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Columbia Basin Research (CBR) is a scientific research group at the University of Washington, School of Aquatic & Fishery Sciences. We investigate salmon biology and survival in the Columbia and Snake river basins. We provide user-friendly data analysis and modeling tools, and maintain DART, an interactive secondary database, for the fisheries community and the general public.

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VOLUME XVI

Survival and Transportation Effects for Migrating Snake River Hatchery Chinook Salmon and Steelhead: Historical Estimates From 1996-2003

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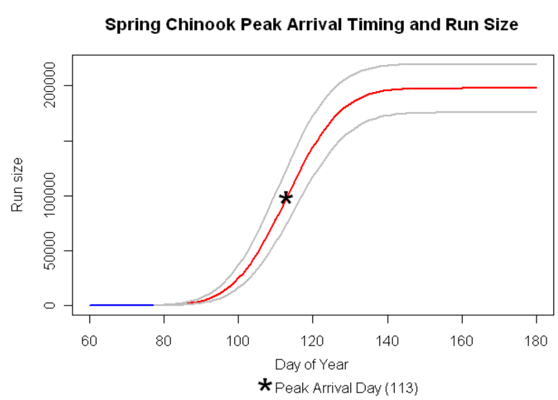

2008 Columbia River Preseason Adult Spring Chinook Run Size and Arrival Timing Predictions

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Report on Results from Program ROSTER Analyses

Historical estimates of survival and transportation effects for PIT-tagged hatchery salmon and steelhead tagged and released in the Snake River Basin from 1996 to 2003 have been calculated using Program ROSTER (River-Ocean Survival and Transportation Effects Routine). The results are presented in the technical report, *Survival and Transportation Effects for Migrating Snake River Hatchery Chinook Salmon and Steelhead: Historical Estimates from 1996-2003*, Volume XVI of the Bonneville Power Administration series on "Monitoring and Evaluation of Smolt Migration in the Columbia Basin." This series is accessible through Pisces, and our report is also available on the internet (M&E Volume XVI).

The report is based on analyses by Program ROSTER of historical data on a total of 3,602,547 tagged fish in 40 release groups from the Snake River Basin. The report provides annual estimates of the following: smolt-to-adult return ratio (SAR), juvenile inriver survival from Bonneville to Lower Granite, ocean return probability from Bonneville to Bonneville, and adult upriver survival from Bonneville to Lower Granite. Annual estimates of transport-inriver (T/I) ratios and differential post-Bonneville mortality (*D*) are reported on both a system-wide basis for all transport dams and also a dam-specific basis. Highlighted below are some of the results.

SARs. *Average* annual SARs, 1996-2003, for PIT-tagged hatchery salmon and steelhead from the Snake River Basin were estimated to be:

- 0.71% (SE = 0.18%) for hatchery spring Chinook salmon, omitting jack returns.
- 1.15% (SE = 0.31%) for hatchery summer Chinook salmon, omitting jack returns.
- 0.45% (SE = 0.11%) for hatchery steelhead, including jack returns (see Fig. 1).

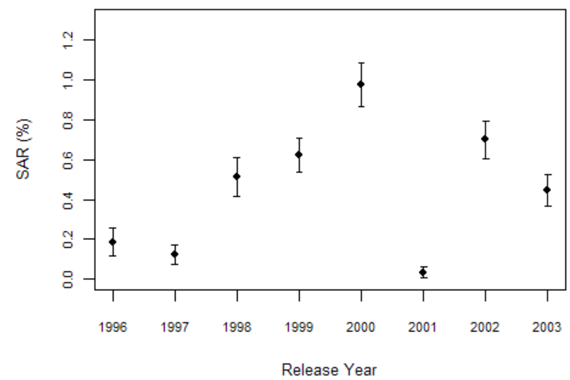

Figure 1. Point estimates and 95% confidence intervals for smolt-to-adult ratio (SAR) for tagged hatchery nontransported steelhead from the Snake River Basin.

Only for the release years 1999 and 2000 did the Chinook salmon SARs approach the target goal of 2% identified by the Northwest Power and Conservation Council as the minimum SAR for recovery.

T/I Ratio. Program ROSTER estimated systemwide T/I, which are averages of dam-specific T/I ratios based on dams with at least 5000 tagged fish transported. The weights are calculated as the probability of being transported at each dam. The systemwide T/I compares observed SARs under the existing transport system with expected SARs as if the transport system did not exist. Estimates of 1.0 indicate the transport system has *no* effect on SARs; estimates <1.0 indicate the transportation *decreases* SARs; and estimates >1.0 indicate the program *increases* SARs.

Too few steelhead were transported to analyze transport effects under Program ROSTER. For hatchery Chinook salmon tagged and released from the Snake River Basin from 1996 to 2003, geometric means were estimated as follows:

The 2001 release groups for spring and summer Chinook salmon were excluded due to high uncertainty on the estimates for that low flow year. In that year, T/I ratios were exceedingly high and would inflate these annual averages.

Mortality. Program ROSTER calculates Total Integrated Mortality as a measure of the contributions to overall mortality from different life stages that are invariant to the order of these life stages. Again, these results are based on hatchery fish PIT-tagged and released from the Snake River Basin from 1993-2006. The ocean life stage accounted for most of the Total Integrated Mortality for the hatchery fish in the study, specifically:

- 87% (SE = 1.3%) of the Total Integrated Mortality for hatchery spring Chinook salmon (see Fig. 2).
- 84% (SE = 2.4%) of the Total Integrated Mortality of hatchery summer Chinook salmon (2001 releases were excluded due to insufficient data).

- 1.15 (SE = 0.03) for hatchery spring Chinook salmon, excluding the 2001 release group.
- 1.28 (SE = 0.13) for hatchery summer Chinook salmon, excluding the 2001 and 2002 release groups.

- 74% (SE = 3.7%) of the Total Integrated Mortality of hatchery steelhead (2001 releases were excluded due to insufficient data).

The inriver juvenile component contributed:

- 9.2% (SE = 1.3%) of the Total Integrated Mortality for hatchery spring Chinook salmon (see Fig. 2).
- 11.6% (SE = 2.1%) of the Total Integrated Mortality of hatchery summer Chinook salmon (2001 releases were excluded due to insufficient data).
- 21.8% (SE = 3.6%) of the Total Integrated Mortality of hatchery steelhead (2001 releases excluded due to insufficient data).

For more information, the report in pdf form is also available upon request (newsletter@cbr.washington.edu).

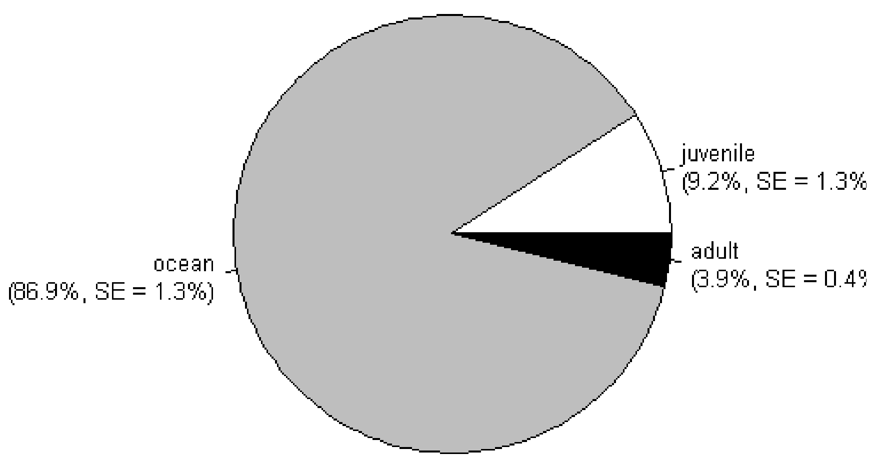

Figure 2. Average components of total integrated mortality for hatchery spring Chinook salmon from the Snake River Basin tagged and released from 1996 to 2003; juvenile inriver migration (white), adult upriver migration (black), and ocean life stage (gray).

2008 Columbia River Preseason Adult Spring Chinook Salmon Run Size and Arrival Timing Predictions

We are pleased to announce the release of Columbia Basin Research's 2008 Adult Spring Chinook Preseason forecasts, which now include mean run timing as well as run size.

The CBR 2008 preseason Adult Spring Chinook prediction is for an above average run size with the peak returns occurring about April 22 (Figure 3).

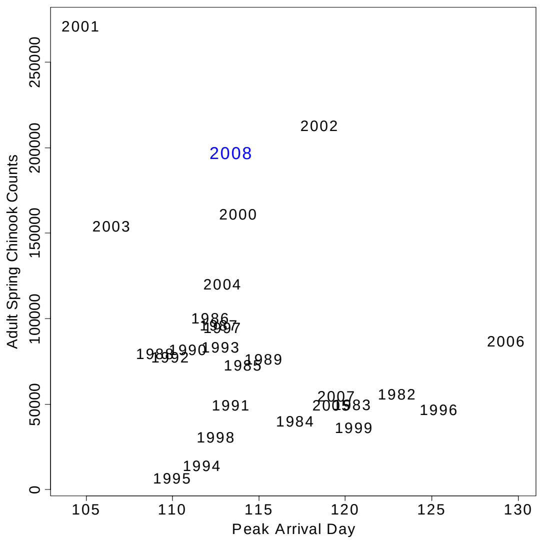

Figure 3. Peak Arrival Day and run size determined by fitting the spring run to a normal distribution (1982-2007). Points are in center of text. 2008 (in blue) represents the estimated timing and run size. The 2008 timing prediction produced by the *Genetics and Environment Timing* model. Counts based on regression of historic counts to previous year's jacks.

In the CBR Adult Spring Chinook Preseason Forecasts web page, we include information about the Columbia River Fisheries (CRM) preseason run size prediction. The CRM is responsible for the management of the anadromous fish runs and fisheries of the Columbia River. CRM develops harvest regulations in cooperation with federal and state agencies and Native American tribes and nations an in accordance with the *U.S. vs. Oregon*. Their 2008 preseason run size forecast for Upriver Spring Chinook is 269,300 fish. The Upriver Spring Chinook forecast is date-based (data through 6/15) and includes Snake River summer Chinook. The CRM forecast is based on age-specific linear regressions of cohort returns in previous run years.

For 2008, we use two methods to predict run size and arrival time of adult spring Chinook at Bonneville Dam.

- The first method is date-based and defines the salmon run as between March 15 and June 15. This method is used by the *Escapement Forecaster* program to produce the preseason run size prediction for 2008 of 307,000 fish. The June 15 cutoff date has been used since 2005 to best match the estimate and run dates used by the CRM.
- The second method is fit-based and defines run size with a normal arrival distribution and no cutoff dates (Figure 3). The 2008 preseason run size prediction is 197,500 spring Chinook. This method is used in conjunction with the *Genetics and Environment Timing* model to predict peak arrival day.

Figure 4 illustrates the difference between the two methods and the portion of the combined runs that are predicted.

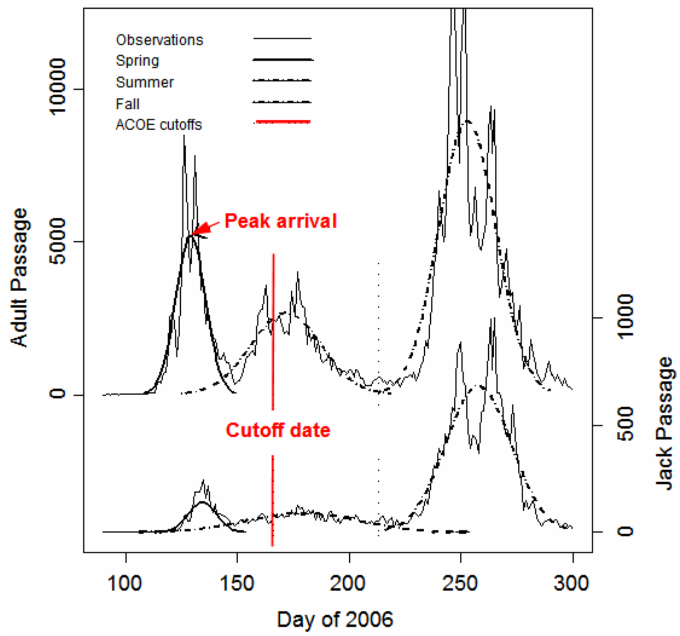

Figure 4. Passage counts of adult and jack Chinook salmon at Bonneville Dam in 2006 showing the tri-modal pattern. The thin line depicts the observed counts. The thick lines depict fitted Gaussian functions for spring, summer and fall runs. The fixed spring run cutoff date (June 15) is depicted with a vertical red line.

Arrival Distribution and Run Peak

The duration of the spring Chinook salmon run is defined by two methods. The *Escapement Forecaster* applies the cutoff date used for management of inriver harvest; the run is the total number of adult spring Chinook salmon passing Bonneville Dam between March 15 and June 15. The *Genetics and Environment Timing* model, a better ecological characterization of the spring run, simultaneously describes the distributions of the spring, summer, and fall runs by fitting three superimposed normal distributions to the combined run. The mean arrival date of each normal distribution characterizes the arrival peak independent of the method used to determine run size. See Run timing of adult Chinook salmon passing Bonneville dam on the Columbia River (white paper) for further details.

Genetics and Environment Timing Model Preseason Prediction

The spring Chinook Peak Run Timing prediction is based on indices of the run's genetically-based run timing plus indices of the ocean and river currents fish encounter on their homeward migration. The genetic run timing basis is inferred from the timing of the previous year's jack run. The effects of ocean currents encountered by both jacks and adult fish approaching the Columbia River are inferred from the January coastal downwelling indices in the years of their respective returns. The river velocities jacks and adults encounter are inferred from river flows in the month prior to their arrivals at Bonneville Dam. The model, calibrated with data between 1978 and 2007, has an r^2 = 0.78. A manuscript describing the run timing model is in review (Anderson and Beer, submitted to *Ecological Applications*).

Escapement Forecaster

The *Escapement Forecaster*, employing the date-based method, preseason adult run size is estimated using a linear regression of the previous year's jack run size against adult run size. We use adult passage counts at Bonneville Dam since 1982. The regression obtained with run size determined by cutoff dates is:
Adult.count = 25667 + 13.9 * *Jack.count*,
with $r^2 = 0.79$.

2008 Adult Chinook Inseason Forecasts

New to the CBR Inseason Forecasts web analyses for the 2008 migration season is the adult spring Chinook Peak Arriving Timing & Run Size Prediction at Bonneville Dam (Figure 5). These predictions for spring Chinook salmon begin with a preseason prediction of run timing from the *Genetics and Environment Timing* model, and a preseason run-size prediction based on the previous year's Jack returns. Because the complete run of Chinook salmon in the Columbia River is the sum of three sub-runs (spring, summer, and fall—each well characterized by a Gaussian distribution), inseason forecasts use daily observations to adjust the parameters that comprise the first mode of the complete distribution to predict the spring Chinook salmon run.

We will continue to produce the Daily Run Size & Passage Prediction with the *Escapement Forecaster*, defining the spring Chinook run as March 15-June 15 (Figure 6). As the season progresses, the prediction switches from the preseason estimate, based on the linear regression of last year's jacks, an optimal pattern matching routine of historic run timing.

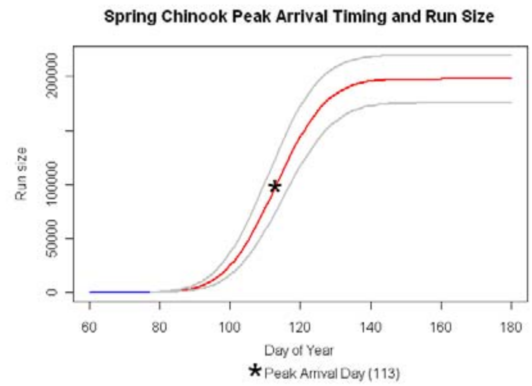

Figure 5. Adult Spring Chinook Preseason Peak Arrival Timing and Run Size Prediction graph.

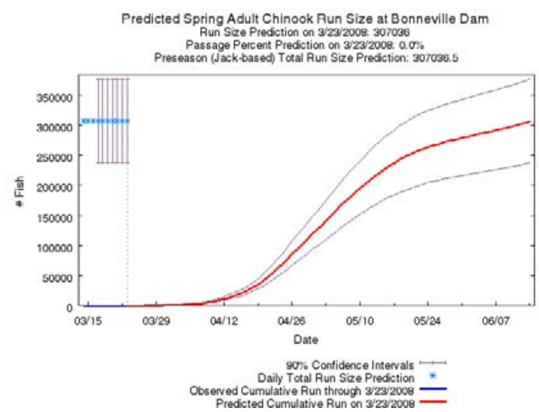

Figure 6. Adult Spring Chinook Preseason Run Size & Passage Prediction graph (date-based).

Daily updates throughout the migration season are accessible from the Adult Passage Predictions, Inseason Forecasts web page.

For more details:
Adult Spring Chinook Preseason Forecasts
www.cbr.washington.edu/crisprt/adult_preseason.html
Adult Passage, Inseason Forecasts
www.cbr.washington.edu/crisprt/index_adult.html