Emergency measures on both sides of the border required to save Southern Resident killer whales

Wild Fish Conservancy & Raincoast Conservation Foundation[1]

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Southern Resident killer whales (SRKW) are listed as endangered under both Canada's Species At Risk Act (SARA) and the U.S. Endangered Species Act (ESA). Recovery plans have been in place in the US and Canada since 2008. Despite the endangered listings and the recovery plans, both the U.S. and Canadian governments are failing in their obligations to protect and rebuild this population. The failure of both governments to implement threat reduction actions or take precautionary measures has resulted in the current critical condition in which there is a higher probability that the population faces extinction. This failure has now placed the region in the position of having to undertake drastic actions to arrest the decline in population numbers and preserve the possibility of recovery. Herein, Wild Fish Conservancy and Raincoast Conservation Foundation propose a suite of critical actions to be taken immediately to achieve the goal of halting the decline and preserving the possibility for recovery of these iconic whales that are so emblematic of the Salish Sea.

The current critical condition of SRKW.

The SRKW population is composed of three pods (J, K, and L) that interact socially and biologically in specific ways. Absolute population numbers are at critically low levels (75 total individual across the three pods. As of June 2018, J pod consisted of 23 members, K pod of 18, and L pod of 34 (Center for Whale Research, https://www.whaleresearch.com/orca-population).

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These low numbers disguise the critical state of the population due to recent reproductive failures (spontaneous abortions, deaths of newborns and calves) and deaths of mature females, which significantly increase the probability that further declines in population numbers will occur. In addition, the numbers of post-reproductive females (~>50 years of age), a critical feature of killer whale demography (Foster *et al.* 2012) is dangerously low. Only one female (L25 age 90) in any of the three pods is older than 50 years of age. Population viability analyses undertaken by scientists at the Department of Fisheries and Oceans Canada (Velez-Espino *et al.* 2014 a, b), and independent scientists (Lacey *et al.* 2017) indicate SRKW had a 25% to 49% risk of functional extinction (less than 30 individuals) by the end of the century under habitat conditions that were present before 2014. Velez-Espino *et al.* (2014a) constructed a two-sex age/stage matrix population model of the SRKW population based on demographic rates from 1987 to 2011, approximately one SRKW generation. Projecting the population of 88 whales in 2011 forward one more generation (i.e., to 2036) assuming status quo environmental conditions present in 2011, the mean expected population size was 75 with an expected minimum abundance of 15 during a 100-year period. However, when they incorporated both environmental and demographic stochasticity the probability of falling below 30 individuals was greater than zero at 10 years, 50% at 47 years and approximately 80% at 100 years.

SRKW have reached the projected mean of 75 individuals in 25% of the time anticipated had conditions remained the same. As such, the assumption of stable environmental conditions has likely been violated and the estimates of extinction risk may significantly under-estimate the rate at which the population will decline in the near-term.

As of August 2018, the population has seen no successful births in three years. A 2017 study on their fecundity found nearly 70% of detected pregnancies between 2008 and 2014 failed due to nutritional stress associated with lack of prey (Wasser *et al.* 2017). Nutritional stress from low salmon abundance is exacerbated by noise and disturbance from vessel traffic (including fishing vessels, whale watching vessels and larger commercial vessel traffic) that reduces successful foraging (Ayers *et al.* 2012, Williams *et al.* 2014a,b, Houghton *et al.* 2015, Holt *et al.* 2017, Tollit *et al.* 2017, Seeley *et al.* 2017).

The drastic reduction in successful births combined with the deaths of mature females (Matkin *et al.* 2017, Wasser *et al.* 2017, table 1) and the severe shortage of post-reproductive females threatens to create a severe disturbance to the age structures of each pod and thus the population as a whole. Disrupted age structure may further destabilize the population, thereby increasing the risk of continued decline and extinction. Only immediate drastic actions that are sustained for several generations of Chinook salmon have a reasonable probability of succeeding in halting the decline of the population and providing it with the breathing room needed to begin the process of rebuilding both population numbers and demographic structure.

Immediate measures required.

Chinook salmon are preferred prey of SRKW throughout the period from May through September (Ford *et al.* 2005, 2010, Ford *et al.* 2016) when most of the three pods are in the Salish Sea and environs, including the southwest corner of Vancouver Island from Barkley Sound to the entrance to the Strait of Juan de Fuca, and north and central Puget Sound. During this late spring-to-early fall period, Fraser River Chinook salmon stocks and northern Puget Sound Chinook stocks dominated as their principal prey (Hanson *et al.* 2010). SRKW target mature adult Chinook as the fish migrate toward their home rivers in SRKW foraging areas from Barkley Sound through the Juan de Fuca Strait, the San Juan and Gulf Islands to the Fraser River and northern Puget Sound.

From fall (October/November) to spring (March and April) when adult Chinook are present in the Salish Sea in very reduced numbers, SRKW appear to forage primarily along the coast from the west side of Vancouver Island to northern California, and particularly in the vicinity of the mouth of the Columbia River (Hanson *et al.* 2013, DFO 2017). SRKWs can be present in Puget Sound and Georgia Strait in the fall while feeding on chum and coho salmon and also enter the Salish Sea over the winter. During the late winter and March in particular, Columbia River spring Chinook salmon are thought to be their primary prey (Hanson *et al.* 2013).

Fishing management actions are required to make mature Chinook salmon on their return migration to the Salish Sea in late-spring through early fall, and spring Chinook along coastal areas during late winter and spring (March – May) accessible to foraging SRKW. In addition to increasing abundance of mature Chinook within critical habitat, identified SRKW foraging refuge areas[2] need to be free from small vessel traffic and undergo dramatic reductions in overall vessel (including shipping) noise. Vessel noise and disturbance near whales can disrupt foraging and socializing activities and interfere with effective echolocation and inter-whale

[2] See description on page 4

communication that is critical to normal, stress-free foraging and socializing (Williams *et al.* 2014a, b, Houghton *et al.* 2015, Holt *et al.* 2017, Tollit *et al.* 2017). The following actions are required during the late-spring-early fall period in the Salish Sea and surrounding environs:

- Designation of SRKW feeding refuges within existing and proposed critical habitat designated under Canada's Species At Risk Act (SARA) and the US Endangered Species Act (ESA) that assure whales the ability to successfully forage in key feeding habitats without noise, interference, and disturbance from vessel traffic, combined with
- Measures to increase the abundance of Chinook salmon in refuge areas and critical habitat to assure that SRKW have the highest priority for accessing these fish.

Securing SRKW access to more mature Chinook salmon.

Canadian scientists have identified key feeding refuges in designated critical habitat under SARA and in additional areas recently identified as candidate critical habitat. These refuges should be in effect from May through October and include the following areas:

- The coastline of Southwest Vancouver Island from Barkley Sound to the mouth of the Strait of Juan de Fuca west to the continental shelf break at the 200 m isobaths, including Swiftsure Bank.
- The coastline of Southwest Vancouver Island through the Juan de Fuca Strait east to Sooke Inlet.
- Haro Strait and the southwest side of San Juan Island and Stewart Island to Turn Point,
- Boundary Pass to Plumper Sound and Active Pass and to East Point in the Gulf Islands,
- critical habitat in the approaches to the Fraser River.

These areas have been described by the Salmon Committee of the Pacific Marine Conservation Caucus (Southern Resident Killer Whale Recovery: Recommendations for 2018 Chinook and Vessel Management, January 2018, attached) and largely identified by DFO in their SRKW discussion paper of February 2018. Additional refuge areas in US critical habitat areas must also be identified, particularly in northern Puget Sound, where returning adult fall Chinook migrate on their approach to the Nooksack, Skagit, and Snohomish rivers.

In order to increase abundance of mature Chinook for SRKW in critical habitat and designated feeding refuges, and to support the rebuilding of Chinook throughout this region, commercial and recreational fishing in mixed stock fisheries along the Washington and Oregon Coasts, the West Coast of Vancouver Island, Northern BC and Southeast Alaska must be drastically reduced if not completely eliminated. Between 1.5 and 2 million Chinook salmon are caught annually in Canadian and the US fisheries under the Pacific Salmon Treaty. In 2016, 1.5 million Chinook were caught, the majority of which were headed to rivers in Southern BC, the West coast of Vancouver Island and the Pacific Northwest, including Puget Sound. These rivers of origin are within the range and habitat of Southern Resident killer whales. It is also noteworthy that incidental mortalities (unlanded "catch") total more than 10% of the total fishing-related mortality bringing the total mortality (landed catch plus estimated incidental, unlanded mortality) to 1.7 million in 2016 and over 1.5 million in 2017. Catch and release studies suggest this may be an underestimate of incidental mortality.

Table 1. 2016 and 2017 Chinook catch and total mortality in ISBM and AABM fisheries. AABM fisheries are co-migrating southern populations headed to rivers primarily in BC and Pacific Northwest. Source: CTC 2017, 2018

Table 1.9.–Summary in nominal fish of preliminary estimates for landed catch (LC), incidental mortality (IM), and total mortality (TM) for US and Canada AABM and ISBM fisheries in 2016.

Fishery	2016		
	LC	IM	TM
SEAK AABM	353,704	54,306	408,009
SEAK hatchery add-on and terminal exclusion	35,768	6,265	42,034
US ISBM	679,146	71,208	750,354
US TOTAL[1]	1,032,849	125,514	1,158,363
NBC AABM	190,181	14,136	204,317
WCVI AABM	99,650	9,394	109,044
CANADA ISBM	181,960	39,339	221,299
CANADA TOTAL	471,791	62,869	534,660
PST FISHERIES TOTAL[1]	1,504,640	188,383	1,693,023

[1] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

Table 1.9–Summary in nominal fish of preliminary estimates for landed catch (LC), incidental mortality (IM), and total mortality (TM) for US and Canada AABM and ISBM fisheries in 2017.

Fishery	2017		
	LC	IM	TM
SEAK AABM	178,348	42,349	220,698
SEAK hatchery add-on and terminal exclusion	32,659	12,427	45,086
US ISBM	648,662	66,935	715,798
US TOTAL[1]	827,211	109,284	936,495
NBC AABM	143,330	19,299	162,629
WCVI AABM	109,533	13,203	122,736
CANADA ISBM	257,227	52,478	309,705
CANADA TOTAL	510,090	84,980	595,070
PST FISHERIES TOTAL[1]	1,337,301	194,264	1,531,565

[1] Does not include SEAK AABM fishery nontreaty catch from hatchery add-on and terminal exclusion.

It is necessary to eliminate fishing mortality on immature Chinook that are feeding in areas targeted by these and other mixed stock fisheries. Chinook mature at multiple ages, ranging from age 2 to age 8. Mixed stock fisheries capture or incidentally kill Chinook that would otherwise mature and return to terminal and near-terminal feeding refuge areas in the following one to four years if they were not caught in the mixed stock fisheries (Riddell *et al.* 2013, p. 11). Reducing or eliminating these fishery impacts by moving fisheries away from coastal Chinook nursery areas into or near Chinook rivers-of-origin, and removing fishing during all times outside of spawning migrations would result in more Chinook returning as older fish, with the larger body sizes favored by foraging SRKW, and would increase the numbers of larger, older, and more fecund female Chinook that spawn more successfully than younger, smaller females (Healey & Heard 1984, Healey 1991).

A particular concern exists for Fraser spring and summer stream-type Chinook populations. These populations are substantially depressed relative to their levels of abundance in the 1980s and 1990s, and are a particularly important component of SRKW diet in the late spring and early summer (May – July). Fisheries are still allowed on these populations despite the fact that they are failing to meet population rebuilding goals (Riddell *et al.* 2013). These fisheries should be closed.

Based on recent bioenergetics modeling of field metabolic rates of SRKW (Noren 2009) and the age composition of the current population, the total SRKW population of 75 needs to consume

14,750,000 kilocalories (kcal) per day just to maintain mean body condition. Assuming a conservative, precautionary average weight of Chinook salmon of 12 pounds and the average energy density of Chinook (10,000 kcal for a 12 to 13 pound Chinook), the SRKW population needs to consume 1480 average-size Chinook per day. Taking the probable foraging efficiency of free-ranging killer whales into account, SRKW likely require three times as many Chinook to be available as potential prey as the number the whales actually manage to capture and consume. Consequently, a precautionary target for the total number of Chinook available for the SRKW population to forage on per day would be approximately 4500. Over the roughly 100 day period from the end of May to Labor Day, a total of 450,000 Chinook need to be available (not considering higher Chinook abundance needed for a rebuilding SRKW population). This is clearly unlikely to occur given current levels of coastal mixed stock Chinook salmon fisheries under the PST. Reductions, if not complete termination, of these AABM and marine ISBM fisheries could provide additional Chinook in Salish Sea critical habitat and refuge areas.

Closing fisheries will increase marine and terminal abundance of Chinook populations

Within two generations of Chinook salmon (8-10 years), the reduction (if not 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. Reduction/elimination will provide more and larger Chinook not only to SRKW but also to terminal areas and to spawning populations of depressed wild Salish Sea Chinook populations.

Reduction/elimination of coastal mixed stock sport and troll Chinook fisheries, particularly along the west coast of Vancouver Island (WCVI), Northern BC and the Southeast Alaska (SEAK) will not only facilitate the return of more mature Chinook to the Salish Sea, but will also increase the abundance of fall Chinook stocks returning to the Washington and Oregon Coasts and to the lower and middle Columbia River (particularly Lewis, Deschutes, and Hanford Reach populations) on which SRKW forage during late summer and fall (Veles-Espino *et al.* 2014b, Hanson *et al.* 2013).

Drastic reduction or elimination of marine mixed-stock fisheries is not a no fishing scenario. Terminal and in-river fisheries whose harvests are managed for ecosystem benefits (i.e. to maximize spawning recruitment in a stock recruitment relationship) can provide fisheries benefits to harvesters. However, such fisheries are designed to occur after whales have had access and after component stocks have diverged to their rivers of origin.

Securing disturbance-free foraging refuge areas.

Whales pursuing Chinook within their critical habitat during the spring to fall have a high likelihood of being in the presence of vessel traffic. Vessel disturbance has been identified by both DFO and NMFS, as well as by independent scientists (Lusseau *et al.* 2009, Holt *et al.* 2009, 2011, Ayres *et al.* 2012, Williams *et al.* 2014b, Houghton *et al.* 2015, Holt *et al.* 2017, Tollit *et al.* 2017) as a factor that reduces the quality of SRKW critical habitat by increasing the costs of foraging and adding to stress, independently of its adverse effects on foraging. The close proximity of fishing and whale watching vessels that interfere with foraging patterns cause whales to extend the time spent chasing prey.

Over the last two decades, 14 to 28 boats routinely followed SRKW in the summer months, with peak numbers exceeding 70 boats (see Ashe *et al.* 2010, Soundwatch 2016, Seeley *et al.* 2017). The presence of these vessels can invoke significant reductions in foraging activity and limit food acquisition (Lusseau *et al.* 2009, Noren *et al.* 2009, Williams *et al*. 2014, Lacy *et al.* 2017, Holt *et al.* 2017). Vessel traffic and noise is also known to increase the duration and amplitude of SRKW calls (Foote *et al.* 2004; Holt *et al.* 2009; 2011) and is likely to adversely affect SRKW by masking and altering vital communication calls and inducing chronic stress.

In order to make foraging refuge areas optimally effective, disruptions from fishing and whale watching vessels must be eliminated from SRKW foraging refuges from spring to fall. The necessity of this action is supported by the results of the recent population viability analysis of Lacey *et al.* (2017) who showed that in the absence of controls on vessel noise and disturbance a 30% increase in the coast-wide abundance of Chinook would be required to increase the population growth rate of SRKW from its present negative rate to as much as 1.9%. If coupled with a 50% reduction in vessel noise and disturbance, the US recovery target growth rate of 2.3% could be achieved by a 15% increase in the coast-wide abundance of Chinook. (NOTE: Much, if not all of that 15% increase could also be achieved in the near term by the reduction/elimination of coastal mixed-stock Chinook fisheries as discussed above!)

Increased hatchery Chinook production will not help SRKW.

In Washington State, fishery co-managers, several state legislators and sports fishing advocacy organizations have recently advocated for increased production of hatchery Chinook to "save" SRKW. While seemingly logical at first blush, such an idea lacks technical merit. It is not a biologically or ecologically credible action. There are several reasons that a hatchery solution would fail to recover SRKW. Perhaps more concerning, pursuing this could undermine recovery efforts for wild Chinook and the needed rebuilding of runs throughout their historic range, Chinook age structure and Chinook run-timing that SRKW evolved with. We discuss this in more detail in the ensuing text. Five general reasons for concern are:

1. *If* the coastal abundance index for migrating Chinook increased due to hatcheries, the catch of migrating Chinook in AABM fisheries of SE Alaska, Northern BC and WCVI would automatically increase according to that level of abundance. Unless fisheries management under the Pacific Salmon Treaty are addressed, little of the increased production from hatcheries would be reflected in the Salish Sea.
2. It is likely that ocean productivity is a limiting factor for Chinook. Releasing more Chinook could just as easily result in smaller Chinook and fewer wild Chinook.
3. 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.
4. Increased abundance of hatchery Chinook are likely to come at a cost to wild Chinook.
5. For SRKW to recover, the age structure and run timing of wild Chinook runs, along with abundance, needs to be restored. This is not the objective of production hatcheries.

Hatchery impacts to wild Chinook runs

Increased production of hatchery Chinook in Puget Sound and elsewhere in the state (or in British Columbia, see Riddell *et al.* 2013) would have two results harmful to the recovery of wild, ESA-listed Chinook that would likely undermine recovery of SRKW.

First, because fisheries do not harvest all hatchery Chinook produced and killer whales are not selectively foraging for them, it would increase the numbers of uncaught hatchery Chinook that stray onto the spawning grounds of wild fish. This would drive down the fitness (productivity) of wild populations further delaying or even preventing Chinook recovery. Even at current levels of hatchery production, the proportion of hatchery origin Chinook on wild salmon spawning grounds (proportion of hatchery origin spawners, or pHOS) in most Washington rivers exceeds "biologically acceptable" levels recommended by the independent Hatchery Scientific Review Group (HSRG 2009, 2015, WDFW Score/Chinook). In short, increasing Chinook hatchery production above current levels would simply result in further increases in pHOS levels, thereby imposing further harm to the productivity of wild Chinook populations.

Second, increased abundance of hatchery (or wild) Chinook would automatically trigger higher catches in the AABM fisheries under the Pacific Salmon Treaty. It would also result in increased pressure from sports and commercial fishers (tribal and non-tribal) for increased fishing opportunities in ISBM fisheries. In addition to higher catches, it would also increase boat traffic and associated noise and activity levels already known to be harmful to SRKW, as well as increasing incidental harvest mortality on depressed wild Chinook stocks.

Closing mixed-stock Chinook fisheries

In order that any such increase in production of hatchery Chinook not have these adverse effects, the configuration of mixed stock commercial and sports fisheries would have to be addressed in the manner described previously. Consequently, any consideration to increase the production of hatchery Chinook *in order to help SRKW survival and recovery* is dependent first on reconfiguring fisheries as described (i.e. reducing or eliminating coastal mixed-stock Chinook fisheries) and providing the necessary SRKW foraging refuges. Unless and until this is done, there should be no increase (and probably some reductions) in the numbers of hatchery Chinook produced in these areas.

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. We believe that such an approach is bound to fail and 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 their Chinook crisis should also be place-based.

Mass-produced hatchery salmon are placeless. Reliance on this failed industrial tool to address the complex ecological issues facing SRKW and wild Chinook is destined to fail both of them. Fisheries managers responsible for Chinook salmon and SRKW have ignored the significant harvest issues that are responsible for a large part of the decline and failure for Chinook to rebuild (Gayeski *et al.* 2018). The current crisis for SRKW is the alarm bell ringing to tell us that it is long past time to pay the piper for fisheries management decisions rooted in business interests.

Measures for the longer-term

Columbia River spring Chinook are likely an important prey item in late winter and early spring when SRKW are more present along the coast. Fisheries targeting and otherwise affecting these runs, and other 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.

Removal of the Snake River dams would likely provide significant help to SRKW in the longer-term and we certainly support efforts to remove them. But this is not going to happen quickly. Even if removals were to be scheduled and funded, they would not begin in the next five years, as federal funding for the removals would have to be secured and an Environmental Impact Statement (EIS) or (optimistically) an Environmental Assessment (EA) produced and a public comment period provided. Even after dam removal was completed, benefits to the recruitment of affected Snake River Chinook populations would not likely accrue to foraging SRKW for one or more Chinook generations thereafter (i.e. another 4-5 years at minimum). Further, Snake River summer (stream-type) and fall (ocean-type) Chinook do not forage or rear inside the Strait of Juan de Fuca, and thus would not be available to SRKW inside the Salish Sea in late spring and summer, though they may provide some summer forage on the southwest side of Vancouver Island in identified feeding refuges and proposed critical habitat. They would contribute significantly to fall to early spring foraging along coastal areas. *SRKW do not have this long to* *wait for these probable benefits.* While dam removal is likely a critical component to SRKW (and Chinook) recovery, it alone is insufficient.

Remove the burden of proof placed on the SRKW.

Until now, SRKW and many of their conservation advocates have been made to bear the burden of proof when proposing conservation measures to benefit SRKW at the expense of more well-heeled stakeholders. It is time the burden was shifted onto those interests and stakeholders whose practices and actions ostensibly threaten or contribute to the decline of SRKW. Under such a shift of the burden of proof, precautionary actions with reasonable probabilities of benefiting SRKW - such as harvest reduction and reconfiguration, would be adopted. The burden would then fall on those interests that argue that such precautionary actions are too severe to acquire the data and independent analyses that demonstrate that such actions are either not needed or are ineffective.

Immediate actions that reduce commercial and recreational fishing and vessel noise from fishing and whale watching activities in the Salish Sea are required now. In addition, fisheries must be managed to prioritize the returns of mature Chinook to all identified SRKW foraging refuge areas described above and to additional areas that may be recognized as a result of future research and monitoring. 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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