

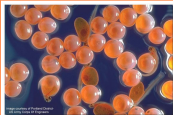


Examining the Early Life History of Coho Salmon (*Oncorhynchus kisutch*) from a Study of Otolith Microstructure

Students:
 Matthew Brewer, Yaron Fireizen, Tim Morschauer, David Koslov, Ernest Ruiz, Paulina Duarte

Advisors:
 Dr. David Lonzarich
 Mary Elger-Lonzarich

Affiliation:
 University of Wisconsin – Eau Claire,
 Department of Biology
 Eau Claire, WI 54701



Stream spawning female salmon will lay several thousand large eggs in gravel nests during cold winter months



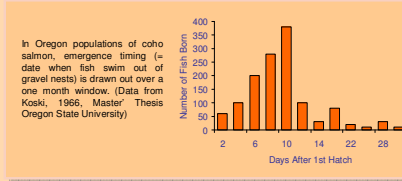
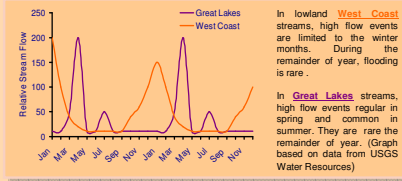
Young salmon hatch following several months of incubation and reside as alevin within their gravel nests for more than one month before emerging as fry.



From the fry stage, salmon move through several life stages before returning to their natal streams as adults.

SALMON EARLY LIFE HISTORY: IMPORTANCE OF BIRTH DATE

- In young stream-dwelling salmon and trout the first few weeks are often associated with high levels of predation, damaging floods and intense competition for limited spatial resources.
- Although survival is usually very poor during the early life of a fish, mortality risks vary geographically depending on ecological and physical conditions. In coho salmon, for example, populations of western North American streams are exposed to flow regimes that are very different from those found in streams of Lake Michigan and Lake Superior, where the species was introduced in the late 1960s (figure to right).
- A potentially important predictor of early mortality and growth in young fish is birth date, which in some species can extend over a relatively long periods of time (figure to right).
- In species with prolonged hatching windows it becomes practical for ecologists to explore questions concerning the costs and benefits of early and late birth dates.
- Especially in salmon, the timing of birth can be a very important determinant of growth and survival.
 - In part this is true because birth date may be linked to developmental (or metabolic) rate, which in turn is positively correlated with competitive success and growth (e.g., Yamamoto and Higashi, 1998, J. Fish Biol 52:281-290).
 - Birth timing also may be important in situations where competitive success and predation risk are associated with size and abundance. We present below two scenarios depicting plausible advantages associated with early and late birth dates.



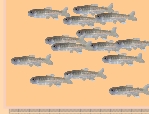
Advantages of an early birth date

Because competitive success is affected by size, fish born early have advantage in securing limited territory space. They also experience a longer growing season



Advantages of a late birth date

Fish born late may experience lower per capita predation risk because more prey are present in the stream



STUDY GOALS

The general aims of this study were to document hatch timing patterns in coho salmon, and to explore the consequences of hatch timing and developmental history on growth of young fish (<2 mos of age).

Our specific objectives were to:

- Characterize hatch timing in coho salmon populations from two streams in Washington and Wisconsin.
- Examine effects of hatch date on growth patterns of juvenile salmon.
- Determine whether development rate (or metabolism) can predict individual variability in growth among juvenile salmon.



West coast salmon were collected from Forks Creek a coastal stream in western WA.



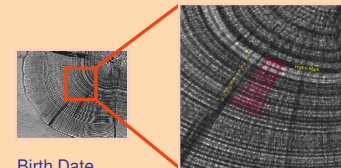
Great Lakes salmon were collected from the Cranberry River a tributary of Lake Superior, WI.

ACKNOWLEDGMENTS

Many students have participated in the project since it began nearly three years ago. In addition to the six involved in the production of this poster, they include Rachel Schoen, Rachel Haazen, Carissa Fannell, Patrick Murack, Bill Hintz, Kristine Funk, Rebecca Kitzman, Kristine Dahlheimer and Nalee Xiong. Mary Lonzarich and Dr. Steven Campana (Bedford Oceanographic Institute in Halifax, Canada) are owed special thanks. Mary for her extraordinary work in organizing and managing a large collection of specimens and data files and Dr. Campana for his generous support of time and expertise in training our lab group in the fine art of otolith analysis. We also wish to thank the UWEC Office of Research and Sponsored programs, which provided funds to support 12 students and the UWEC Diversity Mentoring program, which provided funds for two others. Funding for the printing of this poster was provided by UWEC Differential Tuition and the Office of Research and Sponsored Programs.

EAR BONES TELL A STORY

The internal ears of fish contain bones, known as otoliths, that record many important aspects of an individual's life. Two of these are daily growth and metabolic rate.



Birth Date

Viewed in cross-section, daily growth increments of calcium carbonate are evident. Hatching is a physiologically stressful event, which produces a distinctive landmark upon the otolith.

In this study, daily increments were counted by light microscopy under oil immersion. From the total ring counts, we estimated birth date by back-calculation for over 200 fish in the two streams.

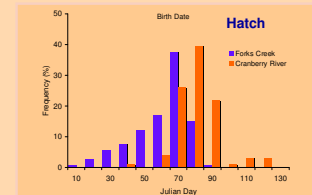
Metabolic Rate

Otolith size at birth is correlated with metabolic rate, suggesting that otolith diameter (shown above) is a good indicator of growth potential in juvenile fish.

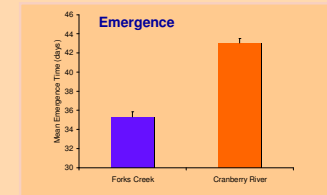
Otoliths were measured at the hatch mark along the long axis. In the present study, we generated data from 52 fish from the Cranberry River population.

RESULTS AND DISCUSSION

Objective 1: Patterns of Hatching and emergence in the two populations

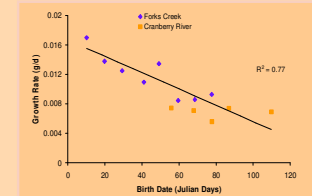


WA fish hatched earlier than WI fish but the hatching season was protracted for both populations (> 2 months).



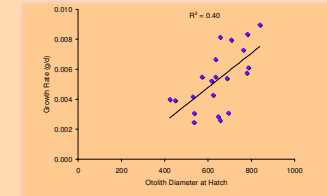
WI fish remained in gravel nests longer than WA fish and most emerged in April, well after the period of peak stream flows.

Objective 2: Effect of Hatch Date on Growth



Early fish grew faster than late fish, suggesting that population differences in size were shaped by birth date rather than locale.

Objective 3: Otolith Size as Predictor of Growth



Otolith size at birth, previously linked to metabolic rate, here served as a good predictor of early season growth in WI fish.

By examining otoliths of young coho salmon we have gained a rare glimpse into the very early life of this species. From our findings we are able to make the following observations and conclusions.

- Protracted hatching periods in both populations suggest that there may be strong ecological effects of birth timing.
- One possible determinant of the different emergence dates for the two populations is fine sediments (Koski 1966). However, it has not escaped our notice that the emergence of WI fish occurred after the spring floods, suggesting that there may be strong selective pressure favoring late emergence.
- Growth patterns were correlated strongly with birth date (-) and metabolic rate (+). Although WA fish were larger than those in WI, growth differences appear to be affected more by birth date than local environmental conditions.
- Finally, our data indicate that fish born early have a growth advantage over those born late, at least during the first two months of life. We are currently analyzing data for older fish to learn whether this advantage erodes with time.