



Effects of Formalin Preservation and Delayed Measurements on Length, Weight, and Condition Estimates of Longfin Smelt, Striped Bass, and Threadfin Shad

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Introduction

The California Department of Fish and Game (CDFG) Long-Term Monitoring Unit recently began collecting weight measurements from preserved fishes and calculating length-weight relationships to evaluate the "body condition" of fishes in the estuary for management purposes. Literature regarding preservative induced changes in length and weight (and its influence on interpretation of condition) is limited, so we decided to investigate.

The objectives of this study were to: (1) quantify the amount of change in the length, weight, and condition index of age-0 longfin smelt (LFS), threadfin shad (TFS), and striped bass (SB) stored in formalin preservative over time and (2) determine if a stabilization period exists for length or weight for these fishes.



Methods

- Upon collection LFS and TFS were placed in chilled 12 ppt isotonic saline solution, returned to the laboratory, and within 48 hours measured (initial saline treatment) for standard length (SL) in millimeters (mm) and weighed (W) in grams (g).
- SB were returned to the laboratory live, measured and weighed, then placed in saline solution and processed the same as the other fishes.
- After completion of initial measurements (week 0) of fish held in saline solution (Table 1), specimens were placed into 10% buffered neutral formalin.
- Specimens in 10% formalin were processed for SL and W again at weeks (formalin treatments): 1, 2, 3, 4, 8, 12, 16, and 20.
- Fulton's condition factor (K) was determined for each specimen at each treatment with the formula: $K = (W / SL^3) \times 100,000$.
- The amount of change in length, weight, and index of condition (K) at each formalin treatment from the initial saline treatment was calculated as: $\text{Percent change} = [(\text{mean treatment} - \text{mean initial}) / (\text{mean initial})] \times 100$.
- \log_{10} -transformed length and weight data were used to generate least squares linear regression relationships of the formula: $\log_{10} W = \log_{10} a + b \times \log_{10} SL$.
- Analysis of covariance (ANCOVA; GLM procedure SYSTAT 10.2) was used to test for a significant ($\alpha < 0.05$) difference among slopes, and among intercepts, of the length-weight linear regressions of the initial saline and formalin treatments.

Results

All three species decreased in length during formalin preservation after initial measurements (Figure 1). TFS and SB gained weight over time, but LFS lost weight (Figure 1). Decreases in length and mostly increases in weight positively affected the condition (K) of all three fishes, for some (e.g., LFS) if not all time intervals (e.g., TFS and SB; Figure 2).

Table 1. Summary of sample number, initial range, and mean (\pm SD) of standard length (mm), weight (g), and condition factor (K) for longfin smelt, threadfin shad, and striped bass stored in 12 ppt saline solution for ≤ 48 hours.

Species	n	Range of initial values		Mean \pm SD		Range of initial values		Mean \pm SD	
		Length (mm)	Weight (g)	Condition (K)	Length (mm)	Weight (g)	Condition (K)		
Longfin smelt	46	31.6 - 54.2	41.7 \pm 4.43	0.26 - 1.58	0.75 \pm 0.28	0.83 - 1.22	0.99 \pm 0.09		
Threadfin shad	21	45.4 - 84.3	69.4 \pm 11.47	1.36 - 9.00	5.49 \pm 2.34	1.37 - 1.76	1.52 \pm 0.11		
Striped bass	48	43.2 - 101.9	73.5 \pm 13.08	1.25 - 18.18	7.67 \pm 3.82	1.51 - 2.07	1.78 \pm 0.15		

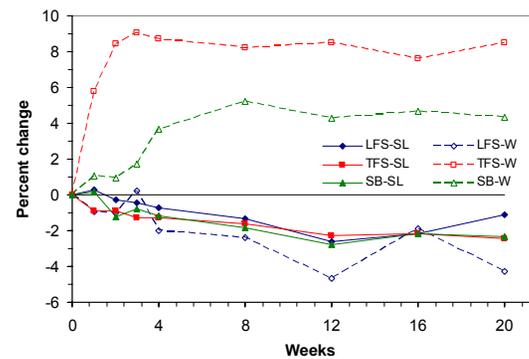


Figure 1. Percentage change (%) in mean standard length (SL) and mean weight (W) relative to the initial mean values for longfin smelt (LFS), threadfin shad (TFS), and striped bass (SB) preserved first in saline solution (week 0) followed by 10% buffered formalin over a 20 week period.

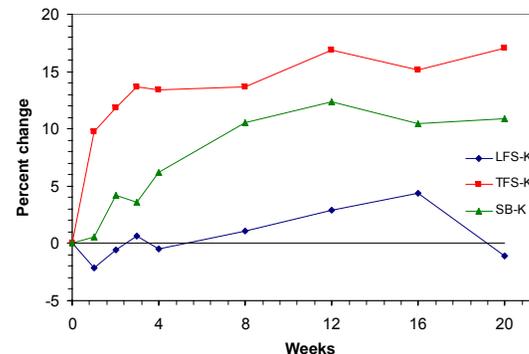


Figure 2. Percentage change (%) in mean condition (K) relative to the initial mean values for longfin smelt (LFS), threadfin shad (TFS), and striped bass (SB) preserved first in saline solution (week 0) followed by 10% buffered formalin over a 20 week period.

Results cont.

Comparison of the length-weight regressions among saline and formalin treatments revealed the following patterns:

- No significant differences among slopes for any species, though both LFS and SB exhibited some modest increases in slope (LFS: $F_{8,396} = 1.944$, $P = 0.052$; TFS: $F_{8,171} = 0.322$, $P = 0.957$; SB: $F_{8,414} = 1.873$, $P = 0.063$).
- Significant differences among intercepts for all species (LFS: $F_{8,404} = 4.651$, $P < 0.001$; TFS: $F_{8,179} = 14.840$, $P < 0.001$; SB: $F_{8,422} = 20.889$, $P < 0.001$).
- Post hoc comparisons of regression lines during weeks 8 through 20, where weight change appeared to stabilize, revealed no significant difference in intercepts for both SB (intercept: $F_{3,187} = 0.917$, $P = 0.434$) or TFS (intercept: $F_{3,79} = 1.491$, $P = 0.223$).

Comparison of the live and isotonic solution preserved SB showed no significant difference in slopes ($F_{1,92} = 0.455$, $P = 0.502$), but did have a significant difference between intercepts ($F_{1,93} = 6.966$, $P = 0.010$) with a significant increase in weight in the saline treatment.

Conclusions

Formalin produced decreases in length and variable responses in weight (consistent increases in 2 of 3 fishes tested) that resulted in significant increases in measures of condition for all three fishes. A significant preservative induced increase in SB condition was observed from live to saline preserved fish and again from saline to formalin preserved fish. The former suggests that the 12 ppt saline solution may have reduced post-mortem water absorption, but not to insignificant levels as intended.

For TFS and SB, there was a stabilization period between weeks 8 and 20, when length stopped decreasing and weight stopped increasing.

It is recommended that comparison of length-weight or condition data should only occur using specimens preserved identically and processed at the same known time interval post-preservation or once a stabilization period is reached.

Acknowledgements

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