

## SALMON TECHNICAL TEAM ANALYSIS OF RISKS AND BENEFITS OF ALTERNATIVE REBUILDING CRITERIA FOR KLAMATH RIVER FALL CHINOOK

### INTRODUCTION

Klamath River fall Chinook (KRFC) failed to meet the minimum escapement goal of 35,000 natural-area adult spawners in 2004, 2005, and 2006, triggering an Overfishing Concern. In 2007 a workgroup was convened by the Council, consisting of members of the Salmon Technical Team (STT) and additional members from other management agencies, to evaluate factors contributing to these escapement shortfalls and develop recommendations for recovering the stock and ending the Overfishing Concern. The recommendations of this workgroup were presented to the Council in a report by the STT at the March 2008 Council meeting. At this meeting the Council tentatively adopted management measures and criteria for ending the Overfishing Concern for KRFC. The management measures included managing for a minimum of 40,700 natural-area adult spawners until the Overfishing Concern is ended.

The management measures and criteria adopted by the Council included most of the recommendations of the workgroup with two exceptions. 1) The workgroup recommended implementation of a sliding scale for the maximum allowable *de minimis* fishing mortality rate, until the Overfishing Concern is ended. The sliding scale would have placed a cap on the age-4 ocean impact rate that increased linearly from 0 percent at a projected adult natural spawner escapement of 21,000, to 10 percent at the minimum targeted escapement of 40,700 adult natural spawners until the Overfishing Concern was ended. The Council rejected this recommendation. 2) The workgroup recommended ending the Overfishing Concern when a minimum of 35,000 natural-area adult spawners was achieved in 3 of 4 consecutive years, with a minimum of 40,700 natural-area adult spawners in at least one of the years. In lieu of this recommendation, the Council adopted a modified criterion for ending the Overfishing Concern: attainment of a minimum of 35,000 adult natural spawners in 3 of 4 consecutive years, or the attainment of 40,700 natural-area adult spawners for 2 consecutive years.

Both of these departures from the workgroup recommendations decrease the expected spawning escapement of KRFC. By not implementing a *de minimis* sliding scale for the age-4 ocean impact rate, greater harvest impacts could occur during the Overfishing Concern. By allowing the Overfishing Concern to end with the attainment of two consecutive years of at least 40,700 natural-area adult spawners, the Overfishing Concern could end sooner than if the workgroup recommendation was adopted. However, the degree to which these departures increase risks to KRFC is extremely difficult to assess. At the March Council meeting, members of the Scientific and Statistical Committee (SSC) suggested that the Stochastic Spawner-Recruit Model (SSRM) be used to evaluate the risks specifically associated with the workgroup recommended and the Council modified criteria for ending the Overfishing Concern.

## METHODS

The SSRM, as currently configured, does not have the capability of specifically modeling either alternative of the criteria for ending the Overfishing Concern. However, it can be used to approximate the potential range of difference in risks between the alternative criteria. The SSRM has the capability of modeling different escapement floors used as fishery targets, and allows the specification of current abundance and recent observed escapements as initial conditions. It simulates the population and fisheries for 40 years and reports performance measures for years 1-5, 6-40, and over the entire 40 year period.

Natural-area spawning escapement of KRFC in 2007 was over 59,000 adults, and the projected escapement to the River mouth in 2008 is 76,900 potential natural-area adult spawners. Under option II (the criteria tentatively adopted by the Council) there is a good chance that the Overfishing Concern could be ended in 2008 with the attainment of two consecutive years of at least 40,700 natural-adult spawners. This would allow management for the escapement floor of 35,000 adult natural-area spawners in 2009, year 2 of the simulation. However, the age-3 forecast abundance in 2008 is the lowest on record, so absent a very strong return of 2-year old fish in 2008, there is a very good chance that the 35,000 floor will not be met in 2009. Under option I (the criteria recommended by the KRFC workgroup), failure to meet the floor in 2009 and again in 2010 would result in the Overfishing Concern persisting for a minimum of 5 years.

The primary consequence of ending the Overfishing Concern is that the minimum natural-area adult spawning escapement that could be targeted, without reducing fisheries to *de minimis* impact levels, would decrease from 40,700 to 35,000. Therefore, simulating the population with current abundance and forecasts, and evaluating performance over the first 5 years with alternative escapement floors, may approximate the alternative criteria. Assuming a minimum escapement goal of 35,000 probably overstates the risks associated with option II because there is some chance that the criteria for ending the Overfishing Concern will not be met this year. It further includes management for the escapement floor of 35,000 in year 1 of the simulation, while the goal should be 40,700 in year 1 under both options. Assuming a minimum escapement goal of 40,700 probably understates the risks associated with option I because there is a reasonable chance that the Overfishing Concern could end prior to the 5-year evaluation period (although there is also some chance that it could extend longer). Hence these approximations likely provide an upper bound on the expected differences in risks associated with the two options, as assessed by the metrics of the SSRM.

In order to evaluate the alternative criteria, a 40 year period was simulated for 1,000 trials using the SSRM. For each trial, initial conditions included the observed adult natural-area spawning escapements from 2006 and 2007, the 2008 forecasts for ages 3-5 ocean abundance, and the percentage of each brood destined to return to hatcheries. Option I trials employed a 40,700 minimum escapement goal and option II trials used a minimum escapement goal of 35,000. Both runs used the same initial seed for the random number generator and thus included identical sequences of pseudo-random numbers.

## RESULTS

Selected performance measures from the SSRM simulation are presented in Table 1 (detailed output are attached). As expected, targeting a higher natural-area spawning escapement results in lower frequencies of falling below escapement benchmarks or failing to meet consultation standards. Differences are small when viewed in absolute terms because of the large random variability in forecasting and management implementation. However the same differences are not so small when considered in a relative sense. For example, the frequency of failing to achieve 35,000 natural-area spawners increases from 0.330 to 0.363 between option I and option II. That is an absolute increase of 0.033, but a relative increase of 10 percent. The frequency with which escapement and age-4 ocean harvest rate fails to meet various benchmarks increases when the minimum adult natural-area escapement target decreases from 40,700 to 35,000 by a relative difference ranging from 10 percent to 39 percent depending on the benchmark. At the same time, the expected harvest increases by 1 percent, and if KRFC were assumed to be the primary limiting stock in ocean fisheries south of Cape Falcon, differences in economic benefits between the options would also be about 1 percent.

Table 1. Short term (years 1-5) results for some performance measures from SSRM resulting from alternate minimum escapement targets. Both alternatives include the California Coastal Chinook Endangered Species Act consultation standard capping age-4 ocean harvest rate at 16%, and allow 10% *de minimis* age-4 ocean impact rate when escapement is projected to be below the target.

Performance measure	Minimum natural escapement target		Absolute difference	Relative difference
	40,700 (Option I)	35,000 (Option II)		
Frequency escapement <35,000	0.330	0.363	0.033	10%
Frequency escapement <12,000	0.018	0.025	0.007	39%
Frequency tributary escapement <720	0.128	0.147	0.019	15%
Frequency age-4 ocean harvest rate >16%	0.320	0.342	0.022	7%
Average ocean harvest (hatchery + wild)	27,452	27,688	236	1%
Average tribal harvest (hatchery + wild)	42,631	43,097	466	1%

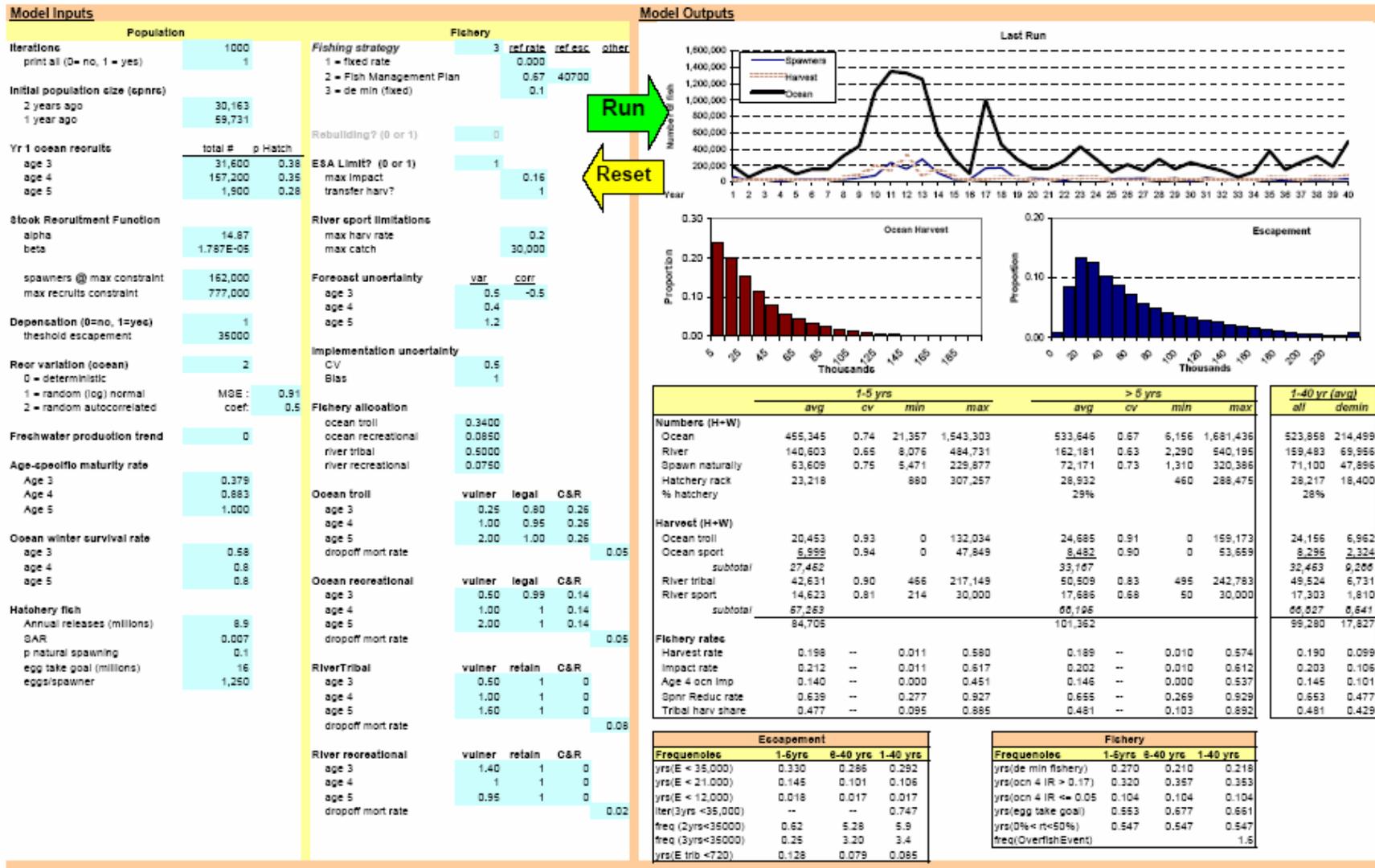
## CONCLUSIONS

Simulations performed with the SSRM evaluated the absolute and relative differences in key management metrics with two alternative minimum natural-area escapement targets. These simulations presuppose that the Overfishing Concern will be active in 2009 under option I, and that it will have ended prior to 2009 under option II. Due to these assumptions, the differences in risks (e.g., failure to meet the 35,000 escapement threshold) and benefits (e.g., increased harvest) described should represent the upper bound estimates.

As demonstrated in Table 1, the SSRM predicts small absolute differences in risks and somewhat larger relative differences in risks between option I and option II. At the same time, the relative difference in benefits, as measured by increased ocean and tribal harvest, are nearly negligible.

The SSRM identifies and quantifies the core metrics associated with the targeting of different minimum escapement levels. A full management strategy evaluation, with the minimum natural escapement target changing dynamically with simulated escapement values, is beyond the capabilities of the SSRM. However, since the level of risks and benefits between the two options are likely to be encompassed by the results presented here, it is unlikely that a full management strategy evaluation would provide substantially more information on which to base a decision.

Option I SSRM output.



Option II SSRM output.

