WDFW Comments:

2.2 The Conclusions of the Panel

Status of Southern Resident Killer Whales

The Panel discusses interactions between pinnipeds, SRKW and Chinook in several sections of the Report (Line 188, line 266; line 797, lines 1001-1004, etc.). The Panel suggests seals and sea lions compete with SRKW for their food supply and this competitive interaction may limit the potential of SRKW to continue to increase in the long-term even if Chinook salmon numbers are increased (presumably because the pinnipeds would increase numerically and/or functionally). This assumption requires that the seals and sea lions (used inconsistently in the report) eat the Chinook before or at the same time that the SRKW have access to them (p. 9, line 267). However, some of the pinniped consumption (and associated diet information) occurs after the Chinook have passed the SRKWs (e.g., in rivers) and are no longer available to SRKW.

We suggest the Panel consider the following information on pinniped population trends, diet and spatial overlap:

Pinniped population trends

- Harbor Seal populations in Washington (Coastal and inland stocks) have reached carrying capacity and have apparently been stable since 1990 (Jeffries et al. 2003. Journal of Wildlife Management 67:208-219). Population growth reached its inflection point in the 1980s. No recent abundance or distribution surveys.

- Harbor seal populations in the Strait of Georgia appeared to stabilize around 1990 [DFO. 2010. Population Assessment Pacific Harbour Seal (*Phoca vitulina richardsi*). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/011.]. Indexed trends for other B.C. localities indicate that the population growth rate reached an inflection point in the early 1990s and then stabilized around 2010 (DFO 2010)

- Oregon harbor seal populations appear to have stabilized around 1990 [Brown et al. 2005. Marine mammal science 21(4):657–670]. Population growth reached its inflection point in the 1980s. No recent abundance or distribution surveys.

- The Washington and Oregon Coast and Washington Inland Water harbor seal stocks considered within their Optimum Sustainable Population (OSP) levels (Caretta et al. 2011. U.S. Pacific marine mammal stock assessments. ACIFIC 2011NOAA-TM-NMFS-SWFSC-488). No recent abundance or distribution surveys.

- Pup production of the U.S. Stock of the California sea lion has continued to increase with an apparent inflection point around 1995 and some slowing in recent years (Caretta et al.

2011. U.S. Pacific marine mammal stock assessments. ACIFIC 2011NOAA-TM-NMFS-SWFSC-488). Lack range-wide abundance and distribution surveys.

- Steller sea lion populations have been increasing off Oregon, northern California, Washington and British Columbia (Brown and Riemer 1997; Brown et al. 2002; Pitcher et al. 2007, Jeffries pers. comm.). Population growth is between 2.3 and 3.5% per year for Oregon (Pitecher et al. 2007) and BC non-pup numbers have increased by 3.5%/year since the 1970s (National Marine Fisheries Service 2012).

Diet and spatial overlap

- Steller sea lion – little overlap in Washington but considerable overlap on west coast of Vancouver Island (Olesiuk et al. 2010). Proportion of salmon in diet ranges from about 7 – 16% with fall diet having the most salmon (Olesiuk et al. 2010). Less than 10% of the salmon diet is in the size class selected by SRKW (Olesiuk et al. 2010). Chinook composed about 18% of the Salmon identified genetically – keep in mind that the percent of salmon in the diet ranges from 7-16% (this is 18% of 7-16%). All Steller rookeries are located in proximity to major Salmon runs ie St. George Reef, Rogue Reef, Scott Islands

- Harbor seal – considerable overlap with SRKW year-round. Some of the salmon consumption is occurring in rivers and at the mouths of rivers and therefore occurs after it has passed SRKW populations. In Strait of Georgia, Salmon in the diet ranged from 1.3-8.6% (Olesiuk 1993). In the San Juan Archipelago, frequency of occurrence of salmon in the diet (n = 1,195 scat samples) ranged from 4.16-51.37% depending on the season with nearly all of the consumption occurring in the fall. For salmon identified to species the overall frequency of occurrence was 8.83% and, of that, adult Chinook salmon frequency of occurrence was 0.58%. Chinook were only consumed in the summer/fall diet (Lance et al. in review). Frequency of occurrence of Juvenile salmon ranged from 0.73-11.58% depending on the season. For juvenile salmon identified to species, frequency of occurrence over all months was 7.3% and, of that, juvenile Chinook frequency of occurence ranged from 1.56-4.75% depending on the time of year (Lance et al. in review).

- California sea lion – considerable overlap in fall and winter. Some of the salmon consumption is occurring in rivers and at the mouths of rivers and therefore occurs after it has passed SRKW populations.

Given this information, the potential competition with SRKW and the potential for pinnipeds to effect recovery of SRKW is not clear but clearly warrants additional investigation. This is especially true because much of the salmon in the pinniped diet has only been identified as "salmon" and not to species or stock. Also, much of the pinniped diet sampling to date has not been conducted in a way to understand the biomass of Chinook consumed by size and age class.

Additional surveys are needed to provide a better understanding of seasonal pinniped distribution and density, which is a key piece of information needed to assess their impacts. Finally, we recommend that the panel not just focus on pinnipeds. Fish die for many reasons including other predators (e.g. sharks and large predatory fish, etc.), disease, etc.

Statistical correlation between Chinook abundance and rates of increase in Southern Resident Killer Whales

Page 8, lines 249-251 – "…*the range of statistical analysis over the years have explored a broad range of Chinook indices, many of which do not show any correlation. In his most recent analyses presented at Workshop 2 Ward et al. explored quite a few indices and again there were varying degrees of correlation, many of them weak."*

Taken out of context, this statement can be misleading. One of the primary reasons for using a broad range of Chinook indices was the result of Eric, and others, responding to the requests of managers and researchers to use the index that best represents the abundance of Chinook available to SRKW. Ultimately, the group of researchers focused on the two indices (FRAM and more recently, the Parken-Kope) that best represented the stocks available to SRKW (with custom modifications). Both of these indices correlate with SRKW vital rates. NOAA researchers with input from the panel landed on using the Parken-Kope because the index was derived using more empirical data. Using this new index, Chinook abundance is correlated with both fecundity and survival. In this analysis, if one looks at the delta-AIC values that are smaller than the null model (no salmon), the majority of the models regardless of stock composition are improvements over the null model for SRKW survival but this relationship is weaker for fecundity. So, yes, some of the analyses have shown no correlation with SRKW vital rates but when the most appropriate indices and stocks are used, the relationship for survival is consistent.

Reducing harvest would increase availability

We agree with the Panel that reduced harvest would likely not have a large impact on the abundance of Chinook available to SRKW. However, the information and reasoning for the conclusion that there is little effect of reduced harvest may not be clearly stated or completely presented in the draft Report. We offer some recommendations to strengthen the Panel's conclusions. Also, we note that the impact of fishing in low fish abundance years might be important to the whales.

The statement (page 9, lines 269-270) "*foregone harvest would likely not consist exclusively of Chinook stocks that are important to SRKW*" is consistent with available information, but Panel may wish to substantiate this important point by referencing study results on prey preference (e.g., Hanson et al, 2010) or information on fishery stock composition presented at Workshop 2 (Adicks). The Panel's statement may be further supported by referencing the presentation by Hagen-Breaux of FRAM analysis that eliminated the effects of mostly immature Age 2 and smaller Age 3 Chinook.

The Panel twice mentions the fishery harvest rate of 20% on Chinook stocks, for example (page 9, lines 276-281) "*harvest rates on Chinook salmon are now quite low (on the order of 20% on average) so that there is limited room for reductions in Chinook harvesting to increase the abundance of Chinook*". While we agree that the harvest rates in current fisheries have been greatly reduced from historical levels, the Report should reference the source for the figure. Fishery exploitation rates on Chinook stocks estimated by the Chinook Technical Committee (e.g., TCCHINOOK (11)-3, April, 2011) show most Chinook stocks are harvested at rates greater than 30% - 40%. The 20% rate the panel used may have been from either the LaVoy analysis or the Hagen-Breaux analysis of increases in available Chinook with closure of all fisheries that were approximately 20%. Alternatively, for some Puget Sound or Fraser River stocks, recent exploitation rates in pre-terminal fisheries are approximately in the range of 20%.

Conclusions

The "*panel cautions against overreliance on the correlation implying causation*" (mentioned in this section, page 10 line 307, and throughout the document). In studies with complex ecosystems, especially with very rare species, experiments to determine cause and effect are often impossible and are not necessarily better than correlative studies. We understand the panel's caution, but recommend the panel simply focus on the lines of evidence, the strength of the evidence, the uncertainty, and the alternative explanations.

2.4 Recommendations for Future Work –

Critical: Contaminant fingerprinting

The panel suggested a need for further contaminant fingerprinting work that "*could establish the major Chinook stocks that contribute to SRKW diets. This would help identify which Chinook indices of abundance are most appropriate indicators of food supply. If the contaminant data indicated a preponderance of Chinook stocks whose indices did not correlate with changes in SRKW rates of increase, support for the underlying hypothesis would be decreased*" (lines 373-378). We question the Panel's advocacy of this approach because of the many assumptions required, including a clear understanding of the toxic map of all runs throughout the range of the SRKW, an understanding of how toxics are routed to various tissues, a better understanding of the biomass consumed by fish species, the toxic loadings of all species consumed by SRKW, and so on. Given the results of Hanson et al (2010), and successful stock origin identification of SRKW Chinook prey in the summer feeding area using genetic identification methods, the Panel's rationale for recommending this alternative method is not apparent. Also, it is not clear that the Panel has recommended this critical need only with respect to obtaining stock identification for the winter feeding period, or for summer feeding as well.

Supporting: Fecal and blubber samples

We also recommend archiving samples from the entire GI tract (not just the stomach as stated in several locations in the paper), in addition to fecal and blubber samples.

<u>4.0 Feeding Habit and Energetic Needs of Killer Whales</u> –

Diet (Species & Size Selectivity)

It would be helpful if the Panel would clarify the statement– "*Selectivity by Southern Residents on different stocks of Chinook salmon is poorly known*" (page 22, lines 587-590) by indicating if the need for more information is referring to the lack of winter diets samples. Selectivity during the summer feeding period appears to be relatively well studied and documented. Hansen et al. (2010) analyzed 339 dietary samples (fecal, tissue and scale combined). Almost all of those samples were from June-Sept. In addition, 178 of the Chinook remains in the feces were identified to stock for those months and they consisted primarily of Fraser River stock (Hansen et al. 2010, Figure 2). There are another 46 diet samples from SRKW in Ford and Ellis (2006) (plus 377 from NRKW). In addition, both Ford and Hansen presented new diet information during the workshops. This information was used to inform selection of appropriate Chinook abundance indices and was considered by workshop contributors when considering the impact of various fisheries to SRKW. Size class selectivity is also well described in these articles. However, there is little information on winter SRKW diet.

Another contribution to the knowledge of selectivity not mentioned by the panel in the draft Report is the information presented by Kyle Adicks in workshop #2 indicating that recreational fishers in the same locations as the SRKW are capturing different salmon species than just Chinook and when they do capture Chinook, the size class distribution is different (much broader) than that consumed by SRKW. These data are potentially biased but they do suggest selectivity by SRKW for large Chinook of Fraser River stock.

Statements such as " . . . *they have a strong preference for large Chinook salmon* . . . " (page 22, lines 579-580) imply that we have information supporting the conclusion that the SRKW are making a choice. We recommend the alternative statement "they primarily consume large Chinook salmon during the June – Sept. window" more accurately reflects the available information. The only study that we are aware of that compares killer whale use to available fish abundance is Ford and Ellis (2006; Figure 4) and this paper suggest strong selectivity by killer whales for Chinook in August but not in October. However, this work was conducted off the NE corner of Vancouver Island and may have only included NRKW.

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4.4 Recommended Information and Analyses –

Diet Analysis

The panel's recommendation for pursuing more fecal samples (lines 752-753) may or may not be helpful to estimating the non-salmonid contribution to SRKW diet. The ability to estimate the proportion of non-salmonids in the diet depends on the biomass of DNA that makes it through the GI tract intact or partially intact, the biomass consumed/species, and some method for relating these variables. To develop this approach, the panel might recommend feeding trials of mixed and non-mixed diets in aquaria.

5.0 Fisheries and Prey Availability

5.1 Context

Recent trends in abundance and fisheries –

The parenthetical reference to Puget Sound Chinook stocks as "(relisted in 2011)" (page 30, line 852).

5.2 General Comments

We are unaware of the source of information available to the panel supporting the conclusions about the size of Puget Sound Chinook passing through the SRKW summer feeding area, referring to the statement - "*Given the relatively small size and young age of most Puget Sound Chinook, particularly of hatchery origin, and the apparent inclination of SRKW to prefer larger age 4 and 5 Chinook, stocks of Fraser River Chinook would a priori appear to be the most vulnerable to SRKW predation and the most important stocks during the summer months*" (lines 901-904). Many populations of Puget Sound wild and hatchery origin Chinook have significant contributions of age 4 fish comprising their mature runs. We do not dispute that mature Fraser River Chinook may be larger and of older age, on average, than Puget Sound Chinook. However, we are not aware of the specific data sets available to the panel that form the basis of this conclusion.

The panel's conclusion that - "*Many Chinook populations would not be available even during this winter period…*" is not consistent with available stock distribution information (e.g., TCCHINOOK (11)-3, April, 2011). It is true that far north migrating Chinook stocks tend to migrate or are caught to a larger degree in Southeast Alaskan fisheries, but coded-wire tag recoveries of stocks such as Columbia River Upriver Bright fall, Columbia River Summer, and Oregon Coastal fall, show that comparable portions are caught in Canadian fisheries that are well within the feeding range of SRKW. Particularly in light of the winter distribution evidence presented by Ford in workshop 2 showing SRKW in Southeast Alaska, how can the panel conclude these stocks would not be available to SRKW feeding during the winter? This point is again made by the panel in the section responding to key question 3 (lines 1064-1072).

5.3 Key Questions and Responses

Mature vs. immature Chinook salmon

SRKW feeding behavior and dependence on Chinook and other species for prey during the winter period is poorly understood. Given this uncertainty, the panel should provide a basis for the suggestion that it is, "*even perhaps likely, that abundance of Chinook salmon during winter months is more critical to successful reproduction and survival of SRKW*" (lines 970-971). Rather than stating "*it is quite possible that winter availability of chinook is even more important for SRKW survival and reproduction*" (lines 1077-1078), we recommend the panel simply point out the uncertainty about prey dependence for the winter period given the paucity of information. Regarding the intention to improve analytical methods, why not state that knowledge about summer diet should not limit investigations into use of other stocks at other times of the year?

Size selectivity

This section lacks focus and the panel's request for more information isn't clear.

The source of the conclusion about age composition of Puget Sound hatchery stocks is not provided – (lines 981-982 "*age 3 is often the dominant age at maturity*". WDFW can provide age composition by stock (and sooner than Workshop 3). Data from two Puget Sound Hatchery stocks that were readily available for review show that age 4 is the dominant age at maturity for some stocks. For example, returns to the Soos Creek Hatchery (Green River) from the 2002-2005 brood year releases averaged 45% age 3, 53% age 4, and 2% age 5. Returns to the Issaquah Creek Hatchery (Lake Washington) have averaged 5% age 2, 25% age 3, 69% age 4, and 1% age 5 for the most recent 4 years.

Size data are available for samples associated with the Area 7 GSI results presented by Kyle Adicks at Workshop 2. These data are from a recreational fishery with a size limit so are not unbiased samples of the Chinook salmon populations but can be used to compare size between Fraser River and Puget Sound stocks.

Row Labels	Count of ForkLength	Average of ForkLength2	StdDev of ForkLength2
Fraser_River	**100**	**73.93**	**13.58**
L_Fraser_River	37	76.43	14.26
Mid_Fraser_River	8	76.50	18.75
N_Thompson_River	6	81.33	13.31
S_Thompson_River	46	70.04	11.27
U_Fraser_River	3	81.00	14.42
Puget_Sound	**291**	**75.16**	**11.22**
PS_Fall_North	3	65.67	15.57
PS_Fall_North_Clipped	32	73.41	11.14
PS_Fall_South	38	76.42	7.96

PS_Fall_South_Clipped	194	75.24	12.06
PS_SpSu	9	80.00	7.30
PS_SpSu_Clipped	15	73.60	7.01
Grand Total	**391**	**74.84**	**11.86**

No significant difference in size between the stocks is apparent, so the higher contribution of Fraser stocks in diet samples may not be due to size.

6.2 Development of Population Model to Forecast Future Status

We are concerned with the panel's statement indicating that additional analyses using Ecopath outputs resulted in a relationship between SRKW vital rates and pinniped abundance (line 1178). It our understanding that Eric Ward was asked to include a time series of pinnipeds as predictors in the SRKW survival/fecundity models. This could not be accomplished because there was no continuous time series for seals, sea lions, etc. Instead, the panel asked Eric to fit Ecopath output from Dave Preikshot's model, and treat his modeled output as data in the model. We recommend not doing this because the Ecopath model suggests that sea lion biomass declined in the last ~ 8-10 years (decreasing by more than 50%). This result is inconsistent with the pinniped data that we describe above.

6.4 Assessing Recovery

Key Question 4.

Regarding additional analyses that could be conducted to understand the relationship between salmon abundance and killer whale population viability "*The Panel suggests that simulation analyses be performed to determine whether any magnitude of realistic increase in salmon fisheries would have a detectable effect on future killer whale growth rates.*" (page 44, lines 1310-1311)

The panel's suggestion is not clear and we recommend the panel provide specific examples of how this question would be addressed in Workshop 3. We offer some thoughts on the matter.

We clearly understand the value of this type of analysis but it is critical that it take into account the uncertainty associated with the data and that it clearly characterize the uncertainty. This is especially important given the interrelated uncertainty associated with 1) Chinook abundance available to SRKW, 2) the impact of the fishery on the abundance available to SRKW, and 3) the affect of Chinook abundance on SRKW survival and fecundity.

An evaluation of the effect of fisheries on SRKW survival and fecundity may, for example, be especially valuable under circumstances of lower than average Chinook abundance. This type

of analysis may discover, for example, if fisheries conducted with low abundance have disproportional impacts on available prey. Seabirds and marine mammals from the Atlantic, Pacific, and Southern Oceans exhibit reduced and more variable productivity when the prey biomass is reduced below a given threshold (e.g., Curry et al. 2011, Science 334:1703-1706). This pattern is likely the result of demographic trade-offs and functional responses. Perhaps there is a similar situation with SRKW and Chinook? If so, there may be a threshold of Chinook abundance, below which, SRKW vital rates decline considerably (a non-linear response). If this were the case, it might only be necessary to consider fishery restrictions when Chinook abundance falls below a given threshold.

Identifying this type of threshold or evaluating the impact of reducing the fishery given the available data - small SRKW population and relatively poor information on the Chinook available to SRKW - may not be possible. If this type of analysis is undertaken we encourage the researchers to recognize the sample size issues and the uncertainty and underlying assumptions of the available data in the analysis.