



**Pacific  
Northwest**  
NATIONAL LABORATORY

# Evaluation of Foster Dam and Green Peter Dam Spillway Operations for Juvenile Fish Passage

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U.S. DEPARTMENT OF  
**ENERGY** **BATTELLE**

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# Spillway Operations Evaluated

- Foster Dam
  - Nighttime spillway and daytime turbine operations
  
- Green Peter Dam
  - Nighttime spillway and 24/7 spillway operations





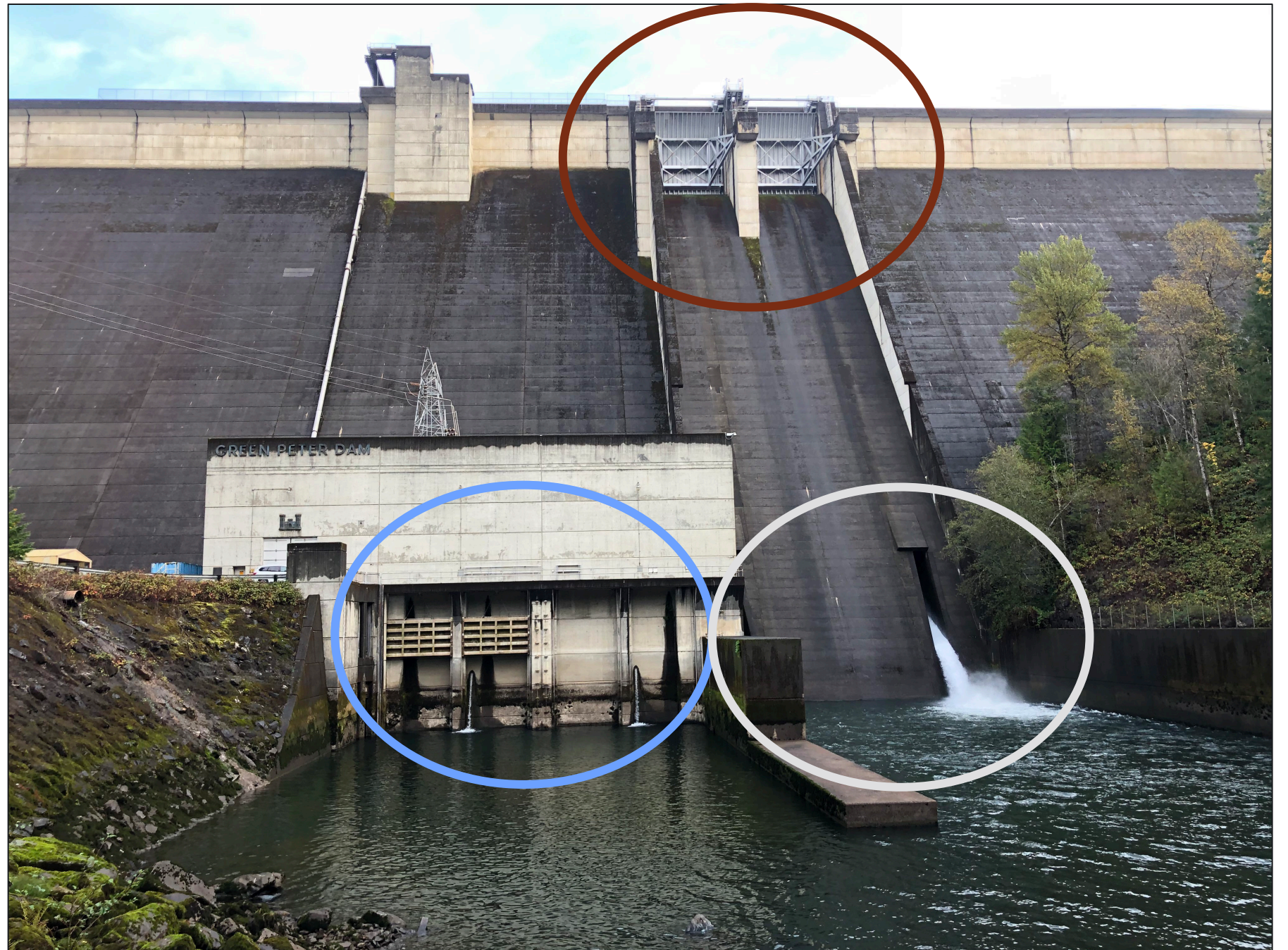
# Green Peter Dam

## Features

- 2 spill bays
- 2 turbine units
- 2 regulating outlets



Upper Willamette River Spring Chinook Salmon





# Foster Dam

## Features

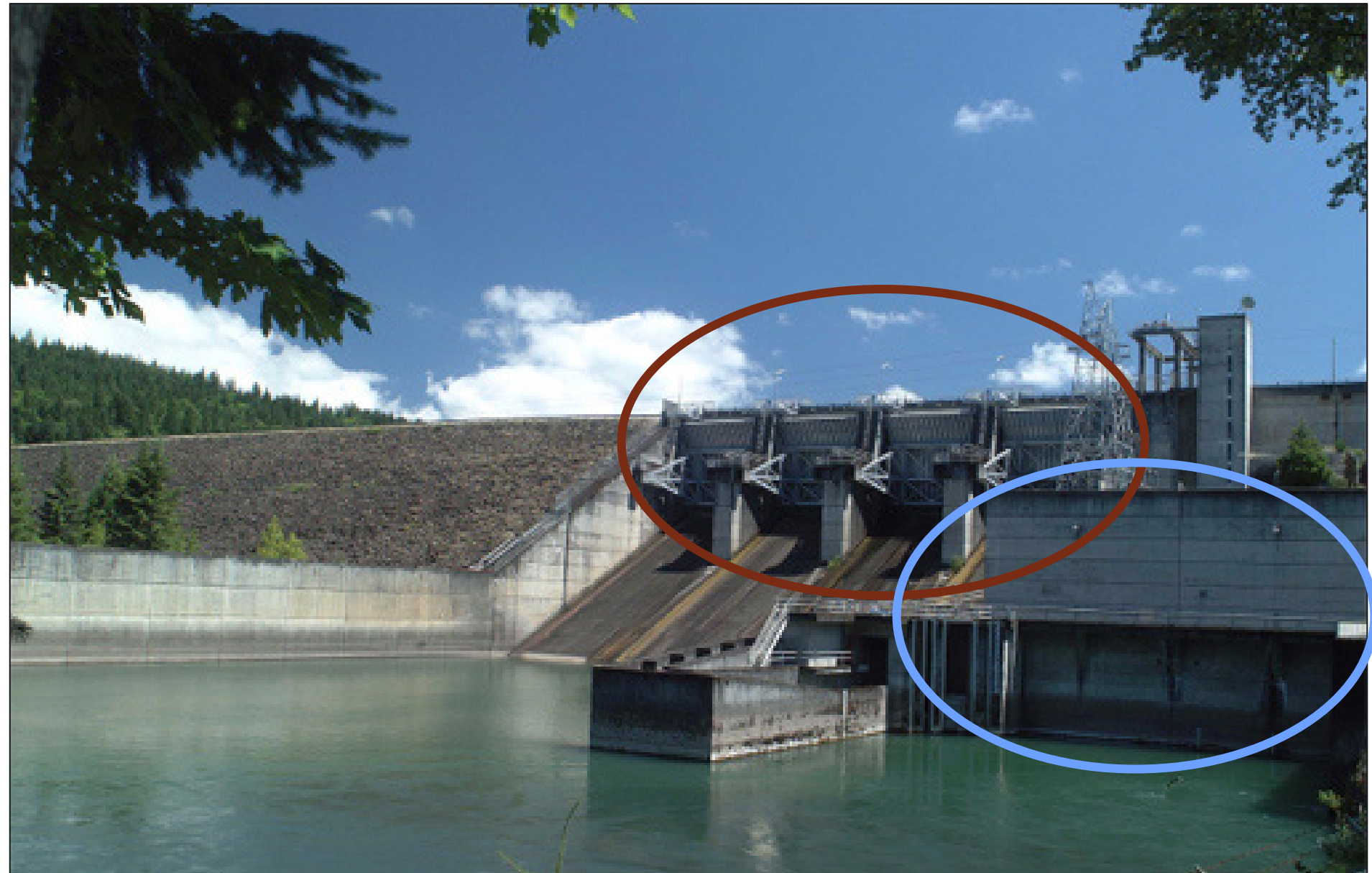
- 4 spill bays
- 2 turbine units



Upper Willamette River Spring Chinook Salmon



Upper Willamette River Winter Steelhead





# Objectives

- Green Peter Dam (GPR)

- Nighttime only spill compared to 24/7 spill dam operations

- ✓ Diel distribution, behavior, and movements into and within the GPR Forebay

- ✓ Downstream passage

- Reservoir survival (immediate dam passage)

- Forebay residency time

- Dam passage efficiency

- Reach survival (confluence of the Santiam and Willamette rivers)

- Foster Dam (FOS)

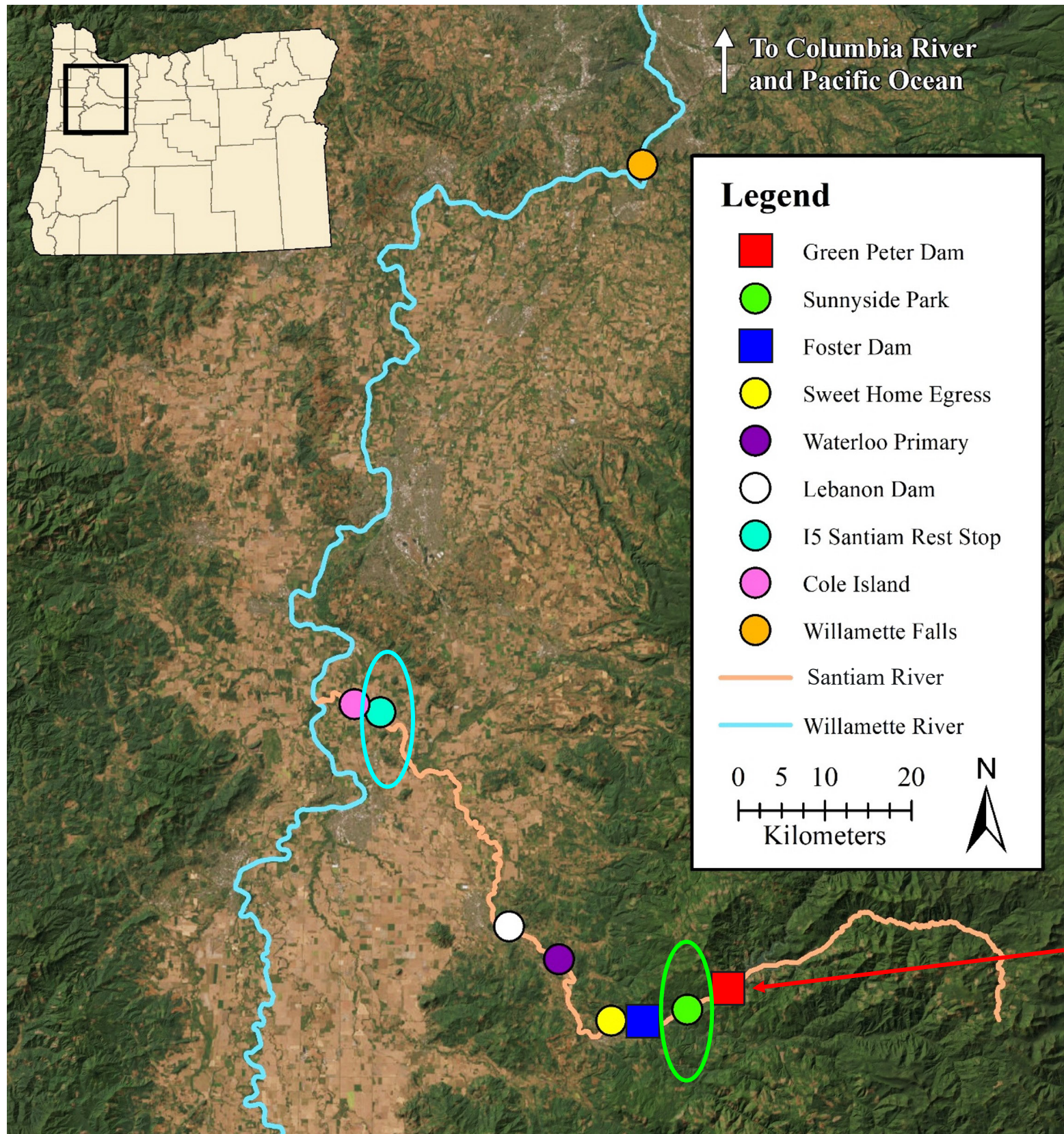
- Nighttime only spill compared to daytime turbine operations

- ✓ Diel distribution, behavior, and movements into and within the FOS Forebay

- ✓ Downstream passage

- ✓ Efficiency and effectiveness of nighttime spillway operation compared to turbine operation



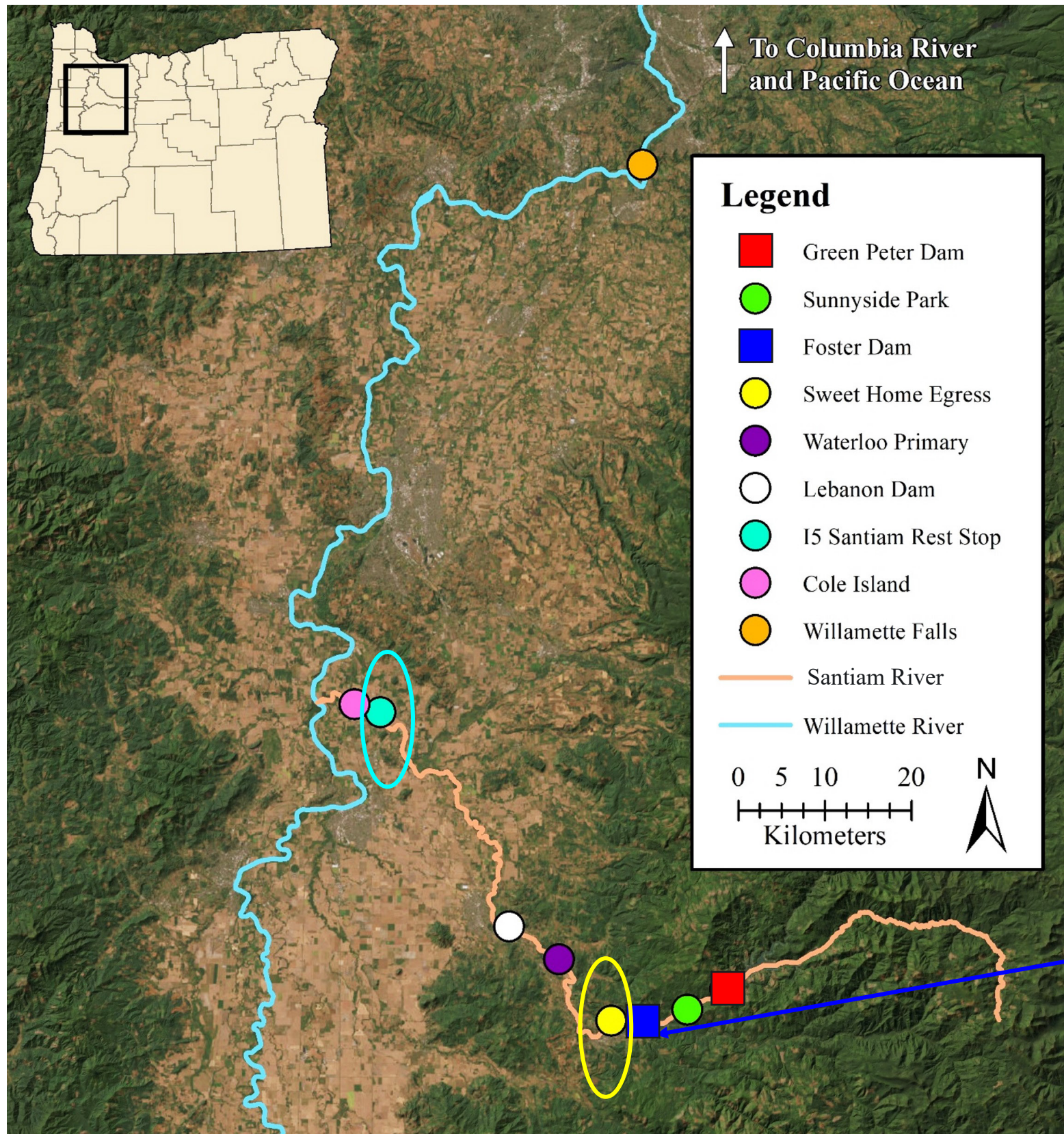


# Study Design



- Green Peter
  - Dam Passage Survival & Reach Survival = Cormack-Jolly-Seber





# Study Design



- Foster

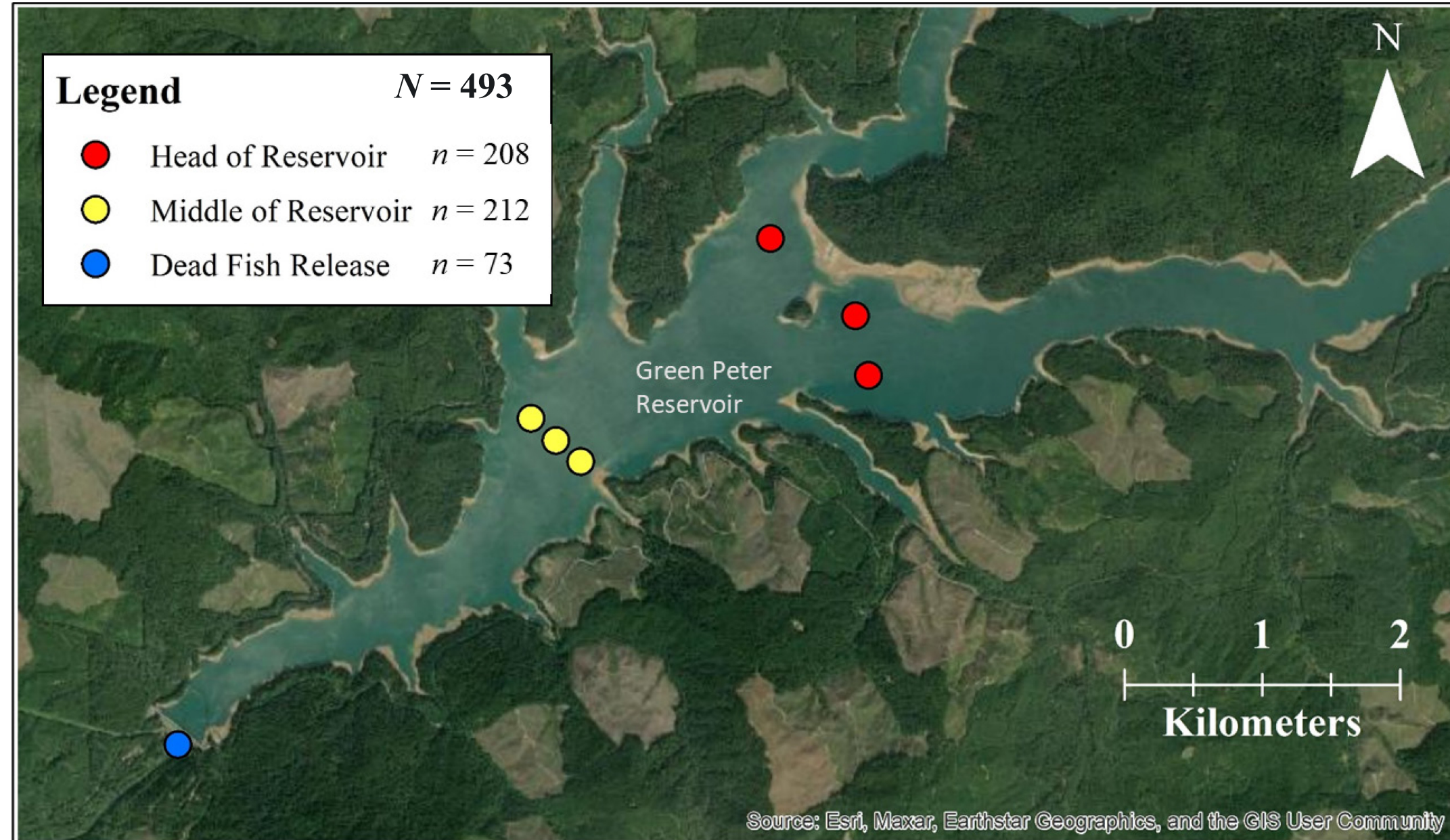
- Dam Passage Survival = ViRDCt
- Reach Survival = Cormack-Jolly-Seber



# Green Peter

## Release Locations & Sample Sizes

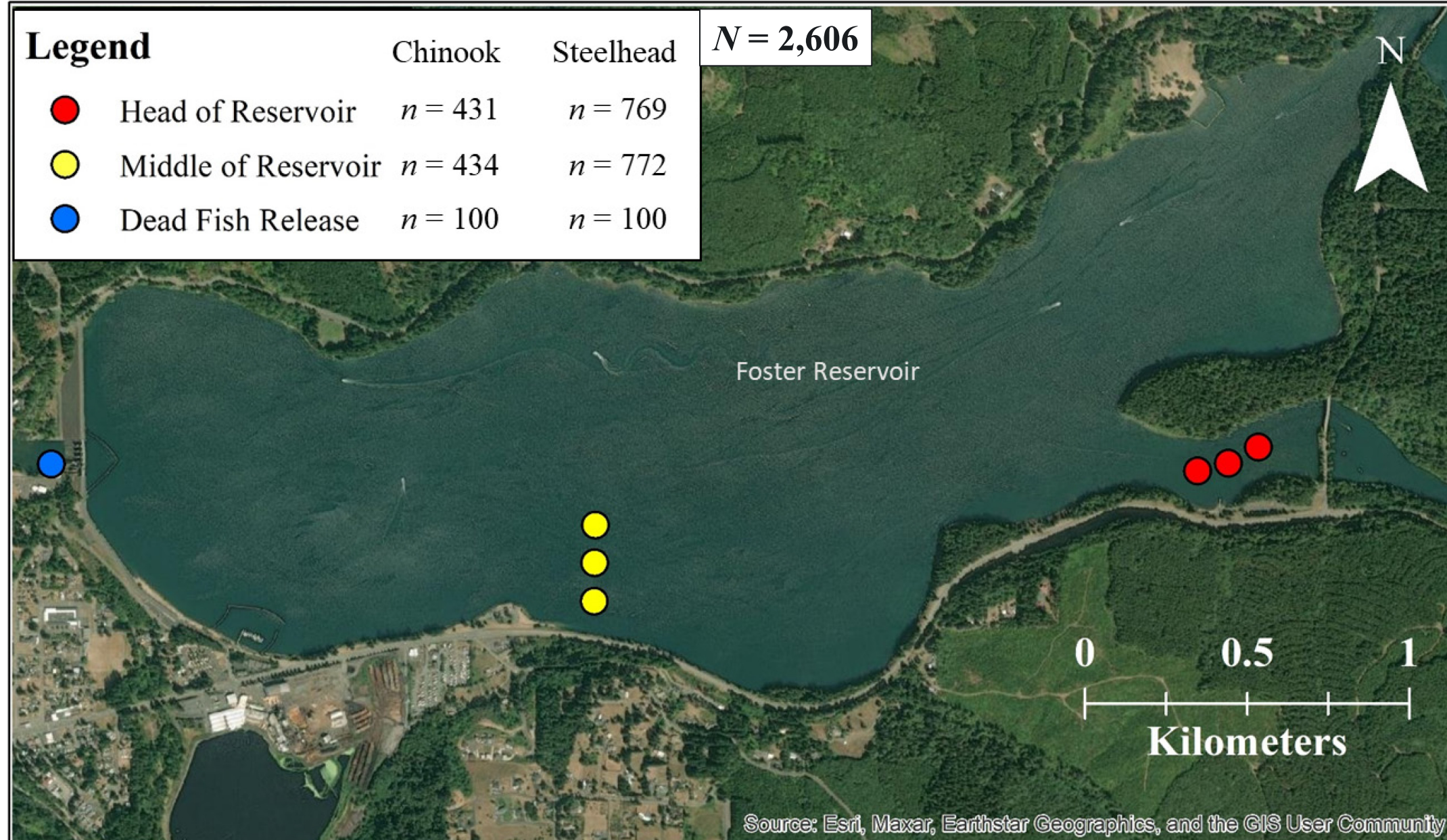
- OSU Wild Fish Surrogate Program
  - Chinook salmon yearlings
- Tags
  - RT: Lotek NTC-M-2
  - PIT: 12-mm
- Operations
  - Nighttime spillway
    - ✓ Apr 1–15
    - ✓  $n = 247$
  - 24/7 spillway
    - ✓ Apr 16–30
    - ✓  $n = 246$





# Foster Release Locations & Sample Sizes

- OSU Surrogates
  - Chinook yearlings
  - Steelhead age-2
- Tags
  - RT: Lotek NTC-M-2
  - PIT: 12-mm
- Operations
  - Nighttime spillway
  - Daytime turbines
- Pool Elevations
  - Low: 3/2–5/15  
✓  $n = 1,064$
  - High: 5/27–6/15  
✓  $n = 1,542$





# Results Outline

- Green Peter Chinook Salmon yearlings
  - Overall dam passage survival
  - Diel behavior and survival
- **Foster** Chinook Salmon yearlings
  - Low Pool
    - ✓ Overall dam passage survival
    - ✓ Diel behavior and survival
  - High Pool
    - ✓ Overall dam passage survival
    - ✓ Diel behavior and survival
- **Foster** Winter Steelhead age-2
  - Low Pool
  - High Pool



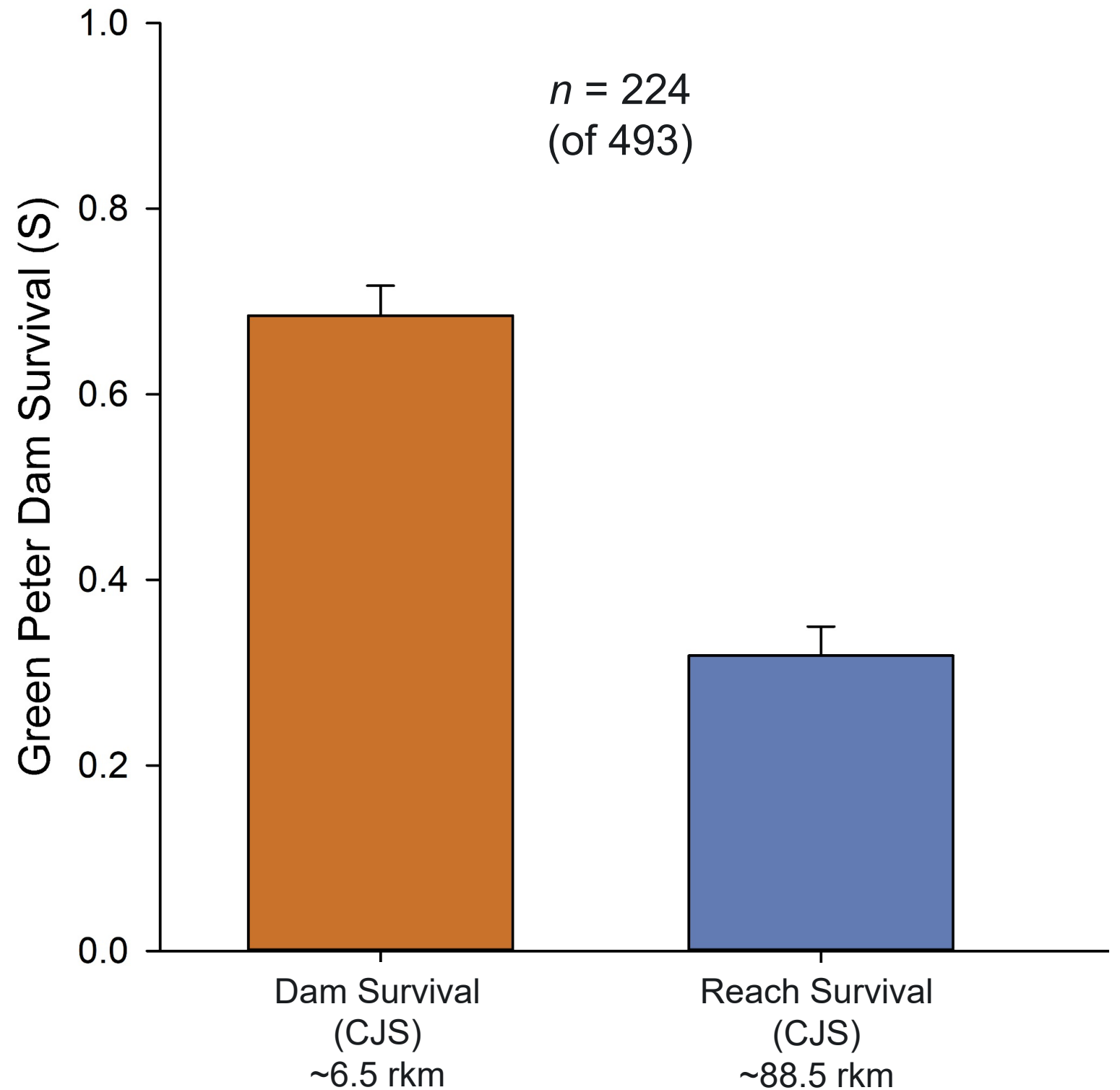




Chinook Salmon

## Green Peter Dam Passage Survival

- Dam survival =  $68.5 \pm 3.2\%$
- Reach survival =  $31.8 \pm 3.1\%$



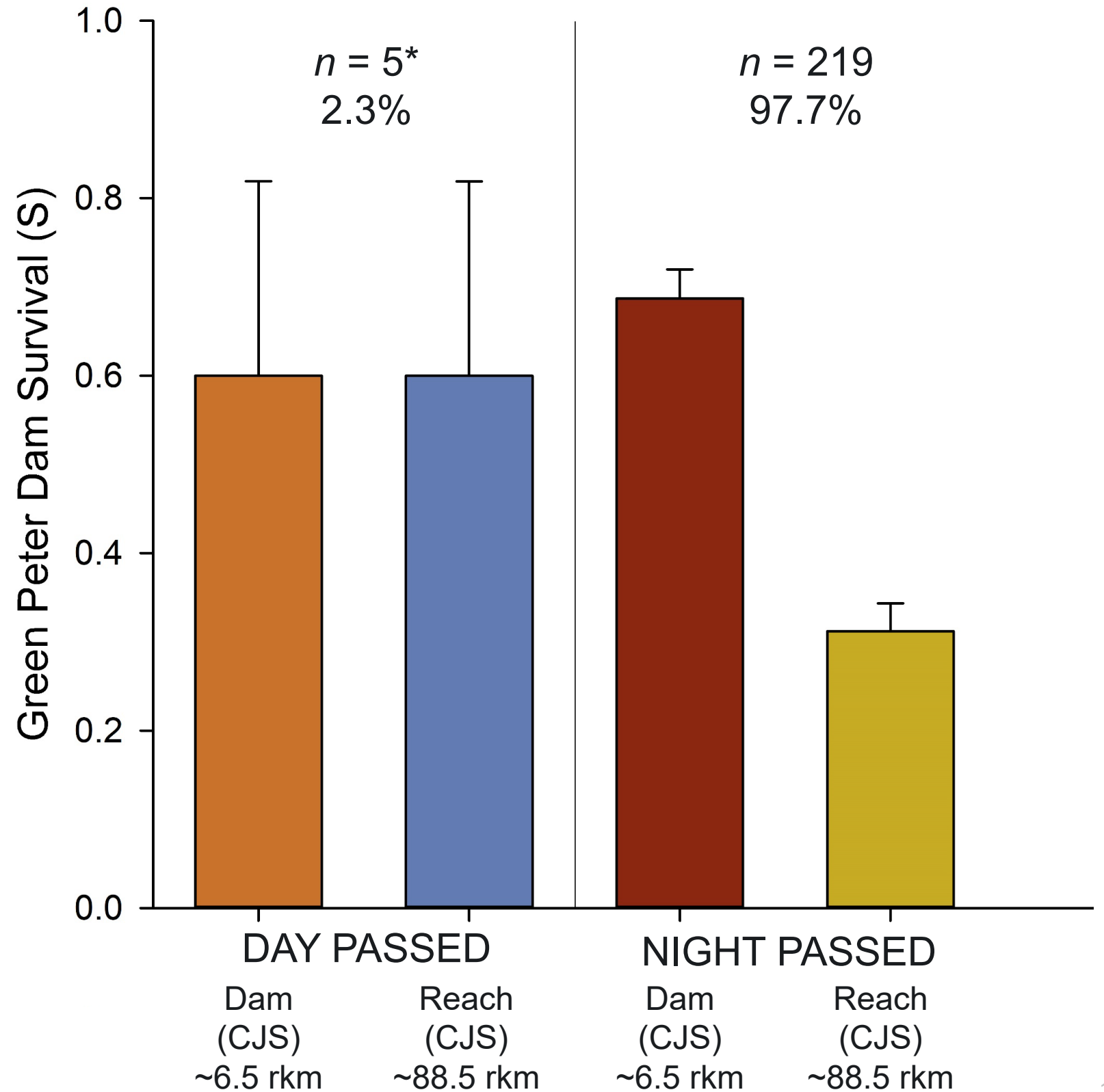




Chinook Salmon

## Green Peter Diel Distributions and Survival

- Day passage spill survival
  - Dam =  $60.0 \pm 21.9\%$
  - Reach =  $60.0 \pm 21.9\%$
  - $*n = 5$
- Night passage spill survival
  - $68.7 \pm 3.3\%$
  - $31.2 \pm 3.1\%$



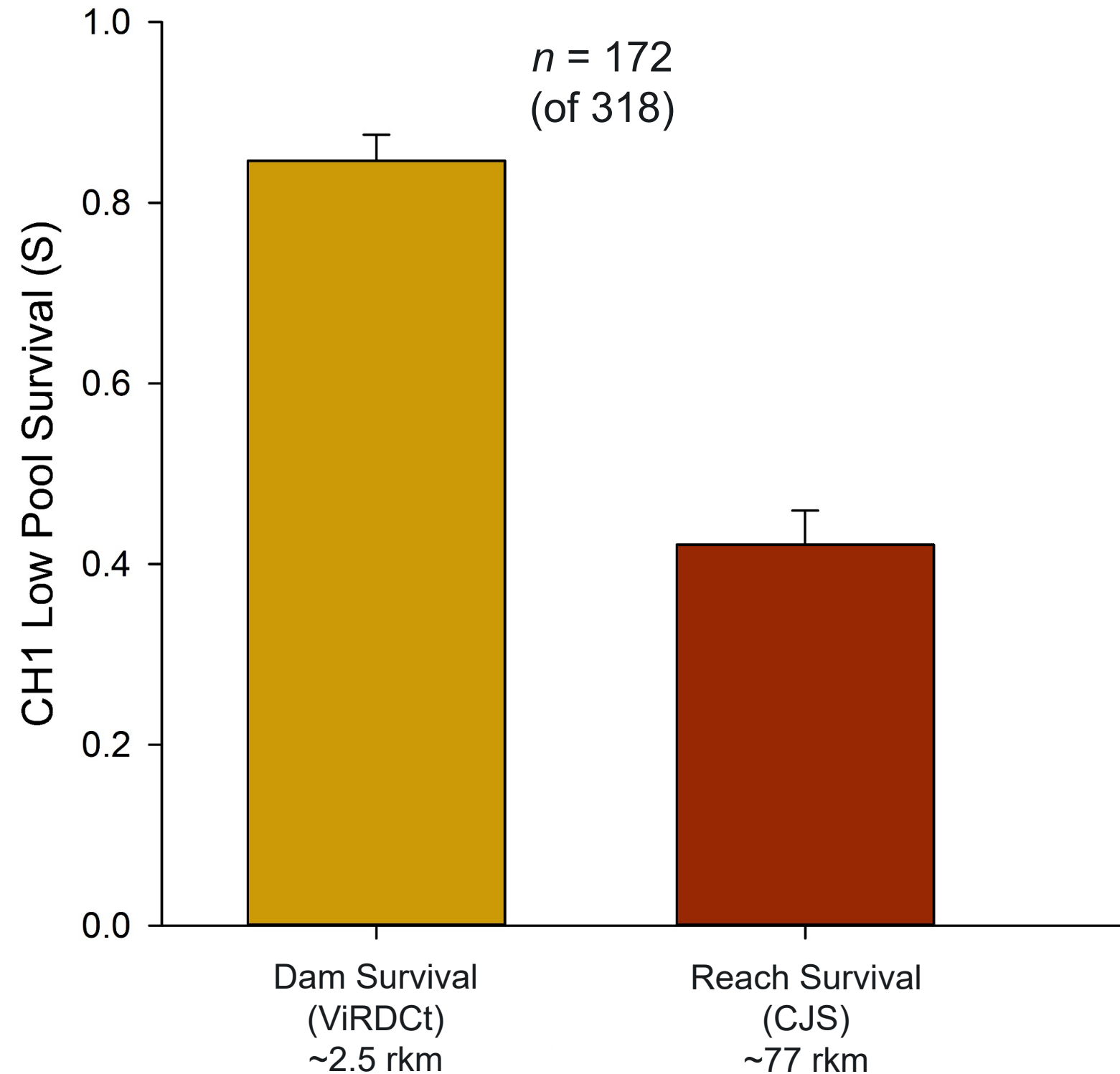




Chinook Salmon

# Foster Dam Passage Survival Chinook Salmon *Low Pool*

- Dam survival =  $84.7 \pm 2.9\%$
- Reach survival =  $42.2 \pm 3.8\%$



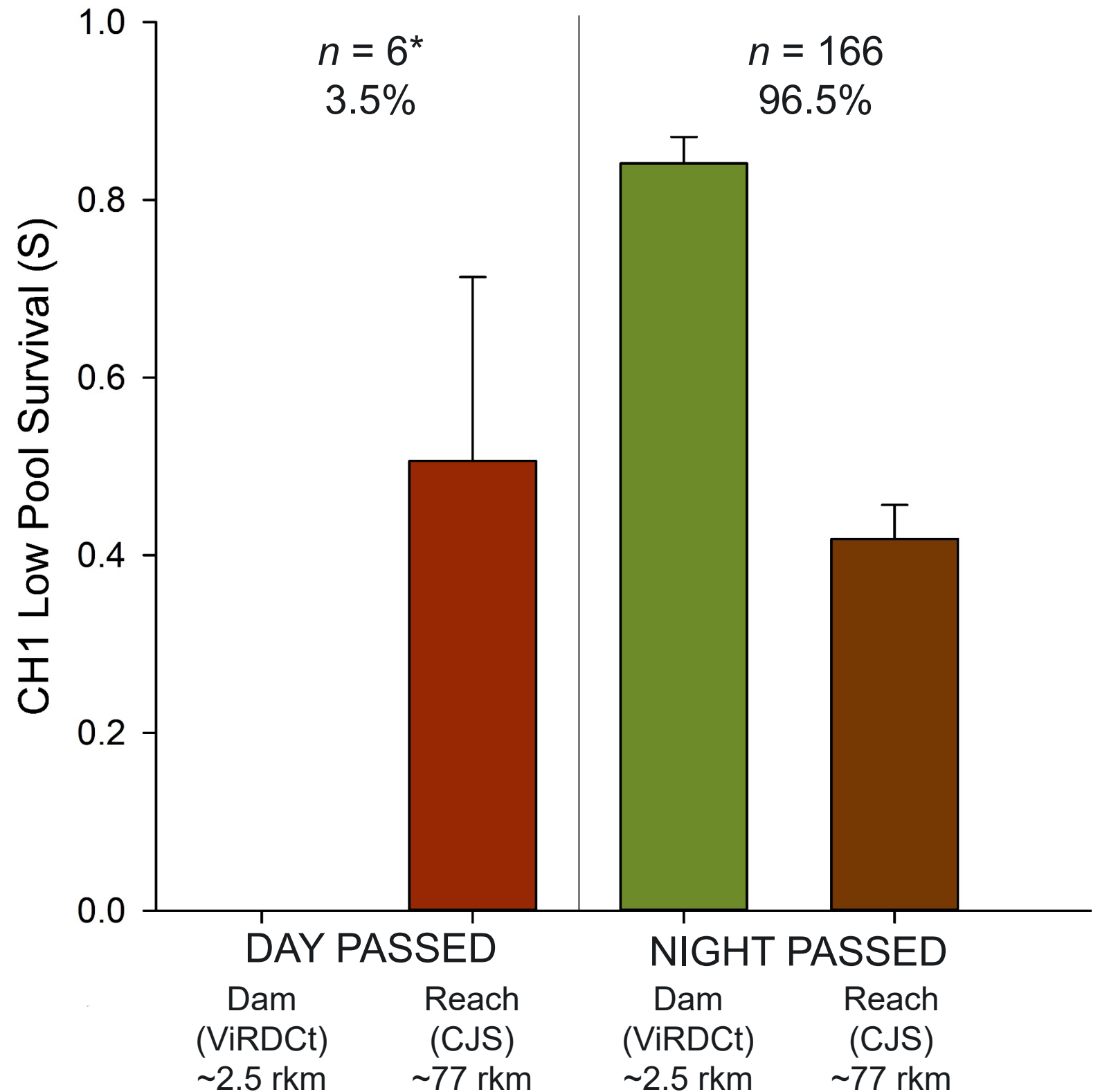




Chinook Salmon

## Foster Diel Distrib. & Survival Chinook Salmon *Low Pool*

- Day passage survival
  - Dam = NA
  - Reach =  $50.6 \pm 20.7\%$
  - $*n = 6$
- Night passage survival
  - $84.1 \pm 3.0\%$
  - $41.8 \pm 3.9\%$



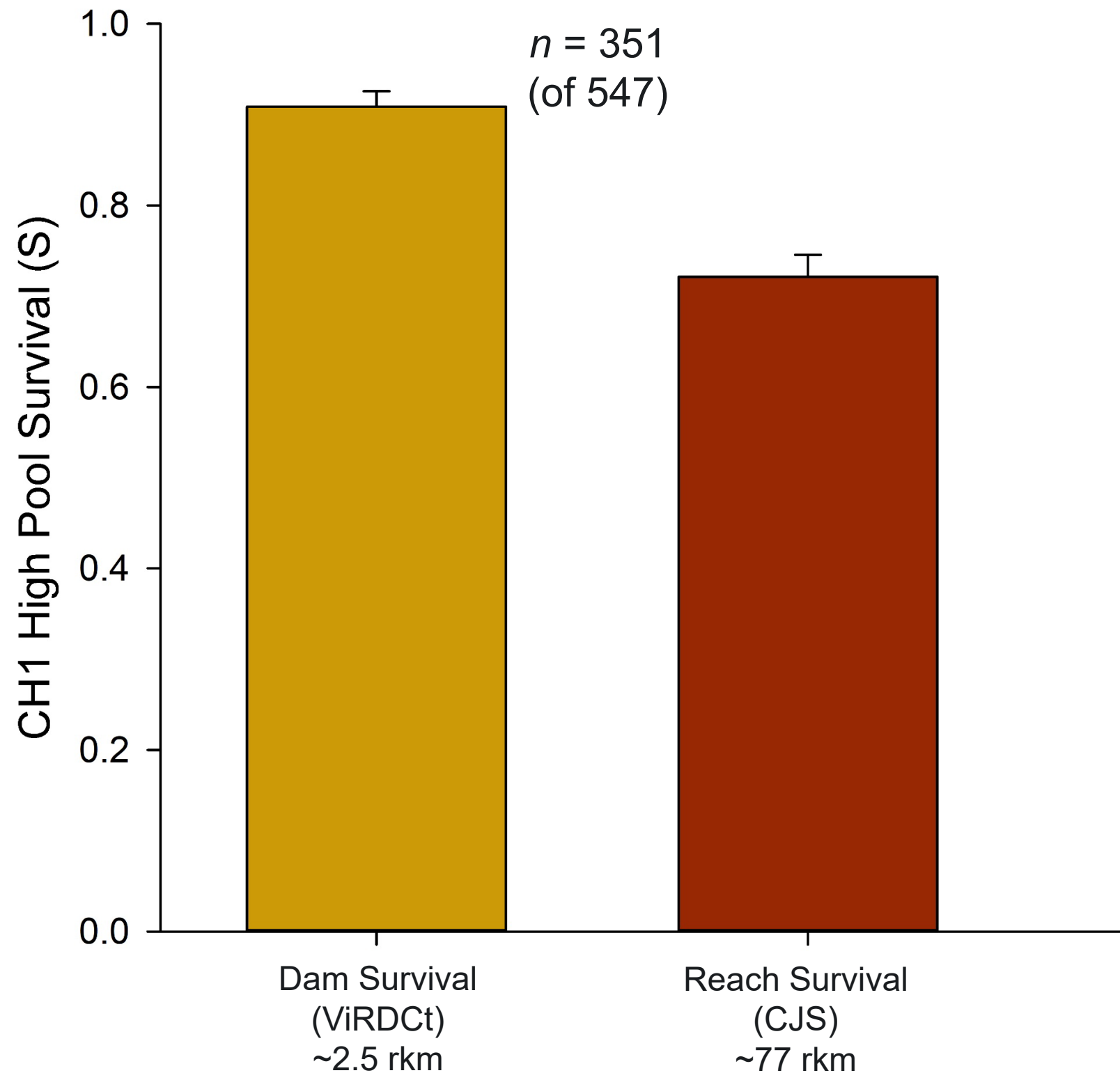




Chinook Salmon

## Foster Dam Passage Survival Chinook Salmon *High Pool*

- Dam survival =  $91.0 \pm 1.7\%$
- Reach survival =  $72.2 \pm 2.4\%$



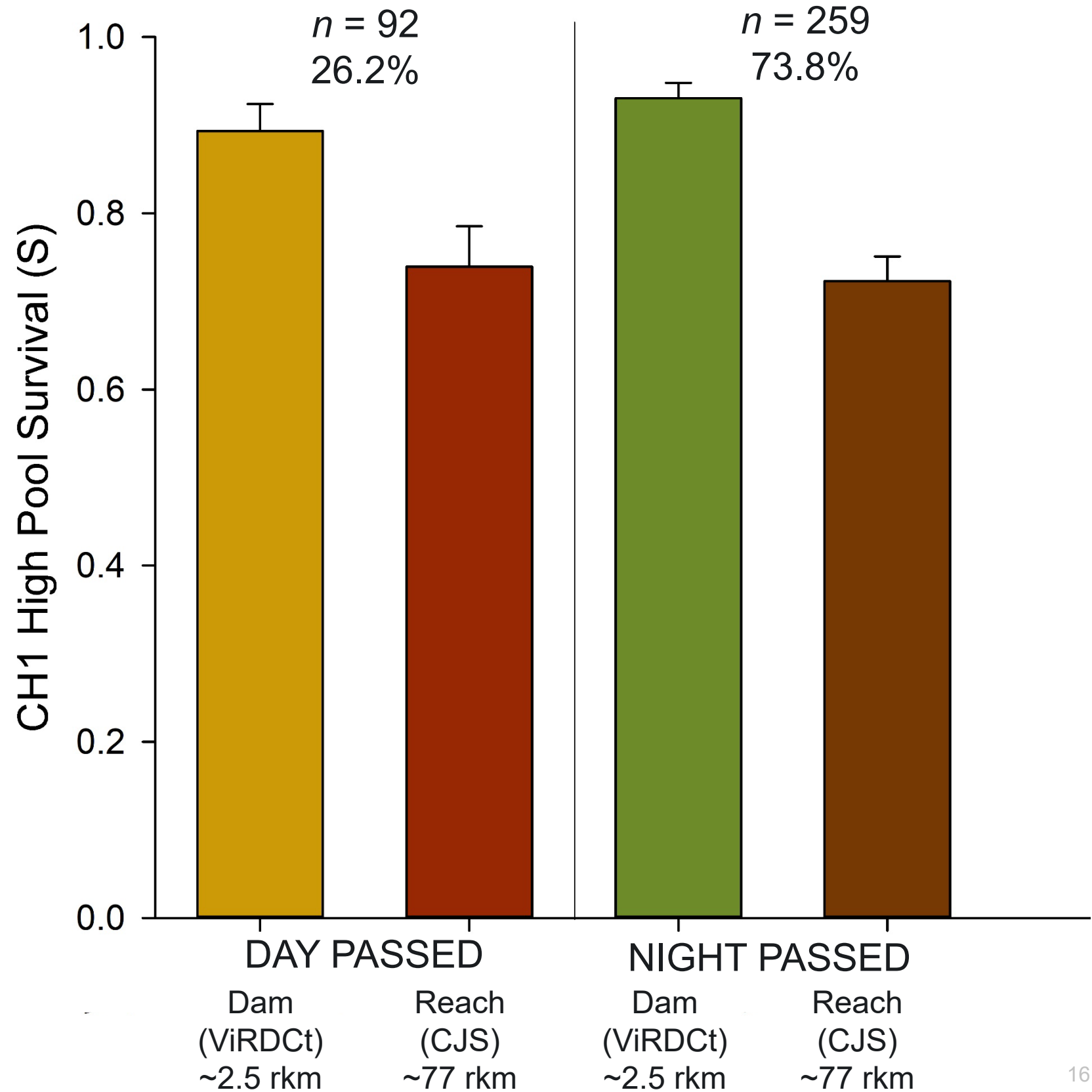




Chinook Salmon

## Foster Diel Distrib. & Survival Chinook Salmon *High Pool*

- Day passage survival
  - Dam =  $89.3 \pm 3.1\%$
  - Reach =  $73.9 \pm 4.6\%$
- Night passage survival
  - Dam =  $93.1 \pm 1.8\%$
  - Reach =  $72.3 \pm 2.8\%$



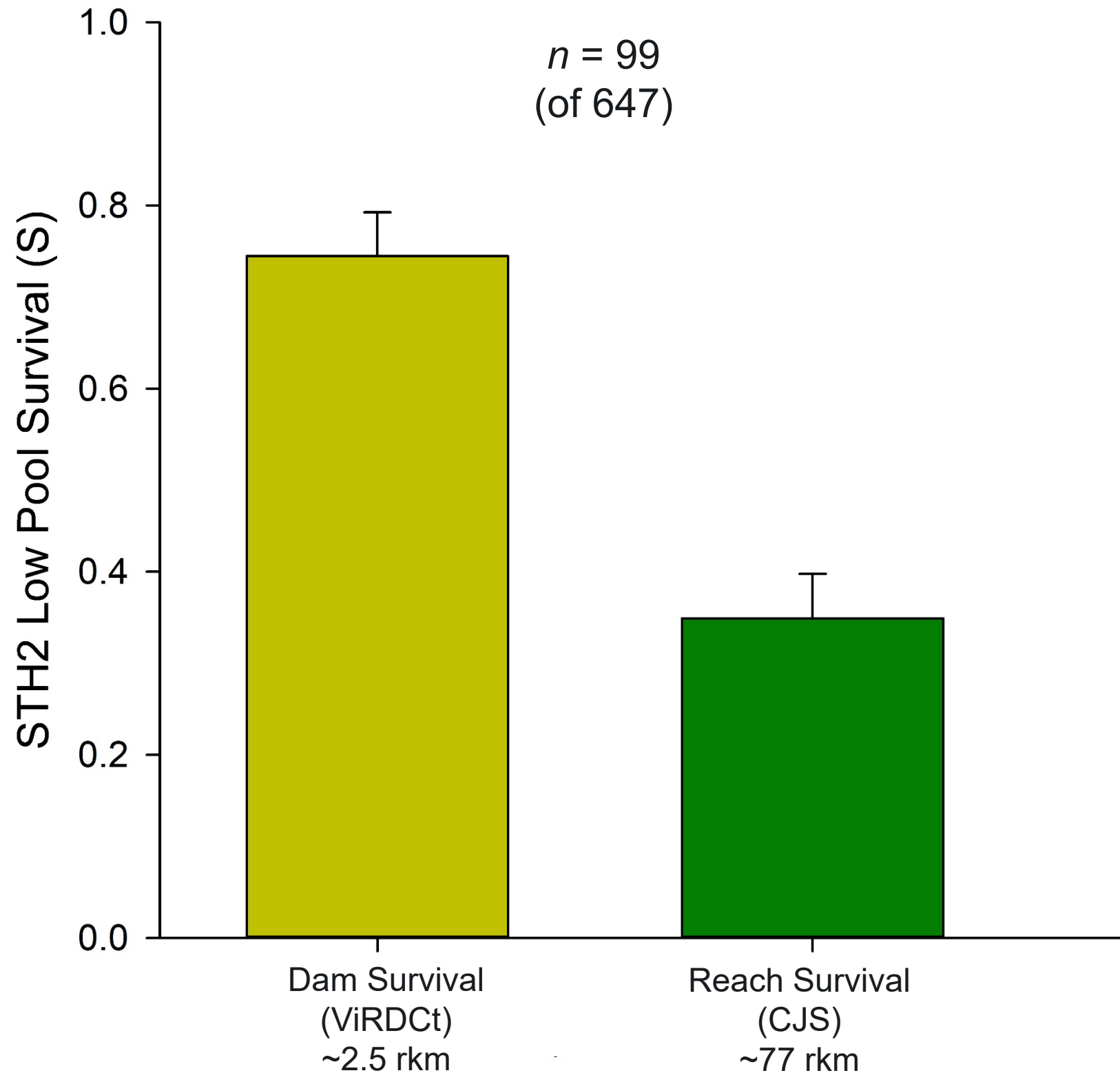




Winter Steelhead

# Foster Dam Passage Survival Winter Steelhead *Low Pool*

- Dam survival =  $74.5 \pm 4.8\%$
- Reach survival =  $34.9 \pm 4.9\%$



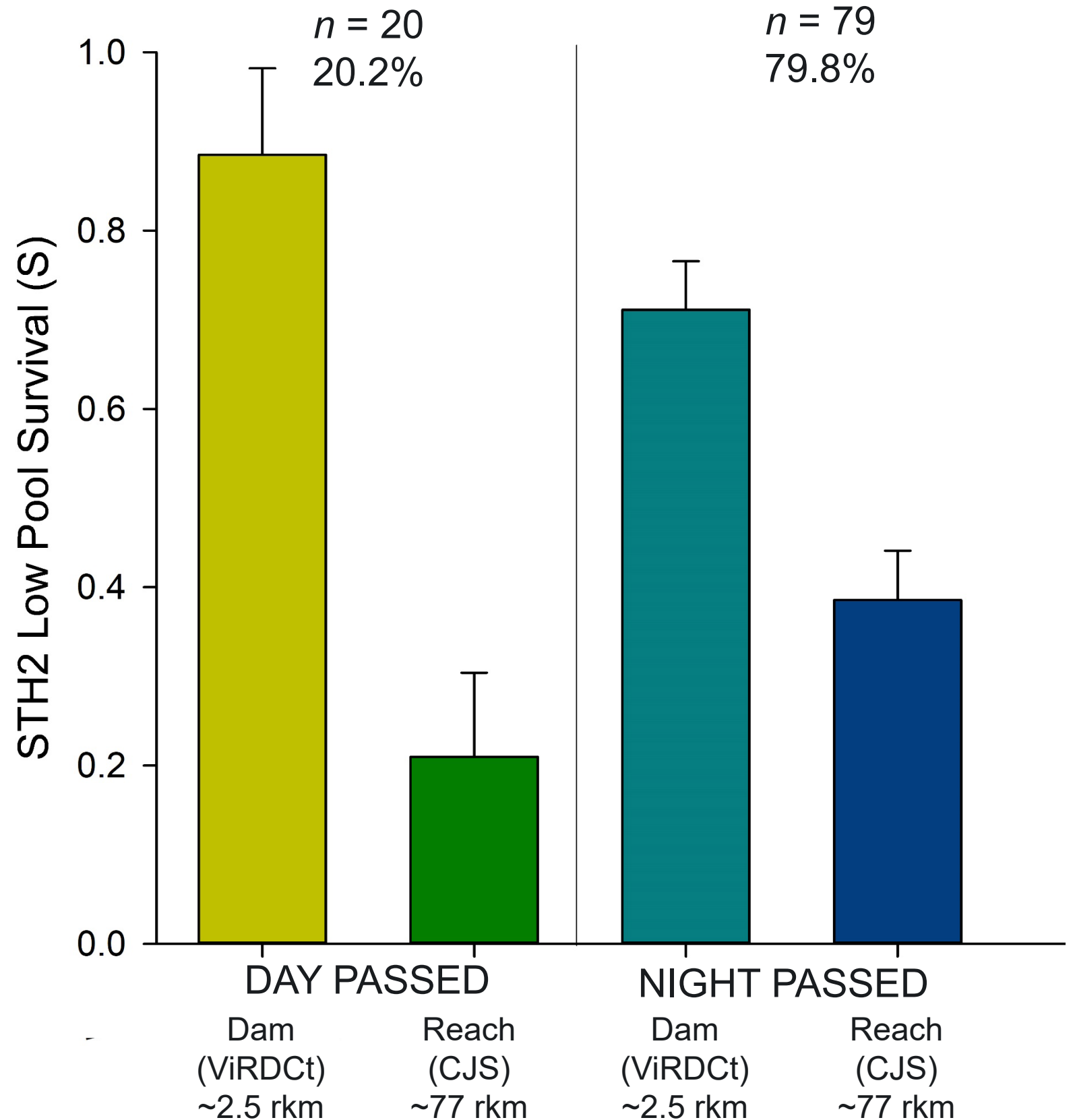




Winter Steelhead

## Foster Diel Distrib. & Survival Winter Steelhead *Low Pool*

- Day passage survival
  - Dam =  $88.5 \pm 9.7\%$
  - Reach =  $21.0 \pm 9.4\%$
- Night passage survival
  - Dam =  $71.1 \pm 5.4\%$
  - Reach =  $38.6 \pm 5.6\%$



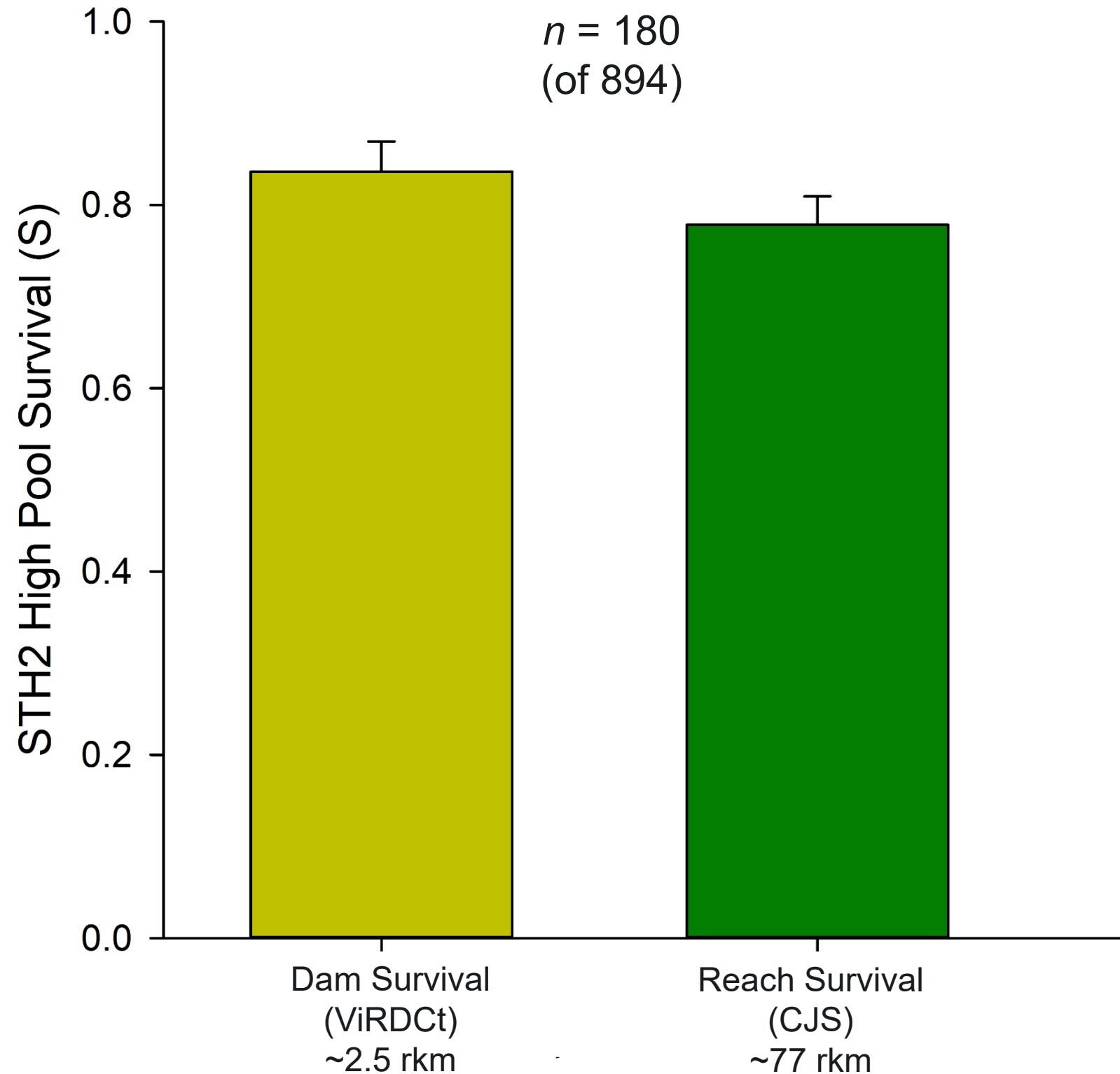




Winter Steelhead

# Foster Dam Passage Survival Winter Steelhead *High Pool*

- Dam survival =  $83.7 \pm 3.3\%$
- Reach survival =  $77.8 \pm 3.1\%$



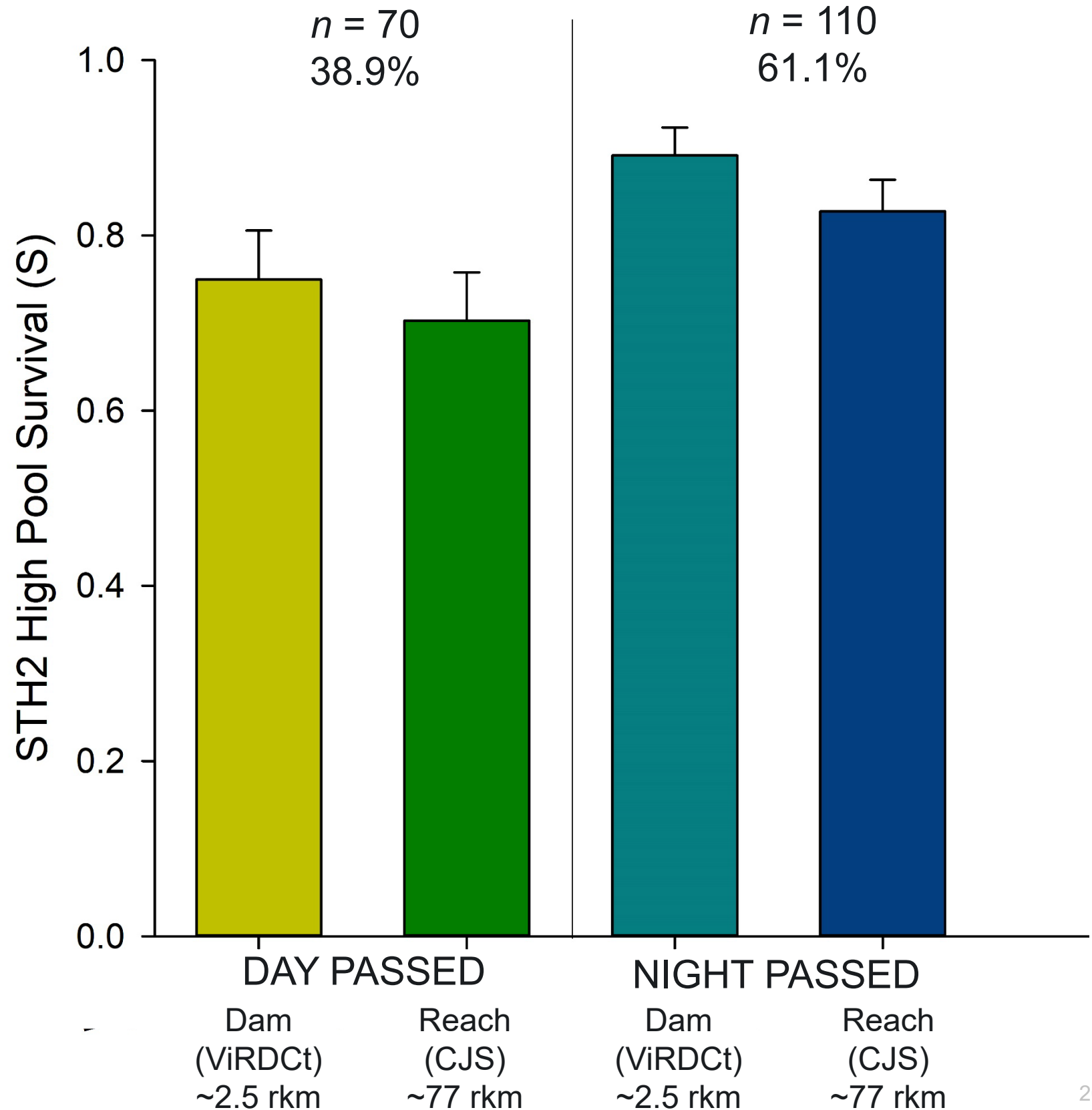




Winter Steelhead

## Foster Diel Distrib. & Survival Winter Steelhead *High Pool*

- Day passage survival
  - Dam =  $75.0 \pm 5.6\%$
  - Reach =  $70.3 \pm 5.5\%$
- Night passage survival
  - Dam =  $89.1 \pm 3.2\%$
  - Reach =  $82.8 \pm 3.6\%$





# Results Summary

- Overall dam passage survival
  - **Green Peter** Chinook salmon
    - ✓ Immediate dam passage =  $68.5 \pm 3.2\%$
    - ✓ Reach survival =  $31.8 \pm 3.1\%$
  - **Foster** Chinook salmon
    - ✓ Low Pool
      - Immediate dam passage =  $84.7 \pm 2.9\%$
      - Reach survival =  $42.2 \pm 3.8\%$
    - ✓ High Pool
      - Immediate dam passage =  $91.0 \pm 1.7\%$
      - Reach survival =  $72.2 \pm 2.4\%$
  - **Foster** Steelhead
    - ✓ Low Pool
      - Immediate dam passage =  $74.5 \pm 4.8\%$
      - Reach survival =  $34.9 \pm 4.9\%$
    - ✓ High Pool
      - Immediate dam passage =  $83.7 \pm 3.3\%$
      - Reach survival =  $77.8 \pm 3.1\%$

- Diel behavior and survival

- **Green Peter** Chinook salmon

✓	Day = 2.3%	Night = 97.7%
Dam	$60.0 \pm 21.9\%$	$68.7 \pm 3.3\%$
Reach	$60.0 \pm 21.9\%$	$31.2 \pm 3.1\%$

- **Foster** Chinook salmon

✓ <b><u>Low</u></b>	Day = 3.5%	Night = 96.5%
Dam	NA	$84.1 \pm 3.0\%$
Reach	$50.6 \pm 20.7\%$	$41.8 \pm 3.9\%$
✓ <b><u>High</u></b>	Day = 26.2%	Night = 73.8%
Dam	$89.3 \pm 3.1\%$	$93.1 \pm 1.8\%$
Reach	$73.9 \pm 4.6\%$	$72.3 \pm 2.8\%$

- **Foster** Steelhead

✓ <b><u>Low</u></b>	Day = 20.2%	Night = 79.8%
Dam	$88.5 \pm 9.7\%$	$71.7 \pm 5.4\%$
Reach	$21.0 \pm 9.4\%$	$38.6 \pm 5.6\%$
✓ <b><u>High</u></b>	Day = 2.3%	Night = 97.7%
Dam	$75.0 \pm 5.6\%$	$89.1 \pm 3.2\%$
Reach	$70.3 \pm 5.5\%$	$82.8 \pm 3.6\%$



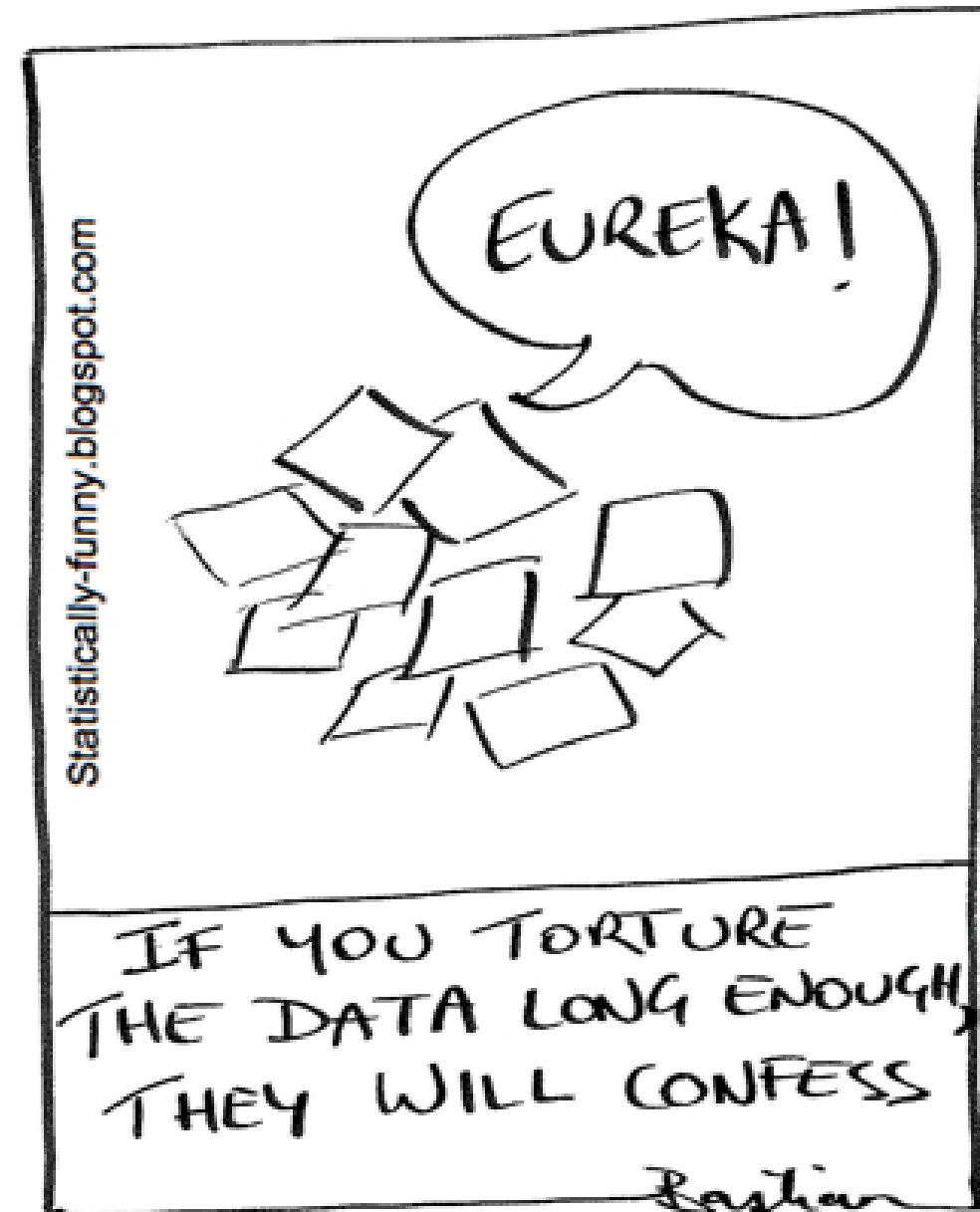
# Summary

- Overall dam passage survival
  - Immediate dam passage survival > reach survival
    - ✓ Reach survival includes other factors that can affect survival
      - River topography
        - Fish straying into another tributary
      - Environmental conditions
        - Temperature
        - Discharge
      - Biological interactions
        - Bird or fish predation
    - ✓ Immediate dam passage survival important to estimate
      - More meaningful comparisons
        - Diel passage, route of passage, or dam operations
      - Less influenced by other factors
- Diel behavior and survival
  - Night passage > day passage
    - ✓ Civil sunrise and sunset + dam ops
  - Immediate dam passage survival > reach survival
- Foster high pool
  - Highest reach survival estimates
    - ✓ Overall dam passage
    - ✓ Diel dam passage
  - Green Peter fish released and passed during Foster low pool
    - ✓ Possible reason for poor reach survival
  - Higher proportion of daytime passage
  - High pool vs. Low pool
    - ✓ Greater discharge (525 cfs vs. 299 cfs)
    - ✓ Higher elevation (636 ft vs 615 ft)



## Next Steps

- Finalize data analyses
  - Civil sunrise/sunset
    - ✓ Daytime passage – which route?
  - Timing
    - ✓ Forebay residency
    - ✓ Travel times
  - Survival by passage route
  - Efficiency and effectiveness
- Year 2 study
  - Inter-annual variability
    - ✓ Environmental conditions
      - Discharge
      - Temperature
      - Operational conditions
    - ✓ Fish stock/genetics
  - GPR – full scale study





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**Questions?  
Thank you**

