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High Head Bypass Fish Passage Investigations: Truck Transport vs. Bypass Pipe

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Stephanie Liss, Jarrod Ver Steeg, Eric Fischer, Ryan Harnish, and James Hughes

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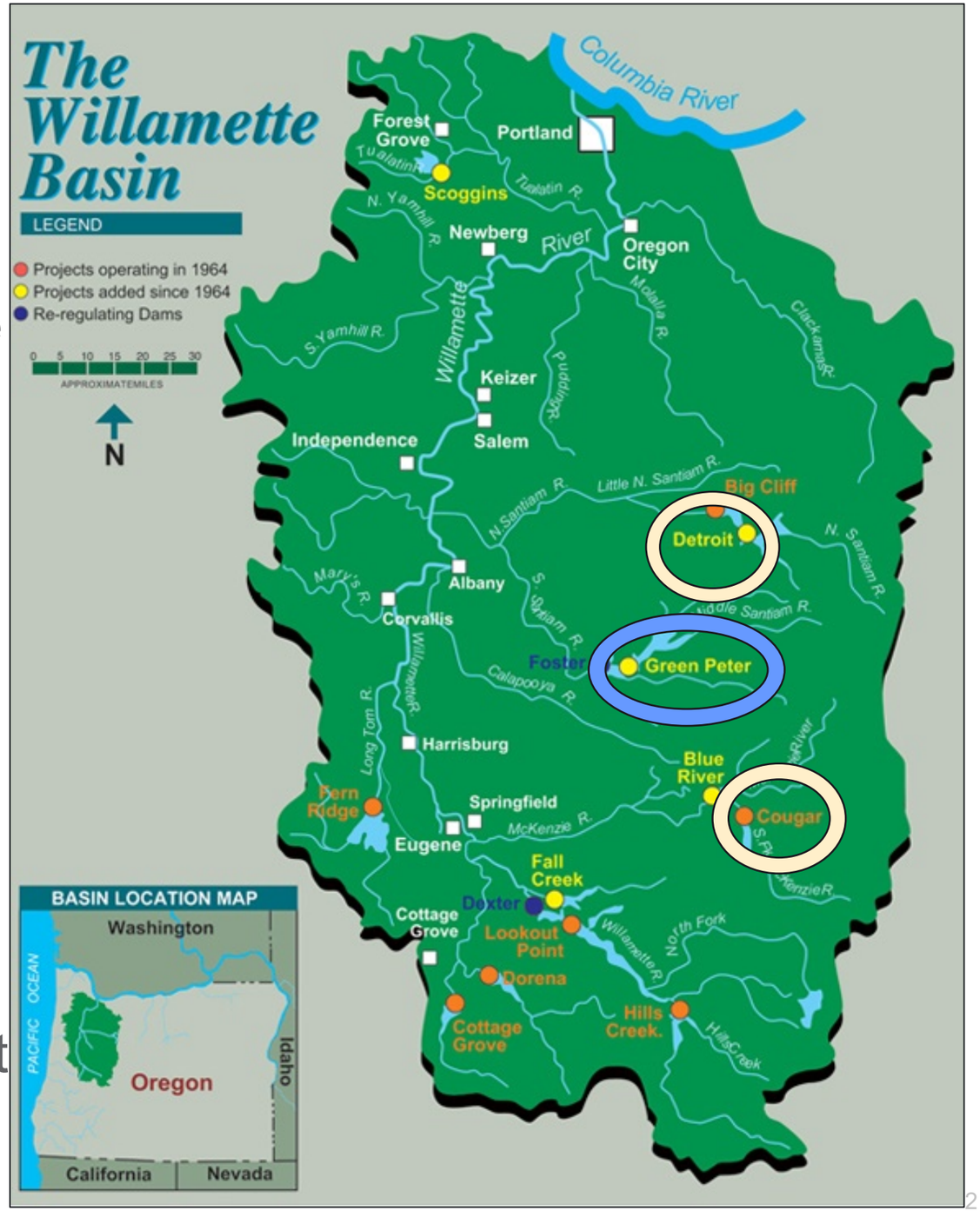
The Willamette Basin

- Juvenile salmon and steelhead passage
- High Head Bypass Product Delivery Team
  - Investigate alternatives to improve downstream fish passage
  - Injury and mortality studies
    - ✓ 2015, 2016, and 2017
- Copepod-infected fish
  - Increased prevalence at Cougar Dam
- What downstream passage method best minimizes stress?



Mimic Potential Stressors for the Cougar Dam Trap and Haul Alternative

Two Objectives:

- Healthy Fish Passage Evaluation
  - Conduct bypass pipe and trap and haul (Floating Screen Structure [FSS] collector and transport) simulations and analyze sub-samples for:
    - ✓ Concentration of cortisol (a stress hormone) present in the blood plasma of fish.
    - ✓ Presence of major injuries (torn operculum or fins, bulging eyes, lacerations, etc.).
    - ✓ Rate of survival.

- Infected Fish Relocation Evaluation Feasibility Study
  - Evaluate practicality of using copepod-infected fish for a full study of bypass pipe vs. transport by estimating:
    - ✓ Rate of survival.

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Study Site: Green Peter Dam

Bypass Pipe

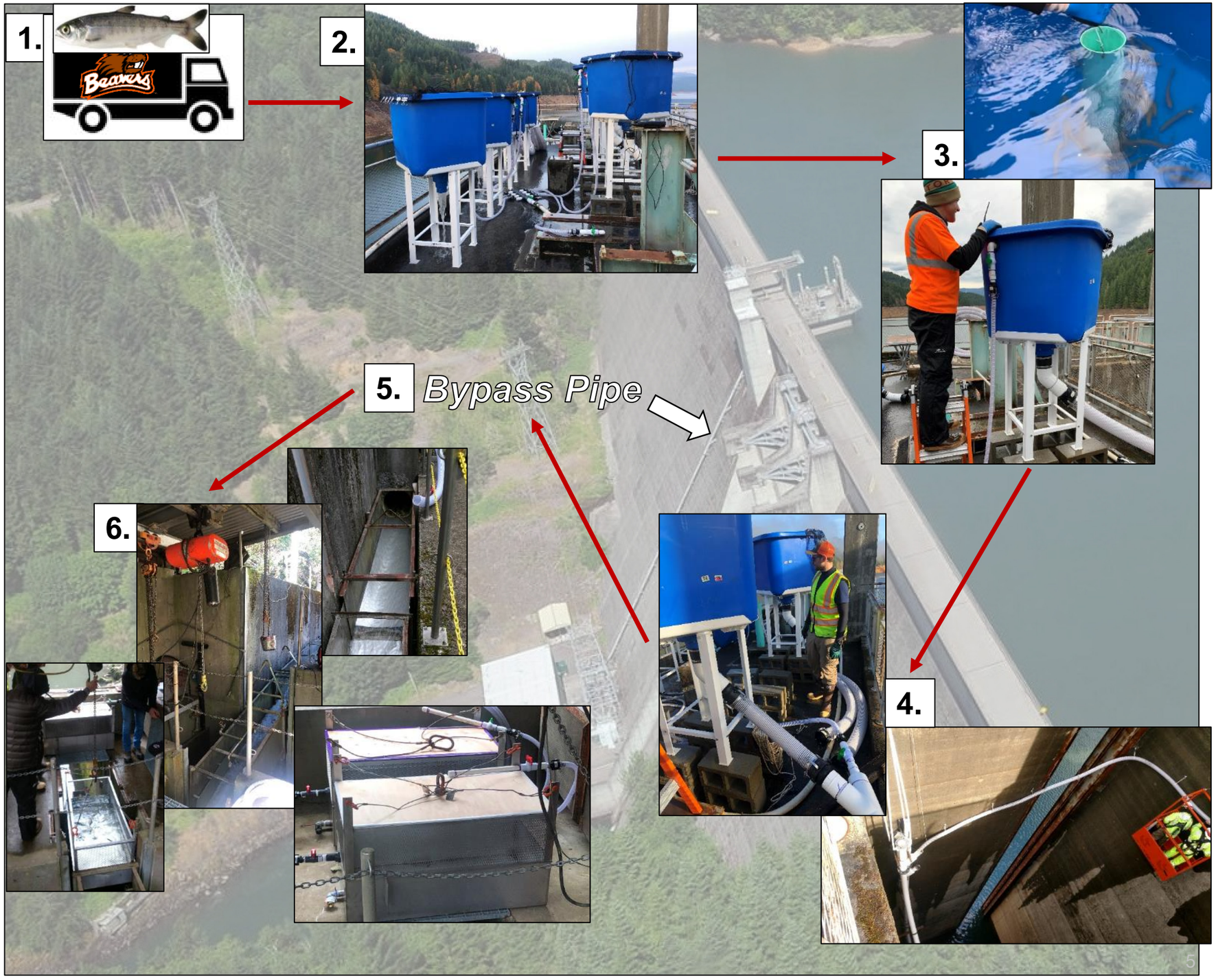
Juvenile Fish Collector

Transport

Mark Ylen – Democrat Herald

Cougar Dam Bypass Pipe Simulation

Real world	Simulation
1. --	1. Relocate fish
2. --	2. Acclimate (2wk)
3. Enter Floating Screen Structure (FSS)	3. Pull center standpipe
4. Chute passage from FSS into bypass pipe	4. Flex pipe from tank to bypass pipe
5. Bypass pipe passage	5. Bypass pipe passage
6. Release into river	6. Release into juv. fish collector Blood sampling (caudal venipuncture)

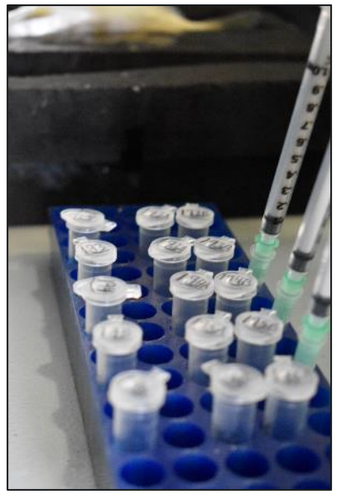


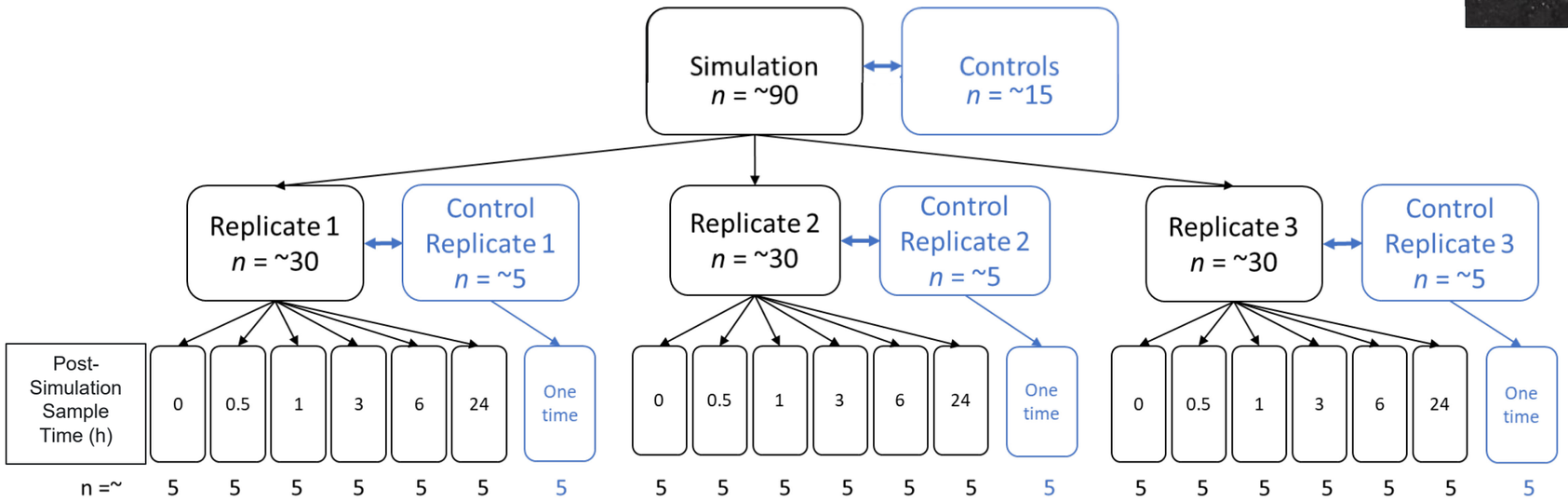
Cougar Dam Transport Simulation

Real world	Simulation
1. --	1. Relocate fish
2. --	2. Acclimate (2wk)
3. Enter FSS	3. Forklift tank
4. Chute passage from FSS to pod	4. Flex pipe from tank to pod
5. Pod holding	5. Pod holding
6. False lid, monorail trip	6. False lid, forklift driving
7. Crane lifts pod onto boat	7. Forklift lifts pod to truck
8. Boat driving	8. Truck driving
9. Pod moves from boat to truck	9. Forklift removes/ replaces pod on truck
10. Truck driving	10. Truck driving
11. Pipe attached to pod, fish released into river	11. Flex hose from pod to release to juv. fish collector Blood sampling

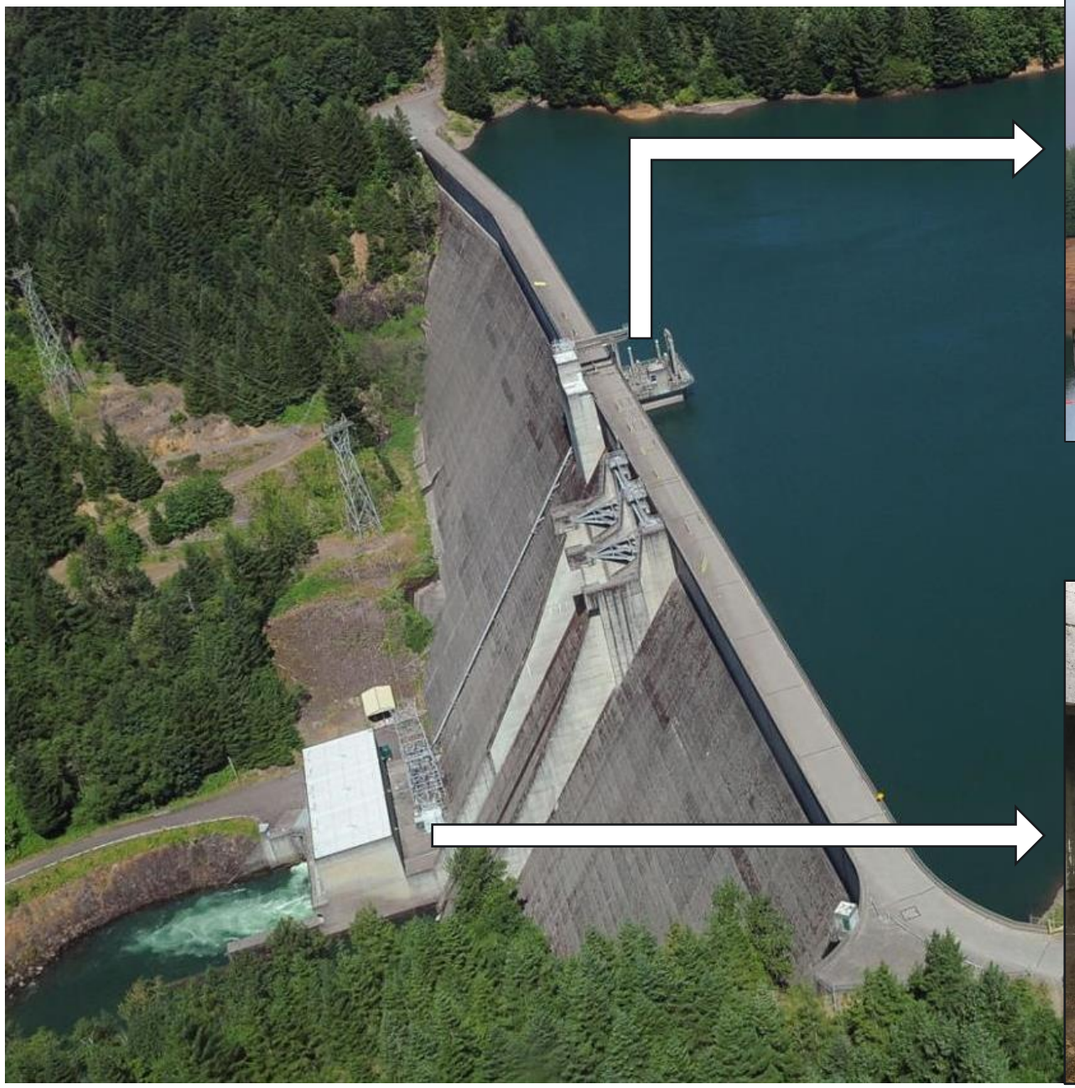
Replicates and Sample Sizes for Blood Sampling

- Bypass Pipe = 3 replicates (*n*=90 total)
- Transport = 9 replicates
  - Different pod holding times
    - ✓ 1 h = 3 replicates (*n*=90 total)
    - ✓ 12 h = 3 replicates (*n*=90 total)
    - ✓ 24 h = 3 replicates (*n*=90 total)





Differences in Environmental Characteristics

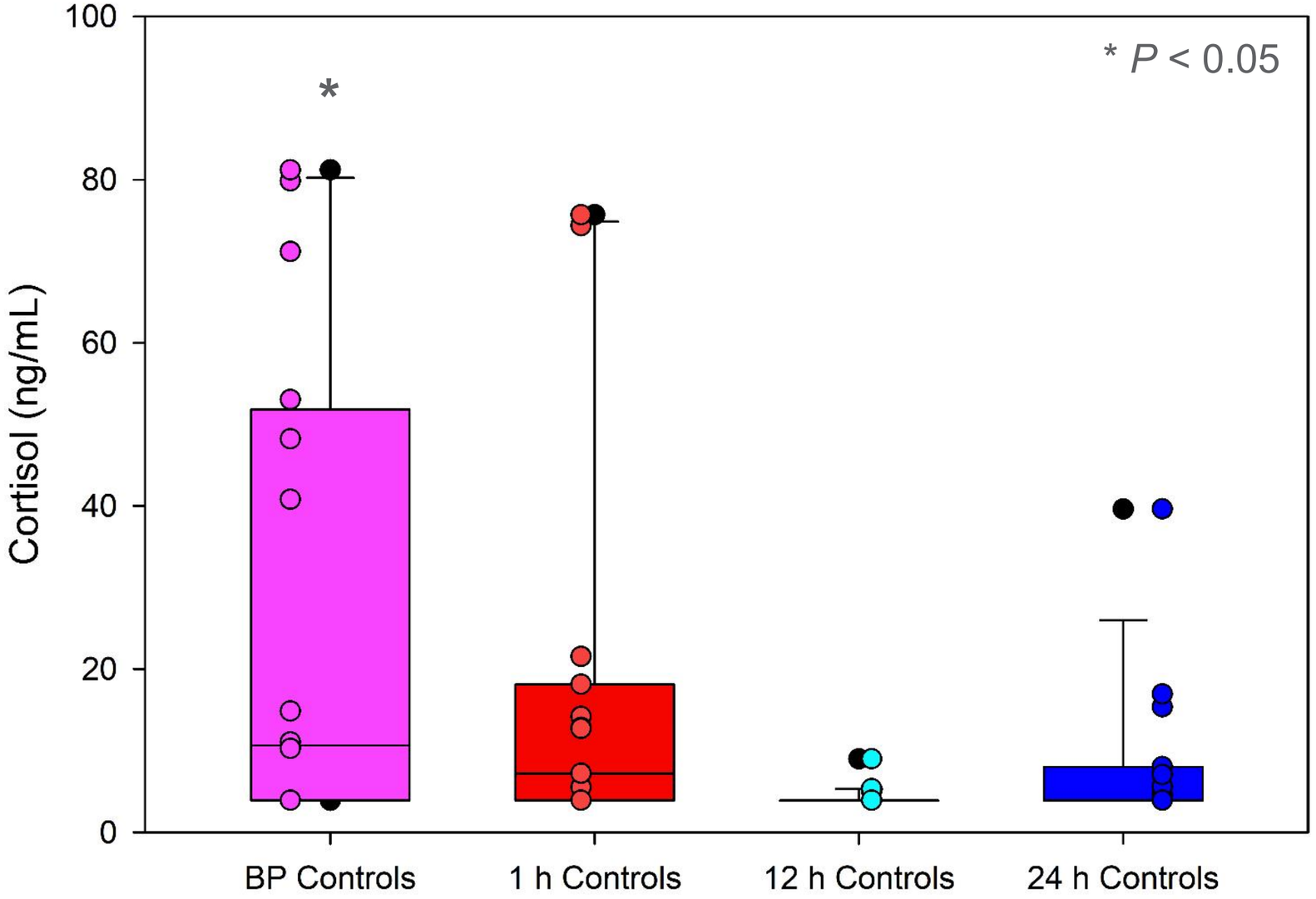


- Water Temperature
  - 13.8 °C (11.5–14.9)*
- Dissolved Oxygen
  - 8.4 mg/L (6.7–9.7)*

- Water Temperature
  - 11.6 °C (10.0–12.7)*
- Dissolved Oxygen
  - 8.0 mg/L (7.0–8.8)*

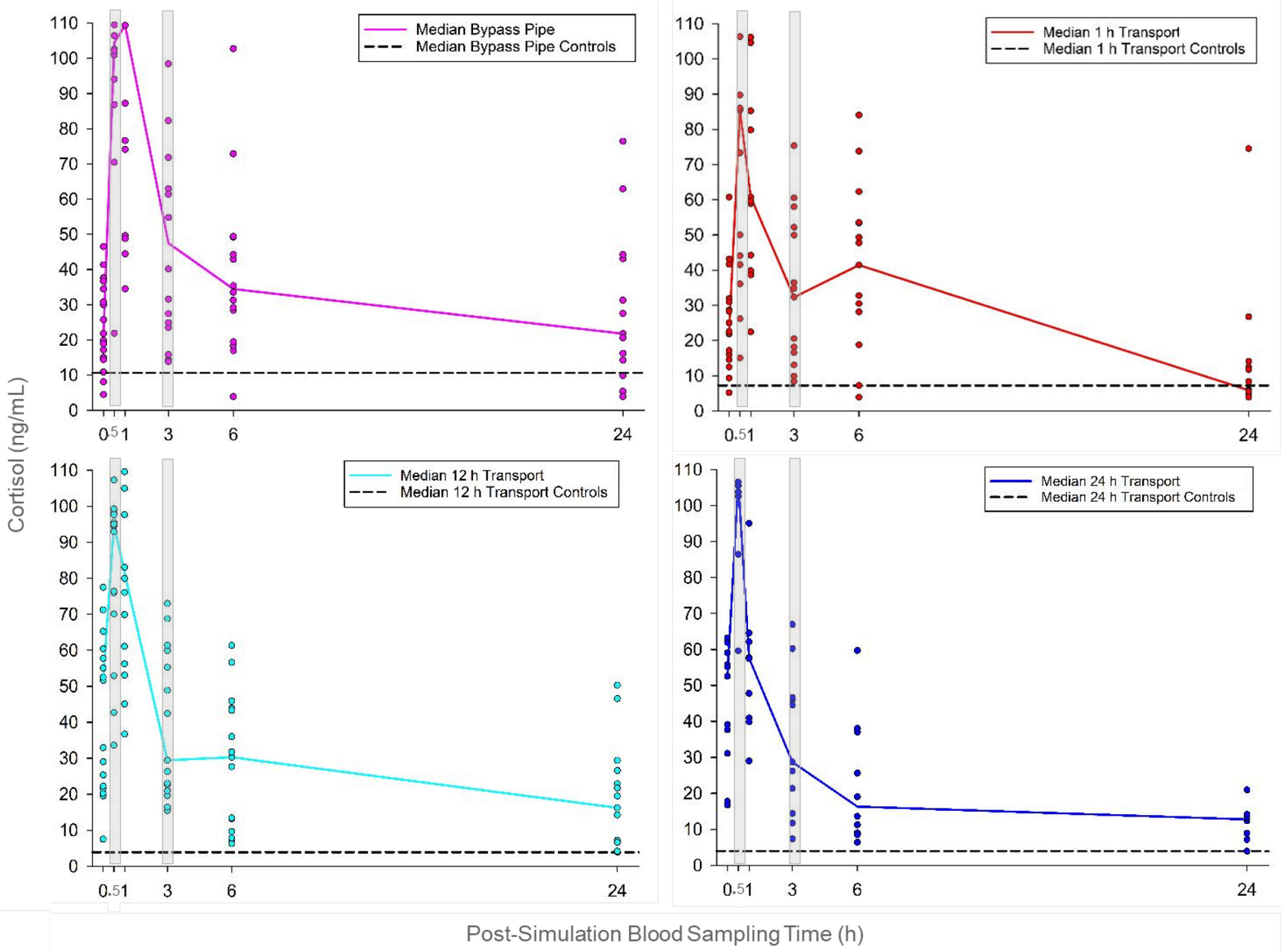
* $P < 0.05$

Higher Cortisol Concentrations for Bypass Pipe Controls



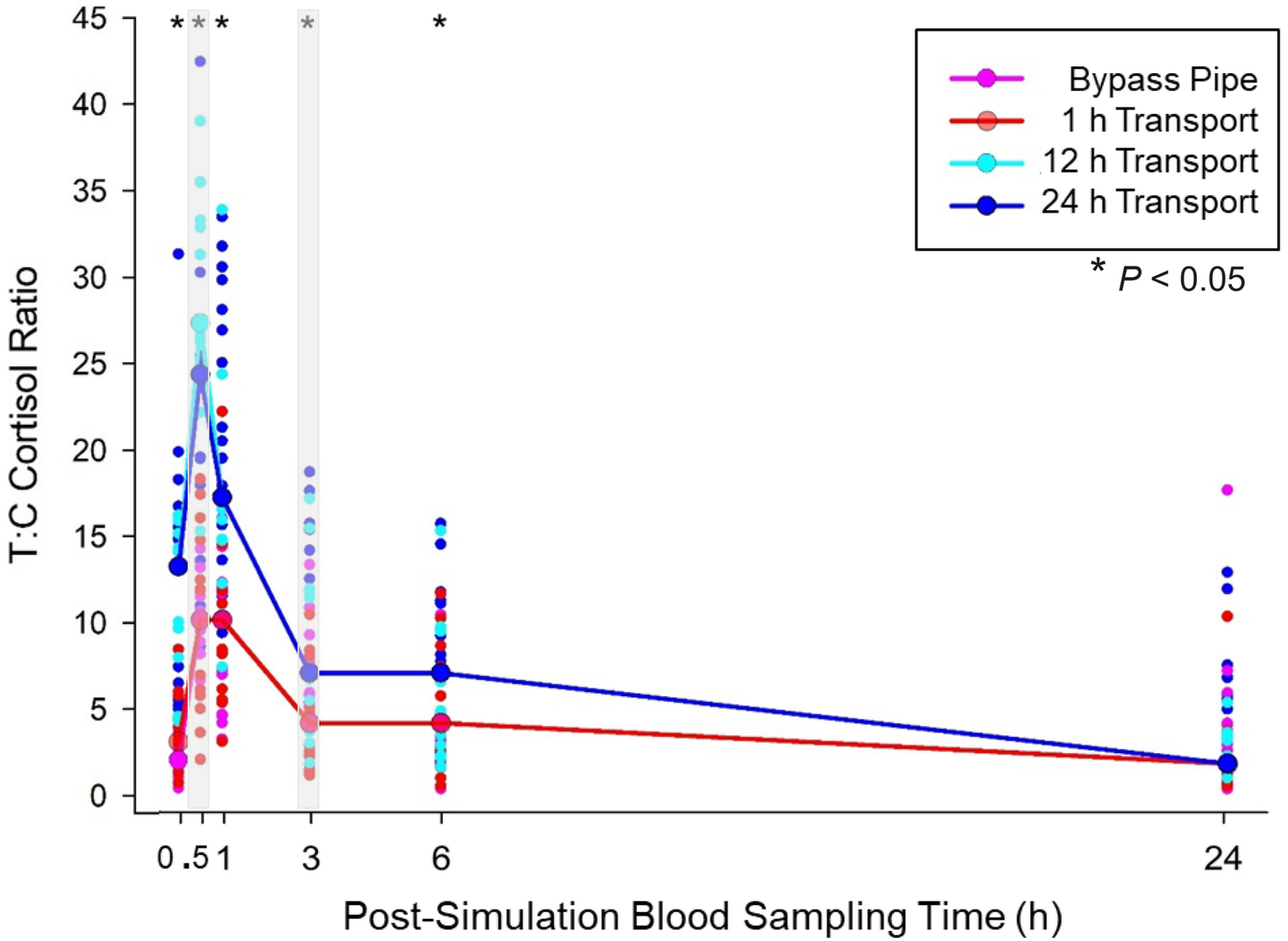
True Cortisol Concentrations Followed the Same Trends Among Simulations

- Simulation replicates were combined at each post-simulation blood sampling time
- Stress response curves peaked at 0.5 or 1 h post-simulation and decreased by 24 h post-simulation



Lower Cortisol Ratios through 6 h Post-Simulation for Bypass Pipe and 1 h Transport

- Simulation replicates were combined at each post-simulation blood sampling time
- Median cortisol concentrations were used for treatment:control (T:C) cortisol ratios



Objective 2
Feasible to Relocate Copepod-Infected Fish

- OSU infected fish with copepods
- 184 copepod-infected fish relocated
  - Placed into 4 tanks
    - ✓ 2 tanks = bypass pipe holding tank location
    - ✓ 2 tanks = transport holding tank location
  - All fish survived 2-day holding period
- Bypass Pipe and Transport (1 h)
  - No blood samples
    - ✓ No 2-week acclimation → not comparable to healthy fish
- Feasible to relocate infected fish

Year One: All Fish Were Stressed; Recovering by 24 h Post-Simulation

- Healthy fish evaluation
  - Cortisol Concentrations
    - ✓ Stress response curve similar for all four simulations
    - ✓ Treatment:control cortisol ratio used
      - Accounted for the underlying stress from pre-simulation tank holding location
      - **Bypass pipe and 1 h transport cortisol ratios were lower than 12 h and 24 h transport, *except* for 24 h post-simulation when all ratios were nearing baseline levels**
  - Injuries and Survival
    - ✓ No differences among the four simulations nor between the two methods (bypass pipe and transport)

- Infected fish relocation evaluation
  - Feasible to relocate and test copepod-infected fish at Green Peter for a full-scale study

- Fall 2020
  - Full-scale study with healthy and copepod-infected fish completed – analysis ongoing

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This research was conducted in compliance with a protocol approved by PNNL's Institutional Animal Care and Use Committee.

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Questions?