Not Just a Big Pipe… The Lower Willamette River and its Role in the Outmigration and Ecology of Juvenile Chinook Salmon

Portland Harbor – Lower Willamette River Cleanup and Restoration Conference

May 4, 2012
Scope of the “Willamette Fish Study”

- Migration
- Diet
- Habitat survey
- Predation
- Invertebrates
- Habitat use
Chinook Outmigration and Ecology

- Timing and density
- Migration rate / residence time
- Habitat use
- Diet
- Growth and rearing
Methods and Fun Facts

- Duration – May 2000 to July 2003
- Electrofishing – 982 (900 sec.) runs
- Beach seining – 568 sets
- Radio telemetry – 95 fish >100 mm released
- Captured ~42,000 fish; 4,383 juvenile Chinook
- Unmarked Chinook = 92% of seine catch
- Hatchery Chinook = 81% of electrofishing catch
- Mean FL: 154 mm (hatchery); ~70 mm (unmarked)
Spring Chinook Life-history Pathways

Fry Migrants (Jan-May)
- Spring Rearing - Willamette
- Summer Rearing - Willamette
- Overwinter - Willamette
- Lower Willamette
- Columbia
- Ocean

Fall Migrants (Oct-Dec)
- Spring Migrants (Feb-Apr)

From spawning areas

Jan-May
Jun-Jul
Sep-Dec
Feb-Apr
Oct-Dec
Mar-May
Apr-Jun
Jun
? Apr-Jun

unknown timing
unknown timing
hypothesized or unknown
documented

Courtesy K. Schroeder
Outmigration Timing (Unmarked Chinook) - LWR

No zero catches

Density Index vs. Effort (sets)

2000 2001 2002 2003

Effort (sets)

Jan Jan Jan Jan

LWR
Results and Conclusions

Migration Timing & Density

- Chinook present virtually all year – 34 of 35 months sampled
- Average outmigration period – January to June
- Peak densities – April and May
- Hatchery fish timing and densities similar to unmarked
- Implications for in-water work timing (December & January)
- Perhaps ~10 M juvenile Chinook pass through the LWR
Chinook Migration Rate (>100 mm FL)
Effect of River Flow on Migration Rate

\[ y = 1.13 \times 10^{-5} x + 0.674 \]

\[ r^2 = 0.408 \]

\[ P < 0.001 \]
Effect of Fork Length on Migration Rate

\[ y = 2.671x - 4.680 \]

\[ r^2 = 0.353 \]

\[ P < 0.001 \]
Chinook Habitat Use (telemetry)

Chi-square = 16.0; df = 6, $P = 0.01$ (n=66)
Chinook Habitat Use (electrofishing)

Multiple Analyses:
- Qualitative habitat
- Habitat clusters
- Season
- Size class
- Hatchery vs. unmarked

Median Catch Rate

Winter
n = 230
Results and Conclusions

Migration & Habitat Use (biotelemetry)

- Chinook >100 mm FL generally move quickly through the LWR (median residence time 3.4 days)
- Some remain as long as 34 days
- Little evidence for habitat “selection”
- No apparent association with littoral areas
- Migration rates related to river flow and fork length
Results and Conclusions

Habitat Use (direct sampling)

- Generally supported telemetry results – Chinook >100 mm FL did not exhibit selection for or avoidance of habitat types

- Exception: seawalls

- Some high catches in off-channel areas, but not significantly different from main channel

- Unmarked subyearling Chinook abundant at beaches; corroborated by literature; use of other habitats unknown
Chinook Diet (by number of prey items)
Chinook Diet (by weight of prey items)

- Daphnia
- Fish
- Corophium
- Chironomidae
- Terrestrial insect
- Others

% Wet weight

0
10
20
30
40
50
60
Chinook Diet ("fullness" index)

![Graph showing % Body Weight comparison between Unmarked and Hatchery groups. The graph indicates a statistically significant difference, with a p-value less than 0.01.]
Feeding Strategy Plot

Juvenile Chinook salmon

Prey-specific abundance (%)

Occurrence frequency (%)

Daphnia

Corophium, chironomids

Specialization

Generalization

Dominant

Rare
Results and Conclusions

Diet

- Chinook actively feeding throughout LWR (≈ 5% empty stomachs and 123 food items / fish)

- *Daphnia*: recommended by 9 out of 10 growing salmon (> 90% of diet by number, > 40% by weight); specialized, selective diet

- Seasonal shift to *Corophium*

- Potential competition with hatchery Chinook, coho, smallmouth bass
Length and Weight of Hatchery Chinook, Upstream vs. Downstream

![Length and Weight of Hatchery Chinook, Upstream vs. Downstream](image-url)
**Research notebook**

**Study links dental X-rays to low infant birth weights**

A study shows that women who have dental X-rays during pregnancy are three times as likely to have a low birth-weight baby as women who do not.

Dr. Philippe Hujol, a professor at the University of Washington School of Dentistry, and his colleagues report their findings today in the Journal of the American Medical Association.

Hujol said the reasons for the low birth weights — less than 5 pounds 8 ounces — are unclear, and more study is needed. The study found an association between the low birth weights in full-term babies and diagnostic X-rays performed during routine dental care.

“We don’t know whether radiation affects neurohormonal mechanisms in the head and neck region, such as thyroid function, or whether factors unrelated to the X-rays are to blame,” Hujol said. The results should not prevent pregnant women from having X-rays if they are suffering from a dental problem, he said.

The study linked dental data from the Washington Dental Service, a nonprofit insurance company, and Washington birth certificates between 1993 and 2000. About 4,500 women who were enrolled with the insurance company and had a baby during that period were included in the study.

**High-powered shrimp kicks caught on video at Berkeley**

The lowly mantis shrimp may be the world’s most powerful kick-boxer. The small crustacean packs a blow that can smash its prey’s shell under water.

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**Around the globe:** A strong windstorm blowing across South Florida causes the large but shallow Lake Okeechobee to slosh back and forth and raises the water level in a lopsided manner normally seen on the Great Lakes.

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**Salmon linger in the Willamette**

Despite a legacy of industrial pollution and urban development, the lower Willamette River supports a surprisingly robust ecosystem, including the nearly year-round presence of young salmon, according to a recently completed four-year study. Among the findings:

-Daphnia: Salmon food source

-Crustacean diet: Daphnia, a free-swimming crustacean about the size of a sesame seed, supply most of the food salmon eat as they move through the lower Willamette. Scientists found by examining stomach contents, Daphnia filter feed on suspended algae, bacteria and bits of organic matter abundant in slow-moving water.

10 percent growth: Yearling chinook salmon caught at the upriver end of the study area near Willamette Falls averaged about 5.5 inches in length. They grew an average of 10 percent by the time they reached sampling sites 28 miles downriver near the Willamette’s mouth on the Columbia River.

Naturally spawned: More than 90 percent of young chinook salmon caught near the mouth of the Willamette River were naturally spawned, the report said.
Results and Conclusions
Growth / Rearing

- Significant (positive) differences in length and weight between upstream and downstream sites.
- Observed FL increases of 1-14 mm realistic to high, based on known growth rates and estimated migration rates.
- Multiple explanations: growth, estuary-type rearing, Columbia outmigrants.
- Differential mortality & other factors...?
Unanswered Questions (and Concerns)

- Subyearling behavior and habitat use
- Predation
- Introduced species
- Habitat modification, conservation
- Contributions of life-history types
Questions?