STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

OFFICE OF THE COMMISSIONER

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To: **Dr. Ray Hilborn**
Chair NOAA/DFO Expert Panel
Mr. Larry Rutter
NOAA Fisheries

From: **John Carlile M.S., David Bernard, Ph.D, John Clark, Ph.D**

Date: **April 4, 2012**

Re: **Alaska Department of Fish and Game Comments Relative to Presentations at Southern Resident Killer Whale Workshop Two**

We appreciate NOAA and DFO convening the workshop process to review the science regarding potential relationships between fisheries and the status of Southern Resident Killer Whales (SRKW). Our presumption is that members of the expert panel were chosen to evaluate the science behind the proposition that salmon, particularly Chinook salmon, as prey are an essential part of the diet of SRKWs.

There can be little doubt that SRKWs eat Chinook salmon. Visual and scatological information on the predation of Chinook salmon by SRKWs has proven sufficient to launch this series of workshops. The panel has asked for, and has received, statistical analyses looking for relationships between population growth rates of whales and various indices of abundance for many stocks of Chinook salmon. The panel has also asked for an evaluation of the efficacy of closing fisheries for Chinook salmon on the growth rates of SRKWs.

After careful evaluation of the presentations and analyses that the science panel has received so far, our conclusion is that scientific argument on the central question of cause and effect has been largely ignored. What is possible has been confused with what is probable. Definitive arguments against cause-and-effect relationships have been ignored in setting up the most pertinent analyses. Improbable scenarios for simulations were arbitrarily chosen. Statistically inconvenient, yet scientifically telling results from these analyses were subsequently ignored. We do not wish to be presumptuous but we do not believe that this is the kind of work product that the science panel expected or needs to appropriately evaluate relationships.

Our comments below are intended to point out specific problems with the science behind the statistical analyses and simulations presented during the second workshop, and to provide some insight on how we believe these problems can be corrected. In other words, we want to suggest ways to have the science drive the analysis instead of the rote of statistical procedures. And lastly, it is our hope that the science panel will reflect on the economic and social consequences that may needlessly result if science does not drive this process.

The presentations and discussions regarding the status of SRKW that occurred at Workshop 2, "Evaluating the Effects of Salmon Fisheries on Southern Resident Killer Whales", were thought provoking. As usual with these types of endeavors the workshop not only provided answers and further clarity to some of the issues surrounding SRKW but also raised new questions and concerns regarding the analytical methods used to assess the current status of the SRKW as well as potential effects that Chinook salmon abundance may or may not have on SRKW dynamics.

In particular, there were two presentations by Eric Ward entitled, "Exploring sensitivity of the relationship between salmon abundance indices with killer whale demographics" and "Quantifying fishing impacts on past and future killer whale growth rates" that raised questions and concerns regarding the underlying assumptions of the analyses that were presented as well as the appropriateness of the Chinook abundance data used as input which in turn, calls into question the validity and significance of the results.

Regarding the underlying assumptions in Eric's analyses, there are five issues that cause us concern:

1. The logistic regression model that was used found a statistical association between the aggregate terminal run abundance (Parken-Kope index; see table and plots below) of Fall-Summer/Fall Chinook stocks and the "expected growth rate", λ^* = (E[animals that survive from t to t+1] + E[births at time t+1]) / (animals alive at time t), of SRKW. This model was then used to estimate the increase in the expected growth rate (λ^*) if the terminal runs were increased due to reductions in or complete elimination of ocean fisheries. The statistical association between the Parken-Kope index and λ^* indicates that there is a correlation between the index and λ^*. However, it does not mean that there is a causal relationship between the index and λ^*. Likely there are other causal agents that drive both the Parken-Kope index and λ^* or this could simply be a spurious result. Yet, Eric's analysis assumes that increasing the terminal runs of the Fall-Summer/Fall Chinook stocks will directly affect the expected growth rate of SRKW. This only makes sense if you make the leap from a correlation to a causal relationship. Issue number two below will shed some light on why that leap would be ill advised.

2. Most of the stocks included in the Parken-Kope index have not shown up in the feeding or fecal samples of SRKW. In addition, several stocks of Chinook in the index have timing and distribution patterns that make it highly unlikely that SRKW would come into contact with them for other than a diminutive period of time during their respective life histories (Oregon Coastal Fall and Washington Coastal Fall stocks for instance). If the life histories of SRKW and several Chinook stocks in the Parken-Kope index barely overlap in terms of time and space, how can a casual predator-prey relationship be supported scientifically? If the hypothesis is true that abundance of Chinook salmon affects SRKW dynamics, how can it be that for those stocks known to be fed upon by SRKWs, there is no statistical correlation yet weak statistical correlations exist for stocks that have a miniscule overlap in range in terms of time and space with SRKWs? Existing scientific data on seasonal ranges of SRKWs and many Chinook stocks support the rejection of the casual relationship hypothesis.

3. Even if one is willing to make the leap from correlation to a causal relationship and proceed with the analysis, the calculation of the increase in the terminal run sizes due to reductions in fisheries is flawed. The analysis of the increase in the expected growth rate

of SRKW assumed that all the Chinook saved due to reductions in or complete elimination of ocean fisheries would accrue to terminal runs in the year of the reduction. This is an obvious oversight since only the Chinook that mature that year would accrue to the terminal runs in the year of the reduction. An analysis that only adds the savings of mature Chinook due to ocean fishery reductions to the terminal runs is lacking. Also, the Parken-Kope index is based on Chinook abundance in terminal areas many of which the whales do not seasonally frequent. From May through September surveys in Puget Sound have been conducted about every 3-4 days showing that from June through September essentially all the SRKWs have been in Puget Sound. For this reason, the only terminal area frequented by whales would be Puget Sound. Abundance for Chinook stocks with their terminal areas not within Puget Sound could not be directly related to the prey field of SRKWs. As a result, limiting the abundance index to terminal areas is a further flaw in the index.

4. The analysis assumed CVs of 5% and 20% in the estimation of the abundance of Fall-Summer/Fall Chinook (Parken-Kope index). It was concluded that a CV of 20% was too variable to produce any meaningful estimates of the increase in the long-term growth rates for SRKW so 5% was used instead. However, the arbitrary choice of the lower CV adds another assumption to the analysis, the assumption that reductions in fisheries produce a radical change in the population dynamics of Chinook salmon. As a demonstration, we have attached a figure of the original Parken-Kope AI scaled to a value of 1,200 as presented on 14 March. We have also overlain 10 simulated series scaled to produce a CV of 5%, a comparison not presented on 14 March. Because coefficients in the logistic regression used in the projections were generated from the original AI series from 1979 – 2010 (Eric Ward, personal communication), scaling that series to have a CV of 5% for projections beyond 2010 produces a future scenario that is radically atypical of the past, or from the general dynamics of salmon populations as has been our experience. Simulated results from the time series of AIs scaled to have a CV of 20% were ignored (not presented on 14 March) ostensibly because projections of λ^* could not be reasonably estimated. Such a result is exactly what would be expected if Chinook abundance was a negligible factor in the dynamics of SRKWs. These unreported results are even more insightful considering that the CV of the original un-scaled AI series is 25%, not 5%. It is our hope that the science panel will weigh its requests carefully to ensure that pertinent evidence is analyzed and that choices in the analysis are not arbitrary.

5. A meaningful and thoughtful comparison of SRKW dynamics and Chinook abundance is still lacking. The first step should be careful identification of the Chinook stocks that have a reasonable likelihood of representing a significant portion of the SRKW diet. Such a list could be developed by first selecting those stocks that have already been documented as prey through scat and other studies. The list could be expanded by adding to that list, stocks of Chinook that have a significant likelihood of substantially overlapping the SRKW population in time and space. An instructive and scientific approach to developing such a list has yet to done, instead a myriad of indices has simply been statistically compared to SRKW dynamics and those with significant results used thereafter, whether or not there is scientific credibility associated with the assemblage of Chinook stocks included. The approach has consisted of the opportunistic selection of data in order to produce a statistical correlation rather than a careful and scientifically

based assemblage of Chinook stocks and statistics that fits well with known distribution data and which could support an analysis of causation.

We have also been concerned about the complete lack of any analysis of the comparative costs and benefits associated with discussions concerning restrictions in fisheries and the potential benefits to the SRKW population. Eric Ward's most recent presentation projected that a 20% increase in the Parken-Kope index, which was determined to be the equivalent of eliminating all ocean fishing for Chinook salmon, would produce at most, on average, one additional whale per year to the population. It was also stated that the same benefit would accrue to the whale population if the current sex ratio was 1:1 instead of 45-55%. While management cannot correct the current sex ratio, it is obvious that the small improvement being contemplated is inconsequential. What is not inconsequential is the potential economic impacts on thousands of small businesses up and down the west coast of North America were fishing for Chinook banned to provide a minor improvement in SRKW dynamics. Thousands of jobs and many millions of dollars would be lost due to the kinds of changes in fisheries that are currently being discussed. The primary effects on commercial and sport fishermen, the secondary effects on businesses and communities that depend upon salmon fishing and the detrimental effect this would have on the economy of coastal communities is staggering to consider.

Finally, an examination of the costs and benefits of actually trying to implement the modeled fishery reductions must also take into account the concerns about the underlying assumptions that we have listed above:

1. Does a causal relationship really exist?

2. Do the stocks in the Parken-Kope index make sense in terms of predictors of SRKW growth rates?

3. The potential increase in the number of SRKW over 50 years will almost certainly be less than 50 animals (less than 1 SRKW per year) once the correction is made to account for ocean fishery reduction savings in mature Chinook.

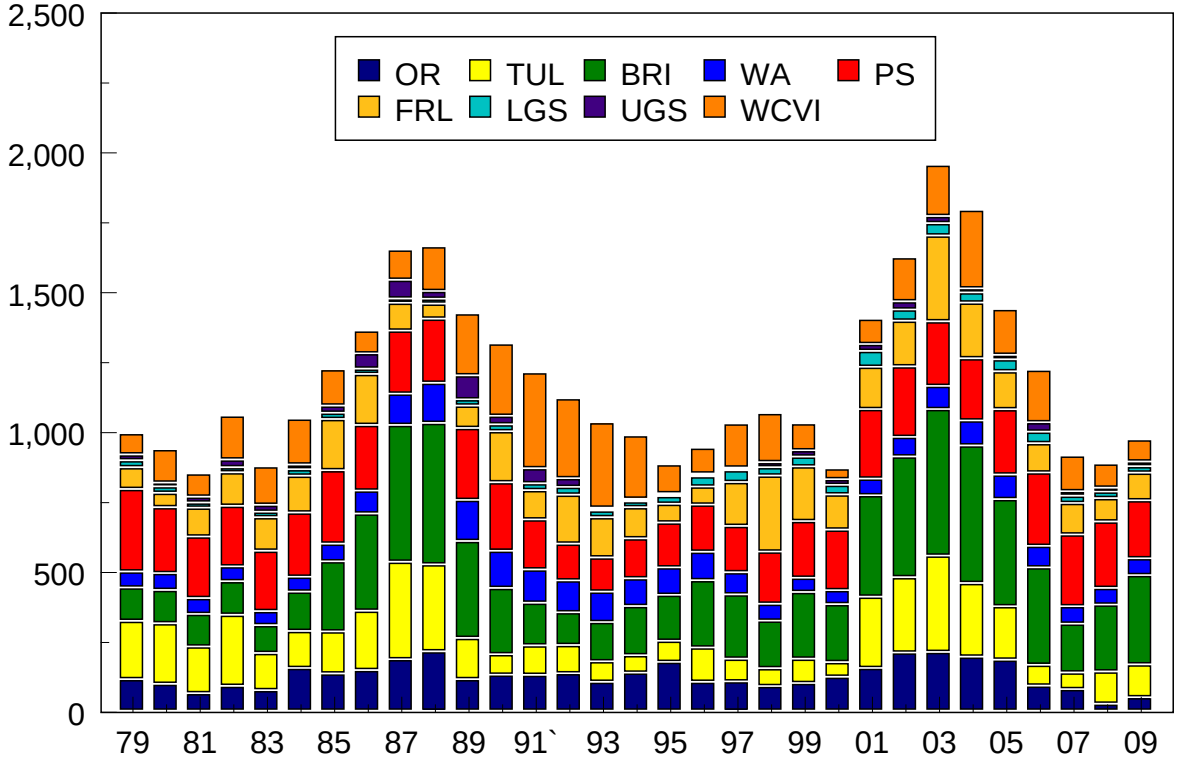
4. Can the increase in SRKW growth rates (λ^*) even be reliably estimated since this analysis assumed a CV of 5% when the true CV is closer to 25% and it has already been stated by Eric Ward in his presentation that a CV of 20% rendered a credible estimation of λ^* impossible?

We realize that tallying potential economic costs of potential restrictions on fisheries may be outside the scope of this workshop. However, in so far as some potential restrictions are made through the U.S. Magnuson-Stevens Reauthorization Act, costs of those restrictions will have to be estimated with the least costly effective set of regulations chosen. Again, without wishing to be presumptuous, we feel that now would be a good time for the science panel to at least recommend analyses that would provide a defensible estimate of the expected benefits and the potential costs of any adjustments made to Chinook fisheries.

Terminal run size (in 1,000's) by year for the Chinook stocks included in the Parken-Kope abundance index used by Eric Ward in his evaluation of relationship between SRKWs and Chinook.

Heading titles of OR = Oregon Coast Fall, TUL = Columbia River Tule Fall, BRI = Columbia River Bright Fall, WC = Washington Coast Fall, PS = Puget Sound Summer/Fall, FRL = Fraser Late Fall, LGS = Lower Georgia Straight H & N Fall, UGS = Upper Georgia Straight Fall, WCVI = West Coast Vancouver Island Fall, and Sum = the sum of all 9 data sets by year.

Year	OR	TUL	BRI	WA	PS	FRL	LGS	UGS	WCVI	Sum
1979	112.8	208.8	119	57.6	295	78	25.1	21	75.7	993
1980	96.4	216.4	119.8	60.1	236	52	23.4	13.3	120.3	937.7
1981	62.5	167.5	116.1	57.2	220	104	18.5	21.2	82.8	849.8
1982	88.9	254.5	120.1	53.3	217.3	120	17.8	27.8	157.4	1,057.10
1983	73.5	133.8	99.8	50.4	216	120	19	25.7	137.3	875.5
1984	152.8	132.6	140.9	53	229.8	132	23.6	16.9	164.3	1,045.90
1985	133.2	150.2	251.3	63.3	262.9	183.1	22.5	26.1	130.7	1,223.30
1986	145.9	211.7	347.4	82.6	235	182.5	19	54.6	81.6	1,360.30
1987	184.5	348.5	489.5	111.5	225.7	99.7	15.9	66.8	108.5	1,650.60
1988	212.3	311.1	505.9	143.5	229.5	54.4	17.2	27.8	159.8	1,661.50
1989	113	147.6	346.8	147	258	79.7	22.3	86.4	221.2	1,422.00
1990	128.6	74.1	237	133.7	244.4	182.7	25.4	30.7	258.7	1,315.30
1991	128.2	105.8	152.8	119	179.4	104.6	25.1	53.9	343	1,211.80
1992	134.2	101.3	117.6	113.7	131.9	175.7	27.8	30.8	286	1,119.00
1993	103.9	72.9	140.5	109.6	122.2	143.6	24.6	10	304.9	1,032.20
1994	135.8	63.2	176	98.9	143.3	111.3	21.5	9.5	226.9	986.4
1995	174.5	75.7	164.6	98.5	160.9	67	28.4	10.2	103.3	883.1
1996	103.4	123.2	240.3	102.3	168.5	65.1	36.6	10.8	92.1	942.3
1997	104.8	82.2	229.5	79.3	165.8	157.2	42.9	9.1	157.6	1,028.40
1998	88.3	64	170.2	60.5	187	271.5	30.4	18	175.4	1,065.30
1999	99.5	87.2	238.6	51	203	196.2	35.2	22.3	97	1,030.00
2000	121.4	52.7	207.2	50.5	216.7	125.7	34.3	21	38.2	867.7
2001	153	255.4	362.6	59.8	248	151.9	56.7	24.6	90.9	1,402.90
2002	207.9	270.3	431.3	69.8	252.8	163.4	40.4	29	158.2	1,623.10
2003	210.5	344.1	524.4	82.8	230.7	307.2	43.9	25.4	183.4	1,952.40
2004	193.2	263.4	492.2	89	222.8	199.6	36	14.6	281	1,791.80
2005	182.6	191.5	383.3	87.8	233.1	135.8	43.3	15.9	164	1,437.30
2006	90	75.3	348	77.3	262.6	104.6	41.5	34.2	187.7	1,221.20
2007	77.4	59.3	174.5	62.9	256.9	112.5	26.5	16.4	127.2	913.6
2008	25	115.6	239.5	59.8	237.3	83.8	23.3	14.1	87.1	885.5
2009	48.1	117.9	318.9	61	207.3	98.7	23.2	17.3	78.9	971.3
2010	78.9	257.5	438.1	70.1	224.4	191.2	25.4	16.4	94.3	1,396.30
Average	123.9	160.5	263.9	81.8	216.4	136.1	28.6	25.7	155.5	1,192.30
Average %	10%	13%	22%	7%	18%	11%	2%	2%	13%	100%



Plot of terminal run size (in 1,000's) by year for the Chinook stocks included in the Parken-Kope abundance index used by Eric Ward in his evaluation of relationship between SRKWs and Chinook.

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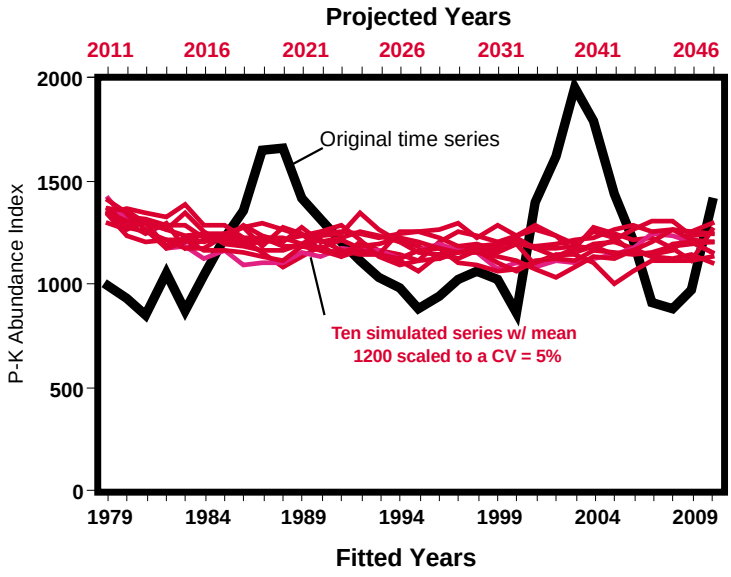

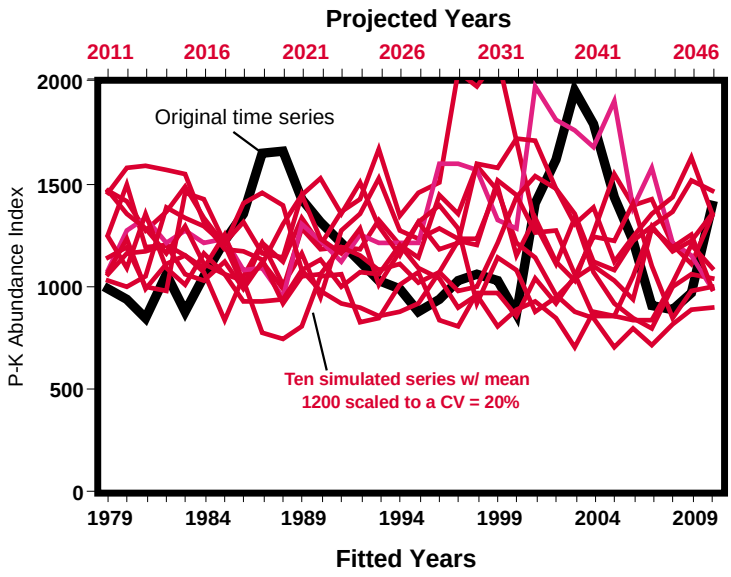

Original time series of Parken-Kope AIs with a mean of 1,200 and an observed CV of 25% and 10 simulated series projected from the original series but scaled to have a CV of 5% (upper panel) or 20% (lower panel).

The scaled CVs of 5% and 20% are the same as those assumed in Eric Ward's analysis presented in "Quantifying fishing impacts on past and future killer whale growth rates" on 14 March. In the analysis, the original un-scaled series was used to generate coefficients linking salmon abundance to whale growth rates (Eric Ward, personal communication). Projected AIs similar to those in the upper panel (CV = 5%) were then applied to those coefficients to project growth rates for whales into the future. It is readily apparent that an assumed CV of 5% does not produce a range of variation in the projected AIs that is remotely similar to the actual variation in the historic time series. Eric stated in his presentation of 14 March that assuming a larger CV of 20% made it "Much more difficult to assess how different levels of salmon might affect growth" and that the choice of 5% was due to a "Tradeoff: short projections with realistic CVs OR long projections with low variability?". If an assumed CV of 20% made it problematic to assess the long-term impacts of Chinook abundance on the growth of SRKWs then the observed CV of 25% would make it more so.