What We Know About Changing Size of Fish

JTC Salmon Size Subcommittee
US/Canada Joint Technical Committee
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- Dani Evenson- ADF&G co-chair
- Pat Milligan- DFO co-chair
Goals

i. Summarize existing literature

ii. Develop hypotheses and evaluate existing ASL data;

iii. ID hypotheses that can not be investigated due to limitations of existing data, and make recommendations to the JTC for data collection;

iv. Assess potential causes for changes in Chinook ASL and weight composition;

v. Recommend research to address data gaps;

vi. Provide updates
A SUMMARY OF FACTORS WITH POTENTIAL TO ALTER YUKON RIVER SALMON POPULATIONS

Goal 1. Summarize existing literature
5 Sections

- Harvest History
- Summary of existing age, sex and size studies
- Gillnet selectivity
- Influences on salmon size at sea
- Heritability of traits
Harvest History
US Total Utilization

![Graph showing US Total Utilization from 1960 to 2005. The x-axis represents years (1960 to 2005), the y-axis represents the number of Chinook. The graph is color-coded with red for subsistence, yellow for commercial, and blue for sport.](image-url)
Data Availability

**AYK Database project**

- Converted ASL data into an electronic format housed in a single location
- Available to the public in July 2007
- Includes ASL data from the Yukon, Kuskokwim and Norton Sound:
  - Commercial, subsistence, and test fisheries
  - Escapement projects
  - Special projects - mark/recap, radio telemetry
ASL data sampled in Chinook salmon fisheries
ASL Studies

Few Studies on the Yukon River

- Hyer and Schleusner 2005
- Bigler et al. 1996
- JTC Report (Buklis) 1998
Chinook Salmon ASL Analysis from Selected Escapement Projects

- the proportion of female Chinook,
- the proportion of large ($\geq 900$ mm) Chinook,
- the proportion of 6- and 7-year-old Chinook,
- the length-at-age of 6- and 7-year-old Chinook.

Hyer and Schleusner 2005
ASL Data collected from 6 Yukon River tributaries

- Gisasa
- Anvik
- Andreafsky
- Chena
- Big Salmon River
- Salcha
Chinook salmon escapement data sets

- Andreafsky weir
- Anvik weir
- Gisasa weir
- Chena weir
- Salcha weir
- Big Salmon weir
Objective 1

In 4 of the 7 escapement data sets the proportion of female Chinook salmon significantly changed over time.

**No Change**
- Andreafsky River Carcass Survey
- Andreafsky River Weir
- Gisasa River Weir

**Decreased**
- Anvik River Carcass Survey
- Chena River Carcass Survey
- Big Salmon River Carcass Survey

**Increased**
- Salcha River Carcass Survey

Hyer and Schlesusner 2005
Objective 2

In 4 of the 7 escapement data sets the proportion of large Chinook ($\geq 900$ mm) significantly decreased over time.

- No Change
  - Andreafsky River Carcass Survey
  - Andreafsky River Weir
  - Gisasa River Weir

- Decreased
  - Anvik River
  - Chena River
  - Salcha River
  - Big Salmon

Hyer and Schleusner 2005
Rivers showing a decreasing trend in the proportion of large (≥ 900 mm) Chinook salmon over time.

The proportion of large Chinook salmon sampled decreased 4% per year.

The proportion of large Chinook salmon sampled decreased 2% per year.

Hyer and Schleusner 2005
Rivers showing a decreasing trend in the proportion of large (≥ 900 mm) Chinook salmon over time.

The proportion of large Chinook salmon sampled decreased 2% per year.

The proportion of large Chinook salmon sampled decreased 7% per year.

Hyer and Schleusner 2005
Objective 3

In 3 of the 7 escapement data sets the proportion of 6-year-old Chinook salmon significantly changed over time.

No Change
- Andreafsky River Carcass Survey
- Andreafsky River Weir
- Gisasa River Weir
- Chena River Carcass Survey

Decreased
- Anvik River Carcass Survey
- Big Salmon River Carcass Survey

Increased
- Salcha River Carcass Survey

Hyer and Schleusner 2005
In 2 of the 7 escapement data sets the proportion of 7-year-old Chinook salmon significantly changed over time.

**No Change**
- Andreafsky River Carcass Survey
- Andreafsky River Weir
- Anvik River Carcass Survey
- Gisasa River Weir
- Salcha River Carcass Survey

**Decreased**
- Chena River Carcass Survey

**Increased**
- Big Salmon River Carcass Survey

Hyer and Schleusner 2005
Objective 4

10 of the 27 escapement data sets showed significant changes in the length-at-age for 6- and 7-year-old male and female Chinook Salmon.

<table>
<thead>
<tr>
<th>River/Survey</th>
<th>No Change</th>
<th>Decrease</th>
<th>Increase</th>
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<tbody>
<tr>
<td><strong>Andreafsky River Carcass Survey</strong></td>
<td>6-year male</td>
<td>6-year female</td>
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<td>7-year male / 7-year female</td>
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<td>7-year female / 7-year male</td>
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<td><strong>Gisasa River Weir</strong></td>
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<tr>
<td><strong>Big Salmon River Carcass Survey</strong></td>
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</table>
Conclusions

- the proportion of female Chinook,
  - 1 increased, 3 decreased, 3 no change
- the proportion of large ($\geq 900$ mm) Chinook,
  - 4 decreased, 3 no change
- the proportion of 6- and 7-year-old Chinook,
  - 1 increased, 2 decreased, 4 no change
- the length-at-age of 6- and 7-year-old Chinook.
  - 9 out of 27 decreased

Hyer and Schleusner 2005
Commercial Weights Analysis

Bigler et al 1996

n=19 years

R² = 0.45

p < 0.01

Weight (kg)

Year

Bigler et al 1996
Bigler et al. 1996

Change in Average Length and Age of Chinook

- Age-6: -5.5%
- Age-5: -2.8%
- Age-4: -3.8%

Bigler et al. 1996
JTC 1998

• Compiled available information on Yukon River Chinook ASL composition

• Examined length-at-age
  – Big Eddy test fishery (1979-1997)
  – Andreafsky River (1981-1997)
  – Canadian border fish wheel (1974-1996)
  – Canadian commercial fishery (1975-1996).
Mean Length by Age
Y-1 Commercial Harvests, Unrestricted Mesh

Females

Males

U.S./Canada Yukon River JTC 1998
Net Selectivity
Background

• Intuitively, large mesh nets catch large fish
  – Verified in numerous investigations
• Most published selectivity studies involve commercially exploited marine species
• Published salmon studies limited
  – North Pacific (NPFC, 1960s)
  – British Columbia (Fraser, Skeena)
  – Yukon River
Yukon River Net Selectivity

• ADF&G initiated selectivity studies to apportion sonar estimates of fish passage to species
• Unique data set for estimating salmon selectivity
  – Data base extends back to 1990
  – Multiple meshes from 2.75 to 8.5 inch
  – Contained over 92,000 records through 2003
Estimated Selectivity

Chinook salmon
Estimated Selectivity

Summer chum salmon
Estimated Selectivity

Fall chum salmon
Estimated Selectivity

*Coho salmon*
Things to note

- Gillnets tend to have peak efficiency for salmon with $length = 3.8 \times stretch\ mesh$
- Any sized mesh can catch a fish of nearly any size
- What is caught depends on
  - Selectivity of the net
  - The size of fish present

Bromaghin 2005
Example 1

Lengths of Chinook Caught by Different Mesh Sizes
Example 2
Chinook CPUE by Mesh

![Bar chart showing Chinook CPUE by mesh size with mesh sizes: 4.00, 5.25, 6.50, 7.50, 8.50 and corresponding CPUE values: 40, 70, 90, 100, 100 respectively.](image-url)
Example 3

Hypothetical Chinook Population

Bromaghin 2005
Example 3

Hypothetical Chinook Population

Bromaghin 2005
Example 3

Effect of 50% Exploitation
Heritability
Heritability

- Heritability measures the degree to which traits pass from one generation to the next
- Fish traits documented to be heritable
  - Body size and shape
  - Age of return
  - Gender
  - Run-timing
  - Resistance to disease
  - Ability to home
Ocean

- Potential oceanic influences
  - Nutrient mixing by winter storms
  - Timing of ice-out
  - Water temperature
  - Availability of prey
  - Competition (hatchery)
  - Timing of entry to sea
  - By-catch
Summary
Summary

• Cause of change difficult to prove
• Management may need to be more precautionary and remain flexible
  – Balance short and long term benefits, uncertainty, and risk
Next Steps

- Develop a set of hypotheses
Thank You!