Interspecies Comparison of αII-Spectrin Protein Abundance Between Chinook Salmon and Steelhead

Brielle D. Kemis, Katie A. Wagner, Christa M. Woodley, Ann L. Miracle

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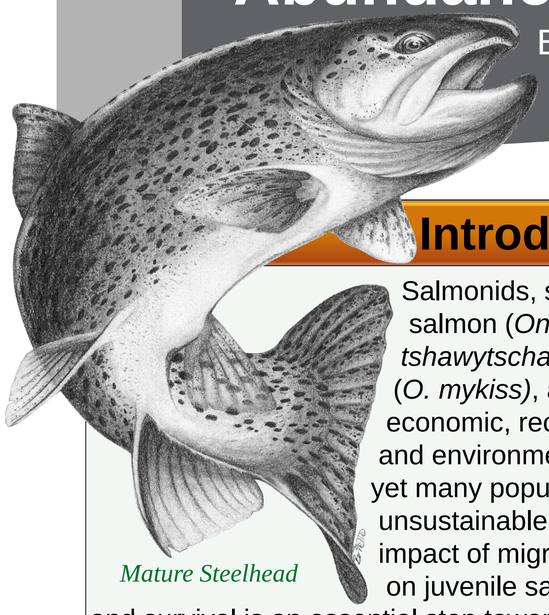


Mature Steelhead

Introduction

Salmonids, such as Chinook salmon (*Oncorhynchus tshawytscha)* and steelhead (*O. mykiss)*, are a staple economic, recreational, tribal, and environmental resource, yet many populations are unsustainable. Monitoring the impact of migratory obstacles on juvenile salmonid health and survival is an essential step towards increasing Smolt-to-Adult-Return ratios (SARs).

- Objective:
  - Determine if juvenile Chinook salmon and steelhead exhibit differing levels of αII-Spectrin Breakdown Products (SBDPs), indicative of dissimilar neurogenesis rates and/or potential head injury
- About αII-Spectrin:
  - Cytoskeletal protein that fragments during apoptosis and necrosis. These fragments, known as SBDPs, have been used to detect head trauma in juvenile Chinook salmon (Miracle et al. 2009)
- Significance of Study:
  - Help explain fluctuating Chinook salmon and steelhead population dynamics.
  - Influence hydropower facility operation, hatchery management, fish transportation, habitat restoration, and funding allocations

Chinook salmon smolt

Steelhead smolt

Approach

- Yearling Chinook salmon and steelhead were collected at John Day Dam in Spring 2010 and Spring 2011 (*Fig. 4*).

Brain tissues of Chinook salmon and steelhead extracted and flash frozen* → Tissues lysed and homogenized to isolate proteins in each sample. → 20 µg of protein per sample resolved by gel electrophoresis techniques. → Western Blot and antibody staining used for detection of intact αII-Spectrin/SBDPs → αII-Spectrin abundance semi quantitatively analyzed utilizing Image J software → Ratio of SBDP/intact αII-Spectrin between species assessed with T-Test in JMP9

** In accordance with Battelle guidelines based US Fish and Wildlife Service fish hatchery management practices, and in accordance with approved animal care and use protocols*

Results

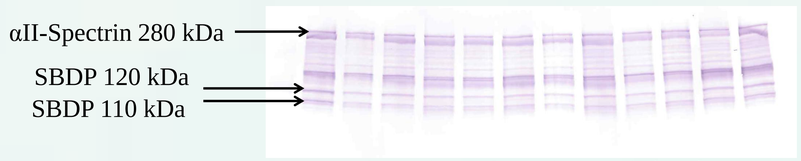


Figure 1. αII-Spectrin protein bands

Figure 2. Mean (+ S.E.) ratio of SBDPs to intact αII-Spectrin in Chinook salmon (N=25) and steelhead (N=25) brains. 2010 steelhead show significantly greater SBDP levels than 2010 Chinook salmon; t(1)=2.5, p=0.02.

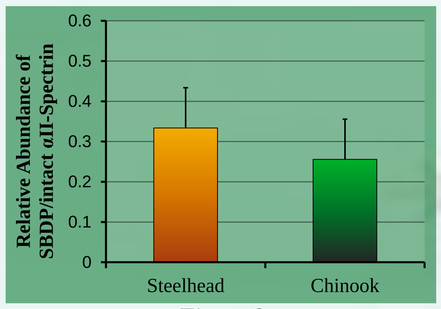


Figure 2

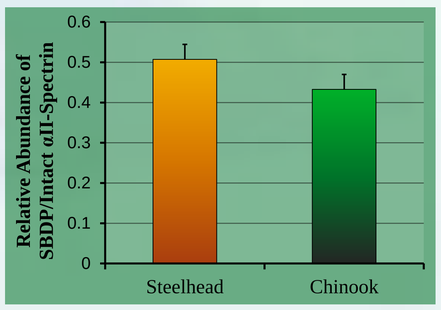


Figure 3

Figure 3. Mean (+ S.E.) ratio of SBDPs to intact αII-Spectrin in Chinook salmon (N=36) and steelhead (N=39) brains. There is no significant difference between the mean values of Chinook salmon and steelhead collected in 2011; t(1)=1.66, p=0.10.

2010 Steelhead Mean Fork Length=212.1mm, Mean Wet Weight=80.4g
2010 Chinook salmon Mean Fork Length=149.0mm, Mean Wet Weight=32.7g

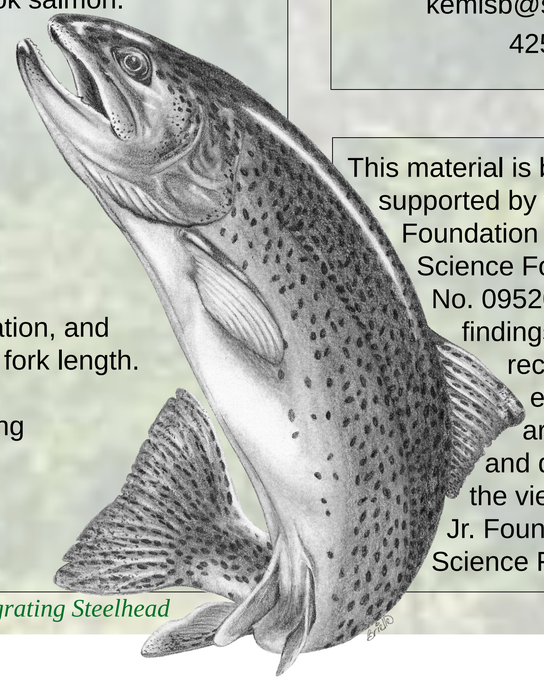
Future Research

- Various factors may influence SBDP presence and must be controlled in future studies.
  - Fish fork length
  - Rearing/migratory conditions
  - Genetic background
  - Brain mass (Lema et al. 2005)
  - Smolting stage
  - Severity of injuries
- Further research is needed to establish cause of elevated αII-Spectrin abundance in steelhead.
- Juvenile (Zupanc, 1999) and adult teleost fishes perform neurogenesis (Zupanc, 2008), but the relation of neurogenesis to developmental stage and body or brain size remains unclear.

Figure 4. Hydropower facility network in Columbia River and surrounding tributaries.

Discussion

- Juvenile steelhead consistently show greater SBDP abundance than juvenile Chinook salmon.
  - Steelhead may experience more brain trauma and/or undergo higher rates of neurogenesis than Chinook salmon.
- 2011 intact αII-Spectrin/SBDP levels are higher than 2010 levels.
  - Possible variation in antibody affinity
  - Potential differences in overall trauma severity and/or neurogenesis
  - May be caused by differing hydrologic environments during the two spring migratory periods
    - Average water flow at John Day Dam (Columbia Fish Passage Center, 2011, www.fpc.org):
      - 4/28/10 to 5/27/10 collection period=196.1 kcfs
      - 4/2611 to 5/24/11 collection period=335.5 kcfs
- Anthropogenic forces, including hydropower facility engineering, hatchery management practices, fish transportation, and other migratory obstacles may cause more brain trauma in steelhead than Chinook salmon due to differences in fork length.
- Variation in rate of basal neurogenesis and biological response to traumatic events are potential factors in varying population dynamics between migrating Chinook salmon and steelhead .
  - 11 year average SAR estimates at Lower Granite Dam (CSS Annual Report, 2010):
    - Wild Chinook salmon=0.79-1.01%
    - Wild steelhead=0.64-0.85%



Migrating Steelhead

Contact

Brielle D. Kemis
kemisb@students.wwu.edu
425.737.4775

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