Retention of PIT tags in hatchery brook trout: effect of tag size, implantation site, and double tagging

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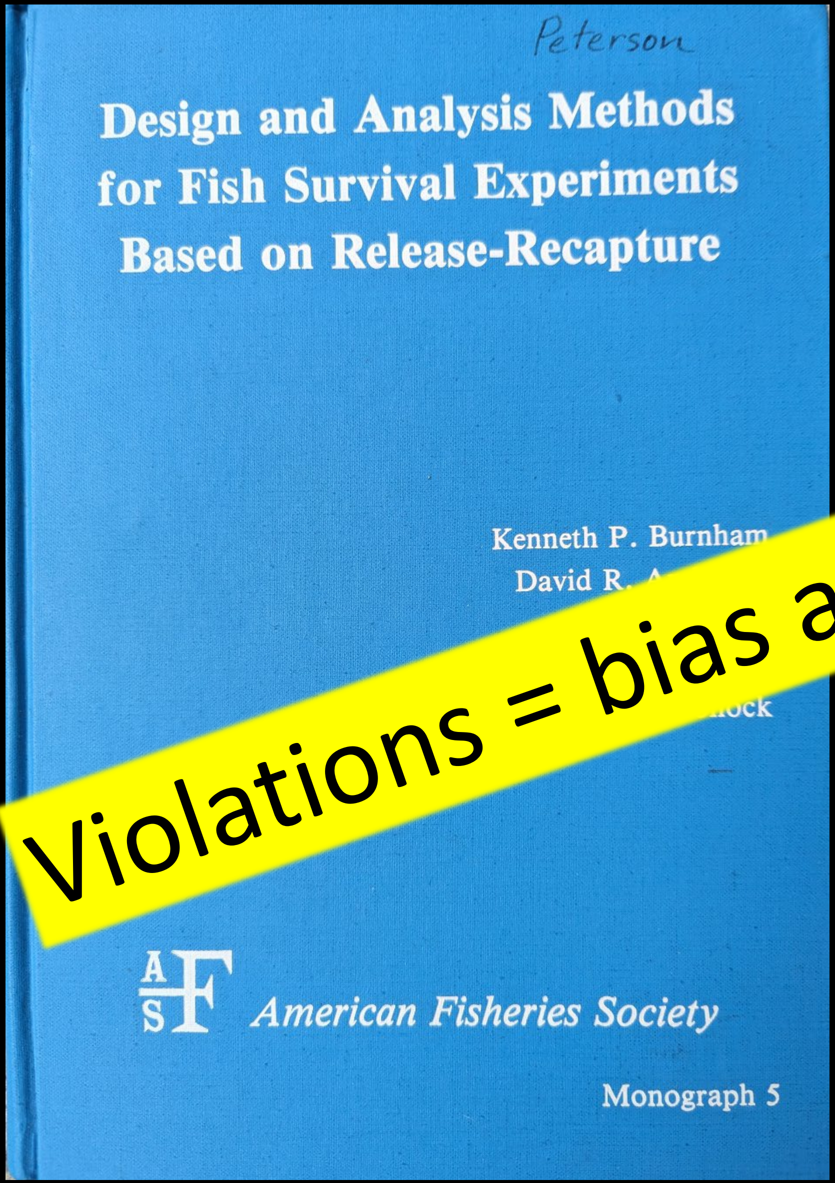
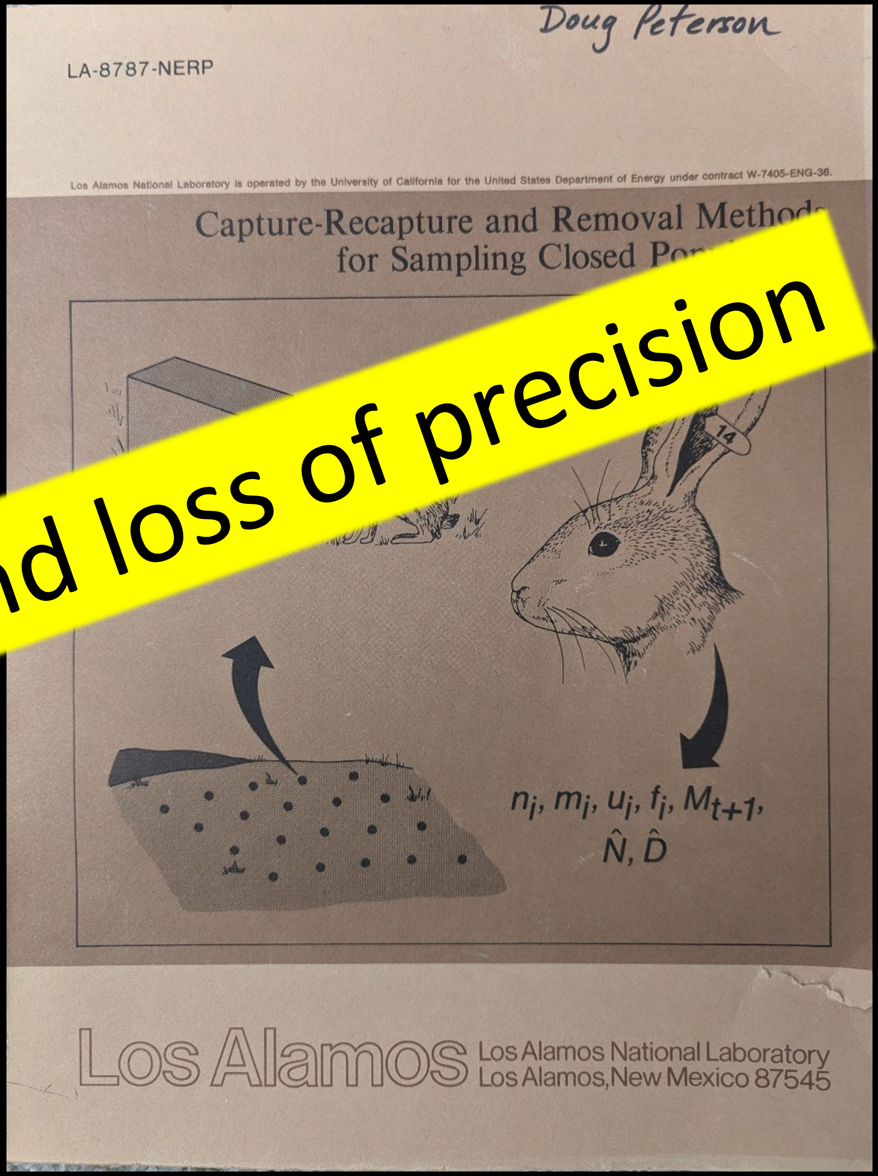
Capture-mark-recapture (CMR) assumptions





Violations = bias and loss of precision

<u>Tagging assumptions</u>:

The number of [tagged] animals released is known.

Animals don’t lose tags.

Tags are recorded correctly during capture occasions.

Dealing with tag loss assumptions & bias

Assume negligible or groups equal

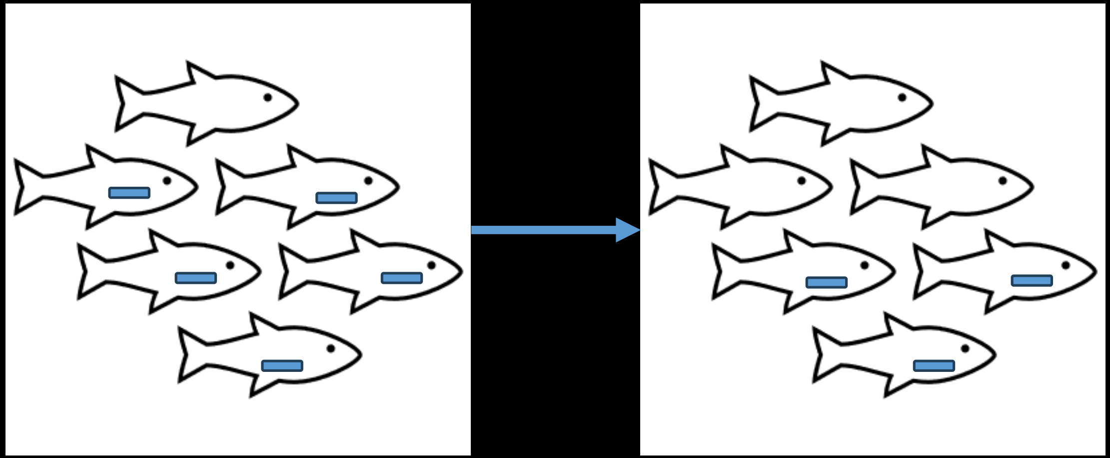
Adjust with analyses: e.g., Berger & Gresswell (2009); Bateman et al. (2009)

Explicitly model: e.g., Jolly-Seber tag loss, Cowan & Swartz (2006); hidden Markov CJS model, Laake et al. (2014)

STILL NEED TO KNOW OR ESTIMATE TAG RETENTION

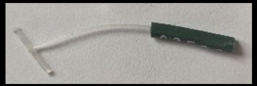
Estimating PIT tag retention

Captive or temporarily held populations



Free-roaming

PIT + [secondary mark]



Secondary mark/tag typically requires physical recapture & inspection

Why not use 2 PIT tags?

Tag collisions

Tag technology (FDX, HDX)

Tag proximity & antenna field characteristics

dual mode readers

FDX + HDX + separation = detection

Will it work in practice? Can fish handle double-tag burden?

Study goals & objectives

Goal: Determine efficacy of double PIT-tagging

Objectives:

- Evaluate the effect of tag size, implantation location, and **double tagging** on tag retention, survival, and growth
- Provide practical guidance for biologists using PIT tags to monitor wild fish populations

METHODS

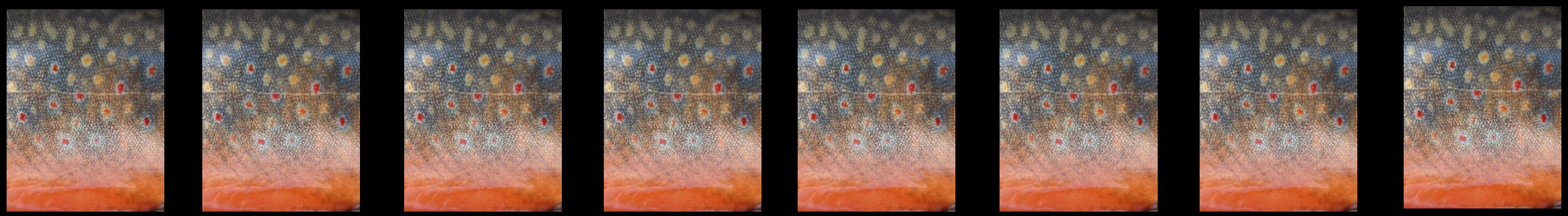
Lab study at Abernathy Fish Technology Center

Fish held in 1.2 m diameter, 905 L circular tanks

<u>Study specimens</u>:

Male hatchery brook trout (83-195 mm FL at tagging)

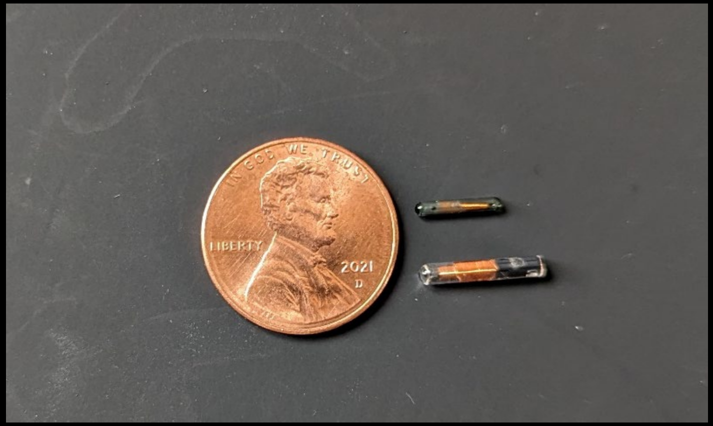
Model organism for iteroparous salmonid



METHODS: Tagging Design

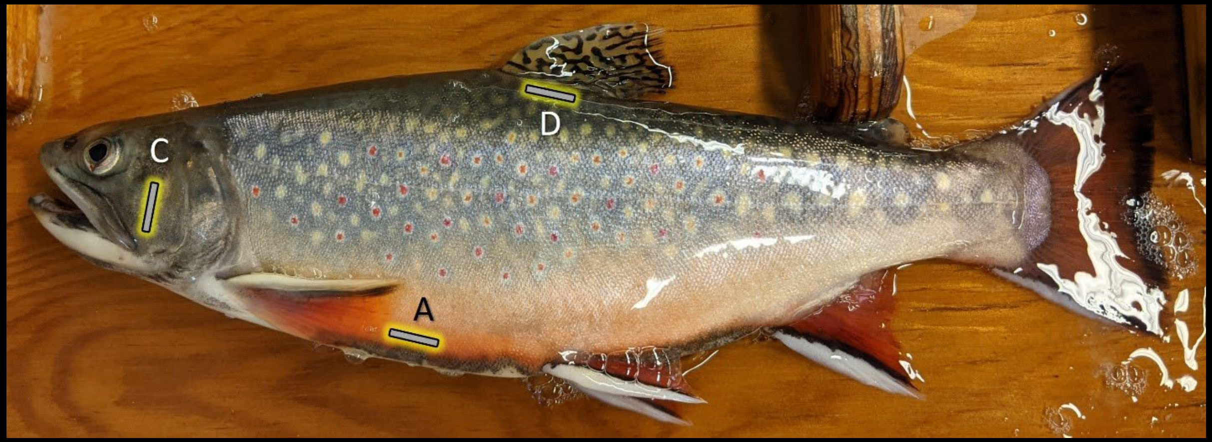
Two tag sizes:

- 8.4 mm FDX (Mini HPT8)
- 12 mm HDX (HDX12)



Three implantation sites:

- Peritoneal cavity (abdomen) – surgical implantation
- Dorsal sinus (dorsal) – syringe
- Operculum (cheek) – syringe



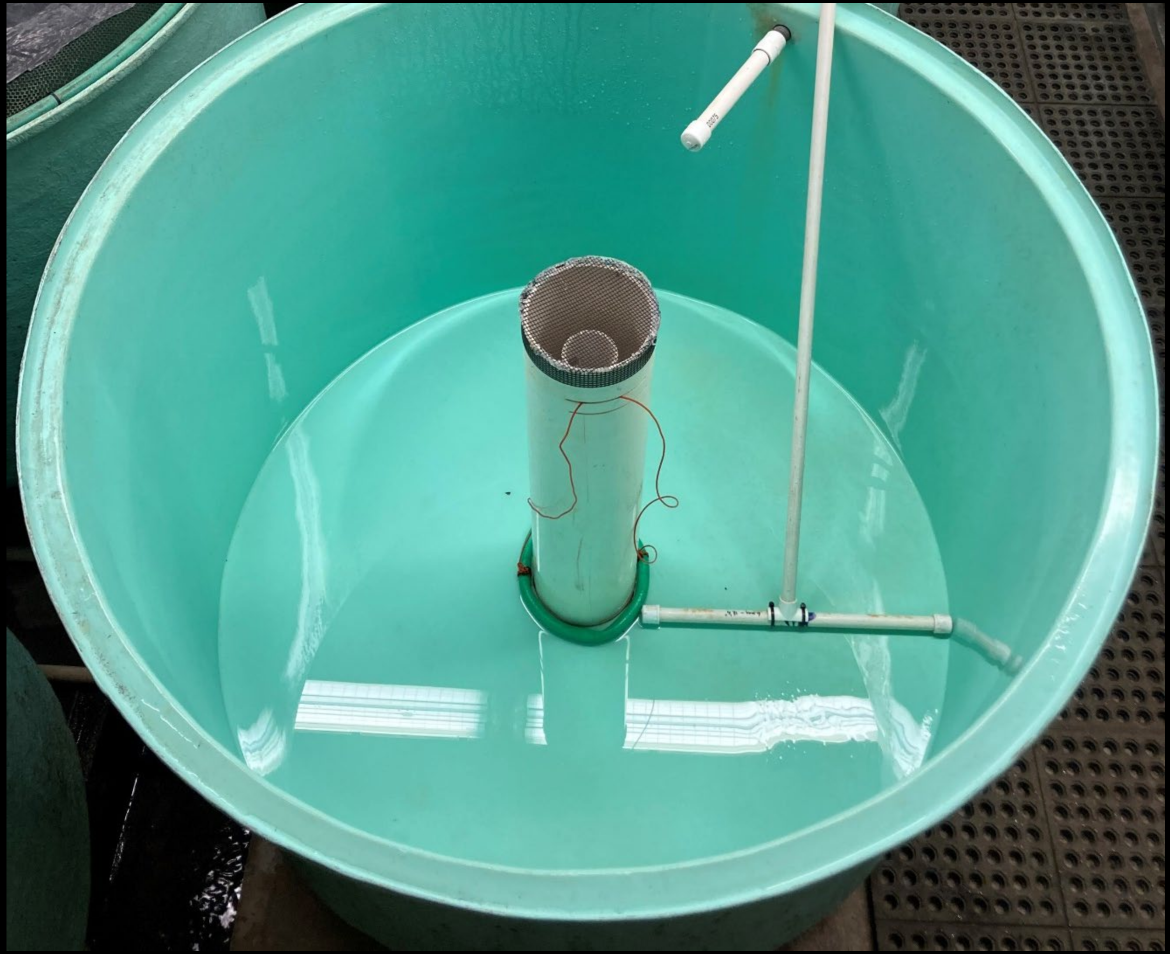
METHODS: Tagging Study Design

Tag placement		Treatment group code
8-mm	12-mm	
Abdomen	-	8A
-	Abdomen	12A
Cheek	-	8C
Dorsal	-	8D
-	Dorsal	12D
Abdomen	Dorsal	8A + 12D
Cheek	Abdomen	8C + 12A
Dorsal	Abdomen	8D + 12A

Select combinations of tag size × placement
80 fish per treatment group
80 controls (10 per treatment group)

METHODS: Data collection

- Daily checks for shed tags
- Seven resampling occasions over ~190 d: tag status & size
- Remove fish that lost all tags (or ingested tags)



METHODS: Radiography (and some Dissections)

Confirm tag placement and ingestion

METHODS: Data analyses

Survival: Kaplan–Meyer (K–M) time-to-event

Tag retention: K–M and Cox regression

Independence of tag loss

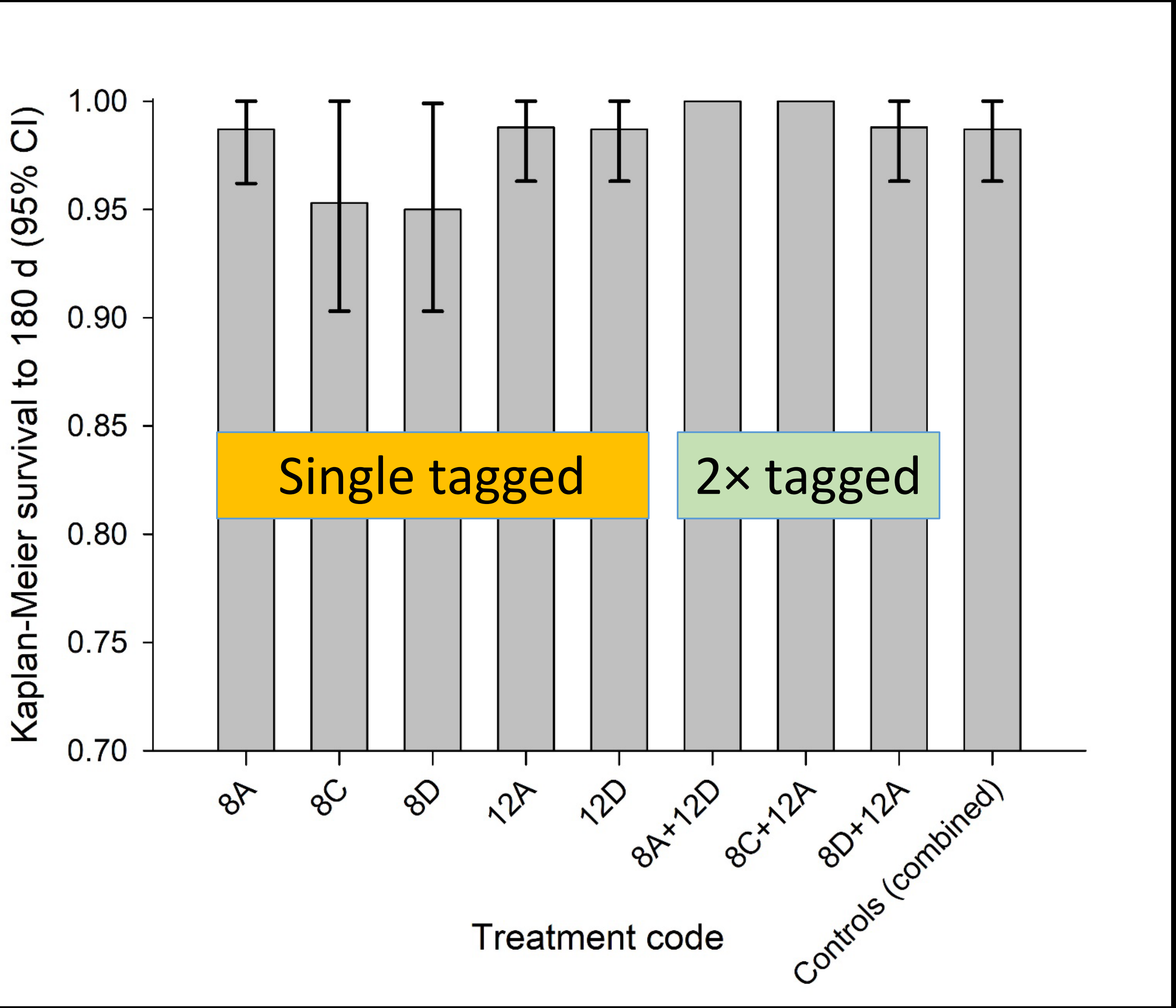
Effect of tagging, tag size, tag position, and fish size

Growth:

Group (Specific Growth Rate, SGR) – GLM & contrasts

Individual (Mass-specific relative growth, G_S; Absolute growth in length, G_L) – mixed models for repeated measures

RESULTS: Survival



- Only 12 of 720 died
- Only 3 died within 30 d of tagging
- Survival among treatment groups was 95–100%

→ Inference: no or minimal effect of tagging or double tagging

RESULTS: Tag retention

<u>32 of 880 tags were shed (96.4% retention)</u>

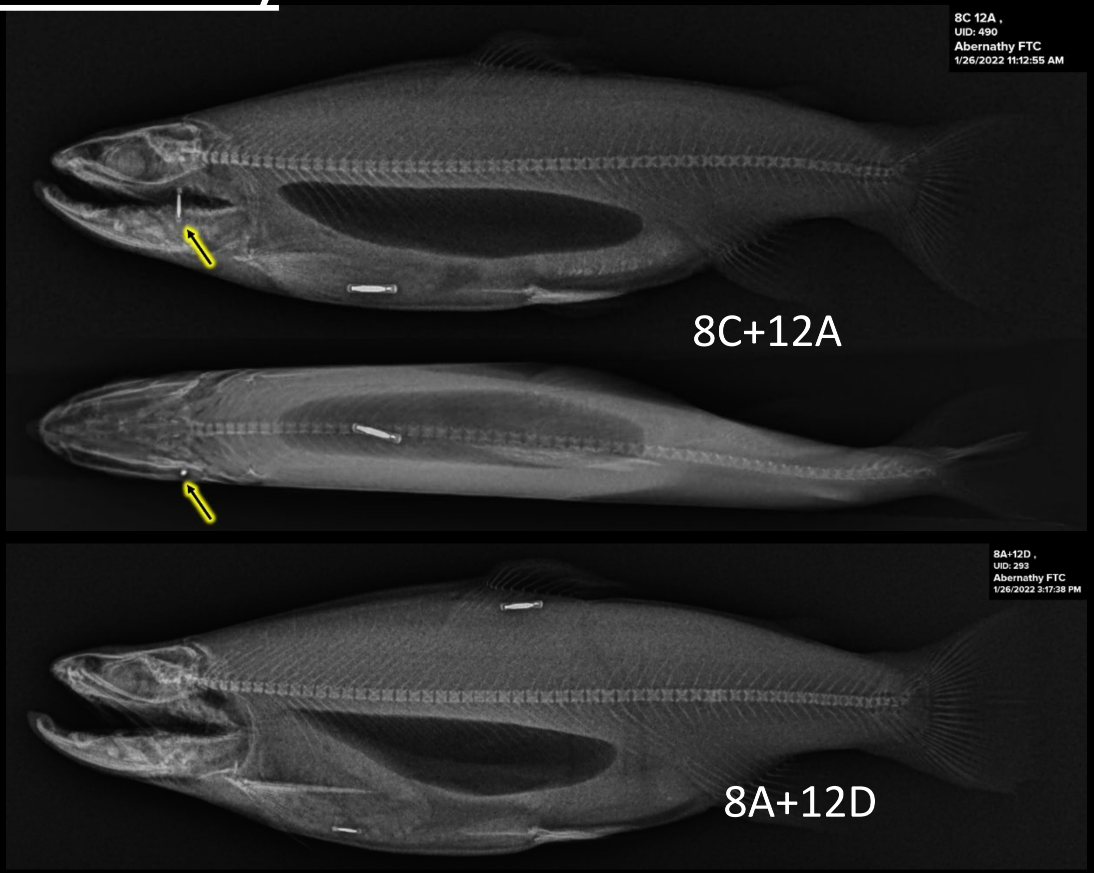
27 shed from cheek position

- n = 13 from 8C
- n = 14 from 8C+12A

5 shed from abdomen position

- n = 3 from 8A
- n = 1 from 8A+12D
- n = 1 from 8D+12A

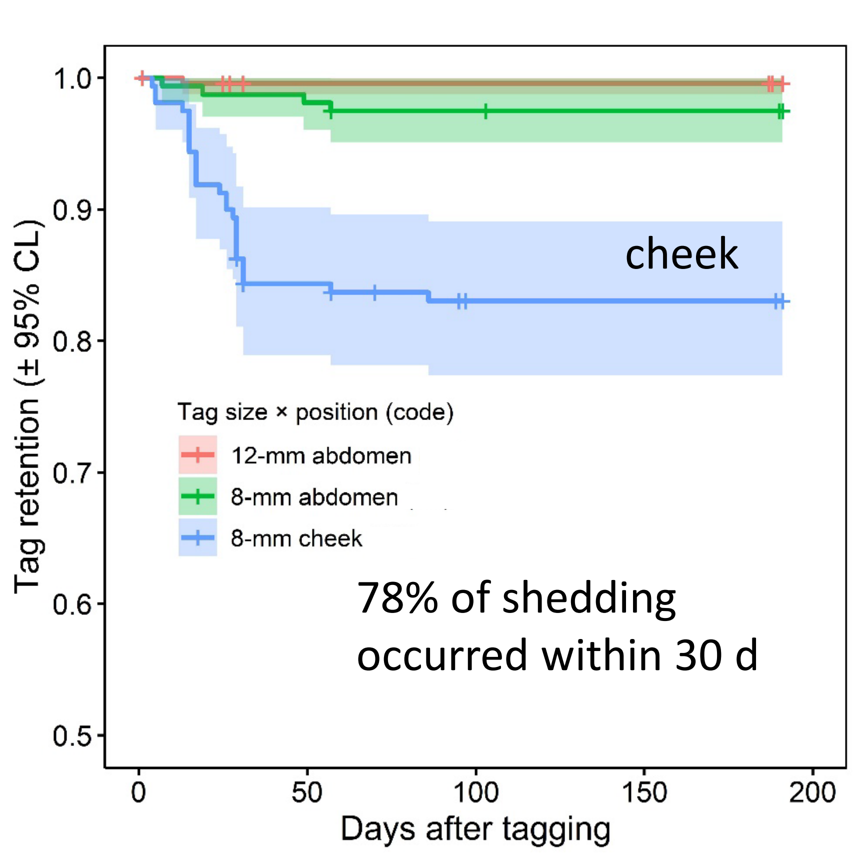
0 shed from dorsal position

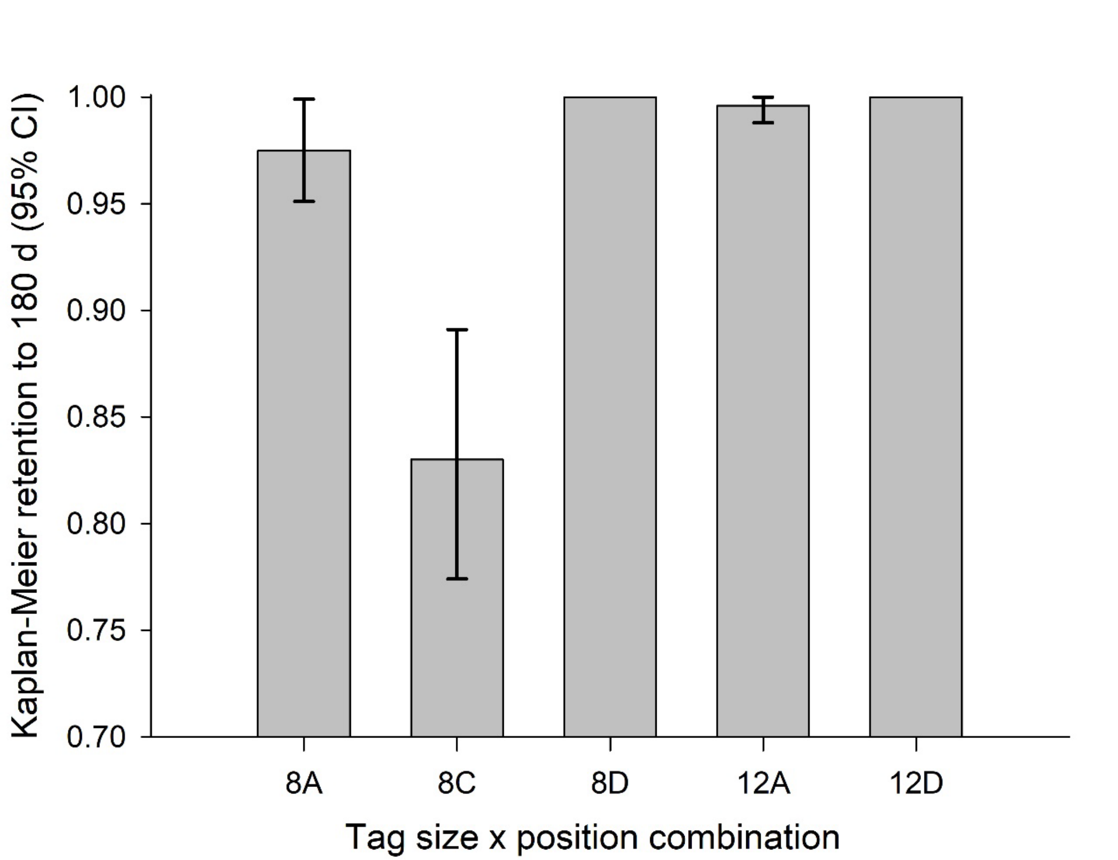


Double-tagged fish retained at least one tag

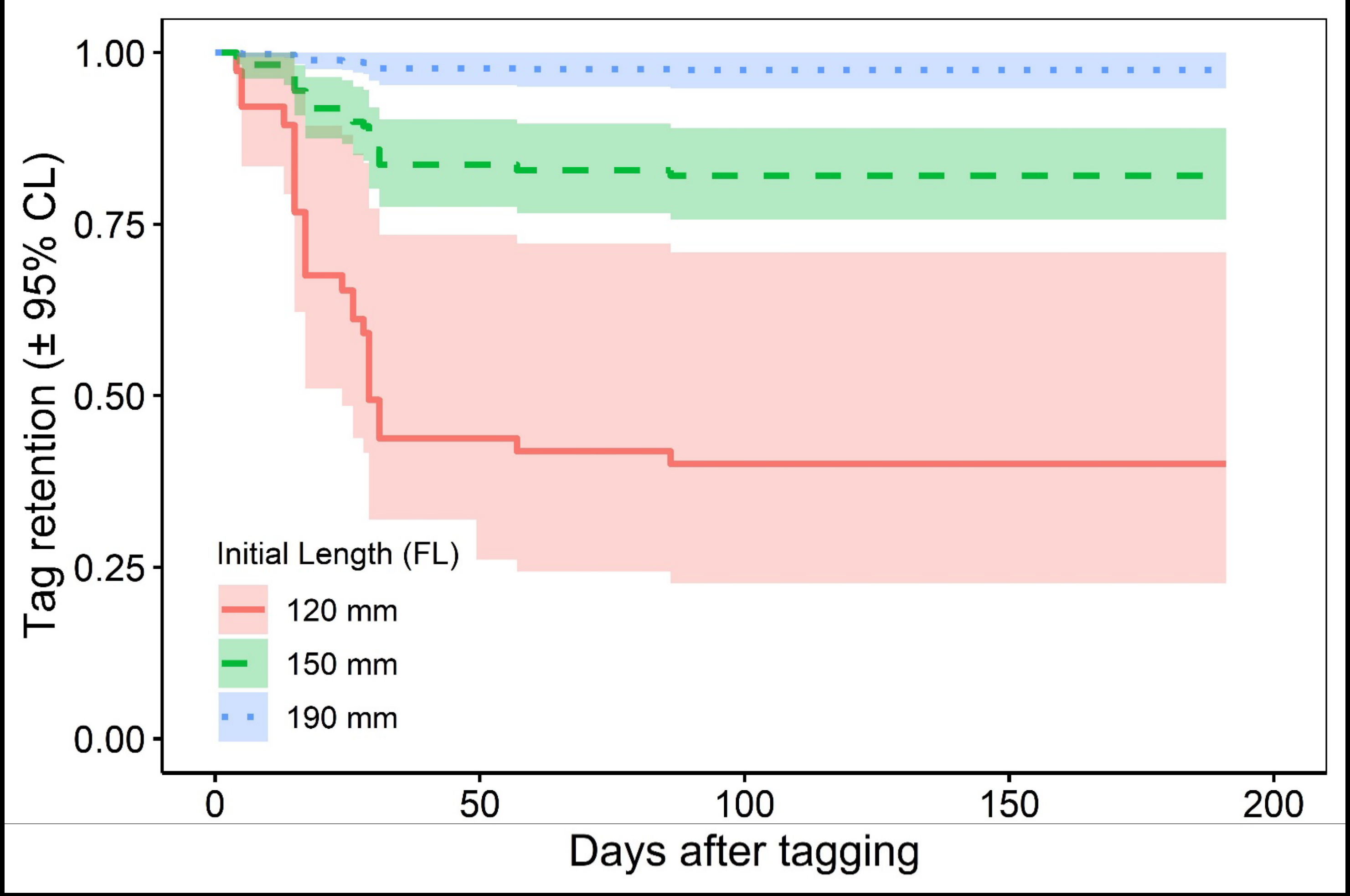
RESULTS: Tag retention

Shedding rates of 8-mm abdomen, 8-mm cheek, and 12-mm abdomen tags did not depend on whether fish were of single- or double-tagged (K-M, log-ranks $p \geq 0.32$) → data were pooled by tag size & position

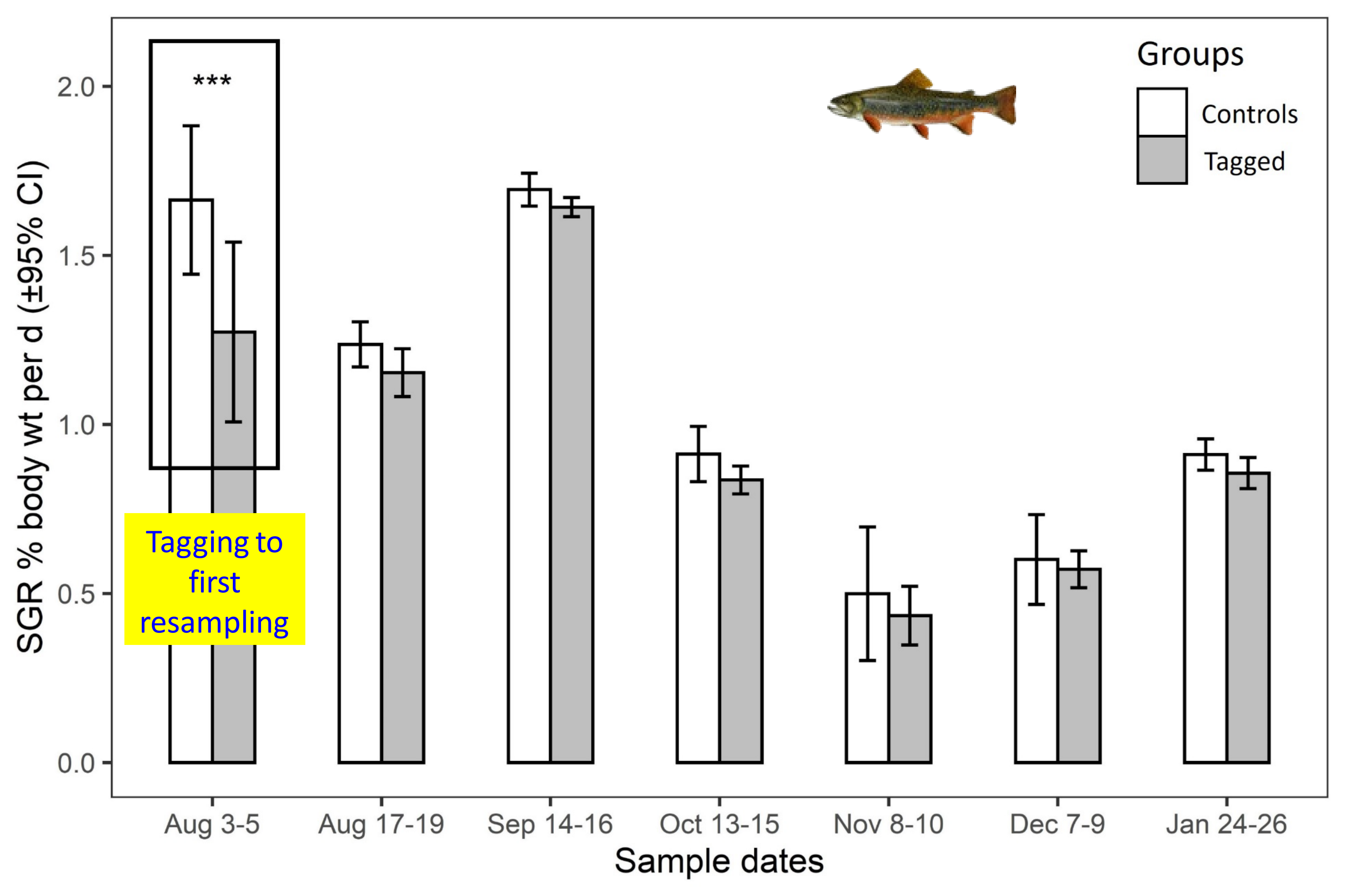




RESULTS: 8-mm cheek tag retention by fish size



RESULTS: Specific Growth Rate (SGR) for groups



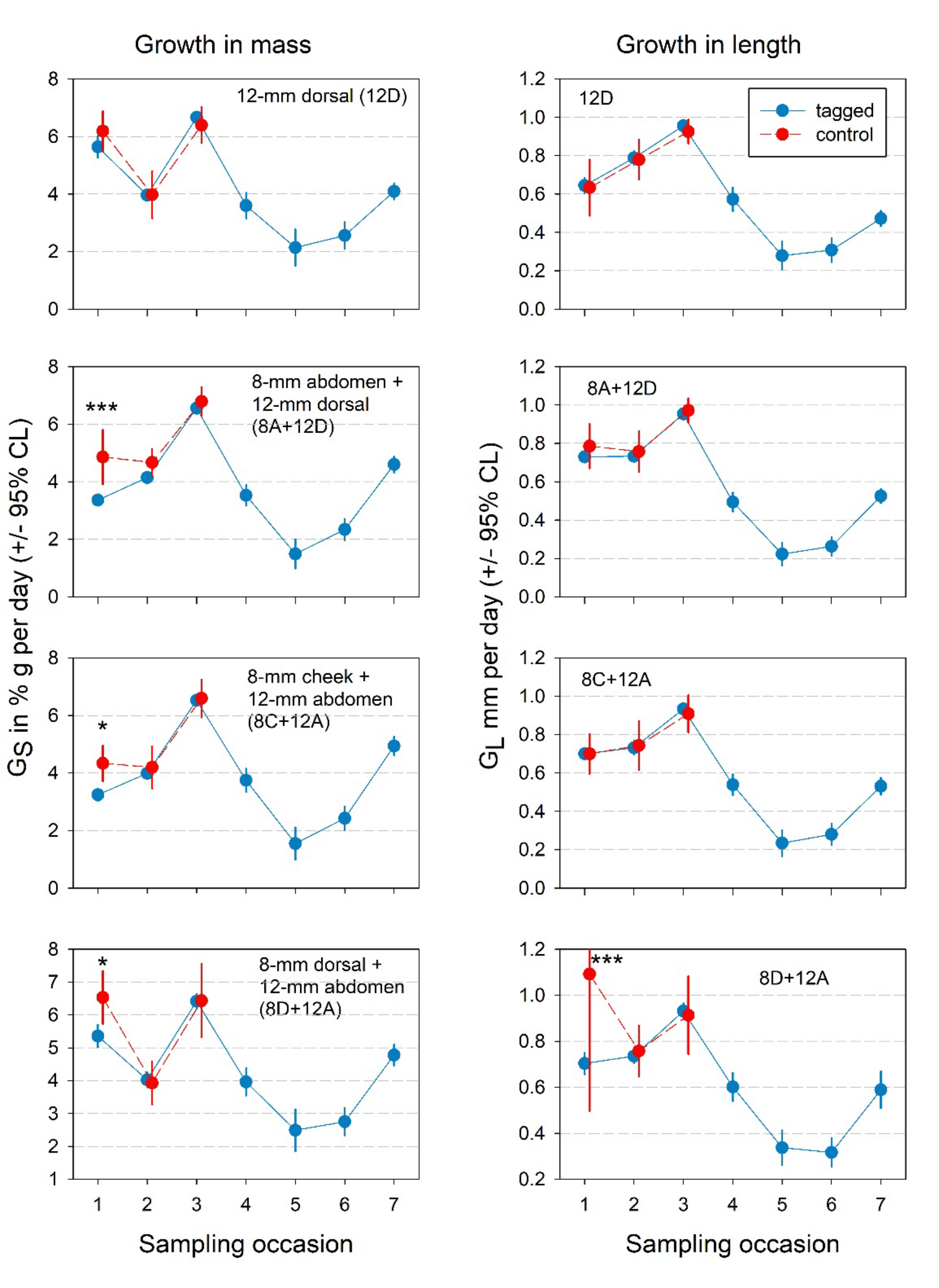
- Positive growth all periods
- Lower growth in tagged fish during first interval
- No diff. in mean sizes during recaptures

RESULTS: Individual growth tagged vs. controls

Comparisons limited to first three recapture events – fin erosion in controls

5 of 8 groups the tagged fish had lower G_S in first interval

Only one difference in G_L



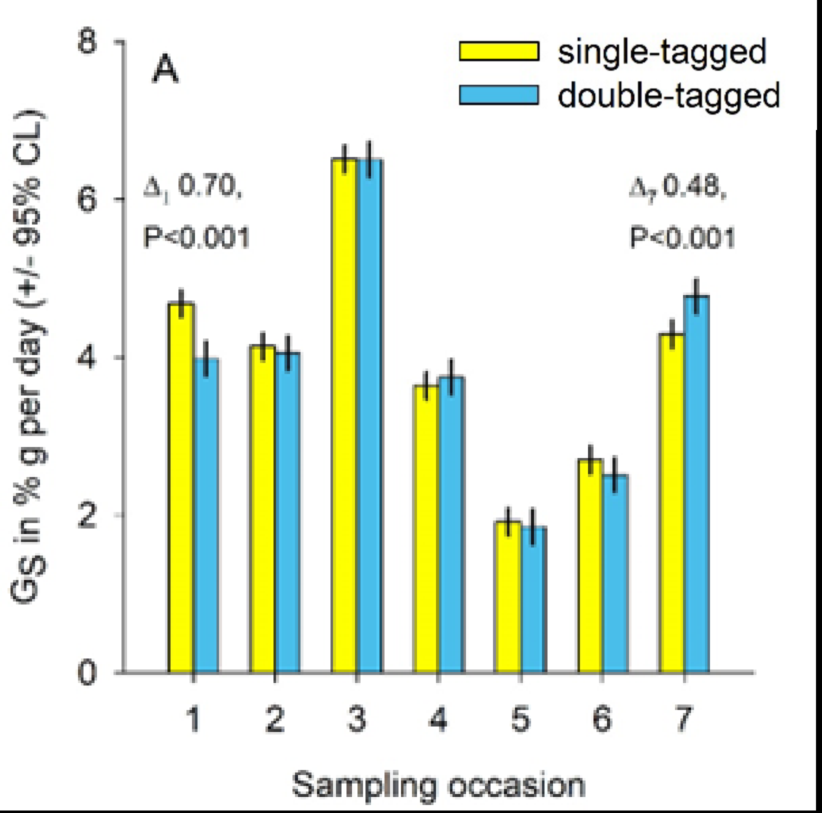
RESULTS: Individual growth – within tagged groups

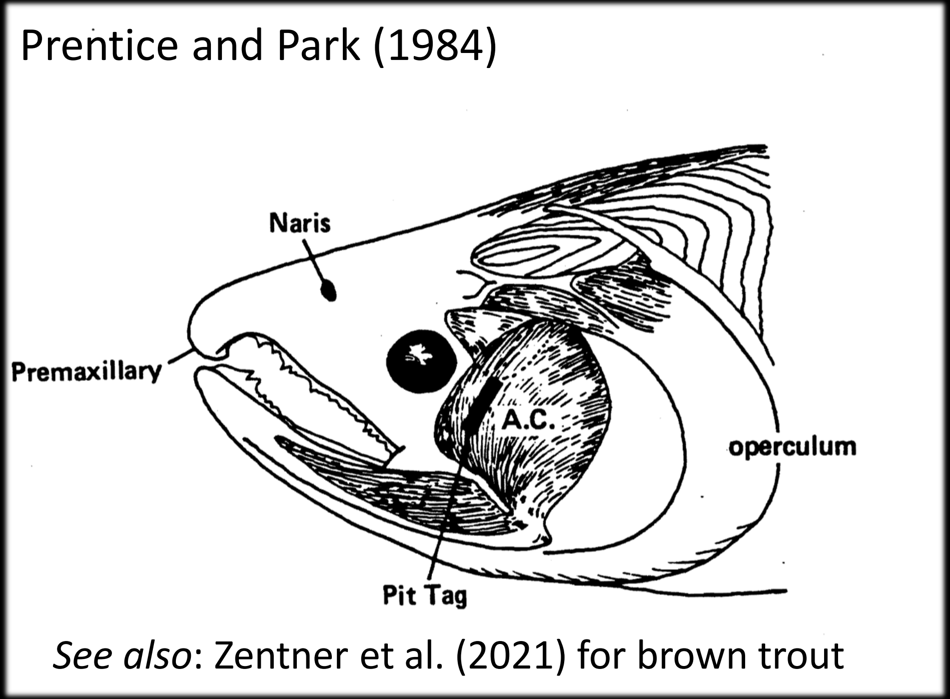
Single- vs. double-tagging: first interval, G_S for double-tagged lower (p<0.001)

Tag size: first interval, G_S lower for 8-mm tag (p<0.001), G_L greater for 8-mm tag (p=0.02)

Tag position: 2 of 4 differences in first interval (cheek, dorsal), but not consistent through time

→ Effects, when present, were temporary





SUMMARY:

The operculum and dorsal sinus are suitable PIT implantation sites for brook trout.

High retention overall:
dorsal (100%) >
abdomen (98%) >
cheek (83%)

Only short-term effect on growth – fish can handle double-tag burden

Abdominal PIT tags and iteroparous salmonids

- 23-30% lower retention for female trout (Mamer & Meyer 2016; Meyer et al. 2011)
- 30% tag loss for post-reproductive female brown trout (Saboret et al. 2021)
- 24% of recaptured brook trout and 32% of recaptured brown trout lost tags during fall season (Dieterman & Hoxmeier 2009)

Double PIT-tagging to hedge against tag loss

Probability of retaining at least one tag, assuming independence

$$P = 1 - (1 - p_1)(1 - p_2)$$

$$P = 1 - (1 - 0.5)(1 - 0.5) = 0.75$$

$$P = 1 - (1 - 0.8)(1 - 0.6) = 0.92$$

$$P = 1 - (1 - 0.9)(1 - 0.6) = 0.96$$

Potential field applications

Advantages:

More detections + maintain individual identifiability

Passive detections yield estimate of tag retention

Leverage situations with multiple antenna technologies

Combination of implantation positions can be used to address risks to animal & human welfare

Disadvantages:

Labor and tag cost

More scientific detritus (“ghost tags”)

Antenna optimization

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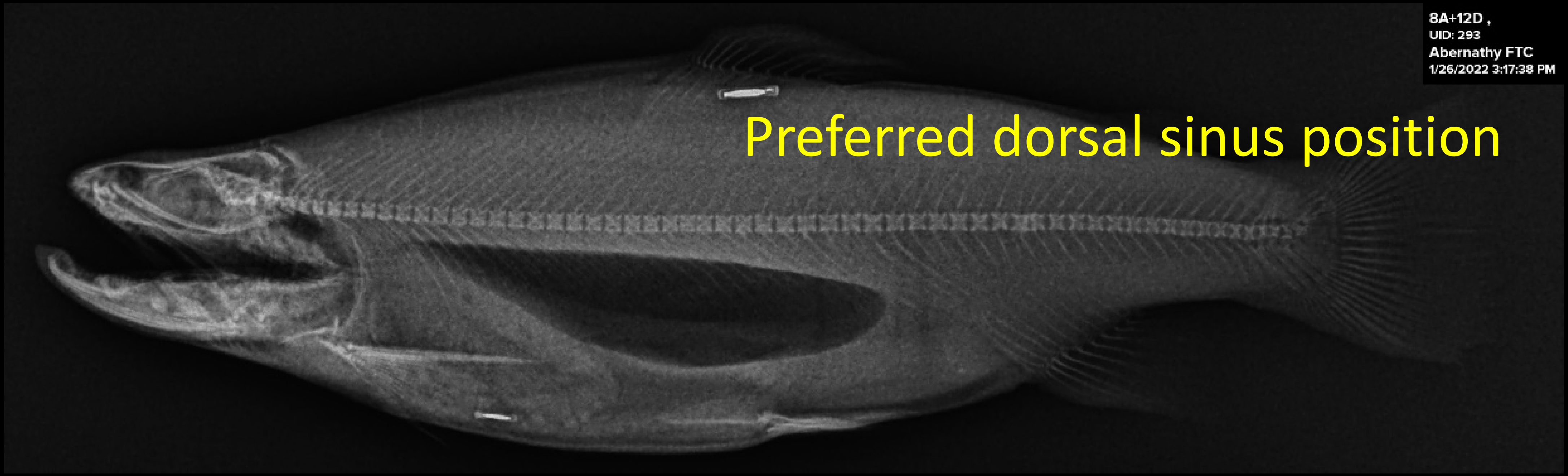
8A+12D ,
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Abernathy FTC
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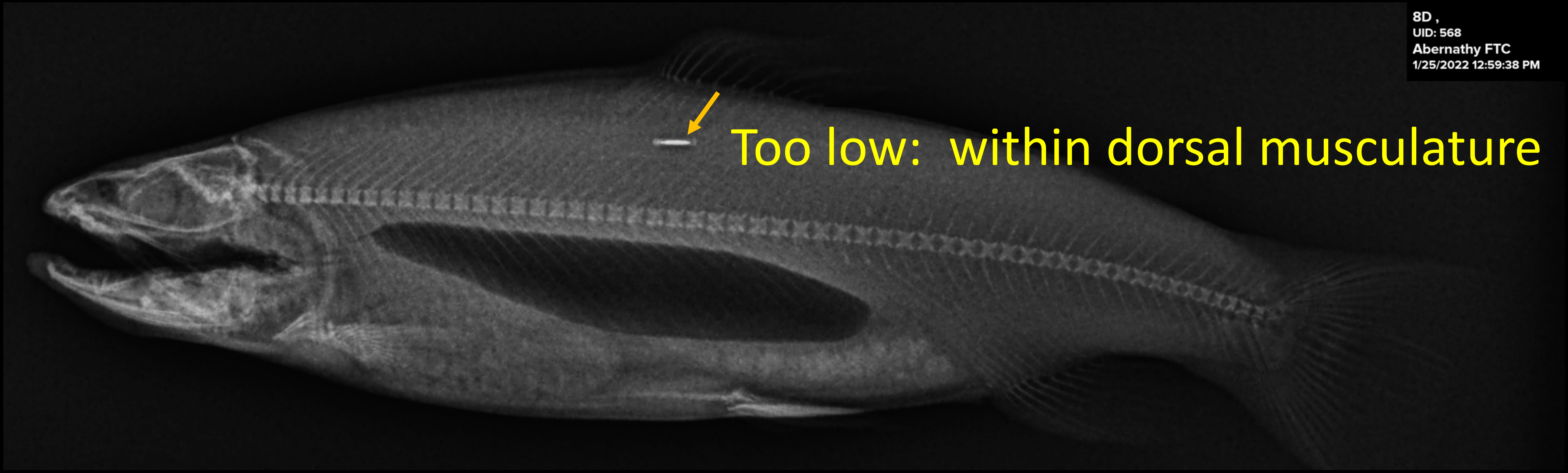
Preferred dorsal sinus position


8D ,
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Too low: within dorsal musculature

Ingestion of shed tags