# Southern Resident killer whales and their need for accommodation within the Chinook Chapter of the Pacific Salmon Treaty

The following submission identifies the need to include Southern Resident Killer whales as a factor in the re-negotiations of the Chinook Chapter of the Pacific Salmon Commission. We have identified the rational for their inclusion, the need for abundance based targets of Chinook CU's and run timing groups to the Salish Sea, and the need to consider such implementation by addressing the coast wide management of Chinook.

1. Recognize the connection between Chinook abundance and availability and the fecundity, survival and mortality of SRKWs
2. Chinook status and the need to Identify abundance based Chinook targets to the Salish Sea
3. Accommodate SRKWs based on forecasted and in-season abundance estimates
4. Address related fishery management issues

**3. The survival and recovery of Southern Resident killer whales is linked to the availability of Chinook Salmon**

The US/ Canada transboundary population of Southern Resident killer whales is a federally designated endangered population listed under Canada's Species at Risk Act (2003) and the US Endangered Species Act (2005). Canada's Recovery plan for SRKWs (2008) and the US Recovery Plan (2008) both identify the role of Chinook salmon in the diets of these whales. Both documents identify prey availability as a likely factor limiting population recovery. The evidence for this theory has strengthened significantly over the last decade.

**Diet**

A five-year study of summer diet (May – Sept) conducted within critical habitat in the Salish Sea, found that salmon always constituted > 90% of SRKW diets and typically more than 98% (Ford et al. 2016). Of their salmon diet, Chinook represented 79.5% on average, but constituted >96% in the early summer, and 51% on average in the late summer (Ford et al. 2016). This study was consistent with earlier work by Hanson et al. (2010) that found Chinook salmon made up 80% of SRKW summer diet. Additional findings have led researchers to conclude that SRKWs populations are highly specialized and dependent on Chinook salmon as their primary, year-round food source (Ford et al. 2010, Ford 2012).

Southern Resident killer whales rely on the Salish Sea year round, but increase their presence in the summer months. While in their critical habitat in the late spring to early fall, Chinook stocks targeted by these whales are returning primarily to the Fraser River (Hanson et al. 2010). Chinook populations targeted by whales in May and June include spring and early summer stream-type Chinook retuning to the mid and upper parts of the Fraser watershed (Hanson et al. 2010). In July, stocks targeted by southern residents shift to the Mid Fraser and North Thompson stream-types, in August targeted stocks shift to the South Thompson ocean-type, and in September, to the lower Fraser ocean-type (Hanson et al. 2010). The presence and timing of these stocks in the diet of whales is consistent with their seasonal stock composition and run timing through the Salish Sea.

**Prey limitations**

The abundance of Chinook salmon influences SRKW birth, survival, and mortality rates and is linked to their level of nutritional and physiological stress (Ward et al. 2009, Ford et al. 2010, Vélez-Espino et al. 2013, Vélez-Espino et al. 2014, Ayers et al. 2012, Lacy et al. 2017, Wasser et al. 2017).

Population trends are driven largely by changes in survival (Ford et al 2010). Survival rates are strongly correlated with the Pacific Salmon Commission's Chinook index, indicating the relative availability of their principal prey species, Chinook salmon (Ward et al. 2009, Ford et al. 2010, Lacy et al. 2017). 30 years of resident killer whale demographic data indicates that periods of unusually high mortality have followed periods of reduced or low Chinook abundance (Ford et al. 2010, Vélez-Espino et al. 2014).

The annual Chinook abundance index is also correlated with reproductive success (Ford et al. 2010; Ward et al. 2009, Vélez-Espino et al. 2014). Specifically, the WCVI Chinook index of abundance available to fisheries in the previous year, positively correlates with fecundity (Ward et al. 2009). Following highly productive salmon years, the probability of calving is 50% higher at the population level compared to years following low Chinook abundance (Ward et al. 2009).

Nutritional and stress analysis undertaken on SRKWs between 2007 and 2009 indicates that food availability is an important limiting factor in recovery. Ayres et al. (2012) show that fecal thyroid hormones exhibit a short-term glucocorticoid (GC) response and a more long- term T3 response to prey availability. Specifically, the rise in temporal GC concentrations correspond to relative Fraser River Chinook abundance (using CPUE at Albion test fishery) from the time the SRKWs arrive in the Salish Sea. Results from GLMs show Chinook CPUE was the only significant main effect (however less variance was explained if other parameters, like vessel traffic, were removed). The authors concluded that prey availability had the greatest physiological impact. This finding was reinforced in Lacy et al. (2017), who found that modelled increases in population growth rate were primarily driven by prey availability, but the greatest increase in growth rate came from the combination of increased prey availability and reduced noise and disturbance from vessels.

Ayres et al. (2012) identify the end of 2007 through 2008 as the poorest overall nutritional state during the study period (prior to 2010). This period corresponds with the highest number of deaths and lowest number of births and surviving calves observed during the study period. Eight whales went missing from December 2007 through October 2008, two of which were reproductive age females and included a visually emaciated pregnant female (Ayres et al. 2012). Since this time, Ward et al. (2009), Ford et al. (2010), and Velez-Espino et al. -Espino et al. (2013 and 2014) all provide estimates of the relationship between abundance of Chinook salmon and demographic rates for Southern Resident Killer Whales. **Importantly, this list includes the paper by Velez- Espino et al. that was specifically prepared for the Pacific Salmon Commission in March 2013.** The details of the data used to quantify Chinook abundance, the co-factors considered, and the statistical methodologies differ in details between these studies. Vélez-Espino et al. examined fecundity for young and old females separately, and examined impacts on survival rates of different age classes, while the other papers assessed relationships with pooled demographic data.

Specifically, in the Velez Espino et al. report commissioned for the PSC in 2013, findings from this report showed:

> Scenarios 2 and 3 are characterized by no ocean fishing on Puget Sound Chinook salmon stocks and no ocean fishing on Fraser Early and Puget Sound Chinook, respectively, thus maximizing terminal runs of these stock aggregates. In these two scenarios the elimination of fishing mortality increased SRKW target vital rates but did not maximize them.
>
> Scenarios 4 and 5 are characterized by the maximization of target SRKW vital rates, which occurred after a 51% reduction in the ocean harvest rates of the five large stocks (WCVI, Columbia Upriver Brights, Fraser Late, Oregon Coastal, and Puget Sound) and a 36% reduction in coastwide (excluding SEAK) ocean harvest rates, respectively. Scenario 6 represents cumulative effects of changes in Chinook abundance and is characterized by 55.5% reduction in the ocean harvest rates of the five large stocks; these reductions maximized SRKW's target vital rate.

Ward et al. (2009) used PSC indices of Chinook abundance for WCVI; Ford et al. (2010) used coast wide PSC indices from SE Alaska to Oregon; and Vélez-Espino et al. used indices for terminal run abundance and ocean abundance for various salmon stocks and combinations of stocks in the region.

The strong positive correlation between high mortality in resident killer whales and low abundance of Chinook salmon has been established to the extent that Chinook availability is considered the primary limiting factor for resident killer whale survival and fecundity (Ford et al. 2010). Wasser et al. (2017) Lacy et al. (2017) identified reduced consumption of Chinook salmon as having the largest effect on depressing the SRKW population size, possibly leading to extinction. Velez-Espino et al. (2013) demonstrated that fisheries reductions and closures would improve vital rates and recovery trajectories of southern resident killer whales.

Lacey et al. (2017) further demonstrated that a 30% increase in the coast-wide Chinook abundance above the 1979-2008 average, would result in an increased Southern Resident growth rate as high as 1.9%. This growth rate is in range of the US recovery target[1] and provides a high probability that the currently impaired population could survive at larger and more viable numbers into the future. When noise and disturbance are addressed in concert with Chinook abundance, a 15% increase in the coast wide abundance coupled with and a 50% reduction in noise/disturbance, can also meet the US recovery target (based on SRKW demographics to 2014).

Importantly, all of these findings undermine the conclusion reached by the Independent Science Panel examining the effects of fisheries on SRKWs, that being fisheries management, including closures, plays a critical role in reversing existing SRKW population declines, and rebuilding SRKW numbers toward recovery.

**2. Chinook status and the need to Identify abundance based Chinook targets to the Salish Sea**

Chinook recovery efforts are a mandated part of DFO's and SARA's legal obligations to implement recovery actions for critically endangered Southern Resident killer whales.

Table 1 shows the status of Southern BC chinook CUs, many of which return to the Salish Sea and have been identified as prey for SRKWs. Many CUs are red listed, data deficient or show depressed productivity. 73% of CUs with an assessed status are red listed. 11 CUs that contain undetermined percentages of wild and enhanced fish were not assessed. The goal of recovery plans must be to maximize Chinook recruitment. Recovery strategies that manage to **meet** MSY escapement targets at Smax would achieve this.

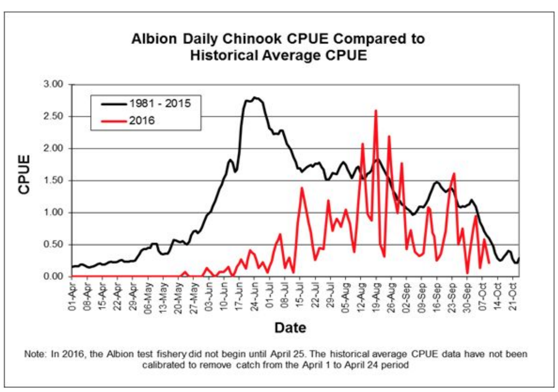
Table 1. Status (as assessed by CSAS 2016) and 2017 outlook for 33 Southern BC CUs that are red, data deficient or undetermined.

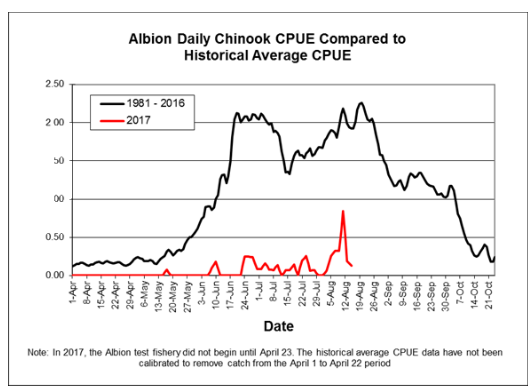
| **CU #** | **Conservation Unit** | **Status** | **2017 Outlook** |
|---|---|---|---|
| 1 | Okanagan | RED | |
| 2 | Boundary Bay- fall | TBD | LOW |
| 4 | Lower Fraser-spring $5_2$ | TBD | LOW |
| 5 | Lower Fraser-Upper Pitt –Summer $5_2$ | DD | LOW |
| 6 | Lower Fraser-summer $5_2$ | DD | LOW |
| 7 | Maria Slough $4_1$ | TBD | |
| 8 | Fraser Canyon-Nahatlatch Spring $5_2$ | DD | LOW |
| 9 | Middle Fraser – Portage- Fall $5_2$ | RED | |
| 10 | Middle Fraser- spring $5_2$ | RED | LOW |
| 12 | Upper Fraser -spring $5_2$ | RED | LOW |
| 14 | South Thompson-summer - $5_2$ | RED-AMBER | LOW |
| 15 | Shuswap -summer $4_1$ | TBD | NEAR TARGET |
| 16 | South Thompson-Bessette Summer $4_2$ | RED | LOW |
| 17 | Lower Thompson-spring - $4_2$ | RED | LOW |

[1] US recovery objective for SRKWs is a growth rate of 2.3% year.

| | | | |
|---|---|---|---|
| 18 | North Thompson-spring $-5_2$ | RED | LOW |
| 19 | North Thompson-summer $5_2$ | RED | LOW |
| 20 | South Coast-Georgia Strait | DD | LOW |
| 21 | ECVI-Goldstream | TBD | LOW |
| 22 | ECVI-Cowichan & Koksilah | TBD | LOW/REBUILDING |
| 23 | ECVI-Nanaimo-Spring | DD | |
| 25 | ECVI-Nanaimo & Chemainus-fall | TBD | LOW |
| 27 | ECVI-Qualicum & Puntledge-fall | TBD | LOW |
| 28 | SC-southern fjords | DD | |
| 29 | NEVI - Fall | RED | LOW/NEAR TARGET |
| 31 | SWVI -Fall | RED | |
| 32 | Nootka & Kyuquot - Fall | RED | |
| 33 | NWVI - Fall | TBD | |
| 34 | Homathko - summer | DD | LOW - WILD |
| 35 | Klinaklini – summer $4_2$ | DD | LOW - WILD |
| 82 | Adams River-Upper -summer | DD | |
| 83 | ECVI - Georgia St-Summer $4_1$ | TBD | LOW |
| 9008 | Harrison Transplant- Chilliwack fall | TBD | LOW |
| 3 | Lower Fraser Fall $4_1$ | GREEN | LOW/ concern |
| 13 | South Thompson Summer $4_1$ | GREEN | NEAR TARGET /POOR |
| 11 | Middle Fraser -summer $5_2$ | AMBER | LOW |

Figure 2a and 2b. 2016 and 2017 historical and current year Albion Chinook CPUE reinforcing the critical decline in abundance of early Fraser stream types.




Ongoing fishing on depressed Chinook populations is failing to allow red listed CUs to rebuild. The most recent exploitation rates available on Fraser spring and summer stream-type chinook indicate total ERs of over 40% and persistent failure to meet escapement targets. Lower benchmark at 40% MSY are often not being met. We propose management reference points for Fraser Spring and Summer stream-type be changed to reflect MSY rebuilding objectives by increasing escapement targets. Such a move would demonstrate that the management priority for these populations is minimizing direct or indirect impacts, rebuilding chinook CUs and addressing the recovery objectives for SRKWs

Table 3. Proposed Management Objectives for Fraser Spring and Summer $5_2$ stream types as proposed by BC's Marine Conservation Caucus

| MSY Escapement goal Spring & Summer $5_2$ Chinook | Zone | Predicted Return | Proposed Actions |
|---|---|---|---|
| S MSY = ~138,000<br>Smax MSY = ~150,000<br>(~ 80,000 Spring $5_2$<br>~ 57,000 Summer $5_2$) | 3 | Greater than 150,000<br>------------------<br>Likely spawners over 100,000 | Managed to meet MSY Smax ~ 150,000<br>----------------------<br>Still below MSY and S Max<br>• Directed FN fisheries allowed<br>• Rec fishery in Areas 18-20 and 29: retention of 1 chinook per day |
| 138,000 | 2 | 75,000 to 150,000<br>-------------------<br>Likely spawners above<br>40% Smsy (55,000) | Spawners below Smsy but above 40% Smsy.<br>--------------------------<br>**Below 100,000:**<br>• FN FSC directed fisheries managed to **total mortality of 10%.** |
| 138,000 | 1 | Below 75,000,<br><br>Spawners likely below<br>40% Smsy (55,000) | Populations **well below** MSY levels.<br><br>Aggressive harvest restrictions required. Total mortality managed to **less than 5%** |

<u>Red listed Fraser spring and summer stream types</u>

- As an Interim Performance Measure, total mortality on Fraser Spring and Summer stream-types should be managed to less than 5%.
- Recreational fishing on marine approaches for Chinook should be closed in Areas 18 -20, and 29 from April to July in both Zones 1 and 2. This should be extended to late July in Area 29.
- Time and Area closures in Zone 1 and 2 must also apply to WCVI commercial fisheries until all Fraser spring and summer run timing groups have migrated through.

<u>Georgia Strait, WCVI, and other Salish Sea CUs of concern</u>

Because of the growing concern for Lower Fraser late CUs and the red listed or depressed state of other fall- timed Lower Georgia Strait CUs, conversation measures need to be implemented on the fall run-timing of red listed CUs.

- Daily recreational catch limits need to be reduced by 50%
- WCVI troll fisheries need to be restricted

- Total mortality limits need to be put in place including on the Northern BC troll and recreation fisheries that intercept Salish Sea migrating chinook. Total mortality performance measures that restrict harvest to a maximum mortality of less than 20% should be implemented as a start.

To further harmonize Chinook recovery with SRKW recovery we recommend DFO and NOAA set a Salish Sea terminal abundance target that maximizes recruitment of Fraser River, Georgia Strait and Puget Sound Chinook populations to the Salish Sea. This will also increase abundance in the approaches to the Juan de Fuca, improving availability in areas beyond immediate critical habitat.

This should be done in concert with the Pacific Salmon Treaty negotiations to address interception of Salish Sea stocks caught in South East Alaska recreation and troll fisheries, Gulf of Alaska troll fisheries, and bycatch in Gulf of Alaska and Berring Sea ground fisheries. If geographic areas beyond the PST cannot be addressed, mortality in these fisheries needs to incorporated into CTC management and mortality estimates.

**Salish Sea terminal abundance targets for Salish Sea bound Chinook**

A Salish Sea terminal abundance target that maximizes recruitment of all Salish Sea bound Chinook stocks including the Fraser River, Georgia Strait and Puget Sound needs to be established.

- Restrict marine harvest in recreational and commercial fisheries on migrating and immature populations of Salish Sea bound Chinook that are below their MSY Smax escapement targets.

- These efforts should be coordinated with NOAA and be further developed through the Pacific Salmon Treaty negotiations to address interception of Salish Sea stocks caught in Northern BC, South East Alaska recreation and troll fisheries, Gulf of Alaska troll fisheries, and bycatch in Gulf of Alaska and Berring Sea ground fisheries.

**3. Accommodate SRKWs based on forecasted and in-season abundance estimates**

DFO, PSC, and Alaskan managers and researchers have forecasted 2018/19 Chinook returns to be very poor. DFO's 2017 Science-based Review of Recovery Actions recommends, "during years of poor Chinook returns, (DFO) implement a more conservative management approach than would be used in typical years to further reduce or eliminate anthropogenic competition for Chinook and other important prey in key SRKW foraging areas during key times".
Assuring that terminal

**4. Addressing other fishery management issues**

In addition, to fisheries abundance management, it is likely necessary to address the noise and disturbance from vessels in key foraging location. While this disturbance in not exclusive to fishing vessels, it does include fishing vessels. We anticipate the need to restrict access

It is estimated the foraging time SRKWs lose from vessel noise and physical disruption is 20-23% of each whale day. 'The response of SRKWs to vessels is likely a result of acoustic disturbance, and in the case of small vessels that may approach them, due to physical disturbance as well. Williams et al. (2014b) estimate that in the noisiest sites in Canadian Pacific waters, SRKWs will lose up to 97% of their acoustic communication space in the frequencies used for social communication calls. A Killer Whale-Noise-Exposure simulation model based on sound propagation modelling, a behavioural dose response model, and published audiograms of killer whales indicate that noise from vessels regionally in the Canadian portion of the Salish Sea is likely impacting SRKWs ability to forage effectively'(DFO 2017).

Noise and disturbance from smaller vessels such as those associated with whale watching and recreational fishing are believed to be responsible for about one third of the time lost to foraging in the presence of vessels, although the high sound frequency of these smaller vessels may mean their impacts are greater than estimated. DFO is aware of the threats posed by small vessel noise but has not introduced any mitigation measures to date (DFO 2017).

Presenters at the Symposium (i.e. Ford and Barrett- Lennard) further identified the role of competition and interference to SRKWs from the number of smaller vessels that are pursuing either salmon or killer whales. The presence and objectives of these vessels physically discourages foraging within key areas of critical habitat such as the shore of Vancouver Island through the Juan de Fuca and the west side of Pender Island.

Furthermore, since vessel noise is identified as an activity likely to destroy Critical Habitat (DFO 2011), any temporary loss of function should warrant very high priority for management action to reduce this threat particularly as it may be considered destruction under the SARA (DFO 2017).

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