PIT-Tag ingestion: the curious fate of shed tags in salmonid hatcheries

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Fish and Aquatic CONSERVATION

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BACKGROUND
Use of PIT Tags in Salmonid Hatcheries

Hagerman National Fish Hatchery

PIT tags are used extensively in salmonid fishery management

PIT tag data can track salmonid survivorship and movement

Fish are tagged in the hatchery, and it is assumed fish shed tags at a low rate

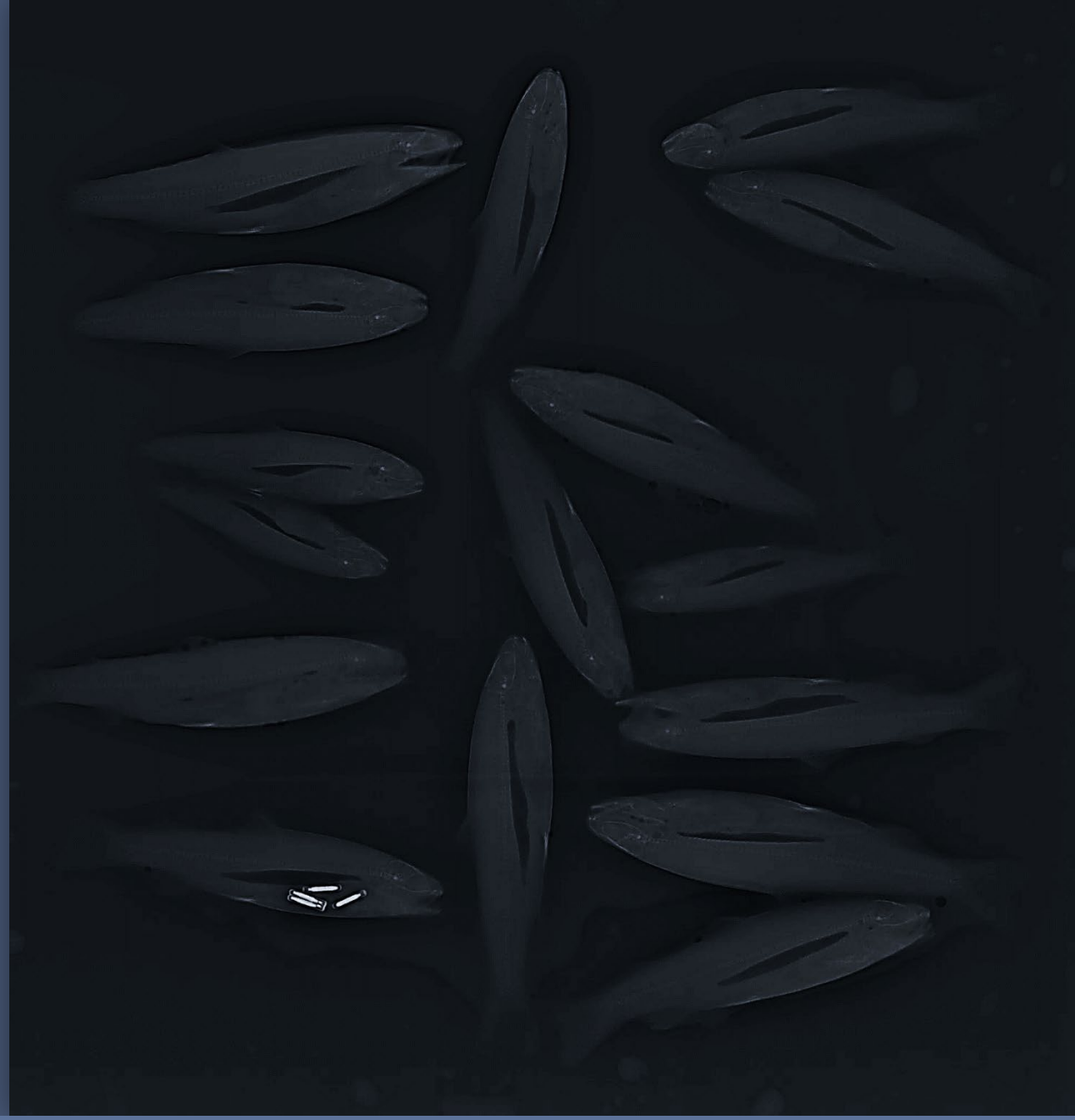
Hatchery tagged fish are often held for weeks or months prior to release

BACKGROUND
Fate of Shed Tags in a Hatchery

Juvenile Steelhead (*O. mykiss*) can ingest 20 - 52% available tags in a hatchery setting (Peterson and Engle 2021)

Tag ingestion can artificially inflate the assumed implantation tag retention rate

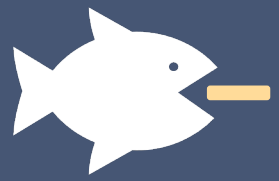
Tag collision can bias survival estimates low



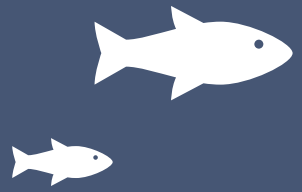
STUDY OBJECTIVES

Spring Chinook | Coho | Steelhead

Collision



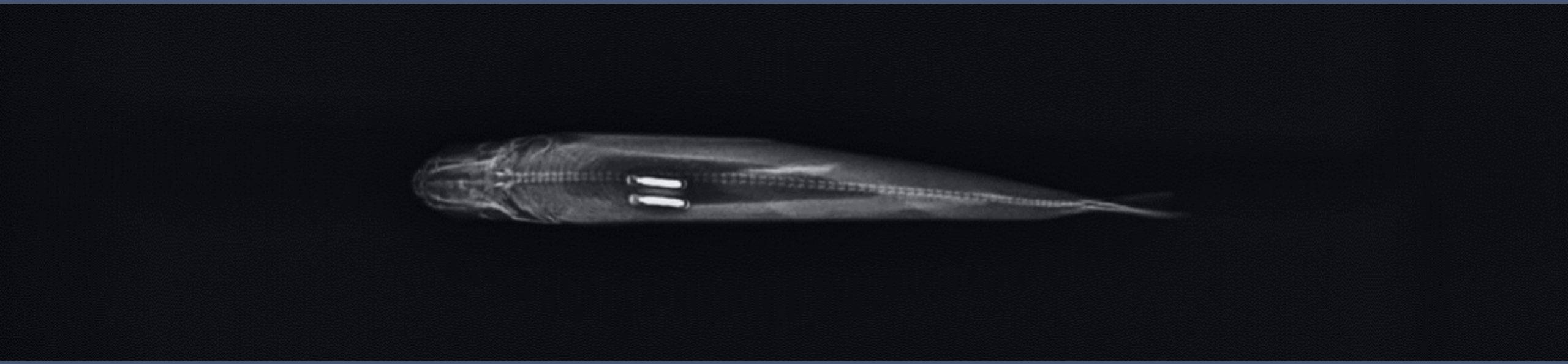
Ingestion Rate



Growth Effects

Retention Time

TAG COLLISION
Methods



Test for tag interference, or collision, between two tags in close proximity within the body

Phase 1: Detection probability of a single tag (gastric implant)

Phase 2: Detection probability of double tags (one gastric implant + one peritoneal cavity implant)

TAG COLLISION
Methods

12 Steelhead

3 Antennas w/
5 passes

15 Replicates

TAG COLLISION
Results

Phase 1: Single Tag

Detection probability$_{Ingested}$ **0.98**

Phase 2: Double Tags

Detection probability$_{Ingested}$ **0.15**

Detection probability$_{Implant}$ **0.06**

Detection probability$_{Either}$ **0.21**

Detection probability$_{Both}$ **0.02**

TAG INGESTION
Methods

Species Evaluated

Spring Chinook, Coho, Steelhead

Study

Trials: **2**

Trial length: **7 days**

Per Trial

Round tanks: **5**

Rectangular tanks: **5**

Fish per tank: **100**

Loose PIT tags per tank: **4**

Round

Rectangular

TAG INGESTION
Results

SPRING CHINOOK

- Ingested **0 tags**

COHO

- **1.26%** of Coho ingested tags
- **51%** loose tags ingested
- **≥ 50% tags ingested by the smallest Coho** (86-119 mm; 7.7-19.6 g)
- Ingested **3.8 times more tags in circular tanks** vs rectangular tanks
- **Tag cycling**: expelled tags were re-ingested

STEELHEAD

- **1.56%** of Steelhead ingested tags
- **69%** loose tags ingested
- No correlation between size and tag ingestion
- Ingested **2.1 times more tags in circular tanks** vs rectangular tanks
- **Tag cycling**: expelled tags were re-ingested

GROWTH EFFECTS
Methods

Absolute Length Growth Rate

$$G_L = \left(\frac{L_2 - L_1}{t_2 - t_1}\right)$$

Mass-Standardized Growth Rate

$$G_S = 100 * \left(\frac{W_2^{\,b} - W_1^{\,b}}{b * [t_2 - t_1]}\right)$$

Biweekly Biometric Data Collection

Generalized Linear Model Covariates

Treatment group, time, trial, total number of ingested tags

GROWTH EFFECTS
Results

Coho Significant Covariates

Length: Treatment

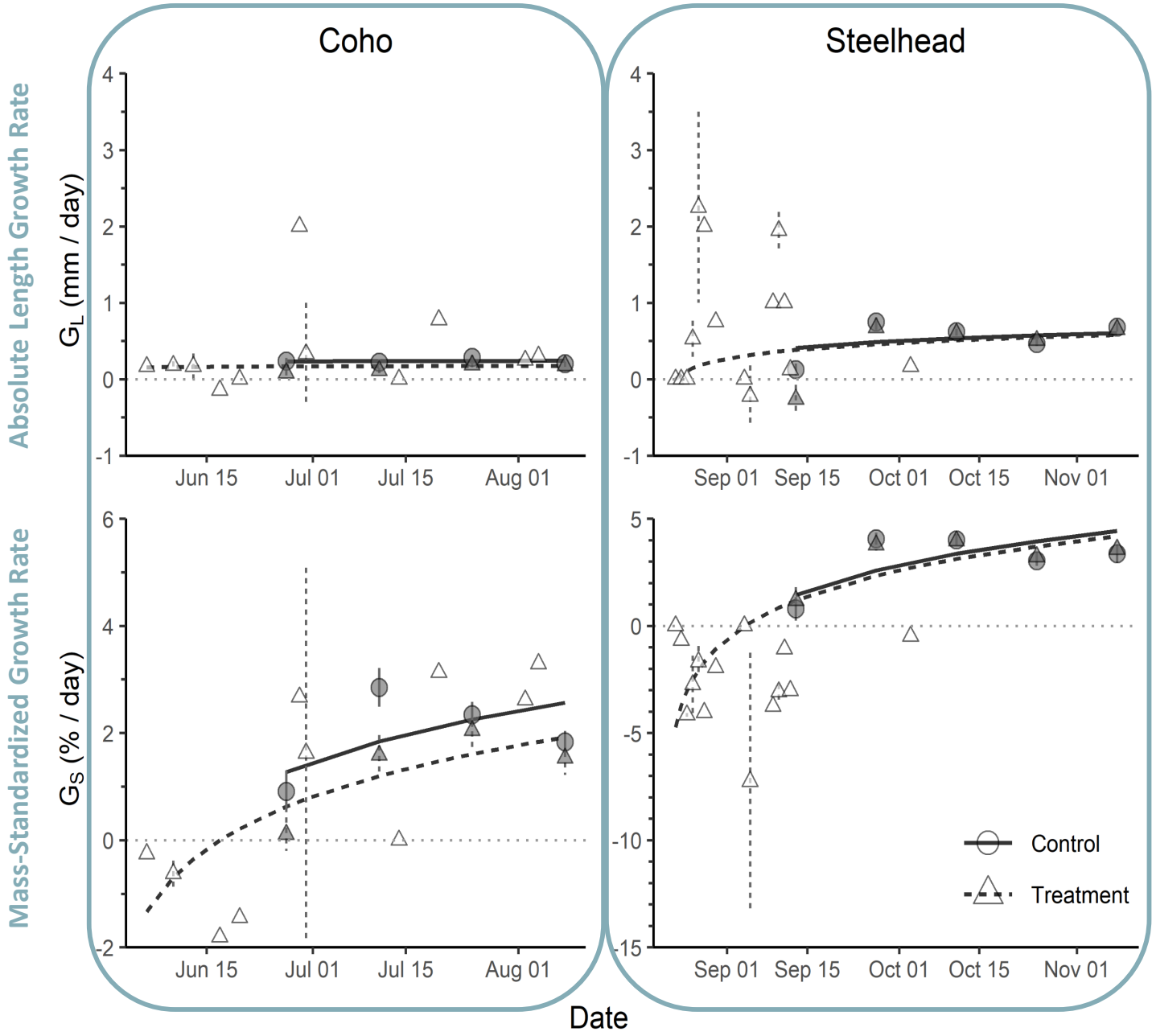
Weight: Treatment + Time

Steelhead Significant Covariates

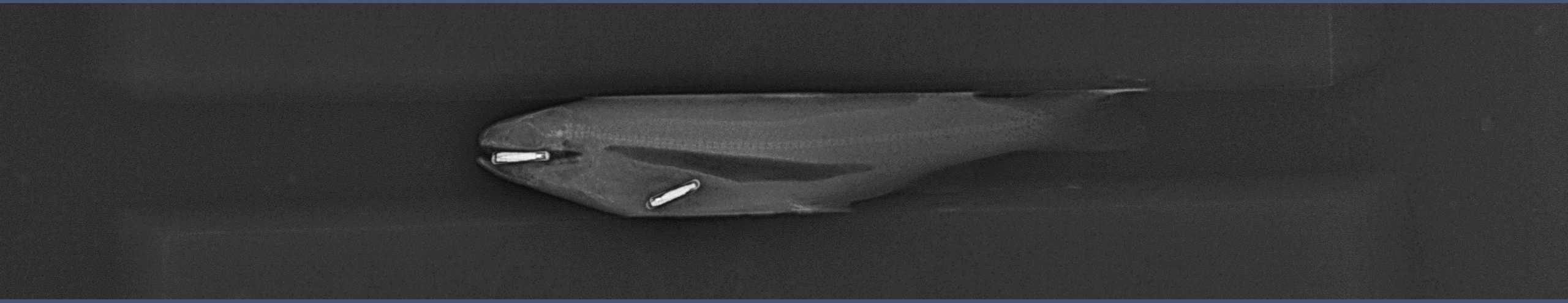
Length: Time

Weight: Time

By end of study, **no significant difference in growth rates** between controls and treatments for both Coho and Steelhead



TAG RETENTION
Methods



Treatment fish held in false-bottom rectangular tanks to prevent tag re-ingestion

Monitored for time to tag expulsion, and tag location verified with radiographic imaging

Retention time evaluated by **Kaplan-Meier** time to event and **Cox-proportional hazards** analyses

Covariates: species, length, weight, maximum number of tags ingested

TAG RETENTION
Results

Number of Ingested Tags

Spring Chinook*: **20**

Coho: **44**

Steelhead: **58**

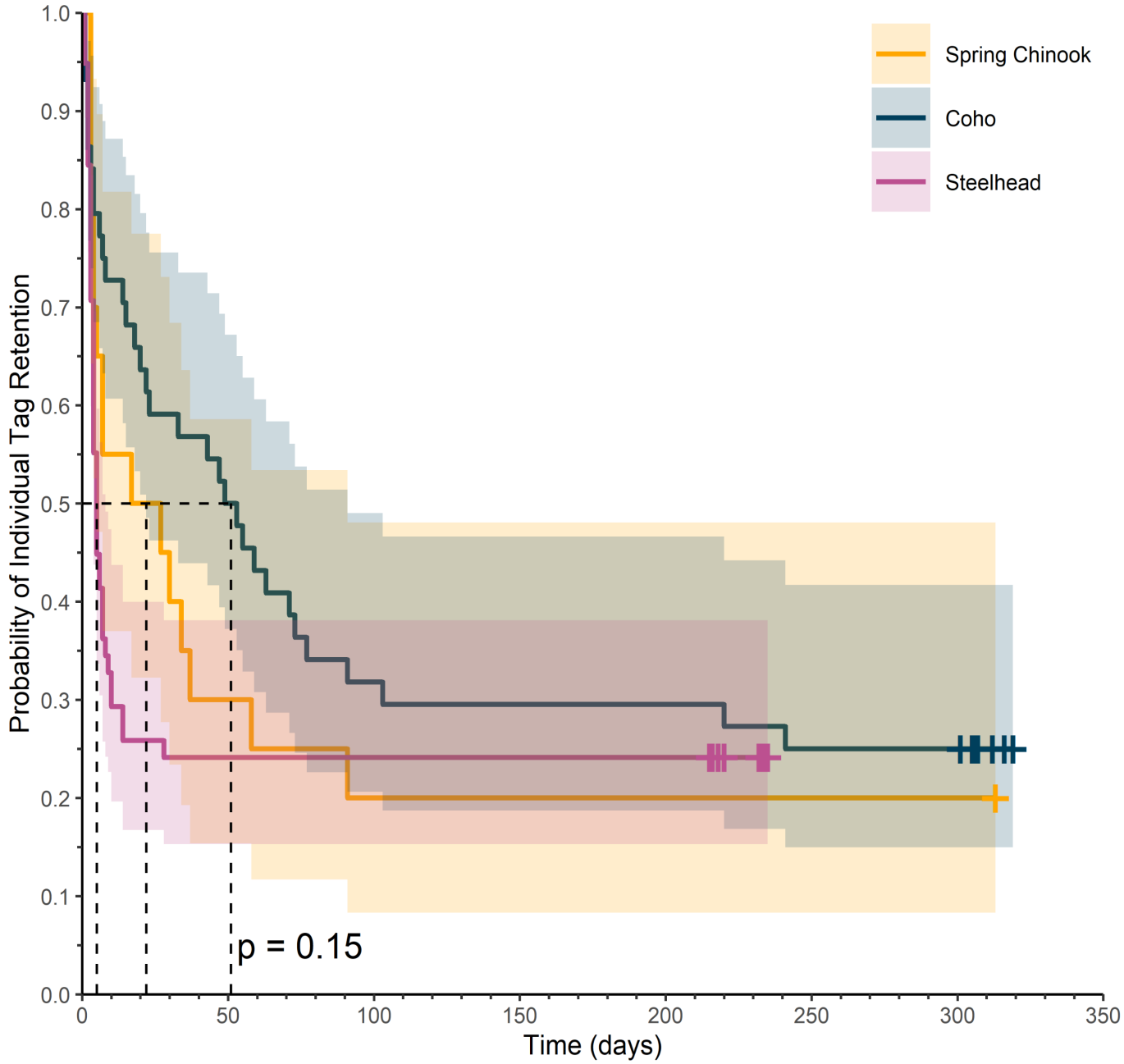
Median Retention Time

Spring Chinook*: **22 days**

Coho: **51 days**

Steelhead: **5 days**

Spring Chinook*: tags manually implanted into stomach



TAG RETENTION
Results

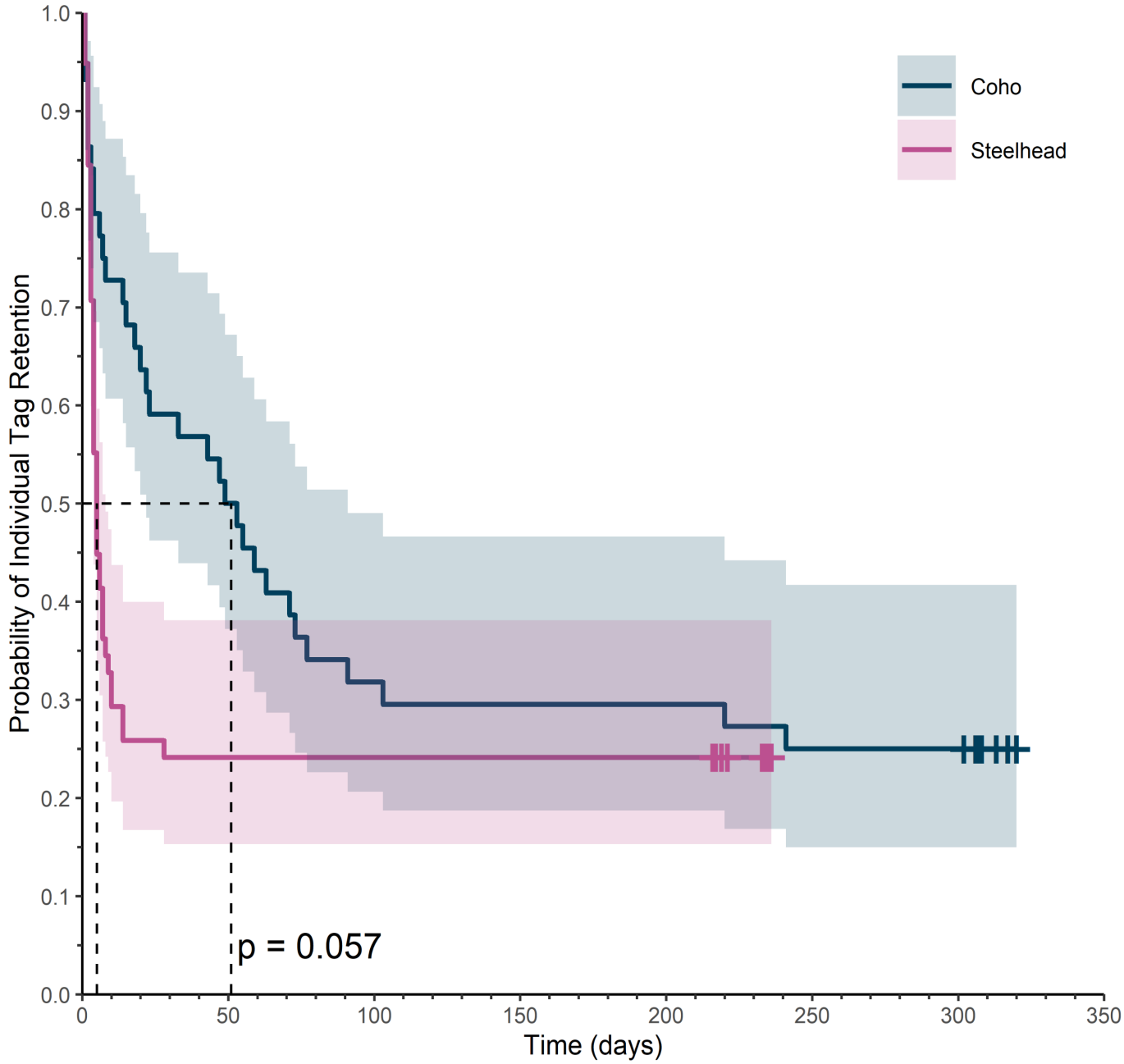
Percent of Tags Retained at Day 200

Coho: **30%**

Steelhead: **24%**

Significant Covariates for Tag Retention

1. Species (Coho vs Steelhead)
2. Maximum Number of Tags Ingested (Steelhead only)



SUMMARY OF RESULTS

- Tag collision reduced tag detection by 85-94%
- Steelhead ingested slightly more tags than Coho
- Spring Chinook did not ingest tags
- Greater than 50% of loose (i.e., shed) tags ingested
- Ingested tags had minimal effect on growth
- Steelhead expelled ingested tags faster than Spring Chinook or Coho

Hagerman National Fish Hatchery

IMPLICATIONS
Telemetry Models

10 INGESTED TAGS ∴ 10 TAG COLLISIONS ∴ 10 ASSUMED MORTALITIES

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CONSERVATION

IMPLICATIONS
Hatchery

Hatchery Scenario

Tanks: **Circular** + **Rectangular**
Species: **Coho** + **Steelhead**
Number of Fish per Tank: **25,000**
Tag Rate: **5%** + **10%**
Shed Rate: **5%** + **10%**

Results

Low Tag Rate Low Shed Rate (n = 63): all shed tags could be **ingested by day 2**

High Tag Rate High Shed Rate (n = 250): all shed tags could be ingested in **2 days (circular)**, or within **8 days (Coho; rectangular)**