SOUTHERN RESIDENT KILLER WHALES & COLUMBIA/SNAKE RIVER CHINOOK: A REVIEW OF THE AVAILABLE SCIENTIFIC EVIDENCE

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In the near future, three federal agencies will release a draft environmental impact statement (DEIS) to evaluate alternatives for managing federal hydroelectric dams on the Columbia and Snake Rivers. This court-ordered DEIS is the most recent step in a long-running controversy over management of these dams and their impacts on threatened and endangered salmon and steelhead. For more than twenty years, the federal agencies have failed to take the steps necessary to protect these species from harm caused by these dams. More recently, substantial scientific evidence has highlighted the important relationship between salmon from the Columbia Basin, particularly Snake River Chinook, and the future survival of our critically endangered Southern Resident Killer Whales (SRKW or orcas).

Restoring healthy, abundant salmon to the Snake River is critical if we are going to provide a more adequate prey base for orcas. As recently as 2018, NOAA's Northwest Fisheries Science Center challenged this relationship in a publication that, we believe, was misleading and contrary to the agency's own prior and subsequent findings. We have prepared this paper to summarize the extensive scientific basis for restoration of the lower Snake River by, among other actions, removal of the earthen portion of four federal dams there. This is the most effective and significant step we can take to help both salmon and orcas recover.

I. The Relationship between Snake River Chinook and Lower Snake River Restoration

1. <u>Restoration of the Lower Snake River Through Dam Removal Would Provide More Certainty of Long-Term Survival and Recovery for Snake River Chinook than Any Other Measure.</u>

In its 2000 Biological Opinion for operation of hydroelectric dams on the Columbia and Snake Rivers, NOAA Fisheries concluded: "breaching the four lower Snake River dams would provide more certainty of long-term survival and recovery than would other measures."[1]

That conclusion was supported by extensive evidence from a peer-reviewed, interagency process, the Plan for Analyzing and Testing Hypotheses (PATH), which summarized available empirical evidence, retrospectively analyzed patterns of survival in the various life stages and across the life cycle, and performed prospective analyses using a wide range of assumptions.[2] PATH analyses showed that dam breaching options were the most likely to recover Snake River salmon and steelhead with the lowest risk under a wide range of assumptions.

A weight of evidence accumulated since the PATH process has continued to consistently demonstrate major adverse impacts from the Snake and Columbia River dams (the FCRPS) on salmon and steelhead.[3] This evidence, from multiple data sets and analytical approaches, has

[1] 2000 BiOp at 9-5.
[2] Marmorek et al. 1998, Deriso et al. 2001, Marmorek and Peters 2001.
[3] Schaller and Petrosky 2007, Petrosky and Schaller 2010, Haeseker et al. 2012, Marmorek et al. 2011, Schaller et al. 2014.

repeatedly demonstrated that survival of Snake River spring/summer Chinook – in the smolt-to-adult stage, in the ocean, and across the life cycle – is lower than that of similar downriver populations that experience fewer dams. There also is considerable evidence that Snake River stream-type Chinook experience substantial delayed mortality in the marine environment as a result of their outmigration experience through the FCRPS.[4] This outmigration experience results in an accumulation of injuries, multiple stress events, and alteration of estuary arrival timing: mechanisms that may explain levels of delayed mortality.[5] Decreased water velocity and increased number of powerhouse passages have been related to large increases in the time required for juveniles to migrate to sea and reductions in life cycle survival, smolt to adult returns, and marine survival rates for Snake River Chinook Salmon.[6] This large body of scientific evidence and analyses identifies a significant level of hydrosystem delayed mortality (latent mortality) for Snake River Chinook populations. As explained further below, the recent paper by Faulkner et al. (2019) does not undercut the weight of evidence for hydrosystem delayed mortality because of the serious scientific flaws in that paper identified by the Fish Passage Center in their review of it.[7]

In sum, the best currently available scientific information continues to strongly support NOAA's conclusion regarding dam removal from the 2000 biological opinion. In its 2017 Annual Report on the Comparative Survival Study (CSS), the Fish Passage Center evaluated the effects of various levels of voluntary spring spill, as well as removal of the four lower Snake River dams, on smolt-to-adult return rates (SARs)[8] for Snake River spring/summer Chinook. Using more than twenty years of empirical data on dam passage survival and SARs, the CSS Report concluded that dam removal on the lower Snake, together with any reasonable level of voluntary spill at the lower Columbia River dams, would lead to significantly higher SARs. It also concluded that dam removal plus spill at 120% Total Dissolved Gas (TDG) or more would lead to SARs at or above the levels identified by the Northwest Power Planning and Conservation Council (NWPPC) as necessary to rebuild salmon populations to healthy levels.[9] The CSS Report reached this conclusion taking into account other variables including ocean conditions.[10]

In addition, the CSS Report compared SARs for salmon stocks that migrate past only three or four lower Columbia River dams to Snake River stocks and noted that SARs for these downstream stocks, which negotiate four or fewer reservoirs and dams, are now consistently more robust than SARs for Snake River stocks, further supporting the conclusion that lower

[4] Williams et al. 2005; Schaller and Petrosky 2007; Marmorek et al. 2011; Schaller et al. 2014).
[5] Budy et al. 2002; Muir et al. 2006; Scheuerell et al. 2009; Rechisky et al. 2012.
[6] Schaller et al. 2007, Petrosky and Schaller 2010, Haeseker et al. 2012, Schaller et al. 2014.
[7] 2019 FPC Memorandum 49-19 (reviewing Faulkner et al. 2019) (Appendix G to the 2019 CSS Final Report) [available at http://www.fpc.org/documents/memos/49-19.pdf].
[8] Smolt-to-adult returns or SARs are the metric the Northwest Power Planning Council first adopted in 2003 as a measure of population health for Columbia/Snake River salmon and steelhead. Generally, the Council has set sustained SARs above 4% as necessary for salmon populations to grow and recover.
[9] 2017 CSS Annual Report, Chapter 2 & Appendix K [available at http://www.fpc.org/documents/CSS/2017%20CSS%20Annual%20Report%20ver1-1.pdf].
[10] *Id*.

Snake River restoration would be likely to substantially improve the conditions of Snake River fish.[11] Because breaching the four Snake River dams with higher spill (to 125% TDG) at the four lower river dams is the only option that can reduce the high levels of mortality for Snake River Chinook, the best currently available science affirms that dam breaching is the most probable option for achieving recovery and rebuilding goals for these populations. Given evidence of climate change, these measures will need to be taken sooner, rather than later, to ensure persistence of these populations.

Two recent letters from a number of independent scientists rely on the CSS analysis – as well as considerable other evidence – to conclude that lower Snake River restoration is necessary to allow Snake River salmon and steelhead populations to not just avoid extinction but also begin to rebuild to a sustainable abundance.[12] The most recent of these letters focuses particularly on the role of the lower Snake River dams in increasing water temperatures and the survival benefits that will accrue from reducing these temperatures as a result of removing these dams. These scientists further emphasize the importance of these benefits to salmon survival and recovery as the climate warms in the years ahead.[13]

Despite this compelling evidence, in a 2018 publication NOAA downplayed the benefits of dam removal by stating that Snake River Chinook abundance has increased in recent years, by focusing narrowly on juvenile survival through the lower Snake River only, and by dismissing as unknowable the precise extent of the delayed effects on salmon survival of hydrosystem passage (called "delayed" or "latent" mortality).[14] More recently still, NOAA has promoted an analysis by its Fisheries Science Center that suggests smolt size has more to do with juvenile survival than the route a smolt takes past dams.[15] This smolt size study is scientifically flawed and draws erroneous conclusions for informing management decisions as explained further below.[16]

Because each of the above points relies on an incomplete presentation of available information, we summarize below a more complete picture of the scientific evidence.

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[11] *Id*.
[12] Letter to Gov. Inslee & Orca Task Force (Oct. 15, 2018) [on file with authors]; Letter to Northwest Policy Makers re River Temperatures (Oct. 22, 2019) [on file with authors].
[13] Letter re River Temperatures (Oct.22, 2019).
[14] NOAA (2018) FAQs Southern Resident killer whales & Columbia/Snake River Chinook salmon stocks (hereafter NOAA FAQs) [available at https://www.nwfsc.noaa.gov/publications/documents/FAQ%20SRKW%20Factsheet%20DRAFT2%20OCT2018%20508.pdf]
[15] Faulkner, J.R., B.L. Bellerud, D.L. Widener and T.W. Zabel (2019), Transactions of the American Fisheries Society 148:1069-1088.
[16] 2019 FPC Memorandum 49-19 (reviewing Faulkner et al. 2019) (Appendix G to the 2019 CSS Final Report).

2. <u>Snake River spring/summer Chinook Abundance Has Actually Declined and Adult Return Rates Are Well Below Levels Necessary for Species Survival, Let Alone for Rebuilding and Recovery.</u>

There is uncontroverted evidence that the current SARs for Snake River spring/summer Chinook are at or below 1%, barely half of the minimum 2% SAR level the Northwest Power and Conservation Council has identified as necessary for maintaining existing populations, and only one quarter or less of the 4% to 6% SAR level that must be achieved and sustained for this population to rebuild and recover.[17] This evidence is at odds with NOAA's claim of increased abundance. Moreover, this unacceptably low SAR has been consistent for many years, indicating that the extensive and expensive efforts so far to rebuild Snake River spring/summer Chinook populations have not been successful.

NOAA's own publication confirms that *wild* Snake River spring/summer Chinook returns to the uppermost Snake River dam have declined by at least 60% since the late 1960s when the lower Snake River dams were built (from an average of 47,615 fish to just 18,774).[18] NOAA's claim that spring/summer Chinook abundance has increased relies entirely on the fact that over this same period, Snake River spring/summer Chinook *hatchery* returns to the uppermost dam have increased by at least 15-fold (from 4,933 fish to 73,487),[19] an increase that actually reflects increased hatchery production to mitigate for losses of salmon due to the FCRPS, rather than improved survival from restoration measures. The point here is not to criticize the role of hatcheries, but to highlight the extent to which NOAA's claim of increased Chinook abundance relies on increased hatchery production, not increased survival rates. It is also important to remember that wild Snake River spring/summer Chinook are protected by law and ultimately must recover and rebuild to sustain the species' health over the long-term.

3. <u>The Benefits of Lower River Restoration and Dam Removal for Imperiled Snake River Salmon Would Be Substantial.</u>

NOAA has taken the position that juvenile salmon survival is already high through the lower Snake River and that restoring the river and removing its dams would not change this survival "dramatically."[20] The basis for NOAA's claim that juvenile survival through the four lower Snake River dams and their reservoirs is already 75% to 80% is unclear and suspect. What we do know is that the lower Snake River dams are only four of eight dams that Snake River juveniles must pass on their migration to the sea, and that the effects of dam passage compound as the number of dams and reservoirs increase. This compounding effect for Snake River Chinook is reflected in downstream juvenile survival rates past all eight dams, which CSS 2019 Appendix Table 1 estimates as only 54% on average from above the upper-most Snake River dam to below Bonneville dam over the period 1994-2019. Table A4 in this Appendix estimates juvenile survival as only 48% on average for steelhead over the same years.

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[17] CSS 2016 Annual Report, Chapter 7 [available at http://www.fpc.org/documents/CSS/2016%20CSS%20Annual%20Report.pdf].
[18] NOAA FAQs at 2 (graph at bottom of page).
[19] *Id*.
[20] *Id.*

The CSS Study has also concluded that for each powerhouse encounter a juvenile salmon experiences, its risk of mortality increases by about 12%.[21] Importantly, this CSS analysis *underestimates* hydrosystem-caused mortality, as it does not account for direct and delayed mortality through powerhouse passage or due to reservoirs, which slow fish migration, and expose juvenile migrants to warmer water, disease, and increased predation pressure. This analysis is a relative measure that reflects the additional mortality that arises later from the delayed effects of passage through bypass systems compared to other routes.[22]

Ultimately, NOAA might say that there is some level of scientific uncertainty about exactly how much juvenile survival and SARs would improve without the dams. But NOAA has also never disclaimed its long-standing conclusion that "breaching the four lower Snake River dams would provide more certainty of long-term survival and recovery than would other measures." The best currently available scientific evidence continues to support this conclusion. Any remaining "uncertainty" about just how "dramatic" juvenile survival improvements would be without the lower Snake River dams must be viewed from this perspective.

4. <u>The Benefits of Lower Snake River Restoration and Dam Removal Are Not Affected by the Difficulty of Precisely Quantifying Latent (or Delayed) Hydrosystem Mortality.</u>

Calculating the precise extent of latent or delayed mortality as a result of dam passage is not actually relevant to concluding that lower Snake River restoration and dam removal would improve Snake River Chinook returns by a very large amount and more than any other available measure. Moreover, as noted above, there is a substantial weight of evidence, from multiple data sets, analytical approaches and scientific publications that consistently demonstrates levels of latent (i.e., delayed hydrosystem) mortality due to the FCRPS that are high over varying ocean conditions.[23] NOAA attempts to cloud these beneficial effects because the precise extent of latent or delayed mortality is difficult to determine.[24]

Whatever the precise extent of these effects, they are captured and reflected in the current unsustainably low SARs – 1% or less – for Snake River spring/summer Chinook.[25] These Chinook are simply not surviving at rates sufficient to avoid extinction, let alone at rates sufficient to allow them to rebuild and recover. CSS analyses indicate that these low return rates would be improved very substantially by lower Snake River dam removal and continued adequate spill levels at the lower Columbia River dams.[26] And again, NOAA itself has said that dam removal will do more than any other available measure to support increased population growth for this species.

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[21] CSS 2016 Annual Report, Chapter 7.
[22] *Id.*
[23] Schaller and Petrosky 2007 (additional references in footnotes 3 and 4 above).
[24] NOAA FAQs at 3.
[25] CSS 2019 Annual Report, Chapter 4 [available at http://www.fpc.org/documents/CSS/2019CSSAnnualReport.pdf].
[26] 2017 CSS Annual Report, Chapter 2.

NOAA further suggests[27] that dam removal should be discounted or set aside because it will require congressional action and take some years to improve salmon survival. This suggestion begs the central question: is there an alternative action with benefits of a similar magnitude for salmon survival that we could take more quickly? NOAA's longstanding answer is "no": "breaching the four lower Snake River dams would provide more certainty of long-term survival and recovery than would other measures." And extensive scientific evidence and analyses, much of it summarized above, continues to support this conclusion.

NOAA's Fisheries Science Center recently released a new analysis which challenges the conclusion that the number of powerhouse (dam) encounters experienced by juvenile salmon has a significant negative impact on survival. This new paper asserts that it is smolt size, not the number of dam encounters, that is most significant in determining survival.[28] The analysis in this new paper, however, does not support NOAA's claim. First, there is no dispute that, as compared to other passage routes (e.g. spill), fish that pass through powerhouses have lower SARs.[29] NOAA's claim is that these lower SARs are driven by fish size, not powerhouse passage, because more smaller fish pass through powerhouses and smaller fish suffer higher mortality in the ocean.[30] What the NOAA analysis does not show is whether SARs for larger fish that pass through the powerhouses are nonetheless still lower than larger fish that pass via spill. Without this critical comparison, NOAA's analysis cannot support its conclusion about the role of fish size in dam passage survival.

A recent review of this paper by the Fish Passage Center found many shortcomings with it, including: 1) study fish all experienced at least two dam bypasses and additional handling; 2) NOAA's analytical approach didn't incorporate spill and flow, which are major factors determining collection efficiency and bypass probability; 3) the analysis ignores the fact that smolts from the John Day River which are similar (or smaller) and migrate at the same time as Snake River fish and which pass fewer dams, have much higher SARs.[31]

In sum, NOAA's conclusion from years ago that "breaching the four lower Snake River dams would provide more certainty of long-term survival and recovery than would other measures" remains valid and has significantly stronger scientific support today than it did years ago.

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[27] NOAA FAQs at 2 ("Even if [dam removal] were decided today, [it] would require congressional authorization and several generations of salmon, at least, before any results could become clear").
[28] Faulkner, et al. (2019).
[29] CSS 2016 Annual Report, Chapter 7.
[30] Faulkner, et al. (2019).
[31] 2019 FPC Memorandum 49-19 (reviewing Faulkner et al. 2019) (Appendix G to the 2019 CSS Final Report).

II. Relationship Between Snake River Chinook and Southern Resident Killer Whales (Orcas)

NOAA listed Southern Resident orcas as endangered under the Endangered Species Act (ESA) in 2005 when the population numbered 88 whales.[32] Despite almost fifteen years of federal protection, the population has continued to decline from a high census count in 1995 of 98 whales to a low point of only 72 whales today. The population must increase by an average 2.3 percent per year for 28 years in order to be removed from the Endangered Species list,[33] yet NOAA projects a continued downward trend over the next 50 years.[34] The overall decline of the population has coincided with years of low salmon abundance,[35] and NOAA itself recognizes that the principle impediment to orca recovery is a severe shortage of the whales' preferred food, Chinook salmon.[36]

Salmon are the mainstay of the Southern Resident orca's diet. This diet must support daily life activities (*e.g.*, foraging, traveling, socializing, resting), in addition to gestation, lactation, and growth.[37] To maintain this high energy balance, Southern Resident orcas preferentially consume Chinook salmon, particularly older (>3 years), larger Chinook age classes.[38] Chinooks' large size, high fat and energy content, and year-round occurrence from multiple sources within the Southern Resident's range contributes to this preference – and the preference persists "despite the much lower abundance of Chinook in some areas and during certain time periods compared to other salmonids."[39] Underscoring the importance of Chinook to Southern Residents, scientists have found a strong correlation between Chinook abundance and Southern Resident impaired body condition ("peanut head"), reduced growth rate, reduced overall length, reduced social cohesion, reduced fecundity, and reduced survival.[40]

The Southern "Resident" killer whales got their name because they used to be seen annually (i.e. "resident") in the inland waters of the Salish Sea/Puget Sound during the late spring through early fall months. Even historically, however, this genetically distinct population of killer whales has spent more than half their time swimming back and forth throughout their known range as far south as Monterey, CA and as far north as Southeast Alaska. Their visits to the

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[32] 70 Fed. Reg. 69,903 (Nov. 18, 2005).
[33] NMFS (2008) Recovery Plan for Southern Resident Killer Whales (Orcinus orca), p. II-82 [available at http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Status/Orca-Recovery-Plan.cfm]
[34] 84 Fed. Reg. at 49,215; National Marine Fisheries Service, West Coast Region, Proposed Revision of the Critical Habitat Designation for Southern Resident Killer Whales, Draft Biological Report at 7-8 (Sept. 2019) (hereafter NOAA Biological Report).
[35] Ward et al. 2009, Ford et al. 2010.
[36] NOAA Biological Report at 28.
[37] *Id.* at 27.
[38] *Id.* at 10, 27.
[39] *Id.* at 10.
[40] *Id.* at 13, Ford *et al.* 2005, Durban *et al.* 2009, Ward *et al.* 2009a, Ford *et al.* 2010, Fearnbach *et al.* 2011, Ayres *et al.* 2012, Ward *et al.* 2013, Groskreutz et al 2019.

coastal waters off Westport, Washington and the mouth of the Columbia River coincide with high concentrations of spring Chinook salmon.[41]

The best available science indicates that the whales are likely to be especially reliant on the Columbia/Snake River watershed's early spring, nutrient-rich Chinook salmon runs.[42] Indeed, the mouth of the Columbia Basin is one of the Southern Resident orcas' favorite places to fish. Data compiled from tagged whales, dedicated surveys, and passive acoustic monitoring indicates the Southern Residents spend significant time in the winter and spring off the mouth of the Columbia and have been present there thirty-five times more often than would be expected by chance.[43] Analysis of fish scale and Southern Resident fecal samples collected on the outer coast indicate that, as is the case in inland waters of the Salish Sea/Puget Sound, Chinook are the primary species consumed on the outer coast and that over half the Chinook consumed by the Southern Residents are from the Columbia River Basin.[44] [45] Elevated triiodothyronine values in early spring indicate that Southern Resident orcas particularly forage on the early spring Columbia River run.[46] [47]

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[41] J. Acoust. Soc. Am., Vol. 134, No. 5, November 2013, Hanson et al.: Killer Whale Acoustic Recorder Occurrence, 3486 [available at http://oceanwidescience.org/cms/wp-content/uploads/2014/12/Hanson-et-al-2013.pdf], 2013 Southern Resident Killer Whale Satellite Tagging [available at http://www.nwfsc.noaa.gov/research/divisions/cb/ecosystem/marinemammal/satellite_tagging/blog.cfm].

[42] Ayres KL, et al., Distinguishing the Impacts of Inadequate Prey and Vessel Traffic on an Endangered Killer Whale (Orcinus orca) Population (2012) PLoS One 7: e36842, http://journals.plos.org/plosone/article?id=10.1371/journal.pone.0036842.

[43] Hanson, M.B., E.J. Ward, C.K. Emmons, and M.M. Holt. 2018. Modeling the occurrence of endangered killer whales near a U.S. Navy Training Range in Washington State using satellite-tag locations to improve acoustic detection data. Prepared for: U.S. Navy, U.S. Pacific Fleet, Pearl Harbor, HI. Prepared by: National Oceanic and Atmospheric Administration, Northwest Fisheries Science Center under MIPR N00070-17-MP-4C419. 8 January 2018. 33 p., Appendix A hereto (Figure from NOAA NWFSC showing concentration of orca presence off Columbia River mouth).

[44] NOAA Biological Report at 11.

[45] During the summer months, Chinook comprise 79.5% of the orcas' overall diet. NOAA Biological Report at 11. The best available data indicate that Chinook remains an important dietary component for Southern Residents in the winter while the orcas range in outer coastal waters. *Id*.

[46] Wasser et al. 2017.

[47] Hanson, M.B., J.A. Nystuen, M.O. Lammers. Assessing the coastal occurrence of endangered killer whales using autonomous passive acoustic recorders, J. Acoust. Soc. Am. 134 (5)(November 2013), Ward, E. et al, NWFSC Science to Inform SRKW Distribution and Diet, Presentation to Pacific Fisheries Management Council SRKW Working Group, May 2019 [available at https://www.fisheries.noaa.gov/webdam/download/92840008, https://www.fisheries.noaa.gov/event/ad-hoc-southern-resident-killer-whale-workgroup].

In partnership with the Washington Department of Fish and Wildlife (WDFW), NOAA created a preliminary priority list of West Coast Chinook salmon stocks important to the Southern Resident orcas' recovery.[48] Of the top fifteen priority stocks, seven are from the Columbia Basin, including both fall and spring Chinook.[49]

Priority Chinook Stocks Using Conceptual Model

ESU / Stock Group	Run Type	Rivers or Stocks in Group
Northern Puget Sound	Fall	Nooksack, Elwha, Dungeness, Skagit, Stillaguamish, Snohomish
Southern Puget Sound	Fall	Nisqually, Puyallup, Green, Duwamish, Deschutes, Hood Canal systems
Lower Columbia	Fall	Fall Tules and Fall Brights (Cowlitz, Kalama, Clackamas, Lewis, others)
Strait of Georgia	Fall	Lower Strait (Cowichan, Nanaimo), Upper Strait (Klinaklini, Wakeman, others), Fraser (Harrison)
Upper Columbia & Snake Fall	Fall	Upriver Brights
Fraser	Spring	Spring 1.3 (upper Pitt, Birkenhead; Mid & Upper Fraser; North and South Thompson) and Spring 1.2 (Lower Thompson, Louis Creek, Bessette Creek)
Lower Columbia	Spring	Lewis, Cowlitz, Kalama, Big White Salmon
Middle Columbia	Fall	Fall Brights
Snake River	Spring-Summer	Snake, Salmon, Clearwater
Northern Puget Sound	Spring	Nooksack, Elwha, Dungeness, Skagit (Stillaguamish, Snohomish)
Washington Coast	Spring	Hoh, Queets, Quillayute, Grays Harbor
Washington Coast	Fall	Hoh, Queets, Quillayute, Grays Harbor
Central Valley	Spring	Sacramento and tributaries
Middle & Upper Columbia Spring	Spring	Columbia, Yakima, Wenatchee, Methow, Okanagan
Middle & Upper Columbia Summers	Summer	

Fig. 1: NMFS & WDFW Priority Chinook Stocks; Table from NMFS & WDFW 2018 at 7.

[48] As Both NOAA and WDFW acknowledge, this is a preliminary list of priority stocks that may change with further data and analysis. This limitation is particularly important because critics of the priority list have pointed out that the priorities are based on conditions at the time data were collected (e.g., stocks depleted before data collection rate lower than they would have if data collection had started earlier), do not take into account potential for recovery of stocks, and may reflect more about sampling locations and sample size than stock priority (e.g., most data comes from Puget Sound sampling with more limited data from the outer coast).

[49] NOAA Fisheries West Coast Region & Washington Department of Fish and Wildlife, Southern Resident Killer Whale Priority Chinook Stocks Report (June 22, 2018).

Unfortunately, these runs are not what they once were, and images from aerial photogrammetry indicate a decline in the orcas' body condition between October and May, precisely the time period when these whales would be foraging on salmon runs from the Columbia River Basin.[50] In particular, reproductive-age females exhibited measurable changes in body condition and physical signs of nutritional stress. *Id.* The disproportionate impact on reproductive females has also been demonstrated in their low fecundity rates and high loss of pregnancies, especially late-term pregnancies.[51]

The current depleted level of adult Chinook returns to the Columbia is a critical component of the prey scarcity these whales face. This shortage is compounded by the fact that adult Chinook returns, especially hatchery stocks that comprise most of these returns, consist of an increasing number of younger – and hence smaller – fish than in the past.[52] This fact means that these whales must expend far more energy today to obtain the same caloric value of prey with the net effect of less nourishment. The claim that maintaining the continued low adult salmon returns to the Columbia does not harm these critically endangered whales is not scientifically supported.

Further, the predicted and uniquely high recovery potential of Chinook from the Columbia Basin should not be discounted.[53] Wilderness acreage provides the highest quality in-stream spawning habitat for spring Chinook. Breaching the four lower Snake River dams would open the gateway to a vast, 5,500-mile expanse of largely intact spawning and rearing streams that run through millions of acres of wilderness. These are the highest elevation streams, and, therefore, the most global warming resistant salmon streams in the entire lower 48 states. In short, breaching these dams would greatly increase a critical food source for the Southern Resident orcas, particularly in the winter months.

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[50] Fearnbach, H. et al, **"**Using aerial photogrammetry to detect changes in body condition of endangered southern resident killer whales," Endang Species Res 35:175-180 [available at https://doi.org/10.3354/esr00883].

[51] Wasser, S.K. et al., Population growth is limited by nutritional impacts on pregnancy success in endangered Southern Resident killer whales (Orcinus orca), PLoS ONE 12: e0179824 (2017).

[52] CSS 2017 Annual Report, Chapter 6 at pp. 171-174.

[53] Ford, Presentation to Orca Recovery Task Force (copy on file with authors), Appendix B hereto (bar graph showing salmon recovery potential in Columbia Basin attached); CSS 2017 Annual Report, Chapter 2 (discussing dramatic improvements in SARs for spring Chinook with dam breach and adequate spill at lower Columbia dams); Fish Passage Center presentation to Orca Recover Task Force (October 2018) (copy on file with authors), Appendix C hereto (graph showing range of increase in spring Chinook adult returns under various management scenarios including lower Snake River dam breach with spill). Note also that NOAA introduces a major bias into their FAQs publication by using returns to the uppermost dam as a reference metric for Chinook available to SRKW. When spring/summer Chinook populations were healthy and sustainable, lower river fisheries were harvesting 50% or more of the run; recent harvest rates are only about 10%. Thus, NOAA should refer to estimated Chinook returns to the Columbia River mouth as the appropriate metric and food source for SRKW.

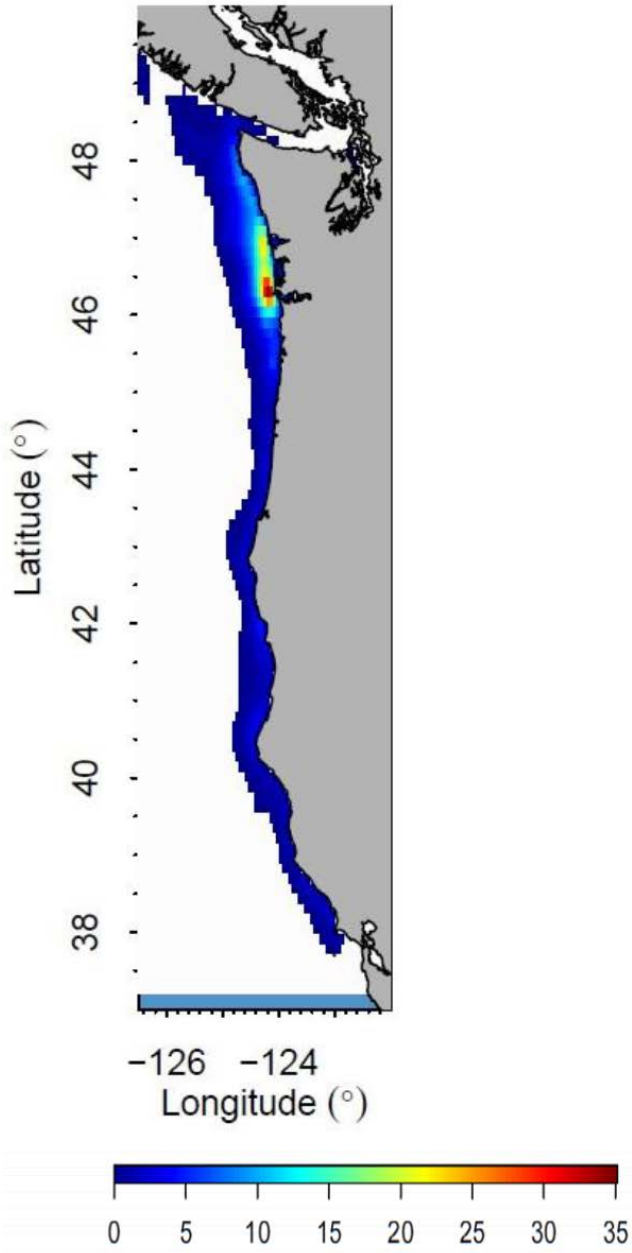
There are four key facts about the Southern Resident orcas that are undisputed: (1) these whales are nutritionally limited;[54] (2) they feed primarily on Chinook;[55] (3) to meet their prey needs requires an adequate supply of Chinook throughout the year and throughout their range, not just in some months;[56] and, (4) the largest potential for increased Chinook abundance – by orders of magnitude – anywhere in the Southern Residents' range is Chinook from the Columbia-Snake River Basin.[57] These basic facts have led many independent scientists to conclude that SRKWs will not be recovered unless major projects like removal of lower Snake River dams, which have the most potential to increase Chinook availability for SRKW, occur promptly. As NOAA itself stated in its 2008 Southern Resident Killer Whale Recovery Plan "[p]erhaps the single greatest change in food availability for resident killer whales since the late 1800s has been the decline of salmon in the Columbia River basin."[58] The Snake, of course, is the Columbia's largest tributary and once produced nearly half of the entire basin's Chinook.

When all of this evidence is taken into account, we believe that, as a matter of scientific evidence, it is clear that lower Snake River restoration, including dam removal, is the single biggest and most effective step we can take to restore these two important species. The evidence of continued decline for both orcas and Snake River Chinook also highlights the great urgency to take this action as soon as possible. It should be a central part of any regional effort to develop effective solutions to restore these species and meet the needs of Northwest people and communities.

[54] Letter to Gov. Inslee & Orca Task Force (Oct. 15, 2018) [on file with authors].
[55] *Id*.
[56] *Id*.
[57] *Id*., Ford, Presentation to Orca Recovery Task Force & Appendix B hereto (graph).
[58] NMFS (2008) *Recovery Plan for Southern Resident Killer Whales (Orcinus orca)*, p. II-82 [available at http://www.nwr.noaa.gov/Marine-Mammals/Whales-Dolphins-Porpoise/Killer-Whales/ESA-Status/Orca-Recovery-Plan.cfm].

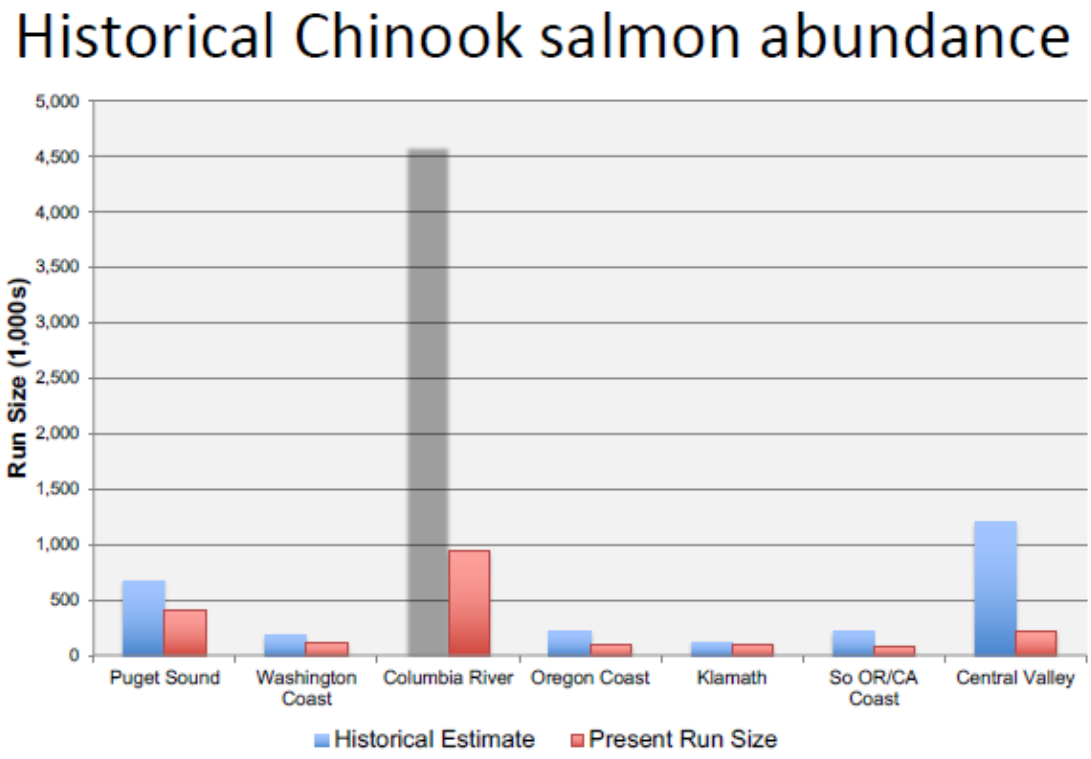
Appendix A - Graph from U.S. Navy/NOAA NWFSC Report (referenced in footnote 41)

Figure 3. Estimated density for the K25and L84 movement tracks using a state space movement model, with 10-minute intervals. The heat map is scaled relative to a uniform distribution of habitat use (e.g. dark red values indicate 35x higher than expected by chance).



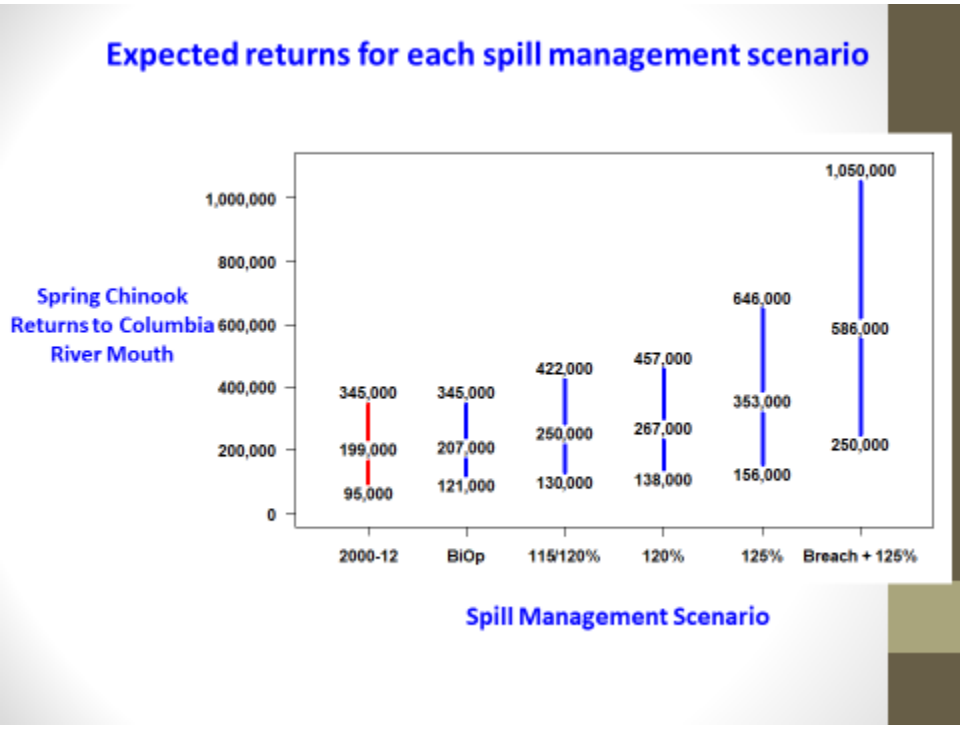
https://www.navymarinespeciesmonitoring.us/files/9315/3186/7492/Hanson_et_al_2018_Modeling_Occurrence_of_SRKW_in_NWTRC.pdf Pg. 31

Appendix B – Graph from Ford Presentation to Orca Recovery Task Force (referenced in footnotes 51 and 55)



Source: Various, compiled by Jim Myers NWFSC

Appendix C – Graph from FPC Presentation to Orca Recovery Task Force (referenced in footnote 51)



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