# Change In Juvenile Salmon Life History, Growth, and Estuarine Residence in the Columbia River Estuary

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## Introduction

- Wild Columbia River salmon populations are declining despite over a 100 years of supplementation and stream habitat restoration efforts
- A simplication through time of early life history behavior of salmon may have contributed to the decline
- Chinook salmon exhibit a variety of life history types, with behavior linked to rearing environment and migratory timing
- Chinook salmon rear throughout the tidal freshwater, estuarine, and marine regimes in the Columbia River estuary
- Expression of life history diversity was influenced by anthropogenic and natural pressures
- Life history diversity changes, i.e. estuarine rearing and growth, migration timing, and duration of migration, manifest in the estuarine regime (Figure 1)
- Estuarine rearing by juvenile chinook salmon plays an important role in the salmon life cycle
- Comparative evaluation of estuarine life history diversity captures the results of changes through the life cycle of chinook salmon

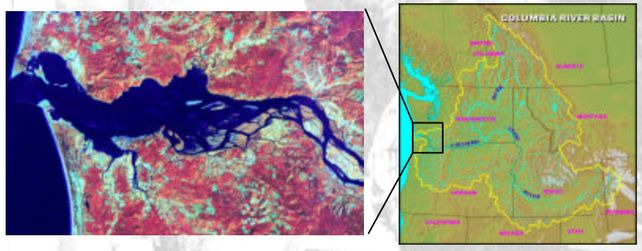


Figure 1. The Columbia River Estuary and basin (photo: courtesy of Genevose and Emmett 1997, and map: courtesy of BPA)

## Methods

- Literature review of salmon life history and anthropogenic changes in the Columbia River Basin
- Collected published and unpublished data
- Reconstructed historic chinook salmon life history
- Analyzed the differences between historical and contemporary salmon life histories in the Columbia River estuary
- Summarized anthropogenic factors that contributed to changes in life history diversity

**References**

Dawley, E. M., R. D. Ledgerwood, and A. L. Jensen. 1985. Beach and purse seine sampling of juvenile salmonids in the Columbia River Estuary and Ocean Plume, 1977 - 1983. Vol. I & II. Coastal Zone and Estuarine Studies Division, NMFS/NOAA. 89 pp.

Genovese, P. V. and R. L. Emmett. 1997. Desktop Geographics Information System for salmonid resources in the Columbia River Basin. NOAA Tech. Memor. NMFS-NWFSC-34.

Rich, W. H. 1920. Early history and seaward migration of chinook salmon in the Columbia and Sacramento Rivers. Bulletin of the United States Bureau of Fisheries 37. 73 pp.

Streamnet http://www.streamnet.org/query-intro.htm

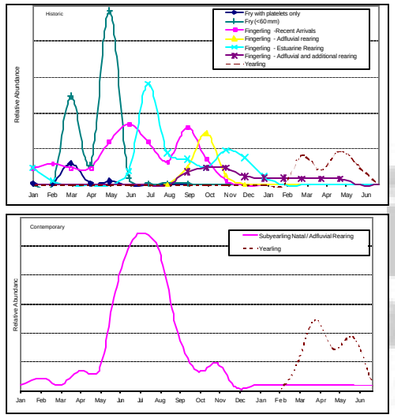


Figure 2. Historic and contemporary early life history types for one-brood year of chinook salmon in the Columbia River estuary. Historic timing and relative abundance based on historic sampling throughout the lower estuary (Rich 1920). Contemporary timing and relative abundance derived from Dawley et al. (1985) sampling at Jones Beach.

## Results

***Historical Reconstruction***

- Historic estuarine sampling dated back to 1914 to 1916 by Rich (1920)
- Scale pattern interpretation of juveniles collected in 1916 identified the rearing regime and life stage
- At least 6 chinook life history types were sampled in the estuary in 1916 (Figure 2)
- Historical behavior included several life stages, i.e. fry, fingerling or yearling, using an array of rearing regimes with varied timing through the estuary (Figure 2)
- Historic salmon populations exhibited estuarine growth based on scale patterns

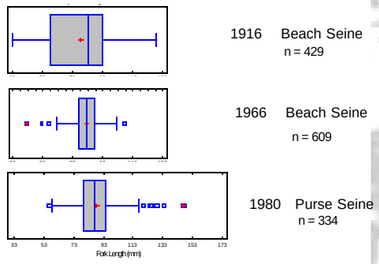


Figure 3. Subyearling chinook salmon fork length range during three summer sampling periods (March to September).

## Results

***Contemporary Comparison***

- Hatchery-reared chinook dominated contemporary populations sampled in the estuary
- Hatchery-reared chinook salmon displayed a relatively homogenous size structure throughout the summer, indicating a lack of population diversity compared to historic runs (Figure 3)
- Timing of salmon through the estuary correlated to hatchery release dates
- Contemporary data lacked comparable estuarine growth measurements

Figure 4. John Day Dam on the Columbia River (photo courtesy of Streamnet)

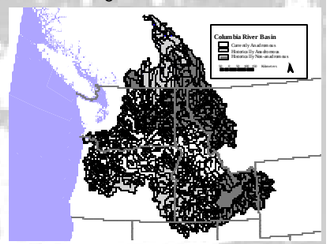


Figure 5. Historical distribution of Columbia River salmon (map data courtesy of Brian Feist, UW, Seattle, WA)

## Results

***Anthropogenic pressures on life history diversity*:**

- Harvest began in the early 1800s, intensified with the advent of canneries along the lower Columbia River, and continues today
- Fish passage limited by the Columbia River dams and irrigation structures during both the upriver migration of adults and the downriver migration of juveniles (Figure 4)
- Watershed alteration includes the loss of populations due to impassable barriers, the degradation of spawning and rearing habitat, and the loss of estuarine habitat (Figure 5)
- Hatcheries supplemented populations beginning in the early 1900s and have failed to restore the natural populations and may contribute to the demise of wild salmon through competitive interactions

## Conclusions

* The life history complexity of historic Columbia River basin salmon populations was evident in the numerous juvenile life history stages, sizes, and timing in the estuary
* A component of the historic wild salmon populations reared for a significant period in the estuary, indicating the importance of the estuarine regime in the life cycle of salmon
* Life history diversity of chinook salmon was reduced during the 20th century
* Contemporary use of the Columbia River estuary by wild juvenile salmon was relatively unstudied
* Documentation of contemporary wild salmon life history diversity was limited
* Hatchery-reared salmon dominated our characterization of salmon life history
* The Columbia River estuary and basin formerly sustained salmon with diverse life histories prior to natural and anthropogenic changes in the basin