Energy allocation in juvenile salmon: adaptive strategies for overwinter survival.

Jim Murphy[1], Katie Howard[2], Keith Cox[1], Jamal Moss[1], Emily Fergusson[1], and Ed Farley[1]
Alaska Fisheries Science Center, NOAA/NMFS, Juneau, Alaska
Alaska Department of Fish and Game, Anchorage, Alaska

Energy storage and survival

Constraints on winter survival (body size, energy storage, and winter duration) introduce selective pressure on juvenile life history patterns resulting in adaptive strategies that differ between species and large marine ecosystems (Conover et al. 2009; Post and Parkinson, 2011; Mogensen and Post, 2012).

Although energy allocation is non-linear over the marine life of salmon, contrasts in energy allocation by species and large marine ecosystem are evident in simple linear models of weight and energy density (Calories/gram) of salmon when restricted to their first summer at sea (juvenile life-history stage). Energy requirements for overwinter survival are believed to introduce selective pressure on energy allocation strategies in juvenile salmon. Key differences between species and large marine ecosystems are believed to reflect differences in size at marine entry (freshwater age) and length of growing season.

Energy density and allocation

Species Contrast

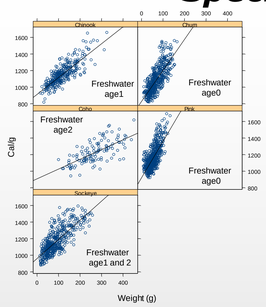


Figure 1. Relationship between energy density and weight of juvenile salmon in the eastern Bering Sea (Aug-Sep, from 2003-2011).

• Energy density increases at a faster rate with respect to weight in species that enter marine habitats at a smaller size (younger freshwater age).

• Some non-linearity exists in species that enter marine habitats at freshwater age 0 (pink and chum salmon).

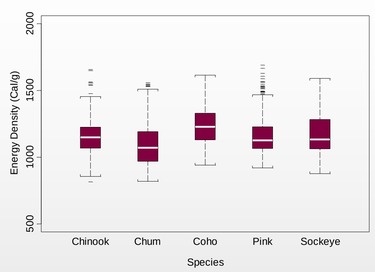
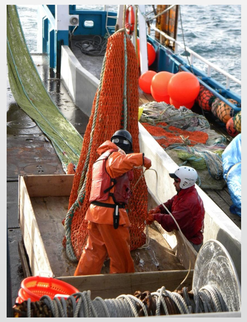


Figure 2. Boxplots of energy density of Bering Sea juvenile salmon (Aug-Sep, 2003-2011).

• Although juvenile size and freshwater age structure vary across species, all reach similar distributions of energy density by the end of their first summer at sea.

• Similarity in energy density across species emphasizes the importance of energy density constraints to winter survival.



Large Marine Ecosystem Contrast

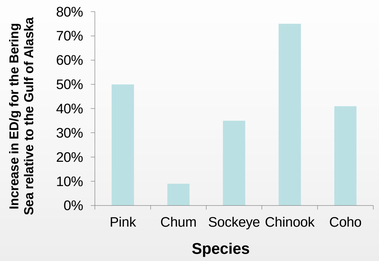


Figure 3. Percent difference in the rate that energy density increases with weight in juvenile salmon from the eastern Bering Sea relative to Gulf of Alaska.

• Energy density increases at a faster rate with respect to weight in all species of juvenile salmon. This is believed to reflect shorter growing seasons in the Bering Sea and counter-gradient variation in juvenile salmon.

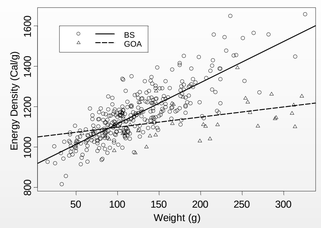


Figure 4. Relationship between energy density (Cal/g) and weight for Bering Sea and Gulf of Alaska juvenile Chinook salmon.

• Chinook salmon exhibit the largest contrast between large marine ecosystems and may reflect a greater contribution of stocks from lower latitudes (Pacific Northwest) than pink and chum salmon which are predominately from southeast Alaska.

References

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