Evaluation of reintroduction strategies for Chinook salmon above Foster Dam on the S. Santiam River, 2017: Release of adult Chinook Foster Dam Reservoir

Study Code APH-09-01-FOS

Christopher C. Caudill

2017 Objectives

- **Objective 5 (NEW):** Determine the effects that releases of adult Chinook salmon into Foster Reservoir have on prespawn mortality and spawner success for Chinook salmon released above Foster Dam

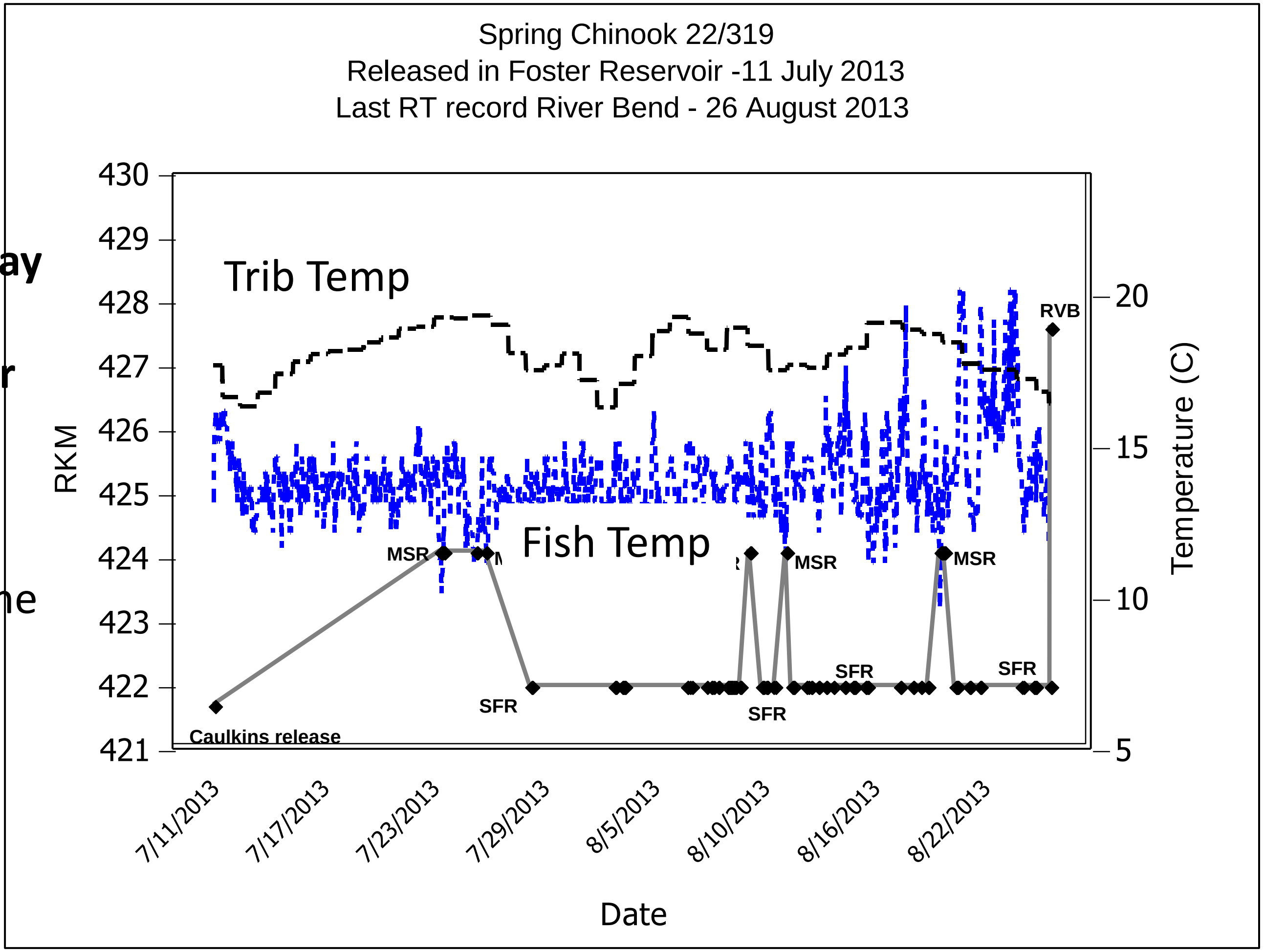
- **Objective 5a:** Compare PSM rate for reservoir-released and tributary-released groups. Estimate thermal exposure in both groups.
- **Objective 5b:** Estimate fallback rate of reservoir-released Chinook salmon using radio-telemetry and PIT detections.
  - 2015: 2 of 14 Reservoir-released Chinook fellback at FOS (14%) compared to 1.4% of river-released.

- **Objective 5c:** (optional or out-year task) Determine origin of adult Chinook salmon falling back over Foster Dam after release if fallback rate is deemed high using genetic pedigree analysis.
  - Majority of previous fallbacks identified using RT did not assign to above-FOS parents

Reservoir Releases

- Selection of natal tributary
- Thermal benefit
- Reduced transport time

23.3% decrease in degree day accumulation during 46 day residence in Foster Reservoir (mean 13.8 C temperature, accumulation of **635** degree days) compared to the temperatures during the same period in the S. Santiam at Cascadia (average 18 C, **828** degree days).



Approach

- PIT+Radio-tag+temp logger at FOS, genetic clips
- Outplant to FOS reservoir or S. Santiam
- Monitor movement into M. and S. Santiam
- Monitor fallback (RT + PIT)
- Recover carcasses, score PSM for ResRel vs. TribRel
- Estimate thermal exposure for ResRel vs. TribRel
- (optional out-year) Genetic back-assignment of fallback vs. non-fallback adults to:
  - above-FOS parents (fallback undesirable)
  - below-FOS parents (fallback represents homing by ‘overshoot’ salmon, potentially offspring of HOS)

2017 Objectives

- **Objective 5 (NEW):** Determine the effects that releases of adult Chinook salmon into Foster Reservoir have on prespawn mortality and spawner success for Chinook salmon released above Foster Dam

- **Objective 5a:** Compare PSM rate for reservoir-released and tributary-released groups. Estimate thermal exposure in both groups.
- **Objective 5b:** Estimate fallback rate of reservoir-released Chinook salmon using radio-telemetry and PIT detections.
  - 2015: 2 of 14 Reservoir-released Chinook fellback at FOS (14%) compared to 1.4% of river-released.

- **Objective 5c:** (optional or out-year task) Determine origin of adult Chinook salmon falling back over Foster Dam after release if fallback rate is deemed high using genetic pedigree analysis.
  - Majority of previous fallbacks identified using RT did not assign to above-FOS parents

Evaluation of reintroduction strategies for winter steelhead above Foster Dam on the S. Santiam River, 2017

Study Code APH-09-01-FOS

Christopher C. Caudill & James Nagler, U. Idaho
Shawn Narum, CRITFC
Cameron Sharpe, ODFW

FOS Winter Steelhead Pedigree

- **Pedigree using STW genetic clips and 200-400 SNP markers**

- **Obj. 1)** Proportion unclipped STW collected at FOS and below FOS that are progeny of STW outplanted above FOS
- **Obj. 2)** Total lifetime fitness of steelhead outplanted above FOS
- **Obj. 3)** Relationship between fitness, release site, release date, handling and transport protocols
- **Obj. 4)** Estimate proportion above-FOS unmarked steelhead with genetic influence of hatchery STS

- **Obj. 5)** Estimate proportion of fry/parr entering and exiting FOS that were progeny of outplanted parents. Compare measures of smoltification between progeny of outplanted parents and captured fry/parr of resident *O. mykiss*

- **Obj. 6)** Estimate annual abundance and age structure of adult winter run steelhead returning to the S. Santiam River using a standardized protocol

Table 1: Number of adult unmarked steelhead outplanted above Foster Dam and the number of those adults sampled for genetic composition.

Brood Year	# Outplanted	# Sampled
2012	327	100
2013	286	273
2014	215	210
2015	129	125

Juvenile samples: 2013 onward; 487+ /year

Smoltification metric

- Can physiological metrics be used to predict downstream passage in *O. mykiss?* Future application to tagging studies.
  - develop less intrusive blood mRNA assay rather than gill arch enzyme assay
  - relate physiological smoltification measures to parentage and external morphology (coloration)

- Foster Reservoir entry: How does reservoir entry relate to parentage and smoltification?
- Foster Reservoir exit: How do growth, parentage, and operations affect smoltification?

Obj. 5: Smoltification indices

Coloration using photographs

Holecek et al. 2012

Physiological

1) “Standard” Gill Na/K-ATPase (McCormick 1993)

2) Blood Na/K-ATPase mRNA transcript levels (novel assay, reduced handling; useful metric for structural mod evaluations)

3) Blood cortisol levels (potentially useful but handling artifacts likely)

Validate 2) and 3) using hatchery juveniles

Assess juveniles from above-FOS and below-FOS using 1) [& 2) and 3)]

FOS Winter Steelhead Pedigree

- **Pedigree using STW genetic clips and 200-400 SNP markers**

- **Obj. 1)** Proportion unclipped STW collected at FOS and below FOS that are progeny of STW outplanted above FOS
- **Obj. 2)** Total lifetime fitness of steelhead outplanted above FOS
- **Obj. 3)** Relationship between fitness, release site, release date, handling and transport protocols
- **Obj. 4)** Estimate proportion above-FOS unmarked steelhead with genetic influence of hatchery STS

- **Obj. 5)** Estimate proportion of fry/parr entering and exiting FOS that were progeny of outplanted parents. Compare measures of smoltification between progeny of outplanted parents and captured fry/parr of resident *O. mykiss*

- **Obj. 6)** Estimate annual abundance and age structure of adult winter run steelhead returning to the S. Santiam River using a standardized protocol

Potential Sources of Unclipped Steelhead in Trap

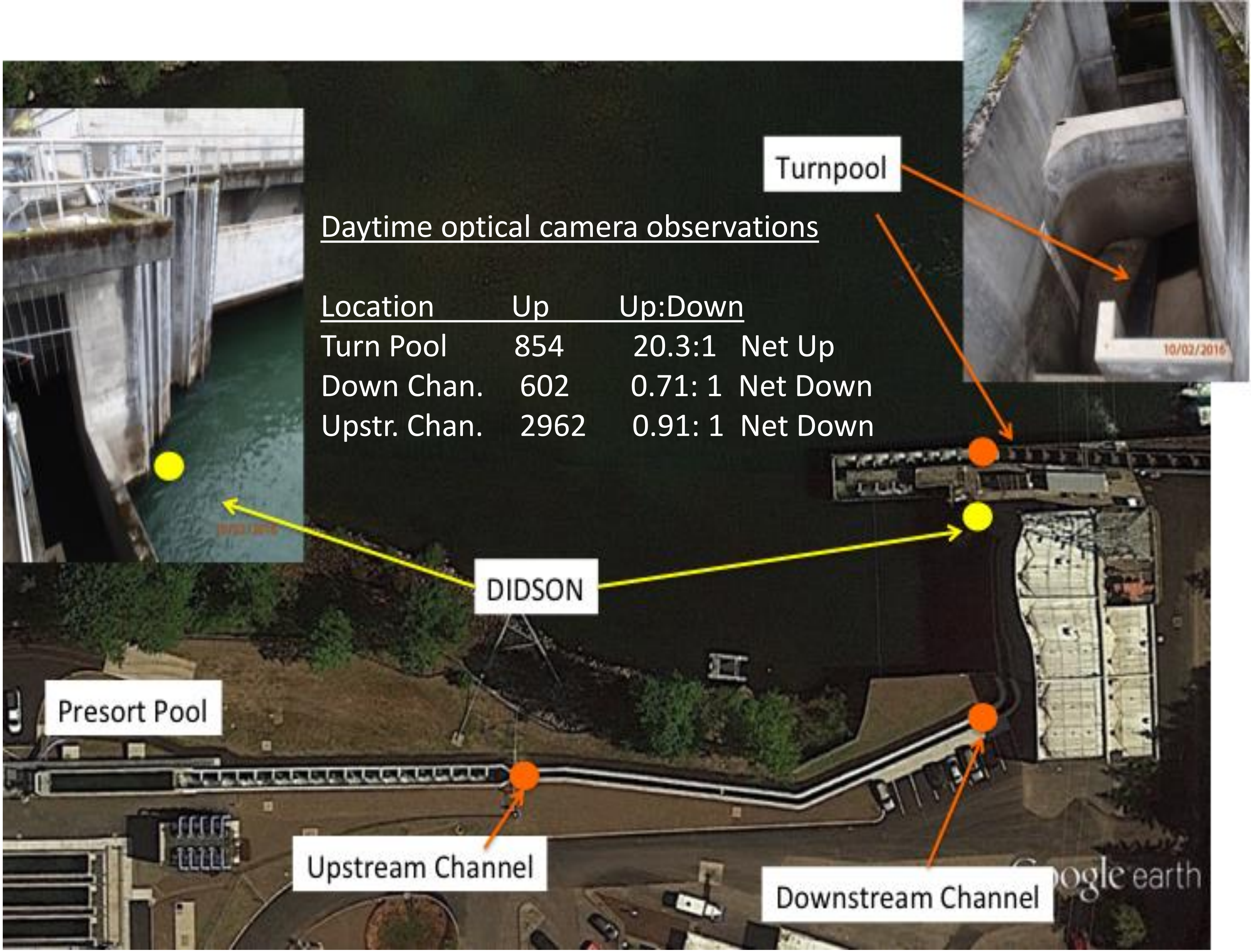
Parents were	Collected at FOS AFF
Wild, below FOS (S. Santiam and overshoots/strays)	Overshoot ('Mining' below FOS populations)
F1 HOR X HOR, HOR X NOR below FOS	Overshoot (Introgression)
Anadromous, above FOS	Homing (Contribution of Wild Fish Sanctuary)
Resident, above FOS	Homing (Unclipped, Apparent below FOS)
Anad x Res crosses	Homing
Unclipped hatchery summers	Overshoot (rare)

Evaluation of Foster Adult Fish Trap Performance, 2017

Study Code APH-15-05-FOS

Chris Caudill, Univ. Idaho

Cam Sharpe, ODFW



Daytime optical camera observations

Location	Up	Up:Down	
Turn Pool	854	20.3:1	Net Up
Down Chan.	602	0.71: 1	Net Down
Upstr. Chan.	2962	0.91: 1	Net Down

Objectives 2017

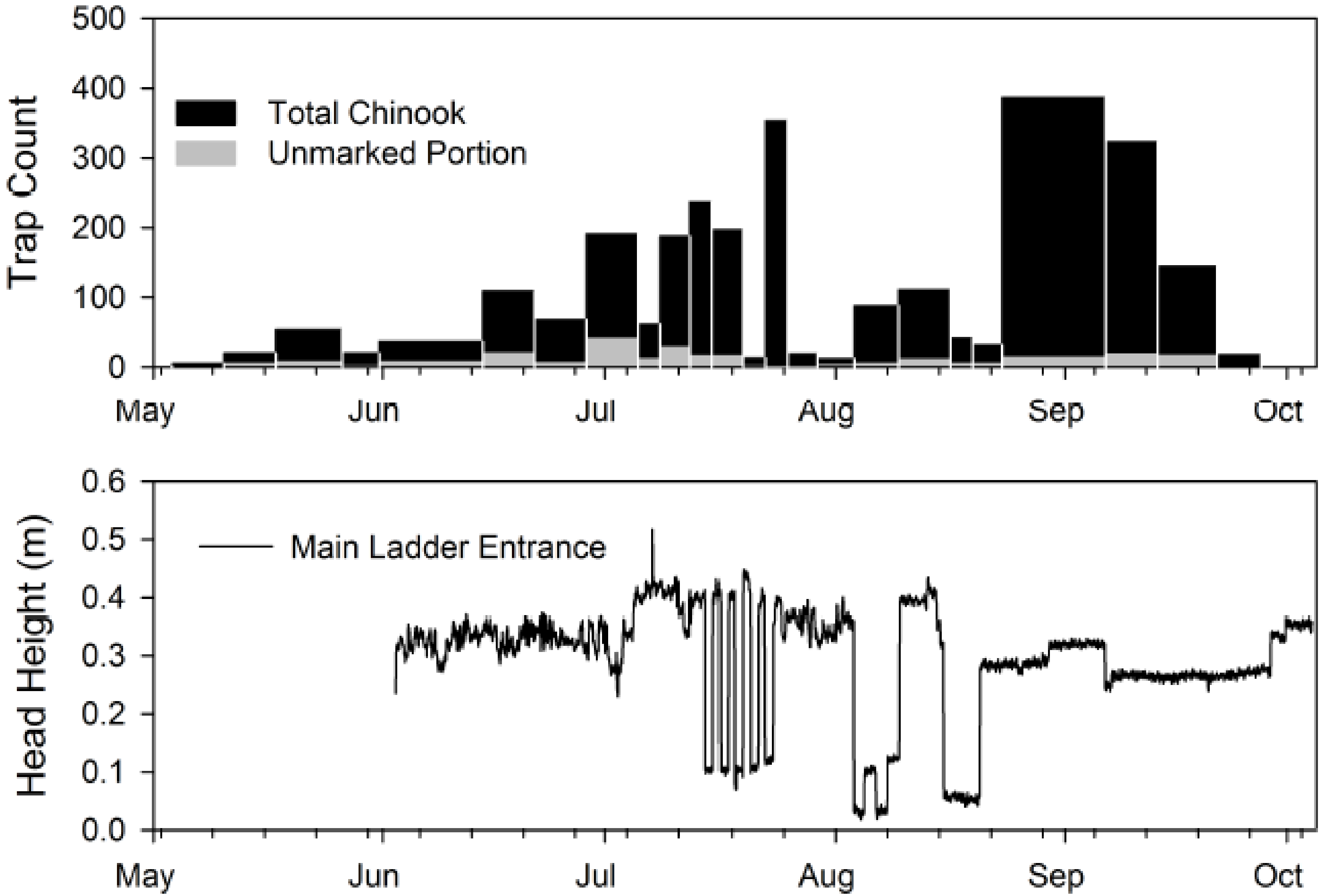
- **Objective 1) Temperature and water quality monitoring (DO, pH, conductivity)**

- **Objective 2) Monitor trap catch and number of adults in tailrace with cameras**

- **Objective 3) Evaluate adult Chinook salmon behavior and fishway passage metrics in the Foster Dam tailrace and the FOS AFF**
  - Radio+PIT tagging
  - Camera and DIDSON monitoring
  - Genetic pedigree to determine collection efficiency for above vs.below FOS-origin adults (out-years).

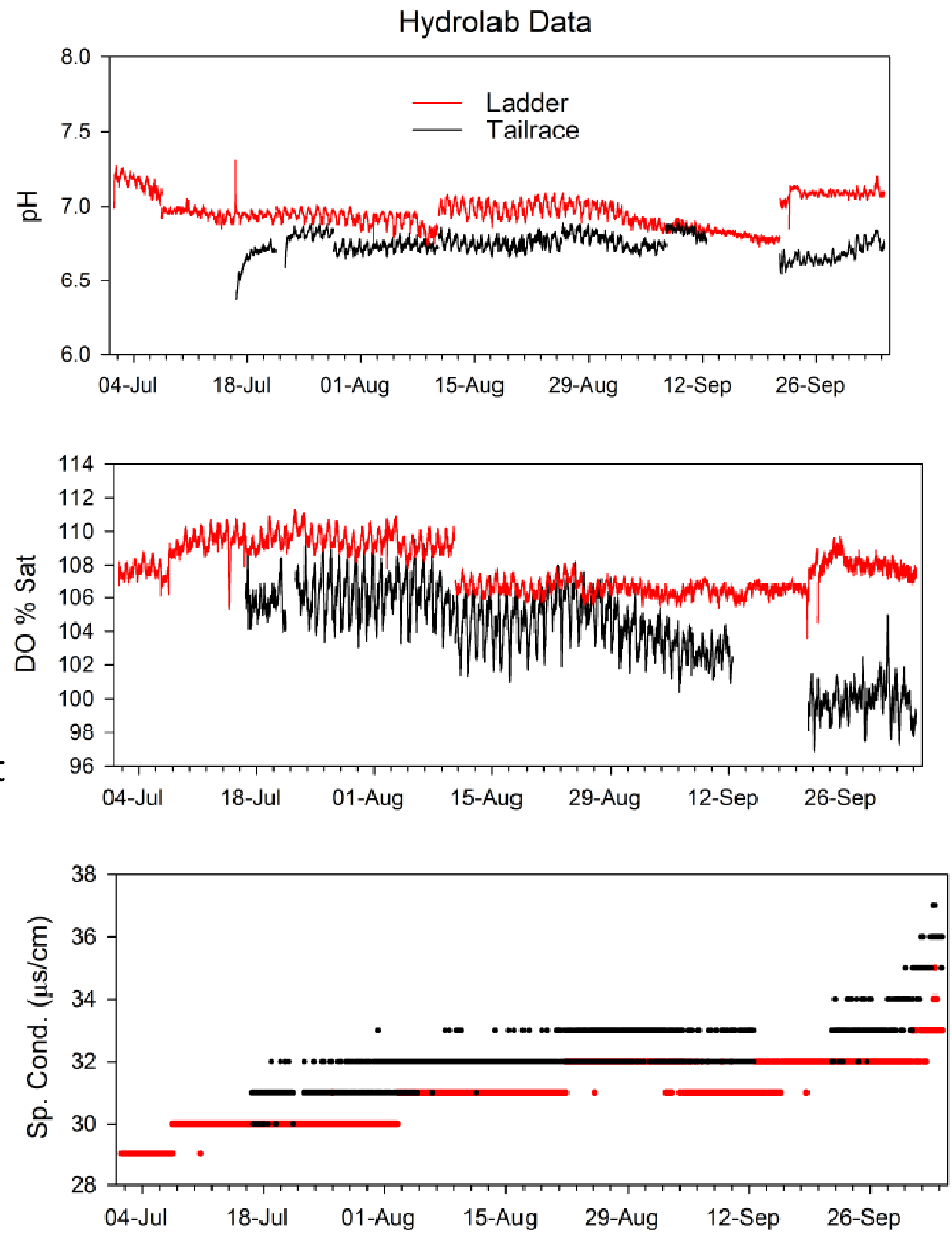
- **Objective 4) Data analysis: Trapping rate, event rate (passive monitoring), and passage behavior (RT) in relation to environment and treatments**

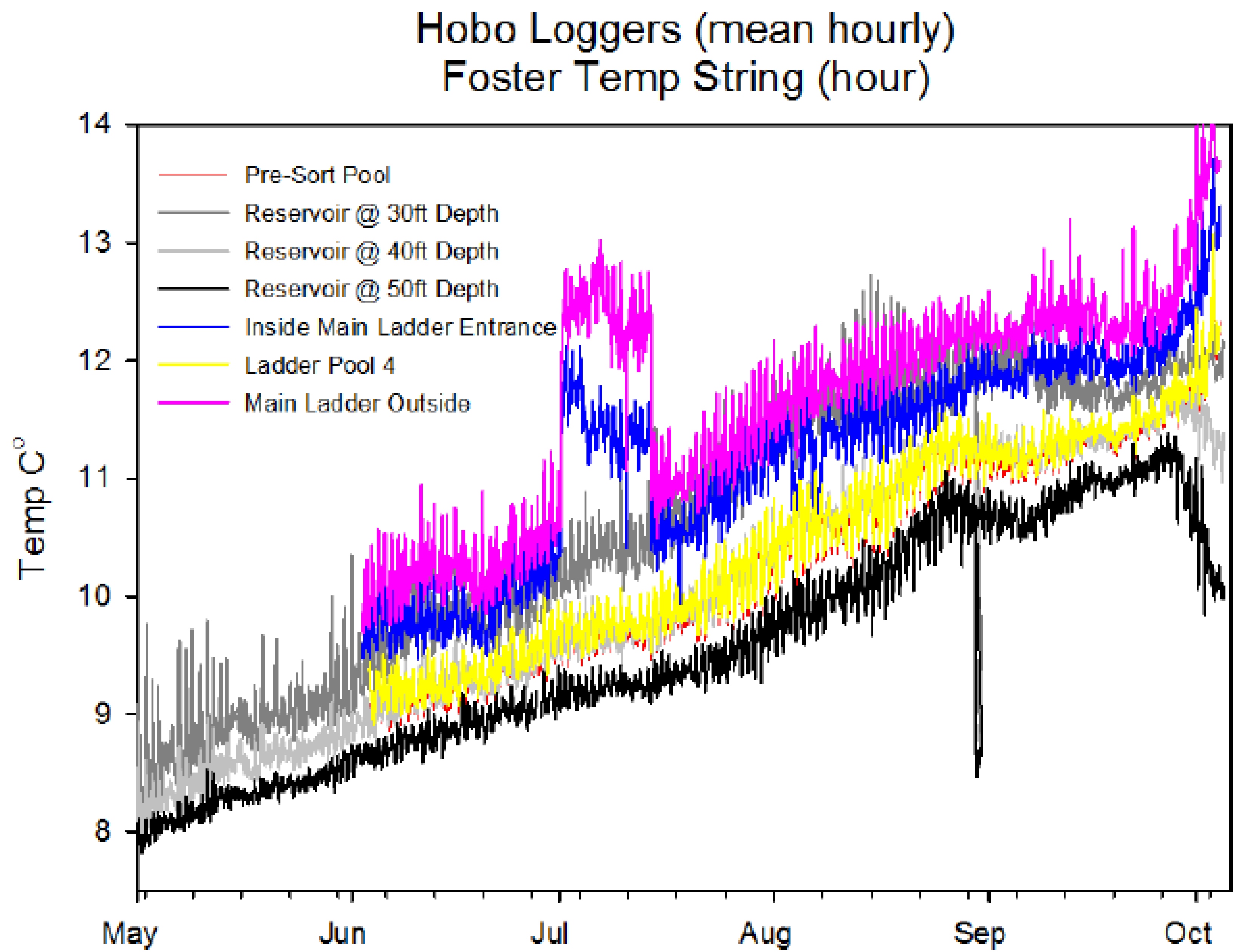
- **Objective 5) Identify potential causal factors and provide recommendations**



Trap Count
Total Chinook
Unmarked Portion
0
100
200
300
400
500
May
Jun
Jul
Aug
Sep
Oct
Head Height (m)
Main Ladder Entrance
0.0
0.1
0.2
0.3
0.4
0.5
0.6
May
Jun
Jul
Aug
Sep
Oct

Preliminary
Uncorrected for Instrument Drift




Hobo Loggers (mean hourly)
Foster Temp String (hour)
Pre-Sort Pool
Reservoir @ 30ft Depth
Reservoir @ 40ft Depth
Reservoir @ 50ft Depth
Inside Main Ladder Entrance
Ladder Pool 4
Main Ladder Outside
Temp C°
14
13
12
11
10
9
8
May
Jun
Jul
Aug
Sep
Oct

Mechanisms/Treatments 2017

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

Mechanism	**Location/ bottleneck**	**Notes**	**Treatment/observations**
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

Radiotelemetry study of behavior

Genetic clips, PIT+RT tag. Target sample: ~50 clipped and 50 unclipped

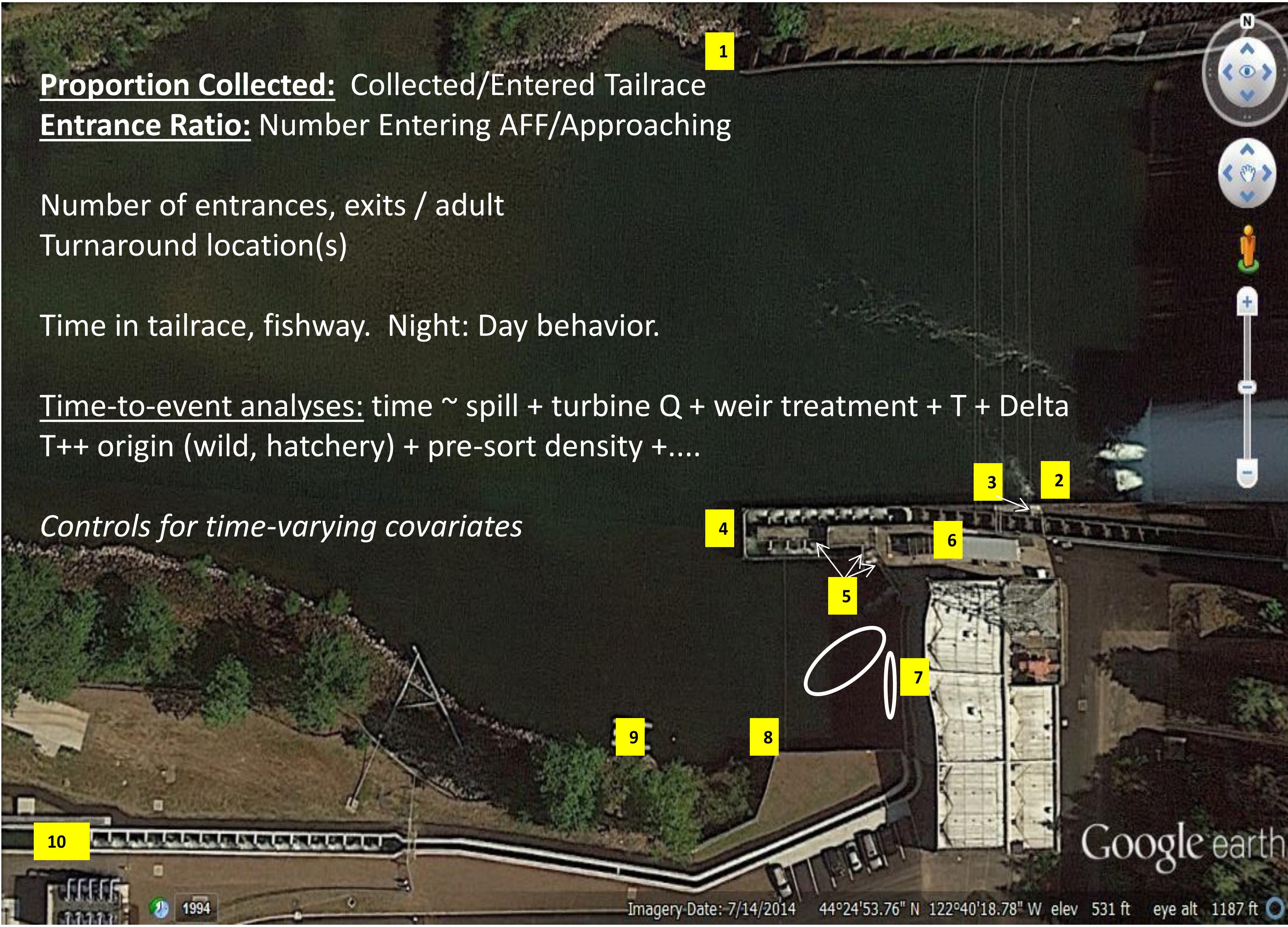
Proportion Collected: Collected/Entered Tailrace
Entrance Ratio: Number Entering AFF/Approaching

Number of entrances, exits / adult
Turnaround location(s)

Time in tailrace, fishway. Night: Day behavior.

Time-to-event analyses: time ~ spill + turbine Q + weir treatment + T + Delta T++ origin (wild, hatchery) + pre-sort density +....

Controls for time-varying covariates



Objectives 2017

- **Objective 1) Temperature and water quality monitoring (DO, pH, conductivity)**
- **Objective 2) Monitor trap catch and number of adults in tailrace with cameras**
- **Objective 3) Evaluate adult Chinook salmon behavior and fishway passage metrics in the Foster Dam tailrace and the FOS AFF**
  - Radio+PIT tagging
  - Camera and DIDSON monitoring
  - Genetic pedigree to determine collection efficiency for above vs.below FOS-origin adults (out-years).
- **Objective 4) Data analysis: Trapping rate, event rate (passive monitoring), and passage behavior (RT) in relation to environment and treatments**
- **Objective 5) Identify potential causal factors and provide recommendations**