April 13, 2012

Response to science panel's Task 5 (received on March 19, 2012):

"In prospective analyses of alternative fish management scenarios, it would be interesting to explore an alternative fish harvest policy which only reduces the harvest rate when Chinook abundances are below some appropriate benchmark. In the short term, it would be interesting to do a sensitivity analysis with an example benchmark level to explore this effect."

Response:
We agree that this is an important topic to explore. Ultimately, if we are to contemplate fishery management measures based on varying salmon abundance, we would need to explore salmon abundance indices that are or could be directly used in pre-season salmon harvest management planning processes. In the short-term, however, we are addressing the panel's request by simply focusing on a sensitivity analysis to explore the potential effects on SRKW of such a policy without regard to its practical implementation feasibility.

In order to compare the new analysis to previous results, we used the same Parken-Kope fall index (-CA) presented in Workshop 2, referred to herein as the P-K index. Stocks included in this index are the Columbia River tule and fall bright stocks, Puget Sound, Upper Georgia Strait, Lower Georgia Strait, Fraser Late, Puget Sound, WA coast, OR coast, and WCVI stocks.
The only modifications to the analysis since workshop 2 were:

1. for the salmon abundance projections, we are now focusing on the results with a CV of 20%, instead of 5%, and
2. a 50% sex ratio at birth was assumed, rather than 45% female / 55% male

For quantities like mean killer whale population size, the results are essentially the same regardless of the CV. Following with E. Ward's other responses following workshop 2, we are only presenting the relative change (not absolute #s). That is, all scenarios explored are compared to what killer whale population dynamics would do under the status quo, i.e., without fishery adjustments. For example, if the status quo (no adjustment of fisheries) would result in a population size of 100, but the modified harvest scenario would result in a population size of 110, the scenario results are presented as an increase of 10 individuals.

After consulting with NOAA colleagues (L. Barre, S. Bishop, P. Dygert, B. Hanson, M. Ford, L. LaVoy, R. Kope, L. Rutter), we thought one way to evaluate the panel's suggestion of adjusting fisheries only in years of poor Chinook abundance would be to examine the effects on SRKW if fishery adjustments were scaled to the P-K abundance index. (Again, this analysis is done without regard to practicality, assumes a causal relationship, and disregards confounding factors like competing predators.) Recall that the mean of the sum of the stocks contained in the P-K index was approximately 1.2 million Chinook. Recall also that the maximum possible increase in the P-K index was approximately 20% if all Chinook fishing was closed.

For this analysis:

Scenario 1 adjusts fisheries only in years when the P-K index is less than the mean value, i.e., the 0.5 quantile. Between the 0.5 quantile and the lower 1/3 (0.33) quantile, we decrease fisheries as necessary to produce a linearly increasing P-K index to achieve a 10% increase at the 0.33 quantile, as illustrated in Figure 1. At all P-K index values less than the lower 1/3 quantile, fisheries are adjusted as necessary to increase the P-K index by 10%.

In addition to the variable harvest rate scenario, we considered two additional scenarios:

In Scenario 2, fisheries are not adjusted except when salmon abundance is extremely high (quantile > 90%). The rationale for this is to examine how the whales might benefit from harvest reductions in years of relatively high salmon abundance compared to reductions at years of low salmon abundance, since the absolute change in salmon abundance for a given fishery harvest rate adjustment is higher at higher abundance.

Scenario 3 is similar to the one presented in Workshop 2, where the P-K index was increased by a constant amount (10%) for all years. The purpose of including this "baseline" scenario is that this is similar to the approaches presented in Workshop 2 (under E. Ward's future projections, the effects of increasing salmon at 0 – 20% could be examined).

Brief summary of results

For each of the three scenarios, we calculated the change relative to the baseline (mean terminal run size is the same at 1200, CV of future projections is 20%). Performance metrics included change in the mean and median SRKW population size, change in whales added per year, changes in probabilities of delisting and downlisting (i.e., from Endangered to Threatened under the U.S. ESA), and changes in the probability of meeting Puget Sound Partnership recovery goals (> 95 whales in 2020).

In general, Scenario 1 (variable harvest rate) results in an increase in killer whale population size that is about 50% of the increase under Scenario 3 (constant increase for all years). Scenario 2 fared slightly worse, and reduced the estimated probability of downlisting / delisting considerably over the next 30 years.

Figure 1. Depiction of how P-K index is increased / modified by reducing fishing in low abundance years (Scenario 1)

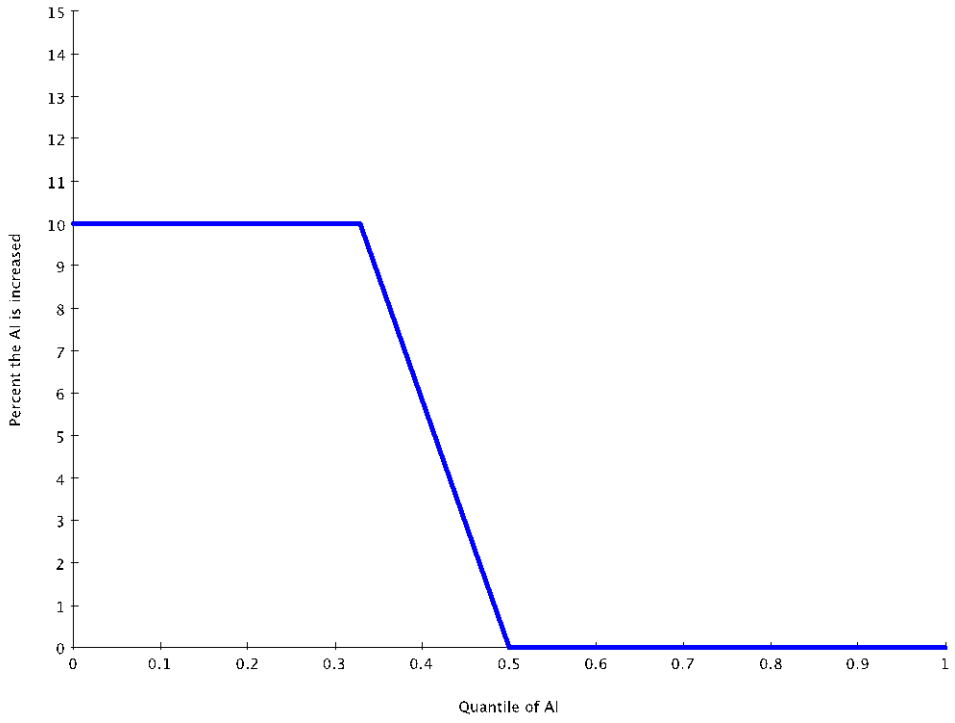

Table 1. Metrics of change in SRKW population size relative to the baseline (status quo = mean terminal run of 1200 thousand, with a CV of 20%).

Increase in Mean Population Size	**5 year**	**15 year**	**30 year**
Baseline (status quo fisheries)	92.1	98.1	115.8
Scenario 3: Increase P-K index by 10% all years	2.12	5.99	12.50
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	0.06	0.41	0.83
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	0.88	2.99	5.96
Increase in Median Population Size	**5 year**	**15 year**	**30 year**
Baseline (status quo fisheries)	92	96	108
Scenario 3: Increase P-K index by 10% all years	3	6	12
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	1	0	0
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	1	3	5
Increase in Mean Whales / Yr	**5 year**	**15 year**	**30 year**
Baseline (status quo fisheries)	1.02	0.74	0.96
Scenario 3: Increase P-K index by 10% all years	0.42	0.40	0.42
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	0.01	0.03	0.03
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	0.18	0.20	0.20

Table 2. Metrics of change in recovery criteria relative to the baseline (status quo = mean terminal run of 1200, with a salmon CV of 20%).

Pr (Downlisting)	**5 year**	**15 year**	**30 year**
Baseline (status quo fisheries)	0.0368	0.1514	0.2598
Scenario 3: Increase P-K index by 10% all years	0.0242	0.0876	0.0860
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	-0.0026	-0.0134	0.0064
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	0.0020	0.0132	0.0196
Pr (Delisting)	**5 year**	**15 year**	**30 year**
Baseline (status quo fisheries)	0	0.0054	0.1250
Scenario 3: Increase P-K index by 10% all years	0.0000	0.0102	0.0684
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	0.0000	-0.0008	-0.0192
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	0.0000	0.0000	0.0000
PSP Recovery	**2020**		
Baseline (status quo fisheries)	0.48 (48%)		
Scenario 3: Increase P-K index by 10% all years	0.11		
Scenario 2: Increase P-K index by 10% only when abundance in top 10%	-0.05		
Scenario 1: Increase P-K index by up to 10% only when P-K index < mean of 1200	0.00		