Please accept the following as the Pacific Marine Conservation Caucus Salmon Sub-Committee's response to DFO's 2020 Priorities Planning Letter and advice into the 2020 IFMP. Our submission includes:

2. Southern Resident killer whales

In August 2019, Fisheries and Oceans Canada completed an updated Population Viability Analysis (PVA) of both Southern and Northern Resident killer whales (Clarke-Murray et al. 2019). The authors conclude that Chinook salmon abundance and its interactions with vessel noise and PCBs strongly influenced modeled killer whale population dynamics. The team examined the known primary threats 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, physical and acoustic vessel disturbance, and PCB contamination), the output of the PVA model closely replicated the observed population trends for Southern (and Northern) Resident killer whale populations.

Of great concern, Clark-Murray et al. (2019) found ongoing population decline with a 26% probability of quasi-extinction (one sex) within 75-97 years. 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 efforts to reduce some threats and implement precautionary measures for SRKWs, these actions have not improved declining trends or improved extinction probabilities. DFO is now in the position of having to undertake drastic actions to arrest SRKW decline and preserve reproductive potential. Recent efforts such as those designed to lower harvest on early timed Fraser stream type CUs or those in the renewed Pacific Salmon Treaty, have lagged behind declining stock status, abundance and productivity and have, at best, simply followed declining stocks down. They have not made significant reductions that would get ahead of population declines and facilitate genuine rebuilding. Further they were not implemented because of lack of salmon abundance for SRKWs.

2.1 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 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.

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.

2.2 Status of Fraser Chinook salmon

Chinook salmon returning to the Fraser River watershed have been identified by COSEWIC as threatened (4) or endangered (7) in spring, early summer, and summer and fall run timing groups. The only assessed aggregate not considered to be at risk by COSEWIC was the summer ocean-type run timing group, however declines in size, fecundity and productivity within this aggregate have been identified by DFO.

Previous efforts in 2018 and 2019 to lower harvest on early timed Fraser stream type CUs (total mortality of 5%) or achieve a 25% reduction on chinook exploitation rates of south coast CUs, have failed. Any harvest reductions achieved have lagged behind actual declines in productivity and stock status and have simply followed declining stocks down. These objectives have not translated to significant harvest reductions that would get ahead of population declines and facilitate time bound recovery designed to rebuild endangered and threatened CUs, other RED and Yellow CU's identified by the WSP, or ensure that escapement targets are met.

2.3 Priorities for 2020

2.3.1 Limit British Columbia's AABM Chinook fisheries and south coast ISBM fisheries (with the potential exception of terminal fisheries in places such as Area 23) to a share of a 5% total mortality cap (US and Canada combined).

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, 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 of limiting total mortalities (US and Canada) on Fraser chinook to a maximum of 5%.

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 both Section 35 and recreational and commercial access.. 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. This will provide significant fishing opportunities although there will be some transition costs as the recreational and commercial industries adjust. Governments should focus on helping the fishing sectors adjust rather than providing them with access to endangered chinook. The first option leads to a sustainable future for SRKW, chinook, and the sectors. The second puts all at risk.

2.3.2 No increases in hatchery production until a full review of the genetic and ecological implications on the recovery of wild Chinook salmon CUs is completed

Hatchery Chinook salmon are produced to subsidize commercial and sport fisheries. The production of Chinook from hatcheries in Canada and the US 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. Pursuing a hatchery strategy with mass marking and Mark Selective Fisheries will not change this situation. It is likely to further 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 hatcheries. If it was, corresponding fishery closures would be implemented to help recovery efforts. There is also concern that increased hatchery production from Puget Sound foolishly proposed under the Governor's Washington State Task Force 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.

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).

2.3.3 Remove the burden of proof placed on the SRKW

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 must fall on fisheries.

2. 4 Conclusion

DFO has generally 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. Reductions 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 on the migration routes of chinook bound for SRKW feeding grounds is required. Closing these 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.

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