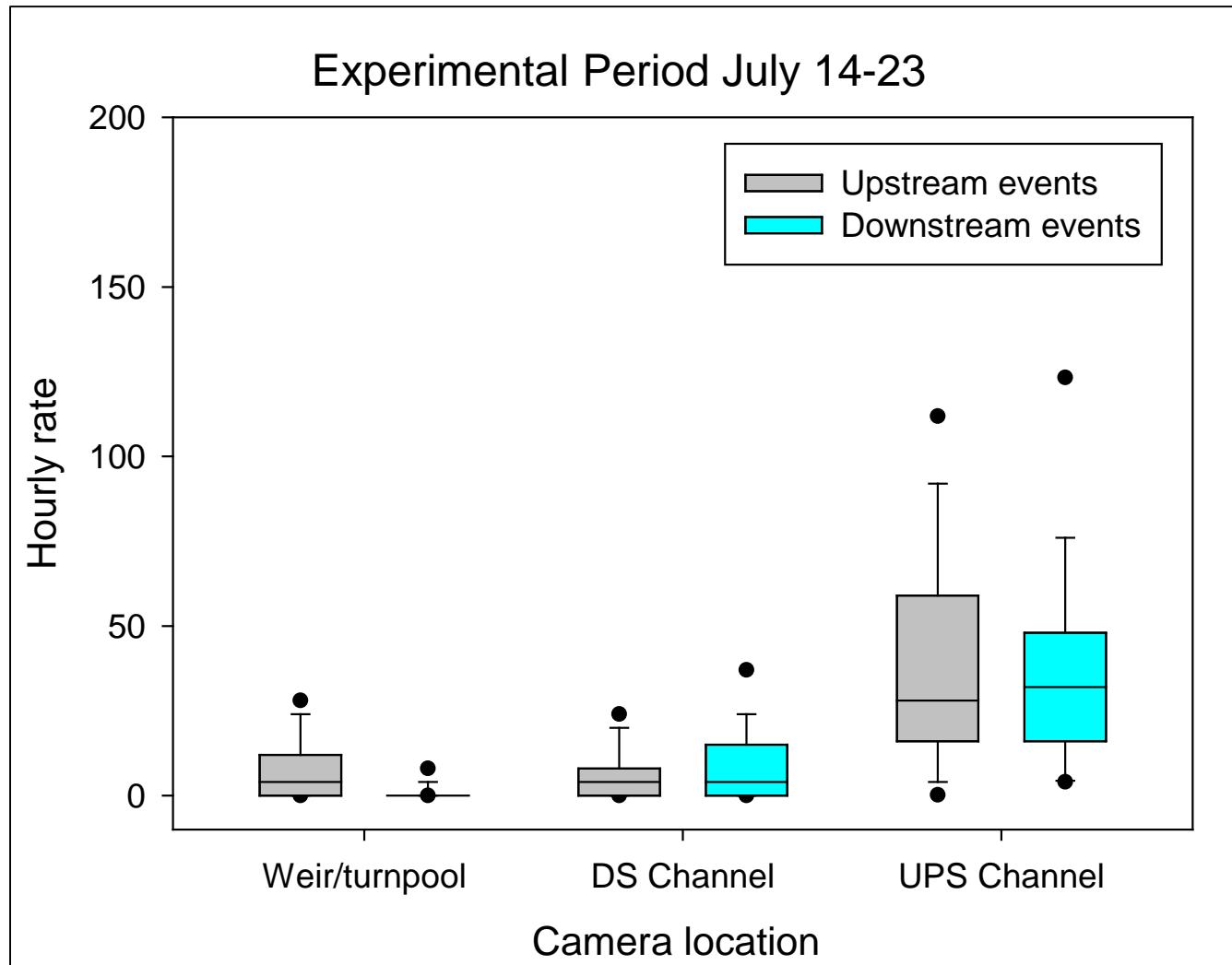
Upper Optical Camera
Upstream Channel

Experimental Period July 14-23
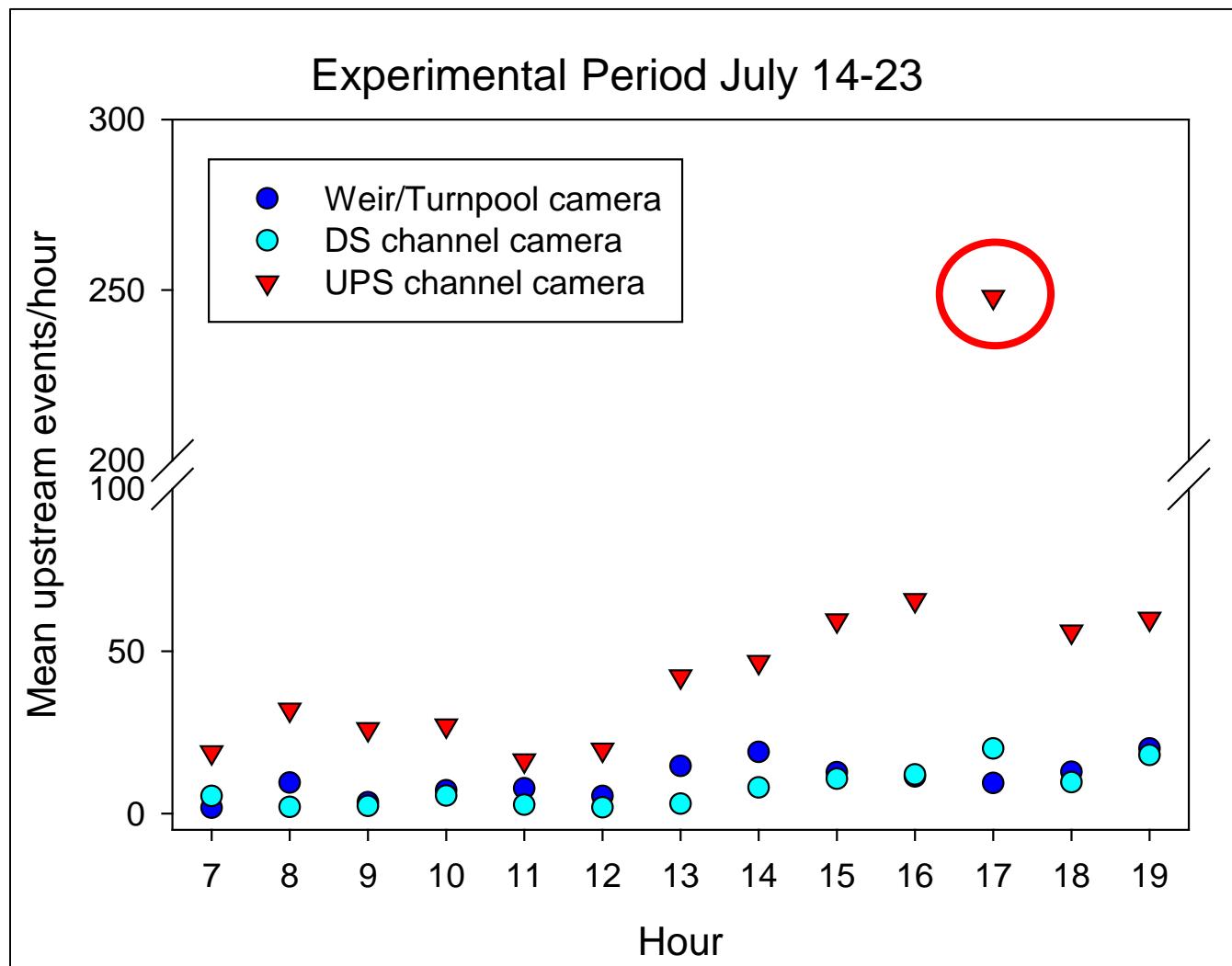
Summary: Optical Cameras
Salmon behavior

Experimental Period July 14-23

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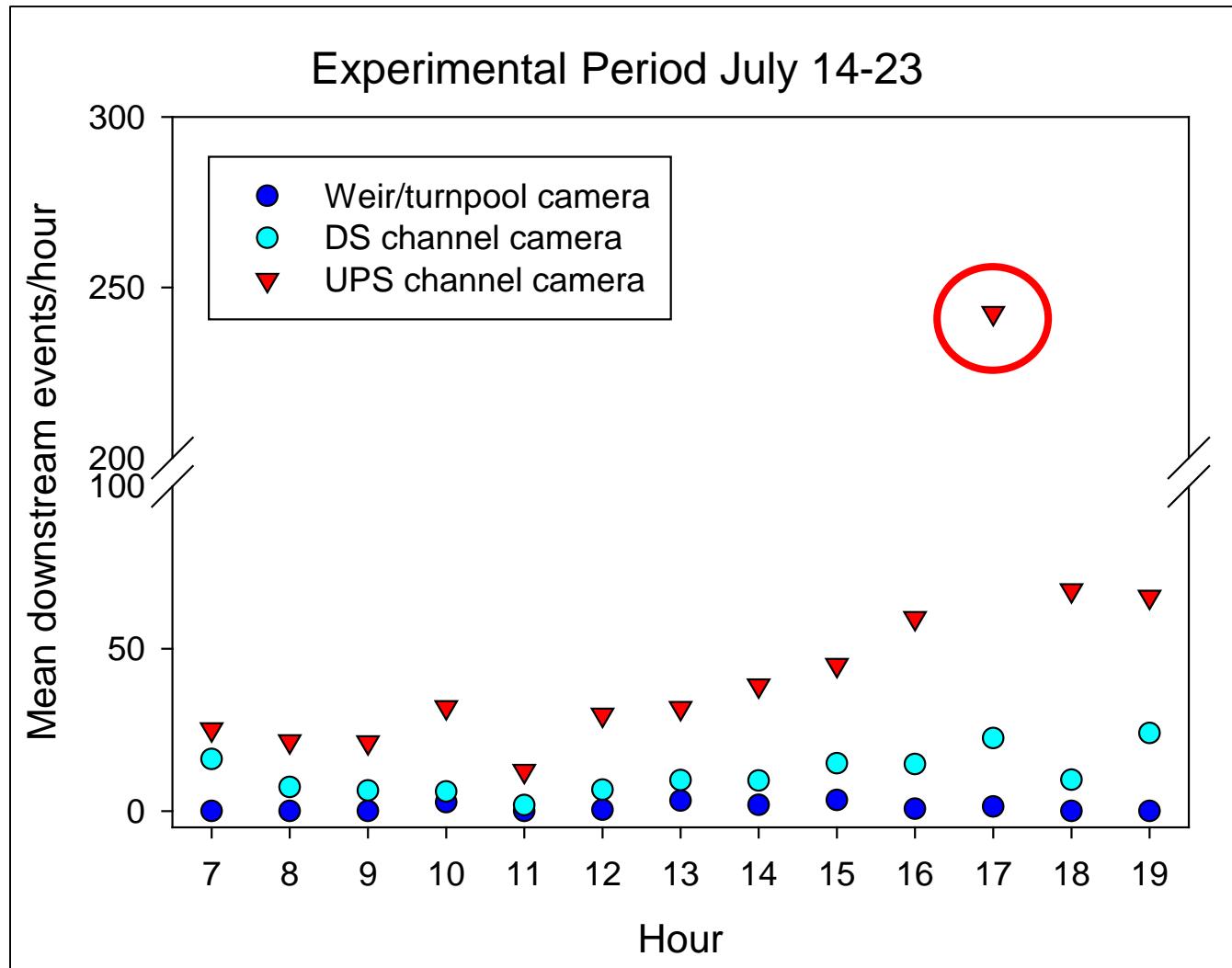
Optical Cameras
Mean upstream events by hour
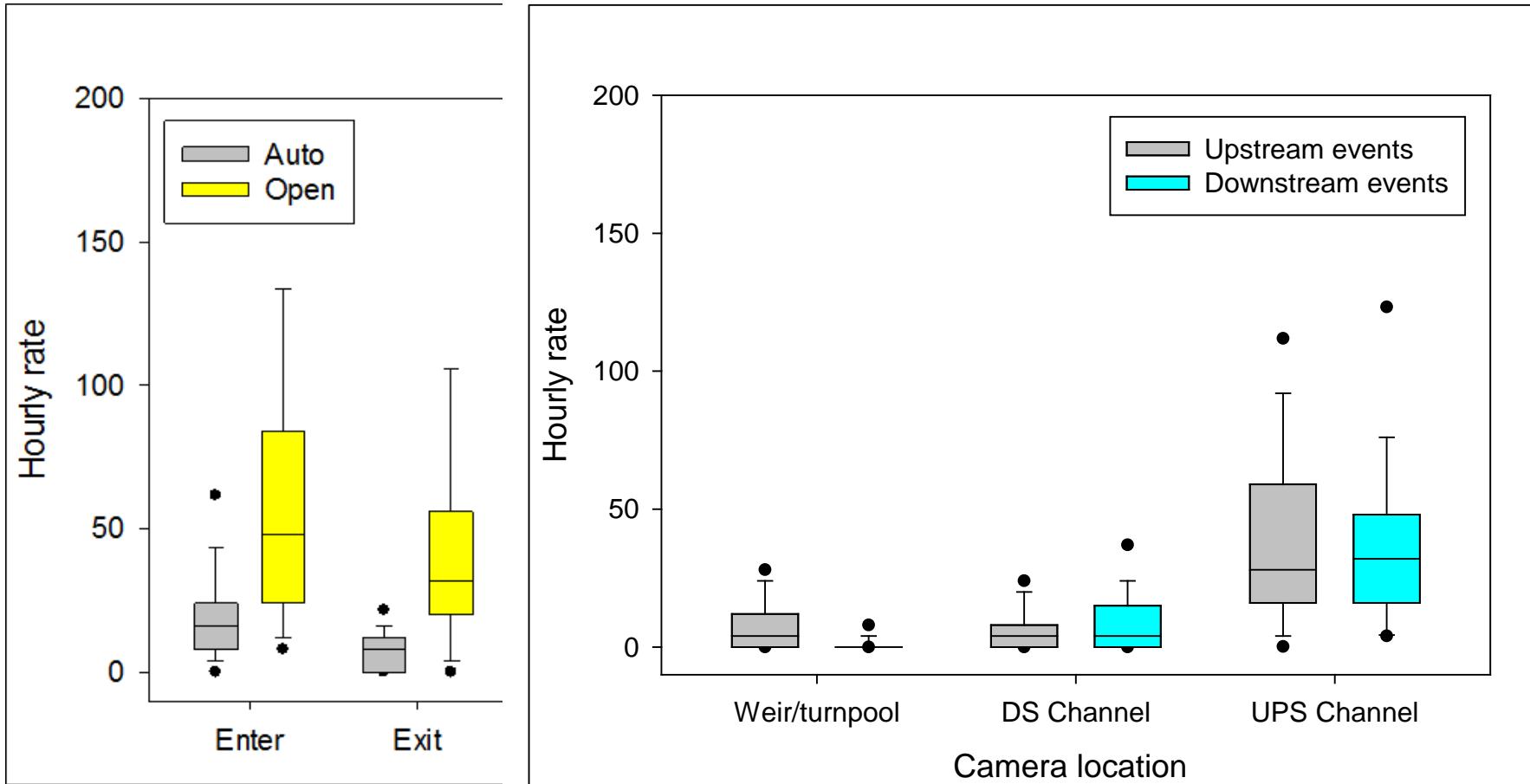
Optical Cameras
Mean downstream events by hour

DIDSON & Optical Cameras
Salmon behavior

Experimental Period July 14-23

Summary

- Pre-sort pool and upper ladder water has strong Middle Santiam temperature signature

- Complex lateral and longitudinal gradients in tailrace and ladder affected by water source(s) and operations; ladder always cool

- Adults active in daytime, peak in evening

- Lower entrance velocities increased entrance rates, but also increased exit rates ~ milling and holding

- Large milling event coincided with end of spill

Summary

- Many adults observed milling at base of upper ladder
  - Upper ladder/presort hydraulics?
  - Temperature?
  - Olfactory cues?
  - Social cues from adults? (manipulate trap densities)
  - Social cues from juveniles?
- Primary limit of study: could not track individuals
  - Individual # entries, # exits, tailrace time etc.
  - Entrance efficiency? How many adults entered but were not collected?
  - Probability(Collection)? How many did not enter?

Looking Ahead

- 2016 analyses: DFAA concentrations, PIT records, trap rate associations

- 2017: Radio-tagging at Lebanon Dam
  - Total AFF efficiency, entrance efficiency, turnaround location(s)
  - Behavior in relation to treatments

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Google earth

Table 1: Summary of potential mechanisms impeding passage and collection of Chinook salmon at the Foster Dam AFF.

Mechanism	Location/ bottleneck	Notes	Treatment/observations
Absolute temperature	Entrance	Fishway water temperature lowers motivation for entry and ascent	Temperature monitoring
Temperature differences	Tailrace vs. fishway, entrance	Changes in temperature impede entry and ascent	Temperature monitoring
Olfactory cues	Tailrace vs. fishway, within fishway	Lack of 1) natal cues or 2) other inappropriate cues such as stress cues from presort pool impede movement	1) DFAA analysis 2) Core water quality monitoring and reconstruction of source waters 3) Manipulate adult density in presort pool by daily vs. normal trap operations. 4) Introduce juvenile cues to presort pool
Hydraulics	Entrance, fishway or ladder-presort transition	Velocity and/or turbulence inappropriate.	Manipulate entrance weir operations
Visual/light conditions	Fishway and presort pool	Light conditions impede passage because too bright or too light of substrate	Manipulate light conditions over channel, upper ladder, and presort pool
Natal origin	Tailrace and downstream vs. Trap	Below FOS-origin adults holding in tailrace prior to spawning will be unmotivated to move into trap	Association between genetic pedigree assignments and collection location

Acknowledgements

ODFW

Brett Boyd, Dan Peck, Tim Wright, Cam Sharpe
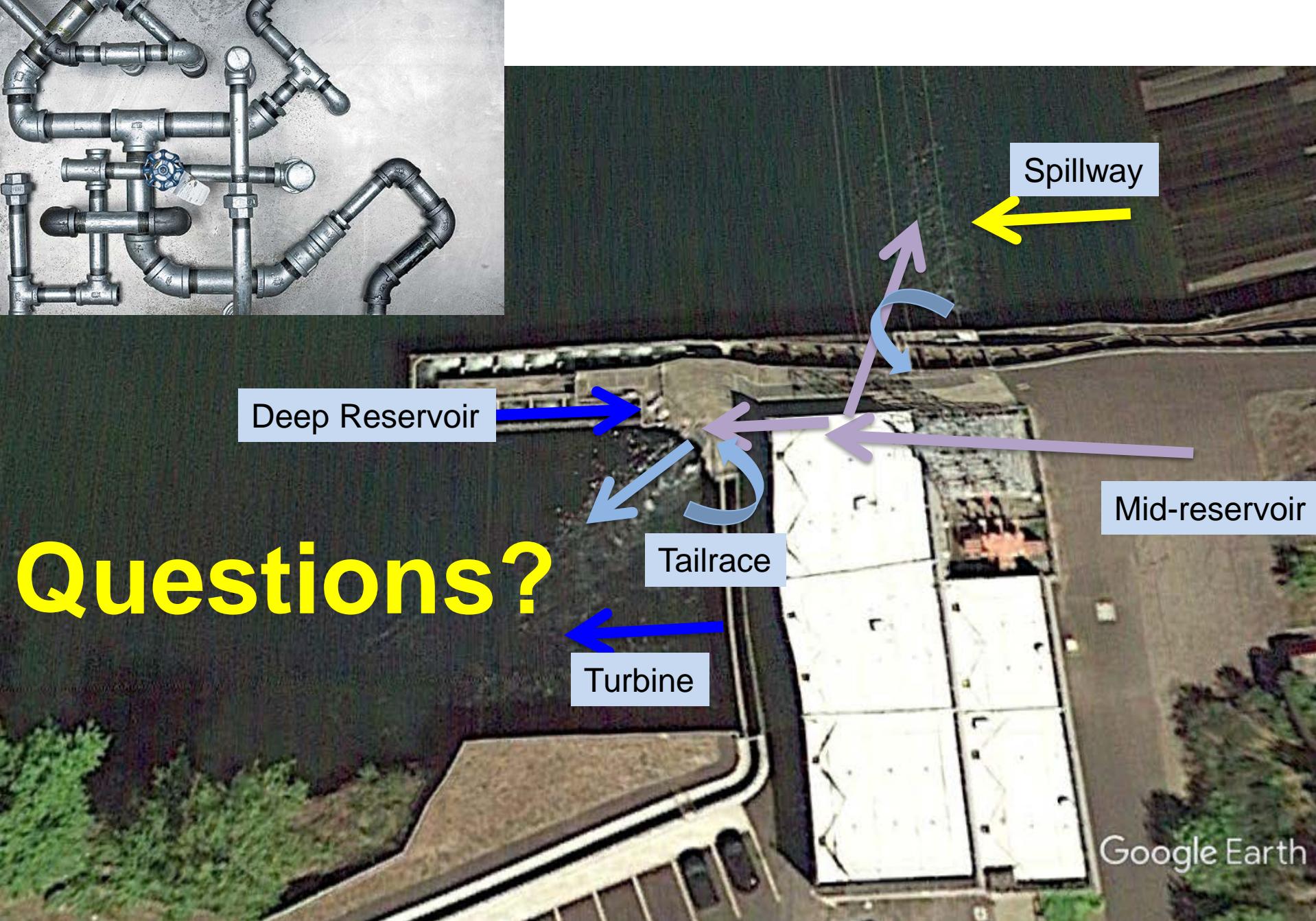
USACE

Fenton Kahn, Rich Piaskowski, Glenn Rhett, Steve Schlenker

Many others!

Questions?

M. Santiam River/ Green Peter Dam Outflow
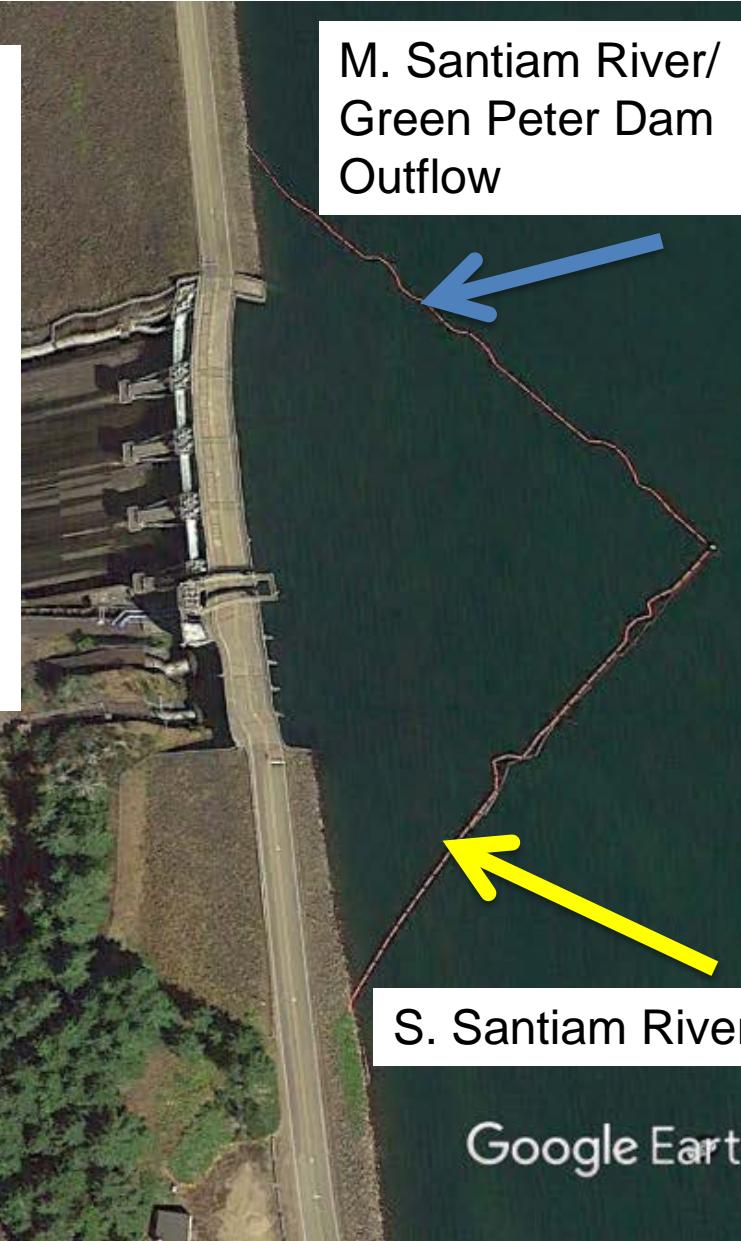
Collection targets (assuming perfect knowledge):

HOS Chinook: 100%
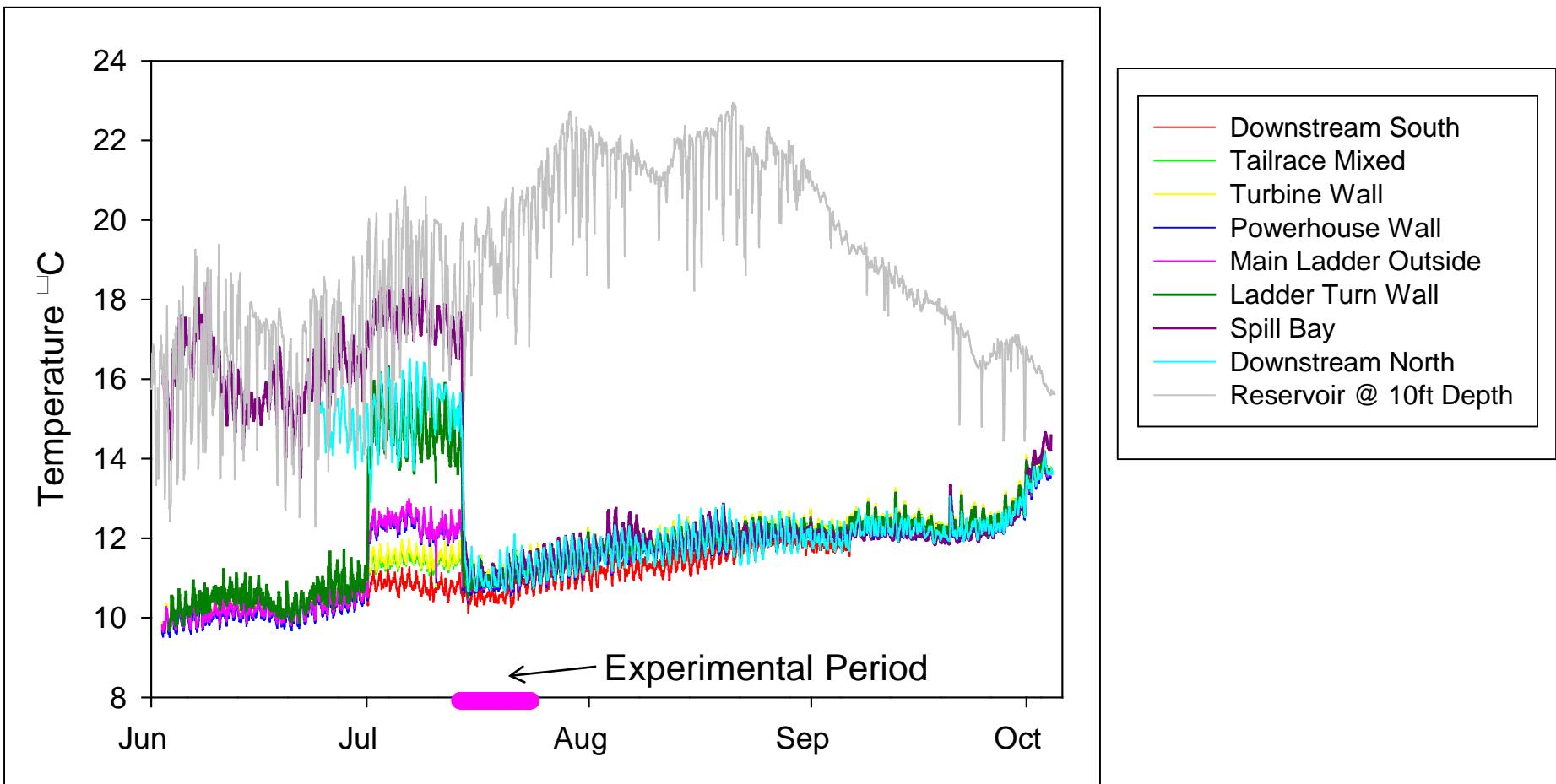
Unclipped Chinook by origin:
  -Above FOS NOS: 100%
  -Below FOS NOS: 0%
 -Below FOS HOSXHOS F_1: 100%
 -Below FOS NOSXHOS F_1: ??%

S. Santiam River

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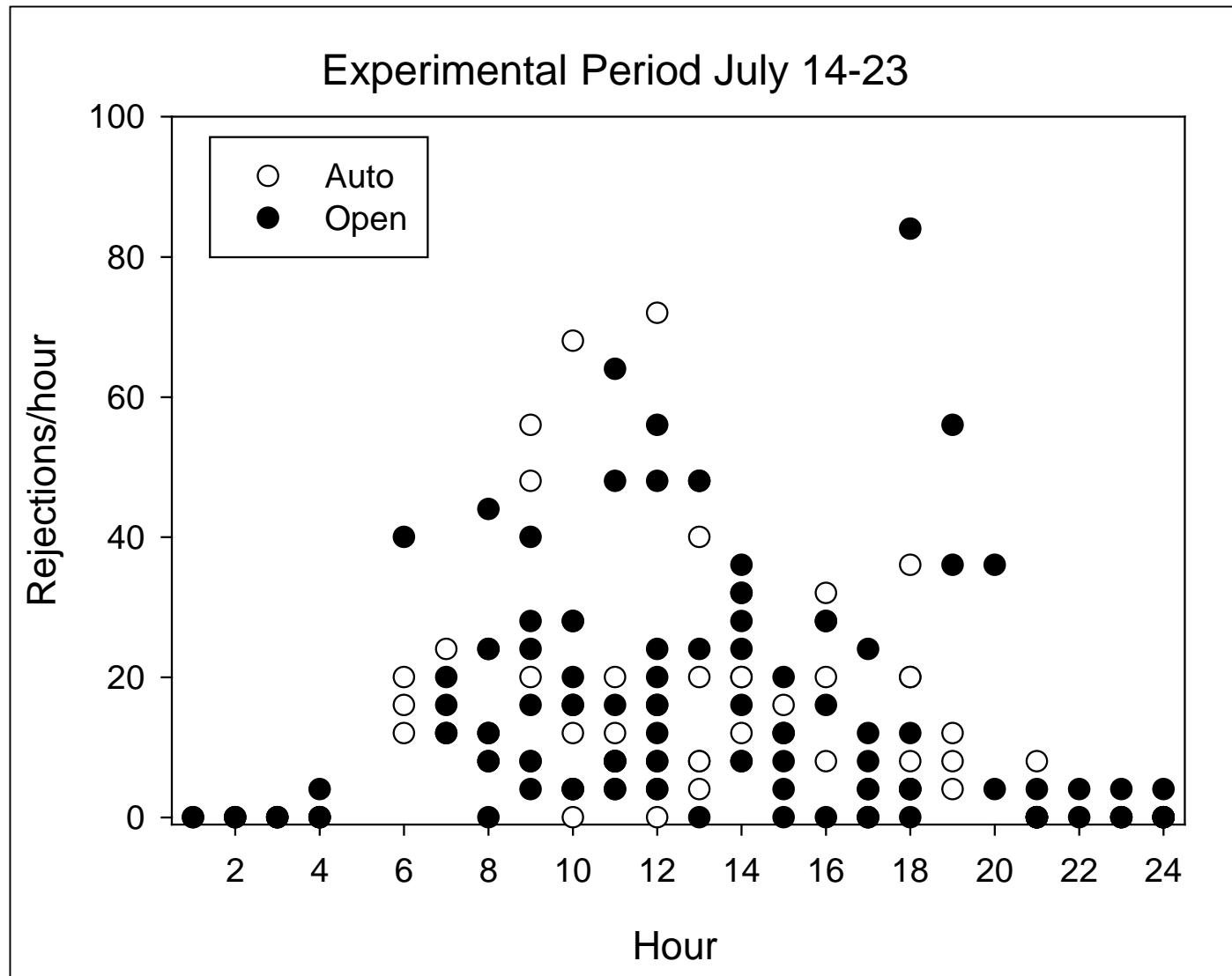
Results: Foster Temperatures
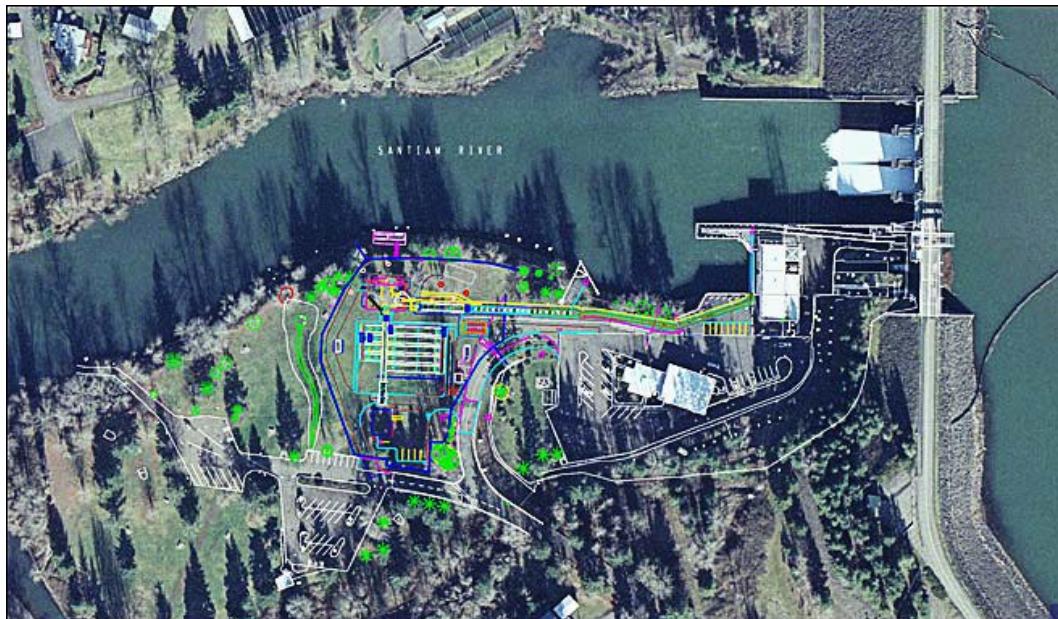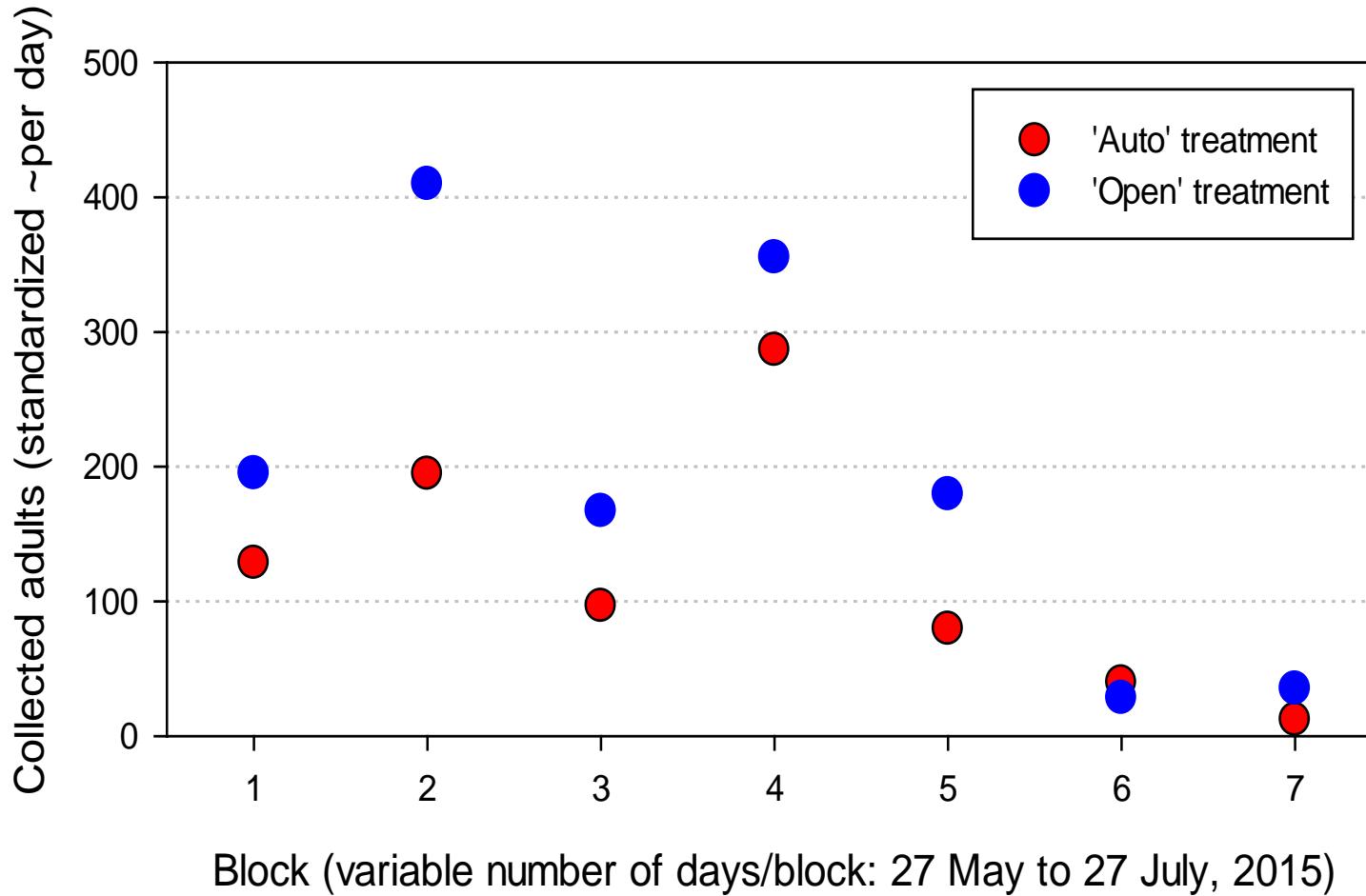
Entrance: DIDSON Rejections/Hour

Experimental Period July 14-23
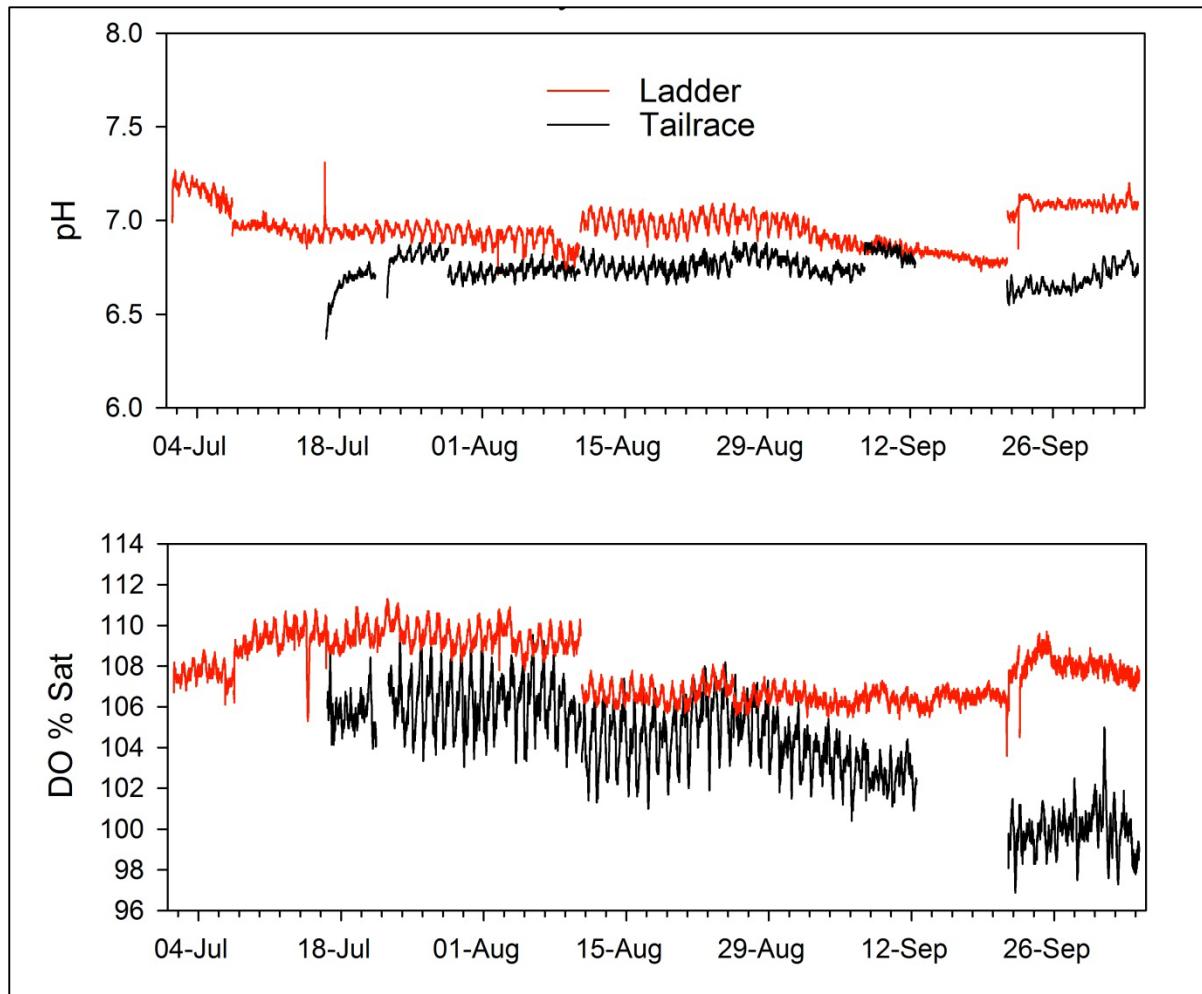
2016 Foster Monitoring Objectives

- **Spill**
- **Dissolved Free Amino Acids, Texas A&M**
- **Water chemistry** (ph conductivity, DO, temperature)
 - *-ladder*
  - *-tailrace below turbine*

Block (variable number of days/block: 27 May to 27 July, 2015)

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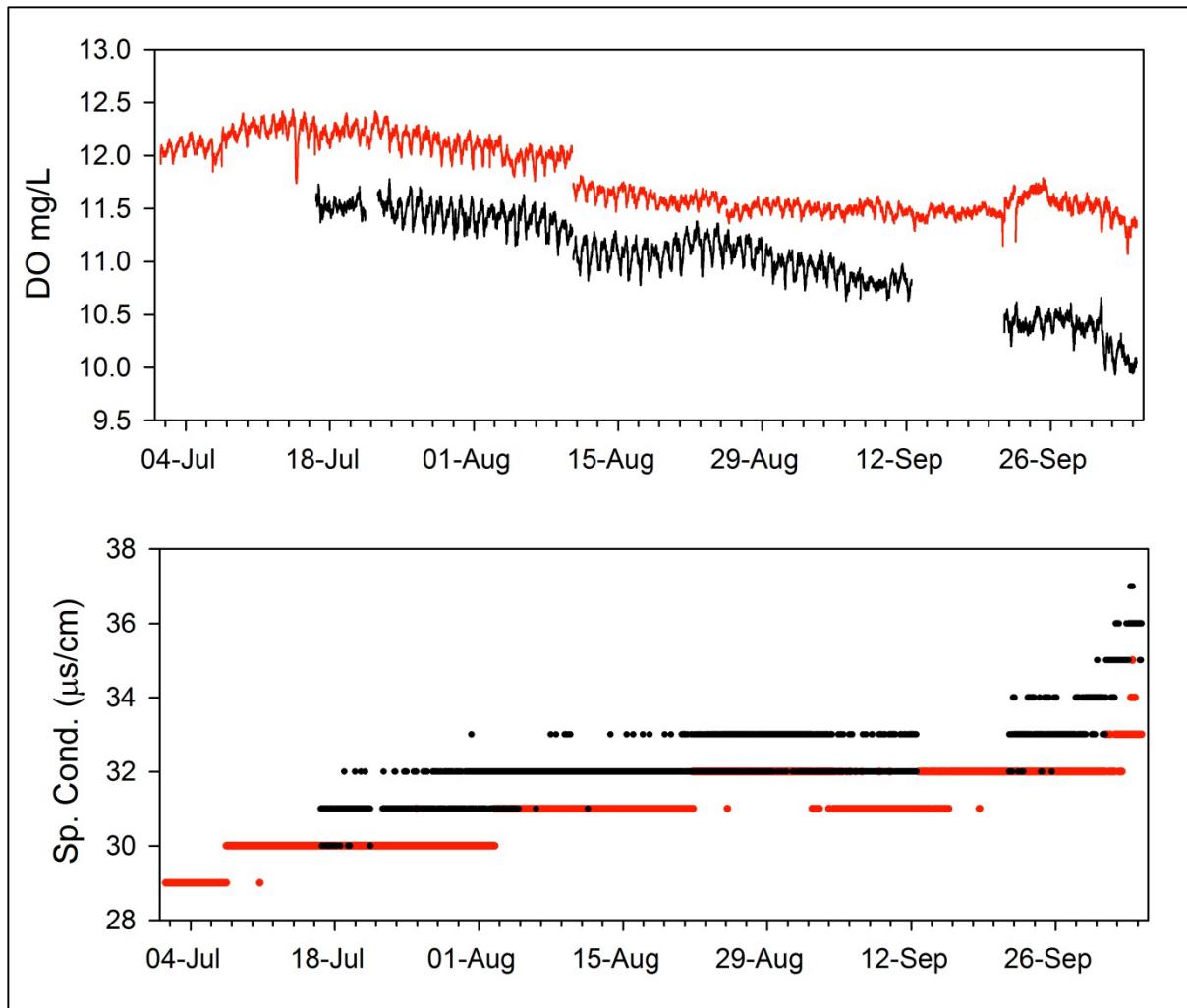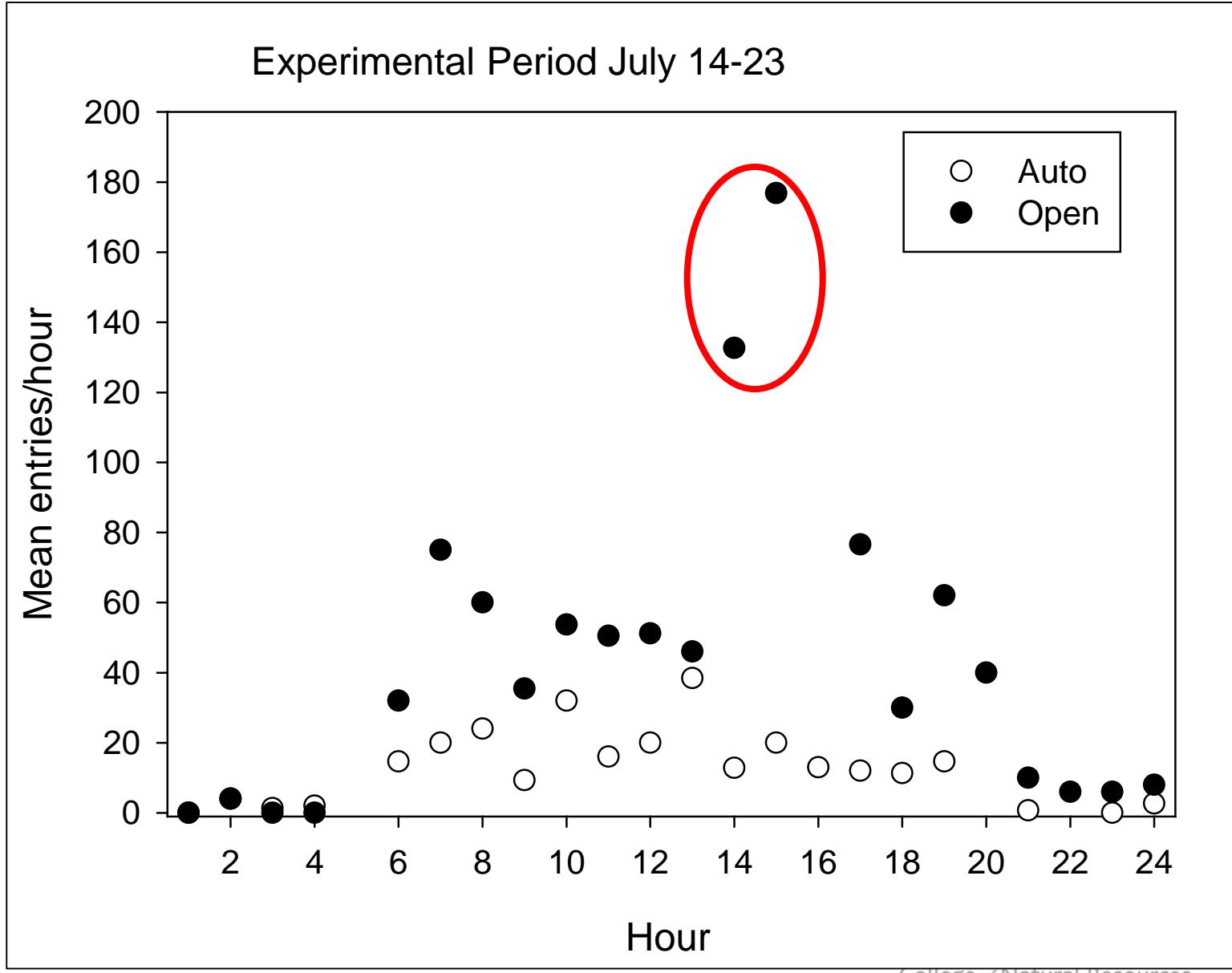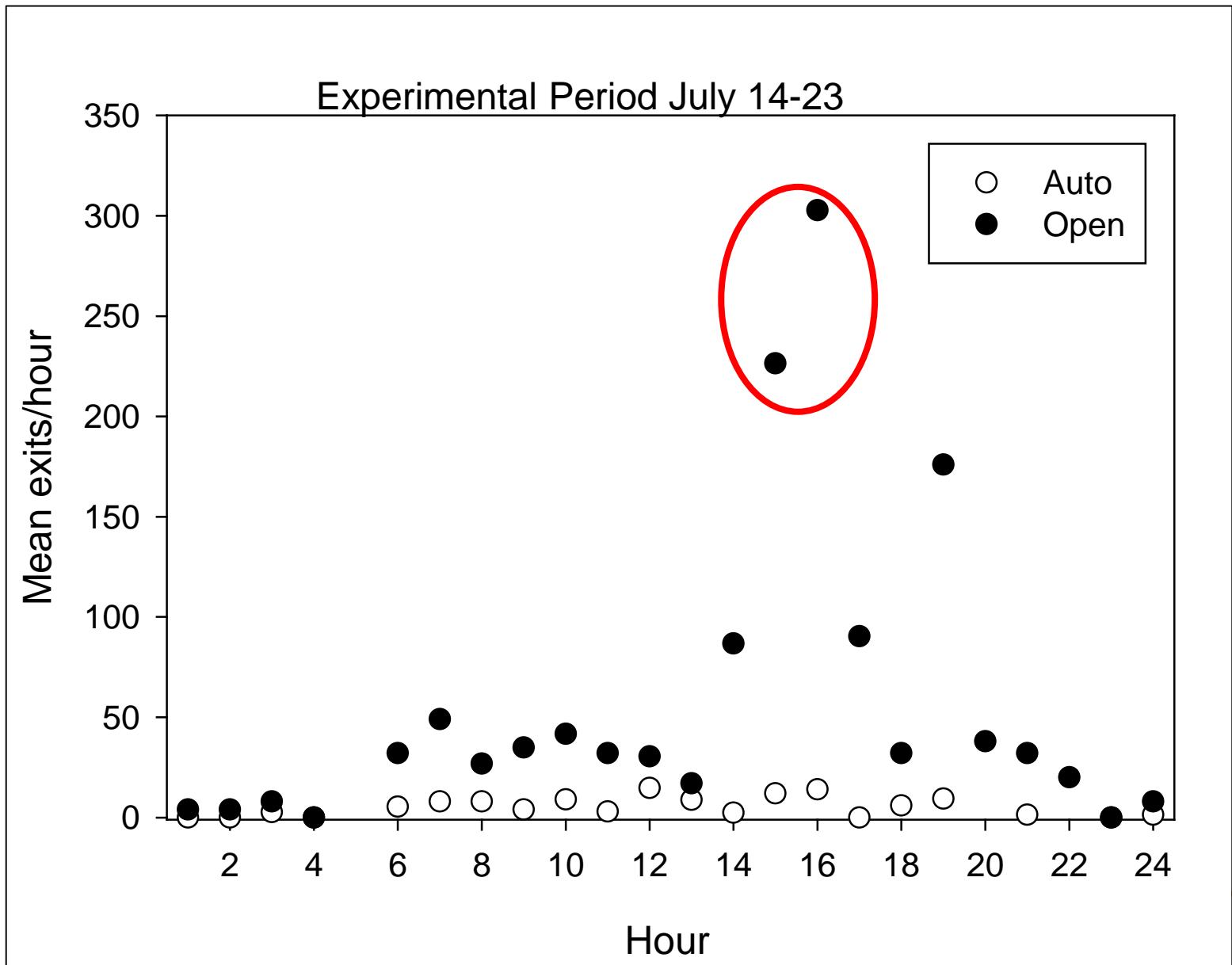
Foster: Hydrolab

Foster: Hydrolab

Entrance Rate: DIDSON

Experimental Period July 14-23
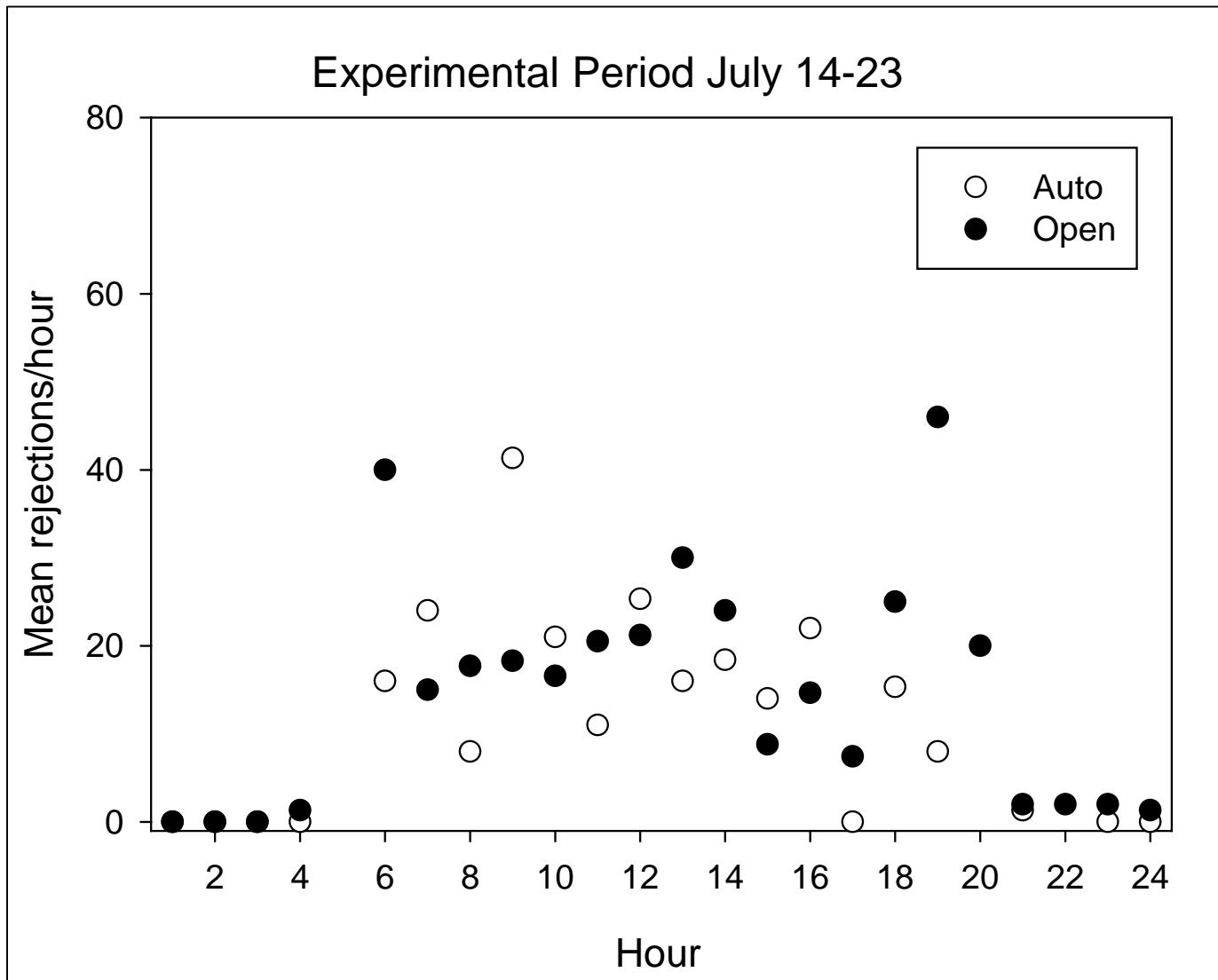
Exit Rate from Entrance : DIDSON

Results: DIDSON Mean Rejections/Hour

Experimental Period July 14-23

Results: Foster Reservoir
Temperature String