Scale resorption in migrating and spawning steelhead trout

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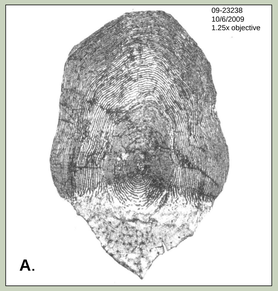
INTRODUCTION

- Iteroparity (repeat spawning) is an important aspect of steelhead life history, but has not been well described in Snake River steelhead.
- Resorption (loss of scale material) occurs during migration, overwintering, and spawning (Fig. 1).
- Varying resorption rates lead to differences in strength and appearance of spawn checks, which are indicative of repeat spawning (Fig. 2).
- We quantified resorption in scales as steelhead transition from a pre- to post-spawn state to increase accuracy in identification and age determination of repeat spawners.



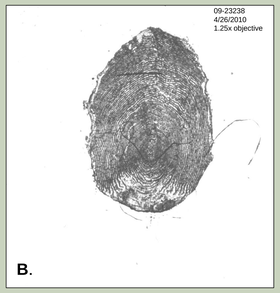
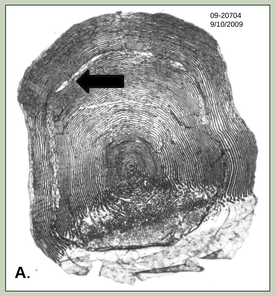


Figure 1. Scale resorption during migration, overwintering, and spawning . Photo A: Prespawn steelhead collected at Lower Granite Dam on 10/6/2009. Photo B: Same steelhead collected at Lower Granite Dam on 4/26/2010 post spawn.



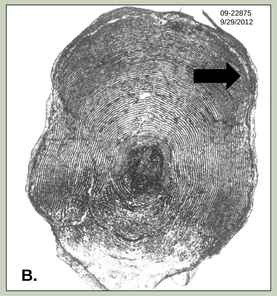


Figure 2. Repeat spawning steelhead showing varying strengths of spawn checks. Arrows indicate spawn check. Photo A shows a typical strong spawn check, Photo B shows a weak spawn check close to the edge.

METHODS

- Pre-spawn scale samples were collected at the Lower Granite Dam (LGR) adult trap 26 August 2009 to 22 April 2010, and post-spawn samples from the juvenile bypass 1 April to 2 July 2010 (Fig. 3).
- Pre- and post-spawn samples were paired using PIT tag codes (n=72).
- Total area and length (mm) from focus to edge on 8 axes were measured for each scale using Image Pro Plus software (Fig. 4). Quality of the last annulus in the post-spawn sample was judged as intact, obscured, or lost.
- To account for differences in scale orientation, we paired lateral axes and averaged their measurements.
  - Paired axes were 0° & 180°, 45° & 135°, and 225° & 315° (Fig. 4).
- Change in each axis and in scale area was calculated as percent difference from the first sample.
- We correlated change in scale area with change in each axis and tested to see which axis had the greatest change.
- We tested effects of collection season (fall vs. spring), time spent above LGR, genetic stock, sex, and fork length on mean change in area using a linear mixed model.

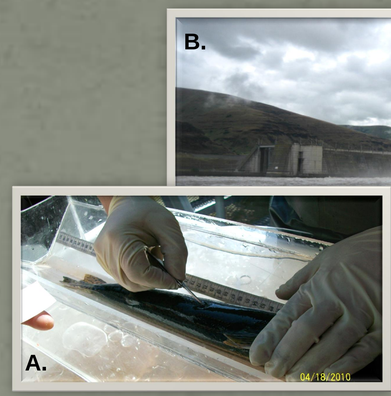


Figure 3. Photo A: Obtaining scale samples from an adult steelhead. Photo B: Lower Granite Dam.

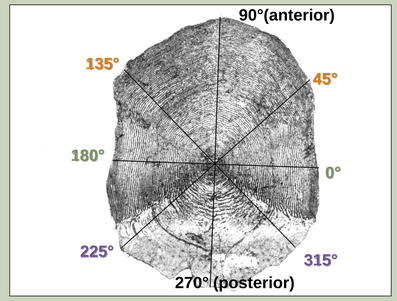


Figure 4. Scale axes used to calculate resorption. Axes that were paired for analysis are designated by similar colors.

RESULTS

- Change in total area and change at each axis was highly variable between fish (Table 1).
- The outer annulus was lost in 13% of fish, while 39% had an obscured outer annulus (e.g., Figure 1B).
- Change in area was most closely correlated to change in the lateral axes (0º, 45º, 135º, 180º) (r^2 >90%), but the posterior (270º) showed more loss than other axes (t=3.66, p<0.001).
- Season of collection influenced mean change in area; other factors were not significant (Table 2). Fall sampled fish averaged -28% (n=66) change in area while spring sampled fish averaged -8% (n=6).

Table 1. Mean percent change with ranges of each axis and scale area between pre- and post-spawn samples. n=72

	Change in Scale Area	Combined 45/135 axes	Combined 180/0 axes	90 axis	Combined 225/315 axes	270 axis
Mean Change	-26%	-13%	-15%	-15%	-14%	-22%
Range	12% to -55%	15% to -33%	19% to -37%	3% to -42%	11% to -35%	15% to -51%

Table 2. Mixed model analysis of factors influencing change in scale area.

Fixed Factors	df	F	P value		Random Factors	df	t	P value
Season	1	4.91	0.03		Days	50	<0.001	1.00
Stock	7	0.64	0.72		Fork Length	50	<0.001	1.00
Sex	1	0.22	0.64					

DISCUSSION

- Spawn checks in Snake River steelhead vary in strength and appearance because of the large amount of variation in scale resorption.
- Lost or obscured annuli complicate age determination of iteroparous steelhead, similarly previous spawn checks may be lost. Therefore iteroparity rates are likely under estimated.
- Strong spawn checks often exhibit a dark line and circuli cutting in the posterior (e.g., Figure 2A), resulting from the large amount of scale loss on the posterior edge.
- Scale resorption occurs more during the winter than during spawning as shown by the significantly greater loss in fall sampled fish.
- To our knowledge, this is the first quantitative study of the loss of scale material in any fish species. Assessment of scale resorption is important to identify life history traits and age accurately .

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