

MERWIN UPSTREAM ADULT TRAP EFFICIENCY



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Regulatory Background

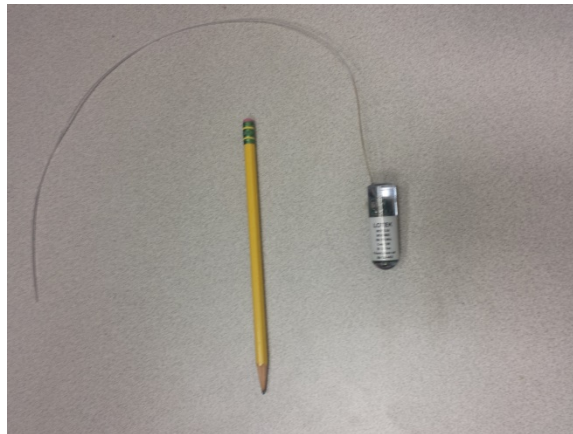
- Lewis River Aquatic Monitoring & Evaluation Plan (PacifiCorp and Cowlitz PUD 2010)
- The plan describes the need for the evaluation of design and adequacy of attraction flow for capturing species of interest
 - spring Chinook salmon (*Oncorhynchus tshawytscha*)
 - coho salmon (*Oncorhynchus kisutch*)
 - winter steelhead (*Oncorhynchus mykiss*)

Objectives

- 1) Determine adult trap efficiency (ATE) for each target species; compare estimates to performance standard
- 2) Determine if fish show direct movement to trap entrance; document behavior patterns in tailrace
- 3) Determine if fish in tailrace spend majority of time at entrance of trap
- 4) Determine total time fish are present in Merwin Dam tailrace; compare to ATE performance standards for safe, timely, and effective passage
- 5) Describe movement and behavior of tagged fish that do not enter/choose to leave Merwin Dam tailrace and move back downstream
- 6) Determine condition of fish that are captured by trap

Methods: Fish Collecting and Tagging

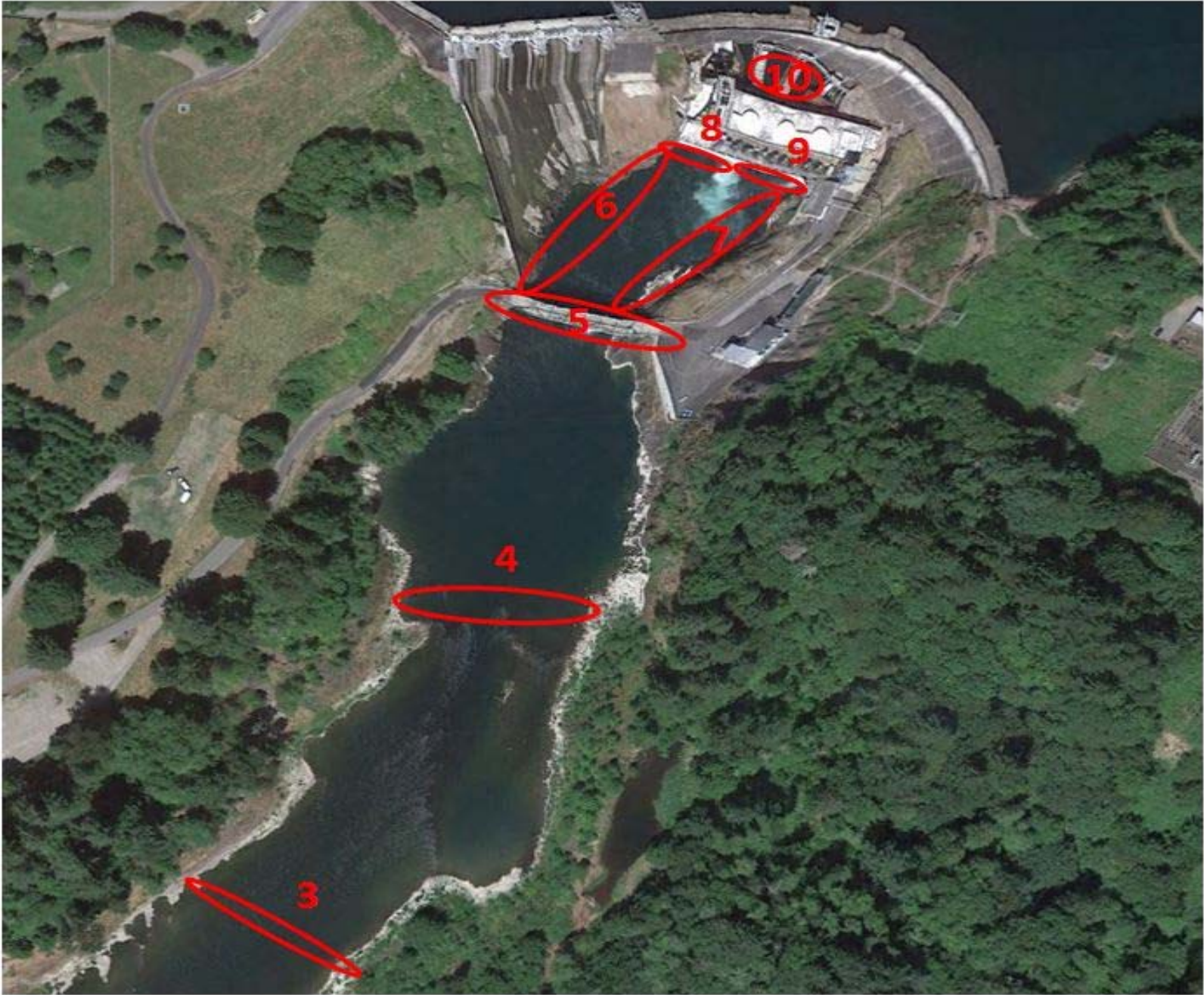
- PacifiCorp staff collected and tagged fish during specific months to effectively utilize each species' peak migration timing:
 - Late-run winter steelhead: March 2015
 - spring Chinook: April 2015
 - coho: September 2015



Methods: Telemetry Array

Location	Site Abbreviation	Type	Antenna	Detection Zone
Downstream: Bed and Breakfast	BBL	Aerial	1	1
Downstream: Lewis River Hatchery	LRH	Aerial	2	2
Downstream: below Merwin boat ramp	BLD	Aerial	3	3
Downstream: Holding Pool	BLU	Aerial	4	4
Tailrace: below bridge	BRG	Aerial	5-7	5
Tailrace: left bank	SS	Aerial	8-9	6
Tailrace: right bank	NS	Aerial	10-11	7
Tailrace: along powerhouse wall	PWS	Aerial	12	8
Tailrace: along powerhouse wall	PWN	Aerial	13	9
Tailrace: gallery behind dam	GAL	Aerial	14	10
Tailrace: downstream of trap	APR	Underwater	15	11
Tailrace: trap entrance	ENT	Underwater	16	12
Trap: upstream in ladder	PL2, PL4	Underwater	17a&17b	13
Trap: processing facility	TRP	Aerial	18	14





Objective 1: Determine trap effectiveness compared to 98% performance standard

- Adult Trap Efficiency (ATE):

$$\text{ATE}_{\text{test}} = C / M^{\text{PS1}}$$

Where C = # captured and M = # actively migrating

- Probability that true mean ATE (X) is greater than 98% is as follows:

$$P(X > 0.98) = P(Z > (0.98 - \mu) / \sigma)$$

Slide 8

PS1

Define c and m

Peter Stevens, 3/7/2016

Objective 1: Results

Metric	Winter Steelhead	Spring Chinook	Coho Salmon
Total tagged (n)	148	40	35
Entered the Tailrace	146	40	35
Entered the Trap	126	36	8
Trap Entrance Efficiency (P_{EE})	86.3%	90.0%	22.9%
Captured	90	15	3
Collection Efficiency (ATE_{Test})	61.6%	37.5%	8.6%
Distribution Z-Score	7.9%	0%	0%

Objective 2: Determine if fish show direct movement to trap; document behavior in tailrace

- Network (graph) theory four network metrics:
 - Number of edges
 - Network diameter
 - Average number of neighbors
 - Edge to diameter ratio
- Route Specific Passage (RSP) efficiency was calculated as the product of tailrace zone efficiencies (ZE):

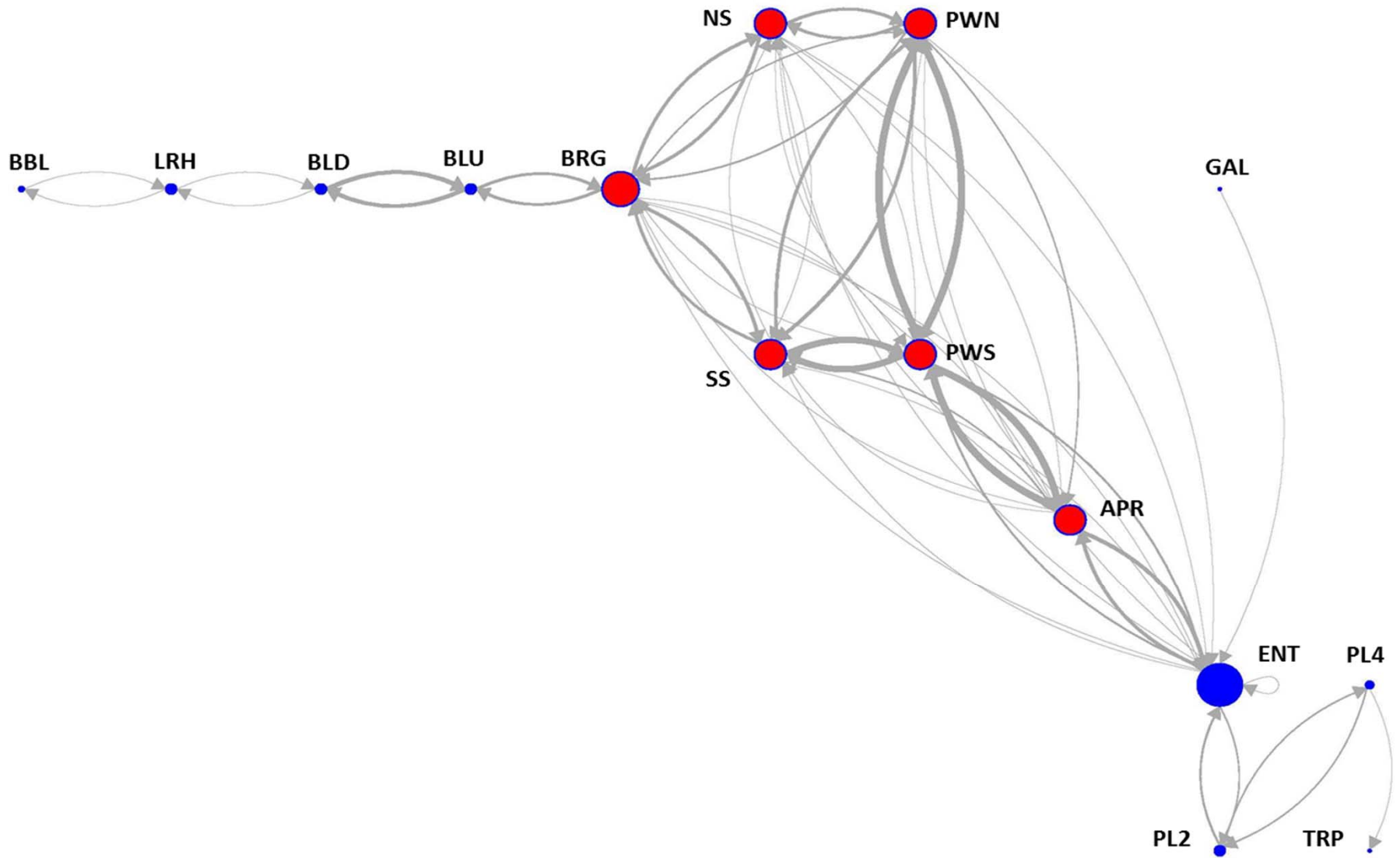
$$ZE = (1 - f_{ij} / n_{ij})$$

- RSP for a given route Z that passes through three zones can then be calculated as:

$$RSP_Z = (n_Z) \times (ZE_{Z1}) \times (ZE_{Z2}) \times (ZE_{Z3})$$

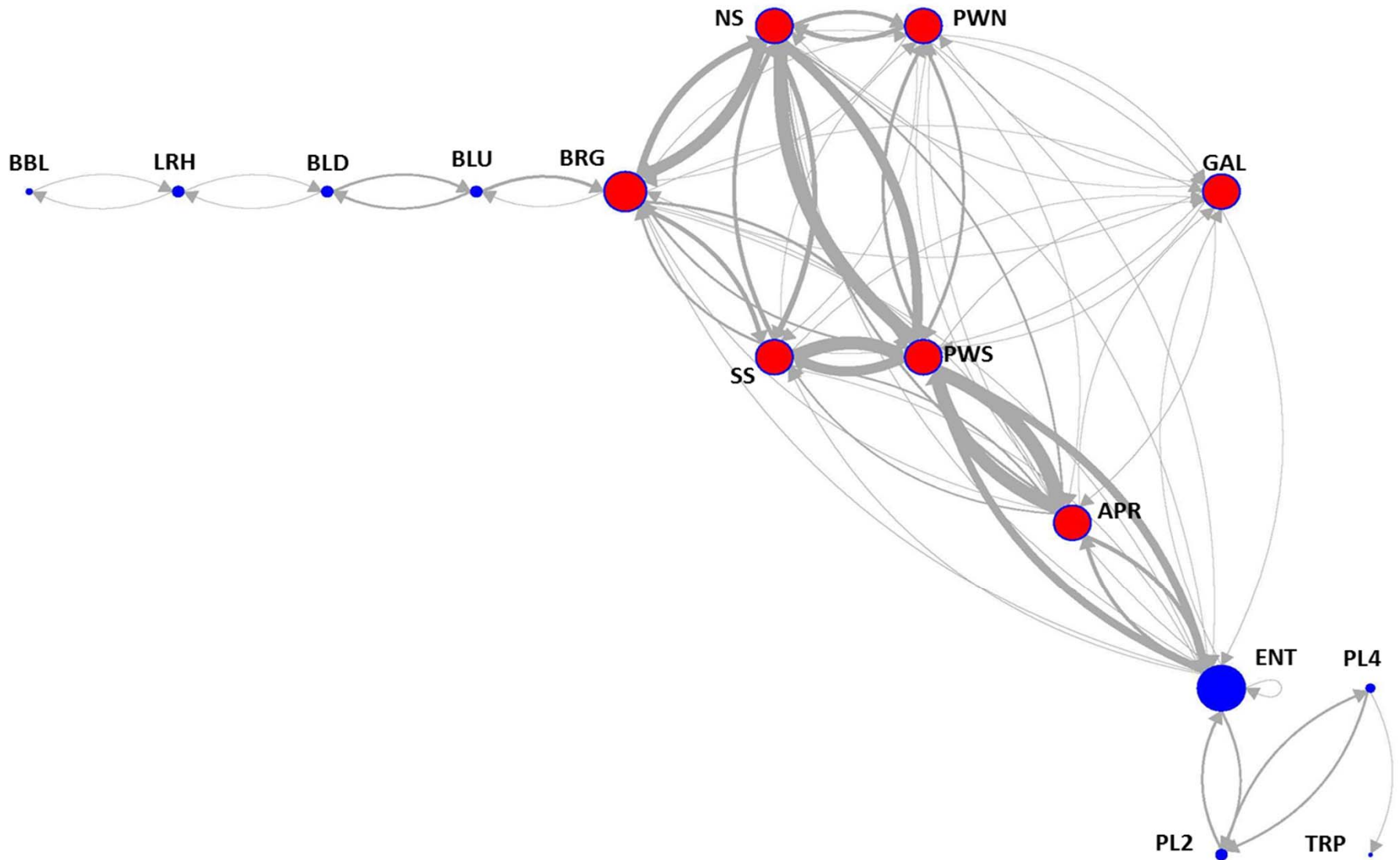
Objective 2: Results

STEELHEAD



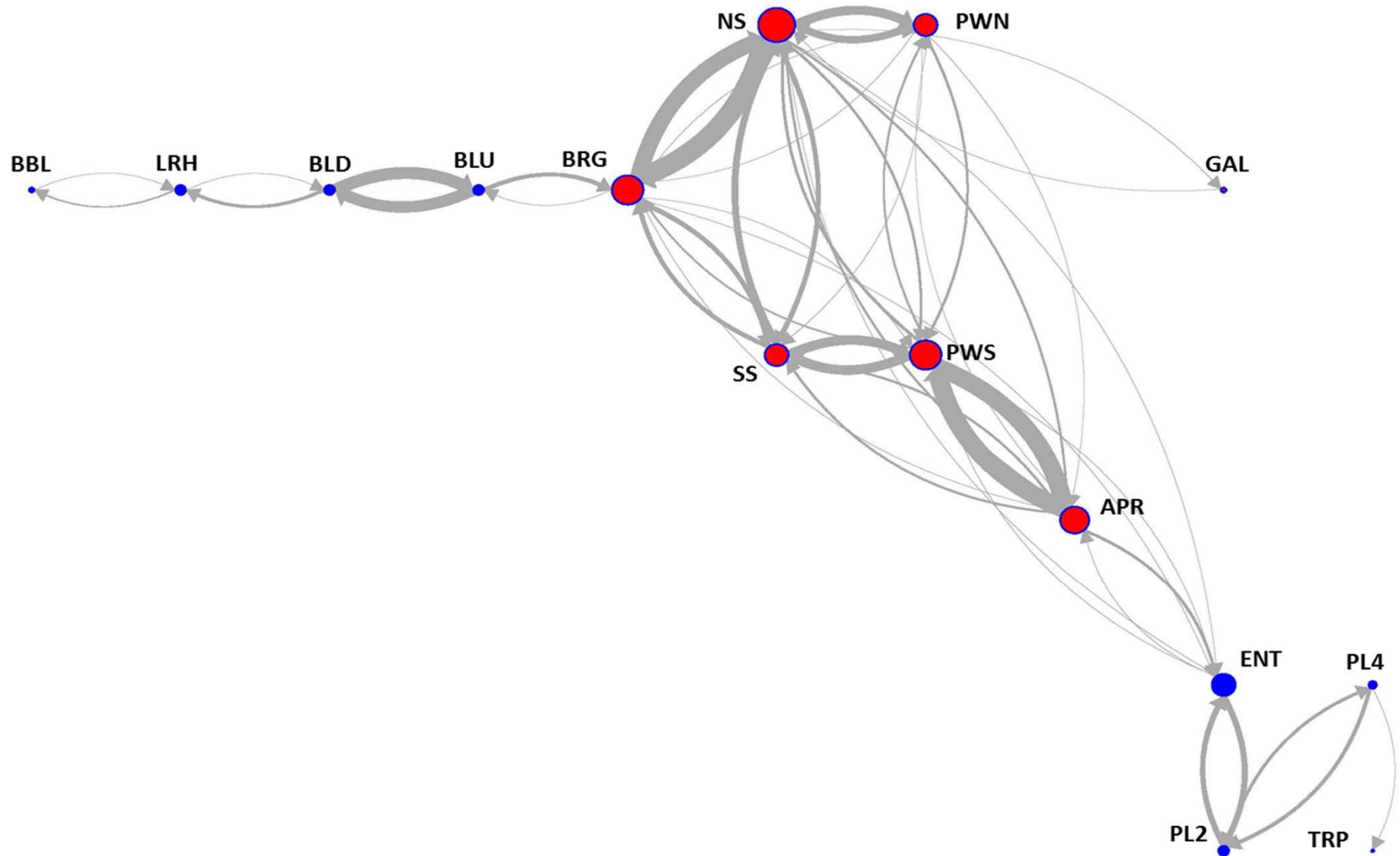
Results: Objective 2

CHINOOK

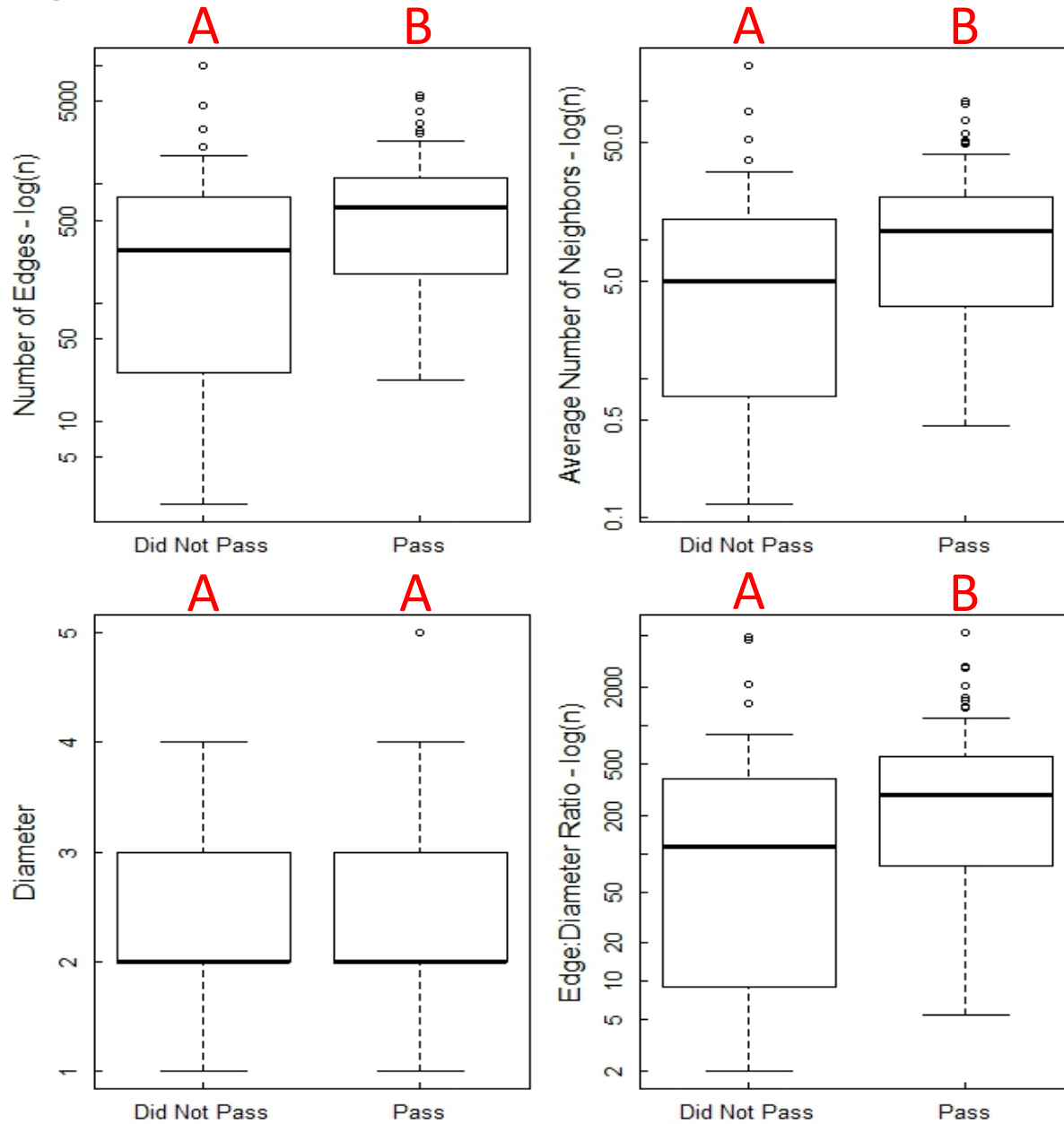


Objective 2: Results

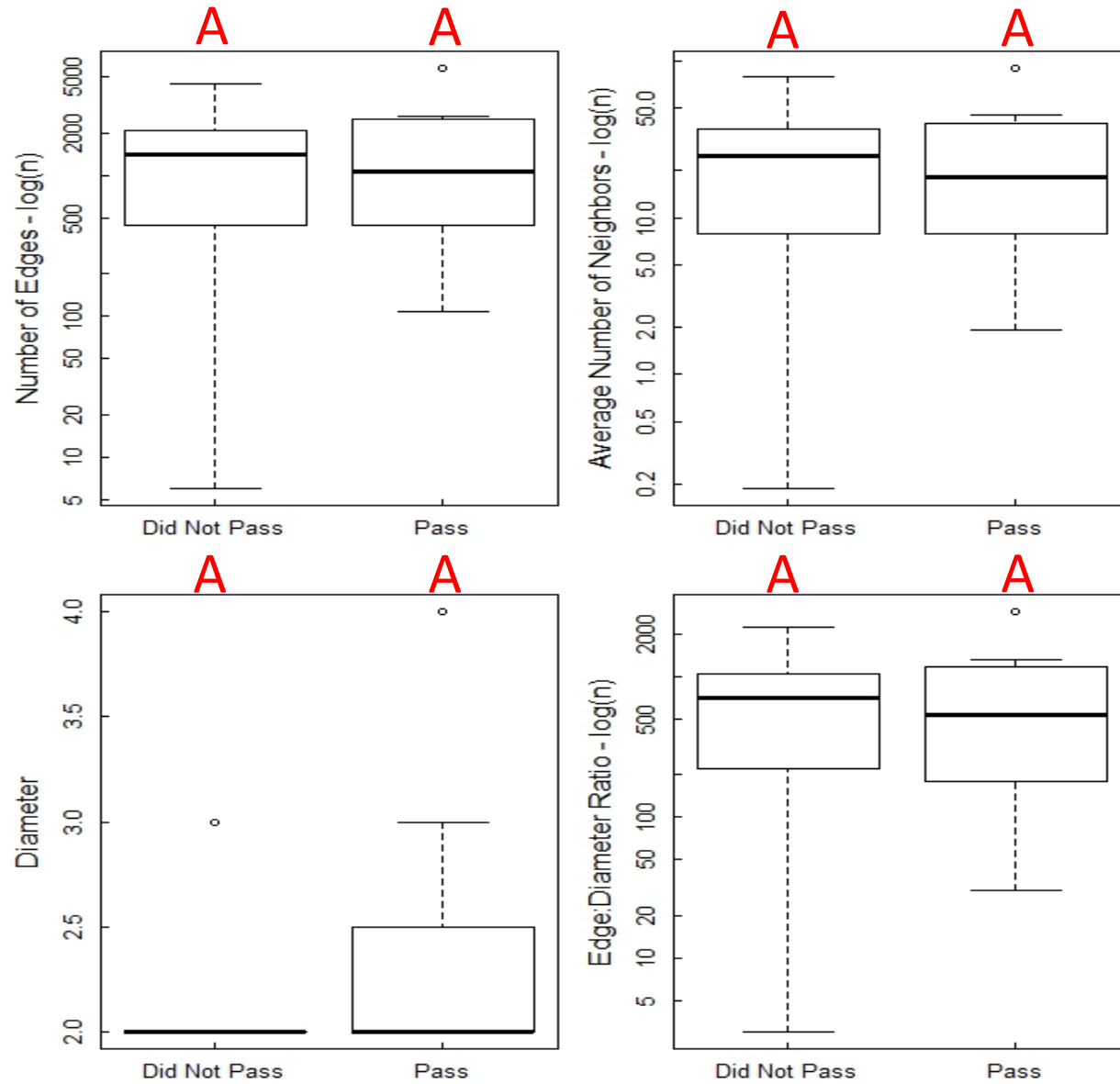
COHO



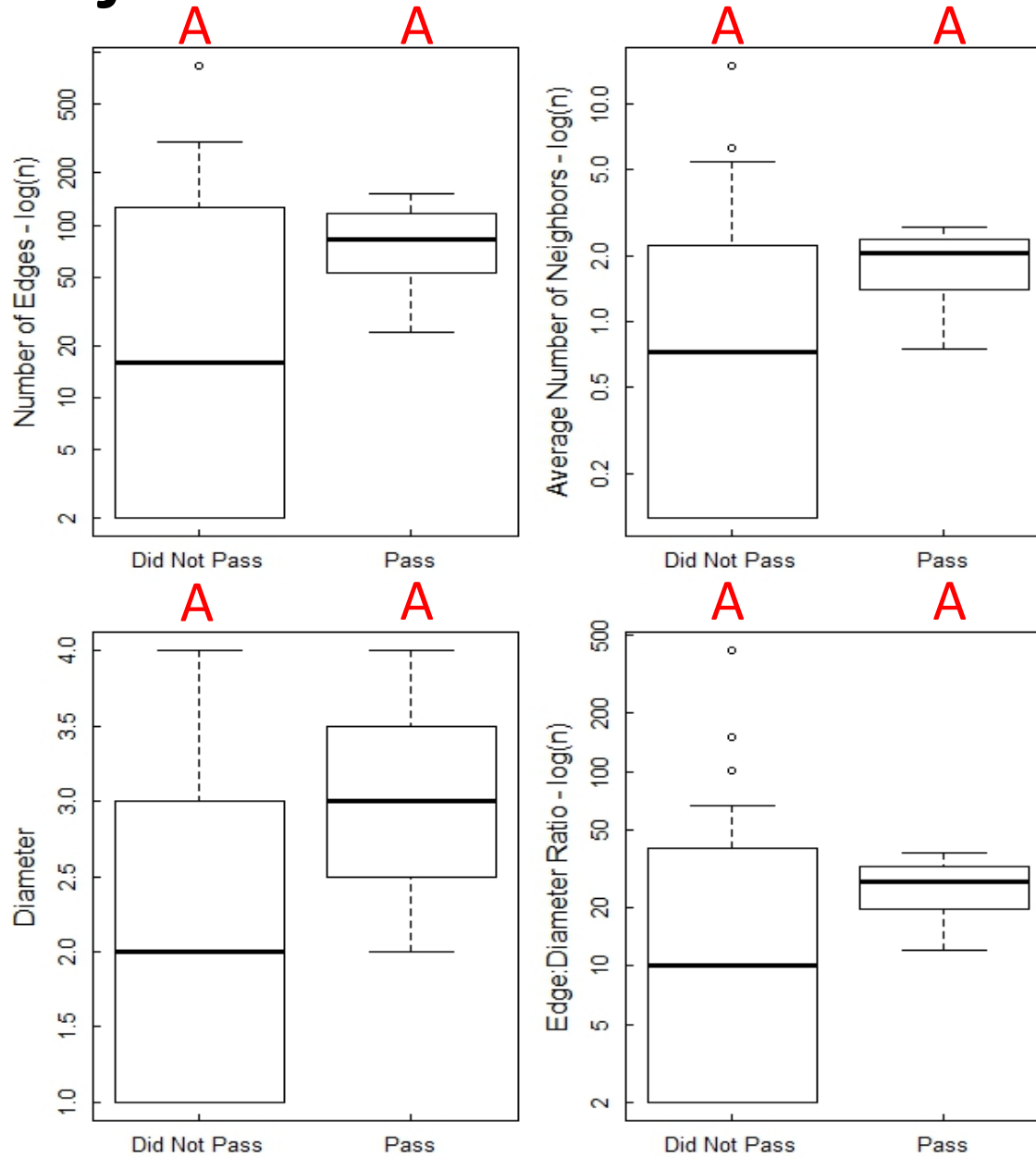
Objective 2: Results - Steelhead



Objective 2: Results - Chinook

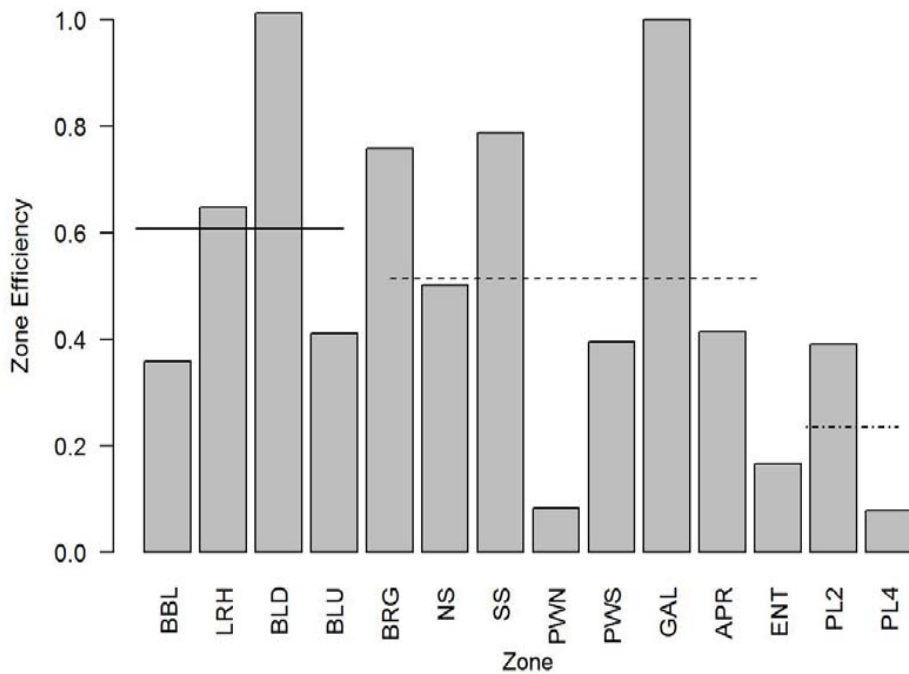


Objective 2: Results - Coho

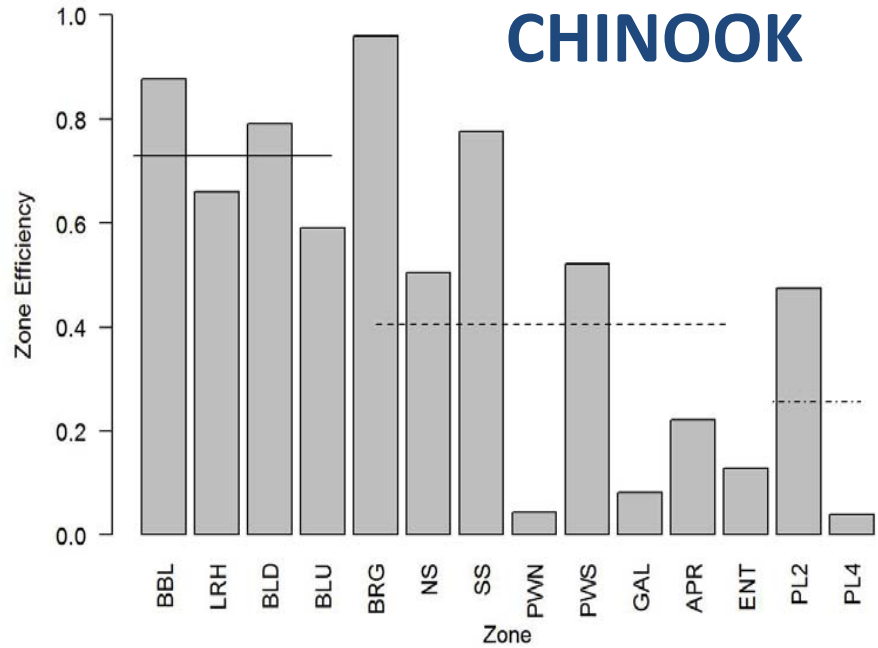


Objective 2: Results

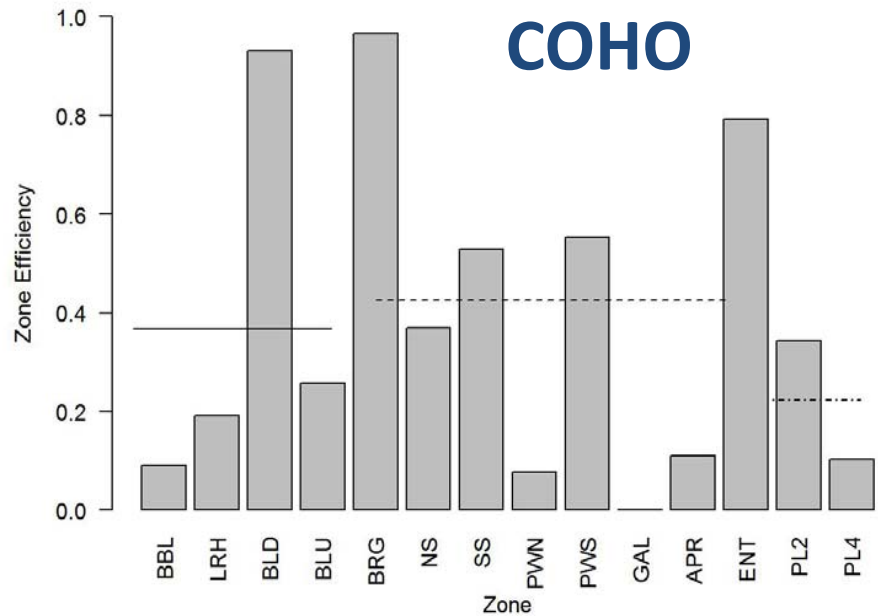
STEELHEAD



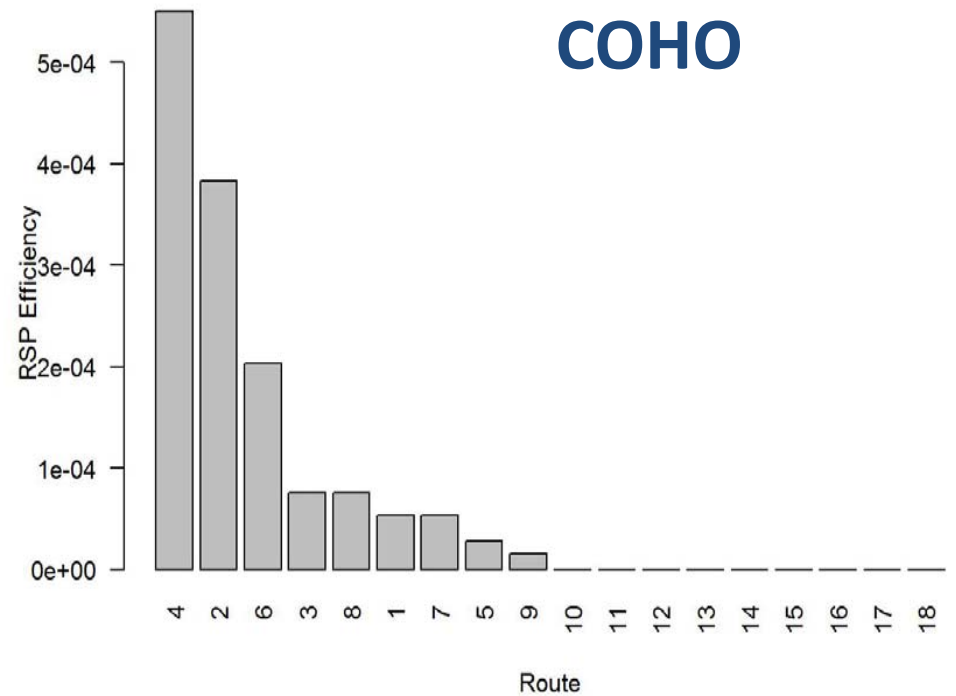
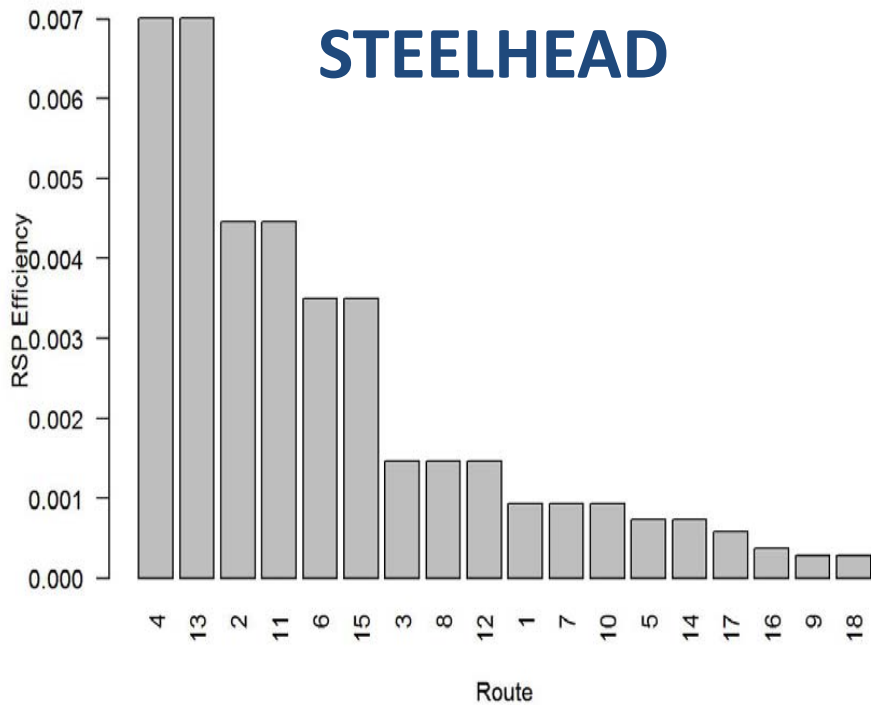
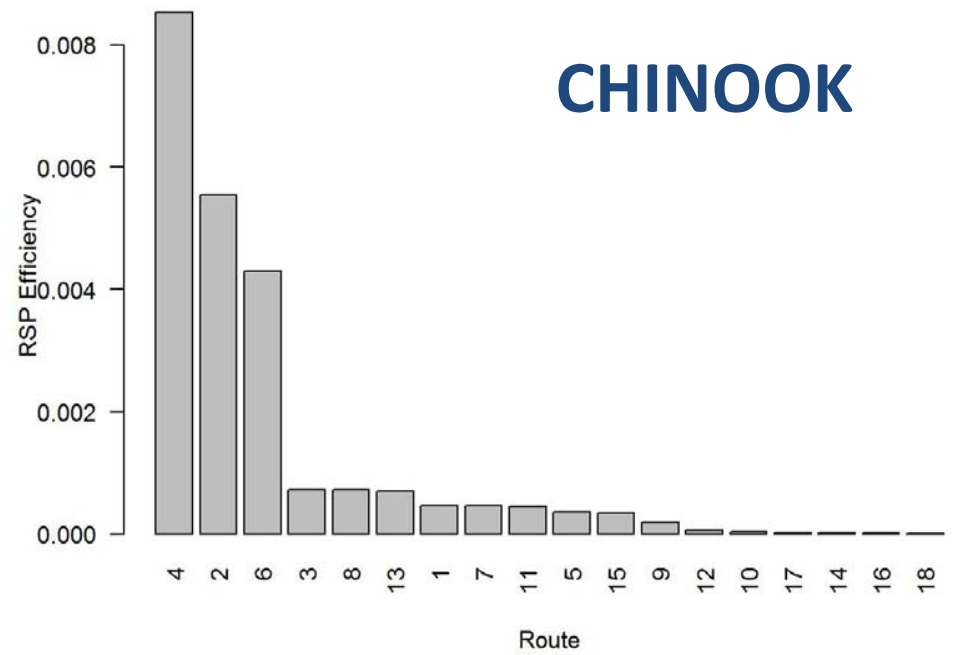
CHINOOK



COHO



Objective 2: Results

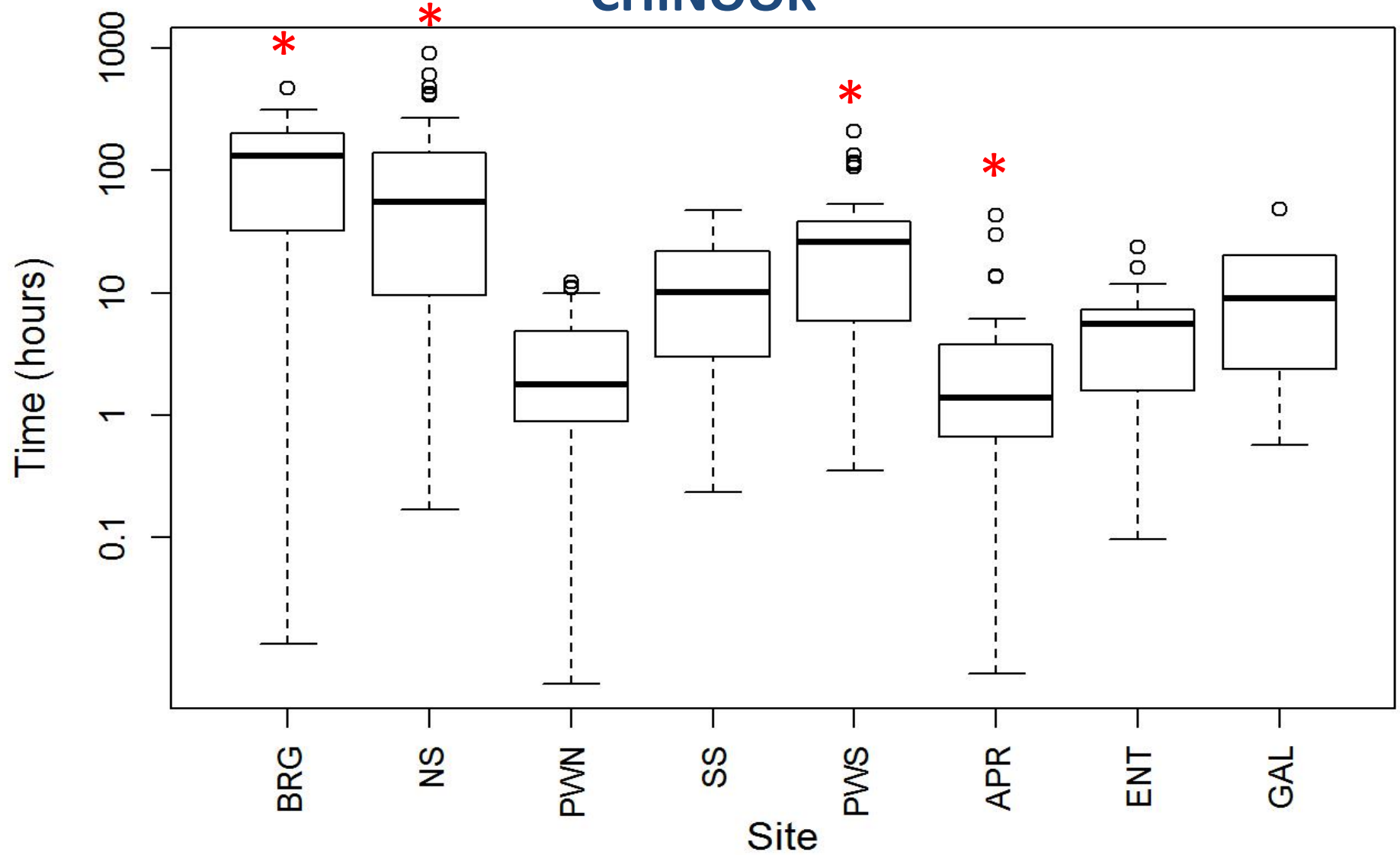


Objective 3: Determine if fish in tailrace spend majority of time in entrance of trap, and if not, determine where they are holding

- Time spent in specific tailrace zones
- Median time within zone for each species was calculated

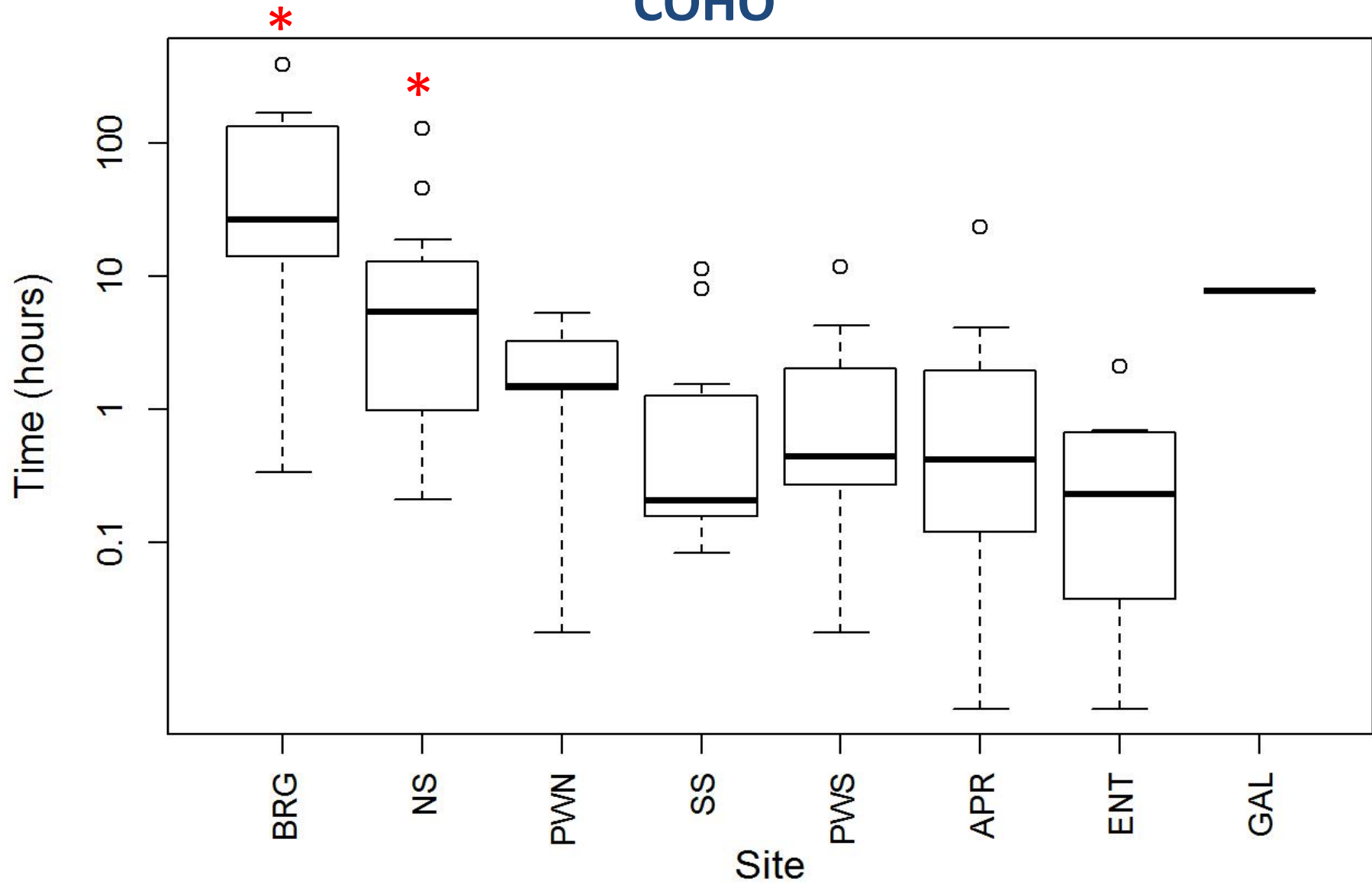
Objective 3: Results

CHINOOK



Objective 3: Results

COHO

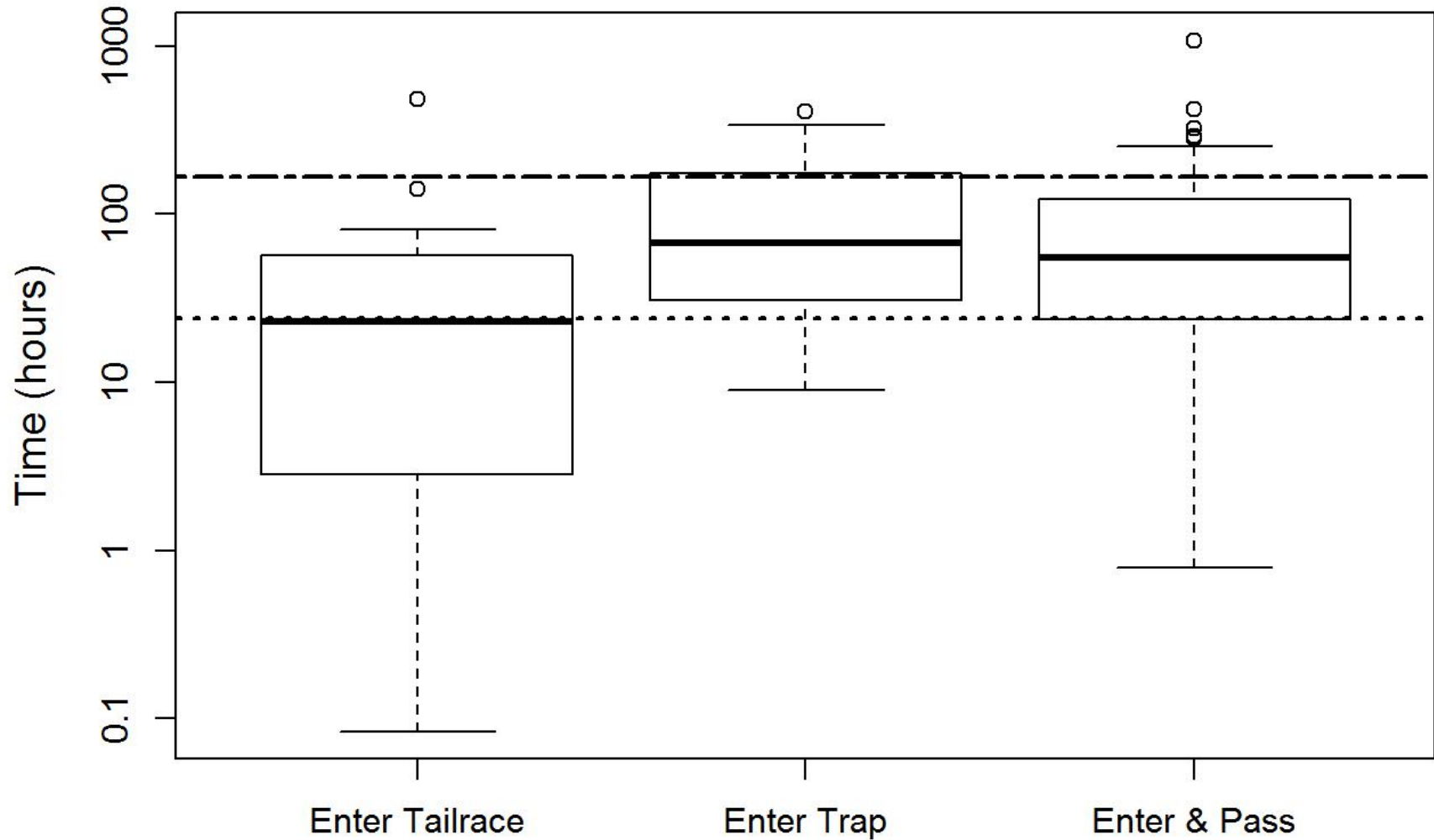


Objective 4: Determine total time fish are present in tailrace, compare to ATE performance standards

- Total tailrace time was calculated as the total time spent in any tailrace zone
- Aggregate of total time spent in any tailrace zone was employed for determining compliance with the ATE performance standard.

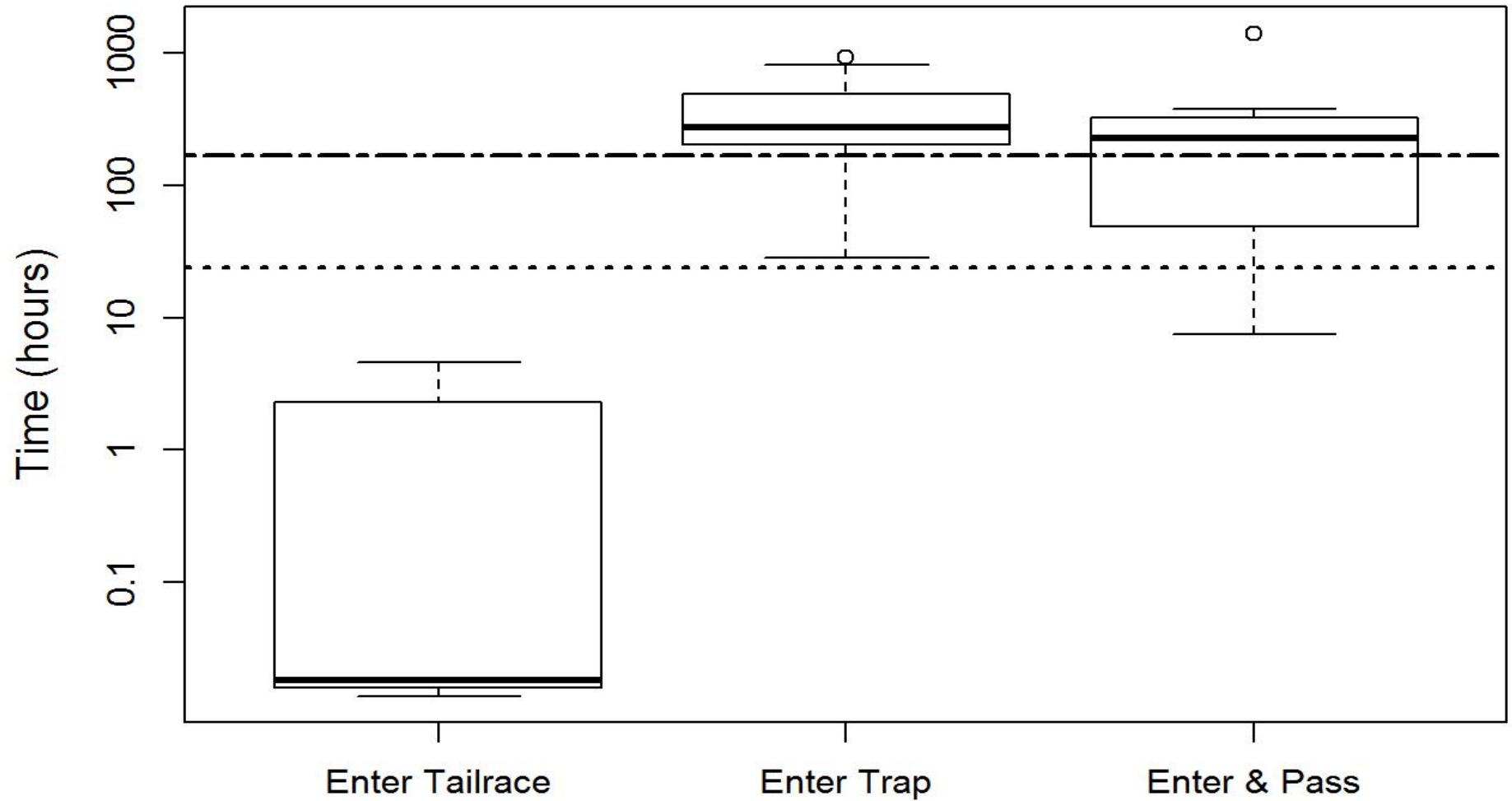
Objective 4: Results

STEELHEAD



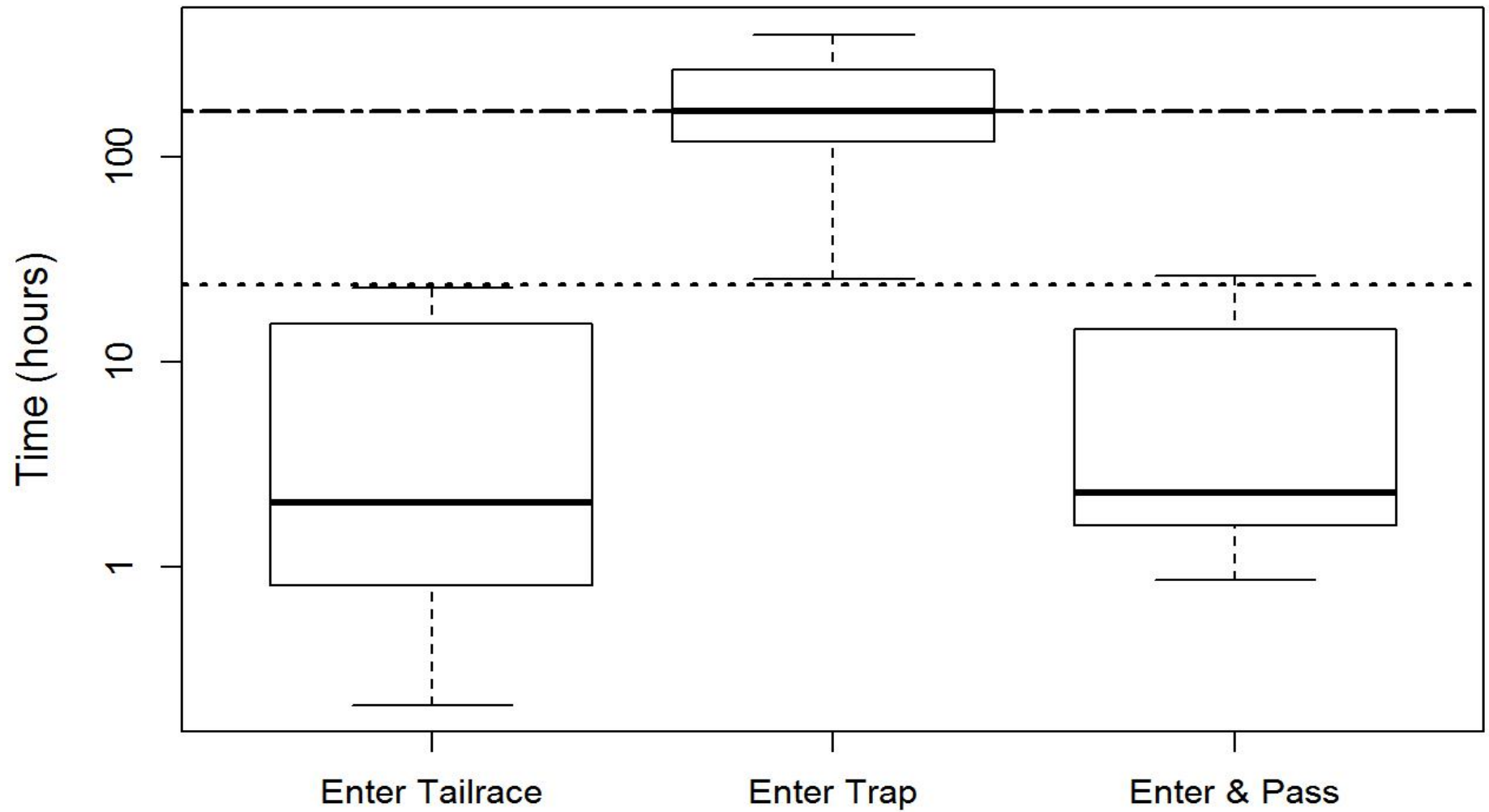
Objective 4: Results

CHINOOK



Objective 4: Results

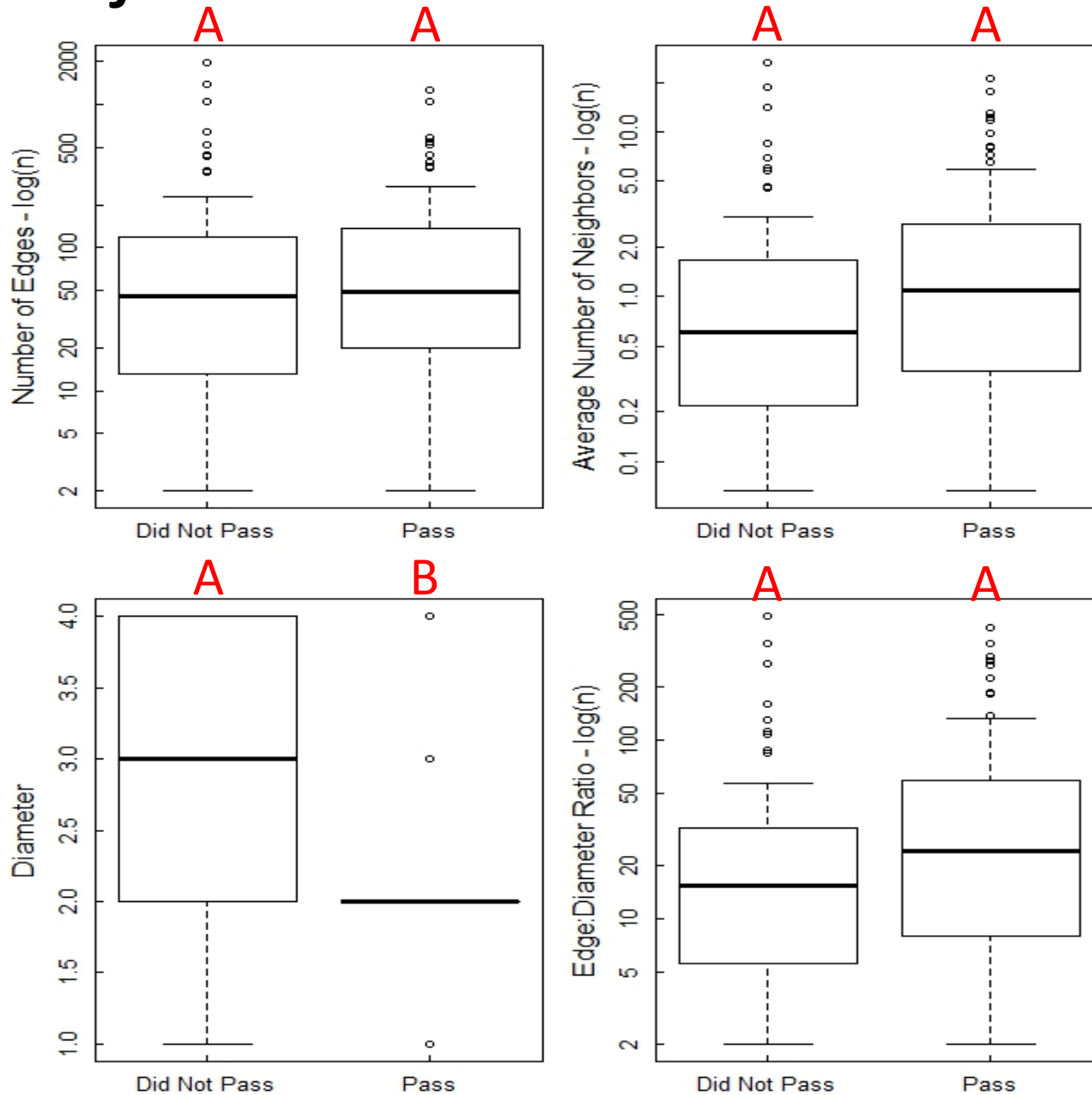
COHO



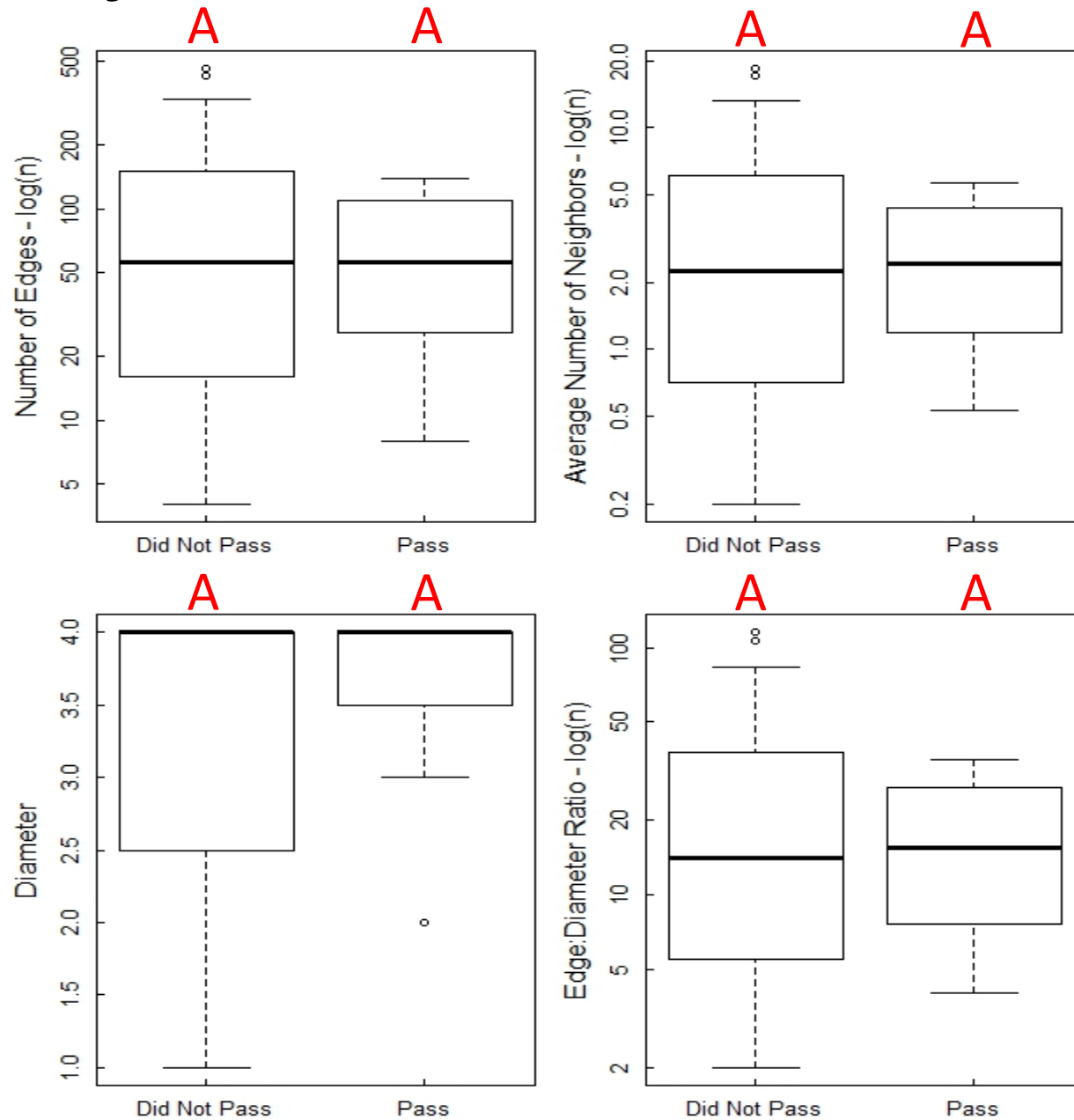
Objective 5: Describe movement and behavior of tagged fish that move back downstream

- Network (graph) theory - four network metrics:
 - Number of edges
 - Network diameter
 - Average number of neighbors
 - Edge to diameter ratio

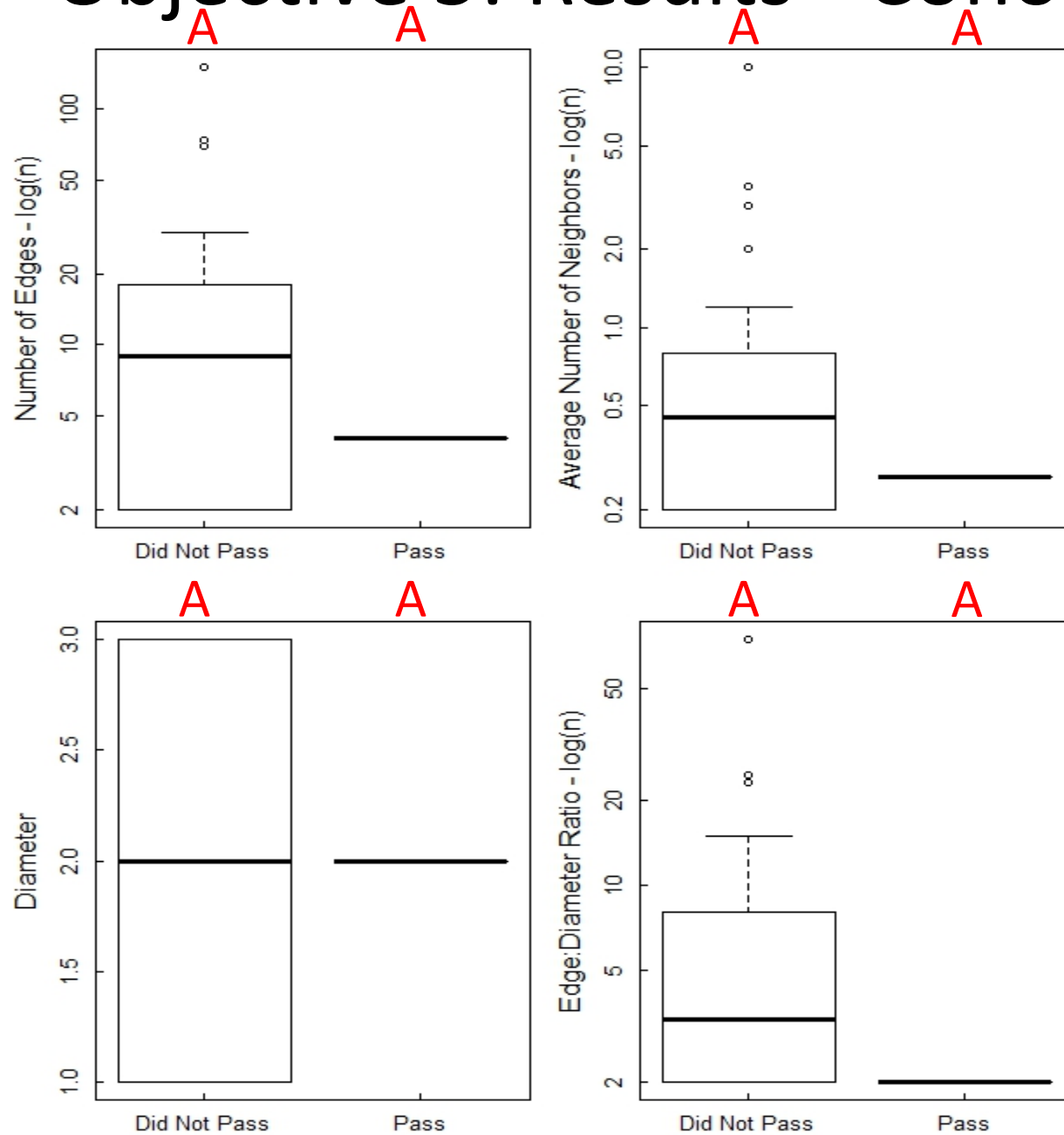
Objective 5: Results - Steelhead



Objective 5: Results - Chinook



Objective 5: Results - Coho



Objective 6: Determine the condition of the fish that are captured by the trap

- PacifiCorp staff handled trapping and tagging of study fish
- Conducted fish health assessments prior to tagging
 - Fish considered in poor condition → disqualified as candidates for tagging
- Ensured condition of tagged fish did not bias analyses or interpretation

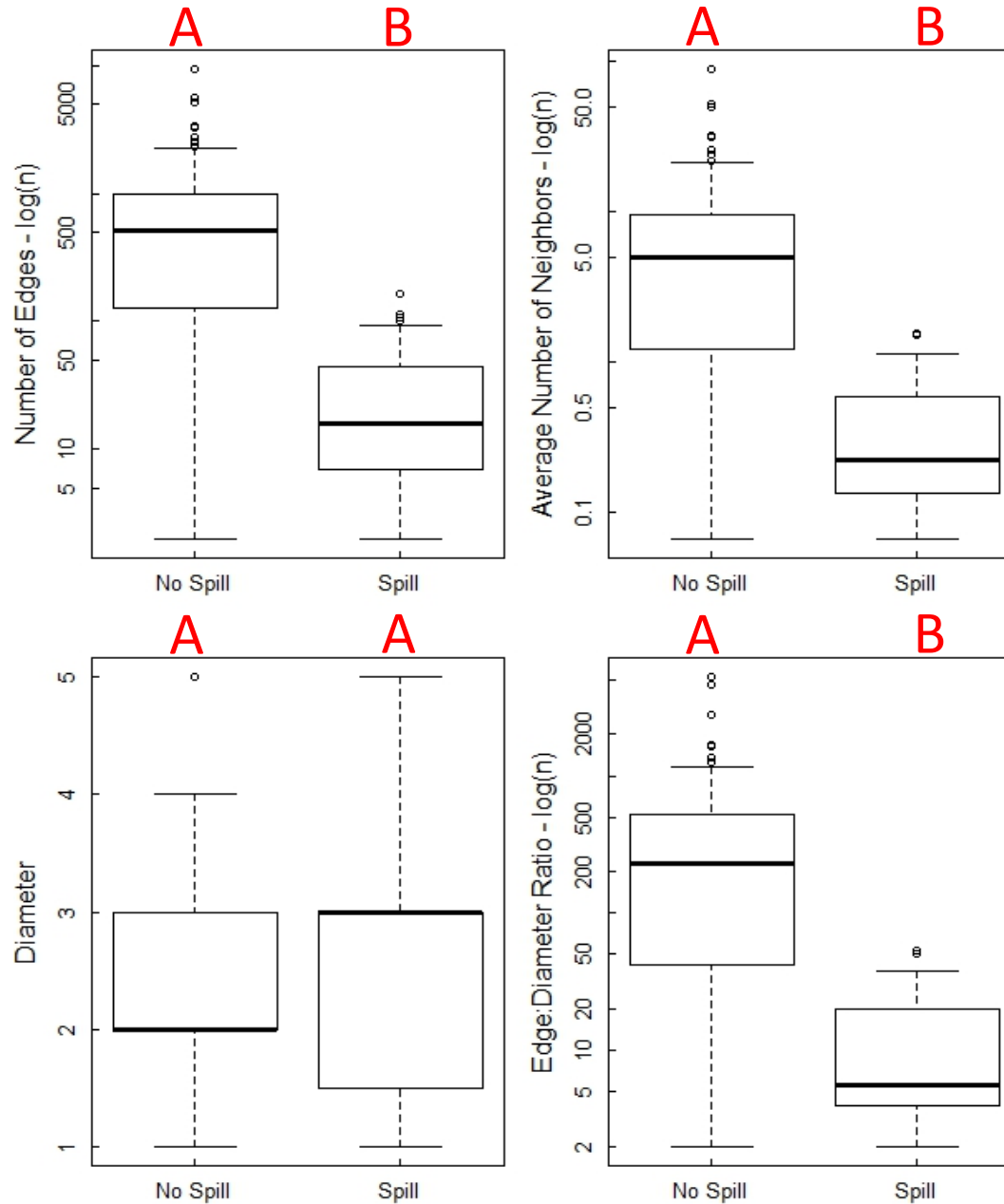
Objective 6 Results

Species	# Recaptured with descaling or injury	Total # Recaptured	Total % recaptured
Late winter- run Steelhead	2	90	2.2%
Spring Chinook	0	15	0%
Coho	0	3	0%

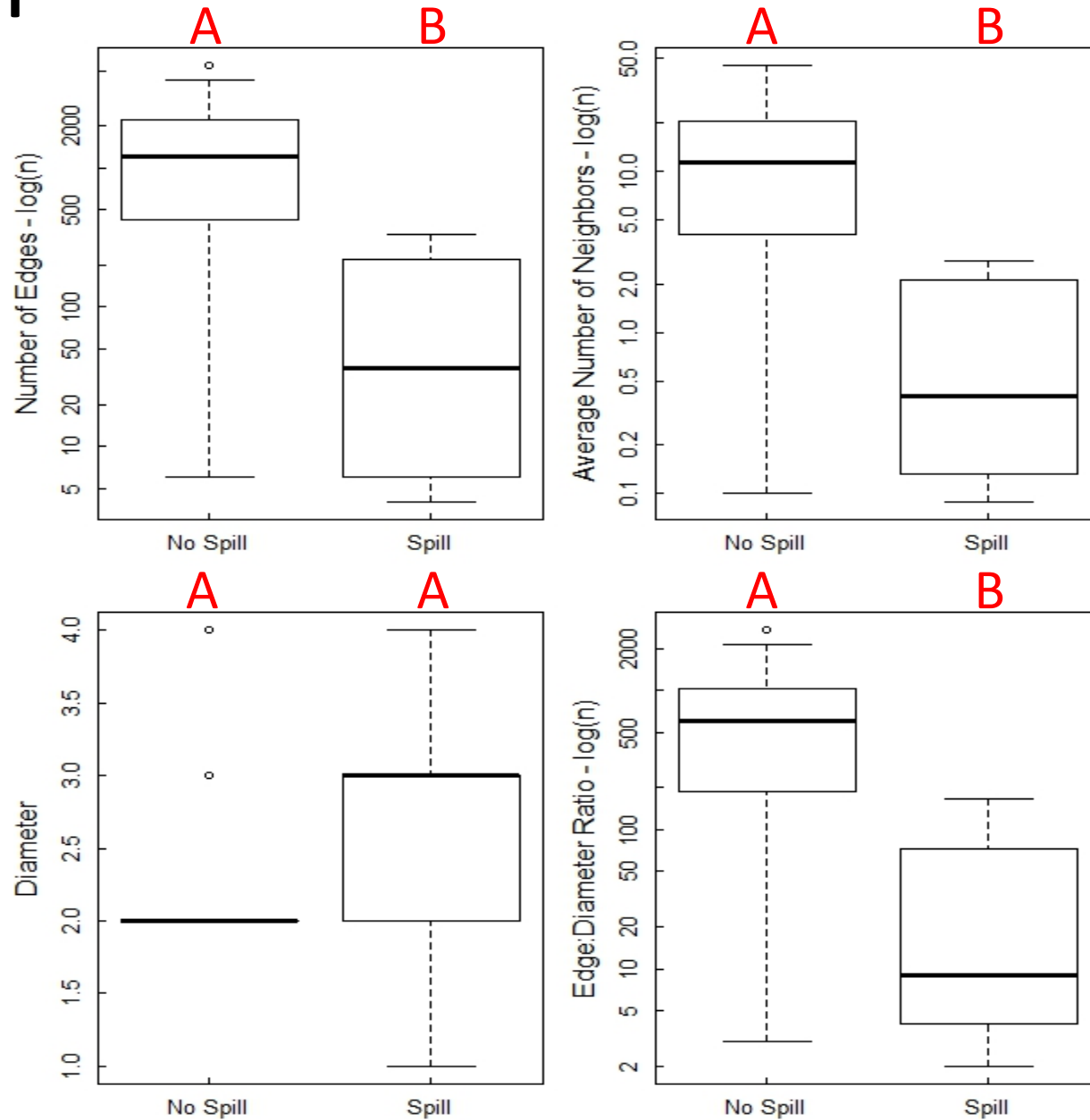
Operational Analyses

- Analyzed spill and generations conditions for impacts on fish movement and behavior within tailrace

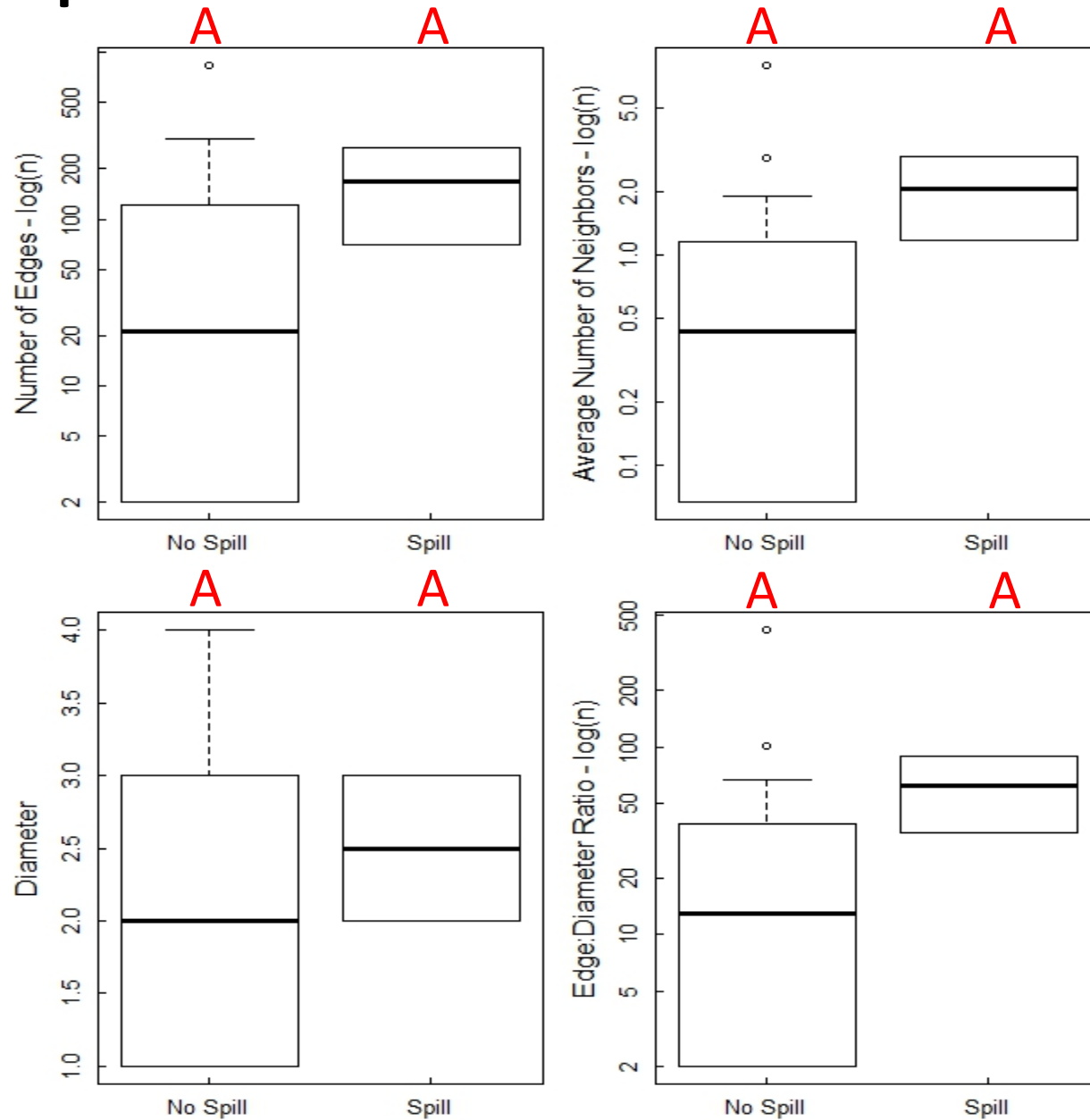
Spill Status: Results - Steelhead



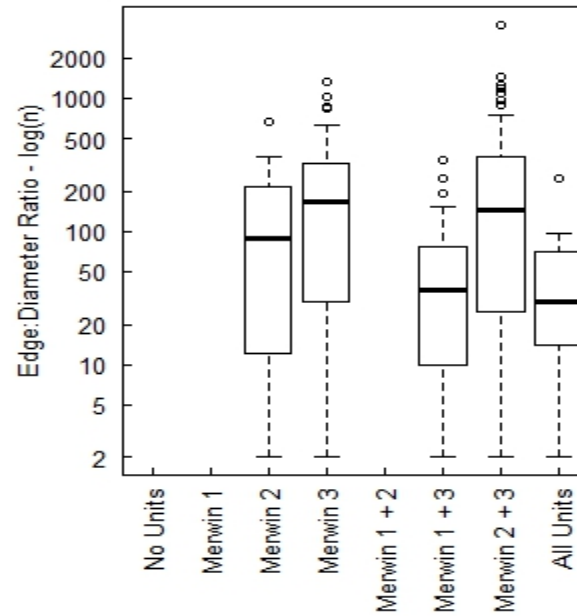
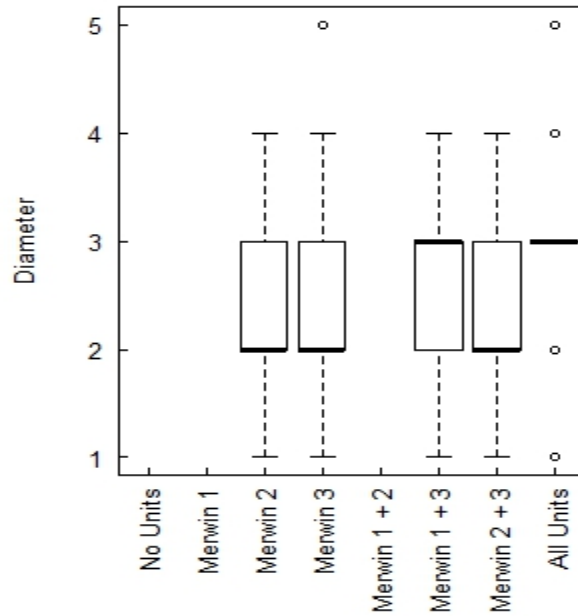
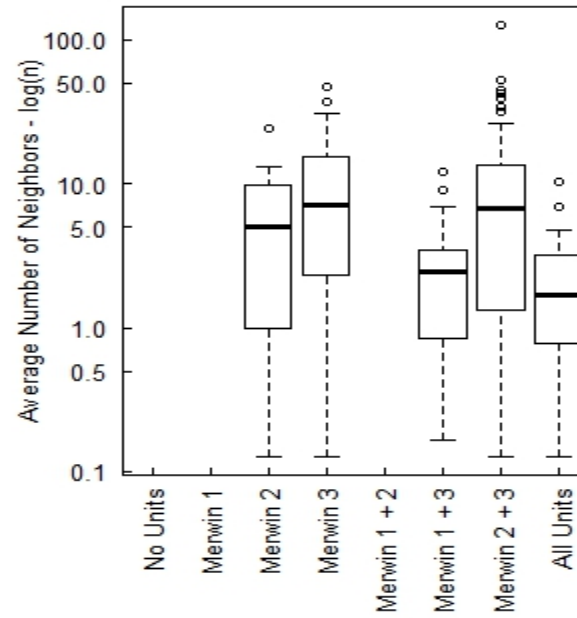
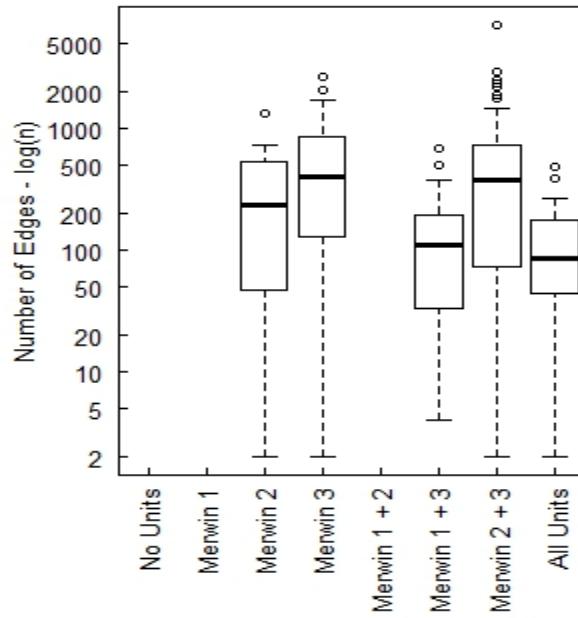
Spill Status: Results - Chinook



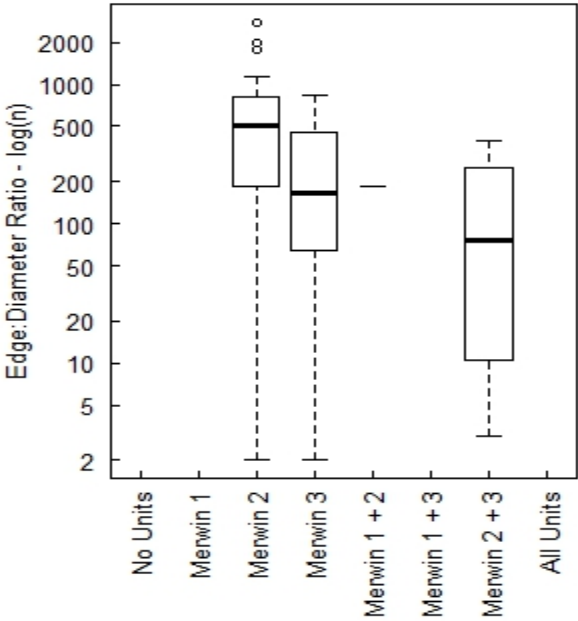
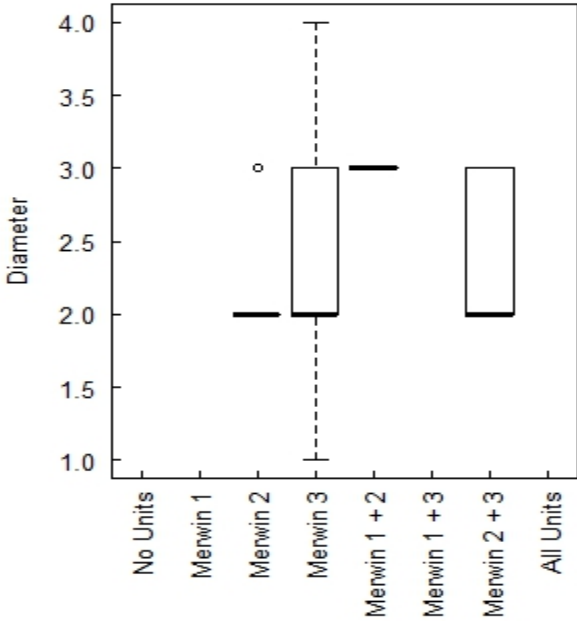
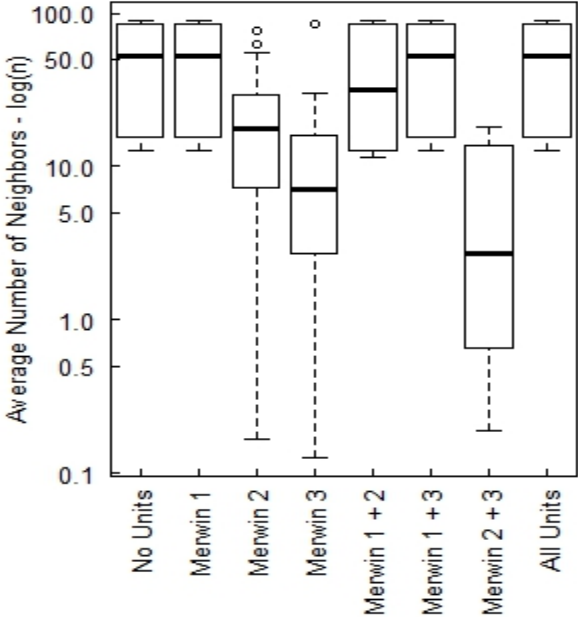
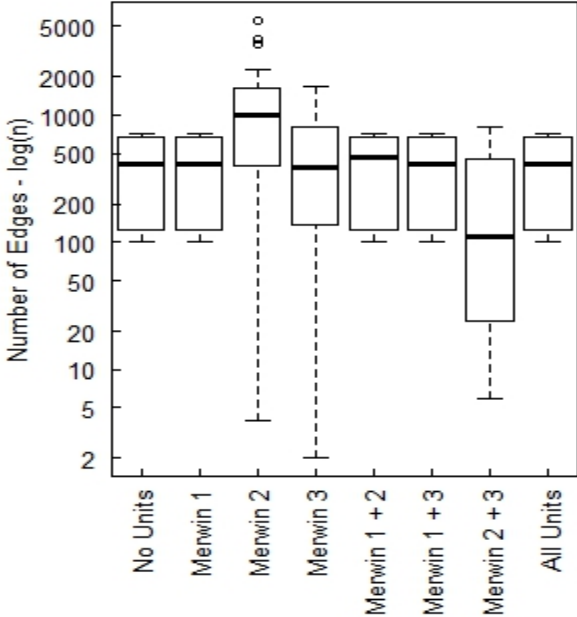
Spill Status: Results - Coho



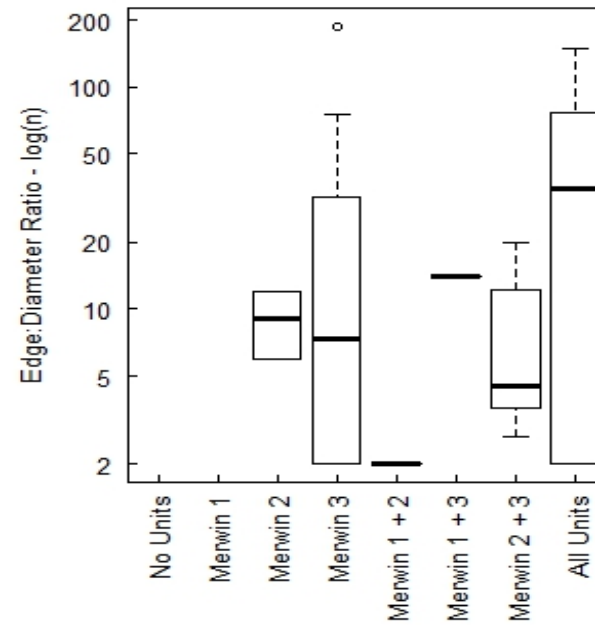
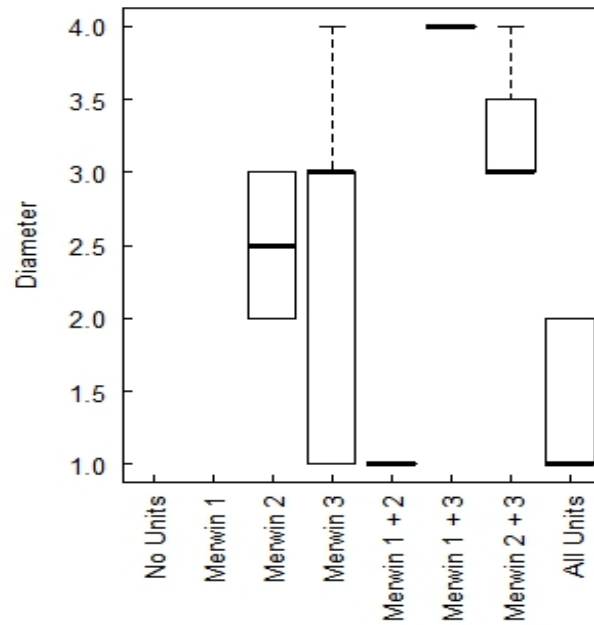
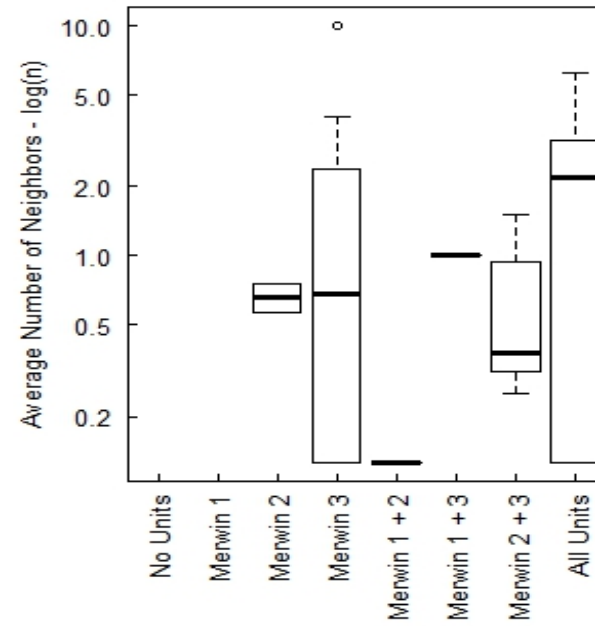
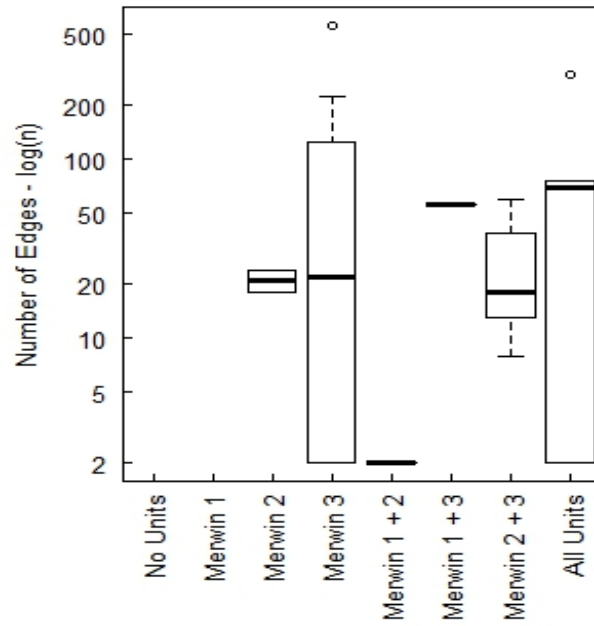
Generation Status: Results - Steelhead



Generation Status: Results - Chinook



Generation Status: Results - Coho



Trap Operation

- Anecdotal observations suggested that operation of the “hopper” may have been impacting fish behavior
- Examined fish movements during trap “cycling” to determine if trap operation may have been startling fish into leaving trap area

Trap Operation: Results

Species	# of instances exiting pool 4 into pool 2	# Occurring under conservative criteria*	# Occurring under liberal criteria**
Late winter-run Steelhead	608	103 (16.9%)	298 (49.0%)
Chinook	327	45 (13.8%)	116 (35.5%)
Coho	18	0 (0%)	10 (55.6%)

*Conservative criteria= Instances occurring during 15 minute period of trap cycling

**Liberal criteria= Instances occurring during or immediately adjacent to 15 min

Final Fates

Metric	Winter Steelhead	Spring Chinook	Coho Salmon
Total tagged (n)	148	40	35
Tag Loss/Recover	4 (3%)	2 (5%)	1 (3%)
Move Downstream	36 (24%)	9 (23%)	10 (29%)
Hatchery Recapture	0 (0%)	0 (0%)	7 (20%)
Captured at Trap	90 (61%)	15 (38%)	3 (9%)
At-large within Area	18 (12%)	14 (35%)	14 (40%)

Preliminary Conclusions

- Adult trap efficiencies are below target but substantially more fish are finding and entering the trap than are being retained and captured
 - Capture efficiencies have capacity to increase dramatically (24.7%, 14.3%, and 52.5% for Steelhead, chinook, and coho, respectively)

Preliminary Conclusions

- Fish are locating attraction flow and entering trap at higher rates than they are being captured.
- Only coho meeting tailrace residency standard but may partly be artifact of how metric is calculated
- Substantial evidence of exploratory behavior across all metrics; critical to trap capture
- Operational Conditions (Spill, Generation and trap cycling) all exert some influence on behavior

Caveats

- Operational effects are difficult to untangle as they were sampled opportunistically
- Low sample sizes for both spring Chinook and Coho
 - Salmon species may not exhibit same migratory drive as steelhead
- 2015 Study Year was extreme climactic outlier

Future Directions

- Continuation of methods and study design from this past year
- Consideration of additional emphasis on documenting and analyzing behavior within the trap
 - Addition of a site within the adult trap positioned at the entrance of the “hopper”
 - Exploring options for acoustic imaging
- Focus analysis on operational conditions or structural design more within PacifiCorp’s control

Questions?

