Product Sustainability Standard: Seafood

Chinook Fishery Evaluations

Version 1.0: August 2020

The following evaluation reports were researched and composed by experts at the National Fisheries Conservation Center (NFCC) to identify acceptable sources of Chinook salmon for PCC Community Markets. Depending upon the season, availability, and quality of product you may find Chinook salmon from one of more of these fisheries in our Meat and Seafood Department.

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, and an A for interception risk.

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Chinook Salmon Fishery Evaluation

Bristol Bay Nushagak

May 26, 2020

2020 Evaluation: Passed **Overall Rating: A**

Fishery Overview:

The Nushagak fishery produces about 80% of Bristol Bay's annual Chinook harvest. This fishery is actively managed to conserve Chinook while these fish are running, enabling high confidence in management science supporting sustainability in the Nushagak harvest. Detailed findings on this fishery's performance against each relevant standard and indicator are contained in the attached supplemental evaluation report, along with full references.

Evaluation Summary:

The Nushagak Chinook fishery on Bristol Bay earns the A rating based on findings that: 1) prey interception risk, exploitation risk, and biomass risk are managed at levels that satisfy standards and indicators underpinning this rating for each category; and 2) knowledge risk for each standard and indicator is constrained sufficiently to produce the necessary confidence in data.

Note that no hatcheries operate on Bristol Bay, so hatchery risk and knowledge of hatchery risk are inapplicable in this case.

Evaluation Chart:

	Findings	Rating	Notes
1. Prey Interception Risk		**A**	
1.1 No Overlap	All indicators met.	A	Fishery is remote from SRKW prey range. Data indicate no sign that Chinook from Southern U.S. or B.C. are caught in Bristol Bay's salmon fisheries.
Indicator 1.1.1			
Indicator 1.1.2			
1.2 Post-Prey			
Indicator 1.2.1			
Indicator 1.2.2			
1.3 Negligible Effect			
Indicator 1.3.1			
2. Stock Risk		**A**	
2.1 Exploitation	All indicators met.	A	Allowing enough fish to escape harvest and swim up to spawning grounds is the primary tool for ensuring control of exploitation rate and protection of spawning biomass. Bristol Bay salmon managers use multiple tools and practices to detect and quickly respond to variations in run strength and catch in order to protect escapement.
Indicator 2.1.1: Exploitation Rate			
Indicator 2.1.2: Reference Points			
Indicator 2.1.3: ETP Species			
Indicator 2.1.4: Uncertainty → Precaution			
Indicator 2.1.5: Compliance			
Indicator 2.1.6: Timely Action			
2.2 Biomass		A	
Indicator 2.2.1: Reference Points			
Indicator 2.2.2: Uncertainty → Precaution			
Indicator 2.2.3: Compliance			
Indicator 2.2.4: Timely Action			
2.3 Hatcheries			
Indicator 2.3.1: Hatchery Management			
Indicator 2.3.2: All-H Integration			
Indicator 2.3.3: Uncertainty → Precaution			
3. Knowledge Risk		**A**	
3.1 Knowledge Risk for Interception			
3.1.1 No Overlap	Indicators met.	A	
Indicator 3.1.1.1			Risk of intercepting SRKW prey is well documented to approximate zero.
Indicator 3.1.1.2			

		3.1.2 Post Prey			
		Indicator 3.1.2.1			
		Indicator 3.1.2.2			
		3.1.3 Negligible Effect			
		Indicator 3.1.3.1			
	3.2 Knowledge of Stock Risk				
		3.2.1 Exploitation	All indicators met with moderate to high confidence.	A	Management of fishery incorporates: 1) multiple data sources to monitor run size, harvest, escapement and other management parameters; 2) review of monitoring methods (includes focus on reducing errors/uncertainty); 3) regular and publicly available reviews of escapement goals.
		Indicator 3.2.1.1: Exploitation rate			
		Indicator 3.2.1.2: Reference points			
		Indicator 3.2.1.3: Uncertainty and Error			
		Indicator 3.2.1.4: Compliance			
		Indicator 3.2.1.5: Timely Action			
		Indicator 3.2.1.6: ETP Species			
		3.2.2 Biomass	All indicators met with moderate to high confidence.	A	
		Indicator 3.2.2.1: Monitoring			
		Indicator 3.2.2.2: Reference Points			
		Indicator 3.2.2.3: Uncertainty → Precaution			
		Indicator 3.2.2.4: Compliance			
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		Indicator 3.2.3.1: Hatchery management			
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		Indicator 3.2.3.4: Uncertainty → Precaution			

Note: Any lines or sections left blank with greyed text are considered not applicable to the specific fishery under evaluation.

Evaluation Details and Notes:

1. Prey Interception Risk (No Overlap)

Bristol Bay is remote from the range of SRKW and their known Chinook prey, and data from multiple sources indicate no sign that Chinook salmon from the Southern U.S. or British Columbia are caught in Bristol Bay's salmon fisheries.

Salmon tags collected over decades and two fishery-independent studies indicate that Chinook salmon from the range of SRKW do pass into the Bering Sea, but they pass far to the west of the Bristol Bay salmon fisheries. Future climate change could alter this migratory pattern, but for now it is a refuge from SRKW concerns.

2. Stock Risk: Exploitation and Biomass

Allowing enough fish to escape harvest and swim up to spawning grounds is the primary tool for ensuring adequate control of exploitation rate and protection of adequate spawning biomass.

Nushagak Chinook escapement met or exceeded its goal in all but one year from 1975 to 2017**.** That amounts to a record of compliance with limits on exploitation in more than 97.3% of years. (Source: ADFG website, http://www.adfg.alaska.gov/index.cfm?adfg=chinookinitiative_nushagak.historical

Reference points for catch and spawning biomass, precautionary response, and terminal harvest adjustments are satisfied by Alaska Department of Fish and Game's (ADFG) use of maximum-sustained-yield (MSY)-based escapement goals, regular scientific review of those goals, and cautious in-season harvest management.

Notes on Rating and Conditions:

- Potential future increases in harvest rates on Nushagak River Chinook salmon could introduce greater risks to the stock, especially if the population continues to trend downward. Further shortfalls in spawning escapement may become more likely as more complete enumeration of fish swimming upriver leads to the reduction or elimination of a "buffer" of adult Chinook that previously swam undetected past sonar counting stations.
- The lack of systematic scientific observations of fishery interactions with protected species (especially seabirds and cetaceans) has posed little risk in the past. This risk may rise in future as warming alters the distribution and behavior of many species.
- The harvest is managed to achieve escapement at 90-100% of MSY. A target that can dip below MSY places increased burdens on managers' ability to predict stock productivity, protect spawners when a run falls short of expectations, and resist political pressure to increase harvest rates. To date managers have met these challenges with multiple precautionary measures to protect the health of the stock, so we recommend a pass on this point for now. However, performance of this fishery should be closely monitored in the future, especially in light of the long-term decline of Chinook throughout their range.

3. Knowledge Risk

Knowledge of Prey Interception Risk

Strong evidence indicates near-zero probability of catching Chinook prey of SRKW in the Nushagak fishery. Decades of Coded Wire Tag (CWT) data and two independent satellite-tagging studies show no record of southern Chinook stocks entering this fishery or nearby waters.

Note on Rating: Warming oceans and increasing incidence of hot water "Blob" events in the North Pacific are shifting the distribution of many species. Although no interactions have been documented in this fishery, we recommend that future evaluations review available data on southern Chinook movements in the Bering Sea, especially during periods of unusually high temperature.

Knowledge of Stock Risk (Exploitation and Biomass)

Management of Bristol Bay's Nushagak Chinook fishery incorporates: 1) multiple data sources to monitor run size, harvest, escapement and other management parameters; 2) regular and rigorous reviews of monitoring methods, including systematic research to identify and reduce errors and uncertainties; 3) regular and publicly available reviews of escapement goals that incorporate lessons from the reviews and research described above.

ADFG managers and scientists conduct regular and rigorous review of escapement goals and uncertainties and errors in data. Escapement goals are based on standard S/R model estimates of escapement sufficient to achieve long-term MSY. Escapement targets effectively govern exploitation and guide conservation of spawning biomass.

> *Note on exploitation and spawning biomass reference points:* The policy setting the escapement goal range at 90-100% of MSY level may result in increased risk during periods of declining abundance— a trend that is visible in recent data for this fishery. Risk to the stock may also be elevated by improving escapement estimates, reducing an inadvertent but longstanding "buffer" of undercounted escapement. Climate change may also elevate risk to the stock.

Managers have access to multiple data sources to forecast and track changes in run size, track harvest rates based on rapid and accurate catch reports, and assess escapement during the annual fishing season, enabling timely management action and achieving escapement goals in 43 out of the 44 years ending in 2017.

Entanglement of seabirds and cetaceans is believed to be rare, based on credible but anecdotal reports from experienced managers who have overseen the fishery for decades. Multiple measures including spatial closures are in place to limit potential disturbance of vulnerable walrus at summer haulouts.

> *Note on ETP species impacts*: Systematic, scientific documentation of interactions with seabirds and cetaceans have been a low priority because interactions have been rare. If interactions increase in the future, systematic data collection may become necessary.

Reliable, timely data from multiple sources give harvest managers a strong toolkit to identify and reduce uncertainties and errors and rapidly constrain harvests to protect or increase escapement. Well-documented measures to avoid disturbing walrus and the apparent rarity of interactions with cetaceans and seabirds indicate that risk to protected species is currently low.

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Chinook Salmon Fishery Evaluation

Columbia River

August 31, 2020

2020 Evaluation: Passed **Overall Rating:** A/B

Fishery Overview:

Three fisheries in the Columbia River provide Chinook salmon to retail consumers: Non-tribal fishers work in the mainstem river from Astoria to Bonneville Dam. Tribal fisheries operate upstream, between Bonneville and McNary Dam. Downstream near the river mouth, a small "Select Area" fishery operates in side-channels and bays off the main river channel, targeting Chinook returning to local hatcheries and avoiding fish bound upstream.

All three fisheries primarily use gillnets, fishing selectively under rigorous rules that control the times, locations, mesh sizes, and other practices to target healthy runs and avoid unsustainable harvests from weak runs.

The Columbia River is the largest historic producer of Chinook salmon in the world (NMFS 1991). Despite profound losses and harm to habitat over the last 150 years, the river, and its vast network of tributaries — a watershed larger than France — still yields substantial salmon runs. In early 2020, biologists forecast that for the year 2020, 1.2 million adult salmon of all species would swim home to the river after feeding in the ocean. Chinook make up the largest share of the return, swimming home in all four seasons. Among Chinook, the fall runs have been the most productive recently, returning an average of more than 737,000 fish annually between 2008 and 2018 (WDFW and ODFW 2019a).

The Endangered Species Act (ESA) has played a major role in rebuilding salmon populations in the Columbia. Since the early 1990s, 13 groups of Columbia Basin salmon and steelhead stocks have been listed as threatened or endangered under the ESA. Federal, state, and tribal resource management agencies have responded by tightening catch limits, regulating fishing and hatchery operations, and investing in habitat restoration and population enhancement efforts. They have made substantial headway in rebuilding many depleted populations despite rising mortalities that appear to be linked to climate change and other environmental pressures. Notably, sockeye and fall Chinook returning to the Columbia's largest tributary, the Snake River, have been salvaged from the brink of extinction, despite continuing threats from dams and other stressors.

The majority of Columbia Chinook originate from hatcheries, which proliferated as modern development ravaged the basin's natural spawning and rearing habitats (NMFS 2018). Hatcheries now produce 75% of the Columbia River spring Chinook returning to the river (and even more for some runs). Hatchery management has improved greatly in recent decades. The first hatcheries built on the Columbia during the late 19th Century were a haphazard attempt to offset damage from overfishing, unchecked development, and habitat degradation. Fish were transplanted and released with little awareness of local adaptation or the risks of ecological and genetic harm to wild populations. Though hatchery science is still evolving, NOAA's National Marine Fisheries Service (NMFS), along with state and tribal co-managers, has used its authorities under the ESA to drive comprehensive, ongoing scrutiny and improvement in hatchery practices.

Evaluation Summary:

Continuous public debate and review are built into management systems for the Columbia River, its fisheries, and the science informing them. The 20th Century conversion of North America's largest salmon producing river into its largest hydropower system left a legacy of contention among multiple, competing institutions and people. One result is that many of them now have a vested interest in the effectiveness of actions to restore and conserve fisheries. This makes for complex and cumbersome discourse, for example, creating many decentralized sources of data and analysis. It also helps to ensure a degree of rigor and transparency. Tribes, state and federal fisheries agencies, dam operators, industrial water and power users, utilities, irrigators, multiple fisheries stakeholders, and scientific experts now scrutinize and check each other's work on salmon in the Columbia Basin.

Spring Chinook salmon returning to the Columbia River constitute an important source of prey for Southern Resident Killer Whales, which are known to feed on returning adult fish off the coast of Oregon and Washington, notably during late winter and spring (NMFS 2018). However, fisheries in the Columbia River target Chinook that have already escaped from the whales' ocean foraging grounds and are no longer accessible to the whales.

Today Chinook harvests in the Columbia River are limited to levels well below replenishment from hatcheries and natural spawning fish. On average, fisheries in the river take less than 10% of natural-origin Chinook returning to the Columbia Basin; some 90.4% of all natural-origin Chinook that return to the river are protected from fishing. During 2008-2016, the total in-river catch of naturally spawning Chinook averaged about 6,900 fish annually, out of an average of 72,000 natural-origin Chinook returning to the river (NMFS 2018).

As a result, the main limiting factors on recovery of these populations now stem from broader environmental threats, such as climate change and habitat alteration. One major constraint on abundance is reduced smolt-to-adult survival in both hatchery and wild fish. What drives the poor survival? One factor is rising heat-induced mortality in the river: out of 475,000 adult sockeye salmon counted at Bonneville Dam, only 2% survived to their spawning grounds in the overheated upper river during 2015, (an exceptionally warm year). Biologists also point to shifting marine foodwebs and impairments of fish passage and habitat in the river basin (NMFS 2018). Nevertheless, a combination of tight harvest limits, hatchery production to offset fishery losses, and basin-wide salmon recovery efforts have been rebuilding salmon returns to the Columbia, and that trend is expected to continue. For fish-eating Southern Residents, the Chinook return produced by hatcheries alone "more than offsets" any diminishment of prey due to fishing in the river (NMFS 2018).

Several layers of precautionary policies limit catches to protect salmon populations in the Columbia. Abundance-based rules curtail harvest rates when fish return in low numbers. Under the ESA, strict impact limits on the weakest populations constrain harvests on abundant runs. Additional rules protect upriver tribal fishing rights and escapement. Taken together, these rules ensure that plenty of fish swim home to spawn and rebuild natural populations. Vigorous protection of escapement also provides a large buffer against other sources of mortality, such as increasing fish kills in an overheated river and tributaries (courtesy of climate change, dams, and water withdrawals).

Uncertainties and knowledge risks persist, but overall**,** Chinook fisheries in the Columbia River operate under precautionary, adaptive management. Fishing is tightly limited to avoid risks of stock depletion. Spawning potential is protected. Hatcheries now operate under rules that are intended to complement and support recovery efforts. Risks from climate change are increasing, and important areas of spawning and rearing habitat are still closed to fish passage by dams, roads, and other obstructions. Nonetheless, the catch of Chinook salmon in the Columbia River and the hatcheries that support it are managed to contribute to recovery and abundance of Chinook salmon.

Evaluation Chart:

	Findings	Rating	Notes
1. Prey Interception Risk		**A**	
1.1 No Overlap			
Indicator 1.1.1			
Indicator 1.1.2			
1.2 Post-Prey	Target Chinook are fish entering the Columbia River from the ocean.		Chinook harvested from in-river fisheries have escaped from ocean feeding grounds of SRKW. Chinook die after spawning, so they don't return to the ocean feeding grounds.
Indicator 1.2.1	Indicator met.		
Indicator 1.2.2			
1.3 Negligible Effect			
Indicator 1.3.1			
2. Stock Risk		**A / B**	
2.1 Exploitation	All indicators satisfied with moderate to high confidence.	A	With minor caveats, these in-river fisheries meet the central goal of our stock risk standards: to avoid depleting the salmon populations that provide the main prey supply for Southern Resident Killer Whales.
Indicator 2.1.1: Exploitation Rate			
Indicator 2.1.2: Reference Points			
Indicator 2.1.3: ETP Species			
Indicator 2.1.4: Uncertainty → Precaution			
Indicator 2.1.5: Compliance			
Indicator 2.1.6: Timely Action			
2.2 Biomass	All indicators satisfied with moderate to high confidence.	A	
Indicator 2.2.1: Reference Points			
Indicator 2.2.2: Uncertainty → Precaution			
Indicator 2.2.3: Compliance			
Indicator 2.2.4: Timely Action			
2.3 Hatcheries	Indicators satisfied with moderate confidence.	B	Hatchery management practices for Chinook have improved significantly since the early 1900s. Many changes are a result of federal actions to protect the 13 groups of Columbia River salmon and steelhead
Indicator 2.3.1: Hatchery Management			
Indicator 2.3.2: All-H Integration			
Indicator 2.3.3: Uncertainty → Precaution			

					populations listed under the Endangered Species Act.
3. Knowledge Risk				**A / B**	
	3.1 Knowledge Risk for Interception			A	
		3.1.1 No Overlap			
		Indicator 3.1.1.1			
		Indicator 3.1.1.2			
		3.1.2 Post Prey	In-river fisheries target fish that have passed SRKW feeding grounds in the ocean and close to the river mouth.		Whales travel along the coast and feed on fish in marine waters near the river mouth, but NOAA reports no confirmed sightings of SRKW in the river. Some transient killer whales do enter the lower river to hunt seals and sea lions, but the fish-eating Southern Residents are believed to stay in marine waters.
		Indicator 3.1.2.1	Met with high confidence.		
		Indicator 3.1.2.2			
		3.1.3 Negligible Effect			
		Indicator 3.1.3.1			
	3.2 Knowledge of Stock Risk				
		3.2.1 Exploitation	All indicators satisfied.	A	Estimates of run size, exploitation rate, and stock composition are subject to uncertainties that are recognized, evaluated, and mitigated through harvest control rules that result in very precautionary escapement levels.
		Indicator 3.2.1.1: Exploitation rate			
		Indicator 3.2.1.2: Reference points			
		Indicator 3.2.1.3: Uncertainty and Error			
		Indicator 3.2.1.4: Compliance			
		Indicator 3.2.1.5: Timely Action			
		Indicator 3.2.1.6: ETP Species			
		3.2.2 Biomass	All indicators satisfied.	A	
		Indicator 3.2.2.1: Monitoring			
		Indicator 3.2.2.2: Reference Points			
		Indicator 3.2.2.3: Uncertainty → Precaution			
		Indicator 3.2.2.4: Compliance			
		Indicator 3.2.2.5: Timely Action			
		3.2.3 Hatcheries	Indicators are satisfied with moderate confidence through compliance with hatchery management requirements.	B	NMFS Biological Opinions set conditions and requirements for hatchery operations. These constitute a far-reaching system of oversight and ongoing improvement in hatchery practice
		Indicator 3.2.3.1: Hatchery management			
		Indicator 3.2.3.2: Monitoring			

			Indicator 3.2.3.3: Hatchery Marking and Tagging			and policy. Uncertainties and scientific debate about long-term effects of hatchery and wild fish interactions remain, but hatcheries now are managed to contribute to harvest, salmon recovery, and ecosystem needs, to limit potential risks, and to support adaptive potential (e.g. preserving gene banks for wild fish, preventing extinction of critically depleted runs such as Snake River sockeye and fall Chinook).
			Indicator 3.2.3.4: Uncertainty → Precaution			

Note: Any lines or sections left blank with greyed text are considered not applicable to the specific fishery under evaluation.

Evaluation Details and Notes:

1. Prey Interception Risk (Post-Prey)

No additional details.

2. Stock Risk

Exploitation and Biomass Risk

Fisheries targeting Chinook salmon in the Columbia River today are tightly controlled, but external factors—notably climate change, impaired fish passage and degraded habitats—now constitute the main constraints on recovery. Fishery managers have warned repeatedly that even the most precautionary harvest controls cannot countermand climate impacts that erode productivity and survival in many salmon stocks. The peak years of the high-temperature ocean "Blob" in 2015 and 2016 produced "some of the poorest outmigration years for juvenile salmon survival in the 20-year time series" (NMFS 2018). Many salmon biologists and resource managers believe this event set the table for poor survival in fish swimming home in 2019 and 2020.

Degradation or damming of habitat often limits potential spawning populations in watersheds. In the Columbia's largest tributary, Snake River Chinook populations collapsed after a series of dams closed off about 80% of their spawning habitat. The current benchmark for recovery of spring/summer Chinook salmon is 25,500 fish reaching Lower Granite Dam. Variable ocean conditions such as the Pacific Decadal Oscillation and El Nino are well-known drivers of changes in abundance. Many scientists and managers also see an increasing influence from climate change, noting that heat spells, floods, and droughts are reducing productivity of both hatchery and wild salmon stocks.

The annual return of Snake River fall Chinook once numbered about half million fish. By 1990 the run had dwindled so far that only 78 fish reached the Lower Granite Dam on the Lower Snake River (CRITFC 2020). The run was listed as threatened in 1992. Since then tribes and state and federal fisheries agencies have labored to rebuild Snake River wild Chinook. Some progress has been made, despite continuing mortalities from dams, lingering impacts of the "Blob" at sea, and dangerously high river temperatures that can weaken and kill both young fish and returning adult fish during the summer and fall when flows are low (Martins et al 2011, Haskell et al 2017, Maier 2015). In 2019, 6,558 fall Chinook reached Lower Granite Dam, and returns since 2010 have mostly been well above that level (WDFW & ODFW 2020b).

Indicator: Exploitation

In-river fisheries operate under rules that keep exploitation rates well below levels that could deplete populations of naturally spawning fish (see discussion and tables below, under Reference Points). Low exploitation rates are primarily driven by measures to limit impacts on 13 groups of salmon populations that are listed under the Endangered Species Act (ESA).

Salmon hatcheries now supply the majority of Chinook salmon returning to the river. Some 80 artificial propagation facilities—mostly run by states, federal agencies, and tribes—release salmon and steelhead to help offset loss of spawning and nursery grounds caused by dams, developments, and other human activities. Hatcheries can pose their own risks, but fish supplied by hatcheries now play an integral role in reducing fishery exploitation rates on wild Chinook in the Columbia, and they increase prey supply for SRKW in the ocean (NMFS 2018).

The combined effects of hatcheries and harvest in the Columbia are scrutinized and regulated tightly under the Endangered Species Act (ESA). In a Biological Opinion (BiOp) evaluating tribal and non-tribal Columbia River fisheries (NMFS 2018), NOAA scientists considered potential effects of fishing on prey available to SRKW and potential for fishery-induced depletion of ESA-listed salmon populations in the basin. The BiOp authors stated that "we do not anticipate an effect on the Southern Resident killer whales' prey base from in-river harvest on hatchery Chinook salmon (i.e., the substantial majority of the catch)." Similarly, they noted that the in-river harvest of wild Chinook amounts to only a fraction of the adult fish hatcheries provide annually: about 81,000 per year. Hatchery production "more than offsets the reduction from harvest," the BiOp authors wrote.

Indicator: Reference Points

Management of Columbia River salmon, geared towards protection of weak stocks and ESA-listed populations, has resulted in several layers of reference points that are substantially more conservative than benchmarks based on Maximum Sustainable Yield (MSY). These include: 1) impact limits designed to protect threatened and endangered fish under ESA; 2) abundance-based harvest rate schedules that constrain exploitation rates in fisheries, mostly to protect listed fish; 3) escapement goals at counting stations in the basin, which seek both to protect harvest for upstream treaty tribes and to leave enough fish to spawn; and 4) rebuilding goals, which seek to increase depleted populations.

Abundance-based harvest control rules in the Columbia are implemented through harvest rate schedules. These schedules adjust the allowable catch based on indicators of abundance, setting thresholds for reducing or halting fishing. These schedules apply "weak stock management," a key tool of modern conservation practice in salmon fisheries that encounter different runs of salmon mingling in the water. Abundance of the most depleted natural runs (especially ESA-listed populations) effectively sets the brakes on exploitation rates for other fish that migrate up the river at the same time. This requires foregoing potential catch of healthier stocks in order to ensure enough fish from small runs escape from fisheries to rebuild those populations.

Harvest rates allowed to both treaty tribal and non-treaty (all-citizens) fisheries are adjusted as the run size fluctuates. Protections for Snake River stocks frequently limit harvests of other fish. At the low end, total harvest rate would be capped at 21.5% on all Upriver Bright (URB) Chinook stocks should the fall wild Chinook run entering the Snake River fall below 1,000 fish. At the high end, a run expected to exceed 8,000 fish at the mouth of the Snake could allow a catch of as much as 45% of returning URB fish. (Note: in practice, precautionary harvest management so far has kept the exploitation rate well below that maximum allowable level, even when escapement exceeds the 8,000-threshold.)

Escapement goals and recovery goals for listed stocks provide additional layers of protection for spawning capacity. Salmon returns in the Columbia as elsewhere are challenged by severe impacts of habitat degradation in watersheds and, more recently, high temperatures that are believed to reduce survival at sea and in rivers, e.g. by reducing feed quality in the ocean, especially during the warm "Blob" years in 2015 and 2016 (NMFS 2018). These conditions have made spawning escapement goals and recovery goals more challenging to attain. Nonetheless, state and tribal co-managers in the Columbia basin and authors of the NMFS 2018 Biological Opinion noted that many runs and hatcheries in the basin were meeting or exceeding these goals, in part due to major efforts to restore habitat and rebuild depleted runs.

Indicator: Endangered, Threatened, and Protected (ETP) Species

Southern Resident Killer Whales, 13 listed assemblages of salmon and steelhead, and two listed populations of sturgeon and eulachon are considered in recent NMFS Biological Opinions evaluating fishery effects on endangered, threatened, and protected (ETP) species under the ESA.

NMFS evaluated effects of Columbia River fisheries on all these stocks in its 2018 BiOp on the formal management agreement for Columbia River fisheries between tribes, states, and federal agencies. The U.S. Fish and Wildlife Service also prepared a Biological Opinion on listed freshwater species that could be affected by fisheries under that management agreement.

Authors of the 2018 NMFS BiOp judged that any effect of Columbia River salmon fisheries on prey available to the endangered SRKW is "more than offset" by hatchery production. They concluded that fisheries in the river are not likely to adversely impact SRKW, a standard that requires zero to near-zero effect. Having found no discernible impact, they also noted that the Columbia River fisheries are not likely to jeopardize the Southern Residents.

In contrast, the 2018 NMFS BiOp authors did find that fisheries were likely to adversely impact—but not to jeopardize—all 13 salmon and steelhead groups listed in the Columbia basin as well as listed green sturgeon and eulachon populations the river. Measures to reduce those impacts to acceptable levels are stipulated in the 2018 NMFS BiOp. Required measures include: use of best available monitoring methods to track impacts on listed fish species; use of in-season management actions and monitoring to ensure compliance with impact limits for incidental catch of ESA-listed fish; monitoring for "competition and predation effects" of the extensive hatchery programs that support fish populations and harvests in the Columbia basin; annual reporting to NMFS of take limits and research, monitoring and evaluation activities associated with the fisheries.

Two other species of concern along the Columbia are the freshwater bull trout and the Bliss Rapids snails. The US Fish and Wildlife Service issued a Biological Opinion in 2018, concluding that the Columbia River hatcheries and fisheries do are unlikely to "appreciably reduce" either species.

Entanglement of seabirds in gillnet fisheries does occur, but studies of these interactions on the Columbia have suggested the impacts are minor (Carter et al 1995).

Concern about seals and sea lions feeding on salmon populations has increased in recent years as the mammal populations have grown. Sea lions may have taken 11% of the spring Chinook returning to the Columbia in 2010, and as much as 43% in 2014 (Harrison 2018b). Historically, the state of Oregon's Fish Commission paid a bounty starting in 1936. From 1959 to 1970 the Commission also hired a seal hunter. His job was "to actively harass seals during the open commercial seasons," and "drive seals out of the Columbia River" with the aim of reducing predation on salmon held in fishermen's nets (Fish Commission of Oregon, 1972). As with most predator control programs, effectiveness of the effort was difficult to document. Officials doubted it worked and recommended ending the contract with the hunter and reducing the bounty (ibid).

Indicator: Uncertainty → Precaution

State and tribal managers of Columbia River fisheries incorporate multiple precautionary measures to minimize risks arising from uncertainties in critical management data. These measures include a "buffer" policy of 30% on early-season harvests on the lower river; this reduces allowable harvest rates on the mainstem when fishing opens each year in case actual returns of Chinook fall short of biologists' forecasts. Monitoring and data collection on dam passage, along with in-season updates on catch and run size, help managers adjust harvest rules.

Indicator: Compliance

Columbia River resource managers have a track record of keeping harvest rates within conservation limits, both for the major target stocks and for populations that are depleted. Overages do occur, but they are rare, generally minor, and rapidly corrected. Strong performance against harvest-rate limits is documented in multiple data sets. Combined harvest rates for treaty and non-treaty fisheries in the river have been kept below the limit, only exceeding harvest once during a 12-year period.

Indicator: Timely Action

Managers receive data on catch volumes daily when fishing is underway and quickly adjust fishing limits, sometimes within hours. Allowable harvests are adjusted based on updates to estimated run-sizes as data come in from catches, fish counts at dams, data on recoveries of tagged and fin-clipped fish (which can be traced to specific runs) and visual stock identification, among other sources.

Hatchery Risk

Despite missteps in their early years, hatcheries have become a fundamental tool in Chinook salmon management and recovery in the Columbia River basin. More than half of all Chinook returning to the Columbia River today were released from hatcheries scattered throughout this vast watershed. Over the years, hatchery management has improved significantly.

The first Columbia basin salmon (Snake River sockeye) were listed under the ESA in 1991. Since then, a series of federal reviews of hatchery operations under ESA have spurred changes in hatchery practices, including creating a framework for improving research and monitoring of hatchery performance. These efforts are believed to be reducing hatchery risks to wild fish populations while increasing their compatibility with salmon recovery goals, according to a recent NMFS BiOp evaluating Columbia River salmon fisheries and hatcheries that support them (NMFS 2018). Authors of the 2018 BiOp note that "these changes are likely to reduce effects such as competition and predation on natural-origin salmon and steelhead compared to current levels, especially for those species that are listed under the ESA" (ibid). The authors state: "We expect reductions in effects on listed salmon and steelhead are likely to occur through changes in:

- "Hatchery monitoring information and best available science
- "Times and locations of fish releases to reduce risks of competition and predation
- "Management of overlap in hatchery- and natural-origin spawners to meet gene flow objectives
- "Decreased use of isolated hatchery programs
- "Increased use of integrated hatchery programs for conservation purposes,

- "Incorporation of new research results and improved best management practices for hatchery operations,
- "Creation of wild fish only areas,
- "Changes in the species propagated and released into streams and rivers and in hatchery production levels,
- "Termination of programs,
- "Increased use of marking of hatchery-origin fish,
- "More accurate estimates of natural-origin salmon and steelhead abundance for abundance-based fishery management approaches."

The NMFS 2018 BiOp concluded that the majority of Columbia River hatcheries do not present a threat to wild stocks any minimal impacts were already being addressed and mitigated through management practices.

The 2018 BiOp authors concluded that current hatchery operations do have some adverse impacts on listed salmon stocks but judged these impacts to be sufficiently controlled. After considering prior ESA evaluations, their mandates for changes in hatchery operations and regular monitoring and reporting, the authors found that hatchery and harvest operations planned until 2027 "are not likely to jeopardize" ESA-listed fish populations in the Columbia Basin. Although interactions between hatchery and wild fish are not completely understood, the BiOp authors noted that model analyses and ongoing field research are improving knowledge of potential risks. Among them, use of tiny Passive-Integrated Transponders and genetic methods such as Parentage-Based Tagging are helping to clarify potential hatchery influences on naturally spawning populations (NMFS 2018; Steele et al 2019).

Some current concepts of best practice for hatcheries rest on science that is still evolving, and outcomes of some practices have yet to be seen, as long-term data must be collected. In February 2020, Washington Department of Fish and Wildlife (WDFW) released a draft assessment of hatchery and fishery reform within its own operations, which include 81 fish hatcheries, the largest "fleet" of such stock-enhancement facilities in North America. The authors (Murdoch and Marsten 2020) took note of one practice that NMFS requires for most hatcheries in the Columbia basin: reducing the proportion of Hatchery-Origin Spawners (pHOS) in nearby streams. In their draft report, Murdoch and Marsten wrote: "Understandably, given the uncertainty (i.e., lack of empirical studies) associated with some hatchery reform actions (e.g., pHOS goals), an evaluation of the policy and subsequent actions taken warrant a quantitative assessment of the effectiveness in achieving the policy goals." However, they noted that such a quantitative assessment cannot yet be conducted because it would require data from multiple generations of fish. Current changes in hatchery practice have been implemented for only a decade at most, too short a time to detect genetic effects attributable to any reduction in straying hatchery fish.

Despite some uncertainties and evolving practices, the Columbia's network of hatcheries benefits from strong oversight and robust, transparent systems for monitoring, research, and performance evaluation. Uncertainty and errors in knowledge of potential hatchery risks may be ineradicable, but they are recognized, regularly reviewed, and adaptively managed.

See Appendix 1 to learn more about the history and complexities of hatcheries in the Columbia River basin.

3. Knowledge Risk

Knowledge of Prey Interception Risk (Post-Prey)

Columbia River fisheries encounter Chinook salmon "after the fish have returned to the river and are no longer available to the whales in the ocean," according to the 2018 NMFS Biological Opinion on in-river fisheries contemplated under the 2018-2027 Management Agreement (NMFS 2018). This finding is supported by recent field research from NMFS scientists investigating habitat use by SRKW along the West Coast. The Draft Biological Report for the agency's 2019 proposal to expand critical habitat of SRKW outside the Salish Sea notes that "there are no data from sightings or satellite tags to indicate that Southern Residents enter river mouths or semi-enclosed bays and estuaries along the outer coast, although data indicate the whales do use the open embayment of Monterey Bay in California." NMFS excludes waters inside the Columbia River (and other rivers) from its proposed expansion of critical habitat for SRKW along the West Coast (NMFS 2019a, NMFS 2019b).

Southern residents from K and L pods have been documented feeding on salmon in marine waters off the mouth of the Columbia River, a finding that contributed to NMFS' decision to propose an expansion of SRKW critical habitat under the ESA. The agency's earlier designation of critical habitat focused on waters within the Salish Sea. The new

designation spans much of the U.S. West Coast (NMFS 2019a, NMFS 2019b). Killer whales do occasionally enter rivers, but this behavior has been documented only in mammal-hunting transient whales, not the fish-eating Southern Residents.

Knowledge of Stock Risk (Exploitation & Biomass)

Indicators: Knowledge of Exploitation Rate, ETP species, & Monitoring

Time series from multiple sources document high rates of compliance with exploitation limits. Allowed vs actual harvest rates on ESA-listed salmon and abundant stocks over time are documented in published Joint Staff Reports by WDFW and ODFW, NMFS Biological Opinions and other sources.

Protection of ETP species is closely monitored and controlled, driving increased levels of precaution in fishery harvest management in the Columbia basin. In general, the denominator in exploitation rates is derived from model estimates of run sizes entering the Columbia which are back-calculated in–season and post-season by using the latest dam passage projections and adding back harvest and mortalities from other potential sources. Data from multiple sources collected during the upriver migration (landings, fish counts at dams, visual identification of fish from specific stocks, tag recoveries, tallies of hatchery marked fish, etc.) progressively increase the expected precision and reliability of estimates of run size and catch composition as fish progress upriver. Statistical uncertainty of run-size estimates currently is not estimated.

Indicator: Reference Points

For most Chinook stocks, tribal, state, and federal co-managers have evolved a system of reference points that are substantially more conservative than MSY. Keeping harvests well below replenishment levels greatly reduces or eliminates any risk of unknowingly setting limits that could allow Columbia River fisheries to deplete Chinook stocks.

Impact limits on 13 ESA-listed salmon populations, abundance-based harvest control rules, and sequential escapement goals for upriver dams provide reference points for in-river harvests that result in very precautionary levels of escapement. Time series data for 2008-2016 show that an estimated 90.4% of all wild Chinook entering the Columbia are allowed to escape from the main fisheries in the river and its tributaries.

Indicators: Uncertainty and Error & Uncertainty → Precaution

Estimates of run size, exploitation rate, and stock composition are subject to uncertainties that are recognized, evaluated, and mitigated through harvest control rules that commonly result in very precautionary escapement levels.

Routinely collected data from coded wire tags, fin-clipped hatchery-marked fish, visual stock identification, and landings reports, among other data sources, permit informed and precautionary responses to changes. Data collection practices in the middle and upper basin vary by sub-basin. As an example, in the Snake River fall run, incidence of fish with adipose-fin clips is "used to construct daily estimates of hatchery proportions in the run," the NMFS BiOp authors note. Use of passive-integrated transponder (PIT) tags has improved understanding of variations in migration timing and also mortality rates associated with warm river waters and large water spills affecting these fish, along with other effects, the authors report (NMFS 2018).

Development of Parentage Based Tagging (PBT), a genetic tracing method, has been hailed as a significant addition to the toolkit for conserving and managing salmon in the Columbia Basin. The use of PBT techniques could help to narrow knowledge gaps and uncertainties that older, established methods (Coded Wire Tags, fin-clipping) do not resolve. Such advances in technology are reducing uncertainties and errors in hatchery and fishery management.

Indicators: Compliance & Timely Action

Publicly available time series clearly document the performance of managers and fishers in meeting both exploitation and escapement requirements. Timely action to control fishing effort is evident in the high rates of compliance (and outperformance) achieved in both exploitation and escapement. In-season response to changes in catch rates and run size can result in closure of mainstem fisheries within hours after landings data are collected. Monitoring and research on fish survival and underlying physical conditions in the ocean and the river, including climate impacts, inform both management and formal evaluations of management and policy.

Knowledge of Stock Risk (Hatchery Risk)

As of 2014, more than 80 hatcheries were running 177 distinct programs to produce salmon and steelhead in the Columbia River basin (NMFS 2014). Since the 1990s, ESA listings of 13 population groups of salmon and steelhead in the Columbia Basin have spurred increased scrutiny of hatcheries to ensure that they contribute to recovery, efficiently produce fish, and minimize genetic, ecological and disease impacts on nearby wild salmonids. NMFS has responded to the listings by driving far-reaching changes, both in hatchery operations and in the research, monitoring and evaluation that shows how they are performing.

The federal marine fisheries agency wields broad authority over salmon hatcheries, both as a funder and a regulator. Under the Mitchell Act, NMFS provides funds for about a third of all Columbia Basin hatchery programs (NMFS 2014). Under the National Environmental Policy Act (NEPA), NMFS evaluates hatchery programs and establishes broad guidelines for assessing and limiting the risks they can pose to wild stocks. Under the ESA, the agency sets performance standards for hatcheries, mandates allowable levels of production, imposes limits on straying to protect wild fish, and specifies monitoring and reporting requirements.

The agency's permit authorities under the ESA help to put teeth in its requirements, especially where hatcheries interact with ESA-listed wild fish. To receive necessary permits to collect broodstock, among other tasks, hatchery operators in the Columbia Basin (and other regions where fish are listed) need NMFS approval of their Hatchery and Genetic Management Plans. Those plans provide detailed guidance for production, operations, and monitoring and research at each facility. Similarly, access to Mitchell Act funds is also contingent on documenting compliance with NMFS requirements through annual reporting on these activities.

The agency's 2017 Biological Opinion (BiOp) on hatcheries funded by the Mitchell Act (NMFS 2017b) codified a detailed list of requirements for oversight and operation of hatcheries in the Columbia River Basin. It mandated measures for all covered hatchery programs and actions at specific facilities in order to reduce potential for harm to listed species, or (in the phrase used in ESA documents) "to minimize incidental take." These requirements echo and consolidate similar rules the agency has instituted through BiOps on hatchery programs throughout the basin. They include multiple required steps to reduce potential genetic and ecological risks to wild fish, protect water quality and quantity, control diseases and other potential impacts. The 2017 BiOP also requires annual reporting on results and specifies detailed approaches to measure impacts through research, monitoring and evaluation. It incorporates many additional NMFS specifications for impact reduction and regulatory compliance, which must be documented in hatchery operators' regular reports to NMFS and their HGMPs.

Beyond broad programmatic guidance provided in its BiOp and EIS reports, NMFS provides detailed oversight of hatchery practices through Hatchery and Genetic Management Plans that operators must submit to the agency in order to obtain necessary permits. Site-specific requirements cover all aspects of hatchery management; integration of hatchery practices to align harvest, habitat, and hydropower programs in a coordinated effort to recover salmon populations; The agency also stipulates monitoring and research requirements to fill gaps in knowledge and constrain important areas of uncertainty about potential hatchery impacts.

See Appendix 1 to learn more about the history and complexities of hatcheries in the Columbia River basin.

Appendix 1: Hatcheries in the Columbia River Basin

Hatcheries have a long and mixed record on the Columbia River. The first salmon hatchery in the basin was built in 1877 by cannery operators hoping to reverse the decline of valuable spring Chinook. It faltered within four years but was later revived with federal government support. Overfishing, unchecked development, and irrigation soon made hatcheries look like an answer too easy to ignore. One promoter, Washington Fish Commissioner A.C. Little, contended that the state's fisheries were out of room to grow, "unless radical measures are taken towards keeping up supply. In no way can this be done successfully but by artificial propagation." This quote from Little comes from a history of hatcheries published by the Northwest Power and Conservation Council, a body established by Congress in 1980 to plan comprehensive salmon restoration and electric power production. With a wry note, the unnamed author of the Council's hatchery report writes of Little: "In effect, he argued that the way to beat the salmon decline was to ignore its obvious causes and simply produce more fish."

Early hatcheries built to mitigate for fish loss at dams didn't always work as intended. The 2018 NMFS BiOp authors note that these early facilities "were operated without a clear understanding of population genetics," transferring fish to hatcheries "without consideration of their actual origin. By 2010, 208 hatchery programs were reported to be producing salmon and steelhead in the Columbia basin (BPA 2010), many of them intended to mitigate losses of habitat and fish caused by dams (some hatchery programs have since been closed). At least 281 hydroelectric dams and "about 200 more dams built for other purposes, such as irrigation and flood control" exist in the Columbia basin today (NWPCC 2020b)." Whether hatcheries helped or hurt wild salmon became a subject of debate that intensified during the late 20th Century. "Although hatcheries were increasing the number of fish returning to the basin there was no evidence that they were increasing the abundance of natural populations and it is considered likely that they were decreasing the diversity of populations they intended to supplement" (Ibid).

Over time, many fisheries biologists came to believe that hatcheries, if not carefully managed, could harm wild salmon populations in multiple ways. Transferring hatchery fish to distant watersheds could lead to interbreeding and dilution of genetic fitness in nearby salmon populations. If released in the wrong places or times, hatchery fish could cause ecological risks to wild fish, for example by preying on them or competing with them for food and space. Without careful management, hatcheries could also become vectors for diseases, could degrade stream water quality with their effluent, and could even dewater streams that neighboring wild fish needed for spawning and migration. Such concerns grew into the basis of a countermovement among fisheries scientists and advocacy groups who have worked to improve or shut down hatchery activities that could weaken wild salmon populations.

While the role of hatcheries is evolving and subject to ongoing debate, hatcheries have come serve many purposes, including mitigating fishery losses from industrial activities and developments that degrade habitat; preserving remnant gene pools; providing fish to repopulate sub-basins; meeting treaty obligations to protect upriver tribes' fisheries, and more. These roles have evolved to take advantage of a key function of hatcheries: they boost productivity per spawner by greatly reducing the normally high mortality that young salmon and steelhead face in the wild, especially in severely altered river systems such as the Columbia. They protect young fish in a controlled environment—providing favorable temperatures, stable waterflow, and protection from predators—until the fish are big enough to swim downriver and fatten up in their ocean pastures.

Co-managers in the Columbia Basin and elsewhere increasingly deploy hatcheries to help restore some depleted populations of salmon and steelhead. Dynamic environmental challenges such as climate change complicate the balancing of conservation priorities for hatcheries. In recent years, reduced survival from smolt to adult stages in many West Coast salmonid populations—both hatchery and wild—has fueled vigorous research and contention among fisheries scientists about potential causes. One such topic is whether hatchery fish may be effectively "overgrazing" marine food webs, or merely experiencing the same poor foraging and survival conditions as wild fish. Meanwhile, recent reductions in hatchery production are themselves a subject of debate. Agencies and tribes are working to boost production strategically to provide more Chinook as prey for Southern Resident Killer Whales.

Tribes, and state and federal agencies also use hatcheries to rescue severely depleted wild salmon populations from immediate threats such as impacts of climate change, dams, and disrupted marine foodwebs. This reflects fishery scientists' judgment that urgent risk of extinction can sometimes take precedence over long-term genetic concerns. Co-managers have intervened to save vanishing stocks, such as Redfish Lake sockeye, by raising some of the fish in hatcheries and then "outplanting" them to bolster the wild population (NMFS 2018). With careful controls—such as ensuring outplanted fish are from local rivers, not distant basins—this approach is considered

an important tool for rebuilding stocks at risk of extinction. However, hatchery fish are not exempt from high mortality caused by poor ocean conditions, overheated river waters, and other environmental threats such as climate-intensified droughts and floods. Poor survival in recent years has eroded returns of both hatchery and wild Chinook.

Some current concepts of best practice for hatcheries rest on science that is still evolving or require balancing competing risk-management strategies. Any simple, unilinear measure of performance is thus incomplete at best. In a system as complex as the Columbia River Basin, with nearly 200 current hatchery programs, some degree of uncertainty about hatchery effects is unavoidable. However, this uncertainty itself can be recognized and used to fuel research and debate over how best to drive improvements. Such a discourse is visible in multiple publications and forums organized by federal, state, tribal and other actors in the Columbia Basin. For example, the Washington Department of Fish and Wildlife in 2019 initiated a review of hatchery reform science (Anderson et al 2020). "Long-term empirical studies of hatchery reform principles are absent in Washington state," the authors note. "Thus, it is difficult to know with any degree of accuracy if management actions based on these reforms are achieving their intended goals."

Columbia River's many salmon populations carry a legacy of consequences from early hatchery operations that swapped populations among distant basins with little attention to local adaptation, genetic effects, ecological impacts, or even whether the effort succeeded in increasing naturally spawning stocks. The results of that legacy and of modern efforts to do better are a subject of ongoing research and discussion.

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Chinook Salmon Fishery Evaluation

Hoodsport Hatchery Terminal Fishery

August 4, 2020

2020 Evaluation: Passed **Overall Rating:** A

Fishery Overview:

The Chinook terminal fishery at Hoodsport Hatchery harvests fish in their final passage from the sea back to a state-run hatchery in the Southern end of Hood Canal, a fjord opening into Puget Sound.

The fishery is managed to target only hatchery fish, which can be identified by adipose fin clips. Chinook are caught with beach seines as they return to their 'natal' hatchery location at the mouth of Finch Creek. Therefore, the target catch consists of Chinook that have already escaped from foraging grounds of Southern Resident Killer Whales (SRKW).

The hatchery program follows best practices recommended for segregated broodstock management and for mitigating the risk of genetic and ecological impacts on neighboring stocks. To ensure complete clipping of hatchery fish, on a daily basis several checks are conducted as the Chinook are released. Records of those samples are kept ensuring a complete clipping rate. At the hatchery level, 100% of the adult Chinook catch is checked for fin clips and Coded Wire Tags (CWT). Additionally, timing and location help ensure low incidental catch of chum, steelhead, and non-salmonid species in the Hoodsport hatchery terminal fishery. The impacts on protected species are believed to be rare and minimal.

Evaluation Summary:

The Hoodsport hatchery Chinook fishery on Finch Creek earns the A rating based on findings that: 1) prey interception risk, exploitation risk, and biomass risk are managed at levels that satisfy standards and indicators underpinning this rating for each category; and 2) knowledge risk for each standard and indicator is constrained sufficiently to produce the necessary confidence in data.

At Hoodsport, indicators for hatchery management, All-H integration, and precautionary response to uncertainty are satisfied by careful and closely scrutinized practices under their Hatchery Genetic Management Plan.

Evaluation Chart:

	Findings	Rating	Notes
1. Prey Interception Risk		**A**	
1.1 No Overlap			
Indicator 1.1.1			
Indicator 1.1.2			
1.2 Post-Prey	Strong evidence indicating near-zero probability of catching SRKW priority Chinook prey.	A	No documented sightings of SRKW in Hood Canal. Fishery is located at the hatchery and harvest targets returning adult fish that have escaped from foraging grounds of SRKW.
Indicator 1.2.1			
Indicator 1.2.2	Indicator met.		
1.3 Negligible Effect			
Indicator 1.3.1			
2. Stock Risk		**A**	
2.1 Exploitation		A	Fishery is managed on the basis of hatchery production. Any fish not needed for broodstock collection are harvested, so indicators for target-stock exploitation rate and protection of spawning biomass (applicable to wild stocks) do not apply. Exploitation rates and impact limits for non-target fisheries are observed, but for the targeted hatchery fish there is no cap on exploitation rate. Close observation of harvest levels and set reference points allow managers to reduce harvest rates as appropriate to meet broodstock needs.
Indicator 2.1.1: Exploitation Rate			
Indicator 2.1.2: Reference Points	Tight control over production and harvest allows for set reference points.		
Indicator 2.1.3: ETP Species	Satisfied provisionally by evidence that little mortality is attributed to the fishery for Chinook salmon returning to Hoodsport hatchery terminal fishing area.		
Indicator 2.1.4: Uncertainty → Precaution	Data and in-season changes ensure hatchery escapement goals are met.		
Indicator 2.1.5: Compliance	Satisfied to extent that exploitation rates and impact limits for non-target fisheries are observed.		
Indicator 2.1.6: Timely Action	Tight control and monitoring allow for in-season adjustments.		
2.2 Biomass		A	
Indicator 2.2.1: Reference Points			
Indicator 2.2.2: Uncertainty → Precaution	Data and in-season changes ensure hatchery escapement goals are met.		

		Indicator 2.2.3: Compliance	Satisfied by practice of adjusting fishing pressure as needed based on in-season data.		
		Indicator 2.2.4: Timely Action	Satisfied by practice of adjusting fishing pressure as needed based on in-season data.		
	2.3 Hatcheries		All indicators met.	A	Location, timing, and segregation from natural spawning populations reflect strong precaution against potential hatchery risks to wild stocks. Management objectives include All-H integration, seeking to integrate management of hatchery, habitat, and harvest according to recognized best practices. This is a segregated hatchery, meaning that only marked hatchery fish are used for broodstock, and no wild salmon inhabit the creek.
		Indicator 2.3.1: Hatchery Management			
		Indicator 2.3.2: All-H Integration			
		Indicator 2.3.3: Uncertainty → Precaution			
3. Knowledge Risk				**A**	
	3.1 Knowledge Risk for Interception			A	
		3.1.1 No Overlap			
		Indicator 3.1.1.1			
		Indicator 3.1.1.2			
		3.1.2 Post Prey		A	Hoodsport is an "extreme-terminal" fishery, and 97% of the harvest can be shown to originate from the hatchery through ongoing marking data. Thus, the fishery meets the relevant requirement to ensure that over 90% of Chinook encountered have escaped from SRKW foraging waters en route to upstream spawning grounds or hatcheries.
		Indicator 3.1.2.1			
		Indicator 3.1.2.2	1) Hood Canal is specifically excluded by NOAA as SRKW Critical Habitat Designation and there have been no sightings of SRKW in Hood Canal; and 2) Ten years of catch records show an average of ~97% of the catch originates with the hatchery. Hatchery origin fish are identified by adipose fin clipping.		
		3.1.3 Negligible Effect			
		Indicator 3.1.3.1			

	3.2 Knowledge of Stock Risk			A	
		3.2.1 Exploitation		A	Reliable, timely data from multiple sources give harvest managers a strong toolkit to identify and reduce errors and rapidly constrain harvests to protect or increase escapement. Monitoring, documentation, and data collection over 10 years provide sufficient confidence that nearly all fish harvested (~97%) are of hatchery origin. If broodstock levels aren't met, managers can take from neighboring hatcheries that use genetically identical broodstock.
			Indicator 3.2.1.1: Exploitation rate		
			Indicator 3.2.1.2: Reference points		
			Indicator 3.2.1.3: Uncertainty and Error	Satisfied with high confidence.	
			Indicator 3.2.1.4: Compliance		
			Indicator 3.2.1.5: Timely Action	Satisfied with high confidence.	
			Indicator 3.2.1.6: ETP Species	Satisfied with moderate to high confidence.	
		3.2.2 Biomass		A	
			Indicator 3.2.2.1: Monitoring	Satisfied with high confidence.	
			Indicator 3.2.2.2: Reference Points		
			Indicator 3.2.2.3: Uncertainty → Precaution	Satisfied with high confidence.	
			Indicator 3.2.2.4: Compliance	Satisfied with high confidence.	
			Indicator 3.2.2.5: Timely Action	Satisfied with high confidence.	
		3.2.3 Hatcheries		Indicators satisfied with high confidence.	A	Managers employ best practices in hatchery management, monitoring, marking, and precautionary response to uncertainties. Use of local broodstock, extensive marking, documentation, and efforts to minimize ecological and genetic impacts permit high confidence in determining that the hatchery meets the relevant standards and indicators.
			Indicator 3.2.3.1: Hatchery management		
			Indicator 3.2.3.2: Monitoring		
			Indicator 3.2.3.3: Hatchery Marking and Tagging		
			Indicator 3.2.3.4: Uncertainty → Precaution		

Note: Any lines or sections left blank are considered not applicable to the specific fishery under evaluation.

Evaluation Details and Notes:

1. Prey Interception Risk (Post-Prey)

Hood Canal has no known sightings of SRKW (NOAA 2006, NOAA 2019). NOAA's 2019 *Proposed Rulemaking to Revise Critical Habitat for the Southern Resident Killer Whale Distinct Population Segment*, specifically excludes the waters of Hood Canal from the critical habitat designation, reaffirming the exclusion made by the agency's earlier designation of critical habitat (NOAA 2006, NOAA 2019).

Approximately 99% of released juvenile hatchery fish are marked (Addae 2020), which allows managers a very high degree of confidence in ensuring that harvested fish originated at the hatchery, and that there is little to no incidental catch of Chinook from either SRKW priority stocks or Endangered Species Act (ESA) listed Chinook stocks. Ten years of catch records indicate that 97% of harvested adult fish were marked and of Hoodsport origin.

2. Stock Risk

Exploitation and Biomass Risk

Some stock risk indicators, except those detailed below, are inapplicable to the Hoodsport terminal Chinook fishery because it targets hatchery fish and harvest occurs directly at the hatchery grounds. The fishery is managed on the basis of hatchery production, which allows for in-season harvest decisions as necessary to meet sustainable hatchery production goals for escapement/broodstock collection. Meeting broodstock goals acts as a proxy for exploitation rate and biomass protection. When goals are expected to be met, the run is open to harvest.

As a terminal hatchery-based fishery, Hoodsport has tight controls over escapement and harvest that have allowed the fishery to be reasonably successful in meeting seasonal escapement goals. Through careful management, the fishery removes a high proportion of returning adult hatchery fish while providing sufficient escapement to perpetuate the hatchery program. Additionally, the fishery is successful in avoiding incidental catch of non-hatchery fish; ten years of catch records indicate that an average of 97% of fish caught have clipped adipose fins indicating hatchery origin.

For this fishery, indicators 2.1.1 and 2.2.1 are satisfied by managers' practice of ensuring that sufficient broodstock are collected (including following the recommended hatchery practice of collecting broodstock throughout the run to ensure diversity), and making in-season decisions about needed closures or reductions in harvest when broodstock collection goals are not being met. As noted above, no exploitation rate limit exists for the target catch. Fish not needed for broodstock are harvested, and protections of biomass are not applicable to a terminal, segregated-broodstock, hatchery fishery.

Indicators: Reference Points, Uncertainty, & Timely Action

To set appropriate harvest limits, managers need access to reliable data to track harvest and return size accurately. Current practices in Washington Department of Fish and Wildlife (WDFW) management of the Hoodsport Chinook fishery meet these requirements.

This terminal fishery is believed to have little to no impact on wild stocks. The number of young hatchery Chinook released is managed to allow for best possible forecasting and desired harvest size. The terminal location of the fishery enables managers to adjust harvest for actual run size and ensure appropriate escapement for hatchery broodstock. Since all hatchery fish are marked and the fishery is mark-selective, managers can have a high degree of confidence that over 95% of harvest originate with Hoodsport Hatchery, with about 3% originating from unmarked stock, believed by managers to be mostly other Hood Canal hatchery Chinook that spawned in the wild (WDFW 2019b, Downen 2019).

State and tribal co-managers of Hoodsport fisheries demonstrate a precautionary response to uncertainty in the fishery by revising harvest limits to ensure adequate broodstock. Harvest is contingent upon abundance and sustainability of the hatchery program. In 2019, the fishery was closed, and a release from managers stated: "Hatchery returns are below projections. This conservation measure is necessary to ensure that hatchery broodstock goals are met" (WDFW 2019f).

Indicator: Endangered, Threatened and Protected (ETP) Species

WDFW managers report little to no indication that the Hoodsport terminal Chinook fishery is responsible for mortality of any endangered, threatened, or protected species. Entanglement with seabirds, pinnipeds, and cetaceans is believed to be rare, with no documented entanglements, based on reports from tribal and WDFW managers overseeing the fishery. This fishery is conducted in a small "extreme terminal area" in waters within a 2,000-foot arc seaward of the yellow marker buoys at the mouth of Finch Creek, using only beach seine gear. While reports note the presence of certain ETP species such as the marbled murrelet (USFWS 2012), migratory birds, and bald eagles (SBE 2015), managers and published scientific articles collected on seabird entanglement do not report any encounters between the Hoodsport terminal beach seine fishery and these species. The risk of such entanglement is considered to be very low (Addae 2020).

Chinook fisheries in Hood Canal are restricted to protect summer chum salmon and other ETP fish species. Finally, use of beach seines enables live release of incidentally caught fish, one of several well-known approaches to achieve selective harvest.

Hatchery Risk

The Hoodsport hatchery is believed to pose minimal risk to wild salmon stocks and surrounding ecosystems, and is managed through a precautionary All-H integration framework, seeking to responsibly align hatchery, habitat, and harvest according to recognized best practices. The latest Hatchery Genetic Management Plan found a negligible risk of genetic or ecological impacts on neighboring stocks (HMGP 2016).

Location, timing, and segregation from natural spawning populations, coupled with the absence of a natural Chinook population, results in minimal impact from any hatchery strays and minimizes bycatch risk during harvest. Timing, location and use of beach seines for harvest allows for easy and immediate release of any bycatch of non-Chinook species, such as chum, steelhead or non-salmonid species. Hoodsport Chinook are expected to migrate quickly through Hood Canal and minimize potential ecological interactions and any adverse effects to listed Chinook.

At Hoodsport, WDFW annually monitors size, age class, number, date of release, location and release type, and records them in the WDFW Hatcheries Headquarters Database. Additionally, staff annually coded-wire tag a portion of the releases to enable evaluation of contribution to fisheries, survival rates, possible straying to other watersheds, and identification at release site (HGMP 2016).

Broodstock selection, marking practices, and disease control practices provide ongoing checks to maintain a high level of precaution. Pathologists from WDFW's Fish Health Section monitor the program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed, and smolts are always inspected in the weeks before release to prevent carrying of disease into outside waters. Returning adult broodstock are inspected for pathogens, and a fish health database is maintained. Flow and discharge from the hatchery are reported monthly and monitored to prevent effluent from detrimentally affecting natural populations and habitat.

Fishery managers and organizations that oversee the recovery of local wild stocks of other species report that the Hoodsport fishery does not interfere with the recovery plans or abundance of those species (Downen 2019, HGMP 2016, HCCC 2020). Endangered summer chum are considered extirpated from Finch Creek (WDFW and PNPTT 2000).

ESA salmonids in the area include the George Adams Hatchery fall Chinook, Skokomish Fall Chinook, Hamma Hamma fall Chinook, Mid Hood Canal Fall Chinook, Puget Sound Chinook, Hood Canal summer chum, and Puget Sound Steelhead. The most recent Hatchery Genetic Management Plan for Hoodsport hatchery finds that none of the listed species are directly affected by the program, but some may be incidentally affected (HGMP 2016). To mitigate the potential of the hatchery program and fishery to harm these listed species, timing, geography of the fishery, and smolt size at release are managed to minimize impacts on other salmonid and non-salmonid wild stocks. Juvenile releases are made at an age to ensure swift migration out of the area, reducing the potential for predation by hatchery fish. In addition, on-site release enhances homing sense, reducing the potential for straying (HGMP 2016).

3. Knowledge Risk

Knowledge of Prey Interception Risk (Post-Prey)

While the area is within the range of SRKW, no known sightings of SRKW have occurred near Hoodsport Chinook fishery, and Hood Canal is specifically excluded from critical habitat of these whales. According to NOAA, there have been no confirmed sightings of Southern Residents in Hood Canal. Additionally, tag recovery data indicates that within the past several decades, no migrating Chinook from British Columbia or the U.S. West Coast have been found in Hoodsport.

All hatchery fish are marked and counted, and records show that over 95% of fish caught in the Hoodsport terminal fishery originated from Hoodsport, with the remainder originating from what managers believe to be primarily other Hood Canal hatchery stocks (Downen 2019). No priority SRKW stocks or non-hatchery fish have been found in the harvest (WDFW 2019b).

Knowledge of Stock Risk (Exploitation & Biomass)

For this hatchery-stock-based terminal harvest, exploitation and biomass indicators are largely inapplicable, but we assessed practices used to meet hatchery broodstock needs. Exploitation rate is managed by first ensuring that broodstock needs are met and making any necessary in-season changes to harvest to meet those needs; what remains determines exploitation (harvest). In a hatchery-based terminal fishery, knowledge and management of exploitation can be carefully overseen and documented. Hoodsport Terminal Chinook escapement (with broodstock egg-take as proxy) met or exceeded its goal for providing hatchery broodstock in 75% of years documented in WDFW's 1999-2019 escapement reports (WDFW 2020b)**.**

Managers report that any shortfall is made up by obtaining broodstock from neighboring hatcheries that have exceeded their needs for that year (neighboring hatcheries use broodstock of identical genetic origin). The fishery isn't opened until managers are confident that returns of adult fish are on track to meet broodstock needs, and harvest is adjusted if it appears that broodstock needs may not be met. Best practice for genetic management of stock requires that broodstock be taken throughout the return period in proportions approximating the timing and age distribution of the population from which broodstock is taken (HGMP 2016). Hoodsport follows this practice.

Harvest of non-hatchery Chinook is avoided, and an ongoing, annual marking program affirms the fishery's performance in this task. To ensure all hatchery fish are clipped, on a daily basis several checks are conducted as the young Chinook are released. Records of those samples are kept ensuring as near to 100% clipping rate as possible (average over 10 years is 99.7%, per WDFW 2019b). At the hatchery level, 100% of the adult Chinook catch is checked for fin clips and Coded Wire Tags (Villarreal 2020).

The streams entering the Hoodsport fishery area do not support native wild stocks (HGMP 2016), and the method of fishing (beach seine) ensures that any bycatch of non-Chinook species can be immediately released alive. Fishery managers and organizations that oversee the recovery of local wild stocks of other species report that the Hoodsport fishery does not interfere with the recovery plans or abundance of those species (Downen 2019, HGMP 2019, HCCC 2020). Further, endangered summer chum are considered extirpated from Finch Creek (WDFW and PNPTT 2000).

Indicators: Compliance & Timely Action

Managers have access to multiple data sources to forecast and track changes in run size, track harvest rates based on current and accurate catch reports, and assess escapement during fishery openings, enabling timely management action and achieving escapement goals needed for broodstock according to hatchery management guidelines.

Finch Creek currently supports no local natural Chinook stock (NOAA 2005, HGMP 2016). Daily checks ensure that juvenile fish from the hatchery are marked before they are released, and all harvested fish are checked to determine the proportion of marked and unmarked fish. Of the Chinook harvested in the Hoodsport Hatchery Zone, approximately 97% of the catch is documented to be hatchery marked. This shows that exploitation of any naturally spawning Chinook is 3% or less (WDFW 2019b).

Indicator: Endangered, Threatened and Protected (ETP) Species

Entanglement of seabirds, cetaceans, and pinnipeds is believed to be rare, based on credible but anecdotal reports from experienced managers who have overseen the fishery for decades. The fishery uses beach seines only, a method of fishing that is less prone than many others to harmful interactions with ETP species; the risk of entanglement is considered very low. Chinook harvest and broodstock collection are conducted using timing and methods that minimize impacts on and interactions with any naturally spawning population or ETP fish species. Use of beach seines permits live release of any non-target fish, which are visually identified by the absence of adipose fin clips.

The apparent rarity of interactions with cetaceans, pinnipeds, and seabirds indicates that risk to protected species is currently low. As elsewhere, the incidence of these interactions may change in the future as climate change alters the distribution and behavior of many species.

The 2005 NOAA Endangered and Threatened Species Listing Determinations (NOAA 2005) states: "In the proposed ESU determination for the Puget Sound Chinook ESU… we conclude that the Hoodsport Hatchery program is not part of the ESU. Finch Creek, where the Hoodsport Hatchery program is located, historically and currently lacks an extant local natural Chinook salmon population."

Knowledge of Stock Risk (Hatchery Risk)

Hoodsport managers employ best practices in hatchery management, monitoring, marking, and precautionary response to uncertainties. The hatchery actively participates in coordinated multi-sector work to achieve "all-H" risk management. As noted above (under Hatchery component of Stock Risk), Hoodsport applies best practices for control of potential hatchery impacts. Hoodsport hatchery's fin-clipping marking system generates adequate and reliable data on catch composition in this terminal Chinook fishery. Use of local broodstock and extensive monitoring of the percentage of marked harvest and the hatchery release clipping program, as well as efforts to mitigate any potential detrimental effects on other Hood Canal fish, permit high confidence in evaluation of potential ecological and genetic impacts.

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Chinook Salmon Fishery Evaluation

Tulalip Bay

August 29, 2020

2020 Evaluation: Passed **Overall Rating:** A

Fishery Overview:

Tulalip Bay is located about 40 miles north of Seattle, near the mouth of the Snohomish River, where the tribe plays a leading role in salmon restoration work. Approximately 77% of tribal Chinook catch occurs inside Tulalip Bay, and the rest is taken just off the beach along the Tulalip reservation. In most years, the tribal Tulalip Bay Chinook fishery harvests a few thousand Chinook salmon, caught selectively as they return to the Tulalip tribal hatchery in the bay. The target catch consists of Chinook that have escaped from foraging grounds of Southern Resident Killer Whales. The tribes' setnet fishers operate inside the bay, and a few tribal gillnet, beach seine, and roundhaul fishers operate just outside the bay along the reservation shore, targeting the same hatchery fish. The Tulalip fishery accounts for a fraction of the 3% incidental mortality on Snohomish wild Chinook collectively attributed to all treaty tribal fisheries. Impacts on non-salmonid protected species are believed to be rare and minimal. Risks of intercepting SRKW prey or depleting Chinook stocks are low to non-existent. Available data and research support the tribes' precautionary, adaptive management.

Evaluation Summary:

The Tulalip Chinook fishery earns the A rating based on findings that: (1) prey interception risk, exploitation risk, and biomass risk are managed at levels that satisfy standards and indicators underpinning this rating for each category; and (2) knowledge risk for each standard and indicator is constrained sufficiently to produce the necessary confidence in data. At Tulalip's hatchery facility, "All-H" integration and precautionary response to uncertainty satisfy the relevant standards and indicators with careful and closely scrutinized practices under a federal permit issued by NOAA.

The evaluation for this particular fishery examines exploitation and biomass jointly; any identically named indicators within the two sections are combined for analysis.

Evaluation Chart:

	Findings	Rating	Notes
1. Prey Interception Risk		**A**	
1.1 No Overlap			
Indicator 1.1.1			
Indicator 1.1.2			
1.2 Post-Prey	Fishery is in enclosed terminal area, where fish-eating SRKW have not been documented in recent decades (though mammal-eating transient orcas have visited the bay in the past).	A	Using small, shallow, closely tended setnets, the Tulalip Tribes' Chinook fishery in Tulalip Bay selectively harvests fish returning from the ocean to the tribal hatchery where they originated.
Indicator 1.2.1	Satisfied by careful tribal management practices and the fishery's geographic isolation from known feeding grounds of SRKW.		
Indicator 1.2.2			
1.3 Negligible Effect			
Indicator 1.3.1			
2. Stock Risk		**A**	
2.1 Exploitation		A	The Tulalip fishery avoids ESA-listed wild Chinook, targeting fish from a hatchery that the tribe built in the 1980s (long before Puget Sound Chinook were listed) to support its fishery while protecting depleted local wild stocks. Incidental impacts on wild Chinook returning to the Snohomish River Basin amount to a fraction of the 3% incidental mortality attributed to all treaty tribal fisheries. Entanglement of marine mammals and birds is believed to be rare to non-existent, and no takes of these species were identified. One manager noted that tribal fishers actively tend their small, shallow
Indicator 2.1.1: Exploitation Rate	Satisfied with moderate to high confidence.		
Indicator 2.1.2: Reference Points	Satisfied by managers' use of Rebuilding Exploitation Rates.		
Indicator 2.1.3: ETP Species	Satisfied Tulalip Tribe & co-manager precautions to limit hatchery impact on wild species, including Chinook.		
Indicator 2.1.4: Uncertainty → Precaution	Satisfied by managers' use of Rebuilding Exploitation Rates.		
Indicator 2.1.5: Compliance	Satisfied with moderate to high confidence.		
Indicator 2.1.6: Timely Action	Satisfied with moderate to high confidence.		
2.2 Biomass		A	
Indicator 2.2.1: Reference Points	Satisfied by managers' use of Rebuilding Exploitation Rates.		
Indicator 2.2.2: Uncertainty → Precaution			
Indicator 2.2.3: Compliance			

		Indicator 2.2.4: Timely Action	Satisfied with moderate to high confidence.		nets in the bay to collect fish before agile seals and sea lions grab them. The tribes' hatchery program may supply prey for a variety of marine mammals that feed in the estuary and adjacent marine waters, according to a 2017 NOAA report.
	2.3 Hatcheries		All indicators satisfied with high confidence. Known and potential impacts of Tulalip's hatchery and state hatchery programs in the Snohomish basin are recognized, carefully monitored, and managed using precautionary best practices.	A	The hatchery program supporting this harvest operates under close scrutiny through NMFS permitting, using recognized best practices for hatchery management and protection of neighboring wild stocks. Use of local broodstock, extensive monitoring and marking of hatchery fish helps to limit potential hatchery risks to neighboring natural stocks of salmon.
		Indicator 2.3.1: Hatchery Management			
		Indicator 2.3.2: All-H Integration			
		Indicator 2.3.3: Uncertainty → Precaution			
3. Knowledge Risk				**A**	
	3.1 Knowledge Risk for Interception			A	
		3.1.1 No Overlap			
		Indicator 3.1.1.1			
		Indicator 3.1.1.2			
		3.1.2 Post Prey	The Tulalip Tribes' carefully documented selective harvest of hatchery Chinook, and the absence of documented SRKW sightings in Tulalip Bay during recent decades provides high confidence that this fishery meets the criteria for "post-prey" status.		Otolith thermal marking of all hatchery-released Chinook shows that an average of 91.5% of the catch taken in the tribe's Tulalip Bay Chinook fishery during 2007-2018 originated from the tribal hatchery. No SRKW have been documented in the bay during recent decades.
		Indicator 3.1.2.1	Satisfied with high confidence.		
		Indicator 3.1.2.2			
		3.1.3 Negligible Effect			
		Indicator 3.1.3.1			
	3.2 Knowledge of Stock Risk				
		3.2.1 Exploitation	Indicators satisfied with high confidence, unless noted otherwise.	A	Carefully documented harvest data and marking of hatchery fish provide high confidence that the
		Indicator 3.2.1.1: Exploitation rate			

			Indicator 3.2.1.2: Reference points			tribal fishery selectively avoids wild Chinook and targets fish from Tulalip's hatchery, protecting escapement and spawning capacity in adjacent wild stocks. Available monitoring shows with high confidence that the fishery's incidental impacts on wild Chinook are kept safely below fishery exploitation limits designed to rebuild wild populations of Snohomish basin Chinook. Increasing evidence suggests that non-fishing impacts—habitat degradation and climate change—now constrain recovery.
			Indicator 3.2.1.3: Uncertainty and Error			
			Indicator 3.2.1.4: Compliance			
			Indicator 3.2.1.5: Timely Action			
			Indicator 3.2.1.6: ETP Species	This indicator is satisfied with moderate confidence.		
		3.2.2 Biomass		All indicators satisfied with high confidence.	A	
			Indicator 3.2.2.1: Monitoring			
			Indicator 3.2.2.2: Reference Points			
			Indicator 3.2.2.3: Uncertainty → Precaution			
			Indicator 3.2.2.4: Compliance			
			Indicator 3.2.2.5: Timely Action			
		3.2.3 Hatcheries		All indicators satisfied with high confidence.	A	Tulalip managers employ best practices in hatchery management, monitoring, marking, and precautionary response to uncertainties.
			Indicator 3.2.3.1: Hatchery management			
			Indicator 3.2.3.2: Monitoring			
			Indicator 3.2.3.3: Hatchery Marking and Tagging			
			Indicator 3.2.3.4: Uncertainty → Precaution			

Note: Any lines or sections left blank with greyed text are considered not applicable to the specific fishery under evaluation.

Evaluation Details and Notes:

1. Prey Interception Risk (Post Prey)

The fishery operates mainly in Tulalip Bay, a shallow, semi-enclosed body of water covering nine square miles, located just north of the Snohomish River mouth at the Tulalip Reservation. A small portion of the catch is taken in waters outside to the bay along the reservation shore.

Selectivity is achieved by tribal fishing rules and rigorously verified by data from the tribes' salmon-marking program. All Chinook from the tribes' hatchery are marked. The hatchery releases fish into the bay when they are ready to begin their ocean migration, feeding in the North Pacific for several years before returning to spawn. Tribal hatchery managers adjust the water temperature while young fish are rearing in the facility. This places a thermal mark on the otoliths (ear bones) of all hatchery Chinook raised by the tribe. When the fish return, the marked otoliths are collected and examined in a Tulalip laboratory.

These marking data show affirmatively that an average of 91.5% of the catch taken in the tribe's fishery during 2007-2018 originated from the Tulalip Bay hatchery (Mike Crewson pers. comm. 2020).

No documented sightings of Southern Residents in Tulalip Bay in recent decades were identified in reports designating critical habitat for SRKW (NMFS 2006) or the recent National Marine Fisheries Service (NMFS) proposal to expand critical habitat (NMFS 2019). Killer whales of unknown origin reportedly frequented Tulalip Bay and nearby open waters during salmon and herring runs in the early 20th Century (when both fish species were more abundant), according to the federal 2008 Recovery Plan for Southern Resident Killer Whales (NMFS 2008).

Not all killer whales in this region are Southern Residents, which rely on fish for food. Seal-eating killer whales were believed to visit waters near Tulalip in ancient times. Tulalip oral history and legends suggest a historical and cultural connection to seal-eating killer whales that are regarded as ancestors and benefactors to the tribes. These whales are credited with saving the Tulalip people from famine. According to one story shared by the tribes, one year strange climate conditions led to a shortage of game on land, and after a hungry winter the spring salmon run was consumed by seals: "Hordes of seals invaded the waters near Priest Point, chasing the salmon and devouring them before the people could catch any" (Tulalip Tribes website, undated). In despair, the starving people called out to their ancestors, two brothers who had been skilled seal hunters who "went to live in the ocean and became killer whales." In one version of this story, "the people called out to them for help, remembering that the two brothers had been expert at getting food for the people. The killer whales heard the peoples' call. They arrived and caught every seal. They ate the seal heads and tossed the seal bodies on the beach for the people. In that way, they saved the people from starvation and preserved the salmon run for coming generations." Another version of this story shared by the tribe reports that "the seals used to come frequently in the spring, and that the killer whales were called many times, not just once" (Tulalip, undated). Either way, the Tulalip's reverence for these seal-eating whales still resonates among tribal members today.

It is not known if the whales visiting the Tulalip area in the early 20th Century were fish-eaters such as SRKW or transient whales that eat predators of the fish, such as pinnipeds. Terry Williams, a tribal elder and longstanding Commissioner of Fisheries and Natural Resources for Tulalip Tribes (full disclosure: also a board member of NFCC), noted that the recent steep decline in local Chinook salmon populations (mainly due to habitat degradation) has depleted the main food source that might have had potential to attract fish-eating Southern Residents to waters near the Tulalip reservation in the past (Terry Williams pers. comm. 2019).

Marine biologists have noted a distinction in use of habitat by different killer whale populations, which informed NMFS's determination that SRKW avoid shallow inshore waters such as Tulalip Bay. The federal fisheries agency excluded waters shallower than 20 feet from designated critical habitat for SRKW inside Puget Sound (NMFS 2006), while noting that other killer whale populations do use these areas. "We do not consider extremely shallow waters of Puget Sound to be within the geographical area occupied by the species," states the agency's 2006 critical habitat report for the SRKW population. "This is in contrast to transient killer whales, which enter shallow water to capture seals and sea lions, and Northern Residents, which spend time in shallow water at rubbing beaches," the 2006 report authors noted.

2. Stock Risk

Exploitation and Biomass Risk

Note on Evaluation Method: Indicators are listed separately for exploitation and biomass, but they are combined for purposes of this evaluation because management practices address these forms of risk jointly. In practice, in salmon fisheries, exploitation and biomass standards are addressed by evaluating numbers of fish, not their weight, even though biomass remains a common and broadly applied term. Similarly, reference points based on Maximum Sustainable Yield (MSY) are still widely applied in policies such as the Magnuson-Stevens Fishery Conservation and Management Act, but in many salmon fisheries they have been supplanted by more precautionary metrics.

Indicators: Exploitation Rate, Compliance, & Timely Actions

Exploitation rate in this fishery meets all applicable limits on harvest, indicating that both managers and fishers are complying with policies governing exploitation rate and conservation of spawning potential. Timely action is reflected both in policies and in management actions that have reduced harvests to protect wild stocks.

The Tulalip Bay treaty tribal Chinook fishery selectively targets hatchery fish, which are produced according to best practices (see *Hatchery Risk* below). The fishery has no direct take of fish from natural spawning Chinook, which are now listed under the ESA. Because the fishery selectively targets hatchery fish in terminal waters within the bay, it has only incidental and minor impact on naturally spawning Chinook returning to the adjacent Snohomish River.

Incidental impacts from the Tulalip Bay fishery fall are kept safely below the 2017 harvest limits developed jointly by the Puget Sound Indian Tribes and Washington Department of Fish and Wildlife (WDFW). This plan sets exploitation rates to allow for rebuilding and reduces those rates when abundance is critically low.

In recent decades, declining stock productivity (linked to climate change impacts and habitat degradation) has required extraordinary action to reduce exploitation rates on wild stocks. To protect Snohomish wild Chinook stocks, total exploitation rates from coastwide fisheries were whittled down from over 60% in 1985 to less than 20% during 2010-2016. Tulalip's Chinook fishery's impact on these fish accounts for a fraction of the small (<3%) incidental mortality attributed to all treaty tribal fisheries, based on model analyses summarized by the Snohomish Basin Salmon Recovery Forum in 2019, originally from FRAM model runs.

Tribal and nontribal fisheries in the region have a strong record of compliance with exploitation limits. Even in the face of severe habitat damage and increasing climate impacts, state and tribal co-managers were able to keep coastwide fishery exploitation rates below the planned limits in all but one year in the decade from 2004-2014.

Managers also were able to modestly increase Snohomish River Chinook escapement during the decade to 2018. However, managers reported that escapement dropped sharply in 2019. Some biologists attribute this decline largely to the hot, fish-killing conditions experienced during 2015, the year much of the 2019 return was spawned. That year, large numbers of returning adult salmon died in their final passage toward spawning grounds in overheated Northwest rivers, resulting in a small year-class of fish returning in 2019.

Recovery of Puget Sound's endangered wild Chinook remains in question, primarily due to ongoing threats to habitat. Tribal and state co-managers of the Puget Sound Chinook fishery state: "Recovery for most populations cannot be accomplished solely by constraint of harvest. For the immediate future, harvest constraint will assist in providing optimal escapement, suited to current habitat condition. Productivity is constrained by habitat conditions, and is not influenced by harvest, provided harvest does not reduce escapement to the point of demographic or genetic instability. The quality and quantity of freshwater and estuarine environment determines embryonic and juvenile survival, and oceanic conditions influence survival up to the age of recruitment to fisheries. Physical or climatic factors, such as stream flow during the incubation period, will vary annually, and have been shown to markedly reduce smolt production in some years" (Puget Sound Indian Tribes & WDFW 2017).

The co-managers also noted that diminished productivity due to adverse habitat and climate conditions have kept the major Snohomish Chinook stock, the Skykomish, "at very low levels, while total natural escapement has either increased or held stable where hatchery supplementation programs exist…. It is evident that natural production has not increased under reduced harvest pressure and is constrained primarily by the condition of freshwater habitat. Therefore, the harvest rates governed by this plan are not impeding recovery."

In a 2019 Biological Opinion evaluating tribal and non-tribal fishery effects on ESA-listed stocks, NMFS affirmed that salmon fisheries in Southern U.S. waters (mainly Washington) have kept exploitation rates on Snohomish wild Chinook well below rebuilding rates in recent years, further indicating that harvests were not impairing recovery. The 2016 actual exploitation rate on Snohomish Chinook was 8%, well below the 15% management objective (NMFS 2019).

Indicators: Reference Points & Uncertainty → Precaution

Rebuilding Exploitation Rates (RER) were initially developed by Tulalip biologists (working with peers at WDFW and NOAA) as a tool for rebuilding Puget Sound salmon runs. The runs became so depleted, mainly by habitat damage, that Puget Sound commercial fishers petitioned to protect them under the Endangered Species Act in 1999. The RER framework has been widely adopted as a primary harvest control tool by federal, state, and tribal resource managers in Puget Sound. The goal is to ensure that any salmon catch still permitted in Washington waters leaves enough fish in the water not just to reproduce at today's levels, but to rebuild healthy natural-spawning populations.

The RER and other reference points for harvest vary by run, incorporating data on abundance, productivity, and, in some basins (including the Snohomish), habitat condition. These benchmarks are more conservative than a maximum-sustained yield (MSY) policy. This higher level of precaution is evident in the fact that exploitation rate on the Snohomish basin's naturally spawning Chinook averaged 17.5% under the RER policy during 2010- 2016. The 2017 Puget Sound Chinook Management Plan incorporated stepped reductions in fishing pressure to be applied when abundance is low, and for some runs, tighter catch limits that will be formally outlined in the next management plan (currently in development) are already being applied.

Among multiple precautionary restraints on fishing pressure, the 2017 management plan "prohibits directed harvest on natural origin populations of Puget Sound Chinook salmon unless they have a harvestable surplus," the plan authors noted. For the region's most depleted stocks, the plan drastically reduced exploitation rate ceilings—including any incidental catch—to protect spawning escapement. The thresholds stepping down exploitation are designed to keep spawner abundance well above the "point of instability," the level that represents high risk to populations.

Given these controls on exploitation, the plan authors affirmed that recovery of Puget Sound Chinook stocks in critical condition now hinges on improving habitat, not further cuts in harvest. "Improvement of these stocks' condition will not occur without significant actions to correct reductions in natural productivity and capacity due to loss and degradation of habitat," they stated. Even "complete closure of all fisheries is unlikely to improve the status of any critical MU" (management unit), the plan authors stated.

Tribal, state, and federal co-managers recognize and address uncertainty and its risks in multiple ways. The 2017 Puget Sound Chinook Management Plan noted that exploitation ceilings based on stock productivity (e.g., for naturally spawning Chinook in the Snohomish Basin) are subject to "uncertainty and bias, and harvest management is subject to imprecision." To address this, plan authors noted that the methodology for setting exploitation rate ceilings "considers specifically these sources of uncertainty and error and manages the consequent risk that harvest rates will exceed appropriate levels. The productivity of each management until will be periodically re-assessed, and harvest objectives modified as necessary."

Puget Sound Chinook fisheries are regulated with explicit recognition of uncertainties about impacts from interception fisheries that are outside the jurisdiction of state and tribal authorities. Authors of the Puget Sound Chinook Management Plan noted that persistent high exploitation of Snohomish Chinook by Alaska and British Columbia fisheries recently pushed Washington managers to reduce planned harvest rates deeply and repeatedly in local fisheries to protect spawning capacity.

Indicator: Endangered, Threatened and Protected (ETP) Species

Precautions undertaken by Tulalip Tribes and co-managers ensure that the fishery and the hatchery supporting it limit any potential impacts. The primary protected species of concern for the Tulalip Bay Chinook salmon fishery are wild spawning Chinook returning to the Snoqualmie and Skykomish tributaries of the nearby Snohomish River, which the fishery selectively avoids.

Entanglement of marine mammals and birds in this fishery is believed to be rare, so (unsurprisingly) no formal studies were found on fishery interactions with these species in Tulalip Bay. The tribal fishery in Tulalip Bay uses shallow setnets (WDFW & NWIFC 2019) that are tended continuously and limited to 300 feet in length under tribal fishing regulations. Continuous tending is necessary as a practical matter because agile seals and sea lions grab the catch from the net if fishers don't get there first. Bird bycatch is believed to be rare or nonexistent; one experienced tribal harvest manager reported that he had never heard of any bird entanglement in the Tulalip Bay fishery (Diego Holmgren, pers. comm. 6.2.2020).

In its 2017 Environmental Assessment of tribal and state hatchery programs in the Snohomish Basin, NOAA determined the risks to ESA listed Chinook salmon and steelhead were minimal, in terms of factors such as genetic diversity, competition, and disease transfer. The agency suggested that fish from the hatchery may benefit wild fish stocks by providing an alternative food source for salmon predators. Tulalip's hatchery program may supply additional prey for Southern Resident Killer Whales, harbor seals, sea lions, harbor porpoises, Dall's porpoises, and Pacific white-sided dolphins located in the bay or nearby marine waters, the authors noted.

Hatchery Risk

The relevant indicators for hatchery management, All-H integration, and precautionary response to uncertainty are satisfied by careful and closely scrutinized practices of the tribe under federal permits issued by NOAA.

From the start in 1983, Chinook production at the Bernie Kai-Kai Gobin Salmon Hatchery ("Tulalip Hatchery") at Tulalip Bay enabled the tribe to shift tribal fishing efforts away from vulnerable wild Chinook (more than a decade before these fish were listed under the ESA).

The hatchery supporting this harvest uses multiple methods to protect neighboring natural stocks of salmon from potential ecological and genetic impacts. These risks and mitigating practices were evaluated by NOAA in a 2017 Environmental Assessment (EA) of Snohomish Basin hatchery programs, including production of Chinook at Tulalip's Bernie Kai-Kai Gobin Hatchery supporting the Tulalip Bay fishery. The NOAA EA's key findings include:

- Hatchery fish pose a negligible risk in terms of predation on wild salmon and competition for resources because they are released into tributaries in Tulalip Bay where wild salmon and steelhead are not present. Additionally, for the same reason, any impacts on wild stocks from the facility itself are not detectible.
- The risk of disease spreading either within the hatchery or being transmitted to wild stocks was considered negligible based on effective compliance with health protocols.
- The risk of negative genetic effects on wild salmon was determined to be low since the hatchery integrates natural origin broodstock from the Skykomish Chinook populations. Additionally, it was determined that the limited take of natural broodstock does not have a detrimental impact on wild stock populations.
- Tulalip hatchery supplementation in fisheries was found to have no substantial adverse impacts, and EA authors noted potential beneficial outcomes: reducing catch of wild stocks and helping to stabilize escapement trends of wild fish.
- Tulalip operates its hatchery with an All-H integrated approach, linking management of hatcheries, habitat, harvest, and hydropower in terms of their impacts on salmon recovery. (Note: The Environmental Assessment notes the tribes' limited powers to control habitat damage beyond the reservation, and acknowledges the tribal view that any assessment of hatchery performance must recognize the extent to which habitat loss now constrains the ability of wild salmon to repopulate the basin.)
- The hatchery mitigates uncertainties of potential impacts through effective monitoring, research, and management strategies.

3. Knowledge Risk

Knowledge of Prey Interception Risk

Thermal marking of 100% of hatchery-released Chinook show affirmatively that an average of 91.5% of the catch taken in the tribe's Tulalip Bay Chinook fishery during 2007-2018 originated from the tribal hatchery (Mike Crewson pers. comm 2020). These data satisfy both the performance requirements and the confidence requirements of this standard.

No documented sightings of Southern Residents in Tulalip Bay in recent decades were identified. Federal reports designating critical habitat for SRKW (NMFS 2006) and a recently proposed significant expansion of habitat area (NMFS 2019) do note that orcas of unknown origin were observed in the area during the early 20th century. Killer whales that visited the tribes' shoreline in the distant past displayed hunting behaviors that identify them as transient, seal-eating killer whales, not fish-eating SRKW.

Knowledge of Stock Risk (Exploitation & Biomass)

Indicators: Exploitation Rate, Monitoring, & Compliance

Extensive, multi-method monitoring of exploitation rate and escapement allows managers to reliably gauge compliance with harvest policy, producing time series that document long-term performance against reference points and conservation limits.

Indicator: Reference Points

Reference points are derived from detailed historic and current understandings of stock productivity, reflecting expert judgment of tribal, state, and federal managers who carefully scrutinize each other's work to enforce both treaty and statutory obligations for conservation of Chinook stocks. Reference points incorporate stepped, abundance-based rules that protect spawning potential by restraining exploitation when abundance is low. Rebuilding exploitation rates generally limit harvest well below MSY levels. A critical exploitation rate limit at very low abundance serves a precautionary role similar to MSST, severely reducing fishing to preserve spawning capacity.

Indicator: ETP Species

Available data and known fishing practices suggest that interactions with protected species (e.g., birds and marine mammals) are limited. Federal evaluators noted (NOAA 2017) that the fishery and supporting hatchery may yield more benefit (via increased prey opportunity) than risk to protected predator species, including SRKW and pinnipeds. However, systematic observations (e.g., through a formal fishery observation program to document interactions with birds and pinnipeds) were not found.

Indicator: Timely Action

Monitoring of run-size, harvest, escapement, and other key parameters has produced time-series data showing compliance with conservation limits over decades. This compliance provides strong evidence that data and management systems enable managers to understand changing conditions and take timely actions when needed. The Tulalip Tribes' curtailment of fishing area and harvest in response to diminishing runs of salmon further confirm this evidence of timely action.

Indicator: Uncertainty and Error

The co-managers' policies and practices reflect recognition of uncertainties and errors that can increase risks to the resource, and commensurate measures to reduce that risk, both through advance planning and real-time precaution in response to changing conditions. Multi-method monitoring of key parameters and cross-checking by tribal, state, and federal managers produce a capable and cautious response to knowledge risks.

Knowledge of Stock Risk (Hatchery Risk)

Tulalip managers employ best practices in hatchery management, monitoring, marking, and precautionary response to uncertainties. The tribe actively drives coordinated multi-sector work to achieve true "all-H" risk management, in part by restoring and protecting habitat and, where possible, tightening controls on habitat degradation across the basin. As noted above (under the hatchery component of Stock Risk), the tribe applies best practices for control of potential hatchery impacts. Tulalip's thermal marking system generates adequate and reliable data on catch composition in the tribal hatchery-supported Chinook fishery in Tulalip Bay. Use of local broodstock and extensive monitoring of hatchery-origin fish in the Snohomish estuary and tributaries permits high confidence in evaluation of potential ecological and genetic impacts.

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