Pit Tagging of Chinook Salmon
Juveniles in Lake Washington Basin:
What Have We Learned from 2003 and Earlier Results?

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2003 Study Participants

- Chuck Ebel, Fred Goetz
- Dave Seiler, Lindsey Fleischer
- Pete Lawson, Bill LaVoie, Bob Pfeifer
- Kyle Bouchard, Gary Yoshida, Adam Weybright, Larry Klube

- Agencies: CoE, SPU, KC/M, WDFW
More Release Sites in 2003

Puget Sound

LWSC

Bear Creek

Issaquah Creek

Hatchery

Cedar River

Lake Washington

Lake Sammamish

Montlake Cut

Madison Park

Duwamish River

Kenmore

Webster Point

Gene Coulon Park

Cedar River

Marymoor Park

Issaquah Creek Hatchery

Locks

Metro Lab

Lake Union

Puget Sound

N

E

S

W

Kenmore

Webster Point

Gene Coulon Park

Cedar River

Marymoor Park

Issaquah Creek Hatchery

- Migration Behavior, Rates & Survival
  - Lake vs. Stream, Shoreline Affinity
- Water Temperature & Outmigration
  - Declining Detection Rates, Residualism
- Passage Behavior at Locks
  - Apogee, Diurnal, Recycling
- Passage Rates & Operations
  - Small Lock Operations, Flume Discharge
- Survival (?)
Migration Behavior
Migration Rate in 2003

Chinook

Percent Less Than

Number of Days Between Release and Detection
Migration Rate in 2003

![Graph showing the migration rate in 2003 with different sites: Cedar River, Gene Coulon Park, Madison Park, and Montlake Cut. The x-axis represents the number of days between release and detection, while the y-axis shows the percent less than. The graph uses different markers to distinguish each site.]
Migration Rate in 2003

Number of Days Between Release and Detection

Metro Lab - North
Metro Lab - South
Gasworks - North
Gasworks - South
Indirect Evidence for Shoreline Affinity in Lakes, Mixing in Fremont/ Montlake Cuts?

- Issaquah Hatchery Fish in Cedar River
- Longer travel time for Gene Coulon, South Lake Union Fish

2002

2003
Annually & Spatially Variable Migration Rates

Bear Creek Chinook

Percent Less Than

Number of Days Between Release and Detection
Annually & Spatially Variable Migration Rates

Cedar River Chinook

Percent Less Than

Number of Days Between Release and Detection
An annually & spatially variable migration rates graph is presented, showing the number of days between release and detection for Chinook fish from the Issaquah Hatchery. The graph tracks the percent less than 0% to 100% over a range of days from 0 to 50.
## Freshwater Recapture Data - 2003

<table>
<thead>
<tr>
<th>Species</th>
<th>Origin</th>
<th>Tagging/Release</th>
<th>Recapture</th>
<th>Release Date</th>
<th>Days to Recapture</th>
<th>Approx. Travel Distance (km)</th>
<th>Average Migration Rate (km/d)</th>
<th>Average Growth Rate (mm/d)</th>
<th>Subsequent Migration to Locks</th>
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<td>W</td>
<td>Bear Creek</td>
<td>Kenmore</td>
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<td>Marymoor Park</td>
<td>05/19/03</td>
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<td>20</td>
<td>22.3</td>
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<td>Webster Point</td>
<td>05/20/03</td>
<td>7.4</td>
<td>44</td>
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<td>Lake Union</td>
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<td>33</td>
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<td>W</td>
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<td>Kenmore</td>
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<td>3.7</td>
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Not Detected at Locks indicates that the migration was not detected at the locks.
Water Temperature and Detection Rates at Locks
Water Temperatures

Large Lock

Water Temperature (°C)

Surface
Near-Surface
Midwater
Bottom

Declining Detection Rates

Detection Rate

Release Date

Chinook

Cedar River

Bear Creek
Declining Detection Rates - 2000-2002

Bear Creek Natural Chinook

% Passing Through Flumes

Release Month/Day

△ 2000
● 2001
○ 2002
Declining Detection Rates

Detection Rate at Locks

Week of Release

Chinook

- Issaquah Hatchery
- Marymoor Park
- Bear Creek
- Kenmore
- Cedar River

Declining Detection Rates?

Would expect higher detection rates closer to Locks than for fish from upstream?
Declining Detection Rates & Surface Water Temperature at the Fremont Bridge

Number of PIT Tagged Fish Detected/Day vs. Mean Daily Water Temperature (°C)

- 2001
- 2002
- 2003
Surface Water Temperatures: Lake Sammamish

(Graph: King Cty Website)

Residualized Fish:
- 2000: Released 6/7/00, detected 2002
- 2001: Released 5/15/01, none detected 2002/3
- 2002: Released 5/31/02, detected 2003
### Residualism, 2003 Detections

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<th>Species</th>
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</table>

1 - Adipose fins intact.

2 - Based on tag number sequencing.
Lunar Influence
Was Apogee as important in 2003 as in 2000-2002?

Bear Creek Chinook

Date Of Detection

Percent Detected Before

2000 2001 2002
Apparantly, yes…

Cumulative Percent Detected

Chinook


Issaquah Hatchery
Marymoor Park
Bear Cr
Kenmore
Moon at Apogee
Moon at Perigee
Apogee...

Cumulative Percent Detected

Chinook

- Cedar R
- Gene Coulon Park
- Moon at Apogee
- Moon at Perigee

Dates:
- 5/1/2003
- 5/15/2003
- 5/29/2003
- 6/12/2003
- 6/26/2003
- 7/10/2003
Survival Estimation
## Estimating Survival Over Migration Route - 2003 Results

<table>
<thead>
<tr>
<th>Species</th>
<th>Approximate Week of Detection</th>
<th>Issaquah Hatchery - Marymoor</th>
<th>Issaquah Hatchery - Bear Creek</th>
<th>Issaquah Hatchery - Webster Point</th>
<th>Issaquah Hatchery - Lake Union</th>
<th>Marymoor - Kenmore</th>
<th>Marymoor - Lake Union</th>
<th>Marymoor - Metro Lab</th>
<th>Webster Point - Lake Union</th>
<th>Montlake - Lake Union</th>
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<tr>
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</table>

1. Based on median travel time of each release group over season (see text)
2. At upstream release point
3. Corrected for Detection Efficiency; U/S = upstream release point, D/S = downstream release point
4. Survival estimates in italics may be affected by unexplained variation

**N.B. Wide Confidence Intervals; Handling/Temperature Mortality at Lake Sites**
## Estimating Survival Over Migration Route - 2003 Results

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<tr>
<th>Species</th>
<th>Approximate Week of Detection</th>
<th>Lake Union - Metro Lab</th>
<th>Bear Creek - Kenmore</th>
<th>Bear Creek - Webster Point</th>
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## Estimating Survival Over Migration Route - 2003 Results

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## Estimating Survival Over Migration Route - Earlier Results

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<th>Species</th>
<th>Year</th>
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<th>Issaquah Hatchery</th>
<th>Bear Creek</th>
<th>Cedar River</th>
<th>Montlake Cut</th>
<th>Fremont Cut</th>
<th>Estimated Migration Route Segment &quot;Survival&quot;</th>
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<td>147</td>
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</tr>
</tbody>
</table>
Locks Operations and Passage
Small Lock Operations May Influence Passage Rates

![Bar Chart]

- **Y-axis**: Number of Fills in Preceding Hour
- **X-axis**: Time Small Lock Begins Filling
- The chart shows a peak in the number of fills around 17:00, suggesting a potential influence on passage rates.
Small Lock Operations May Influence Passage Rates

![Graph showing the total number of detections in prior hour for All Chinook in 2003. The x-axis represents the time of day, and the y-axis represents the total number detected in prior hour. The bars peak at different times, indicating variation in passage rates throughout the day.](image-url)
Passage Rates are ~Twice During Than Between Small Lock Fills:

Mean Ratio = 2.2
Flume Size May Influence Number of Fish, But Not Size of Fish Passed:
Water Efficiency

Chinook: $10^5 m^3$

Flume Inflow (cfs)

19°C

20°C

5B

5C

4B

4A

5/21/03 5/28/03 6/4/03 6/11/03 6/18/03 6/25/03 7/2/03 7/9/03
Future Directions

- How do we address water temperature effects in Lake Washington and the Ship Canal?
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- Shoreline habitat in lakes important until when?
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- Shoreline habitat in lakes important until when?
- How to determine when and how much smolts use other routes through Locks than smolt flume, and operate flumes/Locks accordingly?
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- What is influence of Montlake and Fremont cuts, and what can be done?
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- What is influence of Montlake and Fremont cuts, and what can be done?
- How can smolt flumes/locks be operated optimally for fish and water?