Comments to the Pacific Fishery Management Council regarding final recommendations by the Southern Resident Killer Whales (SRKW) working Group for fishery management and conservation measures to address risks to the SRKW DPS posed by Council Chinook salmon fisheries.

Drafted by:

Kurt Beardslee and Nick Gayeski, Wild Fish Conservancy

Misty MacDuffee, Raincoast Conservation Foundation

Deborah Giles, PhD, Science and Research Director, Wild Orca

Supported by:

Verner Wilson, III, Senior Oceans Campaigner, Friends of the Earth U.S.

Shari Tarantino, Executive Director, Orca Conservancy

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We appreciate the opportunity to provide comments to the Council on the SRKW Working Group (WG) recommendations for fishery management measures to address the risk posed to endangered SRKW by Council Chinook salmon fisheries. We recognize and appreciate the considerable amount of time and effort devoted by the WG to developing the May 2020 Risk Assessment ("RA") and the recommendations in its Draft Range of Alternatives and Recommendations of August 2020("Draft Recommendations"). We hope that these brief comments will assist the Council in choosing an appropriate set of fisheries management alternatives for Council Chinook fisheries that will afford the critically endangered SRKW DPS significant protection from the adverse impacts of fisheries and that will also provide an appropriate range of alternatives for the Environmental Impact Statement (EIS) that we expect the National Marine Fisheries Service (NMFS) to develop as part of the process of producing a new Biological Opinion by May 2021.

For the record we also submit, as part of these Comments, the Note we previously submitted to Council on the Draft RA of September 11, 2019 and comments submitted to NMFS in December 2019. We also submit the Declaration by Dr. Robert Lacy submitted on behalf of Wild Fish Conservancy's Motion for a Preliminary Injunction of Alaska's 2020 Summer Troll season fishery, which includes a Vortex model Population Viability Analysis, updating the PVA published in Lacy et al. 2017.

In brief, we have concerns that the range of alternatives presented in the Draft Recommendations are inadequately precautionary with respect to the dire demographic condition of the SRKW DPS in that they still presume that the burden of proof rests with the SRKW DPS and not the Council fisheries. The Draft Recommendations reveal where they believe the burden lies in subsection 3.1.2.e (List of potential responses if a year's preseason projection fall below a threshold) which states that the "goal of management response(s) would be to benefit SRKWs while still providing some fishing opportunity in years when Chinook abundance is deemed low by surpassing a defined threshold", page 11. The priority is clearly to keep fishers fishing.

First recommended type of alternative:

Consistent with the Precautionary Principle, we offer an alternative approach that appropriately places a greater burden of proof on Council Chinook fisheries and assumes a stronger presumption that the SRKW DPS is likely to be jeopardized (per the ESA) by Council fisheries as currently conducted. We also provide an additional alternative that would require a fundamental re-design of Council Chinook fisheries; one that would further the recovery of ESA-listed wild Chinook populations subject to Council fisheries and better guarantee SRKW access to preferred Chinook prey populations.

The Working Group and NMFS have recognized that no single or multiple Chinook abundance metrics currently appear to be better correlated to SRKW demographic rates than an index of coastwide annual abundance (RA, chapter 5, pp. 73 – 95; NMFS 2019 (section 2.5.4, page 242). In addition, despite the weak relationships between various Chinook abundance indices and SRKW demographic rates, the WG acknowledges that "…in the majority of cases… the point estimates for the fitted relationships were of the expected sign" (i.e., better rates when a Chinook abundance index was "high" and poorer rate when indices were "low", Draft Recommendations page 87).

The RA draws attention to concern that was noted in the Hilborn et al. 2012 Independent Panel Report regarding the statistical or biological significance of correlations between Chinook abundance indices and SRKW demographic rates; specifically the interpretation of such correlations "as confirming a linear causal relationship between Chinook salmon abundance and SRKW vital rates" (RA, page 90). This caution has routinely been raised by skeptics of the significance of Chinook abundance to the current status of the SRKW DPS and by opponents of further restrictions on harvest as conservation actions that are likely to benefit the DPS. Yet, it is never articulated how or why this general point supports claims that further reductions in Chinook harvest will not benefit SRKW.

Regardless of the body of evidence that supports a causal nature, this demographic relationship with Chinook will always be a correlation. There is no (ethical) study that can be conducted to test this relationship in an empirical manner. The skepticism and desire by managers (and others) for *proof* that this relationship is *causal* before taking action is a distraction that leads to irresponsible decision making for an endangered DPS.

There is a strong body of literature that supports acting on the evidence that Chinook abundance is the primary factor driving Southern Resident survival and fecundity, some of which are identified in the RA. Additionally, Velez-Espino et al. (2013) building on findings of Ford et al. (2010) and Ward et al. (2009) demonstrated that fisheries reductions and closures would improve vital rates and recovery trajectories of Southern Resident killer whales. While the role of vessels and contaminants may compound the effects of prey limitation, they do not diminish the primary importance of adequate food.

As noted above, even the RA acknowledges that the correlations between various Chinook abundance indices and SRKW demographic rates are all in the right direction, supporting the conclusion that greater indices of Chinook abundance are likely to result in better SRKW demographic rates.

Further, the skepticism regarding the statistical relationship between Chinook abundance indices and SRKW demographic rates increases the risk that harmful outcomes will eventuate to vulnerable resources. The perspective of Kriebel et al. (2001) is relevant in this context. Regarding uncertainty Kriebel et al. observe "…there is also a strong desire on the part of scientists to be precise. This may result from a confusion of uncertainty with quality of information; but the two concepts are distinct. It is possible to produce high-quality information about greatly uncertain phenomena." The information available to date regarding the relationship of Chinook abundance indices and SRKW demographic rates is of high quality and strongly supportive of risk-averse, precautionary management actions in regard to Council (and other) Chinook fisheries.

The precautionary approach requires that when evidence is inconclusive regarding either the causes of population decline or the effectiveness of potential remedies, strong risk-averse regulatory actions – such as significant change to harvest management – be taken *first* and research presumed to better resolve key uncertainties in status and mechanisms undertaken *subsequently*. The Draft Recommendations imply that strong precautionary reductions in current harvest should await the results of one or several items on a laundry list of potential research topics. We believe, and have argued in previous submissions to the Council and NMFS, that the status of the SRKW DPS is too precarious to justify this "wait-and-see" approach, that flawed logic is being used to avoid risk-averse actions, and this stonewalling contravenes the precautionary approach as it is intended to be applied to an endangered DPS.

We also emphasize a point we have made in past comments, viz; that the state of the SRKW DPS necessitates an immediate need to try to stabilize population numbers and secure the conditions that may permit a slow rebuilding. In the near term, management should aim to halt further decline and secondly achieve a small positive growth rate in the neighborhood of 0.5 to 1%. (For further relevant details, see Lacy 2020, attached). Dismissing potential remedial actions, such as significant coastwide reductions in Chinook harvest, on the grounds that it appears unlikely that such action would achieve the 2.3% annual population growth rate required for de-listing by NMFS' 2008 Recovery Plan, is unjustified and dismissive of the obvious dire condition of the DPS.

We therefore, recommend replacing one or two of the "Alternatives for North of Falcon (NOF) Chinook salmon abundance TS1 Thresholds" listed in Table 3.1.a, page 11 of the Draft Recommendations with the following:

Establish an abundance threshold **below which no fishery can occur**.

We recommend that this threshold be set at a preseason abundance estimate equal to or greater than the error-adjusted TS1 abundance level of 1 to 1.1 million or greater (i.e. between 3.1.2 c and 3.1.2.d). The kinds of "potential responses" in the list in subsection 3.1.2.e of the RA would need to be modified to provide a sliding scale of permissible Chinook harvest levels determined by how far the the TS1 preseason abundance estimate exceeds the threshold.

Adopting this approach will provide greater consideration of the SRKW DPS than the approach embodied in the Draft Report, and it will benefit research and monitoring directed at obtaining more robust time and area knowledge of specific Chinook stocks/populations important to foraging SRKWs. It is more probable that such stocks/populations will be identified when no fishing occurs or when only a deminimus level of fishing occurs when total TS1 Chinook abundance is above the threshold. This also places the burden of justifying and financing the conduct of such research and monitoring on those who wish to expand fishing opportunities.

Adding one or two more alternatives (for different TS1 threshold abundance levels) to Table 3.1.a (in addition to the mandatory no-action 3.1 alternative) would provide a robust set of alternatives for the NMFS (and subsequently the public) to evaluate in the EIS.

Second (new) alternative:

An analysis of age overfishing should be conducted by the Workgroup. Both the Draft Recommendations and the RA acknowledge the fact that most Council Chinook fisheries encounter immature Chinook (as both landed catch and drop off mortality) which contributes to the reduction in age-at-maturity, resulting in a younger average age of spawning populations (which contributes to lower population productivity and reduced capacity for rebuilding) and a younger average age of the catch (with attendant smaller size and lower per-fish landed value).

Southern Resident killer whales are highly selective on large, older Chinook. More than 80% of their Chinook consumption is on salmon greater than 700mm, generally corresponding to fish age 4 and above (Ford and Ellis 2006, Ward et al. 2010). These ages classes typically make up less than 15% of the recent FRAM abundance of 2-5-year-old Chinook in Salish Sea waters. Because of this importance biologically and ecologically, the PFMC needs to expand beyond abundance metrics as the indicator of healthy salmon stocks and recognize the importance of population structure in recovery goals for Chinook and killer whales.

As part of a robust review of this topic, PFMC should examine the benefits to population structure from phasing out, and eventually terminating (within a specified maximum amount of time), fishing in the EEZ north of Falcon (if not from central California to the Canadian border) and moving the PFMC fisheries to terminal areas at and near the mouths of rivers.

Such a transition should significantly reduce, if not eliminate, the risk that immature Chinook are encountered by the fishery. Age overfishing of Chinook in coastal marine mixed stock salmon fisheries is a significant conservation concern because it reinforces the tendency for Chinook to return at younger ages and smaller sizes-at-age, contributing to declines in both fecundity and productivity. Eliminating age overfishing will both increase the proportion of older, larger Chinook in the spawning return (which will benefit population rebuilding) and increase the average size (weight) of individuals in the catch. Increasing the average weight of Chinook caught will permit the same total catch biomass to be attained with fewer numbers of Chinook, further benefitting spawner abundance and population rebuilding.

Transitioning to terminal or near terminal fisheries should also benefit SRKWs by increasing the probability that SRKW "get to the fish first" before the salmon encounter fisheries.

In conjunction with an analysis of age overfishing and population structure, an analysis should be conducted on the economic benefits to terminally located fishing communities from moving fisheries close to or in the coastal rivers of origin. This should include the use of selective fishing gears that can target hatchery-origin Chinook stocks and specific size classes of wild Chinook stocks, which will further the rebuilding of wild population spawning escapement and general wild stock rebuilding. The analysis should also include the potential economic benefits to local fishing communities of obtaining higher prices for landed Chinook catches from receiving certification for attaining a high conservation standard in the conduct of the fisheries.

These two alternatives, plus one or two of the alternatives presented in the draft report should be the focus of a thorough Environmental Impact Analysis pursuant to NEPA. This should be an integral component of achieving the new Biological Opinion for the PFMC Salmon FMP.

Citations.

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List of documents attached as part of these Comments.

Attachment 1: Note on PFMC SRKW Workgroup Draft Risk Assessment of Sept 11 2019: Nick Gayeski, Wild Fish Conservancy and Misty MacDuffee, Raincoast Conservation Foundation, September 26, 2019

Attachment 2: Submission from Wild Fish Conservancy, Raincoast Conservation Foundation, Georgia Strait Alliance, and Natural Resources Defense Council to NOAA on Protective Regulations for Southern Resident killer whales
December 2019

Attachment 3: Declaration of Dr. Robert Lacy, Ph.D. submitted to the United States District Court of Washington at Seattle in support of plaintiffs Wild Fish Conservancy in Case No. 2:20-cv-00417-MLP, April 15, 2020.

ATTACHMENT 1

Note on PFMC SRKW Workgroup Draft Risk Assessment of Sept 11 2019

Nick Gayeski, Wild Fish Conservancy

Misty MacDuffee, Raincoast Conservation Foundation

September 26, 2019

The SRKW workgroup has initiated an important review of PFMC Chinook fisheries and their implications for SRKW. However, the composition of the workgroup indicates that it is not an independent scientific group. It is composed principally of tribal and state fish and wildlife staff whose prime responsibilities are fisheries management. Only a few of the team members, principally NMFS science staff, have the strong technical capabilities in salmon and ecosystem modeling to produce a quantitative assessment of the risk PFMC (Council) Chinook salmon fisheries pose to the survival of the Southern Resident Killer Whale (SRKW) DPS. As such, there are constraints to receiving the products of the workgroup as appropriate to accomplishing this critical task.

The Draft Report (DR) provides a reasonable summary of the status of the SRKW population, its component pods (J, K, and L), and acknowledges the dependence of the population on Chinook salmon. Importantly, the DR acknowledges the evidence accumulated over the past decade that demonstrate significant correlations between various indices of annual Chinook salmon abundance and demographic vital rates of SRKW. Unfortunately, the authors of the DR prevaricate about the significance of this dependence due to inability of the analyses to establish a clear causal relationship between Chinook abundance and SRKW demography.

The DR needs a clear, strong statement regarding the critically endangered status of the SRKW DPS (see DFO's 2019 SAR and PVA model outputs that indicate ongoing population decline with a 26% probability of quasi-extinction (one sex) within 75-97 years https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2019/2019_030-eng.html.) and the associated need for immediate management measures to arrest further decline.

The DR should be clear at the outset that this constitutes a conservation emergency. The benefit of the doubt regarding candidate management measures under the control of the Council must favor the DPS in accordance with the priority that society places on ESA-listed endangered populations.

The DR's description of the management structure of the Council Chinook fisheries under the current Pacific Salmon Plan (PSP) reveals the shortcomings of the data. This applies to annual Chinook salmon abundance and distribution, and fishery impacts on Chinook stocks known or potentially important to foraging SRKW within their existing and proposed critical habitat.

Similarly, the DR provides evidence concerning the uncertainty of the relationship of various indices of Chinook salmon abundance to SRKW demographics. This uncertainty is due to two primary factors: uncertainties regarding the accuracy and appropriateness of the individual indices of Chinook abundance and distribution, and uncertainties concerning the strength of association between Chinook abundance or distribution indices and specific SRKW demographic parameters. Among the former uncertainties, are uncertainties regarding the age-distribution of Chinook, maturation rates, and the abundance and proportion of immature Chinook in the several stocks subject to Council fisheries. The latter uncertainties are due primarily to small sample sizes which themselves are due to the low population size of the SRKW population and its component pods. These uncertainties are further compounded by the interaction of lack of Chinook prey and other factors known to pose threats to the viability of the SRKW population, in particular vessel noise and toxics contamination. Inevitably, therefore, there is considerable noise in much of the demographic data pertaining to the relationships between SRKW demographics and indices of Chinook prey.

The decision to rely primarily on the results of the Shelton model (Shelton et al. 2018) to characterize coast-wide Chinook distribution seems reasonable, although it too, like FRAM, is compromised by having to rely nearly entirely on hatchery CWT data. However, Shetlon et al.'s results show that there is considerable uncertainty in the estimates of the annual abundance and spatial distribution of particular stocks or combinations of stocks that cannot be resolved without additional research and data acquisition. Even with such research, it is unclear that additional precision in estimates of stock-specific abundance and spatio-temporal distribution will resolve the issues surrounding fine-scale adjustments of Chinook harvest to the benefit of SRKW. This highlights the importance of developing a value-of-information analysis as a component of the risk assessment, which is absent in the DR.

This reinforces the importance of emergency reductions in Council Chinook salmon fisheries that should not be delayed until additional research resolves these uncertainties. Such reductions would also be consistent with according SRKW the benefit of the doubt and appropriately placing the burden of proof on Chinook fisheries. Research and monitoring can be undertaken simultaneously with harvest reductions.

These uncertainties also provide evidence that there is a limit to the ability of stock assessment to provide the level of detailed information necessary to conservatively manage individual Chinook populations and stock aggregates in coastal mixed-stock fisheries. The current plight of the SRKW DPS provides clear evidence that this has, and will probably continue to be, the case.

In addition, there is lack of data and associated uncertainty regarding the age-structure and maturation rates of Chinook stocks in both the FRAM and the Shelton et al. model. The DR does acknowledge that SRKW prefer larger, older age 4+ Chinook salmon and notes that ocean mixed-stock Chinook fisheries encounter and harvest immature, particularly age 2 and 3 Chinook. But there is no effort made to consider addressing ocean fisheries as a means to rebuild an older, more historical age structure of Chinook populations within SRKW proposed or existing critical habitat. Given, the uncertainties noted, there seems good reason to doubt that restoring the historical age/size structure of Chinook can be undertaken while continuing with coastal mixed-stock Council (and more generally PST) Chinook fisheries. Thus, the DR should consider that the mixed-stock nature of these fisheries themselves pose a risk to the survival of the SRKW DPS.

All of this argues for a fully Bayesian risk assessment framework capable of providing probability distributions of the risks posed to SRKW by Council Chinook fisheries. Unfortunately, the risk assessment approach outlined in the DR does not adopt such an approach. The most probable outcome of this failure as the workgroup continues, is to significantly under-estimate the risk Council Chinook fisheries pose to SRKW.

The current model runs reported in section 5, page 47, should be reconfigured using a Bayesian framework so that the results of the regressions can be stated as posterior probability distributions, and not uninformative and problematic frequentist p-values and associated confidence intervals (CIs). Such revised analyses would clearly and properly display the uncertainties of the analyses (and associated model assumptions) which is necessary to display the risk posed to SRKW by failing to appropriately revise Chinook harvest rules. This would also make transparent the burden of proof that is being placed on the SRKW.

In commenting on the statistical significance of the fitted regressions (based on a traditional frequentist statistical approach) the DR acknowledges that "especially when the data are noisy or confounding variables are not accounted for, it is possible for a real effect to be present despite the data having a pattern no more extreme than one that could be explained by chance alone (large p-value). Given the lack of statistical significance, the results should be interpreted with caution. Nevertheless, in almost all cases the fitted relationships were of the expected sign (i.e. survival and fecundity increased with increasing Chinook abundance while occurrence of peanut-head decreased with increasing Chinook abundance)" (p. 47).

Bayesian regression analyses would produce probability distributions of the fitted relationships (instead of dubious p-values and CIs) and require that threshold probabilities be identified for concluding that no action on Chinook harvest is warranted. More appropriate still, is to embed such regression analyses in a broader Bayesian population viability analysis (PVA) that would provide a probability distribution of time to extinction or quasi-extinction. This would reflect the manner in which the Chinook indices-SRKW demographic indices regression contribute to the overall extinction risk, and hence how managers are weighting the risk that Chinook abundances and distributions pose to SRKW persistence. In view of the fact that three PVAs on SRKW have been published (Velez-Espino et al. 2014, Lacy et al. 2017, Clarke-Murray et al. 2019) it is surprising and disappointing that neither the workgroup or NMFS have incorporated their findings or undertaken an 'official' PVA themselves. Such considerations could provide guidance on the critical decision facing the workgroup.

The ESA accords the greatest benefit of the doubt to populations listed as endangered. In particular, in any jeopardy evaluation, the burden is to show that the proposed action will not jeopardize the continued existence of the listed population(s). It is clear from the recent history of the SRKW DPS and the management of Chinook salmon harvest under the PST and PSP (which govern Council Chinook fisheries) that the current fishing regimes remove prey from a food-stressed SRKW DPS. The only uncertainties concern which fisheries adversely affect which Chinook salmon stocks and by how much, when and where, with respect to the prey requirements of foraging SRKW. The burden of these uncertainties must fall on the fisheries, not on endangered whales. This is especially so in the current context, where the immediate management emergency is to take actions that have the greatest probability of bounding the SRKW DPS away from its decline toward extinction. This requires stabilizing the population growth rate, which is currently negative (lambda ~ 0.99, equal to an annual decline in DPS abundance of 1% per year (Velez-Espino et al. 2014, Lacey et al. 2017, Clarke-Murray et al. 2019).

Further, in light of the renewal of the PST, the burden of Chinook harvest reductions that may be undertaken to attempt to halt the decline of the SRKW DPS must fall on the Council fisheries. The April 9 2019 NMFS Biological Opinion concerning the Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska makes it clear that NMFS considers Treaty Chinook fisheries as configured pursuant to the 2019 Pacific Salmon Treaty to jeopardize ESA-listed Puget Sound Chinook and SRKW[1]. NMFS's finding that there is a need to further mitigate the effects of Chinook harvest beyond what is provided for in the Treaty is tacit admission that, absent the proposed mitigation measures, NMFS would have had to conclude jeopardy. Regardless of the proposed mitigation measures (which are conjectural and dependent on uncertain future funding), the BiOp makes it clear that Chinook harvest poses jeopardy to SRKW, and since Treaty harvest measures have therein been given ESA take coverage, the burden for further necessary modifications in US coastal Chinook fisheries falls on the Council fisheries.

[1] The 2019 BiOP admittedly does not explicitly use the term 'jeopardy'. The exact language is "… the status of Puget Sound Chinook salmon and SRKWs have declined in recent years. A key objective of the U.S. Section during the negotiating process for a new Agreement was therefore to achieve harvest reductions to help address ongoing conservation concerns for Puget Sound Chinook and coincidentally provide benefits for SRKWs", and continues "Further reductions [in Chinook harvest in PST fisheries] are proposed in conjunction with the 2019 Agreement, but there was a practical limit to what could be achieved through the bilateral negotiation process. As a consequence, and in addition to the southeast Alaska, Canadian, and SUS fishery measures identified in the 2019 PST Agreement, the U.S. Section generally recognized that more would be required to mitigate the effects of harvest and other limiting factors that contributed to the reduced status of Puget Sound Chinook salmon and SRKWs" (pp. 9-10).

Accordingly, the risk assessment to be undertaken (or completed) by the working group must identify changes to Council fisheries that, in conjunction with PST Chinook fisheries beyond the control of the Council, alleviate jeopardy to the SRKW. This requires, as already noted, that the risk assessment be framed as a population viability analysis (PVA) that produces SRKW population trajectories and associated extinction probabilities under the current conditions and under candidate management changes to Council Chinook fisheries, starting with a default complete closure of Council Chinook fisheries for a minimum period of time based on SRKW demography. This will likely be at least 5 and more reasonably 10 years, if not more.

Further, the criterion for the target response by SRKW needed to avoid jeopardy should not be a population growth rate of 2.3% /yr. for 28 years required under the SRKW Recovery Plan. This growth rate is inappropriate to a declining small population on the verge of an extinction vortex. Rather, the issue is to arrest the decline and preserve the reproductive potential of SRKW. This suggests that the target short-term annual population growth rate should be on the order of 1% over the next 10 to 20 years. An annual growth rate of one-half of one percent (0.005) would succeed in stabilizing the SRKW at slightly above the current number (73), provided the variance in that growth rate can be made sufficiently small. A steady average annual population growth rate of 0.005 would result in an average SRKW population of 81 individuals at the end of 20 years (compared to the current population of 73). A growth rate of 0.01 would achieve this population size in 10 years and a population size of 89 in 20 years. Modest as this would be, it is a significant step in the right direction compared to the recent negative population trend. An annual population growth rate in the range of one-half to one percent (0.005 to 0.01) appears to have a high probability of being achieved by the termination of all council directed Chinook fisheries. This also indicates that analyses (e.g., Hilborn et al. 2012, and Velez-Espino et al. 2014) that have concluded that further reduction or even closures of coastal Chinook fisheries are unlikely to achieve (in the near term at least) the NMFS SRKW Recovery Plan target annual population growth rate of 2.3% are misleading, if not misguided. The emergency conservation issue is not how to achieve an immediate annual growth rate of 2.3%, but rather the more urgent and appropriate goal to arrest the recent decline, stabilize the population and facilitate its slow rebuilding.

References

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ATTACHMENT 2

Submission to NOAA on Protective Regulations for Southern Resident killer whales

December 2019

Summary points

- The marine waters of the North East Pacific that provide critical habitat to SRKWs are undergoing rapid changes to their structure (ex. stratification, trophic composition), function (ex. role of carbonate ions) and processes (ex. pH buffering, nutrient cycling, primary production), which the whales have not evolved with, but must recover within.
- These changes include shifts in the population demographics and structure of Chinook salmon, including run timing, genetic diversity, abundance, maturation rates, size at age, age at return, and fecundity.
- These changes are largely driven by fisheries that select for larger salmon and catch immature Chinook, but also include climate change, excessive hatchery production and potential size selective predation by other resident killer whales.
- Southern Resident killer whales selectively forage on large, older Chinook salmon estimated to represent less than 15% of the Chinook abundance within the Salish Sea.
- Hatcheries, and corresponding Mark Selective Fisheries, have direct and indirect interactions with wild Chinook that undermine their fitness, population structure, abundance and conservation. They are produced to subsidize commercial and sport fisheries from Alaska to California and have failed to recover wild Chinook populations.
- Closing marine mixed stock Chinook fisheries and moving fisheries to terminal areas would increase abundance of mature Chinook within SRKW foraging grounds.
- Significant reductions in Chinook hatchery production must be implemented to rebuild Chinook population structure and SRKW food supply.
- Vessel management measures in US SRKW critical habitat should be harmonized with Canada's 2019 measures to reduce vessel disturbance and improve salmon accessibility.
- These steps offer the best, and perhaps only, chance to restore reproductive potential and improve survival for endangered SRKWs.

Recovery plans for endangered Southern Resident killer whales have been in place in the US and Canada since 2008. Despite the listings and recovery plans, these whales have failed to show any signs of population stabilization, a reversal in their declining trend, or recovery. The most recent Population Viability Analysis (PVA) completed by Canada's Department of Fisheries and Oceans (DFO, Clark-Murray et al. 2019) in August 2019 shows ongoing population decline with a 26% probability of quasi-extinction (one sex) within 75-97 years (SAR: https://www.dfo-mpo.gc.ca/csas-sccs/Publications/SAR-AS/2019/2019_030-eng.html; Clarke-Murray et al. 2019).

DFO's PVA examined the known primary threats (abundance of primary prey, Chinook salmon, vessel noise and disturbance, and contaminants) from an individual and cumulative threat perspective. When considered individually, the modeled effects of individual threats did not replicate the observed population trend in SRKWs over the period 2000-2017. When the threats were considered together (Chinook salmon abundance, vessel noise/physical disturbance, vessel strike and PCB contamination), the output of the PVA model closely replicated the observed population trends for Southern (and Northern) Resident killer whale populations. The authors conclude that Chinook salmon abundance and its interactions with vessel noise and PCBs strongly influenced modelled killer whale population dynamics. Importantly, this PVA follows previous DFO (Velez-Espino *et al.* 2014 a, b) and independent (Lacy *et al.* 2017) viability analyses that show declining trajectories with a 25% to 49% risk of functional extinction (less than 30 individuals) by the end of the century depending on the threats considered.

Despite minor efforts to reduce threats and implement precautionary measures for SRKWs, these actions have not improved declining trends nor have they improved estimated extinction probabilities. This failure has placed the region in the position of having to undertake drastic actions to arrest the decline in Southern Resident population numbers and preserve reproductive potential. Past reductions in Chinook salmon fisheries, including those in the recently renewed Pacific Salmon Treaty, have at best simply followed declining stocks down, rather than making significant precautionary reductions and/or implement closures that would get ahead of population declines and facilitate genuine rebuilding. Herein, we propose actions to be taken immediately to halt the decline and preserve the possibility of recovery of these iconic whales.

Despite high profile attention and proclamations for bold recovery actions by governments in the past few years, the SRKW population has only declined. Absolute population numbers are at critically low levels (73 individuals across the three pods with J pod consisting of 22 members, K pod of 17, and L pod of 34; CWR https://www.whaleresearch.com/orca-population). Extensive analysis has been presented to US authorities on the Task Force and to NOAA, describing the population's precarious biological condition. There should be no disputing the demographic information that shows a dramatic reduction in successful births, declining matriarch and breeding females, skewed sex ratios, in-breeding concerns, disrupted age structure, and destabilized population structure that likely has social, as well as biological, implications. The issue at hand is not whether urgent action is warranted, but the adequacy of the measures needed to reverse this dangerous decline and stabilize the population so as to preserve the possibility of recovery (population rebuilding).

A rapidly changing ocean

Underpinning the historical presence, distribution, and resilience of Resident killer whales are evolutionary ecological processes that support ecosystem function and services. As these processes are disrupted or destroyed, the complex ecological webs that underlie the diversity, abundance, and productivity of Chinook salmon and SRKW (among many other components of Pacific Northwest marine and freshwater ecosystems) unravel. Mixed-stock coastal marine salmon fisheries and large-scale salmon hatchery production are contributing causes of this unraveling.

The diet, biological and cultural traits of Southern Residents have evolved over 250 thousand years into an ecotype that is highly specialized on the geographic distribution, run timing, and size and abundance of Chinook salmon, as well as other seasonally abundant species of the larger Pacific salmon. They also evolved with an acoustic environment that supported their use of sound to meet social and biological life requisites.

The quality of the marine environment (warming, acidification, oxygen loss, nutrient cycling and primary production) along with the spatial, temporal and biological structure of Chinook populations that SRKWs rely on, has changed significantly within the last century, especially so in the last 30-40 years.

Today, the rates, scales, kinds, and combinations of regional and global ecosystem change differ from those at any other time in history. For example, heatwaves from El Nino, the blob, and steady warming in the North Pacific Ocean increases salmon metabolism, food consumption and stress. More importantly, warming temperatures change zooplankton composition and distribution (changing food quality), increase vertebrate and invertebrate predators, drive algae blooms, change historic hydrologic patterns, increase ocean stratification, weaken upwelling processes, and change the base of the salmon food web.

Surface waters are not just warmer, they are more acidic. With higher acidity, sound wave absorption is lowered, making ocean noise louder. More CO_2 uptake has consequences for zooplankton at the base of the food web that use carbonate minerals for shells and skeletons. Models predict that large parts of the Arctic will start to cross a carbonate under-saturation threshold in a decade, with forecasts that most Arctic waters will lack adequate aragonite for shell-building organisms by the 2080s (AMAP 2018).

Other ecosystem changes come from disease, invasive species, contaminants, competition, and a multitude of altered freshwater conditions. Sudden leaps in aberrant ecosystem behaviour are also being observed, with changes often occurring faster than we can understand them. Coupled with this is still a fundamental lack of understanding of the functions and processes that underpin natural systems. This understanding is often a prerequisite to link species decline with threat reduction and conservation action. Its absence allows resource managers to stay the course of conventional management and abdicate demonstrating burden of proof of ecosystem harm.

The take home message from this is that both killer whales and Chinook salmon must now recover in an environment that is vastly different from the one in which they evolved. Their ability to recover is unlikely unless significant measures are taken to stop threats and encourage, rather than undermine, their resilience.

Recommendations

1. **NOAA must reform Chinook harvest in AABM and ISBM fisheries**

SRKWs evolved with the spatial and temporal run timing of Chinook salmon that matured between four and eight years of age (and an increasing percentage of females with age). These salmon returned across the months and seasons to select rivers within the range of SRKW. SRKW are highly selective on mature large (70cm+), old (4 yrs +), and increasingly rare Chinook salmon (for example, 4 and 5 yr old Chinook made up less the 15% of the abundance estimate for 2-5 year old Chinook in the 2018 FRAM pre-season abundance model, Chinook older than this are so rare they are not even factored into models). Unless the historic population structure and run timing of Chinook is restored, SRKWs cannot recover.

Chinook salmon abundance trends show synchronous declines throughout BC, the Transboundary rivers, the Yukon, and Southeast Alaska, with declines in Chinook survival reported from Oregon to Alaska (Grant et al. 2019). Declining Chinook abundance is exacerbated by decreases in Chinook size at age, age at return, age at maturity, and reproductive potential, including reductions in egg size and the numbers of eggs per female, especially among age 4 (ocean age 3) and older females, largely due to the reduction in size-at-age (Grant et al. 2019, Ohlberger et al. 2018, 2019). These changes in population structure are perpetuated by Chinook fisheries that target the largest, oldest salmon, and coastal mixed-stock Chinook fisheries that encounter immature Chinook (Riddell et al. 2013). They are also perpetuated by competition when food supply is limited, competition that is exacerbated by releases of large numbers of hatchery Chinook.

As spawning Chinook return younger and smaller, this affects their spawning success. Large female Chinook have the size and strength to bury their fertilized eggs in course gravel and cobble below the typical scour force of the river. In this way, few are crushed or washed away under typical conditions. As female Chinook decline in size, so does their ability to build adequate redds (nests), leading to lower survival in the fewer, smaller eggs that are deposited. In addition, high quality spawning habitats that can only be utilized by larger Chinook go unused, further depressing population productivity, abundance, and diversity and distorting assessment of the effects of habitat preservation and recovery efforts.

Benefits from a coast-wide marine recreational and commercial Chinook closure

Within two generations of Chinook salmon (8-10 years), the elimination of mixed stock fisheries that encounter and kill mature and immature Chinook can be expected to begin rebuilding an older age structure to many Chinook populations that are critical to SRKW, providing more and larger Chinook to these whales. Estimates in Hilborn et al. (2012) show that the probable effects of full marine fishery closures (US and Canada) would increase total abundance (numbers) of mature age 4 and 5 yr old Chinook to the Salish Sea by about 20% for all stocks combined (Puget Sound, Fraser early, Fraser late, and Lower Georgia Strait). Increases in terminal abundance of this magnitude were shown by Lacy et al. (2017) to stop the declining trend of SRKWs. When combined with vessel management actions to reduce noise and disturbance, such increases in abundance could bring about positive growth rates.

Elimination of marine mixed-stock fisheries is not a no fishing scenario. Terminal and in-river fisheries employing selective fishing gears and methods whose harvests are managed for ecosystem benefits (i.e. by setting egg deposition and adult spawner escapement targets that maximize smolt production (Forseth et al. 2013, Gayeski et al. 2018) can provide salmon to First Nation and Tribal needs. Such fisheries are designed to occur after whales have had access and after component stocks that are currently encountered in mixed stock fishery areas have diverged to their rivers of origin. Fisheries targeting and otherwise affecting populations down the Pacific Coast as far as Monterey Bay, will likely need to be reconfigured in similar ways to those conducted on migrations routes between Alaska and the Salish Sea.

Remove the burden of proof placed on the SRKW

Until now, advocates for SRKW recovery have been made to bear the burden of proof when proposing conservation measures at the expense of other stakeholders and interests. This must change. The burden of Chinook harvest reductions that may be undertaken to attempt to halt the decline of the SRKW DPS must fall on fisheries. The April 2019 NMFS Biological Opinion concerning the Consultation on the Delegation of Management Authority for Specified Salmon Fisheries to the State of Alaska makes it clear that NMFS considers Treaty Chinook fisheries as configured pursuant to the 2019 Pacific Salmon Treaty to jeopardize ESA-listed Puget Sound Chinook and SRKW[1]. NMFS's finding that there is a need to further mitigate the effects of

[1] The 2019 BiOP admittedly does not explicitly use the term 'jeopardy'. The exact language is "… the status of Puget Sound Chinook salmon and SRKWs have declined in recent years. A key objective of the U.S. Section during the negotiating process for a new Agreement was therefore to achieve harvest reductions to help address ongoing conservation concerns for Puget Sound Chinook and coincidentally provide benefits for SRKWs", and continues "Further reductions [in Chinook harvest in PST fisheries] are proposed in conjunction with the 2019 Agreement, but there was a practical limit to what could be achieved through the bilateral negotiation process. As a consequence, and in addition to the southeast Alaska, Canadian, and SUS fishery measures identified in the 2019 PST Agreement, the U.S. Section generally recognized that more would be required to mitigate the effects of

Chinook harvest beyond what is provided for in the Treaty is tacit admission that, absent the proposed mitigation measures, NMFS would have had to conclude jeopardy. Regardless of the proposed mitigation measures (which are conjectural and dependent on uncertain future funding), the Biological Opinion makes it clear that Chinook harvest poses jeopardy to SRKW, and since Treaty harvest measures have therein been given ESA take coverage, the burden for further necessary modifications in US coastal Chinook fisheries falls on the Council fisheries.

2. Significantly reduce, not increase, Chinook hatchery production

Hatchery Chinook salmon are produced to subsidize commercial and sport fisheries from Alaska to California. The production of Chinook from Washington, Oregon and California hatcheries has failed to recover Chinook salmon, contributed to overfishing of wild, threatened and endangered populations, contributed to the changes in population structure and run timing, and likely exacerbated competition with wild Chinook in a food limited environment of the North Pacific. Further, the public funds spent on these hatchery programs and facilities takes scarce funding away from wild population monitoring and recovery actions. Continuing to pursue a hatchery strategy will not change this situation. It is likely to undermine recovery efforts for wild Chinook and the needed rebuilding of their age structure, their run-timing, their diversity, their productivity and their abundance. Restoring these attributes is not the objective of production hatcheries. There is also concern that increased hatchery production from Puget Sound will come at a cost to natural production in the Fraser River.

Further, hatchery Chinook are largely late-timing ocean-types. Some of the most endangered Chinook populations, and potentially some of the most important runs for SRKW, are early-timed stream-types and the few remaining winter runs.

At current levels of hatchery production, the proportion of hatchery origin Chinook on wild salmon spawning grounds (pHOS: proportion of hatchery origin spawners) in most Washington rivers exceeds "biologically acceptable" levels recommended by the independent Hatchery Scientific Review Group (HSRG 2009, 2015, WDFW Score/Chinook). This is especially true of most Puget Sound Chinook populations.

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harvest and other limiting factors that contributed to the reduced status of Puget Sound Chinook salmon and SRKWs" (pp. 9-10).

The rush to focus on a conjectural quick fix in the form of increased Chinook hatchery production is symptomatic of the failure of current management to address past mismanagement of Chinook populations coast-wide and the hope that an industrial-technological solution will somehow solve a complex ecological problem. Reliance on this failed industrial tool to address the complex ecological issues facing SRKW and wild Chinook is destined to fail both of them. Such an approach simply repeats the current "placeless" management of salmon that fails to recognize that their great diversity and abundance is rooted in their strong attachment to place: i.e. the rivers of their origin (Gayeski *et al.* 2018). SRKW are an integral component of the Salish Sea ecosystem and any solution to the Chinook crisis affecting them should also be place-based.

Fisheries managers responsible for Chinook salmon and SRKW have ignored the significant harvest issues, perpetuated by hatcheries, that are responsible for a large part of the decline and failure for Chinook to rebuild (Gayeski *et al.* 2018).

3. The role of Pinnipeds

Canadian studies examining the consumption of Chinook by seals and sea lions since pinnipeds numbers have recovered to near historical levels in the last 20+ years, shows that Chinook salmon represent a small percentage of pinniped diet (less than 10% with a mean across all pinnipeds of 0 - 4.4%; DFO 2019). Juvenile, immature and mature salmon have many predators beyond pinnipeds including Humboldt squid, great blue herons and other piscivorous birds, harbour porpoise, Pacific white-sided dolphins, Pacific hake, river lamprey, salmon sharks, sturgeon, tuna, northern fur seals, and other Northeast Pacific Resident killer whales. Relationships that assume single lines between the abundance of prey and a specific predator oversimplify complex marine food webs. A proper appreciation of these food web dynamics and the extent of additive versus compensatory mortality that exists between pinnipeds and their salmon prey make it extremely difficult to predict how the system will react to removal of a predator.

There is also a host of other factors that affect the rate at which salmon are preyed upon. A 2019 workshop (Trites and Rosen *ed*.) identified the extent of kelp forests, habitat complexity, water temperature, stream water height and flow, man-made obstructions to fish passage (bridge, dam, etc.), proximity to pinniped haul outs, alternative prey availability, fishing efforts, and hatchery fish as some of many factors that may be affecting predation. As such, beliefs that a pinniped cull would aid Chinook survival are not supported by available science.

4. **Harmonize U.S. vessel management measures with Canadian measures**

In the spring of 2019, Transport Canada issued an Interim Order prohibiting vessels from approaching any killer whale within 400 metres while in Canadian SRKW critical habitat. Transport Canada also entered into an agreement with identified members of the Pacific Whale Watch Association (PWWA) to avoid and not follow SRKWs.[2] The Transport Canada agreement also enabled listed members of the PWWA to approach Transient/Biggs killer whales to 200 m. Preliminary reports of 2019 vessel compliance with the Order for SRKWs in Canadian waters indicate a good level of compliance and low number of commercial and private whale watch vessel interactions with SRKWs.

5. **Restore access to historical Chinook habitat.**

The rebuilding of wild runs in naturally flowing rivers throughout the historic geographical range of Chinook salmon is a necessary long term goal to give wild salmon the best possibility to recover their population structure, run timing, diversity and abundance. As such, the removal of the Snake River and other dams should be considered part of the long term recovery strategy. Benefits to the recruitment of affected Chinook populations and foraging SRKW would begin to accrue one or more Chinook generations (4+ years) after dam removal. These fish would be available for foraging from southwest Vancouver Island to California and within critical habitat in the Salish Sea.

Conclusion

U.S. government authorities have generally denied the risks of hatchery production to the preservation and recovery of wild Chinook salmon and excluded meaningful discussion of fisheries management issues that perpetuate the decline of wild Chinook salmon. This is a failure to openly and fully consider all factors leading to the current dire condition of the Southern Resident Killer Whale population. There is no credible scientific justification for this. Reductions

[2] See Appendix I “Sustainable Whale Watching Agreement to support the Recovery of Southern Resident Killer Whales”

of Chinook harvest are, with high probability, the most likely tangible action that can provide SRKWs with immediate relief from the major stresses that have been threatening the population with extinction for the past decade or more.

Closing mixed-stock marine commercial and recreational fishing, and significantly reducing hatchery production are required now. Closing such fisheries will ensure they are managed to prioritize the returns of mature Chinook to SRKW foraging refuge areas. The longer this kind of action is postponed, the lower the likelihood that the decline of SRKW can be halted, much less reversed, and the more drastic harvest reductions and other remedial actions will have to be in order to have any chance of success. Absent the actions we advocate, we expect the state of SRKW to get worse, not better, and thus continue the declining trend in the coming few decades, if not sooner.

Contacts for this submission are:

Misty MacDuffee
Wild Salmon Program Director
Raincoast Conservation Foundation

Nick Gayeski
Aquatic Ecologist
Wild Fish Conservancy

Christianne Wilhelmson
Executive Director
Georgia Strait Alliance

Michael Jasny
Director, Marine Mammal Protection Project
Natural Resources Defense Council

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Appendix I

SUSTAINABLE WHALE WATCHING AGREEMENT TO SUPPORT THE RECOVERY OF THE SOUTHERN RESIDENT KILLER WHALE

Between:

The Minister of Transport, responsible for the Department of Transport (TC)
(Hereinafter referred to as the Minister)

And

The Membership of the Pacific Whale Watch Association, as represented by their Board of Directors
(Hereinafter referred to as PWWA
(Hereinafter referred to as the "Parties")

SUSTAINABLE WHALE WATCHING AGREEMENT TO SUPPORT THE RECOVERY OF THE SOUTHERN RESIDENT KILLER WHALE

Contents

PREAMBLE:

A. **Whereas** the Southern Resident Killer Whale (SRKW) is a species which has been listed as Endangered under part 2, Schedule 1 of the federal *Species at Risk Act, 2002* (SARA);

B. **And whereas** Canada is committed to the long-term conservation, survival and recovery of aquatic species at risk to ensure the long-term viability of species and to enhance their survival in the wild;

C. **And whereas** the Parties recognize that a key threat to the SRKW is acoustic and physical disturbance from vessels;

D. **And whereas** on May 24, 2018 the Minister of Fisheries, Oceans and the Canadian Coast Guard and the Minister of Environment and Climate Change Canada, as the Minister responsible for Parks Canada Agency, as competent ministers for the SRKW announced that they were of the opinion that the SRKW population faced imminent threats to its survival and recovery;

E. **And whereas** TC has jurisdiction over maritime traffic, has a mandate to promote efficient, environmentally responsible and safe transportation, and has a responsibility to address the environmental impacts of maritime transportation including the mitigation of acoustic and physical disturbance on endangered marine mammals;

F. **And whereas** the PWWA is committed to education and conservation while advocating responsible whale watching, and is also committed to direct conservation, using their extraordinary access to these sensitive populations of marine mammals to help protect them for generations to come;

G. **And whereas** the Parties wish to cooperate in the taking of measures to support the survival and recovery of the SRKW as aligned with the recovery goal and objectives in the Recovery Strategy and recovery measures in the Action Plan, as well as in any future recovery documents prepared in accordance with SARA legislative requirements;

H. **And whereas** the critical habitat of SRKW is currently defined to include coastal waters off British Columbia;

I. **And whereas** the Minister has issued an Interim Order prohibiting vessels from approaching within 400 metres of a killer whale within SRKW critical habitat;

J. **And whereas** members of the PWWA have specialized knowledge and experience to determine whale ecotypes through observation of their behaviour, activity, and appearance;

K. **And whereas** the Minister may authorize a vessel, or a person operating or navigating a vessel, to approach to approach between 200m and 400m of a killer whale, other than a SRKW, for commercial whale-watching purposes, while within the critical habitat of the SRKW, if the person or vessel is subject to an agreement with the Minister related to whale watching and intended to reduce the risk of physical and acoustic disturbance to SRKW;

L. **And whereas** the members of the PWWA are welcome to leverage this agreement to help educate and raise awareness among their clients of the plight of the SRKW and the reasons these actions are being taken.

M. **Now therefore**, the Parties commit to the following:

1. DEFINITIONS

1.1. The following terms defined hereunder and used in this Agreement, when capitalized, will have the following meaning:

1.1.1. **"2019 season"** refers to the months during 2019, specifically June 1st – October 31st, when SRKW are expected to return to their critical habitat in increasing numbers.

1.1.2. **"Acoustic disturbance"** means anthropogenic noise that interferes with SRKW life functions including feeding and foraging, reproduction, socializing, and resting, such that the marine environment cannot support effective acoustic social signaling and echolocation and results in loss of habitat availability and/or function

1.1.3. **"Best available information"** includes relevant scientific, technical, navigational safety, operational, commercial and economic data, community and Indigenous traditional knowledge;

1.1.4. **"Effective Date"** means the date of the last signature affixed to this Agreement;

1.1.5. "**Physical disturbance"** means the physical presence and proximity of vessels to individual SRKW that impedes functions such as feeding, foraging, reproduction, socializing or resting, which may affect SRKW at both the individual and population level;

1.1.6. **"PWWA vessels"** means a vessel operated by a Pacific Whale Watch Association member for the purposes of whale watching and ecotourism business.

2. GOAL AND PURPOSE

2.1. The goal of this agreement is to reduce the risk of physical and acoustic disturbance to Southern Resident killer whales from PWWA vessels for the 2019 season.

2.2. The purposes of this agreement are to:

2.2.1. Set out the specific commitments from PWWA that will assist in achieving the stated goal;

2.2.2. Enable membership of the PWWA, including both Canadian and U.S. members, to fulfil the requirement of an agreement in order to receive authorization to approach between 200m and 400m of a killer whale, other than a SRKW, for commercial whale-watching purposes, while within the critical habitat of the SRKW;

2.2.3. Establish a mechanism for reporting and review with respect to PWWA commitments.

3. PRINCIPLES

3.1. The following principles will guide interpretation and implementation of this Agreement:

3.1.1. **Precaution**: The efforts of the PWWA are being taken in recognition of the need to act in a precautionary manner given the status of the SRKW;

3.1.2. **Adaptation/Adaptive Management**: The Parties recognize that monitoring the effectiveness of existing and future threat reduction measures to abate threats from PWWA vessels and adjusting approaches as necessary will be critical to success;

3.1.3. **Co-benefits**: The Parties will seek opportunities to implement threat reduction measures for SRKW that may also offer co-benefits to other species at risk;

3.1.4. **Transparency**: The Parties will make non-confidential information related to the development, implementation and monitoring of the Agreement and threat reduction measures publicly available subject to section 8.2 of this Agreement; and

3.1.5. **Engagement**: The Parties will seek opportunities for bilateral engagement on the implementation of the agreement.

4. INTERPRETATION

4.1. The preamble hereof and any appendices hereto form an integral part of this Agreement.

4.2. This Agreement is not intended to create any legally binding obligations, duties, commitments or liabilities (contractual or otherwise) on any of the parties. Nor does it create any new legal powers on the part of the Parties or affect in any way the powers, duties and functions of the Minister of Transport under the *Canada Shipping Act, 2001*, the *Canada Marine Act*, or any other federal legislation.

5. MEASURES UNDERTAKEN FOR THE PROTECTION OF SRKW BY THE MEMBERSHIP OF THE PACIFIC WHALE WATCH ASSOCIATION

5.1. The Parties acknowledge that:

5.1.1. Recovery of the SRKW population will require an ecosystem approach applied on a long-term basis that takes into consideration all three main threats to SRKW and will require additional measures to those undertaken by the Parties pursuant to this Agreement;

5.1.2. Other limiting factors that may affect SRKW survival and recovery are beyond the influence of the Parties, including but not limited to events occurring in SRKW critical habitat in US waters.

5.2. In support of the goal set out in section 2.1 and subject to section 9.1, the PWWA and its members commit to:

A) Continue to practice current PWWA guidelines, including travelling at no more than 7 knots when within 1 kilometre of a whale (all types), and turning off sonar, depth sounders, fish finders and other underwater transducers when in the vicinity of a whale (all types);

B) Focus whale watching tours on populations of Bigg's killer whales (Transients), Northern Resident killer whales, Humpback, and other Baleen Whales, and will not intentionally offer, plan or promote excursions based on viewing of SRKW. When periodically encountering SRKW in the course of viewing other whales, PWWA vessels will focus on conservation and education of the SRKW, will not approach within 400 metres, will not follow SRKW, will continue following the go-slow-within-1km approach, and will continue transiting as soon as possible;

C) Ensure to respect the Interim Sanctuary Zones, as established under the Interim Order, which shall not be entered;

D) Carry any written authorization(s) received to approach between 200m and 400m of a killer whale, other than a SRKW, for commercial whale-watching purposes, on board and produce it on request;

E) Log (and report) any incidents involving unintentional approaches to within 400 metres of SRKW, either observed or experienced.

6. TERM, MODIFICATION, TERMINATION & RENEWAL

6.1. This Agreement takes effect on the date of the last signature affixed to this Agreement ("Effective Date").

6.2. This Agreement remains in force for the duration of the 2019 season, unless terminated earlier by one of the Parties or the Parties mutually agree to modify or terminate it.

6.3. The Agreement can only be modified by mutual consent of the Parties or their representatives.

6.4. The Parties may renew this Agreement or any part of it, and its duration may be extended with the mutual written consent of the Parties prior to the expiration of this Agreement.

7. GOVERNANCE

7.1. Should a member of the PWWA be found in violation of this agreement or of the mandatory applicable approach distance(s), the PWWA executive is expected to take appropriate action to ensure that the integrity of the agreement is not jeopardized and inform Canada of their approach to addressing violations.

7.2. The Minister retains discretion to suspend or revoke this agreement and revoke any authorization granted under the Interim Order, regardless of the action(s) taken by the PWWA with regard to addressing violations.

7.3. Monthly update calls between PWWA leadership and TC, represented by the Environmental Policy Group, shall be held to share information, discuss any issues that have arisen, and identify any on-going challenges.

8. MONITORING, RECORD KEEPING & REPORTING

8.1. The PWWA commits to providing the Minister with a list all its members along with the corporate address of their place of business, contact information and vessel information. The PWWA will ensure the list provided to the Minister is current.

8.2. The PWWA commits members to monitoring and keeping records of the progress on actions identified within the Agreement, specifically the implementation of those committed to in subsection 5.2.

8.3. By December 31, 2019, the Parties will review the Agreement against the agreed upon monitoring and record keeping and prepare and issue a report describing the implementation of measures undertaken as part of this Agreement.

9. INFORMATION SHARING

9.1. Each Party agrees, subject to any applicable data sharing agreements and legislative provisions that would prevent them from doing so, to provide the other Party access at no charge to available data and information relevant to the implementation of this Agreement.

9.2. Some data and information may require confidentiality or may have been obtained with an understanding of confidentiality. Data and information so identified by a Party, or a collaborator in programs and activities related to this Agreement, will be held confidential by the Parties to the extent permitted by any relevant legislation and related policies, procedures, and agreements.

10. DISPUTE RESOLUTION

10.1. Where a dispute arises under this Agreement, the dispute shall be resolved through consultations between the Minister's representatives and representatives of PWWA.

11. PARLIAMENT NOT FETTERED

11.1. Nothing in this Agreement shall prohibit, restrict or affect the right or power of the Parliament of Canada to enact any laws whatsoever with respect to any area of law for which the Parliament of Canada has legislative jurisdiction, even if the enactment of any such law affects this Agreement, its interpretation or the obligations of either party.

12. MINISTER NOT FETTERED

12.1. Nothing in this Agreement shall derogate or otherwise fetter the ability of the Minister to regulate, administer, manage, or otherwise deal with the protection of the marine environment from adverse vessel effects and all attendant matters thereto.

13. SIGNATURES

In witness whereof, the Parties have executed this Agreement.

ATTACHMENT 3

HONORABLE MICHELLE L. PETERSON

UNITED STATES DISTRICT COURT
WESTERN DISTRICT OF WASHINGTON
AT SEATTLE

WILD FISH CONSERVANCY NORTHWEST, a Washington non-profit corporation, Plaintiff, v. BARRY THOM, in his official capacity as Regional Administrator of the National Marine Fisheries Service, *et al*, Defendants.	Case No. 2:20-cv-00417-MLP **DECLARATION OF DR. ROBERT LACY, Ph.D.**

I, Robert Lacy, state and declare as follows;

1. I am over eighteen years of age. I have personal knowledge of the facts contained in this declaration and am otherwise competent to testify to the matters in this declaration.

2. I received my B.A. and M.A. in Biology from Wesleyan University in 1977, where I graduated summa cum laude. I received my Ph.D. in Evolutionary Biology with minors in Genetics and Ecology from Cornell University in 1982. I serve on the faculty of the Committee on Evolutionary Biology at University of Chicago. I was a Conservation Scientist for the Chicago Zoological Society from 1985, until my recent retirement and appointment as a Conservation Scientist Emeritus. Although "retired" I still work actively with the Species

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
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(503) 841-6515

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1001 Fourth Avenue, Suite 3900
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(206) 625-8600

Conservation Toolkit Initiative, a team that develops, distributes, and supports software for species risk assessments and wildlife population management.

3. My qualifications, including publications, is contained in my Curriculum Vitae, which is attached as Exhibit B to this declaration.

4. I have been retained by Wild Fish Conservancy, through its counsel, to provide expert opinions in this matter on issues related to the Southern Resident Killer Whale population and the implications of the National Marine Fisheries Service's ("NMFS") conclusions in the Biological Opinion issued with regard to the 2019 Pacific Salmon Treaty. This declaration describes my opinions and the bases therefor.

5. In addition to drawing upon my knowledge and expertise, I have reviewed the materials cited throughout this declaration and those identified in the list of cited materials attached to this declaration as Exhibit A in developing my opinions expressed herein.

6. In summary, the opinions I express herein are as follows:

a. Analyses conducted in 2015 projected that the Southern Resident Killer Whale population would decline slowly at a rate of about 0.2% per year if environmental conditions and the demographic responses to threats remained as they had been over the previous few decades. Updated analyses on the current population now project about a 1% annual decline, leading to eventual extinction of the population as demographic and genetic problems become worse with the ongoing decline in the breeding population. The numbers of Southern Resident Killer Whales increased from 1976 to a peak in 1993-1996, and has subsequently declined. The 2015 prediction of approximately zero population growth accurately reflected the lack of growth in numbers over the entire time period

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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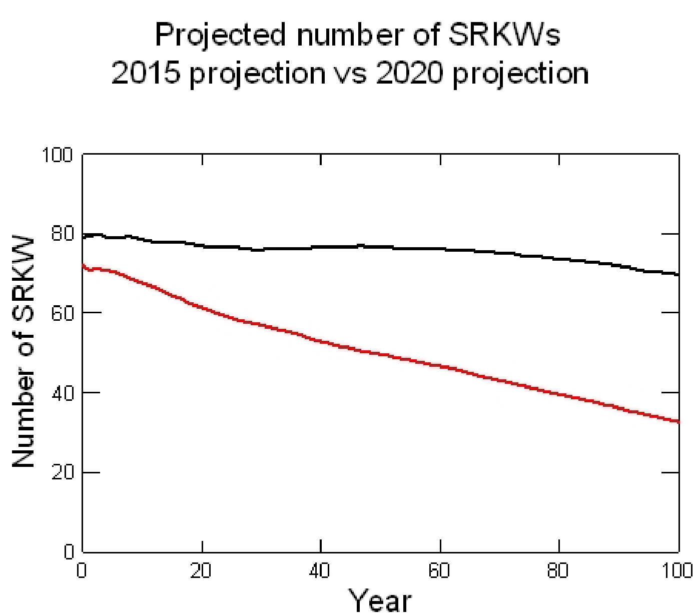
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

from 1976 to 2020, while the more pessimistic current prediction accurately mirrors the 1% average annual decline that has occurred since 1993. Since 2014, the Southern Resident Killer Whale population has declined at an even faster rate of about 2% per year. Although the difference between a 0.2% annual decline and a 1% annual decline might not seem large, the cumulative effect of the faster rate of decline compounds to become considerable damage across the years. The following graph shows the mean projected number of Southern Resident Killer Whales, using the data from 2015 (upper, black line) and the mean projected number using the current (2020) data (lower, red line). In 2015, we estimated a 9% probability that the population would become functionally extinct with fewer than 30 animals within the next 100 years. With updates to reflect the current situation, I now estimate a 59% probability that the population will drop below 30 animals sometime in the next 100 years, becoming functionally extinct.



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(503) 841-6515

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1001 Fourth Avenue, Suite 3900
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(206) 625-8600

b. The abundance of Chinook prey influences the reproductive rate and the survival rates of the Southern Resident Killer Whale. Analyses indicate that prey abundance is the factor that has the largest impact on Southern Resident Killer Whale population growth or decline. Using published estimates of the effect of prey abundance on demographic rates, we calculate that Chinook total abundance available as prey to the Southern Resident Killer Whale needs to increase by about 10% over the mean levels of the last few decades for the decline of the Southern Resident Killer Whale to be halted. Recovery of the Southern Resident Killer Whale population at the rate (2.3% growth) specified for delisting in the species' Recovery Plan will require an increase in the Chinook prey abundance of about 35%.

c. The NMFS 2019 Biological Opinion ("2019 SEAK BiOp") proposes several actions aimed at increasing the number of Chinook salmon available to the Southern Resident Killer Whales. The reduction in the Southeast Alaska salmon fishery of up to 7.5% in the 2019 Pacific Salmon Treaty relative to the preceding agreement, which is described in the 2019 SEAK BiOp, results in very little change in the Chinook available to the Southern Resident Killer Whales, and therefore would not have a measurable benefit for the endangered Southern Resident Killer Whale.

d. A proposed hatchery expansion aims to increase Chinook available to the Southern Resident Killer Whales by 4-5%. That increase in prey can be estimated to reduce the annual rate of decline of the Southern Resident Killer Whale population from about 1% to about 0.5%, but this would not be sufficient to stop

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221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

the slide toward extinction.

e. The benefits to the Southern Resident Killer Whales of other possible mitigation measures are not quantified in the 2019 SEAK BiOp, and those actions would need to amount to a further increase (above that achieved from the two above mentioned measures) of at least another 5% in the Chinook abundance available as prey to Southern Resident Killer Whales in order for me to predict that the decline of Southern Resident Killer Whales would stop.

f. More aggressive management actions would be required to start the Southern Resident Killer Whale population on a reasonably secure path toward recovery or to meet NMFS' annual population growth rate goal of 2.3%.

7. My career has focused on building the capacity of the world to be much more effective in ensuring the long-term sustainability of species. I have done this via advancing the basic science that must underlie successful programs for sustaining species; providing the accessible tools to enable others to apply the science to species assessments, conservation planning, and population management; training students and colleagues in the use of the tools; and – when necessary – doing the analyses that inform and guide conservation for individual species.

8. Over my career I have developed, freely distributed, and supported software tools for guiding species conservation and population management. My approach has always been to provide tools for powerful and flexible analyses, within user interfaces that are accessible to wildlife managers, students, and others who might not have expertise with computer languages and systems. Consequently, the tools are now used globally to guide population management in nature reserves and zoos, viability analyses and recovery planning by wildlife agencies, and

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221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

integrated assessment of threats to species. The software is used also to teach students about population biology and conservation in many universities.

Population Viability Analysis

9. Population viability analysis (PVA) is a class of scientific techniques that uses demographic modeling to assess risks to wildlife populations and evaluate the likely efficacy of protection, recovery, or restoration options (Shaffer 1990; Boyce 1992; Burgman et al. 1993; Sjögren-Gulve and Ebenhard 2000; Beissinger and McCullough 2002; Morris and Doak 2002). (All references cited in this Declaration are listed in Exhibit A.) PVA usually starts with standard demographic analysis ("life table analysis") to make deterministic projections of the expected population growth rate from the mean birth and death rates (Ricklefs 1990; Caswell 2001). PVA then extends the standard demographic projections in two important ways: (1) the impacts of forces external to the population (e.g., changing habitat quality, extent, and configuration; interactions with other species in the community; impacts of disease or contaminants; harvest, incidental killing, or other direct human impacts) on the demographic rates are explicitly considered and evaluated, and (2) uncertainty in the population trajectory caused by intrinsic (e.g., demographic stochasticity, limitations in local mate availability or other density dependent feedbacks, inbreeding impacts) and extrinsic (e.g., environmental variation, occasional catastrophes) factors can be explicitly modeled, usually through the use of simulation modeling. The outputs of PVA include any desired measure of population performance, but commonly assessed metrics include projected mean population size (N) over time, population growth rates (r), expected annual fluctuations in both N and r, probability of population extinction, and probabilities of quasi-extinction (the likelihood of N falling below any specified number within a specific number of years). These outputs are used to assess risk (e.g., for listing under the

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221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

Endangered Species Act or other protective regulations), assess vulnerability to possible threats, determine sustainable harvest in the context of uncertainty, and determine the suites of actions that would be needed to achieve stated resource protection or restoration goals.

10. A requirement for any PVA model to provide sufficiently accurate and robust projections to allow estimation of population performance is the availability of detailed demographic data. Model input is required from the focal population or comparable reference populations for mortality rates, aspects of reproduction (e.g., age of breeding, age of reproductive senescence, inter-birth intervals, and infant survival), population size, and habitat carrying capacity – as well as the natural fluctuations in these rates. The difficulty in obtaining sufficient demographic data on endangered or protected species is a common challenge to the usefulness of PVA models, and many practitioners consequently recommend that PVA models be used only to provide assessments of relative risk and relative value of management options, rather than absolute measures of population trajectories. In the case of the Southern Resident Killer Whale population, however, demographic data are available from studies by the Center for Whale Research and others that are unprecedented in duration and detail of data collection. This exceptional data set provides a complete census of the total abundance as well as the age and sex composition of the Southern Resident Killer Whale population from 1976 to 2020. This allows for much more accurate projections of population performance and the ability to compare predicted trajectories to the precisely documented fate of the population.

11. PVA models were developed initially for quantifying future risk to populations that are vulnerable to collapse due to a combination of threatening processes (Shaffer 1990). They were soon recognized to be more reliable for assessing relative risk than absolute probabilities of decline or extinction (Beissinger and McCullough 2002; but see Brook et al.

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

2000 for evidence that even absolute predictions of population trends can be accurate), and have become most useful in the identification of conservation actions that are most likely to achieve conservation goals (Sjögren-Gulve and Ebenhard 2000). The same methods can be used to quantify injury caused by an externally imposed stress, by comparing measures of population performance in the presence vs. absence of the stress, and to determine what actions would be needed to reverse the impact, restore the population to pre-injury health, and compensate for interim losses. The PVA forecasts can then be used to set the targets for expected performance under proposed restoration plans.

12. The Vortex PVA model that I developed (Lacy and Pollak 2020) is what is known as an individual-based model that projects the fate of each individual in a population. It simulates the effects of both deterministic forces and demographic, environmental and genetic stochastic (or random) events on wildlife populations. Vortex models population dynamics as sequential events that are determined for each individual in a population with probabilities determined from user-specified distributions. Vortex simulates a population by stepping through a series of events that describe an annual cycle of a sexually reproducing organism: mate selection, reproduction, mortality, dispersal, incrementing of age by one year, any managed removals from, or supplementation to, the populations, and limitation of the total population size (habitat "carrying capacity"). The simulations are iterated to generate the distribution of fates that the population might experience. Vortex tracks the sex, age, and parentage of each individual in the population as demographic events (birth, sex determination, mating, dispersal, and death) are simulated. A detailed description of the program structure is provided in Lacy (1993; 2000) and details about the use of Vortex are provided in the manual (Lacy et al. 2020).

13. The Vortex PVA modeling software is well-suited for the analyses of threats to

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

the Southern Resident Killer Whale population, as Vortex is the most widely used, tested, and validated individual-based PVA model, and it is publicly accessible so that anyone can re-examine and repeat published analyses. It is highly flexible in allowing all input demographic parameters to be specified optionally as functions of external forces or as rates that change over time. Vortex has been used for modeling population dynamics of various marine mammal species (including bottlenose dolphins, Indo-Pacific bottlenose dolphins, baiji, manatees, dugongs, Hawaiian monk seals, and Mediterranean monk seals), as well as thousands of other species. Vortex has been shown to produce projections that accurately forecast dynamics of well-studied populations (Brook et al. 2000). Both NMFS in its 2019 SEAK BiOp (e.g., pp. 86, 90, 311) and Fisheries and Oceans Canada (Murray et al. 2019, e.g., pp. 3-5, 30, 33, 44, 62) have relied on analyses completed with Vortex for assessing the status of the Southern Resident Killer Whales.

Southern Resident Killer Whales

14. In 2015, at the request of Canada's National Energy Board ("NEB"), I led a team of six scientists conducting a PVA of the risk associated with aspects of the proposed Trans Mountain Expansion Project (Project) on the endangered Southern Resident Killer Whales. In that analysis, the PVA model was used to estimate the increased risk to the Southern Resident Killer Whales from three threats associated with the marine shipping component of the Project: an oil spill, increased acoustic and physical disturbance from ships, and ship strikes. The report also examined the possible effects of decreased Chinook salmon prey base that might result from climate change or human activities, and evaluated those impacts in comparison to the more immediate threats of the proposed Project and as the environmental context within which the impacts of the Project are likely to occur. The report to NEB (Lacy et al. 2015), including

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

detailed descriptions of the methods and the data used in the PVA, is publicly available at http://docs.neb-one.gc.ca/fetch.asp?language=E&ID=A4L9G2. The analyses were extended and published in a peer-reviewed scientific paper (Lacy et al. 2017). Further updating of analyses using demographic data on the population through 2018 (Lacy et al. 2018) was submitted to NEB and is available at https://apps.cer-rec.gc.ca/REGDOCS/Search?txthl=A96429-3%20A%20-%20Expert%20Report%20of%20Lacy%20et%20al%20-%202018%20-%20Final%20-%20A6L5R2.

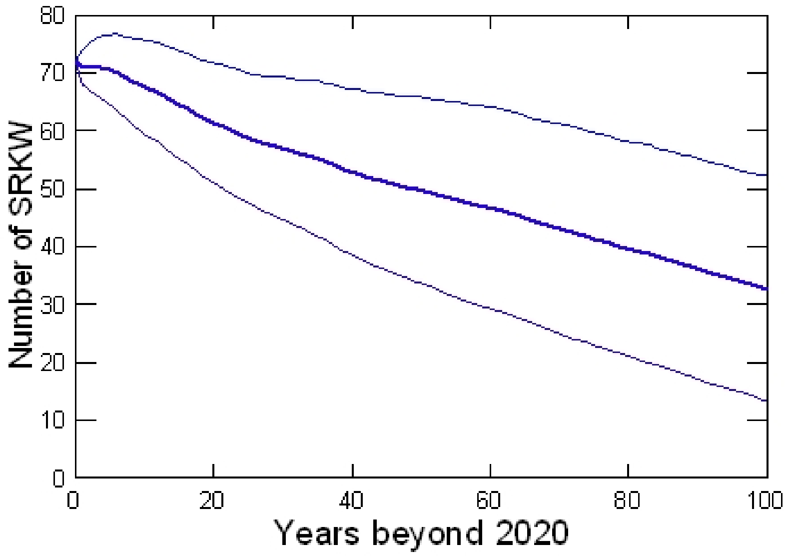
15. As of 2015 and 2017, based on status quo conditions, we projected the Southern Resident Killer Whale population would remain about at its current size or continue a very slow decline (estimated at a mean annual decline of 0.2%). We projected a 9% chance of quasi-extinction within the next 100 years, where the population falls below 30 whales and is no longer viable.

16. I have now updated the PVA model again, using fecundity and survival rates calculated from the detailed records from 1976 through 2018 and applying those rates to the current population of 72 Southern Resident Killer Whales. The following graph shows the mean projected population size (heavier, middle line) and the uncertainty in the trajectory (upper and lower lines showing ± 1 standard deviation among independent repeated simulations of the population).

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

Projected number of SRKWs under current conditions



17. With current data, and if the Chinook availability remains at the mean level of the past few decades, the model projects a mean annual decline in the population of Southern Resident Killer Whales of about 1.0%. This is close to what has been occurring recently, and it compares to our 2018 projection of a smaller decline of 0.6% per year (Lacy et al. 2018). About half of difference between the 2018 and 2020 projections is due to the fact that the population is aging (with the mean age of living whales now just over 22 years, whereas it was just over 21 years in 2018), and more animals are now post-reproductive or nearing post-reproductive age. The other half of the difference is due to the fact that we now have parentage data for more of the animals, and that allows us to have more complete estimates of kinships among animals, and that in turn leads to slightly higher estimates of current and future inbreeding.

18. For our model, we obtained estimates of the impact of Chinook prey abundance on the reproductive rates and survival rates of the Southern Resident Killer Whales from published scientific reports (Ward et al. 2009; Velez-Espino et al. 2015; Ford et al. 2010). We

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

scaled the numerical relationships so that the mean demographic rates observed in the Southern Resident Killer Whales from 1976 through 2015 were correctly predicted. (The details of the methodology are documented in Lacy et al. 2015 and Lacy et al. 2017 publications.) We then use these relationships to project the Southern Resident Killer Whale population trajectory in several scenarios that tested the impact of prey availability, expressed as a percent change in the annual abundance of Chinook salmon available as prey to the Southern Resident Killer Whales from the mean level over the last three decades.

19. The abundance of Chinook varies over time, and that variation in prey can be entered into the PVA model. However, as documented in the 2019 SEAK BiOp, the extent of that variation is very dependent on which stocks of Chinook are assessed, and it is not known precisely what proportion of the Southern Resident Killer Whale diet is composed of salmon from each stock. I examined the model projections with the Chinook abundance varying randomly across years around the long-term mean values being tested. I found that such an elaboration of the model had very little effect on the long-term projections for the Southern Resident Killer Whale population. This occurs because killer whales are very long-lived and slow breeders, so year to year fluctuations in demography will average out over their lifespans. Therefore, as was done in our prior PVA reports, the results from analyses presented in this declaration assume that the abundance of Chinook is at a fixed level each year and does not vary randomly around that value.

20. Also included in the model are the current estimates of both PCBs and noise disturbance, based on published estimates of the current magnitudes and effects of these threats (Hall et al. 2011; Hall and Williams 2015; Lusseau et al. 2009). These threats are part of the current environment for the Southern Resident Killer Whale, and they interact with the effect of

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
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(206) 625-8600

prey limitation. (The documented impact of noise disturbance is via a reduction in time that the Southern Resident Killer Whales spend feeding. The primary impact of PCBs is on survival of calves, compounding the reduction in survival that occurs with low prey availability.) Only with these effects of PCB and noise disturbance in the model do we accurately predict the recent observed rate of decline of the population. However, even if these other threats were completely eliminated—which is not possible in the near term and unlikely in the long term—our modeling shows that there would not be adequate prey available to achieve the population growth goal established in the Recovery Plan for the Southern Resident Killer Whale (Lacy et al. 2017).

21. By applying the published relationships of Southern Resident Killer Whale reproductive and survival rates to Chinook abundance, and then testing the benefits to Southern Resident Killer Whales of incremental improvements in the abundance of Chinook prey, the model shows that to achieve a mean zero population growth (i.e., to stop the decline), there would need to be a sustained 10% increase (relative to the 1976-2015 average) in the mean abundance of the Chinook stocks available as prey to the Southern Resident Killer Whales.

22. The analyses conducted in 2015, 2017, and 2018 estimated that a 30% increase in Chinook could achieve the 2.3% growth called for in the Southern Resident Killer Whale Recovery Plan. With the further decline that has occurred in the population in the last few years, our analysis of the 2020 population now projects that a 30% increase in Chinook would result in about 2% growth per year, and a 35% increase in prey would be necessary to meet the recovery goal. The graph below shows the expected Southern Resident Killer Whale population growth across a range of levels of Chinook abundance. The two horizontal lines indicate zero population growth and the 2.3% growth goal of the Recovery Plan.

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
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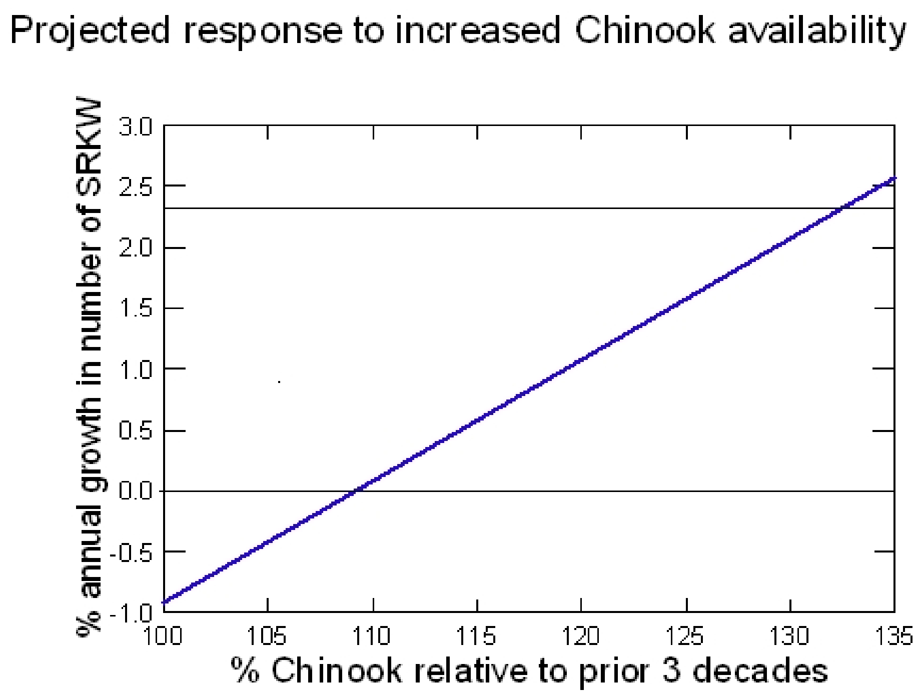
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600



NMFS' Biological Opinion and Impact on Southern Resident Killer Whale Population

23. I was provided with NMFS' 2019 SEAK BiOp for Southeast Alaska salmon fisheries at issue in this matter. I reviewed it closely. In the 2019 SEAK BiOp, NMFS acknowledges that the Southern Resident Killer Whale population is declining, and that is at least partly and maybe mostly due to inadequate prey availability. The 2019 SEAK BiOp cites my previous work (p. 311) as evidence that the biggest threat is that lack of prey, although other factors such as noise, PCBs, oil spills, and other environmental factors all make things worse.

24. In several places, and in various ways, the 2019 SEAK BiOp estimates the reduction in prey available for Southern Resident Killer Whales caused by the Southeast Alaska fisheries (e.g., Tables 41, 42, and 97) as between 2-15% in coastal fisheries and 1-2% in inland fisheries. However, there is significant uncertainty depending on which salmon stocks and for which years the calculations are based. Importantly, the BiOp does not explain how the various percentage reductions mentioned translate to corresponding changes in the total mean abundance of Chinook that provide potential prey for Southern Resident Killer Whales, which is what is

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

required for accurate projections of the benefits expected from reductions in the fisheries. The 2019 SEAK BiOp directly states (p. 94) "the impact of reduced Chinook salmon harvest on future availability of Chinook salmon to the Southern Residents is not clear."

25. The 2019 SEAK BiOp also discusses possible mitigation measures, which could increase the prey availability for Southern Resident Killer Whales. The 2019 SEAK BiOp estimates the newly negotiated 2019 Pacific Salmon Treaty will reduce the Southeast Alaska fishery annual harvest of Chinook by up to 7.5% relative to the harvest under the 2009 Treaty. A proposed increase in hatchery production mitigation seeks to provide 4 to 5% increase in prey available to the Southern Resident Killer Whales. The increase in hatchery production is not yet funded, so I would expect a delay of at least 5 to 10 years to account for allocation of funds, construction of any new facilities, increased programs of production, and then return of hatchery raised Chinook as mature adults.

26. I applied these estimates from the 2019 SEAK BiOp to the Vortex PVA model, in order to project the consequences of the possible scenarios described in the 2019 SEAK BiOp. The estimated 7.5% (maximum) reduction in the Southeast Alaska fishery, applied to a typical 6% reduction in prey available to the Southern Resident Killer Whales caused by the Southeast Alaska fishery as a whole (the 6% being an approximate middle value from the many estimates made in the BiOp), results in a less than 0.5% increase in the Southern Resident Killer Whale prey. This is only 1/20th of the 10% increase that is needed to achieve even a cessation of the decline in Southern Resident Killer Whale population.

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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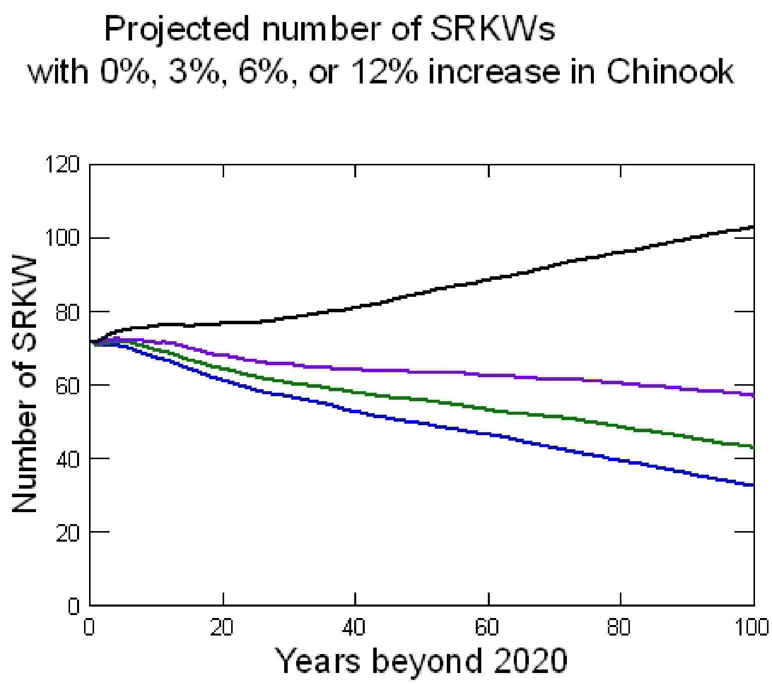
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

27. To estimate the possible reductions in threats to the Southern Resident Killer Whale that might be achieved with greater reductions in the Chinook fisheries, I projected a Southern Resident Killer Whale population growth with an immediate 6% increase in Chinook prey, and a 3% and a 12% increase in prey (half and double the middle estimate, covering most of the range of values reported in the 2019 SEAK BiOp for specific stocks and years). As shown in the following graph, with the existing baseline in blue (bottom line), the PVA projections for these scenarios show that the 3% increase in Chinook results in a mean 0.7% decline in Southern Resident Killer Whale population per year (green line), the 6% increase in Chinook results in a mean 0.4% decline of the Southern Resident Killer Whale population (purple line), and the 12% increase results in 0.3% positive growth annually (top, black line).



28. The impacts on Southern Resident Killer Whales of other estimates of prey increases that could be achieved by reductions in the fisheries can be extrapolated from the projections of Southern Resident Killer Whale population growth across a range of levels of Chinook abundance, as shown in the graph in paragraph 22, above.

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221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

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1001 Fourth Avenue, Suite 3900
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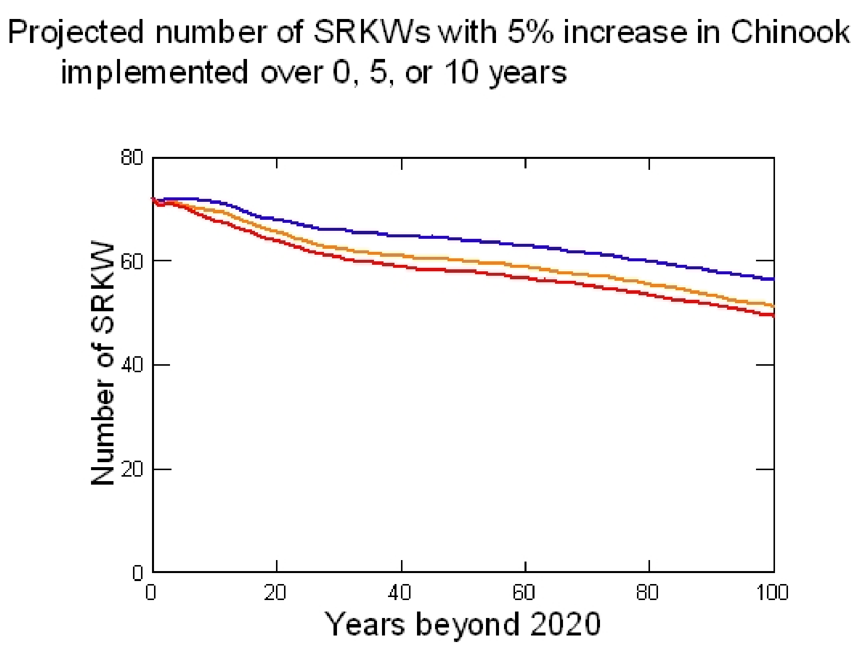
29. I projected the benefits to the Southern Residents of possible (but not yet funded) hatchery projects assuming a 5% increase in Chinook, beginning either 5 years or 10 years in the future. With either time scale for implementation and return of the hatchery-produced Chinook, the mean long-term consequence is a slowing of the decline in Southern Resident Killer Whales from 1.0% to 0.5% per year; therefore, not enough improvement to completely halt the decline. The difference between a 5-year delay and a 10-year delay in enhancement is that by year 10, the slower implementation will result in the Southern Resident Killer Whale population having declined by about 2 more whales before the improvement can begin to take effect. The following graph shows the projections if the mitigation measures achieve a 5% increase in Chinook (as estimated from the proposed hatchery expansion) instantly (top, blue line), after 5 years (middle, orange line), or after 10 years (bottom, red line). As this graph plainly demonstrates, delays in implementation of these theoretical mitigation measures have a very real and lasting impact on the Southern Resident population. Notably, it also shows that the proposed measure – even if implemented immediately – is not enough to stop the decline of Southern Residents.



KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

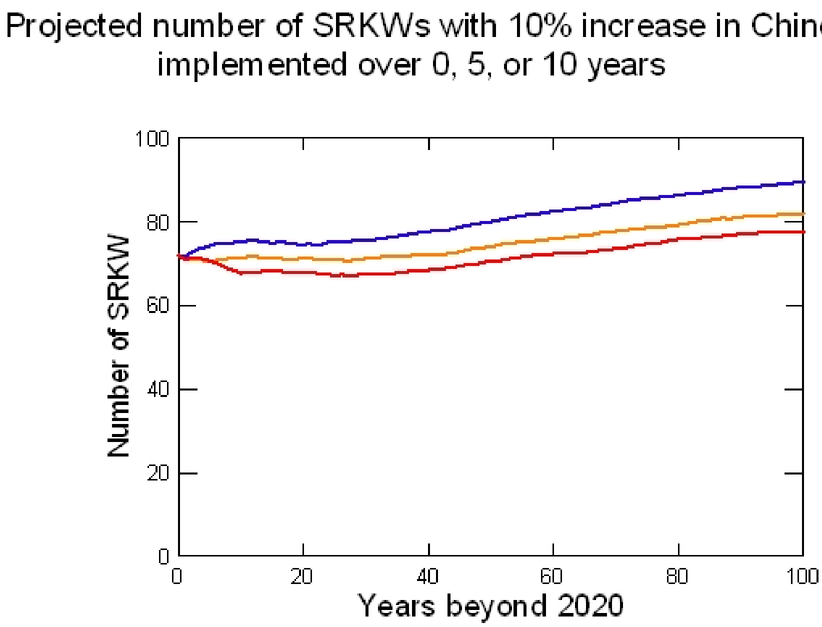
30. Combining the actions of reducing the Southeast Alaska Chinook fishery and increasing abundance to the Southern Resident Killer Whale of hatchery-raised Chinook, and possibly other mitigating actions as well (such as additional reductions in additional fisheries managed under the Pacific Salmon Treaty), could achieve the 10% increase in prey necessary for stabilization of the Southern Resident Killer Whale population or even greater increases in prey that would allow for recovery of the Southern Resident Killer Whales. Importantly, however, none of the scenarios proposed in the 2019 SEAK BiOp are projected to achieve this 10% increase in prey abundance. The analyses described above in paragraph 22 document the long-term growth in the Southern Resident Killer Whale population that could be achieved if Chinook abundance is increased by 35% above the mean levels of the last three decades.

31. Implementing mitigation measures, however, will likely require time. To examine responses of the Southern Resident Killer Whale population to delayed implementation, I tested models with increases in the prey abundance starting either 5 years or 10 years from now. The following graph shows the mean projected Southern Resident Killer Whale population size when a 10% increase in Chinook is implemented immediately (top, blue line), after 5 years (middle, orange line), or after 10 years (bottom, red line). The long-term population growth rates after implementation again show that a 10% increase in prey is needed to stop the decline of Southern Resident Killer Whales. However, before that positive result is achieved, the population will have lost 4 whales if implementation takes 5 years, or 8 whales if implementation takes 10 years, relative to the expected population size if the increase in prey were achieved immediately. With positive growth of Southern Resident Killer Whale numbers after implementation of sufficient mitigation measures, a delay in implementation results in a loss of the potential initial years of recovery, and that lack of growth for those initial years leaves the population at a deficit in

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

numbers throughout the subsequent recovery compared to what could have been. A 20% increase in Chinook allows for a long-term population growth of about 1% annually, but a delay of 5 or 10 years results in a loss of 8 or 16 whales before the growth begins, respectively, relative to the expected population size if growth had started in 2020.



32. In summary, although the 2019 SEAK BiOp does not provide management targets for slowing, stopping, or reversing the decline of the Southern Resident Killer Whale population, and it does not give specific estimates of the benefits to the Southern Resident Killer Whales of the proposed mitigation measures, for the above analyses I extracted from the 2019 SEAK BiOp what I could regarding the expected benefits of proposed actions. The 2019 SEAK BiOp provides various estimates of changes to Chinook stocks that might be expected from two of the mitigation measures – a reduction in the Southeast Alaska Chinook fishery as specified in the 2019 Pacific Salmon Treaty, and a proposed hatchery expansion – and it mentions other possible actions, such as habitat improvements, for which there is no quantification of expected results. Only if the additional, as yet unquantified, mitigation measures can boost Chinook abundance by

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
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CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
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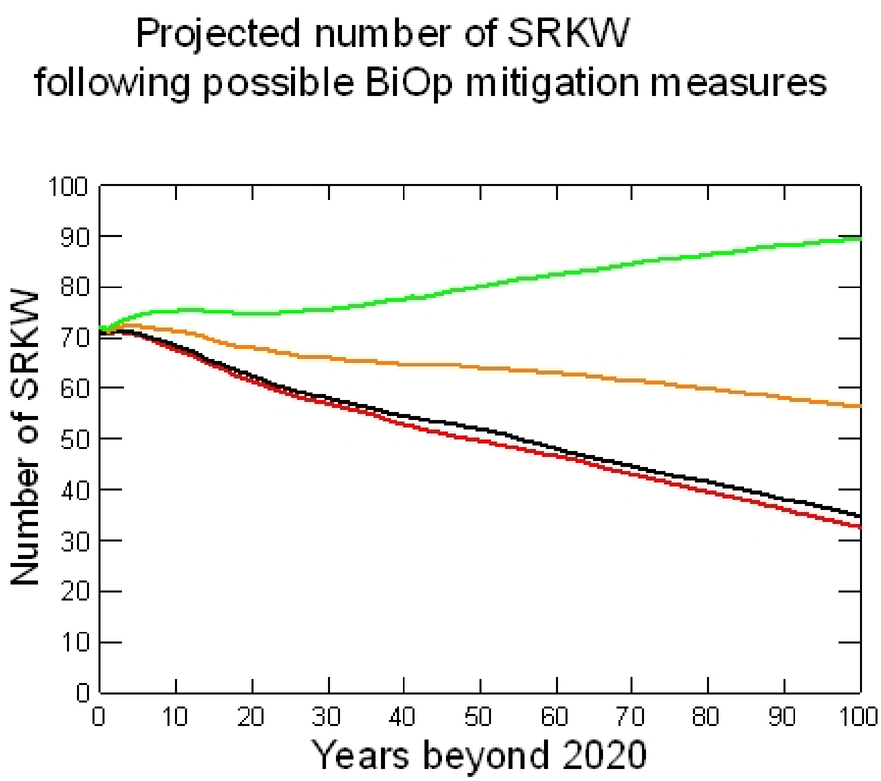
another 5%, would the combined effect of the proposed actions yield the 10% increase in Chinook that is necessary to halt the decline of the Southern Resident Killer Whales. The following graph summarizes the expected trajectory of the Southern Resident Killer Whale population if no changes are made from current conditions (bottom, red line), if a 0.5% increase in overall Chinook available to Southern Resident Killer Whales is produced by the reduced Chinook harvest in the 2019 Pacific Salmon Treaty (black line), if a 5% increase in Chinook is achieved by the hatchery mitigation (orange line), or if sufficient actions can be taken to achieve a 10% increase in Chinook (top, green line).



Conclusions

33. Based on previously published analyses, the results of updated models, my professional experience, and the information contained in the 2019 SEAK BiOp, I make the following conclusions with a reasonable degree of certainty:

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

a. The Southern Resident Killer Whale population is in decline, and the projected status has deteriorated in just the past few years. The PVA models, using the latest available data on the current numbers, reproduction, and survival, project accurately the recent population changes.

b. The abundance of Chinook salmon prey available to the Southern Resident Killer Whales is a critical determinant of Southern Resident Killer Whale reproductive success and survival.

c. The mean Chinook abundance over recent years is not enough to allow reproduction by the Southern Resident Killer Whales sufficient to offset mortalities. An increase of about 10% in Chinook abundance would be required to stop the decline of Southern Resident Killer Whales, and an increase of about 35% in Chinook abundance would be required to achieve the healthy population growth rate of 2.3% that is the stated goal in the Southern Resident Killer Whale Recovery Plan.

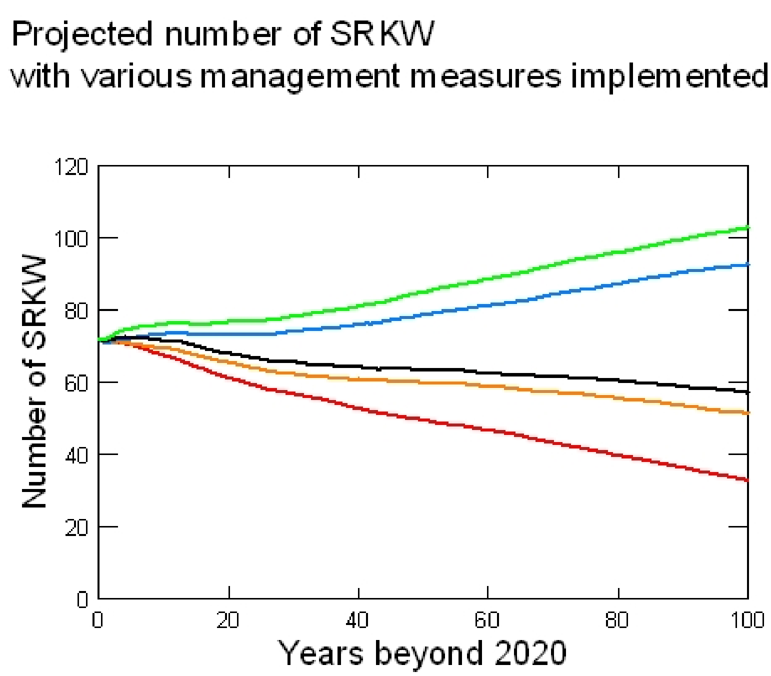
d. The proposed mitigation measures in the 2019 SEAK BiOp have not been shown to be adequate to protect the future of the Southern Resident Killer Whale population – a short-coming that is admitted even within the 2019 SEAK BiOp. The quantitative estimates made in the 2019 SEAK BiOp would account for, at best and after full implementation, a reduction of half in the rate of decline in numbers of Southern Resident Killer Whales.

e. Full closure of the Southeast Alaska Chinook fishery, especially if combined with other mitigation measures, could result in enough prey to sustain a growing population of Southern Resident Killer Whales. Further enhancement measures

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

would be required to achieve the recovery goals set in the Recovery Plan for the Southern Resident Killer Whale. The last graph, below, shows projected Southern Resident Killer Whale numbers under current environmental conditions and management (bottom, red line), with the 5% increase in Chinook prey after 5 years, projected to result from the proposed hatchery enhancements (orange line), with a 6% increase in Chinook prey as might be achieved if the Southeast Alaska Chinook fishery is immediately closed (black line), with both the proposed hatchery project plus an additional 6% increase in Chinook abundance (blue line), or if a 12% increase in prey is achieved by the closure of the Southeast Alaska Chinook fishery (top, green line). The amount of increase in Chinook abundance as a result of reductions or closure of fishery harvests and other measures is uncertain, so responses of both the Chinook abundance and then the Southern Resident Killer Whale demography should be monitored closely, with adaptive management adjusting mitigation and enhancement measures as needed.



KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600

I declare under penalty of perjury under the laws of the United States of America that the foregoing is true and accurate.

Executed this 15th day of April, 2020.

Robert Lacy, Ph.D.

KAMPMEIER & KNUTSEN PLLC
221 S.E. 11th Avenue, Suite 217
Portland, Oregon 97214
(503) 841-6515

CORR CRONIN, LLP
1001 Fourth Avenue, Suite 3900
Seattle, Washington 98154
(206) 625-8600