Product Sustainability Standard: Seafood

Chinook Salmon

Version 2.0: 2024

Reason for Standard

Chinook salmon are an iconic species in the Pacific Northwest with significant ecological, cultural, and economic importance—many subspecies of which are listed as endangered. The Southern Resident Killer Whales (SRKW), also a regionally iconic species, depend on Chinook as a primary food source. Due to a combination of noise pollution, toxic chemicals, food scarcity, and climate change, the populations of SRKW have reached devasting lows and the future of the species is uncertain.

Consumer concern for Chinook salmon, SRKW populations, and the many ecological and cultural systems that depend on them have created a demand for action and increased sourcing consciousness. As a grocery co-op with a strong commitment to social and environmental responsibility, we asked ourselves, "How can we sell Chinook without contributing to the SRKW food shortage or harming already vulnerable populations of Chinook salmon?"

PCC's first step towards this goal came in September of 2018 after Tahlequah (J35), a female member of the J Pod carried her deceased calf across her brow for 17 days. In response to this demonstration and the demands of our customers, we issued a moratorium on all Chinook salmon caught in waters from British Columbia, Washington, and Oregon. This action received wide acclaim, but also brought to the forefront new information from aquatic experts and fishermen that it was an imperfect solution.

After many discussions with stakeholders and a thorough review of existing seafood sustainability certifications to identify if an appropriate standard for sourcing Chinook salmon existed, PCC determined it was necessary to develop an independent standard. PCC commissioned experts from the National Fisheries Conservation Center (NFCC) to examine data, collaborate with fishery and conservation experts, and develop a Chinook sourcing standard that could identify supplies of Chinook salmon that would have no or minimal impact on SRKW prey.

Scope

This is a product-specific standard that applies to fresh or previously frozen Chinook (King) salmon sold in the seafood department or used in PCC-prepared products.

All fresh or previously frozen Chinook salmon sold at PCC or utilized in chef-inspired, or PCC deli-prepared dishes must be sourced in accordance with the prey interception, stock, and knowledge risk standards set forth in sections 1 through 3 below, as well as the additional requirements set forth in section 4.

Fuller standard descriptions, indicators, and letter rating requirements as described in *Standards, Indicators, and Rating Guidelines for Chinook Salmon (Oncorhynchus tshawytscha): Sourcing Chinook while protecting endangered Southern Resident Killer Whales* are incorporated by reference as Appendix A.

By agreement with Monterey Bay Aquarium Seafood Watch, Chinook salmon sourced in accordance with this standard and sold at PCC Community Markets are exempt from Monterey Bay Aquarium Seafood Watch ratings and partnership commitments.

Standard

To meet the purchasing requirements for PCC, Chinook salmon must come from a fishery that earns an A or B in the stock and knowledge risk categories described in sections 2 through 3 of this standard. For interception risk (section 1), only A-rated fisheries qualify.

1. Prey Interception Risk

The fishery must not intercept Chinook that would otherwise be available as prey to SRKW in their foraging grounds or in the case of mixed-stock fisheries must have only negligible impact (<2%) on prey availability. In order to satisfy each component of the prey interception risk standard, a fishery must pass each component's indicators set forth in Appendix A with an acceptable letter rating.

1.1. *No Overlap.* Catch must target Chinook salmon stocks that do not overlap with the range of SRKW and their known prey.

1.2. *Post Prey.* Chinook salmon caught in the fishery must have already passed through the feeding grounds of SRKW, caught in waters where the fish are approaching their home streams or hatcheries.

1.3. *Negligible Effect.* If sourced from a mixed-stock marine waters fishery, Chinook catch must be carefully limited and its impact on SRKW prey availability must be reliably estimated to be negligible (<2%).

2. Stock Risk

The fishery must avoid depletion of SRKW prey and comply with formal control rules and precautionary polices on spawning biomass. A fishery must pass each of the following component's indicators set forth in Appendix A. Components of the stock risk standard include the following:

2.1. *Exploitation.* The fishery must avoid depletion of SRKW prey supply by meeting conservation limits on target and non-target fish.

2.2. *Biomass.* Harvest must comply with formal control rules and precautionary polices that (1) reduce exploitation rates when spawning biomass (or escapement) falls below target reference point, (2) halt fishing or require proven selectivity modifications when biomass of any affected stock falls below a minimum stock size threshold, and (3) regulate mixed-stock fisheries to protect weak, threatened or endangered fish populations, rather than setting catch limits as a function of aggregate abundance.

2.3. *Hatcheries.* Best practice guidance on hatchery management is an evolving and contentious subject, however, the hatchery risk component of the Chinook Standard aims to minimize potential for hatcheries to harm neighboring stocks of naturally spawning salmon. A fishery must receive an appropriate rating on each indicator as set forth in Appendix A with the goal of satisfying that hatcheries and enhancement programs underpinning the fishery use best practices to avoid or mitigate impacts on naturally spawning fish.

3. Knowledge Risk

Incomplete knowledge and data are a universal challenge in the conservation of fish and marine mammal populations. Data and evidence used to assess whether standards set forth in sections 1 through 2 of this standard must meet metrics for precautionary sourcing of Chinook salmon while protecting prey supplies for SRKW. A fishery must satisfy the following knowledge risk components of the standard by receiving the appropriate rating for each indicator, as fully described in Appendix A.

3.1. *Knowledge of Interception Risk.* Available data must provide a high level of certainty that a fishery does not intercept Chinook that would otherwise be available as prey to SRKW or has only negligible impact (<2%) on prey availability. Fisheries can achieve this by demonstrating "no overlap" (e.g., distant harvests of fish that do not overlap with SRKW feeding grounds), by demonstrating that fish are "post-prey" (having already escaped feeding grounds on their way home), or by showing strong evidence that any catch has negligible effect on prey available to SKRW.

3.1.1. *No Overlap.* These indicators (3.1.1.1 through 3.1.1.2) define requirements for evidence to show that certain fisheries catching Chinook far from the range of SRKW and their priority prey (e.g., in parts of Alaska) achieve zero or negligible impact on Chinook that otherwise could be available to Southern Residents.

3.1.2. *Post Prey*. Indicators 3.1.2.1 and 3.1.2.2 define requirements for evidence to demonstrate that Chinook caught in or near certain "terminal areas"—on their final approach to their home streams or hatcheries —have already escaped from SRKW foraging grounds.

3.1.3. *Negligible Effect.* Indicator 3.1.3.1 defines evidence required to meet a precautionary standard for fisheries where Chinook from multiple stocks mix in marine waters.

3.2. *Knowledge of Stock Risk.* Available data must meet the following knowledge of stock risk components and associated indicators set forth in Appendix A:

3.2.1. *Exploitation Risk.* Available data must provide reliable evidence that fishery does not deplete SRKW prey supply and complies with conservation limits to protect Endangered, Threatened or Protected species, satisfying indicators 3.2.1.1 through 3.2.1.5.

3.2.2. *Biomass Risk.* Available data must allow managers to reliably monitor escapement of target and non-target salmon, so that harvest rates can be reduced when necessary to protect spawning biomass, and fishing can be halted or modified if necessary when biomass is low, satisfying indicators 3.2.2.1 through 3.2.2.5.

3.2.3. *Hatcheries.* Available data must be sufficient to show whether hatchery and enhancement programs supporting the fishery use best practices to avoid or mitigate impacts on naturally spawning fish, satisfying indicators 3.2.3.1 through 3.2.3.4.

4. Additional Requirements

The following are additional criteria for seafood sold at PCC, which any Chinook salmon must also meet. This is outside of the above Chinook sourcing standard.

4.1. PCC will not sell Chinook raised in net pens or other aquaculture/farmed operations.

4.2. Processing, Packaging and Handling

4.2.1. The use of carbon monoxide, or any other gas for the purposes of modified atmosphere packaging or to preserve fish color, is prohibited.

4.2.2. The use of Sodium tripolyphosphate (STPP) post-processing for any purpose, including prevention of thaw drip, is prohibited.

4.2.3. Seafood may be vacuum packed wherein excess air is removed from the package using suction and subsequently sealed to preserve freshness.

4.3. Fair Labor

4.3.1. No supplier may utilize or source from suppliers utilizing child labor, forced labor, human trafficking, abuse, harassment, or any other violations of human rights.

4.3.2. PCC will not work with any supplier that has committed human rights violations.

4.3.3. All suppliers must meet local, federal, and international labor laws.

4.3.4. PCC encourages suppliers to seek third-party certifications ensuring the above standards, such as Fair Trade USA.

Glossary: Key Terms

Biomass refers to a standing stock of fish. It is a common shorthand for spawning biomass, or breeding-age fish, used as an indicator of reproductive potential.

Endangered, Threatened, or Protected (ETP) species are aquatic species protected under the United States Endangered Species Act (ESA) or other conservation laws due to critically low population numbers.

Escapement is the proportion of a fish population not caught by fisheries and returning to spawning grounds.

Fair Trade USA is an organization, with accompanying certification system, dedicated to ensuring safe working conditions, protecting the environment, building sustainable livelihoods, and providing additional money to empower and uplift communities.

Fisheries are geographic areas associated with a population of aquatic life harvested for commercial or recreational value.

Hatchery is a place where the hatching of fish eggs is artificially controlled for commercial purposes**.**

Indicators are benchmarks used to determine whether salmon fisheries and hatcheries satisfy the requirements under each standard outlined above.

Mixed stock fisheries are marine fisheries comprised of fish stocks from different natal rivers and of various ages. Harvesting fish far from their origins makes management difficult as healthy river stocks are co-mingled with weak stocks and traceability is difficult, if not impossible.

Modified Atmosphere Packaging (MAP) refers to the process of replacing the air in a packaged fresh food with a specific gas mixture. The intent is to preserve the food and extend shelf life by reducing the oxygen in the package.

Monterey Bay Aquarium Seafood Watch Program educates consumers, creates partnerships with groups along supply chains, and advocates for polices to improve seafood traceability, end illegal fishing, and protect at-risk marine species. It began in 1999 and is officially owned and operated by the Monterey Bay Aquarium Foundation, which was created to generate sufficient capital to build the aquarium that is located in Monterey, California. The Seafood Watch program evaluates aquaculture operations and fisheries and rates them as Green Best Choice, Yellow Good Alternative, and Red Avoid.

Net pens are used in open water aquaculture operations and confine fish with a mesh enclosure with a rigid frame around the top at the surface of the water. Sometimes referred to as “cages,” these systems are considered a very risky form of aquaculture, as they allow for the free exchange of waste, chemicals, parasites, and disease with the surrounding environment. Escapes are also highly common with open net pens, leading to the introduction of potentially invasive species into the surrounding waters.

Southern Resident Killer Whales (SRKW) are the orcas that remain in the waters of Puget Sound and the western coast of North America. Comprised of three pods (J, K, and L), the SRKW are listed as an endangered species. Unlike transient orcas who hunt for fish and smaller marine mammals, the SRKW subsist entirely on fish, their primary food source being the also endangered Chinook salmon.

Terminal Fisheries target adult fish as they return to upstream spawning areas or hatcheries. Chinook caught in terminal fisheries have already passed through SRKW feeding grounds.

Appendix A

Standards, Indicators, and Rating Guidelines for Chinook Salmon

Standards, Indicators, and Rating Guidelines for Chinook Salmon *(Oncorhynchus tshawytscha)*

Sourcing Chinook While Protecting Endangered Southern Resident Killer Whales

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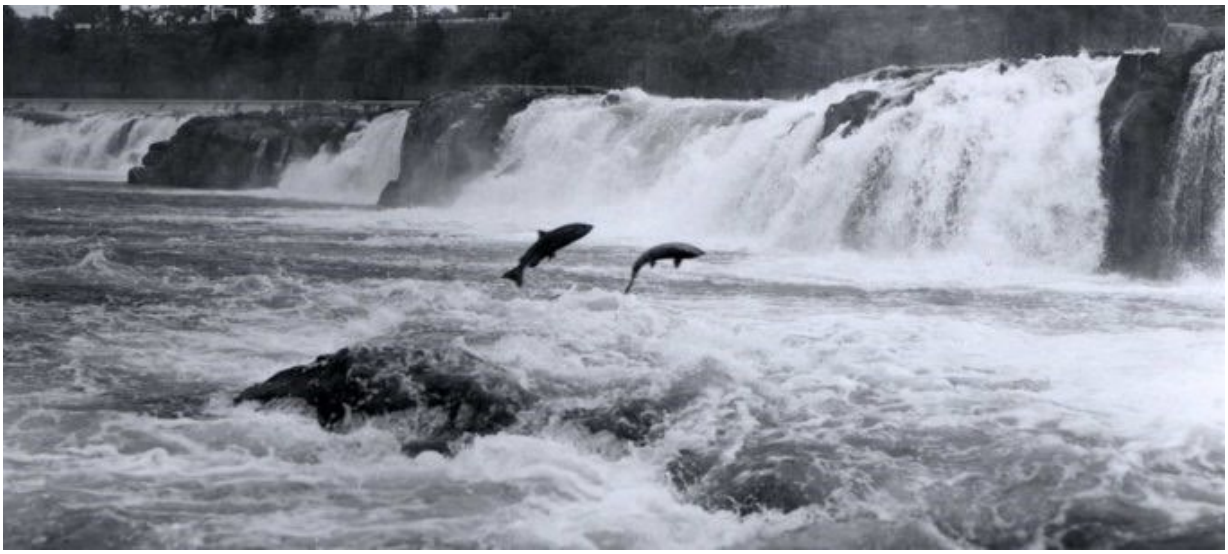

Chinook salmon leaping at Willamette Falls, Oregon. *Photo: American Rivers*

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Introduction

The standards, rating guidelines, and indicators offered here are designed to enable PCC Community Markets (PCC) to source Chinook salmon in a way that supports recovery of Southern Resident Killer Whales (SRKW) and their Chinook salmon prey. This work was prepared in response to PCC's request for precautionary, place-based purchasing standards that neither usurp nor erode Southern Resident whales' access to Chinook.

This work presents a strategy to identify Chinook salmon that can be purchased without harm to this critically endangered population of whales. The rating guidelines offer three tiers (**A, B,** and **C**) for evaluating performance of fisheries against the standards and indicators. The indicators represent benchmarks for use in determining whether salmon fisheries and hatcheries satisfy the requirements for each standard.

These standards address three broad categories of risk:

> **Prey Interception Risk.** This is the risk of taking Chinook prey from Southern Resident Killer Whales.
>
> **Stock Risk.** This is the risk of depleting Chinook prey through excessive fishing pressure on target or non-target stocks, or through inappropriate hatchery practices.
>
> **Knowledge Risk.** This is the risk that errors and uncertainties in knowledge of the resource or the fishery could result in harm.

These tools are intended to help PCC identify sources of Chinook that can be offered in good conscience on its store shelves. As with broader seafood sustainability standards (e.g., Marine Stewardship Council or Monterey Bay Aquarium), it is recommended that retail purchasing managers rely on expert advisors to assess performance of fisheries under these standards on a routine basis. This work itself, like all work in the field of fisheries science and management, should be reviewed, revised, and updated periodically by experts in marine resource conservation and management.

This guidance is prepared at a time when ocean conditions, climate, rivers, and watersheds are undergoing rapid and accelerating change. These changes already have deeply eroded Chinook populations, forcing historically high reliance on hatchery production and on ambitious habitat restoration to sustain them. Climate impacts in particular are becoming larger and more worrisome. Thus, the fate of SRKW and their Chinook prey is unavoidably tied to human actions. Under these conditions, seafood purchasing decisions alone cannot save Chinook salmon or the whales that depend on them for food. But a precautionary sourcing approach may provide a good place to begin the work that matters most: tackling the root causes of the trouble.

Standards, Indicators & Rating Guidelines

Salish Sea L-pod orca. *Photo: Center for Whale Research*

1. Prey Interception Risk

The goal of this standard is to ensure that a subject fishery targets Chinook that would not otherwise be available in SRKW foraging grounds.

We identified three approaches for avoiding or tightly limiting potential interception of SRKW prey. Indicators are designed for use in evaluating a fishery's performance under each approach:

No Overlap. Indicators 1.1.1 and 1.1.2 apply to fisheries that are remote from the range of both SRKW and their prey, and that can demonstrate that the fishery never encounters or has negligible impact (defined in Indicator 1.3.1) on availability of Chinook from SRKW priority prey stocks.

Post-Prey. Indicators 1.2.1 and 1.2.2 apply to fisheries located in or near rivers and hatcheries, where they carefully target returning adult Chinook that have escaped from the whales' foraging grounds.

Negligible Effect. Indicator 1.3.1 applies primarily to mixed-stock fisheries in marine waters. It sets a minimum confidence level for determining that the fishery removes no more than 2% of identified priority prey Chinook available in the whales' foraging grounds. This indicator can also apply to fisheries that normally operate under "no overlap" provisions, e.g., if fish from SRKW priority prey stocks do stray into remote waters in Alaska. In addition, this "negligible effect" indicator could be applied to "post-prey" fisheries if SRKW begin to enter their waters.

1.1 No overlap. Catch must target Chinook salmon stocks that do not overlap with the range of Southern Residents. Indicators 1.1.1 and 1.1.2 apply to fisheries such as Bristol Bay that are remote from the range of both SRKW and their prey, and where harvesters demonstrably do not encounter Chinook from stocks identified as priority prey for the SRKW population.

> **Indicator 1.1.1:** This indicator includes two components: Fishery location is confidently known to be 1) outside of SRKW range; and 2) stock identification data collected over at least 10 years shows no record of Chinook from stocks identified as priority prey of SRKW (per NOAA and WFDFW 2018 or subsequent updates by federal, state and tribal resource managers).
>
> **Indicator 1.1.2:** This indicator applies specifically to Chinook fisheries that are remote from SRKW range but are prone during anomalously warm years (e.g., "The Blob") to catch Chinook that originate from rivers or hatcheries within the whales' range (e.g., this indicator would apply to commercial harvests at the mouth of the Copper River). To qualify under this indicator, a fishery must: (1) produce Chinook harvests in which Chinook originating from SRKW priority prey stocks are documented to comprise no more than 10% of the catch, on average over the past one to three decades; (2) offer a catch from specific fishing periods when real-time thermal records indicate that cool or normal temperatures prevailed during the season up to date of harvest and during the preceding spring.

1.2 Post-Prey. Chinook salmon caught in the fishery must have already passed through the feeding grounds of Southern Residents, caught in waters where the fish are approaching their home streams or hatcheries. Indicators 1.2.1 and 1.2.2 apply to fisheries in or near rivers or hatcheries where they can carefully target returning adult Chinook that have already escaped from the whales' foraging grounds.

> **Indicator 1.2.1:** Fishery occurs within SRKW range in a terminal or near-terminal area, and managers estimate with ≥80% confidence that at least 90% of Chinook encountered have already escaped from SRKW foraging waters en route to upstream spawning grounds or hatcheries.
>
> **Indicator 1.2.2:** Fishery occurs within SRKW range in specific waters that SRKW are believed to avoid (such as Hood Canal), where confirmed observations of SRKW do not exceed one and no confirmed observations have occurred within five years.

1.3 Negligible Effect. This criterion and Indicator 1.3.1 apply to mixed-stock Chinook fisheries in marine waters. Today, even highly selective, well-managed fisheries in salmon mixing areas at sea are unlikely to meet the tests above. This is because they are managed using models (FRAM or CTC) that estimate harvest impacts on various stocks but are not designed to qualify those estimates with quantified confidence metrics. However, it appears possible that genetic stock identification and perhaps other tools could enable some mixed-stock marine fisheries to achieve high confidence in estimates of their success in avoiding the whales' identified prey stocks. This indicator provides an option for these fisheries.

> **Indicator 1.3.1:** Scientists estimate with at least 80% confidence that the fishery intercepts no more than 2% of returning adult fish from the 30 stocks identified as priority prey for SRKW (per NOAA and WFDFW 2018 or subsequent updates by federal, state, and tribal resource managers).

RATING GUIDELINES FOR INTERCEPTION RISK

A: Fishery must satisfy at least one indicator for interception risk to show that the fishery does not significantly reduce Chinook from priority stocks that would otherwise be available as prey to SRKW. *Note: In "No Overlap" fisheries in Alaska, the <2% negligible impact threshold from Indicator 1.3.1 can be applied if fish from SRKW priority prey stocks are encountered; this negligible impact threshold could also be applied in "post-prey" fisheries if SRKW begin to enter their waters.*

B: Not applicable. Under these standards, a high level of precaution is required in avoiding interception of priority prey.

C: Not applicable. Under these standards, a high level of precaution is required in avoiding interception of priority prey.

2. Stock Risk

Stock risk for Chinook salmon fisheries includes three major components: exploitation, biomass, and hatcheries. Of these, exploitation and biomass apply mainly to fisheries targeting naturally spawning fish. In some cases, effects on non-target stocks could also be evaluated under this standard.

Exploitation. Stock risk associated with exploitation arises from fishing pressure. It is controlled by reliably measuring and limiting exploitation rates to sustainable levels.

Biomass. Stock risk associated with biomass can arise either from fishing or from environmental pressures such as habitat degradation. In salmon fisheries, management of exploitation and biomass risks are often tightly integrated through use of escapement goals, which govern exploitation explicitly to let enough fish swim home and reproduce (conserving spawning biomass). However, standards used to evaluate fisheries for retail sourcing typically treat exploitation and biomass risks separately, as this is common practice across most major fisheries. Salmon experts will recognize some redundancy in this separation here. We chose this approach to simplify the challenge of integrating this standard with fishery performance standards that are widely used in seafood supply chains, such as Monterey Bay Aquarium's Seafood Watch Program and the Marine Stewardship Council's label.

Hatcheries. Hatchery risk includes a suite of hazards that hatcheries can present to neighboring, naturally spawning fish. Without proper controls, straying domesticated hatchery fish may dilute genetic resilience of natural populations, compete with wild salmon for scarce habitat and food, or prey upon their young. In some cases, hatchery staff collecting fish for breeding can impose unsustainable removals on natural populations in order to sustain hatchery production ("broodstock mining").

Below are standards, indicators, and rating guidelines for exploitation risk, biomass risk and hatchery risk.

2.1 Exploitation. The fishery avoids depletion of SRKW prey supply by meeting conservation limits on target and non-target fish.

Indicator 2.1.1: Exploitation Rate. Exploitation rate meets applicable conservation limits in law, state and federal harvest rules, and treaty management agreements.

Indicator 2.1.2: Reference Points. This indicator sets two requirements: (1) On target stocks, fishing pressure must be managed to a target reference point ≤ maximum sustainable yield (e.g., FMSY, SMSY, or a reliable substitute); and (2) harvest managers must use abundance-based control rules that reduce the allowed exploitation rate when abundance of returning fish is low, and halt fishing when abundance drops below a minimum threshold.

Indicator 2.1.3: ETP Species. Incidental take of Endangered, Threatened or Protected (ETP) populations, if any, complies with applicable limits in law and treaty management agreements.

Indicator 2.1.4: Uncertainty → Precaution. Management policy responds to errors and uncertainties in key management parameters (such as run-size forecast, exploitation, survival and escapement), by implementing precautionary harvest control rules and in-season adjustments in allowable catch and/or fishing practices (e.g., to selectively avoid impacts on lower-than-expected runs, while targeting healthy stocks).

Indicator 2.1.5: Compliance. Both fishery managers and fishers comply with applicable exploitation rate limits and impact limits on target and non-target species, including ETP species.

Indicator 2.1.6: Timely Action. In terminal and near-terminal fisheries, managers adjust harvest rules in-season when necessary to meet applicable conservation limits.

RATING GUIDELINES FOR STOCK RISK: EXPLOITATION

A: Fishery meets indicators 2.1.1 through 2.1.6 with moderate (≥60%) to high (≥80%) confidence. *Allowance: Partial compliance with up to two indicators may qualify, provided that improvements are undertaken to correct the shortfall within the next five assessment periods for this purchasing standard.*

B: Moderate confidence (≥60%) that the fishery satisfies all the requirements in indicators 2.1.1 through 2.1.6, indicating that exploitation rate limits are met at least 60% of the time. *Allowance for improvement: Partial satisfaction of up to three requirements may qualify, provided that improvements are undertaken to correct the shortfall within the next five assessment periods under this standard.*

C: Available data fail to satisfy four or more requirements in indicators 2.1.1 through 2.1.6.

2.2 Biomass. Harvest must comply with formal control rules and precautionary polices that: (1) reduce exploitation rates when spawning biomass (or escapement) falls below target reference point; (2) halt fishing or require proven selectivity modifications when biomass of any affected stock falls below a minimum stock size threshold (MSST) or proxy; and (3) regulate mixed-stock fisheries to protect weak, threatened, or endangered fish populations, rather than setting catch limits as a function of aggregate abundance.

Indicator 2.2.1: Reference Points. As a corollary to exploitation risk policies, spawning potential is protected by a stepped, abundance-based control rule governing harvest based on biological reference points. This rule must include:

2.2.1.1: A target reference point for biomass or escapement ≥ maximum sustainable yield (e.g., BMSY or SMSY) or a reliable substitute.

2.2.1.2: A limit reference point that requires suspension of directed harvest when escapement in the target stock falls below a minimum threshold.

2.2.1.3: Stepped reductions in exploitation rate or harvest rate to protect spawning potential when escapement declines from the target and approaches the limit reference points.

2.2.1.4: Harvest policy must protect weak populations, e.g., via abundance-driven exploitation-rate caps or other measures designed to preserve spawning potential of vulnerable stocks.

Indicator 2.2.2: Uncertainty → Precaution. As with exploitation rules, management policy protects spawning potential from errors and uncertainties in key management data (such as run-size forecasts, exploitation rates, survival and escapement), by implementing precautionary harvest control rules and in-season adjustments in allowable catch and/or fishing practices (e.g., to selectively avoid impacts on lower-than-expected runs, while targeting healthy stocks).

Indicator 2.2.3: Compliance. Both fishery managers and fishers implement applicable escapement protections, e.g., catch reductions, closures, and selective fishing requirements to protect spawning biomass of target and non-target populations.

Indicator 2.2.4: Timely Action. In terminal and near-terminal area fisheries, managers adjust harvest rules in-season when necessary to prevent the fishery from causing or contributing significantly to any failure to meet escapement goals for target and non-target stocks.

RATING GUIDELINES FOR STOCK RISK: BIOMASS

A: Fishery satisfies indicators 2.2.1 through 2.2.4 with moderate to high confidence. *Allowance: Partial satisfaction of two requirements may qualify, provided that improvements are undertaken to correct the shortfall within the next five assessment periods.*

B: Moderate confidence that available data satisfy all the requirements in indicators 2.2.1 through 2.2.4. *Allowance: Partial satisfaction of up to three requirements may qualify, provided that improvements are undertaken to address the shortfall within the next five assessment periods.*

C: Available data fail to satisfy three or more conditions in indicators 2.2.1 through 2.2.4.

Tribal salmon fishing *Photo: NWIFC*

2.3 Hatcheries. Hatcheries and enhancement programs underpinning the fishery use recognized best practices to avoid or mitigate impacts on naturally spawning fish.

Before identifying indicators on this subject, some background may be helpful. Modern civilization has wrecked so much habitat—especially in rivers and estuaries—that hatcheries are now tasked to do nature's work in raising young salmon. For better or worse, they now provide 75% of the catch in Puget Sound, 90% in the Columbia River (WDFW 2011), and most of the Chinook available to SRKW in much of their range. The job of replacing nature's damaged spawning and nursery grounds with engineered fish-rearing systems has been problematic. Possibly the best news in this story is not merely that lessons are being learned, but that open, vigorous debates continue about exactly what those lessons tell us to do.

Best practice guidance on hatchery management is an evolving and (perhaps usefully) contentious subject. Despite broad areas of agreement, expert views diverge on the benefits and risks of hatchery propagation, and exchanges among these camps can be fierce. These debates reflect disagreements about how to balance multiple, competing mandates and goals for hatcheries.

One of those goals now is to make fish for whales to eat. This is easier said than done. Consider this recommendation from Washington State's Southern Resident Killer Whale Task Force, which Gov. Inslee convened to tackle the crisis facing the whales: "Significantly increase hatchery production and programs to benefit Southern Resident orcas *consistent with sustainable fisheries and stock management, available habitat, recovery plans, and the Endangered Species Act*" (Italics added) (SRKW Task Force 2019). That mouthful of conditions and constraints gives a hint of the balancing act that tribal, state, and federal resource managers now face. Making more salmon just isn't as simple as turning a spigot.

Such contention over hatcheries is perhaps inevitable when so much hinges on our beliefs about the role of humans in nature. Is it possible for hatcheries to tightly limit risks such as erosion of genetic fitness in neighboring populations, competition with wild salmon for food and habitat, predation on young wild fish, and unsustainable "mining" of wild stocks for broodstock? Is hatchery production, as some critics contend, fundamentally an arrogant blunder into nature's sacred work, an intrusion that should be halted? Or would shutting down hatcheries today just starve more killer whales, undercut the public's access to salmon, and thus collapse public support for the costly and essential work of recovering salmon populations after more than a century of degrading their habitats? Would cutting hatcheries also violate Indian tribes' treaty fishing rights now that our damaged rivers can no longer produce abundant salmon? Are human beings wise enough to responsibly boost abundance while protecting neighboring salmon populations?

Decades of debate have not laid these questions to rest, and perhaps that is for the best. When pat answers fail, we are left standing on hot, uncomfortable ground. That can help keep us alert to the risks we have taken on and awake to the cascade of ecological changes we now must learn to manage.

In the Pacific Northwest, three sources of guidance for hatcheries are particularly influential:

1. Hatchery and Genetic Management Plans (HGMPs) are the main official guidance documents for most hatcheries. They are produced by federal, state, and tribal resource management agencies as a tool for compliance with conservation laws, notably the Endangered Species Act (ESA). Salmon hatcheries operating in regions that have endangered or threatened populations now face heightened scrutiny to get permits under the ESA. As the agency responsible for salmon protected under this act, NOAA has pressed hatchery operators to demonstrate that precautions are adequate. Most hatchery managers now embrace many of the practices advocated by their critics.

2. Guidance from the Hatchery Scientific Review Group (HSRG), a long-running hatchery reform consortium, has also migrated toward middle ground with operators of salmon enhancement facilities. HSRG has recognized evolving practices in hatcheries, notably articulating a framework for benchmarking hatchery performance at different stages of salmon recovery (HSRG 2015). By 2018, 88% of hatchery programs in Washington were consistent with HSRG's recommendations, according to the Governor's Salmon Recovery Office (2018).

3. Washington Department of Fish and Wildlife (WDFW) is updating its policy on hatchery and fishery reform, partly in response to the crisis facing endangered Southern Residents (WDFW 2020a). The department operates more than 60 hatcheries, the largest "fleet" of salmon enhancement facilities in North America, so its recommendations could have considerable reach. The state Fish and Wildlife Commission, which oversees the agency, called for this policy review and update in 2018. The Commission also suspended three of its hatchery reform standards "to allow for some flexibility in hatchery production for Southern Resident Killer Whales while still providing adequate protection for wild fish." Meanwhile, the agency's 2020 review of hatchery reform science (WDFW 2020b) provides recommendations that may be applicable to some hatcheries.

In addition to these three sources, other US states, tribes, and Canadian agencies publish their own policy recommendation and guidance documents. Washington State treaty tribes run 51 hatcheries, making them the region's second-largest producers of salmon fry.

A buyer seeking to source salmon in good conscience need not be paralyzed by this polyphony of hatchery policies. The main sources of guidance share a primary focus: to minimize potential for hatcheries to harm neighboring stocks of naturally spawning salmon. Here, we attempt to distill the main principles into a few indicators. Those interested in the technical details may reference the hatchery provisions provided under Knowledge Risk, in the next section of this report.

> **Indicator 2.3.1: Hatchery Management.** Hatcheries supplying the harvest follow current best practice guidance (e.g., HGMPs, latest WDFW or tribal guidance, or other applicable best practices) to mitigate hatchery risks to neighboring salmon populations.
>
> **Indicator 2.3.2: All-H Integration.** Harvested fish come from hatchery programs whose management objectives include integrating hatchery, harvest, habitat, and (where applicable) hydroelectric operations in order to limit unintended impacts on neighboring populations and support recovery.
>
> **Indicator 2.3.3: Uncertainty → Precaution.** Hatchery managers respond with precaution to errors and uncertainties in key management parameters, e.g., indications of increased genetic and ecological impacts on neighboring stocks.

RATING GUIDELINES FOR STOCK RISK: HATCHERIES

A: Hatcheries supporting the catch meet the conditions in indicators 2.3.1 through 2.3.3 with moderate to high confidence. *Allowance: At the discretion of fishery evaluators applying this standard, partial satisfaction of one indicator may qualify, provided that improvements are under way to correct the shortfall and completion is expected within the next five assessment periods.*

B: Moderate confidence that available data satisfy all the conditions in indicators 2.3.1 through 2.3.3. *At the discretion of fishery evaluators applying this standard, partial satisfaction of one indicator may qualify, provided that improvements are underway to correct the shortfall and completion is expected within the next five assessment periods.*

C: Available data fail to satisfy two or more conditions in indicators 2.3.1 through 2.3.3.

3. Knowledge Risk

Incomplete knowledge is a universal challenge in conservation of fish and marine mammal populations. Fishery scientists and policymakers have evolved multiple approaches for limiting risks that can result from uncertainty and errors in available data. The standards, indicators, and rating guidelines below are built on that foundation. They are designed to provide metrics for precautionary sourcing of Chinook salmon while protecting prey supplies for SRKW.

3.1 Knowledge Risk for Interception.

Available data provide a high level of confidence (80%) that the fishery effectively targets Chinook that would not otherwise be available as prey to SRKW, or that it has only negligible impact (<2%) on availability of Chinook from identified priority prey stocks. Like the interception risk assessments, indicators to evaluate knowledge risk for interception falls into three categories of indicators: no overlap, post-prey, and negligible effect.

3.1.1 No overlap.

These indicators define requirements for evidence to show that certain fisheries catching Chinook far from the range of SRKW and their priority prey (e.g., in parts of Alaska) achieve zero or negligible impact on Chinook that otherwise could be available to Southern Residents.

> **Indicator 3.1.1.1:** This indicator sets two evidence requirements. First, the fishery must be documented to occur outside of SRKW range as defined by NOAA in the agency's latest reports to inform SRKW Critical Habitat designation. For example, Fig. 2 in the 2019 draft biological report on designation of critical habitat (NOAA Fisheries 2019b) shows distribution of SRKW observations from Southeast Alaska to Monterey Bay. Second, the fishery must occur in waters where at least 10 years of coded wire tag (CWT) data from fishery-independent tag studies, and/or genetic stock identification (GSI) data show no record of Chinook from stocks identified as priority prey for SRKW.
>
> **Indicator 3.1.1.2:** This indicator sets three conditions that must be met to show that the harvest tightly controls overlap-related risk that varies with temperature. First, the fishery location must be remote from SRKW range (as defined in 3.1.1.1 above). Second, stock composition data spanning at least a decade must indicate with high confidence (≥80%) that catch of Chinook from runs originating within the SRKW range is rare (≤5%) at cool or normal temperatures, but can increase during prolonged marine heatwaves (i.e., "the Blob"). Third, thermal records must indicate that cool or normal sea surface temperatures prevail during the harvest season and the preceding spring.

3.1.2 Post-Prey.

Indicators 3.1.2.1 and 3.1.2.2 define requirements for evidence to demonstrate that Chinook caught in or near certain "terminal areas"—on their final approach to their home streams or hatcheries—have already escaped from SRKW foraging grounds.

> **Indicator 3.1.2.1:** This indicator sets two requirements for evidence to show that the catch consists of Chinook that have already escaped from SRKW foraging grounds. First, the fishery must be clearly documented to occur in terminal or near-terminal waters (where adult fish are approaching a hatchery or upstream spawning area), as documented in regulatory maps and fishing rules. Second, catch composition data must show with high confidence (≥80%) that at least 90% of Chinook encountered are local fish returning to

upstream spawning grounds or hatcheries. This determination may be based on time-series data from tagging, marking (e.g., clipped adipose fins on hatchery fish), genetic techniques, or other rigorous methods.

Indicator 3.1.2.2: This indicator sets two evidence requirements: First, geographically, the fishery must be documented to occur within SRKW range, in waters that NOAA (e.g., in SRKW Critical Habitat designation reports) specifically excludes from its habitat designation, e.g., due to absence of confirmed observations of these whales (as in Hood Canal). Second, available data must show with high confidence (≥80%) that at least 90% of Chinook caught are fish returning to spawning grounds or hatcheries within that area, indicating that these fish have escaped from SRKW foraging grounds.

3.1.3 Negligible Effect. Indicator 3.1.3.1 defines evidence required to meet a precautionary standard for fisheries where Chinook from multiple stocks mix in marine waters.

Indicator 3.1.3.1: This indicator is applicable to Chinook caught in mixed-stock marine fisheries. It requires data sufficient to provide high confidence (≥80%) that the fishery has negligible impact (≤2%) on marine abundance of adult Chinook from stocks identified as priority prey for SRKW. In many cases, current data from coded wire tag analysis may not provide this level of confidence. However, genetic stock identification in some cases does provide high confidence in tracing origin of salmon; improvements in CWT model capabilities are also under discussion. The "negligible effect" threshold may also be applied to other fisheries, for example in "no-overlap" areas in the event that Chinook from southern waters begin to stray into their remote Alaskan waters, and "post-prey" fisheries if SRKW begin to enter their waters.

RATING GUIDELINES FOR KNOWLEDGE OF INTERCEPTION RISK

A: To meet the precautionary requirements of this standard, at least one indicator above must be satisfied, providing high confidence that a fishery either avoids intercepting Chinook from priority prey stocks, or that any removals meet the ≤2% test for negligible impact.

B: Not applicable. High certainty of zero or near zero risk is required.

C: Not applicable. High certainty of zero or near zero risk is required.

3.2 Knowledge of Stock Risk.

3.2.1 Exploitation. Available data provide evidence that fishery does not deplete SRKW prey supply and complies with conservation limits to protect Endangered, Threatened, or Protected (ETP) species.

Indicator 3.2.1.1: Exploitation Rate. Available time-series data must be sufficient to quantify the degree of compliance with applicable conservation limits on exploitation rates both for target and non-target species. In Chinook salmon fisheries, applicable limits frequently are found in rebuilding exploitation rates set under the Endangered Species Act, harvest constraints in co-management agreements, or in published pre-season and in-season fishery regulations.

Indicator 3.2.1.2: Reference Points. This indicator requires that managers have sufficient information to achieve two aims: (1) to estimate biological reference points for exploitation based on maximum sustainable yield or a reliable substitute, in order to guide exploitation rate policies; and (2) to assess whether current exploitation rate limits are conservative enough to protect the population. Data to inform this evaluation will vary by fishery, but typically will be found in Fishery Management Plans, technical reports from agency and tribal managers, co-management agreements, and proceedings and minutes of management science meetings.

Indicator 3.2.1.3: **Uncertainty and Error**. This indicator sets two requirements: (1) routinely collected data must be sufficient to enable managers to identify and respond to errors and uncertainties (e.g., in estimates of run size, escapement, survival rate, harvest rate etc.) by implementing precautionary policies to constrain any potential harm to target and non-target stocks; and (2) regular, public evaluations by scientists provide checks on errors and uncertainties.

Indicator 3.2.1.4: Compliance. Fishery monitoring data must be sufficient to discern levels of compliance both by fishery managers and by fishers with policies limiting exploitation rate in the fishery.

Indicator 3.2.1.5: Timely Action. For fisheries in terminal and near-terminal areas, monitoring of harvest impacts must be complete and timely enough to support rapid response to unexpected changes in the number of returning adult fish in target and non-target runs and any incidentally encountered species. In short, monitoring must be able to rapidly compare fishery performance against the applicable target and limit reference points for exploitation and/or escapement, and applicable limits on impacts on non-target species.

Indicator 3.2.1.6: ETP Species. Available data from monitoring or publicly available research must be sufficient to show whether incidental take of ETP populations, if any, complies with applicable conservation requirements in law, management agreements, and regulations.

RATING GUIDELINES FOR KNOWLEDGE OF STOCK RISK: EXPLOITATION

A: Available data satisfy all the conditions in indicators 3.2.1.1 through 3.2.1.5 with moderate (≥60%) to high (≥80%) confidence, and indicator 3.2.1.6 with high confidence. *Allowance: Partial satisfaction of one condition from indicators 3.2.1.1 through 3.2.1.5 may qualify, provided that improvements are undertaken to correct the shortfall within the next five assessment periods for this standard.*

B: Moderate confidence (≥60%) that available data satisfy all the requirements in indicators 3.2.1.1 through 3.2.1.5, and indicator 3.2.1.6 with high confidence. *Allowance: Partial satisfaction of up to two conditions may qualify, provided that improvements are undertaken to address the shortfall within the next five assessment periods for this standard.*

C: Available data fail to satisfy three or more requirements in indicators 3.2.1.1 through 3.2.1.6.

Purse seining salmon in Alaska Photo: ADFG

3.2.2: Biomass Risk. Available data allows managers to reliably monitor escapement of target and non-target salmon, so that harvest rates can be reduced when necessary to protect spawning biomass, and fishing can be halted or modified if necessary when biomass falls below any minimum stock size thresholds.

Indicator 3.2.2.1: Monitoring. Available monitoring data must produce reliable in-season estimates of run size, harvest, and escapement for target and non-target stocks, sufficient to evaluate performance against escapement goals, any applicable biomass target and limit reference points (e.g., BMSY or proxy), and any applicable conservation limits in law, regulations, and management agreements.

Indicator 3.2.2.2: Reference Points. This indicator requires that stock dynamics are sufficiently understood to enable managers to estimate a target reference point for biomass or escapement producing maximum sustainable yield (BMSY, SMSY) or a reliable substitute, as well as "step down" reference points for abundance-based harvest control rules (these are rules that require reduced exploitation rate when abundance falls below its target level, and cessation of fishing if run size or escapement falls below a minimum stock-size threshold).

Indicator 3.2.2.3: Uncertainty → Precaution. Managers must have adequate monitoring data to guide precautionary responses to errors and uncertainties in spawning escapement estimates. This capacity can be important when environmental change or unforeseen human actions alter survival, growth rate, reproductive success, or pre-spawn mortality in adult Chinook, in some cases even after they have escaped fisheries.

Indicator 3.2.2.4: Compliance. Monitoring data must be sufficient to distinguish level of compliance both by fishery managers and by fishers with escapement targets and limits.

Indicator 3.2.2.5: Timely Action. Monitoring of run size, harvest, and escapement support rapid response capability, enabling managers to adjust harvest rules in-season when necessary to meet applicable conservation limits. And, at minimum, available data give managers timely information required to prevent fishing-induced violations of recovery exploitation limits on listed salmon stocks.

RATING GUIDELINES FOR KNOWLEDGE OF STOCK RISK: BIOMASS

A: Available data satisfy all the conditions in indicators 3.2.2.1 through 3.2.2.5 with moderate (≥60%) to high confidence (≥80%). *Allowance: Partial satisfaction of one condition may qualify, provided that improvements are undertaken to correct the shortfall within the next five assessment periods under this standard.*

B: Moderate confidence that available data satisfy all the requirements in indicators 3.2.2.1 through 3.2.2.5. *Allowance: Partial satisfaction of up to two requirements may qualify, provided that improvements are undertaken to address the shortfall within the next five assessment periods.*

C: Available data fail to satisfy three or more conditions in indicators 3.2.2.1 through 3.2.2.5.

3.2.3: Hatcheries. Available data must be sufficient to show whether hatcheries and enhancement programs supporting the fishery use best practices to avoid or mitigate impacts on naturally spawning fish.

Indicator 3.2.3.1: **Hatchery Management.** Hatcheries supplying Chinook must be reliably documented to follow current best practice guidance under any applicable Hatchery and Genetic Management Plans (HGMPs), and any applicable federal, tribal, or state guidelines for mitigation of risks to naturally spawning salmon.

Indicator 3.2.3.2: Monitoring. Hatchery program must monitor and disclose metrics for potential genetic and ecological harm to neighboring salmon stocks, demonstrating compliance with requirements of HGMPs and other applicable legal requirements. In general, this monitoring tracks at least the following parameters: stray rates, gene flow, and ecological interaction monitoring to demonstrate performance against hatchery-specific targets for protecting genetic and ecological resilience of neighboring salmon populations; proportion of hatchery fish on spawning grounds; number, size, age, and timing of fish released (to assess compliance with guidelines for control of straying, predation, and competition with naturally spawned fish); documenting compliance with broodstock collection protocols; and monitoring operating conditions to protect water quality, avoid trapping fish swimming past the facility, and avoid potential to spread disease.

Indicator 3.2.3.3: Hatchery Marking and Tagging. Available documents on hatchery performance must show extent and form of marking and tagging practices, (CWT, genetic parentage-based tagging, fin-clipping, etc.) and their use to support conservation, e.g., via harvest selectivity, stock identification, and identifying origin of hatchery strays.

Indicator 3.2.3.4: **Uncertainty → Precaution.** Public data and documents must demonstrate precautionary response by managers to uncertainties and errors encountered in hatchery operations, including changes in hatchery practices to improve the "All-H" integration (harvest, hatchery, habitat, and where applicable, hydroelectric operations), and avoid impairment of recovery in depleted natural Chinook populations.

RATING GUIDELINES FOR KNOWLEDGE OF STOCK RISK: HATCHERIES

A: Available data documents comprehensive activities that satisfy indicators 3.2.3.1 through 3.2.3.4, including monitoring of all parameters listed under each indicator.

B: Available data satisfy all the conditions in indicators 3.2.3.1 through 3.2.3.4 but monitoring of up to three recommended parameters in the subcomponents cannot be confirmed.

C: Available data fail to confirm monitoring of 4+ parameters noted in subcomponents of indicators 3.2.3.1 through 3.2.3.3.

Glossary

ADFG	Alaska Department of Fish and Game.
All-H	The term used to reference hydropower, hatcheries, harvest, and habitat, four variables that are important to the health of Chinook salmon populations.
Biomass	Biomass refers to a standing stock of fish. It is a common shorthand for spawning biomass, or breeding-age fish, used as an indicator of reproductive potential.
BMSY	Estimate of Biomass (B) associated with maximum sustainable yield (MSY).
CTC	Chinook Technical Committee, a scientific advisory body to the US–Canada Pacific Salmon Commission.
CWT	Coded Wire Tags.
ESA	Endangered Species Act.
Escapement	Portion of population not caught by fisheries, returning to spawning grounds.
ETP	Endangered, Threatened, or Protected, referring to species listed under the Endangered Species Act or protected under other laws.
Exploitation Rate	Proportion of population removed by fishing.
FMSY	Level of fishing mortality (F) calculated to produce maximum sustained yield (MSY).
FRAM	Fishery Regulation Assessment Model.
Gene Flow	Exchange of genetics between hatchery and natural populations.
GSI	Genetic Stock Identification.
Harvest Rate	Proportion of returning salmon caught (similar to exploitation rate). It is also sometimes used to describe the speed of harvest.
HGMP	Hatchery and Genetic Management Plan.
HSRG	Hatchery Scientific Review Group, a hatchery reform panel established by Congress in 2000, influential in salmon enhancement policy.

Limit Reference Point	A predetermined threshold on exploitation or biomass used in fishery management plans, typically requiring immediate action to reduce or halt fishing.
Mixed-Stock Fishery	A fishery harvesting stocks from multiple populations.
MSST	Minimum Stock Size Threshold, a "floor" level of biomass or abundance, below which management policies typically restrict or halt fishing.
MSY	Maximum Sustainable Yield, the largest average catch or yield that can be continuously harvested under existing environmental conditions. Estimated from surplus production models, MSY levels of biomass and fishing mortality have well-known shortcomings, but MSY remains a central (and difficult-to-replace) tool for guiding harvest limits worldwide.
Northern Fisheries	In Pacific US Northwest salmon management, typically refers to fisheries in Alaska and British Columbia.
NWIFC	Northwest Indian Fisheries Commission.
Parentage-Based Tagging	A non-invasive tagging approach that genetically samples parent fish to assign origins to their offspring encountered later. Used to monitor genetic origin of strays, escapement, and survival contribution to various fisheries.
PNI	Proportionate Natural Influence, a measure of natural spawning fish vs. hatchery-origin fish in a population.
pHOS	Proportion of Hatchery-Origin Spawners, indicating percent of naturally spawning fish that are hatchery-origin.
pNOB	Proportion of Natural-Origin Broodstock used in hatchery.
Run Size Forecast	An estimate of the number of salmon returning to river of origin.
SMSY	Level of escapement (S) estimated to produce maximum sustained yield (MSY) over the long term.
Southern Resident	Southern Resident Killer Whale.
SRKW	Southern Resident Killer Whale(s).
Stock Composition Analysis	Estimate of contributions to harvest from identified stocks of salmon.
SUS	Southern US, shorthand for fisheries occurring south of Canadian border.

Target Reference Point	A target level usually for biomass or exploitation, often constructed in relation to MSY.
Terminal Area	An area typically near a river mouth or hatchery where adult salmon approach the "terminus" of their ocean migration. In such areas, returning adult salmon may be selectively caught.
WDFW	Washington Department of Fish & Wildlife.

References

Governor's Salmon Recovery Office 2018. State of Salmon in Watersheds 2018. Governor's Salmon Recovery Office. https://stateofsalmon.wa.gov

HSRG 2015. Annual Report to Congress On the Science of Hatcheries: A report on the application of up-to-date science in the management of salmon and steelhead in the Pacific Northwest. A. Appleby, H.L. Blankenship, D. Campton, K. Currens, T. Evelyn, D. Fast, T. Flagg, J. Gislason, P. Kline, C. Mahnken, B. Missildine, L. Mobrand, G. Nandor, P. Paquet, S. Patterson, L. Seeb, S. Smith, and K. Warheit. Hatchery Scientific Review Group, July 2015.

NMFS and WDFW 2018. Southern Resident Killer Whale Priority Chinook Stocks Report, NOAA Fisheries West Coast Region and Washington Department of Fish and Wildlife, June 22, 2018. https://archive.fisheries.noaa.gov/wcr/publications/protected_species/marine_mammals/killer_whales/recovery/srkw_priority_chinook_stocks_conceptual_model_report__list_22june2018.pdf

NOAA Fisheries 2019a. 2019 Draft Biological Report on Designation of Critical Habitat for the Southern Resident Killer Whale, https://www.fisheries.noaa.gov/action/critical-habitat-southern-resident-killer-whale

SRKW Task Force 2019. Final Report and Recommendations, November 2019, Washington State Southern Resident Killer Whale Task Force (with staff support from Cascadia Consulting Group). https://www.governor.wa.gov/sites/default/files/OrcaTaskForce_FinalReportandRecommendations_11.07.19.pdf

WDFW 2011. WDFW Hatcheries—Overview. Washington Department of Fish and Wildlife Website, originally published 2011. https://fortress.wa.gov/dfw/score/score/hatcheries/hatcheries.jsp

WDFW 2020a. Hatchery and fishery reform policy and scientific review. Washington Department of Fish and Wildlife website updated 2020. https://wdfw.wa.gov/fishing/management/hatcheries/hatchery-reform-policy-review#faqs

WDFW 2020b. Anderson, JH, KI Warheit, BE Craig, TR Seamons and AH Haukenes, A review of hatchery reform science in Washington State, Washington Department of Fish and Wildlife, Final Report to the Washington Fish and Wildlife Commission, Jan 23, 2020. https://wdfw.wa.gov/sites/default/files/publications/02121/wdfw02121_0.pdf