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TACOMA POWER
TACOMA PUBLIC UTILITIES

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Tacoma, Washington 98409-3192

TACOMA PUBLIC UTILITIES

ELECTRONIC FILING

October 2, 2020

Kimberly D Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, N.E.
Washington, DC 20426

SUBJECT: City of Tacoma, Cowlitz River Project, FERC No. 2016 License Article 6, 2020 Fisheries and Hatchery Management Plan

Dear Secretary Bose:

The City of Tacoma (Tacoma Power) hereby is submitting the Fisheries and Hatchery Management Plan (FHMP) required by the Cowlitz Settlement Agreement Article 6, the Order Issuing License, Appendix A, Article 6, and the Order Modifying and Approving Fisheries Management Plan, Article 6.

Tacoma's most recent FHMP was approved by FERC on October 14, 2014. In that Order FERC required that the licensee's next FHMP be filed with the Commission by April 18, 2016 to remain consistent with the 6-year cycle provided under paragraph (K) of the April 2006 Order. However, because of technical disagreements within the Fisheries Technical Committee (FTC) pertaining to proposed modifications to the FHMP and to complete the technical work, conduct more than a dozen collaborative workshops with the FTC, hold several public meetings, and to accommodate an extensive review of the details of the FHMP by both the FTC and the public, Tacoma did not file the FHMP by April 18, 2016 and instead requested several extensions of time. In its most recent Order Granting Extension of Time, dated March 9, 2020 ("March 9, 2020 Order"), the Commission extended the deadline for filing the updated FHMP until October 18, 2020.

The final draft of this document was developed under the schedule collaboratively developed by the FTC and described in the letter to the Commission from Tacoma dated October 18, 2019. The FHMP filed on this date is the result of considerable effort by the FTC and Tacoma Power to meet the goals of restoration and recovery of natural stocks in the Cowlitz River basin while continuing to produce fish for harvest.

Due to the complex fisheries topics involved, the FHMP adopts an adaptive management approach that involves the development of several Transition Plans and an updated Monitoring and Evaluation Plan within one year of submitting the FHMP to the Commission. It also includes an Annual Program Review, which incorporates steps for data collection, data analysis, results reporting, and decision making and planning.

Additionally, this plan describes the intent to operate under a 10-year cycle, rather than the previous 6-year cycles with the intent of revising this plan 10 years from this submittal.

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Tacoma is currently working towards submittal of a request to modify Article 6 by the end of 2020 to ensure consistency between this FHMP and the License.

If you have any questions regarding this submittal, please do not hesitate to contact Matt Bleich, Adaptive Program Manager, at 253-337-1079.

Sincerely,

Keith Underwood

Keith Underwood,
Natural Resources Manager

Attachment

cc: Federal Energy Regulatory Commission, Portland Regional Office
Fisheries Technical Committee

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Fisheries and Hatchery Management Plan (FHMP)

Final

Cowlitz Hydroelectric Project

FERC No. 2016

Tacoma Power

3628 S 35th Street

Tacoma, WA 98409

October 2020

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Acronyms and Abbreviations

AOP	Annual Operating Plan
APR	Annual Program Review
BPA	Bonneville Power Administration
BY	brood year
CAA	Coastal Conservation Association
CSFP	Lower Columbia Conservation and Sustainable Fisheries Plan
CWT	coded wire tag
DIP	demographically independent population
DNA	deoxyribonucleic acid
DPS	distinct population segment
EDT	Ecosystem Diagnosis & Treatment
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FERC	Federal Energy Regulatory Commission
FHMP	Fisheries and Hatchery Management Plan
fpp	fish per pound
FPS	Fish Passage Survival
FTC	Cowlitz River Fisheries Technical Committee
HGMP	Hatchery and Genetic Management Plan
HOR	hatchery-origin
HSRG	Hatchery Scientific Review Group
IHN	infectious hematopoietic necrosis
IHOT	Integrated Hatchery Operations Team
ISAB	Independent Scientific Advisory Board
ISIT	In-Season Implementation Tool
LCFRB	Lower Columbia Fish Recovery Board
M&E	Monitoring and Evaluation
NMFS	National Marine Fisheries Service
NOAA Fisheries	National Oceanic and Atmospheric Administration, National Marine Fisheries Service
NOR	natural-origin
NPPC	Northwest Power Planning Council
NWFSC	Northwest Fisheries Science Center
ODFW	Oregon Department of Fish and Wildlife
pHOB	proportion of hatchery-origin broodstock
pHOS	proportion of hatchery-origin spawners in nature
PIT	Passive Integrated Transponder
PNI	proportionate natural influence
pNOB	proportion of natural-origin salmon in the hatchery broodstock
PUD	Public Utility District
QA/QC	Quality Assurance/Quality Control
R/S	recruits per spawner
rkm	river kilometer
RMIS	Regional Mark Information System
RSI	Remote Site Incubation
SA	Settlement Agreement
SAFE	Select Area Fishery Enhancement

SAR	smolt-to-adult return
SPS	smolt passage survival
TRT	Technical Recovery Team
TSAR	total smolt-to-adult return
USFWS	U.S. Fish & Wildlife Service
VSP	Viable Salmonid Population
WDF	Washington Department of Fisheries
WDFW	Washington Department of Fish and Wildlife
WDG	Washington Department of Game
WDOE	Washington Department of Ecology
WRIA	Water Resource Inventory Area

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CHAPTER 1:
INTRODUCTION

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1. Introduction

The Cowlitz River was once highly productive and the major drainages supported fifteen populations of five species of native anadromous salmonids (Chinook Salmon *Oncorhynchus tshawytscha*, Chum Salmon *O. keta*, Coho Salmon *O. kisutch*, winter steelhead *O. mykiss*, and sea-run Cutthroat Trout *O. clarkii*; Table 1-1). These runs originally supported subsistence fisheries and later commercial and recreational fisheries, but the natural-origin portions of most of these runs have been diminished to a fraction of their former abundance and some have been functionally extirpated. Every endemic population of anadromous salmonid in the Cowlitz River above Mayfield Dam was greatly diminished or extirpated due to the construction of Mayfield and Mossyrock dams (Myers et al. 2006). However, a wide range of factors contributed to population declines, both before and since dam construction, including long periods of overharvest, habitat loss and alteration, introduced species, and hatchery production (LCFRB 2010).

The history of the Cowlitz River salmon populations is similar to those of other Columbia Basin populations, in which the combination of overharvest and habitat degradation caused population abundances to decline through the mid-1900s. Canneries opened in the 1860s and led to chronically unsustainable harvest levels. Intensive logging, including the use of splash dams to transport logs downstream and denuding hillsides, resulted in degradation of spawning and rearing habitats (GAIA Northwest, Inc. 1994). The construction of Mayfield and Mossyrock dams in the 1960s and further land use development resulted in reduced abundance of all populations and drove many to extinction (Myers et al. 2006). The dams blocked access to habitat above dams, inundated riverine habitat, and made downstream migration much more difficult. Gravel mining and other land use practices destroyed or severely damaged the habitat that remained. Blocked upstream passage also resulted in the aggregation of the formerly distinct populations. Salmon and steelhead from above Mayfield Dam were forced to spawn in the Lower Cowlitz Subbasin or were captured, along with Lower Cowlitz Subbasin salmon, for use in hatchery broodstock. At times, groups of fish not distinguished by population were sometimes captured and transported above Mayfield Dam.

The subsequent intensive hatchery programs were used to mitigate hydroelectric system impacts. These programs produced adults for harvest but further diminished the remaining natural-origin populations (Lichatowich 2001). The original broodstock for all hatchery programs (for endemic stocks) came from adults that returned to Mayfield Dam, which resulted in the hatchery populations being an aggregate of all historical populations upstream of Mayfield Dam with some strays from the lower river habitats and likely still contain a portion of the genetic legacy of those populations (Table 1-2). Hatchery production was intended to mitigate for lost natural production and provided (and continues to provide) a positive economic benefit to a broad region, but it came at a cost to the remnant natural populations. After Mossyrock Dam eliminated anadromous salmonid runs in the upper Cowlitz River, the hatcheries became the primary source for the fish to reestablish these runs. Mayfield Dam continued to have juvenile and adult fish passage, but, while these hatchery programs provided a demographic boost to salmon populations, as a whole, they did not result in an increase in natural-origin abundance. The hatcheries supported large fisheries that were not selective for the hatchery-origin salmon, resulting in further reduced abundance of natural-origin salmon, until mass marking of hatchery salmon allowed for mark-selective fisheries. Also, large numbers of hatchery-origin salmon escaped the fisheries and spawned in nature, which reduced the reproductive fitness of the natural-origin salmon by up to 50% for Cowlitz Basin salmon and steelhead populations (HSRG 2009; LCFRB 2010).

Table 1-1. Baseline viability status, viability and abundance objectives, and productivity improvement targets for Cowlitz River Chinook Salmon, Chum Salmon, Coho Salmon, and steelhead populations (from Table 6-1; LCFRB 2010).

	Baseline Viability[2]						Natural-origin Abundance		
Run, Population, Recovery Priority[1]	Abundance & Productivity	Spatial Structure	Diversity	Net Status[3]	Viability Objective[4]	Productivity Improvement[5]	Historic[6]	Baseline[7]	Min. Viability Abundance Target[8]
Chinook Salmon									
Fall									
Lower Cowlitz River									
Contributing	VL	H	M	VL	M+	50%	24,000	500	3,000
Upper Cowlitz Subbasin (includes the Cispus, upper Cowlitz, and Tilton rivers)									
Stabilizing	VL	VL	M	VL	VL	--	28,000	0	--
Spring									
Upper Cowlitz River									
Primary	VL	L	M	VL	H+	>500%	22,000	300	1,800
Cispus River									
Primary	VL	L	M	VL	H+	>500%	7,800	150	1,800
Tilton River									
Stabilizing	VL	VL	VL	VL	VL	0%[9]	5,400	100	--
Chum Salmon									
Fall									
Cowlitz River									
Contributing	VL	H	L	VL	M	>500%	195,000	<300	900
Summer									
Cowlitz River									
Contributing	VL	L	L	VL	M	>500%	NA	NA	900
Coho Salmon									
Lower Cowlitz River									
Primary	VL	M	M	VL	H	100%	18,000	500	3,700

	Baseline Viability[2]						Natural-origin Abundance		
Run, Population, Recovery Priority[1]	Abundance & Productivity	Spatial Structure	Diversity	Net Status[3]	Viability Objective[4]	Productivity Improvement[5]	Historic[6]	Baseline[7]	Min. Viability Abundance Target[8]
Upper Cowlitz River									
Primary	VL	M	L	VL	H	>500%	18,000	<50	2,000
Cispus River									
Primary	VL	M	L	VL	H	>500%	8,000	<50	2,000
Tilton River									
Stabilizing	VL	M	L	VL	VL	0%[9]	5,600	<50	--
				Steelhead					
Winter									
Lower Cowlitz River									
Contributing	L	M	M	L	M	5%	1,400	350	400
Upper Cowlitz River									
Primary	VL	M	M	VL	H	>500%	1,400	<50	500
Cispus River									
Primary	VL	M	M	VL	H	>500%	1,500	<50	500
Tilton River									
Contributing	VL	M	M	VL	L	>500%	1,700	<50	200

1. Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance targets.
2. Viability status is based on Technical Recovery Team viability rating approach. VL = Very Low (>60% chance of extinction over the next 100 years); L = Low (26-60% chance of extinction).
3. The net baseline status is equal to the lowest of the attribute ratings.
4. Viability objective is based on the scenario contribution. VL = Very Low (>60% chance of extinction); L = Low (26-60% chance of extinction); M = Medium (6-25% chance of extinction); H = High (1-5% chance of extinction); VH = Very High (<1% chance of extinction).
5. Improvement is the relative increase in population production required to reach the prescribed viability goal.
6. Historical population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS professional judgment calculations.
7. Approximate mean annual number of naturally produced fish returning to the watershed in the 1990s.
8. Abundance targets were estimated by population viability simulations based on minimum viability goals. No minimum viability abundance target was set for Stabilizing populations.
9. Improvement increments are based on abundance and productivity; however, this population will require improvements in spatial structure or diversity to meet minimum viability abundance target.

Table 1-2. Historical populations of anadromous salmonids in the Cowlitz River and potential remaining genetic legacy (Table 4-1 from 2004 FHMP).

Species, Run, Historical Population	Potential Genetic Legacy
Chinook Salmon	
Fall Lower Cowlitz River Upper Cowlitz River	Lower Cowlitz River and Cowlitz Salmon Hatchery fall Chinook Salmon populations are believed to be a mixture of all historical Cowlitz River fall Chinook Salmon populations. Between 1953 and 1993, 92% of all fall Chinook Salmon released into the Cowlitz River were from Cowlitz Salmon Hatchery.
Spring Cispus River Upper Cowlitz River Tilton River	Cowlitz Salmon Hatchery spring Chinook Salmon population is believed to be a mixture of all historical Cowlitz River spring Chinook Salmon populations. Between 1948 and 1993, 96% of all spring Chinook Salmon released into the Cowlitz River were from Cowlitz Salmon Hatchery.
Chum Salmon	
Summer Cowlitz River Fall Cowlitz River	Wild salmon only, no hatchery program.
Coho Salmon	
Lower Cowlitz River Cispus River Upper Cowlitz River Tilton River	Lower Cowlitz River and Cowlitz Salmon Hatchery Coho Salmon populations are believed to be a mixture of all historical Cowlitz River populations.
Steelhead	
Winter Lower Cowlitz River Cispus River Upper Cowlitz River Tilton River	Lower Cowlitz River and Cowlitz Trout Hatchery late winter steelhead populations are assumed to be a mixture of all historical Cowlitz River winter steelhead populations.
Cutthroat Trout	
Coastal Cowlitz River	Population present. Cowlitz Trout Hatchery has developed an anadromous population from returns to the hatchery using stock from the Upper Cowlitz and Tilton subbasins to start the program.

As a result, all endemic populations of Cowlitz River Chinook Salmon, Chum Salmon, Coho Salmon, and steelhead were listed as threatened under the Endangered Species Act (ESA) between 1998 and 2005. Since then, recovery plans have been developed, and efforts have been made to protect and bolster the Cowlitz Basin populations and to reintroduce the populations above the hydropower system; however, hydropower licensing goals and, in many cases, minimum viability abundance targets (as defined below) have not been reached. For anadromous salmonid populations in the Cowlitz River, the hydropower system, habitat, harvest, and hatcheries are the key limiting factors (LCFRB 2010). All populations remaining in the lower Cowlitz River are still considered to be at high or very high risk of extinction (NMFS 2013).

The decline of these populations has caused negative ecological, sociological, and economic impacts, and a variety of actions are being taken to reverse those detrimental impacts. Mitigation hatcheries were developed to replace the lost production of areas that were flooded by reservoirs or became inaccessible, and to mitigate for the inevitable ecological impacts of hydroelectric development to the lower Cowlitz River ecosystem. In addition to mitigating for lost production, these hatcheries now supplement the remaining extant populations, and hatchery salmon of native stock have been used in an effort to reintroduce salmon to their historic habitat in reaches above the dams.

To meet ESA-related recovery goals, Cowlitz River salmon and steelhead must be restored to Medium or High levels of population viability, referred to as "minimum viability abundance targets" (<25% risk of extinction over the next 100 years). Recovery of each salmon and steelhead population requires healthy and harvestable levels, as defined by LCFRB (2010). Health is defined based on species status. A species is considered healthy when it is recovered to viable levels where it is no longer in danger of extinction or likely to become endangered within the foreseeable future and can be removed from listing under ESA. A species is harvestable when it is viable and when fish numbers are sufficient to allow direct and sustainable sport, commercial, and tribal harvest without jeopardizing the species' viability.

Moving forward, the goal of this Fisheries and Hatchery Management Plan (FHMP) is to continue our progress in developing a rigorous management program for Cowlitz River anadromous salmonids. We begin by recognizing the shared interests and goals of all interested parties, as well as their differences, in an effort to embrace collaboration and cooperation. We fully embrace adaptive management with the understanding that it can only be accomplished when we have sufficient information, both in quantity and in quality, to make informed decisions. Improvements to the existing monitoring program and best management practices (Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017) (in the hatchery, at collection facilities, and in nature) will be the result of the information collected through monitoring and evaluation in an effort to improve our ability to effectively manage these populations. These activities will be conducted with the collaboration of state and federal agencies, under the umbrella of the Federal Energy Regulatory Commission (FERC) license to operate the Cowlitz River Hydroelectric Project (FERC 2002, 2004) and the Biological Opinion (NOAA Fisheries 2004), within the framework of the recovery plans (LCFRB 2010; NMFS 2013) and with the recommendations of the Cowlitz River Fisheries Technical Committee (FTC).

1.1 Federal Energy Regulatory Commission License

FERC issued the original license for the Cowlitz River Hydroelectric Project in 1951. This license expired in 2001, at which point the Project operated pursuant to an annual license until the Project was relicensed in 2002 for a period of 35 years (FERC 2002, 2004).

1.1.1. Settlement Agreement

The Cowlitz River Hydroelectric Project Settlement Agreement (Settlement Agreement; SA) was signed in 2000 (Tacoma Power et al. 2000) and incorporated into the new license (FERC 2002, 2004). Parties to the SA included the following: Tacoma Power; Washington Department of Fish and Wildlife (WDFW); Washington Department of Ecology (WDOE);

Washington State Parks and Recreation Commission; United States Fish and Wildlife Service (USFWS); National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries); United States Forest Service - Gifford Pinchot National Forest; Recreation and Conservation Office (formerly the Interagency Committee for Outdoor Recreation); Lewis County; Confederated Tribes and Bands of the Yakama Nation; and three Conservation Groups (Washington Council of Trout Unlimited, Sport Fishing Guides of Washington, and American Rivers). The purpose of the Cowlitz River Hydroelectric Project Settlement Agreement (Section 5.1; Tacoma Power et al. 2000) is to:

> *"resolve, to the satisfaction of the Parties, all issues associated with issuance of a new license for the Project regarding fish passage, fish production, fish habitat, water quality, instream flows, wildlife, recreation and cultural and historic resources. This Agreement establishes Tacoma's obligations for the protection, mitigation and enhancement of natural resources affected by the Project under a new license issued by FERC. It also specifies procedures to be used among the Parties to ensure the implementation of those license articles consistent with this Agreement, and with other legal and regulatory mandates, including but not limited to those described in Sections 4.2 and 4.3 above. It is the intent of the Parties to establish a framework for future collaborative efforts for the protection, mitigation and enhancement of the natural resources of the Cowlitz River basin."*

Section 6.1.1 of the SA, titled Guidance for Future Interpretation and Decision Making, states:

> *"The emphasis of this agreement is ecosystem integrity and the restoration and recovery of wild indigenous salmon runs, including ESA-listed indigenous and unlisted stocks to harvestable levels."*

This is the first and most important priority of the Settlement Agreement.

The SA also recognizes the importance of harvest, stating in Section 6.1.2 that:

> *"Fisheries obligations will be met through a combination of effective upstream and downstream passage, habitat restoration and improvement, an adaptive management program to restore natural production coupled with continued artificial production program to compensate for unavoidable impacts at levels consistent with ESA recovery, and providing fish production for sustainable fisheries."*

Section 6.15 further accentuates the hatchery production as it relates to recovery directing that:

> "*Fisheries management and hatchery production will be consistent with the overall goal of restoring and recovering wild stocks in the Cowlitz River basin. The hatchery complex will be designed with flexibility so managers can employ innovative rearing practices, low densities, and replication of historic fish out-migration size and timing."*

Section 6.1.6 reiterates the importance of the recreational fishery but emphasizes that recovery of indigenous stocks is the priority:

> *"Maintenance of a recreational fishery is important. Implementation of the wild salmonid recovery measures shall allow for the continued support of a recreational fishery on the Cowlitz River, including the production of non-indigenous stock, provided this is*

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consistent with the priority objective to maximize the recovery of wild, indigenous salmon stocks."

By signing the SA, the signatories committed to the continued advancement of the goals listed above.

1.1.2. Applicable License Articles

The Settlement Agreement (2000) contains an appendix with 25 license articles addressing specific issues, such as water quality, quantity, flow, and ramping requirements; fish and wildlife, including species listed under the ESA; habitat; Tacoma Power's comprehensive operations and development plans and capabilities; recreation; cultural resources; and compliance with the Federal Power Act.

- Article 1: Downstream Fish Passage: Riffe Lake and Cowlitz Falls Collection and Passage
- Article 2: Downstream Fish Passage: Mayfield
- Article 3: Upstream Fish Passage: Barrier, Mayfield, and Mossyrock
- Article 4: Juvenile Tagging and Monitoring
- Article 5: Fish Production and Hatcheries
- Article 6: Fisheries and Hatchery Management Plan
- Article 7: Hatchery Complex Remodel and Phase-In Plan
- Article 8: Disease Management Plan
- Article 9: Large Woody Debris
- Article 10: Gravel Augmentation
- Article 11: Fish Habitat Fund
- Article 12: Coordination with Wildlife Settlement Wetlands Acquisition Fund
- Article 13: Instream Flows
- Article 14: Ramping Rate Conditions
- Article 15: Fish Monitoring Plan
- Article 16: Instream Flow Implementation
- Article 17: Recreation Facilities
- Article 18: Recreation Operation, Maintenance, and Safety
- Article 19: Water Access Facilities
- Article 20: Recreation Reporting
- Article 21: Forest Service Facilities
- Article 22: Forest Service Report
- Article 23: Cultural and Historic Resources
- Article 24: Wildlife
- Article 25: Reservation of Commission Authority

Eight of the articles pertain directly to fish and/or their management (License Articles 1-8), and an additional six articles address fish habitat (9-11 and 13-15).

License Articles 1, 2, and 3 address fish passage, both upstream and downstream, for anadromous salmonids. Juvenile migrants (smolts) are captured at facilities at Cowlitz Falls and Mayfield dams for transport or bypass around the dams and release into the Cowlitz River to continue their migration to the ocean. Mature salmon are collected at the Barrier Dam Adult Facility and transported above Mayfield Dam to the Tilton River and above Cowlitz Falls Dam to the Cispus and upper Cowlitz rivers in the Upper Cowlitz Subbasin. License Article 8 addresses

Ceratonova (Ceratomyxa) shasta and other diseases related to hatchery conditions and the transport of fish upstream of Mayfield Dam.

License Article 5 identifies fish production and hatchery obligations in the near and long term. Tacoma Power is to fund the operation and maintenance of the Cowlitz Hatchery Complex, consisting of the Cowlitz Salmon Hatchery, Cowlitz Trout Hatchery, and three satellite rearing facilities (yet to be developed). Indigenous populations to be supplemented by hatchery production are: fall Chinook Salmon, spring Chinook Salmon, Coho Salmon, late winter steelhead, and sea-run Cutthroat Trout. Non-indigenous stocks of steelhead (e.g., summer and early winter steelhead) and Rainbow Trout *O. mykiss* that are important to the angling community may also be produced, provided that production shall emphasize the recovery of indigenous stocks. License Article 5 also defines various factors influencing production levels and directs Tacoma Power to fund any monitoring required for adaptive management at the hatcheries, as included in the Fisheries and Hatchery Management Plan required by License Article 6 (see below).

Pursuant to License Article 11, Tacoma Power established a fish habitat fund for the purpose of fisheries habitat protection, restoration, and enhancement in the lower Cowlitz River through acquisition, easements, or restoration projects. Tacoma Power established this fund in 2004 and submits annual reports detailing the use of funds to FERC. As of October 2019, 535.96 acres within the Lower Cowlitz Subbasin have been acquired.

Tacoma Power's habitat restoration activities in the lower Cowlitz River include large woody debris placement (required by License Article 9) and gravel augmentation (License Article 10). A total of 183 linear meters of large woody debris and 382 m^3 of gravel are intended to be placed in the lower Cowlitz River annually. Tacoma Power has identified river reaches suitable for restoration and protection in the Upper Cowlitz Subbasin (License Article 3), but no actions have been taken to date.

License Article 15 mandated that a plan be developed to monitor the effects of the instream flow requirements of the new license on the Cowlitz River fishes. The plan then became a license requirement.

The 25 SA articles were incorporated into the 2002 FERC license, which was stayed by FERC action and not made effective until 2003. In addition, the license contained 4(e) Conditions (License Appendix B), Water Quality Certification Conditions (License Appendix C), and Section 18 Prescriptions (License Appendix D). In addition to those from the SA, the 2002 license added 13 new license articles:

- Article 201: Annual Payments
- Article 202: Drawings and Exhibits
- Article 203: Headwater Benefits
- Article 301: Revised Exhibits After Construction
- Article 302: Construction Notification to FERC for Articles 1,2,3
- Article 303: Pool Elevations and Flood Regulation
- Article 401: Plan to Abandon Volitional Upstream Fish Passage
- Article 402: Annual Instream Flow Monitoring Report
- Article 403: Historic Preservation
- Article 404: Archaeology Monitoring Plan
- Article 405: Public Information Management Plan
- Article 406: Fish Passage Facilities
- Article 407: Use of Project Lands

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On 18 July 2003 (license effective date), the license stay was lifted and one additional license article (408) was added:

- Article 408: Implementing Future Biological Opinion

In 2004, an amendment of the new license (FERC 2004) was issued by FERC. It included a new Appendix E (Construction Practices Near Water and Pollution and Erosion Control Plan), modified two previous articles (401 and 402), and added several additional license articles (409-417):

- Article 409: Lower Cowlitz River Side Channel Habitat
- Article 410: Water Quality Monitoring
- Article 411: Fisheries and Hatchery Management Plan - modified Settlement Article 6 in 2004 to include a “Chum Salmon analysis.”
- Article 412: Agency-Specified Stream Flows
- Article 413: Trap and Haul Plan
- Article 414: Adaptive Management
- Article 415: Final Fish Passage Plan
- Article 416: Control Sediment During Construction in or Near Waterways
- Article 417: Minimize Impact to Listed Fish while Addressing Articles 9 and 10

1.2 Fisheries and Hatchery Management Plan (FHMP)

License Article 6 of the Cowlitz River Hydroelectric Project Settlement Agreement (Tacoma Power et al. 2000) and the FERC license order (FERC No. 2016; FERC 2002) directed Tacoma Power to develop a Fisheries and Hatchery Management Plan (FHMP) for managing supplemented Cowlitz River salmonid populations. The text of Settlement Agreement and License Article 6 is as follows:

> *“Within 9 months of license issuance, the Licensee shall submit a Fisheries and Hatchery Management Plan. The plan shall be updated every 6 years, starting in year 7, of the license. The plan shall identify: a) the quantity and size of fish to be produced at the Cowlitz Hatchery Complex; b) rearing and release strategies for each stock, including upward and downward production adjustments to accommodate recovery of indigenous stocks; c) credit mechanisms for production of high quality natural stocks; d) plans for Licensee-funded on-going monitoring and evaluation; and e) a fisheries management strategy consistent with the priority objective of maximizing the natural production of wild indigenous fish stocks and species in the basin. The Licensee shall prepare the plan in collaboration with the Fisheries Technical Committee provided for in the August 2000 Settlement Agreement, or if the Settlement Agreement has become void, with the U.S. Fish and Wildlife Service, National Marine Fisheries Service, Washington Department of Fish and Wildlife and Washington Department of Ecology (referred to as “the FTC or agencies”). When a draft plan has been prepared, it shall be provided to all affected agencies and Tribes for 30-day review and comment. The Licensee shall include with the final plan documentation of consultation and copies of comments and recommendations, and specific descriptions of how the final plan accommodates all comments and recommendations. If the Licensee does not adopt a recommendation, the filing shall include the Licensee’s reasons, based on Project-specific information. The Commission reserves the right to make changes to the plan. Upon Commission approval, the Licensee shall implement the plan, including any*

changes required by the Commission. Following Commission approval, the plan becomes a requirement of the license, enforceable by the Commission."

License Article 6 also directed the creation of the Cowlitz River Fisheries Technical Committee (FTC), which is comprised of seven representatives - one from each of Tacoma Power, NOAA Fisheries, USFWS, WDFW, WDOE, the Yakama Nation, and one representative from the Parties included in the Conservation Groups. The FTC assists Tacoma Power with implementation of the terms of the SA by advising Tacoma Power in the review of plans (such as the FHMP), monitoring plans and studies, reviewing and evaluating resulting data, and decisions on adaptive management measures associated with the fisheries measures.

In its 2004 Order Amending New License, FERC (2004) added the requirement that the FHMP "shall include a Chum Salmon analysis and be updated at 6-year intervals." The initial FHMP was submitted in 2004 and approved by FERC in 2006 (115 FERC ¶ 62,029). A second FHMP was updated in 2011 and approved by FERC in 2014 (149 FERC ¶ 62,032). As the previous two plans have, this FHMP addresses fall and spring Chinook Salmon, Chum Salmon, Coho Salmon, winter and summer steelhead, and Cutthroat Trout populations and guides Cowlitz River fisheries and hatchery management. This FHMP will replace the 2004 and 2011 update. As described in Chapter 12, Adaptive Management: Annual Program Review and Annual Operating Plan, Tacoma Power and the FTC are proposing an amendment to change the interval for revising the FHMP. Rather than the current 6-year revision process as specified under License Article 6 and FERC's 2004 Order Amending New License, the FHMP will be revised every 10 years, with input and support from the FTC. If major changes and/or revisions beyond Annual Program Review (APR) issues were deemed necessary by the FTC, a revision could be completed within the 10-year period.

Each FHMP is to be developed in collaboration with the FTC. This FHMP represents an extensive revision of the two previous (i.e., 2004 and 2011) FHMPs, and we have revised the strategies and/or have developed a process for revising strategies for each species, based on the best available science, strategies to make steps toward recovery goals, and maintain angler opportunity. This has been done through extensive consultation with the FTC, including six separate Monitoring and Evaluation and Management Workshops to address areas of disagreement and information gaps for each species and population. These workshops were successful in developing agreed-upon management themes for each species and population, which are presented in the appropriate species and population sections below (Chapters 3-9). Additionally, a second round of five workshops was conducted to identify and address unresolved issues in the October 2019 Draft FHMP during the FTC review period (November 18, 2019 – May 30, 2020), as well as a sixth workshop to develop an Interim Plan for a single unresolved topic, which is included as a White Paper in Appendix D (Fall Chinook Salmon Broodstock Collection). In compliance with License Article 6, a draft final version of the 2020 FHMP was distributed for a 30-day public review and comment period in August 2020. Tacoma Power also hosted a virtual public meeting on August 12, 2020, to present the draft final FHMP and provide an opportunity for questions and comments. More details on the public review and comment period, including Tacoma Power's responses to comments received, are presented in Appendix E.

Lastly, we have developed a "Big Table" for each species, which provides metrics to be monitored for each species and population; goals, where appropriate, for those metrics; and documentation of the most recent 5-year means for those metrics and FHMP and minimum viability abundance targets for those metrics, where appropriate. The Big Table Dataset (Appendix A) will be accessible to all FTC members and will be linked to one or more databases so that they can be continually updated with the most recently available data. As such, this extensively revised FHMP supersedes the two previous versions and addresses fall and spring

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Chinook Salmon, Chum Salmon, Coho Salmon, winter steelhead, summer steelhead, and Cutthroat Trout populations, and guides Cowlitz River fisheries and hatchery management and population monitoring and evaluation needs.

During the period covered by this 2020 FHMP, Tacoma Power and the FTC will develop Transition Plans for the fall Chinook, spring Chinook, Coho Salmon, and winter steelhead programs in order to continue recovery efforts. For additional information on the Transition Plans, see Chapter 12 and Appendix B.

The data presented in this 2020 FHMP are the most recently available, consolidated for FTC consideration. The data presented are preliminary, pending a full quality assurance/quality control (QA/QC) review of the Big Tables (Appendix A) by the Monitoring & Evaluation (M&E) Subgroup for accuracy and source. Some of the data reported in this 2020 FHMP are from the In-season Implementation Tool (ISIT), which is a tool that relates natural and hatchery population metrics to hatchery program adjustments, and stores information needed for the tool to operate. M&E efforts have made considerable improvements in recent years and over the term of the last FHMP. However, not all data collected are currently housed in or utilized by the ISIT tool, and the ISIT tool has not been updated during the last FHMP period. During this FHMP period, all data required to achieve FHMP objectives will need to be consolidated into a single database that can be used for analysis and reporting. Moving forward, the intended approach is to develop standardized methods for each measure or calculation to the degree possible. A work plan will be developed following completion of this FHMP to identify and prioritize metrics within 1 year. Additional information on the use of ISIT and its relationship to the “Big Tables” is presented in Section 10.3.1.

1.2.1. Purpose of the Fisheries and Hatchery Management Plan

The FHMP is used for managing the Cowlitz Salmon Hatchery, Cowlitz Trout Hatchery, and the endemic anadromous salmonid populations in the Cowlitz Basin. FERC License No. 2016 (FERC 2002, 2004) directs Tacoma Power to implement measures to restore and recover natural-origin populations of indigenous anadromous salmonids in the Cowlitz Basin (primary emphasis), while continuing to support sustainable fisheries, including important recreational fisheries. This dual (restoration and harvest) mandate is a consideration in all of the recommended actions in this FHMP.

To effectively restore and manage these populations, the appropriate information is needed at the required level of detail relating to each population’s recovery phase. Therefore, we have added additional performance standards and metrics to be monitored and evaluated so that we can better assess the program and how well it is achieving its goals during each recovery phase.

Population recovery is the ultimate goal for all involved with managing depleted, threatened, or endangered species. While population recovery is an integral component of every aspect of this FHMP, it is designed to be a flexible document that provides attainable goals for the FHMP period, while allowing that recovery may require more time to achieve. It is a guide that provides clear direction for achieving those goals, which are steps toward achieving the long-term minimum viability abundance targets and population recovery. Each FHMP is a stepping stone on the path to recovery of these populations. In this FHMP, we provide two sets of goals:

- **Long-term Goals**: The long-term goal for all of these populations is full recovery to a viable salmonid population (McElhany et al. 2000) that returns at healthy and harvestable levels (LCFRB 2010). The directional goals and specific targets for each

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population come from the Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010) and the ESA Recovery Plan (NMFS 2013). Throughout Chapters 3-9, these goals are sometimes characterized as still requiring definition.

- **FHMP Goals:** Goals that we plan to achieve during the period of this FHMP. These are intended to serve as stepping stones toward recovery by addressing specific factors inhibiting our understanding of each population and its progress toward recovery. FHMP goals may be directional (increase or decrease) or specific targets (e.g., numbers of natural-origin salmon spawning in nature, proportion of natural-origin salmon in the hatchery broodstock [pNOB], proportion of hatchery-origin spawners in nature [pHOS], or smolt production) and may include targets for metrics that are not listed as triggers for transitioning among recovery phases. FHMP goals may also be programmatic (e.g., develop plans for specific segments of the program). For populations for which no minimum viability abundance target has been set, such targets will be developed in coordination with the FTC during the period covered by this FHMP.

The conclusions and recommendations in this revised FHMP are consistent with the SA and represent adjustments and clarifications of the 2011 FHMP. It is intended to improve implementation of the adaptive management process and the effectiveness of these supplementation programs by incorporating the most recent science to effectively meet resource priorities identified in the SA. It employs rigorous monitoring and evaluation protocols, using the results of studies and baseline monitoring conducted in the Cowlitz Basin, as well as incorporating the most current fisheries science and new knowledge that has been developed by the broader scientific community, in an adaptive management process that includes feedback from key stakeholders. To a large degree, the scientific foundation for the FHMP rests upon the work of the Independent Scientific Advisory Board (ISAB) as presented in Northwest Power Planning Council (NPPC) (2001), and of the Hatchery Scientific Review Group (HSRG 2009). Feedback from affected agencies, Tribes, and the public has also provided guidance in the preparation of this document.

Each version of the FHMP reflects maturation of the program and of the document as a management tool. Revising the FHMP is important for adaptive management, as it provides an excellent opportunity to evaluate our success at moving toward population recovery. Each FHMP is an opportunity to make appropriate programmatic changes to refocus our trajectory toward our shared ultimate goal of recovered populations. Organizational changes have been incorporated to make the 2020 FHMP a more useful document for the implementing parties. The plan provides overarching guidance for decisions for the period covered by this FHMP; however, species- and population-specific information changes annually, which renders portions of chapters of even the most recent FHMPs obsolete. Therefore, species-specific Annual Operating Plans will be developed outside of this FHMP and will guide each year's management activities, such as hatchery smolt production goals, disposition of trapped salmon, broodstock collection and spawning, rearing, marking, and release strategies, transport of smolts and mature salmon, data collection, and pHOS, pNOB, and proportionate natural influence (PNI) goals (see Chapter 12).

When FERC license obligations and FHMP objectives (such as recovery and harvest, or recreation and instream flow) conflict, management priorities will be defined by agencies with management authority in conjunction with Tacoma Power and the FTC. These conflicts must be clearly identified and understood so that a plan to resolve the conflict can be developed and subsequently followed. Development of a successful management strategy will involve creative thinking to identify new alternatives, allow flexibility to adapt to changes, and take advantage of new opportunities when they arise. It will also incorporate opportunities to explore and evaluate new alternatives in order to advance our knowledge, thereby being better able to manage the populations.

Additional factors/changes taken into consideration in the preparation of this FHMP include, but are not limited to: legal requirements under the ESA, State of Washington obligations for resource management, new knowledge and information from sources outside the Cowlitz River program, changes in fisheries and hatchery operations outside the Project area that affect fish populations in the Project area, lessons learned from the experience of the FTC during its tenure, advice and recommendations from interested parties, and the public record of implementation of actions called for in the 2004 and 2011 FHMPs. Additionally, this FHMP was written with the intent to update existing Hatchery and Genetic Management Plans (HGMPs) for each of the hatchery populations to ensure agreement between the FHMP and HGMPs.

1.3 Endangered Species Act Regulatory Framework

All actions conducted in association with the Cowlitz Hydroelectric Project are governed by their effects on species listed under the Endangered Species Act (ESA). NOAA Fisheries published a Biological Opinion (NOAA Fisheries 2004) and published an ESA Recovery Plan for lower Columbia River Coho Salmon, lower Columbia River Chinook Salmon, Columbia River Chum Salmon, and lower Columbia River steelhead Evolutionarily Significant Units (ESUs)/Distinct Population Segments (DPSs; NMFS 2013). A population is a group of fish of the same species that spawns in a particular location at a particular season and does not interbreed substantially with fish from any other group (Lawson et al. 2007). An ESU represents a distinct group of Pacific salmon populations under the ESA that is substantially reproductively isolated from other conspecific populations and represents an important component of the evolutionary legacy of the species (Waples 1991). A biological stratum is a subset of an ESU, which groups populations in which “there is substantial genetic and geographic structure, with genetic similarities clustering into a few geographic units” (Lawson et al. 2007).

In the Cowlitz Basin, historical populations of each species have been characterized. Distinct populations of fall Chinook Salmon, Coho Salmon, and winter steelhead were identified in the Lower Cowlitz Subbasin - the lower Cowlitz River and tributaries below Mayfield Dam. The Toutle and Coweeman subbasins were identified as having independent populations separate from the Lower Cowlitz Subbasin populations (except for Chum Salmon), and therefore are not included in this FHMP. Above Mayfield Dam, distinct populations of spring Chinook Salmon, Coho Salmon, and winter steelhead were identified in each of the Cispus, upper Cowlitz, and Tilton rivers. For fall Chinook Salmon above Mayfield Dam, a single “Upper Cowlitz Subbasin” population has been identified, which comprises all three of the Cispus, upper Cowlitz, and Tilton drainages. Because there is currently no means to differentiate the subbasin of origin for adult salmon or steelhead that are caught at the Barrier Dam Adult Facility, for management purposes we have pooled them into an “Upper Cowlitz Subbasin” population for each species. Additionally, for current management purposes, population recovery efforts for spring Chinook Salmon are limited to and focused on the Upper Cowlitz Subbasin (Cispus and upper Cowlitz drainages), so no spring Chinook Salmon are being transported to the Tilton Subbasin. Conversely, current restoration efforts for fall Chinook Salmon above Mayfield Dam are focused solely on the Tilton River drainage and no fall Chinook Salmon are transported to the Cispus or upper Cowlitz rivers. The separate populations are described further in the species overview and populations sections (see Chapters 3-9).

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1.3.1. NOAA Fisheries Biological Opinion

In conjunction with Cowlitz Project relicensing, NOAA Fisheries issued a Biological Opinion (NOAA Fisheries 2004), establishing conditions for the Project's continued operation. The Biological Opinion found that continuing the Project's operations would adversely affect essential fish habitat for Chinook Salmon and Coho Salmon and recommended essential fish habitat conservation measures. These measures, including passage performance standards, instream flows, ramping rate restrictions, fish monitoring plan, side channel habitat monitoring, water quality monitoring plan, and others, were subsequently included in the amended license as modified license articles and Settlement Agreement articles.

1.3.2. Cowlitz River Subbasin Plans

The Lower Columbia Fish Recovery Board (LCFRB 2010) published the Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan, which describes a vision and framework for rebuilding ESA-listed Chinook Salmon, Chum Salmon, Coho Salmon, and steelhead populations in the Lower Columbia Basin, including the Cowlitz Basin. Specific priority actions to improve population viability for Cowlitz Basin anadromous salmonids include:

- Restoring access above dams to the upper portion of the basin;
- Protecting intact forests in headwaters;
- Managing forest land pursuant to Forest and Fish Rules to protect and restore watershed processes;
- Managing growth and development to protect watershed processes and habitat conditions;
- Restoring passage at culverts and other artificial barriers;
- Restoring lowland floodplain function, riparian conditions, and stream habitat diversity;
- Addressing immediate risks with short-term habitat fixes;
- Aligning hatchery priorities with conservation objectives; and
- Reducing out-of-subbasin impacts.

A more specific plan, with recommendations and minimum viability abundance targets, was provided for each species and population in separate chapters for each subbasin, including the Lower Cowlitz Subbasin and Upper Cowlitz Subbasin.

1.3.2.1 Lower Cowlitz Subbasin Plan

The Lower Cowlitz Subbasin Plan (LCFRB 2010) identifies habitat connectivity, habitat diversity, channel stability, riparian function, floodplain function, streamflow, water quality, and substrate and sediment as limiting factors in the Lower Cowlitz Subbasin and prioritizes a number of habitat and hatchery implementation measures. Hatchery measures include developing a conservation management strategy for natural- and hatchery-origin fall Chinook Salmon production; precluding the release of out-of-basin fall Chinook Salmon, spring Chinook Salmon, or Coho Salmon eggs or juveniles into the Cowlitz Basin; adipose fin-clipping 100% of hatchery-origin fall Chinook Salmon, Coho Salmon, spring Chinook Salmon, steelhead, and sea-run Cutthroat Trout; using Cowlitz Basin hatcheries to supplement and enhance natural Coho Salmon and Chum Salmon populations; adopting juvenile release strategies to minimize impacts on natural populations; evaluating facility operations; and monitoring, evaluating, and implementing adaptive management.

1.3.2.2 Upper Cowlitz Subbasin Plan

Similar to the Lower Cowlitz Subbasin Plan, objectives are identified in the Upper Cowlitz Subbasin Plan for improving fishery resources upstream of Mayfield Dam, including the Cispus, upper Cowlitz, and Tilton rivers (LCFRB 2010). The hydropower system is the primary factor for salmonid population decline in the Upper Cowlitz Subbasin, as it has flooded riverine habitat and impeded volitional access to and from upstream habitats. Habitat limiting factors in the Upper Cowlitz Subbasin include habitat connectivity (due to dams), habitat diversity, channel stability, riparian function, floodplain function, water quality, substrate and sediment, and streamflow. Hatchery program actions are the same as those for the Lower Cowlitz Subbasin, with the addition of marking/tagging of smolts collected at Mayfield Dam and Cowlitz Falls Dam so that they can be uniquely identified for broodstock collection or transport and release into their natal streams upon their return at maturity.

1.3.3. National Marine Fisheries Service Recovery Plan

The National Marine Fisheries Service published a Recovery Plan for each of the four species of anadromous salmonids in the Lower Columbia Basin that are listed under the ESA (NMFS 2013). It incorporated the LCFRB Subbasin Plan and provides overarching guidance for this FHMP. Listed populations in the Cowlitz River are defined as part of the Lower Columbia River ESU. There are four ESA-listed salmonid species in the Cowlitz Basin, all of which are listed as threatened: lower Columbia River Chinook Salmon, lower Columbia River Chum Salmon, lower Columbia River Coho Salmon, and lower Columbia River steelhead. As described in Section 1.3, NOAA Fisheries has characterized the various populations for each of these species within the Cowlitz Basin.

The Recovery Plan uses recovery scenarios developed by the Willamette/Lower Columbia Technical Recovery Team (TRT; McElhaney et al. 2000) that identify viability objectives for each population that meet TRT recovery criteria for a viable ESU. The viability objectives are based on Viable Salmonid Population (VSP) attributes:

- **Abundance**: The numerical size of the population, primarily based on annual numbers of spawners in nature but may also include other metrics (e.g., smolts leaving the system and mature salmon returning to the basin, hatchery, and spawning grounds).
- **Population Growth Rate (Productivity)**: A population’s ability to replace itself and rebound to the equilibrium population level from a low level. Several metrics for productivity can be measured. Adult-to-adult productivity is a measure of the growth (or decline) of a population over time. It is measured by the number of progeny that survive to spawn (recruits) for each parental spawner (recruits / spawner). Freshwater or juvenile productivity may also be measured and is the number of smolts produced for each parental spawner (smolts / spawner).
- **Spatial Structure:** The spatial structure of a population is comprised of the geographic distribution of individuals in the population, as well as the processes that generate that distribution. A population’s spatial structure depends fundamentally on habitat quality and quantity, the configuration of that habitat, and dynamics, as well as the ability of individuals in the population to disperse within that habitat.
- **Diversity**: The genetic variability in life history, behavioral, and physiological traits within a population. These range in scale from DNA sequence variation at single genes to complex life-history traits and include anadromy, morphology, fecundity, run-timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size,

developmental rate, ocean distribution patterns, male and female spawning behavior, physiology, and molecular genetic characteristics.

VSP metrics will be evaluated collaboratively with NOAA Fisheries and the FTC during the period covered by this FHMP. Approaches and standards to allow for meaningful management decisions will be considered annually in the context of the recovery phase for each program (as described in Chapters 10 and 12). The guidance presented in Crawford and Rumsey (2011) will be considered for monitoring recovery for each population.

The Recovery Plan established a target viability status for each population, taking into consideration:

1) Each population's potential for improvement, considering available habitat and historical production; and
2) The degree of improvement needed in each stratum to meet Willamette/Lower Columbia TRT guidelines for a viable ESU.

These targets are considered the minimum contribution by each individual population toward the recovery of the ESU as a whole to consider for delisting and do not represent full recovery, which includes objectives for healthy and harvestable populations.

The viability (= inverse of extinction risk) of each population over the next 100 years was then rated (Very Low to Very High) for each viability attribute and was then given a net baseline viability rating and an objective rating (Table 1-1). The objective rating is the viability goal for that population and that rating determined its recovery designation:

- **Primary**: Populations that are targeted for restoration to High or greater level of viability - High or Very High viability (≥95% persistence probability = ≤5% extinction risk). These populations are the foundation of salmon recovery, and at least two populations per stratum must be at High or better viability to meet recommended TRT criteria for a viable ESU. Primary populations are typically those with the best prospects for protection or restoration and typically include populations at High or Medium viability during the listing baseline. In some cases, populations with Low or Very Low baseline viability were also designated as Primary populations in order to achieve viable strata and ESU conditions.
- **Contributing**: Populations for which some improvement in viability is needed to achieve the TRT recommended strata-wide average of Medium viability (40-94% persistence probability = 6-60% extinction risk). As such, most Contributing populations are targeted for a Medium viability level and might include those of Low to Medium significance and viability but where improvements can be expected to contribute to recovery. Varying levels of improvement are identified for Contributing populations, with some being targeted for substantial improvements whereas more limited increases are identified for others.
- **Stabilizing**: These are typically populations that are currently at Very Low viability (<40% persistence probability = >60% extinction risk) and are expected to be maintained at their current viability level. Stabilizing populations might include those where significance is low, feasibility is low, and uncertainty is high. While Stabilizing populations are not targeted for significant improvement, substantive recovery actions will typically be required to avoid further degradation.

Cowlitz River anadromous salmonid populations were all given a net baseline viability rating of Very Low (or Low in the case of Lower Cowlitz Subbasin winter steelhead) (Table 1-1). Objective ratings ranged from Very Low for Stabilizing populations (upper Cowlitz River fall Chinook Salmon and Tilton River spring Chinook Salmon and Coho Salmon) to High+ (Cispus

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and Upper Cowlitz rivers spring Chinook Salmon). Populations were also given natural-origin productivity and abundance targets for achieving recovery. The approach described in the species chapters (3-9) and associated population sections is consistent in taking steps to achieve the NOAA Fisheries recovery strategies. The approaches are consistent in working to achieve natural self-sustaining ESUs by protecting and improving populations through fish management actions that reduce the influence of hatchery-origin spawners in nature over time; build abundance, quality, and distribution; and implement fish management strategies that consider impacts from harvest on productivity and natural-origin abundance.

1.3.4. Hatchery and Genetic Management Plans (HGMPs)

HGMPs are technical documents that thoroughly describe the composition and operation of each individual hatchery program. The primary goal of an HGMP is to describe biologically based artificial propagation management strategies that ensure the conservation and recovery of ESA-listed salmon and steelhead populations. NOAA Fisheries uses the information provided by HGMPs to evaluate impacts on ESA-listed salmon and steelhead. Draft HGMPs were prepared by WDFW and submitted jointly by WDFW and Tacoma Power in 2014 for the six hatchery programs at Cowlitz Salmon Hatchery and Cowlitz Trout Hatchery. These documents are currently in draft and will be revised in collaboration with the FTC to ensure alignment with this FHMP:

Cowlitz Salmon Hatchery

- Chinook Salmon
  - Cowlitz River fall Chinook Salmon
  - Cowlitz River spring Chinook Salmon
- Coho Salmon
  - Cowlitz Type N Coho Salmon

Cowlitz Trout Hatchery

- Steelhead
  - Cowlitz River winter steelhead
  - Cowlitz River summer steelhead
- Cutthroat Trout
  - Cowlitz River sea-run Cutthroat Trout

To date, NOAA Fisheries has not consulted on these HGMPs.

1.3.5. Conservation and Sustainable Fisheries Plan

The Conservation and Sustainable Fisheries Plan (CSFP) was developed jointly by WDFW and the LCFRB from 2009 through 2016 (WDFW and LCFRB 2016). The management actions within the CSFP were developed from 2009 to 2011, and WDFW was implementing the majority of them by 2011. The formal finalization and adoption process occurred from 2012 to 2016.

The CSFP set forth the strategies, actions, and management practices that WDFW will use in maintaining and operating its Lower Columbia hatcheries and in managing related fisheries, in a manner that helps to achieve the threat reduction and Viable Salmonid Population (VSP) targets identified in the NOAA-approved Recovery Plan. The actions identified in the

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CSFP align with specific actions in the Recovery Plan, and are a critical part of an integrated "All-H" approach to salmon recovery embodied in the Recovery Plan.

The 2011 FHMP was grounded in many of the same principles of the CSFP, including the use of Hatchery Scientific Review Group (HSRG) guidelines, as a means to achieve established productivity improvement and threat reduction targets identified in the Recovery Plan. The management approaches within the 2011 FHMP were therefore aligned with the CSFP, and included an adaptive management process. The FHMP is now being updated per FERC requirement, and the status of populations has continued to change. The CSFP includes an adaptive management process that utilizes population responses to evaluate the effectiveness of actions implemented to date and determine if, and what kind of, adjustments are needed to achieve population targets set forth in the Recovery Plan. It will therefore be important to evaluate strategies, actions, and management practices proposed in this 2020 FHMP, to ensure they align with the productivity improvement and threat reduction targets established in the Recovery Plan, and to then update the CSFP and/or FHMP accordingly. This needs to be done collaboratively between WDFW, Tacoma Power, and the LCFRB. While it is Tacoma Power's intent to work toward alignment with the CSFP State plan, it is important to note that conflicts with federal obligations may conflict with this intent. In these circumstances, Tacoma Power will convey both the applicable principles outlined in the Recovery Plan, as well as potential conflict with the guidance and requirements of the FERC license.

1.4 Population Restoration and Recovery

All entities involved in managing depleted, threatened, or endangered species, such as these programs, have the ultimate goal of recovering these populations to self-sufficiency and at abundance levels that will allow them to support sustainable harvest. Tacoma Power is amongst those entities and will use this FHMP as a guide for progressing toward that ultimate goal. This FHMP is a plan with specific interim targets, and a guide for achieving those targets, which are steps forward in our path to population recovery. Population recovery is an integral component of every aspect of this FHMP and it is the intent that this ultimate goal of population recovery is consistently maintained, while achieving the nearer term goals of this document.

The HSRG (2014) defined four phases (biological/recovery) of population restoration: Preservation, Recolonization, Local Adaptation, and Full Restoration (Table 1-3). These phases inform management decisions by providing a framework to monitor and evaluate progress toward the recovery of natural populations.

Each natural population is monitored and its progress toward recovery is evaluated using specific indicators, metrics, and triggers:

- **Indicator:** Information on population performance used to evaluate whether the goals for a given restoration phase have been met.
- **Metric:** Actual measures selected to represent each performance indicator.
- **Trigger:** Threshold values for a given metric that indicate the goal of the restoration phase has been met. All triggers associated with one restoration phase must be met for the population to progress to the next restoration phase. However, not all triggers must be met in order to shift management strategies for that indicator. Draft triggers are identified for each population in subsequent sections of the FHMP describing each population (Chapters 3-9) and in Chapter 12 (Adaptive Management: Annual Program

Review and Annual Operating Plan). These will be finalized during development of Transition Plans (as described in more detail in Chapter 12 and Appendix B).

Table 1-3. Biological phases of restoration and objectives for different ecosystem conditions (HSRG 2014).

Biological Phase	Ecosystem Conditions	Objectives
Preservation	Low population abundance; habitat unable to support self-sustaining population; ecosystem changes pose immediate threat of extinction.	Prevent extinction; retain genetic diversity and identity of existing population.
Recolonization	Underutilized habitat available through restoration and improved access.	Re-populate suitable habitat from pre-spawning to smolt outmigration (all life stages).
Local Adaptation	Habitat capable of supporting abundances that minimize risk of extinction as well as harvest needs; prevent loss of genetic diversity; and promote life history diversity.	Meet and exceed minimum viable spawner abundance for natural-origin spawners; increase fitness, reproductive success, and life history diversity through Local Adaptation.
Full Restoration	Habitat restored and protected to allow full expression of abundance, productivity, life history diversity, and spatial distribution.	Maintain viable population based on all VSP attributes using long-term adaptive management.

We use five performance indicators, each with a set of metrics (Table 1-4):

- **Abundance**: These are the numbers (by origin, sex, and age) of salmon at specific life stages and locations that many of the other indicators rely on. Important metrics include the numbers of mature salmon returning to the Cowlitz River, spawning (in the hatchery and in nature), and smolts produced and leaving the Cowlitz River.
- **Distribution**: This information tells us how broadly the salmon are using the available habitat. Distributions may be spatial or temporal and may address factors such as spawning, rearing, and migrations of hatchery- and natural-origin salmon.
- **Productivity**: This performance indicator gives us an additional indication of whether a population is increasing or decreasing and is the primary monitoring metric for natural-origin populations. Productivity metrics include recruits-per-spawner (R/S), which is calculated as the number of F_1 generation recruits for each F_0 generation spawner. Recruits can be either spawners ("spawner-to-spawner" R/S) or smolts (smolts/spawner). Spawner-to-spawner R/S provides an overall view of population viability, where:
  - If productivity >1, the population is increasing.
  - If productivity <1, the population is declining.

  Therefore, spawner-to-spawner R/S also indicates the trajectory of a population - whether it is self-sufficient and growing or it is failing.

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- **Survival**: Survival indicators show us where a population (hatchery- and natural-origin) may be limited. Important metrics include juvenile hydropower system collection efficiency, passage survival, smolt-to-adult return (the percentage of smolts that survive to return to their natal spawning grounds - hatchery or nature), and total smolt-to-adult survival (the percentage of smolts that survive to be harvested in fisheries, return to the hatchery, or spawn in nature).
- **Diversity**: A population is unlikely to persist without a sufficient amount of diversity to allow it to withstand perturbations that decrease survival. Life history diversity, age composition, proportion of hatchery-origin salmon spawning in nature (pHOS), proportion of natural-origin salmon in the hatchery broodstock (pNOB), proportionate natural influence (PNI) growth rate, health, tissue samples collected for the ability to conduct periodic genetic sampling in the future, and smolt size of hatchery- and natural-origin salmon are important metrics. Also, spawning matrices (the number of individuals of the opposite sex that each individual spawned in the hatchery is crossed with) can be important for maintaining diversity in hatchery populations.

These performance indicators and their metrics provide the information needed to address the five license-required topics described for License Article 6 in Section 1.2. They also expand upon the five topics to provide the greater amount of information that is needed, and at a greater level of detail, to adequately monitor and evaluate each program and assess its progress toward achieving its goals. We apply these indicators, as appropriate, to both hatchery and natural populations because hatchery salmon may affect natural populations at many stages in the life cycle, and it is critical to manage the effects of hatchery salmon on the viability of natural populations at all possible phases in the life cycle of each group of salmon.

Specific metrics and their trigger values may vary among species and populations, in accordance with their recovery phase, viability status, and objective. Trigger values are set by HSRG guidelines, VSP standards, minimum viability abundance targets, or management objectives. When data show that a trigger has been met, the population may shift to a higher or lower recovery phase. All triggers associated with one restoration phase must be met for the population to progress to the next higher/lower recovery phase. However, management actions may be taken to achieve the trigger for the next (higher or lower) recovery phase as soon as a specific trigger for the current phase has been met. Additionally, trigger values may need to be updated and adaptively managed as restoration of a population continues through time. Data gaps result in uncertainty about the status of a population relative to an indicator and indicate a need for improved monitoring efforts or analytical approaches. This (2020) FHMP includes a Summary of Data Gaps and Potential Monitoring Future Needs, presented as Appendix C. The summary matrix is a list identifying current areas of monitoring and existing data gaps, organized by fish species and population.

Table 1-4. Important baseline monitoring indicators and metrics for hatchery- and natural-origin salmon for advancement through the recovery phases. Note: 'X' indicates that data should be collected, usually by origin, age, and sex.

	Origin	
Indicators and Metrics	Hatchery	Natural
Abundance		
Harvest	X	X
Jack and Adult Salmon		

Indicators and Metrics	Origin: Hatchery	Origin: Natural
Returned to Hatchery/Spawning Grounds	X	X
Transported above dams	X	X
Spawners		
In Hatchery	X	X
In Nature	X	X
Pre-smolt life history stages		
Green eggs	X	
Eyed eggs	X	
Fry	X	X
Parr	X	X
Smolts		
Released/Produced	X	X
Leaving the Cowlitz River	X	X
Distribution		
Space		
Spawning		
Range		X
Density		X
Rearing		
Range		X
Density		X
Time (timing)		
Returning (run-timing)		
Range	X	X
Frequency	X	X
Spawning (spawn timing)		
Range	X	X
Frequency	X	X
Rearing		
Range		X
Frequency		X
Smoltification (smolt migration)		
Range	X	X
Frequency	X	X
Productivity (recruits-per-spawner)		
Fecundity (data collected at hatchery)	X	X
Smolts	X	X
Adults	X	X
Jacks + Adults	X	X
Females	X	X

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Indicators and Metrics	Origin: Hatchery	Origin: Natural
Survival		
Smolt-to-adult return	X	X
Total smolt-to-adult survival	X	X
Collection Efficiency		X
Smolt passage survival (SPS)		X
Diversity		
Spawning matrices	X	
Life history		X
Smolt size	X	X
Size at maturity (by age and sex)	X	X
Age composition	X	X
Proportionate Natural Influence		
pHOS	X	X
pNOB	X	X
PNI	X	X

1.4.1. Preservation to Recolonization

Preservation programs are developed for natural populations that are threatened by imminent extinction and are in dire need of support. These populations are usually threatened by habitat loss and/or connectivity to habitat, so the primary goal of the program is to maintain the existing genetic identity and diversity of the population until the habitat can be sufficiently restored and/or accessed so that it can support all life stages of the population. Efforts to increase abundance are also underway through hatchery supplementation. At this stage, natural abundance and productivity metrics are monitored, and the influence of hatchery salmon on the natural population (while of importance) is secondary to increasing abundance while maintaining genetic diversity. Following best management practices for well-managed hatchery programs is critical (Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017).

1.4.2. Recolonization to Local Adaptation

During the Recolonization phase, the emphasis is on increasing population size to further reduce the threat of extinction. As such, the performance indicators associated with movement between the Recolonization and Local Adaptation phases are based on abundance, productivity, and survival. As a result, HSRG guidelines do not guide the selection of trigger values associated with advancement between the Recolonization and Local Adaptation phases. Instead, the trigger values have been developed by managers and are intended to guide the population toward the triggers for advancement to Local Adaptation. At this stage, natural abundance and productivity metrics are monitored, and the influence of hatchery-origin salmon on the natural population (while important) is still secondary to increasing abundance while maintaining genetic diversity.

Metrics of the abundance indicator that should be evaluated during the Recolonization phase are the numbers of mature salmon returning to the system (or transported above dams), actually spawning in nature, and of smolts that they produce. Including smolts as a trigger in the Recolonization phase ensures that adults released into the upper watershed are successfully producing juveniles before advancing to the Local Adaptation phase.

Population productivity is the primary monitoring metric for any population, especially natural populations (HSRG 2017). Measuring spawner-to-spawner R/S is critical, and smolts/spawner will be useful if spawner-to-spawner R/S is below replacement.

Survival metrics, such as smolt-to-adult return and total smolt-to-adult survival rates, can be informative as well, and are the primary metric for evaluating hatchery programs. Survival at additional juvenile life stages may also be monitored, particularly if there is a concern for survival during a specific period. For populations in the Upper Cowlitz and Tilton subbasins, collection efficiency and smolt passage survival are critical metrics.

However, we want to be cognizant of the potential of the population to become domesticated and the risk that this will pose when we try to get it to adapt to spawning and rearing in the natural environment. Some distribution and diversity metrics, such as age composition and run and spawn timing, are more readily affected by hatchery rearing. These metrics should be evaluated at early stages in the process of recovery, and management efforts may be taken to limit the effect of hatchery rearing to improve the potential for adaptation to spawning and rearing in the natural environment. Spawning matrices may be used to help maintain genetic diversity, and pHOS, pNOB, and PNI triggers are useful for monitoring and reducing the potential for domestication and its deleterious effect on natural populations. Best management practices for well-managed hatchery programs remain critical.

1.4.3. Local Adaptation to Full Restoration

The emphasis of the Local Adaptation phase is the development of self-sustaining natural populations that are capable of supporting directed harvest of natural-origin salmon upon advancement to the Full Restoration phase. Additionally, the distribution and diversity of the population become important. During this phase and based on current knowledge, triggers will be set to meet or exceed the appropriate HSRG guidelines and minimum viability goals from the Recovery Plan.

Abundance metrics to be monitored and evaluated during the Local Adaptation phase are similar to those for the Recolonization phase. However, because we are expecting the population to withstand some level of harvest, abundance triggers for both spawners and smolts will increase, and the trigger for returned mature salmon may shift to an emphasis on natural production.

Productivity metrics to be evaluated during the Local Adaptation phase may include recruits-per-spawner (both spawner-to-spawner and smolts/spawner). The survival metrics (e.g., smolt passage survival, smolt-to-adult return rate, total smolt-to-adult survival rate) become more important for highlighting sources of low survival, and triggers for these metrics may be included or increased.

Distribution indicators for this phase focus on spawning and rearing of critical life stages. Metrics to be evaluated may include the range in both space (lowest to uppermost) and time (earliest to latest) and density of specific life stages, overall and within index reaches of historical importance.

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Diversity indicators for the Local Adaptation phase will focus on whether all appropriate life stages are present in the system. Presence and abundance of all life stages will indicate whether the habitat is capable of supporting the desired population size. Additionally, hatchery-oriented metrics, such as matrix spawning, age composition, run and spawn timing, and pHOS, pNOB, and PNI criteria, become important as we are actively encouraging population traits that are beneficial to salmon in nature. High expectations are sought for the trigger values to ensure that the populations meet the HSRG guidelines and best management practices for well-managed hatchery programs.

1.4.4. Full Restoration

The goal of the Full Restoration phase is a self-sustaining natural population that supports a managed harvest. The performance indicators associated with the Full Restoration phase include abundance, distribution, productivity, and diversity. Metrics that need to be evaluated are the same as those that were monitored during the Local Adaptation phase. Trigger values are changed to reflect natural populations that continue to be self-sustaining and increased adaptation to local watershed conditions while supporting fisheries. Hatchery supplementation is no longer needed, but a hatchery program may be maintained for harvest purposes. If so, hatchery indicators must still be monitored and evaluated, including restrictive pNOB, pHOS, and PNI triggers, and best management practices remain a critical metric.

1.4.5. Recovery Plan Productivity Targets

The Washington Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010) set productivity improvement targets for each population. These targets are the relative increase in population production required to reach its prescribed viability goal. Meeting the Recovery Plan goals is necessary to achieve minimum viability for the population. Moving these populations to the Full Restoration phase would require additional productivity improvements for all H's (Hatchery, Harvest, Hydro, and Habitat), as well as ecological interactions, beyond those called for in the Recovery Plan.

Separate historical populations of spring Chinook Salmon, Coho Salmon, and steelhead have been described in the upper Cowlitz and Cispus rivers (Myers et al. 2006), and each population has its own minimum viability abundance target (LCFRB 2010). However, current management is for a single Upper Cowlitz Subbasin population, comprised of the Cispus River and the upper Cowlitz River and their tributaries above Lake Scanewa. The Cowlitz Falls Fish Facility captures smolts from these streams and marks them as coming from the Upper Cowlitz Subbasin, but the two rivers merge in Lake Scanewa just upstream of the Cowlitz Falls Fish Facility. Currently, there are no weirs or other structures on these rivers that permit managers to capture and mark smolts migrating downstream from each river, so the river of origin of these smolts cannot be determined. Subsequently, when mature salmon return, managers can only identify them as having originated in the Upper Cowlitz Subbasin, where they are transported to spawn naturally, after being released into one of the two rivers or into Lake Scanewa, from which they can select their preferred stream. In the future, facilities or genetic tools may become available for segregating the two populations. Until then, managers combine the minimum viability abundance targets and other viability metrics for these two populations into a single goal/target for the Upper Cowlitz Subbasin population.

CHAPTER 2:
COWLITZ BASIN OVERVIEW

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2. Cowlitz Basin Overview

The Cowlitz Basin encompasses approximately 6,586 square kilometers and lies within Water Resource Inventory Area (WRIA) 26 (Figure 2-1). The Cowlitz River is an important tributary to the lower Columba River, joining the Columbia River at river kilometer (rkm) 109, approximately 5.6 km southeast of Longview, WA. For fisheries management purposes, the basin is separated into the Lower and Upper Cowlitz subbasins, demarcated by Mayfield Dam at rkm 84, which blocks all volitional passage of adult anadromous fish to the Upper Cowlitz Subbasin. Hydropower operation is the dominant influence in the Cowlitz River from Lake Scanewa to the Toutle River, which is sufficiently large to give the Cowlitz River a natural seasonal discharge regime. This FHMP addresses anadromous fish populations in the Cowlitz Basin, except those in the Coweeman and Toutle rivers.

The Cowlitz River Hydroelectric Project consists of two dams and is Tacoma Power's largest hydroelectric project. Mayfield Dam is located at rkm 84 and Mossyrock Dam is located at rkm 105. Tacoma Power owns and funds operation of the Cowlitz Salmon Hatchery, with its associated Barrier Dam and Adult Facility (rkm 81), and the Cowlitz Trout Hatchery (rkm 68). Cowlitz Falls Dam, owned by Lewis County Public Utility District (PUD), is located at rkm 142 in the Upper Cowlitz Subbasin. This hydroelectric project includes the Cowlitz Falls Fish Facility for collection and downstream transportation of naturally produced smolts that was constructed by Bonneville Power Administration (BPA) and is operated by Tacoma Power under an agreement with Lewis County PUD and BPA. This dam is also the location of the Cowlitz Falls North Shore Collector that was constructed in 2017 and is operated by Tacoma Power.

The Lower Cowlitz Subbasin encompasses approximately 2,986 square kilometers within Lewis and Cowlitz counties (Figure 2-1). Significant tributaries within the basin are Salmon, Lacamas, Olequa, Delameter, and Ostrander creeks; the Coweeman and Toutle rivers also flow into the Lower Cowlitz Subbasin but are not considered part of the basin for the purposes of this FHMP. Land uses in this portion of the watershed are largely rural mixed use. The lower 27 km of the mainstem Cowlitz River is tidally influenced and contains pool habitat of low quality due to channelization. Additionally, the eruption of Mount St. Helens in 1981 inundated the Cowlitz River below the Toutle River with a large amount of sediment that has continued for decades. Diking, the placement of dredge spoils, and transportation corridors have eliminated most side-channel habitat on the lower Cowlitz River and the lower reaches of tributaries (Wade 2000). Gravel mining also has eliminated historical side channel habitat at various sites along the mainstem from rkm 32-80.

The Upper Cowlitz Subbasin includes approximately 3,600 square kilometers in portions of Lewis, Skamania, Pierce, and Yakima counties. Major tributaries to the upper Cowlitz River are the Cispus, Clear Fork, Ohanapecosh, and Tilton rivers. Land management in the Upper Cowlitz Subbasin is largely comprised of areas of rural mixed use and natural resource areas, including patches of State-owned land and a large portion of the watershed upstream of Cowlitz Falls Dam, which is managed by the U.S. Forest Service for multiple uses.

In the Upper Cowlitz Subbasin, the Cispus and mainstem upper Cowlitz rivers and their tributaries above Cowlitz Falls Dam, the mainstem Tilton River, and lower reaches of Tilton River tributaries provide abundant spawning and rearing habitats for anadromous salmonids. Aquatic and floodplain habitat in these reaches has been affected by timber harvest, road building, channelization, and rural development. Natural barriers occur on many tributaries within a few miles of their confluences with the Upper Cowlitz River (Wade 2000), restricting access to low-gradient habitat.

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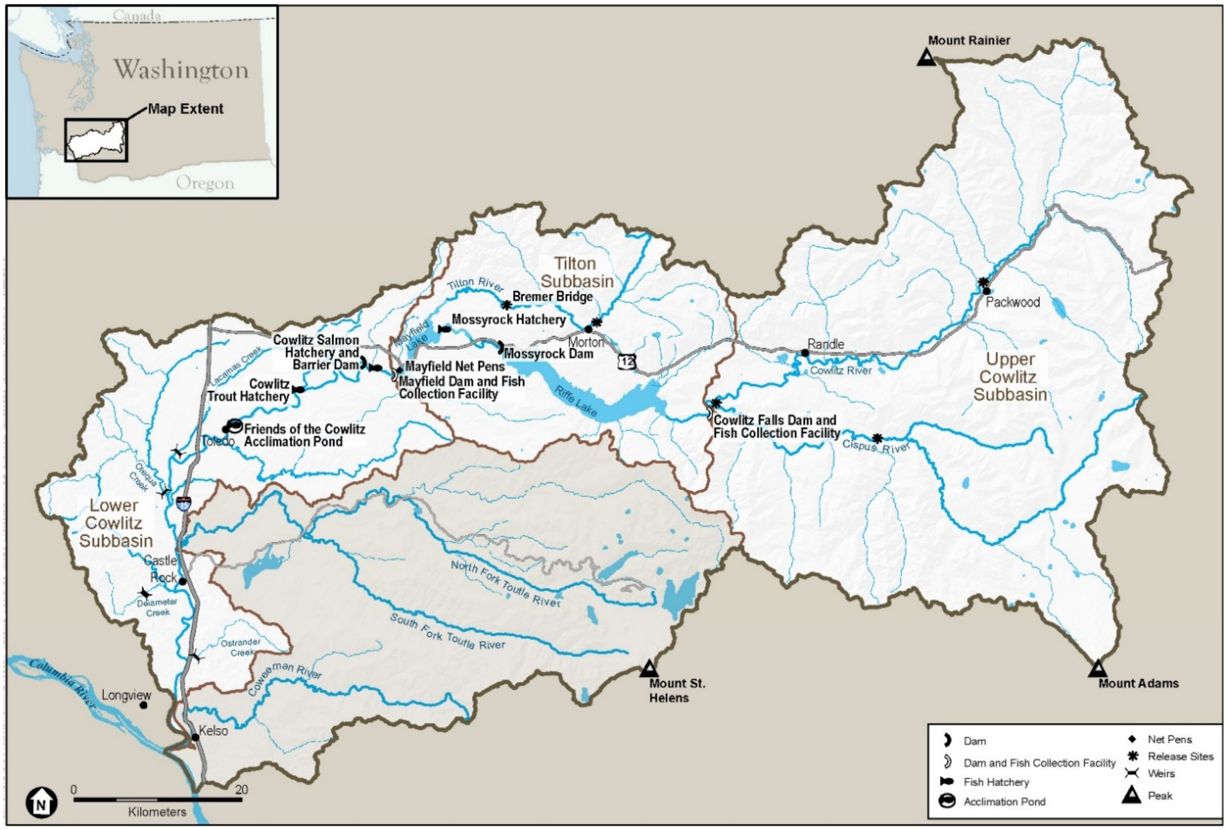

Figure 2-1. Cowlitz Basin, Washington, with the Lower Cowlitz, Cispus, Upper Cowlitz, and Tilton subbasins and important fisheries management sites.

Channel alterations, combined with increased sediment inputs, have created low-flow passage problems and reduced habitat quality within these important reaches. In addition, large woody debris is generally lacking, resulting in limited pool habitat, cover, and habitat diversity in the mainstem and lower reaches of most tributaries (Wade 2000).

For the purposes of this FHMP, there are three subbasins of importance in the Cowlitz Basin, which are defined as:

1. **Lower Cowlitz Subbasin**: The mainstem Cowlitz River and tributaries below the Barrier Dam at rkm 81, excluding the Toutle and Coweeman rivers.
2. **Tilton Subbasin**: The Tilton River and all of its tributaries.
3. **Upper Cowlitz Subbasin**: The Cispus and upper Cowlitz rivers, above Cowlitz Falls Dam, and all of their tributaries.

Distributions of each species vary by population (Table 1-1). The Cispus River is considered to have contained demographically independent populations (DIPs) of spring Chinook Salmon, Coho Salmon, and winter steelhead (Myers et al. 2006). However, it is currently logistically infeasible to distinguish the Cispus River DIP migrants from those originating from the upper Cowlitz River DIP. To mitigate for this uncertainty, many adults transported to the Upper Cowlitz Subbasin are currently released into Lake Scanewa so they can seek out their river of origin (upper Cowlitz or Cispus). Data collected on adults and juveniles in the Upper Cowlitz Subbasin have been combined to represent a single Upper Cowlitz Subbasin population. Spawning surveys could be separated by subbasin, but this work is not currently being conducted. In the future, however, it may be possible to distinguish smolts and mature salmon from each of these rivers. At that time, we may move toward developing separated datasets for each river.

2.1 Hydroelectric Facilities

There are three major hydropower facilities on the Cowlitz River (Figure 2-1). The Mayfield and Mossyrock hydroelectric facilities are operated by Tacoma Power, and Cowlitz Falls Dam is operated by Lewis County PUD.

Cowlitz Falls Dam, located at rkm 142, generates 70 megawatts (Figure 2-1). Completed in 1994, it is 43 m high and creates the 247-hectare Lake Scanewa that extends about 18 km upstream into the Cispus and upper Cowlitz rivers. The land in the Upper Cowlitz Subbasin is largely managed by the U.S. Forest Service and National Park Service (Mt. Rainier National Park).

The Mossyrock Hydroelectric Project is a 300 megawatt facility that was completed in 1968 and impounds the Cowlitz River below Cowlitz Falls Dam (Figure 2-1). Mossyrock Dam is a 185-m high concrete arch dam that forms the 37 km long Riffe Lake, covering 4,787 hectares and with 84 km of shoreline.

The Mayfield Hydroelectric Project is a 162 megawatt facility that was completed in 1963 (Figure 2-1). It includes a 76-m high dam that impounds the lower reaches of the Tilton River, as well as the Cowlitz River below Mossyrock Dam to form 911-hectare Mayfield Lake. Mayfield Dam is operated to reregulate flows from Mossyrock Dam to reduce fluctuations in the Cowlitz River downstream.

2.2 Cowlitz River Management Time Line

Table 2-1. Time line of important dates and events in fisheries and river management in the Cowlitz Basin.

Year	Event
1933	Washington Hydraulics Division issues permit to construct Mayfield Dam.
? - 1949	A salmon hatchery operated in the upper Cowlitz River near the mouth of the Clear Fork River. Operations discontinued due to poor returns.
circa1946	Construction of Mayfield and Mossyrock dams was proposed.
1946	Tacoma bought water rights on the Cowlitz River.
1948	License application submitted to FERC for construction of Mayfield and Mossyrock dams.
1948	The Washington Department of Fisheries (WDF) and the Washington Department of Game (WDG) estimated spawning escapement and total production (harvest plus spawning escapement) of salmon, steelhead, and Cutthroat Trout in the Cowlitz River above the Mayfield Dam site to be:

Species	Total Harvest	Spawning Escapement	Total Production
Spring Chinook Salmon	23,490	9,000	32,490
Fall Chinook Salmon	49,612	14,000	63,612

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Year	Event			
	Coho Salmon	53,000	24,000	77,000
	Steelhead	11,000	11,000	22,000
	Cutthroat Trout	24,861	24,861	49,722
	Totals	161,963	82,861	244,824
1948	Moore (1948) estimated that the fishing "industry" in the Cowlitz River was worth $1,000,000 (~$10,600,000 in 2019).			
1949	Columbia River Fish Sanctuary law enacted by Washington State, requiring approval of WDF to build any dam over 25 feet in the designated lower Columbia River area. WDF did not approve the construction of Mayfield Dam.			
Late 1940s - Late 1950s	• Fish passage was identified as the key issue and necessary for run continuance by Tacoma Power, its consultants, and the fishery resource agencies. • Salmonid hatchery technology was not advanced, so relying on hatchery production to compensate for fish losses was not seriously considered.			
1950s	Many fish passage designs were developed and hydraulic studies conducted.			
1950	Strunk and Hubbs (1950) noted the dramatically depressed populations rather than habitat limitations in the Cowlitz Basin.			
1951	Tacoma was issued a license by FERC to construct, operate, and maintain the Mayfield and Mossyrock Hydroelectric Project.			
1957	USFWS approved the installation of the skimmer and other fish facilities for Mayfield Dam to collect downstream migrants (Richey 1956).			
1961	Mayfield Dam adult collection and transfer facility began operations. Adult salmonids were collected at the base of Mayfield Dam, and a tram took them 100 m up the hillside to a transfer house, where they were released into a 3-foot diameter pipe that routed them directly into Mayfield Lake.			
1962	An upstream fish passage system was completed at Mayfield Dam, which consisted of a fish ladder, an elevator system, and an adult passage flume.			
1963	Mayfield Dam was completed, with volitional upstream salmon migration blocked at rkm 84.			
1963	Juvenile fish bypass system at Mayfield Dam began operating. It included a surface collection system consisting of louver panels and a fish bypass system. However, it was not completed before dam closure, so smolts from the Upper Cowlitz Subbasin were initially passed over the spillway.			
1965	Fisheries agencies confirmed the poor performance of floating Merwin traps at upper end of Mayfield reservoir and proposed a series of traps in the future Mossyrock reservoir to trap and transport juveniles downstream by truck, to trap-and-haul upstream migrants at the future Mossyrock Dam, and to build hatcheries to supplement fish production.			
1966	A plan for managing anadromous fishes above Mayfield Dam was developed, which included the elimination of upstream facilities at Mossyrock Dam, the construction of hatcheries and a barrier dam downstream of Mayfield Dam on the Cowlitz River, the transportation of adults from Mayfield Dam to above Mossyrock reservoir, floating smolt collection traps in Mossyrock reservoir, and the continuation of downstream migrant collection facilities at Mayfield Dam.			
1967	Tacoma Power and WDF signed an agreement in which Tacoma would pay for the construction, operation, and maintenance of the Cowlitz Salmon Hatchery and existing fish collection facilities already in place on the Cowlitz River at the			

Year	Event
	level necessary to maintain the existing runs of Chinook Salmon and Coho Salmon at the following annual return levels: • Coho Salmon: 25,500 • Spring Chinook Salmon: 17,300 • Fall Chinook Salmon: 8,300
1967	Cowlitz Salmon Hatchery and Cowlitz Trout Hatchery opened.
1968	Mossyrock Dam completed.
1968	Cowlitz River was diverted over the Barrier Dam adjacent to the hatchery, with volitional salmon migration blocked at rkm 81.
1968	Operation of upstream fish facilities at Mayfield Dam terminated because no fish had entered the facilities since 3 July 1968.
1971	Federal Power Commission formally approved abandonment of Mayfield upstream fish transport facilities.
1974	Last field season for the Riffe Lake downstream migrant collectors.
1974 - Present	Mayfield Dam downstream fish bypass facilities opened. They have been operational year round with the attraction pumps for the fish louver system being operational from April through July, annually.
1980	Mt. Saint Helens eruption.
Early 1980s	Management of the Upper Cowlitz Subbasin shifted from anadromous fish production to recreational harvest opportunities upon stocked anadromous salmonids and resident trout.
1986-2000	Mass marking of smolts at Cowlitz Salmon Hatchery begins; smolts are adipose fin-clipped and some groups are also 100% coded-wire tagged. First brood year that was mass marked: Species — Brood Year Fall Chinook Salmon — 1995 Spring Chinook Salmon — 1997 Coho Salmon — 1997 Early Winter Steelhead — 1986 Late Winter Steelhead — 2000 Summer Steelhead — 1991 Cutthroat Trout — 1991
1994	Completion of Cowlitz Falls Dam.
1994	Trap-and-haul program restored to transport adult salmon to the Upper Cowlitz Subbasin.
1996	Cowlitz Falls Fish Facility completed by BPA; downstream migrant trapping begins at Cowlitz Falls Dam with WDFW as lead agency.
2000	Settlement Agreement was signed by 12 Parties resolving, to the satisfaction of the Parties, all issues associated with issuance of a new license for the Project.
2002	FERC issues “Order Approving Settlement and Issuing New License” for the Cowlitz River Hydroelectric Project No. 2016. (2002 downstream collector multi-agency workshop.)
2004	NOAA Fisheries issues the Cowlitz River Hydroelectric Project Biological Opinion (NOAA Fisheries 2004).
2004	An amendment to the license was issued adding an additional eight license articles.

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Year	Event
2006	Initial FHMP (submitted in 2004) was approved by FERC in 2006 (115 FERC ¶ 62,029).
2009-2011	Downstream Team develops Conceptual Design Report for fish passage at or near Cowlitz Falls Dam.
2011	Weirs installed in lower Cowlitz River tributaries by WDFW, allowing control of hatchery-origin summer steelhead. Tacoma Power funding later allowed monitoring of natural-origin salmon and control of all hatchery fish entry into those streams.
2014	A second FHMP (updated in 2011) was approved by FERC in 2014 (149 FERC ¶ 62,032).
2014	Tacoma Power takes over ownership of Cowlitz Falls Fish Facility from BPA. BPA continues financial support of facility operations.
2017	New smolt collection facility at Cowlitz Falls Dam begins operation.
2018	Tacoma Power takes over operation of Cowlitz Falls Fish Facility and Cowlitz Falls North Shore Collector from WDFW.

2.3 Cowlitz River Fishes

Historically, the Cowlitz River supported large populations of Chinook Salmon, Coho Salmon, steelhead, and sea-run Cutthroat Trout throughout much of the watershed, with Chum Salmon generally in the lower river. Anadromous sea-run Cutthroat Trout, sturgeon *Acipenser* sp., Eulachon *Thaleichthys pacificus*, and Pacific Lamprey *Entosphenus tridentatus* are also present in the lower reaches of the Cowlitz River. Today, anadromous fish populations persist downstream of Mayfield Dam. Natural production in the Upper Cowlitz Subbasin is gradually increasing as a result of supplementation with hatchery-origin salmon for reintroduction programs for spring Chinook Salmon, Coho Salmon, and winter steelhead.

Resident fishes include Cutthroat and Rainbow Trout; Largescale *Catostomus macrocheilus*, Bridgelip *C. columbianus*, and Mountain suckers *C. platyrhynchus*; Mountain Whitefish *Prosopium williamsoni*; sculpin *Cottus* spp.; Longnose Dace *Rhinichthys cataractae*; Speckled Dace *R. osculus*; Western Brook Lamprey *Lampetra richardsoni*; and Northern Pikeminnow *Ptychocheilus oregonensis*. Introduced fishes in the basin include Largemouth *Micropterus salmoides* and Smallmouth *M. dolomieu* bass, Brook Trout *Salvelinus fontinalis*, Crappie *Pomoxis* spp., Bluegill *Lepomis macrochirus*, and Brown Bullhead *Ameiurus nebulosus*. Mayfield Lake is stocked with tiger muskellunge *Esox lucius* x *E. masquinongy* as sport fish and for Northern Pikeminnow control.

The Cowlitz River is fished intensively by sport anglers. It has been a top winter steelhead river in Washington and is also a popular summer steelhead river. The Cowlitz River also attracts intense angler effort for spring Chinook Salmon, fall Chinook Salmon, and Coho Salmon. Additionally, sea-run Cutthroat Trout are an important indigenous species that are produced in the Cowlitz River hatcheries to provide recreational opportunities for anglers.

As is the case with most watersheds in the region, salmon runs dramatically declined in the Cowlitz Basin due to overharvest and habitat loss, and the construction of Mayfield and Mossyrock dams further contributed to the decline of these populations. Construction of Cowlitz Falls Dam facilitated reintroduction of anadromous salmonids into the Upper Cowlitz Subbasin. Since the license renewal in 2002 (FERC 2002), Tacoma Power has had an obligation to work with the Settlement Agreement Parties to successfully reintroduce and recover anadromous fish populations for both harvest and recovery.

Myers et al. (2006) examined the historical records to identify and characterize DIPs of listed Chinook Salmon, Coho Salmon, and Chum Salmon and steelhead within the lower Columbia River ESU for each species (Table 2-2). Good information on historical abundance, life history characteristics, and genetics was scarce for most populations (particularly for Upper Cowlitz Subbasin winter steelhead), while information on historical presence and geographic distribution was more plentiful and of higher quality (except for summer Chum Salmon).

Table 2-2. Ratings of the quantity and quality of historical information available for ESA-listed salmonid species and populations in the Cowlitz River (from Myers et al. 2006).

Information scale:

0 No information is available.
1 Some information is available but of limited quality or quantity.
2 Information is available but of limited use because of quality issues (i.e., hatchery, nonnative stock influences, environmental degradation, etc.).
3 Good information is available that directly pertains to historical populations or to present populations that are representative of historical populations.

Species / Population	Historical Presence	Historical Abundance	Life History Characteristics	Genetics	Geography
Fall Chinook Salmon					
Lower Cowlitz River	3	2	2	2	3
Upper Cowlitz River	3	1	2	1	3
Spring Chinook Salmon					
Cispus River	3	2	1	0	3
Upper Cowlitz River	3	2	1	2	3
Tilton River	3	2	1	0	3
Winter Steelhead					
Lower Cowlitz River	3	1	1	1	2
Cispus River	3	1	0	0	3
Upper Cowlitz River	3	2	0	0	2
Tilton River	3	1	0	0	3
Coho Salmon					
Lower Cowlitz River	3	2	1	2	3
Cispus River	3	1	1	0	3
Upper Cowlitz River	3	2	1	2	3
Tilton River	3	1	1	0	3
Chum Salmon					
Cowlitz River Summer	1	1	1	2	2
Cowlitz River Fall	3	2	2	0	3

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2.4 Fish Facilities

To meet production requirements, Tacoma Power developed and funds the operation of the Cowlitz Hatchery Complex, as stipulated in the Settlement Agreement. The complex is comprised of two hatcheries and facilities for the collection and transport of returning salmonids from the lower Cowlitz River to rivers above the dams. During the period covered by this FHMP, Tacoma Power will initiate the planning for the satellite rearing facilities, including inception (what they will be used for), location, and design phases. Tacoma Power also owns facilities at Cowlitz Falls and Mayfield dams, for downstream transport of outmigrants to the lower Cowlitz River.

2.4.1. Hatchery Facilities

Tacoma Power’s Cowlitz Hatchery Complex includes Cowlitz Salmon Hatchery, located about 4 km downstream of Mayfield Dam, and Cowlitz Trout Hatchery, about 12 km downstream of Cowlitz Salmon Hatchery (Figure 2-1). The hatcheries were constructed by Tacoma Power and began operation in 1967. Both hatcheries are operated by WDFW with funding provided by Tacoma Power. Cowlitz Salmon Hatchery was fully remodeled in 2010, and a major remodel of Cowlitz Trout Hatchery is currently in the design phase. On-site housing and back-up generators provide emergency response capabilities at both hatcheries.

In its 2006 “Order Modifying and Approving Fisheries and Hatchery Management Plan, Article 6,” FERC (2006) dictates that the “principal stocks of fish to be produced are the indigenous stocks” (fall and spring Chinook Salmon and Coho Salmon, produced at Cowlitz Salmon Hatchery, and sea-run Cutthroat Trout and late winter steelhead, raised at Cowlitz Trout Hatchery). It further states that “non-indigenous stocks, such as early winter and summer steelhead, may be produced, provided that production shall emphasize the recovery of indigenous stocks, and production and management of all stocks shall be consistent with that goal.” Specific production details have changed since FERC (2006), but total hatchery production has not (Table 2-3). The hatchery programs as described in this FHMP are limited by facility, by program, and by license capacity. Consistent with ESA recovery planning, however, there may be additional room for capacity within the basin, and future goals should be coordinated with the FTC through the APR process to maximize basin-wide effectiveness. The proposed program goals may be subject to modification pending completion of the Transition Plans and the resulting bio-programming of the hatchery facilities based on overall capacity, as described later in this FHMP. (For more information on the Transition Plans, see Chapter 12 and Appendix B.)

As described above, Barrier Dam directs migrating adult salmon and steelhead into an adult collection and transportation facility. The adult fish ladder is operated year-round, with an auxiliary water source to provide additional attraction flow. An electric fish barrier system is in place to reduce the inclination of fish to try to jump over the Barrier Dam. At the top of the ladder, fish enter a holding pond, which has a capacity for 2,540 kg of fish or approximately 350 adult Chinook Salmon or 700 Coho Salmon. During sorting, the fish are crowded into the sorting facility, where the salmon are sorted and directed for release to on-site holding ponds or for transport upstream to designated release sites in the Tilton, Cowlitz, and Cispus basins.

Broodstock are held in nine adult raceways at Cowlitz Salmon Hatchery, with two crowders that can crowd any of the holding ponds into the common crowding channel. A channel crowder directs the adults to an uplift crowder and into the spawning room, which is equipped with an electro-anesthesia basket. Eggs are collected and fertilized inside the hatchery building and then placed in one of three incubation rooms. Incubation facilities are

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supplied by five wells and include vertical stack and kitoi-style incubators with recirculation capability. Fry are ponded into either six starter troughs or routed directly to the 36 California-style raceways, which are supplied by 4.7 m^3/s of water pumped from the river and where they are raised to smoltification. Smolts are volitionally released through the pond drain system and into the Cowlitz River just downstream of the Barrier Dam. Fish waste is vacuumed via a venturi system and routed to offline settling ponds. Total production capacity is 294,835 kg, approximately 7.5 million smolts, pursuant to the Settlement Agreement.

Cowlitz Trout Hatchery produces and releases about 1.5 million steelhead each year. Although it is equipped with a fish ladder and adult ponds, collection and spawning of broodstock occurs at the Barrier Dam Adult Facility. Green eggs and sperm are collected at Cowlitz Salmon Hatchery and transported to the trout hatchery incubation facility, where they are combined and the fertilized eggs are incubated in 88 shallow troughs, two deep troughs, and two heated tanks supplied by nine wells, which provide a total of approximately 91 L/s. Fry are ponded into 30 raceways and held until marking, after which a portion of the steelhead parr are transported to four rearing lakes, equipped with rotating outlet screens, and held until volitional release into Blue Creek (the tributary leading to the Cowlitz Trout Hatchery). Fish waste within the raceways is pumped to an offline settling pond. The hatchery pumps approximately 1.42 m^3/s of river water, of which 0.57 m^3/s is treated via an ozone plant strategically operated to avoid *Ceratonova shasta* outbreaks throughout the year.

Within the period covered by this FHMP, Tacoma Power will perform various upgrades throughout the Cowlitz Trout Hatchery. The purpose of these remodeling upgrades is ultimately to improve infrastructure reliability, fish health, and overall survival. Changes in infrastructure will undoubtedly necessitate program flexibility as we seek creative solutions to maintain fish production. Temporary modifications to programs will be required because of the remodeling activities, and will be vetted through the FTC and, whenever possible, communicated prior to each annual APR process.

2.4.2. Upstream Passage

There are no upstream passage or collection facilities at any of the three major dams. Most upstream-migrating salmon are stopped at the Barrier Dam and diverted into the adult facility by a velocity/electric barrier. Collected fishes are separated by species, sex, and disposition. A trap-and-haul strategy is used to transport natural- and hatchery-origin salmon and steelhead that are not retained for hatchery broodstock past the Cowlitz River dams and reservoirs to the Tilton and Upper Cowlitz subbasins for recovery and harvest purposes (Figure 2-1).

2.4.3. Downstream Passage

Salmon and steelhead smolts migrating downstream from the upper Cowlitz and Cispus rivers are collected at the Cowlitz Falls Fish Facility, located at Cowlitz Falls Dam. These smolts are transported by truck to one of eight stress relief ponds at Cowlitz Salmon Hatchery, where they are held for an acclimation period and then volitionally released to the lower Cowlitz River immediately below the Barrier Dam to continue their journey to the ocean. Downstream migrating salmon and steelhead encountering Mayfield Dam are diverted by a louver system to a fish passage channel at Mayfield Dam and then pass to the lower Cowlitz River.

Table 2-3. Hatchery production goals at Cowlitz Salmon Hatchery (Chinook and Coho Salmon) and Cowlitz Trout Hatchery (steelhead and Cutthroat Trout) in 2006 (based on the Future Brood Document [WDFW 2004]), after the hatchery rebuild in 2010, and current production levels (updated from FERC 2006).

	2004 Future Brood Document			Current Program				
	Total Production			Total Production			Mean Weight	
Species/ Run / Population	Number	kg	Pounds	Number	kg	Pounds	g	fpp
Chinook Salmon								
Fall	5,000,000	28,409	62,500	3,500,000	19,950	43,750	5.7	80
Spring	1,267,000	28,409	62,500	1,738,529	99,458	218,956		
				438,529	39,818	87,706	90.8	5
				800,000	45,440	100,000	56.8	8
				500,000	14,200	31,250	28.4	16
Coho Salmon	3,210,000	96,974	213,343	2,178,000	65,993	145,200	30.3	15
Integrated				978,000	29,633	65,200	30.3	15
Segregated				1,200,000	36,360	80,000	30.3	15
Steelhead	1,440,000	112,122	246,667	1,297,000	95,617	210,610		
Late Winter	590,000	36,364	80,000	647,000	41,963	92,429	64.9	7
Lower Cowlitz Subbasin				481,000	31,196	68,714	64.9	7
Upper Cowlitz Subbasin				118,000	7,653	16,857	64.9	7
Tilton Subbasin				48,000	3,113	6,857	64.9	7
Early Winter	300,000	27,273	60,000					
Summer	550,000	48,485	106,667	650,000	53,655	118,182	82.5	5.5
Sea-run Cutthroat Trout	160,000	17,045	37,500	100,500	11,097	24,443		
Cowlitz Trout Hatchery				90,500	10,272	22,625	114	4
To Friends of the Cowlitz				10,000	825	1,818	82.5	5.5
Totals	11,077,000	282,959	622,509	8,814,029	292,116	642,959		

Since 2014, WDFW has operated net pens to rear an additional 2 million juvenile fall Chinook Salmon in the forebay of Mayfield Dam (Figure 2-1). The resulting smolts are trucked to Cowlitz Salmon Hatchery for release. Net pens are currently owned and operated by WDFW; discussions about their future use for final rearing of fall Chinook Salmon and other species in Mayfield Lake are ongoing.

2.4.4. Satellite Rearing Facilities

Article 5 of the Settlement Agreement requires that Tacoma Power "shall be responsible for funding the operation and maintenance of the Cowlitz Hatchery Complex consisting of the remodeled Cowlitz Salmon Hatchery, the remodeled Cowlitz Trout Hatchery, and three satellite rearing facilities, for the duration of this license." During the period covered by this FHMP, Tacoma Power will initiate the planning for the satellite rearing facilities, including inception (what they will be used for), location, and design phases.

2.5 Hatchery Production

Hatchery production begins with the collection of broodstock, which are held until they are ready to spawn, at which time gametes are collected and combined to form fertilized eggs. The eggs are incubated until they hatch and the resulting offspring are reared until release, usually at the smolt stage. For conservation/recovery programs, the goal is to produce salmon that resemble and perform like natural-origin salmon as best as possible. Best management practices (Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017) should be employed at all stages and include the collection of broodstock that are representative of the natural population in all aspects (and are predominantly natural-origin for a high pNOB and PNI), spawning within matrices to incorporate as much genetic diversity as possible in the resulting F_1 generation, and rearing conditions and growth rates that produce offspring that will survive and mature at similar rates as natural-origin salmon and have similar or improved reproductive success. Development of Transition Plans outlining changes in hatchery programs from their current state to those proposed in this FHMP will be developed assuming that best management practices will be employed as possible within facility constraints. The Transition Plans will include an evaluation of space, water, and infrastructure required to accommodate newly proposed programs under these best management practices.

Hatchery practices will continue to be evaluated in order to look for ways to improve these programs. The Settlement Agreement (Section 6.1.5), states that, "The hatchery complex will be designed with flexibility so managers can employ innovative rearing practices, low densities, and replication of historic fish out-migration size and timing." The intent of the SA is to rear the salmon so that they are as similar, in both appearance and performance, to natural-origin salmon as possible if that is determined to be a successful strategy that meets objectives. Programs will be evaluated with the goal to rear fish to the size and release strategy that provides the best returns for population recovery and harvest.

The HSRG (2017) provided guidance on the various types of hatchery programs available as tools to managers. These include integrated, segregated, and stepping-stone programs. Each strategy has pros and cons, and each requires proper implementation and management to be successful. The HSRG (2017) presented guidelines for implementing hatchery reform in the context of recovery planning and determined that an integrated hatchery program may be appropriate when: (1) the hatchery program has a conservation goal, or (2) the

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proportion of hatchery salmon on the spawning grounds cannot be reduced sufficiently to meet guidelines for a segregated program. Integrated hatchery programs are intended to artificially increase the demographic abundance of a naturally spawning population and have a goal that natural selection in the natural environment drives the fitness of the population as a whole. To accomplish this, pNOB should exceed pHOS (HSRG guidelines for Primary populations are that pNOB >2 * pHOS). This means that well-integrated programs require a natural population that is self-sustaining (or nearly so) in order to provide fish for broodstock (Paquet et al. 2011).

A segregated hatchery program may be appropriate: (1) when there is a very low probability of hatchery salmon spawning with natural populations, (2) for mitigation programs where spawning habitat no longer exists, or (3) where smolt release and adult recollection facilities are physically separated from natural spawning areas. Segregated hatchery programs create a new, hatchery-adapted population that is genetically distinct from the natural population (Paquet et al. 2011). As such, these hatchery salmon may pose significant genetic and ecological risks to naturally spawning populations, if programs are not managed appropriately.

Stepping-stone hatchery programs may provide a transition to a fully integrated program. They have the goal of increasing hatchery production while maintaining genetic continuity with the natural population. As such, they retain some genetic continuity between the hatchery- and natural-origin populations, particularly when natural-origin broodstock is in short supply. Stepping-stone programs may be appropriate for supplementing harvest when the small size of an integrated program does not meet harvest objectives. Salmon from the integrated and segregated portions of the stepping-stone program must be able to be non-lethally identified by separate marks.

The 2011 FHMP states that “in the future, consideration could be given to converting to an integrated hatchery program to further improve fitness of the natural population”; the Hatchery Action Implementation Plans (WDFW 2009) lists “modify programs to achieve goals for PNI, pHOS, and pNOB” as a needed improvement action for Cowlitz River hatchery programs; and the Lower Columbia Basin Conservation and Sustainable Fisheries Plan (WDFW and LCFRB 2016) recommends that programs “convert from segregated programs to integrated or local brood source.” All current hatchery programs on the Cowlitz, except the non-endemic summer steelhead, have a local broodstock source. Moving forward in the near term, Tacoma Power and the FTC will develop Transition Plans for the fall Chinook, spring Chinook, Coho Salmon, and winter steelhead programs in order to continue recovery efforts. The timeframe for development of each Transition Plan (e.g., developed within 1 or 2 years) and overall strategy will depend on species and population. An objective of the Transition Plans will be to improve pNOB and PNI for the Cowlitz River hatchery programs and improve the fitness of the natural populations that they supplement. For more information on the Transition Plans, see Chapter 12 and Appendix B.

Best management practices will be developed from state, federal, tribal, and private hatcheries, as well as the scientific literature (e.g., Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017) and will include protocols for:

- **Broodstock collection -** To ensure that the broodstock are representative of the entire run and fit with the management goals of the program.
- **Spawning**: To ensure that the spawners are representative of the population that they will supplement and fit with the management goals of the program.
- **Egg incubation:** To ensure maximum survival and that the hatch timing fits with the planned growth profile.

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- **Rearing**: To ensure that the juveniles grow at the expected rate and remain healthy.
- **Release**: To maximize survival to maturity.
- **Marking**: So that we can identify the hatchery salmon, by release group.

Best management practices will change as technology and knowledge improve. Specific strategies may include:

- The use of spawning matrices to maximize the genetic diversity of our hatchery populations and the natural populations that they supplement.
- Evaluation of raising hatchery salmon to a more natural size and at a more natural rate, with the goal that they mature at a more natural (older) age.
- Developing new protocols and improved databases to better monitor hatchery production at all stages.

Additionally, procurement of new technology and infrastructure may also be utilized to achieve best management practices. Examples might be:

- Automated fish and egg counters.
- Smaller innovative (nature-mimicking) rearing vessels.
- Artificial spawning channels.

2.6 Fish Management

Management of Cowlitz River anadromous fish populations has evolved over time, as managers have learned more about how the populations respond to anthropogenic and natural perturbations, as human societal desires and demands have changed, and as recovery goals have been set. Effective management relies on the best available data. Increased monitoring efforts have provided improved data, which allow for better-informed decision-making.

The low abundance of natural populations, fractured habitat, and a myriad of competing interests, among other issues, make managing these populations challenging. Recovery efforts into the Tilton and Upper Cowlitz subbasins are progressing. The Lower Cowlitz Subbasin and hatchery populations are being used as the parent stocks for all of the restoration programs, with the assumption that these populations still carry at least some of the genes that were present in the original populations that inhabited the streams above Mayfield Dam.

The Settlement Agreement goal of population restoration is self-sustaining natural populations at harvestable levels. We will continue to improve the rigor of the monitoring programs so as to estimate, with greater confidence, the abundance of these populations and when they have become self-sufficient, as well as to identify areas where we can improve survival. Additionally, the M&E Program will allow for evaluation of activities facilitated by Tacoma Power to protect and enhance habitat in the Cowlitz Basin and the impacts of this work on smolt production and the subsequent return of adult salmon.

2.7 Adaptive Management

Adaptive management is and will continue to be an integral part of the management of these populations as a whole, and of the fisheries that benefit from them, the hatcheries that support the populations, all of the management activities, and, hence, this FHMP. We will

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adaptively manage these populations and programs, as directed by the Settlement Agreement and license and as recommended (HSRG 2009; NMFS 2013; WDFW and LCFRB 2016). The adaptive management program is described in more detail in Chapter 12 and in each species and population section (below).

Adaptive management is a resource management approach that seeks to improve the management of biological resources by using a process where management actions and strategies are adjusted based on new information, which comes from monitoring data that are rigorously collected and evaluated. It is a structured, iterative process of robust decision making where management actions are designed, implemented, and monitored as experiments, and uses data to adjust specific parts of programs (e.g., hatchery production or broodstock collection). There are five steps in this process and each is conducted, in order, and documented during each decision-making cycle (see Figure 12-1 in Chapter 12):

1) Conduct Program & Collect Data
2) Data Analysis (Monitoring & Evaluation)
3) Reporting Results (Annual Report)
4) Decision-making (Annual Program Review [APR])
5) Planning (Annual Operating Plan [AOP])

2.8 Monitoring and Evaluation

Monitoring (data collection) and evaluation of those data are critical to effective adaptive management (IHOT 1995; HSRG 2009). We introduce some important concepts here but describe the M&E Program in further detail in each species chapter (Chapters 3-9) and Chapter 10, Monitoring & Evaluation (M&E).

Rigorous monitoring and collection of the necessary data are the key to effectively monitoring a population (Table 1-4) and will be conducted following regionally standardized practices. Effective adaptive management requires monitoring data for the most recent available year, as well as past years, so that the appropriate questions can be considered and decisions made. This information tells managers whether the populations are meeting trigger values for each metric associated with a recovery phase and, if not, these data may provide clues to potential explanations. The recent year's data tell us the current condition of the population, and the historical data (as much as are available) provide context and trend information.

Ideally, we would continuously monitor a population, but anadromous salmon may spend over half of their lives in the Pacific Ocean. While monitoring their growth and survival during this period is important for understanding each population, it is impractical. Tacoma Power has no direct influence over this part of their life cycle, and WDFW has only minimal influence, through setting harvest levels in ocean and Columbia River fisheries, which cannot target or avoid specific populations, such as natural-origin fall Chinook Salmon from the Cowlitz Basin. Further, little is known about the natural mortality of outmigrating juveniles or returning salmon, including impacts of *C. shasta,* and avian (e.g., kingfishers, cormorants, mergansers, and terns), piscivore (e.g., pikeminnow, pacific hake, shark, and mackerel), and mammalian predators (e.g., orcas, harbor seals, and California and Steller sea lions).

There are many points at which a population can be monitored and data and samples (from which additional data are obtained) can be collected. All of these data are important for providing insight into the status and condition of the population. Monitoring focuses on key

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diagnostic points in the life cycle of a population (Figure 2-2), when individual salmon can be directly counted to collect data; this allows for monitoring abundance, growth, condition, and survival. Some of those monitoring points provide key metrics that are critical to understanding a population and for effective management. Additional management metrics are calculated or modeled from the collected data that further describe the status of the population and are important for adaptive management. Without adequate monitoring data, a population cannot be effectively managed.

Current monitoring efforts (since 2010) have mainly focused on the Cowlitz River but also include the ocean and Columbia River fisheries. Once a salmon enters the Cowlitz River, it may either survive to spawn (in a hatchery or in nature), be removed at a weir or hatchery (hatchery-origin salmon), or die prior to spawning either from harvest in a fishery or from natural causes (predation or disease). While we cannot individually count the salmon as they approach the Columbia River or enter the Cowlitz River, we can estimate the numbers of salmon at major locations (e.g., fisheries, weirs/traps, and spawning grounds) and the sum of these represent the estimate of the total number that returned.

The most critical management metrics concern abundance, so this is the most common type of data collected and includes total run size, number harvested, number captured at the hatchery or remaining in nature, number of spawners in nature and the hatchery, and numbers of smolts produced in nature and the hatchery. These metrics are also used to calculate additional monitoring and management metrics, such as survival and population productivity, and can identify where a population may be limited and management actions can be taken to alleviate that limitation, thereby improving survival and increasing abundance. Also, fish managers use these data to reconstruct salmonid run sizes and make forecasts for future returns to the Columbia River system, which is important for establishing management strategies. Whenever data are collected, they should be, if practical, collected by origin, age, and sex, in order to understand the population to the greatest extent possible. Additionally, data collection methods and the estimates they produce must be unbiased with enough precision to make meaningful assessments and decisions.

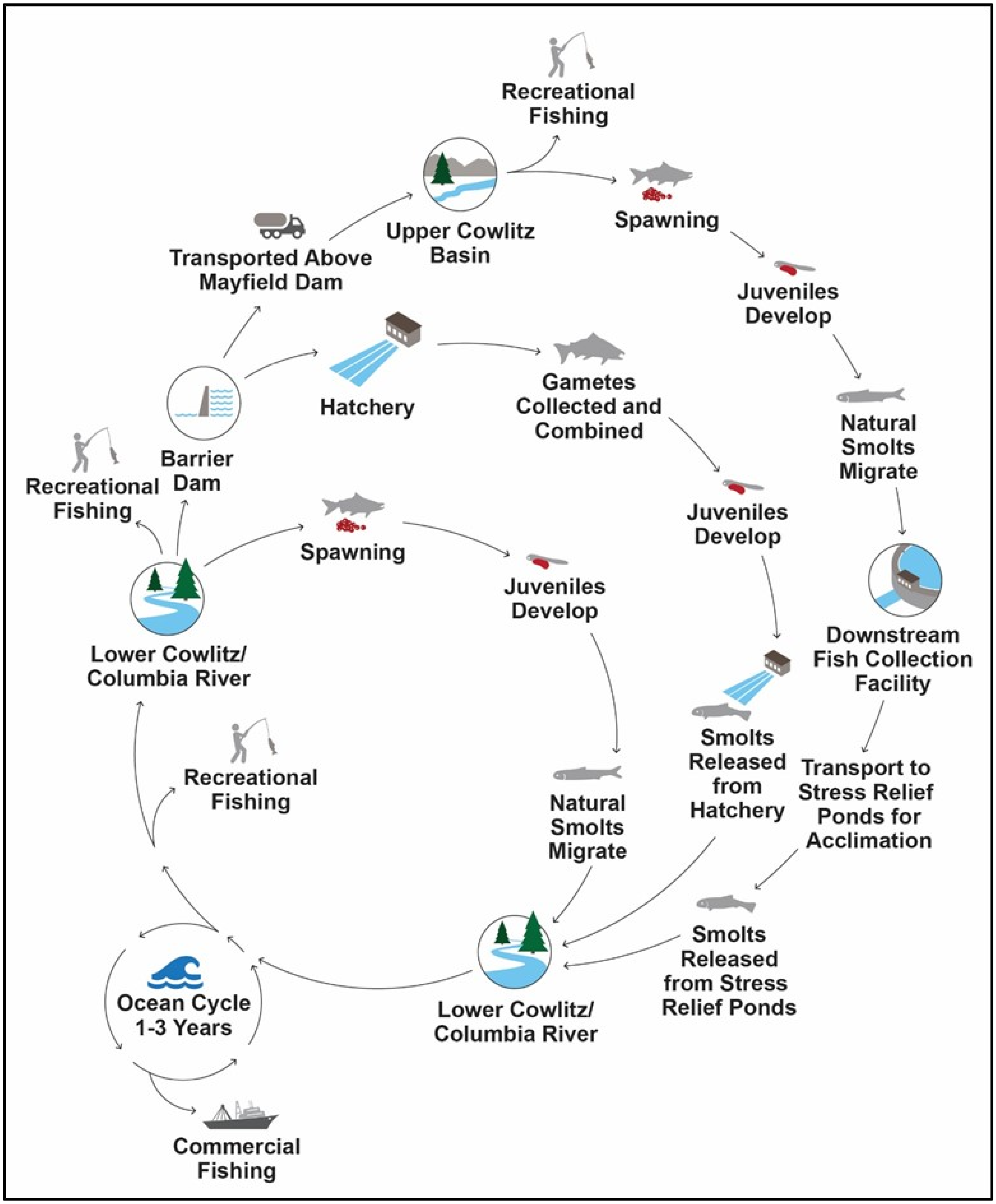

Figure 2-2. The general life cycle and handling points of Cowlitz River salmon and steelhead.

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CHAPTER 3:
FALL CHINOOK SALMON

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Fall Chinook Salmon *Oncorhynchus tshawytscha*

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Lower Columbia River Chinook Salmon
Major Population Group:	Cascade Chinook Salmon
Recovery Region:	Lower Columbia River Salmon
Populations, Recovery Designations, and Minimum Viability Abundance Targets (natural-origin adults spawning in nature):	Lower Cowlitz Subbasin - Contributing, 3,000 Upper Cowlitz Subbasin (includes Cispus, upper Cowlitz, and Tilton drainages) - Stabilizing, not established
Current Hatchery Program(s):	Lower Cowlitz Subbasin - Integrated; 1.1 million sub-yearling smolts Lower Cowlitz Subbasin - Segregated; 2.4 million sub-yearling smolts
Proposed Hatchery Program(s):	Tilton River (Upper Cowlitz Subbasin) - Integrated; 3.5 million sub-yearling smolts

3.0. Fall Chinook Salmon: Overview

3.0.1. Program Focus

The focus for fall Chinook Salmon is on population recovery in both the Lower Cowlitz and Upper Cowlitz subbasins. The Recovery Plan (LCFRB 2010) identifies a Contributing fall Chinook Salmon population in the Lower Cowlitz Subbasin and a single Stabilizing fall Chinook Salmon population, encompassing the Cispus, upper Cowlitz, and Tilton river basins, upstream of Mayfield Dam. However, the current effort for recovering the Upper Cowlitz Subbasin fall Chinook Salmon population is focused on the Tilton Subbasin, in order to prevent interference with the recovery of spring Chinook Salmon in the Upper Cowlitz Subbasin (a Primary population). Therefore, fall Chinook Salmon will not be transported and released into the Cispus or upper Cowlitz rivers, upstream of Cowlitz Falls Dam and spring Chinook Salmon will not be released into the Tilton Subbasin during the period covered by this FHMP, unless directed by the FTC. Because we cannot easily discern fall Chinook Salmon smolts from spring Chinook Salmon smolts, mixing the runs would greatly reduce the certainty of monitoring data for managers so that we would not be able to determine whether any potential problem in adult recruitment was due to poor freshwater survival or poor saltwater survival. A framework will be developed for the eventual release of fall Chinook Salmon above Cowlitz Falls Dam by the Cowlitz FTC. Such a framework requires an understanding of the key population parameters, referred to as Viable Salmonid Population (VSP) parameters (which include population abundance, productivity, spatial structure, and diversity) for both fall and spring Chinook Salmon in the affected basins, which will be amongst the parameters and considerations for releasing fall Chinook Salmon above Cowlitz Falls Dam (McElhany et al. 2000).

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Due to blocking of upstream migration following dam construction in the 1960s, the subsequent aggregation of the populations, and continued genetic exchange since that time, the two fall Chinook Salmon populations (Lower Cowlitz and Upper Cowlitz subbasins) identified within the ESA framework have functionally become a single Cowlitz Subbasin population. Recovery of the Upper Cowlitz Subbasin population will rely on the extant Lower Cowlitz Subbasin population, which has increased and is now nearing its minimum viability abundance target of 3,000 natural-origin adults spawning in nature, with pHOS <0.3 in the lower Cowlitz River. The long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. If needed, a Segregated Hatchery Program will continue to be used to ensure that the annual hatchery production goal is met and fish are available for harvest. Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper describing various perspectives, which is included as Appendix D of this FHMP for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B. During this period of focus on the Lower Cowlitz and Tilton subbasins, we will continue to evaluate the appropriate program structure to manage for individual populations in the future.

3.0.2. Population Structure

Historically, Cowlitz River fall Chinook Salmon spawned and reared in mainstem and lower reaches of major tributaries from the mouth of the Cowlitz River, upstream into the Cispus, upper Cowlitz, and Tilton basins. Excluding the Coweeman and Toutle rivers (lower tributaries that are unaffected by the Tacoma Power hydroelectric dams), two historical independent populations have been recognized in the Cowlitz Basin: the Lower Cowlitz Subbasin (below Mayfield Dam) and the Upper Cowlitz Subbasin (comprised of the Cispus, upper Cowlitz, and Tilton drainages (LCFRB 2010; Figure 3.0-1; Table 3.0-1). In the Recovery Plan, the Lower Cowlitz Subbasin fall Chinook Salmon population is classified as a Contributing population toward recovery of the lower Columbia River fall Chinook Salmon ESU, with a minimum viability abundance target of 3,000 natural-origin adults spawning in nature in the Lower Cowlitz Subbasin (LCFRB 2010). The Upper Cowlitz Subbasin fall Chinook Salmon population was assigned the lower classification of Stabilizing and does not have a minimum viability abundance target identified. However, all potential management options will include strategies for recovery and persistence of both populations. The population-level sections that follow provide performance indicators or the need to develop criteria for each of these populations and a strategy for achieving their recovery.

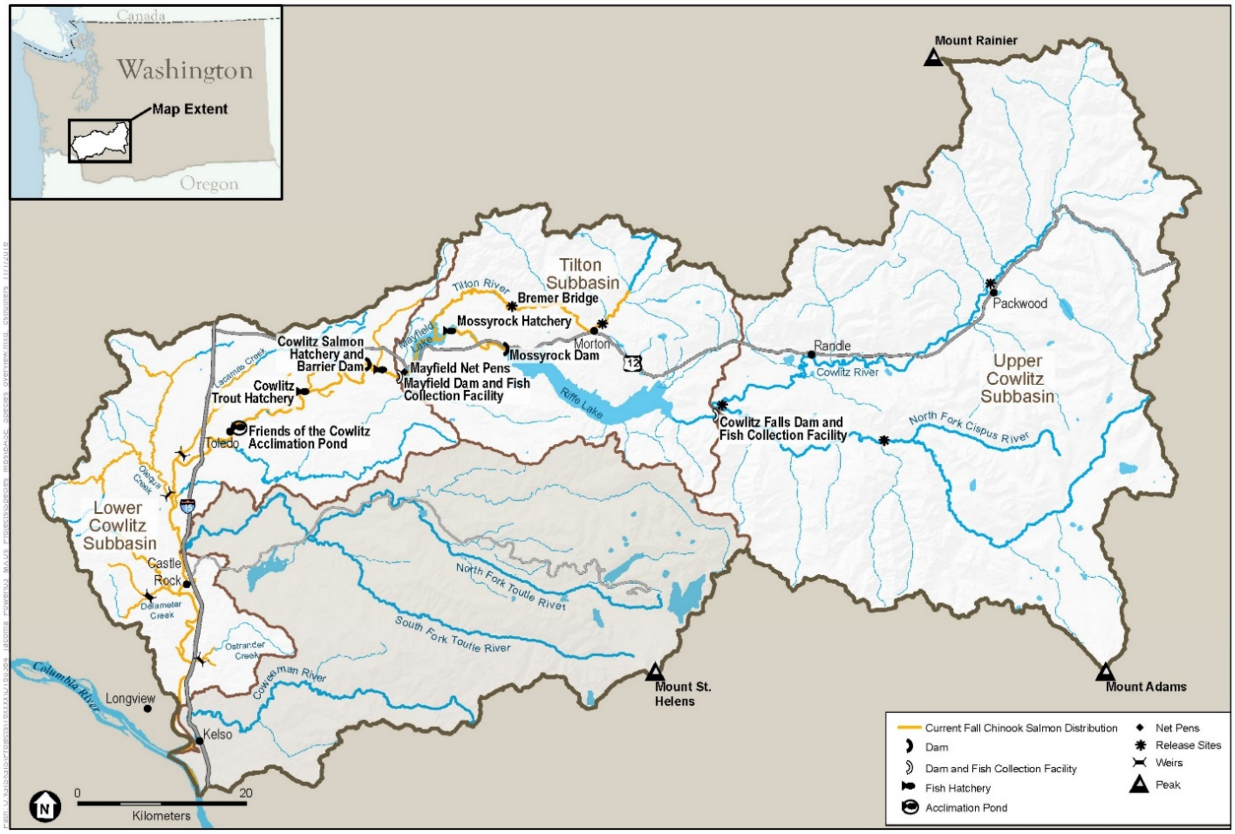

Figure 3.0-1. Distribution of fall Chinook Salmon and locations of important fish management sites in the Cowlitz Basin (not including the Coweeman and Toutle basins).

The genetic composition of the extant fall Chinook Salmon population has been heavily influenced by construction of the dams, past overharvest, habitat degradation throughout the basin, loss of access to habitat above Mayfield Dam, and hatchery supplementation. Any population differentiation that previously existed was eliminated when volitional upstream access was blocked by the dams and the subsequent failure of the juvenile passage systems. At that time, salmon from the Upper Cowlitz Subbasin population were forced to spawn in the Lower Cowlitz Subbasin or were incorporated into the Cowlitz Salmon Hatchery broodstock.

Although genetic work has not been conducted to determine if two distinct populations remain, the Lower Cowlitz Subbasin population currently occupies the mainstem and the lower reaches of some tributaries of the lower Cowlitz River, while the current Upper Cowlitz Subbasin population is found only in the Tilton River. Recovery actions have been undertaken over the past three decades, but delisting cannot occur until all populations that historically existed have been restored with a probability of persistence that is consistent with Recovery Plan objectives. The current mixed Lower Cowlitz Subbasin population is believed to still contain genes from the Upper Cowlitz Subbasin population, so recovery of fall Chinook Salmon in the Cispus, upper Cowlitz, and Tilton rivers relies on this genetic diversity existing in the Lower Cowlitz Subbasin fall Chinook Salmon population as the founding population.

Table 3.0-1. Recovery priority, baseline viability status, minimum viability abundance targets, and productivity improvement targets for Cowlitz River fall Chinook Salmon populations (from LCFRB 2010).

	Demographically Independent Population	
	Lower Cowlitz River	Upper Cowlitz Subbasin
Recovery Priority Designation[1]	Contributing	Stabilizing
Abundance		
Historic[2]	24,000	28,000
Current (last 5 years)[3]	3,134	2,716[4]
Target[5]	3,000	N/A[6]
Baseline Viability[7]		
Abundance & Productivity	Very Low	Very Low
Spatial Structure	High	Very Low
Diversity	Medium	Medium
Net Viability Status	Very Low	Very Low
Viability Improvement[8]	+50%	Medium[6]
Recovery Viability Objective[7]	Medium +	Very Low
Proportionate Natural Influence		
pHOS	<0.3	N/A
pNOB	>0.3	N/A
PNI	>0.5	N/A

1 Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance targets.
2 Historical population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS professional judgment calculations.
3 Approximate current mean annual number of naturally produced salmon returning to the watershed. Note that these values are 5-year means (2013-2017) and are not necessarily consistent with mean values over various intervals that are presented elsewhere in the FHMP.
4 Currently, only released into the Tilton River.
5 Abundance targets were estimated by population viability simulations based on viability goals.
6 No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
7 Viability status is based on Technical Recovery Team viability rating approach. Viability target is based on the scenario contribution. Very Low (>60% chance of extinction); Low (26-60% chance of extinction); Medium (6-25% chance of extinction); High (1-5% chance of extinction); Very High (<1% chance of extinction).
8 Improvement is the relative increase in population abundance and productivity required to reach the prescribed viability goal.

3.0.3. Life History Diversity

In the Cowlitz Basin, maturing fall Chinook Salmon return to the Barrier Dam Adult Facility beginning in late August, with some temporal separation between return and spawn timing of fall Chinook Salmon and spring Chinook Salmon. Spatial separation of spawning areas also occurs; generally, fall Chinook Salmon spawn in the larger mainstem reaches and lower river tributaries, whereas spring Chinook Salmon typically spawn higher in the system. Spawning of fall Chinook Salmon in the Cowlitz River is protracted, compared to most fall Chinook Salmon populations in the Columbia River ESU, and primarily occurs between late September and late December, with peak activity usually around the first week of November (LCFRB 2010).

In the Lower Cowlitz Subbasin, fry emerge in December through June, with peaks in January through April, and rear downstream of spawning areas for several months prior to migration to the Columbia River in spring and summer as sub-yearlings (LCFRB 2010). LCFRB (2010) reports that age of maturation of natural-origin Cowlitz River fall Chinook Salmon ranges from age-2 to age-6, with most maturing at age-3 (16.5%), age-4 (58.1%), and age-5 (19%), although the source of this information is unclear. In contrast, for brood years 1977-2011 fall Chinook Salmon smolts released from Cowlitz Salmon Hatchery with coded wire tags (CWTs), a mean of 9% matured at age-2, 35% at age-3, 49% at age-4, 8% at age-5, and 0.2% at age-6 [data from Regional Mark Information System (RMIS), www.rmpc.org on 9 October 2018]. For years since 2011, age structure information is available for known natural production (since mass mark implementation); during this FHMP period, these data will be consolidated into a central data source and evaluated for trends and management needs.

3.0.4. History

The history of fall Chinook Salmon in the Cowlitz Basin is similar to those of other Columbia Basin populations. Historically, fall Chinook Salmon populations in the Lower and Upper Cowlitz subbasins ranged from 30,000-40,000 and 24,000-28,000 adults, respectively (LCFRB 2010). However, the combination of overharvest in the early to mid-1900s, hydropower development in the 1960s, and the consistent, continuing, and pervasive effects of habitat loss and hatchery supplementation took their toll on these populations (see Table 3.0-2; WDF et al. 1993; Myers et al. 2006). Current population estimates represent a small fraction of historic returns, despite continued recovery efforts. Early efforts on the Cowlitz River to mitigate for the problems caused by habitat loss and overharvest included implementation of hatchery programs. Until the Settlement Agreement was implemented, these programs were intended to produce fish for harvest, not natural origin population supplementation, which likely further degraded the natural populations.

Table 3.0-2. Hatchery releases of fall Chinook Salmon into the Cowlitz Basin, excluding the Coweeman and Toutle rivers (updated from Myers et al. 2006).

Release Location	Release Years	Years[1]	Broodstock Origin	Total Released[2]
Cowlitz River	1952	1	Carson NFH	24,506
	1953, 1955	2	Spring Creek NFH	586,673
	1953-1981	3	Lower Kalama Hatchery	2,830,087
	1961-2017	49	Cowlitz Hatchery	403,440,663
	1968, 1979	2	Toutle Hatchery	1,008,357
	1978, 1990	2	Washougal Hatchery	2,606,330
	1981	1	Big Creek Hatchery (OR)	807,000
	1981	1	Bonneville Hatchery	4,217,937
Total				**415,521,553**

[1] Total number of years that salmon were actually released within the time frame.
[2] Releases indicated herein were all classified by Myers et al. (2006) as derived from within the lower Columbia River Chinook Salmon ESU.

Since 2011, natural-origin abundance in the Lower Cowlitz Subbasin may be nearing minimum viability abundance targets. Changes to fishery and hatchery practices, as well as improved monitoring, have played a large role in this determination. However, habitat in the Lower Cowlitz Subbasin has continued to suffer major degradations associated with

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hydroelectric development. Land development and increasing human population pressures likely contribute to further habitat degradation, especially in lowland areas along the mainstem Cowlitz River that are important to fall Chinook Salmon. Additionally, although returns have improved, poor ocean conditions can cause rapid population declines, and most populations in the lower Columbia River ESU are still considered to be at High Risk, including the Cowlitz Basin populations (NWFSC 2015).

In 1948, the Washington Department of Fisheries (WDF) and Washington Department of Game (WDG) estimated that the Cowlitz River above the current Mayfield Dam site produced 63,612 fall Chinook Salmon, of which 46,000 were harvested outside the Cowlitz River, 3,552 were harvested in the lower Cowlitz River, and 16,500 spawned or were harvested above the site of Mayfield Dam (WDF and WDG 1948). In 1951, WDF estimated that 19,500 fall Chinook Salmon spawned in the Cowlitz Basin (excluding the Toutle and Coweeman rivers; WDF 1951) but declined to about 18,000 spawners in the 1950s and only 12,000 in the 1960s (LCFRB 2010).

Prior to the early 1950s, fall Chinook Salmon returning to the Cowlitz River would have been nearly all natural-origin due to very few hatchery releases (Table 3.0-2). From 1952-1960, fall Chinook Salmon redd counts in the Cowlitz Basin ranged from 494-1,759, with 43% above the Mayfield Dam site (Thompson and Rothfus 1969). Run size decreased further and dramatically when Mayfield Dam blocked volitional access to the Cowlitz Basin above rkm 84 in 1961. From 1961-1966, redd counts dropped to a range of 280 to 794, but 37% were still located above the Mayfield Dam site (Thompson and Rothfus 1969). From 1961-1966, a mean of 4,992 adult fall Chinook were transported above Mayfield Dam but declined precipitously afterward (Thompson and Rothfus 1969). An adult fish trap was initially operated at Mayfield Dam to collect returning salmon for upstream transport. Operation of the trap was terminated after the 1968 construction of the Barrier Dam with adult collection facilities. This trap-and-haul system has been used to transport fish to both the Tilton and upper Cowlitz. Transportation of fall Chinook was intermittent after this due to low abundance, failure of the upper Cowlitz smolt collector in Riffe Lake and prioritization of the hatchery system. Fall Chinook have been regularly transported to the Mayfield Lake and the Tilton River since 1996, Collection of both spring and fall Chinook Salmon juveniles at Mayfield Dam averaged 397,346 from 1964-1966 (Thompson and Rothfus 1969). Hatchery releases of fall Chinook in the Cowlitz River increased somewhat in the 1950s and 1960s (Table 3.0-2), but the majority of returns were still likely natural-origin prior to the late 1960s.

Completion of Cowlitz Salmon Hatchery in 1968 also incorporated a Barrier Dam at rkm 81 that included adult handling facilities and became the collection point for the trap-and-haul system used to provide passage for adults to the habitat upstream of the hydropower system. When Mossyrock Dam was completed in 1968, it lacked juvenile passage facilities, effectively eliminating the ability of downstream migrating juveniles to leave the upper Cowlitz watershed. From 1964-2001, total (hatchery- and natural-origin) annual escapement estimates for Cowlitz River fall Chinook Salmon ranged from 1,045 to 23,345 (mean = 5,522; LCFRB 2010). Thompson and Rothfus (1969) estimated that 28% of the fall Chinook Salmon spawning habitat above Mayfield Dam was lost by inundating Mayfield and Riffe reservoirs by Mayfield and Mossyrock dams, respectively.

Fish hatcheries have operated on the Cowlitz River for over 100 years, with releases of fall Chinook Salmon beginning in 1952 (Table 3.0-2). Annual hatchery releases of Chinook Salmon were minor before the construction of the Cowlitz River hydroelectric dams but have exceeded 5 million smolts since then. The broodstock has largely been from within the Cowlitz Basin and almost solely from within the ESU, so there appears to be little influence from out-of-

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basin populations (Myers et al. 2006). Estimates of fall Chinook Salmon returns beginning in the late 1960s contain a large percentage of hatchery-origin fish; however, this percentage was less certain prior to mass marking of returning fall Chinook Salmon.

Some adults were transported around Mayfield Dam to the Tilton River and/or Cispus/upper Cowlitz rivers from 1961 until 1976, after which only jacks were sporadically released until 1996. This resulted in the composite population of fall Chinook Salmon that is currently found in the Lower Cowlitz Subbasin and has been transported to the Tilton River nearly continuously since 1996. Downstream migrating juveniles have been and still are bypassed downstream at Mayfield Dam.

Following the construction of Mayfield and Mossyrock dams, WDFW and Tacoma Power reached an agreement with an annual mitigation goal of 8,300 adult fall Chinook Salmon returning to the Barrier Dam Adult Facility, much lower than the annual fall Chinook Salmon returns of 52,000 prior to dam construction (Table 3.0-1). To accomplish this, Cowlitz Salmon Hatchery opened in 1968 and was designed to release approximately 5 million fall Chinook Salmon smolts annually.

Following completion of Cowlitz Falls Dam, upstream of Riffe Lake in 1994 by Lewis County PUD, a reintroduction effort in the Upper Cowlitz Subbasin was begun by Bonneville Power Administration. During relicensing of Mayfield and Mossyrock dams, a new Settlement Agreement was reached in 2000 that required Tacoma Power to prioritize the recovery of wild, indigenous salmonid runs, including fall Chinook Salmon, to harvestable levels. With the listing of these populations under the ESA in 2005, the management focus turned to recovery of the two original populations and conservation was elevated to a higher management priority, resulting in changes in hatchery, harvest, and habitat actions. The minimum viability abundance target for the Lower Cowlitz Subbasin was set at 3,000 natural-origin spawners in nature (LCFRB 2010). Just prior to relicensing (1996), an upstream trap-and-haul program was reinstated. Excess hatchery-origin fall Chinook Salmon from the Lower Cowlitz Subbasin population began to be transported to the Tilton River and above Cowlitz Falls Dam in an effort to reintroduce the historical populations in the Tilton, Cispus, and upper Cowlitz rivers.

As soon as the natural-origin offspring of these salmon began returning, a combination of hatchery- and natural-origin fall Chinook Salmon adults were transported and released, with the intent to produce as many natural smolts as possible and, ultimately, to produce a self-sustaining natural population above the Cowlitz River hydroelectric complex. While this is expected to benefit the restoration effort, transport and release of fall Chinook Salmon upstream of Mayfield Dam is currently limited to the Tilton River until the FTC decides to reinitiate transportation upstream of Cowlitz Falls Dam. The spring Chinook Salmon populations in the Cispus River and upper Cowlitz River are both Primary populations and are critical for recovery of the ESU, making them a higher priority than fall Chinook Salmon.

Natural-origin fall Chinook Salmon abundance has varied widely but has been improving. Based on spawning ground surveys in the Lower Cowlitz Subbasin and survival estimates for adults transported above Mayfield Dam, we estimate that the total number of natural-origin spawners in the Cowlitz Basin (excluding the Coweeman and Toutle rivers) has ranged from 3,566-6,629 from 2011-2017 (Figure 3.0-2; Table 3.0-3). Since 1964, juvenile fall Chinook Salmon have been collected at Mayfield Dam and passed downstream to complete their migration. Returns of natural-origin fall Chinook Salmon to the Cowlitz River from 2007-2017 have ranged from 4,272-8,255, with 1,876-5,689 of them returning to the Barrier Dam Adult Facility; these return rates indicate that both upstream and downstream salmon passage programs are now allowing for the return of relatively large numbers of naturally produced salmon to areas where populations had been extirpated.

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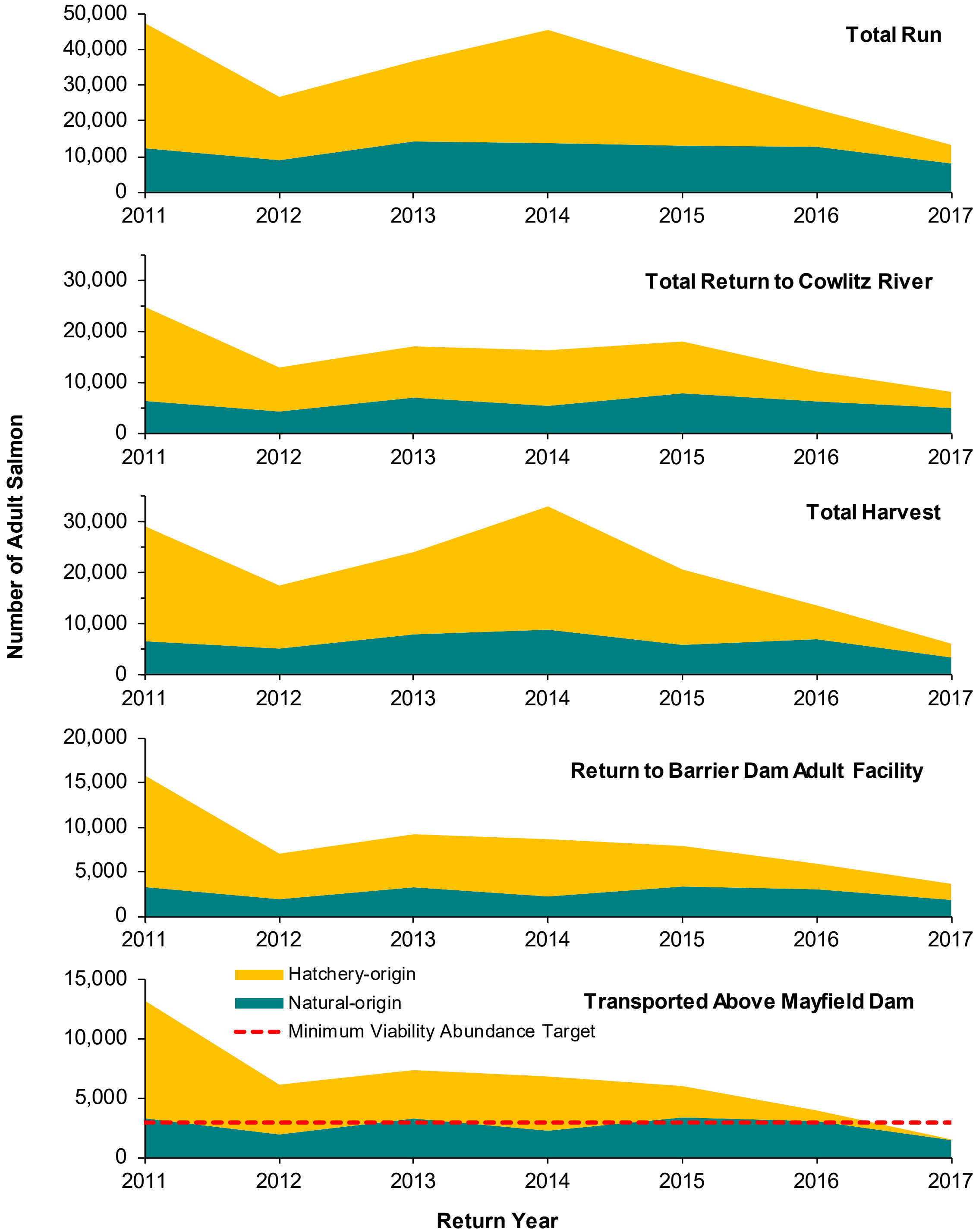

Figure 3.0-2. Estimated total run size for adult natural- and hatchery-origin fall Chinook Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, and were transported above Mayfield Dam, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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Table 3.0-3. Mean, minimum, and maximum numbers of all adult hatchery- and natural-origin fall Chinook Salmon from the Cowlitz Basin, excluding the Coweeman and Toutle rivers, that could be accounted for at recovery locations, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin, Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run (unique to or below hatchery)[1]	9,804	3,360	18,773
Harvest (total for harvest rate)[2]	3,451	839	6,244
Total Return to Cowlitz River[3]	9,624	3,182	18,464
Return to Hatchery	5,607	1,805	12,527
Collected for Broodstock	1,739	803	2,264
Survived to Spawn [4]	3,760	694	8,877
Natural-origin			
Total Run (unique to or below hatchery)[1]	11,900	8,078	14,262
Harvest (total for harvest rate)[2]	6,291	3,302	8,749
Total Return to Cowlitz River[3]	6,003	4,272	7,841
Return to Hatchery	2,735	1,876	3,380
Collected for Broodstock	57	0	396
Survived to Spawn in Nature[4]	5,015	3,566	6,629
Total			
Total Run (unique to or below hatchery)[1]	21,704	11,438	31,117
Harvest (total for harvest rate)[2]	9,742	4,141	12,726
Total Return to Cowlitz River[3]	15,628	8,137	24,806
Return to Hatchery	1,796	803	2,264
Collected for Broodstock	5,619	3,288	10,372
Survived to Spawn[4]	9,233	5,789	15,396

[1] Sum of all harvest below Mayfield Dam, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries.
[3] Sum of Lower Cowlitz Subbasin harvest, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[4] Calculated as number transported to the Upper Cowlitz Subbasin minus harvest in the Upper Cowlitz Subbasin, 12% fallback, and 10% pre-spawn mortality.

However, managers are unable to identify the origin (above vs. below Mayfield Dam) of natural-origin fall Chinook Salmon returning to the Cowlitz River, so the observed increase in natural-origin abundance at Barrier Dam may be due, at least in part, to increased production by the Lower Cowlitz Subbasin population. Likewise, it is likely that some Tilton Subbasin salmon remain below Barrier Dam and have contributed to the observed increase in the Lower Cowlitz Subbasin natural population, where natural-origin escapement has increased from 1,276 in 2007 to 2,979 in 2017 and has had a mean of 3,317 from 2013-2017. It is assumed that improvements at the Mayfield Dam downstream juvenile collection facility will further increase the survival of smolts leaving the Cowlitz River, further increasing adult returns, and improving the status of the Tilton Subbasin population.

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3.0.5. Distribution

Historically, Cowlitz River fall Chinook Salmon were distributed from the mouth of the Cowlitz River upstream in mainstem Cowlitz River and larger tributaries (WDF and WDG 1948, WDF 1951, Thompson and Rothfus 1969). Construction of Mayfield Dam (rkm 83.7) in 1961-1963 and subsequent cessation of upstream transport of adults in 1976 blocked access to the spawning grounds above Mayfield Dam. Fall Chinook Salmon continued above Mayfield Dam until 1981, when the Upper Cowlitz Subbasin fall Chinook Salmon population became functionally extinct. Fall Chinook Salmon transport above Mayfield Dam (mostly, but not exclusively, to the Tilton River) resumed in 1996 and the current spawning distribution of the Lower Cowlitz Subbasin population includes the Cowlitz River mainstem from its mouth upstream to Barrier Dam (rkm 81) and the Tilton Subbasin. In the mainstem lower Cowlitz River, spawning is concentrated between the I-5 Bridge and the Barrier Dam (rkm 55-81; Figure 3.0-1; Klett et al. 2013). Small numbers of fall Chinook Salmon have also been observed spawning below the weirs in the lower reaches of Delameter and Olequa creeks (Gleizes et al. 2014). In 1998, 2001, and from 2010-2016, fall Chinook Salmon were also released upstream of Cowlitz Falls Dam in Lake Scanewa, the upper Cowlitz River, and the Cispus River. However, transport of fall Chinook Salmon upstream of Cowlitz Falls Dam has been suspended since 2017 and is intended to remain so for the period of this FHMP.

3.0.6. Abundance

Prior to mass marking of the hatchery fall Chinook Salmon taking full effect in 2011 adult returns, estimates of natural production from the Lower Cowlitz Subbasin were less certain because only a small fraction of the hatchery-origin salmon were marked, so we have presented data only since 2011. Since the implementation of mass marking, the estimate of total natural-origin fall Chinook Salmon for this population has improved but is still subject to error associated with: (1) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from upstream of Mayfield Dam; (2) collection of unmarked fall Chinook Salmon at the Barrier Dam Adult Facility that originated from the Lower Cowlitz Subbasin (all natural-origin salmon captured at the Barrier Dam Adult Facility are currently assumed to have originated from above Mayfield Dam); and (3) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from outside the Cowlitz Basin.

From 2011-2017, mean total run size (all hatchery- and natural-origin salmon that can be accounted for from ocean and freshwater fisheries, captured at weirs, returns to the hatchery, and remaining in rivers and tributaries) of Lower and Upper Cowlitz fall Chinook Salmon populations, was 21,704 (ranging from 11,438-31,117), of which 55% were natural-origin and 45% were hatchery-origin (Figure 3.0-2; Table 3.0-3). An annual total mean of 15,628 fall Chinook Salmon returned to the Cowlitz Basin from 2011-2017. A mean of 42% of the total run was harvested in the ocean, lower Columbia River, and lower Cowlitz River fisheries, combined. The remaining 58% escaped those fisheries, and about 38% (of the total run) returned to the Barrier Dam Adult Facility, with 19% remaining to spawn in the Lower Cowlitz Subbasin. A mean of 30% of the total run was transported and released above Mayfield Dam, and we estimate that 23% of the total run survived to spawn there.

3.0.7. Harvest

One of the main purposes of the fall Chinook Salmon Hatchery Program is mitigation for the impacts from dam construction in the Cowlitz River. Maintaining a fishery is an important objective of the Cowlitz River Project Settlement Agreement and the management of Cowlitz Basin fall Chinook Salmon. Fisheries can affect population recovery and therefore require careful management. These fisheries are managed by WDFW. Cowlitz River fall Chinook Salmon are an important component of commercial, sport, and tribal harvest and are harvested in ocean, lower Columbia River, and lower and upper Cowlitz River fisheries. CWT recoveries of hatchery-origin Cowlitz River fall Chinook Salmon (1989-1994 brood years) from ocean fisheries indicate that harvest is greatest off the Washington coast, followed by British Columbia and Alaska (LCFRB 2010).

Managing for recovery would support high harvest rates for hatchery-origin salmon while keeping harvest of the natural-origin salmon as low as possible until the population can support harvest (Paquet et al. 2011). Until 2011, when mass marking of all age classes of returning adults became complete, naturally-produced fall Chinook Salmon were managed the same as hatchery salmon and were subjected to similar harvest rates. Since that time, fisheries for fall Chinook Salmon have been mark-selective in the Cowlitz River (i.e., only hatchery-origin Chinook Salmon may be harvested). Therefore, impacts on natural-origin salmon from the Cowlitz River fishery are limited to mortality after release (i.e., hooking mortality). However, natural-origin fall Chinook Salmon may still be legally caught in the ocean and a portion of Columbia River fisheries, which reduces the number that return to the Cowlitz River by some unknown amount, as the method for allocating their harvest to specific populations is imprecise.

Increasing the harvest of hatchery-origin fall Chinook Salmon is a means of reducing the number of hatchery-origin salmon spawning in nature. Relatively large numbers of hatchery-origin salmon escaping the ocean, lower Columbia River, and lower Cowlitz River fisheries may result in a large number of excess hatchery-origin salmon reaching the Barrier Dam Adult Facility. Returning hatchery-origin fall Chinook Salmon that are not needed for the hatchery programs or for Upper Cowlitz Subbasin reintroduction and harvest may be utilized in the future for nutrient enhancement or donated to local or statewide foodbanks.

Currently, the main overall fishery goal is to maximize harvest of hatchery-origin fall Chinook Salmon while not exceeding impact limits on natural-origin fall Chinook Salmon set by NOAA Fisheries. WDFW established long-term goals for harvest of Cowlitz Basin fall Chinook Salmon in terms of catch numbers, harvest rates, and seasons, by fishery (Tacoma Power 2011). These are not necessarily the goals associated with the Settlement Agreement (which calls for mitigation to be met by a combination of hatchery production, effective passage, and recovery of populations) but rather long-term goals that may require implementation of measures beyond the scope of the Settlement Agreement. During this FHMP period, these fisheries goals will need to be reviewed for alignment with the goals of this FHMP.

From 2011-2017, 85% of the harvest of hatchery-origin salmon occurred in the lower Cowlitz River, while 65% and 29% of the natural-origin harvest occurred in the ocean and lower Columbia River, where direct harvest of natural-origin fall Chinook Salmon is allowed (Figure 3.0-3). Only 2% and 3%, respectively, of the natural-origin indirect mortality occurred in the lower Cowlitz River and above Mayfield Dam, where direct harvest of natural-origin fall Chinook Salmon is not allowed, and most of this harvest-related mortality is thought to be post-release hooking mortality. Means of 4%, 1%, and 10% of the hatchery-origin harvest occurred in the ocean, Columbia River, and above Mayfield Dam, respectively.

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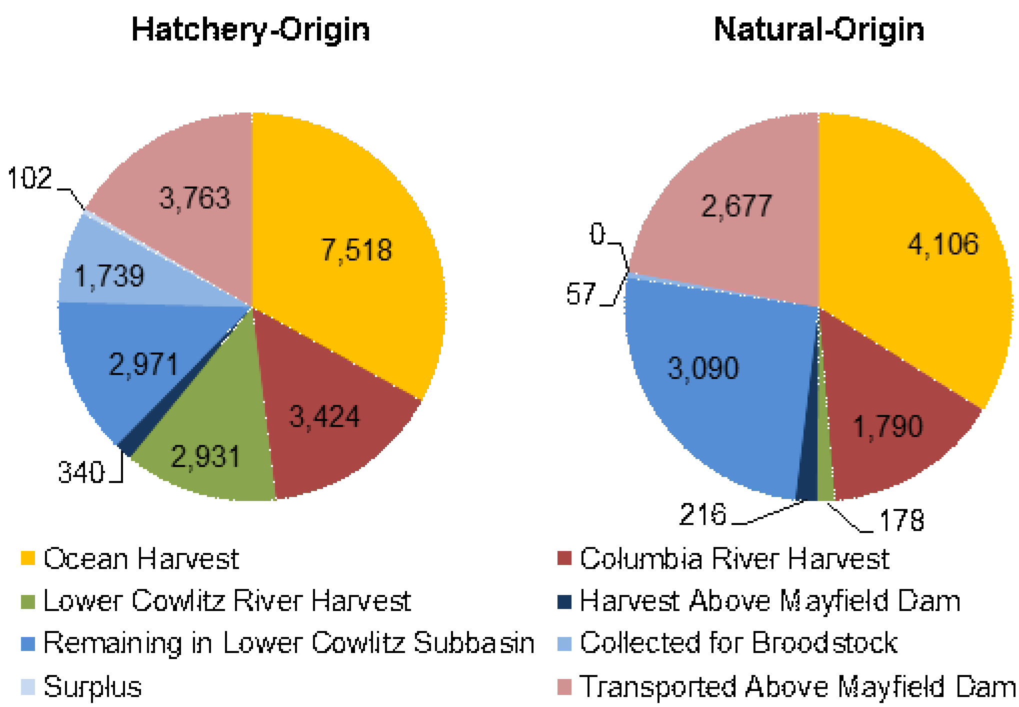

Figure 3.0-3. Mean numbers and proportions of hatchery-origin and natural-origin Cowlitz Basin fall Chinook Salmon harvested, by fishery location, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

3.0.8. Natural Production

To recover a salmon population, a self-sustaining natural population is required. For management toward population recovery, it is also important to know the limiting factors of the population at intermediate points in the life history. Therefore, as much as possible we need to know (by origin, sex, and age) how many salmon are spawning in each habitat component (F_0 generation) and how many of their offspring (F_1 generation) survive to produce the subsequent (F_2) generation. Spawning ground surveys (aerial redd counts and carcass surveys) have been routinely conducted in the mainstem lower Cowlitz River since 2011 to estimate spawner abundance and composition of fall Chinook Salmon (e.g., Gleizes et al. 2014). The current method relies on an unvalidated expansion factor that does not have a measure of bias or precision associated with the abundance estimates. The 2011 FHMP proposed alternative methods that have not been implemented. The M&E Subgroup will review alternative methods to improve these abundance estimates. However, current monitoring points for natural-origin Lower Cowlitz Subbasin fall Chinook Salmon from which metrics for earlier life history stages can be estimated are limited to lower Cowlitz smolt trap estimates and fry stranding studies. For the population above Mayfield Dam, adults are collected at the Barrier Dam Adult Facility and transported upstream, but spawning ground surveys have not been conducted. Therefore, only a rough estimate of spawners is currently possible by simply using the numbers of hatchery- and natural-origin adults transported multiplied by a standard survival rate, which does not reflect inter-annual variability. In the future, estimating productivity at intermediate points in the life history of the salmon (e.g., number of smolts) may allow managers to identify critical periods and take appropriate action to ameliorate problems.

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The minimum viability abundance target for fall Chinook Salmon in the Cowlitz River is 3,000 adult natural-origin spawners in nature; this target reflects only the Lower Cowlitz Subbasin population (Table 3.0-1; LCFRB 2010). No minimum viability abundance target was established in the Recovery Plan for the Upper Cowlitz Subbasin population because it is a Stabilizing population. Because the ultimate fate (i.e., spawning, harvest, or pre-spawn mortality) of fall Chinook Salmon transported above Mayfield Dam is not monitored, the status of fall Chinook Salmon recovery in the Upper Cowlitz Subbasin is currently based exclusively on estimates of for these fish.

3.0.8.1. Adult Transport/Natural Spawning

No effort is currently conducted to identify the true population origin of natural-origin salmon returning to the Barrier Dam Adult Facility, so all natural-origin returns to the Barrier Dam Adult Facility are assumed to have originated from the Tilton Subbasin and are transported upstream of Mayfield Dam. Implementing marking of Chinook Salmon juveniles captured at the Mayfield Downstream Collection Facility and assessment of guidance efficiencies and survival by route are characterized as steps to understanding fall Chinook Salmon production from the Tilton River in the Transition Plans. Along with adult return data, we will then be able to estimate smolt-to-adult return (SAR) and productivity and estimate the proportion of salmon returning to the Barrier Dam Adult Facility that originate from the Tilton River.

For the 2011-2017 run years, a mean of 4,531 hatchery-origin and 1,909 natural-origin fall Chinook Salmon were transported and released upstream of Mayfield Dam, of which a mean of 67% (1,782 hatchery-origin and 1,906 natural-origin) went to the Tilton Subbasin. However, from 2010-2016, annual means of 3,634 hatchery-origin and 114 natural-origin adult fall Chinook Salmon (42% of those transported) were released into the Upper Cowlitz Subbasin. Spawning ground surveys have not been regularly conducted in the Tilton Subbasin, so the number of transported fall Chinook Salmon that actually spawn in nature above Mayfield Dam can only be roughly estimated. Using the harvest estimate and estimated fallback (12%) and pre-spawn mortality (10%) rates, we estimate that from 583-2,447 (mean = 1,383) natural-origin fall Chinook Salmon spawned in nature above Mayfield Dam from 2011-2017.

Based on spawning ground surveys in the mainstem lower Cowlitz River, the mean estimated natural-origin adult abundance on the Lower Cowlitz Subbasin spawning grounds (3,090) from 2011-2017 was greater than the minimum viability abundance target of 3,000 spawning natural-origin salmon, and the goal was exceeded in both 2013 (3,477) and 2015 (4,182), as well as the mean for the last 5 years (3,317). The Lower Cowlitz Subbasin fall Chinook Salmon population appears to be close to the minimum viability target for natural-origin adult abundance, and this improved viability has been the starting point to begin working on recovery of the population above Mayfield Dam as well.

3.0.8.2. Smolt Production/Transport

Fall Chinook Salmon smolts are captured and counted at Mayfield Dam, where an annual mean of 74,721 juvenile fall Chinook Salmon were captured from 2007-2017. However, because Fish Passage Survival (FPS) studies have not been completed on the Mayfield Dam downstream collection facility, the juvenile Chinook Salmon counts at Mayfield Dam do not account for those that survive passing through the dam or bypass system mortality, so they only provide an index of fall Chinook Salmon production in the Tilton Subbasin.

Based on the proportion of adult Chinook Salmon transported to the Upper Cowlitz Subbasin that were fall Chinook Salmon, a rough estimate of 6,446 sub-yearling fall Chinook

Salmon smolts were caught at Cowlitz Falls Dam from 2011-2016 (2010-2015 brood years, when adults were released in the Cispus and upper Cowlitz rivers).

Monitoring juvenile production of the Lower Cowlitz Subbasin fall Chinook Salmon population is difficult. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Chinook Salmon abundance. However, any juvenile Chinook Salmon captured may be either spring or fall Chinook Salmon from either the Lower Cowlitz Subbasin or above Mayfield Dam. Therefore, we will now focus on adult productivity (adult recruits/spawner) to monitor the Lower Cowlitz Subbasin fall Chinook Salmon population. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting, and further information is needed to fill data gaps.

3.0.9. Hatchery Production

The overall goals of the current hatchery programs for fall Chinook Salmon within Cowlitz Basin are to:

1) Promote recovery of populations inhabiting the Cowlitz Basin.
2) Mitigate for harvest opportunities reduced by construction and operation of the Cowlitz River Project, for commercial, and recreational, and tribal fisheries.
3) Support educational and research opportunities.

Specific and quantifiable objectives of the hatchery program to achieve these goals are described in detail within the respective sections for each of the fall Chinook Salmon populations.

The fall Chinook Salmon Hatchery Program at Cowlitz Salmon Hatchery began in 1967 (WDFW 2014b). The program was integrated by default because the hatchery-origin fall Chinook Salmon were not 100% marked until return year 2011. Prior to that, managers could not be certain about the origin of the salmon collected for broodstock. The Segregated Hatchery Program for Lower Cowlitz Subbasin fall Chinook Salmon began in 2011 and currently has a production goal of 2,400,000 sub-yearling smolts. The Integrated Hatchery Program began in 2013, with an annual production goal of 1.1 million age-1 smolts and a target of 30% of the broodstock being of natural-origin. The Integrated Hatchery Program has had difficulty collecting natural-origin salmon for broodstock, and mean pNOB = 0.077. The natural-origin contribution came solely from salmon that WDFW captured on the spawning grounds by netting, hook and line, or snagging.

Initially, males and all females captured were taken to Cowlitz Salmon Hatchery for spawning. To increase the number of fish used in the integrated program, sperm was collected from males, after which they were released, and their sperm was transported to Cowlitz Salmon Hatchery, where it was used to fertilize the eggs of hatchery-origin females. A mean of 87% of these natural-origin adults were males. Relying so heavily on males for the natural-origin contribution is not well understood (personal communication, R. Waples, J. Hard, and P. Moran, NOAA Fisheries) and needs to be addressed by the M&E Subgroup as part of the APR process.

However, because of low abundance in recent years (i.e., 2017 and 2018), natural-origin broodstock have been collected from those captured at the Barrier Dam Adult Facility. All hatchery-origin salmon have been visually identifiable since 2011. As described below, Tacoma Power and the FTC will develop a Transition Plan that identifies the marking strategy for natural-origin smolts captured at Mayfield Dam (and other data gaps and monitoring needs). In addition, with the transition to the single Upper Cowlitz Subbasin Integrated Hatchery Program,

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all future broodstock (both hatchery- and natural-origin) will be collected solely from returns to the Barrier Dam Adult Facility.

From 2007–2017, an annual mean of 5,098 adult hatchery-origin fall Chinook Salmon returned to the Barrier Dam Adult Facility, of which 2,066 were collected for broodstock and 1,903 were spawned. The Segregated Hatchery Program spawned 2,162 adults in 2011 and 748 adults in 2012. From 2013-2017, a mean of 1,795 adults were spawned for the combined Integrated and Segregated Hatchery Programs, 93% (1,662) of which were hatchery-origin and 7% (133) were natural-origin. From 2007–2017, a combined total mean of 3,969,970 sub-yearling smolts were released from the Integrated and Segregated Hatchery Programs.

All hatchery-reared salmon are released into the Cowlitz River directly from Cowlitz Salmon Hatchery and, upon their return, they support fisheries both below and above Mayfield Dam. Those transported to the Tilton Subbasin that escape harvest will spawn naturally and support the restoration of the natural fall Chinook Salmon population there. Returns of natural-origin adults to the Barrier Dam Adult Facility have ranged from 1,876-3,380 from 2011-2017.

Hatchery best management practices will be used for all facets of hatchery production. Hatchery production metrics will be monitored to ensure that production goals and fish quality are met, as well as to understand the magnitude of hatchery influence on the natural population being supplemented. Key hatchery production monitoring metrics are the following:

- Number of salmon collected and spawned by origin (i.e., pNOB, pHOB), age, and sex.
- Fecundity.
- Survival by life stage (green eggs, eyed eggs, fry, parr, smolts released).
- Precocity rates (i.e., percent precocious/mini-jacks).
- Hatchery adult and jack returns by age and sex.
- pHOS.
- Calculation of PNI, SAR, and hatchery return rates.

Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper describing various perspectives, which is appended to the FHMP for use during development of the Transition Plan. During development of the Transition Plan, additional suggestions raised during the public review process for management of fall Chinook Salmon will be considered (such as bio-programming considerations for fall Chinook Salmon versus spring Chinook Salmon rearing strategies, examination of the natural-origin program to determine what is required to define an escapement level that allows for natural harvest, and marking juveniles caught at the Mayfield trap with the objective of differentiation from lower river production). For additional information on the Transition Plan, see Appendix B.

3.0.10. Survival and Productivity

Mean SAR (which includes all mature salmon that could be accounted for) of hatchery-origin fall Chinook Salmon with CWTs for the 1977-2012 brood years was 0.30% (0.02-1.95%). SAR of natural-origin salmon is unknown because necessary data are unavailable, but is expected to be greater than that of the hatchery-origin salmon. Because the numbers of returns by brood year are unavailable, productivity (spawner-to-spawner) also cannot be calculated.

3.0.11. Proportionate Natural Influence and Age Composition

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI is calculated using two proportions: the proportion of spawners in nature that are hatchery-origin (pHOS) and the proportion of the hatchery broodstock that is comprised of natural-origin salmon (pNOB). The Hatchery Scientific Review Group (HSRG; 2009) recommended that Contributing populations with segregated hatchery programs should have pHOS <0.1. For those with integrated hatchery programs, pHOS should be <0.3 and pNOB should exceed pHOS so that PNI >0.5.

Prior to 2011, the Cowlitz River fall Chinook Salmon population was supplemented by a single hatchery program with limited marking, so we could identify only a small proportion of the hatchery-origin salmon. Therefore, any estimation of pNOB, pHOS, or PNI may be inaccurate. In 2011 and 2012, hatchery production came from only the Segregated Hatchery Program, so pNOB = 0 and PNI = 0. From 2013-2017, mean pNOB = 0.077, mean pHOS = 0.260, and mean PNI = 0.198. From 2011-2012, mean pHOS = 0.653. From 2013-2017, mean pHOS was 0.321, mean pNOB was 0.077, and mean PNI was 0.395. Given that there was little differentiation between the Lower Cowlitz Subbasin and Tilton Subbasin fall Chinook Salmon populations until 2016 and 2017, when pHOS was 0.004 and 0.038, respectively, we estimate that pHOS for the combined Lower Cowlitz, Upper Cowlitz, and Tilton subbasins was 0.606 in 2011 and 0.506 in 2012. During the 2013-2017 spawn years, we operated both the Integrated and Segregated Hatchery Programs and mean pNOB was 0.077. Mean pHOS = 0.334 for the combined Lower Cowlitz, Upper Cowlitz, and Tilton subbasins, and the resulting mean PNI = 0.184. We achieved the HSRG guideline for pHOS in 2016 (0.245) and 2017 (0.157). However, mean pHOS did not achieve the HSRG guidelines, and the program did not achieve the HSRG guidelines for pNOB or PNI for any individual year or the mean.

For brood years 1977-2012 fall Chinook Salmon with CWTs, mean age at maturity was 3.62 years (3.00-4.24). An annual mean of 6% of these salmon matured at age-2, 36% at age-3, 50% at age-4, 9% at age-5, and 0.2% at age-6.

3.0.12. Marking and Tagging

Currently, all hatchery-origin fall Chinook Salmon are marked with an adipose fin-clip (Table 3.0-4). Additionally, 10% of those from the Segregated Hatchery Program and all of those from the Integrated Hatchery Program have a CWT implanted. A marking strategy for the new Integrated Hatchery Program will be developed as part of the Transition Plan within the first year following completion of this FHMP. This marking strategy will take into account data gaps, including current knowledge or assumptions regarding survival by passage route so that returning adults can be identified and the unknown portion of the returning adults can be managed appropriately.

Marking and tagging schemes may vary from year to year, especially for hatchery-origin releases, which also may include experimental groups. Marking and tagging schemes for each group, within each brood year, will be addressed during the development of the Transition Plan, and re-evaluated each year by the M&E Subgroup as part of the APR process.

Table 3.0-4. Current and proposed hatchery programs, smolt production, and marking/ tagging for fall Chinook Salmon.

Origin & Stock	Hatchery Program	Juvenile Production		Mark / Tag	
		Current	Proposed	Current	Proposed
Hatchery-origin					
Lower Cowlitz Subbasin	Integrated	1,100,000	None	100% Ad + CWT	None
	Segregated	2,400,000	None	100% Ad + 10% CWT	None
Combined Lower and Upper Cowlitz subbasins	Integrated	None	3,500,000	None	100% Ad + Fractional CWT
	Segregated	None	As needed	None	As needed
Natural-origin					
Lower Cowlitz Subbasin	None	Unknown	NA	None	None
Upper Cowlitz Subbasin	None	NA		NA	
Tilton Subbasin	None	13,000-142,000		None	All Captured/ handled

3.0.13. Summary

- Continued genetic exchange across the Upper Cowlitz and Lower Cowlitz subbasins since 1963 has caused Cowlitz Basin fall Chinook Salmon to functionally become a single population; however genetic testing has not been conducted to confirm this.
  - For consistency with the ESA framework, this FHMP separates fall Chinook Salmon into two populations, the Lower Cowlitz Subbasin population and the Tilton Subbasin population, with the latter representing the entirety of the current Upper Cowlitz Subbasin population.
  - Recovery efforts for fall Chinook Salmon will focus on the Lower Cowlitz and Tilton subbasins; fall Chinook Salmon will not be released above Cowlitz Falls Dam to avoid interfering with spring Chinook Salmon recovery there.
  - A framework will be developed using Viable Salmonid Population parameters for the eventual release of fall Chinook Salmon above Cowlitz Falls Dam, which will occur after spring Chinook Salmon have become established there.
- Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as

Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period for fall Chinook Salmon. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

The following sections present information on the two managed fall Chinook Salmon populations in the Cowlitz Basin: fall Chinook Lower Cowlitz Subbasin population (Section 3.1), and fall Chinook Tilton Subbasin population (Section 3.2).

Population: Lower Cowlitz Subbasin Fall Chinook Salmon *Oncorhynchus tshawytscha*

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Lower Columbia River Chinook Salmon
Major Population Group:	Cascade Chinook Salmon
Recovery Region:	Lower Columbia River Salmon
Population Recovery Designation:	Contributing
Population Viability Rating:	
Baseline	Very Low
Objective	Medium +
Minimum Viability Abundance Target:	3,000 natural-origin adults spawning in nature in the Lower Cowlitz Subbasin
Current Recovery Phase:	Local Adaptation
Current Hatchery Program(s):	Cowlitz Salmon Hatchery Segregated Hatchery Program, 2.4 million smolts Cowlitz Salmon Hatchery Integrated Hatchery Program, 1.1 million smolts
Proposed Hatchery Program(s):	None

3.1. Fall Chinook Salmon: Lower Cowlitz Subbasin Population

3.1.1. Purpose

This section describes the current status of the Lower Cowlitz Subbasin fall Chinook Salmon population based on recent and available data. In addition, we identify Viable Salmonid Population (VSP) metrics needed to evaluate the status of this population with regard to reaching recovery under ESA guidelines. Where appropriate, changes to hatchery and/or monitoring programs are proposed to facilitate evaluation of progress toward population recovery. During the period covered by this FHMP, a single Integrated Hatchery Program to produce 3.5 million sub-yearling smolts is proposed to supplement natural spawning in the Tilton Subbasin population and provide fisheries both below and above Mayfield Dam. The hatchery program and fisheries management will continue to be refined or adjusted, as described in this FHMP, to effectively supplement and manage the Lower Cowlitz Subbasin fall Chinook Salmon population. Moving forward and until a Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for

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broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B.

3.1.2. Population Description

The Lower Cowlitz Subbasin fall Chinook Salmon population includes all natural-origin fall Chinook Salmon that occupy the lower Cowlitz River and all tributaries from the mouth of the Cowlitz River up to the Barrier Dam (rkm 81), including those from the current hatchery programs at Cowlitz Salmon Hatchery but excluding those from the Toutle and Coweeman rivers (Figure 3.1-1; NMFS 2016). Except for the Toutle and Coweeman rivers, the lower Cowlitz River is the sole remaining population of the original two fall Chinook Salmon populations that inhabited the Cowlitz Basin (NOAA Fisheries 2004). It was found to be “Depressed” (WDFW 2002) and, as part of the lower Columbia River ESU, was listed as threatened under the ESA in 2005 and reaffirmed in 2011 and 2016. This population is classified as a Contributing population for recovery of the lower Columbia River ESU and must attain its recovery and viability goals for the ESU to be considered recovered (LCFRB 2010).

The Lower Cowlitz Subbasin fall Chinook Salmon population is currently supplemented by hatchery production from Cowlitz Salmon Hatchery. The combined hatchery- and natural-origin Lower Cowlitz Subbasin population is relatively abundant (Table 3.1-1) and is the source population for restoring the population originally found above Mayfield Dam (Figure 3.1-1). The most recent 5-year mean hatchery-origin adult run size and return to the Lower Cowlitz Subbasin have met hatchery production goals, while the number of natural-origin spawners in nature is approaching the minimum viability abundance target. Numbers of broodstock spawned in the hatchery and smolts produced have also consistently met their respective targets.

3.1.3. Natural Production

3.1.3.1. Abundance

Among the suite of VSP metrics, critical monitoring metrics for salmon management are the numbers of smolts leaving the system and of mature salmon (all ages) that return at maturation and their dispositions, by origin and age (Table 3.1-1). Lower Cowlitz Subbasin fall Chinook Salmon that survive to begin their spawning migration may contribute to commercial, sport, or tribal fisheries in the ocean, Columbia River, or Cowlitz River. Those escaping harvest may return to the Barrier Dam Adult Facility or natural spawning grounds, where they may be recovered and counted. They may also die from predation or disease at any time and not be recovered. Monitoring the returns and their dispositions is critical for evaluating population health, productivity, and progress toward recovery. However, these data have only been collected in the Lower Cowlitz Subbasin since improved marking and monitoring were implemented in 2010.

Prior to mass marking of the hatchery salmon in 2010, estimates of natural production from the Lower Cowlitz Subbasin were unreliable because only a small fraction of the hatchery-origin salmon were adipose fin-clipped or Coded Wire Tagged. Since the implementation of mass marking, the estimated abundance of total natural-origin salmon for this population has improved, but is still subject to error associated with: (1) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from upstream of Mayfield Dam; (2) collection of unmarked fall Chinook Salmon at the Barrier Dam Adult Facility that originated from the Lower Cowlitz Subbasin (all natural-origin salmon captured at the

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Barrier Dam Adult Facility are assumed to have originated from above Mayfield Dam); and (3) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from outside the Cowlitz Basin. Additionally, current methods for estimating natural-origin spawner abundance rely on aerial redd counts and an expansion factor (e.g., Gleizes et al. 2014). Considerations for an improved monitoring methodology will be described in the Transition Plan.

The minimum viability abundance target for the Lower Cowlitz Subbasin fall Chinook Salmon population is an annual abundance of 3,000 natural-origin adults spawning in nature in the Lower Cowlitz Subbasin (LCFRB 2010). From 2011-2017, mean total natural-origin fall Chinook Salmon run size was 5,956 adults and a mean of 3,174 natural-origin adults entered the Cowlitz River (Table 3.1-1).

3.1.3.2. Harvest

Harvest is an important component of the management of Lower Cowlitz Subbasin fall Chinook Salmon and potentially affects population recovery. Both hatchery- and natural-origin Lower Cowlitz Subbasin fall Chinook Salmon contribute to important commercial and recreational fisheries in the Pacific Ocean and lower Columbia River.

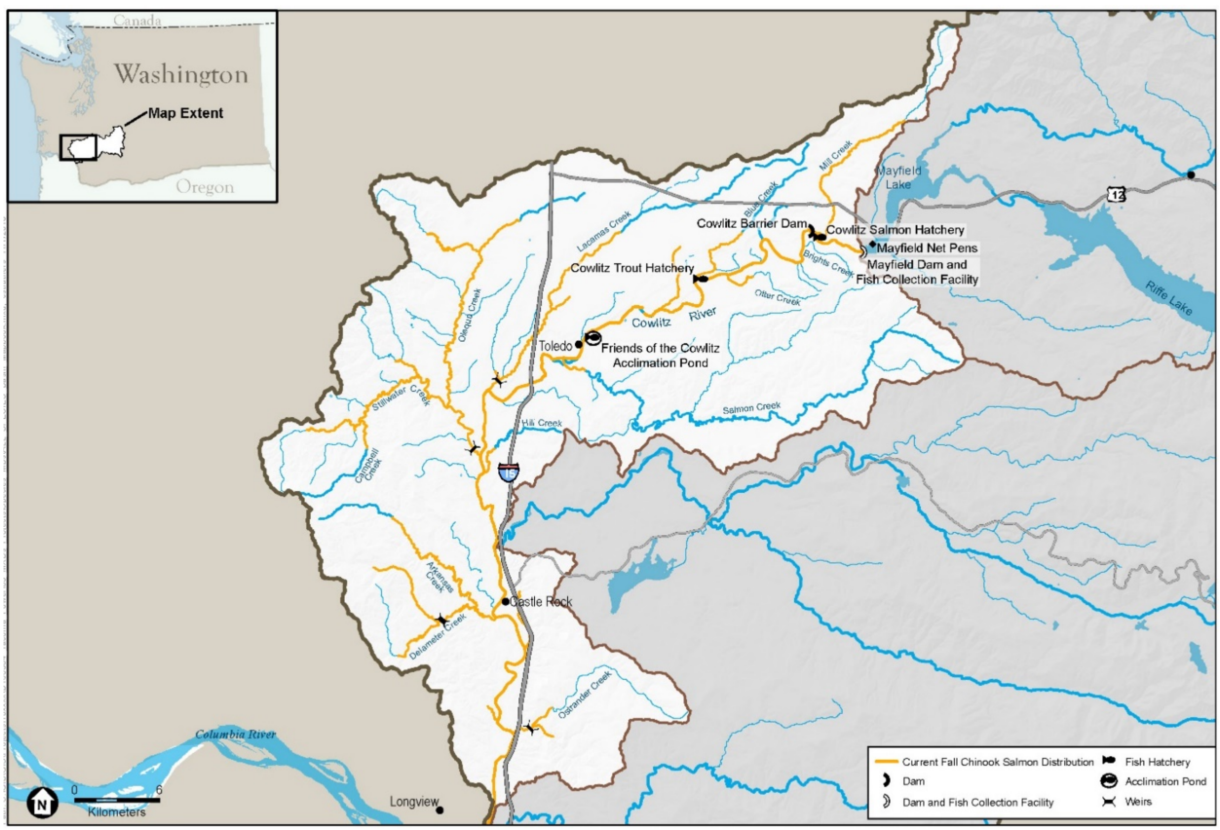

Figure 3.1-1. Distribution of fall Chinook Salmon in the Lower Cowlitz Subbasin, excluding the Coweeman and Toutle rivers.

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Table 3.1-1. Estimated mean, minimum, and maximum numbers of all hatchery- and natural-origin fall Chinook Salmon from the Lower Cowlitz Subbasin population that could be accounted for at recovery locations, and percentage of total at that recovery location, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	20,567	5,222	35,113
Harvest[2]	14,214	2,701	24,218
Ocean harvest	7,518	1,478	14,110
Columbia River harvest	3,424	562	6,737
Lower Cowlitz River harvest	2,931	658	4,997
Upper Cowlitz Subbasin harvest	340	3	938
Total Return to Cowlitz River[3]	9,624	3,182	18,464
Remain in Lower Cowlitz Subbasin	1,086	650	1,879
Return to Barrier Dam Adult Facility	5,607	1,876	3,380
Collected for Broodstock	1,739	803	2,264
Transported to Upper Cowlitz Subbasin	3,763	59	9,902
Spawners in Upper Cowlitz Subbasin	2,674	44	6,998
Natural-origin			
Total Run[1]	5,956	4,186	7,526
Harvest[2]	2,867	1,245	3,699
Ocean harvest	1,936	883	2,445
Columbia River harvest	846	323	1,248
Lower Cowlitz River harvest	84	39	125
Upper Cowlitz Subbasin harvest	0	0	0
Total Return to Cowlitz River[3]	3,174	2,245	4,307
Remain in Lower Cowlitz Subbasin	3,090	2,180	4,182
Return to Barrier Dam Adult Facility	0	0	0
Collected for Broodstock	0	0	0
Transported to Upper Cowlitz Subbasin	0	0	0
Spawners in Upper Cowlitz Subbasin	0	0	0
Combined Hatchery- and Natural-origin			
Total Run[1]	15,115	5,853	26,299
Harvest[2]	6,732	2,085	12,494
Ocean harvest	2,422	959	7,166
Columbia River harvest	993	341	2,373
Lower Cowlitz River harvest	2,975	697	5,318
Upper Cowlitz Subbasin harvest	342	0	1,284
Total Return to Cowlitz River[3]	11,700	3,025	22,771
Remain in Lower Cowlitz Subbasin	3,627	1,395	6,061
Return to Barrier Dam Adult Facility	3,210	1,876	5,689
Collected for Broodstock	1,439	117	2,264
Transported to Upper Cowlitz Subbasin	3,531	1	9,902
Spawners in Upper Cowlitz Subbasin	2,489	1	6,998

[1] Sum of all harvest Mayfield Dam, remaining in the Lower Cowlitz subbasin, and returns to the Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and above Mayfield Dam.
[3] Sum of lower Cowlitz River harvest, remaining in the Lower Cowlitz subbasin, and returns to the Barrier Dam Adult Facility.

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From 2011-2017, an estimated mean of 48% of the natural-origin fall Chinook Salmon returning to the Lower Cowlitz Subbasin were harvested (Table 3.1-1; Figures 3.1-2 and 3.1-3). For natural-origin salmon, means of 33% were harvested in the ocean and 14% in the lower Columbia River. Fisheries in the Cowlitz Basin are mark-selective so only hatchery-origin salmon are harvested, but natural-origin salmon are also caught and experience a low rate (approximately 7%) of incidental mortality; based on the most recently available data, 1% of the total run was estimated to be impacted due to the sport fishery in the Lower Cowlitz Subbasin. During this FHMP period, it will be necessary to consolidate these estimates into a single database.

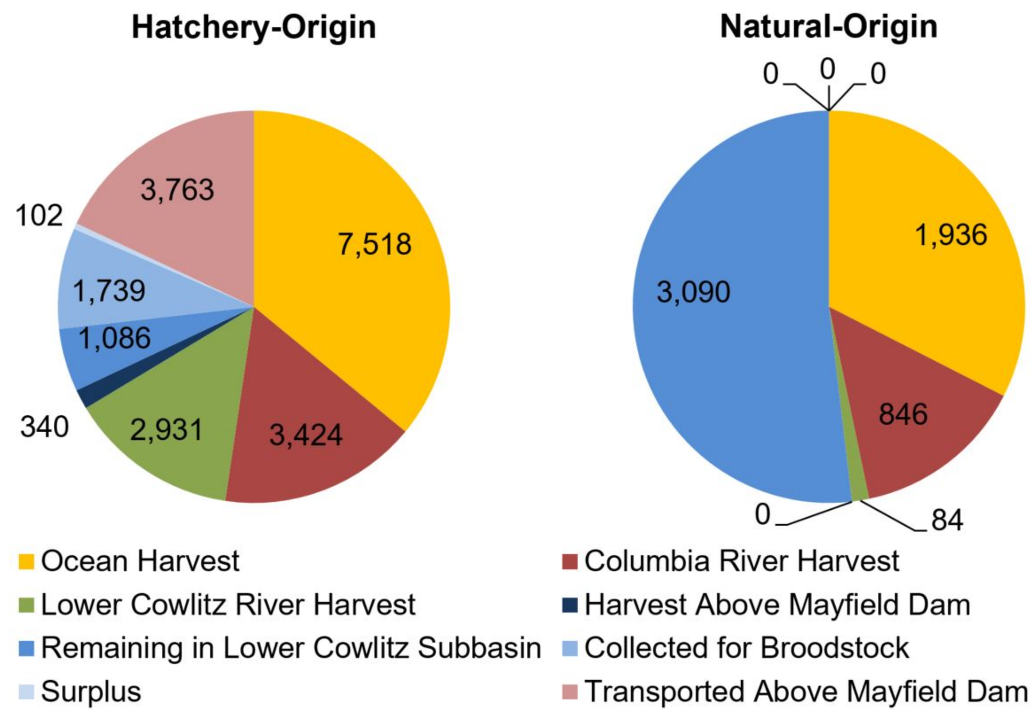

Figure 3.1-2. Estimated mean numbers and proportions of hatchery- and natural-origin Lower Cowlitz Subbasin fall Chinook Salmon caught in ocean, Columbia River, or lower Cowlitz River fisheries, or that were transported above Cowlitz Falls Dam (and were harvested or remained in the Upper Cowlitz Subbasin), 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

3.1.3.3. Disposition

From 2011-2017, none of the natural-origin salmon collected at the Barrier Dam Adult Facility were collected for broodstock, as they were considered to have originated from above Mayfield Dam (Table 3.1-1).

Transport to the Tilton River of natural-origin fall Chinook Salmon originating from the lower Cowlitz River returning to the Barrier Dam likely reduces the estimated abundance of natural-origin Lower Cowlitz Subbasin fall Chinook Salmon, as well as the actual number spawning in nature in the Lower Cowlitz Subbasin, and their subsequent juvenile production. Conversely, it is also likely that some Tilton Subbasin natural-origin salmon remain in the Lower Cowlitz Subbasin to spawn.

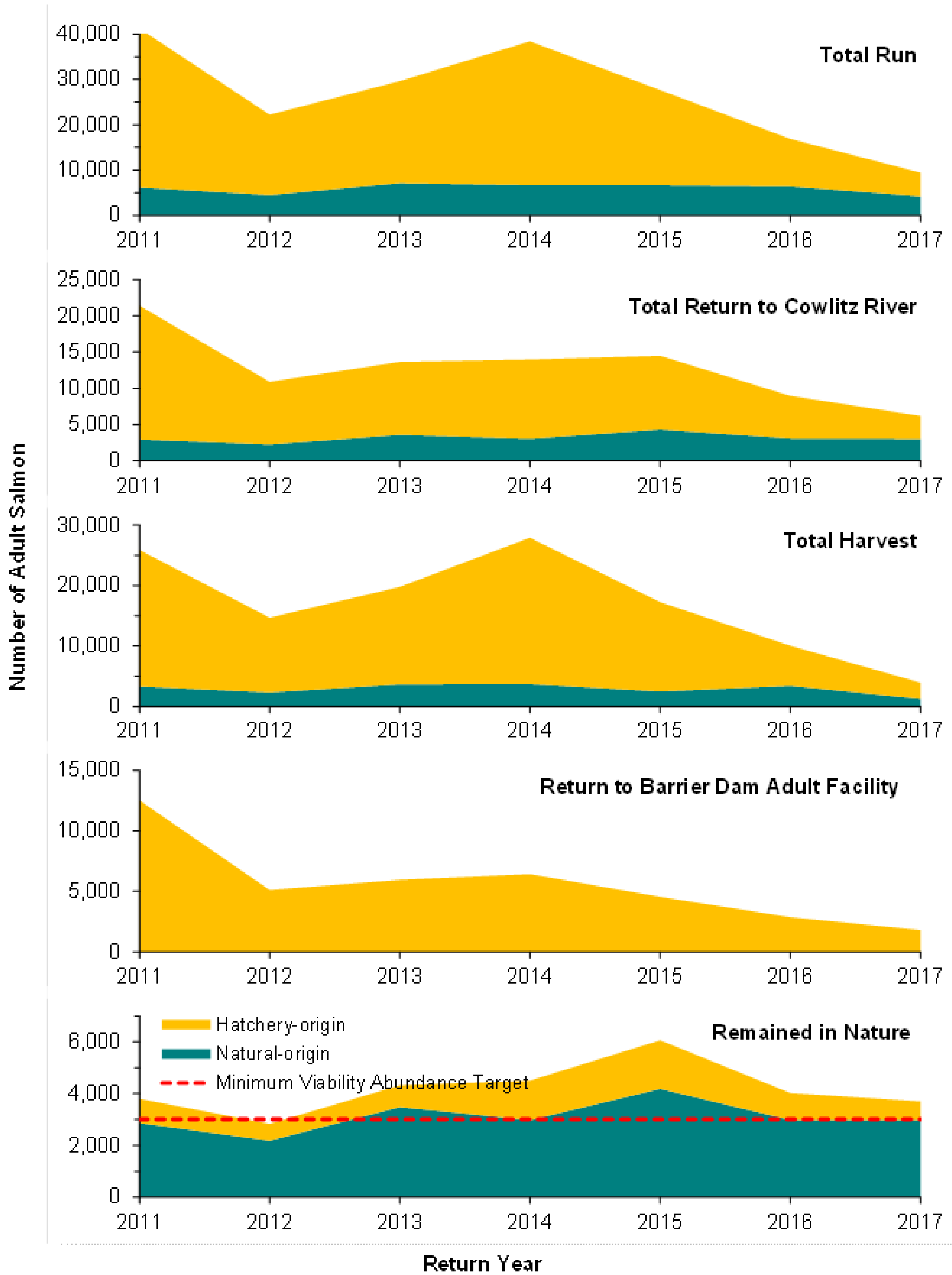

Figure 3.1-3. Estimated total run size for adult hatchery- and natural-origin Lower Cowlitz Subbasin fall Chinook Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, or remained in nature in the Lower Cowlitz Subbasin, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

No effort is currently conducted to identify the true origin of salmon returning to the Barrier Dam Adult Facility, so the effect of these adult returns spawning out of location on actual adult natural-origin abundance is uncertain but should be considered in the future to effectively manage populations in both the Lower Cowlitz and Upper Cowlitz subbasins. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps and monitoring needs required to be filled prior to transition. For more information on the Transition Plan, see Chapter 12 and Appendix B.

3.1.3.4. Spawning in Nature

The Lower Cowlitz Subbasin fall Chinook Salmon population minimum viability abundance target of 3,000 natural-origin salmon spawning in nature was exceeded in 2013 (3,477) and 2015 (4,182) (Figure 3.1-3; Tables 3.1-1 and 3.1-2). From 2011-2017, a mean of 3,090 natural-origin adults (52% of the total Cowlitz natural-origin run) spawned in the Lower Cowlitz Subbasin.

3.1.3.5. Smolt Production

Monitoring juvenile production of the Lower Cowlitz Subbasin fall Chinook Salmon population is difficult. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Chinook Salmon abundance. Therefore, we will now focus on adult productivity (adult recruits/spawner) to monitor the Lower Cowlitz Subbasin fall Chinook Salmon population.

Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps. The M&E Subgroup will evaluate these data gaps in the context of the Transition Plan and prioritize data that will inform management decisions as part of the Annual Program Review process.

3.1.3.6. Natural-origin Survival and Productivity

Survival and productivity are key metrics for monitoring populations. However, productivity has not been calculated and SAR cannot be calculated for the Lower Cowlitz Subbasin fall Chinook Salmon population because smolt abundance estimates are not yet available. Production of natural-origin juveniles in the Lower Cowlitz Subbasin is not well-documented, as minimal monitoring is conducted.

3.1.3.7. Age Composition

Age composition data for natural-origin fall Chinook Salmon from the Lower Cowlitz Subbasin have not been consolidated into a single database for reporting and analysis and therefore are not available for reporting during preparation of this FHMP. During this FHMP period, a mutually agreed-upon database will be used to compile and analyze this information.

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Table 3.1-2. Estimated mean, minimum, and maximum hatchery and natural spawning metrics for Lower Cowlitz Subbasin fall Chinook Salmon, 2011-2017 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2011-2017 Spawn/Brood Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery			
Adults Collected for Broodstock	1,796	803	2,264
Hatchery-origin	1,739	803	2,264
Natural-origin	47	0	139
Pre-spawn Survival Rate	92%	88%	96%
Adults Spawned	1,711	748	2,162
Hatchery-origin	1,603	748	2,162
Natural-origin	43	0	125
Total Green Eggs	4,690,819	1,707,046	6,087,141
Mean Fecundity	4,810	4,476	5,281
Smolts Released [2]	4,108,772	1,519,271	5,104,829
Green Egg-to-Smolt Survival	82%	79%	86%
Smolt Productivity (smolts / spawner)	1,911	1,723	2,086
Nature			
Spawners	4,176	2,830	6,061
Hatchery-origin	1,086	650	1,879
Natural-origin	3,090	2,180	4,182
Smolts Produced		no data	
Smolt Productivity (smolts / spawner)		not available	

3.1.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, to evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population that it is supplementing (see Section 3.0.9).

Cowlitz Salmon Hatchery initiated a fall Chinook Salmon Hatchery Program in 1967 (WDFW 2014b). The program was integrated by default because the hatchery-origin fall Chinook Salmon were not 100% marked until the 2011 return year; in addition, because prior to this, only a fraction of the hatchery-origin salmon were marked at all, the integration rates were unknown. A truly segregated program began in 2011 when the hatchery-origin salmon were 100% adipose fin-clipped and managers could be fairly certain about the origin (hatchery-origin/natural-origin) of the salmon collected for broodstock. The Segregated Hatchery Program for the Lower Cowlitz Subbasin fall Chinook Salmon population currently has a production goal of 2,400,000 smolts.

The current Integrated Hatchery Program was initiated in 2013 with a consistent annual production goal of 1.1 million smolts for Lower Cowlitz Subbasin fall Chinook Salmon. It has a target of 30% of the broodstock being of natural-origin (assumed to be those with an intact adipose fin) but has struggled to reach a meaningful integration rate due to difficulty collecting natural-origin salmon for broodstock - mean pNOB = 0.077 for the 2013-2017 spawn years.

Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information during the development of the Transition Plan. Depending on annual approach, it may be necessary to evaluate effectiveness and methods to improve integration.

3.1.4.1. Abundance

Based on a maximum combined release of 3.5 million smolts from both hatchery programs and SAR of 0.22%, WDFW (2014b) estimated an annual production goal of 7,700 hatchery-origin adults. From 2011-2017, mean total run size was 20,567 hatchery-origin fall Chinook Salmon (Table 3.1-1). Means of 9,624 hatchery-origin fall Chinook Salmon entered the Cowlitz River, 5,607 returned to the Barrier Dam Adult Facility, and 1,086 remained on the spawning grounds in the Lower Cowlitz Subbasin.

3.1.4.2. Harvest

From 2011-2017, an estimated mean of 69% of the hatchery-origin fall Chinook Salmon returning to the Lower Cowlitz Subbasin were harvested (Table 3.1-1; Figures 3.1-2 and 3.1-3). Hatchery-origin fall Chinook Salmon from the Cowlitz Salmon Hatchery contributed to many fisheries, including ocean and Lower Columbia sport and commercial fisheries.

3.1.4.3. Disposition

Hatchery-origin salmon captured at the Barrier Dam Adult Facility that were not used for broodstock nor transported upstream are considered surplus. From 2011-2017, a mean of 3,865 (65-10,243) hatchery-origin fall Chinook Salmon were collected at the Barrier Dam Adult Facility that were in excess of broodstock needs. Of those, a mean of 3,763 were released above Mayfield Dam, primarily into the Tilton River, and 102 were donated to food banks.

3.1.4.4. Hatchery Spawning

From 2007-2017, a mean of 5,607 hatchery-origin fall Chinook Salmon returned to the Barrier Dam Adult Facility and 1,739 were kept for broodstock (Figures 3.1-2 and 3.1-3; Table 3.1-1). Mean pre-spawn survival for hatchery broodstock was 92%, and a mean of 1,603 of those were spawned, 49% of which were females. From 2013-2017, an annual mean of 83 natural-origin adults were captured by WDFW in the Lower Cowlitz Subbasin. Sperm was collected from most males in the field, after which they were released. Some males and all females were taken to Cowlitz Salmon Hatchery for spawning. Gametes were collected from a mean of 76 of those adults.

3.1.4.5. Hatchery Rearing

Hatchery juvenile production for Lower Cowlitz Subbasin fall Chinook Salmon comes from the Integrated and Segregated Hatchery Programs at Cowlitz Salmon Hatchery. From 2011-2017, a mean of 3,027,955 age-1 (sub-yearling) smolts were released annually from Cowlitz Salmon Hatchery (Table 3.1-2).

Prior to 2011, managers could not identify all hatchery-origin salmon, so the numbers of hatchery- and natural-origin salmon spawned are unknown. In 2011 and 2012, the Segregated Hatchery Program was initiated and only hatchery-origin salmon were used as broodstock. The Integrated Hatchery Program began in 2013, and mean pNOB has been 0.077 through 2017.

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Through 2017, the natural-origin component of the fall Chinook Salmon Integrated Hatchery Program has come solely from salmon that were captured by netting or hook and line in the lower Cowlitz River in order to assert that they truly belong to the Lower Cowlitz Subbasin population. A mean of 10 females, 66 adult males, and 1 jack were collected annually from 2013-2018, and a mean of 74% of the females and 87% of the adult males collected contributed to the F_1 generation.

Because of low abundance in recent years (i.e., 2017 and 2018), natural-origin broodstock have been collected from those captured at the Barrier Dam Adult Facility in addition to those on the spawning grounds. Prior efforts for broodstock collection resulted in poor pNOB and PNI values, so this change may prove to be positive for increasing the natural influence in the population. All hatchery-origin salmon have been visually identifiable since 2011; the Transition Plan, to be developed by the first year following completion of this FHMP, will address marking strategies for the new Integrated Hatchery Program. In addition, following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC.

From 2011-2015, a mean of 4,690,819 green eggs were collected from a mean of 967 females at the Barrier Dam Adult Facility, and mean fecundity was 4,810 green eggs / female (Table 3.1-2). Mean green egg-to-smolt survival was 82%, and a mean of 4,108,722 smolts were released.

3.1.4.6. Hatchery-origin Survival and Productivity

Smolt-to-adult survival and return rates are key metrics for monitoring hatchery populations. Mean total smolt-to-adult survival rate (all salmon that could be accounted for) and smolt-to-adult return rate (to the Barrier Dam Adult Facility) for hatchery-origin Lower Cowlitz Subbasin fall Chinook Salmon were 0.306% (0.011-1.955%) and 0.103% (0.006-0.569%), respectively, for the 1977-2011 brood years. Total smolt-to-adult return (TSAR) must be ≥0.22% to achieve the hatchery return goal of 7,700 adults. While the mean TSAR was well over 0.22%, this target was actually achieved for only 14 of the 35 years from 1977-2011. Mean TSAR was only 0.243% for the last 10 complete brood years (2002-2011) and exceeded 0.22% for only half of those brood years. Similarly, the mean SAR has not achieved the required level for self-sufficiency (0.056%) for 15 of the 35 brood years and for 4 of the most recent 10 brood years. The Cowlitz Basin fall Chinook Salmon Hatchery Program is close to not being self-sustaining. As noted in Chapter 1, the data presented in this FHMP are the most recently available data consolidated for FTC consideration and are preliminary, pending a full QA/QC review by the M&E Subgroup. Moving forward, the intended approach is to develop standardized methods for each measure or calculation to the degree possible. In this case, doing so will provide critical information to inform limiting factors associated with TSAR for this population.

All of the data are not available to calculate productivity (adult returns/spawner). Data will be collected to calculate productivity for the hatchery populations to ensure that they are always exceeding replacement (1), as is expected for hatchery programs.

3.1.4.7. Age Composition

We are able to use the extensive data from CWTs (RMIS) to estimate age composition for hatchery-origin salmon. Additionally, this information can be compared with data collected from broodstock scales to estimate age and natural-origin fish from spawning ground surveys, once the information has been consolidated into a single database for analysis and reporting.

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For brood years 1977–2013, means of 0.02%, 6%, 35%, 51%, 8%, and 0.1% of the fall Chinook Salmon with CWTs were recovered at age-1, age-2, age-3, age-4, age-5, and age-6, respectively. As noted above, moving forward, the intended approach is to develop standardized methods for each measure or calculation to the degree possible.

3.1.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI and its components, pNOB and pHOS, are useful metrics for monitoring both hatchery and natural populations. Changes in PNI, pNOB, and/or pHOS can indicate an increase or decrease in the effect of hatchery-origin salmon on the natural population.

From 2011-2017, mean pHOS for the Lower Cowlitz Subbasin was 0.254 (0.194-0.340), achieving the pHOS target of <0.3. Prior to 2013, no known natural-origin salmon were used as broodstock, so for those years, pNOB was equal to 0 and mean pHOS was 0.235. The Integrated Hatchery Program began in 2013 and, from 2013-2017, pNOB has ranged from 0.010-0.234 (mean = 0.077). During this period, mean pHOS = 0.260 (0.194-0.340) and PNI has ranged from 0.048-0.546, with a mean of 0.198.

3.1.6. Future Management

The Lower Cowlitz Subbasin fall Chinook Salmon population is designated as a Contributing population for achieving MPG and ESU recovery goals, with a minimum viability abundance target of 3,000 natural-origin spawners in the lower Cowlitz River. Population viability was rated as Very Low in 2010 (LCFRB 2010), but natural-origin abundance has improved since then (Table 3.1-1). The minimum viability abundance target was exceeded in 2013 (3,477) and 2015 (4,182), and the most recent (2013-2017) 5-year mean was 3,090 natural-origin adults spawning in nature, so this population appears to be meeting the natural-origin spawner minimum viability abundance target of 3,000. This population is in the Local Adaptation recovery phase and also met the HSRG guideline of pHOS <0.3 in 3 of the 5 years from 2013-2017 (mean pHOS was 0.260). As we transition, we will evaluate pHOS targets and their applicability to fish management during the current and upcoming recovery phase. As hatchery production transitions to an integrated hatchery program for the Upper Cowlitz Subbasin, pNOB and PNI will increase, resulting in an improvement for this Stabilizing population. This change will also benefit the Lower Cowlitz Subbasin fall Chinook Salmon population through reduced usage of natural-origin fish for broodstock. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition. Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. Additionally, as this population continues to move toward recovery during this FHMP period, clear goals for defining “healthy and harvestable” levels will be established. For additional information on the Transition Plan, see Chapter 12 and Appendix B.

3.1.6.1. Goals for Conservation, Recovery, and Harvest

This section describes the metrics for improving both population health and fishing opportunity (Table 3.1-3). Some metrics include a proposed timeline within the period covered by this FHMP, while others will likely not be accomplished until a later date, although progress toward achieving long-term goals should be made. Progress toward achieving conservation

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and recovery goals is evaluated through monitoring of standard fisheries management metrics (Appendix A, Big Table Dataset). The Lower Cowlitz Subbasin fall Chinook Salmon population had an historical abundance of about 24,000 salmon and has a minimum viability abundance target of 3,000 natural-origin spawners in nature. In 2010, the abundance and productivity of this population were rated as Very Low (LCFRB 2010). Today, it is on the verge of meeting its minimum viability abundance target (Figure 3.1-3; Table 3.1-1).

Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. During the Transition Plan, the current 1.1 million Lower River Segregated Hatchery Program and 2.4 million Upper Cowlitz Integrated Hatchery Program will be considered to be combined into a single 3.5 million Upper River integrated program during this recovery phase. The returning adults are anticipated to remain available for harvest in years that broodstock needs can be met. For additional information on the Transition Plan, see Chapter 12 and Appendix B.

- **Long-term Goals:** The goal for this Contributing fall Chinook Salmon population is full recovery, which would include, but not be limited to:
  - >3,000 natural-origin adults spawning in nature in the Lower Cowlitz Subbasin (Table 3.1-3).
  - As programs transition, evaluate pHOS targets and their applicability to fish management during the current and upcoming recovery phase.
  - Harvestable population of Lower Cowlitz Subbasin natural-origin fall Chinook Salmon.
- **FHMP Goals:** Goals for this program are attainable steps toward population recovery and emphasize natural-origin spawners in nature and hatchery-origin return to the Barrier Dam Adult Facility as key population metrics for fall Chinook Salmon. The goals for the Lower Cowlitz Subbasin fall Chinook Salmon population for the period covered by this FHMP are:
  - Use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC.
  - Maintain natural-origin spawner abundance >3,000 (5-year average).
  - As we transition, evaluate appropriate pHOS targets and associated fish management applications in the Lower Cowlitz Subbasin.
  - Maintain or improve data collection for monitoring and evaluation of the program, including numbers and age, sex, and origin of all recoveries:
    - Natural smolts produced.
    - Returning to the Barrier Dam Adult Facility.
    - Retained as broodstock.
    - Transported and released upstream of Mayfield Dam.
    - Hatchery surplus.
    - Hatchery strays to/from outside of the Cowlitz Basin.
    - Actual spawners in lower Cowlitz River habitats.

- Reduce the abundance of hatchery surplus by increasing hatchery-origin harvest without a concomitant increase in natural-origin exploitation rate.
- Estimate rates of harvest.

Table 3.1-3. Recovery phase targets for Lower Cowlitz Subbasin fall Chinook Salmon. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Recovery Designation: Contributing
Current Recovery Phase: Local Adaptation

	RECOVERY PHASE				
Target Metric	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years (2013-2017)
Natural Production					
Natural-origin Spawners in Nature	500[1]	1,000[1]	2,000[1]	TBD[1]	3,317
Smolt Abundance (below hatchery)	20,000[2]	40,000[2]	80,000[2]	120,000[2]	?
Smolt Passage Survival	N/A	N/A	N/A	N/A	N/A
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Int/Seg	Int	Int	Int	Seg/Int
Broodstock to be Collected	1,108	530	530	530	1,849
Integrated Hatchery Program	530	530	530	530	1,688
Hatchery-Origin	265	265	265	265	1,628
Natural-Origin	265	265	265	265	60
Segregated Hatchery Program	578	0	0	0	?
Smolts to be Produced	2,300,000	1,100,000	as needed		2,962,151
Integrated Hatchery Program	1,100,000	1,100,000	as needed		?
Segregated Hatchery Program	1,200,000	0	as needed		?
Total Smolt-to-Adult Survival	0.5%	0.7%	0.8%	1%	0.374%[3]
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.3	0.2	0.260
Integrated Hatchery Program / Segregated Hatchery Program	0.1	0.1	0.05	0.05	0.260
pNOB (>)	0.2	0.5	N/A	N/A	0.077
PNI (>)	0.3	0.55	N/A	N/A	0.198
Max % of Natural-Origin Return to the Barrier Dam Adult Facility Collected for Broodstock	50%	40%	30%	30%	1.2%

[1] No minimum viability abundance target has been set for these populations; the numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.
[2] Natural-origin smolt abundance target set based on target for natural-origin spawners in nature and SAR = 1%.
[3] Data from RMIS.

3.1.6.2. Management Targets

As part of this FHMP, Tacoma Power will continue to implement a rigorous monitoring program focused on evaluating program effectiveness based on regionally accepted VSP parameters that was started in 2011 will continue with concerted effort on improving the program to fill critical monitoring and data gaps. These monitoring efforts documenting the total number of hatchery- and natural-origin salmon entering the Cowlitz River, the numbers that are harvested/exploited, the number of hatchery-origin salmon that return to the Barrier Dam Adult Facility, the numbers of both origins that survive to spawn, their respective pre-spawn mortality rates, and pHOS, are critical metrics for achieving recovery. Counts of salmon returning to the Barrier Dam are considered to be reliable numbers, while estimates of harvest, returns to spawning grounds, and spawners in nature have improved since monitoring began in 2011.

- **Natural Production:** The goal of population restoration is to develop self-sustaining, naturally reproducing populations, and the Settlement Agreement has the additional objective that this population be sufficiently large to be harvestable. Monitoring the Lower Cowlitz Subbasin fall Chinook Salmon population has been conducted in recent years to estimate timing, productivity, and abundance for the freshwater stage. During this FHMP period, we will use the broader metric of spawner-to-spawner productivity to monitor the benefit of management actions, such as habitat improvement, while potentially using directed studies to evaluate the freshwater phase in the future should it appear to be a limiting factor. Other specific monitoring issues and challenges are identified below.
  - **Abundance – Natural Spawning:** Recent data indicate that the Lower Cowlitz Subbasin fall Chinook Salmon population may have achieved its minimum viability abundance target of 3,000 natural-origin spawners in nature in the Lower Cowlitz Subbasin, even when a mean of 48% of the natural-origin run is impacted by harvest. If exploitation remains at or below the present level, the population may be able to maintain itself above 3,000. Exploitation in the lower Cowlitz River is low, with only 3% of the total harvest-related mortality of natural-origin salmon occurring there and 3% of the natural-origin salmon entering the Cowlitz River being exploited. Two issues may confound accurately estimating abundance of the Lower Cowlitz Subbasin fall Chinook Salmon population. First, the accuracy of spawner abundance estimates are a function of the statistical rigor of spawning ground surveys and may have broad error bounds. Second, it is difficult to determine the origin of unmarked salmon returning to the Cowlitz River; specifically, fish from the Lower Cowlitz and Tilton subbasins or any other source of unmarked fall Chinook Salmon. For management purposes, all unmarked/untagged (assumed to be natural-origin) salmon that are captured at the Barrier Dam Adult Facility are considered to be from the Tilton Subbasin because they have swum past the spawning reaches in the lower Cowlitz River. Likewise, all natural-origin salmon remaining in the Lower Cowlitz Subbasin are assumed to have originated there. While it is likely that this is an accurate characterization for most salmon, at this time it is unknown how many Tilton Subbasin salmon remain below Barrier Dam and that some of those captured at the hatchery were from the Lower Cowlitz Subbasin, or strayed from some other location. These scenarios compromise the ability to accurately evaluate recovery but they also provide a source of genetic diversity to the respective populations. However, if this straying becomes excessive, it may preclude the ability of the respective populations to differentiate and adapt to local conditions.

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- **Smolts Produced in Nature:** Monitoring juvenile production of the Lower Cowlitz Subbasin fall Chinook Salmon population is difficult. A smolt trap has been operated in the lower Cowlitz River for several years, and we now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Chinook Salmon abundance. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting, and further information is needed to fill data gaps. Estimates of production from the entire area above the smolt trap, including the Tilton Subbasin, can largely be expanded from fish captured at Mayfield Dam. During development of the Transition Plan, we will evaluate survival improvement, and the estimation of guidance efficiency at Mayfield Dam and consider this in determining distinguishing production from the Lower Cowlitz Subbasin.
- **Smolt-to-Adult Survival:** Because smolt abundance is not currently characterized in a mutually agreed-upon database and returns are not documented by age, SAR cannot be estimated. This metric is important but less critical for monitoring natural populations than for hatchery populations. This index will be monitored as the means to do so become available, through our M&E Program.
- **Productivity (Recruits/Spawner):** Productivity (mature natural-origin F_1 recruits / F_0 spawner) is the primary metric for monitoring natural populations, so collection of the necessary data is critical. However, mature returns are not currently characterized in a common database by age, so this metric has not been calculated here. We will monitor this index as the data become available through our M&E Program.
- **Age Composition:** In ISIT, age classes are only characterized as “adults (>49 cm)” or “jacks (<49 cm),” and these data are only available for the returns to the Barrier Dam Adult Facility. Additional data regarding age composition have been collected but not compiled into a standard database for analysis and reporting at this time. Similarly, for natural-origin salmon, only incomplete ISIT data are currently available, so we can only provide percentages of “jacks” and “adults” (and only for those that returned in 2007-2015), as we cannot separate the age-3, age-4, age-5, and age-6 adults.
- **Habitat:** Activities to protect and enhance habitat in the Lower Cowlitz Subbasin are expected to benefit smolt production and the subsequent returns of natural-origin salmon. However, it is difficult to monitor these benefits due to a large number of confounding factors as discussed above.

- **Hatchery Production:** Recently, the numbers of hatchery-origin salmon that return to the Barrier Dam Adult Facility have not been sufficient to support the program. Strategies will be developed, tested, and evaluated to improve the survival and subsequent returns of the hatchery-origin salmon.

  The proposed hatchery production will follow the transition planning and would shift from combined Segregated and Integrated Hatchery Programs for the Lower Cowlitz Subbasin to a single Integrated Hatchery Program for supplementing natural production and harvest in the Tilton Subbasin, as well as to maintain support for fisheries both below and above Mayfield Dam. Hatchery production will remain at 3.5 million smolts, and any shortfall in Upper Cowlitz Subbasin Integrated Hatchery Program production will be made up using HxH crosses (Segregated Hatchery Program), which will be uniquely marked and used only for harvest, unless absolutely necessary. Implementation of the best management practices is necessary for well-managed hatchery programs (Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017).

- **Abundance:** The Cowlitz Salmon Hatchery fall Chinook Salmon Program is expected to produce an annual run of 7,700 adult hatchery-origin fall Chinook Salmon (WDFW 2014b).
- **Broodstock Collection and Spawning:** A mean of 1,796 adult fall Chinook Salmon were collected for hatchery broodstock at the Barrier Dam Adult Facility each year from 2011-2017, and 1,711 have been spawned. Of the hatchery broodstock, a mean of 1,739 and 1,603 hatchery-origin adults were collected and spawned, respectively. The remaining 3% of the adults that were collected and 9% that were spawned were natural-origin adults that were captured in the lower Cowlitz River. Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC.
- **Strays and Spawning in Nature:** Only about 5% of the total hatchery-origin run, and about 8% of the hatchery-origin run entering the Cowlitz River, are recovered on the natural spawning grounds. This is likely a low estimate, based only on hatchery-origin salmon carcasses being collected in monitored reaches in the Lower Cowlitz Subbasin and when conditions are conducive for carcass recovery. Additionally, this is not a complete estimate of straying because it specifically does not include salmon recovered at locations outside of the Cowlitz Basin. Examining CWT data for strays outside of the Cowlitz Basin would improve rigor for estimating stray rates and our understanding of the biology and management of these salmon.
- **Surplus:** A surplus of hatchery-origin salmon returning to the Cowlitz River can affect the viability of the natural-origin population if a sufficient number of them remain to spawn in nature and increase pHOS. The harvest of hatchery-origin salmon is an important tool to help limit pHOS.
- **Smolt Production:** Fall Chinook Salmon hatchery-origin smolts are reared at Cowlitz Salmon Hatchery. Smolts are targeted for release as sub-yearlings in May or June and at a mean weight of 5.7 g. The intent of the hatchery program is to raise and release smolts that perform as well as possible in nature so the development, testing, and evaluation of different rearing and release strategies will be utilized to develop an optimum strategy for this population.
- **Smolt-to-Adult Survival and Productivity:** SAR is the primary metric for monitoring hatchery populations, especially those for which return abundance is lower than expected. To support calculations of SAR, estimates of returns of hatchery-origin salmon by age class are needed. Additional data needs include the rate of precocious maturation and the sex ratio of hatchery-origin salmon by age class. We will monitor this index as the means to do so become available, through our M&E Program.

  Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner) is the primary monitoring metric for any population, especially natural populations. This metric is of less importance for monitoring hatchery populations, where survival to the smolt stage is unnaturally high, but is still useful. Productivity is not currently calculated, but the metric will be monitored over time through the M&E Program.

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- **Age Composition:** In ISIT, age classes are only characterized as “adults (>49 cm)” or “jacks (<49 cm),” and these data are only available for the returns to the Barrier Dam Adult Facility; all other abundance data in ISIT (e.g., harvest, spawners in nature, or hatchery broodstock) provide no information about the ages of the salmon included in the number provided. However, data from CWTs in the RMIS database (www.rmis.org) provide reliable information on age composition for the tagged hatchery-origin salmon for brood years 1977-2011 (later brood years have not completely returned). For natural-origin salmon, we have only the incomplete ISIT data, so we can only provide percentages of “jacks” and “adults” (and only for those that returned in 2007-2015), as we cannot separate the age-4, age-5, and age-6 adults. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

  Given the high proportion of hatchery-origin mini-jacks (age-1_1) and both hatchery- and natural-origin jacks (age $2_{1)}$, and the potential for hatchery production to increase these rates in both the hatchery and in nature, this trend will be monitored. Collection of samples (scales and tags) to estimate the age of both hatchery- and natural-origin salmon will be done regularly at all collection sites to better characterize each cohort and more clearly understand the age composition of these salmon and the factors influencing their age at maturity. To reverse this trend in hatchery-origin salmon maturing precociously, hatchery rearing practices will be evaluated. Large smolts tend to mature at a younger age (Bilton 1984; Martin and Wertheimer 1989; Morley et al. 1996; Feldhaus et al. 2016), so we will develop, implement, and evaluate alternative strategies to decrease the abundance of mini-jacks and jacks, and increase the abundance of the older age-5 and age-6 adults.

- **Harvest:** Harvest of natural-origin salmon reduces the abundance of natural-origin salmon that return to the spawning grounds and is one of the factors that constrains the ability of managers to meet pHOS goals and, therefore, PNI targets for this Contributing population. Conversely, harvest of hatchery-origin salmon would ideally be higher to reduce pHOS. While harvest management of the Lower Cowlitz Subbasin fall Chinook Salmon population should focus on increasing the harvest of hatchery-origin salmon, especially in the lower Cowlitz River, doing so is likely to also result in an increase in the natural-origin catch and subsequent mortality (exploitation). Identifying a means to increase harvest of hatchery-origin salmon while also maintaining or increasing existing escapement of natural-origin salmon remains a challenge. Hatchery-origin harvest will be monitored using the CWT recovery and sampling rate data in RMIS and robust creel surveys.

- **Proportionate Natural Influence:** This population will be managed to maximize the total numbers of spawners in nature (HSRG guidelines), natural smolt production, and survival but also with the goal of reducing the effect of hatchery-origin salmon on the natural population. We propose to increase the influence of the natural environment on the Lower Cowlitz Subbasin fall Chinook Salmon population in the following ways:

  - Develop a Transition Plan to identify data gaps and implementation steps necessary prior to transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River.

- Explore means of decreasing pHOS by increased harvest of hatchery-origin salmon and/or improved return rates to the Barrier Dam Adult Facility.

  Under the Upper Cowlitz Subbasin Integrated Hatchery Program, more natural-origin salmon will be incorporated as broodstock, so PNI should increase, depending on pHOS. As we transition, we will evaluate appropriate pHOS and pNOB targets and associated fish management applications to meet or exceed HSRG guidelines.

3.1.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted on a regular basis to track the population’s trajectory and variability, and includes the basic data required to operate a one-stage or two-stage life cycle model.

Monitoring and evaluation needs of the Lower Cowlitz Subbasin fall Chinook Salmon population are similar to other populations in the basin and include spawning ground surveys, accurate counts of hatchery releases and returns of both hatchery- and natural-origin salmon, additional marking, and evaluation of alternative management and hatchery rearing strategies. To support recovery, rigorous monitoring programs that enable estimation, with greater confidence, of population abundance when the population is self-sufficient, as well as to identify ways to improve survival. Improvement is needed to monitor and evaluate the recovery status and trends that are specific to this population. Improved monitoring rigor for VSP and hatchery metrics is needed, including, but not limited to:

- Natural-origin smolt abundance.
- Hatchery- and natural-origin age at maturity (age of salmon from all recovery locations).
- Natural-origin productivity.
- Smolt-to-adult survival and return rates.
- Estimates of total mature salmon abundance, by origin, age, and sex.
- Estimates of numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
- Returns to the Barrier Dam Adult Facility, by origin, age, and sex.

- Improved harvest estimates of both hatchery- and natural-origin salmon, by age.
- Numbers of salmon collected for broodstock and spawned, by origin, age, and sex.
- Fecundity and fertility rates, survival rates between age classes, disease prevalence, and numbers of smolts produced at Cowlitz Salmon Hatchery.

Directed Studies

Directed studies are designed to diagnose and solve specific problems associated with achieving FHMP goals and to fill management needs and information gaps in the Big Table Dataset (Appendix A). Examples of important areas of study for the Lower Cowlitz Subbasin fall Chinook Salmon population include the following:

- **Spawning Ground Surveys -** Scales, marks, and tags, numbers of actual spawners, pHOS, pre-spawn mortality rates, genetics, spatial distribution (upper extent), and reach-specific adult densities.
- **Freshwater Life History and Natural-origin Juvenile Rearing Studies -** Abundance and life stage-specific survival rates, available habitat, habitat-specific (run/riffle/pool/reservoir) densities, and carrying capacity.
- **In-river Migratory Survival and Behavior** - Survival of migrating juveniles and movement timing, routes, and rates.
- **Hatchery Supplementation Experiments** - Assessing the impact of returning hatchery-origin adults on natural-origin salmon.

3.1.7. Summary

- The Lower Cowlitz Subbasin population is the only remaining population of the two original fall Chinook Salmon populations. The Recovery Plan intends for the distinct populations in the Lower Cowlitz and Upper Cowlitz subbasins to be managed separately moving forward.
- Natural-origin spawner abundance in the Lower Cowlitz Subbasin is approaching the minimum viability abundance target.
- Mean pHOS has remained below the recommended maximum under HSRG guidelines but is over the 10% limit that will be triggered by discontinuing the lower Cowlitz integrated program
- A specific Lower Cowlitz Subbasin fall Chinook Salmon Segregated Hatchery Program was initiated in 2011 and the Integrated Hatchery Program was initiated in 2013.
- The proposed long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition

(e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period for fall Chinook Salmon. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

Population: Upper Cowlitz Subbasin Fall Chinook Salmon *Oncorhynchus tshawytscha*

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Lower Columbia River Chinook Salmon
Major Population Group:	Cascade Chinook Salmon
Recovery Region:	Lower Columbia River Salmon
Population Recovery Designation:	Stabilizing
Population Viability Rating:	
Baseline	Very Low
Objective	Very Low
Minimum Viability Abundance Target:	No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
Current Recovery Phase:	Local Adaptation
Current Hatchery Program(s):	None
Proposed Hatchery Program(s):	Integrated Hatchery Program of 3.5 million sub-yearling (age-1) smolts

3.2. Fall Chinook Salmon: Upper Cowlitz Subbasin Population

3.2.1. Purpose

This section describes the current status of the Upper Cowlitz Subbasin fall Chinook Salmon population, based on available data. For management purposes, fall Chinook Salmon are currently only being reintroduced into the Tilton River and not the Cispus and upper Cowlitz rivers. For the sake of clarity, specificity, and to reduce confusion among other species for which there are separate populations in the Tilton and Upper Cowlitz subbasins, we will hereafter refer to this as the Tilton Subbasin population (Figure 3.2-1). The FHMP identifies the VSP metrics needed to evaluate the status of this population with regard to recovery under ESA guidelines. Where appropriate, we propose changes to both hatchery and monitoring programs to facilitate progress toward population recovery and our evaluation of that progress. The proposed long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program. This will include a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information.

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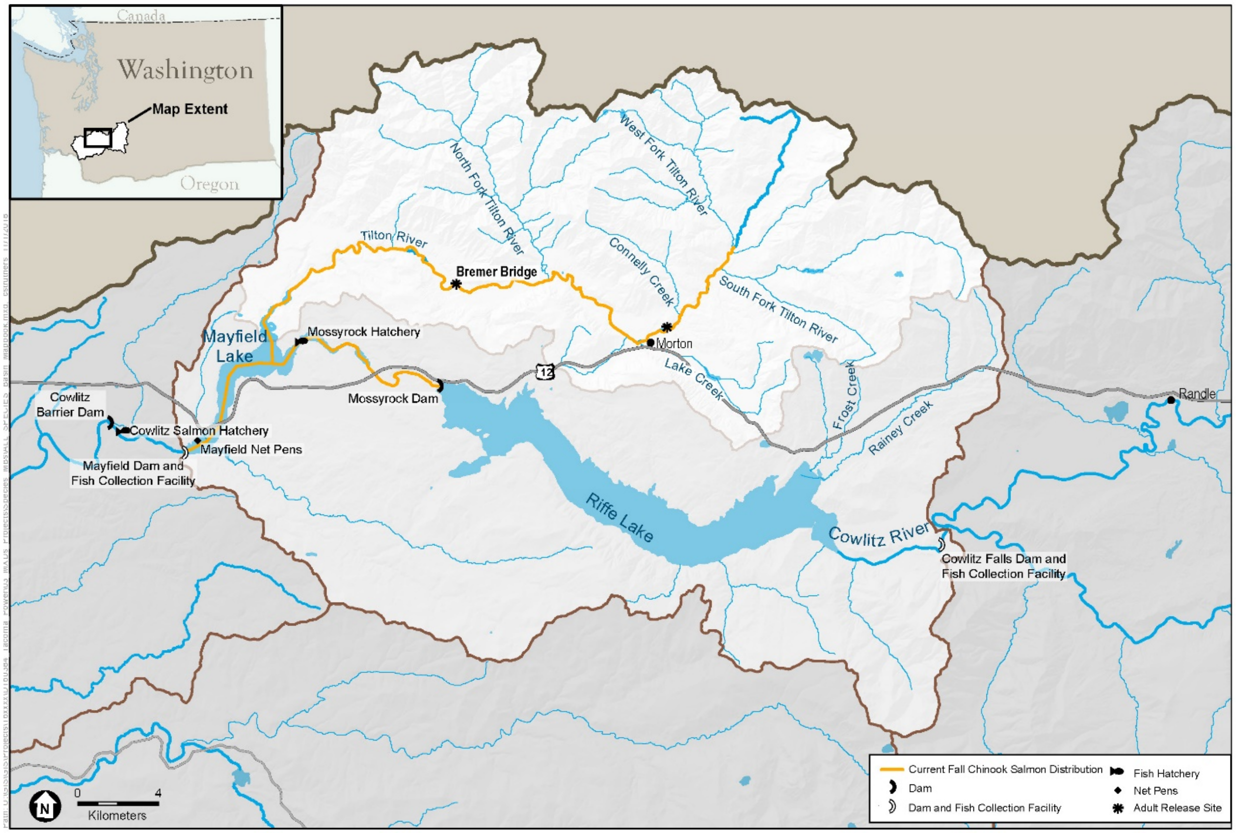

Figure 3.2-1. Distribution of fall Chinook Salmon in the Tilton Subbasin.

Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B. We will continue to evaluate the hatchery program and fisheries management and make refinements or adjustments, as described in this FHMP, to effectively supplement and manage the Tilton Subbasin fall Chinook Salmon population.

3.2.2. Population Description

The Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (LCFRB 2010) delineates a demographically independent fall Chinook Salmon population above Mayfield Dam, comprising the Cispus, Upper Cowlitz, and Tilton subbasins. Currently, and for the near term, the Upper Cowlitz Subbasin population is found only in the Tilton Subbasin, which is the focus of this section, and is comprised of all hatchery- and natural-origin fall Chinook Salmon transported and released above Mayfield Dam (LCFRB 2010).

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After construction of Mayfield Dam, trap-and-haul of adult fall Chinook Salmon was discontinued from 1976 until 1996, extirpating them from habitats above the dam for 20 years (Figure 3.2-2). However, it is likely that the persisting Lower Cowlitz Subbasin and hatchery populations absorbed the adult salmon returning from the Upper Cowlitz Subbasin, resulting in an aggregated population that replaced the original populations. Beginning in1996, adults from this aggregated population returning to the Barrier Dam Adult Facility have been transported to the Tilton River, as well as to the Cispus and upper Cowlitz rivers (2010-2016). In addition, the Lower Cowlitz Subbasin population has been incorporated into an Integrated Hatchery Program, which serves as the founding stock for ongoing restoration of the Tilton Subbasin fall Chinook Salmon population (WDFW 2014b).

The Tilton Subbasin fall Chinook Salmon population was found to be "Depressed" (WDFW 2002) and, as part of the lower Columbia River ESU, was listed as threatened under the ESA in 2005, and reaffirmed in 2011 and 2016. With a current baseline viability rating of Very Low, and its classification as a Stabilizing population for recovery of the lower Columbia River ESU, minimum viability abundance targets for this population have not been set (WDFW and LCFRB 2016). Targets will be set during the period covered by this FHMP in coordination with the FTC.

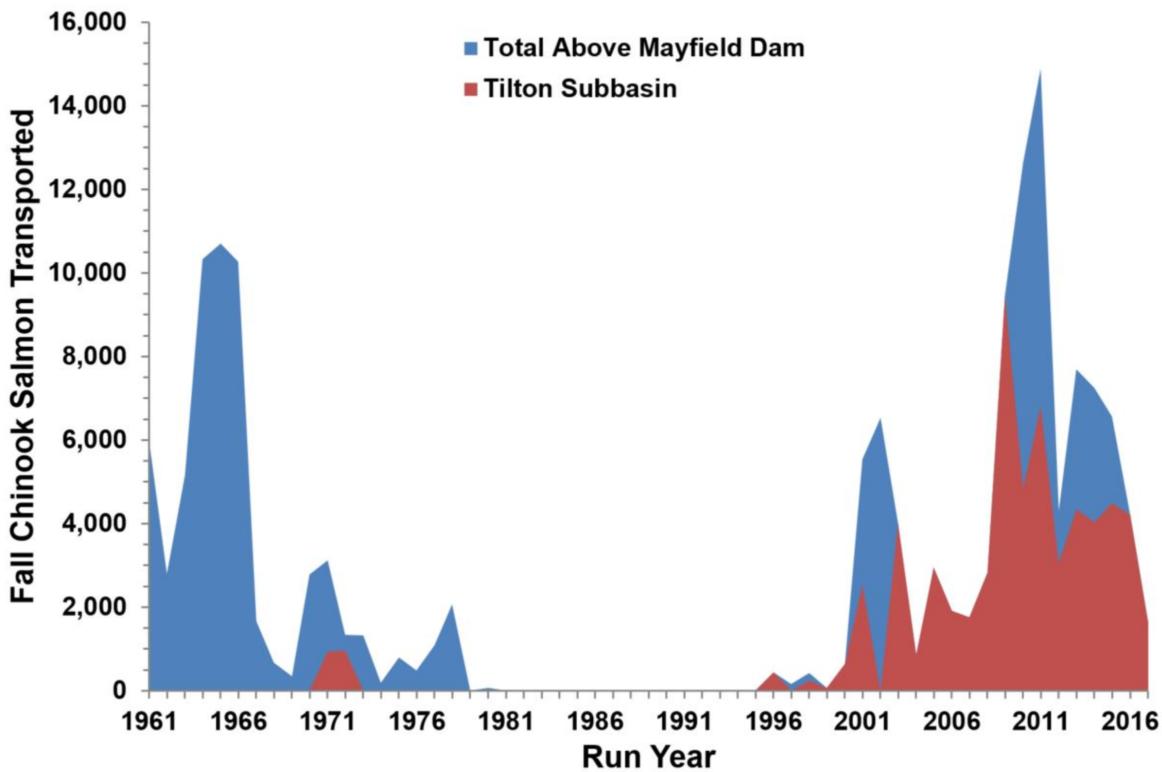

Figure 3.2-2. Total number of fall Chinook Salmon transported above Mayfield Dam and specifically to the Tilton Subbasin, 1961-2017. Note: specific destination of the salmon was not documented in all years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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3.2.3. Natural Production

3.2.3.1. Abundance

Two critical monitoring metrics for salmon management are the numbers that return at maturation and their disposition, especially those that spawn in nature (Figures 3.2-3 and 3.2-4; Table 3.2-1). Tilton Subbasin fall Chinook Salmon that survive to begin their spawning migration may be harvested in commercial, sport, or tribal fisheries in the ocean, Columbia River, or Cowlitz Basin. Those escaping harvest may return to the Barrier Dam Adult Facility or the natural spawning grounds, where they may be recovered and counted. They may also die from predation or disease at any time and not be recovered. Monitoring these dispositions allows us to evaluate population health, productivity, and progress toward recovery, but not all of these data, which are critical to monitoring the Tilton Subbasin fall Chinook Salmon population, have been collected for each year, making population trends difficult to discern at this time.

Although the total number of adult salmon transported and released in the Tilton Subbasin is accurately and precisely known, no spawning ground surveys are conducted. Therefore, we can only roughly estimate spawners by simply using the numbers of hatchery- and natural-origin adults transported multiplied by a standard survival rate, which does not reflect inter-annual variability in pre-spawn mortality.

Additionally, estimates of total natural-origin salmon returning to the subbasin have been subject to error. Prior to mass marking of the hatchery salmon in 2011, estimates of natural production from the Lower Cowlitz Subbasin were less certain because only a small fraction of the hatchery-origin salmon were marked, so we have presented data only since 2011. Since the implementation of mass marking, the estimate of total natural-origin salmon for this population has improved but is still subject to error associated with: (1) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from upstream of Mayfield Dam; (2) collection of unmarked fall Chinook Salmon at the Barrier Dam Adult Facility that originated from the Lower Cowlitz Subbasin (all natural-origin salmon captured at the Barrier Dam Adult Facility are assumed to have originated from above Mayfield Dam); and (3) spawning or harvest observations in the Lower Cowlitz Subbasin of unmarked fall Chinook Salmon that originated from outside the Cowlitz Basin.

Abundance of the Tilton Subbasin population is largely determined by the number of adults that are transported above Mayfield Dam and our estimate of those that survive to spawn, and the number of resulting progeny that are captured at Mayfield Dam, transported to the lower Cowlitz River, and subsequently return as natural-origin adults. From 2011-2017, a mean of 2,677 adult natural-origin salmon were transported and released above Mayfield Dam (Table 3.2-1). Of those, a mean of 2,673 natural-origin fall Chinook Salmon were released into the Tilton Subbasin and 4 were released above Cowlitz Falls Dam.

3.2.3.2. Harvest

Harvest is an important component of the management of Tilton Subbasin fall Chinook Salmon and has great potential for impacting population recovery. Natural-origin salmon contribute to important commercial and recreational fisheries in the Pacific Ocean and lower Columbia River. They are not targeted in Cowlitz Basin fisheries but are caught and suffer a low rate (approximately 7%) of incidental mortality. From 2011-2017, a mean of 58% of the natural-origin run was harvested in all fisheries combined (Figure 3.2-3). Means of 37% and 16% of the run were harvested in the ocean and lower Columbia River, respectively, while means of 2% and 4% indirect mortality in fisheries in the lower Cowlitz River and above Mayfield Dam, respectively.

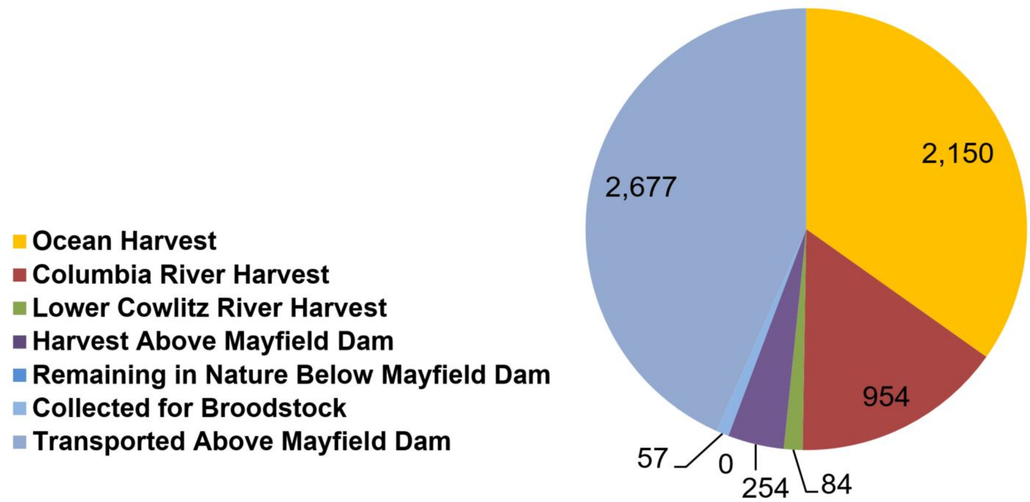

Figure 3.2-3. Estimated mean numbers and proportions of natural-origin Tilton Subbasin fall Chinook Salmon caught in ocean, Columbia River, or lower Cowlitz River fisheries, or that returned to the Barrier Dam Adult Facility (and were collected for broodstock or were transported to the Tilton Subbasin) from 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

3.2.3.3. Disposition

No effort is currently conducted to estimate the identity of natural-origin salmon returning to the Barrier Dam Adult Facility, so all natural-origin returns to the hatchery are assumed to have originated from the Tilton Subbasin and are transported upstream of Mayfield Dam. For the 2011-2017 run years, a mean of 2,677 natural-origin Tilton Subbasin fall Chinook Salmon were transported and released upstream of Mayfield Dam (Figures 3.2-3 and 3.2-4; Table 3.2-1).

3.2.3.4. Spawning in Nature

Because the Tilton (Upper Cowlitz) Subbasin fall Chinook Salmon population is classified as Stabilizing for recovery of the lower Columbia River ESU, no minimum viability abundance target has been established for natural-origin spawners in nature (LCFRB 2010). Targets will be set during the period covered by this FHMP in coordination with the FTC, including the number of natural-origin adults spawning in nature in each of the Cispus, upper Cowlitz, and Tilton drainages. Adults were transported above Mayfield Dam from 1961-1975, which resumed in 1997 and continues through present day.

All natural-origin fall Chinook Salmon returns to the Barrier Dam Adult Facility are assumed to have originated from the Tilton Subbasin, but some may originate from the Lower Cowlitz Subbasin or include strays from outside the basin. Transport to the Tilton Subbasin of natural-origin fall Chinook Salmon caught at the Barrier Dam Adult Facility likely reduces the abundance of natural-origin Lower Cowlitz Subbasin fall Chinook Salmon, as well as the actual number spawning in nature, and their subsequent juvenile production, in the lower Cowlitz River. On the other hand, it is also likely that some Tilton Subbasin natural-origin salmon remain in the Lower Cowlitz Subbasin to spawn. The effect that this spawning out of location has on natural-origin adult abundance is uncertain but should be considered in the future to facilitate effective management of populations in both the Lower Cowlitz and Tilton subbasins.

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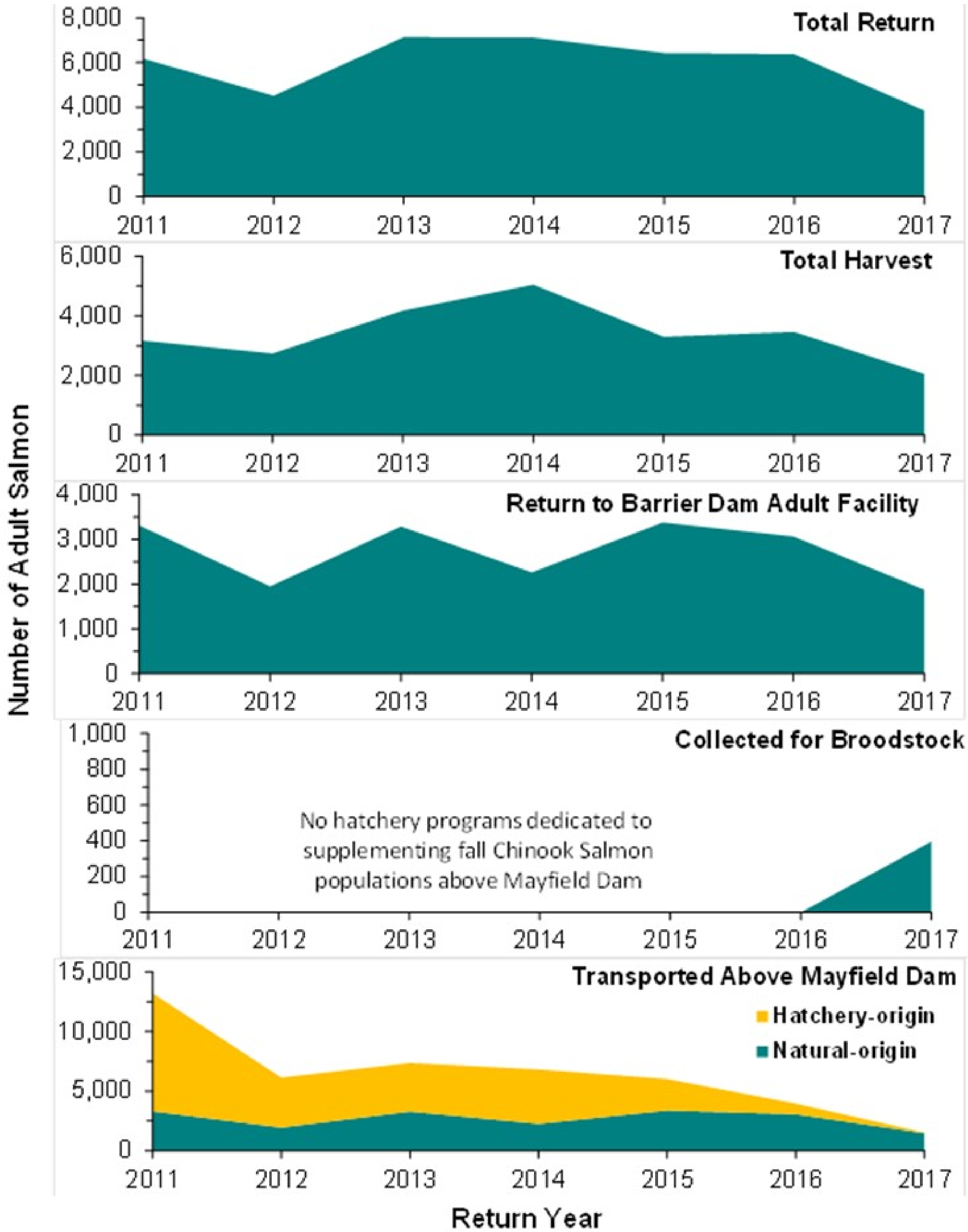

Figure 3.2-4. Estimated total run size for natural-origin Tilton Subbasin fall Chinook Salmon and the numbers that were harvested, returned to the Barrier Dam Adult Facility, were collected for broodstock, or were transported to the Tilton River, 2010-2017 return years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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Table 3.2-1. Estimated mean, minimum, and maximum numbers of all hatchery- and natural-origin adult fall Chinook Salmon from the Tilton Subbasin population that could be accounted for, and percentage of total at that recovery location, 2011-2017. Note: there was no hatchery program dedicated to supplementing the Tilton Subbasin. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]			
Harvest[2]			
Ocean harvest			
Columbia River harvest	No hatchery programs are dedicated to supplementing the fall Chinook Salmon populati above Mayfield Dam		
Lower Cowlitz River harvest			
Upper Cowlitz Subbasin harvest			
Total Return to Cowlitz River[3]			
Remain in Lower Cowlitz Subbasin			
Return to the Barrier Dam Adult Facility			
Collected for Broodstock			
Transported Above Mayfield Dam	3,763	59	9,902
Spawners Above Mayfield Dam[4]	2,674	44	6,998
Natural-origin			
Total Run[1]	5,943	3,853	7,141
Harvest[2]	3,424	2,056	5,051
Ocean harvest	2,170	1,403	3,207
Columbia River harvest	944	513	1,564
Lower Cowlitz River harvest	94	62	154
Upper Cowlitz Subbasin harvest	216	79	332
Total Return to Cowlitz River[3]	2,830	1,938	3,534
Remain in Lower Cowlitz Subbasin	0	0	0
Return to the Barrier Dam Adult Facility	2,735	1,876	3,380
Collected for Broodstock	57	0	396
Transported Above Mayfield Dam	2,677	1,478	3,380
Spawners Above Mayfield Dam[4]	1,925	1,100	2,447
Combined Hatchery- and Natural-origin			
Total Run[1]	5,943	3,853	7,141
Harvest[2]	3,424	2,056	5,051
Ocean harvest	2,170	1,403	3,207
Columbia River harvest	944	513	1,564
Lower Cowlitz River harvest	94	62	154
Upper Cowlitz Subbasin harvest	216	79	332
Total Return to Cowlitz River[3]	2,830	1,938	3,534
Remain in Lower Cowlitz Subbasin	0	0	0
Return to the Barrier Dam Adult Facility	2,735	1,876	3,380
Collected for Broodstock	57	0	396
Transported Above Mayfield Dam	5,351	1,522	10,304
Spawners Above Mayfield Dam[4]	4,600	1,144	9,335

[1] Sum of all harvest Mayfield Dam, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and above Mayfield Dam.
[3] Sum of lower Cowlitz River harvest, remaining in the Lower Cowlitz Subbasin, and returns to the Barrier Dam Adult Facility.
[4] Estimated by subtracting the estimated harvest loss and multiplying by estimated fallback (12%) and pre-spawn mortality (10%) rates from the numbers transported.

3.2.3.5. Smolt Production

From 2013-2017, a mean of 65,859 juvenile fall Chinook Salmon were captured at the Mayfield Dam Juvenile Collection Facility, which captures juveniles from the Tilton Subbasin. Of those, a mean of 61,132 (92.8%) were sub-yearlings and 4,727 (7.2%) were yearlings. While these juvenile production rates are likely reasonable estimates, they are likely conservative when estimating actual numbers due to uncertain capture efficiencies and route-specific survival rates through Mayfield Dam.

From 2010-2015, a mean of 3,983 fall Chinook Salmon adults were also released above Cowlitz Falls Dam (only 11 fall Chinook Salmon adults were released above Cowlitz Falls Dam in 2016). However, during those same years, a mean of 5,214 adult spring Chinook Salmon were released above Cowlitz Falls Dam. During 2011-2016, a mean of 14,463 sub-yearling Chinook Salmon were captured at the Cowlitz Falls Fish Facility, which captures juveniles emigrating from the Cispus and upper Cowlitz river drainages. Of those captured, 13,930 (96.3%) were sub-yearlings and 533 (3.7%) were yearlings. However, offspring of fall and spring Chinook Salmon cannot be easily differentiated and both seem to migrate past Cowlitz Falls Dam as sub-yearlings, so we do not know how many were juvenile fall Chinook Salmon. Additionally, any adults returning to the Barrier Dam Adult Facility from these migrants were released into the Tilton River.

3.2.3.6. Natural-origin Survival and Productivity

Survival and productivity are key metrics for monitoring populations. However, estimates for SAR and productivity for Tilton Subbasin fall Chinook Salmon may be imprecise, as capture efficiency at the Mayfield Dam Collection Facility is uncertain. Additionally, returns are not compiled in a single database by age, so a full run reconstruction of each brood year is not possible at this time.

3.2.3.7. Age Composition

Age composition was not completely calculated because the data have not been compiled into a database for analysis and reporting by age or brood year. Currently, in ISIT age classes are only characterized as “jacks (<49 cm)” or “adults (>49 cm),” and these data are only available for the returns to the Barrier Dam Adult Facility. From run years 2011-2017, a mean of 6% of the natural-origin returns to the Barrier Dam Adult Facility were jacks and 94% were adults. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

3.2.4. Hatchery Production

At present, no hatchery programs are dedicated to supplementing the Tilton Subbasin fall Chinook Salmon population. The proposed long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. Moving forward and until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance).

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Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B.

3.2.4.1. Hatchery-origin Upstream Transport

As described in the Transition Plan, salmon returning to the Barrier Dam Adult Facility that are deemed in excess of broodstock requirements to supplement the Lower Cowlitz Subbasin population may be transported upstream of Mayfield Dam. Salmon transported to the Tilton Subbasin are available for harvest, and those that survive may spawn naturally. From 2011-2017, a mean of 3,763 hatchery-origin fall Chinook Salmon were transported and released above Mayfield Dam, a mean of 1,014 were released into the Tilton Subbasin, and 2,749 were released above Cowlitz Falls Dam. We estimate that 340 of them (from these areas combined) were harvested and 2,674 survived to spawn in nature above Mayfield Dam.

3.2.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI and its components, pNOB and pHOS, are useful metrics for monitoring both hatchery and natural populations. Changes in PNI, pNOB, and/or pHOS can indicate an increase or decrease in the effect of hatchery-origin salmon on the natural population.

From 2011-2017, we estimate that mean pHOS (based on the numbers transported to the Tilton Subbasin, rather than observed spawners) was 0.448. Because there is no dedicated hatchery program for supplementing populations above Mayfield Dam, neither pNOB nor PNI can be calculated. Since inception of the Lower Cowlitz Subbasin fall Chinook Salmon Integrated Hatchery Program in 2013, pNOB has ranged from 0.010-0.234, and PNI has ranged from 0.012-0.859.

3.2.6. Future Management

The entire Upper Cowlitz Subbasin fall Chinook Salmon population is designated as a Stabilizing population for achieving MPG and ESU minimum viability abundance targets. Population viability is rated as Very Low (LCFRB 2010), and recovery efforts for the Upper Cowlitz Subbasin population are currently limited to the Tilton Subbasin. Specific minimum viability abundance targets are not quantified for Stabilizing populations, so targets for natural-origin adults spawning in nature in each of the Cispus, upper Cowlitz, and Tilton drainages will be set during the period covered by this FHMP in coordination with the FTC (Table 3.2-2).

3.2.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation and recovery goals are evaluated through monitoring of standard fisheries and hatchery management metrics (Appendix A, Big Table Dataset). The historical Upper Cowlitz Subbasin fall Chinook Salmon population had an abundance of about 28,000 salmon with an estimated production capacity of 522,294 smolts. Although it has “Very Low” viability (WDFW and LCFRB 2016), it can still provide a Stabilizing role in the recovery of the lower Columbia River Chinook Salmon ESU (LCFRB 2010). The number of natural-origin adults transported above Mayfield Dam from 2007-2017 peaked at

3,380 in 2015 (Figure 3.2-3; Table 3.2-1); however, transport of fall Chinook Salmon upstream of Cowlitz Falls Dam is currently suspended.

Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. During the Transition Plan, the current 1.1 million Lower River Segregated Hatchery Program and 2.4 million Upper Cowlitz Integrated Hatchery Program will be considered to be combined into a single 3.5 million Upper River integrated program during this recovery phase. The returning adults are anticipated to remain available for harvest in years that broodstock needs can be met. For additional information on the Transition Plan, see Chapter 12 and Appendix B.

- **Long-term Goals:** Specific minimum viability abundance targets are not quantified for Stabilizing populations, so targets for natural-origin adults spawning in nature in each of the Cispus, upper Cowlitz, and Tilton drainages will be set during the period covered by this FHMP in coordination with the FTC (Table 3.2-2).
- **FHMP Goals:** Program goals for this FHMP period are attainable steps toward population recovery. Within the current Recolonization phase of population recovery, the FHMP goals for the Tilton Subbasin fall Chinook Salmon population are:
  - At the end of this FHMP period, we anticipate that criteria will be established and that this population will transition into the Local Adaptation phase.
  - The long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC.
  - In consultation with the FTC, establish a minimum viability abundance target for natural-origin spawner abundance and initiate monitoring of natural spawning in the Tilton Subbasin.
  - Keep spawner pHOS <0.5.
  - Consider increased or improve monitoring, evaluation, and data collection, including for:
    - Natural smolt production.
    - Age, sex, and origin of all recoveries.
    - Length and weight of a sample of all recoveries.
    - Hatchery-origin strays to/from locations outside of the Cowlitz Basin.
    - Numbers:
      - Returning to the Barrier Dam Adult Facility.
      - Retained as broodstock.
      - Spawned.
      - Transported and released upstream of Mayfield Dam.
      - Spawners in nature, not just the number transported and released.
      - Hatchery surplus.

- Reduce influence of hatchery-origin spawners in the Tilton Subbasin by increasing natural-origin abundance, reducing the number transported and released upstream, or by increasing hatchery-origin harvest without an associated increase in the natural-origin exploitation rate, and/or acceptance of pHOS rates higher than HSRG guidelines.
- Develop, evaluate, and implement strategies for improving hatchery SAR and age composition to be similar to those of natural-origin salmon.
- Estimate rates of harvest.

Table 3.2-2. Recovery phase targets for Tilton Subbasin fall Chinook Salmon. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Recovery Designation: Stabilizing
Current Recovery Phase: Recolonizing

	RECOVERY PHASE				
Target Metric	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	TBD[1]	TBD[1]	TBD[1]	TBD[1]	1,951[2]
Smolt Abundance (below hatchery)	?	?	?	?	92,242
Smolt Passage Survival	40%	60%	70%	75%	~77%
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Int/Seg	Int	Int	Int	Seg/Int
Broodstock to be Collected	1,108	1,686	1,686	1,686	NA
Integrated Hatchery Program	530	1,686	1,686	1,686	NA
Hatchery-Origin	265	843	422	0	NA
Natural-Origin	265	843	1,265	1,686	NA
Segregated Hatchery Program	578	0	0	0	NA
Smolts to be Produced	2,300,000	3,500,000	3,500,000	3,500,000	NA
Integrated Hatchery Program	1,100,000	3,500,000	3,500,000	3,500,000	NA
Segregated Hatchery Program	1,200,000	As Needed	As Needed	As Needed	NA
Total Smolt-to-Adult Survival	0.5%	0.7%	0.8%	1%	NA
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.3	0.2	0.385
Integrated Hatchery Program					?
Segregated Hatchery Program	0.1	N/A	N/A	N/A	?
pNOB (>)	0.2	0.5	0.75	1	NA
PNI (>)	0.3	0.55	0.7	0.8	NA
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	50%	40%	30%	30%	NA

[1] No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
[2] Estimated by subtracting estimated harvest loss and multiplying by estimated fallback (12%) and pre-spawn mortality (10%) rates from the numbers transported.

3.2.6.2. Management Targets

Between 2011 and 2017, the mean number of natural-origin fall Chinook Salmon transported and released into the Tilton Subbasin was 2,677. However, the proportion of transported adults that originated from the Tilton Subbasin, and their subsequent spawning success following release, is largely unknown. Improvements in smolt passage survival will be required before a naturally spawning population can be reliably sustained in the subbasin without being supplemented by hatchery-origin salmon. Unknown factors (such as Cutthroat Trout predation, *Ceratonova shasta* infection, etc.) can affect natural-origin survival and result in poor natural productivity. To retain harvest benefits and meet conservation goals, the Integrated Hatchery Program, with pNOB >0.5 and a production goal of 3.5 million sub-yearling smolts, will supplement natural spawning and support fisheries.

- **Natural Production:** The goal of population recovery is to develop self-sustaining, naturally reproducing populations. Efforts to improve downstream smolt passage survival continue and recruitment from natural production will increase with the success of these efforts. Likewise, the ability to accurately estimate natural production will improve as collection efficiency at downstream passage facilities improves. Counts of salmon transported to the Tilton Subbasin are reliable numbers, but we are not certain that all natural-origin salmon transported to the Tilton Subbasin originated there. In addition, pre-spawn mortality has not been estimated for salmon (both hatchery- and natural-origin) spawning in nature, so spawner pHOS can only be estimated. As part of this FHMP, Tacoma Power and the FTC will continue to develop and implement a rigorous monitoring program that is focused on evaluating program effectiveness based on regionally accepted VSP parameters.
    - **Abundance – Transport and Natural Spawning:** Reestablishing a self-sustaining population will ultimately require natural spawning by a sufficient number of natural-origin salmon and that their survival exceeds replacement (spawner-to-spawner productivity >1). We will focus our monitoring of natural-origin production on documenting the total number of hatchery- and natural-origin salmon released, their respective pre-spawn mortality rates, the number that survive to spawn, and spawner pHOS. These metrics are critical for achieving recovery.

      Our inability to determine the origin of unmarked salmon returning to the Barrier Dam Adult Facility affects our ability to effectively monitor recovery of the Tilton Subbasin fall Chinook Salmon population. For management purposes, all unmarked/untagged (assumed to be natural-origin) salmon that are captured at the Barrier Dam Adult Facility are considered to be from the Tilton Subbasin because they have swum past the spawning reaches in the lower Cowlitz River. Likewise, all natural-origin salmon remaining in the Lower Cowlitz Subbasin are assumed to have originated there. While it is likely that this is an accurate characterization for most of them, it is very likely that some Tilton Subbasin salmon remain below Barrier Dam and that some of those captured at the hatchery were from the Lower Cowlitz Subbasin salmon or strayed from some other location. These scenarios compromise our ability to evaluate recovery but also provide a source of genetic diversity to the respective populations and, if this straying rate becomes excessive, may also preclude the ability of populations to differentiate and adapt to local conditions.
    - **Smolts Produced in Nature:** Natural-origin smolt production from the Tilton Subbasin is not well known. We will increase collection efficiency estimate at the Mayfield Collection Facility, which will also improve our estimate of natural-origin smolt production.

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- **Smolt-to-Adult Survival:** Because smolt abundance estimates have not been thoroughly analyzed and returns are not well documented by age, SAR has not been estimated at this time. This metric is important, and we will monitor this index as the means to do so become available through the development of a comprehensive database for analysis and reporting, through our M&E Program.
- **Productivity (Recruits/Spawner):** Because returns are not characterized within a single consolidated database by age, productivity also cannot be estimated. Productivity (mature natural-origin F_1 recruits / F_0 spawner) is the primary metric for monitoring natural populations, so collection of the necessary data is critical. We will monitor this index as the means to do so become available through our M&E Program.

- **Hatchery Production:** The numbers of hatchery-origin salmon that return to the Barrier Dam Adult Facility have not always been sufficient to support the program in recent years. Strategies will be developed, tested, and evaluated to improve the survival and subsequent returns of the hatchery-origin salmon. The proposed long-term goal for restoration of fall Chinook Salmon in the Upper Cowlitz Subbasin will be accomplished by transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River. Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the Barrier Dam Adult Facility will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC.
  - **Abundance:** The Cowlitz Salmon Hatchery fall Chinook Salmon Program is expected to be able to produce an annual run of 7,700 adult hatchery-origin fall Chinook Salmon (WDFW 2014b). We will focus our monitoring of hatchery-origin abundance on the numbers that are harvested and that return to the Cowlitz River and to the Barrier Dam Adult Facility, which are critical for calculating SAR and TSAR, as well as the number that remain to spawn in nature, used for pHOS and PNI calculations.
  - **Broodstock Collection and Spawning:** We will employ hatchery best management practices for broodstock collection and spawning to ensure that the broodstock represents the entire population in age and run-timing and to maximize genetic diversity of the F_1 generation. Transferring the hatchery production to a Tilton Subbasin Integrated Hatchery Program will make it easier to achieve the hatchery smolt production targets and integration rates, as we can collect all broodstock from those salmon returning to the Barrier Dam Adult Facility. This will ensure that both male and female natural-origin genotypes are incorporated in the broodstock for the Integrated Hatchery Program. The Integrated Hatchery Program will maintain a high level of natural influence in the hatchery-origin salmon by having at least 50% of the broodstock of natural-origin and avoiding HxH crosses. This will also minimize the hatchery influence on the F_1 generation and any population that it spawns with.

    Additionally, we will rigorously monitor and report important hatchery metrics, such as numbers of salmon collected for broodstock, pre-spawn mortality rates, numbers spawned, fecundity, fertility, and survival rates to release. We will use the most recent 5-year means of these metrics to determine the numbers of adults to collect for broodstock in order to have the maximum number available to be released to support fisheries above Mayfield Dam and to spawn in nature.

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- **Smolt Production:** Currently, smolts are targeted for release as sub-yearlings in May-June (mean weight = 5.7 g). However, releases from 2002-2013 consistently occurred after 1 June and at a mean weight of 6.6 g. We will develop, test, and evaluate different rearing and release strategies to develop an optimum strategy for this population.
- **Smolt-to-Adult Survival:** SAR is the primary metric for monitoring hatchery populations, especially those for which return abundance is lower than expected. To support calculations of SAR, we will continue to rigorously estimate returns of hatchery-origin salmon, by age class. Additional data needs include the rate of precocious maturation and the sex ratio of hatchery-origin salmon by age class. We will monitor this index, using the coded-wire tag data in RMIS (www.rmis.org), through our M&E Program.
- **Productivity:** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner) is the primary monitoring metric for any population, especially natural populations. This metric is of less importance, but is still useful, for monitoring hatchery populations, where survival to the smolt stage is unnaturally high. We will use the CWT data in RMIS to develop age compositions of each brood year of hatchery-origin salmon and support calculations of productivity and to monitor this metric over time through our M&E Program.
- **Strays and Spawning in Nature:** Only about 5% of the total hatchery-origin run, and about 8% of the hatchery-origin run entering the Cowlitz River, are recovered on the natural spawning grounds. This estimate is likely a low estimate based only on hatchery-origin salmon being identified as having spawned in monitored reaches in the mainstem lower Cowlitz River. Additionally, the data from ISIT specifically do not include salmon recovered at locations outside of the Cowlitz Basin. Implementation of spawning surveys, as well as examining CWT data for strays outside of the Cowlitz Basin, will improve data collection and rigor for estimating stray rates and our understanding of the biology and management of these salmon. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.
- **Surplus:** A surplus of hatchery-origin salmon returning to the Cowlitz River can affect the viability of the natural-origin population if a sufficient number of them spawn in nature and increase pHOS. Our goal is to maximize the harvest of hatchery-origin salmon but, if hatchery-origin salmon are going to spawn in nature, we would prefer that they came from an integrated program, hence the priority to advance that program.

- **Harvest:** Harvest of natural-origin salmon outside of the Cowlitz Basin constrains the ability of managers to meet pHOS and, therefore, PNI targets for this Stabilizing population. Conversely, harvest of hatchery-origin salmon would ideally be higher to reduce pHOS. Given the ability to control numbers of hatchery-origin salmon transported upstream, harvest management of the Tilton Subbasin fall Chinook Salmon population should focus on minimizing pHOS. Hatchery-origin harvest will be monitored using the CWT recovery and sampling rate data in RMIS and robust creel surveys.
- **Proportionate Natural Influence:** We will manage this population to maximize the total numbers of spawners in nature, natural smolt production, and survival but also with the goal of reducing the effect of hatchery salmon on the natural population. We propose to increase the influence of the natural environment on the Tilton Subbasin fall Chinook Salmon population in three ways:

  - Develop a Transition Plan to identify data gaps and implementation steps necessary prior to transitioning the current Lower Cowlitz Subbasin Segregated and Integrated Hatchery Programs into a single Tilton Subbasin Integrated Hatchery Program, with a production goal of 3.5 million sub-yearling smolts, which will support supplementation of both natural spawning in the Tilton Subbasin and fisheries below Mayfield Dam and in the Tilton River.
  - Increase natural influence on hatchery-origin salmon by continuing to increase the percentage of natural-origin salmon used as broodstock (pNOB) for the new Tilton Subbasin Integrated Hatchery Program, with all offspring having at least one natural-origin parent.
  - As we transition, we will evaluate appropriate pHOS targets and associated fish management applications to meet relative to HSRG guidelines.

    The low PNI for Cowlitz Basin fall Chinook Salmon is a reflection of the low numbers of natural-origin salmon incorporated into the broodstock (14-125). Under the Tilton Subbasin Integrated Hatchery Program, more natural-origin salmon will be incorporated as broodstock, and pNOB will be >0.5, so PNI should also increase, depending on pHOS. We expect that pHOS will decrease with increased natural production.

- **Age Composition:** In ISIT, age classes are only characterized as “adults (>49 cm)” or “jacks (<49 cm)” and these data are only available for the returns to the Barrier Dam Adult Facility; all other abundance data in ISIT (e.g., harvest, spawners in nature, or hatchery broodstock) provide no information about the ages of the salmon included in the number provided. However, the RMIS database (www.rmis.org) provides reliable age composition data for the CWT hatchery-origin salmon for brood years 1977-2011 (later brood years have not completely returned). For natural-origin salmon, we have only the incomplete ISIT data, so we can only provide percentages of “jacks” and “adults” (and only for those that returned in 2011-2017), as we cannot separate the age-4, age-5, and age-6 adults. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

  Given the high proportion of hatchery-origin mini-jacks (age-2) and both hatchery- and natural-origin jacks and the potential for hatchery production to increase these rates in both the hatchery and in nature, we will more carefully monitor this trend. Collection of samples (scales and tags) to estimate the age of both hatchery- and natural-origin salmon will be done regularly at all collection sites to better characterize each cohort and more clearly understand the age composition of these salmon and the factors influencing their age at maturity. To reverse this trend in hatchery-origin salmon maturing precociously, we will evaluate our hatchery rearing practices. Large smolts tend to mature at a younger age (Bilton 1984; Martin and Wertheimer 1989; Morley et al. 1996; Feldhaus et al. 2016), so we will develop, implement, and evaluate alternative strategies that we believe will decrease the abundance of mini-jacks and jacks and increase the abundance of the older age-5 and age-6 adults.

3.2.6.3. Monitoring & Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted on a regular basis to track the population's trajectory and variability, and includes the basic data required to operate a one-stage or two-stage life cycle model.

Monitoring and evaluation needs of the Tilton Subbasin fall Chinook Salmon population are similar to other populations in the basin and include spawner surveys, accurate counts of hatchery releases and returns of both hatchery- and natural-origin salmon at all recovery locations, additional marking, and evaluation of alternative management and hatchery rearing strategies. To support recovery, monitoring programs must be rigorous and allow for estimation, with confidence, of population abundance when the population is self-sufficient, as well as to identify ways to improve survival. Improved monitoring rigor for VSP and hatchery metrics may be needed to monitor and evaluate the recovery status and trends that are specific to this population:

- Population origin - Identification of returning adults to population of origin.
- Natural-origin smolt abundance.
- Hatchery- and natural-origin age at maturity (age of salmon from all recovery locations).
- Natural-origin productivity.
- Smolt-to-adult survival and return rates.
- Estimates of total mature salmon abundance, by origin, age, and sex.
- Estimates of actual numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
- Returns to the Barrier Dam Adult Facility, by origin, age, and sex.
- Improved harvest estimates of both hatchery- and natural-origin salmon, by age.
- Numbers of salmon collected for broodstock and spawned, by origin, age, and sex.
- Fecundity and fertility rates, survival rates between age classes, disease prevalence, and numbers of smolts produced at Cowlitz Salmon Hatchery.

Directed Studies

Directed studies are designed to diagnose and solve specific problems associated with achieving FHMP goals and to fill management needs and information gaps in the Big Table Dataset (Appendix A). Examples of important areas of study for the Tilton Subbasin fall Chinook Salmon population include the following:

- **Spawning Ground Surveys:** Scales, marks, and tags; numbers of actual spawners; pHOS; pre-spawn mortality rates; genetics; spatial distribution (upper extent); and reach-specific adult densities.
- **Freshwater Life History and Natural-origin Juvenile Rearing Studies:** Abundance and life stage-specific survival rates, available habitat, habitat-specific (run/riffle/pool) densities, and carrying capacity.
- **In-river Migratory Survival and Behavior:** Survival of migrating juveniles and movement timing and rates.
- **Hatchery Supplementation Experiments:** Assessing the impact of returning hatchery-origin adults on natural-origin salmon.
- **Hatchery Practices:** Broodstock collection and spawning protocols, growth rate in hatchery, and examining smolt size and timing of release.

3.2.7. Summary

- Although functionally extirpated from upstream habitats following the completion of Mayfield Dam, Upper Cowlitz Subbasin population genes were likely absorbed into the persisting Lower Cowlitz Subbasin population, which likely has become an aggregated population and has provided the founding stock for recovery.
- Fall Chinook Salmon recovery efforts since 2016 have focused exclusively on the recovery of the Tilton Subbasin portion of the Upper Cowlitz Subbasin population; releases of fall Chinook Salmon upstream of Cowlitz Falls Dam were suspended in 2016 to avoid conflicting with spring Chinook Salmon recovery efforts above Cowlitz Falls Dam. This approach will continue in the near-term, with a goal of eventually expanding fall Chinook Salmon reintroduction to include habitats upstream of Cowlitz Falls Dam.
- Mean numbers of natural-origin adults transported and released into the Tilton Subbasin have exceeded 1,000 since at least 2004. However, the number of natural-origin salmon that survive to spawn is uncertain. Minimum viability abundance targets will be set during the period covered by this FHMP in coordination with the FTC.
- Increasing monitoring rigor for VSP metrics may be needed to evaluate recovery status and trends, including, but not limited to:
    - Identifying returning adults to population of origin.
    - Hatchery- and natural-origin smolt numbers.
    - Estimates of total run size by origin, age, and sex.
    - Harvest estimates of both hatchery- and natural-origin salmon, by age.
    - Estimates of numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
    - Returns to the Barrier Dam Adult Facility by origin, age, and sex.
- Until the Transition Plan is developed, Tacoma Power and the FTC will use the APR process annually to determine how best to collect broodstock based on the available preseason information. Within the first year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, fish collected at the

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Barrier Dam Fish Separator will be used as the primary source for broodstock, unless other circumstances warrant additional consideration by the FTC. In addition, Tacoma Power and the FTC have developed a White Paper (included as Appendix D) describing various perspectives for use during development of the Transition Plan. For additional information on the Transition Plan, see Appendix B.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period for fall Chinook Salmon. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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CHAPTER 4:
SPRING CHINOOK SALMON

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Spring Chinook Salmon *Oncorhynchus tshawytscha*

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Lower Columbia River Chinook Salmon
Major Population Group:	Cascade Chinook Salmon
Recovery Region:	Lower Columbia River Salmon
Populations, Recovery Designations, and Abundance Targets (natural-origin adults spawning in nature):	Tilton River drainage – Stabilizing, not established Upper Cowlitz River drainage – Primary, 1,800 Cispus River drainage – Primary, 1,800
Current Hatchery Program(s):	Cowlitz Salmon Hatchery Segregated Hatchery Program, approximately 1.8 million smolts
Proposed Hatchery Program(s):	Continue Segregated Hatchery Program while developing a Transition Plan for integrating a portion of the hatchery production, and eventually moving to a fully Integrated Hatchery Program; targets will be set during the period covered by this FHMP in coordination with the FTC.

4.0. Spring Chinook Salmon: Overview

4.0.1. Program Focus

The management focus for spring Chinook Salmon is population recovery in the Upper Cowlitz Subbasin and harvest opportunity in the Lower Cowlitz Subbasin. The Recovery Plan (LCFRB 2010) identifies three spring Chinook Salmon populations, all upstream of Mayfield Dam (Figure 4.0-1):

- Cispus River - Primary population
- Upper Cowlitz River - Primary population
- Tilton River - Stabilizing population

Near-term recovery efforts for Cowlitz River spring Chinook Salmon are focused on the Cispus and upper Cowlitz drainages, which are combined to comprise the Upper Cowlitz Subbasin because we currently do not have the ability to differentiate these populations, at present. To maximize spring Chinook Salmon recovery efforts and to prevent the confounding of recovery monitoring results, only spring Chinook Salmon will be transported and released above Cowlitz Falls Dam; no fall Chinook Salmon will be released there for the period of this FHMP, unless determined by the FTC. For the same reason, no spring Chinook Salmon will be released into the Tilton Subbasin for the period of this FHMP. Tacoma Power and the FTC will re-evaluate this management strategy, periodically, and at the end of this FHMP period and will develop a framework for the eventual release of spring Chinook Salmon into the Tilton Subbasin.

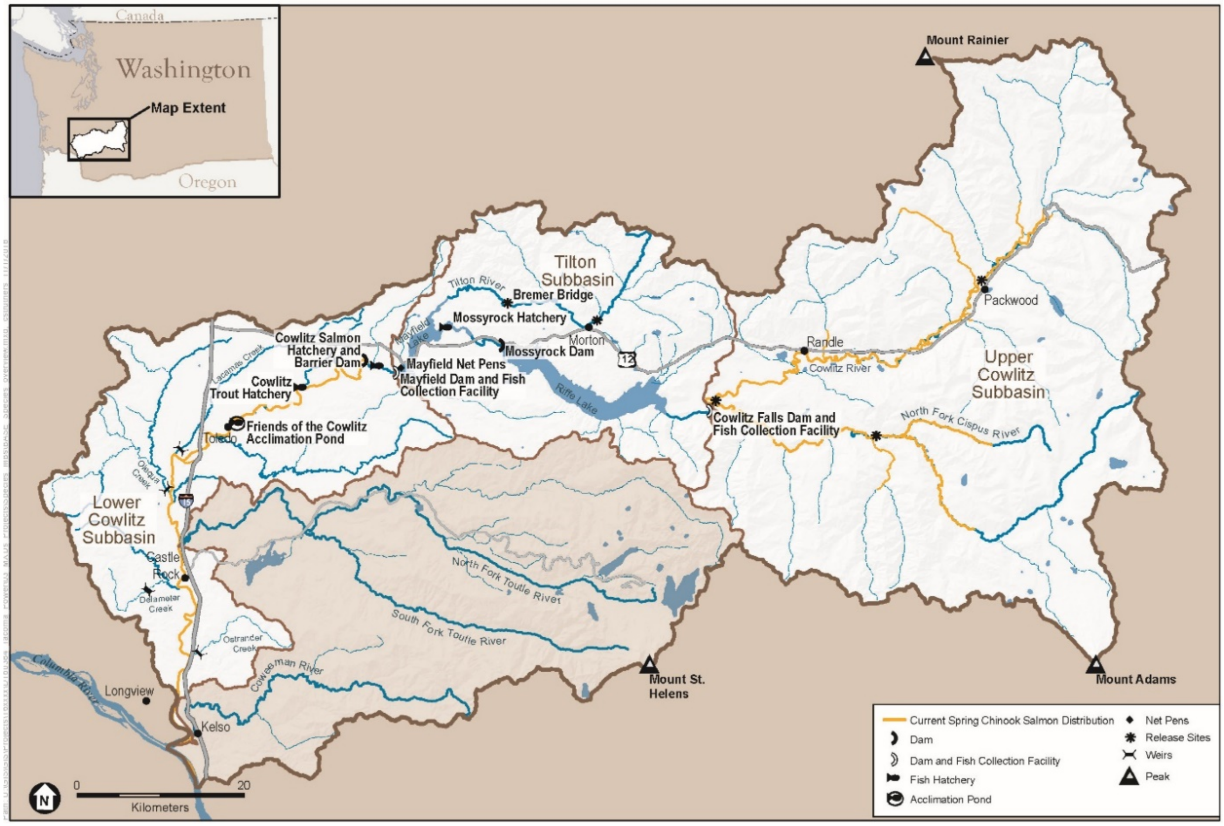

Figure 4.0-1. Distribution of spring Chinook Salmon and locations of important fish management sites in the Cowlitz Basin (not including the Coweeman and Toutle basins).

This framework will require an understanding of the key population parameters (VSP parameters; population abundance, productivity, spatial structure, and diversity) of both fall and spring Chinook Salmon in the affected basins, which will be amongst the parameters and considerations for releasing spring Chinook Salmon into the Tilton Subbasin (McElhany et al. 2000).

The initial management focus for restoration of spring Chinook Salmon will be in the Upper Cowlitz Subbasin, and for fall Chinook Salmon will be the Tilton Subbasin. This will allow each restoration effort to proceed without being confounded by the other population. Nevertheless, a framework will be developed for the eventual release of spring Chinook Salmon into the Tilton Subbasin once fall Chinook Salmon have been reestablished there. Because the smolt collection point for the Cispus and upper Cowlitz rivers is at Cowlitz Falls Dam, downstream of the confluence of these rivers, we cannot differentiate smolts from these two populations, which also means that we cannot differentiate returning adults by population. Therefore, the upper Cowlitz River and Cispus River populations are currently managed as one combined “Upper Cowlitz Subbasin” population, with a combined minimum viability abundance target of 3,600 natural-origin adults spawning in nature (Tacoma Power 2011; WDFW and LCFRB 2016). While these populations are managed as a single unit, monitoring, when practical, may occur by population. The population-level sections that follow (Sections 4.1 and 4.2) provide performance indicators for each of these populations and strategies for achieving their recovery.

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The current Recolonization phase will focus on increasing abundance of spring Chinook Salmon spawners in the Upper Cowlitz Subbasin. The current Segregated Hatchery Program will continue and be the main source of hatchery-origin salmon used to supplement natural spawning. The Transition Plan for spring Chinook Salmon will be developed within 1 year of completion of this FHMP to begin integrating the hatchery program with natural-origin broodstock. The Integrated Hatchery Program will be implemented as quickly as possible and the timeline will be the described in the Transition Plan, using new Decision Rules (triggers) that include adult abundance and the VSP parameters (McElhany et al. 2000). The long-term goal (beyond this FHMP) for spring Chinook Salmon recovery is to use the Integrated Hatchery Program to support all of the supplementation and mitigation for lost production and harvest. For additional information on the Transition Plan, see Chapter 12 and Appendix B.

Poor collection efficiency and passage survival of downstream migrants at Cowlitz Falls Dam has historically been a key limiting factor for population recovery. Recent improvements associated with the construction and operation of the Cowlitz Falls North Shore Collector are substantial and will continue to be monitored for improved collection efficiency and passage survival. These metrics will not be used to limit management options, but rather will be considered along with all limiting factors influencing recovery efforts.

Lastly and consistent with a focus on recovery of spring Chinook Salmon in the Cowlitz Basin, in the first year of this FHMP, we will also develop a disposition plan as part of the spring Chinook Salmon Transition Plan regarding the use of spring Chinook Salmon for hatchery broodstock, recovery objectives, nutrient enhancement, and to meet WDFW obligations in other basins. Spring Chinook Salmon eggs from Cowlitz Salmon Hatchery are currently used by WDFW to meet other State obligations outside of the Cowlitz Basin but this may reduce the number of salmon that would otherwise have been available to spawn naturally in the Cowlitz Basin. The plan will define fish/egg disposition and harvest objectives, minimum escapement targets, hatchery surplus disposition, and associated triggers. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will clearly be communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.

4.0.2. Population Structure

Historically, three distinct populations of Cowlitz River spring Chinook Salmon spawned in the upper mainstem and tributaries of the Cispus, upper Cowlitz, and Tilton rivers (Figure 4.0-1; Table 4.0-1; WDFW and LCFRB 2016). However, the genetic composition of these populations has been heavily influenced by past overharvest and any distinct population substructure that previously existed was eliminated by the construction of Mossyrock Dam and subsequent failure and abandonment of the Riffe Lake juvenile passage systems in the early 1970s, which blocked all of these salmon from reaching their historical spawning locations. Returning natural-origin spring Chinook Salmon adults were incorporated into the Cowlitz Salmon Hatchery broodstock, creating the current Cowlitz River spring Chinook Salmon population, which is one composite hatchery population. Management of Spring Chinook Salmon then focused on hatchery production with limited natural spawning in the Lower Cowlitz Subbasin.

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Table 4.0-1. Recovery priority, baseline viability status, viability and abundance objectives, and productivity improvement targets for Cowlitz River spring Chinook Salmon populations (from LCFRB 2010).

	Demographically Independent Population		
	Upper Cowlitz River	Cispus River	Tilton River
Recovery Priority Designation[1]	Primary	Primary	Stabilizing
Abundance			
Historic[2]	22,000	7,800	5,400
Current (last 5 years)[3]	239		100[4]
Target[5]	1,800	1,800	TBD[6]
Baseline Viability[7]			
Abundance & Productivity	Very Low	Very Low	Very Low
Spatial Structure	Low	Low	Very Low
Diversity	Medium	Medium	Very Low
Net Viability Status	Very Low	Very Low	Very Low
Viability Improvement[8]	>500%	>500%	0%
Min. Viability Abundance Target[7]	High +	High +	Very Low
Proportionate Natural Influence			
pHOS	<0.3	<0.3	<0.3[6]
pNOB	>0.6	>0.6	>0.5[6]
PNI	>0.67	>0.67	TBD[6]

[1] Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance target.
[2] Historical population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS professional judgment calculations.
[3] Current mean annual number of naturally-produced fish returning to the watershed - 2013-2017.
[4] Currently, only released above Cowlitz Falls Dam.
[5] Abundance targets were estimated by population viability simulations based on viability goals.
[6] No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
[7] Viability status is based on Technical Recovery Team viability rating approach. Viability objective is based on the scenario contribution. Very Low (>60% chance of extinction); Low (26-60% chance of extinction); Medium (6-25% chance of extinction); High (1-5% chance of extinction); Very High (<1% chance of extinction).
[8] Improvement is the relative increase in population abundance and productivity required to reach the prescribed viability goal.

Since completion of the Cowlitz Salmon Hatchery in 1967, the Cowlitz River spring Chinook Salmon population has been sustained by hatchery production, with an unknown level of natural-origin integration into the hatchery broodstock until a fully segregated program with mass-marked releases began in 1998. Although Cowlitz River spring Chinook Salmon were heavily influenced by in-basin hatchery practices over the years (Table 4.0-2), influence from non-endemic stocks was minimal, as 96% of all spring Chinook Salmon hatchery releases from 1948-1993 and 100% of subsequent releases were Cowlitz hatchery stock (WDFW 2014a).

This composite hatchery population, created from the mixing of the three extirpated populations, does not functionally exist within the historic distribution of spring Chinook Salmon spawning and rearing in the Cowlitz Basin. Nevertheless, the current Cowlitz Salmon Hatchery spring Chinook Salmon is considered a genetic legacy population, as it is an endemic hatchery population that is derived from the original native populations that we aim to restore. It has served as a gene bank and was the founding population for the reintroduction of spring Chinook Salmon populations in the Cispus, upper Cowlitz, and Tilton rivers. Spring Chinook Salmon from this composite population are currently found in the Lower Cowlitz and Upper Cowlitz

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subbasins. Recovery objectives ultimately include reestablishing spring Chinook Salmon in the Tilton Subbasin.

With the listing of these populations under the ESA in 1999, the management focus turned to recovery of the original population structure, and conservation was elevated to a higher management priority, resulting in changes in hatchery, harvest, and habitat actions. In the Recovery Plan, the Cispus and upper Cowlitz rivers spring Chinook Salmon populations are designated as Primary populations for ESU recovery, each with a minimum viability abundance target of 1,800 natural-origin adults spawning in nature (LCFRB 2010). The Tilton River population is classified as a Stabilizing population; the current operating conditions were considered adequate to meet conservation goals, so no minimum viability abundance target was established. Targets will be set during the period covered by this FHMP in coordination with the FTC, including the number of natural-origin adults spawning in nature.

Table 4.0-2. Hatchery releases of spring Chinook Salmon into the Cowlitz Basin, excluding the Toutle River (updated from Myers et al. 2006).

Release Location	Release Years	Years[1]	Broodstock Origin	Total Released
Cowlitz River	1948-1970	4	Unknown[2]	1,716,588
	1968-1969	2	Willamette Hatchery[3]	999,295
	1968-2018	26	Cowlitz Hatchery	133,101,370
	1979	1	Little White Salmon NFH	224,590
Grand Total				136,041,843

[1] The total number of years that fish were actually released within the time frame.
[2] Stocks of unknown origin are assumed to be from within the ESU. Releases derived from adults returning to that river are also assumed to be native regardless of past introductions, unless the hatchery broodstock is known to be from outside the ESU.
[3] Releases classified by Myers et al. (2006) as derived from outside the lower Columbia Chinook Salmon ESU.

4.0.3. Life History Diversity

In the Cowlitz Basin, maturing spring Chinook Salmon generally return to the Barrier Dam Adult Facility before 30 September, which distinguishes them from fall Chinook Salmon, which return later. There is also a temporal separation between the spawn timing and spatial separation between spawning areas of the spring and fall runs. Spring Chinook Salmon typically enter the Cowlitz River from March through June and natural spawning occurs between late August and early October, with a peak around mid-September (LCFRB 2010). All Cowlitz River spring Chinook Salmon historically spawned upstream of the current site of Mayfield Dam, particularly in the upper reaches of the Cispus River and upper Cowlitz River mainstem and their tributaries. Early entry into fresh water is a defining characteristic of spring Chinook Salmon populations, which are thought to take advantage of higher spring and summer snowmelt flows to access the higher reaches of watersheds in which they typically spawn (Myers et al. 2006).

Spring Chinook Salmon fry emerge from November to March and outmigrate as sub-yearling or yearling smolts. The manner and rate at which these life history strategies are expressed are not well understood in the Cowlitz Basin and may be further examined during this FHMP period. The age at which mature salmon return ranges from age-3 jacks to ages-4-6 adults. The dominant age-class for mature salmon is age-4 (44%).

4.0.4. History

The history of spring Chinook Salmon in the Cowlitz Basin is similar to those of other Columbia Basin populations. Historically, spring Chinook Salmon population sizes in the upper Cowlitz, Cispus, and Tilton rivers were 22,000, 7,800, and 5,400 salmon, respectively (Table 4.0-1; WDFW and LCFRB 2016). However, the combination of overharvest in the early to mid-1900s, hydropower development in the 1960s, and the consistent, continuing, and pervasive effects of habitat loss and hatchery supplementation took their toll on these populations (WDF et al. 1993; Myers et al. 2006). Current population estimates represent a small fraction of historic returns despite continued recovery efforts. Early efforts to mitigate for the problems caused by dams, habitat loss, and overharvest included hatchery supplementation programs focused on producing fish for harvest rather than supporting natural production, which did not provide increases in natural-origin abundance and further degraded the populations. Land development and increasing human population pressures will likely continue to degrade habitat in the Cowlitz Basin, especially in lowland areas. Likewise, poor ocean conditions can cause rapid population declines and most populations in the lower Columbia River ESU are considered to be at High Risk, including the Cowlitz River populations (NWFSC 2015).

In 1948, WDF estimated that 32,490 spring Chinook Salmon returned to the Cowlitz Basin (LCFRB 2010), but harvest in the 1940s and 1950s was heavy and WDF reported that only 10,400 returned to the basin in the early 1950s. Run size decreased further in 1961, when Mayfield Dam required passage facilities for fish to access the Cowlitz Basin above rkm 84, including the entirety of the spring Chinook Salmon spawning habitat. From 1961-1967, a mean of 10,921 spring Chinook Salmon were passed upstream by the Mayfield Dam adult passage facilities (Stober 1986). Mossyrock Dam was completed in 1968 without adult or juvenile passage facilities. The Cowlitz Salmon Hatchery and Barrier Dam were also created at this time, and hatchery broodstock was taken from returning spring Chinook Salmon to create the hatchery run. Unsuccessful attempts were made to collect outmigrating smolts in Riffe Lake for the next 6 years. The length and thermal stratification of Riffe Lake combined with the deep turbine intakes of Mossyrock Dam proved to be a formidable barrier to smolt passage. After smolt collection was abandoned at Riffe Lake, spring Chinook Salmon transportation ceased after 1980, even with juvenile bypass operating at Mayfield Dam, and spring Chinook Salmon production became fully dependent on hatchery production. As a result, annual escapement estimates of Cowlitz River spring Chinook Salmon continued to decline, ranging from 36-1,116 (mean = 338) from 1980-2001(LCFRB 2010).

Fish hatcheries have been operated on the Cowlitz River for over 100 years, with releases of spring Chinook Salmon beginning in the 1940s (Table 4.0-2). Mean annual releases have exceeded 5 million smolts, but the broodstock source has largely been from within the Cowlitz Basin and almost solely from within the ESU, so there appears to be little influence from out-of-basin populations (Myers et al. 2006). Cowlitz River spring Chinook Salmon are genetically similar to, but distinct from, Kalama Hatchery and Lewis River wild stocks, and significantly different from other Columbia River stocks (LCFRB 2010).

Following the construction of Mossyrock Dam, WDFW and Tacoma Power reached a Settlement Agreement with a mitigation goal of 17,300 adult spring Chinook Salmon returning annually to the Barrier Dam Adult Facility (WDFW 2014a). To accomplish this, Cowlitz Salmon Hatchery has been producing spring Chinook Salmon smolts for release into the lower Cowlitz River; the current production goal for the Segregated Hatchery Program is 1.8 million yearling (age-2) smolts.

Following completion of Cowlitz Falls Dam in 1994, Bonneville Power Administration agreed to construct a downstream fish collection system on the new dam. The original license for the Cowlitz River Hydroelectric Project expired in 2000 and a new Settlement Agreement was reached, prioritizing recovery of “wild, indigenous salmonid runs,” including spring Chinook Salmon, to harvestable levels. The minimum viability abundance target for the Upper Cowlitz Subbasin population was set at 3,600 natural-origin adults spawning in nature (1,800 for each of the Cispus and upper Cowlitz rivers; LCFRB 2010). A reintroduction program, including reinstituting trap-and-haul program, was begun in 1994 in an effort to reintroduce the historical populations above Cowlitz Falls Dam, and hatchery-origin spring Chinook Salmon were transported and released into the Upper Cowlitz Subbasin, upstream of Cowlitz Falls Dam, but not into the Tilton Subbasin. The Cowlitz Falls Fish Facility was completed in 1996. As soon as the natural-origin offspring of these salmon began returning, a combination of hatchery- and natural-origin spring Chinook Salmon adults were transported and released, with the intent to produce as many natural smolts as possible, with the ultimate goal of producing a self-sustaining natural population above the Cowlitz River Hydroelectric Complex (Myers et al. 2006). Transport and release of fall Chinook Salmon upstream of Mayfield Dam is currently limited to the Tilton Subbasin until spring Chinook Salmon have become established above Cowlitz Falls Dam and managers are able to distinguish between spring and fall Chinook Salmon smolts originating from the Upper Cowlitz Subbasin for monitoring and management purposes. The spring Chinook Salmon populations in the Cispus River and upper Cowlitz River are both Primary populations, critical for recovery of the ESU, and managers do not want to hinder or confound the recovery effort. Likewise, spring Chinook Salmon are not currently released in the Tilton Subbasin, where they are considered a Stabilizing population.

Since 1996, juvenile spring Chinook Salmon have been collected at Cowlitz Falls Dam and transported and released downstream to complete their migration. The upstream and downstream transport and release programs have restored natural-origin adult returns to the Upper Cowlitz Subbasin. However, collection efficiency at Cowlitz Falls Dam was historically poor and subsequent adult abundance remains low, with an annual maximum of only 397 natural-origin adults transported upstream of Cowlitz Falls Dam since 2007 (Figure 4.0-2; Table 4.0-3). However, construction of additional downstream collection facilities at Cowlitz Falls Dam in 2017 appears to have increased collection efficiency from a mean of 19% (3-39%) from 1996-2016 to 46% in 2017, 66% in 2018, and 71% in 2019. The subsequent increase in outmigrants released into the lower Cowlitz River should help to increase the abundance of natural-origin adults returning to the Upper Cowlitz Subbasin.

Recovery actions have been undertaken over the past three decades, but delisting cannot occur until all populations that historically existed have been restored with a probability of persistence that is consistent with Recovery Plan objectives. The Northwest Fisheries Science Center (NMFS 2016) reported generally minor changes in abundance, productivity, diversity, and spatial structure of Cowlitz River Chinook Salmon populations. Natural-origin abundance remains low and hatchery supplementation still provides an overwhelming contribution to escapement. With access to historical spawning grounds requiring direct handling and transportation and historically low downstream juvenile passage efficiencies, Cowlitz River spring Chinook Salmon populations are not currently self-sustaining. Under the 2011 FHMP update (Tacoma Power 2011), all natural-origin returns plus hatchery-origin returns in excess of broodstock requirements (minus those used to supplement populations outside of the Cowlitz Basin) were to be released upstream of Cowlitz Falls Dam, with a goal of at least 8,000 adults released into the Upper Cowlitz Subbasin.

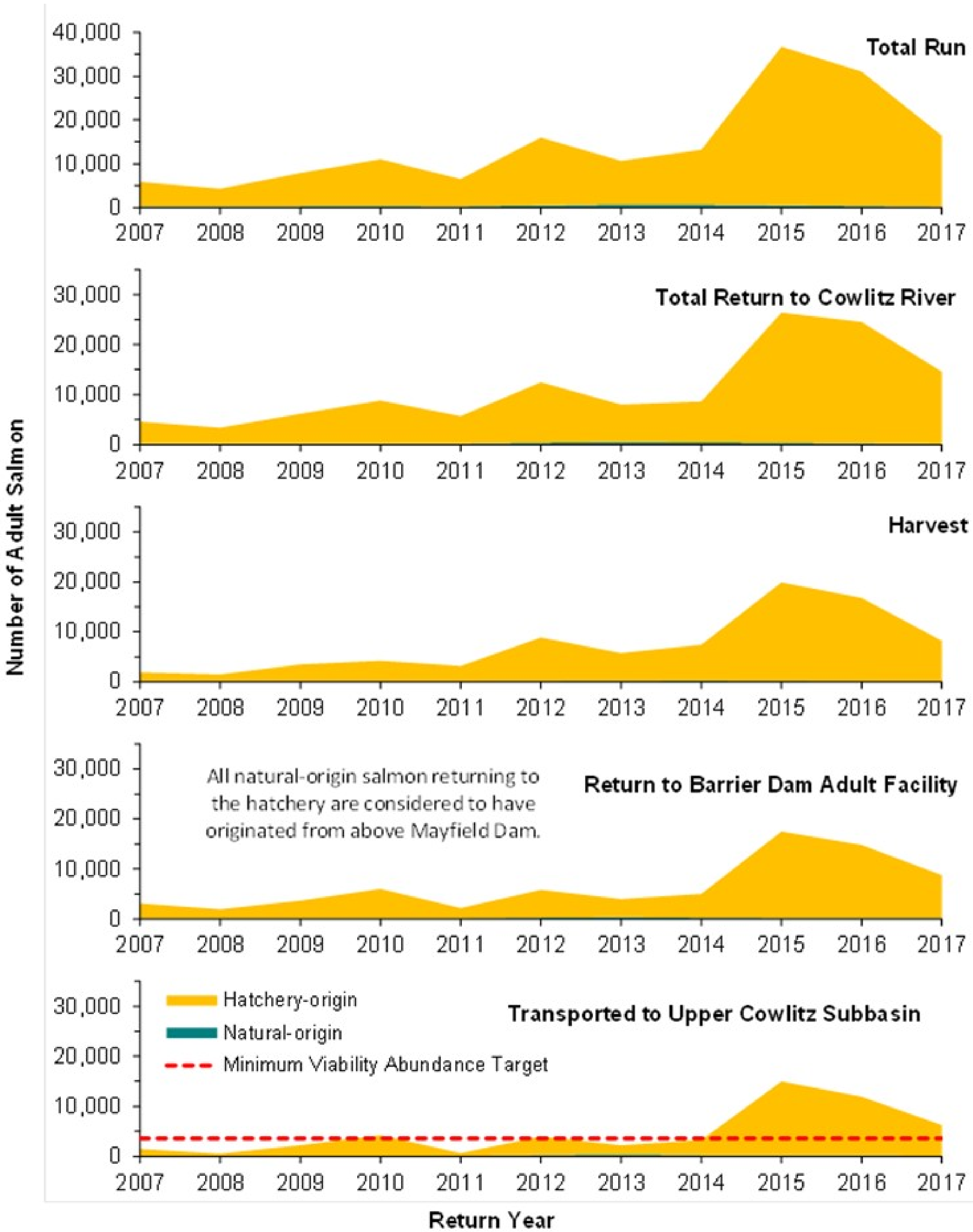

Figure 4.0-2. Estimated total run size for adult natural- and hatchery-origin spring Chinook Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, and were transported above Cowlitz Falls Dam, 2007-2017. Note: numbers of natural-origin adults may be too small to be visible. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Table 4.0-3. Estimated mean, minimum, and maximum numbers of all hatchery- and natural-origin adult spring Chinook Salmon from the Cowlitz Basin, excluding the Toutle River, that could be accounted for at recovery locations and percentage of total at that recovery location, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run (unique to or below hatchery)[1]	14,145	4,070	36,233
Harvest (total for harvest rate)[2]	7,306	1,453	19,747
Total Return to Cowlitz River[3]	13,998	3,180	26,052
Return to the Barrier Dam Adult Facility	6,458	1,884	17,318
Collected for Broodstock	1,459	906	2,146
Transported to Upper Cowlitz Subbasin	4,538	475	14,790
Spawned in Nature[4]	3,266	347	10,446
Natural-origin			
Total Run (unique to or below hatchery)[1]	380	171	693
Harvest (total for harvest rate)[2]	98	24	224
Total Return to Cowlitz River[3]	335	154	523
Return to the Barrier Dam Adult Facility	180	80	397
Collected for Broodstock	0	0	0
Transported to Upper Cowlitz Subbasin	178	70	397
Spawned in Nature[4]	140	55	314
Combined Hatchery- and Natural-origin			
Total Run (unique to or below hatchery)[1]	14,525	4,317	36,760
Harvest (total for harvest rate)[2]	7,404	1,507	19,921
Total Return to Cowlitz River[3]	11,207	3,374	26,412
Return to the Barrier Dam Adult Facility	6,638	1,964	17,511
Collected for Broodstock	1,459	906	2,146
Transported to Upper Cowlitz Subbasin	4,716	555	14,983
Spawned in Nature[4]	3,406	428	10,598

[1] Sum of all harvest below Mayfield Dam, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries.
[3] Sum of Lower Cowlitz Subbasin harvest, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[4] Calculated as number transported to the Upper Cowlitz Subbasin minus harvest in the Upper Cowlitz Subbasin, 12% fallback, and 10% pre-spawn mortality.

4.0.5. Distribution

Historically, all Cowlitz River spring Chinook Salmon spawned in the Upper Cowlitz Subbasin, upstream of the site of Mayfield Dam (LCFRB 2010); specific spawning grounds included the mainstem upper Cowlitz River above Packwood and the Cispus River between Iron and East Canyon creeks. Spring Chinook Salmon are also presumed to have spawned historically in the Tilton River, although this has not been confirmed and their specific spawning distribution within the Tilton River is unknown.

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Construction of Mayfield Dam (rkm 83.7) in 1962-1963 contained adult passage facilities that were utilized until the construction of the Barrier Dam and Cowlitz Salmon Hatchery blocked access 2.5 km below Mayfield Dam. At that point, access to the spawning tributaries in the Upper Cowlitz Subbasin was by trap-and-haul. Adult spring Chinook Salmon were transported to the upper Cowlitz and the Tilton River until Riffe Lake juvenile collection was abandoned in the mid-1970s, although the intermittent transport of spring Chinook Salmon continued until 1980 when all upstream transportation of adults was discontinued until the reintroduction began. Adult spring Chinook Salmon collected at the Barrier Dam Adult Facility have been transported and released upstream of Cowlitz Falls Dam into the Cispus and upper Cowlitz rivers since 1996 (LCFRB 2010; Tacoma Power 2011). To date, these reintroduction efforts have not included releases into the Tilton River, where no population is currently thought to exist.

4.0.6. Abundance

The abundance estimates provided in this FHMP include all of the hatchery-origin spring Chinook Salmon that could be accounted for in the most recent data sets, which include harvest estimates, spawning ground surveys, hatchery collections, and transport records, as well as all of the Upper Cowlitz Subbasin natural-origin spring Chinook Salmon that could be accounted for through these activities. Natural-origin spring Chinook Salmon that were considered to have originated in the Lower Cowlitz Subbasin were not included because they are not considered for determination of recovery. All spring Chinook Salmon from the Toutle River were also excluded.

From 2007-2017, mean total run size of spring Chinook Salmon was 14,525 (4,317-36,760), which included all hatchery- and natural-origin spring Chinook Salmon that can be accounted for Figure 4.0-2; Table 4.0-3). The vast majority (97%) of those salmon were hatchery-origin, with only 3% being natural-origin.

Productive spawning and rearing habitats still exist above the Cowlitz River Hydroelectric Complex, but reintroduction efforts have been hindered by poor collection efficiency of smolts at Cowlitz Falls Dam and virtually no survival through Riffe Lake and Mossyrock Dam. Downstream collection facilities are operated for juvenile salmon at Cowlitz Falls Dam and help to assess the success of the adult releases, but collection efficiency has not met the license requirement levels to date. However, collection efficiency was greatly improved with the construction of the Cowlitz Falls North Shore Collector in 2017.

4.0.7. Harvest

Harvest is an important component of Cowlitz River spring Chinook Salmon management and has great potential for impacting population recovery. Cowlitz River spring Chinook Salmon are an important component of commercial, sport, and tribal harvest and are harvested in ocean, lower Columbia River, and lower Cowlitz River fisheries, as well as in fisheries above Cowlitz Falls Dam (where salmon captured at the Barrier Dam Adult Facility may be transported).

Managing for population recovery would support high harvest rates for hatchery-origin salmon while keeping harvest of the natural-origin salmon as low as possible until the population can support harvest (Paquet et al. 2011). In the past, naturally produced spring Chinook Salmon were managed the same as hatchery salmon and were subjected to similar harvest rates. However, harvest restrictions were placed on ocean and mainstem Columbia River fisheries to protect ESA-listed natural-origin spring Chinook Salmon (LCFRB 2010). Columbia River and Cowlitz River fisheries only target hatchery-origin spring Chinook Salmon.

However, natural-origin spring Chinook Salmon are caught in ocean fisheries, which are not stock- or mark-selective, and hooking mortality in mark-selective (i.e., hatchery-origin) or catch-and-release fisheries can result in indirect mortality impacts on natural-origin salmon. Prior to implementation of mass marking for spring Chinook Salmon and mark-selective fishery implementation, CWT recoveries of hatchery-origin Cowlitz River spring Chinook Salmon (brood years 1989-1994) indicated that 40% of Cowlitz River spring Chinook Salmon were harvested; harvest was greatest in the Cowlitz River sport fishery (35%), followed by British Columbia (29%), Washington Coast (22%), Columbia River (6%), Oregon Coast (5%), and Alaska (3%) fisheries (LCFRB 2010).

Post mass-marking and mark selective fishery implementation, from 2010-2017, the mean ocean harvest rate for hatchery-origin spring Chinook Salmon was 19%, and from 2013-2017, the harvest rate in the Columbia River was 3%. From 2007-2017, a mean of 3,712 hatchery-origin Cowlitz River spring Chinook Salmon were harvested annually in the lower Cowlitz River, and 365 were harvested above Mayfield Dam (Table 4.0-3; Figure 4.0-3). The harvest/exploitation of natural-origin spring Chinook Salmon is not known. WDFW uses a standard 10% hooking mortality rate for released salmon, so we estimate that 8 and 1 natural-origin spring Chinook Salmon died annually as a result of indirect fishery mortality in the lower Cowlitz River and Upper Cowlitz Subbasin, respectively.

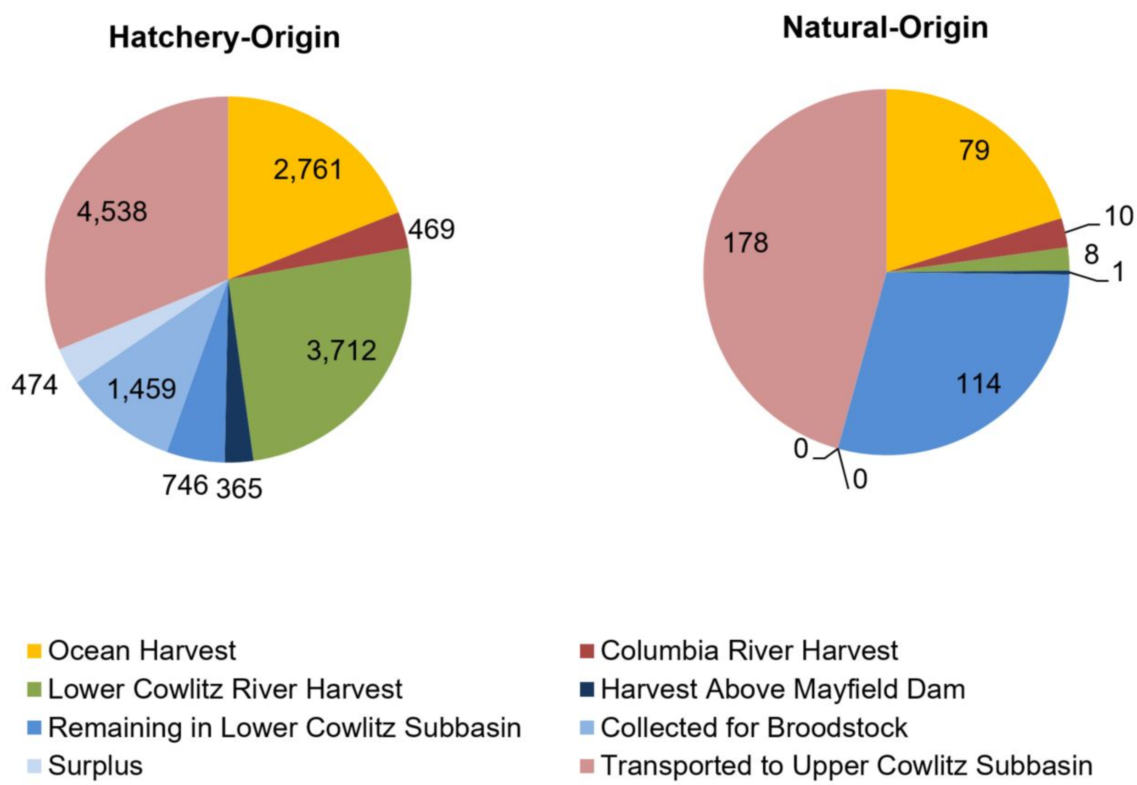

Figure 4.0-3. Mean numbers and proportions of hatchery-origin and natural-origin Cowlitz River spring Chinook Salmon harvested, by fishery location, collected for broodstock, surplused, and transported to the Upper Cowlitz Subbasin, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

4.0.8. Natural Production

To recover a salmon population, a self-sustaining natural population is necessary. To successfully manage toward population recovery, it is also important to know the abundance of the population at important points in their life history. Overall, it is important to estimate (by origin, sex, and age) how many salmon are spawning in nature (F_0 generation) and how many of their offspring (F_1 generation) smolt and leave the Cowlitz River and subsequently survive to produce the next (F_2) generation. Because spawning ground surveys are not conducted in the Upper Cowlitz Subbasin, any estimate to date of spring Chinook Salmon successfully reproducing on the spawning grounds is a relative rather than direct metric and is based simply on the number transported above the dams; we do not know how many survive to spawn, but we roughly estimate that number by simply subtracting a harvest mortality estimate from the number transported and multiplying that by fallback and estimated pre-spawn mortality (10%) rates. Collections of spring Chinook Salmon smolts at Cowlitz Falls Dam offer an important monitoring point and provide a reliable number of smolts transported and released downstream.

The minimum viability abundance target for spring Chinook Salmon in the Cowlitz River is 3,600 natural-origin adults spawning in nature (Table 4.0-1); this target consists of 1,800 adult spawners in each of the Primary populations in the Cispus and upper Cowlitz drainages (LCFRB 2010). No minimum viability abundance target was established in the Recovery Plan for the Tilton Subbasin population because it is only a Stabilizing population; minimum viability abundance targets for the Tilton Subbasin population will be set during the period covered by this FHMP in coordination with the FTC.

Consistent with the recent approach of managing spring Chinook Salmon in the Upper Cowlitz Subbasin as a combined population, ISIT provides combined data for the Cispus River and upper Cowlitz River populations. No spring Chinook Salmon are transported to the Tilton Subbasin and natural-origin spring Chinook Salmon spawners in the Lower Cowlitz Subbasin are not considered part of the ESU. Thus, the Upper Cowlitz Subbasin population currently represents the entirety of natural production of spring Chinook Salmon in the Cowlitz River.

Although natural spawning of hatchery-origin salmon is not directly credited toward meeting natural production targets, hatchery-origin adults are currently transported upstream of Cowlitz Falls Dam to spawn naturally as part of the recovery program. As natural-origin spawner abundance increases, the proportion of hatchery-origin spring Chinook Salmon released into the Upper Cowlitz Subbasin will decrease.

4.0.8.1. *Adult Transport and Natural Spawning*

For the 2007-2017 run years, a mean of 178 natural-origin Upper Cowlitz Subbasin spring Chinook Salmon were transported and released upstream of Cowlitz Falls Dam, and for the purposes of this document we estimate that 140 survived to spawn (Table 4.0-3). No effort is currently conducted to identify the true origin of natural-origin salmon returning to the Barrier Dam Adult Facility, so all natural-origin returns to the hatchery are assumed to have originated from the Upper Cowlitz Subbasin and are transported upstream of Cowlitz Falls Dam.

4.0.8.2. *Smolt Production*

Natural-origin smolt production from the Upper Cowlitz Subbasin is not well known. From 1997-2018, a mean of 16,425 smolts (age-1 and age-2) were collected and mean collection efficiency has been 22%. Between 236,012 and 745,075 spring Chinook Salmon fry were planted annually into habitat in the upper Cowlitz subbasins from 1996 to 2009 (Serl and

Morril 2011). Those released after 2004 were marked with a right ventral fin clip. Additionally, from 2011-2017, smolt numbers were confounded by the presence of fall Chinook Salmon, whose parents had been released into the Upper Cowlitz Subbasin. Collection efficiency at the Cowlitz Falls Fish Facility has increased with the operation of the new North Shore Collector and we expect our collections to further improve by expanding our operation into the fall. This should increase the numbers of natural-origin smolts released downstream and, subsequently, of adults returning.

4.0.9. Hatchery Production

Cowlitz Salmon Hatchery initiated a Chinook Salmon Hatchery Program in 1967 utilizing adult spring Chinook Salmon collected at the Mayfield Dam adult passage facilities (WDFW 2014a). The program was integrated by default because hatchery-origin Chinook Salmon were not 100% marked until 1998 and because natural-origin adults continued to return until at least the mid-1970s. A truly segregated program began once the hatchery-origin salmon were 100% adipose fin-clipped and managers could be certain about the origin of the salmon collected for broodstock, but with very low natural production it is unlikely that the integration rate was significant.

Moving forward, in the near-term, the FTC will continue the Segregated Hatchery Program, while developing a plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. Decision Rules for this new Integrated Hatchery Program will be developed, based on adult abundance and VSP metrics. The long-term goal is for all hatchery production to come from the Integrated Hatchery Program, which will support both the recovery of Cowlitz Basin spring Chinook Salmon populations and provide for lost harvest opportunities.

The Transition Plan for spring Chinook Salmon will be developed within 1 year of completion of this FHMP and will address such factors as monitoring & evaluation strategies for the optimal rearing strategies to improve SAR. (For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.) In the interim, the Segregated Hatchery Program and management practices from 2019 will continue, until the Transition Plan is developed and approved with support and input from the FTC.

Hatchery best management practices will be used for all facets of hatchery production. Hatchery production metrics will be monitored to ensure that production goals and fish quality are met, as well as to understand the magnitude of hatchery influence on the natural population being supplemented. Key hatchery production monitoring metrics are the following:

- Number of salmon collected and spawned by origin (i.e., pNOB, pHOB), age, and sex.
- Fecundity.
- Survival by life stage (green eggs, eyed eggs, fry, parr, smolts released).
- Precocity rates (i.e., percent precocious/mini-jacks).
- Hatchery adult and jack returns by age and sex.
- pHOS.
- Calculation of PNI, SAR, and hatchery return rates.

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4.0.9.1. *Overall Hatchery Program Goals*

The overall goals of the hatchery program for spring Chinook Salmon within the Cowlitz Basin are to:

1) Promote recovery of populations inhabiting the Cowlitz Basin,
2) Provide harvest opportunities for commercial and recreational fisheries, and
3) Support educational and research opportunities.

Specific and quantifiable objectives of the hatchery program to achieve these goals are described in detail within the respective sections for each of the Cowlitz River spring Chinook Salmon populations (Section 4.1 and Section 4.2).

4.0.9.2. *Existing Hatchery Program*

The Cowlitz River spring Chinook Salmon hatchery production currently comes exclusively from the Segregated Hatchery Program, which has an annual production goal of approximately 1.8 million smolts released into the Cowlitz River from Cowlitz Salmon Hatchery. However, between 2000 and 2018 a mean of 55,156 additional parr per year have been provided to the Friends of the Cowlitz for rearing and release as 90 g smolts from their acclimation pond, near Toledo, Washington (Figure 4.0-1); these fish were provided for the sole purpose of supporting harvest below Mayfield Dam and were not expected to return to the Barrier Dam Adult Facility. The corresponding total run-size goal is to produce 17,000 adults (WDFW 2014a). From 2010-2017, a mean of 1,272,801 age-2 and 334,540 age-1 (2007-2011, only) juvenile spring Chinook Salmon were released from Cowlitz Salmon Hatchery. Over that same period, a mean of 13,998 adults have returned to the Cowlitz River (Table 4.0-4).

Table 4.0-4. Current and proposed hatchery programs, smolt production, and marking/tagging for spring Chinook Salmon.

	Hatchery Program		Juvenile Production		Mark / Tag	
Origin & Stock	Current	Proposed	Current	Proposed	Current	Proposed
Hatchery						
Cowlitz Salmon Hatchery	Segre-gated	Segre-gated	1,741,899	1,800,000[1]	100% Ad + 100k CWT/group[2]	100% Ad + 100k CWT/group[2]
Upper Cowlitz Subbasin	None	Integrated	None		NA	?
Natural						
Upper Cowlitz Subbasin	NA		23,982[3]	~50,000[4]	No Mark	No Mark
Tilton Subbasin	NA		NA		NA	

1 Numbers of smolts proposed for production from the Segregated and Integrated Hatchery Programs will gradually change during recovery exclusively to the Integrated Hatchery Program, with targets to be set in coordination with the FTC based on the Transition Plan.
2 All hatchery-origin salmon are adipose fin-clipped; 100,000 are implanted with a coded-wire tag.
3 Number of juvenile Chinook Salmon captured at Cowlitz Falls Fish Facility, 2014-2018.
4 Reflects expected increases in numbers of spawners and improvements in collection efficiency at Cowlitz Falls Dam.

4.0.9.3. *Adult Transport and Natural Spawning*

In addition to all natural-origin spring Chinook Salmon collected at the Barrier Dam Adult Facility, hatchery-origin returns in excess of broodstock requirements are transported above Cowlitz Falls Dam. From 2007-2017, an annual mean of 4,716 adult spring Chinook Salmon were transported and released into the Upper Cowlitz Subbasin, of which 4,538 (97%) were hatchery-origin (Table 4.0-3). We estimate that 3,266 of these survived to spawn.

Spring Chinook Salmon transported and released above Cowlitz Falls Dam provide for natural spawning and harvest opportunity. Because all salmon must be transported above the dams, the number of hatchery-origin salmon in the Upper Cowlitz Subbasin can be managed. However, because harvest rates have not been estimated and spawning ground surveys have not been regularly conducted, the number of those transported spring Chinook Salmon that actually spawn in nature and the proportion of spawners that are of hatchery-origin are unknown.

Currently, hatchery-origin salmon comprise the vast majority of adults reaching the Upper Cowlitz Subbasin, and they provide a large demographic boost to natural production, likely well over what it would be without them, given the relative numbers of hatchery- and natural-origin salmon that have been transported. As downstream passage survival improves and an increasing number of natural-origin salmon are available to spawn naturally, the Cowlitz River spring Chinook Salmon populations will benefit in two ways: (1) the size of the Integrated Hatchery Program can increase, and (2) the ratio of hatchery-origin to natural-origin salmon transported and that subsequently spawn naturally in the Upper Cowlitz Subbasin will be reduced. Both of these actions will result in a beneficial reduction of the influence of the hatchery environment on the natural population.

4.0.10. Survival and Productivity

Mean SAR (includes all mature salmon that could be accounted for) of hatchery-origin spring Chinook Salmon with CWTs for the 2000-2011 brood years was 1.03%. SAR of natural-origin salmon is unknown because returns are not distinguished by age, but is expected to be greater than that of the hatchery-origin salmon. Because the numbers of spawners and the numbers of returns by brood year are unavailable, productivity (spawner-to-spawner) also cannot be calculated. As described in Chapter 1, the data presented in this FHMP are preliminary, pending a full QA/QC review of the Big Table Dataset (Appendix A) by the M&E Subgroup for accuracy and source. Moving forward, the intended approach is to develop standardized methods for each measure or calculation to the degree possible.

4.0.11. Proportionate Natural Influence and Age Composition

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI is calculated using two proportions: the proportion of spawners in nature that are hatchery-origin (pHOS) and the proportion of the hatchery broodstock that is comprised of natural-origin salmon (pNOB). The Hatchery Scientific Review Group (HSRG 2009) recommended that Primary populations with segregated hatchery programs should have pHOS <0.05. For those with integrated hatchery programs, pHOS should be <0.3 and pNOB should exceed pHOS by a factor of two so that PNI >0.67.

For the period over which we can calculate PNI (2007-2017), the Cowlitz River spring Chinook Salmon population was supplemented only by the Segregated Hatchery Program. Mean pHOS was 0.921, as expected for a population that was in Recolonization, which was well above the upper HSRG guideline. However, we must recognize that the limiting factors are not well understood and that juvenile collection efficiency was below the level that would allow for a self-sustaining population. Collection efficiency of Chinook Salmon smolts at the Cowlitz Falls Fish Facility was highly variable and generally very poor. Mean collection efficiency was 19% from 1996-2016, but increased to 46% in 2017 and 66% in 2018 and 71% in 2019, with the operation of the new North Shore Collector. When the natural-origin abundance increases sufficiently, an Integrated Hatchery Program may be started. As we transition, we will evaluate the appropriate pHOS, pNOB, and PNI targets and associated fish management applications.

For hatchery-origin spring Chinook Salmon recovered with CWTs from brood years 2000-2011, a mean of 10% were recovered at age-2, 27% at age-3, 52% at age-4, 11% at age-5, and 0.2% at age-6.

4.0.12. Marking and Tagging

Currently, all hatchery-origin spring Chinook Salmon are marked with an adipose fin-clip and 100,000 of each release group have a CWT implanted (Table 4.0-4). We plan to maintain this marking/tagging scheme until the Integrated Hatchery Program begins, and then we will adjust our marking/tagging scheme per the Transition Plan. Currently, the juvenile natural-origin spring Chinook Salmon from the Upper Cowlitz Subbasin are not marked when they are captured at the Cowlitz Falls Fish Facility, and this may also change.

Marking and tagging schemes may vary from year to year, especially for hatchery-origin releases, which may also include experimental groups. Marking and tagging schemes for each group, within each brood year, will be identified in the Transition Plan and further defined by the M&E Subgroup and documented in each year's Annual Operating Plan (as described in more detail in Chapters 10 and 12, respectively, of this FHMP).

4.0.13. Summary

- The continued genetic exchange among spring Chinook Salmon in the hatchery and the few spawning naturally in the Lower Cowlitz Subbasin since 1967 has caused Cowlitz River spring Chinook Salmon to functionally become a single population.
  - Although the ESA framework identifies distinct spring Chinook Salmon populations in the Cispus and upper Cowlitz rivers, returning adults cannot be differentiated. Thus, these populations are managed as a combined "Upper Cowlitz Subbasin" population and allowed to self-select subbasin of origin post transportation.
  - Recovery efforts for spring Chinook Salmon will focus on the Upper Cowlitz Subbasin; spring Chinook Salmon will not be released in the Tilton Subbasin to avoid conflicting management activities for fall Chinook Salmon recovery in the Tilton Subbasin.
  - A framework will be developed using VSP parameters for the eventual release of spring Chinook Salmon into the Tilton Subbasin once the fall Chinook Salmon population there has been established and the capacity to differentiate spring and fall Chinook Salmon smolts has been achieved or other criteria are established.
- Cowlitz River spring Chinook Salmon are currently in the Recolonization phase of recovery and, over the period of this FHMP, the focus will be on rebuilding abundance of the natural-origin population by maximizing the numbers of salmon (regardless of origin) spawning in nature in the Upper Cowlitz Subbasin.

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  - Juvenile Fish Passage Survival is a key limiting factor for abundance.
  - The current Segregated Hatchery Program will be continued, with continued transport and release of hatchery-origin adults to supplement natural production while also sustaining harvest opportunity.
  - The Transition Plan for eventually moving to a fully integrated program for spring Chinook Salmon will be developed within 1 year of completion of this FHMP.
  - An Integrated Hatchery Program will be initiated during this FHMP period if appropriate as determined by the Transition Plan.
  - Cowlitz Basin program needs, including both recovery and harvest objectives, will be prioritized by developing a surplus plan as part of the Spring Chinook, Transition Plan to define fish/egg disposition and harvest objectives, minimum escapement targets, hatchery surplus disposition, and associated triggers. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will clearly be communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.
- The long-term goal (beyond this FHMP) will be for the Integrated Hatchery Program to support all recovery and harvest management needs, providing for:
  - Population recovery upstream of Mayfield Dam.
  - Mitigating for lost harvest opportunity, in which a percentage of the run will be managed exclusively for harvest.
- We will continue to evaluate the appropriate program structure to manage for individual populations and Local Adaptation.
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

The following sections present information on the Upper Cowlitz Subbasin spring Chinook population (Section 4.1) and Tilton Subbasin spring Chinook Salmon population (Section 4.2).

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Population: Upper Cowlitz Subbasin Spring Chinook Salmon
Oncorhynchus tshawytscha

Evolutionarily Significant Unit:	Cascade spring Chinook Salmon stratum Lower Columbia River Chinook Salmon Evolutionarily Significant Unit (ESU) Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened; Listed in 2005, reaffirmed in 2011 and 2016
Population Recovery Designation:	Primary
Population Viability Rating:	
Baseline:	Very Low
Objective:	Very High
Minimum Viability Abundance Target:	3,600 natural-origin salmon spawning in the Upper Cowlitz Subbasin
Current Recovery Phase:	Recolonization
Current Hatchery Program(s):	Cowlitz Salmon Hatchery Segregated Hatchery Program, approximately 1.8 million smolts
Proposed Hatchery Program(s):	Continue Segregated Hatchery Program while developing a Transition Plan for integrating a portion of the hatchery production, and eventually moving to a fully Integrated Hatchery Program; targets will be set during the period covered by this FHMP in coordination with the FTC.

4.1. Spring Chinook Salmon: Upper Cowlitz Subbasin Population

4.1.1. Purpose

This section describes the current status of the Upper Cowlitz Subbasin spring Chinook Salmon population based on recent and available data. For management purposes, spring Chinook Salmon are currently only being reintroduced above Cowlitz Falls Dam (Cispus and upper Cowlitz drainages). All spring Chinook Salmon above Cowlitz Falls Dam are being managed as a single population because unique populations in the Cispus and upper Cowlitz rivers are not currently distinguished and share many critical pathways (e.g., Fish Passage Survival at Cowlitz Falls Dam, collection at and transport from the Barrier Dam Adult Facility). Therefore, for the sake of clarity, specificity, and to reduce confusion, this population is hereafter referred to in the FHMP as the Upper Cowlitz Subbasin spring Chinook Salmon population (Figure 4.1-1). The FHMP identifies VSP metrics needed to evaluate this population's status with regard to reaching recovery under ESA guidelines. Where appropriate, the FHMP proposes changes to both hatchery and monitoring programs to facilitate evaluation of progress toward population recovery. Evaluation of the hatchery program and fisheries management will inform program refinements or adjustments, as described in this FHMP, to effectively supplement and manage the Upper Cowlitz Subbasin spring Chinook Salmon population.

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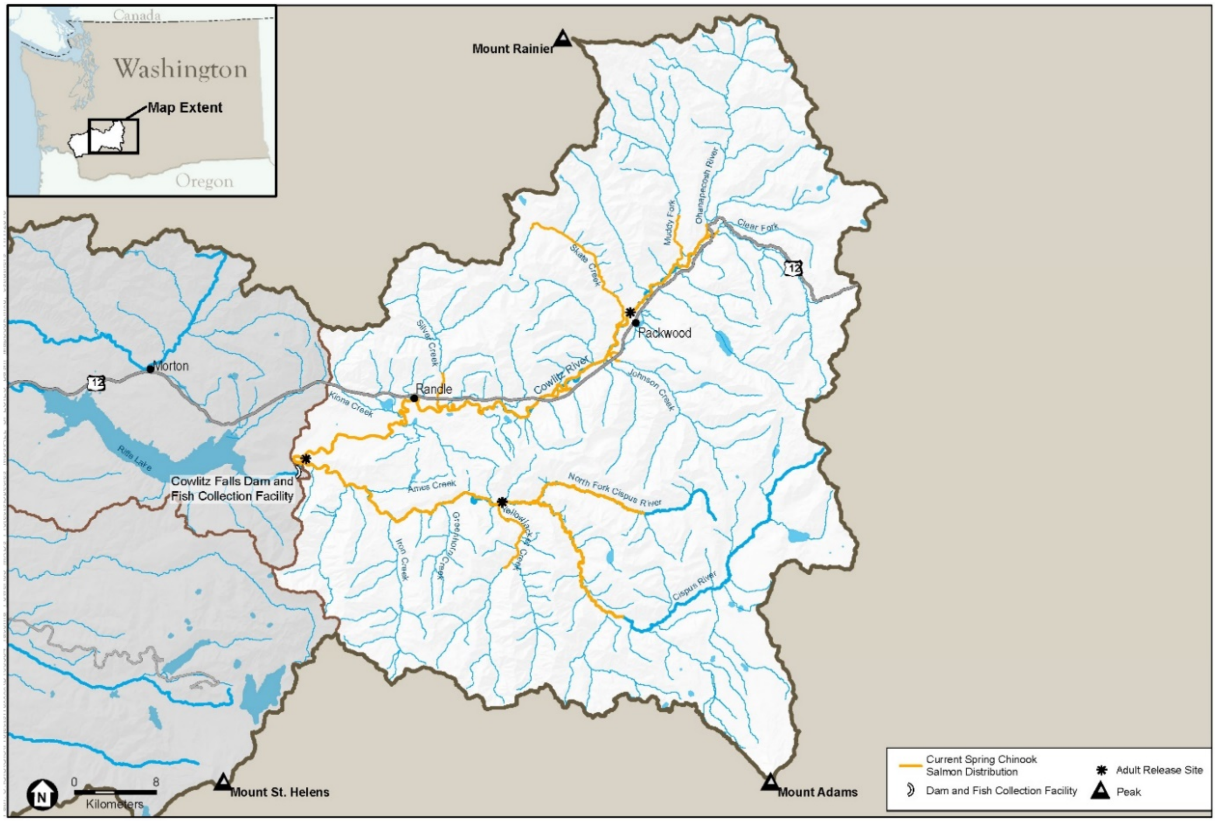

Figure 4.1-1. Distribution of spring Chinook Salmon in the Upper Cowlitz Subbasin.

During the first year of this FHMP period, we will develop a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. The long-term goal is for all hatchery production to come from the Integrated Hatchery Program, which will support both the recovery of Cowlitz River basin spring Chinook Salmon populations and provide for lost harvest opportunities. In the interim, the Segregated Hatchery Program and management practices from 2019 will continue, until the Transition Plan is developed and approved with support and input from the FTC. For additional information on the Transition Plan, see Chapter 12 and Appendix B.

4.1.2. Population Description

The Upper Cowlitz Subbasin spring Chinook Salmon population includes all spring Chinook Salmon that occupy the Cispus River and upper Cowlitz River and all of their tributaries above Cowlitz Falls Dam (Figure 4.1-1). Spring Chinook Salmon from the Segregated Hatchery Program at Cowlitz Salmon Hatchery contribute to this population through the transport and release of hatchery-origin adults in the Upper Cowlitz Subbasin to supplement natural production during the current Recolonization phase of recovery. This combined population in the Upper Cowlitz Subbasin is currently the only spring Chinook Salmon population remaining of the three populations (Cispus, upper Cowlitz, and Tilton rivers) that historically inhabited the Cowlitz Basin upstream of the Toutle River (NOAA Fisheries 2004).

This population was found to be “Depressed” (LCFRB 2010) and, as part of the lower Columbia River ESU, was listed as threatened under the ESA in 2005, and reaffirmed in 2011 and 2016. Because this population is classified as a Primary population for recovery of the

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lower Columbia River ESU, it must attain its minimum viability abundance targets for the ESU to be considered recovered (LCFRB 2010). Although hatchery-origin adult returns from the Segregated Hatchery Program are relatively abundant, returns of natural-origin adults remain well below the minimum viability abundance target of 3,600 natural-origin adults spawning in the Upper Cowlitz Subbasin (Table 4.1-1), requiring continued supplementation of natural production through the transport and release of hatchery-origin adults to the Upper Cowlitz Subbasin (Figure 4.1-2).

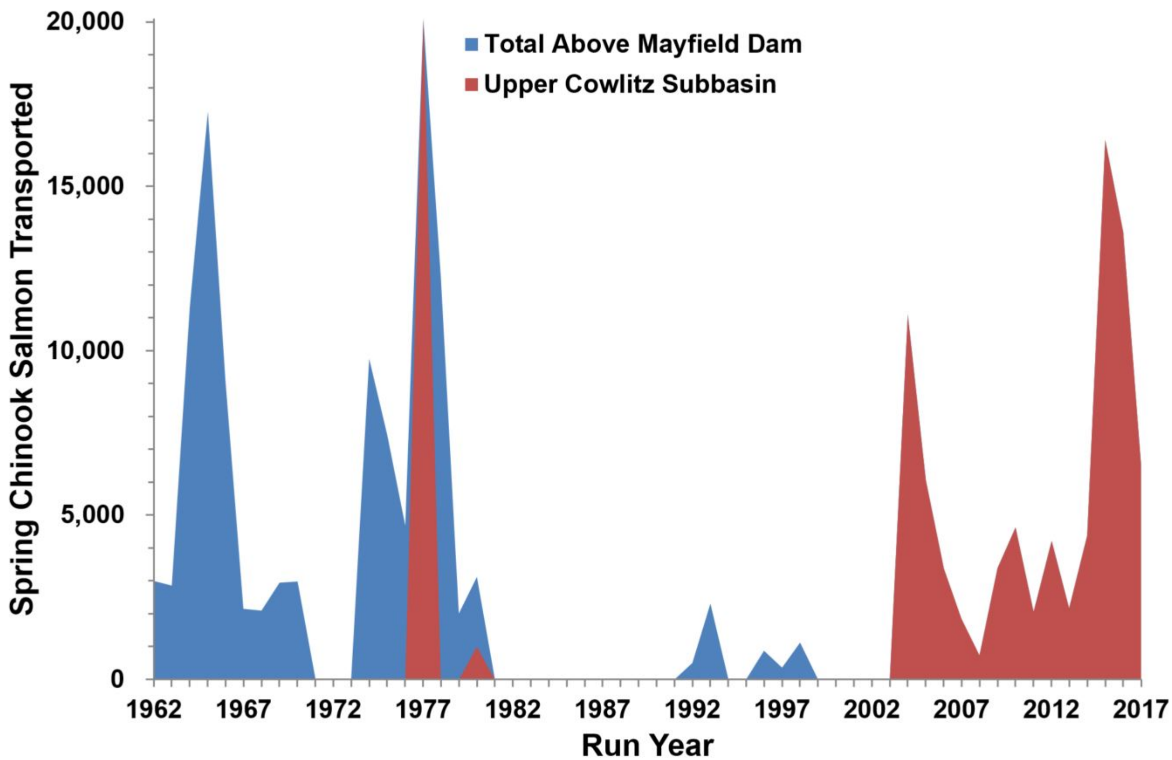

Figure 4.1-2. Numbers of total spring Chinook Salmon transported above Mayfield Dam and specifically to the Upper Cowlitz Subbasin, 1962-2017. Note: specific destination of the salmon was not documented in all years. Data are from WDFW annual reports and Tacoma Power data.

4.1.3. Natural Production

4.1.3.1. Abundance

Two critical monitoring metrics for salmon management are the numbers that return at maturation and their disposition (Figures 4.1-2 and 4.1-3; Table 4.1-1). Spring Chinook Salmon that survive to begin their return migration may be harvested in ocean, Columbia River, or lower Cowlitz River fisheries. Those escaping harvest may return to the Barrier Dam Adult Facility and be used as broodstock or be transported upstream to the natural spawning grounds, where they may also be recovered and counted in fisheries or as carcasses on the spawning grounds. They may also die prior to spawning from predation or disease and never be recovered, or they may remain in the Lower Cowlitz Subbasin and attempt to spawn there. Monitoring these dispositions allows us to evaluate population health, productivity, and progress toward recovery.

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Table 4.1-1. Estimated mean, minimum, and maximum numbers of all adult hatchery- and natural-origin adult spring Chinook Salmon from the Upper Cowlitz Subbasin population that could be accounted for at recovery locations, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	14,145	4,070	36,233
Harvest[2]	7,306	1,453	19,747
Ocean harvest	2,761	616	8,656
Columbia River harvest	469	117	1,525
Lower Cowlitz River harvest	3,712	550	9,199
Upper Cowlitz Subbasin harvest	365	12	1,408
Total Return to Cowlitz River[3]	13,998	3,180	26,052
Remain in Lower Cowlitz Subbasin	746	230	1,273
Return to the Barrier Dam Adult Facility	6,458	1,884	17,318
Collected for Broodstock	1,459	906	2,146
Transported to Upper Cowlitz Subbasin	4,538	475	14,790
Spawners in Upper Cowlitz Subbasin[4]	3,266	347	10,446
Natural-origin			
Total Run[1]	240	102	554
Harvest[2]	62	14	158
Ocean harvest	49	9	131
Columbia River harvest	6	0	31
Lower Cowlitz River harvest	6	0	22
Upper Cowlitz Subbasin harvest	1	1	2
Total Return to Cowlitz River[3]	185	80	419
Remain in Lower Cowlitz Subbasin	0	0	0
Return to the Barrier Dam Adult Facility	180	80	397
Collected for Broodstock	0	0	0
Transported to Upper Cowlitz Subbasin	178	70	397
Spawners in Upper Cowlitz Subbasin[4]	140	55	314
Combined Hatchery- and Natural-origin			
Total Run[1]	14,525	4,317	36,760
Harvest[2]	7,404	1,507	19,921
Ocean harvest	2,840	641	8,767
Columbia River harvest	479	123	1,581
Lower Cowlitz River harvest	3,720	551	9,209
Upper Cowlitz Subbasin harvest	366	13	1,410
Total Return to Cowlitz River[3]	11,207	3,374	26,412
Remain in Lower Cowlitz Subbasin	849	230	1,359
Return to the Barrier Dam Adult Facility	6,638	1,964	17,511
Collected for Broodstock	1,459	906	2,146
Transported to Upper Cowlitz Subbasin	4,716	555	14,983
Spawners in Upper Cowlitz Subbasin[4]	3,406	428	10,598

[1] Sum of all harvest in fisheries below Mayfield Dam, those remaining in the Lower Cowlitz Subbasin, and returns to the Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries.
[3] Sum of lower Cowlitz River harvest, those remaining in the Lower Cowlitz Subbasin, and returns to the Barrier Dam Adult Facility.
[4] Estimated by subtracting estimated harvest loss and multiplying by estimated fallback (12%) and pre-spawn mortality (10%) rates from the numbers transported.

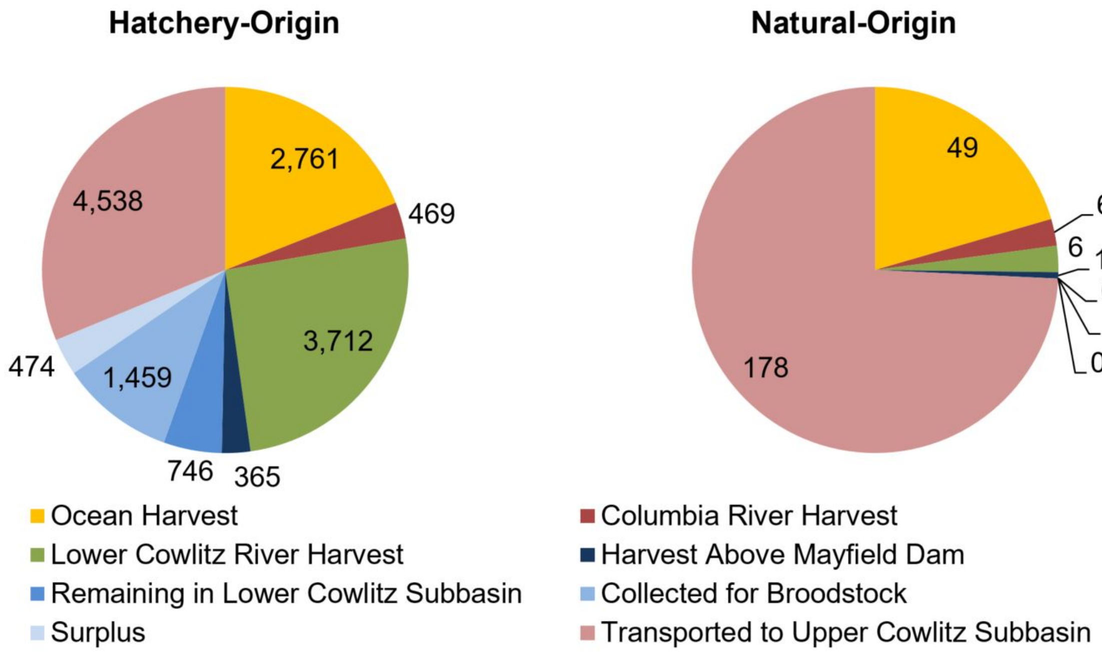

Figure 4.1-3. Mean numbers and proportions of hatchery- and natural-origin adult Upper Cowlitz Subbasin spring Chinook Salmon caught in ocean, Columbia River, or lower Cowlitz River fisheries, or that were transported above Cowlitz Falls Dam (and were harvested or remained in the Upper Cowlitz Subbasin), 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

The minimum viability abundance target for the Upper Cowlitz Subbasin spring Chinook Salmon population is a total annual abundance of 3,600 natural-origin adults spawning in nature in the Upper Cowlitz Subbasin - 1,800 in each of the Cispus and Upper Cowlitz subbasins (LCFRB 2010). Only natural-origin spring Chinook Salmon that are captured at the Barrier Dam Adult Facility, transported to the Upper Cowlitz Subbasin, and survive to spawn in nature in the Upper Cowlitz Subbasin are counted toward the minimum viability abundance target.

Data that are critical to monitoring the Upper Cowlitz Subbasin spring Chinook Salmon population have been only sporadically collected and are incomplete. Natural production estimates for juveniles are only collected at Cowlitz Falls Fish Facility, where collection efficiency has historically been poor and the data have been confounded by the presence of fall Chinook Salmon in some years, which were released into the Upper Cowlitz Subbasin (2010-2016); thus, trends in juvenile spring Chinook Salmon abundance and survival are difficult to discern. Second, adult returns have not been reconstructed by brood year. The ability to evaluate abundance and survival will improve due to the cessation of fall Chinook Salmon releases into the Upper Cowlitz Subbasin and improved juvenile Chinook Salmon collection efficiency at Cowlitz Falls Fish Facility. Improvements in the monitoring program may enable full reconstructions of each brood year.

Monitoring the trend in smolt-to-adult survival is more readily achieved because the numbers of natural-origin smolts released into the lower Cowlitz River and adults collected at the Barrier Dam Adult Facility and transported above Cowlitz Falls Dam are known. From 2007-2017, a mean of 305 adult natural-origin Spring Chinook Salmon escaped the ocean and Columbia River fisheries and entered the Cowlitz River and 169 returned to the Barrier Dam

Adult Facility. A mean of 178 adult natural-origin spring Chinook Salmon were transported to the Upper Cowlitz Subbasin, where we estimate that an annual mean of 1 natural-origin salmon died due to post-hooking mortality. Spawning ground surveys to estimate spawner abundance have not been conducted in the Upper Cowlitz Subbasin; however, by using our estimate of incidental mortality and assumed fallback (over Cowlitz Falls Dam; 12%) and pre-spawn mortality (10%) rates, we estimate that a mean of 140 of those transported survived to spawn. Some spring Chinook Salmon spawn naturally in the Lower Cowlitz Subbasin but these salmon are not considered part of the Upper Cowlitz Subbasin population and, therefore, are not included in abundance estimates.

4.1.3.2. Harvest

Natural-origin Upper Cowlitz Subbasin spring Chinook Salmon contribute to important commercial, sport, and tribal fisheries in the Pacific Ocean, lower Columbia River, and within the Cowlitz Basin. From 2007-2017, an annual mean of 62 natural-origin spring Chinook Salmon were harvested, comprising 26% of the total run, with 80%, 9%, 9%, and 2% of the total harvest/incidental mortality occurring in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries, respectively. Columbia River and Cowlitz spring Chinook fisheries are mark selective, meaning that non-adipose fin-clipped (assumed to be natural-origin) spring Chinook Salmon must be released and any harvest mortality is due to incidental mortality. From 2007-2017, a mean of 4% of the total Cowlitz Basin natural-origin spring Chinook Salmon entering the Cowlitz River were lost to indirect mortality from sport angling.

4.1.3.3. Disposition

All unmarked salmon that are collected at the Barrier Dam Adult Facility are assumed to be natural-origin that originated from the Upper Cowlitz Subbasin and are transported above Cowlitz Falls Dam. From 2007-2017, a mean of 180 natural-origin spring Chinook Salmon adults returned to the Barrier Dam Adult Facility. Of those, none were kept for broodstock, so a mean of 178 natural-origin Upper Cowlitz Subbasin adult spring Chinook Salmon were transported and released into the Upper Cowlitz Subbasin (Figures 4.1-2 and 4.1-3; Table 4.1-1).

4.1.3.4. Spawning in Nature

Upper Cowlitz Subbasin natural-origin spring Chinook Salmon abundance has been far below its minimum viability abundance target of 3,600 natural-origin adults spawning in nature (Figure 4.1-3; Tables 4.1-1 and 4.1-2). From 2007-2017, a mean of 178 natural-origin spring Chinook Salmon adults were transported to the Upper Cowlitz Subbasin. Of these, a mean of 1 (0.8%) was removed by sport fisheries in the Upper Cowlitz Subbasin; using assumed fallback (12%) and pre-spawn mortality (10%) rates, we estimate that 140 (79%) survived to spawn.

4.1.3.5. Smolt Production

In 2017 and 2018, 56,049 and 25,920 age-1 (sub-yearling) and 296 and 1,150 age-2 (yearling) spring Chinook Salmon were captured at Cowlitz Falls Fish Facility, which captures juveniles emigrating from the Upper Cowlitz Subbasin. Collection efficiency was estimated to be 46.2% and 65.7%, respectively, so we estimated that 121,318 and 39,452 age-1 spring Chinook Salmon were produced from the 2016 and 2017 brood years, respectively, and 641 and 1,750 age-2 spring Chinook Salmon were produced from the 2015 and 2016 brood years in the Upper Cowlitz Subbasin.

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Table 4.1-2. Mean, minimum, and maximum hatchery and natural spawning metrics for Upper Cowlitz Subbasin spring Chinook Salmon, 2007-2017 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2007-2017 Spawn/Brood Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery			
Adults Collected for Broodstock	1,459	906	2,146
Hatchery-origin	1,459	906	2,146
Natural-origin	0	0	0
Pre-spawn Survival Rate	90%	86%	96%
Adults Spawned	1,317	814	1,886
Hatchery-origin	1,317	814	1,886
Natural-origin	0	0	0
Total Green Eggs	1,864,239	1,072,235	2,772,220
Mean Fecundity	2,791	1,355	3,663
Smolts Released	1,424,865	881,377	1,990,454
Green Egg-to-Smolt Survival	77%	72%	82%
Smolt Productivity (smolts / spawner)	1,144	570	1,545
Nature			
Spawners*	3,406	428	10,598
Hatchery-origin	3,266	347	10,446
Natural-origin	140	55	314
Smolts Produced	Unknown - fall Chinook Salmon were present		
Smolt Productivity (smolts / spawner)			

* Calculated as Number Transported - Estimated Harvest - 12% Fallback - 10% pre-spawn mortality.

From 2007-2017, a mean of 4,716 (combined hatchery- and natural-origin) spring Chinook Salmon adults were released into the Upper Cowlitz Subbasin. However, from 2010-2015, a mean of 3,983 adult fall Chinook Salmon, along with a mean of 4,894 adult spring Chinook Salmon (a mean of 55% of the Chinook Salmon released were fall Chinook Salmon) were also released into the Upper Cowlitz Subbasin. During 2011-2016, a mean of 14,463 juveniles were captured at the Cowlitz Falls Fish Facility, of which 13,930 (96.0%) were age-1 and 533 (4.0%) were age-2. However, offspring of fall and spring Chinook Salmon are not distinguishable; therefore, the years following transportation of adult fall Chinook Salmon to the Upper Cowlitz Subbasin spring Chinook Salmon sub-yearling production estimates are confounded by the presence of the fall Chinook Salmon juveniles captured at the same time. Therefore, we do not know how many juvenile spring Chinook Salmon were produced in the Upper Cowlitz Subbasin from the 2010-2016 spawn years.

4.1.3.6. Natural-origin Survival and Productivity

Survival and productivity are key metrics for monitoring populations. However, currently neither SAR nor productivity can be calculated for the Upper Cowlitz Subbasin spring Chinook Salmon population with confidence. Smolt abundance estimates are accurate, based on the numbers captured at Cowlitz Falls Dam and transported to and released into the lower Cowlitz

River, but returns have not been documented by age into a shared database for analysis and reporting, so a full run reconstruction of each brood year is not possible at this time. Additionally, no spawning ground surveys to estimate spawner abundance have been conducted to document survival of adults from release to spawn, so the number of spawners can only be estimated for this timeframe during the upcoming FHMP period.

4.1.3.7. Age Composition

Age composition of natural-origin salmon cannot be calculated from available data at this time because the data for adult returns to the Barrier Dam Adult Facility, and other recovery locations, have not been compiled into a single database for analysis and reporting. From ISIT data (provided by WDFW on 28 June 2019), jacks comprised 13% and adults 87% of the natural-origin salmon that returned to the Barrier Dam Adult Facility from 2007-2017. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

4.1.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals (quantity and quality) are met, evaluate the effectiveness of the program, and understand the magnitude of hatchery influence on the natural population (see Section 4.0.9).

Most hatchery-origin smolts are released directly from Cowlitz Salmon Hatchery and support both the recovery of the Upper Cowlitz Subbasin population and harvest below and above Mayfield Dam. However, between 2000 and 2018, a mean of 55,156 additional parr per year have been provided to the Friends of the Cowlitz for rearing and release as 90 g smolts from their acclimation pond, near Toledo, Washington (Figure 4.0-1), for the sole purpose of supporting harvest below Mayfield Dam and were not expected to return to the Barrier Dam Adult Facility. Cowlitz Basin hatchery-origin spring Chinook Salmon is an endemic stock that was derived from the native populations in the Tilton and Upper Cowlitz subbasins. This hatchery population is part of the lower Columbia ESU and serves as a temporary gene bank for the reintroduction of spring Chinook Salmon above the Cowlitz River dams.

4.1.4.1. Abundance

From 2007-2017, a mean of 13,998 hatchery-origin spring Chinook Salmon escaped the ocean and Columbia River fisheries and returned to the Cowlitz River. Of those, 6,458 hatchery-origin salmon were collected at the Barrier Dam Adult Facility and a mean of 4,538 were transported to the Upper Cowlitz Subbasin, where we estimate that means of 365 were harvested, 545 (12%) fell back over Cowlitz Falls Dam, 363 (10%) died before spawning, and 3,266 survived to spawn.

4.1.4.2. Harvest

Hatchery-origin Cowlitz Subbasin spring Chinook Salmon contribute to important commercial, sport, and tribal fisheries in the Pacific Ocean, lower Columbia River, and within the Cowlitz Basin. From 2007-2017, annual mean total harvest of hatchery-origin spring Chinook Salmon was 7,306 adult salmon, comprising 52% of the total run, with 38%, 6%, 51%, and 5% of the total harvest occurring in the ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries, respectively (Figure 4.1-3; Table 4.1-1). From 2007-2017, a mean of 29% of the hatchery-origin salmon entering the Cowlitz River were harvested.

4.1.4.3. Disposition

From 2007-2017, a mean of 6,458 hatchery-origin salmon returned to the Barrier Dam Adult Facility. A mean of 1,459 were collected for broodstock. Hatchery-origin spring Chinook Salmon returning to the Barrier Dam Adult Facility that are in excess of broodstock requirements may be transported above Cowlitz Falls Dam to supplement natural spawning and provide harvest opportunities in the Upper Cowlitz Subbasin or surplused for fish management purposes. From 2007-2017, a mean of 4,538 hatchery-origin spring Chinook Salmon were transported to the Upper Cowlitz Subbasin, representing 32% of those returning to the Cowlitz River (Figures 4.1-3 and 4.1-4; Table 4.1-1). A mean of 365 (8%) were harvested in sport fisheries in the Upper Cowlitz Subbasin (personal communication, T. Wadsworth, WDFW). No spawning ground surveys have been conducted to estimate survival to spawning; however, by estimating fallback (12%) and pre-spawn mortality (10%) rates, we estimate that 3,266 (78%) survived to spawn. A mean of 658 hatchery-origin adult spring Chinook Salmon were surplused each year.

4.1.4.4. Hatchery Spawning

From 2007-2017, an annual mean of 1,459 adult hatchery-origin spring Chinook Salmon were retained for broodstock, comprising 23% of those returning to the Barrier Dam Adult Facility (Figure 4.1-3; Table 4.1-1). Mean pre-spawn survival was 90% and a mean of 1,317 adults were spawned over those years.

4.1.4.5. Hatchery Rearing

The Upper Cowlitz Subbasin spring Chinook Salmon population is currently in the Recolonization phase and production from the Segregated Hatchery Program supplements the natural population through the transport and release of hatchery-origin adults to spawn naturally in the upper subbasin. From 2007-2017, a mean of 1,272,801 age-2 (yearling) hatchery-origin smolts were released into the lower Cowlitz River, along with 334,540 age-1 (sub-yearling) salmon from 2007-2011. Hatchery production will be rigorously monitored by documenting disease, origin, sex, and age of salmon retained for broodstock and those spawned, fecundity, fertility, and survival between life stages, and the numbers released at all life stages.

4.1.4.6. Hatchery-origin Survival and Productivity

Brood years 2005-2012 (released in 2007-2014) had a mean TSAR of 1.13% and a mean SAR of 0.63%. An annual mean of 4,143 adults returned to the Barrier Dam Adult Facility from brood years 2007-2011 (the years for which we have a full complement of returns). All data are not available for calculating productivity. As described in Chapter 1, the data presented in this FHMP are preliminary, pending a full QA/QC review by the M&E Subgroup for accuracy and source. Moving forward, the intended approach is to develop standardized methods for each measure or calculation to the degree possible.

4.1.4.7. Age Composition

As noted above, age composition cannot currently be fully calculated from the data in ISIT because they are not compiled by age or brood year. Age classes are only characterized as “jacks (<59 cm)” or “adults (>59 cm)” and these data are only available for returns to the Barrier Dam Adult Facility, not for any other recovery locations. However, the data from CWTs in the RMIS database (www.rmis.org) do provide reliable age composition data for the tagged hatchery-origin salmon.

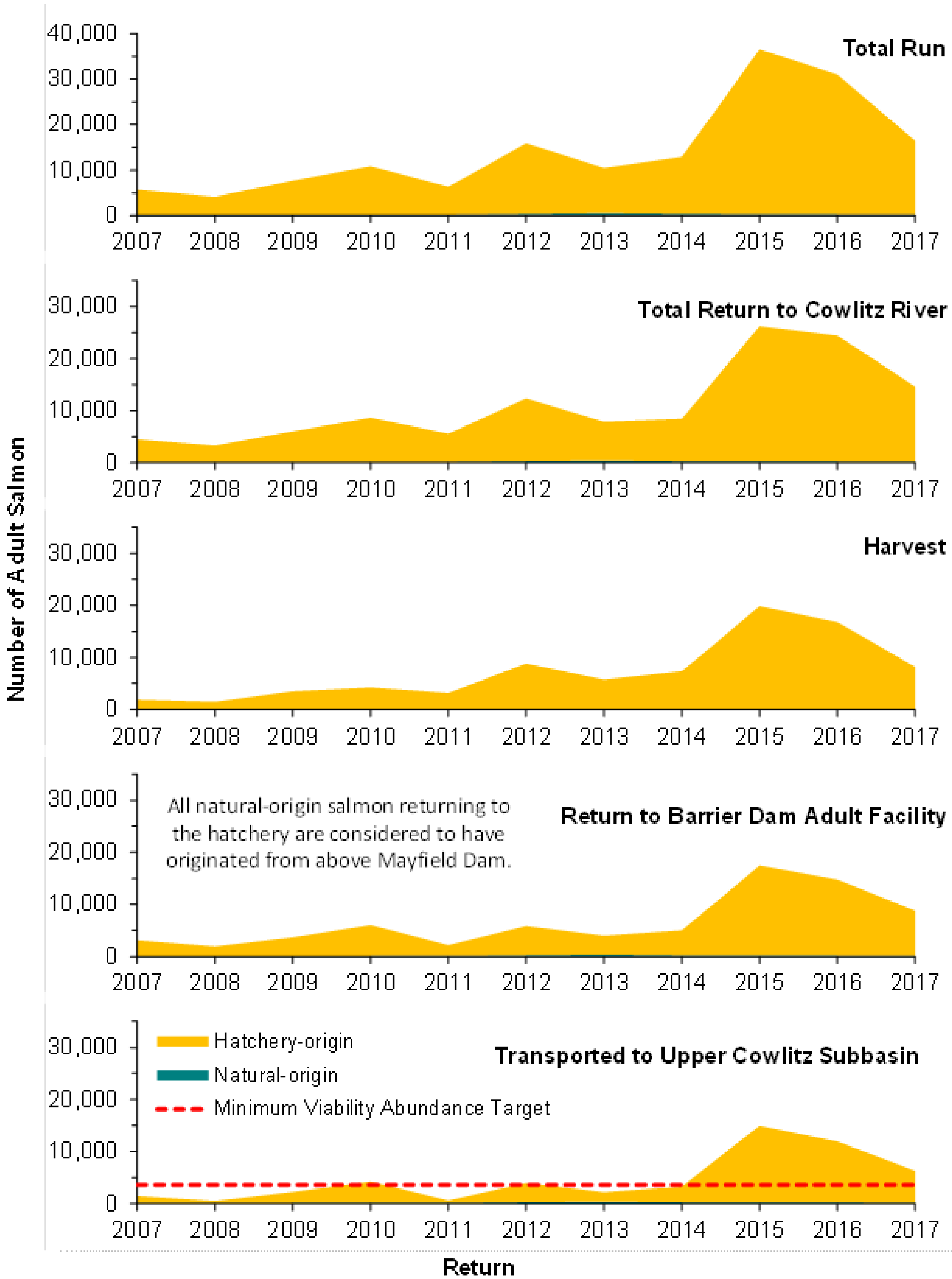

Figure 4.1-4. Estimated total run size for adult natural- and hatchery-origin Upper Cowlitz Subbasin spring Chinook Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, and were transported above Cowlitz Falls Dam, 2007-2017. Note: numbers of natural-origin adults may be too small to be visible. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

These data show that, for the 1999-2012 brood years, a mean of 10% of the hatchery-origin salmon collected at the Barrier Dam Adult Facility were recovered at age-2, 26% at age-3, 52% at age-4, 11% at age-5, and 0.3% at age-6 (ISIT). In comparison with natural-origin age composition during the 2007-2017 run years (Section 4.1.3.7), a mean of 34% of the hatchery-origin salmon returned as jacks and 66% returned as adults. During this FHMP period, this information will be combined with other monitoring data within a single analysis and reporting database.

4.1.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in this metric can indicate an increase or decrease in the effect of hatchery-origin salmon on the natural population once this program transitions into the Local Adaptation phase of recovery. From 2007-2017, mean pHOS was 0.921 (0.794-0.986), based on the numbers of hatchery- and natural-origin salmon transported above Cowlitz Falls Dam minus the estimated harvest and assumed 12% fallback and 10% pre-spawn mortality. The Segregated Hatchery Program uses 100% hatchery-origin salmon for broodstock, so mean pNOB = 0 and mean PNI = 0 for the Upper Cowlitz Subbasin spring Chinook Salmon population. HSRG guidelines (HSRG 2009) Primary populations with segregated hatchery programs are that pHOS <0.05. For Primary populations with integrated hatchery programs, pHOS should be <0.3 and pNOB greater than two times pHOS, so that PNI >0.67. During this FHMP period, we will evaluate the appropriate pHOS targets and associated fish management applications, so they may be considered in relation to current and upcoming recovery phases.

4.1.6. Future Management

The Upper Cowlitz Subbasin spring Chinook Salmon population is designated as a Primary population for achieving MPG and ESU recovery goals, with a minimum viability abundance target of 3,600 natural-origin spawners in nature (1,800 in each of the Cispus and upper Cowlitz rivers). Population viability remains at a rating of Very Low, with natural production being supplemented by Segregated Hatchery Program adults being transported to the Upper Cowlitz Subbasin (WDFW and LCFRB 2016).

During the interim period while the Transition Plan is being developed, the existing Segregated Hatchery Program will continue to produce approximately 1.8 million smolts to sustain harvest opportunities downstream of Mayfield Dam, while also continuing to provide additional adults to support the transport and reintroduction activities of spring Chinook Salmon above Cowlitz Falls Dam to supplement natural production. It is hoped that collection efficiency at Cowlitz Falls Dam will continue to improve so it is reasonable to expect natural-origin returns to increase.

4.1.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation goals and minimum viability abundance targets is evaluated through monitoring of standard fisheries management metrics (Table 4.1-3; Appendix A, Big Table Dataset). Prior to dam construction, the Upper Cowlitz Subbasin spring Chinook Salmon population had an historical abundance of about 29,800 salmon and currently has a minimum viability abundance target of 3,600 natural-origin adult spawners (Table 4.0-1 in Overview section). In 2016, the abundance and productivity of this population was rated as Very Low (WDFW and LCFRB 2016) and remains very far from meeting its minimum viability abundance target (Figure 4.1-3; Table 4.1-1).

Table 4.1-3. Recovery phase targets for Upper Cowlitz Subbasin spring Chinook Salmon.

Recovery Designation: Primary

Current Recovery Phase: Recolonization

Target Metric	RECOVERY PHASE				
	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	400[1]	900[1]	1,800[1]	TBD[1]	168[2]
Smolt Abundance (below hatchery)	20,000[3]	45,000[3]	90,000[3]	TBD[3]	23,982[4]
Smolt Passage Survival	40%	60%	70%	75%	26%
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Seg	Seg/Int	Int/Seg	Int	Seg
Broodstock to be Collected	1,250	1,250	1,250	1,250	1,825
Integrated Hatchery Program	0	250	625	1,250	0
Hatchery-Origin	0	175	313	0	0
Natural-Origin	0	75	313	1,250	0
Segregated Hatchery Program	1,250	1,000	625	0	1,825
Smolts to be Produced	1,800,000	1,800,000	1,800,000	1,800,000	1,385,715
Integrated Hatchery Program	0	360,000	900,000	1,800,000	0
Segregated Hatchery Program	1,800,000	1,440,000	900,000	0	1,385,715
Total Hatchery Returns	17,000	17,000	17,000	17,000	?
Total Smolt-to-Adult Survival	0.94%	0.94%	0.94%	0.94%	0.717%[5]
Proportionate Natural Influence					
pHOS (<)					
Total	1	0.5	0.3	0.3	0.944
Integrated Hatchery Program	1	0.5	0.3	0.3	NA
Segregated Hatchery Program	1	0.05	0	0	0.944
pNOB (>)	0	0.3	0.6	1	0
PNI (>)	0	0.38	0.67	0.77	0
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	50%	50%	40%	30%	0%

1 No minimum viability abundance target has been set for these populations; the numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.
2 Adults transported above Cowlitz Falls Dam minus estimated harvest, 12% fallback, and 10% pre-spawn mortality.
3 Based on 2% SAR.
4 Caught at Cowlitz Falls Fish Facility and includes some fall Chinook Salmon in 2014-2016.
5 Brood years 2008-2012.

Moving forward, in the near-term, the FTC will continue the Segregated Hatchery Program, while developing a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. Decision Rules for this new Integrated Hatchery Program will be developed, based on adult abundance and VSP metrics.

- **Long-term Goals**: The long-term goal is for all hatchery production to come from the Integrated Hatchery Program, which will support both the recovery of Cowlitz River basin spring Chinook Salmon populations and provide for lost harvest opportunities.
- **FHMP Goals:** The goals for this program during this FHMP period as defined by the FTC focus on population recovery by increasing the abundance of natural-origin spring Chinook Salmon in the Upper Cowlitz Subbasin, based on the following:
  - Maximizing the total number of spring Chinook Salmon spawning in the Upper Cowlitz Subbasin by using an Integrated Hatchery Program to supplement natural production.
  - Improve Fish Passage Survival at Cowlitz Falls Dam so that it is not a limiting factor:
    - Improve juvenile collection and Fish Passage Survival
    - Maintain high survival of the collected smolts.
  - Develop a disposition plan during the first year of the FHMP period that:
    - Cowlitz Basin program needs, including both recovery and harvest objectives, will be prioritized by developing a surplus plan as part of the Spring Chinook, Transition Plan to define fish/egg disposition and harvest objectives, minimum escapement targets, hatchery surplus disposition, and associated triggers. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will clearly be communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.
    - Identifies decision point triggers and objectives for salmon/egg dispositions and harvest.
    - Defines surplus.
    - Balances when salmon and/or their offspring are surplus and no longer critical to Cowlitz Basin restoration needs.
  - The Transition Plan for spring Chinook Salmon will be developed within 1 year of completion of this FHMP and will address such factors as monitoring & evaluation strategies for the optimal rearing strategies to improve SAR.
  - Improve monitoring, evaluation, and data collection efforts, including origin, age, sex and genetic samples of all spring Chinook Salmon collected at the Barrier Dam Adult Facility and sampled on spawning grounds. This allows for accurate assessment of spring Chinook Salmon:
    - Returning to the Barrier Dam Adult Facility
    - Retained as broodstock.
    - Transported and released upstream of Mayfield Dam.
    - Hatchery surplus.
    - Hatchery strays to/from outside of the Cowlitz Basin.
    - Actual spawners in nature.

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- Reduce the abundance of hatchery surplus by increasing hatchery-origin harvest without a concomitant increase in natural-origin incidental mortality.
- Estimate rates of harvest.

4.1.6.2. Management Targets

Reestablishing a self-sustaining population will require natural spawning by a sufficient number of natural-origin salmon and for their survival to exceed replacement (spawner-to-spawner productivity >1). Currently, low natural-origin abundance (due to low smolt production, marginal collection efficiency, and natural-origin harvest impacts) prevents this population from meeting its minimum viability abundance targets.

- **Natural Production:** The goal of population restoration is to develop self-sustaining, naturally reproducing populations at harvestable abundances. The construction of additional collection facilities with improved operational capacity at Cowlitz Falls Dam has resulted in an increase in collection efficiency in 2017 and 2018, resulting in an increase in natural-origin adult abundance, beginning in 2021. Likewise, the ability to estimate natural production will improve as collection efficiency improves at downstream passage facilities. Counts of salmon transported to the Upper Cowlitz Subbasin are considered to be reliable numbers but harvest estimates are imprecise and pre-spawn mortality (a critical measure for estimating the number of actual spawners) has not been estimated for salmon spawning in nature (neither hatchery- nor natural-origin), so actual pHOS is currently only an estimate. As part of this FHMP, Tacoma Power and the FTC will continue to implement a rigorous monitoring program that is focused on evaluating population status and program effectiveness based on regionally accepted VSP parameters.

  During the current Recolonization phase of recovery, natural production in the Upper Cowlitz Subbasin has relied primarily on spawning by transported hatchery-origin adults. We are accepting the resulting near-term increase in pHOS (>0.3) in order to receive the expected demographic boost that the population needs because FPS has historically been too low to sustain the population. As such, hatchery returns that are not used for Upper Cowlitz Subbasin hatchery production will continue to be used to supplement natural production in the Upper Cowlitz Subbasin during this FHMP period as characterized through the Transition plan and each Annual Program Review. As natural-origin productivity and abundance increase, reductions in the ratio of hatchery-origin to natural-origin adults into the Upper Cowlitz Subbasin, reductions in natural-origin exploitation, and/or increased hatchery-origin harvest will be considered to reduce pHOS once recovery phase criteria have been established and the population is determined to be in the Local Adaptation phase.

  - **Abundance – Transport and Natural Spawning:** Abundance is the primary VSP metric for monitoring natural populations. We will focus our monitoring of natural-origin production on documenting the total number of hatchery- and natural-origin salmon released, their respective pre-spawn mortality rates, the number that survive to spawn, and pHOS. These metrics are critical for achieving recovery. The numbers of hatchery- and natural-origin adults transported to the Upper Cowlitz Subbasin will be managed to maximize natural-origin production.
  - **Smolts Produced in Nature:** Natural-origin smolt production from the Upper Cowlitz Subbasin is not well known. We will continue to follow the adaptive management plan process to guide attempts to increase collection efficiency at the

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Cowlitz Falls Fish Facility, and increase the numbers of natural-origin smolts released downstream and, subsequently, of adults returning.

- **Smolt-to-Adult Survival:** Smolt abundance has been low and uncertain and returns of mature natural-origin salmon have not been documented by age in a single consolidated database, so SAR cannot currently be estimated. To monitor this index through our M&E Program, we will continue to collect scale samples from recoveries at sampling sites and consolidate the data for reporting and analysis.
- **Productivity (Recruits/Spawner):** Productivity (adult natural-origin F_1 recruits / F_0 spawner) is a key metric for monitoring natural populations, so collection of the necessary data is critical. However, the necessary data have not been collected. We will monitor this index as the data become available through our M&E Program.
- **Age Composition:** Age composition cannot be calculated from available data at this time because the data for adult returns to the Barrier Dam Adult Facility, and other recovery locations, have not been compiled into a single database for analysis and reporting. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.
- **Habitat:** Activities by Tacoma Power and key partners to protect and enhance habitat in the Upper Cowlitz Subbasin are expected to benefit smolt production and the subsequent return of natural-origin salmon, but it is difficult to monitor these benefits due to a number of confounding factors.

- **Hatchery Production:** During recovery efforts to date this population (which is in the Recolonization phase of recovery) is building abundance. As such, hatchery influences on the Upper Cowlitz Subbasin spring Chinook Salmon population have consisted of the transport and release of relatively large numbers of hatchery-origin adults to spawn naturally (mean pHOS = 0.921) and there has been no natural-origin salmon in the broodstock, meaning that both pNOB and PNI equal zero. Given the low returns of natural-origin adults and the abundance of hatchery-origin adults released in the subbasin, pHOS consistently exceeds minimum viability abundance targets and natural influence on the Upper Cowlitz Subbasin population has been minimal. During this FHMP period, we will evaluate the appropriate pHOS targets and associated fish management applications, so they may be considered in relation to current and upcoming recovery phases.

  To give the population the demographic boost that it needs, we will continue transporting hatchery- and natural-origin adults to the Upper Cowlitz Subbasin over the period of this FHMP. In the near-term, the FTC will continue the Segregated Hatchery Program, while developing a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. Decision Rules for this new Integrated Hatchery Program will be developed, based on adult abundance and VSP metrics (Table 4.1-3). The long-term goal is for all hatchery production to come from the Integrated Hatchery Program, which will support both the recovery of Cowlitz River basin spring Chinook Salmon populations and provide for lost harvest opportunities.

  We will also use best management practices for well-managed hatchery programs as a critical component to our strategy (Piper et al. 1982; IHOT 1995; Flagg and Nash 1999; Wedemeyer 2002; Williams et al. 2003; Campton 2004; Galbreath et al. 2008; HSRG 2004, 2009, 2017).

  - **Abundance:** The existing Segregated Hatchery Program for Cowlitz Salmon Hatchery spring Chinook Salmon has a goal of producing an annual run of 17,000

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adult hatchery-origin spring Chinook Salmon (WDFW 2014a). From 2007-2017, this was only achieved in 2015 (36,223) and 2016 (30,741). As we implement an Integrated Hatchery Program, we will focus our monitoring of hatchery-origin abundance on the numbers that are harvested and that return to the Cowlitz River and to the Barrier Dam Adult Facility, which are critical for calculating SAR and TSAR, as well as the number that spawn in nature, for monitoring pHOS and PNI. We should also recognize that the observed survival rates may be lower than was anticipated at inception of these programs, especially as ocean conditions fluctuate, and that our hatchery production goals may be insufficient to achieve the expected total return of 17,000 adults.

- **Broodstock Collection and Spawning:** We will collect all broodstock from salmon that return to the Barrier Dam Adult Facility and will ensure that both natural-origin males and females are incorporated into the broodstock for the Integrated Hatchery Program, once initiated. The currently low abundance of natural-origin returns will initially constrain natural-origin broodstock collection and spawning decisions.

  We will employ hatchery best management practices for broodstock collection and spawning to ensure that the broodstock represents the entire population in age and run-timing and to maximize genetic diversity of the F_1 generation. We will use spawning matrices for all hatchery spawning to maximize genetic diversity. Hatcheries, especially those with a conservation mandate, should use spawning matrices in which the gametes from every individual are mixed (approximately evenly) with those of at least two individuals of the opposite sex (Campton 2004) whenever total spawners are <200.

- **Strays and Spawning in Nature:** Upper Cowlitz Subbasin spring Chinook Salmon that stray could potentially spawn in lower Cowlitz River tributaries or other locations outside the Cowlitz Basin. Likewise, unmarked spring Chinook Salmon originating from the lower Cowlitz River or outside of the Cowlitz Basin could potentially return to the Barrier Dam Adult Facility, where they would be assumed to have originated from the Upper Cowlitz Subbasin. Spawning surveys, as well as examining CWT data for strays outside of the Cowlitz Basin, will be evaluated for their utility in improving our estimates of stray rates and our management of these salmon.

- **Surplus:** As part of the plan for developing the Integrated Hatchery Program, we will identify Decision Rules and triggers for management actions regarding the disposition of hatchery-origin salmon that are caught at the Barrier Dam Adult Facility but are not needed for broodstock. Surplus will be defined as it applies to these management triggers and these Decision Rules will be based on recovery and harvest objectives in the Cowlitz Basin to determine harvest rates and the disposition of surplus eggs/salmon. In the interim, the Segregated Hatchery Program and management practices from 2019 will continue, until the Transition Plan is developed and approved with support and input from the FTC. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will clearly be communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.

- **Smolt Production:** Spring Chinook Salmon hatchery-origin smolts will be reared at Cowlitz Salmon Hatchery. We will continue the Segregated Hatchery Program while developing a Transition Plan for integrating a portion of the hatchery production, and eventually moving to a fully Integrated Hatchery Program. Targets will be set during the period covered by this FHMP in coordination with the FTC. We will develop, test, and evaluate different rearing and release strategies to develop an optimum strategy for this population that will maximize survival, while minimizing the abundance of mini-jacks and jacks and maximizing the abundance of adults of age-5 and older.
- **Smolt-to-Adult Survival and Productivity:** SAR is a key metric for monitoring hatchery populations, especially those for which return abundance is lower than expected. We will collect scales and/or CWTs from, at least, a sample of recoveries at all collection sites. Additional data needs may include the rate of precocious maturation and the sex ratio of hatchery-origin salmon by age. We will monitor this index as the data become available, through our M&E Program.

  Population productivity (the number of F_1 generation recruits that survive to spawn for each F_0 generation spawner) is of less importance, but is still useful, for monitoring hatchery populations, where survival to the smolt stage is unnaturally high. Consideration for expanded data collection to include tags and scales at additional collection sites would allow us to estimate age and support calculations of productivity and monitoring of this metric over time through our M&E Program.
- **Age Composition:** Age composition cannot be calculated from available data at this time because the data for adult returns to the Barrier Dam Adult Facility, and other recovery locations, have not been compiled into a single database for analysis and reporting. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

  Given the high proportion of hatchery-origin mini-jacks (age-2) and both hatchery- and natural-origin jacks (age-3) as reported in ISIT and the potential for hatchery production to increase these rates in both the hatchery and in nature, we will more carefully monitor this trend. Samples of scales and tags will be regularly collected at collection sites to estimate the age of both hatchery- and natural-origin salmon to better characterize each cohort and more clearly understand the age composition of these salmon and the factors influencing their age at maturity. To reverse this trend in hatchery-origin salmon maturing precociously, we will evaluate our hatchery spawning and rearing practices. Large smolts tend to mature at a younger age (Bilton 1984; Martin and Wertheimer 1989; Morley et al. 1996; Feldhaus et al. 2016), so we will develop, implement, and evaluate alternative rearing strategies to decrease the abundance of mini-jacks and jacks and increase the abundance of age-5 and age-6 adults. Additionally, since there is a genetic component to age at maturity, we will consider re-using older (age-5+) males.

- **Harvest:** Although the high level of harvest/indirect mortality has not historically prevented us from meeting our hatchery production goals, in the future, harvest of natural-origin salmon will constrain the ability of managers to minimize pHOS and further our progress toward population recovery, which is defined by the numbers of natural-origin adults spawning in nature. Therefore, wherever possible, harvest management of the Upper Cowlitz Subbasin spring Chinook Salmon population should focus on minimizing the harvest of natural-origin salmon and consider potential negative impacts from introducing harvest on hatchery-origin salmon in the upper basin at each recovery phase prior to implementation. Hatchery-origin harvest outside of the Cowlitz Basin will be monitored using the CWT recovery and sampling rate data in the RMIS database and robust creel surveys in the Cowlitz Basin. Harvest in the Cowlitz Basin will be monitored with rigorous creel surveys and analysis of catch record cards.

- **Proportionate Natural Influence:** We propose to increase the influence of the natural environment on the Upper Cowlitz Subbasin spring Chinook Salmon population in two ways:
    - Moving forward, in the near-term, the FTC will continue the Segregated Hatchery Program, while developing a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program.
    - Developing criteria to determine when a shift between the current Recolonization phase to the Local Adaptation phase is appropriate. As natural-origin abundance increases, decrease pHOS by reducing the number of hatchery-origin adults transported to the Upper Cowlitz Subbasin.

4.1.6.3. Monitoring & Evaluation and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly to track the population's trajectory and variability, and includes the basic data required to operate a one-stage or two-stage life cycle model.

Monitoring and evaluation needs of the Upper Cowlitz Subbasin spring Chinook Salmon population are similar to other populations in the basin and include spawning ground surveys, accurate counts of hatchery releases and returns of both hatchery- and natural-origin salmon, adequate marking, and evaluation of alternative management and hatchery rearing strategies. To support recovery, monitoring programs are needed that are rigorous and that will allow for estimation, with confidence, of population abundance, as well as to identify ways to improve survival. Areas of interest specific to this population include the following:

- Monitoring for VSP and hatchery metrics is needed to evaluate recovery status and trends, including, but not limited to:
    - Estimates of total mature salmon abundance, by origin, age, and sex.
    - Estimates of numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
    - Returns to the Barrier Dam Adult Facility, by origin, age, and sex.

    - Improved harvest estimates of both hatchery- and natural-origin salmon, by age.
    - Numbers of salmon collected for broodstock and spawned, by origin, age, and sex.
    - Fecundity and fertility rates, survival rates between age classes, disease prevalence, and numbers of smolts produced at Cowlitz Salmon Hatchery.
- Determine hatchery- and natural-origin age at maturity by collecting scales and/or tags from at least a subsample of all recoveries from all recovery locations.
- Estimate the numbers of actual spawners in nature (by origin, age, and sex).
- Calculate natural-origin productivity, as estimates of numbers of spawners become available, by origin and age.
- Calculate smolt-to-adult survival and return rates, as estimates of numbers of smolts and spawners become available, by origin and age.

Directed Studies

Directed Studies are designed to diagnose and solve problems associated with achieving FHMP goals and to fill management needs and information gaps in the Big Table Dataset (Appendix A). Examples of important areas of study for the Upper Cowlitz Subbasin spring Chinook Salmon population include:

- **Spawning Ground Surveys:** Scales, marks and tags, numbers of actual spawners, pHOS, pre-spawn mortality rates, genetics, spatial distribution (upper extent), and reach-specific adult densities.
- **Freshwater Life History and Natural-origin Juvenile Rearing Studies:** Abundance and life stage-specific survival rates, available habitat, habitat-specific (run/riffle/pool) densities, and carrying capacity.
- **In-river Migratory Survival and Behavior:** Survival of migrating juveniles and movement timing and rates.
- **Hatchery Supplementation Experiments:** Assessing the impact of returning hatchery-origin adults on natural-origin salmon.
- **Hatchery Practices:** Broodstock collection and spawning protocols, in-hatchery growth rate, and examining smolt size and timing of release.
- **Reservoir Survival:** Predation rate and natural mortality.

4.1.7. Summary

- Although extirpated from upstream habitats following completion of Mossyrock Dam, Upper Cowlitz Subbasin population genes were incorporated into the hatchery population, providing the founding stock for recovery.
- Spring Chinook Salmon recovery efforts have focused exclusively on the Upper Cowlitz Subbasin population to avoid conflicting with management activities for restoring fall Chinook Salmon in the Tilton Subbasin.
- Juvenile fish collection and passage survival at Cowlitz Falls Dam have historically been key limiting factors for natural-origin abundance and productivity.

- Providing a demographic boost to the population by increasing the total number of spring Chinook Salmon spawning in the Upper Cowlitz Subbasin is currently the primary management goal.
- Natural-origin smolt abundance will be increased by improving collection efficiency and downstream passage survival at Cowlitz Falls Dam.
- Cowlitz Basin program needs, including both recovery and harvest objectives, will be prioritized by developing a surplus plan as part of the Spring Chinook Transition Plan to define fish/egg disposition and harvest objectives, minimum escapement targets, hatchery surplus disposition, and associated triggers. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will clearly be communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.
- Moving forward, in the near-term, the FTC will continue the Segregated Hatchery Program, while developing a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. The long-term goal is for all hatchery production to come from the Integrated Hatchery Program, which will support both the recovery of Cowlitz Basin spring Chinook Salmon populations and provide for lost harvest opportunities.
- Monitoring for VSP, hatchery, and harvest metrics is needed to evaluate recovery status and trends during different phases of recovery. These include but are not limited to:
    - Abundance/ Diversity:
        - Estimates of total mature salmon numbers by origin, age, and sex.
        - Estimates of numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
            - Calculation of pHOS.
        - Hatchery- and natural-origin smolt numbers.
        - Returns to the Barrier Dam Adult Facility by origin, age, and sex.
        - Fecundity and fertility rates, survival rates between age classes, disease prevalence, and numbers of smolts produced at Cowlitz Salmon Hatchery.
    - Spatial Structure
        - Capture spatial distribution through:
            - Transport records.
            - Spawning Ground Surveys.
    - Harvest
        - Improved harvest estimates of both hatchery- and natural-origin salmon, by age.
        - Calculation of harvest and indirect mortality rates.
    - Hatchery

    - Numbers of salmon collected for broodstock and spawned, by origin, age, and sex to provide pNOB.
  - Calculate PNI.
  - Survival and Productivity
    - Utilize estimates above to calculate productivity
      - Smolt-to-Adult Return and Total Survival rates
      - Adult-to-Smolt Productivity – Freshwater productivity
      - Adult-to-Adult Productivity – capturing marine variability
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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Population: Tilton Subbasin Spring Chinook Salmon *Oncorhynchus tshawytscha*

Evolutionarily Significant Unit:	Cascade Spring Chinook Salmon stratum Lower Columbia River Chinook Salmon Evolutionarily Significant Unit (ESU) Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened; Listed in 2005, reaffirmed in 2011 and 2016
Population Recovery Designation:	Stabilizing
Population Viability Rating:	
Baseline	Very Low
Objective	Very Low
Minimum Viability Abundance Target:	No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
Current Recovery Phase:	NA
Current Hatchery Program(s):	None
Proposed Hatchery Program(s):	None under the current FHMP. Future programs may be established, as deemed necessary by the FTC.

4.2. Spring Chinook Salmon: Tilton Subbasin Population

The Tilton Subbasin contained one of the three historical spring Chinook Salmon populations in the Cowlitz Basin (Myers et al. 2006). It was heavily impacted by overharvest, habitat destruction and, ultimately, the construction and operation of Mayfield Dam. Returning salmon utilized the Mayfield Dam adult facilities until 1968 when the Barrier Dam and Cowlitz Salmon Hatchery were completed. Adults continued to be transported to the Tilton Subbasin until 1980. At that time, the Tilton Subbasin spring Chinook Salmon population became functionally extinct. However, fisheries managers believe that some of the genetic legacy of the original Tilton Subbasin population remains in the spring Chinook Salmon population that has been maintained at Cowlitz Salmon Hatchery.

Currently, the effort to restore the Tilton Subbasin spring Chinook Salmon population has been delayed so that efforts to restore fall Chinook Salmon to the Tilton Subbasin can be more accurately assessed and better managed. Cowlitz River spring Chinook Salmon outmigrate predominantly as sub-yearlings, and this does not allow juvenile spring Chinook Salmon to be positively distinguished from fall Chinook Salmon juveniles, which makes evaluation of juvenile restoration programs difficult. Because of these complications as well as spring Chinook Salmon having the greatest probability of success in the Cispus and upper Cowlitz rivers due to topography, geography, and the thermal profile of these watersheds, managers decided to initially focus restoration efforts on fall Chinook Salmon on the Tilton Subbasin and to focus spring Chinook Salmon restoration on the Cispus and upper Cowlitz rivers (Upper Cowlitz Subbasin).

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During the FHMP period, we will develop a Transition Plan for integrating a portion of the hatchery production and eventually moving to a fully integrated program. The Transition Plan will address how the Integrated Hatchery Program will be used to supplement natural spawning and harvest in the Tilton Subbasin, with targets developed in coordination with the FTC (Table 4.2-1).

Table 4.2-1. Recovery phase targets for Tilton Subbasin spring Chinook Salmon.

Recovery Designation: Stabilizing
Current Recovery Phase: NA

Target Metric	RECOVERY PHASE: Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	TBD[1]	TBD[1]	TBD[1]	TBD[1]	NA
Smolt Abundance (below hatchery)	25,000[2]	50,000[2]	100,000[2]	200,000[2]	NA
Smolt Passage Survival	40%	60%	70%	75%	NA
Productivity (5-year mean)	>1	>1	>1	>1	NA
Hatchery Production					
Type of Hatchery Program	Int	Int	Int	Int	NA
Broodstock to be Collected	1,200	1,200	1,200	1,200	NA
Integrated Hatchery Program	1,200	1,200	1,200	1,200	NA
Hatchery-Origin	0	0	0	0	NA
Natural-Origin	1,200	1,200	1,200	1,200	NA
Segregated Hatchery Program	0	0	0	0	NA
Smolts to be Produced	1,000,000	1,000,000	1,000,000	1,000,000	NA
Integrated Hatchery Program	1,000,000	1,000,000	1,000,000	1,000,000	NA
Segregated Hatchery Program	0	0	0	0	NA
Total Smolt-to-Adult Survival					
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.3	0.3	NA
Integrated Hatchery Program	0.5	0.4	0.3	0.3	NA
Segregated Hatchery Program	NA	NA	NA	NA	NA
pNOB (>)	1	1	1	1	NA
PNI (>)	0.67	0.71	0.77	0.77	NA
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	30%	30%	30%	30%	NA

[1] No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
[2] Based on 1% SAR.

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CHAPTER 5:
COHO SALMON

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Coho Salmon *Oncorhynchus kisutch*

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Lower Columbia River Coho Salmon
Major Population Group:	Cascade Coho Salmon
Recovery Region:	Lower Columbia River Salmon
Populations, Recovery Designations, and Abundance Targets (natural-origin adults spawning in nature):	• Lower Cowlitz Subbasin – Primary, 3,700 • Upper Cowlitz River drainage – Primary, 2,000 • Cispus River drainage – Primary, 2,000 • Tilton Subbasin – Stabilizing, not established
Current Hatchery Program(s):	• Cowlitz Salmon Hatchery Segregated Hatchery Program (Lower Cowlitz Subbasin); 1.2 million smolts • Cowlitz Salmon Hatchery Integrated Hatchery Program (Upper Cowlitz Subbasin); 978,000 smolts
Proposed Hatchery Program(s):	Short-Term Goal: Upper Cowlitz Subbasin Integrated Hatchery Program; 2.2 million yearling smolts Long-Term Goal: Upper Cowlitz Subbasin and Tilton Subbasin Integrated Hatchery Programs; combined production of 2.2 million yearling smolts

5.0. Coho Salmon: Overview

5.0.1. Program Focus

The management focus for Coho Salmon is population-level recovery and harvest opportunity. Since the last FHMP (2011), returns of natural-origin adults to spawning grounds both below Barrier Dam and above Mayfield Dam have increased, and some of these populations are on the verge of meeting their minimum viability abundance targets. However, hatchery influence on the natural population is high and believed to be detrimental. During this FHMP period, criteria will be developed to update the recovery phases of each of the Coho Salmon populations and adapt our recovery efforts, appropriately.

The long-term goal for hatchery production of Coho Salmon in the Cowlitz Basin will be to transition to a single Integrated Hatchery Program, derived from the Upper Cowlitz Subbasin. The 2011 FHMP states that “in the future, consideration could be given to converting to an integrated hatchery program to further improve fitness of the natural population.” Additionally, the WDFW Hatchery Action Implementation Plans (2009) states that “modify(ing) programs to achieve goals for PNI, pHOS, and pNOB” is a needed improvement action for Cowlitz River hatchery programs. The Lower Columbia Basin Conservation and Sustainable Fisheries Plan (WDFW and LCFRB 2016) recommends that programs “convert from segregated programs to integrated or local brood source.” A single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin Segregated and Upper Cowlitz Subbasin Integrated hatchery programs and will meet all

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program population supplementation and harvest needs. Moving to a single integrated hatchery program is expected to accomplish the following:

- Prioritizes increasing adult abundance in the Upper Cowlitz Subbasin.
- Prioritizes Local Adaptation for all populations, particularly those in the larger, more pristine Cispus and upper Cowlitz rivers.
- Allows for continued harvest at current or higher levels in the Lower Cowlitz Subbasin.
- Creates increased harvest opportunity in the Upper Cowlitz Subbasin.
- Having a single program allows for easier hatchery M&E and assessment of alternative hatchery strategies.
- Provides the opportunity to align production practices with historical natural run-timing for each subbasin by collecting Upper Cowlitz Subbasin broodstock throughout the run-time migration to reconstruct the original run-timing of Coho Salmon above Mayfield Dam.
- Presents an opportunity to fill information gaps regarding density dependence, juvenile rearing capacity, and trends toward Local Adaptation between the Upper Cowlitz and Lower Cowlitz subbasins without negatively impacting the Stabilizing population in the Tilton Subbasin.
- Provides opportunity to move the smaller, more heavily impacted Tilton Subbasin population (a Stabilizing population) toward Local Adaptation.

This management shift will greatly benefit our efforts to restore the natural Cowlitz Basin Coho Salmon populations and the fisheries that these populations and hatchery programs support. As described in more detail below, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs.

5.0.2. Population Structure

Excluding the Toutle and Coweeman rivers, four historical populations of Coho Salmon have been recognized in the Cowlitz Basin: lower Cowlitz River, Cispus River, upper Cowlitz River, and Tilton River (Myers et al. 2006; Figure 5.0-1; Table 5.0-1). These endemic populations spawned and reared in the tributaries and mainstem of the larger rivers in each basin. Construction of Mayfield Dam (beginning in 1963), the subsequent development and operation of the hatchery programs, the inability to identify the basin of origin of natural-origin salmon, and the sporadic transport of adult salmon above the dams all resulted in the aggregation of the four Cowlitz Coho Salmon populations. By the mid-1990s, the Lower Cowlitz Subbasin Coho Salmon population was recognized to be at risk of extinction due to overharvest since the early 1900s, hydroelectric development in the 1960s, and ongoing habitat degradation and hatchery influences (McElhany et al. 2007; LCFRB 2010; Ford et al. 2011). By 2013, the Lower Cowlitz Subbasin Coho Salmon population was not considered to be viable (NMFS 2013), but the Lower Cowlitz Subbasin hatchery population has been the genetic source for Coho Salmon transported above Mayfield Dam. Improved monitoring since 2011 has enhanced our understanding of Lower Cowlitz Subbasin Coho Salmon populations and resulted in an apparent increase in abundance. This, along with continued reintroduction efforts, led to an improvement in the status of the entire Cowlitz Basin Coho Salmon population from High Risk to Moderate Risk of extinction (NMFS 2016).

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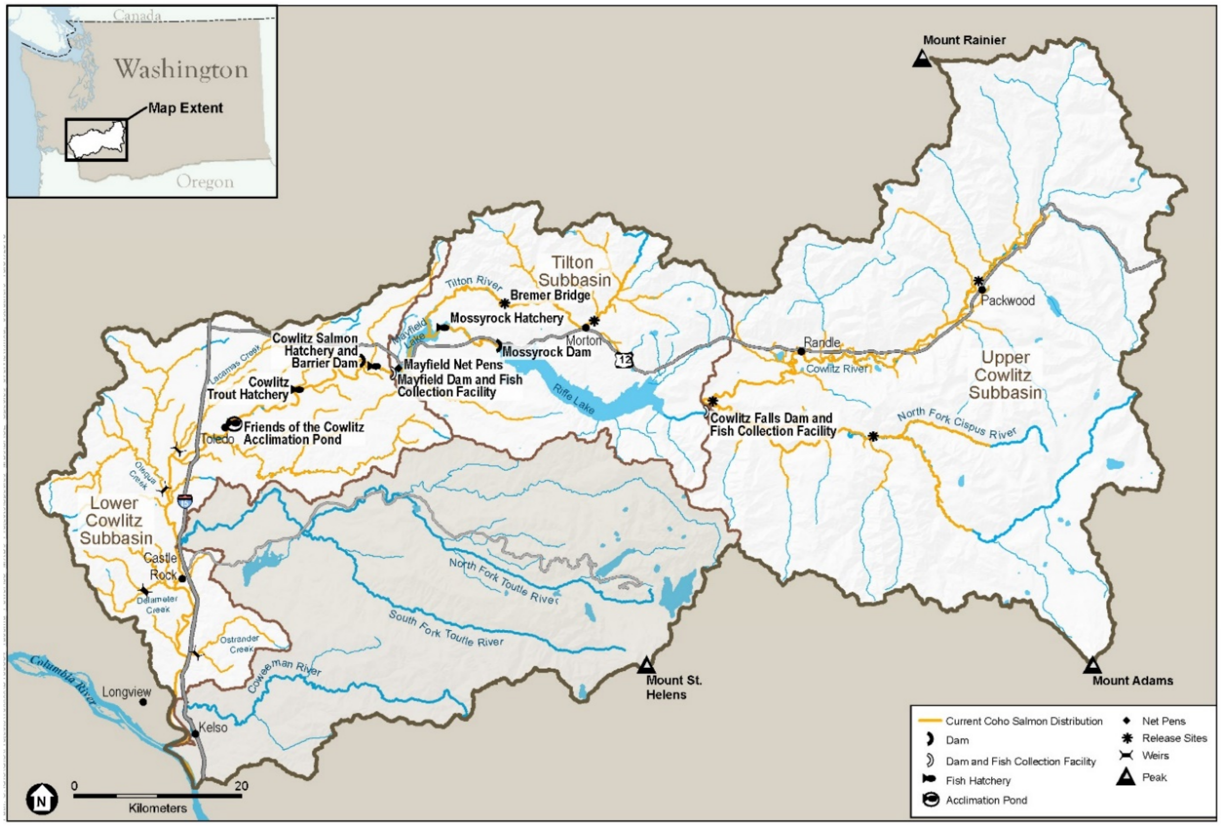

Figure 5.0-1. Distribution of Coho Salmon in the Cowlitz Basin, Washington.

After the listing of these populations under the ESA, management focused on recovery of the four populations and conservation was elevated to a higher management priority. This reprioritization resulted in changes to hatchery, harvest, transport, and habitat actions. The Lower Cowlitz, Cispus, and Upper Cowlitz Subbasin populations are designated as Primary populations, while the Tilton Subbasin population is designated as a Stabilizing population in relation to their contribution to recovery of the lower Columbia River ESU (LCFRB 2010). Recovery relies on the extant Lower Cowlitz Subbasin Coho Salmon hatchery population as the founding population for supplementing the populations above Mossyrock Dam. Recovery actions have been undertaken over the past three decades, but delisting cannot occur until all four historical populations have been restored with a high probability of persistence or, at a minimum, is consistent with their historical condition. Delisting is also dependent on the improved viability of other (i.e., non-Cowlitz Basin) populations within the ESU. Reintroductions to the Upper Cowlitz Subbasin have provided opportunities for the continued growth and genetic diversification of the entire Cowlitz Basin population.

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Table 5.0-1. Recovery priority, baseline viability status, viability and abundance objectives, and productivity improvement targets for Cowlitz Basin Coho Salmon populations (from LCFRB 2010; updated from ISIT, WDFW, 28 June 2019).

	Demographically Independent Population			
	Lower Cowlitz Subbasin	Cispus Subbasin[1]	Upper Cowlitz Subbasin[1]	Tilton Subbasin
Run	Late	Early and Late	Early and Late	Early and Late
Recovery Priority Designation[2]	Primary	Primary	Primary	Stabilizing
Abundance				
Historic[3]	18,000	8,000	18,000	5,600
Current (last 5 years)[4]	5,253	2,510[1]		4,237
Target[5]	3,700	2,000	2,000	N/A[6]
Baseline Viability[7]				
Abundance & Productivity	Very Low	Very Low	Very Low	Very Low
Spatial Structure	Medium	Medium	Medium	Medium
Diversity	Medium	Low	Low	Low
Net Viability Status	Very Low	Very Low	Very Low	Very Low
Viability Improvement[8]	100%	>500%	>500%	0%
Minimum Viability Abundance Target[7]	High	High	High	Very Low
Proportionate Natural Influence				
pHOS	<0.3	<0.3	<0.3	N/A
pNOB	>0.6	>0.6	>0.6	N/A
PNI	>0.67	>0.67	>0.67	N/A

1 For current management purposes, the Cispus Subbasin and Upper Cowlitz Subbasin populations are combined into an Upper Cowlitz Subbasin population, with abundances equal to the sum of the two separate populations.
2 Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance targets.
3 Historical population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS based on professional judgment calculations.
4 2013-2017 run years.
5 Abundance targets were estimated by population viability simulations based on viability goals.
6 No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
7 Viability status is based on Technical Recovery Team viability rating approach. Viability objective is based on the scenario contribution. Very Low (>60% chance of extinction); Low (26-60% chance of extinction); Medium (6-25% chance of extinction); High (1-5% chance of extinction); Very High (<1% chance of extinction).
8 Improvement is the relative increase in population abundance and productivity required to reach the prescribed viability goal.

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5.0.3. Life History Diversity

Historically, there were two distinct runs of Coho Salmon in the Cowlitz Basin: an early run and a late run (Moore and Clarke 1946; Myers et al. 2006). Smolts from the early run (Type S) migrate south, along the Oregon coast, upon leaving the Columbia River. The early run returned to the Cowlitz River during late August and September and spawned mostly in the upper parts of the watershed, with a spawning peak in late October. Conversely, late run (Type N) smolts migrate north, along the Washington coast, when they enter the ocean and comprised the majority of the Coho Salmon returning to the Cowlitz River. They entered the Cowlitz River as early as October and as late as March and spawned in available habitat throughout the watershed (generally in lower reaches), with a spawning peak in late November. Fry and parr of both runs spent their first spring and summer within their natal streams and most smolted in their second spring (with peak outmigration typically in May). Smaller pulses of juveniles moved downstream during their first spring of life and, again, the following December (Stockley 1961). However, scale data from returning adults indicate that most Coho Salmon reach the ocean during their second spring, so it is thought that either these earlier (alternative) downstream migrations are movements to rearing habitat in the lower Cowlitz or Columbia rivers, or that these younger migrants have limited success transitioning to the ocean but may still provide a life history diversity component (Myers et al. 2006).

The current Cowlitz Basin Coho Salmon population is now a composite population, whose genetic composition has been heavily influenced by dams blocking spawning habitat access and egress, combining endemic populations into a hatchery stock, and by past harvest management. The current hatchery population is predominantly Type N, based on CWT recoveries in ocean fisheries, mostly north of the Columbia River (WDF et al. 1993). As a result of the hybridization of the Cowlitz Basin populations, a component of the current population exhibits elements of the Upper Cowlitz Subbasin early run, as Coho Salmon now enter the Columbia River from August through January (LCFRB 2010). Most of the early run arrives in mid-August through September and spawns in late October. The late run arrives in late September to October and spawns from November through early January. In nature, eggs hatch and fry emerge from January through April, depending on spawn date and water temperature (Sandercock 1991). Variable, weather-related upwelling patterns and the short ocean life cycle of Coho Salmon cause highly variable population abundance.

Recovery of Coho Salmon populations in the Cispus, Upper Cowlitz, and Tilton subbasins is being accomplished using the extant Lower Cowlitz Subbasin Coho Salmon hatchery population as the founding population. Since the inception of the Lower Cowlitz Subbasin Coho Salmon Hatchery Program in 1968, it is likely that individuals from both the early and late returning populations were collected for hatchery broodstock (Myers et al. 2006). Promoting diversity in the natural populations through the use of a well-structured hatchery program and management strategies will be important to successful recovery in the face of a changing natural environment (i.e., climate change).

5.0.4. History

The Cowlitz Basin Coho Salmon population is thought to have been one of the largest in the Lower Columbia Basin, although it is now a fraction of its original size. The historical annual Cowlitz Basin Coho Salmon run (combined Lower Cowlitz, Cispus, Upper Cowlitz, and Tilton subbasins) is estimated to have been 40,000-190,000 (LCFRB 2010). Bryant (1949) described the Cowlitz River as the “greatest silver salmon producing area in the entire Columbia River watershed,” and most of those Coho Salmon certainly came from upstream of the Toutle River. However, the combination of harvest in the early to mid-1900s, habitat alteration and migration blockage due to hydropower development in the 1960s, and the consistent, continuing, and pervasive effects of habitat loss and hatchery supplementation have taken their toll on these populations and resulted in their subsequent listing under the ESA (WDF et al. 1993; Myers et al. 2006; LCFRB 2010).

Hatcheries have been operated on the Cowlitz River for over 100 years (Table 5.0-2). The Tilton River Hatchery released Coho Salmon in the Cowlitz Basin from 1915-1921, and a salmon hatchery operated in the upper Cowlitz River near the mouth of the Clear Fork River until 1949. Both of these hatchery programs were relatively small compared to the post-1968 Cowlitz Salmon Hatchery Programs and were discontinued due to poor success. In 1948, WDF estimated that 77,000 Coho Salmon returned to the Cowlitz Basin, including 24,000 above the future site of Mayfield Dam. Harvest in the 1940s and 1950s was heavy and WDF reported that only 32,500 returned to the basin in the early 1950s. Run size decreased further, and dramatically in 1968 when Mossyrock Dam was completed, Cowlitz Salmon Hatchery and the adjacent Barrier Dam were completed (blocking upstream access at rkm 81), and the volitional trap in Riffe Lake was abandoned (NOAA Fisheries 2004). Natural-origin smolts from the Cispus and upper Cowlitz failed to negotiate the 23.5-mile-long Riffe Lake formed by Mossyrock Dam and further failed to find the turbine intakes that are situated 250 feet below full pool. Very few smolts are able to successfully navigate Riffe Lake and Mossyrock Dam to continue an ocean-ward migration. As mitigation for this lost production, Cowlitz Salmon Hatchery was designed to release 4.2 million late run Coho Salmon smolts annually, based on an agreement between Tacoma Power and the Washington Department of Fisheries, with a goal of producing enough smolts to maintain annual returns of 25,500 Coho Salmon. The Cowlitz Salmon Hatchery populations were created using the returning adult salmon at Mayfield Dam and then the Barrier Dam, creating a hatchery population likely derived predominantly from the populations above Mayfield Dam These traits will be important for restoring the populations above Mayfield Dam.

From 1970-1983, total combined harvest of Columbia River Coho Salmon ranged from 70% to >90% of the total run (LCFRB 2010). In 1985, it was estimated that only 5,229 Coho Salmon spawned naturally in the lower Cowlitz River tributaries above the Toutle River and most of those were assumed to be strays from Cowlitz Salmon Hatchery (LCFRB 2010). Harvest restrictions on ocean fisheries to protect wild coastal Washington Coho Salmon populations began in the mid-1980s. This trend continued into the 1990s, when Canadian Coho Salmon fisheries were severely restricted and Coho Salmon fisheries in the ocean off California and in the Columbia River were closed. Likewise, Coho Salmon ocean fisheries in Oregon and Washington were dramatically reduced in 1993 in response to the Depressed status of Oregon Coast natural Coho Salmon and their subsequent ESA listing. Beginning in 1999, Coho Salmon ocean fisheries in Oregon and Washington enacted adipose fin-clipped mark-selective fishing in response to the continued Depressed status of Oregon Coast natural Coho Salmon.

Cowlitz Falls Dam was completed in 1994, and excess hatchery-origin Coho Salmon from the Lower Cowlitz Subbasin population began to be transported above Mayfield and Cowlitz Falls dams in an effort to reintroduce the historical populations in the Cispus, Upper Cowlitz, and Tilton drainages (Myers et al. 2006). Mass marking of hatchery Coho Salmon also began as the reintroduction program began along with CWT marking of natural origin Coho Salmon smolts collected at the Mayfield Dam juvenile facility. This allowed adult Coho Salmon arriving at the Barrier Dam Adult Facility to be separated into hatchery, Tilton, and Upper Cowlitz origin. As soon as the natural-origin offspring of these salmon began returning, a combination of hatchery- and natural-origin Coho Salmon were transported, with the desire to produce as many natural smolts as possible and, ultimately, to produce a self-sustaining natural population in each of the three basins above the hydroelectric complex.

Table 5.0-2. Hatchery releases of Coho Salmon into each demographically independent population (DIP) in the Cowlitz Basin, excluding the Coweeman and Toutle rivers (updated from Myers et al. 2006 using Tacoma Power/Cowlitz Salmon Hatchery data).

Release Location	Release Years	Years[1]	Broodstock Origin	Total Released
Lower Cowlitz Subbasin				
Lower Cowlitz Subbasin DIP				
Cowlitz River	1954-1966	5	Green River (Puget Sound)[2]	569,724
	1954, 1958, 1990	3	Lewis River Hatchery	249,246
	1956-1957, 1964	3	Big Creek Hatchery (OR)	98,952
	1956-1969	3	Toutle (Type N)	404,785
	1962, 1965	2	Klaskanine Hatchery (OR)	669,756
	1965-1971	3	Kalama Hatchery	1,246,024
	1969-1993	24	Cowlitz River Hatchery	125,520,849
	1974	1	Elochoman Hatchery	31,838
	1995-1999	5	Cowlitz Hatchery (Type N)	28,129,260
	2000-2006	7	Cowlitz Salmon Hatchery	27,842,550
	2007-2016	10	Lower Cowlitz Subbasin (Segregated)[3]	18,728,472
	2009-2016	8	Upper Cowlitz Subbasin (Integrated)	7,278,242
Riffe Lake	1995-1999	5	Cowlitz Hatchery (Type N)	3,035,832
	1982-1992	11	Cowlitz Hatchery	3,110,589
DIP Total				216,916,119
Upper Cowlitz Subbasin				
Cispus Subbasin DIP				
North Fork Cispus River	1972-1986	7	Cowlitz Hatchery	1,088,985
Iron Creek	1954	1	Toutle River (Type N)	24,050
	1972-1992	20	Cowlitz Hatchery	4,945,686
	1976-1986	9	Cowlitz Hatchery	685,252
DIP Total				6,743,973
Upper Cowlitz Subbasin DIP				
Upper Cowlitz River	1972-1989	17	Cowlitz Hatchery	17,776,163
Ohanapecosh River	1972-1993	23	Cowlitz Hatchery	3,909,445
DIP Total				21,685,608
Tilton Subbasin				
Tilton Subbasin DIP				
Tilton River	1954-1984	12	Cowlitz Hatchery (Type N)	2,618,815
DIP Total				2,618,815
Grand Total Cowlitz Basin above Toutle River				**247,964,515**

[1] Years is the total number of years that salmon were actually released within the time frame.
[2] Green River is part of the Puget Sound ESU.
[3] The Segregated Program has operated since 1998 (WDFW 2014c).

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Success of this program acknowledged the need for downstream transport of juvenile salmonids and included construction of the Cowlitz Falls North Shore Collector and its associated license requirements. The transplanted salmon likely have genes from the original populations above Mayfield Dam, and these genes will be of great benefit to the restoration effort.

However, the process of building a self-sustaining natural population in the Upper Cowlitz Subbasin has been slow. Fish Passage Survival has not been historically sufficient to support a self-sustaining population in most years since 1996. The construction of the Cowlitz Falls North Shore Collector in 2017 promises to increase Coho Salmon smolt passage survival to a self-sustaining level. In 2004, the LCFRB wrote that “current returns (to the lower Cowlitz River) are unknown but assumed to be low,” highlighting the dire straits that the population was assumed to be in and the lack of effective monitoring. The lower Columbia River Coho Salmon ESU, including the Lower Cowlitz Subbasin population and the Coho Salmon raised at Cowlitz Salmon Hatchery, was subsequently listed as threatened under the ESA in 2005, and that listing was reaffirmed in 2011 and 2016.

In 2015, the Northwest Fisheries Science Center reported generally positive changes in abundance, productivity, diversity, and spatial structure of Cowlitz Basin Coho Salmon populations (NMFS 2016). They noted, however, that these apparent increases were more likely due to improved monitoring and the subsequently improved and more complete data rather than a real change in population metrics, which suggests there were more natural-origin Coho Salmon returning in previous years than originally assumed. Continued improvements in understanding important population metrics will allow these populations to be more effectively managed.

Additionally, both upstream and downstream fish passage programs are now allowing for the return of relatively large numbers of naturally produced salmon to populations that had been extirpated in the Upper Cowlitz Subbasin. Improvements made at the juvenile capture and downstream transport facilities at Mayfield and Cowlitz Falls dams are expected to increase the contribution of Cowlitz River outmigrants and should help to improve the status of the Tilton Subbasin and Upper Cowlitz Subbasin Coho Salmon populations, respectively. Natural-origin abundance varies widely but is improving. Based on spawning ground surveys in the Lower Cowlitz Subbasin and survival rates for adults transported above Mayfield Dam, we estimate that the number of natural-origin spawners in nature has ranged from 3,526-24,837 from 2007-2017 and has exceeded the entire Cowlitz Basin minimum viability abundance target of 7,700 adults for 8 of those 11 years. For the entire Cowlitz Basin, land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. Future impacts from climate change are unknown but will likely have population-level effects. Coho Salmon are notorious for boom and bust cycles and poor ocean conditions can cause rapid population declines, so this ESU is still considered to be at Moderate risk (NWFSC 2015).

5.0.5. Distribution

Natural spawning in the Cowlitz Basin occurs in most areas accessible to Coho Salmon, including the mainstem and all accessible tributaries in the Lower Cowlitz Subbasin, as well as those above Mayfield Dam to which Coho Salmon are transported (Figure 5.0-1). Historically important spawning streams for Coho Salmon included Arkansas, Lacamas, and Ostrander creeks in the Lower Cowlitz Subbasin and Burton, Butter, Kiona, Lake, Silver, and Skate creeks in the Upper Cowlitz Subbasin (Bryant 1949). Birtchet and LeMier (1955) counted 329 Coho Salmon entering Arkansas Creek from October 1954 until high flood waters washed out the weir in December. Natural spawning in the Lower Cowlitz Subbasin upstream of the Toutle River

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now occurs primarily in Blue, Brights, Campbell, Foster, Hill, Lacamas, Mill, Olequa, Otter, and Stillwater creeks, with Olequa Creek being the most productive (LCFRB 2010). It is also possible that Coho Salmon spawn in the mainstem lower Cowlitz River, especially side channels, but this is poorly documented (mostly due to poor survey conditions). However, endemic *C. shasta* may limit survival during multi-summer rearing in these habitats. Since 1994, returning Coho Salmon have been transported above Cowlitz Falls Dam, where they spawn in the Cispus and upper Cowlitz rivers and suitable tributaries, such as the Ohanapecosh and Clear Fork rivers. Coho Salmon have been released into the Tilton Subbasin every year (except two) since Mayfield Dam was constructed. Habitat in the Upper Cowlitz and Tilton subbasins appears to be productive, but historically reintroduction efforts have been hindered by poor capture efficiency at Cowlitz Falls Dam. From 2013-2019, however, collection efficiency at Cowlitz Falls Fish Facility has improved, resulting in annual collection efficiency exceeding 50% (mean = 76%).

Historically, natural spawning by Coho Salmon (both hatchery- and natural-origin) was not extensively monitored or managed. In recent years, however, both monitoring and management have improved. To reduce the abundance of hatchery-origin strays spawning in Lower Cowlitz Subbasin tributaries, and monitor abundance of natural-origin Coho Salmon, weirs were installed on Delameter, Lacamas, Olequa, and Ostrander creeks in the Lower Cowlitz Subbasin; during normal operations, only natural-origin salmon are released above the weirs. The weirs provide locations to monitor abundance via mark-recapture. In addition, spawning ground surveys are conducted on the streams with weirs and a subsample of other lower Cowlitz River tributaries (but not in the mainstem lower Cowlitz River). This lower Cowlitz River tributary monitoring framework allows for data on the distribution of Coho Salmon to be collected alongside collection of these other key population monitoring metrics. In the Tilton and Upper Cowlitz subbasins, where both hatchery- and natural-origin salmon are transported and released, the numbers transported and released are known, but how many survive to spawn is not known. The lack of stream surveys in these reaches also limits the known distribution and habitat usage by transported adults. The numbers of spawners are estimated by using the numbers of hatchery- and natural-origin adults transported multiplied by survival rates, which does not reflect inter-annual variability. pHOS estimates of the Cowlitz Basin Coho Salmon population are effectively based on numbers transported and harvested, not actual spawners.

5.0.6. Abundance

Mean total adult abundance of all Cowlitz River Coho Salmon (excluding the Coweeman and Toutle rivers populations) from 2007-2017 was 124,607 (37,420-281,143); this estimate includes all hatchery- and natural-origin Coho salmon that can be accounted for from ocean, Columbia River, and lower Cowlitz River fisheries, plus those spawning in the Lower Cowlitz Subbasin or captured at the Barrier Dam Adult Facility (Figure 5.0-2; Table 5.0-3). A mean of 62,989 salmon returned to the Cowlitz River, 48,382 returned to the Barrier Dam Adult Facility, and 21,687 of these were transported to the Tilton or Upper Cowlitz subbasins.

Productive spawning and rearing habitats still exist above the Cowlitz River Hydroelectric Complex, but reintroduction efforts have historically been hindered by poor capture efficiencies at downstream fish collection facilities and poor survival of smolts through the dams. Downstream migrant traps are operated for juvenile salmon at Mayfield and Cowlitz Falls dams and help to assess the success of the adult releases. But historically, their poor collection efficiencies have hindered the recovery efforts. Recently, smolt collection has improved, and mean collection efficiency at the Cowlitz Fall Fish Facility has been 76% over the last 5 years.

Historically, WDFW supported Remote Site Incubation (RSI) programs, which incubated eggs from the Segregated Hatchery Program for release of the resulting offspring into lower Cowlitz River tributary habitat. However, these offspring were not marked in a way that distinguished these fish from natural-origin salmon and, upon any subsequent capture, they may be misidentified as natural-origin salmon. This confusion inflates the abundance estimates of natural origin fish. WDFW worked with key partners to discuss these issues and these programs were discontinued after brood year 2017. The effects of their programs should diminish after 2021.

5.0.7. Harvest

Harvest is an important management component for Cowlitz Basin Coho Salmon and has great potential for impacting population recovery. Cowlitz River Coho Salmon are an important contributor to commercial, sport, and tribal harvest and are harvested in ocean, lower Columbia River, and lower Cowlitz River fisheries, as well as in fisheries above the Cowlitz dams complex (where salmon captured at the Barrier Dam Adult Facility may be transported). Based on RMIS data, Coho Salmon are occasionally harvested in both ocean and Columbia River fisheries; similarly, Coho Salmon from the Cowlitz Salmon Hatchery (brood year 2006) were caught in the Section 4B Treaty Troll fishery in 2009. Historically, however, creel surveys have been infrequent and much of the harvest information relies heavily on WDFW catch record cards, which may have unacceptable levels of uncertainty for specific management purposes in the Cowlitz Basin. Of the mean total adult abundance of all Cowlitz River Coho Salmon from 2007-2017 described above, the majority (87%) were hatchery-origin, with only 13% being natural-origin. A mean of 59% (73,196) of the total combined run was harvested in the various fisheries combined.

Ideal management for population recovery would support high harvest rates for hatchery-origin salmon while keeping harvest impacts on the natural-origin salmon as low as possible until the population can support harvest (Paquet et al. 2011). Prior to 1998 when mass marking of hatchery-origin fish enabled the identification of hatchery or natural origin, naturally produced Coho Salmon were managed like hatchery salmon and were subjected to similar harvest rates. Combined ocean and Columbia River harvest of Columbia River Coho Salmon (commercial, sport, and tribal) ranged from 70% to over 90% from 1970-1983. An annual mean of 1,494 Coho Salmon were harvested in the Cowlitz Basin sport fishery from 1986-1990. As noted above, ocean and Columbia River fisheries were reduced in the 1980s and 1990s in California, Oregon, Washington, and Canada to protect several Puget Sound and Washington coastal wild Coho Salmon populations. Natural-origin lower Columbia River Coho Salmon benefitted from these harvest limits and the 1999-2002 harvest of ESA-listed Coho Salmon was less than 15% annually. For the 1994 and 1997 brood years of Cowlitz Salmon Hatchery Coho Salmon, 36% escaped the fishery, while 64% were captured in fisheries: 55% in the Columbia River, 30% in the Washington ocean, and 15% in the Oregon ocean. Excess hatchery-origin salmon are also harvested in the Tilton and Upper Cowlitz subbasins, where they are transported to contribute to natural production and to support fisheries.

WDFW has established long-term contribution goals for harvest of Cowlitz Basin Coho Salmon in terms of catch numbers, harvest rates, and seasons, by fishery (Tacoma Power 2011). From 2007-2017, a mean of 68,860 hatchery-origin Cowlitz River Coho Salmon were harvested annually, comprising 94% of the total harvest (Table 5.0-3; Figure 5.0-3). Most hatchery-origin harvest occurred in the ocean (57%), Columbia River (27%), and Lower Cowlitz Subbasin (12%) fisheries, with the remainder harvested in the Tilton or Upper Cowlitz subbasins (4%).

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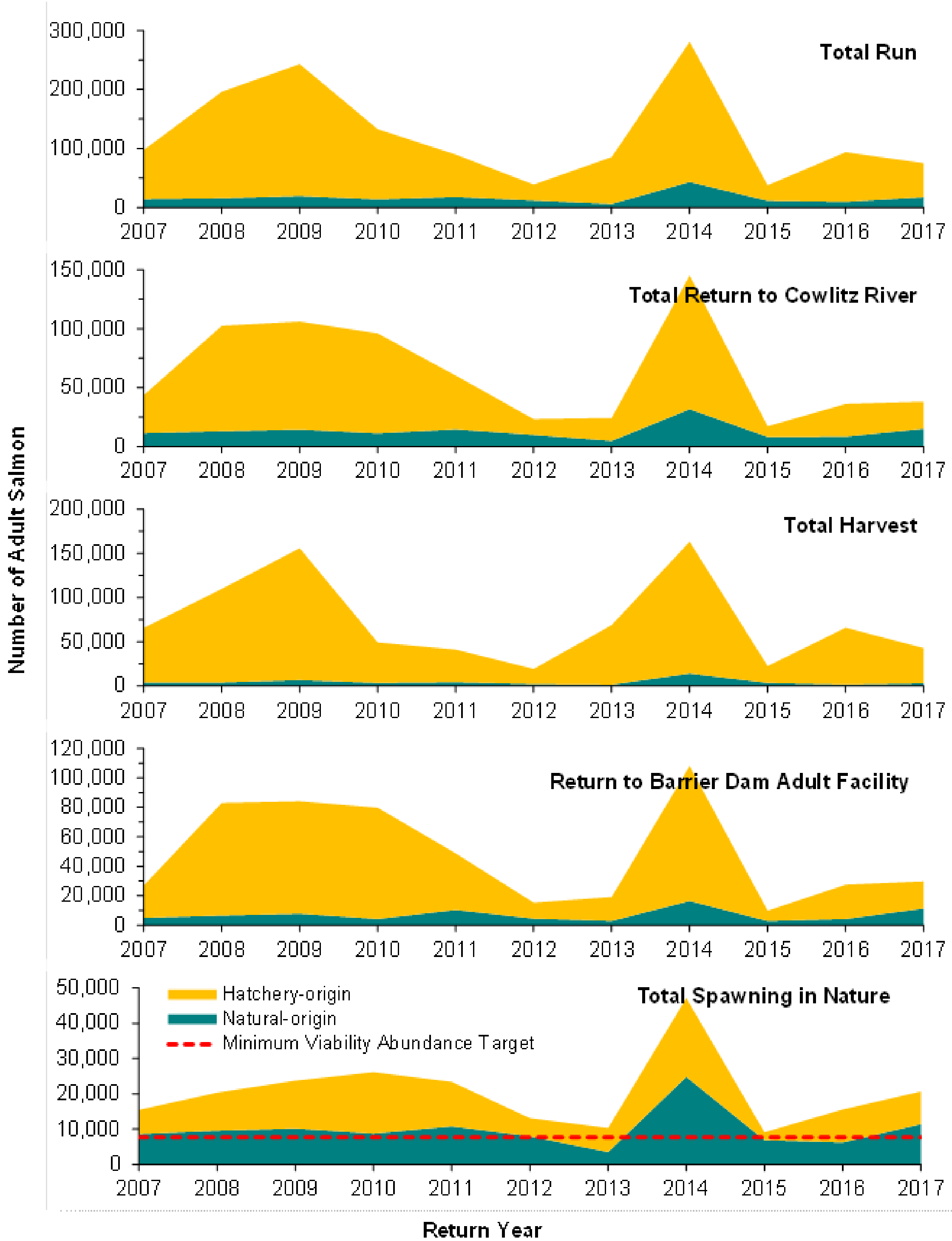

Figure 5.0-2. Estimated total run size for adult hatchery- and natural-origin Coho Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, and were transported above Cowlitz Falls Dam, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Table 5.0-3. Mean, minimum, and maximum numbers of all adult hatchery- and natural-origin Coho Salmon from the Cowlitz Basin, excluding the Coweeman and Toutle rivers, that could be accounted for at recovery locations and percentage of total at that recovery location, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW and may not be complete.

Origin,	Number of Adults		
Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run (unique to or below hatchery)[1]	108,413	26,193	238,229
Harvest (total for harvest rate)[2]	68,860	17,169	149,404
Total Return to Cowlitz River [3]	50,037	9,060	113,635
Return to Hatchery	41,525	7,071	91,809
Collected for Broodstock	1,457	689	2,751
Survived to Spawn in Nature[4]	10,577	2,236	22,319
Natural-origin or Integrated Hatchery-origin			
Total Run (unique to or below hatchery)[1]	16,195	5,738	42,915
Harvest (total for harvest rate)[2]	4,335	1,455	14,063
Total Return to Cowlitz River [3]	12,952	4,769	31,714
Return to Hatchery	6,858	2,759	16,391
Collected for Broodstock	630	229	809
Survived to Spawn in Nature[4]	9,891	3,526	24,837
Combined Hatchery- and Natural-origin			
Total Run (unique to or below hatchery)[1]	124,607	37,420	281,143
Harvest (total for harvest rate)[2]	73,196	19,313	163,391
Total Return to Cowlitz River [3]	62,989	17,238	145,349
Return to Hatchery	48,382	9,830	108,200
Collected for Broodstock	2,087	1,383	3,224
Survived to Spawn in Nature[4]	20,469	9,139	47,156

[1] Sum of all harvest below Mayfield Dam, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries.
[3] Sum of Lower Cowlitz Subbasin harvest, returns to hatchery, and spawning in nature in Lower Cowlitz Subbasin.
[4] Calculated as number transported to the Upper Cowlitz Subbasin minus harvest in the Upper Cowlitz Subbasin, 12% fallback, and 10% pre-spawn mortality.

For natural-origin Coho Salmon, mean total harvest from 2007-2017 was 17,848 salmon, 6% of the total harvest of Cowlitz Basin Coho Salmon (Table 5.0-3; Figure 5.0-3). Most of the natural-origin harvest occurred in the ocean (58%) and Columbia River (26%) fisheries, with 10% and 6% being lost to indirect mortality in the Lower Cowlitz and Tilton/Upper Cowlitz subbasins, respectively.

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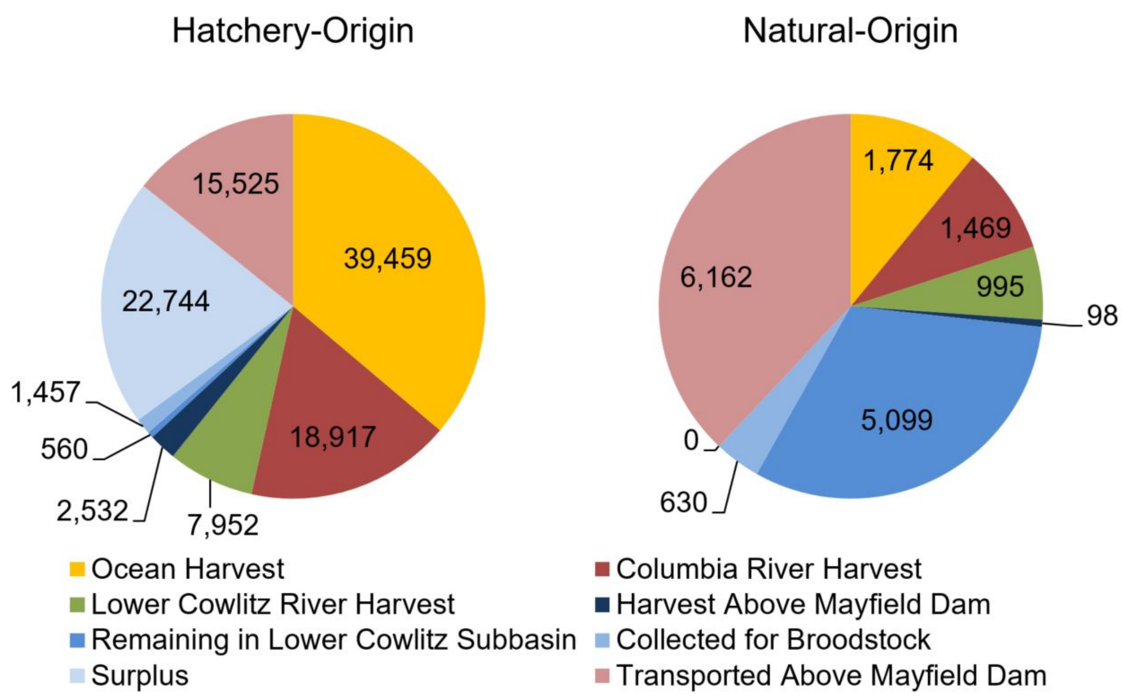

Figure 5.0-3. Mean numbers and proportions of hatchery-origin and natural-origin Cowlitz Basin Coho Salmon harvested, by fishery location, 2011-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

5.0.8. Natural Production

A recovered natural salmon population must be self-sustaining. To successfully manage toward population recovery, it is important to know the abundance of the population at important points in their life history. Understanding how many salmon are spawning in nature (F_0 generation) and how many of their offspring (F_1 generation) smolt and emigrate the Cowlitz River and subsequently survive to produce the next (F_2) generation can benefit recovery efforts. Because spawning ground surveys are not conducted in the Upper Cowlitz or Tilton subbasins, any estimates to date of Coho Salmon successfully reproducing on the spawning grounds are based on the number transported above the dams; it is unknown how many actually survive to spawn. Collection of Coho Salmon smolts at Cowlitz Falls and Mayfield dams offers an important monitoring point during a critical life stage and provides a baseline number of smolts migrating out of the system by transporting and releasing captures downstream.

The minimum viability abundance target for the combined Coho Salmon populations in the Cowlitz Basin is 7,700 natural-origin adults spawners (Table 5.0-1); this target consists of the Primary populations in the Lower Cowlitz (3,700 spawners) and Upper Cowlitz (including the Cispus River drainage) subbasins (4,000 spawners; LCFRB 2010). The Recovery Plan does not establish an abundance target for the Tilton Subbasin population because it is only a Stabilizing population.

From 2007-2017, estimated natural-origin abundance on the spawning grounds in the Primary populations (Lower Cowlitz and Upper Cowlitz subbasins) exceeded the minimum viability abundance target in 8 of 11 years, ranging from 3,526 in 2013 to 24,830 in 2014, with a

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mean of 9,891. Over that same period, the Upper Cowlitz Subbasin population achieved its minimum viability abundance target of 4,000 natural-origin adults spawning in nature for 7 of the 11 years (mean = 2,851), and the Stabilizing Tilton Subbasin population achieved 2,000 natural-origin adults spawning in nature twice, with a mean of 1,941.

Although natural spawning of hatchery-origin salmon is not directly credited toward meeting natural production targets, hatchery-origin adults are currently transported to the Upper Cowlitz and Tilton subbasins to spawn naturally as part of the recovery program. Ultimately, the goal is for the Cowlitz hatchery programs to continue to meet all program supplementation and harvest needs.

5.0.8.1. Smolt Production / Transport

Monitoring juvenile production of the Lower Cowlitz Subbasin Coho Salmon population is difficult. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Coho Salmon abundance. However, any juvenile Coho Salmon captured may be from either the Lower Cowlitz Subbasin or above Mayfield Dam. Therefore, we will now focus on adult productivity (adult recruits/spawner) to monitor the Lower Cowlitz Subbasin Coho Salmon population. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps.

Smolt production of natural-origin Coho Salmon from the Tilton Subbasin is estimated from collection at Mayfield Dam. Collection efficiency at Cowlitz Falls Fish Facility has greatly improved and has been consistently monitored since the beginning of the reintroduction efforts in 1996. From 2007-2017, a mean of 86,968 Coho Salmon smolts from the Upper Cowlitz Subbasin were captured at Cowlitz Falls Dam and transported to Cowlitz Salmon Hatchery. A mean of 34,115 Tilton Subbasin smolts were bypassed at Mayfield Dam, with an additional number of unguided smolts passing through the turbines. Survival through the bypass and turbine routes is not well known and could affect the number of smolts continuing their migration in the lower Cowlitz River. Based on studies from the 1960s, typically one-third of smolts from the Tilton and other Mayfield Lake tributaries are not collected at the Mayfield Collection Facility and pass through Mayfield Dam.

5.0.8.2. Adult Transport / Natural Spawning

Currently, Coho Salmon smolts captured at the Cowlitz Falls Fish Facility are marked with a CWT but not adipose fin-clipped, so they are identifiable when they return to the Barrier Dam Adult Facility as a CWT positive, adipose fin-intact fish. However, the natural-origin salmon from the Lower Cowlitz and Tilton subbasins cannot be distinguished from each other. All unmarked natural-origin returns to the Barrier Dam Adult Facility are assumed to have originated from the Tilton Subbasin and are transported there. This assumption is based on the lack of a migration corridor for smolts that are not collected at the Cowlitz Falls collector and become entrained in Riffe Lake and partial collection of smolts for tagging at Mayfield Dam. For the 2007-2017 run years, a mean of 3,650 natural-origin adults were transported and released into the Upper Cowlitz Subbasin, while a mean of 2,512 natural-origin adults were transported and released into the Tilton Subbasin. Collectively, this represented 38% of the total natural-origin run and 48% of those returning to the Cowlitz River.

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5.0.9. Hatchery Production

A Coho Salmon hatchery program was initiated at Cowlitz Salmon Hatchery in 1967 using natural-origin Coho Salmon returning to the Mayfield Dam adult passage facilities (WDFW 2014c). The program was integrated by default because the hatchery-origin Coho Salmon were not 100% marked (adipose fin-clipped) until 1998 and, because only a fraction of the hatchery-origin salmon was marked at all, the integration rates were unknown. Prior to 1998, the only fish that were adipose fin-clipped were those that had been CWT marked. An intentionally segregated program began in 1998 when 100% of the hatchery-origin salmon were adipose fin-clipped and managers could be more certain about the origin of the salmon collected for broodstock. The Segregated Hatchery Program for the Lower Cowlitz Subbasin Coho Salmon population currently has a production goal of 1,200,000 age-2 smolts but may vary, depending on factors such as the projected return of natural-origin salmon and the size of the Upper Cowlitz Subbasin Integrated Hatchery Program.

The Upper Cowlitz Subbasin Coho Salmon Integrated Hatchery Program at Cowlitz Salmon Hatchery was initiated in 2007 with pNOB = 1 and a goal of producing 978,000 smolts annually that are marked (CWT and adipose fin-clip) as the F_1 progeny of natural-origin broodstock from the Upper Cowlitz Subbasin. These fish are reared at Cowlitz Salmon Hatchery and directly released into the Lower Cowlitz River.

Moving forward in the near term, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. Hatchery broodstock will be collected at the Barrier Dam Adult Facility following the return timing of the natural Upper Cowlitz Subbasin population. The result is that the Cowlitz Basin hatchery programs will continue to meet all program supplementation and harvest needs:

- Total hatchery production of Coho Salmon in the Cowlitz Basin will be maximized, recognizing Settlement Agreement obligations, facility capacity (i.e., bio-programming with other hatchery production), and ESA constraints.
- Fisheries will continue to be supported both below Mayfield Dam and in the Tilton and Upper Cowlitz subbasins.
- The Cowlitz Basin Coho Salmon population will be well integrated, with the goal of spawning hatchery-origin salmon with at least one natural parent (i.e., pNOB ≥ 50%), reducing domestication of the hatchery population.
- Because pNOB will be $\geq$ 0.5, it is assumed that hatchery-origin salmon that spawn in nature will have at least one natural parent (reducing the detrimental effect on the natural population of hatchery-origin salmon spawning in nature).
- We will continue the Local Adaptation process for the populations above Mayfield Dam by protecting natural-origin salmon to the best of our abilities.

The Transition Plan for Coho Salmon will be developed within 2 years of completion of this FHMP. In the interim, the hatchery integration and management practices from 2019 will continue, until the Transition Plan is developed and approved with support and input from the FTC. In the longer term, additional steps toward encouraging Local Adaptation of the three

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separate populations will continue above Mayfield Dam in the Tilton and Upper Cowlitz subbasins. During development of the Transition Plan, additional suggestions raised during the public review process for management of Coho Salmon will be considered (such as examining the timing of broodstock collection in order to mimic historic run timing, and considering bio-programming options for rearing a portion of the Coho Salmon in alternate locations such as net pens or satellite ponds to make room to raise spring Chinook Salmon). For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

Hatchery best management practices will be used for all facets of hatchery production. Hatchery production metrics will be monitored to ensure that production goals and fish quality are met, as well as to understand the magnitude of hatchery influence on the natural population being supplemented. Key hatchery production monitoring metrics are the following:

- Number of salmon collected and spawned by origin (i.e., pNOB, pHOB, age, and sex).
- Fecundity.
- Survival by life stage (green eggs, eyed eggs, fry, parr, smolts released).
- Precocity rates (i.e., percent precocious/mini-jacks).
- Hatchery adult and jack returns by age and sex.
- pHOS.
- Calculation of PNI, SAR, and hatchery return rates.

5.0.9.1. Overall Hatchery Program Goals

The overall goals of the Cowlitz Basin Coho Salmon hatchery program are to:

1) Promote the recovery of populations in the Cowlitz Basin.
2) Provide harvest opportunities for commercial, recreational, and ocean tribal fisheries.
3) Support educational and research opportunities.

To achieve these goals, specific and quantifiable objectives for the hatchery program are described in detail within the respective sections for each of the Cowlitz Basin Coho Salmon populations (see Sections 5.1, 5.2, and 5.3).

In the near term, the completion of this FHMP will inform the development of minimum viability abundance targets and management goals. As noted above, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. The Transition Plan for Coho Salmon will be developed within 2 years of completion of this FHMP. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

5.0.9.2. Existing Hatchery Program

Salmon that are captured at the Barrier Dam Adult Facility may be hatchery-origin salmon from in-basin (majority) or out-of-basin (strays) production, natural-origin salmon that are attempting to migrate above the hydroelectric dams, or natural-origin salmon from the Lower Cowlitz Subbasin that strayed upstream and entered the hatchery trap. From 2003-2017, a mean of 48,382 adult Coho Salmon returned to the Barrier Dam Adult Facility, of which 41,525 (86%) were hatchery-origin while 6,858 (14%) were natural-origin. From 2007-2017, a mean

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total of 1,716 Coho Salmon were spawned at the Barrier Dam Adult Facility, 1,163 (68%) of which were hatchery-origin and 553 (32%) were natural-origin. Those salmon produced a mean of 2,564,120 age-2 (yearling) smolts, of which 1,804,727 (70%) came from the Segregated Hatchery Program and 759,393 (30%) from the Integrated Hatchery Program.

5.0.9.3. Adult Transport and Natural Spawning

The existing hatchery program also involves the transport of salmon collected at the hatchery to habitats above Mayfield and Cowlitz Falls dams. From 2007-2017, a mean of 21,687 adult Coho Salmon were transported to either the Tilton Subbasin (segregated) or above Cowlitz Falls Dam to the Upper Cowlitz Subbasin (integrated) to provide for reintroduction via natural spawning and fisheries. Of those, means of 15,525 (72%) were hatchery-origin and 6,162 (28%) were natural-origin Coho Salmon.

From 2007-2017, a mean of 20,469 Coho Salmon spawned in nature, 10,577 (52%) of which were hatchery-origin and 19,891 (48%) were natural-origin. From 1994-2016, the salmon that spawned above Mayfield Dam produced an annual mean of 138,604 smolts that were captured and released into the lower Cowlitz River to continue their migration to the ocean. A mean of 33,018 smolts were captured at the Mayfield Dam Collection Facility (Tilton Subbasin) and 105,586 smolts were captured at the Cowlitz Falls Fish Facility (Upper Cowlitz Subbasin).

5.0.10. Survival and Productivity

Based on the CWT data in the RMIS database, the mean total smolt-to-adult return (TSAR) rate for coded-wire-tagged hatchery-origin Coho Salmon for the 2005-2014 brood years was 1.61%. Natural-origin Coho Salmon smolts captured at Cowlitz Falls Dam have been coded-wire-tagged since 2013 (brood year ~2011). Mean smolt-to-adult return rate (to the Barrier Dam Adult Facility, since natural-origin Coho Salmon are rarely sampled for CWTs in other locations) for Coho Salmon tagged as juveniles from 2013-2015 was 8.53%. For comparison, hatchery-origin TSAR (which includes harvest) over that same period was 0.64%. As noted in Chapter 1 (Section 1.2), the data presented in this FHMP are preliminary, pending a full QA/QC review of the Big Table Dataset (Appendix A) by the M&E Subgroup for accuracy and source.

Mean productivity (adult recruits that returned to the Barrier Dam Adult Facility or spawned in nature/spawning parent; R/S) is not currently estimated. We will monitor this index as the data become available through our M&E Program.

5.0.11. Proportionate Natural Influence and Age Composition

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI is calculated using two proportions: the proportion of spawners in nature that are hatchery-origin (pHOS) and the proportion of the hatchery broodstock that is comprised of natural-origin salmon (pNOB). HSRG guidelines for Primary populations with integrated hatchery programs are that pHOS <0.3 (or ½ pNOB) and that pNOB should be greater than twice pHOS (so that PNI >0.67) once in the Local Adaptation phase of recovery (HSRG 2009). For Primary populations with a segregated hatchery program, the HSRG guideline is pHOS <0.05.

Because of the large proportions of hatchery-origin salmon transported to the Upper Cowlitz and Tilton subbasins and the low numbers of natural-origin salmon spawning in Lower Cowlitz Subbasin tributaries, mean pHOS for the Cowlitz Basin from 2007-2017 was 0.506.

Mean pNOB for all Coho Salmon spawned at the Barrier Dam Adult Facility was 0.315, mostly because the Integrated Hatchery Program usually uses 100% natural-origin salmon for its broodstock. As a result, mean PNI for the Coho Salmon population in the Cowlitz Basin was 0.374 from 2007-2015. In the Lower Cowlitz Subbasin, mean estimated pHOS = 0.101. The Upper Cowlitz Subbasin is supplemented by the Integrated Hatchery Program, which has a mean pNOB = 0.861 and estimated mean pHOS = 0.736, so mean PNI = 0.523.

Age composition was not calculated from available data in ISIT because they are not compiled by age or brood year. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question. Age classes are only characterized as "jacks (<42 cm)" or "adults (>42 cm)" and these data are only available for returns to the Barrier Dam Adult Facility, not for any other recovery locations. Mean age composition of mature Coho Salmon that returned to the Barrier Dam Adult Facility from 2007-2017 was 28% age-2 (jacks) and 72% ages-3-4 (adults) for hatchery-origin salmon. However, age composition is more informative when examined by brood year. Data from coded wire tagged hatchery-origin salmon from RMIS indicate that, for the 2005-2014 brood years, 20% of the hatchery-origin Coho Salmon were recovered at age-2 (jacks) and 73% and 7% at ages-3 and -4 (adults), respectively. ISIT combines natural-origin and Integrated Hatchery Program returns to the hatchery. Age data collection by origin and hatchery program will monitor this index as the data become available through our M&E Program.

5.0.12. Marking and Tagging

Assigning the origin and/or release group with reasonable confidence to which a salmon belongs is crucial to effective monitoring and evaluation (Table 5.0-4). All hatchery-origin Coho Salmon are marked with an adipose fin-clip. Other types and locations of various marks and tags will be applied to a sufficient portion of all hatchery release groups so that programs can be adequately monitored and evaluated. Additionally, during development of the Transition Plan, we will be considering a change from tagging natural-origin smolts captured at the Cowlitz Falls Fish Facility to those captured at the Mayfield Dam Juvenile Bypass Facility so that each can be differentiated upon any later recapture (those from the Upper Cowlitz Subbasin will be identified by the absence of a tag). Marking and tagging schemes may differ from year to year, especially for hatchery-origin releases, which may also include experimental groups. Marking and tagging schemes for each group, within each brood year, will be set by the M&E Subgroup, approved by the FTC, and documented in each year's Annual Operating Plan.

Table 5.0-4. Current and proposed hatchery programs, smolt production, and marking/ tagging for Coho Salmon.

Origin & Stock	Hatchery Program	Juvenile Production: Current	Juvenile Production: Proposed	Mark / Tag: Current	Mark / Tag: Proposed
Hatchery					
Lower Cowlitz Subbasin	Integrated	None	None	None	NA
	Segregated	1,200,000	None	100% Ad	NA
Upper Cowlitz Subbasin	Integrated	978,000	2,200,000	Ad clip + 100% CWT	Ad or Ad +CWT
Natural					
Lower Cowlitz Subbasin	None	Unknown	50,000	None	None
Upper Cowlitz Subbasin	None	50,000-200,000		CWT	None
Tilton Subbasin	None	20,000-70,000		None	Partial CWT

5.0.13. Summary

- The continued genetic exchange among Coho Salmon in the hatchery and those spawning naturally in the Lower Cowlitz and Tilton subbasins since 1968 has caused the Lower Cowlitz Subbasin hatchery Coho Salmon to functionally become a single mixed population. Reintroduction efforts above Cowlitz Falls Dam began in 1994, along with a focus on Local Adaptation for the Tilton River Coho Salmon population, have begun to diverge these populations once again.
- Although the Recovery Plan identifies distinct Coho Salmon populations in the Cispus and upper Cowlitz rivers, returning adults are not differentiated or estimated separately. Thus, these populations are managed as a combined “Upper Cowlitz Subbasin” population, but allowed to migrate to natal habitats post-release into the Upper Cowlitz and Cispus rivers.
- Recovery efforts for Coho Salmon will focus on increasing the abundance of natural-origin adults spawning in nature in the Lower Cowlitz, Upper Cowlitz, and Tilton subbasins. Hatchery fish are being used in the Upper Cowlitz/Tilton subbasins to build abundance.
- In the near term, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts.
- The program will continue to evaluate the appropriate structure to manage for individual population Recolonization, Local Adaptation, and recovery. During this FHMP period, it is anticipated that these populations will move from Recolonization to Local Adaptation. Criteria to evaluate this shift will be developed, along with the resulting changes in management strategy.
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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Population: Lower Cowlitz Subbasin Coho Salmon
Oncorhynchus kisutch

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Columbia River Coho Salmon
Major Population Group:	Cascade Coho Salmon
Recovery Region:	Lower Columbia River Salmon
Population Recovery Designation:	Primary
Population Viability Rating:	
Baseline	Very Low
Objective	High
Minimum Viability Abundance Target:	3,700 natural-origin adults spawning in nature in the Lower Cowlitz Subbasin
Current Recovery Phase:	Local Adaptation
Current Hatchery Program(s):	Cowlitz Salmon Hatchery Segregated Hatchery Program, 1.2 million (yearling) smolts
Proposed Hatchery Program(s):	None; production will transfer to the Upper Cowlitz Subbasin Integrated Hatchery Program

5.1. Coho Salmon: Lower Cowlitz Subbasin Population

5.1.1. Purpose

This section describes the current status of the Lower Cowlitz Subbasin Coho Salmon population based on recent and available data. In addition, we identify VSP metrics needed to evaluate the status of this population with regard to reaching minimum viability abundance targets under ESA guidelines. Where appropriate, we propose changes to both hatchery and monitoring programs to better evaluate progress toward population recovery. Although the Lower Cowlitz Subbasin Coho Salmon population is on the verge of meeting its minimum viability abundance target, hatchery influence on the natural population is slightly above target. During the period covered by this FHMP, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. We will continue to evaluate the hatchery program and fisheries management and will make refinements or adjustments, as described in this FHMP, to effectively manage the Lower Cowlitz Subbasin Coho Salmon population.

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5.1.2. Population Description

The Lower Cowlitz Subbasin Coho Salmon population includes all natural-origin Coho Salmon that occupy the Cowlitz River and all tributaries, excluding the Toutle and Coweeman rivers, from the mouth of the Cowlitz River up to the Barrier Dam (rkm 81), as well as those from the current Segregated Hatchery Program at Cowlitz Salmon Hatchery (Figure 5.1-1). The Coho Salmon population is the major extant population of the original four Coho Salmon populations above the Toutle River. It was found to be "Depressed" (WDFW 1993) and was listed in 2005 as threatened under the ESA, and reaffirmed in 2011 and 2016. This population is classified as a Primary population for contributing to recovery of the lower Columbia River ESU and must attain its minimum viability abundance targets (in conjunction with other non-Cowlitz River Primary populations) for the ESU to be considered recovered (LCFRB 2010).

The Lower Cowlitz Subbasin Coho Salmon population is currently supplemented by hatchery production. The combined hatchery- and natural-origin Lower Cowlitz Subbasin population is relatively abundant and is the source population for restoring populations above Mayfield Dam (Figure 5.1-1). The most recent 5-year means for total run size, returns to the Lower Cowlitz Subbasin, total harvest, and spawners in nature for hatchery- and natural-origin salmon have exceeded the minimum viability abundance targets/management goals for the population.

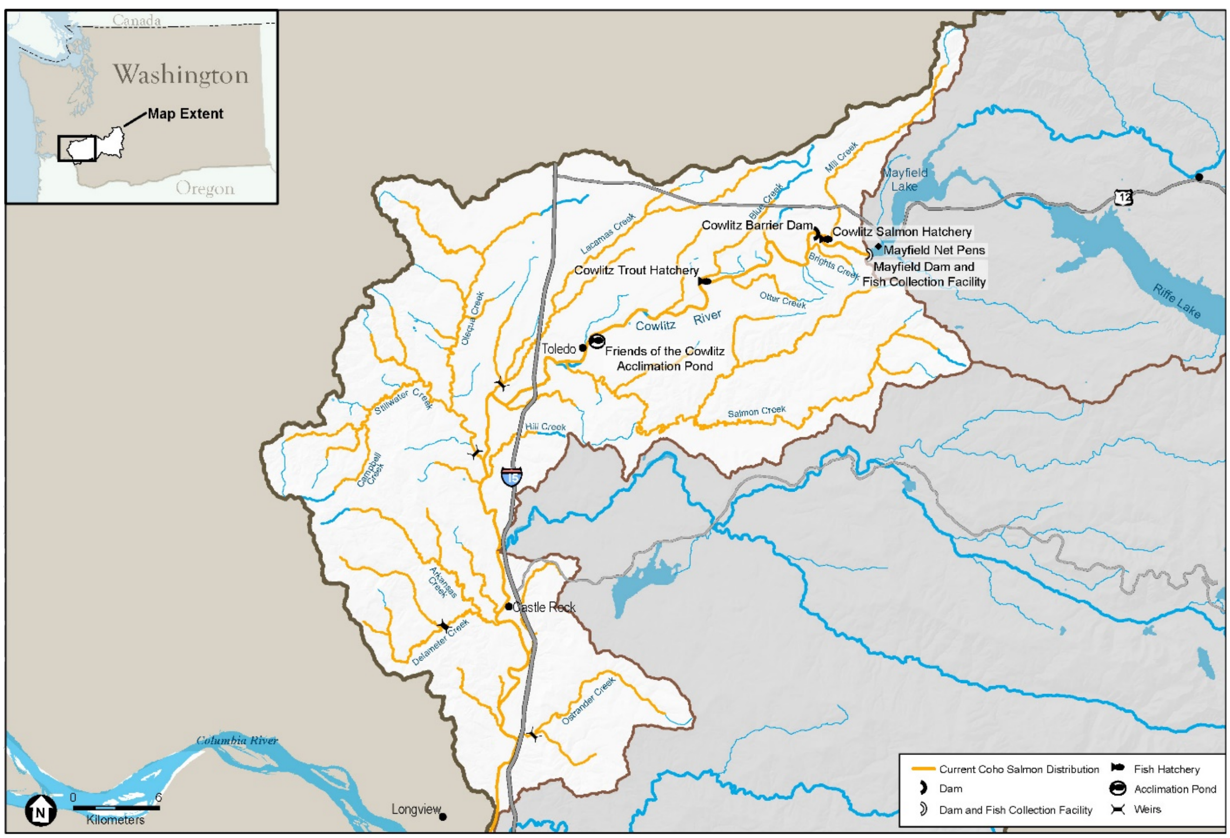

Figure 5.1-1. Distribution of Coho Salmon in the Lower Cowlitz Subbasin.

5.1.3. Natural Production

Two critical monitoring metrics for salmon management are the numbers that return at maturation and their disposition (Table 5.1-1; Figures 5.1-2 and 5.1-3). Lower Cowlitz Subbasin Coho Salmon that survive to begin their spawning migration may be harvested in commercial, sport, or tribal fisheries in the ocean; commercial or sport in the Columbia River; or sport-only in the Cowlitz River. Those escaping harvest may return to the Barrier Dam Adult Facility or natural spawning grounds, where they may be recovered and counted. They may also die from predation or disease at any time and not be recovered. Monitoring these metrics allows us to evaluate population health, productivity, and progress toward recovery; however, these data, which are critical to monitoring the Lower Cowlitz Subbasin Coho Salmon population, have been only sporadically collected and are incomplete, making population trends difficult to discern at this time.

5.1.3.1. Abundance

The minimum viability abundance target for the Lower Cowlitz Subbasin Coho Salmon population is 3,700 natural-origin salmon spawning in nature (LCFRB 2010). From 2007-2017, means of total run sizes were 7,484 natural-origin Coho Salmon (Figures 5.1-2 and 5.1-3; Table 5.1-1). A mean of 5,663 natural-origin salmon entered the Cowlitz River (32% of the total return to the Cowlitz River) and 5,099 natural-origin Coho Salmon remained on the spawning grounds in the Lower Cowlitz Subbasin.

Juvenile production of Coho Salmon in the Lower Cowlitz Subbasin includes smolts released from Cowlitz Salmon Hatchery plus natural production. Estimates of natural production for juvenile Coho Salmon specific to the Lower Cowlitz Subbasin population are not available.

5.1.3.2. Harvest

Harvest is an important component of the management of Lower Cowlitz Subbasin Coho Salmon and has the potential to impact population recovery. Lower Cowlitz Subbasin Coho Salmon contribute to important commercial and recreational fisheries in the Pacific Ocean, lower Columbia River, and Lower Cowlitz Subbasin. From 2007-2017, 32% (2,385) of the Lower Cowlitz Subbasin natural-origin population run was harvested (Figures 5.1-2 and 5.1-3; Table 5.1-1). Most (42%) of the natural-origin harvest was in the ocean, while 35% were harvested in the lower Columbia River, and 24% of the indirect harvest-related mortality occurred in the Lower Cowlitz Subbasin.

5.1.3.3. Disposition

Based on the current assumption that all natural-origin coho arriving at the Barrier Dam Adult Facility are of Tilton River origin, no natural-origin Coho Salmon from the Lower Cowlitz Subbasin arrived at the Barrier Dam Adult Facility. Therefore, there are no dispositions of natural-origin Lower Cowlitz Subbasin Coho Salmon to discuss.

Table 5.1-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin adult Coho Salmon from the Lower Cowlitz Subbasin population accounted for at recovery locations, and percentage of total at each recovery location, 2010-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	Number of Adults		
Origin, Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	27,703	16,115	48,856
Harvest[2]	18,588	7,106	30,456
Ocean harvest	10,897	2,761	22,246
Columbia River harvest	4,860	2,178	11,823
Lower Cowlitz River harvest	1,776	1,017	4,031
Above Mayfield Dam harvest[3]	1,054	162	1,922
Total Return to Cowlitz River[4]	11,945	6,221	23,304
Remain in Lower Cowlitz Subbasin	560	20	1,094
Return to Barrier Dam Adult Facility	9,609	4,015	18,646
Collected for Broodstock	1,323	689	2,086
Transported Above Mayfield Dam	4,163	1,512	6,206
Spawners Above Mayfield Dam[5]	2,348	823	4,223
Natural-origin			
Total Run[1]	7,484	2,442	20,482
Harvest[2]	2,385	826	7,821
Ocean harvest	996	304	2,978
Columbia River harvest	826	94	3,341
Lower Cowlitz River harvest (indirect mortality)[6]	564	100	1,502
Above Mayfield Dam harvest	0	0	0
Total Return to Cowlitz River[3]	5,663	1,819	14,163
Remain in Lower Cowlitz Subbasin	5,099	1,565	12,661
Return to Barrier Dam Adult Facility	0	0	0
Collected for Broodstock	0	0	0
Transported Above Mayfield Dam	0	0	0
Spawners Above Mayfield Dam[5]	0	0	0
Combined Hatchery- and Natural-origin			
Total Run[1]	35,187	18,557	69,338
Harvest[2]	20,973	7,932	38,277
Ocean harvest	11,893	3,065	25,224
Columbia River harvest	5,686	2,272	15,164
Lower Cowlitz River harvest	2,340	1,117	5,533

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Origin, Recovery Location	Number of Adults		
	Mean	Minimum	Maximum
Above Mayfield Dam harvest[3]	1,054	162	1,922
Total Return to Cowlitz River[4]	17,608	8,040	37,467
Remain in Lower Cowlitz Subbasin	5,659	1,585	13,755
Return to Barrier Dam Adult Facility	9,609	4,015	18,646
Collected for Broodstock	1,323	689	2,086
Transported Above Mayfield Dam	4,163	1,512	6,206
Spawners Above Mayfield Dam[5]	2,348	823	4,223

[1] Sum of all harvest below Mayfield Dam, remaining in the Lower Cowlitz Subbasin, and returns to the Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and above Mayfield Dam.
[3] Transported above Mayfield Dam for harvest.
[4] Sum of lower Cowlitz River harvest, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.
[5] Estimated by subtracting estimated harvest loss and multiplying by assumed fallback (12%) and pre-spawn mortality (10%; ISIT, WDFW) rates from the numbers transported.
[6] Estimates derived from ISIT data.

Table 5.1-2. Mean, minimum, and maximum hatchery and natural spawning metrics and proportionate natural influence for Lower Cowlitz Subbasin Coho Salmon, 2007-2015 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Spawning Location, Metric	2007-2015 Spawn/Brood Years		
	Mean	Minimum	Maximum
Hatchery			
Adults Collected	1,311	689	2,086
Hatchery-origin	1,311	689	2,086
Natural-origin	0	0	0
Pre-spawn Survival Rate	0.895	0.801	0.956
Adults Spawned	1,158	600	1,760
Hatchery-origin	1,158	600	1,760
Natural-origin	0	0	0
Total Green Eggs	1,716,343	909,186	2,710,393
Mean Fecundity	3,000	1,300	4,123
Total Eyed Eggs		data unavailable	
Smolts Released	1,477,266	810,085	2,349,911
Green Egg-to-Smolt Survival	86%	73%	97%
Smolt Productivity (smolts / spawner)	1,329	621	1,838
Nature			
Spawners	5,990	1,585	13,730
Hatchery-origin	525	20	1,069
Natural-origin	5,465	1,565	12,661
Smolts Produced		data unavailable	
Smolt Productivity (smolts / spawner)		data unavailable	
Proportionate Natural Influence			
pNOB	0.000	0.000	0.000
pHOS	0.086	0.013	0.150
PNI	0.000	0.000	0.000

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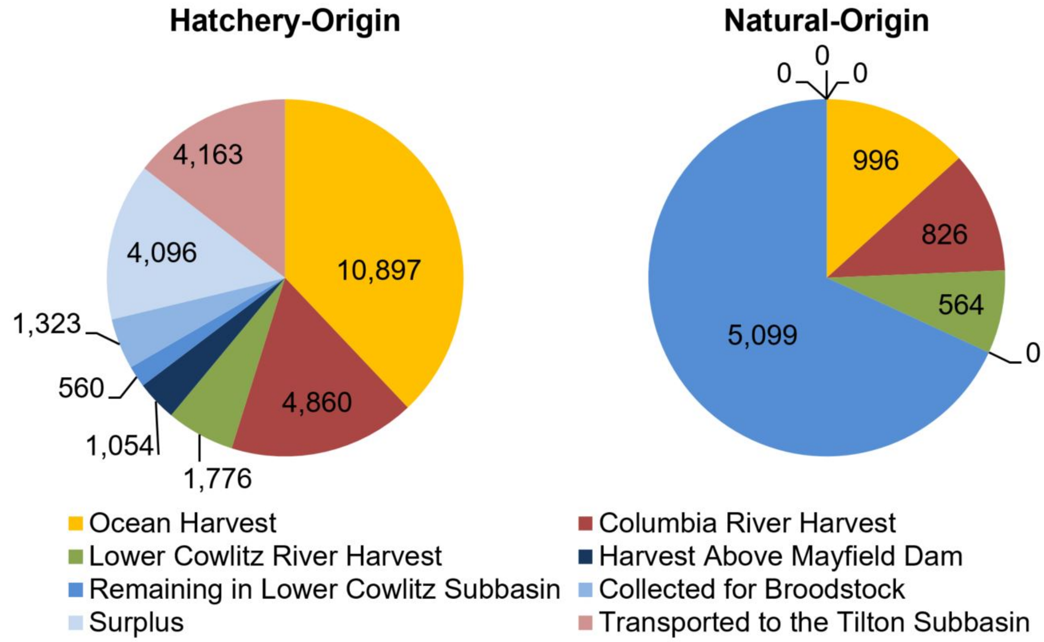

Figure 5.1-2. Mean numbers and proportions of hatchery- and natural-origin Lower Cowlitz Subbasin Coho Salmon caught in ocean, Columbia River, or lower Cowlitz River fisheries, or that were transported above Cowlitz Falls Dam (and were harvested or remained in the Upper Cowlitz Subbasin), 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

5.1.3.4. Spawning in Nature

The Lower Cowlitz Subbasin Coho Salmon minimum viability abundance target of 3,700 natural-origin salmon spawning in nature was exceeded during four of the eight years for which data are available in ISIT (mean = 5,099 from 2010-2017; Figures 5.1-2 and 5.1-3; Table 5.1-1). (As described in Section 1.2, the data presented in this 2020 FHMP are the most recently available, consolidated for FTC consideration, and include data from ISIT. The data are preliminary, pending a full QA/QC review of the Big Tables [Appendix A] by the M&E Subgroup.) From 2007-2017, a mean of 5,663 natural-origin Coho Salmon from the Lower Cowlitz Subbasin population returned to lower Cowlitz River tributaries (the mainstem lower Cowlitz River is not monitored for Coho Salmon). Of those, 10% were the result of indirect mortality from the sport fishery, and 90% remained in nature. No Lower Cowlitz Subbasin Coho Salmon were recorded as having returned to the Barrier Dam Adult Facility because all unmarked natural-origin salmon captured there are assumed to have come from the Tilton Subbasin.

Transport to the Tilton Subbasin of natural-origin Coho Salmon caught at the Barrier Dam Adult Facility reduces the documented abundance of natural-origin Lower Cowlitz Subbasin Coho Salmon by an unknown amount, as well as the actual number spawning in nature and their subsequent juvenile production in the Lower Cowlitz Subbasin. On the other hand, it is also likely that some Tilton Subbasin natural-origin salmon remain in the Lower Cowlitz Subbasin to spawn. No effort is currently conducted to identify the true origin of salmon returning to the Barrier Dam Adult Facility, so the effect of these adult returns spawning out of location on actual adult natural-origin abundance is uncertain but should be considered in the future to facilitate effective management of populations both above and below Mayfield Dam.

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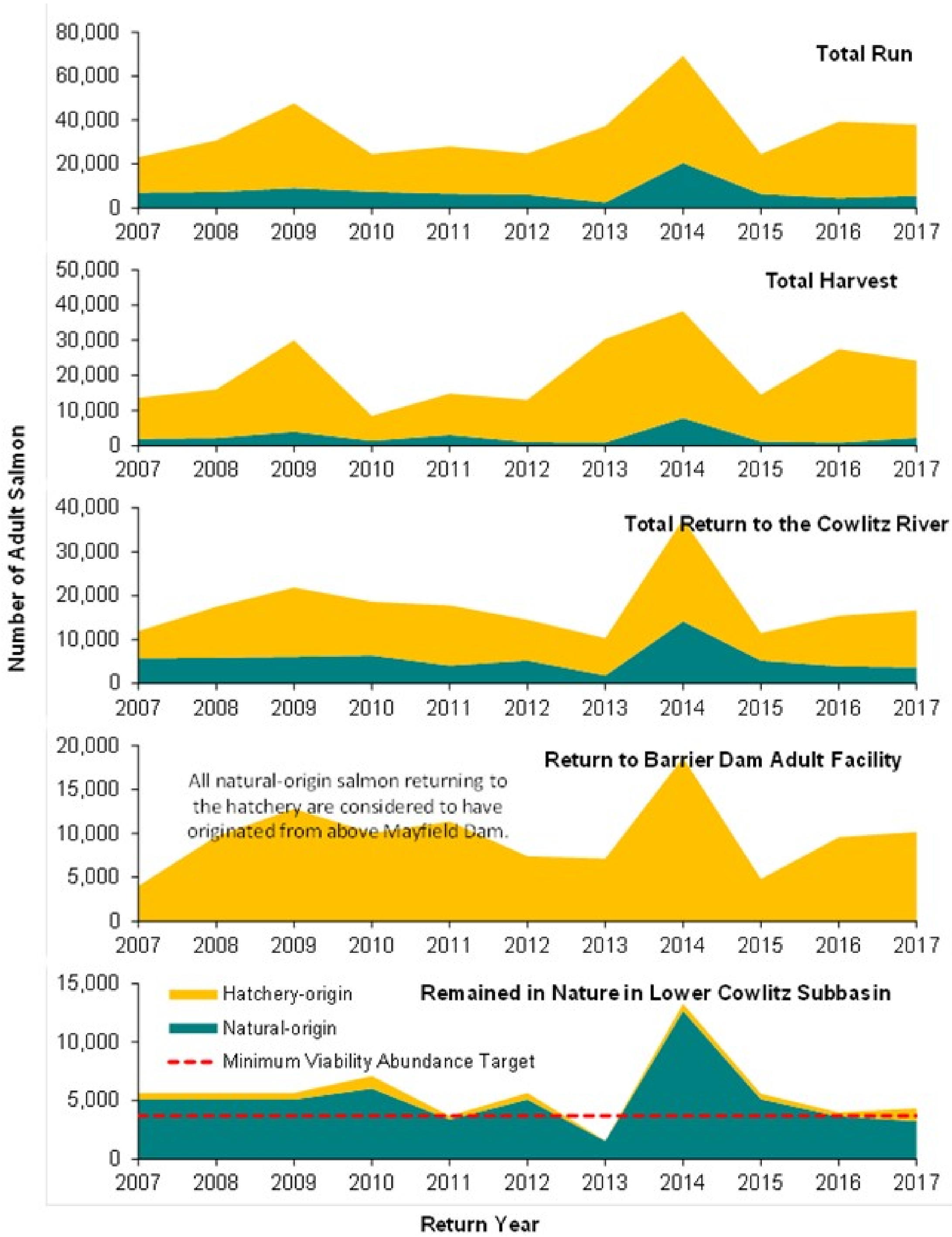

Figure 5.1-3. Estimated total run size for natural- and hatchery-origin (Segregated Hatchery Program) adult Lower Cowlitz Subbasin Coho Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, or returned to Lower Cowlitz Subbasin spawning grounds, 2007-2017. Note: Numbers of natural-origin adults may be too small to be visible. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

5.1.3.5. Smolt Production

Monitoring juvenile production of the Lower Cowlitz Subbasin Coho Salmon population is difficult, so no estimate of smolt abundance is available specifically for this population. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Coho Salmon abundance. However, any juvenile Coho Salmon captured in the smolt trap may be from either the Lower Cowlitz or the Tilton or Upper Cowlitz subbasins, above Mayfield Dam. Additionally, production from tributaries downstream from the smolt trap was not sampled. Smolts captured from the Upper Cowlitz Subbasin are identifiable, since each is marked with a CWT. However, smolts from the Tilton Subbasin (caught at Mayfield Dam or that pass through the dam) are not marked. Data are further confounded due to the proportions trapped or passed through the turbines at the Mayfield Downstream Collection Facility are not monitored on a regular basis. During this FHMP period, we will focus monitoring of the Lower Cowlitz Subbasin Coho Salmon population on adult productivity (adult recruits/spawner). Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps.

5.1.3.6. Natural-origin Survival and Productivity

Survival and productivity are key metrics for monitoring populations. However, neither SAR, TSAR, nor smolts/spawner can be calculated for the Lower Cowlitz Subbasin Coho Salmon population because smolt abundance in the Lower Cowlitz Subbasin is not estimated, nor is the age of returning mature salmon currently available in a consolidated database. For reference, mean smolt-to-adult return rate (to the Barrier Dam Adult Facility) for Coho Salmon coded-wire-tagged as smolts at Cowlitz Falls Dam from 2013-2015 was 8.53%. We will monitor this metric for the Lower Cowlitz Subbasin population as the data become available, through our M&E Program.

If we can develop a good estimate of smolt numbers, we will also monitor smolt productivity. Smolts produced/spawner provides an indication of the productivity of the freshwater rearing habitat and limiting factors, but this metric is a lower priority for overall population monitoring.

5.1.3.7. Age Composition

Age composition has not been completely calculated from the data in ISIT because they are not compiled by age or brood year. During this FHMP period, it will be necessary to develop a single consolidated data source. Age classes are characterized as “jacks (<42 cm)” or “adults (>42 cm),” and these data are available for returns to the Barrier Dam Adult Facility and tributary weirs. Because natural-origin returns to the hatchery are assumed to originate from populations above Mayfield Dam, no natural-origin Lower Cowlitz Subbasin Coho Salmon are assumed to be handled at the hatchery. We will monitor this index as the data become available, through our M&E Program.

5.1.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, to evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population that it is supplementing (see Section 5.0.9).

Cowlitz Salmon Hatchery initiated a Coho Salmon hatchery program in 1967 utilizing adults originating from the upper Cowlitz, Cispus and Tilton rivers that were collected at the Mayfield Dam Fish Passage Facility (WDFW 2014c). The program was integrated by default because the hatchery-origin Coho Salmon were not 100% marked until 1998 and because only a fraction of the hatchery-origin salmon was marked, the integration rates were unknown as was the case throughout the region. A truly segregated program began in 1998 when the hatchery-origin salmon were 100% adipose fin-clipped and managers could be certain about the origin of the salmon collected for broodstock. For the 1995-2017 brood years, total hatchery production goals for Coho Salmon yearling smolts has ranged from 1,842,716 to 8,000,000 (Table 5.1-3).

Table 5.1-3. Coho Salmon smolt production goal and actual smolt production, by hatchery program, 1995-2017 brood years.

Brood	Lower Cowlitz River		Lower Cowlitz River Segregated		Lower Cowlitz River Integrated		Total	
Year	Goal	Actual	Goal	Actual	Goal	Actual	Goal	Actual
1995	4,000,000	4,645,761					4,000,000	4,645,761
1996	?	5,227,597					?	5,227,597
1997	4,000,000	5,382,421					4,000,000	5,382,421
1998	4,000,000	8,853,698					4,000,000	8,853,698
1999	4,000,000	4,847,088					4,000,000	4,847,088
2000	?	3,457,360					?	3,457,360
2001	8,000,000	7,007,709					8,000,000	7,007,709
2002	3,200,000	3,757,474					3,200,000	3,757,474
2003	3,200,000	3,429,570					3,200,000	3,429,570
2004	3,200,000	3,260,568					3,200,000	3,260,568
2005	3,200,000	3,387,572					3,200,000	3,387,572
2006	3,200,000	3,446,199					3,200,000	3,446,199
2007			2,361,254	2,349,911	500,000	472,248	2,861,254	2,822,159
2008			1,835,435	1,970,202	1,000,000	938,202	2,835,435	2,908,404
2009			1,904,746	1,990,284	1,000,000	1,079,002	2,904,746	3,069,286
2010			842,716	810,085	1,000,000	1,069,796	1,842,716	1,879,881
2011			1,200,000	1,378,915	978,000	996,198	2,178,000	2,375,113
2012			1,200,000	1,301,180	978,000	768,474	2,178,000	2,069,654
2013			1,200,000	1,205,571	978,000	1,056,400	2,178,000	2,261,971
2014			1,200,000	1,165,720	978,000	897,922	2,178,000	2,063,642
2015			1,200,000	1,454,483	978,000	1,201,922	2,178,000	2,656,405
2016			1,200,000	1,246,317	978,000	1,127,160	2,178,000	2,373,477
2017			1,200,000	1,280,316	978,000	1,055,449	2,178,000	2,335,765

5.1.4.1. Abundance

From 2007-2017, the mean total run size of hatchery-origin Coho Salmon was 27,703 (Figures 5.1-2 and 5.1-3; Table 5.1-1). A mean of 11,945 hatchery-origin Coho Salmon entered the Cowlitz River, 9,609 returned to the Barrier Dam Adult Facility, 1,776 were harvested, and 560 remained on the spawning grounds in the Lower Cowlitz Subbasin.

5.1.4.2. Harvest

From 2007-2017, 67% (18,588) of the Lower Cowlitz Subbasin hatchery-origin (Segregated Hatchery Program) population run was harvested (Figures 5.1-2 and 5.1-3; Table 5.1-1). From 2007-2017, 59% (10,897) of the total hatchery-origin harvest was in the ocean, 26% (4,860) was in the Columbia River, 10% (1,776) in the Lower Cowlitz Subbasin, and 6% (1,054) in the Tilton Subbasin (salmon that were transported upstream).

5.1.4.3. Disposition

From 2007-2017, a mean of 9,609 adult Coho Salmon from the Segregated Hatchery Program returned to the Barrier Dam Adult Facility. Of those, a mean of 1,323 were collected for broodstock and 1,163 were spawned. A mean of 4,163 were transported to the Tilton Subbasin to provide harvest opportunities and to supplement natural spawning. The remaining surplus of 4,096 were provided to food bank programs.

5.1.4.4. Hatchery-origin Returns

From 2007-2017, a mean of 11,945 hatchery-origin Coho Salmon returned to the Cowlitz River, where 15% (1,776) were harvested, 80% (9,609) returned to the Barrier Dam Adult Facility, and 5% (560) remained in nature.

5.1.4.5. Hatchery Rearing

From 2007-2015, a mean of 1,311 mature hatchery-origin Coho Salmon were collected for broodstock in the Segregated Hatchery Program (Table 5.1-2). Mean pre-spawn survival was 90% and a mean of 1,158 of those collected were spawned, of which a mean of 52% were females. The Segregated Hatchery Program uses only mature salmon from the Segregated Hatchery Program for broodstock, so pNOB = 0 for all years.

From 2007-2015, an estimated mean of 1,716,343 green eggs were collected for the Segregated Hatchery Program from a mean of 602 females. Mean fecundity was 3,000 green eggs, mean green egg-to-smolt survival was 87%, and 1,477,266 smolts were released. Some eggs and/or fry were provided to RSI programs. However, juvenile production from these programs is unknown. Additionally, these offspring were not marked, so mature production is also unknown.

5.1.4.6. Hatchery-origin Survival and Productivity

We cannot calculate separate survival estimates for the Segregated and Integrated Hatchery Programs, as only one of those groups had CWTs and the necessary information is not available in ISIT or RMIS. However, we see little reason for survival to differ substantially between the programs. During this FHMP period, it will be necessary to develop a single consolidated data source to describe these estimates and assumptions.

Based on the CWT data in the RMIS database, the mean total smolt-to-adult return (TSAR) rate for coded-wire-tagged hatchery-origin Coho Salmon for the 2005-2014 brood years was 1.61. Mean productivity (adult recruits that returned to the Barrier Dam Adult Facility/ spawned parent; R/S) has not been estimated, as all data are not yet available. We will monitor this index as the data or estimating methods become available through our M&E Program. As noted in Chapter 1 (Section 1.2), the data presented in this FHMP are preliminary, pending a full QA/QC review of the Big Table Dataset (Appendix A) by the M&E Subgroup for accuracy and source.

5.1.4.7. Age Composition

Age composition has not been completely calculated from the data in ISIT because they are not compiled by age classes. For hatchery-origin salmon, mean age composition of mature Coho Salmon that returned to the Barrier Dam Adult Facility from the 2007-2017 run years was 28% jacks (age-2) and 72% adults (ages-3 and -4). CWT data show that, for the 2000-2015 brood years, means of 7.7%, 92.2%, and 0.03% of the hatchery-origin Coho Salmon returned at age-2, age-3, and age-4, respectively. During this FHMP period, a single consolidated database will be developed for analysis and reporting to address this question.

5.1.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in PNI and the metrics that are used to calculate it (pNOB and pHOS) can indicate an increase or decrease in the effect of hatchery-origin salmon on the natural population.

From 2007-2017, a mean of 5,659 Coho Salmon spawned in the Lower Cowlitz Subbasin other than the Toutle and Coweeman rivers (Figures 5.1-2 and 5.1-3; Table 5.1-1). Of those, a mean of 560 were hatchery-origin (Segregated Hatchery Program) and 5,099 were natural-origin. Mean estimated spawner pHOS was 0.101 and ranged from 0.013-0.252. Because the Segregated Hatchery Program uses only hatchery-origin salmon for broodstock, pNOB is always equal to 0, so PNI = 0, as well. No natural-origin salmon were collected because the Segregated Hatchery Program uses only hatchery-origin salmon for broodstock. Therefore, the natural-origin escapement was not mined to support the hatchery program.

5.1.6. Future Management

The Lower Cowlitz Subbasin Coho Salmon population is designated as a Primary population for contribution to MPG and ESU recovery goals, with a minimum viability abundance target of 3,700 natural-origin spawners in nature. Population viability was rated as Very Low (LCFRB 2010, WDFW and LCFRB 2016) but natural-origin abundance has improved and the minimum viability abundance target was exceeded in 2010, 2014, and 2015 (ranging from 1,565-12,661). While the target was not met in 2011, 2013, 2016, or 2017 (ranging from 1,565-3,654), the most-recent (2013-2017) 5-year mean was 5,253 so this population may be meeting its minimum natural-origin spawner abundance goal of 3,700. However, this population is not meeting the HSRG guideline of pHOS <0.05 for hatchery influence in a Primary population with a segregated hatchery program. The 2011 FHMP (Tacoma Power 2011) noted that “better information about spawner abundance and composition is required” and monitoring effectiveness has improved since that time. Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs.

5.1.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation and minimum viability abundance targets is evaluated through monitoring of standard fisheries management metrics (Table 5.1-4; Appendix A, Big Tables). The Lower Cowlitz Subbasin Coho Salmon population had an historical abundance of about 18,000 salmon and has a minimum viability abundance target of 3,700 natural-origin spawners in nature. In 2010, abundance and productivity of this population were rated as Very Low (LCFRB 2010). Today, the population is on the verge of meeting its minimum viability abundance target (Figure 5.1-3; Table 5.1-1). Within 2 years following completion of the FHMP, a Transition Plan will be developed to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts.

- **Long-term Goals:** The goal for this Primary Coho Salmon population is full recovery, which would include, but not be limited to (with specifics to be determined and agreed upon during the development of the Transition Plan):
  - Maintaining natural-origin spawner abundance >3,700 in the Lower Cowlitz Subbasin.
  - There will be no hatchery supplementation for this population, so PNI cannot be calculated. Hatchery supplementation for the entire basin will be shifted to a single program for the Upper Cowlitz Subbasin. In the Lower Cowlitz Subbasin, it is anticipated that pHOS will be unregulated; as we transition, we will evaluate appropriate pHOS targets and associated fish management applications.
  - A harvestable population of natural-origin Coho Salmon in the Lower Cowlitz Subbasin.
- **FHMP Goals:** The goals for the Lower Cowlitz Subbasin Coho Salmon population for the duration of this FHMP are to achieve attainable steps toward population recovery by:
  - Maintaining natural-origin spawner abundance >3,700 in the Lower Cowlitz Subbasin.
  - Define the disposition of surplus salmon and management strategies for high and low return years.
  - Emphasize as key population monitoring and VPS metrics:
    - Adult and juvenile abundance estimates.
    - Numbers returning to the Cowlitz River.
    - Natural-origin spawners in nature and hatchery-origin return to the Barrier Dam Adult Facility.
    - Spawning distribution in the Lower Cowlitz Subbasin.
    - Adult productivity - numbers of adult progeny returning per parent.
    - Population diversity.
    - Relative numbers of natural- and hatchery-origin salmon spawning in nature in the Lower Cowlitz Subbasin.
    - Estimates of harvest rates.
  - Evaluate the appropriate pHOS targets and associated fish management applications in the natural lower Cowlitz spawning population.

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Table 5.1-4. Recovery phase targets for Lower Cowlitz Subbasin Coho Salmon. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Species:	Coho Salmon
Population Name:	Lower Cowlitz Subbasin
Recovery Designation:	Primary
Current Recovery Phase:	Local Adaptation

	RECOVERY PHASE				
Target Metric	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	400[1]	900[1]	1,800[1]	TBD[1]	5,253
Smolt Abundance (below hatchery)	?	?	?	?	?
Smolt Passage Survival	N/A	N/A	N/A	N/A	N/A
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Int/Seg	Int/Seg	Int	Int	Seg
Broodstock to be Collected	1,340	675	670	670	1,393
Integrated Hatchery Program	330	340	500	670	0
Hatchery-Origin	165	170	165	0	0
Natural-Origin	165	170	335	670	0
Segregated Hatchery Program	1,010	335	170	0	1,393
Smolts to be Produced	1,200,000	1,200,000	1,200,000	1,200,000	1,182,149
Integrated Hatchery Program	300,000	600,000	900,000	1,200,000	0
Segregated Hatchery Program	900,000	600,000	300,000	0	1,182,149
Total Smolt-to-Adult Survival					
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.2	0.1	0.479
Integrated Hatchery Program	0.5	0.4	0.2	0.1	
Segregated Hatchery Program	0.1	0.1	0.1	N/A	0.479
pNOB (>)	0.2	0.3	0.5	1	0
PNI (>)	0.3	0.55	0.7	0.9	0
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	50%	40%	30%	30%	0%

[1] No minimum viability abundance target has been set for these populations; the numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.

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- Consider improved methods to estimate, monitor, evaluate, and collect and analyze data, including numbers and age, sex, and origin of all recoveries:
  - Harvested in fisheries in the ocean, Columbia River, and Cowlitz River.
  - Returning to the Barrier Dam Adult Facility.
  - Retained as broodstock.
  - Transported and released upstream of Mayfield Dam.
  - Hatchery surplus.
  - Hatchery strays to/from outside of the Cowlitz Basin.
  - Actual spawners in nature.
  - Natural smolts produced.
- Reduce the abundance of hatchery surplus by increasing hatchery-origin harvest without a concomitant increase in natural-origin rate of indirect mortality.
- Maintain flexibility to increase production within FERC licensing and ESA constraints.

5.1.6.2. Management Targets

The factor that inhibit progress toward conservation goals for this population is the high proportion of hatchery-origin salmon spawning in nature. Also, estimates of Coho Salmon spawning in the mainstem are lacking and the survival of offspring produced in the mainstem is unknown, thus, limiting our ability to fully assess progress toward recovery. In recent years, harvest of this population has occurred primarily in ocean and mainstem Columbia River fisheries. This exploitation of the natural-origin population directly reduces natural spawning. Likewise, the abundance of hatchery-origin adults and jacks increases the likelihood of natural spawning and, subsequently, introgression of hatchery traits into the natural-origin population.

- **Natural Production:** A goal of Tacoma Power's Cowlitz license is to restore self-sustaining, naturally reproducing populations to harvestable levels. Activities by Tacoma Power to protect and enhance habitat in the Lower Cowlitz Subbasin are expected to benefit smolt production and the subsequent return of natural-origin salmon, but the current monitoring program is insufficient to evaluate the effectiveness of those efforts. Current estimates of spawner abundance only include Lower Cowlitz tributaries; estimates of mainstem spawners and survival of their progeny are lacking. In addition, pre-spawn mortality is unknown. As part of this FHMP, Tacoma Power will refine the existing monitoring program to prioritize and implement a program focused on evaluating program effectiveness based on regionally accepted VSP parameters specific to each recovery phase (Crawford and Rumsey 2011); see Chapter 10, Monitoring & Evaluation (M&E).
  - **Abundance – Natural Spawning:** Recent data indicate that the Lower Cowlitz Subbasin Coho Salmon population may have achieved its minimum viability abundance target of 3,700 natural-origin spawners in nature. This has been achieved along with a recent (5-year mean) total natural-origin harvest rate of 22%. If exploitation remains at or below the current level, the population may be able to maintain itself above 3,700. Exploitation in the Lower Cowlitz Subbasin is low, with only 9% of the total harvest-related mortality of natural-origin salmon occurring there; only 2.5% of the natural-origin salmon entering the Cowlitz River die due to the fishery. During this FHMP period, we will focus our monitoring of abundance on

documenting estimates of the total number of hatchery- and natural-origin spawners, their respective pre-spawn mortality rates, and pHOS. These metrics are critical for achieving recovery and the number of spawners is used to calculate productivity (recruits/spawner).

Two issues may confound accurately estimating abundance of the Lower Cowlitz Subbasin Coho Salmon population. First, no surveys are conducted in the mainstem Cowlitz River, where some Coho Salmon likely spawn (especially in side channels). Second, we cannot determine the origin of unmarked salmon returning to the Cowlitz River; specifically, we cannot distinguish between those from the Lower Cowlitz and Tilton subbasins or any other source of unmarked Coho Salmon. For management purposes, all unmarked/untagged (assumed to be natural-origin) salmon that are captured at the Barrier Dam Adult Facility are considered to be from the Tilton Subbasin because they have swum past the spawning reaches in the Lower Cowlitz Subbasin. While many of them likely did come from the Tilton Subbasin, we cannot know for certain and it is very likely that some originated in the Lower Cowlitz Subbasin (and simply wandered a little too far upstream while exploring suitable spawning areas) or strayed from some other location. It is also likely that some Tilton Subbasin salmon remain below Barrier Dam. Although these scenarios provide a source of genetic diversity, they compromise our ability to evaluate recovery and may preclude the ability of populations to adapt to local conditions.

- **Smolts Produced in Nature:** Monitoring juvenile production of the Lower Cowlitz Subbasin Coho Salmon population is difficult. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile Coho Salmon abundance. However, any juvenile Coho Salmon captured may be from either the Lower Cowlitz Subbasin or above Mayfield Dam. Therefore, we will now focus on adult productivity (adult recruits/spawner) to monitor the Lower Cowlitz Subbasin Coho Salmon population. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps.
- **Smolt-to-Adult Survival:** Because smolt abundance specific to the Lower Cowlitz Subbasin population is not estimated and returns are not fully documented by age, SAR cannot be estimated. This metric is important to understanding and identifying key limiting factors. This management target relies on obtaining estimates of smolts produced in nature.
- **Productivity (Adult Recruits/Spawner):** Because returns are not documented by age, adult-to-adult productivity has not yet been estimated. Productivity (mature natural-origin F_1 recruits/F_0 spawner) is the primary metric for monitoring natural populations, so collection of the necessary data is critical. Estimating adult to adult productivity is a key management target.

- **Hatchery Production:** The Lower Cowlitz Subbasin natural-origin population is approaching its minimum viability abundance target and does not appear to need supplementation. However, fisheries are supported by the Segregated Hatchery Program, so that hatchery production is proposed to be shifted to a single Upper Cowlitz Subbasin Integrated Hatchery Program to be developed as part of the Transition Plan. Specific targets will be set during the period covered by this FHMP in coordination with the FTC. In the interim, the hatchery program will be operated as it was in 2019.
  - **Abundance:** The Cowlitz Salmon Hatchery Coho Salmon Program is expected to produce an annual run of 25,500 hatchery-origin Coho Salmon (WDFW 2014c),

which was exceeded for all return years from 2007-2017 (mean = 108,413). Indeed, the Segregated Hatchery Program, alone exceeded 25,500 for 5 of the 11 years (mean = 27,703). We will focus our monitoring of abundance on the numbers that are harvested and that return to the Cowlitz River and the Barrier Dam Adult Facility (which are critical for calculating SAR and TSAR), as well as the number that remain to spawn in nature (used for pHOS and PNI calculations).

- **Broodstock Collection and Spawning:** Pending the Transition Plan, no hatchery-origin salmon are proposed to be produced to supplement the Lower Cowlitz Subbasin.
- **Smolt Production:** Pending the Transition Plan, no hatchery-origin salmon are proposed to be produced to supplement the Lower Cowlitz Subbasin.
- **Smolt-to-Adult Survival:** SAR is the primary metric for monitoring hatchery populations, especially those for which return abundance is lower than expected. However, because returns are not documented by age, SAR has not been estimated. We will collect scales and/or CWTs from at least a subsample of recoveries at available collection sites. Additional data may include the rate of precocious maturation and the sex ratio of hatchery-origin salmon by age. We will monitor this index as the data become available, through our M&E Program.

  SAR and total smolt-to-adult survival (TSAR) are the primary indices for monitoring a hatchery program. SAR indicates the success of the program in producing salmon that survive in nature and return to the hatchery; a sufficient number is needed to support hatchery broodstock (for segregated or partially integrated programs) or for release into nature to support natural spawning. TSAR is indicative of the overall success of a hatchery program to support all aspects that hatchery salmon may support: commercial, tribal, and recreational fisheries in the ocean, Columbia River, and Cowlitz River and tributaries, hatchery broodstock, and natural spawning.
- **Productivity:** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner) is of less importance, but is still useful, for monitoring hatchery populations, where survival to the smolt stage is unnaturally high. For the Cowlitz River Segregated Hatchery Program, an R/S ratio of 34 is needed for 750 spawners to achieve the 25,500 annual return goal.
- **Strays and Spawning in Nature:** Only about 4% of the total hatchery-origin run (about 2% of those entering the Cowlitz River) are recovered on the natural spawning grounds. This estimate is based only on hatchery-origin salmon identified as having spawned in monitored streams in the Lower Cowlitz Subbasin. During this FHMP period, this information will be analyzed in more detail. Estimates of natural-origin fish spawning above or hatchery-origin fish removed from weirs on Delameter, Lacamas, Olequa, and Ostrander creeks are available beginning in 2010 but have not been consolidated into a single database for reporting and analysis at this time. This information is also used for expansion estimates to other lower river tributaries. Conversely, hatchery-origin salmon that spawn in Mill Creek (which passes through the grounds of Cowlitz Salmon Hatchery) or immediately below the hatchery ladder are also considered to be strays. Developing estimates for strays outside of the Cowlitz Basin may also improve rigor for estimating stray rates and our understanding of the biology and management of these salmon.
- **Surplus:** A surplus of hatchery-origin salmon returning to the Cowlitz River can affect the viability of the natural-origin population if a sufficient number of them

remain to spawn in nature and increase pHOS. Our goal is to maximize the harvest of hatchery-origin salmon; as we transition, we will evaluate appropriate pHOS targets and associated fish management applications.

- **Harvest:** A mean of 60% of the combined Lower Cowlitz Subbasin Coho Salmon run is harvested each year, including 32% of natural-origin salmon. A mean of 50% of the combined run is harvested in the ocean and Columbia River fisheries (40% of the hatchery-origin and 13% of the natural-origin runs). Conversely, only 7% of the run (6% of the hatchery-origin and 8% of the natural-origin runs) is harvested in the Lower Cowlitz Subbasin. An additional 4% of the Lower Cowlitz Subbasin Coho Salmon hatchery-origin run is harvested in the Tilton Subbasin, after being transported there from the Barrier Dam Adult Facility. However, even with this level of exploitation natural-origin salmon, the population appears to be achieving its minimum viability abundance target. Given that population productivity appears to be above replacement, we expect the population to continue to grow. As natural-origin abundance increases, the focus can shift to allowing a directed harvest on these populations as called for in the Settlement Agreement.

  Harvest management of the Lower Cowlitz Subbasin Coho Salmon population should focus on increasing the harvest of hatchery-origin Coho Salmon, especially in the Lower Cowlitz Subbasin. Increasing the harvest of hatchery-origin salmon in all fisheries would decrease the potential for them to remain in the river to spawn in nature. However, this will likely result in an increase in the natural-origin catch and subsequent indirect mortality.

  Hatchery-origin harvest outside of the Cowlitz Basin will be monitored using the CWT recovery and sampling rate data in the RMIS and robust creel surveys. Harvest in the Cowlitz Basin will be monitored with rigorous creel surveys.

- **Proportionate Natural Influence:** During the interim period, the hatchery program will be operated as it was in 2019; PNI does not apply to the Segregated Hatchery Program. Moving forward, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. Specific targets will be set during the period covered by this FHMP in coordination with the FTC.

  As noted, PNI is not calculated for segregated hatchery programs. However, although mean pHOS exceeds the 0.05 limit for Primary populations with segregated hatchery programs, it appears to be fairly low (0.101), and only 2% of the Segregated Hatchery Program salmon entering the Cowlitz River are recovered on the natural spawning grounds. Weirs are operated on Delameter, Lacamas, Olequa, and Ostrander creeks, where all hatchery-origin salmon captured are removed. Spawning ground surveys are conducted on these and a set of other streams in the basin, but not all streams (including the mainstem Cowlitz River) are surveyed and not all surveyed streams are surveyed extensively.

- **Age Composition:** A mean of 20% of the hatchery-origin salmon that returned to the Barrier Dam Adult Facility matured as jacks. Because natural-origin returns to the hatchery are assumed to originate from populations above Mayfield Dam, no natural-origin Lower Cowlitz Subbasin Coho Salmon are assumed to be handled at the hatchery; thus, ISIT does not estimate the ratio of jacks for natural-origin Lower Cowlitz Subbasin Coho Salmon. However, as long as we can keep pHOS low, the natural-origin population will likely produce a lower percentage of jacks.

5.1.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly to track the population's trajectory and variability, and includes the basic data required to operate a one-stage or two-stage life cycle model. Monitoring and evaluation needs of the Lower Cowlitz Subbasin Coho Salmon population are similar to other populations in the basin and include spawning ground surveys, accurate counts of hatchery releases and returns of both hatchery- and natural-origin salmon, adequate marking, and evaluation of alternative management and hatchery rearing strategies. To support recovery, monitoring programs need to be rigorous and allow for estimation with low bias and high precision that provides managers with sufficient confidence to guide management decisions, as well as to identify ways to improve survival. Areas of improvement for consideration that are specific to this population include the following:

- Estimating harvest rates of hatchery- and natural-origin salmon in all fisheries.
- Estimating hatchery- and natural-origin escapement to the Lower Cowlitz Subbasin, including expanding current monitoring program to include the mainstem.
- Controlling hatchery-origin escapement to Lower Cowlitz Subbasin spawning areas.
- Estimating hatchery- and natural-origin escapement to Lower Cowlitz Subbasin spawning areas, spawners in nature, and pre-spawning mortality.
- Documenting hatchery- and natural-origin returns to the Barrier Dam Adult Facility.
- Documenting numbers of salmon collected for hatchery broodstock and spawned.
- Estimating pHOS, pNOB, and PNI.
- Estimating natural-origin population productivity (spawner-to-spawner).
- Estimating natural and hatchery-origin SAR.
- Estimating natural-origin spawners in nature and hatchery-origin return to the Barrier Dam Adult Facility.
- Estimating spawning distribution in the Lower Cowlitz Subbasin.
- Estimating population diversity.

Directed Studies

Directed Studies are designed to diagnose and solve problems associated with achieving FHMP goals, and to fill management needs and information gaps in the Big Table (Appendix A). Examples of important areas of study for the Lower Cowlitz Subbasin Coho Salmon population include the following:

- **Juvenile rearing capacity studies**: Available habitat and habitat-specific (run/riffle/pool) densities.
- **Hatchery program studies:** Size at release, time of release, growth rates, broodstock collection, and spawning protocols.
- **Early life stage survival studies:** Egg to fry, fry to parr, and parr-to-smolt survival in the hatchery.
- **In-river migratory survival and behavior:** Survival of migrating juveniles and movement rates.
- **Hatchery supplementation experiments**: Assessing the impact of returning hatchery-origin adults.
- **Hatchery practices**: Examining the size and timing of release, growth rate in hatchery, broodstock collection techniques, and spawning protocols and smolt outmigration timing and hatchery rate predation.
- **Evaluation of impacts of *Ceratonova shasta*** on natural and hatchery production survival.
- **Conducting spawning ground surveys**, including information on scales, hatchery-/natural-origin ratio, pre-spawn, genetics, spatial distribution (upper extent), and reach specific adult densities (sub-sample).

5.1.7. Summary

- The Lower Cowlitz and Tilton subbasins Coho Salmon populations are the only remaining populations of the original four Coho Salmon populations above the Toutle River.
- A Coho Salmon hatchery program has supported the Lower Cowlitz and Tilton Subbasin populations since 1967. This hatchery program began operating as a fully segregated hatchery program in 1998, when mass-marking allowed for all hatchery-origin salmon to be differentiated.
- Natural-origin spawner abundance in the Lower Cowlitz Subbasin is approaching the minimum viability abundance target of 3,700. However, mean pHOS for the Lower Cowlitz Subbasin natural population is about 0.1 and therefore is not meeting the HSRG guideline of pHOS <0.05 for hatchery influence in a Primary population with a segregated hatchery program. This will be evaluated for appropriate management recommendations during this FHMP period.
- In the near term, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated)

hatchery programs, with an annual production target of 2.2 million yearling smolts. The Transition Plan for Coho Salmon will be developed within 2 years of completion of this FHMP. As an interim strategy and until the Transition Plan is developed, Tacoma Power and the FTC will operate the programs as they were operated in 2019. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

Population: Upper Cowlitz Subbasin Coho Salmon
Oncorhynchus kisutch

Evolutionarily Significant Unit:	Cascade Coho Salmon Columbia River Coho Salmon Evolutionarily Significant Unit (ESU) Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened; Listed in 2005, reaffirmed in 2011 and 2016
Population Recovery Designation:	Primary
Population Viability Rating:	
Baseline	Very Low
Objective	High
Minimum Viability Abundance Target:	4,000 natural-origin salmon spawning in the Upper Cowlitz Subbasin (2,000 in each of the Cispus and upper Cowlitz rivers)
Current Recovery Phase:	Recolonization
Current Hatchery Program(s):	Cowlitz Salmon Hatchery Integrated Hatchery Program, 978,000 yearling smolts
Proposed Hatchery Program(s)	Cowlitz Salmon Hatchery Integrated Hatchery Program, 2.2 million yearling smolts

5.2. Coho Salmon: Upper Cowlitz Subbasin Population

5.2.1. Purpose

This section describes the current status of the Upper Cowlitz Subbasin Coho Salmon population, based on recent and available data. We identify VSP metrics needed to evaluate the status of this population with regard to minimum viability abundance targets under ESA guidelines. Where appropriate, we propose changes to both hatchery and monitoring programs to better evaluate progress toward population recovery and achieving the Settlement Agreement requirements of 95% Fish Passage Survival or 75% Fish Passage Survival with the best available technology. The Upper Cowlitz Subbasin Coho Salmon population is currently in the Recolonization phase of recovery. During the period covered by this FHMP, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. We will continue to evaluate the hatchery program and fisheries management and make refinements or adjustments, as described in this FHMP, to effectively supplement and manage the Upper Cowlitz Subbasin Coho Salmon population.

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5.2.2. Population Description

The Upper Cowlitz Subbasin Coho Salmon population includes all natural-origin Coho Salmon that occupy the Cowlitz River and its tributaries upstream of Cowlitz Falls Dam (upper Cowlitz and Cispus river basins; Figure 5.2-1). Completion of Mossyrock Dam in 1968 and the subsequent abandonment of juvenile collection in Riffe Lake (then Davidson Lake) in 1973 resulted in the extirpation of the Coho Salmon populations in the Cispus and upper Cowlitz rivers and the aggregation of their genes into the existing Lower Cowlitz hatchery population. These upper river populations were then considered to be functionally extinct or at Very High Risk of extinction (LCFRB 2010).

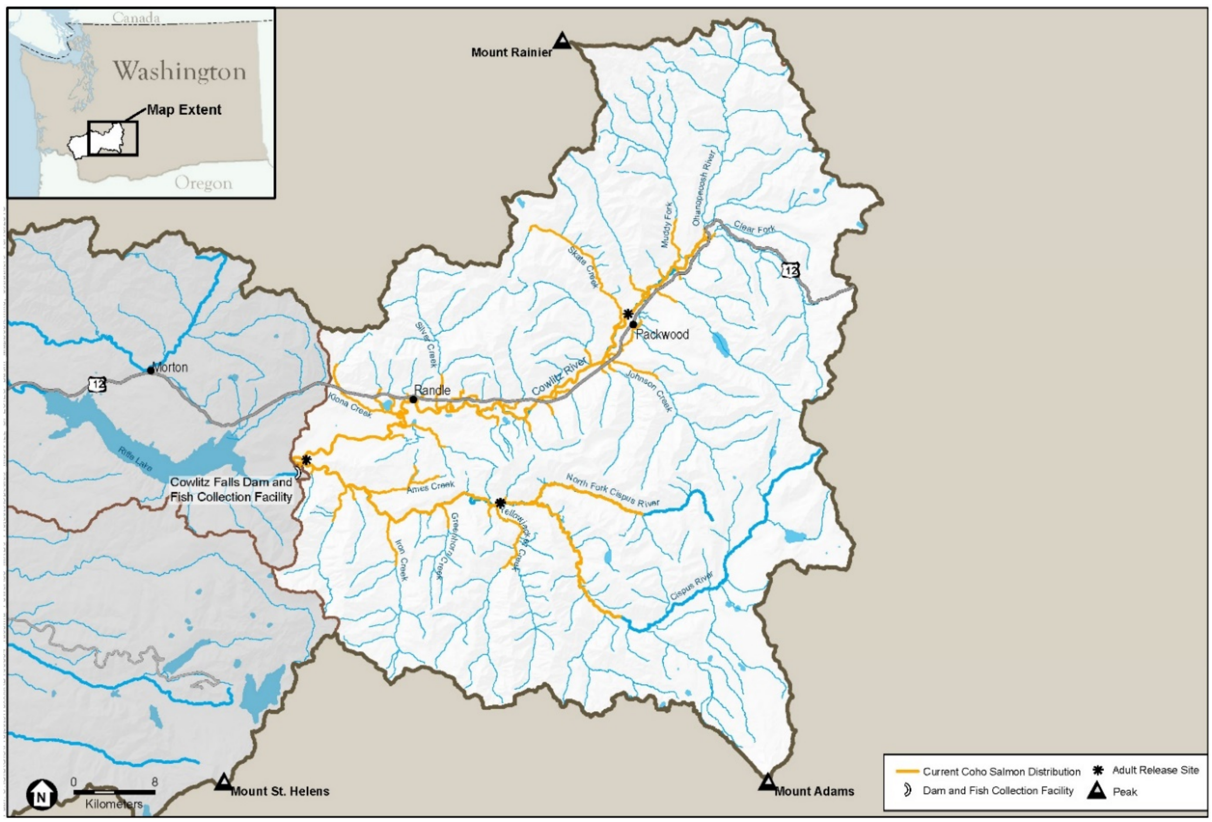

Figure 5.2-1. Distribution of Coho Salmon in the Upper Cowlitz Subbasin.

The lower Cowlitz River Coho Salmon hatchery population has been used as the genetic preserve and source for reintroductions of Coho Salmon to the Upper Cowlitz Subbasin (Cispus and upper Cowlitz rivers) after a reintroduction effort was initiated by the Bonneville Power Administration and WDFW with the construction of Cowlitz Falls Dam in 1994. The Upper Cowlitz Subbasin Coho Salmon population was found to be “Depressed” (LCFRB 2010) and, as part of the lower Columbia River ESU, was listed as threatened under the ESA in 2005. The reintroductions and improved monitoring, since 2011, have increased the abundance of Coho Salmon throughout the Cowlitz Basin. In turn, greater abundance has led to an improvement in the status of all Cowlitz River Coho Salmon populations, including upper river populations, from a High to Moderate risk of extinction, but they were reaffirmed as threatened under the ESA in 2011 and 2016 (NMFS 2016). Because this population is classified as a Primary population for recovery of the lower Columbia River ESU, it must attain its minimum viability abundance

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targets (in conjunction with other non-Cowlitz River Primary populations) for the ESU to be considered recovered (LCFRB 2010).

The Upper Cowlitz Subbasin Coho Salmon population is currently supplemented by the Integrated Hatchery Program, which is managed separately from the Lower Cowlitz River Segregated Hatchery Program. The Upper Cowlitz Subbasin Integrated Hatchery Program releases yearling smolts directly from Cowlitz Salmon Hatchery into the lower Cowlitz River each spring. In addition, both hatchery- and natural-origin adults and jacks are transported and released above Cowlitz Falls Dam to spawn naturally. Currently, spawning by Coho Salmon in the Upper Cowlitz Subbasin occurs in the mainstem and tributaries of the upper Cowlitz and Cispus rivers (LCFRB 2010; WDFW 2014c).

5.2.3. Natural Production

Two critical monitoring metrics for salmon management are the numbers that return at maturation and their disposition (Figures 5.2-2 and 5.2-3; Table 5.2-1). Upper Cowlitz Subbasin Coho Salmon that survive to maturity may be harvested in commercial, sport, or tribal fisheries in the ocean; commercial or sport fisheries in the lower Columbia River; or sport fishing in the lower Cowlitz River. Those escaping harvest may return to the Barrier Dam Adult Facility or remain on the natural spawning grounds in the Lower Cowlitz Subbasin. Natural-origin Coho Salmon from the Upper Cowlitz Subbasin that are caught at the Barrier Dam Adult Facility may be retained for broodstock or transported above Cowlitz Falls Dam for release (along with hatchery-origin salmon), where they may die prior to spawning from predation, disease, or indirect mortality from angling, or survive to spawn naturally. Monitoring these dispositions allows us to evaluate population health, productivity, and progress toward recovery.

The Upper Cowlitz Subbasin Coho Salmon population had an historical abundance of about 26,000 salmon (18,000 in the upper Cowlitz River and 8,000 in the Cispus River) (LCFRB 2010). The minimum viability abundance target for this population is a minimum annual abundance of 4,000 natural-origin adults spawning in nature; 2,000 in each of the Cispus and Upper Cowlitz rivers (LCFRB 2010). Only natural-origin Coho Salmon that are released into the Upper Cowlitz Subbasin and survive to spawn are counted toward the minimum viability abundance target.

5.2.3.1. Abundance

Critical data for monitoring the natural-origin Upper Cowlitz Subbasin Coho Salmon population have not been consistently collected and are incomplete. All smolts collected at Cowlitz Falls Dam are currently CWT tagged to allow for positive adult identification upon return. Adult abundance for this population has consisted of known census counts of transported fish and those used for the Integrated Hatchery Program. Collection of outmigrants at the Cowlitz Falls Fish Facility offers some indication of natural-origin smolt production, specifically the numbers collected and released downstream. While collection efficiency has improved in recent years, it has historically ranged widely and has not been as high as required by the Settlement Agreement. Smolts are captured at Cowlitz Falls Dam and transported to the Cowlitz Salmon Hatchery for release into the lower Cowlitz River. Smolts that are not collected and pass through Cowlitz Falls Dam to Riffe Lake are believed to have a very low rate of survival and passage through Mossyrock Dam and are lost to anadromy.

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Table 5.2-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin adult Coho Salmon from the Upper Cowlitz Subbasin population that could be accounted for at recovery locations, and percentages of total at each recovery location, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin,	Number of Adults		
Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	82,773	8,827	192,930
Harvest[2]	50,012	5,380	122,889
Ocean harvest	29,363	3,539	78,412
Columbia River harvest	14,429	1,143	46,689
Lower Cowlitz River harvest	6,176	517	17,168
Above Mayfield Dam harvest[3]	44	0	108
Total Return to Cowlitz River[4]	38,982	3,053	92,027
Remain in Lower Cowlitz Subbasin	383	12	929
Return to Barrier Dam Adult Facility	32,423	2,383	74,352
Collected for Broodstock	135	0	866
Transported to Upper Cowlitz Subbasin	11,362	953	25,435
Spawners in Upper Cowlitz Subbasin[5]	8,959	751	20,081
Natural-origin			
Total Run[1]	7,064	1,527	17,854
Harvest[2]	2,829	1,273	10,438
Ocean harvest	1,186	529	3,948
Columbia River indirect mortality	964	143	4,429
Lower Cowlitz River indirect mortality[6]	635	246	1,991
Above Mayfield Dam indirect mortality	44	0	108
Total Return to Cowlitz River[4]	4,915	606	9,477
Remain in Lower Cowlitz Subbasin	0	0	0
Return to Barrier Dam Adult Facility	4,280	231	8,358
Collected for Broodstock	630	229	809
Transported to Upper Cowlitz Subbasin	3,650	2	7,633
Spawners in Upper Cowlitz Subbasin[5]	2,851	2	5,948
Combined Hatchery- and Natural-origin			
Total Run[1]	89,837	12,832	210,783
Harvest[2,7]	52,840	6,907	128,578
Ocean harvest	30,548	4,443	79,716
Columbia River indirect mortality	15,393	1,502	51,118
Lower Cowlitz River indirect mortality	6,811	770	19,159
Above Mayfield Dam indirect mortality	88	0	216
Total Return to Cowlitz River[4]	43,897	4,373	101,504
Remain in Lower Cowlitz Subbasin	383	12	929
Return to Barrier Dam Adult Facility	36,703	3,450	81,838
Collected for Broodstock	765	341	1,339
Transported to Upper Cowlitz Subbasin	15,012	1,547	32,131
Spawners in Upper Cowlitz Subbasin[5]	11,810	1,217	25,322

[1] Sum of all harvest below Mayfield Dam, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Upper Cowlitz Subbasin fisheries.
[3] Represents Lower Cowlitz hatchery-origin fish transported to the Tilton Subbasin.
[4] Sum of lower Cowlitz River harvest, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.
[5] Estimated by subtracting estimated harvest loss and multiplying by assumed fallback (12%) and pre-spawn mortality (10%) rates from the numbers transported.
[6] Estimates derived from ISIT data.
[7] No direct harvest of NOR Coho Salmon in the Columbia or lower Cowlitz rivers; these are estimates of indirect mortalities.

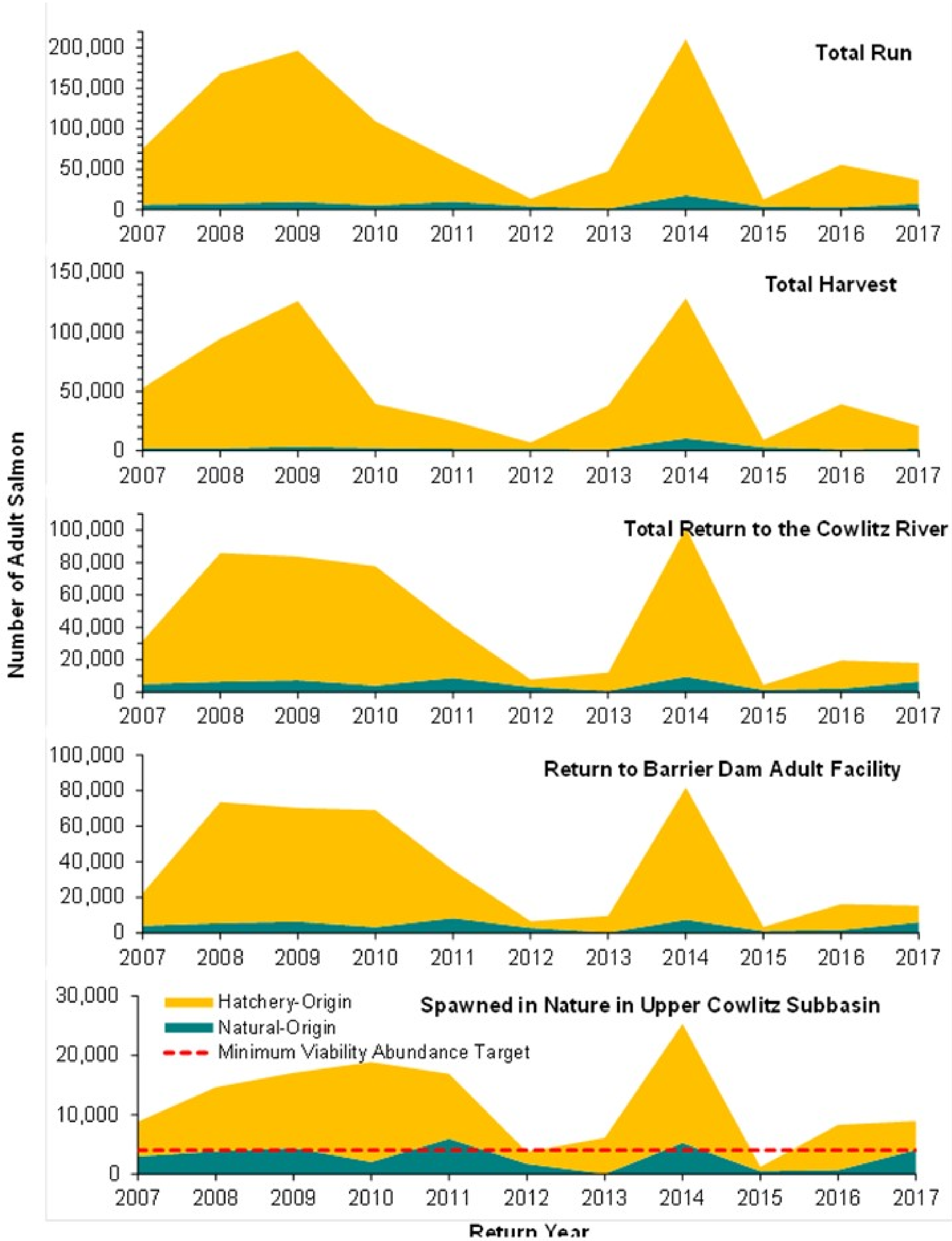

Figure 5.2-2. Total run size of hatchery- (Segregated Hatchery Program) and natural-origin / combined natural-origin and Integrated Hatchery Program Upper Cowlitz Subbasin Coho Salmon and numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, or were transported upstream of Cowlitz Falls Dam, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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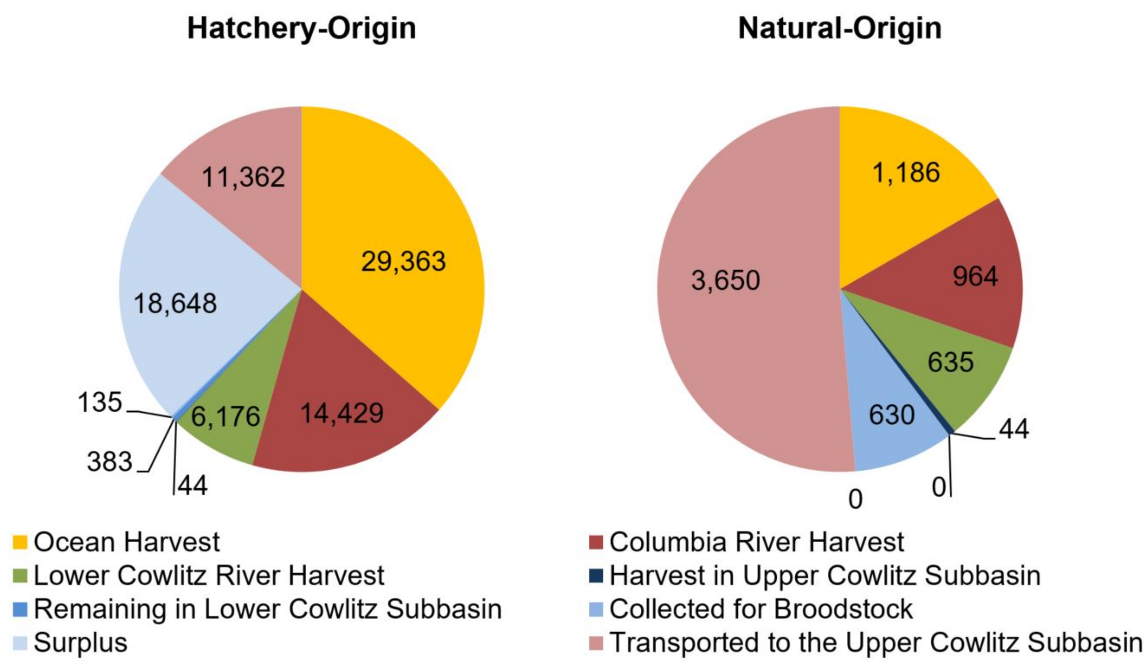

Figure 5.2-3. Mean numbers and proportions of hatchery- and natural-origin Upper Cowlitz Subbasin Coho Salmon caught in ocean, Columbia River, or lower Cowlitz River, or returned to the Barrier Dam Adult Facility (including Upper Cowlitz Subbasin harvest, Upper Cowlitz Subbasin spawning grounds, hatchery broodstock, and hatchery surplus) and those that were transported to the Upper Cowlitz Subbasin, from 2007-2017. (No direct harvest of NOR Coho Salmon in the Columbia or lower Cowlitz rivers; the harvest estimates indicate indirect mortalities.) Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

From 2007-2017, a mean of 7,064 Upper Cowlitz Subbasin natural-origin Coho Salmon returned to the Barrier Dam Adult Facility or were indirectly impacted or strayed to the lower river on their way back (Figures 5.2-2 and 5.2-3; Table 5.2-1). A mean of 4,915 natural-origin Upper Cowlitz Subbasin Coho Salmon escaped the ocean and Columbia River fisheries and entered the Cowlitz River. Of those salmon reaching the Cowlitz River, a mean of 4,280 returned to the Barrier Dam Adult Facility, and 3,650 were transported and released upstream of Cowlitz Falls Dam to spawn naturally in the Upper Cowlitz Subbasin.

5.2.3.2. Harvest

Upper Cowlitz Subbasin Coho Salmon contribute to important commercial, sport, and tribal fisheries in the Pacific Ocean, lower Columbia River, and within the Cowlitz Basin. From 2007-2017, mean total harvest of the natural-origin run of Upper Cowlitz Subbasin Coho Salmon was 2,829 adults (40% of the total run; Table 5.2-1). Of the total harvest, 42% were in the ocean, while 34% were harvested in the lower Columbia River, 22% in the lower Cowlitz River, and 2% in the Upper Cowlitz Subbasin.

Although a large percentage of Coho Salmon were caught in the ocean and Columbia River fisheries, of those that returned to the Cowlitz River, most escaped harvest and arrived at the hatchery (Table 5.2-1). From 2007-2017, the lower Cowlitz River fishery harvested a mean of only 13% (635) of all natural-origin Upper Cowlitz Subbasin Coho Salmon that entered the Cowlitz River. Of those transported upstream, a mean of 1% (44) were harvested in the Upper Cowlitz Subbasin fishery.

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5.2.3.3. Disposition

No effort is currently conducted to identify the true origin of natural-origin salmon returning to the Barrier Dam Adult Facility; all natural-origin returns to the hatchery are assumed to have originated from above Mayfield Dam and are either kept for broodstock or transported to the Tilton Subbasin. Fish from above Cowlitz Falls Dam are currently coded wire tagged and returning adults are identified for transport back to the Upper Cowlitz Subbasin. The Coho Salmon marking plan will be addressed and further modified as necessary during development of the Transition Plan. For the 2007-2017 run years, a mean of 630 adults were collected for broodstock in the Integrated Hatchery Program. A mean of 3,650 natural-origin adult Upper Cowlitz Subbasin Coho Salmon were transported and released into the Upper Cowlitz Subbasin, representing 52% of the natural-origin total adult run and 74% of those returning to the Cowlitz River (Figures 5.2-2 and 5.2-3; Table 5.2-1).

5.2.3.4. Spawning in Nature

The Upper Cowlitz Subbasin Coho Salmon population has a minimum viability abundance target of 4,000 natural-origin salmon spawning in nature: 2,000 in each of the Cispus and upper Cowlitz rivers (Table 5.2-2). Estimating the numbers of salmon that survive to spawn in the Upper Cowlitz Subbasin is confounded by the fact that no spawning ground surveys are conducted in the Upper Cowlitz Subbasin, so the fallback (over Cowlitz Falls Dam) and pre-spawn mortality rates are assumed to be constant. Additionally, harvest is estimated by angler self-reporting and an assumed rate of indirect hooking mortality (Table 5.2-1). We roughly estimated the numbers of spawners in the Upper Cowlitz Subbasin by subtracting the estimates of exploitation, fallback (12%), and pre-spawn mortality (10%) from the numbers transported and released into the subbasin. As described in Section 1.2, the data presented in this 2020 FHMP are the most recently available, consolidated for FTC consideration. The data are preliminary, pending a full QA/QC review of the Big Table Dataset (Appendix A) by the M&E Subgroup.

Of the 3,650 natural-origin adults from the Upper Cowlitz Subbasin population that were transported to the Upper Cowlitz Subbasin, a mean of 1% (44) were removed by sport fisheries in the Upper Cowlitz Subbasin (indirect mortality), and we assume that 12% (438) fell-back over Cowlitz Falls Dam and 10% (317) died prior to spawning. That left a mean of 2,851 (78% of those transported and 40% of the entire run) to spawn in the Upper Cowlitz Subbasin.

5.2.3.5. Smolt Production

From 2009-2017, an annual mean of 90,457 yearling Coho Salmon were captured at Cowlitz Falls Fish Facility, which is located at Cowlitz Falls Dam and captures juveniles emigrating from the Upper Cowlitz Subbasin. Mean collection efficiency was estimated to be 50.8%, so we estimated that an annual mean of 188,918 age-2 Coho Salmon smolts were produced from the Upper Cowlitz Subbasin. Since construction of the Cowlitz Falls North Shore Collector in 2017, capture efficiency rates have increased to a mean of 74% between 2017 and 2019. Downstream migrants that are not collected are assumed to be either lost to natural mortality within Lake Scanewa or lost to anadromy in Riffe Lake. Fry and parr life stages are also collected and are transported upstream to continue rearing in the Upper Cowlitz Subbasin.

Table 5.2-2. Mean, minimum, and maximum hatchery and natural spawning metrics for Upper Cowlitz Subbasin Coho Salmon, 2007-2015 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2007-2015 Run Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery Spawning			
Adults Collected	755	341	1,339
Hatchery-origin	163	0	866
Natural-origin	592	229	790
Adults Spawned	88.3%	80.0%	95.1%
Hatchery-origin	654	328	1,139
Natural-origin	150	0	782
Pre-spawn Survival Rate	504	128	748
Total Green Eggs	1,068,190	573,813	1,269,034
Mean Fecundity	3,357	2,181	4,406
Smolts Released	928,147	472,248	1,079,002
Green Egg-to-Smolt Survival	87%	82%	97%
Smolt Productivity (smolts / spawner)	1,478	944	1,900
Natural Spawning			
Adult Spawners in Upper Cowlitz Subbasin	12,519	1,217	25,322
Hatchery-origin	2,961	2	5,948
Natural-origin	12,519	1,217	25,322
Smolts Produced	188,918	36,032	393,545
Smolt Productivity (smolts / spawner)	20.0	3.1	30.6

5.2.3.6. Natural-origin Survival and Productivity

Survival and productivity are the key metrics for monitoring populations. SAR and productivity are currently estimated from fish captured at the Cowlitz Falls Fish Facility. The precision and necessary assumptions associated with this calculation will be validated during this FHMP period during development of a single consolidated database and review of the Big Table Dataset.

5.2.3.7. Age Composition

Only returns to the Barrier Dam Adult Facility offer an indication of age composition, where they are characterized as being “<42 cm” (presumably age-2 jacks) or “>42 cm” (presumably age-3 adults). For natural-origin salmon, jacks comprised a mean of 13% and adults comprised a mean of 87% of the 2007-2017 return years. Age composition is more informative when examined by brood year, but those data are not available at present. We will collect the necessary data/samples and estimate and report this metric as the data become available through our M&E Program. During this FHMP period, it will be necessary to develop a single consolidated data source.

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5.2.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, to evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population (see Section 5.0.9).

The Coho Salmon Integrated Hatchery Program at Cowlitz Salmon Hatchery was initiated in 2007 with a goal to produce 978,000 smolts annually, using 100% natural-origin salmon for broodstock (pNOB = 1). The first jack returns were in 2009/10 and the first adults in 2010/11 from the Integrated Hatchery Program for Coho Salmon. Smolts from the Integrated Hatchery Program are reared at Cowlitz Salmon Hatchery, marked (CWT and adipose fin-clip), and released directly into the lower Cowlitz River because satellite rearing facilities have not been constructed.

5.2.4.1. Abundance

From 2007-2017, mean total run size was 82,773 adult hatchery-origin (Integrated Hatchery Program) Coho Salmon that returned to the Barrier Dam Adult Facility or were harvested on their way back (Figures 5.2-2 and 5.2-3; Table 5.2-1). Means of 38,982 hatchery-origin adults escaped the ocean and Columbia River fisheries and entered the Cowlitz River. Of those salmon reaching the Cowlitz River, a mean of 32,423 hatchery-origin Coho Salmon returned to the Barrier Dam Adult Facility, and 11,362 were transported and released upstream of Cowlitz Falls Dam, where they were available for harvest or to spawn naturally in the Upper Cowlitz Subbasin.

5.2.4.2. Harvest

From 2007-2017, mean total harvest of Integrated Hatchery Program Upper Cowlitz Subbasin Coho Salmon was 50,012 adults (60% of the total hatchery-origin run; Table 5.2-1). Of the total harvest, 59% were in the ocean, while 29% were harvested in the lower Columbia River, 12% in the lower Cowlitz River, and <1% in the Upper Cowlitz Subbasin.

5.2.4.3. Disposition

Hatchery-origin Coho Salmon returning to the Barrier Dam Adult Facility are either kept for broodstock, transported to the Upper Cowlitz Subbasin to supplement natural spawning and provide harvest opportunities, or surplused. Of the mean 32,423 Integrated Hatchery Program hatchery-origin Coho Salmon adults that returned to the Barrier Dam Adult Facility, a mean of 135 were kept for broodstock for the Integrated Hatchery Program (Figures 5.2-2 and 5.2-3; Table 5.2-1). A mean of 11,362 were transported and released into the Upper Cowlitz Subbasin from 2007-2017, representing 14% of the total hatchery-origin run and 29% of those returning to the Cowlitz River. Within the Cowlitz system, a mean of 18,648 were surplused to food banks.

5.2.4.4. Hatchery Spawning

A mean of 32,423 Integrated Hatchery Program Coho Salmon adults returned to the Barrier Dam Adult Facility from 2007-2017, of which a mean of 135 were kept for broodstock and 124 were spawned in the Integrated Hatchery Program, along with a mean of 553 natural-origin adults. Mean pNOB for the Integrated Hatchery Program was 0.861. This is lower than the goal pNOB of 1 because Fish Passage Survival at Cowlitz Falls Dam was not meeting the required level at that time and this, along with poor ocean conditions, did not return sufficient natural-origin adults to meet broodstock needs in several years.

5.2.4.5. *Hatchery Rearing*

From 2007-2015, an estimated mean of 1,068,190 green eggs were collected for the Integrated Hatchery Program from a mean of 331 females (Table 5.2-2). Mean fecundity was 3,357 green eggs. Mean green egg-to-smolt survival was 87%, and a mean of 928,147 smolts were released in 2009-2017.

5.2.4.6. *Hatchery-origin Survival and Productivity*

Mean total smolt-to-adult (TSAR) survival of coded-wire-tagged hatchery-origin Coho Salmon from brood years 2000-2014 was 1.67%, and the mean smolt-to-adult return (to the Barrier Dam Adult Facility) rate was 0.75%. Age composition data have not been compiled into a single database to characterize assumptions and calculate productivity, but we will begin to calculate this index through our M&E Program during this FHMP period. As noted in Chapter 1 (Section 1.2), the data presented in this FHMP are preliminary, pending a full QA/QC review of the Big Table Dataset (Appendix A) by the M&E Subgroup for accuracy and source.

5.2.4.7. *Age Composition*

Age composition has not been completely calculated from the data in ISIT because they are not compiled by age class. For hatchery-origin salmon, mean age composition of mature Coho Salmon that returned to the Barrier Dam Adult Facility from the 2007-2017 run years was 28% jacks (age-2) and 72% adults (ages-3 and -4). CWT data show that, for the 2000-2015 brood years, means of 7.7%, 92.2%, and 0.03% of the hatchery-origin Coho Salmon returned at age-2, age-3, and age-4, respectively. During this FHMP period, a single consolidated database will be developed for analysis and reporting to address this question.

5.2.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in PNI can indicate an increase or decrease in the effect of hatchery-origin salmon on the natural population. This program will strive to reduce the effect of hatchery supplementation on the natural population that it supplements. To do so, we will try to maximize the number and percentage of natural-origin salmon in the hatchery broodstock and minimize the number and percentage of hatchery-origin salmon spawning in nature.

The Upper Cowlitz Subbasin Coho Salmon Integrated Hatchery Program generally uses 100% natural-origin salmon for its broodstock (pNOB = 1). However, natural-origin returns were low in 2 years, so 571 and 782 hatchery-origin salmon were incorporated into the broodstock in 2013 and 2015-2017, respectively, to support the Integrated Hatchery Program, and small numbers of hatchery-origin salmon were used as broodstock in 2016 (3) and 2017 (13). Overall, a mean of 135 hatchery-origin salmon were used as broodstock from 2007-2017. Mean pNOB from 2007-2017 was 0.861, but pNOB was 0.183 in 2013 and 0.313 in 2015.

Based on the numbers transported to the Upper Cowlitz Subbasin, estimates of harvest, and constant fallback and pre-spawn mortality rates, we estimate that means of 8,959 hatchery-origin and 2,851 natural-origin Coho Salmon spawned in the Upper Cowlitz Subbasin from 2007-2017. Mean pHOS from 2007-2017 was 0.736, and the resulting mean PNI was 0.523, ranging from 0.155-0.650.

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5.2.6. Future Management

The Upper Cowlitz Subbasin Coho Salmon population is designated as a Primary population for achieving MPG and ESU recovery goals, with a minimum viability abundance target of 4,000 natural-origin adult spawners in nature, which is the combined abundance targets of 2,000 spawners in each of the Upper Cowlitz and Cispus rivers. Although population viability was rated as Very Low in the Recovery Plan (LCFRB 2010), a minimum goal of High viability was established for this population (WDFW and LCFRB 2016). Following initiation of reintroduction in 1996, and since the Recovery Plan was drafted in 2010, natural-origin spawner abundance (based on number transported and harvest estimates) has exceeded the 4,000 spawner target in 4 of the 11 years (2009, 2011, 2014, and 2017). However, other years have seen dramatically lower abundance, such as 2012 (649), 2015 (466), and 2013 (2). Estimates of pHOS have exceeded the HSRG guideline of <0.3 every year from 2007-2017 during the Recolonization recovery phase. Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs.

5.2.6.1. Goals for Conservation, Recovery, and Harvest

The Upper Cowlitz Subbasin Coho Salmon population was identified as a high recovery priority (LCFRB 2010) and will play a primary role in the recovery of the lower Columbia River Coho Salmon ESU. Progress toward achieving conservation goals and minimum viability abundance targets and identification of factors that limit recovery are evaluated through monitoring of standard fisheries management metrics (Table 5.2-3; Appendix A, Big Table Dataset). The Upper Cowlitz Subbasin Coho Salmon population had an historical abundance of about 26,000 salmon (18,000 in the upper Cowlitz River and 8,000 in the Cispus River) and has a minimum viability abundance target of 4,000 natural-origin adult spawners in nature. In 2010, the abundance and productivity of this population was rated as Very Low, with less than 50 in of the Upper Cowlitz and Cispus river subpopulations (LCFRB 2010). Due to improved management, downstream collection efficiency, and monitoring at Cowlitz Falls Dam, natural-origin spawner abundance has increased dramatically, to a mean of 3,168 from 2007-2017 and as high as 5,948 in 2011.

Within 2 years following completion of the FHMP, a Transition Plan will be developed to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts.

- **Long-term Goals:** The overarching goal for this Primary Coho Salmon population is full recovery, which would include, but not be limited to:
  - Harvestable population of natural-origin Coho Salmon.
  - Adult abundance of >4,000 adult natural-origin salmon spawning in nature; 2,000 in each of the Cispus River and upper Cowlitz River (Table 5.2-3).
  - pHOS <0.3 or as determined appropriate per the Transition Plan (HSRG 2009).
  - pNOB more than two times pHOS, such that PNI ≥0.67 or as determined appropriate per the Transition Plan.

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Table 5.2-3. Recovery phase targets for Upper Cowlitz Subbasin Coho Salmon.

Species:	Coho Salmon
Population Name:	Upper Cowlitz Subbasin
Recovery Designation:	Primary
Current Recovery Phase:	Recolonization

	RECOVERY PHASE				
Target Metric	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	500[1]	1,000[1]	2,000[1]	TBD[1]	2,084
Smolt Abundance (transported from Cowlitz Falls Fish Facility)	10,000	20,000	40,000	80,000	123,581
Smolt Passage Survival	40%	60%	70%	75%	72%
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Seg/Int	Int	Int	Int	Int
Broodstock to be Collected	780	780	780	780	915
Integrated Hatchery Program	NA	NA	NA	NA	NA
Hatchery-Origin	624	390	195	0	135
Natural-Origin	156	390	585	780	630
Segregated Hatchery Program	0	0	0	0	0
Smolts to be Produced	1,000,000	1,000,000	1,000,000	1,000,000	958,815
Integrated Hatchery Program	500,000	1,000,000	2,200,000	TBD	958,815
Segregated Hatchery Program	500,000	0	0	0	NA
Total Smolt-to-Adult Survival					
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.3	TBD	0.775
Integrated Hatchery Program					0.775
Segregated Hatchery Program	0.1	NA	NA	NA	NA
pNOB (>)	0.2	0.5	0.75	1	0.695
PNI (>)	0.3	0.55	0.7	0.8	0.442
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	50%	40%	30%	30%	43%

1 No minimum viability abundance target has been set for these populations; the numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.

- **FHMP Goals:** The goals for the Upper Cowlitz Subbasin Coho Salmon population for the duration of this FHMP are to achieve attainable steps toward population recovery by:
  - Maintain sustainable adult Coho Salmon fishery opportunity in the Upper Cowlitz Subbasin.
  - Develop a plan for the disposition of surplus salmon and management strategies for high and low return years.

- Emphasize as key population monitoring and VSP metrics:
  - Adult and juvenile abundance estimates.
  - Numbers returning to the Cowlitz River.
  - Numbers of natural-origin salmon returning to the Barrier Dam Adult Facility.
  - Accurate numbers of mature natural- and hatchery-origin salmon transported and released in the Upper Cowlitz Subbasin.
  - Accurate numbers of natural- and hatchery-origin salmon spawning in nature in the Upper Cowlitz Subbasin.
  - Estimates of harvest rates.
- Maintain natural-origin spawner abundance >4,000 and begin monitoring natural spawning in the Upper Cowlitz Subbasin.
- During development of the Transition Plan within the next 2 years, assess the marking strategies used for natural-origin salmon collected (i.e., at Mayfield Dam instead of Cowlitz Falls Dam).
- Develop criteria for evaluating when the population will move to the Local Adaptation phase of recovery and the commensurate management actions.
- Develop methods to estimate pre-spawn mortality and actual spawner pHOS during the Local Adaptation phase of recovery.
- Following transition to Local Adaptation phase of recovery, reduce the abundance of hatchery-origin spawners in the Upper Cowlitz Subbasin by:
  - Increasing natural-origin abundance,
  - Reducing the number transported and released upstream, and/or
  - Increasing hatchery-origin harvest without a concomitant increase in the natural-origin exploitation rate.
- Increase and improve methods to estimate, monitor, analyze, and report for numbers and age, sex, and origin of all recoveries:
  - Harvested in fisheries in the ocean, Columbia River, and Cowlitz River.
  - Returning to the Barrier Dam Adult Facility.
  - Retained as broodstock.
  - Transported and released upstream of Mayfield Dam.
  - Hatchery surplus.
  - Hatchery strays to/from outside of the Cowlitz Basin.
  - Actual spawners in nature.
  - Natural smolts produced.
- Continue to support fisheries at current or increased levels.
- Maintain flexibility to increase production within FERC licensing and ESA constraints.

5.2.6.2. *Management Targets*

The factors that may inhibit progress toward conservation goals into the next phase of recovery for this population are downstream Fish Passage Survival at Cowlitz Falls Dam and pHOS. To minimize pHOS, only hatchery-origin salmon that are positively identified as from the Upper Cowlitz Subbasin Integrated Hatchery Program will be transported to the Upper Cowlitz Subbasin. No Lower Cowlitz Subbasin Coho Salmon will be released above Cowlitz Falls Dam.

In most years, the current hatchery program uses 100% natural-origin salmon for broodstock. The juveniles produced are reared and released from Cowlitz Salmon Hatchery. Meeting this pHOS target during Local Adaptation will require a combination of increased Fish Passage Survival (FPS), increased harvest on hatchery-origin salmon, and/or limiting the number of hatchery-origin salmon that are transported to the Upper Cowlitz Subbasin.

- **Natural Production:** The goal of population restoration is to produce self-sustaining natural-origin populations. We will develop monitoring programs that are rigorous and will allow us to estimate key VSP metrics, with sufficient confidence, including the abundance of salmon in these populations, when populations have become self-sustaining, as well as to identify areas where we can improve survival. Efforts to improve downstream FPS continue and recruitment from natural production will increase with the success of these efforts. The efforts of Tacoma Power and its partners to protect and enhance habitat in the Upper Cowlitz Subbasin are expected to benefit smolt production and the subsequent return of mature salmon, but the current monitoring program may be insufficient to know whether those efforts are successful. Census counts of salmon returning to the Barrier Dam Adult Facility for transport to the Upper Cowlitz Subbasin are reliable numbers, while estimates of harvest, returns to spawning grounds, and the number of spawners in nature have wide variances because of low sampling rates, when estimated at all. Pre-spawn mortality (largely due to senescence) is not currently estimated for spawners in nature.
    - **Abundance – Transport and Natural Spawning:** The minimum viability abundance target for the Upper Cowlitz Subbasin Coho Salmon population is 4,000 natural-origin spawners, which has been met intermittently during recent years. When it becomes appropriate to manage for a pHOS target, the likelihood of meeting the pHOS target could be increased by the following approaches, either individually or in combination:
        - Increase the abundance of natural-origin spawners in the Upper Cowlitz Subbasin by:
            - Increasing historic FPS for naturally produced downstream migrants. Increasing the number of natural origin adults transported upstream by increasing FPS rates of smolts emigrating from the Upper Cowlitz Subbasin.
            - Reducing harvest of natural-origin adults in pre-terminal fisheries and the Upper Cowlitz Subbasin.
        - Reduce the number of hatchery-origin spawners in the Upper Cowlitz Subbasin by:
            - Reducing the number of hatchery-origin adults transported upstream and released in the Upper Cowlitz Subbasin, or
            - Increasing harvest of hatchery-origin adults in the Upper Cowlitz Subbasin.

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To meet minimum viability abundance targets, the number of returning natural-origin spawners must increase and eventually the proportional contribution of hatchery-origin salmon spawning in the Upper Cowlitz Subbasin must decrease. We will focus our estimates of abundance on the numbers of hatchery- and natural-origin Coho Salmon that return to the Barrier Dam Adult Facility that are transported to the Upper Cowlitz Subbasin, and that spawn in nature each year.

- **Smolts Produced in Nature:** Natural-origin smolts are collected at the Cowlitz Falls Fish Facility and efficiency of the collector is evaluated annually. These components allow for calculation of the total number of smolts produced and, when combined with the number of spawners, allow for calculation of freshwater productivity (smolts per spawner). This is a critical management need for evaluating habitat capacity, and population viability as reintroduction of Coho Salmon to the Upper Cowlitz Subbasin continues.
- **Smolt-to-Adult Survival:** The number of smolts collected and hauled to the lower Cowlitz River is known, but the age composition of the returning salmon is not currently known so we have not estimated SAR. This metric is important to understanding and identifying key limiting factors for the Upper Cowlitz Subbasin Coho Salmon population. We will estimate these indices as means to do so become available.
- **Productivity (Adult Recruits/Spawner):** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner; "spawner-to-spawner") is the primary monitoring metric for any population, especially natural populations. It provides an overall view of population performance and trajectory, where:
  - If productivity >1, the population is increasing.
  - If productivity <1, the population is declining.

Estimating adult-to-adult productivity is a key management target. Given the current lack of age composition data for the returning salmon, deriving an adult productivity estimate remains a challenge and a significant data gap.

- **Hatchery Production:** The Upper Cowlitz Subbasin Integrated Hatchery Program was initiated in 2007 and uses up to (or in some years more than) 30% of the natural-origin returns to the hatchery as broodstock (WDFW 2014c). All of the resulting hatchery progeny of these broodstock receive an adipose fin-clip and a CWT so that they can be distinguished from the lower Cowlitz River Segregated Hatchery Program upon their return as mature salmon. Up to 25,000 of these hatchery-origin returns from the Integrated Hatchery Program (i.e., F_1 progeny) are transported and released upstream of Cowlitz Falls Dam. This cap will be evaluated for its appropriateness during this FHMP period. Natural-origin returns to the hatchery carrying a CWT that exceed broodstock needs are also transported upstream. A goal of 978,000 smolts from the integrated program are released in the Cowlitz River during the spring (May) as yearlings at a targeted mean weight of 30 g.

  We will continue to develop and implement a rigorous sampling and monitoring program, along with an improved database for the hatchery program, to allow the managers to better evaluate and manage the hatchery programs. Guidance for the numbers of broodstock to be collected (by origin, sex, age) and collection schedule (by week) for each hatchery program (integrated and segregated) will be based on data from the previous 5 years and pre-season run estimates, including arrival timing, expected age composition, pre-spawn survival rate, fecundity, and average survival by stage through hatchery (i.e., green egg-to-eyed egg, eyed egg-to-fry, fry-to-smolt).

The Upper Cowlitz Subbasin population is currently in the Recolonization phase of recovery and releases of hatchery-origin adults and jacks from the Integrated Hatchery Program into the Upper Cowlitz Subbasin at pHOS levels greater than 0.3 will constrain efforts to achieve minimum viability abundance targets in the Local Adaptation phase, which recommend pHOS <0.3 and PNI >0.67. Notably though, hatchery-origin spawners in the Upper Cowlitz Subbasin during this time will be F_1 generation progeny of 100% natural-origin broodstock originating from the Upper Cowlitz Subbasin.

- **Abundance:** The Integrated Hatchery Program was developed for supplementation of the Upper Cowlitz Subbasin Coho Salmon population. The program's goal is to release 978,000 smolts and have at least 16,800 adults return. From those returns, a maximum of 25,000 adults from the Integrated Hatchery Program may be transported to the Upper Cowlitz Subbasin (WDFW 2014c; WDFW and LCFRB 2016). For return years 2007-2017, the mean total run size of hatchery-origin salmon from the Integrated Hatchery Program was 82,773, well above the goal. We will focus our monitoring of abundance on the numbers of hatchery-origin Coho Salmon that return to the Cowlitz River and to the Barrier Dam Adult Facility, which are critical for calculating SAR and TSAR.
- **Broodstock Collection and Spawning:** While the goal of the Integrated Hatchery Program is to use 100% natural-origin broodstock, hatchery-origin salmon were used to supplement broodstock in 2013 and 2015-2017, years in which pNOB was less than 1. Based on the mean pre-spawn survival rate, fecundity, green egg-to-smolt survival rate, and sex ratio, in order to produce the target of 978,000 smolts, 752 mature salmon (380 females) must be collected and 664 must be spawned (335 females). The mean for these metrics will be updated annually along with the resulting broodstock collection targets.

  We will employ hatchery best management practices for broodstock collection and spawning to ensure that the broodstock represents the entire population in age and run-timing in order to maximize genetic diversity of the F_1 generation. Whenever $\leq$100 females are spawned in a specific group, hatcheries (especially those with a conservation mandate) should use spawning matrices in which the gametes from every individual are mixed (approximately evenly) with those of at least two individuals of the opposite sex (Campton 2004; Busack and Knudsen 2007; Bartron et al. 2018). We will also strive to ensure that there are no HxH crosses in order to minimize the hatchery influence on the F_1 generation and any population that it spawns with.
- **Smolt Production:** The Settlement Agreement (Section 6.1.5) states that, "*The hatchery complex will be designed with flexibility so managers can employ innovative rearing practices, low densities, and replication of historic fish out-migration size and timing.*" It is clear that the intent of the SA is to provide options to rear the salmon so that they are as similar, in both appearance and performance, to natural-origin salmon as possible. Satellite rearing facilities in the Upper Cowlitz Subbasin may be instrumental in rearing salmon with conditions emulating the natural population. So, we will begin developing and evaluating novel rearing and release strategies (e.g., smaller, natural-sized Coho Salmon smolts) to improve program performance by decreasing the rates of precocious maturation (jacks) and straying, and increasing in-hatchery survival, smolt-to-adult survival, and smolt-to-adult return rates. This will

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further minimize the hatchery influence on the F_1 generation and any population that it spawns with.

- **Smolt-to-Adult Survival:** SAR and total smolt-to-adult survival (TSAR) are the primary indices for monitoring a hatchery program. SAR indicates the success of the program in producing salmon that survive in nature and return to the hatchery; a sufficient number is needed to support hatchery broodstock (for segregated or partially integrated programs) or for release into nature to support natural spawning. TSAR is indicative of the overall success of a hatchery program to support all aspects that hatchery salmon may support: commercial, tribal, and recreational fisheries in the ocean, Columbia River, and the Cowlitz River and tributaries, hatchery broodstock, and natural spawning. We will monitor these indices primarily via downstream collection facilities at Cowlitz Falls and Mayfield Dams. It will be necessary to estimate abundances at these locations and evaluate limiting factors, which may require baseline and directed studies to characterize additional estimates for management purposes directing recovery phases.
- **Productivity (Adult Recruits/Spawner):** Population productivity (the number of F_1 generation recruits that survive to spawn for each F_0 generation spawner; "spawner-to-spawner") is the primary monitoring metric for any population, especially natural populations. However, this metric is of less importance to hatchery-origin populations, where population productivity should be well above replacement (R/S = 1) because of the huge pre-smolt survival advantage afforded by rearing in a hatchery. Therefore, recruits/spawner (smolt recruits or mature recruits) is less important for monitoring hatchery populations.
- **Strays and Spawning in Nature:** Because all mature Coho Salmon reaching the Upper Cowlitz Subbasin are sorted for transport, and because only F_1 progeny hatchery-origin Coho Salmon (i.e., marked with both ad-clip and CWT) are transported and released into the Upper Cowlitz Subbasin, the risk of hatchery-origin strays from outside the integrated program spawning naturally in the subbasin is low.

  While it is likely that stray rates to out-of-basin locations are low, it is reasonably certain that Cowlitz River hatchery-origin salmon do stray into other streams such as the Toutle, Coweeman, Kalama, Lewis, or Willamette rivers, and that Coho Salmon from other basins stray into the Cowlitz River. The magnitude of both forms of straying is not known, as the data are either not collected or not reported. During this FHMP period, a means to characterize estimates and assumptions associated with this metric will be developed and characterized in a mutually agreed-upon analysis and reporting database.
- **Surplus:** The Integrated Hatchery Program allows for flexibility in dealing with hatchery returns that exceed broodstock needs because hatchery-origin salmon can be transported upstream of Cowlitz Falls Dam to advance the restoration of Coho Salmon to the Upper Cowlitz Subbasin, and support harvest opportunities. In some cases, surplus salmon are sent to food banks or a fish buyer. However, an excess of hatchery-origin salmon returning to the Barrier Dam Adult Facility can have indirect effects on the viability of the natural-origin population. Although it is far preferable for a surplus of hatchery-origin salmon to return to the hatchery than to remain in nature to spawn in the lower Cowlitz River or be transported upstream.

- **Harvest:** A mean of 59% of the combined Upper Cowlitz Subbasin Coho Salmon run is harvested each year, including 40% of natural-origin salmon. Although this level of exploitation does not prevent meeting hatchery egg-take and smolt production goals,

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harvest of natural-origin salmon does constrain the ability of managers to minimize pHOS. While the abundance of hatchery-origin spawners can be effectively regulated by controlling the numbers transported upstream, the production provided by hatchery-origin spawning is still required until returns of natural-origin spawners are sufficient to maintain a self-sustaining population. Given the ability to control numbers of hatchery-origin salmon transported upstream, harvest management of the Upper Cowlitz Subbasin Coho Salmon population should focus on minimizing the harvest of natural-origin salmon rather than increasing harvest on hatchery-origin salmon. This is most critical in the ocean and Columbia River. Fishery management outside the Cowlitz Basin is complicated and involves multiple state and federal agencies.

The hatchery-origin harvest will be monitored using the CWT recovery and sampling rate data in RMIS and robust creel surveys. Natural-origin harvest and exploitation rates will be monitored in terms of the following metrics:

- Pre-terminal Exploitation Rate
- Terminal Harvest Rate
- Expected Catch
- Terminal Catch

Decreasing the harvest of natural-origin salmon would incrementally increase potential natural spawning abundance. However, given the already low harvest rates, particularly in the Cowlitz River, reducing harvest rates further may be an impractical means of substantially increasing natural-origin abundance.

- **Proportionate Natural Influence:** We plan to increase the influence of the natural environment on the Upper Cowlitz Subbasin Coho Salmon population, with specific targets to be established in coordination with the FTC during development of the Transition Plan. We will also explore means of decreasing pHOS by increased harvest of hatchery-origin salmon and/or decreased transport of hatchery-origin salmon upstream of Cowlitz Falls Dam as natural production increases. Increasing FPS at Cowlitz Falls Dam will increase the numbers of natural-origin adults available to transport to the Upper Cowlitz Subbasin. During the Local Adaptation phase of recovery, we will assess the HSRG guidelines for pHOS and PNI by assessing their applicability to achieving management goals during this recovery phase. In early years of the Integrated Hatchery Program, pHOS has consistently exceeded 0.3 (pHOS was 0.54 or greater for all but one year from 2007-2015), but as the results from FPS increases become apparent, we expect that both natural-origin abundance and natural production will quickly increase.
- Despite high pNOB values that are typically 1, from 2007-2017, PNI has never met the $\geq$0.67 HSRG guideline, which will likely be our target for this FHMP period once we enter the Local Adaptation recovery phase. This reflects the high pHOS upstream of Cowlitz Falls Dam. As annual transports of natural-origin Coho Salmon to the Upper Cowlitz Subbasin consistently approach the minimum viability abundance target (4,000 natural-origin spawners), we plan to allow for increased influence of the natural environment on the Upper Cowlitz Subbasin Coho Salmon population by progressively decreasing the number of hatchery-origin adults that are released in the Upper Cowlitz Subbasin.
- **Age Composition:** Only returns to the Barrier Dam Adult Facility offer an indication of age composition; they are characterized as being “<42 cm” (presumably age-2 jacks) or “>42 cm” (presumably age-3 adults). Based on these data, jacks comprised a mean of 23% and 13%, respectively, of hatchery- and natural-origin returns from 2007-2017

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(Table 5.2-2). During this FHMP period, necessary data gaps will be assessed, and available data will be compiled into a single consolidated database for analysis and reporting to address this question.

5.2.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly to track the population's trajectory and variability and includes the basic data required to operate a one-stage or two-stage life cycle model. To support recovery, monitoring programs need to be rigorous and allow for estimation, with sufficient confidence, to estimate population abundance, as well as to identify ways to improve survival. Baseline studies for this population currently focus on census counts for smolt transported downstream from Cowlitz Falls Dam, FPS, and smolt production. In the future, we are also likely to focus on mature salmon returns. As part of this FHMP, Tacoma Power will refine the existing monitoring program to prioritize and implement a rigorous program focused on evaluating program effectiveness based on regionally accepted VSP parameters (Crawford and Rumsey 2011); see Chapter 10, Monitoring & Evaluation (M&E).

Current M&E work for Upper Cowlitz Subbasin Coho Salmon may be focused on VSP metrics and other monitoring needs, such as:

- Estimating harvest rates of hatchery- and natural-origin salmon in all fisheries.
- Upper basin creel survey: Exploitation rate and hatchery-/natural-origin handling ratio.
- Estimating pHOS.
- Estimating natural-origin population productivity (spawner-to-spawner).
- Quantifying the number of smolts produced in the Upper Cowlitz Subbasin for freshwater productivity evaluation.
- Identifying the ability to differentiate Coho Salmon smolts naturally produced in the Upper Cowlitz Subbasin from those naturally produced in the Tilton River.

Directed Studies

Directed studies are designed to diagnose and solve problems associated with achieving FHMP goals. These studies inform future designs, operations, and fish management strategies that will improve the existing FHMP program so that Settlement Agreement goals can be achieved. Metrics that are most likely to provide the greatest added benefit for the FHMP are

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those for which we do not currently have good information and, as such, are left out of population assessment methodologies. Without that information, data from another population or conglomerate, which may or may not accurately reflect the current population, must be substituted for a parameter value in a life cycle model. Most of the metrics in the Upper Cowlitz Subbasin Coho Salmon "Big Table" (Appendix A) currently lack information. Conducting directed studies to address metrics that lack data and have a high potential to affect life cycle model sensitivity would be beneficial. Examples of important areas of study include:

- Spawning ground surveys: Scales, pHOS, pre-spawn, genetics, spatial distribution (upper extent), and reach specific adult densities (sub-sample).
- Juvenile rearing capacity studies: Available habitat and habitat specific (run/riffle/pool) densities.
- Early life stage survival studies: Egg to fry, fry to parr, and parr to smolt survival rates.
- In-river migratory survival and behavior: Survival of migrating juveniles and movement rates.
- Reservoir survival: Predation rate.
- Estimating hatchery- and natural-origin pre-spawn mortality, spawning areas, and natural spawning in the Upper Cowlitz Subbasin.
- Identifying the source of natural-origin returns to the Barrier Dam.

5.2.7. Summary

- Although functionally extirpated from upstream habitats following completion of Mossyrock Dam, Upper Cowlitz Subbasin Coho Salmon population genes were the basis for the Lower Cowlitz Subbasin population, which served as a genetic legacy and provided the founding stock for reintroduction.
- Although the ESA framework identifies distinct Coho Salmon populations in the Cispus and Upper Cowlitz rivers, returning adults are not differentiated. Therefore, these populations are currently managed as a combined "Upper Cowlitz Subbasin" population.
- Coho Salmon recovery efforts have focused on transporting hatchery-origin fish during Recolonization to re-establish natural spawning and production. Now, natural-origin fish are transported to continue to build the population.
- Recent abundance of natural-origin adults transported to the Upper Cowlitz Subbasin has approached minimum viability abundance targets. However, ongoing releases of hatchery-origin adults from the Integrated Hatchery Program contribute to hatchery influence on the natural-origin population, as appropriate during Recolonization.
- The Upper Cowlitz Subbasin Coho Salmon population is currently in the Recolonization phase of recovery, and over the period covered by this FHMP (beginning in February 2020), the focus will be on rebuilding abundance of the natural-origin population by maximizing the numbers of salmon spawning in nature.
- Development of key criteria and an evaluation process is needed to determine when the Upper Cowlitz Subbasin Coho Salmon population has moved from the Recolonization phase of recovery into the Local Adaptation phase, and to determine the commensurate management actions that will affect.

- In the near term, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. The Transition Plan for Coho Salmon will be developed within 2 years of completion of this FHMP. As an interim strategy and until the Transition Plan is developed, Tacoma Power and the FTC will operate the programs as they were operated in 2019.
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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Population: Tilton Subbasin Coho Salmon
Oncorhynchus kisutch

ESA Listing

Status:	Threatened Listed in 2005, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Columbia River Coho Salmon
Major Population Group:	Cascade Coho Salmon
Recovery Region:	Lower Columbia River Salmon
Population Recovery Designation:	Stabilizing
Population Viability Rating:	
Baseline	Very Low
Objective	Very Low
Minimum Viability Abundance Target:	No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
Current Recovery Phase:	Recolonization
Current Hatchery Program(s):	None
Proposed Hatchery Program(s):	None

5.3. Coho Salmon: Tilton Subbasin Population

5.3.1. Purpose

This section describes the current status of the Tilton Subbasin Coho Salmon population, based on recent and available data. VSP metrics are also identified that are needed to evaluate the status of this population with regard to recovery under ESA guidelines. Where appropriate, we propose changes to both the hatchery and monitoring programs to facilitate progress toward population recovery and our evaluation of that progress. During the period covered by this FHMP, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. The new hatchery program is also specifically intended to supplement the Tilton Subbasin natural-origin Coho Salmon population, and some of the mature salmon that return from this program will be released into the Tilton Subbasin to provide harvest opportunities and to supplement natural spawning.

Adults from this program will be used to supplement natural spawning in the Tilton Subbasin and provide fisheries both below Mayfield Dam and in the Tilton Subbasin. This will

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benefit the Tilton Subbasin population because the hatchery-origin salmon released into the Tilton Subbasin will have a high pNOB and they will include both the early and late run individuals, which better resembles the historical population. We will continue to evaluate the hatchery program and fisheries management and make refinements or adjustments, as described in this FHMP, to effectively supplement and manage the Tilton Subbasin population.

5.3.2. Population Description

The Lower Columbia Salmon Recovery and Fish and Wildlife Subbasin Plan (Recovery Plan; LCFRB 2010) identifies Mayfield Dam as the delineation between the Lower and Upper Cowlitz subbasins, with the Tilton Subbasin falling within the Upper Cowlitz Subbasin (Figure 5.3-1). However, because the Recovery Plan identifies Tilton Subbasin Coho Salmon as a distinct population, they are not considered part of the Upper Cowlitz Subbasin Coho Salmon population. Unless otherwise noted hereafter, references to the Upper Cowlitz Subbasin do not include the Tilton Subbasin.

Figure 5.3-1. Distribution of Coho Salmon in the Tilton Subbasin.

The completion of Mossyrock Dam in 1968 and the subsequent termination of downstream capture in 1973 resulted in the extirpation of Coho Salmon populations in the Cispus and Upper Cowlitz subbasins. The Tilton Subbasin Coho Salmon population persisted via juvenile passage and turbine passage at Mayfield Dam being continuously available since dam construction. Adult Coho Salmon were transported in all but 2 years since the Mayfield Dam adult transportation system was abandoned. When the Upper Cowlitz Reintroduction Program began with the construction of Cowlitz Falls Dam in 1994, the opportunity was taken to improve the Tilton River Coho Salmon population by marking smolts captured at the Mayfield

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Dam Juvenile Collection Facility so that natural-origin returns could be distinguished between those from the Upper Cowlitz and Tilton subbasins. Mass marking was also implemented, and this allowed for improved observations of natural-origin adults returning to the Tilton Subbasin. The Tilton Subbasin Coho Salmon population was found to be "Depressed" (LCFRB 2010) and, as part of the lower Columbia River ESU, was listed as threatened under the ESA in 2005, and reaffirmed in 2011 and 2016. With a current baseline viability rating of Very Low, and its classification as a Stabilizing population for recovery of the lower Columbia River ESU, minimum viability abundance targets for this population have not been established (WDFW and LCFRB 2016). Targets for the Tilton Subbasin will be set during the period covered by this FHMP in coordination with the FTC. Currently, spawning by Coho Salmon in the Tilton Subbasin occurs in the mainstem, and likely all accessible tributaries (LCFRB 2010; WDFW 2014c).

5.3.3. Natural Production

Two critical monitoring metrics for salmon management are the numbers that return at maturation and their disposition (Figures 5.3-2 and 5.3-3; Table 5.3-1). Tilton Subbasin Coho Salmon that survive to begin their spawning migration may be harvested in commercial, sport, or tribal fisheries in the ocean; commercial and sport fisheries in the Columbia River; or sport fisheries in the Cowlitz Basin. Those escaping harvest may return to the Barrier Dam Adult Facility and be used as broodstock, transported to the Tilton Subbasin, or surplused. They may also die prior to spawning from predation or disease and may or may not be recovered, or they may survive and attempt to spawn in the Lower Cowlitz Subbasin. Monitoring these dispositions allows us to evaluate population abundance, productivity, and progress toward recovery.

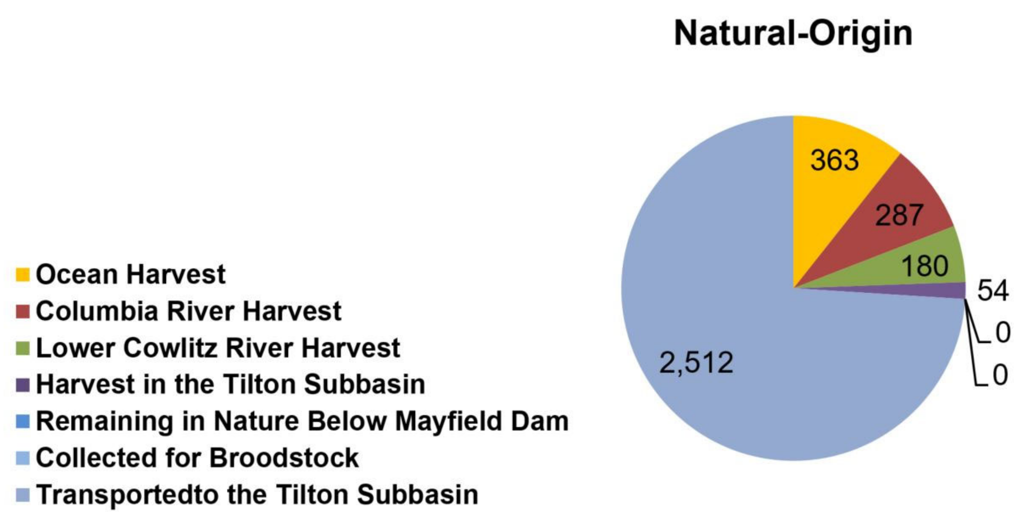

Figure 5.3-2. Mean numbers and proportions of natural-origin Tilton Subbasin Coho Salmon caught in ocean, Columbia River, or lower Cowlitz River fisheries, or that were transported to the Tilton Subbasin (and were harvested or remained in the Tilton Subbasin) from 2007-2017. HOR harvest for the Tilton is represented in Section 5.1. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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Table 5.3-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin Coho Salmon from the Tilton Subbasin population that could be accounted for at recovery locations, and percentage of total at that recovery location, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin,	Numbers		
Recovery Location	Mean	Minimum	Maximum
Hatchery-origin (Lower Cowlitz Subbasin hatchery-origin salmon)			
Total Run[1]			
Harvest[2]			
Ocean harvest			
Columbia River harvest			
Lower Cowlitz Subbasin harvest			
Harvest in Tilton Subbasin	162	590	863
Total Return to Cowlitz River[3]			
Return to Barrier Dam Adult Facility			
Collected for Broodstock			
Transported to Tilton Subbasin	4,163	1,512	6,206
Natural-origin			
Total Run[1]	2,348	823	4,223
Harvest[2]	883	278	4,288
Ocean harvest	363	57	1,583
Columbia River harvest	287	51	1,776
Lower Cowlitz Subbasin harvest	180	49	798
Harvest in Tilton Subbasin	54	7	130
Total Return to Cowlitz River[3]	2,692	780	9,703
Return to Barrier Dam Adult Facility	2,512	691	8,905
Collected for Broodstock	0	0	0
Transported to Tilton Subbasin	2,512	691	8,905
Combined Hatchery- and Natural-origin			
Total Run[1]	3,341	962	13,062
Harvest[2]	1,937	440	5,161
Ocean harvest	363	57	1,583
Columbia River harvest	287	51	1,776
Lower Cowlitz Subbasin harvest	180	49	798
Harvest in Tilton Subbasin	1,108	169	2,011
Total Return to Cowlitz River [3]	2,692	780	9,703
Return to Barrier Dam Adult Facility	2,512	691	8,905
Collected for Broodstock	0	0	0
Transported to Tilton Subbasin	6,675	2,203	14,877

[1] Sum of all harvest below Mayfield Dam, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, lower Cowlitz River, and Tilton Subbasin fisheries.
[3] Sum of lower Cowlitz River harvest, remaining in the Lower Cowlitz Subbasin, and returns to Barrier Dam Adult Facility.

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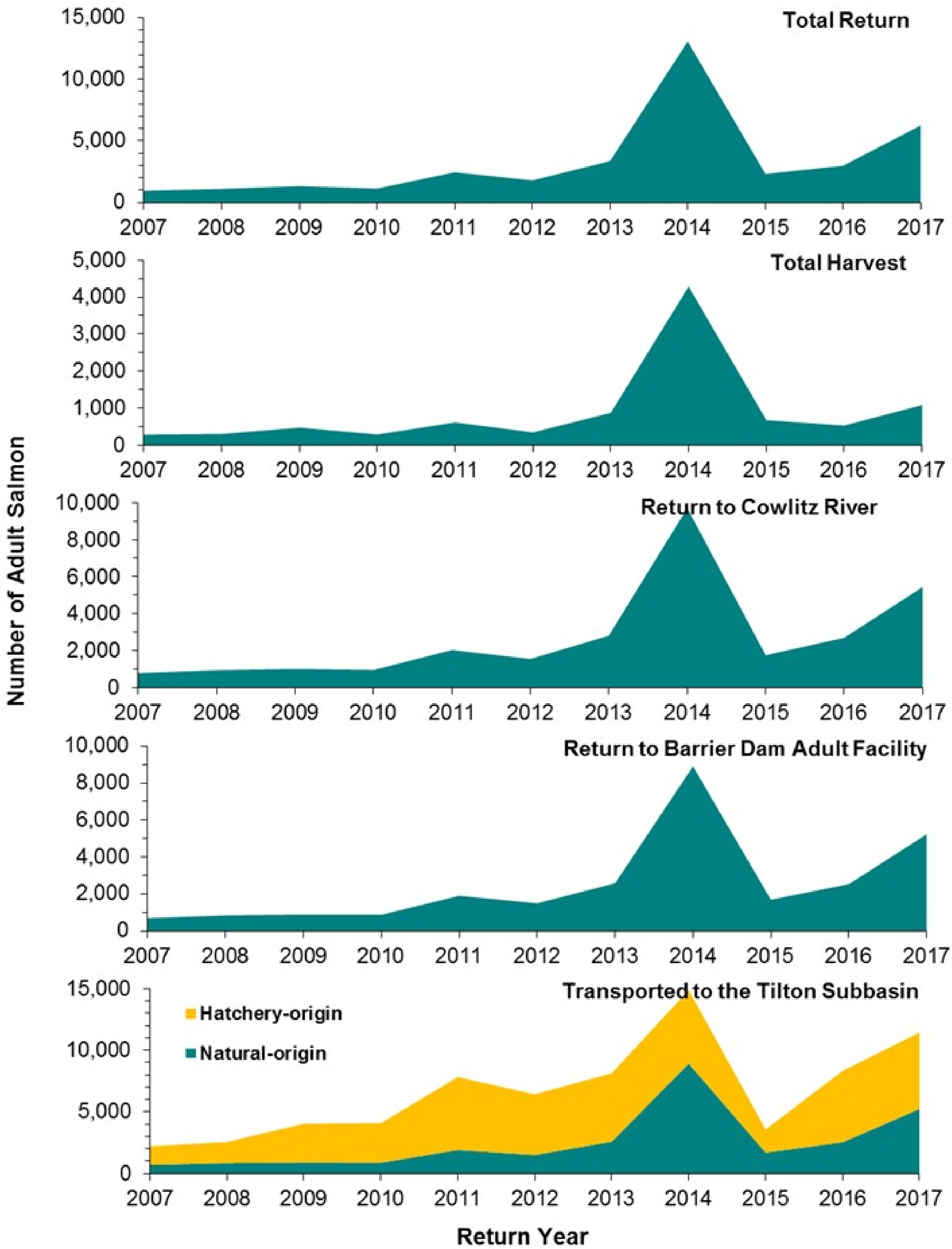

Figure 5.3-3. Estimated total run size for adult natural-origin Tilton Subbasin Coho Salmon and the numbers that returned to the Cowlitz River, were harvested, returned to Barrier Dam Adult Facility, or were transported to the Tilton Subbasin, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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5.3.3.1. Abundance

Harvest, spawning success, and recruitment from natural- and hatchery-origin spawners all directly influence the size of this population. Data for monitoring the Tilton Subbasin Coho Salmon population have been only sporadically collected and are incomplete. The total number of adult salmon transported and released into the Tilton Subbasin is accurately and precisely known. However, estimates of total natural-origin salmon for the population are subject to error associated with Tilton Subbasin Coho Salmon spawning in the Lower Cowlitz Subbasin as well as the collection, transport, and release into the Tilton Subbasin of unmarked Coho Salmon that may have originated from the Lower Cowlitz Subbasin or from outside the Cowlitz Basin.

From 2007-2017, a mean of 3,341 natural-origin Coho Salmon from the Tilton Subbasin population returned to the Cowlitz River or were harvested (Figures 5.3-2 and 5.3-3; Table 5.3-1). A mean of 2,692 natural-origin Tilton Subbasin Coho Salmon escaped the ocean and Columbia River fisheries and entered the Cowlitz River.

5.3.3.2. Harvest

Tilton Subbasin Coho Salmon contribute to important commercial, sport, and tribal fisheries in the Pacific Ocean, lower Columbia River, and within the Cowlitz Basin. From 2007-2017, a mean of 26% (883) of the total natural-origin Tilton Subbasin Coho Salmon run was harvested (Figure 5.3-2; Table 5.3-1). Of the total harvest, 41% were in the ocean and 32% were harvested in the Columbia River, while 20% and 6% were lost due to incidental mortality in the lower Cowlitz River and Tilton Subbasin, respectively. Although a large percentage of the natural-origin Tilton Subbasin Coho Salmon were caught in ocean and Columbia River fisheries, 93% of those that returned to the Cowlitz River escaped harvest and arrived at the hatchery to be transported to the Tilton Subbasin. Of those transported upstream, a mean of 2% were harvested in the Tilton Subbasin fishery.

5.3.3.3. Disposition

No effort is currently conducted to identify natural-origin salmon from the Tilton Subbasin vs. those from the Lower Cowlitz Subbasin that return to Barrier Dam Adult Facility. All unmarked natural-origin returns to the hatchery are assumed to have originated from the Tilton Subbasin and are transported there. For the 2007-2017 run years, a mean of 2,512 natural-origin Tilton Subbasin Coho Salmon were transported and released into the Tilton Subbasin, representing 75% of the total Tilton Subbasin natural-origin run and 93% of those Tilton Subbasin salmon that returned to the Cowlitz River (Figures 5.3-2 and 5.3-3; Table 5.3-1).

5.3.3.4. Spawning in Nature

Spawner abundance in the Tilton Subbasin is determined by the number of adults (both hatchery- and natural-origin) that are transported to the subbasin and survive to spawn. Progeny that migrate downstream to Mayfield Dam either pass through the dam or are captured and released into the lower Cowlitz River and may subsequently return as natural-origin adults. From 2007-2017, a mean of 2,512 natural-origin adults were released into the Tilton Subbasin (Table 5.3-1). Because no spawning ground surveys have been conducted, we do not have actual spawning data. However, we can get a rough estimate of the number of spawners, based on the numbers transported to the Tilton Subbasin minus the number harvested and assuming a constant rate of fallback over Mayfield Dam (12%) and pre-spawn mortality rate (10%). Using this method, we estimate that a mean of 1,941 natural-origin salmon spawned in

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the Tilton Subbasin from 2007-2017. However, Coho Salmon populations are notorious for following “boom and bust” cycles, and the Tilton Subbasin population does not appear to be an exception, as the estimated number of adult spawners ranged from 541-6,936 from 2007-2017.

5.3.3.5. Smolt Production

From 2010-2017 (brood years 2008-2015), a mean of 40,837 parr and smolts were captured at the Juvenile Collection Facility at Mayfield Dam and released into the lower Cowlitz River, below Mayfield Dam. Using a constant 67% collection efficiency, we estimate that a mean of 60,951 downstream migrants were produced in the Tilton Subbasin. Using an assumed constant rate of survival through Mayfield Dam of 80%, we estimate that an additional mean of 16,091 parr and smolts survived, for an annual total mean of 56,928 that survived to the lower Cowlitz River each year.

5.3.3.6. Natural-origin Survival and Productivity

Survival and productivity are the key metrics for monitoring populations, but SAR and spawner-to-spawner productivity can only be estimated for the Tilton Subbasin Coho Salmon population. First, returns are not documented by age, so a full run reconstruction of each brood year is not possible. Additionally, smolt abundance estimates are imprecise and impractical because we do not fully understand the collection efficiency of the Mayfield Dam Juvenile Collection Facility. We know that some of the smolts that are not captured and pass through the dam survive at an estimated rate of 80%. We can use the numbers of Coho Salmon caught at the Juvenile Collection Facility and a constant 67% guidance efficiency rate to roughly estimate total smolt production (Steig et al. 2015).

5.3.3.7. Age and Composition

Only returns of those salmon that were released into the Tilton Subbasin offer an indication of age composition of this population; they are characterized as being “jacks” or “adults” because Coho Salmon are typically only two ages. For natural-origin Tilton Subbasin Coho Salmon, jacks comprised a mean of 43% of the mature salmon released into the Tilton Subbasin from 2007-2017, and adults comprised the remaining 57%.

5.3.4. Hatchery Production

The Tilton Subbasin population currently is not supported by hatchery production that is dedicated to supplementing the population; hatchery-origin Coho Salmon are primarily transported to support harvest opportunity in this Stabilizing population. Thus, hatchery production metrics are only relevant to the population inasmuch as they influence the number of surplus Lower Cowlitz Subbasin hatchery-origin adults available for transport to the Tilton Subbasin. From 2007-2017, a mean of 4,163 hatchery-origin Coho Salmon from the Segregated Hatchery Program were transported and released into the Tilton Subbasin. A mean of 162 of those were harvested, and we estimate (based on assumed 12% fallback and 10% pre-spawn mortality rates) that a mean of 2,348 survived to spawn.

Although there is no hatchery program dedicated to supplementing the Tilton Subbasin Coho Salmon population, some hatchery production metrics must still be monitored to understand the magnitude of hatchery influence on the natural population. Key monitoring metrics are the numbers of hatchery- and natural-origin salmon transported to the Tilton Subbasin and the number estimated to be remaining in nature in the Tilton Subbasin.

5.3.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Because the hatchery-origin adults that are released into the Tilton Subbasin are from the Lower Cowlitz Subbasin Segregated Hatchery Program, which has pNOB = 0, PNI is also zero. The Tilton Subbasin population is not currently supported by a dedicated hatchery program, and hatchery influences are limited to the transport and release of hatchery-origin adults to spawn naturally.

5.3.6. Future Management

Because the Tilton Subbasin Coho Salmon population is designated as a Stabilizing population for achieving MPG and ESU recovery goals, specific minimum viability abundance targets have not been quantified. Targets will be set during the period covered by this FHMP in coordination with the FTC (Table 5.3-2). Population viability has been rated as Very Low (LCFRB 2010). However, since 2007, the total number of Coho Salmon transported to the Tilton Subbasin has ranged from 2,203-14,877 (mean = 6,675), with means of 4,163 hatchery-origin and 2,512 natural-origin Coho Salmon, resulting in a mean pHOS of 0.594. As a Stabilizing population, HSRG guidelines for hatchery influence require that pHOS not exceed “current levels” (HSRG 2009).

5.3.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation and minimum viability abundance targets is evaluated through monitoring of standard fisheries management metrics (Appendix A, Big Table Dataset). The Tilton Subbasin Coho Salmon population had a historical abundance of about 5,600 salmon (LCFRB 2010). In 2010, the abundance and productivity of this population were rated as Very Low, and natural-origin abundance was estimated to be <50 (LCFRB 2010). Due to improved management, natural-origin spawner abundance has increased dramatically compared to when the Recovery Plan was drafted. However, assuming that all adults transported above Mayfield Dam successfully spawn, hatchery-origin salmon comprise a large proportion of those spawning naturally in the Tilton Subbasin (Table 5.3-1), elevating pHOS. While the Transition Plan is in in development, no modifications are anticipated to adult disposition and harvest. The Transition Plan is not anticipated to result in a dedicated hatchery program, but the Tilton Subbasin would continue to be supplemented with Coho Salmon from the Upper Cowlitz Subbasin Integrated Hatchery Program to increase natural production and support harvest.

- **Long-term Goals:** The goal for this Stabilizing Coho Salmon population is full recovery in the Tilton Subbasin to healthy and harvestable levels. Minimum viability abundance targets for natural-origin adults spawning in nature will be set during the period covered by this FHMP in coordination with the FTC. In addition, we will evaluate the appropriate pHOS, pNOB, and PNI targets and associated fish management applications to meet HSRG guidelines.
- **FHMP Goals:** The goals for the Tilton Subbasin Coho Salmon population for the duration of this FHMP are to achieve attainable steps toward population recovery by focusing on increasing abundance of the natural-origin Tilton Subbasin Coho Salmon population based on the following:
    - No dedicated hatchery program but the Tilton Subbasin will be supplemented with salmon from the Upper Cowlitz Subbasin Integrated Hatchery Program to increase natural production and support harvest.

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Table 5.3-2. Recovery phase targets for Tilton Subbasin Coho Salmon. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Recovery Designation: Stabilizing
Current Recovery Phase: Recolonization

Target Metric	RECOVERY PHASE: Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	TBD[1]	TBD[1]	TBD[1]	TBD[1]	3,244[2]
Smolt Abundance (below hatchery)	25,000[3]	50,000[3]	100,000[3]	200,000[3]	43,756
Smolt Passage Survival	40%	60%	70%	75%	~77%
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Seg	Int	Int	Int	NA
Broodstock to be Collected	940	940	940	940	NA
Integrated Hatchery Program	0	940	940	940	NA
Hatchery-Origin	0	470	235	0	NA
Natural-Origin	0	470	705	940	NA
Segregated Hatchery Program	940	0	0	0	NA
Smolts to be Produced	1,200,000	1,200,000	1,200,000	1,200,000	NA
Integrated Hatchery Program	0	1,200,000	1,200,000	1,200,000	NA
Segregated Hatchery Program	1,200,000	0	0	0	NA
Total Smolt-to-Adult Survival	>1%	>1%	>1%	>1%	NA
Proportionate Natural Influence					
pHOS (<)					
Total	0.5	0.4	0.3	0.3	0.502
Integrated Hatchery Program	0.5	0.4	0.3	0.3	N/A
Segregated Hatchery Program	0.1	N/A	N/A	N/A	0.502
pNOB (>)	0.2	0.5	0.75	1	NA
PNI (>)	0.3	0.55	0.7	0.8	0
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	50%	40%	30%	30%	NA

[1] No minimum viability abundance target has been set for Stabilizing populations. Targets will be set during the period covered by this FHMP in coordination with the FTC.
[2] Estimated by subtracting estimated harvest loss and multiplying by assumed fallback (12%) and pre-spawn mortality (10%) rates from the numbers transported to the Tilton Subbasin.
[3] Based on 1% SAR.

- Maintain flexibility to increase production within FERC licensing and ESA constraints. Additional returning hatchery-origin adults will require increased harvest management in order to manage for high return years.
- Develop goals that take into account SARs from the Integrated vs. Segregated Hatchery Programs.

- During development of the Transition Plan within the next 2 years, assess the marking strategies used for natural-origin salmon collected (i.e., at Mayfield Dam instead of Cowlitz Falls Dam).
- Develop a plan for the disposition of surplus salmon.
- Emphasize as key VSP and population metrics:
  - Monitoring of natural-origin salmon returning to the Barrier Dam adult facility.
  - Monitoring of Coho Salmon transported and released in the Tilton Subbasin.
  - Estimates of harvest and pre-spawn mortality rates in the Tilton Subbasin.
  - Estimates of Coho Salmon spawning in nature in the Tilton Subbasin.
- Consider improved methods to estimate, monitor, evaluate, and collect and analyze data, including numbers and age, sex, and origin of all recoveries:
  - Total run size and numbers returning to the Cowlitz River and Barrier Dam Adult Facility.
  - Harvested in fisheries in the ocean, Columbia River, and Cowlitz River.
  - Transported and released into the Tilton Subbasin and that survived to spawn.
  - Hatchery surplus.
  - Hatchery strays to/from outside of the Cowlitz Basin.
  - Hatchery rearing, growth, and survival and numbers released.
  - Natural-origin smolt production from the Tilton Subbasin.

5.3.6.2. Management Targets

The Tilton Subbasin Coho Salmon population is designated as a Stabilizing population, population viability is rated as Very Low, and recent releases of hatchery-origin adults from the Lower Cowlitz Subbasin Segregated Program have increased hatchery influence on the population (LCFRB 2010).

- **Natural Production:** The goal of the Settlement Agreement is to recover self-sustaining, naturally reproducing populations to harvestable levels. Continued efforts to improve downstream passage survival and recruitment from natural production will be implemented in the future. Likewise, the ability to accurately estimate natural production will improve with further understanding juveniles collected at Mayfield Dam. Counts of salmon transported to the Tilton Subbasin are reliable, but we are not certain that all natural-origin salmon transported to the Tilton Subbasin originated there. In addition, pre-spawn mortality has not been estimated for salmon (both hatchery- and natural-origin) spawning in the Tilton River subbasin, so actual pHOS is uncertain. As part of this FHMP, Tacoma Power will work with the FTC to determine the priority of this monitoring need relative to others within the Cowlitz Basin, and determine when it is appropriate to develop and begin to implement monitoring efforts focused on evaluating program effectiveness based on regionally accepted VSP parameters.
  - **Abundance – Transport and Natural Spawning:** Recolonization efforts since 1996 have increased the natural-origin total run size to a mean of 3,341 (2007-2017). We will focus our monitoring of abundance on the numbers of hatchery- and natural-

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origin Coho Salmon that return to the Cowlitz River, are released into the Tilton Subbasin and of estimated spawners in Tilton Subbasin each year. These metrics will be used to track progress toward recovery.

- **Smolts Produced in Nature:** Natural-origin smolt production from the Tilton Subbasin is not well known. Smolts are counted or bypassed at the Mayfield Dam Juvenile Bypass Facility, but trapping efficiency and route-specific survival have not been completed. Having this information would allow for calculation of the total number of smolts produced and, when combined with the number of spawners, allow for calculation of freshwater productivity (smolts per spawner). This is a management need for evaluating habitat capacity and population viability as reintroduction of coho to the Tilton River continues.
- **Smolt-to-Adult Survival:** SAR estimates are limited to data available from juvenile outmigrants at Mayfield Dam and adult returns at the Barrier Dam Adult Facility. Because this information has not been compiled into a single data set for analysis and reporting it is not reported here. This metric is important to the understanding of key limiting factors for the Tilton Subbasin population. We will estimate this index as means to do so become available through our M&E Program.
- **Productivity (Adult Recruits/Spawner):** Because assumptions for returns are not documented by age within a reporting and analysis database, productivity has not been estimated here. However, during this FHMP period, methods to estimate productivity will be evaluated by the M&E Program using assumptions about age structure and existing available data.

- **Hatchery Production:** No hatchery production is dedicated to supplementing the Tilton Subbasin Coho Salmon population. Hatchery influence is currently limited to the transport and release of hatchery-origin adults to provide harvest opportunity and spawn naturally in the subbasin. Because the hatchery-origin salmon that are released into the subbasin are from the Lower Cowlitz Subbasin Segregated Hatchery Program, pNOB and the resulting PNI are equal to zero. Moving to a single Upper Cowlitz Subbasin Integrated Hatchery Program that will have high pNOB may benefit the Tilton Subbasin population. pHOS is also an important metric for this population, and the HSRG guidelines for Stabilizing populations stipulate simply maintaining pHOS at "current levels."
- **Harvest:** A mean of 26% of the natural-origin Tilton Subbasin Coho Salmon run is harvested each year. Harvest of natural-origin salmon constrains the ability of managers to minimize pHOS, while maximizing the number of total spawners in nature. While the abundance of hatchery-origin spawners in nature can be effectively regulated by controlling the numbers transported to the Tilton Subbasin, the continued production from hatchery-origin spawners can provide benefits until returns of natural-origin spawners is sufficient to maintain a self-sustaining population. Given the ability to control numbers of hatchery-origin salmon transported upstream, harvest management of the Tilton Subbasin Coho Salmon population should focus on minimizing the harvest of natural-origin salmon rather than increasing harvest on hatchery-origin salmon. However, most of the harvest of natural-origin Tilton Subbasin Coho Salmon occurs in the Pacific Ocean and Columbia River. Fishery management outside the Cowlitz Basin is complicated, involves multiple state and federal agencies, and is beyond the scope of this FHMP.
- **Proportionate Natural Influence:** Because the hatchery-origin Coho Salmon that are released into the Tilton Subbasin are from a segregated hatchery program (Lower

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Cowlitz Subbasin), pNOB (and thus PNI) are zero. Recent pHOS has been as high as 0.716 (2009) and has exceeded 0.5 for all years, except 2014 and 2015. We plan to increase the influence of the natural environment on the Tilton Subbasin Coho Salmon population by developing a Transition Plan for a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. At that time, the hatchery-origin salmon released into the Tilton Subbasin would have some natural influence from the Upper Cowlitz population. Until then, salmon from the Segregated Hatchery Program will continue to be released to supplement natural spawning and support fisheries.

5.3.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward recovery goals, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

<u>Baseline Studies</u>

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted on a regular basis to track the population’s trajectory and variability and includes the basic data required to operate a one-stage or two-stage life cycle model. Monitoring and evaluation needs of the Tilton Subbasin Coho Salmon population are primarily focused on improving monitoring of juvenile outmigration at Mayfield Dam and estimating the number of actual spawners in the Tilton Subbasin habitats, along with metrics similar to other populations in the basin. This includes accurate counts of hatchery releases, harvest and returns of both hatchery- and natural-origin salmon, adequate marking, and development and evaluation of alternative management and hatchery rearing strategies. As part of this FHMP, Tacoma Power will refine the existing M&E Program to prioritize and implement a rigorous program focused on evaluating program effectiveness based on regionally accepted VSP parameters (Crawford and Rumsey 2011); see Chapter 10, Monitoring & Evaluation (M&E). Areas of improvement that are specific to this population include:

- Quantifying the number of smolts produced in the Tilton Subbasin by estimating the proportion of smolts guided into the Mayfield Dam Juvenile Collection Facility and estimating the survival of smolts through the bypass facility and those passing through the turbines annually.
- Estimating harvest rates in all fisheries, by origin and age.
- Identifying the source of natural-origin returns to Barrier Dam Adult Facility.
- Estimating actual pHOS (spawners).

- Estimating natural population productivity (spawner-to-spawner).

Directed Studies

Directed studies are to diagnose and solve problems associated with achieving FHMP goals and to fill information gaps in the Big Table for management needs (Appendix A). Examples of important areas of study for the Tilton Subbasin Coho Salmon population include:

- **Spawning ground surveys:** Scales, pre-spawn mortality, genetics, spatial distribution, and reach-specific adult densities, by origin, age, and sex.
- **Juvenile rearing capacity studies:** Available habitat and habitat-specific (run/riffle/pool) densities.
- **Early life stage survival studies:** Egg to fry, fry to parr, and parr to smolt survivals.
- In-river migratory survival and behavior: Survival of migrating juveniles and movement rates.
- **Reservoir survival:** Predation rate and parasite loadings.
- Estimating pre-spawn mortality, spawning areas, natural spawning, in the Tilton Subbasin, by origin and age.

5.3.7. Summary

- Although poorly managed from Mayfield Dam construction through 1996, the Tilton Subbasin Coho Salmon population persisted through the availability of juvenile passage and adult transportation but was heavily impacted by the lack of differentiation between natural- and hatchery-origin salmon that was common practice though out the region during this period.
- Coho Salmon recovery efforts have focused on transporting natural-origin Coho Salmon returning to Barrier Dam Adult Facility to the Tilton Subbasin.
- Additionally, surplus hatchery-origin Coho Salmon from the Lower Cowlitz Subbasin Segregated Hatchery Program have been consistently transported to the Tilton Subbasin for harvest opportunity and to supplement natural spawning.
- Recent abundances of natural-origin adults transported to the Tilton Subbasin have approached or exceeded the proposed minimum viability abundance target. However, ongoing releases of hatchery-origin adults from the Segregated Hatchery Program contribute to hatchery influence on the natural-origin population.
- In the near term, Tacoma Power and the FTC will develop a Transition Plan to move to a single Integrated Hatchery Program derived from Upper Cowlitz Subbasin broodstock that meets all program supplementation and harvest needs. This single, Upper Cowlitz Subbasin Integrated Hatchery Program will encompass all hatchery production from the current Lower Cowlitz Subbasin (Segregated) and Upper Cowlitz Subbasin (Integrated) hatchery programs, with an annual production target of 2.2 million yearling smolts. The Transition Plan for Coho Salmon will be developed within 2 years of completion of this FHMP. As an interim strategy and until the Transition Plan is developed, Tacoma Power and the FTC will operate the programs as they were operated in 2019.

- Goals for the period covered by this FHMP:
    - No dedicated hatchery program, but the Tilton Subbasin will be supplemented with salmon from the Upper Cowlitz Subbasin Integrated Hatchery Program to increase natural production and support harvest.
    - Maintain flexibility to increase production within FERC licensing and ESA constraints.
    - During development of the Transition Plan, assess strategies for marking natural-origin smolts collected (i.e., at Mayfield Dam instead of Cowlitz Falls Dam).
    - Develop a plan for the disposition of surplus salmon.
    - Emphasize key population monitoring metrics, such as smolt production, survival, productivity, and other VSP metrics.
    - Improve monitoring, evaluation, and data collection, and/ or estimation methods (including numbers and age, sex, and origin of recoveries).
- The long-term goal for this Stabilizing Coho Salmon population is full recovery in the Tilton Subbasin to healthy and harvestable levels. Minimum viability abundance targets for natural-origin adults spawning in nature will be set during the period covered by this FHMP in coordination with the FTC. In addition, we will evaluate the appropriate pHOS, pNOB, and PNI targets and associated fish management applications to meet HSRG guidelines.
- Monitoring for VSP metrics needed to evaluate recovery status and trends. Data should be collected by origin, age, and sex and include, but are not limited to:
    - Hatchery- and natural-origin smolt numbers.
    - Estimates of total mature salmon numbers by origin, age, and sex.
    - Estimates of numbers of spawners in nature, strays, and pre-spawn mortalities, by origin, sex, and age.
    - Returns to Barrier Dam Adult Facility by origin, age, and sex.
    - Improved harvest estimates of both hatchery- and natural-origin salmon, by age.
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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CHAPTER 6:
WINTER STEELHEAD

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Winter Steelhead *Oncorhynchus mykiss*

ESA Listing

Status:	Threatened Listed in 1998, revised 2006, reaffirmed in 2011 and 2016
Distinct Population Segment[1]:	Lower Columbia River Steelhead
Major Population Group:	Cascade Winter Steelhead
Recovery Region:	Lower Columbia River Salmon
Populations and Recovery Designations:	Lower Cowlitz Subbasin – Contributing Upper Cowlitz Subbasin – Primary Tilton Subbasin – Contributing
Current Hatchery Program(s):	• Lower Cowlitz Subbasin Late-Winter Steelhead Integrated Hatchery Program • Upper Cowlitz Subbasin Late-Winter Steelhead Integrated Hatchery Program • Tilton Subbasin Late-Winter Steelhead Integrated Hatchery Program • Lower Cowlitz Subbasin Summer Steelhead Segregated Hatchery Program
Proposed Hatchery Program(s):	• Lower Cowlitz Subbasin Winter Steelhead Integrated or Segregated Hatchery Program • Upper Cowlitz Subbasin Winter Steelhead Integrated Hatchery Program • Tilton Subbasin Winter Steelhead Integrated Hatchery Program • Lower Cowlitz Subbasin Summer Steelhead Segregated Hatchery Program

[1] Lower Columbia River Steelhead were initially listed as threatened by NMFS under the Evolutionarily Significant Unit (ESU) policy (71 Federal Register 8844). However, NMFS revised the listing in 2006, applying the Distinct Population Segment (DPS) policy (61 Federal Register 4722).

6.0. Winter Steelhead: Overview

6.0.1. Program Focus

The focus for winter steelhead will be population recovery and harvest opportunity. The Recovery Plan (LCFRB 2010) identifies four winter steelhead populations, excluding the Toutle and Coweeman rivers, in the Cowlitz Basin (Figure 6.0-1):

- Lower Cowlitz Subbasin – Contributing population
- Cispus River - Primary population
- Upper Cowlitz River - Primary population
- Tilton Subbasin - Contributing population

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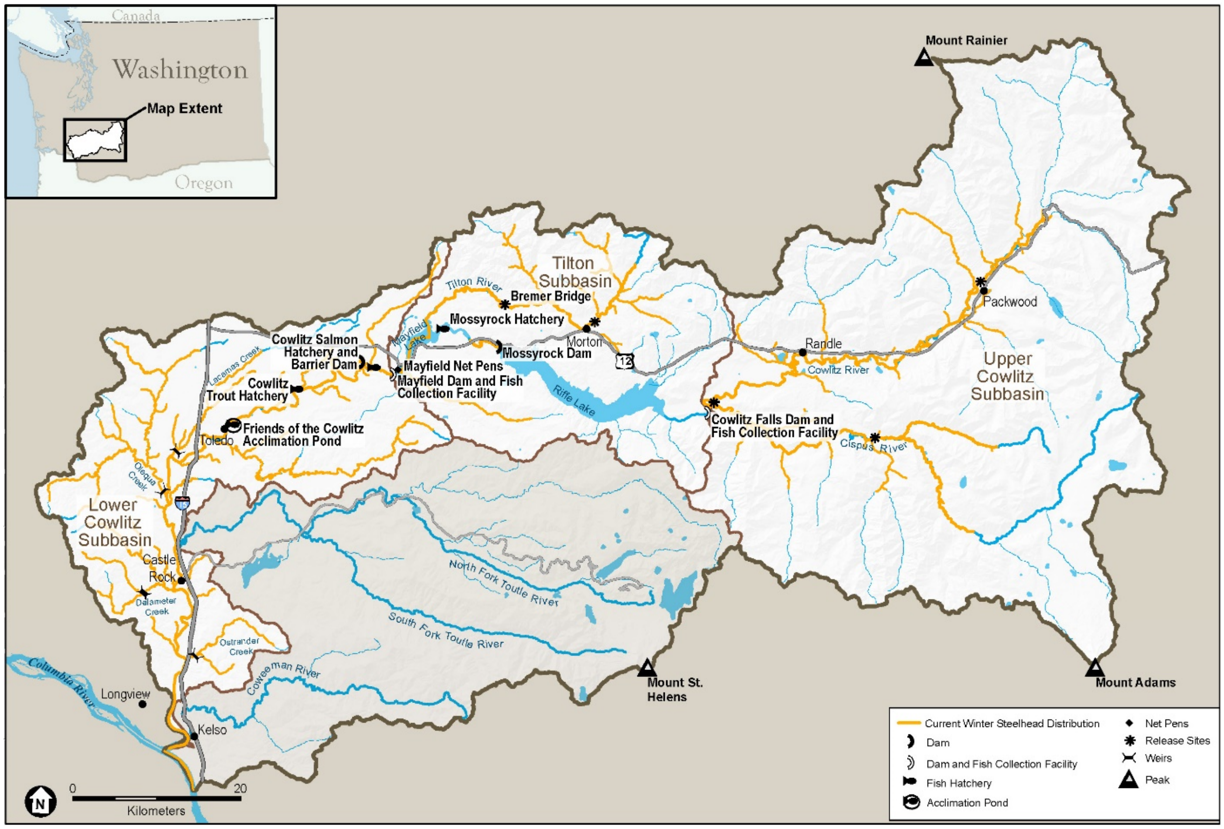

Figure 6.0-1. Distribution of winter steelhead in the Cowlitz Basin, Washington.

Following the construction of Mayfield Dam, adult steelhead continued to be passed upstream via adult passage facilities at Mayfield Dam to continue their migration to the Cispus, Upper Cowlitz, and Tilton rivers. With the construction of Mossyrock and Barrier dams, along with the implementation of Cowlitz Steelhead hatchery programs, broodstock was collected from steelhead returning to the Cowlitz Basin upstream of the Barrier Dam. Transfer of adult steelhead upstream of Mayfield Dam was suspended after 1980 after an outbreak of IHN was detected (IHN, or infectious hematopoietic necrosis, is a virus deadly to salmonids). "Unfortunately, this undesirable situation is a product of relying solely on hatcheries to mitigate for fish losses caused by hydroelectric development" (letter dated March 13, 1987, from Jim DeShazo, Division Chief, Washington Department of Game). At this point, upper Cowlitz and Tilton river populations were extirpated, and the Lower Cowlitz Subbasin winter steelhead population became an aggregation of all four populations, representing the only extant population remaining in the Cowlitz Basin upstream of the Toutle River that continued to exist in tributaries to the lower Cowlitz River and as a combined hatchery program. As such, the Lower Cowlitz Subbasin population has served as the founding stock for reintroductions upstream of Mayfield Dam. The hatchery steelhead program that was derived from Upper Cowlitz Subbasin returns was joined by additional programs using imported early winter and summer steelhead stocks.

Although the ESA framework identifies distinct populations in the Cispus and Upper Cowlitz rivers, returning adults cannot be differentiated by population. These populations are therefore managed as a combined "Upper Cowlitz Subbasin" population. Recovery efforts for winter steelhead continue to focus on Recolonization in the Upper Cowlitz and Tilton subbasins and on Local Adaptation in the Lower Cowlitz Subbasin. The main purpose of the Recolonization phase of recovery has been to increase the abundance of natural-origin winter steelhead spawning in nature. In the Upper Cowlitz and Tilton subbasins, this has involved the transport and release of hatchery-origin winter steelhead adults from the Integrated Hatchery Programs to reintroduce and then supplement spawning by natural-origin adults. In the Tilton Subbasin, the number of natural-origin adults transported and released into the subbasin has been approaching the minimum viability abundance target for natural spawning. In contrast, numbers of natural-origin adults transported and released in the Upper Cowlitz Subbasin is well below the target for that population. This is likely in part due to Cowlitz Basin-wide productivity tests that took place from 2010 to 2013, during which only natural-origin steelhead were transported above Mayfield and Cowlitz Falls dams while productivity was being assessed in association with license obligations. The Local Adaptation phase in the Lower Cowlitz Subbasin has focused on minimizing hatchery influence, and phasing in an Integrated Hatchery Program that has required the collection of natural-origin broodstock from Lower Cowlitz Subbasin tributaries.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin programs, as well as correctly size the Lower Cowlitz Subbasin program when appropriate. This plan will evaluate the current strategies and consider new options for expanding winter steelhead returns earlier in the year. Until the Transition Plan is developed, we will continue to implement the hatchery integration and management practices from 2019. In the interim, Tacoma Power and the FTC will use the APR process annually to determine how best to consider moving to a segregated program in the lower Cowlitz River, and gather input on options for expanding winter steelhead return timing earlier in the year. Tacoma Power and the FTC acknowledge that HSRG guidelines for pHOS might not be met in all cases during this interim period. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

The near-term period covered by this FHMP will:

- Prioritize population recovery while still providing harvest opportunity, as feasible within FERC license, ESA, and basin constraints.
- Identify and monitor pHOS in each subbasin to assess hatchery influence.
- Increase total abundance (natural- and hatchery-origin) of adults in the Upper Cowlitz Subbasin to increase natural production and advance recovery.
- Within 1 year of FHMP completion, develop the Transition Plan and implementation timelines for hatchery steelhead programs, outlining a path to move from current programs to those discussed/proposed throughout the specific population chapters.
  - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
  - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
    - Minimize conflict with restoration of late-winter steelhead run in the upper basin.

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        - Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run/spawn timing.
    - Define how soon we want this program to begin.
    - Recognize the need for some harvest opportunity.
    - These actions would need to fit within minimum viability abundance targets and ESA constraints.
- Define the triggers or thresholds for moving from one stage of recovery to another (e.g., abundance, spatial distribution) while considering various recovery strategies.
- Reduce the abundance of hatchery-origin winter steelhead spawners in the Lower Cowlitz Subbasin.

The long-term goal for winter steelhead in the Cowlitz Basin will be to prioritize recovery of the Upper Cowlitz and Tilton subbasin populations, while promoting Local Adaptation in the Lower Cowlitz Subbasin.

6.0.2. Population Structure

As noted above, four historical populations of winter steelhead have been recognized in the Cowlitz Basin, excluding the Toutle and Coweeman river populations, which are outside the scope of this FHMP: Lower Cowlitz Subbasin, Upper Cowlitz/Cispus Subbasin, and Tilton Subbasin populations (Myers et al. 2006; Figure 6.0-1; Table 6.0-1). These endemic populations spawned and reared in the tributaries and mainstem of the larger rivers in each basin. Historically, the Lower Cowlitz Subbasin population alone may have represented one of the largest winter steelhead runs in the Lower Columbia Basin (LCFRB 2010). Construction of Mossyrock Dam in 1968, with juvenile passage attempts abandoned shortly thereafter, caused the extirpation of the upper Cowlitz and Cispus river populations. Steelhead were intentionally extirpated from the Tilton River after 1980 to protect the Cowlitz hatchery complex from disease risk. Although the Lower Cowlitz Subbasin winter steelhead population persists, by the early 1990s it was recognized to be at Moderate risk of extinction due to hydroelectric development in the 1960s and ongoing habitat degradation and hatchery influences (Nehlsen et al. 1991; Busby et al. 1996; LCFRB 2010; Ford et al. 2011). While the Upper Cowlitz Subbasin-derived hatchery population has been the genetic source for reintroductions of winter steelhead to the Upper Cowlitz and Tilton subbasins since 1995, by 2013, the Lower Cowlitz Subbasin population was not considered to be viable (NMFS 2013). The most recent 5-year status review (NMFS 2016) concluded that the lower Columbia River winter steelhead DPS, of which the Cowlitz Basin populations are a component, continues to be at Moderate risk of extinction. The Lower Columbia Conservation and Sustainable Fisheries Plan (WDFW and LCFRB 2016) classifies the current status of these populations as at “high risk” of extinction (Lower Cowlitz Subbasin) or “extinct or at very high risk” of extinction (Tilton, Upper Cowlitz, and Cispus subbasins). However, ongoing reintroduction efforts and improved monitoring since 2011 have enhanced our understanding of the Cowlitz Basin steelhead populations, and recent trends in natural-origin abundance have approached minimum viability abundance targets for some populations. Recent efforts have focused on improving downstream Fish Passage Survival and our understanding of life history diversity and natural productivity.

Table 6.0-1. Recovery priority, baseline viability status, viability and abundance objectives, and productivity improvement targets for Cowlitz Basin winter steelhead populations (from LCFRB 2010).

	Demographically Independent Population			
	Lower Cowlitz Subbasin	Cispus Subbasin[1]	Upper Cowlitz Subbasin[1]	Tilton Subbasin
Run	Late	Late	Late	Late
Recovery Priority Designation[2]	Contributing	Primary	Primary	Contributing
Abundance				
Historic[3]	1,400	1,500	1,400	1,700
Current (last 5 years)[4]	350	<50	<50	<50
Target[5]	400	500	500	200
Baseline Viability[6]				
Abundance & Productivity	Low	Very Low	Very Low	Very Low
Spatial Structure	Medium	Medium	Medium	Medium
Diversity	Medium	Medium	Medium	Medium
Net Viability Status	Low	Very Low	Very Low	Very Low
Viability Improvement[7]	+5%	>500%	>500%	>500
Recovery Viability Objective[6]	Medium	High	High	Low
Proportionate Natural Influence				
pHOS	<0.3	<0.3	<0.3	<0.3
pNOB	>0.3	>0.6	>0.6	1
PNI	>0.5	>0.67	>0.67	>0.5

1 For current management purposes, the Cispus Subbasin and Upper Cowlitz Subbasin populations are combined into an Upper Cowlitz Subbasin population with abundances equal to the sum of the two separate populations.

2 Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance targets.

3 Historic population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS professional judgment calculations.

4 Approximate current mean annual number of naturally produced fish returning to the watershed. Note that these values are 5-year means and are not necessarily consistent with mean values over various intervals that are presented elsewhere.

5 Abundance targets were estimated by population viability simulations based on minimum viability abundance targets.

6 Viability status is based on Technical Recovery Team viability rating approach. Viability objective is based on the scenario contribution. Very Low (>60% chance of extinction); Low (26-60% chance of extinction); Medium (6-25% chance of extinction); High (1-5% chance of extinction); Very High (<1% chance of extinction).

7 Improvement is the relative increase in population abundance and productivity required to reach the prescribed viability goal.

With the listing of these populations under the ESA in 1998, the focus was on recovery of the original four populations, and conservation was elevated to a higher management priority, resulting in changes in hatchery, harvest, and habitat actions. The Upper Cowlitz and Cispus rivers populations are designated as Primary populations in relation to their contribution to recovery of the lower Columbia River DPS, while the Lower Cowlitz and Tilton subbasin populations are designated as Contributing populations (LCFRB 2010). Recovery relies on the extant Lower Cowlitz Subbasin winter steelhead population as the founding population for re-establishing the populations above Mayfield Dam. Recovery actions have been undertaken over the past three decades, but delisting of the DPS cannot occur until all four historical

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populations have been restored with a probability of persistence that is high or, at a minimum, is consistent with their historical condition. Delisting is also reliant on other non-Cowlitz populations within the DPS improving their viability. Reintroductions of the populations above Mayfield Dam have provided opportunities for the continued growth and genetic diversification of all populations in the Cowlitz Basin.

6.0.3. Life History Diversity

Winter steelhead adults from the indigenous Lower Cowlitz, Upper Cowlitz, and Tilton subbasin populations historically had a return timing from late November through June, with peak returns in April and spawning generally occurring in March-June, with peaks in late April or early May. However, Winter steelhead hatchery adults derived from the indigenous Lower Cowlitz, Upper Cowlitz, and Tilton subbasin populations are currently classified as a late-winter run, based on the timing of their return to the Cowlitz River from February to as late as early June (Tacoma Power 2011). Until recently, the Segregated Hatchery Program also supported a non-native (Chambers Creek of Puget Sound origin) early-winter steelhead run, which was manipulated to have return and spawn timing that was temporally separated from natural-origin fish. These were distinguished by their return to the Cowlitz River from November through early March and earlier spawn timing peaking in December and January. The early-winter run program was terminated following the 2011 FHMP to reduce the risk of hatchery introgression during spawning overlap in late February and early March. A non-native (Skamania origin) Segregated Summer Steelhead Hatchery Program continues today but is thought to pose a lesser risk of introgression because of its high return fidelity to the Barrier Dam Adult Facility and low stray rate to tributary spawning areas, where spawning is mostly temporally isolated.

Natural origin winter steelhead spawning in the Cowlitz Basin generally occurs from early March through early June, and fry emerge from June through August (LCFRB 2010). Although information on smolt age is limited, most juveniles are thought to rear for 2 years in the Cowlitz Basin before outmigrating, with the remainder rearing for 1, 3, or 4 years (LCFRB 2010). Based on juvenile monitoring efforts, the annual outmigration typically occurs in April and May, with a peak in early May. Limited age composition data indicate that most natural-origin Cowlitz Basin winter steelhead spend 2 (54.2%) or 3 (32.2%) years in the ocean before returning to spawn (LCFRB 2010). Hatchery-origin winter steelhead demonstrate a more uniform age-structure, primarily returning after 2 years in the ocean.

6.0.4. History

The Cowlitz Basin winter steelhead population is thought to have been one of the largest in the Lower Columbia Basin, including an estimated historical escapement of 6,000 spawners upstream of the Toutle River, but current baseline escapement (<500 natural-origin spawners) represents <9% of the original size (Table 6.0-1; WDFW and LCFRB 2016). Other estimates of historical abundance suggest an annual run size of 22,000 winter steelhead in the Cowlitz Basin, with a spawning escapement of 11,000 above Mayfield Dam (WDF and WDG 1946, as cited in Myers et al. 2006). By the early 1960s, a mean of 11,081 adult steelhead were enumerated annually at the Mayfield Dam Fish Passage Facility. However, the combination of hydropower development and hatchery mitigation, and the resultant effects of habitat loss and increased harvest took their toll on these populations and resulted in their subsequent listing under the ESA (WDF et al. 1993; Myers et al. 2006; LCFRB 2010).

Hatcheries have been operated on the Cowlitz River for over 100 years and, since 1957, have included releases of hatchery winter steelhead (LCFRB 2010; Myers et al. 2006). A mean of roughly 180,000 hatchery winter steelhead smolts were released annually in the Cowlitz

Basin from 1967-1994 (LCFRB 2010). However, by this period (late 1970s and 1980s), the mean run size of natural-origin winter steelhead in the Cowlitz Basin fell dramatically to only 309 steelhead, representing just 1.7% of the combined historical (hatchery- and natural-origin) run (LCFRB 2010). To limit the harvest of natural-origin steelhead, mark-selective regulations have been in place for most lower Columbia River tributaries, including the Cowlitz Basin, since the late 1980s (WDFW and LCFRB 2016).

Cowlitz Falls Dam was completed in 1994, with a downstream fish collection facility completed in 1996. As part of a reintroduction effort, fingerling, smolt, and adult hatchery late winter steelhead were released to the watershed upstream of Cowlitz Falls Dam (GAIA Northwest, Inc. 1994). At the same time, excess hatchery-origin winter steelhead from the Lower Cowlitz Subbasin population began to be transported to the Tilton Subbasin (Myers et al. 2006). Smolts were marked at Mayfield Dam to differentiate adult returns, and as the natural-origin offspring of these salmonids began returning, a combination of hatchery- and natural-origin winter steelhead were transported to their subbasin of origin (note: between 2010 and 2013 when productivity tests were taking place, only natural-origin fish were transported upstream of Mayfield and Cowlitz Falls Dam). The desire is to produce as many natural smolts as possible and, ultimately, to produce a self-sustaining natural population in each of the three basins above the hydroelectric complex. The transplanted steelhead likely have genes from the original populations above Mayfield Dam, and with their return to those areas, it is expected that these genes will be of great benefit to the restoration effort.

Segregated hatchery programs using out-of-basin (Skamania stock) broodstock were also operated in the Cowlitz Basin for summer steelhead since at least 1971 (Meyers et al. 2006) and early-winter steelhead (Chambers Creek Puget Sound stock) since 1957 (LCFRB 2010). From 1995-2014, roughly 200,000-700,000 summer steelhead and 150,000-700,000 early-winter steelhead hatchery smolts were released annually (WDFW and LCFRB 2016). Releases of Cowlitz Basin origin late-winter steelhead hatchery smolts during this period ranged from 100,000 to over 700,000 (WDFW and LCFRB 2016). To minimize hatchery influence on the endemic winter steelhead population, the late-winter steelhead hatchery program was converted to three Integrated Hatchery Programs in 2012 (Lower Cowlitz, Tilton, and Upper Cowlitz).

The process of building self-sustaining natural populations that meet abundance targets has been slow. Historically, smolt survival associated with dam and reservoir passage has not been sufficient to support a self-sustaining population. However, both upstream and downstream fish passage programs now allow for the return of increasing numbers of naturally produced steelhead to populations that had been extirpated. Improvements made at the downstream juvenile facilities at Mayfield and Cowlitz Falls dams are expected to increase the abundance of outmigrants and should help to improve the status of the Tilton Subbasin and Upper Cowlitz Subbasin winter steelhead populations, respectively. Natural-origin abundance varies widely and has generally been below the combined minimum viability abundance target of 1,600 spawners; from 2013-2017, the estimated number returning to spawning grounds or transported above the dams has ranged from 656 to 1,628 (Figure 6.0-2). For the entire Cowlitz Basin, land development and increasing human population pressures will likely continue to degrade habitat, especially in lowland areas. In addition, poor ocean conditions can increase the risk of extinction. As such, this DPS is still considered to be at Moderate risk of extinction (NWFSC 2015).

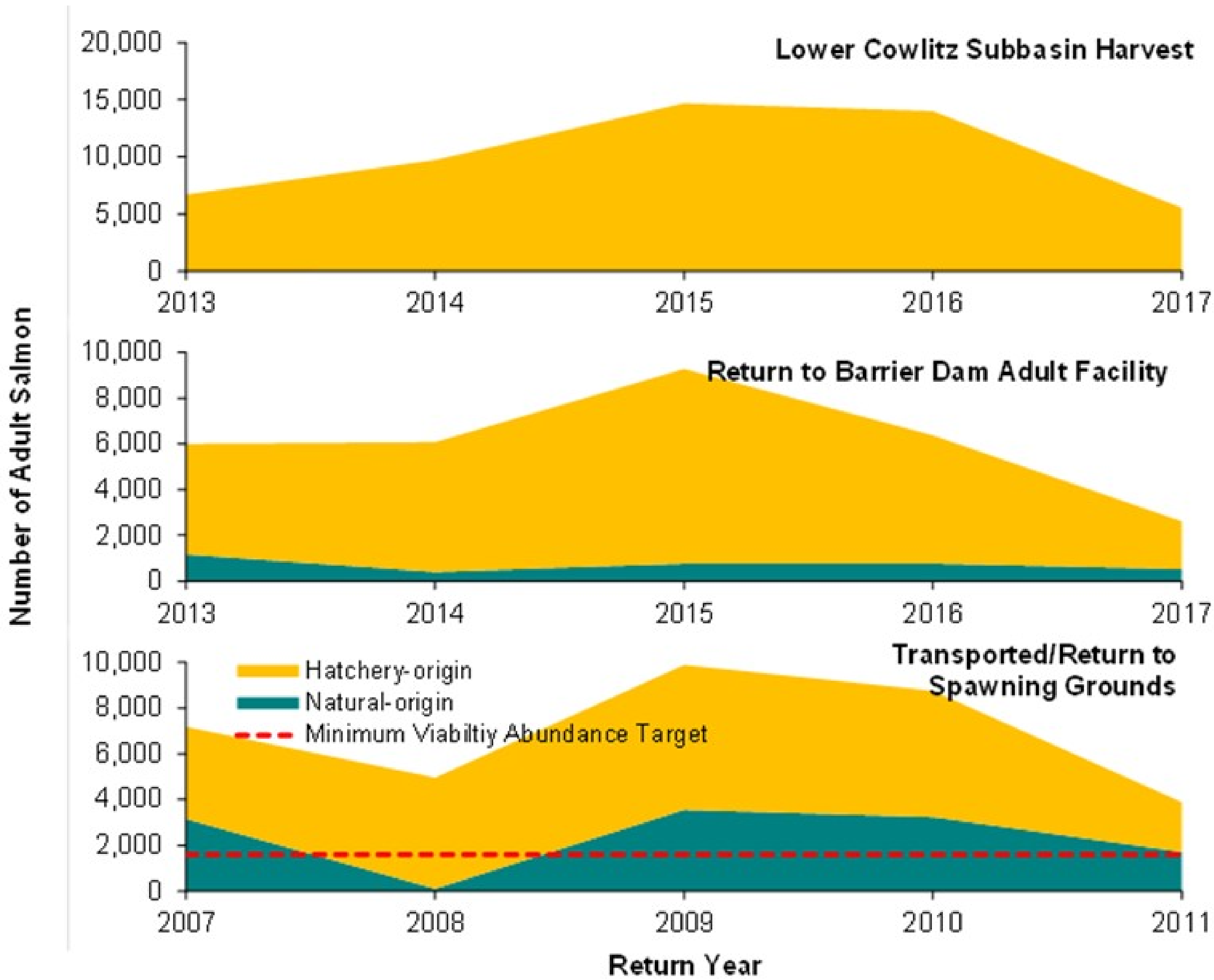

Figure 6.0-2. Numbers of hatchery- and natural-origin winter steelhead from the Cowlitz Basin above the Toutle River returning to Cowlitz Barrier Dam Adult Facility, and/or transported or returning to spawning grounds, 2013-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

6.0.5. Distribution

Historically, winter steelhead were distributed throughout the Cowlitz Basin in the mainstem and accessible tributaries, including in the Upper Cowlitz, Cispus, and Tilton subbasins. Below Mayfield Dam, winter steelhead are currently distributed throughout the mainstem Cowlitz River, with spawning documented in Olequa, Ostrander, Salmon, Arkansas, Delameter, Stillwater, and Whittle creeks (LCFRB 2010; Figure 6.0-1). The upstream transport program provides access to the Tilton, upper Cowlitz, and Cispus rivers and their accessible tributaries. In the Upper Cowlitz Subbasin, known spawning areas are in the mainstem Cowlitz River near the town of Packwood in the mainstem reach between its confluences with the Muddy and Clear forks, and in the lower Ohanapecosh River (LCFRB 2010).

Habitat above Mayfield and Cowlitz Falls dams appears to be productive, but this reintroduction effort has been hindered by the poor survival of smolts through the dams and associated reservoirs, as well as historically poor capture efficiency of out-migrating smolts for

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transport around the dams. Fish migrating from the Upper Cowlitz Subbasin make their way through Lake Scanewa before being captured at the Cowlitz Falls Fish Facility, where they are sampled, marked, and transported downstream to the stress relief ponds at the Cowlitz Salmon Hatchery and exit of their own volition. Juveniles from the Tilton Subbasin make their way down to Mayfield Lake and rear in the reservoir or migrate down to Mayfield Dam, where they are either captured at the counting house or pass through the turbines. Although winter steelhead also inhabit the Toutle and Coweeman rivers, both tributaries to the lower Cowlitz River, these are considered separate populations for recovery purposes and outside the scope of this FHMP.

Historically, natural spawning by winter steelhead (both hatchery- and natural-origin) has not been extensively monitored or managed, but both monitoring and management have improved in recent years. To reduce the abundance of hatchery-origin strays spawning in tributaries and improve abundance estimates of natural-origin steelhead, weirs have been installed on Delameter, Lacamas, Olequa, and Ostrander creeks in the Lower Cowlitz Subbasin; only natural-origin late-winter steelhead are released above the weirs. Any hatchery-origin fish above the weirs are individuals that successfully passed when the weirs were overtopped or compromised by high flows. The weirs provide facilities to monitor timing, distribution, and abundance. Spawning ground surveys are also conducted on lower Cowlitz River tributaries with weirs and a subsample of other lower Cowlitz River tributaries, but not in the mainstem lower Cowlitz River. In the Tilton and Upper Cowlitz subbasins, known numbers of both hatchery- and natural-origin steelhead are transported and released, but neither their survival to, nor location of, spawning is currently monitored in any systematic way. Also, survival to the smolt stage may be limiting productivity of the Lower Cowlitz Subbasin steelhead population. Survival of juveniles produced in the mainstem and/or parr migrating there may be impacted by *C. shasta* during over-summer rearing. This impact is not well understood.

6.0.6. Abundance

The total run size of winter steelhead to the Cowlitz Basin includes the number of hatchery- and natural-origin steelhead that can be accounted for from ocean, Columbia River, and lower Cowlitz River fisheries, plus those spawning in the Lower Cowlitz Subbasin or captured at the Barrier Dam Adult Facility. Harvest data are incomplete, so total run size cannot be accurately estimated for any of the winter steelhead populations based on available information. Returns to the Barrier Dam Adult Facility offer a relative indication of total abundance; from 2013-2017, a mean of 4,420 hatchery-origin and 588 natural-origin late-winter steelhead returned to the Barrier Dam Adult Facility (Figure 6.0-2; Table 6.0-2).

Productive spawning and rearing habitats still exist above the Cowlitz River Hydroelectric Complex. It is assumed that recent improvements in steelhead smolt survival have helped reintroduction efforts. Although downstream migrant traps are operated for juvenile steelhead at Cowlitz Falls and Mayfield dams and help to assess the success of the adult releases, fish guidance efficiency at Mayfield Dam has not been measured recently, and therefore precise estimates of smolt abundance from the Tilton Subbasin population must be examined prior to application. Likewise, limited effort is expended to examine annual abundance of natural-origin juveniles prior to smoltification. As a result, there is uncertainty about the abundance of natural-origin steelhead smolts in the Cowlitz Basin.

6.0.7. Harvest

Although no commercial or tribal fisheries target Cowlitz Basin winter steelhead (LCFRB 2010), recreational harvest is an important component of Cowlitz Basin winter steelhead management and has the potential to affect population recovery. The Cowlitz Basin is one of

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the most intensively fished basins in Washington and is considered the top winter steelhead river in the state for recreational fishing (LCFRB 2010). The mark-selective regulations in place since the 1980s, as well as ESA restrictions on recreational fisheries, help to limit harvest impacts on natural-origin winter steelhead. LCFRB (2010) reports that <2% of natural-origin Cowlitz Basin steelhead are lost in recreational fisheries. ISIT assumes a 2% harvest across all years, but no comprehensive annual estimates of natural-origin harvest are available. Current estimates of natural-origin indirect mortality are based on natural-origin encounter rate and hatchery-origin catch (from Catch Record Cards) from the lower Cowlitz River creel survey.

ISIT contains average or estimated hatchery-origin harvest rates for terminal fisheries in the respective subbasins for each population (i.e., harvest of Lower Cowlitz Subbasin steelhead in the Lower Cowlitz Subbasin and Upper Cowlitz Subbasin steelhead in the Upper Cowlitz Subbasin), but neither hatchery- nor natural-origin harvest data are available for the Tilton Subbasin terminal fishery. Also, no estimates of ocean or Columbia River harvest are provided. Moreover, harvest rates for the lower Cowlitz River fishery are not population-specific (the Tilton and Upper Cowlitz subbasin populations are assumed to experience the same harvest rates in the lower Cowlitz River terminal fishery as the Lower Cowlitz Subbasin population). All available information on this topic will need to be consolidated into a single analysis and reporting database during this FHMP period.

Managing for population recovery would support high harvest rates for hatchery-origin steelhead while keeping harvest impacts of the natural-origin salmonids as low as possible until the population can support harvest (Paquet et al. 2011).

6.0.8. Natural Production

To recover a steelhead population, we must first develop a self-sustaining natural population. To successfully manage toward population recovery, it is also important to know the abundance of the population at important points in their life cycle. Overall, for management and recovery purposes, it is desirable to estimate (by origin, sex, and age) how many steelhead are spawning in nature (F_0 generation) and how many of their offspring (F_1 generation) smolts leave the Cowlitz River and subsequently survive to produce the next (F_2) generation. Because spawning ground surveys have not been consistently conducted in the Upper Cowlitz or Tilton subbasins, any estimates to date of steelhead successfully reproducing on the spawning grounds are based on the number transported above the dams and outmigrating smolts; it is unknown how many survive to spawn. Collections of steelhead smolts and kelt at Cowlitz Falls and Mayfield dams offer an important monitoring point and provide a reliable number of fish transported (Cowlitz Falls) or bypassed (Mayfield) and released downstream.

The combined minimum viability abundance target for winter steelhead populations in the Cowlitz Basin is 1,600 natural-origin adults spawning in nature (Table 6.0-1); this target consists of the Primary population in the Upper Cowlitz Subbasin (1,000 spawners, including the Cispus River drainage) and Contributing populations in the Lower Cowlitz (400 spawners) and Tilton (200 spawners) subbasins (LCFRB 2010).

Although natural spawning of hatchery-origin salmonids is not directly credited toward meeting natural production targets, hatchery-origin adults are currently transported above Mayfield and Cowlitz Falls dams to spawn naturally as part of the recovery program. While these hatchery-origin steelhead are F_1 progeny of at least one natural-origin parent, the goal is to ultimately evaluate the need for natural spawning of hatchery-origin salmonids once natural-origin abundance targets are met.

6.0.8.1. Natural Origin Adult Transport and Natural Spawning

Naturally produced smolts from the Upper Cowlitz Subbasin are marked with rostrally implanted CWTs when collected at Cowlitz Falls Dam so that they can be identified as belonging to the Upper Cowlitz Subbasin population. Upon returning to the hatchery as adults, these steelhead are either transported back to the Upper Cowlitz Subbasin to spawn naturally or retained as broodstock. Steelhead smolts sampled at Mayfield Dam are dorsally tagged with a CWT. All dorsally CWT-tagged natural-origin returns to the hatchery are assumed to have originated from the Tilton Subbasin and are either transported back to that subbasin to spawn naturally or retained as broodstock. There will also be untagged natural-origin steelhead returning to the Barrier Dam, including unguided fish surviving the turbines at Mayfield Dam and strays from the Lower Cowlitz Subbasin or other rivers below Mayfield Dam, or fish that have lost their CWT. While some uncollected smolts from the Upper Cowlitz Subbasin may pass Cowlitz Falls Dam without receiving a CWT, they are not thought to successfully pass below Mossyrock Dam and so are an unlikely component of the untagged adults returning to the Barrier Dam Adult Facility.

ISIT provides estimates of natural spawning abundance in the Lower Cowlitz Subbasin, but for the Tilton and Upper Cowlitz subbasins, the number of natural-origin adults transported and released represents the best approximation of natural spawner abundance. For the 2013-2017 run years, a mean of 644 natural-origin adults spawned naturally in the Lower Cowlitz Subbasin, 319 were transported to the Tilton Subbasin, and 166 were transported to the Upper Cowlitz Subbasin. These estimates suggest that abundance is approaching the minimum viability abundance target of 400 natural-origin spawners in the Lower Cowlitz Subbasin and 200 natural-origin spawners in the Tilton Subbasin, although the number transported to the Tilton Subbasin does not account for losses from harvest, pre-spawn mortality, or fallback. In contrast, the number transported to the Upper Cowlitz Subbasin is still well below the combined minimum viability abundance target of 1,000 natural-origin spawners in the Upper Cowlitz and Cispus rivers.

6.0.8.2. Natural Origin Smolt Production and Transport

Natural-origin smolt production specifically from the Lower Cowlitz Subbasin is unknown and cannot be estimated at present. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile steelhead abundance. However, confounding these estimates is the presence of unmarked steelhead smolts from Mayfield Dam turbine passage, which cannot be discerned from those from the Lower Cowlitz Subbasin. Moving forward, we will focus on adult productivity (adult recruits/spawner) to monitor the Lower Cowlitz Subbasin steelhead population. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps.

6.0.9. Hatchery Production

Hatchery winter steelhead have been released in the Cowlitz Basin since 1957, and production currently occurs exclusively at Cowlitz Trout Hatchery (LCFRB 2010). Until 2012, Segregated Hatchery Programs supported production of the non-native early-winter (Chambers Creek Puget Sound stock) and summer (Skamania stock) steelhead stocks, as well as the indigenous late-winter stock. During development of the 2011 FHMP, concerns arose about the use of the non-native early winter steelhead program in terms of potential genetic and ecological impacts on the natural Cowlitz Basin population. Genetic analyses, described in the 2011

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FHMP (Tacoma Power 2011), compared the level of introgression into the natural Cowlitz Basin populations among the three Segregated Hatchery Programs. Results indicated that the early-winter steelhead stock had the highest level of introgression; these factors resulted in termination of the program. While the summer steelhead Segregated Hatchery Program continues, the late-winter steelhead program began transitioning from a Segregated to an Integrated Hatchery Program in 2012.

For the Lower Cowlitz Subbasin population, this transition began with the collection of natural-origin adults from tributary weirs in the Lower Cowlitz Subbasin for use as broodstock through crosses with Cowlitz Basin origin hatchery-origin returns to the Barrier Dam Adult Facility in a stepping stone type program to assess implementation feasibility and effectiveness. Initial concern regarding over-mining of the Lower Cowlitz River natural-origin population limited the integration rate. Improved monitoring of the natural-origin population has reduced this concern; however, integration rates remain lower than desired. Also, maturation timing differences between hatchery- and natural-origin fish have created challenges in integrating these fish. The Integrated Hatchery Programs for the Upper Cowlitz and Tilton subbasins were developed using natural-origin returns to the Barrier Dam Adult Facility as broodstock and supplemented with hatchery-origin returns as needed. Beginning in 2015, as the first adults from the new Integrated Hatchery Programs started to return, both natural- and hatchery-origin adults from the Integrated Hatchery Programs have been transported and released in the Upper Cowlitz and Tilton subbasins. The purpose of these releases during the Recolonization phase of recovery is to increase spawning in nature and the subsequent number of natural-origin returns becoming available to use as broodstock and in spawn in nature.

Moving forward, this approach for the Upper Cowlitz and Tilton subbasin populations will continue until the targets of the Recolonization phase of recovery are met and the Local Adaptation phase begins. In addition, options will be explored for providing increased opportunity for recreation and harvest while ensuring that achieving population recovery goals is prioritized. Hatchery best management practices will be used, and hatchery production metrics must be monitored to ensure that production goals are met, to understand the magnitude of hatchery influence on the natural population that it is supplementing.

Hatchery best management practices will be used for all facets of hatchery production. Hatchery production metrics will be monitored to ensure that production goals and fish quality are met, as well as to understand the magnitude of hatchery influence on the natural population being supplemented. Key hatchery production monitoring metrics are the following:

- Number of salmon collected and spawned by origin (i.e., pNOB, pHOB), age, and sex.
- Fecundity.
- Survival by life stage (green eggs, eyed eggs, fry, parr, smolts released).
- Precocity rates (i.e., percent precocious/mini-jacks).
- Hatchery adult and jack returns by age and sex.
- pHOS.
- Calculation of PNI, SAR, and hatchery return rates.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. Until the

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Transition Plan is developed, we will continue to implement the hatchery integration and management practices from 2019. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

6.0.9.1. Overall Hatchery Program Goals

The overall goals of hatchery programs for steelhead within the Cowlitz Basin are to:

1) Promote recovery of populations inhabiting the Cowlitz Basin, particularly the Upper Cowlitz and Tilton Subbasin populations.
2) Provide fisheries for recreational and harvest opportunities while prioritizing population recovery.
3) Support educational and research opportunities.

Specific and quantifiable objectives of the hatchery programs to achieve these goals are described in detail within the respective sections for each of the Cowlitz Basin winter steelhead populations (Sections 6.1, 6.2, and 6.3).

6.0.9.2. Existing Hatchery Program

Winter steelhead that are captured at the Barrier Dam Adult Facility may be hatchery-origin steelhead, natural-origin steelhead that are attempting to migrate above the hydroelectric dams, or natural-origin steelhead from the Lower Cowlitz Subbasin that strayed upstream and entered the ladder and separator facility. From 2013-2017, a mean of 5,008 adult winter steelhead returned to the Barrier Dam Adult Facility, of which 4,420 (88%) were hatchery-origin while 588 (12%) were natural-origin (Table 6.0-2). During this period, across all three Integrated Hatchery Programs (Lower Cowlitz, Tilton River, Upper Cowlitz Basin), a mean total of 413 winter steelhead were collected as broodstock at the Barrier Dam Adult Facility, of which 295 (71%) were hatchery-origin and 118 (29%) were natural-origin. Those salmonids produced a mean of 648,881 smolts from the Integrated Hatchery Programs. Broodstock were also collected at the weirs during this time, but the proportion included in each program is not currently available. A single consolidated reporting and analysis database will be compiled during this FHMP reporting period to assist in this characterization.

6.0.9.3. Adult Transport and Natural Spawning

As part of the Integrated Hatchery Program, adult winter steelhead collected at the Barrier Dam Adult Facility are transported to habitats above Mayfield Dam where they may spawn naturally. In addition, natural- and hatchery-origin steelhead from the Integrated Hatchery Programs that do not return to the hatchery may remain in the Lower Cowlitz Subbasin to spawn naturally. From 2013-2017, a mean of 1,574 winter steelhead adults returned to the spawning grounds in the Lower Cowlitz Subbasin or were transported above Mayfield Dam to either the Tilton or Upper Cowlitz subbasins. Of those, means of 445 (28%) were hatchery-origin and 1,129 (72%) were natural-origin winter steelhead (further described in Sections 6.1, 6.2 and 6.3). This number does not account for losses from harvest, pre-spawn mortality, or fallback for upriver populations, so the actual number of hatchery-origin steelhead spawning in nature is unknown, and pHOS is not characterized as accurately as the available data represent. When only fish transported to the Tilton River are considered over the same time period, a mean of 72 hatchery-origin and 303 natural-origin steelhead were transported to Gust Backstrom Park. During the same period numbers for the Upper Cowlitz Basin were 193 hatchery-origin and 164 natural-origin steelhead.

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Table 6.0-2. Mean, minimum, and maximum numbers of all hatchery- and natural-origin winter steelhead from the Cowlitz Basin above the Toutle River that could be accounted for at recovery locations and percentage of total at that recovery location, 2013-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	4,420	2,046	6,716
Collected for Broodstock	295	244	385
Transported/Return to Spawning Grounds	445	51	740
Natural-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	588	369	918
Collected for Broodstock	118	64	166
Transported/Return to Spawning Grounds	1,129	656	1,628
Combined Hatchery- and Natural-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	5,008	2,520	7,276
Collected for Broodstock	413	376	449
Transported/Return to Spawning Grounds	1,574	1,177	2,222

[1] Sum of all harvest in ocean, Columbia River, and Lower Cowlitz Subbasin fisheries, plus number returning to Lower Cowlitz Subbasin spawning grounds, and collected at Barrier Dam Adult Facility or tributary weirs in the Lower Cowlitz Subbasin.
[2] Total of harvest in ocean, Columbia River, Lower Cowlitz Subbasin, and Upper Cowlitz Subbasin fisheries.
[3] Sum of Lower Cowlitz Subbasin harvest plus number returning to Lower Cowlitz Subbasin spawning grounds and collected at Barrier Dam Adult Facility or tributary weirs in the Lower Cowlitz Subbasin.

6.0.10. Survival and Productivity

SAR of hatchery-origin winter steelhead is unknown because the age of returning adults (i.e., brood year) is not recorded in ISIT. SAR of natural-origin winter steelhead is also unknown because necessary data are unavailable but is expected to be greater than that of the hatchery-origin steelhead. Because the numbers of spawners and the numbers of returns by brood year are unavailable, productivity (spawner-to-spawner) has not been calculated at this time. Data to inform this metric will be characterized in a consolidated analysis and reporting database during this FHMP period.

6.0.11. Proportionate Natural Influence and Age Composition

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. PNI is calculated using two proportions: the proportion of spawners in nature that are hatchery-origin (pHOS) and the proportion of the hatchery broodstock that is comprised of natural-origin salmonids (pNOB). HSRG (2009) guidelines for Primary populations with integrated hatchery programs are that pHOS <0.3 (or ½ pNOB) and that pNOB should be greater than twice pHOS so that PNI >0.67. For Primary populations with a segregated hatchery program, the HSRG (2009) recommends pHOS <0.05.

Age composition cannot be completely calculated from the data in ISIT because they are not compiled by age or brood year; during this FHMP period it will be necessary to develop a single consolidated data source to address this question. Age classes are only characterized as "jacks" or "adults," and these data are only available for returns to the Barrier Dam Adult Facility, not for any other recovery locations. One salts comprise a small percentage of mature returns to the Barrier Dam Adult Facility. From 2012-2017, <1% of mature steelhead returning to the hatchery spent a single year in the ocean.

6.0.12. Marking and Tagging

Identifying the origin and/or release group to which a steelhead belongs is crucial to effective monitoring and evaluation. All hatchery-origin steelhead are marked with an adipose fin-clip (Table 6.0-3). In addition, hatchery-origin steelhead from the Tilton Subbasin and Upper Cowlitz Subbasin Integrated Hatchery Programs are marked with a left- or right-ventral clip or CWT. Natural-origin smolts from the Upper Cowlitz Subbasin are implanted with a CWT in the snout upon collection at Cowlitz Falls Fish Facility[1], while natural-origin smolts from the Tilton Subbasin are either untagged (i.e., if uncollected) or are implanted with a CWT in the dorsal sinus. Marking and tagging schemes may differ from year to year, especially for hatchery-origin releases, which may also include experimental groups. Recent marking strategies have relied on CWTs implanted in steelhead smolts from the Upper Cowlitz Subbasin. Marking and tagging schemes for each group, within each brood year, will be recommended by the M&E Subgroup at the Annual Program Review meeting, approved by the FTC, and documented in the Annual Operating Plan (see Chapter 12).

Table 6.0-3. Current and proposed hatchery program, smolt production, and marking/ tagging for winter steelhead.

Origin & Population	Hatchery Program	Juvenile Production		Mark / Tag	
		Current	Proposed	Current	Proposed
Hatchery					
Lower Cowlitz Subbasin	Integrated	481,389	350,000	Ad only	Ad only
Upper Cowlitz Subbasin	Integrated	118,000	200,000	Ad+CWT (snout)	Ad+CWT (snout)
Tilton Subbasin	Integrated	48,000	100,000	Ad+LV	Ad+LV
Natural					
Lower Cowlitz Subbasin	None	Unknown	?	None	None
Upper Cowlitz Subbasin	None	9,439	90% CE	CWT (snout)	CWT (snout)
Tilton Subbasin	None	7,649	90% CE	CWT (dorsal sinus)	CWT (dorsal sinus)

[1] It is assumed that any natural-origin steelhead smolts from the Upper Cowlitz Subbasin that pass Cowlitz Falls Dam without being collected are unable to reach the ocean; thus, all returning adults from the Upper Cowlitz Subbasin population are assumed to have a CWT in their snout.

6.0.13. Summary

- The continued genetic exchange among winter steelhead in the hatchery and those spawning naturally in the Lower Cowlitz Subbasin since 1968 caused Cowlitz Basin winter steelhead to functionally become a single population. However, since reintroduction programs were implemented in 1996, divergence through Local Adaptation is again possible.
- Although the ESA framework identifies distinct winter steelhead populations in the Cispus and Upper Cowlitz rivers, returning adults cannot be differentiated by population. These populations are therefore currently managed as a combined “Upper Cowlitz Subbasin” population but are intended to be monitored as separate programs in the future.
- Activities covered by this FHMP will prioritize the recovery of the indigenous winter steelhead populations, while still promoting harvest opportunity. Implementation will be guided by ESA, the FERC license, and basin-specific constraints.
- Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin program when appropriate.
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
- The Upper Cowlitz Subbasin population is currently in the Recolonization phase of recovery. This FHMP period will prioritize increasing the abundance of winter steelhead (both hatchery- and natural-origin) spawning in the Upper Cowlitz Subbasin to increase the subsequent number of natural-origin F1 returns.
- While the Tilton Subbasin population is still in the Recolonization phase, the abundance of natural-origin adults transported and released in the subbasin is approaching the minimum viability abundance target for natural-origin spawners. However, actual spawner abundance is unknown and must be estimated before triggers to transition to the Local Adaptation phase can be considered.
- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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The following sections present information on the three managed winter steelhead populations in the Cowlitz Basin: Lower Cowlitz Subbasin population (Section 6.1), Upper Cowlitz Subbasin population (Section 6.2), and Tilton Subbasin population (Section 6.3). Please note that the data cited throughout the sections in Chapter 6 include 2007-2008 and 2013-2017 as these were readily available at the time of this writing. During this FHMP period, data between 2009-20012 and more current will be updated, as described in Chapters 10 and 12.

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Population: Lower Cowlitz Subbasin Winter Steelhead
Oncorhynchus mykiss

Distinct Population Segment:	Cascade Winter Steelhead Lower Columbia River Steelhead DPS Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened Listed in 1998, revised 2006, reaffirmed in 2011 and 2016
Population Recovery Designation:	Contributing
Population Viability Rating:	
Baseline	Low
Objective	Medium
Minimum Viability Abundance Target:	400 natural-origin winter steelhead spawning in the Lower Cowlitz Subbasin
Current Recovery Phase:	Local Adaptation
Current Hatchery Program(s):	• Cowlitz Trout Hatchery Integrated Late Winter (Cowlitz-origin) Steelhead Hatchery Program; • Cowlitz Trout Hatchery Segregated Summer (Skamania-origin) Steelhead Hatchery Program
Proposed Hatchery Program(s):	• Adjusted Cowlitz Trout Hatchery Integrated Winter (Cowlitz-origin) Steelhead Hatchery Program to include earlier run-timing, reduced natural-origin broodstock collection from Lower Cowlitz Subbasin, and reduced production of hatchery-origin late-winter steelhead in Lower Cowlitz Subbasin • Adjusted Cowlitz Trout Hatchery Segregated Summer (Skamania-origin) Steelhead Hatchery Program (in combination with changes to winter steelhead program adjustments)

6.1. Winter Steelhead: Lower Cowlitz Subbasin Population

6.1.1. Purpose

This section describes the current status of the Lower Cowlitz Subbasin winter steelhead population based on recent and available data. In addition, we identify the VSP metrics needed to evaluate this population's status with regard to reaching recovery under ESA guidelines. Where appropriate, we propose changes to both hatchery and monitoring programs to facilitate the evaluation of progress toward population recovery. Although the Lower Cowlitz Subbasin winter steelhead population has exceeded the minimum viability abundance target in four of the last 5 years, the PNI remains below the target. During the period covered by this FHMP, we begin working toward increasing natural influence on the population. Although the transition

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from a Segregated Hatchery Program to an Integrated Hatchery Program began in 2013, the number of natural-origin broodstock collected from tributaries in the Lower Cowlitz Subbasin has utilized conservative collection protocols and has been insufficient to fully meet HSRG guidelines for integration rates. Moreover, natural-origin steelhead taken as broodstock for the integrated program are effectively removed from spawning naturally in the Lower Cowlitz Subbasin. One means of reducing the influence of hatchery-origin spawners is to increase the number of natural-origin spawners available to spawn naturally. Another means is to limit the number of hatchery fish accessing the spawning habitat either through removals via harvest or weirs, or reducing the number of hatchery fish produced.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the upper and lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin when appropriate. This plan will evaluate the current strategies and consider new options for expanding winter steelhead returns earlier in the year. Until the Transition Plan is developed, we will continue to implement the hatchery integration and management practices from 2019. In the interim, Tacoma Power and the FTC will use the APR process annually to determine how best to consider moving to a segregated program in the lower Cowlitz River, and gather input on options for expanding winter steelhead return timing earlier in the year. Tacoma Power and the FTC acknowledge that HSRG guidelines for pHOS might not be met in all cases during this interim period. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

Winter steelhead adults from the indigenous Lower Cowlitz, Upper Cowlitz, and Tilton subbasin populations historically had a return timing from late November through June, with peak returns in April and spawning generally occurring in March-June with peak in late April or early May. However, winter steelhead hatchery adults derived from the indigenous Lower Cowlitz, Upper Cowlitz, and Tilton subbasin populations are currently classified as a late-winter run, based on the timing of their return to the Cowlitz River from February to as late as early June (Tacoma Power 2011). The short-term goal for steelhead in the Lower Cowlitz Subbasin is to continue promoting recovery through management of pHOS while still providing harvest opportunity. To achieve that goal, the Transition Plan will focus on adjusting the current suite of Cowlitz River hatchery steelhead programs to:

- Reduce the use of Lower Cowlitz Subbasin natural-origin steelhead for broodstock.
- Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
- Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run and spawn timing.
- Define how soon this program should begin.
- Recognize need for some harvest opportunity.
- Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.

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- Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.

In addition, we will continue to evaluate the hatchery program and fisheries management and will make refinements or adjustments, as described in this FHMP, to effectively manage the Lower Cowlitz Subbasin winter steelhead population.

6.1.2. Population Description

The Lower Cowlitz Subbasin winter steelhead population includes all natural-origin winter steelhead that occupy the Cowlitz River and all tributaries downstream of the Barrier Dam (rkm 81), excluding the Toutle and Coweeman rivers, as well as those from the current Integrated Hatchery Program at Cowlitz Trout Hatchery (Figure 6.1-1).

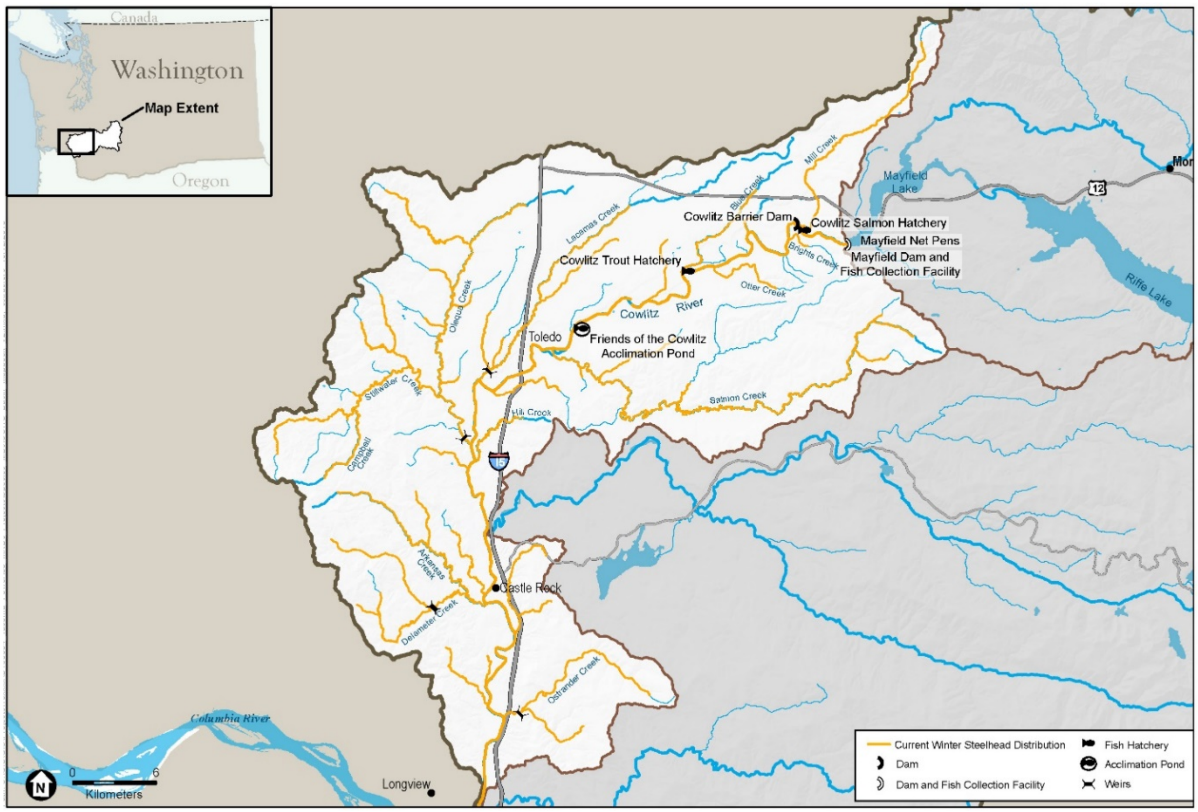

Figure 6.1-1. Distribution of winter steelhead in the Lower Cowlitz Subbasin.

Following the extirpation of winter steelhead populations upstream of Mayfield Dam in 1980 and to protect the hatcheries from disease, the Lower Cowlitz Subbasin winter steelhead population became an aggregation of all three populations[1], representing the only extant population remaining in the Cowlitz Basin upstream of the Toutle River. Although no run size information was available, this population was found to be "Depressed" (WDFW 1993) and, as part of the lower Columbia River DPS, was listed as threatened under the ESA in 1998, and reaffirmed in 2011 and 2016. This population is classified as a Contributing population for

[1] The Lower Cowlitz Subbasin population may have also been similarly influenced by the Toutle River population following the eruption of Mount St. Helens.

recovery of the lower Columbia River DPS and must attain its minimum viability abundance targets for the DPS to be considered recovered (WDFW and LCFRB 2016). Delisting is also dependent on the improved viability of other (i.e., non-Cowlitz Basin) populations within the DPS.

The Lower Cowlitz Subbasin winter steelhead population is currently supplemented by hatchery production. The most recent 5-year means for natural-origin spawners has exceeded the minimum viability abundance target for the population.

6.1.3. Natural Production

Two critical monitoring metrics for salmonid management are the numbers that return at maturation and their disposition (Table 6.1-1; Figures 6.1-2 and 6.1-3). Lower Cowlitz Subbasin winter steelhead that survive to begin their spawning migration may be harvested in commercial, sport, or tribal fisheries in the ocean or impacted through indirect mortality in the Columbia River commercial harvest. Those escaping harvest may return to the Barrier Dam Adult Facility or natural spawning grounds, where they are recovered and counted (Table 6.1-1). They may also die from predation or disease at any time and not be recovered. Monitoring the frequency of these fates allows us to evaluate population health, productivity, and progress toward recovery. However, these data, which are critical to monitoring the Lower Cowlitz Subbasin winter steelhead population, have been only sporadically collected and are incomplete, making population trends difficult to discern at this time.

Juvenile production of winter steelhead in the Lower Cowlitz Subbasin includes the natural production of smolts as well as fish released from Cowlitz Trout Hatchery. Estimates of natural production for juvenile winter steelhead specific to the Lower Cowlitz Subbasin population are not currently available.

6.1.3.1. Abundance

The minimum viability abundance target for the Lower Cowlitz Subbasin winter steelhead population is an annual abundance of 400 natural-origin salmonids spawning in nature (LCFRB 2010).

Total run size was not estimated for either hatchery- or natural-origin winter steelhead because numbers harvested from the ocean and Columbia River fisheries are not currently available. From 2007-2008, and 2013-2017 (the years for which data for natural-origin winter steelhead were consistently available), means of total returns to the Cowlitz River were 555 natural-origin winter steelhead (Figures 6.1-2 and 6.1-3; Table 6.1-1). A mean of 533 natural-origin winter steelhead remained on the spawning grounds in the Lower Cowlitz Subbasin. Beginning with the initiation of the Integrated Hatchery Program in 2013 and continuing through 2017, a mean of 14 natural-origin winter steelhead were collected at Lower Cowlitz Subbasin weirs and were used as broodstock. Natural-origin winter steelhead returning to the Barrier Dam Adult Facility are assumed to have originated from populations upstream of Mayfield Dam. During this FHMP period, this topic will be further examined once a single consolidated database is developed for analysis and reporting.

Table 6.1-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin adult winter steelhead from the Lower Cowlitz Subbasin population accounted for at recovery locations, and percentage of total at each recovery location, 2007, 2008, and 2013-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Not All Data Are Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz Subbasin harvest	8,891	5,011	14,512
Total Return to Cowlitz River[3]	12,964	7,829	20,811
Return to spawning grounds	219	51	535
Return to Cowlitz Salmon Hatchery	3,854	1,725	6,189
Collected for Broodstock	280	243	338
Natural-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Not All Data Are Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz Subbasin harvest[4]	11	4	24
Total Return to Cowlitz River[3]	555	202	1,200
Return to spawning grounds	533	198	1,156
Return to Cowlitz Salmon Hatchery	0	0	0
Collected for Broodstock[5]	11	0	30
Combined Hatchery- and Natural-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Not All Data Are Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz Subbasin harvest	8,902	5,015	14,536
Total Return to Cowlitz River[3]	13,519	8,135	22,011
Return to spawning grounds	753	337	1,266
Return to Cowlitz Salmon Hatchery	3,854	1,725	6,189
Collected for Broodstock[5]	291	246	338

[1] Sum of all harvest plus number returning to Lower Cowlitz Subbasin spawning grounds, and Cowlitz Salmon Hatchery (hatchery-origin) or collected at weirs for broodstock (natural-origin).
[2] Total of harvest in ocean, Columbia River, and Lower Cowlitz Subbasin fisheries from ISIT harvest.
[3] Sum of Lower Cowlitz Subbasin harvest plus number returning to Lower Cowlitz Subbasin spawning grounds, and Cowlitz Salmon Hatchery (hatchery-origin) or collected at weirs for broodstock (natural-origin).
[4] Based on ISIT assumption of a 2% harvest rate on natural-origin winter steelhead in the Lower Cowlitz Subbasin.
[5] Natural-origin winter steelhead were not collected for broodstock prior to 2013, although values reflect the 2007-2008 and 2013-2017 period.

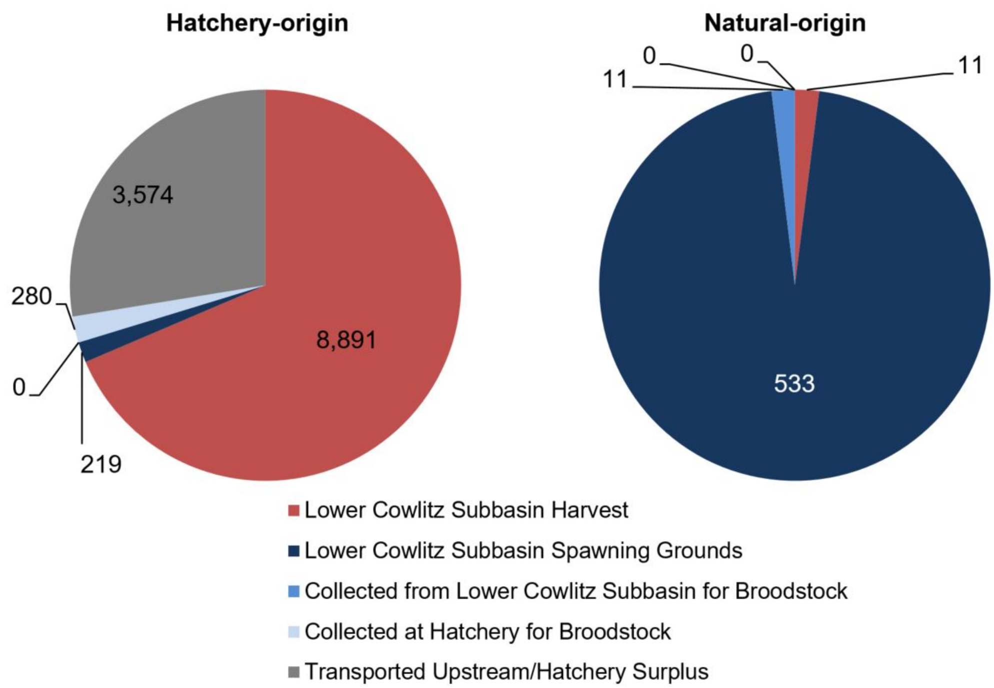

Figure 6.1-2. Mean numbers and proportions of hatchery- and natural-origin Lower Cowlitz Subbasin winter steelhead caught in non-ocean fisheries, collected from the Lower Cowlitz Subbasin for use as broodstock (natural-origin only), returned to Lower Cowlitz Subbasin spawning grounds, or returned to Cowlitz Salmon Hatchery (comprised of hatchery broodstock and hatchery surplus), 2013-2017. Note: No natural-origin Lower Cowlitz Subbasin winter steelhead were recorded as having returned to Cowlitz Salmon Hatchery because those caught at the hatchery are assumed to have come from populations upstream of Mayfield Dam. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

6.1.3.2. Harvest

Harvest is an important component of the management of Lower Cowlitz Subbasin winter steelhead and has the potential to affect population recovery. Few natural-origin winter steelhead are harvested in ocean and Columbia River fisheries, so harvest rates are not provided in ISIT and total exploitation cannot be estimated comprehensively, but can be approximated closely. Retention of natural-origin winter steelhead is not permitted in sport fisheries, including Cowlitz Basin fisheries, so natural-origin exploitation rates reflect incidental mortality; because this rate is unknown, ISIT assumes a 2% indirect mortality rate on natural-origin winter steelhead in the Lower Cowlitz Subbasin.

6.1.3.3. Disposition

According to the current assumption that all natural-origin winter steelhead arriving at the Barrier Dam Adult Facility are Tilton River origin, no natural-origin steelhead from the Lower Cowlitz Subbasin arrived at the Barrier Dam Adult Facility. Therefore, there are no dispositions of natural-origin Lower Cowlitz Subbasin winter steelhead to describe.

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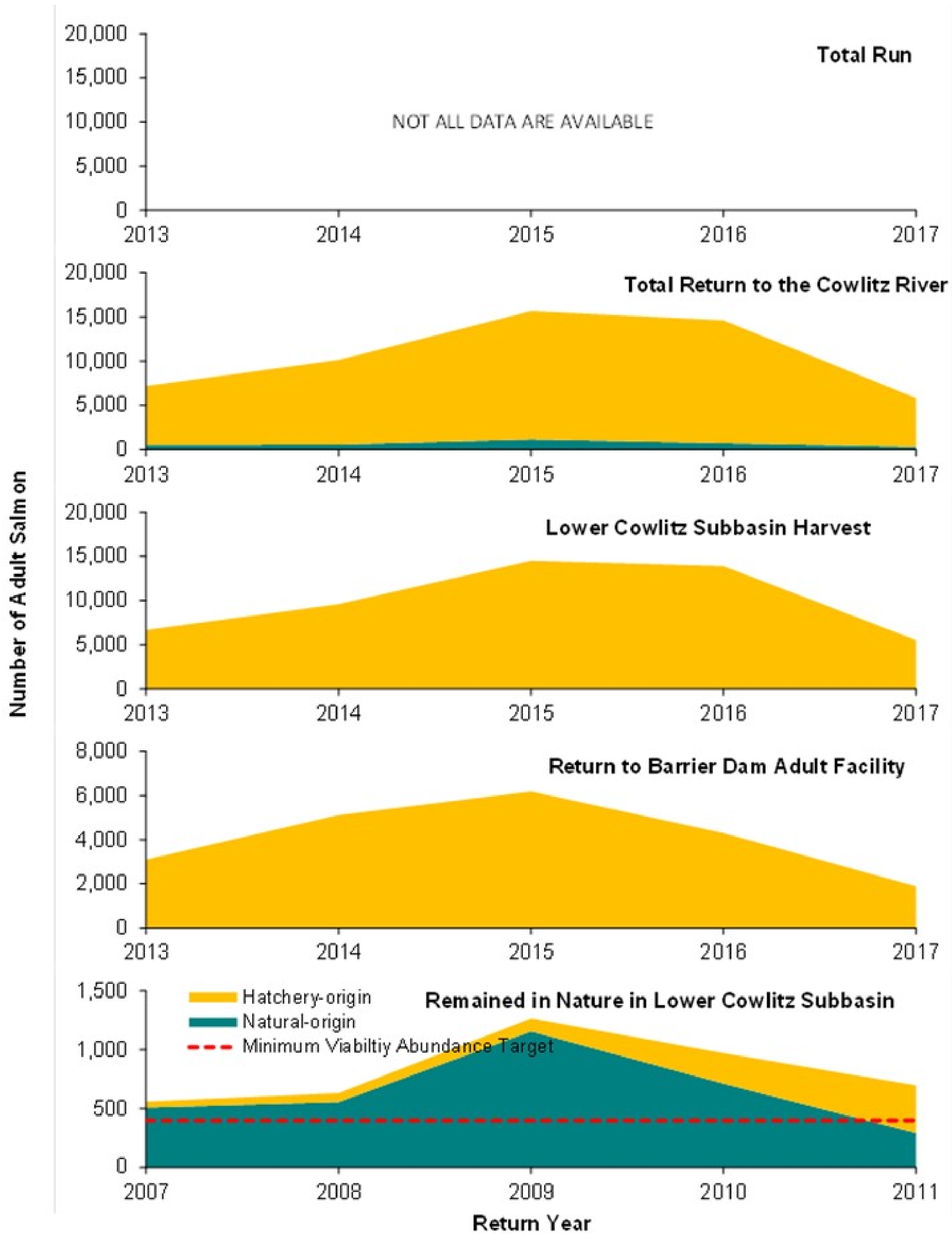

Figure 6.1-3. Estimated total run size for natural- and hatchery-origin adult Lower Cowlitz Subbasin winter steelhead and the numbers that returned to the Cowlitz River, were harvested, returned to the Barrier Dam Adult Facility, or returned to Lower Cowlitz Subbasin spawning grounds, 2013-2017. Notes: Distinct scale is used for spawning ground returns. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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6.1.3.4. Spawning in Nature

The Lower Cowlitz Subbasin winter steelhead population minimum viability abundance target of 400 natural-origin steelhead spawning in nature was exceeded during 4 (2013-2017) of the 7 (2007-2008 and 2013-2017) years for which data are available (mean = 533; Figure 6.1-3; Table 6.1-1). From 2007-2008 and 2013-2017, a mean of 555 natural-origin winter steelhead from the Lower Cowlitz Subbasin population returned to the Cowlitz River (Figure 6.1-2 and 6.1-3; Table 6.1-1). Of those, 2% were estimated to have suffered indirect mortality in sport fisheries, 96% returned to Lower Cowlitz Subbasin tributary spawning grounds, and 2% were collected at Lower Cowlitz Subbasin weirs for use as hatchery broodstock. Steelhead spawner abundance is not monitored in the mainstem Cowlitz River. No Lower Cowlitz Subbasin winter steelhead were recorded as having returned to Cowlitz Salmon Hatchery because all unmarked natural-origin steelhead captured there are assumed to have come from populations upstream of Mayfield Dam. From 2007-2008 and 2013-2017, a mean of 753 total winter steelhead spawned in the Lower Cowlitz Subbasin, of which 533 (71%) were natural-origin (Figures 6.1-2 and 6.1-3; Table 6.1-1).

Collecting and transporting natural-origin winter steelhead from natural straying to the Cowlitz Barrier Dam to the Tilton Subbasin likely reduces the abundance of natural-origin Lower Cowlitz Subbasin winter steelhead in the Lower Cowlitz Subbasin, as well as their spawning and subsequent juvenile production. On the other hand, it is also likely that some Tilton Subbasin natural-origin winter steelhead remain in the Lower Cowlitz Subbasin to spawn and offset any numeric reduction to the Lower Cowlitz Subbasin population. Currently, all juvenile natural-origin steelhead handled at the Cowlitz Falls Fish Facility (snout) and the Mayfield Dam Counting House (dorsal-sinus) are implanted with CWT. This strategy was implemented in 2018/19, so it will be possible to positively identify disposition at the separator starting in 2021. These fish will be readily distinguishable from untagged natural-origin returns that could have originated from Mayfield Dam turbine passed smolts, fish that lost an applied CWT, or natural-origin fish from below Mayfield Dam. Taken in total, the effects associated with adult returns spawning out of location on actual adult natural-origin abundance are uncertain, but should be considered in the future to facilitate effective management of populations in both the Lower Cowlitz and Tilton subbasins.

6.1.3.5. Smolt Production

No estimate of winter steelhead smolt abundance is available specifically for the Lower Cowlitz Subbasin winter steelhead population. A smolt trap was operated in the lower Cowlitz River, but the origin of juveniles captured was unknown. Additionally, production from tributaries and mainstem areas downstream from the smolt trap was unsampled. Moving forward, the focus will be on adult abundances, and we will reassess if smolt trap operations or other juvenile sampling techniques would be beneficial to fill in critical data gaps.

6.1.3.6. Natural-origin Survival and Productivity

Survival and productivity are key metrics for monitoring populations. However, neither SAR, TSAR, nor smolts/spawner can be calculated for the Lower Cowlitz Subbasin winter steelhead population because smolt abundance in the Lower Cowlitz Subbasin is not estimated. Recent harvest rates in the ocean and Columbia River are also unavailable, which precludes estimating total run size and, consequently, estimates of survival and productivity. A rough estimate of recruits/spawner can be calculated, but it is an underestimate because a substantial number of natural-origin spawners and/or recruits are likely not being accounted for in the mainstem Cowlitz River, or natural-origin recruits trapped at Cowlitz Salmon Hatchery. Additionally, age composition data for natural-origin returns that do not return to the Barrier Dam Adult Facility are unavailable in a consolidated database, so a full run reconstruction for each brood year is not possible at this time.

Without the information necessary for full run reconstruction, such as recruits per spawner and spawner-to-spawner R/S, estimates of productivity have not been be developed at this time. Likewise, smolt abundance is difficult to ascertain because of poor smolt trap collection efficiency in the lower Cowlitz River and because smolts produced naturally in the Lower Cowlitz Subbasin cannot be effectively distinguished from those produced upstream of Mayfield Dam. However, if we can develop a good estimate of smolt numbers, we will also monitor smolt productivity. Smolts produced/spawner provides a view of the productivity of the freshwater rearing habitat and limiting factors, but this metric is a lower priority for overall population monitoring.

6.1.3.7. Age Composition

Age composition cannot be completely calculated from the data because they have not yet been compiled by age or brood year in a single database. Age classes are only characterized as jacks or adults, and these data are only available for returns to the Barrier Dam Adult Facility, not for other recovery locations. Because natural-origin returns to the hatchery are assumed to originate from populations above Mayfield Dam, no natural-origin Lower Cowlitz Subbasin winter steelhead are handled at the Barrier Dam

6.1.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, to evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population that it is supplementing (see Section 6.0.9).

Hatchery winter steelhead have been planted in the Cowlitz Basin since 1957 (LCFRB 2010). The recent termination of the Segregated Early-Winter Steelhead Hatchery Program (non-native Chamber's Creek stock) reduced introgression risks for the late-winter steelhead stock indigenous to the Cowlitz Basin. Continuation of the non-native (Skamania origin) Summer Steelhead Segregated Hatchery Program poses fewer risks of introgression because of its high return fidelity to the Barrier Dam Adult Facility and low stray rate to tributary spawning areas, where their spawning is mostly temporally isolated. For more information on the Summer Steelhead Hatchery Program, see Chapter 7. As of the 2011 FHMP (Tacoma Power 2011), the Lower Cowlitz Subbasin Late-Winter Steelhead Hatchery Program had a production target of releasing 362,855 smolts in 2012 (brood year 2011) and 478,122 smolts in 2013 (brood year 2012). Since 2013, the program goal has been 478,000 smolts.

For the Lower Cowlitz Subbasin population, this transition began with the collection of natural-origin adults from tributary weirs in the Lower Cowlitz Subbasin for use as broodstock through crosses with Cowlitz Basin origin hatchery-origin returns to the Barrier Dam Adult Facility in a stepping stone type program to assess implementation feasibility and effectiveness. Initial concern regarding over-mining of the lower Cowlitz River natural-origin population limited the integration rate. Improved monitoring of the natural-origin population has reduced this concern; however, integration rates remain lower than desired. Also, maturation timing differences between hatchery- and natural-origin fish have created challenges in integrating these fish.

6.1.4.1. Abundance

As noted above under *Natural Production* for natural-origin steelhead, data that are critical to monitoring the Lower Cowlitz Subbasin winter steelhead population have been only sporadically collected and are incomplete, making population trends difficult to discern at this time.

Juvenile production of winter steelhead in the Lower Cowlitz Subbasin includes natural production of smolts as well as fish released from Cowlitz Trout Hatchery. From 2007-2008 and 2013-2017, a mean of 441,837 Lower Cowlitz Subbasin smolts were released annually from Cowlitz Trout Hatchery (Table 6.1-2).

Table 6.1-2. Mean, minimum, and maximum hatchery and natural spawning metrics for Lower Cowlitz Subbasin winter steelhead, 2007-2008 and 2013-2017 spawn years. Note: Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2007-2008, 2013-2017 Spawn Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery			
Adults and Jacks Collected	291	246	338
Hatchery-origin	280	243	338
Natural-origin	11	0	30
Pre-spawn Survival Rate	88%	81%	93%
Adults and Jacks Spawned	255	225	301
Hatchery-origin	246	208	301
Natural-origin	9	0	27
Total Green Eggs	653,756	521,656	725,328
Mean Fecundity	5,493	4,501	6,116
Mean Fertility	Data Not Available		
Total Eyed Eggs	Data Not Available		
Smolts Released*	441,837	304,581	588,893
Green Egg-to-Smolt Survival	69%	43%	87%
Smolt Productivity (smolts/spawner)	1,757	1,012	2,187
Nature			
Spawners	753	337	1,266
Hatchery-origin	219	51	535
Natural-origin	533	198	1,156
Smolts Produced	Data Not Available		
Smolt Productivity (smolts/spawner)	Data Not Available		

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The minimum viability abundance target for the Lower Cowlitz Subbasin winter steelhead population is an annual minimum abundance of 400 natural-origin salmonids spawning in nature (LCFRB 2010). The total run size could not be estimated for hatchery- nor natural-origin winter steelhead. From 2007-2008, and 2013-2017 (the years for which data for natural-origin winter steelhead were consistently available), means of total returns to the Cowlitz River were 12,964 hatchery-origin winter steelhead (Figures 6.1-2 and 6.1-3; Table 6.1-1). A mean of 219 hatchery-origin winter steelhead remained on the spawning grounds in the Lower Cowlitz Subbasin, while a mean of 3,854 hatchery-origin winter steelhead returned to Cowlitz Salmon Hatchery.

6.1.4.2. Harvest

Harvest is an important component of the management of Lower Cowlitz Subbasin winter steelhead and has the potential to impact population recovery. Hatchery-origin winter steelhead are the foundation of an important recreational fishery in the Lower Cowlitz Subbasin. They are also captured in the Columbia River recreational fishery and can be caught incidentally in ocean fisheries targeting other species. Few natural-origin winter steelhead are harvested (as indirect mortality) in ocean and Columbia River fisheries, so harvest rates are not provided in ISIT and total exploitation cannot be estimated comprehensively. However, the vast majority of harvest occurs in the Lower Cowlitz Subbasin. Of the population returning to the Cowlitz River from 2007-2008 and 2013-2017, a mean of 8,891 was harvested (Figure 6.1-1). As expected in this mark-selective fishery, >99% were hatchery-origin winter steelhead.

6.1.4.3. Hatchery Spawning

Total returns to the Cowlitz River offer a relative metric of performance; from 2007-2008 and 2013-2017, a mean of 12,964 hatchery-origin adults from the Lower Cowlitz Subbasin Hatchery Program returned to the Cowlitz River (Figures 6.1-2 and 6.1-3; Table 6.1-1). Of those, 69% were harvested, 30% returned to the Barrier Dam Adult Facility, and less than 2% returned to the Lower Cowlitz Subbasin spawning grounds (Figures 6.1-2 and 6.1-3; Table 6.1-1). The majority of hatchery-origin steelhead spawning in the Lower Cowlitz Subbasin were observed in Blue Creek, adjacent to the Cowlitz Trout Hatchery. Mean spawner pHOS was 0.31, ranging from 0.09-0.73.

6.1.4.4. Disposition

Steelhead that return to the Barrier Dam Adult Facility are collected for broodstock, sent upstream, or given to surplus. Adipose fin-clipped steelhead are considered to be part of the Lower Cowlitz Integrated Hatchery Program. Hatchery-origin adipose fin-clipped steelhead are collected for broodstock on a weekly basis, and any fish above broodstock need are sent to surplus. Adipose-intact steelhead with no CWT are not collected as part of the program. Adipose fin-intact steelhead that return to the Barrier Dam Adult Facility are considered to be Tilton River rather than Lower Cowlitz natural-origin steelhead. Approximately 50 natural-origin adults are collected for the Tilton River Integrated Hatchery Program. Once this broodstock need is met, all natural-origin fish are transported upstream to the Tilton River. Natural-origin steelhead with a snout CWT are from the Upper Cowlitz Subbasin as it indicates they were captured and tagged as a juvenile at the Cowlitz Falls Fish Facility. A dorsal sinus marking strategy for juvenile steelhead captured at the Mayfield Dam Counting House has begun. Starting in 2021, it will be possible to positively identify steelhead with a CWT implanted in their dorsal sinus as Tilton River origin. This does not mean that adipose fin-intact steelhead with no CWT can be positively identified as Lower Cowlitz natural-origin steelhead because collection efficiency at Mayfield Dam is not perfect and some fish passing through the turbines do survive.

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6.1.4.5. Hatchery Rearing

From 2007-2008 and 2013-2017, a mean of 280 hatchery-origin winter steelhead were collected for broodstock (Table 6.1-2). Mean pre-spawn survival was 88% and a mean of 246 of those collected were spawned, of which a mean of 47% were females. A mean of 11 natural-origin broodstock were collected annually from 2007-2008 and 2013-2017 at tributary weirs in the Lower Cowlitz Subbasin for use as broodstock. However, none were collected until 2013, when the Integrated Hatchery Program was initiated.

From 2007-2008 and 2013-2017, an estimated mean of 653,756 green eggs were collected at Cowlitz Salmon Hatchery from a mean of 119 females (Table 6.1-2). Mean fecundity was 5,493 green eggs. From brood years 2007-2008 and 2013-2017, a mean of 441,837 smolts were released. Mean green egg-to-smolt survival for these brood years was 69%.

6.1.4.6. Age Composition

As noted above for natural-origin steelhead, age composition cannot be completely calculated from the data in ISIT because they are not compiled by age or brood year. Age classes are only characterized as jacks or adults and these data are only available for returns to the Barrier Dam Adult Facility, not for any other recovery locations. From 2007-2008 and 2013-2017, less than 1% of the hatchery-origin winter steelhead that returned to Cowlitz Salmon Hatchery were identified as 1-salts. Fish used for broodstock are sampled for scales so age can be estimated.

6.1.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in PNI can indicate an increase or decrease in the effect of hatchery-origin steelhead on the natural population and an increase or decrease in the influence of the natural population on the hatchery program. From 2007-2008 and 2013-2017, a mean of 753 winter steelhead spawned in the Lower Cowlitz Subbasin, excluding the Toutle and Coweeman rivers (Figures 6.1-2 and 6.1-3; Table 6.1-1). Of those, a mean of 219 were hatchery-origin and 533 were natural-origin. Prior to 2013, the hatchery program was segregated, so no natural-origin winter steelhead were used as broodstock, so, as expected, both pNOB and PNI during that period were equal to 0. The Integrated Hatchery Program began in 2013, and pNOB has ranged from 0.01-0.11 (mean = 0.05) over the most-recent 5-year period (2013-2017), while PNI has ranged from 0.05-0.47 (mean = 0.22). Over the same 2012-2017 period, pHOS has declined to a mean of 0.23.

6.1.6. Future Management

The Lower Cowlitz Subbasin winter steelhead population is designated as a Contributing population for meeting MPG and DPS recovery goals, with a minimum viability abundance target of 400 natural-origin spawners in nature. Population viability was rated as Low (LCFRB 2010, WDFW and LCFRB 2016), but natural-origin abundance has improved and the minimum abundance target was exceeded annually from 2013-2016. Although the target was not met in 2007, 2008, or 2017 and natural-origin abundance data are unavailable for 2009-2012, the most-recent (2013-2017) 5-year mean was 645, so this population may be meeting its minimum viability abundance target. It is worth noting that these estimates are representative of tributary surveys, which are believed to make up the majority of the production; however, additional contribution may also be derived from the mainstem. Likewise, the most-recent 5-year (2013-2017) mean pHOS was 0.23, suggesting that this population is meeting the HSRG guideline of pHOS <0.3 for hatchery influence in a Contributing population with an integrated hatchery program. However, natural influence on the hatchery program remains low; mean pNOB from 2013-2017 was only 0.05 and the resulting mean PNI was only 0.22, well below the HSRG guideline of >0.5.

Going forward, the goals and plans for this program are responsive to the current status of the population and are described in the following sections (Table 6.1-3). It is assumed the program will focus on exceeding the minimum viability abundance target, with a high PNI (>0.5) and low pHOS (<0.3) or other management strategies determined to be effective to accomplish objectives associated with each recovery phase. In addition, the Transition Plan will evaluate the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin when appropriate.

6.1.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation goals and minimum viability abundance targets is evaluated through monitoring of standard fisheries management metrics (Appendix A, Big Table Dataset). The Lower Cowlitz Subbasin winter steelhead population had an historical escapement of about 1,400 natural-origin winter steelhead and has a minimum viability abundance goal of 400 natural-origin spawners in nature (LCFRB and WDFW 2016). In 2010, abundance and productivity of this population were rated as Low (LCFRB 2010). While on the verge of meeting the minimum viability abundance target for natural-origin spawners (Figure 6.1-3; Table 6.1-1), hatchery influence on the population remains high. Hatchery reform and optimization form the basis of making progress toward conservation goals and minimum viability abundance targets. Opportunities for recreational/harvest will be maximized by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints. In addition, we will explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate the historic run-timing of winter steelhead in the basin.

- **Long-term Goals:** The goal for this Contributing winter steelhead population is full recovery, which would include, but not be limited to, the following actions.
    - Establishment of clear targets for determining that Full Recovery has been achieved.
    - A harvestable population of natural-origin steelhead in the Lower Cowlitz Subbasin.
    - Maintain natural-origin spawner abundance >400 in the Lower Cowlitz Subbasin (Table 6.1-3).
    - Continued support of recreational harvest opportunity,
    - Reducing or eliminating late-run hatchery-origin Lower Cowlitz Subbasin winter steelhead.
        - This will support minimizing or eliminating the removal of natural-origin winter steelhead from Lower Cowlitz Subbasin tributaries for use as broodstock.
        - Shifting production to Upper Cowlitz Subbasin winter steelhead would prioritize recovery of that population.

- Exploring termination of the Lower Cowlitz Subbasin Late-winter Steelhead Hatchery Program relative to meeting minimum viability abundance targets. HSRG guidelines for a Contributing population with an integrated hatchery program are the lesser of pHOS <0.3 or pNOB and PNI >0.5. However, increasing pNOB would likely require increased mining of natural-origin broodstock from tributaries, a measure that is inconsistent with the goal of increasing the abundance of natural-origin spawners in the Lower Cowlitz Subbasin. The pHOS limit from a segregated hatchery program for a contributing population would be 0.1.

Table 6.1-3. Recovery phase targets for Lower Cowlitz Subbasin winter steelhead.

Species:	Winter Steelhead
Population Name:	Lower Cowlitz Subbasin
Recovery Designation:	Contributing
Current Recovery Phase:	Local Adaptation

Target Metric	RECOVERY PHASE Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	200[1]	300[1]	400[1]	TBD[1]	645
Smolt Abundance (below hatchery)	?	?	?	?	?
Smolt Passage Survival	N/A	N/A	N/A	N/A	N/A
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Int/Seg	Int/Seg	Int	Int	Int
Broodstock to be Collected	?	?	?	?	?
Integrated Hatchery Program	?	?	?	?	?
Hatchery-Origin	?	?	?	?	?
Natural-Origin	?	?	?	?	?
Segregated Hatchery Program	?	?	?	?	?
Smolts to be Produced	?	?	?	?	?
Integrated Hatchery Program	?	?	?	?	?
Segregated Hatchery Program	?	?	?	?	?
Total Smolt-to-Adult Survival	?	?	?	?	?
Proportionate Natural Influence					
pHOS (<)					
Total	0.3	0.3	0.3	0.3	0.23
Integrated Hatchery Program	0.3	0.3	0.3	0.3	0.23
Segregated Hatchery Program	0.1	0.1	0.1	0.1	NA
pNOB (>)	0.3	0.3	0.3	0.3	0.05
PNI (>)	0.5	0.5	0.5	0.5	0.22
Max % of Natural-Origin Return to Cowlitz Salmon Hatchery Collected for Broodstock	%	%	%	%	NA

[1] No minimum viability abundance target has been set for these populations; the numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.

- **FHMP Goals:** Program goals for the period covered by this FHMP are attainable steps toward population recovery. The goals for the Lower Cowlitz Subbasin winter steelhead population are to:
  - Maintain natural-origin spawner abundance >400 in the Lower Cowlitz Subbasin (Table 6.1-3).
  - Increasing recreational/harvest opportunity in the Lower Cowlitz Subbasin by adjusting the Segregated Summer Steelhead Hatchery Program and exploring the possibility of developing an Early-winter Hatchery Program that is consistent with minimum viability abundance targets.
  - Developing an early-winter steelhead program to more closely emulate historic run-timing of winter steelhead. This action advances Local Adaptation of populations and increases duration of harvest opportunity.
  - Develop a Transition Plan within 1 year of FHMP completion that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins to:
    - Reduce the use of Lower Cowlitz Subbasin natural-origin steelhead for broodstock.
    - Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
    - Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run and spawn timing.
    - Define how soon this program should begin.
    - Recognize need for some harvest opportunity.
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
  - Define the triggers or thresholds for moving from one stage of recovery to another (e.g., abundance, spatial distribution) while considering various recovery strategies.
  - Define the disposition of surplus winter steelhead and management strategies for high and low return years.
  - Identify a strategy to estimate pHOS in the mainstem lower Cowlitz River.
  - Assess the current strategy for monitoring of natural spawning steelhead in the Lower Cowlitz Subbasin, including assessing the magnitude of steelhead spawning in the mainstem and the survival to smolting, knowing there are likely impacts from *C. shasta*.
  - Consider improved methods to estimate, monitor, evaluate, and collect and analyze data, including numbers and age, sex, and origin of all recoveries:
    - Harvested in fisheries in the ocean, Columbia River, and Cowlitz River.

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- Returning to the Barrier Dam Adult Facility.
  - Retained as broodstock.
  - Transported and released upstream of Mayfield Dam.
  - Hatchery surplus.
  - Hatchery strays to/from outside of the Cowlitz Basin.
  - Actual spawners in nature.
- Natural smolts produced.

- Emphasize natural-origin spawners in nature and hatchery-origin return to the Barrier Dam Adult Facility as key population metrics for winter steelhead.
- Reduce the abundance of hatchery surplus by increasing hatchery-origin harvest without increasing natural-origin exploitation rate.

6.1.6.2. Management Targets

This section describes the data necessary to develop management targets for hatchery-origin and natural-origin steelhead. The focus is on abundance by origin, which allows us to examine issues such as an excess of hatchery-origin winter steelhead spawning naturally in the Lower Cowlitz Subbasin, incidental catch and associated mortality that reduces the number available to spawn, and overall productivity of natural-origin and hatchery-origin steelhead. There is little information concerning diseases such as *C. shasta*, and associated impacts on hatchery-origin or natural-origin steelhead in the Cowlitz River.

- **Natural Production:** The goal of population restoration is to develop self-sustaining, naturally reproducing population. A goal of the Settlement Agreement is to recover these stocks to harvestable levels. Activities by Tacoma Power to protect and enhance habitat in the Lower Cowlitz Subbasin are expected to benefit smolt production and the subsequent return of natural-origin winter steelhead, but the current monitoring program is insufficient to evaluate the effectiveness of those efforts. Counts of winter steelhead returning to the hatchery are reliable, while estimates of harvest, returns to spawning grounds, and spawners in nature have wide variances. As part of this FHMP, Tacoma Power will refine the existing M&E Program and ensure implementation of a monitoring program that is focused on evaluating program effectiveness based on regionally accepted VSP parameters and NOAA monitoring guidance (Crawford and Rumsey 2011).
  - **Abundance – Natural Spawning:** Recent data indicate that the Lower Cowlitz Subbasin winter steelhead population is approaching its minimum viability abundance target of 400 natural-origin spawners in nature. However, two issues confound accurately estimating the abundance of the population. First, some steelhead spawning in nature are missed because no surveys are conducted in the mainstem Cowlitz River, where some steelhead spawning likely occurs (however, the presence of the *C. shasta* parasite suggests that survival of steelhead over-summering in the mainstem Cowlitz River would be very low). Second, we cannot determine the origin of some unmarked winter steelhead returning to the Cowlitz River; specifically, we cannot distinguish between those from the Lower Cowlitz and any other source of unmarked winter steelhead other than the Upper Cowlitz and Tilton due to CWT tagging efforts. For management purposes, all unmarked/untagged (assumed to be natural-origin) steelhead that are captured at

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the Barrier Dam Adult Facility are considered to be turbine passed from the Tilton Subbasin because they have migrated past the spawning reaches in the Lower Cowlitz Subbasin and lack the nasal or dorsal CWT identifying them as originating from the Upper Cowlitz or Tilton subbasins, respectively. While it is likely that many did come from the Tilton Subbasin, we cannot know for certain, and some likely originated from the Lower Cowlitz Subbasin (and simply wandered too far upstream while exploring suitable spawning areas) or strayed from some other location. It is also likely that some Upper Cowlitz or Tilton Subbasin winter steelhead remain below Barrier Dam.

Going forward, we will focus on estimating abundance and documenting the total number of hatchery- and natural-origin spawners. The number of spawners is used to calculate recruits/spawner. Additionally, it will be determined if pre-spawn mortality rates and pHOS should be prioritized relative to other efforts. These metrics may prove critical for achieving recovery.

  - **Smolts Produced in Nature:** Natural-origin smolt production specifically from the Lower Cowlitz Subbasin is unknown and cannot be estimated at present. Smolt monitoring in the Lower Cowlitz Subbasin has been conducted using a smolt trap in the mainstem Cowlitz River and is difficult because of the large size of the river and swimming ability of steelhead smolts. Additionally, a proportion of winter steelhead smolts from the Tilton Subbasin pass through the Mayfield Dam turbine and are not marked, which cannot be discerned from those from the Lower Cowlitz Subbasin and further confounds these estimates. A better understanding of juvenile survival and estimate of smolt production specific to the Lower Cowlitz Subbasin steelhead population to evaluate freshwater productivity is the desired management target, although achieving this goal is not anticipated to be a priority during this FHMP period. During this FHMP period, we will focus monitoring of the Lower Cowlitz Subbasin Steelhead population on adult productivity (adult recruits/spawner). Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps.
  - **Smolt-to-Adult Survival:** Because smolt abundance is not estimated and returns are not documented by age, SAR has not been estimated here. This metric is important to understanding and identifying key limiting factors. This management target is reliant on obtaining estimates of smolts produced in nature.
  - **Productivity (Adult Recruits/Spawner):** Because returns are not documented by age in a single database for analysis and reporting, adult to adult productivity has not yet been estimated. Productivity (mature natural-origin F_1 recruits/F_0 spawner) is the primary metric for monitoring natural populations, so collection of the necessary data is critical. Estimating adult to adult productivity is a key management target.

- **Hatchery Production:** The Lower Cowlitz Subbasin Integrated Hatchery Program began in 2013 with a plan to slowly develop an integrated program over time, but was being tentatively implemented due to concerns with natural origin abundance and program operation; because of this, pNOB and PNI have not met HSRG guidelines for this program. Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations

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that may follow. The Transition Plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin when appropriate. This plan will evaluate the current strategies and consider new options for expanding winter steelhead returns earlier in the year.

- **Abundance:** The Cowlitz Trout Hatchery Winter Steelhead Program produced a mean annual return to the Cowlitz River of 12,964 adult hatchery-origin steelhead from 2007-2008 and 2013-2017. Based on our anticipated modifications to the Integrated Hatchery Program, we will develop production goals going forward to meet the minimum viability abundance targets for natural-origin adults spawning in the Lower Cowlitz Subbasin, minimum viability abundance targets for hatchery influence, as well as harvest targets. Because information on harvest outside of the Lower Cowlitz Subbasin is lacking, estimates of total run size cannot be developed for recent years. Going forward, we will focus our monitoring of abundance on the numbers that are harvested and that return to the Cowlitz River and to the Barrier Dam Adult Facility, which are critical for calculating SAR and TSAR, as well as the number that remain to spawn in nature, used for pHOS and PNI calculations.
- **Broodstock Collection and Hatchery Spawning:** Mining of natural-origin broodstock from natural spawning populations reduces the number of natural-origin spawners in nature which, indirectly, increases pHOS. Weirs are also used to control pHOS by providing a control point for natural-origin fish allowed to spawn in key tributaries. The Transition Plan will review methods to no longer collect broodstock in this manner, rather shifting implementation of the Winter Steelhead Integrated Hatchery Program to collection of natural-origin broodstock from returns to Cowlitz Salmon Hatchery. This would effectively terminate the Integrated Hatchery Program for Lower Cowlitz Subbasin winter steelhead. Thus, the Integrated Hatchery Program would shift to focus on supplementing recovery of the Upper Cowlitz and Tilton Subbasin winter steelhead populations, while also providing harvest opportunity in the Cowlitz Basin, including in the Lower Cowlitz Subbasin.

  We would collect all broodstock from salmonids that return to the Barrier Dam Adult Facility and ensure that both male and female natural-origin genotypes are incorporated into the broodstock for the Integrated Hatchery Program. Initially, when low abundance of natural-origin returns constrains natural-origin broodstock collection and spawning decisions, the percentage of natural-origin returns to Cowlitz Salmon Hatchery collected for broodstock may not exceed 30%.

  We will employ hatchery best management practices for broodstock collection and spawning to ensure that the broodstock represents the entire population in age and run-timing and to maximize genetic diversity of the F_1 generation. We will use spawning matrices for all hatchery spawning when the number of spawners is less than 100. Hatcheries, especially those with a conservation mandate, should use spawning matrices for programs with low numbers of spawners in which the gametes from every individual are mixed (approximately evenly) with those of at least two individuals of the opposite sex (Campton 2004).
- **Smolt Production:** Winter steelhead hatchery-origin smolts will be reared at Cowlitz Trout Hatchery. The production goals for the lower Cowlitz Winter Steelhead Hatchery Program will be determined during the first year of the FHMP.

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We will develop, test, and evaluate different rearing and release strategies to develop an optimum strategy for this population.

- **Smolt-to-Adult Survival:** SAR is the primary metric for monitoring hatchery populations, especially those for which return abundance is lower than expected. However, age data for returning adults have not been analyzed, and SAR is not currently being estimated. To support calculations of SAR, estimates of the returns of hatchery-origin steelhead by age class are needed. To do so, we will continue to collect scales and/or CWTs from at least a sample of recoveries at all collection sites. Additional data needs for the M&E Subgroup include the rate of precocious maturation and the sex ratio of hatchery-origin steelhead by age. We will monitor this index as the data become available and summarized in a consolidated analysis and reporting database, through our M&E Program.
- **Productivity (Adult Recruits/Spawner):** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner) is of less importance, but is still useful, for monitoring hatchery populations, where survival to the smolt stage is unnaturally high. Once production goals for the Integrated Hatchery Program are established, we will estimate the number of winter steelhead recruited to the maturing and mature population per F_0 spawner to evaluate whether production goals are being met. Expanded data collection and consolidation into a single analysis and reporting database to include age at all collection sites will support calculations of productivity and monitoring of this metric over time through our M&E Program.
- **Strays and Spawning in Nature:** Only about 2% of hatchery-origin winter steelhead entering the Cowlitz River are recovered on the natural spawning grounds in the Lower Cowlitz Subbasin. However, this estimate is based only on hatchery-origin steelhead identified as having spawned in monitored streams in the Lower Cowlitz Subbasin, so it is likely a low estimate for three reasons. First, hatchery-origin winter steelhead are captured at weirs on Delameter, Lacamas, Olequa, and Ostrander creeks and removed. The ultimate destination of these salmonids, had they not been captured, is unknowable, but some of them likely would have remained to spawn in nature and should be considered strays. The number of natural-origin and hatchery-origin winter steelhead spawning in these streams is also unknown, but the proportion may be similar to that of those captured and removed from the weirs. Lastly, there has been no accounting for hatchery-origin winter steelhead that stray to other spawning locations, outside of the Cowlitz Basin. To get an accurate estimate of the true stray rate, these winter steelhead (probably a small number, but we do not know) must also be accounted for. Conversely, most hatchery-origin steelhead observed to be spawning in lower Cowlitz River tributaries are observed in Blue Creek (which passes through the grounds of Cowlitz Trout Hatchery) or immediately below the hatchery ladder and are also considered strays.
- **Surplus:** A surplus of hatchery-origin winter steelhead returning to the Cowlitz River can affect the viability of the natural-origin population if a sufficient number of them remain to spawn in nature and increase pHOS. Our goal is to maximize the harvest or recapture of hatchery-origin winter steelhead.

- **Harvest:** A mean of 52% of the combined Lower Cowlitz Subbasin winter steelhead returning to the Cowlitz River are harvested each year in the Lower Cowlitz Subbasin. The majority (53%) of hatchery-origin returns are harvested compared to only 2% of

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natural-origin returns, which experience indirect mortality associated with harvest opportunity. Harvest of hatchery-origin steelhead would ideally be as high as possible to reduce pHOS, while still allowing sufficient broodstock. Empirical harvest rates on natural-origin steelhead (whether greater or smaller) would provide clearer guidance for management decisions. Of the remaining hatchery-origin steelhead entering the Cowlitz River, 46% return to the Barrier Dam Adult Facility; the remaining 1% return to spawning grounds in the Lower Cowlitz Subbasin. While this is a small percentage, the number of hatchery-origin returns to the spawning grounds from 2007-2008 and 2013-2017 (mean = 219) is on the same order of magnitude as the number of natural-origin spawning ground returns (mean = 533). The vast majority of hatchery fish encountered have been in Blue Creek (the tributary leading to the Cowlitz Trout Hatchery).

To clearly understand harvest rates on Lower Cowlitz Subbasin winter steelhead, harvest will be monitored with rigorous creel surveys.

- **Proportionate Natural Influence:** During the Transition Plan we will consider increasing the influence of the natural environment on the Lower Cowlitz Subbasin winter steelhead population by no longer mining natural-origin broodstock from Lower Cowlitz Subbasin tributaries, allowing these steelhead to spawn naturally in the subbasin, which will decrease pHOS.
- **Age Composition:** From 2007-2008 and 2013-2017, less than 1% of the hatchery-origin winter steelhead that returned to Cowlitz Salmon Hatchery were identified as one salts. The natural-origin population will likely also produce a low percentage of jacks.

6.1.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

<u>Baseline Monitoring</u>

Monitoring and evaluation needs for the Lower Cowlitz Subbasin winter steelhead population are similar to other populations in the basin and include spawning ground surveys, accurate counts of hatchery releases and returns of both hatchery- and natural-origin steelhead, adequate marking, and evaluation of alternative management and hatchery rearing strategies. To support recovery, our monitoring programs need to be rigorous and to allow for estimation, with confidence, of population abundance, as well as to identify ways to improve survival. Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly to track the population’s trajectory and variability, and includes the basic data required to operate a one-stage or two-stage life cycle model. The following are areas of for consideration that are specific to this population:

- Estimating harvest rates of hatchery- and natural-origin salmonids in all fisheries.
- Estimating hatchery- and natural-origin escapement to Lower Cowlitz Subbasin spawning areas, spawners in nature, and pre-spawning mortality including consideration to expand current monitoring program to include the mainstem.
- Documenting hatchery- and natural-origin returns to the Barrier Dam Adult Facility.
- Documenting numbers of winter steelhead collected for hatchery broodstock and spawned.
- Estimating pHOS, pNOB, and PNI.
- Estimating natural-origin population productivity (spawner-to-spawner).
- Estimating natural- and hatchery-origin smolt production and SAR.

Directed Studies

Directed studies are designed to diagnose and solve problems associated with achieving FHMP goals and to fill management needs and information gaps in the Big Table Dataset (Appendix A). Examples of important areas of study for the Lower Cowlitz Subbasin winter steelhead population include:

- **Juvenile rearing capacity studies:** Available habitat and habitat-specific (run/riffle/pool) densities.
- **Hatchery program studies:** Size at release, time of release, growth rates, broodstock collection, and spawning protocols.
- **Early life stage survival studies:** Egg to fry, fry to parr, and parr-to-smolt survival rates.
- **In-river migratory survival and behavior:** Survival of migrating juveniles, predation rates, and movement/outmigrant and timing rates.
- **Hatchery supplementation experiments:** Assessing the impact of returning hatchery-origin adults.
- **Hatchery practices:** Examining the size and timing of release, growth rate in hatchery, broodstock collection techniques, and spawning protocols.
- **Hatchery fish performance:** Identify the source and potential solutions to solving prevalent and persistent diseases within hatchery steelhead programs.
- Evaluation of impacts of *C. shasta* on natural and hatchery production survival.

6.1.7. Summary

- Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin. Pending development of the Transition Plan, rather than removing natural-origin spawners from the Lower Cowlitz Subbasin to use as broodstock in supporting the Integrated Hatchery Program, those steelhead will be left to spawn naturally. Instead, the Integrated Hatchery Program will rely on natural-origin steelhead returning to Cowlitz Salmon Hatchery, and the

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focus will be on recovery of the Upper Cowlitz and Tilton Subbasin winter steelhead populations through supplementation from the Integrated Hatchery Program and continuing to provide harvest opportunity.

- Hatchery-origin steelhead have been planted in the Cowlitz Basin since 1957. This has included planting of stocks of both in-basin and out-of-basin origin with considerably different run-timing (summer and early-winter run) that is dramatically different from the indigenous winter-run stock.
- Natural-origin spawner abundance in the Lower Cowlitz Subbasin is approaching the minimum viability abundance target of 400. However, the stepping stone Integrated Hatchery Program is not meeting all HSRG guidelines for hatchery influence (pHOS is >pNOB and PNI is <0.5).
- Pending development of the Transition Plan, the proposed program would eliminate the collection of natural-origin broodstock from the Lower Cowlitz Subbasin and will effectively terminate the hatchery program for the Lower Cowlitz Subbasin winter steelhead population. To provide additional harvest opportunity and promote Local Adaptation of the other two populations, we will explore options for establishing an early-winter run of steelhead. In addition, we will adjust the summer run steelhead program to further increase recreational/harvest opportunity and continue to provide harvest opportunity.
- Goals for the period covered by this FHMP are to:
    - Maintain natural-origin spawner abundance >400 in the Lower Cowlitz Subbasin (Table 6.1-3).
    - Define the triggers or thresholds for moving from one stage of recovery to another (e.g., abundance, spatial distribution) while considering various recovery strategies.
    - Define the disposition of surplus winter steelhead and management strategies for high and low return years.
    - Improve monitoring, evaluation, and data collection, and/ or estimation methods (including numbers and age, sex, and origin of recoveries).
    - Develop a Transition Plan within 1 year of FHMP completion that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins to:
        - Reduce the use of lower Cowlitz natural origin steelhead for broodstock
        - Prioritize recovery of the Upper Cowlitz winter steelhead population (Primary population).
        - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
        - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
        - Develop goals that account for integrated vs. segregated SARs.

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    - Evaluate the current monitoring program to address implementation of baseline and directed studies as described above and in the M&E chapter, including clearly defined annual baseline monitoring expectations, prioritization of directed studies with implementation timelines. Complete this within 1 year of FHMP plan finalization.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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Population: Upper Cowlitz Subbasin Winter Steelhead
Oncorhynchus mykiss

Evolutionarily Significant Unit:	Cascade Winter Steelhead Lower Columbia River Steelhead DPS Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened Listed in 1998, revised 2006, reaffirmed in 2011 and 2016
Population Recovery Designation:	Primary
Population Viability Rating:	
Baseline	Very Low
Objective	High
Population Viability Rating:	1,000 natural-origin steelhead spawning in the Upper Cowlitz Subbasin (500 in both the Cispus and upper Cowlitz rivers)
Current Recovery Phase:	Recolonization
Current Hatchery Program(s):	Cowlitz Trout Hatchery Winter Steelhead Integrated Hatchery Program, 118,000 smolts
Proposed Hatchery Program(s)	Cowlitz Trout Hatchery Winter Steelhead Integrated Hatchery Program, 236,000

6.2. Winter Steelhead: Upper Cowlitz Subbasin Population

6.2.1. Purpose

This section describes the current status of the Upper Cowlitz Subbasin winter steelhead population, based on recent and available data. We identify VSP metrics needed to evaluate the status of this population with regard to recovery under ESA guidelines. Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin when appropriate.

The Upper Cowlitz Subbasin winter steelhead population is currently in the Recolonization phase of recovery. As a Primary population for recovery of the lower Columbia River steelhead DPS, we will prioritize recovery of this population, while still allowing for recreational angling and harvest opportunity, by increasing the abundance of natural- and hatchery-origin winter steelhead in the Upper Cowlitz Subbasin. In addition, we will evaluate opportunities and develop a plan to increase the early returning component of the population so that it more closely emulates the historic run-timing of winter steelhead and increases diversity as well as recreational angling and harvest opportunity.

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During the period covered by this FHMP, we will continue to produce at least 118,000 smolts from the Upper Cowlitz Subbasin Integrated Hatchery Program and continue to release hatchery-origin steelhead spawners from this program upstream of Cowlitz Falls Dam. As downstream Fish Passage Survival continues to improve and increasing numbers of natural-origin adults return, reaching criteria (to be established) to move to the Local Adaptation phase, we will balance the number of hatchery-origin adults released upstream of Cowlitz Falls Dam to reduce hatchery influence on the natural-origin population.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:

- Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
- Reduce the use of Lower Cowlitz Subbasin natural origin steelhead for broodstock.
- Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
- Explore the possibilities for expanding the run-timing of the existing hatchery program to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
- Expand existing hatchery program run-timing to increase fishing opportunities.
- Develop a naturally timed steelhead program to more closely emulate historic run-timing.
    - Develop a plan for this within a year.
        - Minimize conflict with restoration of late-winter run in upper basin.
        - Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run/spawn timing.
    - Define how soon we want this program to begin.
    - Recognize the need for some harvest opportunity.
- This needs to fit within minimum viability abundance targets and ESA constraints.

We will develop specific criteria needed to determine when the population has moved from the Recolonization phase to the Local Adaptation phase and will also continue to evaluate the hatchery program and fisheries management, and make refinements or adjustments, as described in this FHMP, to effectively supplement and manage the Upper Cowlitz Subbasin winter steelhead population.

6.2.2. Population Description

The Upper Cowlitz Subbasin winter steelhead population includes all natural-origin winter steelhead that occupy the Cowlitz River and its tributaries upstream of Cowlitz Falls Dam (Upper Cowlitz and Cispus subbasins; Figure 6.2-1). Completion of Mossyrock Dam in 1968 and the subsequent termination of transport of steelhead smolts originating above Mossyrock Dam after 1973 resulted in the extirpation of the steelhead populations in the Cispus and upper

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Cowlitz rivers and the aggregation of their genes into the Lower Cowlitz hatchery population or into a residualized Rainbow Trout population in the Upper Cowlitz Subbasin. These upper river populations are now considered to be at Very High risk of extinction (LCFRB 2010).

The Cowlitz hatchery winter steelhead population that was founded with steelhead arriving at Mayfield Dam in the late 1960s has persisted as a late-returning winter stock and has been used as the genetic source for reintroductions to the Upper Cowlitz Subbasin (Cispus and upper Cowlitz rivers) since transport of mature steelhead to the Upper Cowlitz Subbasin resumed in 1994. The Upper Cowlitz Subbasin winter steelhead population, as part of the lower Columbia River DPS, was listed as threatened under the ESA in 1998. NMFS (2016) reaffirmed the threatened status of the DPS, which remains at “moderate risk” of extinction. They cite the passage program in the Cowlitz Basin as having the potential to provide considerable improvements in abundance and spatial structure. NMFS (2016) also states that, while reintroduction efforts have not yet produced a self-sustaining population, “recent low winter-run returns to the upper Cowlitz River may be anomalous, related more to the development of an integrated hatchery broodstock and temporary modifications at the Cowlitz Falls Dam to benefit Chinook salmon than to a decline in viability”. Because this population is classified as a Primary population for recovery of the lower Columbia River DPS, it must attain its minimum viability abundance targets for the DPS to be considered recovered (LCFRB 2010). Delisting is also dependent on the improved viability of other (i.e., non-Cowlitz Basin) populations within the DPS.

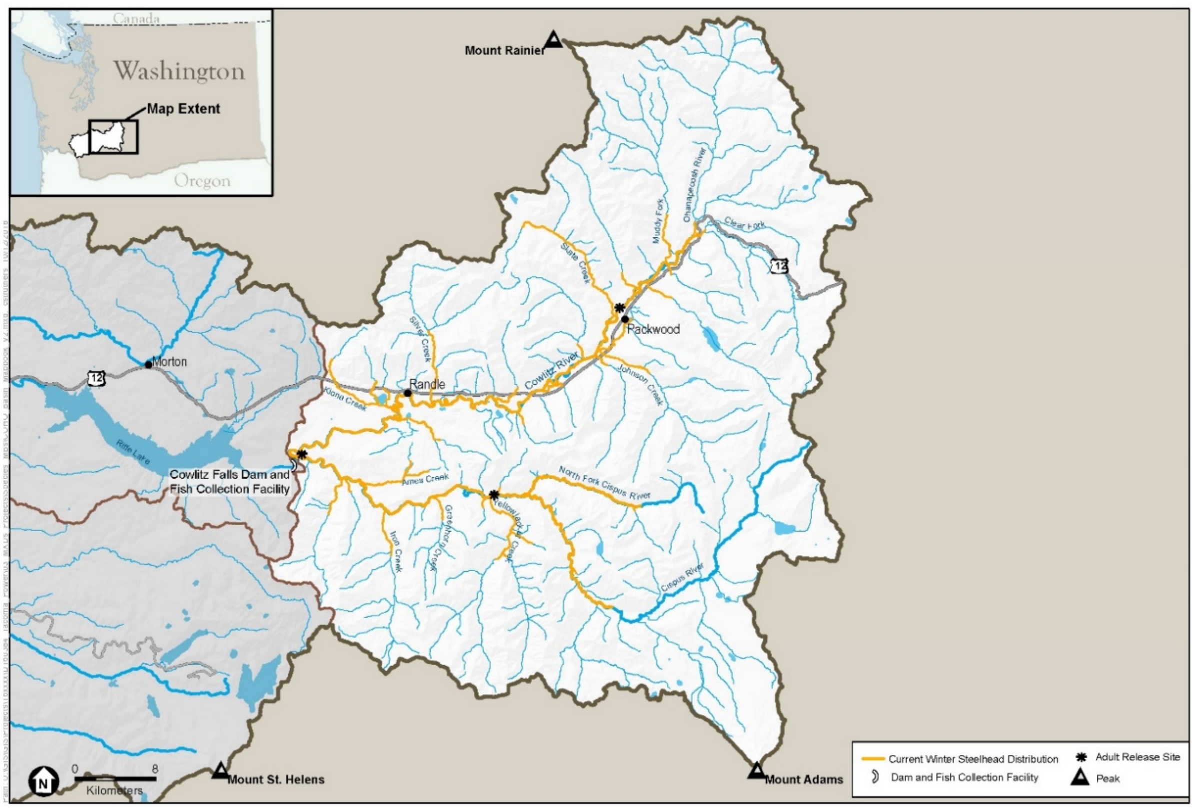

Figure 6.2-1. Distribution of winter steelhead in the Upper Cowlitz Subbasin.

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The Upper Cowlitz Subbasin winter steelhead population is currently supplemented by a Winter Steelhead Integrated Hatchery Program and through trap-and-haul activities. The current goal is for the Integrated Hatchery Programs for this population and the Lower Cowlitz and Tilton subbasin populations to be managed separately. However, during years when Upper Cowlitz and/or Tilton subbasin returns are low, these programs have incorporated hatchery-origin returns from the Lower Cowlitz Subbasin. The Upper Cowlitz Subbasin Integrated Hatchery Program releases yearling smolts directly from Cowlitz Trout Hatchery into the lower Cowlitz River each spring. In addition, mature steelhead of both integrated hatchery- and natural-origin are transported and released upstream of Cowlitz Falls Dam to spawn naturally. Currently, steelhead spawning in the Upper Cowlitz Subbasin occurs in the mainstem and tributaries of the upper Cowlitz and Cispus rivers (LCFRB 2010).

6.2.3. Natural Production

The primary metric that Tacoma Power is responsible for is Fish Collection Efficiency of steelhead smolts collected at the Cowlitz Falls Fish Facility. Two other critical monitoring metrics for steelhead management are the numbers that return at maturation and their disposition (Figure 6.2-2; Table 6.2-1). Upper Cowlitz Subbasin winter steelhead that survive to maturity may be harvested in commercial, sport, or tribal fisheries in the ocean or the lower Cowlitz River, and may suffer indirect mortality from commercial harvest in the Columbia River. Those escaping harvest may return to the Barrier Dam Adult Facility or remain on the natural spawning grounds in the Lower Cowlitz Subbasin. Natural-origin winter steelhead from the Upper Cowlitz Subbasin that are collected at the Barrier Dam Adult Facility may be retained for broodstock or transported above Cowlitz Falls Dam for release, along with returning integrated hatchery-origin winter steelhead, where they may suffer indirect mortality in sport fisheries, die prior to spawning from predation or disease, or survive to spawn naturally. Monitoring these dispositions allows us to evaluate population health, productivity, and progress toward recovery.

6.2.3.1. *Abundance*

The minimum viability abundance target for the Upper Cowlitz Subbasin winter steelhead population is an annual abundance of 1,000 natural-origin steelhead spawning in nature, 500 in each the Cispus and upper Cowlitz rivers (LCFRB 2010). Only natural-origin winter steelhead that were released into the Upper Cowlitz Subbasin and survive to spawn are counted toward the goal.

Data that are critical to monitoring the Upper Cowlitz Subbasin winter steelhead population have not been fully captured in a single analysis and reporting database. Collection of outmigrants at the Cowlitz Falls Fish Facility offers some indication of smolt abundance, specifically collection efficiency and numbers collected and released downstream. Although collection efficiency has not been as high as required by the Settlement Agreement and Biological Opinion and has ranged widely. Estimates of total natural-origin juvenile winter steelhead production are expected to continue to improve.

Data are unavailable for harvest of Upper Cowlitz Subbasin winter steelhead in the ocean, Columbia River, or lower Cowlitz River fisheries, so estimates of total run size or returns to the Cowlitz River have not been developed here. Returns to the Barrier Dam Adult Facility offer a relative indication of total abundance; from 2012-2017, a mean of 297 natural-origin Upper Cowlitz Subbasin winter steelhead returned to Cowlitz Barrier Dam (Figure 6.2-2; Table 6.2-1).

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Table 6.2-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin adult winter steelhead from the Upper Cowlitz Subbasin population that could be accounted for at recovery locations 2012-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Ocean harvest	Data Not Available		
Columbia River harvest	Data Not Available		
Lower Cowlitz River harvest	Data Not Available		
Upper Cowlitz Subbasin harvest	56	0	149
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	187	0	369
Collected for Broodstock	27	0	61
Transported above Cowlitz Falls Dam	161	0	331
Remain in Upper Cowlitz Subbasin	105	0	256
Natural-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Ocean harvest	Data Not Available		
Columbia River harvest	Data Not Available		
Lower Cowlitz River harvest	Data Not Available		
Upper Cowlitz Subbasin harvest	Data Not Available		
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	297	31	672
Collected for Broodstock	62	7	92
Transported above Cowlitz Falls Dam	235	24	580
Remain in Upper Cowlitz Subbasin	Data Not Available		
Combined Hatchery- and Natural-origin			
Total Run[1]	Not All Data Are Available		
Harvest[2]	Not All Data Are Available		
Ocean harvest	Data Not Available		
Columbia River harvest	Data Not Available		
Lower Cowlitz River harvest	Data Not Available		
Upper Cowlitz Subbasin harvest	Data Not Available		
Total Return to Cowlitz River[3]	Not All Data Are Available		
Return to Barrier Dam Adult Facility	484	321	686
Collected for Broodstock	88	68	113
Transported above Cowlitz Falls Dam	396	253	580
Remain in Upper Cowlitz Subbasin	Not All Data Are Available		

[1] Sum of all harvest below Barrier Dam plus numbers returning to Barrier Dam Adult Facility.
[2] Total of harvest in ocean, Columbia River, Lower Cowlitz Subbasin, and Upper Cowlitz Subbasin fisheries.
[3] Sum of Lower Cowlitz Subbasin harvest plus number returning to Lower Cowlitz Subbasin spawning grounds, and Barrier Dam Adult Facility (hatchery-origin) or collected at weirs for broodstock (natural-origin).

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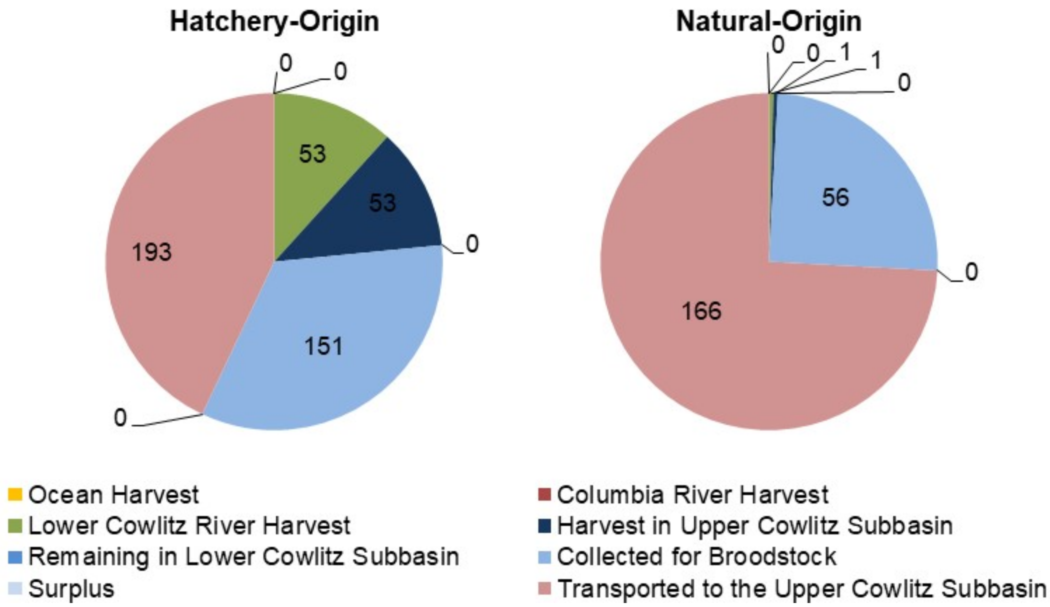

Figure 6.2-2. Mean numbers and proportions of hatchery- and natural-origin Upper Cowlitz Subbasin winter steelhead caught in non-ocean fisheries, collected for broodstock (natural-origin), transported to the Upper Cowlitz Subbasin, or returned to Barrier Dam Adult Facility (comprised of hatchery broodstock and hatchery surplus), 2013-2017. Note: All natural-origin winter steelhead that returned to Barrier Dam Adult Facility are assumed to be either Tilton River (no CWT) or Upper Cowlitz Basin (CWT) because those caught at the hatchery are assumed to have come from populations upstream of Mayfield Dam. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

6.2.3.2. *Harvest*

Upper Cowlitz Subbasin winter steelhead that survive to maturity may be harvested in commercial, sport, or tribal fisheries in the ocean or the lower Cowlitz River, and may suffer indirect mortality from commercial harvest in the Columbia River. However, harvest data for Upper Cowlitz Subbasin winter steelhead are only available for the Upper Cowlitz Subbasin fishery, and exclusively for hatchery-origin steelhead. Upper Cowlitz Subbasin winter steelhead that survive to maturity may be harvested in commercial, sport, or tribal fisheries in the ocean, or the lower Cowlitz River, and may suffer indirect mortality from commercial harvest in the Columbia River, as well as from the sport fishery in the Cowlitz Basin. However, harvest data for Upper Cowlitz Subbasin winter steelhead are only available for the Upper Cowlitz Subbasin fishery, and exclusively for hatchery-origin steelhead. From 2007-2017, a mean of 98 (range: 41-214) hatchery-origin steelhead were harvested in the Upper Cowlitz Subbasin.

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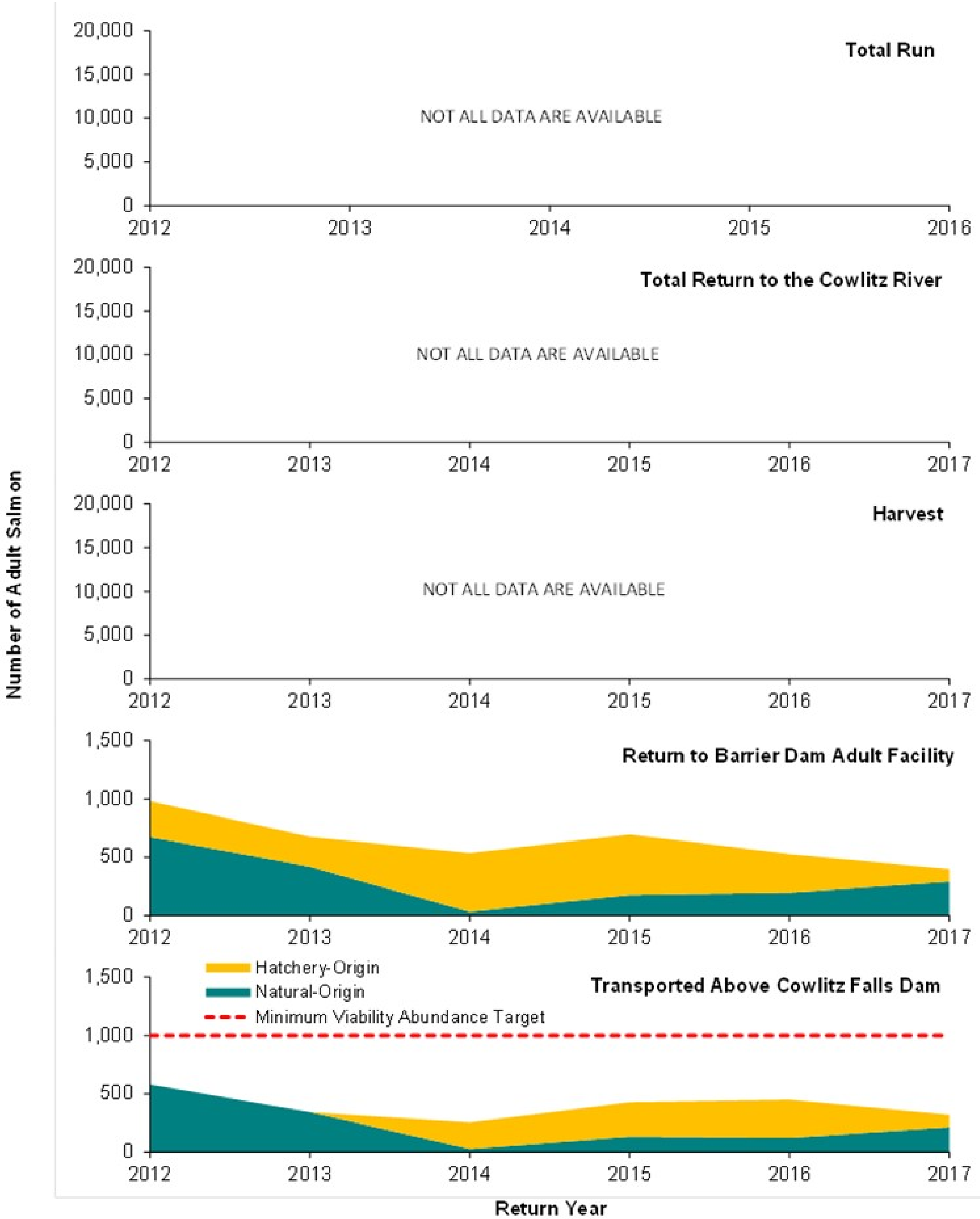

Figure 6.2-3. Total run size of hatchery- (Integrated Hatchery Program) and natural-origin Upper Cowlitz Subbasin winter steelhead and numbers that returned to the Cowlitz River, were harvested, returned to the Cowlitz Barrier Dam Adult Facility, or were transported upstream of Cowlitz Falls Dam, 2012-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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6.2.3.3. *Disposition*

From 2013-2017, an annual mean of 235 natural-origin adults collected at the Barrier Dam Adult Facility were transported and released in the Upper Cowlitz Subbasin (Figure 6.2-2). It is unknown what percentage of the total Upper Cowlitz population run size these steelhead comprise.

6.2.3.4. *Spawning in Nature*

Because total run size cannot currently be estimated, the number of natural-origin steelhead returning to the Barrier Dam Adult Facility offers the best indication of total natural production. From 2012-2017, a mean of 297 natural-origin winter steelhead from the Upper Cowlitz Subbasin population returned to the Barrier Dam Adult Facility (Table 6.2-1). While actual spawning abundance is unknown, the numbers of natural-origin adult returns indicate that the population is still well below the minimum viability abundance target of 1,000 natural spawners.

6.2.3.5. *Smolt Production*

From 2014-2018, a mean of 9,439 winter steelhead juveniles were captured at the Cowlitz Falls Fish Facility, which captures juveniles and kelts emigrating from the Upper Cowlitz Subbasin. Mean collection efficiency was estimated to be 68.9%, so we estimated that 13,270 winter steelhead smolts were produced from the Upper Cowlitz Subbasin. Uncollected fish are assumed to be subject to natural mortality in Lake Scanewa or lost to anadromy downstream into Riffe Lake. Other life histories are also expressed and collected at this location. Fry and parr are transported upstream to continue rearing prior to outmigration, while kelts are transported downstream so that their contribution to the population as returning spawners may be realized.

6.2.3.6. *Natural-origin Survival and Productivity*

Survival and productivity are the key metrics for monitoring populations. However, neither SAR nor productivity can currently be calculated for the Upper Cowlitz Subbasin winter steelhead population because returns have not been analyzed for age, so a full run reconstruction of each brood year is not currently available. Available information, assumptions, and estimates will be consolidated into a single analysis and reporting database during this FHMP period.

6.2.3.7. *Age Composition*

For run years 2012-2017, ISIT data indicate that only adult winter steelhead (i.e., no jacks) returned to the Barrier Dam Adult Facility or were transported upstream of Cowlitz Falls Dam. Other available information, assumptions, and estimates will be consolidated into a single analysis and reporting database during this FHMP period.

6.2.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, to evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population (see Section 6.0.9).

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Winter steelhead were reintroduced to the Upper Cowlitz Subbasin before the 2011 FHMP (Tacoma Power 2011), relying on the Cowlitz-derived Segregated Late-Winter Steelhead Hatchery Program as the brood source. As the reintroduction progressed, the Upper Cowlitz Subbasin Integrated Winter Steelhead Hatchery Program was initiated. Beginning in 2013, natural-origin winter steelhead that originated from the Upper Cowlitz Subbasin and returned to the Barrier Dam Adult Facility were incorporated into the broodstock with a target of 100% pNOB. Since 2013, broodstock spawned to support this program have consisted of a mean of 57 natural-origin and 25 hatchery-origin steelhead annually (Table 6.2-2). In several years, due to low returning numbers of Upper Cowlitz Subbasin natural-origin and hatchery-origin fish, hatchery-origin fish from the Lower Cowlitz integrated program were used to backfill the need to reach the egg take goal. The goal of the Integrated Hatchery Program has been to produce approximately 118,000 smolts annually that are marked (CWT and adipose fin-clip) as the F_1 progeny of natural-origin broodstock. These fish are reared at Cowlitz Trout Hatchery and directly released into the lower Cowlitz River to avoid the loss due to low Fish Passage Survival at Cowlitz Falls Dam.

Table 6.2-2. Mean, minimum, and maximum hatchery and natural spawning metrics for Upper Cowlitz Subbasin winter steelhead, 2012-2017 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2012-2017 Run Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery Spawning			
Mature Steelhead Collected	88	68	113
Hatchery-origin	27	0	61
Natural-origin	62	7	92
Mature Steelhead Spawned	82	66	102
Hatchery-origin	25	0	61
Natural-origin	57	7	86
Pre-spawn Survival Rate	93%	88%	100%
Total Green Eggs	154,163	118,218	207,523
Mean Fecundity	3,740	3,040	4,816
Mean Fertility	Data Not Available		
Total Eyed Eggs	Data Not Available		
Smolts Released[1]	121,429	104,113	138,103
Green Egg-to-Smolt Survival	77%	70%	89%
Smolt Productivity (smolts / spawner)[1]	1,519	1,245	1,739
Natural Spawning			
Spawners	Data Not Available		
Hatchery-origin	Data Not Available		
Natural-origin	Data Not Available		
Smolts Produced	Data Not Available		
Smolt Productivity (smolts / spawner)	Data Not Available		

1 Brood years 2012-2016.

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6.2.4.1. *Abundance*

As noted above under *Natural Production*, data are currently unavailable for harvest of Upper Cowlitz Subbasin winter steelhead in ocean or Columbia River fisheries, so estimates of total run size or returns to the Cowlitz River are not presented here. Returns to the Barrier Dam Adult Facility offer a relative indication of total abundance; from 2012-2017, a mean of 187 integrated hatchery-origin[1] Upper Cowlitz Subbasin winter steelhead returned to the Barrier Dam Adult Facility (Figure 6.2-2; Table 6.2-1).

6.2.4.2. *Harvest*

As noted above under *Natural Production*, harvest data for Upper Cowlitz Subbasin winter steelhead are only available for the Upper Cowlitz Subbasin fishery, and exclusively for hatchery-origin steelhead. No hatchery-origin winter steelhead were transported above Cowlitz Falls Dam from 2012-2013 due to productivity testing, but from 2014-2017, mean harvest in the Upper Cowlitz Subbasin fishery was 56 steelhead (Table 6.2-1), 32% of the hatchery-origin winter steelhead transported above Cowlitz Falls Dam from 2014-2017.

6.2.4.3. *Disposition*

Upper Cowlitz Subbasin integrated hatchery-origin winter steelhead returning to the Barrier Dam Adult Facility that are deemed in excess of broodstock requirements are transported above Cowlitz Falls Dam to supplement natural spawning and provide harvest opportunities in the Upper Cowlitz Subbasin. A mean of 161 hatchery-origin winter steelhead were transported and released above Cowlitz Falls Dam from 2012-2017, representing 86% of those returning to the Barrier Dam adult facility (Figure 6.2-2; Table 6.2-1). Hatchery-origin steelhead transported to the Upper Cowlitz Subbasin are available for harvest, and those that survive may spawn naturally. No surveys are currently conducted to document survival to spawning.

6.2.4.4. *Hatchery Spawning*

As with natural-origin returns, estimates of the total run size for hatchery-origin Upper Cowlitz Subbasin winter steelhead are hindered by the lack of harvest data below Mayfield Dam. The number of hatchery-origin steelhead returning to the Barrier Dam Adult Facility therefore offers the best indication of run size. From 2012-2017, a mean of 187 hatchery-origin winter steelhead assigned to the Upper Cowlitz Subbasin population returned to the Barrier Dam Adult Facility (Table 6.2-1). Of those returning to the Barrier Dam Adult Facility, a mean of 27 were collected for broodstock while the remainder were transported and released above Cowlitz Falls Dam.

6.2.4.5. *Hatchery Rearing*

From 2012-2015, an estimated mean of 154,163 green eggs were collected from a mean of 85 adults for the Integrated Hatchery Program (Table 6.2-2). Mean fecundity was 3,740 green eggs, but eyed-egg data are not available so fertility rate cannot be calculated. From brood years 2012-2016, a mean of 121,429 smolts were released in 2013-2015. Mean green egg-to-smolt survival for brood years 2012-2016 was 77%.

[1] For the purposes of this section, hatchery-origin Upper Cowlitz winter steelhead consist of those collected for broodstock at the Barrier Dam Adult Facility or transported above Cowlitz Falls Dam.

6.2.4.6. *Age Composition*

As noted above under Natural Production, for run years 2012-2017, ISIT data indicate that only adult winter steelhead (i.e., no jacks) returned to the Barrier Dam Adult Facility or were transported upstream of Cowlitz Falls Dam. This and any additional available data will be added to a single consolidated database for analysis and reporting during this FHMP period.

6.2.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in PNI can indicate an increase or decrease in the effect of hatchery-origin steelhead on the natural population and an increase or decrease in the influence of the natural population on the hatchery program.

To reduce the effect of hatchery supplementation on the natural population that it supplements, we will try to maximize the number (and percentage) of natural-origin steelhead in the hatchery broodstock and minimize spawning by hatchery-origin steelhead in nature during the Local Adaptation phase of recovery. Absent spawning survey data, the best approximation of pHOS we can derive is based on the number of steelhead transported above Cowlitz Falls Dam, minus the number removed through harvest. This approach fails to account for other losses, such as fallback, predation, and pre-spawn mortality and is also constrained by the lack of spawning surveys. Nonetheless, the resulting estimate of mean pHOS for 2012-2017 was 0.47, which exceeds the HSRG guideline of <0.3 for a Primary population with an integrated hatchery program, as is expected for a population in the Recolonization phase of recovery being supported by hatchery releases.

Given the known broodstock contribution for both natural- and hatchery-origin steelhead, pNOB can be more accurately quantified. Natural-origin broodstock were first used in the Integrated Winter Steelhead Hatchery Program in 2012. From 2012-2017, mean pNOB was 0.64, which exceeds the HSRG guideline of >0.60 for a Primary population with an integrated hatchery program.

Estimates of PNI are subject to the same constraints as pHOS in terms of data availability (i.e., no spawning survey data). Based on this limited data, mean PNI from 2012-2017 was 0.57, which is below the HSRG guideline of >0.67 for a Primary population with an integrated hatchery program that will be the target during the Local Adaptation phase of recovery (Table 6.2-3).

6.2.6. Future Management

The Upper Cowlitz Subbasin winter steelhead population is designated as a Primary population for achieving MPG and DPS recovery goals, with a minimum viability abundance target of 1,000 natural-origin spawners in nature, which is the combined abundance targets for the Upper Cowlitz (500 spawners) and Cispus (500 spawners) River populations. Population viability remains at a rating of Very Low, with natural production being supplemented by hatchery-origin adults transported to the Upper Cowlitz Subbasin (WDFW and LCFRB 2016). From 2012-2017, the total number of natural-origin winter steelhead transported to the Upper Cowlitz Subbasin has ranged from 24-580 (mean = 235). The maximum number transported during this period (n = 580) occurred prior to initiation of the Integrated Hatchery Program, so natural-origin spawner abundance is well below the minimum natural-origin spawner abundance target of 1,000. However, the population is in the early stages of transitioning to an Integrated Hatchery Program, and the expectation is that as supplementation with hatchery-origin adults spawning in the subbasin continues and Fish Passage Survival increases, the number of subsequent natural-origin spawners will increase.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin. This plan will evaluate the current strategies and consider new options for expanding winter steelhead returns earlier in the year. The intent is to increase the transport and release of both hatchery- and natural-origin adults above Cowlitz Falls Dam so that natural production increases, while also sustaining harvest opportunities downstream of Mayfield Dam. The long-term goal will be to transition fully to an Integrated Hatchery Program that supports the recovery of the Upper Cowlitz Subbasin population, as well as harvest both downstream of Mayfield Dam and in the Upper Cowlitz Subbasin. To accomplish this, within the first year of the FHMP, we will define the triggers or thresholds for moving from one stage of recovery to another (e.g., adult abundance, spatial distribution, Fish Passage Survival) while considering various recovery strategies in the Transition Plan. For additional information on the Transition Plan, see Chapter 12, Table 12-2, and Appendix B.

6.2.6.1. *Goals for Conservation, Recovery, and Harvest*

The Upper Cowlitz Subbasin winter steelhead population was identified as a high recovery priority (LCFRB 2010) and will play a primary role in the recovery of the lower Columbia River steelhead DPS. Progress toward achieving conservation goals and minimum viability abundance targets and identification of factors that limit recovery are evaluated through monitoring of standard fisheries management metrics (Table 6.2-3; Appendix A, Big Table Dataset). The Upper Cowlitz Subbasin winter steelhead population had an historical abundance of about 2,900 steelhead (1,400 in the upper Cowlitz River and 1,500 in the Cispus River) and has a minimum viability abundance target of 1,000 natural-origin spawners in nature (LCFRB 2010). In 2010, the abundance and productivity of this population was rated as Very Low, with <50 spawners in the Upper Cowlitz and Cispus river subpopulations (LCFRB 2010). Today, natural-origin spawner abundance is >50 in most years, but still well below the minimum viability abundance target. Opportunities for recreational/harvest will be maximized by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.

- **Long-term Goals:** The goal for this Primary winter steelhead population is full recovery, which would include, but not be limited to:
    - Prioritizing population recovery while still providing harvest opportunity.
    - Establishment of clear targets for establishing that Full Recovery has been achieved.
    - A harvestable population of winter steelhead in the Upper Cowlitz Subbasin.
    - Maintain minimum adult abundance of >1,000 natural-origin winter steelhead spawning in nature, with at least 500 in each subbasin.
    - pHOS <0.3 (HSRG 2009).
    - pNOB more than two times pHOS, such that PNI ≥0.67.
    - Continued support of recreational harvest opportunity.

Table 6.2-3. Recovery phase targets for Upper Cowlitz Subbasin winter steelhead.

Species: Winter Steelhead
Population Name: Upper Cowlitz Subbasin
Recovery Designation: Primary
Current Recovery Phase: Recolonization

	RECOVERY PHASE				
Target Metric	Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	1,000[1]	1,000[1]	1,000[1]	TBD[1]	359[2]
Smolt Abundance (below hatchery)	TBD	TBD	TBD	TBD	NA
Smolt Passage Survival	40%	50%	TBD	TBD	78%
Productivity (5-year mean)	>1	>1	>1	>1	?
Hatchery Production					
Type of Hatchery Program	Seg/Int	Int	Int	Int	Int
Broodstock to be Collected	TBD	TBD	TBD	TBD	85
Integrated Hatchery Program	TBD	TBD	TBD	TBD	85
Hatchery-Origin	TBD	TBD	TBD	TBD	29
Natural-Origin	TBD	TBD	TBD	TBD	56
Segregated Hatchery Program	0	0	0	0	0
Smolts to be Produced	TBD	TBD	TBD	TBD	121,429
Integrated Hatchery Program	TBD	TBD	TBD	TBD	121,429
Segregated Hatchery Program	TBD	TBD	TBD	TBD	0
Total Smolt-to-Adult Survival	TBD	TBD	TBD	TBD	NA
Proportionate Natural Influence					
pHOS (<)					
Total	TBD	TBD	TBD	TBD	0.47*
Integrated Hatchery Program	TBD	TBD	TBD	TBD	0.47*
Segregated Hatchery Program	0.1	N/A	N/A	N/A	N/A
pNOB (>)	TBD	TBD	TBD	TBD	0.64
PNI (>)	TBD	TBD	TBD	TBD	0.57*
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	TBD	TBD	TBD	TBD	26%

1 No minimum viability abundance target has been set for these populations; numbers listed here are preliminary; actual targets will be set during the period covered by this FHMP in coordination with the FTC.
2 Based on numbers transported rather than spawning.

- **FHMP Goals:** The goals for this program during the period covered by this FHMP are to:
  - Increase total abundance (both natural- and hatchery-origin) in the Upper Cowlitz Subbasin to advance recovery while in the Recolonization phase.
  - Within 1 year following completion of this FHMP, develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:
    - Reduce the use of Lower Cowlitz Subbasin natural-origin steelhead for broodstock.
    - Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
  - Define triggers (i.e., Decision Rules) for moving from one stage of recovery to another (e.g., adult abundance, spatial distribution, Fish Passage Survival) while considering various recovery strategies.
  - Emphasize as key population monitoring and VSP metrics:
    - Abundance, population growth rate, productivity, spatial structure, and diversity.
    - Numbers returning to the Cowlitz River.
    - Numbers of natural-origin steelhead returning to the Barrier Dam Adult Facility.
    - Numbers of mature natural- and hatchery-origin steelhead transported and released in the Upper Cowlitz Subbasin.
    - Numbers of natural- and hatchery-origin steelhead spawning in nature in the Upper Cowlitz Subbasin.
    - Estimates of harvest rates.
  - Begin monitoring natural spawning in the Upper Cowlitz Subbasin to achieve natural-origin spawner abundance >1,000 with at least 500 in each subbasin.
  - Increase and improve monitoring and evaluation, including:
    - Natural smolt production.
    - Abundance of hatchery- and natural-origin spawners.
    - Age, sex, and origin of recoveries at all recovery locations.
    - Document strays from outside of the Cowlitz Basin and Cowlitz River strays at sites outside the Cowlitz Basin.

6.2.6.2. *Management Targets*

Improved Fish Passage Survival will aid in creating a self-sustaining naturally spawning population in the subbasin, but will not solve all of the problems. Reestablishing a self-sustaining population will ultimately require natural spawning by a sufficient number of natural-origin steelhead and for their survival to exceed replacement (spawner-to-spawner productivity >1). A Transition Plan will be developed within 1 year of the submittal of this FHMP to consider reducing the pNOB rate of the current program to 0.5 and double the size of the current hatchery production for the Upper Cowlitz Subbasin to 236,000 smolts. This approach would not change the number of natural-origin fish being taken into the hatchery and increase the number of hatchery-origin fish returning to the separator. If the Integrated Hatchery Program exhibits a smolt-to-adult survival rate of only 2%, we would expect to get 4,720 adults back to meet broodstock needs and seed the Upper Cowlitz Subbasin prior to moving onto the next phase of recovery.

- **Natural Production:** The goal of the Settlement Agreement is restoration to produce self-sustaining natural-origin populations to harvestable levels. We will develop monitoring programs that allow us to estimate VSP parameters including the abundance of steelhead in these populations, when populations have become self-sustaining, as well as to identify areas where we can improve survival. Efforts to improve downstream Fish Passage Survival continue, and recruitment from natural production will increase with the success of these efforts. Counts of steelhead returning to the Upper Cowlitz Subbasin are reliable, but estimates of harvest and the number of spawners in nature have wide variances due to low sampling rates, when estimated at all, so actual pHOS is unknown. As part of this FHMP, Tacoma Power will develop a monitoring program that prioritizes monitoring needs across the basin for consideration by the FTC and agencies that is focused on evaluating program effectiveness based on regionally accepted VSP parameters and NOAA Monitoring Guidance (Crawford and Rumsey 2011).

  During the current Recolonization phase of recovery, while Fish Passage Survival was not meeting Settlement Agreement and Biological Opinion requirements, natural production in the Upper Cowlitz Subbasin has relied on spawning by a combination of transported hatchery- and natural-origin adults. We have accepted the resulting near-term increase in pHOS (>0.3) in order to receive the demographic boost that the population needs and, as such, will continue utilizing hatchery production during the period covered by this FHMP to supplement natural production. However, as the transition to an Integrated Hatchery Program progresses during this period, and program sizes are adjusted, we will increase the contribution of natural-origin broodstock, as run size permits. In the long term, all hatchery production will transition to a fully Integrated Hatchery Program that relies entirely on natural-origin broodstock. However, as natural-origin productivity and abundance increase, reductions in releases of hatchery-origin steelhead into the Upper Cowlitz Subbasin, reductions in natural-origin exploitation, and/or increased hatchery-origin harvest may be needed to reduce pHOS to an acceptable level. Until abundance improves, greater releases of hatchery-origin adults above Cowlitz Falls Dam will be continued to increase natural smolt production, and the subsequent return of natural-origin spawners to meet minimum viability abundance targets.

  - **Abundance – Transport and Natural Spawning:** The minimum viability abundance target for the Upper Cowlitz Subbasin winter steelhead population of 1,000 natural-origin spawners has not yet been met. While pNOB has met the HSRG guidelines in recent years, pHOS and PNI have not during this Recolonization phase of recovery. However, this population is still in the Recolonization phase of recovery and the Integrated Hatchery Program was only recently initiated.

To meet HSRG guidelines, the number of returning natural-origin spawners must increase and the proportional contribution of hatchery-origin steelhead spawning in the Upper Cowlitz Subbasin must decrease. We will focus our monitoring on VSP parameters associated with the relevant recovery phase each year. These metrics are critical for achieving recovery.

- **Smolts Produced in Nature:** Natural-origin smolts are collected at the Cowlitz Falls Fish Facility. Natural-origin smolt production from the Upper Cowlitz Subbasin is comprehensive because only smolt transported are successful and we have a census count of these. Efficiency of the collector is evaluated annually. These components allow for calculation of the total number of smolts produced and, when combined with the number of spawners, allow for calculation of freshwater productivity (smolts per spawner). This is a critical management need for evaluating habitat capacity and population viability as reintroduction of steelhead to the Upper Cowlitz continues.
- **Smolt-to-Adult Survival:** Since the number of smolts collected at the Cowlitz Falls Fish Facility and hauled to the lower river is known, this information can be combined with counts of returning natural-origin adults to calculate SAR. This metric is important to understanding and identifying key limiting factors for the Upper Cowlitz Subbasin steelhead populations. To date, rates of iteroparity and kelting have not been fully examined, but should be during the period of this FHMP, and the Upper Cowlitz Subbasin presents a unique opportunity in that fish are handled on the way up and down stream.
- **Productivity (Recruits/Spawner):** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner; “spawner-to-spawner”) is the primary monitoring metric for any population, especially natural populations. It provides an overall view of population performance and trajectory, where:
  - If productivity >1, the population is increasing.
  - If productivity <1, the population is declining.
  - Estimating adult to adult productivity is a key management target.

- **Hatchery Production:** During recovery efforts to date, hatchery influences on the Upper Cowlitz Subbasin population have consisted of the transport and release of hatchery-origin adults that spawn naturally and the use of both hatchery- and natural-origin broodstock (mean pNOB = 0.64). The number of adults successfully spawning in the Upper Cowlitz Subbasin is unknown, so our best estimates of pHOS (mean = 0.47) and PNI (mean = 0.57) can currently only be approximated based on the numbers transported and released. Given the low returns of natural-origin adults and the abundance of hatchery-origin adults released in the subbasin, these metrics of hatchery influence exceed minimum viability abundance targets during this recovery phase, and natural influence on the Upper Cowlitz Subbasin population has been limited.

  Decisions for implementing the Integrated Hatchery Program will be reviewed and revised, as necessary throughout this FHMP period during the APR process (e.g., based on the number of returning natural-origin adults) (see Chapter 12).

We will continue transporting hatchery-origin adults to the Upper Cowlitz Subbasin over the period covered by this FHMP. We will continue to develop and implement a rigorous sampling and monitoring program, along with an improved database for the hatchery program, to allow managers to better evaluate and manage the hatchery programs. Guidance for the numbers of broodstock to be collected, by week, origin, age class, and sex, will be determined at the Annual Program Review meeting and documented in the Annual Operating Plan (see Chapter 12). The collection schedule will be based on the smolt production needs of each program and the most recent 5-year means of pre-spawn mortality, fecundity, fertility, hatching rates, and survival rates from hatching-to-swim-up fry, fry-to-parr (at marking), and parr-to-smolt survival rates. Improved estimates of returns will also be needed to characterize stray and smolt-to-adult survival and return rates and evaluate the hatchery programs. These data will be used to inform decisions for implementing and revising the Integrated Hatchery Program, as necessary (e.g., based on the number of returning natural-origin adults).

- **Abundance:** We will focus our monitoring of abundance on the numbers of Upper Cowlitz Subbasin integrated hatchery-origin winter steelhead that return to the Cowlitz River and to the Barrier Dam Adult Facility, which are critical for calculating SAR and TSAR. As the Integrated Hatchery Program continues to develop, we will establish production goals that align with the prioritization of recovery, while also providing for harvest opportunity.

- **Broodstock Collection and Spawning:** We will collect all broodstock from steelhead that return to the Barrier Dam Adult Facility and will ensure that both male and female natural-origin genotypes are incorporated into the broodstock for the Integrated Hatchery Program. The currently low abundance of natural-origin returns may initially constrain natural-origin broodstock collection and spawning decisions, as the percentage of natural-origin returns to the Barrier Dam Adult Facility collected for broodstock are not currently anticipated to exceed 30%.

  We will employ hatchery best management practices for broodstock collection and spawning to ensure that the broodstock represents the entire population in age and run-timing in order to maximize genetic diversity of the F_1 generation.

- **Smolt Production:** Winter steelhead hatchery-origin smolts will be reared at Cowlitz Trout Hatchery. The Settlement Agreement (Section 6.1.5), states that, "The hatchery complex will be designed with flexibility so managers can employ innovative rearing practices, low densities, and replication of historic fish out-migration size and timing." It is clear that the intent of the Settlement Agreement is to aspire to rear steelhead so that they are as similar, in both appearance and performance, to natural-origin steelhead as possible. Satellite rearing facilities in the upper Cowlitz subbasins may be instrumental in rearing salmon with conditions emulating the natural population. We will begin developing and evaluating novel rearing and release strategies (e.g., smaller, natural-sized steelhead smolts) to improve program performance by decreasing the rates of straying, and increasing the rates of in-hatchery survival, smolt-to-adult survival, and smolt-to-adult return. This will further minimize the hatchery influence on the F_1 generation and any population that it spawns with.

- **Smolt-to-Adult Survival:** SAR and TSAR are the primary indices for monitoring a hatchery program. SAR indicates the success of the program in producing steelhead that survive to return to the hatchery; a sufficient number is needed to support hatchery broodstock (for segregated or partially integrated programs) or for release

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into nature to support natural spawning. TSAR is indicative of the overall success of a hatchery program to support all aspects that hatchery steelhead may support—commercial, tribal, and/or recreational fisheries in the ocean, Columbia River, and the Cowlitz River and/or its tributaries, hatchery broodstock, and/or natural spawning. We will develop monitoring programs that allow us to estimate VSP parameters including the abundance of steelhead in these populations, when populations have become self-sustaining, as well as to identify areas where we can improve survival.

- **Productivity (Adult Recruits/Spawner):** Population productivity (number of F_1 generation recruits that survive to spawn for each F_0 generation spawner; "spawner-to-spawner") is the primary monitoring metric for any population, especially natural populations. However, this metric is of less importance to hatchery-origin populations, where survival to the smolt stage is unnaturally high. Population productivity for hatchery-origin steelhead should be well above replacement (R/S = 1) because of the huge survival advantage afforded by rearing in a hatchery. Therefore, recruits / spawner (smolt recruits or mature recruits) is less important for monitoring hatchery populations.
- **Strays and Spawning in Nature:** Because all mature steelhead reaching the Upper Cowlitz Subbasin are sorted for transport, and because only F_1 progeny hatchery-origin steelhead (i.e., marked with both ad-clip and CWT) are transported and released into the Upper Cowlitz Subbasin, the risk of hatchery-origin strays from outside the integrated program spawning naturally in the subbasin is low.

  While stray rates to out-of-basin locations are also likely low, it is reasonably certain that Cowlitz River hatchery-origin steelhead do stray into other streams such as the Toutle, Coweeman, Kalama, Lewis, or Willamette rivers.
- **Surplus:** The Integrated Hatchery Program allows for flexibility in dealing with hatchery returns that exceed broodstock needs because hatchery-origin steelhead can be transported upstream of Cowlitz Falls Dam to advance the restoration of steelhead to the Upper Cowlitz Subbasin, and support harvest opportunities in the subbasin. However, an excess of hatchery-origin steelhead returning to the Barrier Dam Adult Facility can have indirect effects on the viability of the natural-origin population. While an overabundance of hatchery-origin steelhead could result in overcrowding in the Upper Cowlitz Subbasin if holding areas are limited, current abundance levels are low. In addition, the increased natural smolt production afforded by hatchery-origin adults spawning in nature will continue to be needed until the abundance of natural-origin spawners are sufficient to maintain a self-sustaining population.

- **Harvest:** Decreasing the exploitation of natural-origin steelhead would incrementally increase potential natural spawning abundance. Because retention of natural-origin is prohibited in recreational fisheries, impacts are limited to indirect mortality which is likely low. Reducing mortality rates further may be an impractical means of substantially increasing natural-origin abundance. However, an important data gap in ISIT is the harvest rates for natural-origin steelhead, particularly in terminal fisheries. Gaining a clear understanding of harvest impacts on natural-origin Upper Cowlitz Subbasin winter steelhead is valuable, but likely to be low.
- **Proportionate Natural Influence**: We will increase the influence of the natural environment on the Upper Cowlitz Subbasin winter steelhead population by increasing pNOB through the use of an increasing number and proportion of natural-origin broodstock. This will depend on an anticipated increase in the returns of natural-origin

steelhead to the Barrier Dam Adult Facility as the progeny of natural spawning by hatchery-origin adults in the Upper Cowlitz Subbasin return. During the Local Adaptation recovery phase, we will also explore means of decreasing pHOS by increased harvest of hatchery-origin steelhead and/or decreased transports of hatchery-origin steelhead upstream of Cowlitz Falls Dam as natural production increases. During this FHMP period, we will use the HSRG guidelines for pHOS and PNI to assist in evaluating the appropriate management strategies during each recovery phase. In early years of the Integrated Hatchery Program, pHOS has exceeded 0.3, but we expect that as Fish Passage Survival increases, both natural-origin abundance and natural production will quickly increase.

- **Age Composition:** Because all steelhead returning to the Upper Cowlitz Subbasin are handled, the age composition of those transported can be monitored. Summarizing this information into a single analysis and reporting database in the future will be important for evaluating potential effects of releasing early-maturing steelhead for natural production in the Upper Cowlitz Subbasin.

6.2.6.3. *Monitoring and Evaluation (M&E) and Research*

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Monitoring

Baseline studies are required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly to track the population’s trajectory and variability and includes the basic data required to operate a one-stage or two-stage life cycle model. To support recovery, monitoring programs need to be rigorous and allow for estimation, with sufficient confidence, of population abundance, as well as to identify ways to improve survival.

Current M&E work for Upper Cowlitz Subbasin winter steelhead is focused on addressing monitoring needs, such as:

- Quantifying the number of smolts produced in the Upper Cowlitz Subbasin.
- Estimating harvest rates of hatchery- and natural-origin steelhead in all fisheries.
- Estimating hatchery- and natural-origin pre-spawn mortality, spawning areas, and natural spawning in the Upper Cowlitz Subbasin.
- Estimating kelt abundance.
- Estimating natural-origin population productivity (spawner-to-spawner).

- Evaluating the ability to differentiate steelhead smolts naturally produced in the Upper Cowlitz Subbasin from those naturally produced in the Tilton River.

Directed Studies

Directed studies are designed to diagnose and solve problems associated with achieving FHMP goals. These studies inform future designs, operations, and fish management strategies that will improve the existing FHMP program so that Settlement Agreement goals can be achieved. Metrics that are most likely to provide the greatest added benefit for the FHMP are currently those for which we do not have good information and, as such, are left out of population assessment methodologies. Without that information, data from another population or conglomerate, which may or may not accurately reflect the current population, must be substituted for a parameter value in a life cycle model. Most of the metrics for the Upper Cowlitz Subbasin winter steelhead in the Big Table Dataset (Appendix A) currently lack information. Conducting directed studies to address metrics that lack data and have a high potential to affect life cycle model sensitivity would be beneficial. Examples of important areas of study include:

- **Spawning ground surveys**: Scales, hatchery-origin/natural-origin ratio, pre-spawn, genetics, spatial distribution (upper extent), and reach-specific adult densities (sub-sample).
- **Juvenile rearing capacity studies:** Available habitat and habitat-specific (run/riffle/pool) densities and juvenile rearing distribution.
- **Early life stage survival studies:** Egg to fry, fry to parr, and parr to smolt survival rates.
- **In-river migratory survival and behavior:** Survival of migrating juveniles and kelts and movement rates.
- **Reservoir survival:** Predation rate.

6.2.7. Summary

- Although functionally extirpated from upstream habitats following completion of Mossyrock Dam, genes from the Upper Cowlitz Subbasin population were incorporated into the Lower Cowlitz Subbasin population, providing the founding stock for recovery.
- Although the ESA framework identifies distinct winter steelhead populations in the Cispus and Upper Cowlitz rivers, returning adults cannot be differentiated by population. Thus, these populations are managed as a combined “Upper Cowlitz Subbasin” population until spawning ground surveys are able to estimate spawner abundance by subbasin.
- Recovery efforts for winter steelhead have focused on transporting natural-origin steelhead returning to the Barrier Dam Adult Facility to the Upper Cowlitz Subbasin. Additionally, hatchery-origin adults from the Integrated Hatchery Program have been transported to the Upper Cowlitz Subbasin to supplement natural spawning and harvest opportunity.
- Historic estimates of Fish Passage Survival for smolts emigrating from the Upper Cowlitz Subbasin have been below Settlement Agreement and Biological Opinion requirements. Improvements are expected to continue.
- Recent abundance estimates of natural-origin adults transported to the Upper Cowlitz Subbasin are well below minimum viability abundance targets. Additional releases of hatchery-origin adults from the Integrated Hatchery Program are needed to increase

natural production in the Upper Cowlitz Subbasin until a self-sustaining population of natural-origin spawners is established.

- Goals for the Upper Cowlitz Subbasin population will prioritize population recovery while still providing harvest opportunity.
- The Upper Cowlitz Subbasin winter steelhead population is currently in the Recolonization phase of recovery, and over the period covered by this FHMP the focus will be on rebuilding abundance of the natural-origin population by maximizing the numbers of steelhead spawning in nature.
- In the near-term (i.e., the period covered by this FHMP), we will:
  - Increase total abundance (both natural- and hatchery-origin) in the Upper Cowlitz Subbasin to advance recovery.
  - Define triggers (i.e., Decision Rules) for moving from one stage of recovery to another (e.g., adult abundance, spatial distribution, Fish Passage Survival) while considering various recovery strategies.
  - Consider improvements to monitoring and evaluation, with an emphasis on key population metrics.
  - Develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:
    - Reduce the use of Lower Cowlitz Subbasin natural origin steelhead for broodstock.
    - Prioritize recovery of the Upper Cowlitz winter steelhead population (Primary population).
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
  - Expand existing hatchery program run-timing to increase fishing opportunities.
  - Develop a naturally timed steelhead program to more closely emulate historic run-timing.
    - Develop a plan for this within 1 year.
      - Minimize conflict with restoration of late-winter run in upper basin
      - Consider hatchery rearing strategies, brood collection techniques/timing and other hatchery management practices to modify run/spawn timing.
    - Define how soon we want this program to begin.
    - Recognize the need for some harvest opportunity.
  - This needs to fit within minimum viability abundance targets and ESA constraints.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

Population: Tilton Subbasin Winter Steelhead
Oncorhynchus mykiss

Distinct Population Segment:	Cascade Winter Steelhead Lower Columbia River Steelhead DPS Lower Columbia River Salmon Recovery Region
ESA Listing Status:	Threatened Listed in 1998, revised 2006, reaffirmed in 2011 and 2016
Population Recovery Designation:	Contributing
Population Viability Rating:	
Baseline	Very Low
Objective	Low
Minimum Viability Abundance Target:	200 natural-origin steelhead spawning in the Tilton Subbasin
Current Recovery Phase:	Recolonization
Current Hatchery Program(s):	Cowlitz Trout Hatchery Late Winter Steelhead Integrated Hatchery Program; 48,500 smolts
Proposed Hatchery Program(s):	Cowlitz Trout Hatchery Winter Steelhead Integrated Hatchery Program; 100,000 smolts

6.3. Winter Steelhead: Tilton Subbasin Population

6.3.1. Purpose

This section describes the current status of the Tilton Subbasin winter steelhead population, based on recent and available data. We will identify VSP metrics needed to evaluate the status of this population with regard to recovery under ESA guidelines. Where appropriate, we propose changes to both hatchery and monitoring programs to facilitate progress toward population recovery and our evaluation of that progress.

The Integrated Hatchery Program began in 2012, using primarily natural-origin broodstock to continue recolonizing the Tilton Subbasin by increasing the abundance of natural-origin spawners. Currently, the number of natural-origin returns appears to be approaching the minimum viability abundance target of 200 spawners in nature. During the period covered by this FHMP, the Integrated Hatchery Program will continue to operate for the recovery of the Tilton Subbasin population and to provide recreational angling and harvest opportunity. Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential recommendations that may follow. The Transition Plan will consider and address how to appropriately size the upper basin, as well as correctly size the Lower Cowlitz Subbasin when appropriate.

Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead

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programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:

- Prioritize recovery of the Upper Cowlitz winter steelhead population (Primary population).
- Reduce the use of Lower Cowlitz Subbasin natural origin steelhead for broodstock.
- Maximize recreational/harvest opportunity by adjusting Lower Cowlitz Subbasin winter-run Integrated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
- Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
- Expand existing hatchery program run-timing to increase fishing opportunities.
- Develop a naturally timed steelhead program to more closely emulate historic run-timing.
    - Develop a plan for this within a year.
        - Minimize conflict with restoration of late-winter run in upper basin.
        - Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run/spawn timing.
    - Define how soon we want this program to begin.
    - Recognize the need for some harvest opportunity.
- This needs to fit within minimum viability abundance targets and ESA constraints.

We will develop specific criteria needed to determine when the population has moved from the Recolonization phase to the Local Adaptation phase and will continue to evaluate the hatchery program and fisheries management and make refinements or adjustments, as needed to effectively supplement and manage the Tilton Subbasin population.

6.3.2. Population Description

The Tilton Subbasin winter steelhead population includes all natural-origin winter steelhead that occupy the Tilton Subbasin and its tributaries (Figure 6.3-1). The completion of Mayfield Dam in 1963 eliminated volitional passage into the Tilton Subbasin, but trap-and-haul continued until 1980 when transportation of steelhead to the Tilton Subbasin was discontinued to protect the downstream hatchery programs from potential disease impacts. The lower Cowlitz River winter steelhead population has persisted and has been used as the genetic source for reintroductions of steelhead to the Tilton Subbasin. The Tilton Subbasin winter steelhead population was listed as threatened in 1998 under the ESA as part of the lower Columbia River DPS. NMFS (2016) reaffirmed the threatened status of the DPS, which remains at “moderate risk” of extinction. The Tilton Subbasin winter steelhead population is classified as a Contributing population for recovery of the lower Columbia River DPS and must attain some improvement toward its minimum viability abundance targets for the DPS to be considered recovered (WDFW and LCFRB 2016).

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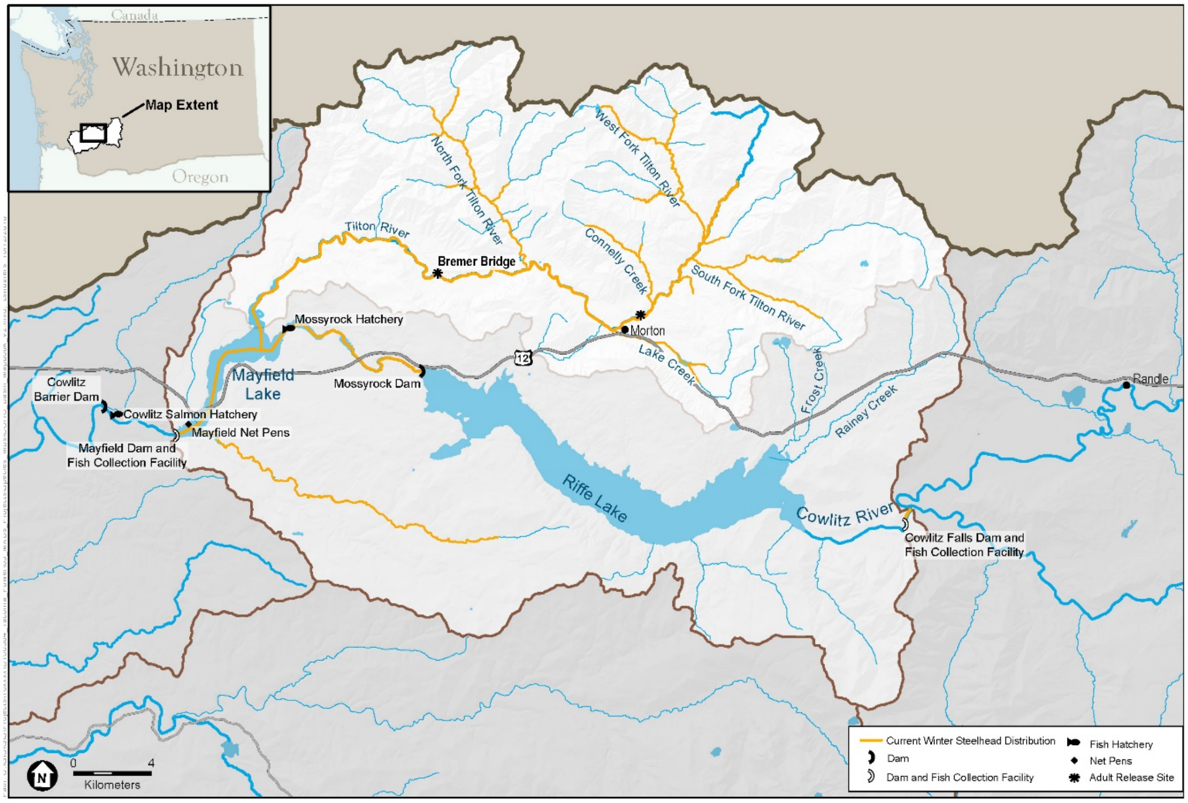

Figure 6.3-1. Distribution of winter steelhead in the Tilton Subbasin.

6.3.3. Natural Production

The primary metric that Tacoma Power is responsible for is dam passage survival of steelhead smolts passing Mayfield Dam. Two other critical monitoring metrics for steelhead management are the numbers that return at maturation and their disposition (Figure 6.3-2; Table 6.3-1). Tilton Subbasin winter steelhead that survive to maturity may be harvested in commercial, sport, or tribal fisheries in the ocean or impacted through indirect mortality in the Columbia River commercial harvest. Those escaping harvest may return to the Barrier Dam Adult Facility or remain on the natural spawning grounds in the Lower Cowlitz Subbasin. Natural-origin winter steelhead from the Tilton Subbasin that are collected at the Barrier Dam Adult Facility may be retained for broodstock or transported to the Tilton Subbasin for release, along with some hatchery-origin winter steelhead, where they may suffer indirect mortality in sport fisheries, die prior to spawning from predation or disease, or survive to spawn naturally. Monitoring these dispositions allows us to evaluate population health, productivity, and progress toward recovery.

6.3.3.1. Abundance

The minimum viability abundance target for the Tilton Subbasin winter steelhead population is an annual abundance of 200 adult natural-origin steelhead spawning in nature (LCFRB 2010). Only natural-origin winter steelhead that were released into the Tilton Subbasin and survive to spawn are counted toward the minimum viability abundance target.

Table 6.3-1. Mean, minimum, and maximum numbers of all hatchery- and natural-origin winter steelhead from the Tilton Subbasin population that could be accounted for at recovery locations 2012-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

Origin and Recovery Location	Mean	Minimum	Maximum
Hatchery-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Data Not Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz River harvest		Data Not Available	
Tilton Subbasin harvest		Data Not Available	
Total Return to Cowlitz River[3]		Not All Data Are Available	
Return to Barrier Dam Adult Facility[4]	63	0	195
Collected for Broodstock	3	0	11
Transported to Tilton Subbasin	60	0	186
Remain in Tilton Subbasin		Data Not Available	
Natural-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Data Not Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz River harvest		Data Not Available	
Tilton Subbasin harvest		Data Not Available	
Total Return to Cowlitz River[3]		Not All Data Are Available	
Return to Barrier Dam Adult Facility[4]	362	184	500
Collected for Broodstock	49	32	61
Transported to Tilton Subbasin	313	152	445
Remain in Tilton Subbasin		Data Not Available	
Combined Hatchery- and Natural-origin			
Total Run[1]		Not All Data Are Available	
Harvest[2]		Data Not Available	
Ocean harvest		Data Not Available	
Columbia River harvest		Data Not Available	
Lower Cowlitz River harvest		Data Not Available	
Tilton Subbasin harvest		Data Not Available	
Total Return to Cowlitz River[3]		Not All Data Are Available	
Return to Barrier Dam Adult Facility[4]	425	218	581
Collected for Broodstock	52	43	61
Transported to Tilton Subbasin	373	175	528
Remain in Tilton Subbasin		Data Not Available	

1 Sum of all harvest below Barrier Dam plus numbers returning to Barrier Dam Adult Facility.
2 Total of harvest in ocean, Columbia River, Lower Cowlitz Subbasin, and Tilton Subbasin fisheries.
3 Sum of Lower Cowlitz Subbasin harvest plus number returning to Barrier Dam Adult Facility.
4 Sum of numbers collected for broodstock plus numbers transported to Tilton Subbasin.
5 ISIT data for numbers transported to Tilton Subbasin exceeded numbers reported for hatchery returns, so unpublished data from Tacoma Power were used for numbers transported.

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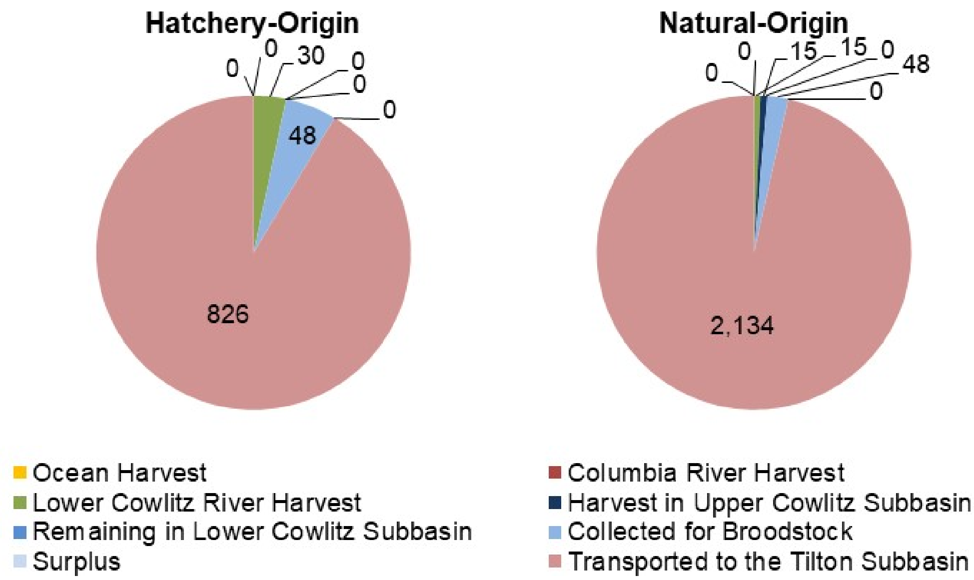

Figure 6.3-2. Mean numbers and proportions of hatchery- and natural-origin Tilton River winter steelhead caught in non-ocean fisheries, collected for broodstock (natural-origin), transported to the Tilton River, or returned to Barrier Dam Adult Facility (comprised of hatchery broodstock and hatchery surplus), 2013-2017. Note: All natural-origin winter steelhead that returned to Barrier Dam Adult Facility are assumed to be either Tilton River (no CWT) or Upper Cowlitz Basin (CWT) because those caught at the hatchery are assumed to have come from populations upstream of Mayfield Dam. Data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete

Monitoring data for the Tilton Subbasin winter steelhead population have been sporadically collected and may not be complete. Although the total number of adult steelhead transported and released in the Tilton Subbasin is accurately and precisely known, estimates of total natural-origin steelhead for the population are subject to error associated with: (1) spawning in the Lower Cowlitz Subbasin of unmarked steelhead that originated from the Tilton Subbasin; (2) the potential collection, transport, and release into the Tilton Subbasin of unmarked steelhead that originated from the Lower Cowlitz Subbasin that are assumed to have originated from upstream of Mayfield Dam; and (3) any collection, transport, and release into the Tilton Subbasin of unmarked steelhead that originated from outside the Cowlitz Basin.

Data are also unavailable for harvest of Tilton Subbasin winter steelhead in the ocean and Columbia River fisheries, so it is not possible to develop an accurate estimate of total run size or returns to the Cowlitz River. Returns to the Barrier Dam Adult Facility offer a relative indication of total abundance; from 2012-2017, a mean of 362 natural-origin Tilton Subbasin winter steelhead returned to the Barrier Dam Adult Facility (Figure 6.3-2; Table 6.3-1).

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6.3.3.2. Harvest

Tilton Subbasin winter steelhead that survive to maturity may be impacted through indirect mortality in commercial, sport, or tribal fisheries in the ocean or Columbia River commercial harvest.

6.3.3.3. Disposition

From 2012-2017, an annual mean of 313 natural-origin adults collected at the Cowlitz Barrier Dam Adult Facility were transported and released in the Tilton Subbasin (Figure 6.3-3; Table 6.3-1). It is unclear what percentage of the total Tilton population run size these steelhead comprise, but of those natural-origin returns to the Barrier Dam Adult Facility, a mean of 86% were transported upstream to the Tilton Subbasin. The remainder of the natural-origin fish were transferred to broodstock.

6.3.3.4. Spawning in Nature

Because the total run size cannot currently be estimated, the number of natural-origin steelhead returning to the Barrier Dam Adult Facility offers the best indication of total natural adult production. These steelhead are either collected as broodstock for the Integrated Hatchery Program or transported to the Tilton Subbasin. From 2012-2017, a mean of 362 natural-origin winter steelhead from the Tilton Subbasin population returned to the Barrier Dam Adult Facility (Figure 6.3-2; Table 6.3-1).

6.3.3.5. Smolt Production

From 2013-2017, a mean of 7,419 winter steelhead juveniles were captured at the Mayfield Dam Juvenile Collection Facility, which captures juveniles from the Tilton Subbasin. Productivity can be estimated by assuming a capture efficiency of 67% and turbine survival of 83% (Steig et al. 2014) for a mean of 10,452.

6.3.3.6. Natural-origin Survival and Productivity

Survival and productivity are the key metrics for monitoring populations. However, neither SAR nor productivity have been calculated for the Tilton Subbasin winter steelhead population because smolt abundance estimates are imprecise, and returns have not been documented by age in a single consolidated database. As a result, full run reconstruction of each brood year is not presented here, and actual numbers of spawners in nature are unknown. However, recent modifications in marking strategies will make estimation possible for future returns.

6.3.3.7. Age Composition

For run years 2012-2017, ISIT data indicate that only adult steelhead (i.e., no jacks) were transported upstream of Mayfield Dam. Because scale data for Tilton River steelhead have not been analyzed, we have not reconstructed the returns by brood year at this time. During this FHMP period, it will be necessary to develop a single consolidated data source to analyze this question.

Figure 6.3-3. Estimated total run size for adult natural-origin Tilton Subbasin winter steelhead and the numbers that returned to the Cowlitz River, were harvested, returned to Barrier Dam Adult Facility, or were transported to the Tilton Subbasin, 2012-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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6.3.4. Hatchery Production

Hatchery production metrics must be monitored to ensure that production goals are met, evaluate the effectiveness of the program, and to understand the magnitude of hatchery influence on the natural population (see Section 6.0.9).

Winter steelhead were reintroduced to the Tilton Subbasin in 1994 in conjunction with the upper Cowlitz reintroduction project, relying on the Lower Cowlitz Subbasin Late-Winter Steelhead Segregated Hatchery Program as the brood source. Following the 2011 FHMP, the Tilton Subbasin winter steelhead Integrated Hatchery Program was initiated. Beginning in 2012, natural-origin winter steelhead that originated from the Tilton Subbasin and returned to the Barrier Dam Adult Facility were incorporated into the broodstock and supplemented with minimal hatchery-origin broodstock, as needed (i.e., 2015 and 2017). From 2012-2017, broodstock spawned to support this program have consisted of means of 45 natural-origin and 3 hatchery-origin steelhead annually (Table 6.3-2).

Table 6.3-2. Mean, minimum, and maximum hatchery and natural spawning metrics for Tilton Subbasin winter steelhead, 2012-2017 spawn/brood years. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

	2012-2017 Run Years		
Spawning Location, Metric	Mean	Minimum	Maximum
Hatchery Spawning			
Mature Steelhead Collected	52	43	61
Hatchery-origin	3	0	11
Natural-origin	49	32	61
Mature Steelhead Spawned	48	41	58
Hatchery-origin	4	0	11
Natural-origin	45	31	58
Pre-spawn Survival Rate	92%	86%	98%
Total Green Eggs	Data Not Available		
Mean Fecundity	Data Not Available		
Mean Fertility	Data Not Available		
Total Eyed Eggs	Data Not Available		
Smolts Released[1]	43,812	40,030	52,292
Green Egg-to-Smolt Survival	71%	60%	77%
Smolt Productivity (smolts / spawner)[1]	900	776	1,046
Natural Spawning			
Spawners	Data Not Available		
Hatchery-origin	Data Not Available		
Natural-origin	Data Not Available		
Smolts Produced	Data Not Available		
Smolt Productivity (smolts / spawner)	Data Not Available		

1 Brood years 2012-2016.

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Since 2012, the goal of the Integrated Hatchery Program has been to produce approximately 48,500 smolts annually that are marked (adipose and left-ventral clip) as the F1 progeny of natural-origin broodstock. These smolts are reared at Cowlitz Trout Hatchery and directly released into the lower Cowlitz River to avoid losses from transiting Mayfield Lake and Dam. In addition to these hatchery-origin returns, unmarked natural-origin adults returning to the hatchery that are in excess of broodstock needs are also transported and released into the Tilton River.

6.3.4.1. Abundance

As noted above under *Natural Production*, data used to monitor the Tilton Subbasin winter steelhead population have been only sporadically collected and are incomplete. Additionally, data are unavailable for harvest of Tilton Subbasin winter steelhead in the ocean and Columbia River fisheries, so it is not possible to develop an accurate estimate of total run size or returns to the Cowlitz River. Returns to the Barrier Dam Adult Facility offer a relative indication of total abundance; from 2012-2017, a mean of 63 hatchery-origin[1] Tilton Subbasin winter steelhead returned to the Barrier Dam Adult Facility (Figure 6.3-2; Table 6.3-1).

6.3.4.2. Harvest

Tilton Subbasin winter steelhead may be harvested in commercial, sport, or tribal fisheries in the Pacific Ocean, lower Columbia River, and within the Cowlitz Basin. While harvest numbers for hatchery-origin steelhead are provided in ISIT, the fishery in which these steelhead were harvested is unclear. Over the 2012-2017 period, an annual mean of 60 hatchery-origin winter steelhead were transported and released in the Tilton Subbasin. However, this practice only began in 2015, after the hatchery-origin progeny from the initial brood year of the Integrated Hatchery Program returned as mature steelhead. Given the small number of hatchery-origin broodstock, most (95%) of the hatchery-origin Tilton Subbasin winter steelhead returning to the Barrier Dam Adult Facility are transported and released in the Tilton Subbasin (Figure 6.3-2; Table 6.3-1). Hatchery-origin steelhead transported to the Tilton Subbasin are available for harvest, and those that survive may spawn naturally.

6.3.4.3. Disposition

Excluding the small number used as broodstock in some years, hatchery-origin Tilton Subbasin winter steelhead returning to the Barrier Dam Adult Facility are transported to the Tilton Subbasin to supplement natural spawning and provide harvest opportunities.

6.3.4.4. Hatchery Spawning

As with natural-origin returns, estimates of the total run size for hatchery-origin Tilton Subbasin winter steelhead are hindered by the lack of harvest data below Mayfield Dam. The number of hatchery-origin steelhead returning to the Barrier Dam Adult Facility offers the best indication of run size. From 2012-2017, a mean of 63 hatchery-origin Tilton Subbasin winter steelhead returned to the Barrier Dam Adult Facility. A mean of 3 were collected for broodstock, while the remainder were transported and released in the Tilton Subbasin (Table 6.3-1).

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[1] For the purposes of this section, hatchery-origin Tilton Subbasin winter steelhead consist of those collected for broodstock at the Barrier Dam Adult Facility or transported to the Tilton Subbasin; ISIT does not distinguish Tilton Subbasin winter steelhead returns to the Barrier Dam Adult Facility by origin, but the data are available in Tacoma Power datasets.

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6.3.4.5. Hatchery Rearing

From 2012-2017, a mean of 17 females were spawned annually to support the Integrated Hatchery Program. Neither the number of green nor eyed-eggs are readily available at this time so fecundity and fertility have not been calculated here. From brood years 2012-2016, a mean of 43,812 smolts were released in 2013-2017. Mean green egg-to-smolt survival for brood years 2012-2016 was 71% and mean smolt productivity was 900 smolts/spawner.

6.3.4.6. Age Composition

For run years 2012-2017, ISIT data indicate that only adult steelhead (i.e., no jacks) were transported upstream of Mayfield Dam. Because we do not have scale data for Tilton River winter steelhead, we cannot reconstruct the returns by brood year.

6.3.5. Proportionate Natural Influence

PNI is an index of the influence that the natural population has on an integrated salmon population as a whole. Changes in PNI can indicate an increase or decrease in the effect of hatchery-origin steelhead on the natural population and an increase or decrease in the influence of the natural population on the hatchery program.

To reduce the effect of hatchery supplementation on the natural population that it supplements, we will try to maximize the percentage of natural-origin steelhead in the hatchery broodstock and minimize spawning by hatchery-origin steelhead in nature during the Local Adaptation phase of recovery. Absent spawning survey data, the best approximation of pHOS is based on the number of steelhead transported to the Tilton Subbasin, minus the number removed through harvest. This approach fails to account for other losses, such as fallback, predation, and pre-spawn mortality, and is also constrained by the lack of sport-fishery indirect mortality data for natural-origin steelhead in the Tilton Subbasin. Nonetheless, the resulting estimate of mean pHOS, based on the number of hatchery-origin and natural-origin fish transported, for 2012-2017 was 0.16. During the Recolonization phase of recovery, this has been below the HSRG guideline of <0.3 for a Contributing population with an integrated hatchery program. Hatchery-origin adults were not transported to the Tilton Subbasin until 2015; pHOS from 2015-2017 ranged from 0.13-0.35 with a mean of 0.26.

Given the known hatchery broodstock contribution for both natural- and hatchery-origin steelhead, pNOB can be more accurately quantified. From 2012-2017, mean pNOB was 0.95, which exceeds the HSRG guideline of pHOS for a Contributing population with an integrated hatchery program. However, hatchery-origin steelhead were not incorporated into the broodstock until the first progeny from the initial brood year of the Integrated Hatchery Program returned as mature steelhead in 2015. From 2015-2017, pNOB ranged from 0.74-1.00 with a mean of 0.86, still consistently well above the HSRG guideline.

6.3.6. Future Management

The Tilton Subbasin winter steelhead population is designated as a Contributing population for achieving MPG and DPS recovery goals, with a minimum viability abundance target of 200 natural-origin spawners in nature. Population viability was rated as Very Low to Low (LCFRB 2010, WDFW and LCFRB 2016), but natural-origin abundance has improved, with a mean of 362 natural-origin Tilton Subbasin winter steelhead returning to the Barrier Dam Adult Facility from 2012-2017 (ranging from 184-500). Although the number of natural-origin steelhead spawning in nature is not estimated, a mean of 313 natural-origin adults are

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transported to the subbasin annually, indicating that abundance has approached or exceeded the minimum viability abundance target of 200 natural-origin spawners in nature (LCFRB 2010). Likewise, since the Integrated Hatchery Program began transporting and releasing hatchery-origin adults in the Tilton Subbasin in 2015, pHOS has been below the HSRG guideline of pHOS <0.3 in 2 of the 3 years (2015 pHOS = 0.35) during this Recolonization phase of recovery. Because the Integrated Hatchery Program has used primarily natural-origin broodstock, natural influence on the population is high.

Because this population appears close to achieving HSRG guidelines for hatchery influence, we will focus on refining monitoring efforts to validate this assumption (i.e., spawner surveys and estimates of harvest and strays). This will require establishing criteria to transition to the Local Adaptation recovery phase of this population. In addition, to replace the proposed reduction in Lower Cowlitz Subbasin hatchery production and maintain harvest opportunity both below Mayfield Dam and in the Tilton Subbasin, we will develop a Transition Plan to evaluate increases in hatchery production to 100,000 smolts annually.

6.3.6.1. Goals for Conservation, Recovery, and Harvest

Progress toward achieving conservation goals and minimum viability abundance targets is evaluated through monitoring of standard fisheries management metrics (Table 6.3-3; Appendix A, Big Table Dataset). The Tilton Subbasin winter steelhead population had an historical abundance of about 1,700 steelhead. In 2010, the abundance and productivity of this population were rated as Very Low (LCFRB 2010). Today, natural-origin abundance has increased compared to when the Recovery Plan (LCFRB 2010) was drafted (i.e., <50). However, adults access the Tilton Subbasin through transport and release, rather than volitionally, and only that portion handled at the Mayfield Dam juvenile facility possess unique marks/tags identifying their origin. This increases the potential for overestimating the abundance of Tilton Subbasin returns. Likewise, although pHOS is currently thought to be low based on numbers transported to the subbasin, rates of harvest, pre-spawn mortality, and natural spawning of both hatchery- and natural-origin steelhead in the Tilton Subbasin are unknown. As production increases, goals for the number of hatchery-origin adults released in the Tilton Subbasin will be assessed relative to the number of natural-origin returns and the results of monitoring efforts to ensure that pHOS remains low. Opportunities for recreational/ harvest will be maximized by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.

- **Long-term Goals:** The goal for this Contributing winter steelhead population is full recovery in the Tilton Subbasin, which would include, but not be limited to:
  - Establishment of clear targets for establishing that Full Recovery has been achieved.
  - Establish clear goals for defining a harvestable population of winter steelhead in the Tilton Subbasin.
  - Maintaining minimum adult abundance of >200 natural-origin winter steelhead spawning in nature.
  - Continued support of recreational harvest opportunity.

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Table 6.3-3. Recovery phase targets for Tilton Subbasin winter steelhead.

Species:	Winter Steelhead
Population Name:	Tilton Subbasin
Recovery Designation:	Contributing
Current Recovery Phase:	Recolonization

Target Metric	RECOVERY PHASE Preservation	Recolonization	Local Adaptation	Fully Recovered	Last 5 Years
Natural Production					
Natural-origin Spawners in Nature	TBD[1]	TBD[1]	TBD[1]	TBD[1]	319[2]
Smolt Abundance (below hatchery)	TBD	TBD	TBD	TBD	N/A
Smolt Passage Survival	0.97	0.97	0.97	0.97	0.97
Productivity (5-year mean)	>1	>1	>1	>1	N/A
Hatchery Production					
Type of Hatchery Program	Seg	Seg/Int	Int	Int	N/A
Broodstock to be Collected					
Integrated Hatchery Program	32	64	64	64	52
Hatchery-Origin	16	16	0	0	4
Natural-Origin	16	48	64	64	48
Segregated Hatchery Program	0	0	0	0	0
Smolts to be Produced					
Integrated Hatchery Program	50,000[3]	100,000	100,000	100,000	43,812
Segregated Hatchery Program	0	0	0	0	N/A
Total Smolt-to-Adult Survival	TBD	TBD	TBD	TBD	N/A
Proportionate Natural Influence					
pHOS (<)					
Total	0.3	0.3	0.3	0.3	0.15[2]
Integrated Hatchery Program	0.3	0.3	0.3	0.3	0.15[2]
Segregated Hatchery Program	N/A	N/A	N/A	N/A	N/A
pNOB (>)	1	1	1	1	0.91
PNI (>)	0.5	0.5	0.5	0.5	0.87[1]
Max % of Natural-Origin Return to Barrier Dam Adult Facility Collected for Broodstock	30%	30%	30%	30%	14%

[1] No minimum viability abundance target has been set for these populations; targets will be set during the period covered by this FHMP in coordination with the FTC.

[2] Based on numbers transported.

[3] From WDFW and LCFRB (2016).

N/A – not available.

- **FHMP Goals:** The goals for the program during the period covered by this FHMP are attainable steps toward population recovery, focusing on increasing abundance of, and reducing hatchery influence on, the natural-origin Tilton Subbasin winter steelhead population based on the following:
  - Within 1 year following completion of this FHMP, develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:
    - Reduce the use of Lower Cowlitz Subbasin natural-origin steelhead for broodstock.
    - Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
  - Establish clear goals for defining a harvestable population of winter steelhead in the Tilton Subbasin.
  - Define the disposition of surplus steelhead and management strategies for high and low return years.
  - Emphasize key population monitoring and VSP metrics:
    - Abundance, population growth rate, productivity, spatial structure, and diversity.
    - Numbers returning to the Cowlitz River.
    - Numbers of natural-origin steelhead returning to the Barrier Dam Adult Facility.
    - Census numbers of mature natural- and hatchery-origin steelhead transported and released in the Tilton Subbasin.
    - Estimates of the numbers of natural- and hatchery-origin steelhead spawning in nature in the Tilton Subbasin.
    - Census numbers of hatchery-origin and natural-origin adults spawned in hatchery broodstock.
    - Estimates of harvest rates.
  - Improve monitoring, evaluation, and data collection, and/ or estimation methods (including numbers and age, sex, and origin of recoveries):
    - Dam passage survival, including survival by route.
    - Estimate the proportion of route use at Mayfield Dam by based on management needs.
    - Natural smolts produced.

- Returning to the Barrier Dam Adult Facility.
- Retained as broodstock.
- Transported and released upstream of Mayfield Dam.
- Hatchery surplus.
- Hatchery strays to/from outside of the Cowlitz Basin.
- Actual spawners in nature.

o Transition to Local Adaptation.

6.3.6.2. Management Targets

Based on available data, the Tilton Subbasin winter steelhead population appears to be approaching minimum viability abundance targets for natural-origin abundance and hatchery influence since the initiation of the Integrated Hatchery Program. However, key uncertainties remain regarding the contribution of natural-origin strays from the Lower Cowlitz Subbasin or other downstream populations and the actual number of hatchery and natural-origin adults spawning in nature. To meet conservation goals and retain or expand harvest opportunity in the subbasin, we will refine our M&E Program such that key metrics are monitored to evaluate program performance.

- **Natural Production:** The goal of the Settlement Agreement is to recover self-sustaining, naturally reproducing populations to harvestable levels. Efforts to improve downstream dam passage survival continue and recruitment from natural production will increase with the success of these efforts. Counts of adult steelhead transported to the Tilton Subbasin are reliable, but we are not certain that all natural-origin steelhead transported to the Tilton Subbasin originated there. In addition, pre-spawn mortality (a critical measure for estimating natural production) has not been estimated for steelhead (both hatchery- and natural-origin) spawning in nature, so actual pHOS is unknown. As part of this FHMP, Tacoma Power will develop and begin to implement an M&E Program for consideration by the FTC and agencies that is focused on evaluating program effectiveness based on regionally accepted VSP parameters and NOAA Monitoring Guidance (Crawford and Rumsey 2011).

  We will continue the Integrated Hatchery Program, relying on 100% natural-origin broodstock, as available, while also continuing to transport and release both natural- and hatchery-origin adults in the Tilton Subbasin in numbers that are consistent with meeting established targets for hatchery influence on the population. Criteria will be developed during this FHMP period related to transitioning to the Local Adaptation phase of recovery.

  o **Abundance – Transport and Natural Spawning:** The population appears to be approaching the minimum viability abundance target of 200 natural-origin spawners. We will focus our monitoring of abundance on the numbers of hatchery- and natural-origin winter steelhead that return to the Cowlitz River, to the Barrier Dam Adult Facility, transported to the Tilton River, and on estimates of actual spawners in nature.

  o **Smolts Produced in Nature:** Natural-origin smolt production from the Tilton Subbasin is currently estimated from smolts handled at Mayfield Dam Counting House. Steelhead smolts are collected throughout Mayfield Dam's entire operational window of April-December; however, most of the smolts are collected from April-June. A mean of 5% are collected in April, 60% in May, 33% in June, and the remaining 2% in July – December (years 2012-2019). Total annual smolt collection from 2012-2019 ranged from 5,555 in 2012 to 11,152 in 2015, with an annual mean total of 7,018. During this FHMP period, this information will be evaluated in conjunction with historic fish guidance efficiency to estimate the total number of smolts produced. When combined with estimates of spawners, this information will be used for evaluating habitat capacity, and population viability as reintroduction of steelhead to the Tilton River continues.

- **Smolt-to-Adult Survival:** Smolt abundance will be estimated during this FHMP period using data available from fish handled at the Counting House, and available data from natural-origin/hatchery-origin broodstock for age to estimate SAR. This metric is important to understanding key limiting factors for the Tilton population and we will monitor this index through our M&E Program.
- **Productivity (Adult Recruits/Spawner):** Productivity (mature natural-origin F_1 recruits / F_0 spawner) is the primary metric for monitoring natural populations, so collection of the necessary data is critical. We will monitor this index as the data become available through our M&E Program.

- **Hatchery Production:** During recovery efforts to date, hatchery influences on the Tilton Subbasin population have consisted of the transport and release of hatchery-origin adults to spawn naturally (mean pHOS = 0.13) and the use of some hatchery-origin broodstock to supplement natural-origin broodstock (mean pNOB = 0.93), resulting in a mean PNI of 0.89. During this Recolonization phase of recovery, returns of natural-origin adults have exceeded returns of hatchery-origin adults, these metrics of hatchery influence are within minimum viability abundance targets and natural influence on the Upper Cowlitz Subbasin population is high.

  Within 1 year following completion of this FHMP, Tacoma Power and the FTC will develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin. During this period, we plan to increase production of the Integrated Hatchery Program to 100,000 smolts annually. This increase in production is intended to offset the proposed reduction in hatchery smolts produced in the Lower Cowlitz Subbasin so that harvest opportunity is maintained in both the Lower Cowlitz and Tilton subbasins. Achieving this goal would require additional egg take, which would be accomplished through the continued use of similar numbers of natural-origin broodstock in addition to an increased number of hatchery-origin broodstock.

  We will develop and implement a sampling and monitoring program, along with a single consolidated analysis and reporting database for the hatchery program, to allow the managers to better evaluate and manage the hatchery programs. Guidance for the numbers of broodstock to be collected, by week, origin, age, and sex, will be determined at the Annual Program Review meeting and documented in the Annual Operating Plan (see Chapter 12). The collection schedule will be based on the smolt production needs of each program and the most recent 5-year means of pre-spawn mortality, fecundity, fertility, hatching rates, and survival rates from hatching-to-swim-up fry, fry-to-parr (at marking), and parr-to-smolt survival rates. Improved monitoring of returns will also be needed to estimate stray and smolt-to-adult survival and return rates and evaluate the hatchery programs.

  Hatchery-origin steelhead returning to the Barrier Dam Adult Facility are transported and released into the Tilton Subbasin for harvest and to supplement natural production, along with natural-origin steelhead collected at the hatchery that are transported into the

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Tilton Subbasin. It will also be important to monitor these releases and determine the numbers of steelhead that survive to spawn in their respective release locations.

- **Harvest:** Decreasing the harvest of natural-origin steelhead would incrementally increase potential natural-origin spawning abundance. Because retention of natural-origin steelhead is prohibited in recreational fisheries, impacts are limited to indirect mortality, which is likely low. Reducing mortality rates further may be an impractical means of substantially increasing natural-origin abundance. However, an important data gap in ISIT is the harvest/exploitation rates for natural-origin steelhead, particularly in terminal fisheries. Gaining a clear understanding of harvest impacts on natural-origin Tilton Subbasin steelhead is valuable, but likely to be low.
- **Proportionate Natural Influence:** The Integrated Hatchery Program is intended to prioritize recovery of the indigenous Tilton Subbasin population while still providing for harvest opportunity. Harvest opportunity in the Tilton Subbasin is controlled by the number of hatchery-origin adults transported and released in the subbasin. Increases in this number will require careful management to ensure that pHOS remains below the established threshold. This can be accomplished by either concomitant increase in the number of natural-origin spawners in the subbasin, or by managing harvest to ensure that the number of hatchery-origin spawners remains below a critical level.
- **Age Composition:** Because all steelhead returning to the Tilton Subbasin are handled at the Barrier Dam Adult Facility, the age composition of those transported can be monitored. ISIT reports only “adult” steelhead being transported upstream of Mayfield Dam, but the age composition of these steelhead is not provided. Collecting and characterizing this information in a single consolidated database in the future will be important for evaluating potential effects of releasing early maturing steelhead for natural production in the Tilton Subbasin.

6.3.6.3. Monitoring and Evaluation (M&E) and Research

Each year, monitoring and evaluation efforts will be focused on two areas. First, baseline evaluations will be used to inform population progress toward minimum viability abundance targets, including how closely the Settlement Agreement goals are being achieved under varying conditions. Second, directed studies are designed to diagnose problems identified from baseline information and inform critical data gaps that are inhibiting managers from effectively moving a population from one recovery phase to the next.

In each year, all efforts will be considered for their value in evaluating population viability and progress toward recovery during the current recovery phase. Consideration for how the parameter will be used to affect programmatic outcomes, uncertainty about the parameter, the amount of time it takes to collect data to characterize it, and the cost of gathering this information will all be considered. Each year, it will be necessary to prioritize information that is most critical to inform programmatic decisions while balancing these considerations.

Baseline Studies

Baseline studies are those required to adequately monitor a population so that we can effectively manage it. Baseline monitoring is conducted regularly in order to track the population’s trajectory and variability and includes the basic data required to operate a one-stage or two-stage life cycle model. Baseline studies for this population will focus on addressing monitoring needs, such as:

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- Estimating harvest rates of hatchery- and natural-origin steelhead in all fisheries.
- Estimating hatchery- and natural-origin pre-spawn mortality, spawning areas, and natural spawning in the Tilton Subbasin.
- Identifying the source of natural-origin returns to the hatchery trap.
- Estimating pHOS and pNOB.
- Estimating natural-origin population productivity (spawner-to-spawner).
- Quantifying the number of smolts produced in the Tilton Subbasin.
- Evaluating the ability to differentiate steelhead smolts naturally produced in the Upper Cowlitz Subbasin from those naturally produced in the Tilton River.

Directed Studies

Directed studies are designed to diagnose and solve problems associated with achieving FHMP goals and to fill management needs and information gaps in the Big Table Dataset (Appendix A). Examples of important areas of study for the Tilton Subbasin winter steelhead population include:

- **Juvenile rearing capacity studies:** Available habitat and habitat-specific (run/riffle/pool) densities and juvenile rearing distribution.
- **Early life stage survival studies:** Egg-to-fry, fry-to-parr, and parr-to-smolt survival rates.
- **In-river migratory survival and behavior:** Survival of migrating juveniles and kelts and movement rates.
- **Reservoir survival:** Predation rate and parasite loadings.

6.3.7. Summary

- Although functionally extirpated in 1980 to protect the hatchery complex from diseases, Tilton Subbasin winter steelhead population genes were incorporated into the Lower Cowlitz Subbasin population, providing the founding stock for recovery.
- The Integrated Hatchery Program began in 2012, in which natural-origin winter steelhead returning to the Barrier Dam Adult Facility are collected and used as broodstock, with little or no use of hatchery-origin steelhead broodstock. Both natural-origin returns in excess of broodstock requirements, and hatchery-origin returns that are the F_1 progeny of natural-origin broodstock are released in the Tilton Subbasin.
- Abundance is approaching the minimum viability abundance target based on natural-origin returns to the Barrier Dam Adult Facility and the numbers transported to the Tilton Subbasin.
- Uncertainties in assessing progress toward minimum viability abundance targets include:
    - All untagged natural-origin returns to the Barrier Dam Adult Facility are assumed to belong to the Tilton Subbasin population, but the proportion that may be unmarked strays from the Lower Cowlitz Subbasin still needs to be estimated under the current tagging scheme for further analysis of route-specific dam passage survival estimates.

- Spawner surveys are not conducted in the Tilton Subbasin, so the numbers that actually spawn are unknown. Numbers transported and released in the Tilton Subbasin do not account for factors such as pre-spawn mortality, harvest, or fallback.

- In the near-term (i.e., this FHMP), we will:
  - Increase and improve monitoring, evaluation, and data collection, with an emphasis on key population metrics including dam passage survival and the number, age, sex, and origin of all recoveries.
  - Within 1 year following completion of this FHMP, develop a Transition Plan that evaluates the potential for modifying hatchery winter steelhead programs in both the Upper and Lower Cowlitz subbasins and adult release strategies in the Upper Cowlitz Subbasin, including potential strategies to:
    - Reduce the use of Lower Cowlitz Subbasin natural-origin steelhead for broodstock.
    - Prioritize recovery of the Upper Cowlitz Subbasin winter steelhead population (Primary population).
    - Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter-steelhead programs within FERC license, ESA, and facility constraints.
    - Explore the possibilities for expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter run steelhead program to more closely emulate historic run-timing of winter steelhead in the basin.
  - Expand existing hatchery program run-timing to increase fishing opportunities.
  - Develop a naturally timed steelhead program to more closely emulate historic run-timing.
    - Develop a plan for this within a year.
      - Minimize conflict with restoration of late-winter run in upper basin.
      - Consider hatchery rearing strategies, brood collection techniques/timing, and other hatchery management practices to modify run/spawn timing.
    - Define how soon we want this program to begin.
    - Recognize the need for some harvest opportunity.
  - This needs to fit within minimum viability abundance targets and ESA constraints.
  - Maintain flexibility to increase production within FERC licensing, ESA, and basin constraints. Additional returning hatchery-origin adults will require increased harvest management to manage for high return years.
  - Define the disposition of surplus salmonids and management strategies for high and low return years.
  - Define triggers (i.e., Decision Rules) for moving from one stage of recovery to another (e.g., adult abundance, spatial distribution, dam passage survival) while considering various recovery strategies.

- This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. The summary matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period. The summary matrix is intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

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CHAPTER 7:
SUMMER STEELHEAD

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Summer Steelhead *Oncorhynchus mykiss*

ESA Listing

Status:	Not ESA-listed
Distinct Population Segment:	NA
Major Population Group:	NA
Recovery Region:	NA
Populations and Recovery Designations:	There is no natural-origin summer-run population in the Cowlitz Basin.
Current Hatchery Program(s):	Cowlitz Trout Hatchery Segregated Hatchery Program - 650,000 yearling smolts
Proposed Hatchery Program(s):	Cowlitz Trout Hatchery Segregated Hatchery Program - 650,000 yearling smolts in the interim. Adjusted Cowlitz Trout Hatchery Segregated Summer (Skamania-origin) Steelhead Hatchery Program (in combination with changes to winter steelhead program adjustments)

7.0. Summer Steelhead

7.0.1. Program Purpose

Tacoma Power and the FTC support a summer steelhead hatchery program, which is designed to mitigate for steelhead lost as a result of hydroelectric development in the Cowlitz Basin and to augment the recreational steelhead fishery in the lower Cowlitz River, while eliminating the directed harvest of natural-origin winter steelhead (Tacoma Power et al. 2000). The production goal for hatchery juveniles has been 650,000 yearling smolts since brood year 2011 (released in 2013). Fisheries that benefit from this program include the lower Columbia River and lower Cowlitz River recreational fisheries. Selective fishing regulations and the differences in the timing of runs focus harvest on hatchery summer steelhead and minimize effects to hatchery- and natural-origin winter steelhead.

7.0.2. Population Description

Historically, the Cowlitz River did not support a native summer-run steelhead population (LCFRB 2010). The Cowlitz summer steelhead stock is non-indigenous to the Cowlitz River, being a mixture of Washougal River and Klickitat River summer steelhead (WDFW 2014d). Hatchery-origin summer steelhead stocks have been planted into the Cowlitz River since 1968 to provide both a sport fishery and enough escapement to the hatchery to maintain the program. Broodstock from 1972 and subsequent releases were collected on the Cowlitz River. The hatchery stock has been self-sustaining in the Cowlitz Basin since the program began (WDFW 2014d). There is no intention of trying to develop a self-sustaining natural-origin population of summer steelhead in the Cowlitz Basin.

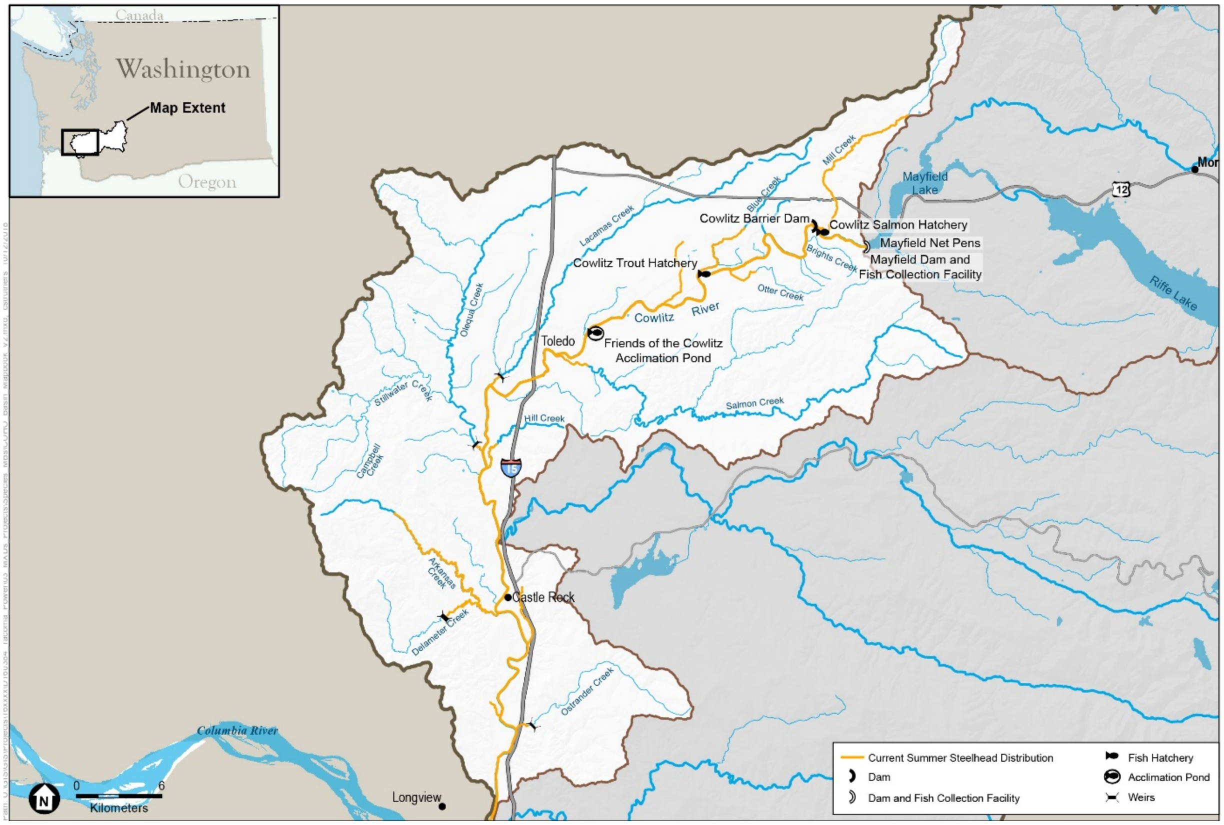

Figure 7.0-1. Potential Distribution of summer steelhead in the Cowlitz Basin, Washington. Note: Distribution does not continue above the weirs due to removal of hatchery-origin steelhead.

7.0.3. Life History Diversity and Distribution

Summer-run steelhead begin entering the Cowlitz River system in April and continue through January, with a peak in late July. Spawning occurs from late November through January. The Technical Recovery Team (2004) identified no indigenous populations of summer steelhead in the Cowlitz River system. Current distribution has been restricted to the Lower Cowlitz Subbasin as a result of introduced out-of-basin Skamania stock, which has been sustained through hatchery production.

Adults that return to the Barrier Dam Adult Facility adult handling facility and lower tributary weirs are identified and removed to exclude adults from entering major tributaries. Tagging and recycling studies of returning adults have shown little proclivity for straying into lower Cowlitz River tributaries. Since 2011, when tributary weir operations began, only 15 hatchery-origin summer steelhead have been encountered. Only one hatchery-origin summer steelhead has been encountered from 2013 through 2017, when weir operations were expanded to four tributaries (Gleizes and Glaser 2018; Kock et al. 2014). In addition, very few natural-origin (no adipose fin-clip) summer steelhead (an average of 4.2 adults/year over the last 5 years) have been encountered at collection locations, suggesting little successful natural reproduction of the hatchery-origin summer steelhead within the Cowlitz Basin. All arrivals to the Barrier Dam Adult Facility are either held for broodstock, surplused to food banks, or recycled downstream for additional recreational fishing opportunity.

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7.0.4. Natural Production

Natural production is assumed to be minimal, as returning adults have shown little proclivity for straying into lower Cowlitz River tributaries and high affinity to returning to hatchery facilities. Low numbers of natural-origin summer steelhead can likely be attributed to high harvest rate, low stray rate, limited access to tributaries, and poor spawning performance. Additionally, the potential for interaction between hatchery-origin summer-run and natural-origin winter-run adults is expected to be low, due to the relative numbers of hatchery- and natural-origin *O. mykiss* and their temporal and spatial segregation (LCFRB 2010).

7.0.5. Hatchery Production

The hatchery program is designed to maximize harvest and minimize impacts on indigenous fish species. The program utilizes broodstock derived from hatchery-origin adults returning to the Barrier Dam Adult Facility at Cowlitz Salmon Hatchery, and the size of the program has been tailored to meet harvest objectives, based on the Cowlitz Hydroelectric re-licensing process and the FTC and research/M&E activities (FERC No. 2016).

Smolts are targeted for a mean release weight of 83 g (5.5 fpp) in the spring (April/May) from the Cowlitz Trout Hatchery outlet into Blue Creek (Table 7.0-1). Since the program's inception, all releases have been below the Cowlitz River Barrier Dam, except in 1998 (2,008 into the Tilton Subbasin) and 1991 (12,824 into the Upper Cowlitz Subbasin). All steelhead released through this hatchery program have been mass-marked (adipose fin-clipped) since 1984. Since 1972, the Cowlitz Trout Hatchery has produced early summer steelhead through a Segregated Hatchery Program. Since brood year 2011 (released in 2013), the goal of this program has been to produce 650,000 yearling smolts to yield an annual return of ~26,000 adults. From 1991-2019, a mean of 450,867 yearling summer steelhead smolts were released at a mean weight of 80 g (5.9 fpp; Table 7.0-1), with a mean of 534,897 since 2013.

7.0.6. Returns

An annual mean of 18,472 summer steelhead adults returned to the Cowlitz River from 2007 through 2017 (Figure 7.0-2). The total return exceeded the annual goal of 26,000 summer steelhead from 2014-2016, ranging from 27,962 to 35,852. SAR values for the program have fluctuated between 2% and 5%.

7.0.7. Harvest

Selective fishing regulations and the differences in the timing of runs focus harvest on hatchery-origin summer steelhead and minimize effects to winter steelhead (both hatchery- and natural-origin). Additionally, a high harvest rate of summer steelhead reduces the likelihood that many will remain in nature and spawn with natural-origin Cowlitz River winter steelhead.

Summer steelhead are harvested in a variety of sport fisheries in Washington and are occasionally harvested in marine fisheries, but the number of Cowlitz River steelhead taken in marine fisheries is assumed to be inconsequential. Fisheries directed at the harvest of Cowlitz River summer steelhead operate in the lower Columbia and lower Cowlitz rivers. An annual mean of 11,766 summer steelhead were caught in the Cowlitz River from 2007 through 2017, which comprised 64% of the total summer steelhead returning to the Cowlitz River (Figure 7.0-2). The annual catch ranged from 4,358 in 2017 to 27,843 in 2015, but exceeded 10,000 in only 2008 and from 2014-2016.

Table 7.0-1. Total number of yearling summer steelhead smolts released below the Cowlitz River Barrier Dam, 1991-2019. In some years, there were multiple releases and weight varied among release groups; in those instances, the combined total number and mean weight is shown.

		Mean Weight	
Release Year	Total Number Released	Grams	Fish Per Pound
1991	331,775	91	5
1992	463,945	87	5.2
1993	493,170	78	5.8
1994	484,491	81	5.58
1995	401,061	75	6.02
1996	461,025	73	6.2
1997	448,712	35	13
1998	427,605	95	4.8
1999	674,515	78	5.85
2000	561,288	94	4.83
2000	89,484	82	5.55
2001	703,559	80	5.67
2002	534,151	91	5
2002	80,076	86	5.25
2003	158,679	99	4.6
2004	378,602	90	5.02
2005	184,764	85	5.34
2006	427,158	85	5.35
2007	404,848	58	7.8
2008	547,105	77	5.9
2009	560,613	73	6.25
2010	467,354	97	4.7
2011	477,098	73	6.2
2012	471,529	69	6.6
2013	673,578	78	5.8
2014	618,681	84	5.4
2015	478,395	84	5.4
2016	183,626	73	6.2
2017	600,000	83	5.5
2018	598,000	83	5.5
2019	592,000	57	7.91

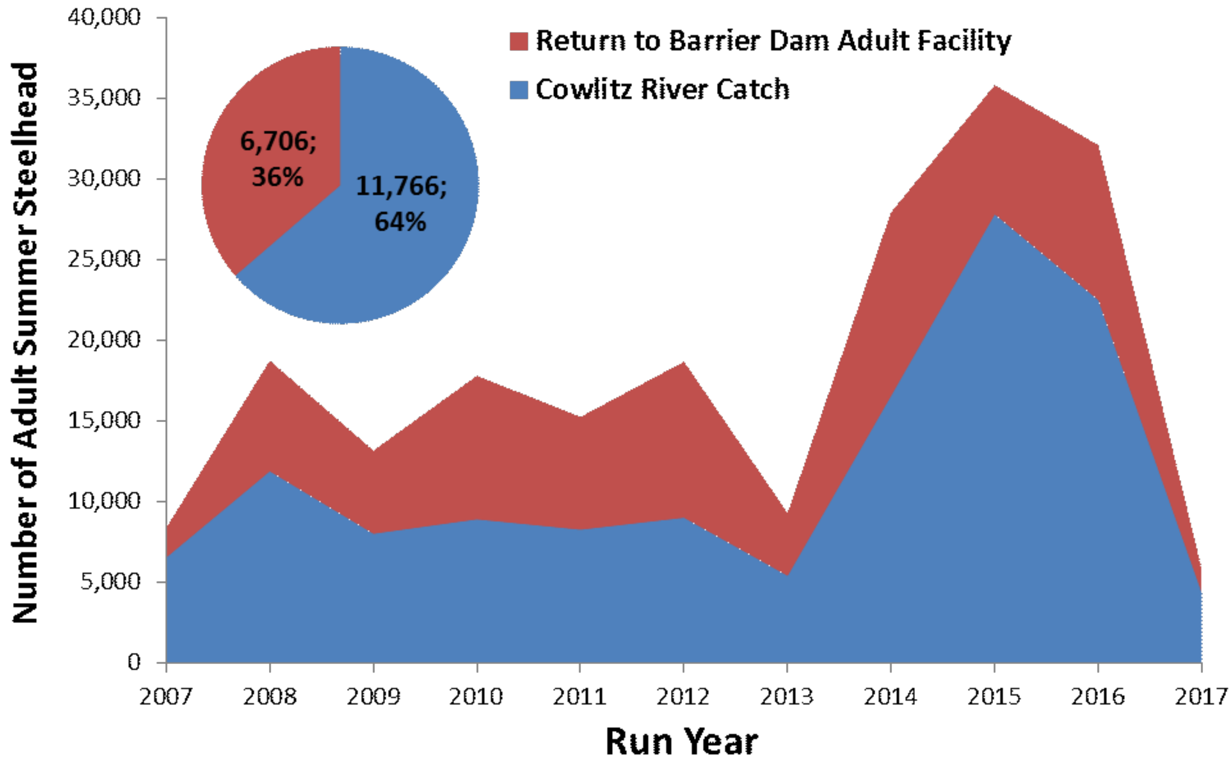

Figure 7.0-2. Numbers of adult summer steelhead caught in the Cowlitz River fishery and that returned to the Barrier Dam Adult Facility at Cowlitz Salmon Hatchery, 2007-2017. Inset pie chart shows means for those years.

7.0.8. Recycling

The summer steelhead program is managed exclusively for harvest. Recycling of hatchery-origin adults returning to the Barrier Dam Adult Facility at Cowlitz Salmon Hatchery is used as a means to increase harvest opportunity.

Since the inception of the summer steelhead program and until 2007, surplus summer steelhead were collected at the Barrier Dam Adult Facility, marked with an opercle punch, transported and released (recycled) back to the lower Cowlitz River (Gibson et al. 2015). The full-scale recycling program did not occur between 2010 and 2013 due to concerns that the summer steelhead may be negatively impacting winter steelhead. The primary driver for ending the recycling program was the risk from potentially high numbers of summer steelhead remaining in the lower Cowlitz River and tributaries, which could increase introgression with the natural-origin winter steelhead population. In 2010, the percentage of recycled summer steelhead in the Lower Cowlitz Subbasin was conservatively estimated at 10% and were considered to be at risk to enter tributaries and spawn with winter steelhead (Tacoma Power 2011).

Kock et al. (2014) examined the fate of the recycled summer steelhead during the 2012-2013 and 2013-2014 seasons. They reported that 48.4% of 218 radio-tagged summer steelhead returned to the hatchery, 19.2% were reported captured by anglers, and 21.1% appeared to have been harvested but not reported, leaving only 11.3% remaining in the river. Further, only 2.3% of all radio-tagged summer steelhead entered tributaries where natural-origin

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steelhead spawned. Based on these results, the summer steelhead recycling program was re-initiated and 1,600 were recycled in 2014. However, no evaluation of the releases was conducted (Gibson et al. 2015). In 2015, the assumed rate of summer steelhead remaining in nature that was used to model the allowable recycling cap was reduced from 10% to 2% (FTC discussion; Zimmerman 2015).

Beginning in 2015, the FTC recommended that Tacoma Power could recycle up to 3,300 summer steelhead in the lower Cowlitz River and that Tacoma Power should evaluate the releases using numbered Floy tags. This evaluation has continued annually through 2020. Since 2013, study results have been variable. Since 2013 a mean of 34% of the recycled summer steelhead were recaptured at the Barrier Dam Adult Facility, and a mean of 21% were caught by anglers. However, the majority (51%; range = 42-59%) of the recycled summer steelhead had an unknown fate (Table 7.0-2). The unknown fate is likely a combination of unreported harvest, straying out-of-basin, spawning in the mainstem Cowlitz River, or natural mortality but, based on weir returns, does not appear to include movement into Lower Cowlitz spawning tributaries.

Table 7.0-2. Summer steelhead recycling program results, 1998-2017 (sources: Kock et al. 2014; Tipping 1998; and date from Tacoma Power).

Year	Number of Adults Recycled	Returned to Facility		Caught by Anglers		Unknown Fate	
		Number	Percent	Number	Percent	Number	Percent
1998	632	348	55%	95	15%	190	30%
2012	549	275	50%	99	18%	176	32%
2013	502	251	50%	100	20%	151	30%
2014	1,598	655	41%	NA	NA	943	59%
2015	3,298	1,055	32%	627	19%	1,616	49%
2016	3,300	1,353	41%	561	17%	1,386	42%
2017	141	30	21%	37	26%	75	53%

Currently, a maximum of 3,300 adult summer steelhead can be recycled annually, from 15 June to15 August. In recent years of low adult abundance, managers have extended the beginning and end of the recycling period to maximize fishing opportunity.

As part of Transition Plan development for the winter steelhead programs, summer steelhead program adjustments, including recycling caps, will be reviewed. This will include a review of the time period when summer steelhead are recycled and the total number recycled to maximize harvest opportunity, while meeting management constraints. Additionally, managers should continue to investigate all available data sources to better understand summer steelhead stray rates within and outside of the Cowlitz Basin, as this value is the primary driver for determining the allowable program size. In the interim, Tacoma Power and the FTC will use the APR process annually to determine how best to recycle summer steelhead in the lower Cowlitz River. As the current program appears to have minimal impact on the Lower Cowlitz Subbasin natural-origin winter steelhead population, it can be used to balance any constraints that arise from ESA and/or HSRG guidelines for the winter steelhead population while maintaining opportunities for steelhead harvest.

7.0.9. Management

The summer steelhead program is managed to concentrate return numbers in the early portion of the summer return timing, to maximize harvest rates, and to minimize effects on the Lower Cowlitz Subbasin winter steelhead population. The program utilizes broodstock derived from hatchery-origin adults returning to the Barrier Dam, and the size of the program has been tailored to meet harvest objectives, based on the Cowlitz Hydroelectric relicensing process and research/M&E activities (FERC No. 2016). The Barrier Dam located below Mayfield Dam prevents the majority of these early summer steelhead from accessing stream reaches above Mayfield Dam. Competition with native species in the lower Cowlitz River is considered low, and preliminary Passive Integrated Transponder (PIT) tag data suggest that summer steelhead smolts move downstream rapidly. The vast majority (73 of 77 smolts detected) took less than 1 week to migrate from Blue Creek to the Columbia River estuary, so it takes them very little time to reach the mouth of the Columbia River.

WDFW has implemented restrictive regulations permitting the retention of marked adult hatchery-origin steelhead only and requiring the release of natural-origin steelhead (Tacoma Power 2011). All summer steelhead are externally marked with an adipose fin-clip to allow for these selective fisheries and differentiation between hatchery- and natural-origin steelhead returning to the Cowlitz Hatchery Complex. WDFW manages the steelhead harvest in the Cowlitz River, and the summer steelhead program provides steelhead for harvest while minimizing adverse effects on ESA-listed winter steelhead. Any summer steelhead that are not needed for hatchery needs are recycled to the lower Cowlitz River fishery of surplused to the food bank.

Regarding ESA-listed fishes, the key issue of the summer steelhead program is the impact of hatchery-origin smolts on lower Cowlitz River native Chinook Salmon, Coho Salmon, Chum Salmon, and winter steelhead. Non-indigenous hatchery-origin summer steelhead may affect ESA-listed fishes through predation, disease, and competition, along with genetic introgression with the native winter steelhead.

Evaluating performance indicators for harvest will be accomplished by continuing mass-marking (adipose fin-clip). Monitoring and evaluation activities are modified annually through the M&E Plan and APR process and will be updated as part of the adaptive management process (Chapters 10 and 12).

7.0.10. Summary

- The Summer Steelhead Program should continue to be used to support recreational harvest opportunity. As the current program has had minimal impacts on the Lower Cowlitz Subbasin natural-origin winter-run steelhead population, it can be used to balance any constraints that arise from ESA or HSRG guidelines for the winter steelhead population while maintaining opportunities for steelhead harvest.
- Recycling adult hatchery-origin summer steelhead returning to the Barrier Dam Adult Facility has been successful in enhancing harvest opportunity, while minimizing the threat to the natural-origin winter steelhead population.
- During transition planning, the total number of adults recycled and the time period when summer steelhead are recycled should be evaluated to maximize efficient use of this resource, while meeting management constraints. In the interim, Tacoma Power and the FTC will use the APR process annually to determine how best to recycle summer steelhead in the lower Cowlitz River.

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CHAPTER 8:
CUTTHROAT TROUT

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Cutthroat Trout *Oncorhynchus clarkii*

ESA Listing

Status:	Not ESA-listed; Species of Concern (federal), Depressed (state)
Distinct Population Segment:	Southwestern Washington/Lower Columbia River Coastal Cutthroat Trout
Major Population Group:	NA
Recovery Region:	NA
Populations and Recovery Designations:	Cowlitz Basin Coastal Cutthroat Trout – not designated
Current Hatchery Program(s):	100,500 yearling smolts:
	Cowlitz Trout Hatchery Segregated Hatchery Program - 90,500 smolts
	Friends of the Cowlitz - 10,000 smolts
Proposed Hatchery Program(s):	100,500 yearling smolts:
	Cowlitz Trout Hatchery Segregated Hatchery Program - 90,500 smolts
	Friends of the Cowlitz - 10,000 smolts

8.0. Cutthroat Trout

8.0.1. Program Focus

Coastal Cutthroat Trout are not listed under the ESA, nor does the Recovery Plan set specific minimum viability abundance targets for the species (WDFW and LCFRB 2016). However, coastal Cutthroat Trout are a federal species of concern and the Cowlitz Basin population was classified as Depressed by WDFW (Blakley et al. 2000). Recovery of the natural population is focused on reversing declining trends in adult and smolt abundance and maintaining life history diversity (LCFRB 2010).

Following completion of Mayfield Dam, anadromous Cutthroat Trout were restricted to the Lower Cowlitz Subbasin, while resident forms persisted upstream. The Cowlitz Basin anadromous Cutthroat Trout Segregated Hatchery Program began in 1968 to mitigate for losses caused by dam construction and the current hatchery production goal is 100,500 yearling smolts and 5,000 returning adults (Tacoma Power 2011). Over the period covered by this FHMP, the focus for the Segregated Hatchery Program will be to provide harvest opportunity, while minimizing hatchery impacts on the natural population. As such, we will continue the Segregated Hatchery Program at the same level of annual production.

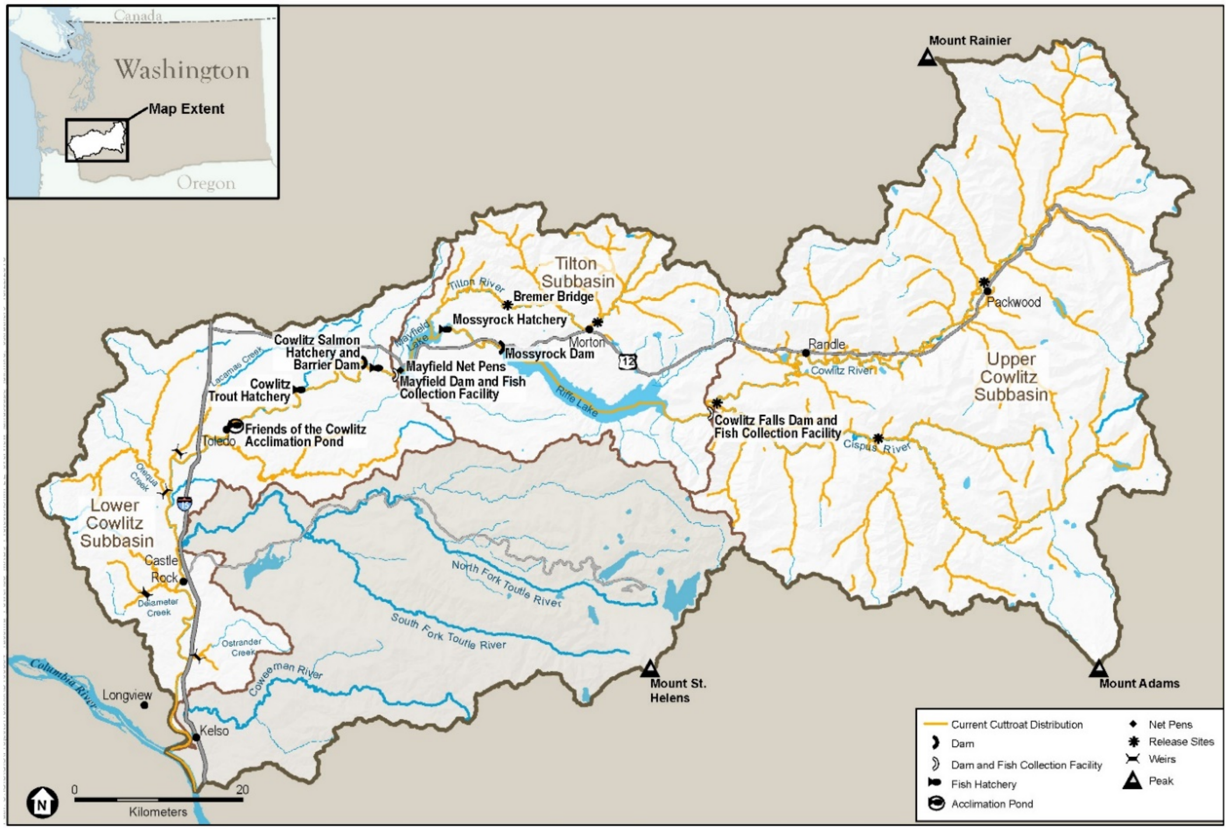

Figure 8.0-1. Distribution of Cutthroat Trout in the Cowlitz Basin, Washington.

8.0.2. Demographically Independent Population

The Cowlitz Basin Cutthroat Trout population is part of the Southwestern Washington/ lower Columbia River Coastal Cutthroat Trout DPS. Based on their geographic spawning distribution (Figure 8.0-1) and genetic sampling, all Cutthroat Trout within the Cowlitz Basin (excluding the populations in the Toutle and Coweeman basins) are considered a single population that is separate from those of other lower Columbia River tributaries (Blakley et al. 2000; LCFRB 2010).

8.0.3. Life History Diversity and Distribution

Cutthroat Trout inhabiting the Cowlitz Basin exhibit three different life history forms: anadromous, resident, and adfluvial (LCFRB 2010). Historically, the anadromous form occurred throughout the basin but was mostly restricted to the Lower Cowlitz Subbasin following construction of Mayfield Dam. However, natural-origin Cutthroat Trout smolts are still captured at the juvenile collection facilities at Cowlitz Falls and Mayfield dams and adults captured at the Barrier Dam Adult Facility are transported upstream. A resident form that primarily utilizes headwater habitats is found throughout the basin and an adfluvial form resides in the Tilton and Upper Cowlitz subbasins that utilizes larger riverine habitats and the reservoirs created by Mayfield, Mossyrock, and Cowlitz Falls dams (Blakley et al. 2000).

Anadromous natural-origin adults return to the Cowlitz Basin from July to October, with peak returns in August and September (Blakley et al. 2000; LCFRB 2010). Spawning occurs from January through mid-April and smolts outmigrate in the spring, generally after rearing for 2-3 years in freshwater. Natural origin sea-run Cutthroat Trout exhibit diverse adult life histories including multiparous and skip spawn strategies. Resident and adfluvial Cutthroat Trout are thought to exhibit similar spawn timing as natural-origin anadromous trout and likely interbreed where their ranges overlap. Cowlitz Trout Hatchery produces Cutthroat Trout smolts to supplement the anadromous component of the population. The returning hatchery-origin adults spawn earlier, from November to February, as a result of artificial selection for early-maturing trout (Blakley et al. 2000).

8.0.4. History and Recent Abundance

Historically, anadromous Cutthroat Trout were able to access most of the Cowlitz Basin except for the upper portions of tributaries, where steep gradients and high flows limited passage (Blakley et al. 2000). Completion of Mossyrock Dam limited anadromy by blocking upstream access by adults to the Upper Cowlitz Subbasin. The resident life history form has persisted in the Tilton and Upper Cowlitz subbasins. The adfluvial components of the population have adapted to the reservoirs associated with Mayfield, Mossyrock, and Cowlitz Falls dams (Blakley et al. 2000). By 1990-1994, the 5-year mean number of anadromous adult Cutthroat Trout returning to Mayfield Dam (1,628 trout) was only 19% of the mean of 8,698 trout from 1962-1966 (LCFRB 2010; Blakley et al. 2000). Recent returns of anadromous adults to the Barrier Dam Adult Facility remain low; a mean of 1,179 adults returned from 2007-2017, of which 1,045 were hatchery-origin and 134 were natural-origin (Figure 8.0-2; WDFW 2019). No abundance estimates are available for the resident or adfluvial components of the population.

Smolt abundance above Cowlitz Falls and Mayfield dams has been low, with <2,000 smolts typically counted annually from 1978-2006, representing roughly 10% of counts when collections began in the early 1960s (LCFRB 2010). From 2007-2017, a mean of 584 and 810 smolts were collected annually at Cowlitz Falls Dam (Upper Cowlitz Subbasin) and Mayfield Dam (Tilton Subbasin), respectively. Smolt production from the Lower Cowlitz Subbasin has not been estimated.

8.0.5. Harvest

Anadromous Cutthroat Trout are not harvested in ocean fisheries, but hatchery-origin trout from the Segregated Hatchery Program are harvested by anglers in mainstem Columbia River and Lower Cowlitz Subbasin fisheries (LCFRB 2010). If caught, natural-origin Cutthroat Trout are required to be released.

Annual harvest rates for Cowlitz Basin Cutthroat Trout are unknown because there is no catch record card recording requirements. However, WDFW has established long-term goals for harvest of Cowlitz Basin anadromous Cutthroat Trout in terms of catch numbers, harvest rates, and seasons by fishery (Tacoma Power 2011):

- Preterminal fishery: <1% exploitation rate.
- Lower Cowlitz Subbasin fishery (June-November): in-river catch of 4,500 adults.
- Upper Cowlitz Subbasin fishery: None.
- Tilton Subbasin fishery: None.

These are not necessarily the goals associated with the Settlement Agreement, but rather long-term goals and achieving them may require implementation of measures beyond the scope of the Settlement Agreement.

8.0.6. Natural Production

Natural production of Cutthroat Trout in the Lower Cowlitz Subbasin is provided by anadromous hatchery- and natural-origin adults that are not harvested/exploited and survive to spawn successfully. From 2007-2017, a mean of 127 (86-211) adults (all natural-origin) were transported and released above Mayfield Dam to spawn naturally (Figure 8.0-2). Of those, a mean of 105 (65-162) were released into the Tilton Subbasin and 22 (4-49) into the Upper Cowlitz Subbasin. Some natural production is also provided by resident and adfluvial trout throughout the Cowlitz Basin, but the degree to which these spawners contribute to anadromous smolt production is unknown.

Natural-origin smolt production from the Lower Cowlitz Subbasin is unknown and cannot be estimated at present. Smolt monitoring in the Lower Cowlitz Subbasin has been conducted using a screw trap in the mainstem Cowlitz River and is difficult due to the low number of smolts present. Accurate estimates of natural-origin Cutthroat Trout smolt production from the Tilton and Upper Cowlitz subbasins are not monitored. Means of 810 and 584 natural-origin smolts were collected annually from 2007-2017 at Mayfield and Cowlitz Falls dams, respectively.

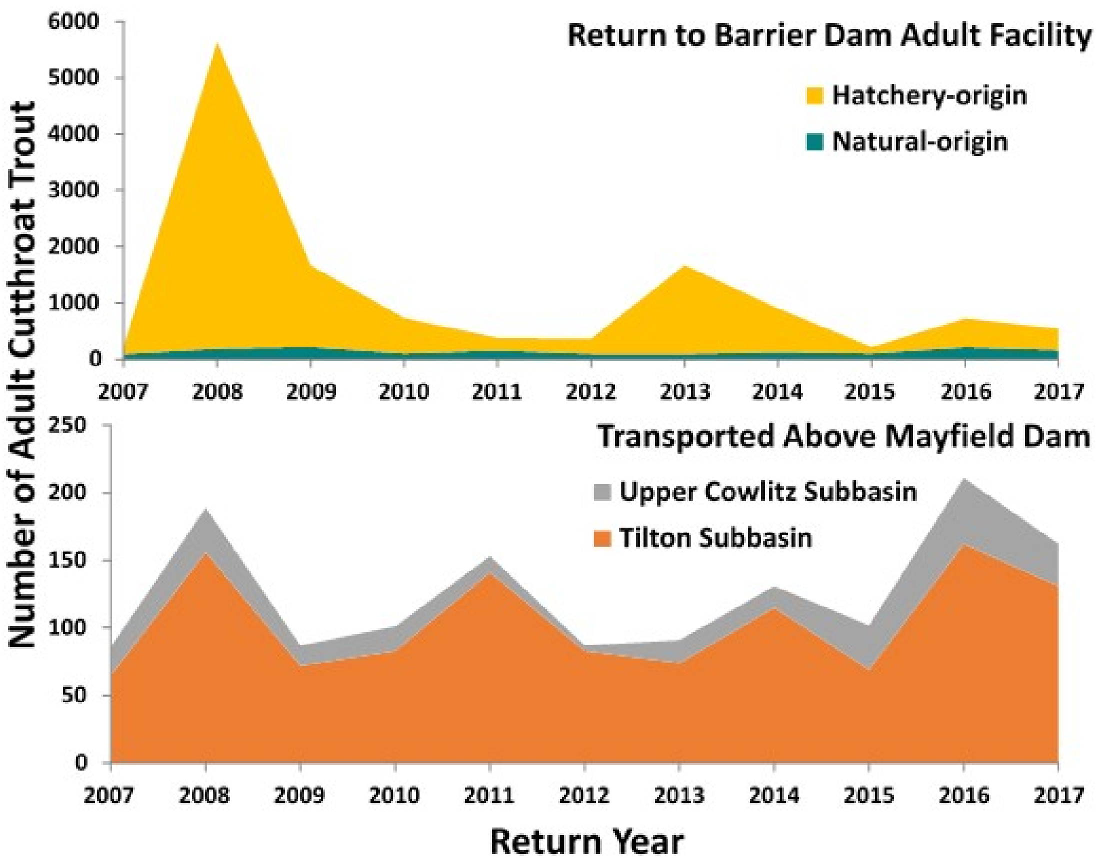

Figure 8.0-2. Numbers of adult Cutthroat Trout of hatchery- and natural-origin returning to the Barrier Dam Adult Facility and of total adults transported upstream of Mayfield Dam, 2007-2017. Note: data are the most recently available, as compiled by Tacoma Power and WDFW, and may not be complete.

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8.0.7. Hatchery Production

Since 1968, the Cowlitz Trout Hatchery has produced anadromous Cutthroat Trout through a Segregated Hatchery Program (LCFRB 2010). The current goal of this program is to produce 100,500 yearling smolts to yield an annual return to the hatchery of 5,000 adults. At present 90,500 smolts are produced at Cowlitz Trout Hatchery and 10,000 parr are transported to the Friends of the Cowlitz for final rearing to smolt and release.

Broodstock requirements and production goals are consistently met; therefore, this hatchery program will continue at the same level of production and continue to provide harvest opportunity in the lower Cowlitz River terminal fishery. However, the efficacy of moving from a segregated to an Integrated hatchery program during this FHMP period will be evaluated.

8.0.8. Future Management

Current smolt production was decreased in the 2011 FHMP to reduce the possibility and level of impact of Cutthroat Trout smolts and residualized juveniles to natural populations. Management of the Cowlitz Basin Cutthroat Trout population will focus on the anadromous life history and the fishery that it supports. The hatchery program appears to be popular but there is little documentation of this popularity or the actual harvest. Improved creel survey efforts will improve the monitoring of this fishery.

Directed studies focused on improving the efficacy and management of the Cutthroat Trout hatchery program may be implemented. There is some concern that the large (90 g) hatchery-origin smolts released from Cowlitz Trout Hatchery may prey on juveniles of other anadromous salmonids, particularly Chinook Salmon. WDFW conducted a small study to examine the presence of Cutthroat Trout in the lower Cowlitz River and their diet. Annual reports from 2014 (Gleizes et al. 2015) and 2015 (Gleizes et al. 2017) show that only 15.5% and 7.1%, respectively, of the hatchery-origin Cutthroat Trout examined contained fish in their stomachs and only 2.4% and 1.2% contained identifiable juvenile Chinook Salmon. While this study indicated that a low percentage of the Cutthroat Trout examined were piscivorous, it did not estimate the total number of hatchery-origin Cutthroat Trout that had residualized in the lower Cowlitz River nor their potential impact on juvenile anadromous salmonids. Further examination of this issue may be warranted.

Residualization of hatchery-origin Cutthroat Trout is a potential threat to juveniles of other anadromous salmonids but also counter to the focus of this hatchery program. If a substantial proportion of the hatchery-origin smolts are residualizing in the lower Cowlitz River, instead of migrating to the ocean, then the program is not achieving its goals of providing fisheries opportunity. Possible examination of scales and/or otoliths from Cutthroat Trout returning to the hatchery would document ocean entry by these trout. Additionally, if there is substantial residualism, examination of potential causes, such as the large smolt size or testing alternative rearing methods to increase anadromy and reduce the possible impacts on other salmonids, may be considered.

8.0.9. Summary

- Construction of Mayfield and Mossyrock dams blocked anadromous Cutthroat Trout from volitionally accessing habitat in the Tilton and Upper Cowlitz subbasins.
- A Segregated Hatchery Program was initiated in 1968 to supplement the remaining anadromous Cutthroat Trout in the Lower Cowlitz Subbasin and maintain harvest opportunity.
- Continue the Segregated Hatchery Program for anadromous Cutthroat Trout, with an annual goal of producing 100,500 yearling smolts.
- Continue to evaluate the program for harvest opportunity participation and effectiveness while minimizing hatchery influence on the natural Cutthroat Trout population.

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CHAPTER 9:
CHUM SALMON

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Chum Salmon *Oncorhynchus keta*

ESA Listing

Status:	Threatened Listed in 1999, reaffirmed in 2011 and 2016
Evolutionarily Significant Unit:	Columbia River Chum Salmon
Major Population Group:	Cascade Chum Salmon
Recovery Region:	Lower Columbia River Salmon
Populations, Recovery Designations, and Minimum Viability Abundance Targets (natural-origin adults spawning in nature):	Cowlitz Basin Summer - Contributing, 900 Cowlitz Basin Fall - Contributing, 900
Current Hatchery Program(s):	None
Proposed Hatchery Program(s):	None

9.0. Chum Salmon

Chum Salmon in the Cowlitz Basin are considered by the Recovery Plan to be part of a single, larger population that is comprised of those produced naturally in the Lower Cowlitz, Toutle, and Coweeman subbasins (LCFRB 2010; WDFW and LCFRB 2016). As part of the Columbia River Chum Salmon ESU, this population was listed as threatened in 1999. Historically, the Cowlitz Basin Chum Salmon population was the largest in the Lower Columbia Subbasin, producing 300,000-500,000 adults; however, recent estimates of returns (<150 salmon; LCFRB 2010) and baseline escapement (<300 salmon; WDFW and LCFRB 2016) are currently Very Low, and the population is considered to be at a High to Very High Risk of extinction (Table 9.0-1). The Cowlitz Basin Chum Salmon population is listed as Contributing (LCFRB 2010) and thus is important to recovery of the ESU. Additionally, recovery will benefit other salmonid species within the Cowlitz Basin by bringing in and releasing ocean nutrients into the ecosystem. Only small, experimental hatchery releases of Chum Salmon have occurred in the Cowlitz Basin, and these have not occurred after 1999. There is no current or proposed hatchery program. However, four hatchery programs in the lower Columbia River (Grays River, Big Creek, Lewis River, and Washougal hatcheries) currently release juvenile Chum Salmon (NMFS 2016) and could potentially influence the Cowlitz Basin population through straying.

The dramatic and persisting declines in abundance of Columbia River Chum Salmon have resulted from the combined impacts of human activities involving freshwater and estuary habitat degradation, dam construction and operation, over-fishing, fish hatcheries, and ecological factors, such as predation. The reduction of Cowlitz Basin Chum Salmon is primarily attributed to the severe and long-term degradation of habitat in the Lower Cowlitz Subbasin (LCFRB 2010), including the loss of productive off-channel spawning areas. Additionally, regulated flows and the loss of sediment transport from areas upstream of the dam have disrupted naturally habitat-forming and maintenance processes below Mayfield Dam. The construction of Mayfield Dam in the 1960s also blocked access to historical spawning areas. While historic harvest rates contributed to reduced abundance, current fisheries impacts on the Cowlitz Basin population are thought to be minimal.

Since 2013, the possession and sale of Chum Salmon caught in mainstem Columbia River commercial fisheries have been prohibited, and tributary fisheries have been closed to

Chum Salmon retention since the 1990s. The overall incidental mortality rate is limited to no more than 5% (LCFRB 2010). From 2007-2018, the total in-river harvest rates of Columbia River Chum Salmon in the lower Columbia River were estimated to be 0.05% (WDFW and ODFW 2019). Hatchery production of Chum Salmon in the lower Columbia River has likely had a limited impact on the Cowlitz Basin population. There have never been any direct plants of Chum Salmon in the Cowlitz Basin. Large hatchery production programs were not developed for Chum Salmon in the Columbia Basin, even as their population declined, because of the low market value compared to other species. Currently, there are four conservation hatchery programs for Chum Salmon in the lower Columbia River (Grays River, Big Creek [ODFW], Lewis River, and Washougal/Vancouver) that cumulatively release approximately 500,000 fry per year. These hatchery-produced Chum Salmon could potentially influence the Cowlitz Basin Chum Salmon population through straying. Juvenile Chum Salmon might also be subject to predation by the hatchery Coho Salmon and steelhead that are released at much larger sizes, but the significance of this effect has not been determined (LCFRB 2010).

Table 9.0-1. Recovery priority, baseline viability status, viability and abundance objectives, and productivity improvement targets for Cowlitz Basin Chum Salmon populations (from LCFRB 2010).

	Demographically Independent Population	
	Lower Cowlitz Subbasin	Lower Cowlitz Subbasin
Run	Fall	Summer
Recovery Priority Designation[1]	Contributing	Contributing
Abundance		
Historic[2]	195,000	unknown
Current (last 5 years)[3]	<300	unknown
Target[4]	900	900
Baseline Viability[5]		
Abundance & Productivity	Very Low	Very Low
Spatial Structure	High	Low
Diversity	Low	Low
Net Viability Status	Very Low	Very Low
Viability Improvement[6]	>500%	>500%
Minimum Viability Abundance Target[5]	Medium	Medium
Proportionate Natural Influence		
pHOS	<0.1	<0.1
pNOB	NA	NA
PNI	NA	NA

1 Primary, Contributing, and Stabilizing designations reflect the relative contribution of the population to Major Population Group minimum viability abundance targets.

2 Historic population size was mean number, inferred from presumed habitat conditions using EDT Model and NMFS professional judgment calculations.

3 Approximate current mean annual number of naturally produced Chum Salmon returning to the watershed. Note that these values are 5-year means and are not necessarily consistent with mean values over various intervals that are presented elsewhere.

4 Abundance targets were estimated by population viability simulations based on viability goals.

5 Viability status is based on Technical Recovery Team viability rating approach. Viability objective is based on the scenario contribution. Very Low (>60% chance of extinction); Low (26-60% chance of extinction); Medium (6-25% chance of extinction); High (1-5% chance of extinction); Very High (<1% chance of extinction).

6 Improvement is the relative increase in population abundance and productivity required to reach the prescribed viability goal.

The Cowlitz Basin Chum Salmon population is managed as a single population but is the combination of two separate populations recognized during ESA recovery planning: a predominant fall run and a summer run that was identified based on returning adults recovered in the Cowlitz River and at the Barrier Dam Adult Facility (LCFRB 2010). Genetic analysis following the 1999 listing of the population suggested that this summer run existed historically and occupied the upper reaches of the Chum Salmon distribution in the Cowlitz Basin (Ford et al. 2011). Concluding that the Cowlitz Basin summer run represents a unique life history of the ESU and an important component of diversity, the 2011 NOAA Fisheries Status Review (Ford et al. 2011) suggested adding Cowlitz Basin summer Chum Salmon as a new population.

The current size of both runs is poorly understood, and estimates are limited to the small numbers collected at the Barrier Dam Adult Facility (typically less than 20 adults per year; LCFRB 2010). Both summer and fall Cowlitz Basin Chum Salmon are considered Contributing populations for recovery of the ESU; the minimum viability abundance target is to achieve an abundance of 1,800 natural-origin spawners; 900 for each of the summer and fall runs (LCFRB 2010).

Historically, Chum Salmon are thought to have migrated upstream past the site of Mayfield Dam. The current distribution of Cowlitz Basin Chum Salmon includes production from the lower mainstems of the Cowlitz (downstream of Barrier Dam), Toutle, and Coweeman rivers, as well as limited spawning in the lower reaches of Ostrander, Arkansas, Salmon, Olequa, and Lacamas creeks (LCFRB 2010; Figure 9.0-1). Fall Chum Salmon return to the Cowlitz Basin from mid-October through early December, with peak spawning in late November; summer Chum Salmon have been observed as early as late July although specific run and spawn timing are unclear. Following spawning and incubation, fry emerge in early spring and migrate downstream as fry from March to May (LCFRB 2010).

There are currently no plans to release hatchery-origin chum salmon in the Cowlitz Basin during the period covered by this FHMP. However, establishing viable Chum Salmon populations within the Cascade stratum remains a recovery challenge, so keeping options open for approaches that may involve some form of recovery support is important. Therefore, this FHMP does not preclude any entity from artificially propagating Chum Salmon within the Cowlitz Basin so long as these efforts are consistent with a recovery strategy that has been established for Columbia River Chum Salmon (LCFRB 2010; NMFS 2013; WDFW and LCFRB 2016) and are coordinated with the Artificial Propagation Strategy for Chum Salmon that is being developed by WDFW in 2020. As part of the overall programmatic efforts described for the other species in this FHMP, we will increase and improve data collection for monitoring and evaluation, which may provide managers with a better understanding of potential spawning locations, abundance, productivity and biology of Cowlitz Basin Chum Salmon and progress toward meeting population minimum viability abundance targets.

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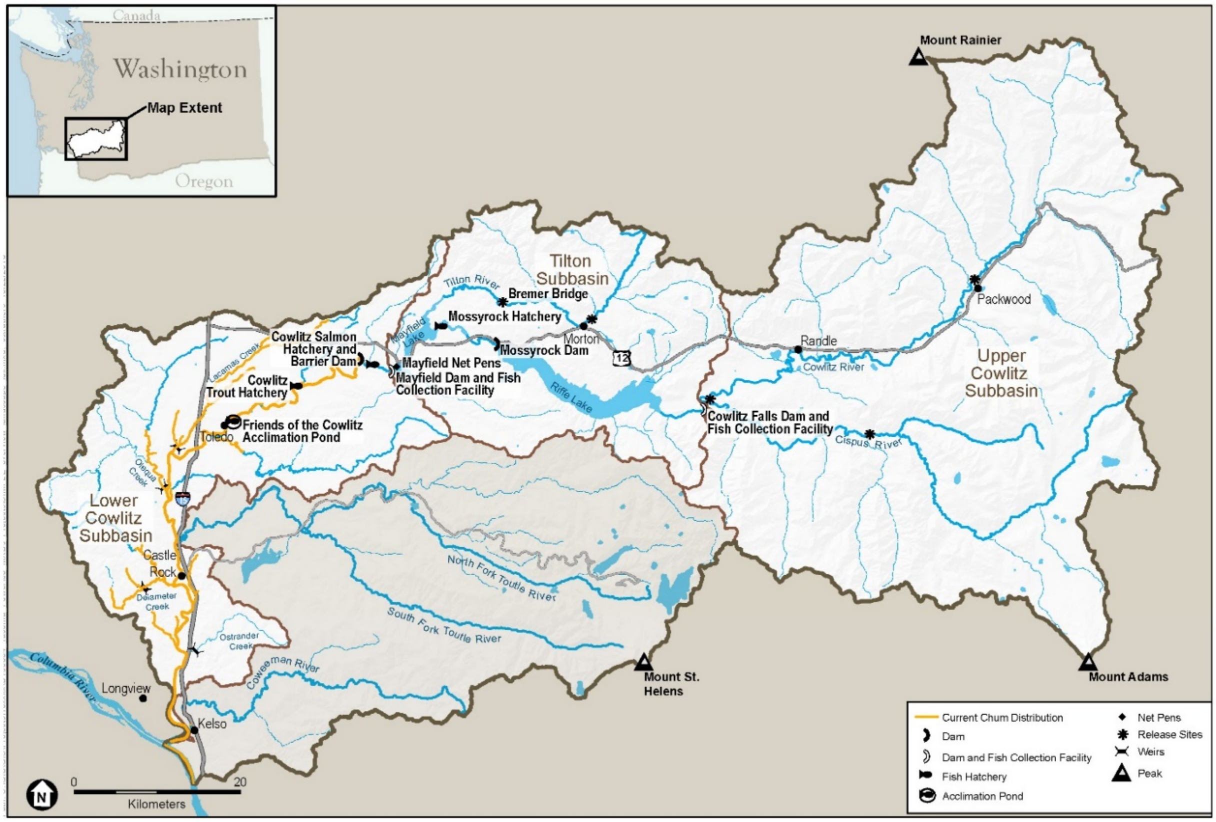

Figure 9.0-1. Current distribution of Chum Salmon in the Cowlitz Basin, Washington.

CHAPTER 10:
MONITORING & EVALUATION

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10.0. Monitoring & Evaluation (M&E)

10.1. Purpose

Monitoring & Evaluation (M&E) data provide the basis for management and operation decisions. The M&E chapter of the FHMP describes our current state of knowledge about fish populations throughout the Cowlitz Basin, our ongoing M&E work, and pressing data gaps that need to be addressed over the time frame of this FHMP. Baseline data collected feeds directly into population viability analysis needed to track progress toward recovery, decisions about hatchery programs and fish dispositions, while directed study data address pressing data gaps that would improve fish or population management. In a broader perspective, this M&E chapter describes the parameters that characterize and allow managers to better understand the impact of Tacoma Power's hatchery programs on natural populations and if those natural populations are progressing toward recovery. The data collected and analyzed, as characterized in this chapter, are intended to provide Tacoma Power and the FTC with information necessary to manage fisheries and hatcheries effectively, with the goal of achieving population recovery and harvest objectives. The status and trends of these measures will be evaluated in the context of VSP metrics or other measures used to inform the status and progress in relation to the current and upcoming recovery phase for each population.

This chapter does not focus on individual studies by species and population; instead, it serves as a road map for all species and populations by identifying parameters that must be monitored to assess population status as well as those of interest for improving operations to maximize benefit to salmonids in the Cowlitz Basin. This chapter describes the measures necessary to assess program performance through baseline and directed studies. The Monitoring Plan, which is briefly described in this chapter, will be updated annually. The plan will contain up-to-date details on measures identified for baseline and directed studies, along with detailed study designs and implementation methods. Regardless of the study type, the ultimate goal of FHMP baseline studies is to gather the data required to inform parameter estimates that can be input into a life cycle model to understand current and potential future population performance. Directed studies are focused on better understanding specific issues that may or may not contribute to the life cycle model. The M&E chapter also defines how and when M&E data gathered will be summarized and inform the Annual Program Review process.

The Monitoring Plan will capture the necessary detail to ensure that the proper data are gathered to successfully complete all required monitoring actions. The Monitoring Plan will be reviewed on an annual basis as part of the APR process as most (if not all) data collected feed into the process that is meant to assess population performance and hatchery program sizes and changes. The Monitoring Plan will define the monitoring actions necessary to complete baseline and directed studies. The actions will be focused on the work addressing data gaps in the Big Table Dataset (directed studies) or data needed for the Condensed Big Table (baseline studies). The Monitoring Plan will define potential actions that could be implemented to gather data to satisfy the identified data need. The Monitoring Plan will also define the minimum standard of statistical resolution for each study to ensure that meaningful work is completed to further the understanding of fish species/populations and hatchery programs.

The first version of the Monitoring Plan will build on previous work elements and descriptions of M&E work in past FHMPs and appendices (specifically Appendices H and J of the 2011 FHMP), and will propose updated methods, priorities, and new work elements to address data gaps identified in this FHMP. The Monitoring Plan will annually detail the current work necessary as stated in the FHMP, and the first version will be completed within 1 year of the FHMP being completed and implemented. This plan will be submitted to the FTC for review and approval, and implemented within 1 year after FHMP completion. While the Monitoring Plan is developed, Appendix J of the 2011 FHMP will serve as the interim plan for 1 year unless mutually agreed to based on a work plan to be developed within 3 months of FHMP submittal. If the Monitoring Plan is not completed within the time identified within the work plan, the measures identified in the Condensed Big Table (Table 10-1, at the end of this chapter) will continue to be estimated in consultation with the FTC with as much consistency as possible. A description of the baseline and directed studies is presented below.

Each M&E work element within the Monitoring Plan should include the following:

<u>Study Design Elements</u>

- Baseline/Directed
- Introduction/Background Information
- Objectives/Hypotheses/Research Question being addressed (i.e., “applies to”)
- Area of focus (e.g., study area and/or species)
- Field methods – Data Collection
- Analysis Methods
  - Analysis Approach
  - Equations
  - Uncertainty (characterize as necessary to make appropriate management decisions)
- Assumptions -
  - How will they be tested or addressed?
  - How do we ensure estimates are unbiased?
- Anticipated Results – (“Deliverables”)
  - How does this answer Objectives/Hypotheses/Research Questions?

10.2. Overview of Baseline and Directed Studies

Throughout this chapter, we, refer to both baseline and directed studies, as defined below.

Baseline Studies are basic monitoring activities and are completed on a regular basis (e.g., annually, every 5 years, when specific events occur) in order to track population progress toward recovery objectives, including how closely the Settlement Agreement goals are being achieved under varying conditions.

Directed Studies are designed to diagnose problems identified from baseline information—for example, if hatchery adult returns are low but the juvenile production goal is consistently being met, a directed study to examine juvenile migration survival from the facility to the mouth of the Toutle River might be implemented. Directed studies are intended to inform future actions, designs, and operations that will improve program performance of the topic of interest so that goals of the Settlement Agreement can be achieved. The focus and level of effort assigned to this type of study will vary based specific needs as identified within the APR process (Chapter 12). These studies will be documented in the Monitoring Plan.

10.3. Monitoring Plan

The Monitoring Plan is designed to provide the information needed to track population status toward recovery objectives and for the Annual Program Review decision making process described in Chapter 12 of this FHMP. For any given natural-origin run size, the Decision Rules will calculate the management targets in terms of natural escapement abundance and composition (pHOS), harvest, hatchery broodstock composition (pNOB), or other targets determined appropriate through the APR process. The 5-year mean of these management targets will then determine the actions needed for the coming season. These Decision Rules and management targets are designed to drive the system toward biological targets, which, in turn, are the basis for the metrics that define resource goals. Given this path, monitoring will focus on the management and biological targets to determine if progress is being made (i.e., status and trends). In addition, monitoring should focus on critical uncertainties within the key metrics and the triggers found in the Decision Rules. However, the actions proposed in the Monitoring Plan are based on a set of key assumptions that are consistent with current scientific knowledge and the available information. The sensitivity of the expected outcomes from actions and the uncertainty of these assumptions are the drivers for M&E priorities that most directly affect management decisions.

A Monitoring Plan will be developed that describes the baseline and directed studies and contains detail regarding the necessary data, and annually reviewed and adjusted corresponding field and analytical protocols that will be utilized to gather the information. The first version of this plan will build upon previous work elements and descriptions of M&E work in past FHMPs and appendices (specifically Appendices H and J of the 2011 FHMP), and will propose updated methods, priorities, and new work elements to address data gaps identified in this FHMP (as described in more detail below in Section 10.3.1). The Monitoring Plan will characterize the critical data necessary to assess status and trends associated with the current and upcoming recovery phase. The methodology to collect this data will remain flexible and will be evaluated annually. It is not possible to know all of the potential analytical and methodological techniques that will be available as time progresses, or what developments in species/population status will necessitate directed studies; therefore, detailed methodologies captured in the Monitoring Plan will be reviewed annually to ensure that the best and most efficient methods are being implemented.

10.3.1. Current Knowledge Base and Gaps

The In-season Implementation Tool (ISIT) is a tool that relates natural and hatchery population metrics to hatchery program adjustments, and stores information needed for the tool to operate. M&E efforts have made considerable improvements in recent years and over the term of the last FHMP. However, not all data collected are currently housed in or utilized by the ISIT tool, and the ISIT tool has not been updated during the last FHMP period. In this FHMP, we have introduced the “Big Table,” which serves as a source of data and a way to easily identify existing data gaps by species, population, and origin. During this FHMP period all data required to achieve FHMP objectives will need to be consolidated into a single database that can be used for analysis and reporting. Numerous metrics are identified in the Big Table Dataset, and data are not currently available for many of them; these are the data gaps that baseline and selected directed studies will address and fill (see Section 10.5). This (2020) FHMP includes a Summary of Data Gaps and Potential Future Monitoring Needs, presented as Appendix C. Appendix C is a comprehensive list identifying current areas of monitoring and existing data gaps as presented in the previous fish species and population chapters. The

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Summary of Data Gaps and Potential Future Monitoring Needs matrix clearly identifies baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period, as described in Chapters 3 through 9. The summary matrix is intended as a working tool to help identify critical data needs required for prioritization of tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset.

10.3.2. Current and Future Efforts

Current M&E efforts in the Upper Cowlitz Subbasin primarily focus on “fish-in, fish-out” metrics, which are important for tracking the achievement of annual and generational goals, as well as progress toward recovery. For Lower Cowlitz Subbasin populations, additional monitoring effort has been focused on generating additional VSP metrics, including improved information on abundance, distribution, and diversity. For most species and populations, this occurs related to returning adults and migrating juveniles. In addition, we currently have a limited understanding of the abundance and productivity of the populations occupying the tributaries between Mayfield and Cowlitz Falls dams (e.g., the Tilton Subbasin populations). As described above, data gaps are presented in Appendix C, Summary of Data Gaps and Potential Future Monitoring Needs.

10.3.2.1. Lower Cowlitz Subbasin

Currently, the highest effort and most complicated area from an M&E perspective is the lower Cowlitz River. All species, populations, and stages are present in this area at one point or another and potentially interact with one another. Because of this complication in the lower river, data for populations in the subbasin can only currently estimate adult-to-adult production. We have operated a smolt trap in the lower Cowlitz River and now have sufficient data to estimate juvenile migration timing and to develop an index of juvenile abundance. Therefore, we will now focus on adult productivity (adult recruits/spawner) to monitor populations in the Lower Cowlitz Subbasin. Resumption of smolt monitoring may be useful in the future if the freshwater phase is thought to be limiting and further information is needed to fill data gaps. Current efforts in the Lower Cowlitz Subbasin have included spawning ground surveys for all species, creel surveys, and catch record cards to understand natural-origin/hatchery-origin encounter rates in fisheries, weirs for broodstock collection, pHOS management, mark-recapture surveys for spawner estimates in specified areas, and broodstock biosampling, and up until recently, operating a smolt trap to characterize the timing and abundance of juvenile migration in the lower Cowlitz River.

10.3.2.2. Hatcheries

The majority of M&E hatchery efforts are currently focused on basic data collection such as broodstock biosampling, tracking the loss of fish during the rearing period (between green egg and mass marking), assessing results from CWT returns, and counting juveniles as they exit the lakes at the Cowlitz Trout Hatchery. Moving forward, greater emphasis should be put on assessing different release sizes and timing for hatchery programs that are currently underperforming. Before any such actions are taken, it is critical to fully understand the performance of existing programs based on adult returns and CWT returns. The broodstock

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biosampling yields a great deal of data for the hatchery programs and for the natural-origin populations when the hatchery program is integrated. Fish are sampled for scales, otoliths, and genetics; measured; and sexed. This process is especially important for natural-origin fish as it is often difficult to recover carcasses from the spawning grounds. Finally, the tracking of fish from green eggs to smolt release is critical to understand the performance of juveniles in the hatchery. Currently, there is considerable uncertainty about where loss is occurring in the salmon and trout hatcheries. Significant effort has been placed on evaluating survival of steelhead in the lakes at the trout hatchery, as this was believed to be an area of high loss; however, the first 3 years of study have suggested loss rates of less than 10%. This result emphasizes the need to gain a better understanding of loss occurring between the green egg stage and mass marking to improve hatchery performance.

10.3.2.3. Fish Transported Upstream

Due to the utilization of a trap-and-haul system in the upper basins (Tilton River/Cispus River/upper Cowlitz River), most information currently comes from fish collected at the Barrier Dam and transported upstream by truck to release sites above Mayfield Dam. The number and hatchery-origin/natural-origin composition of the fish to be released at each site, as well as targets for harvest rates and subsequent pHOS of actual spawners, are determined in the Annual Operating Plan (see Chapter 12). Through 2019, the number of jacks and adults transported upstream has been treated as a proxy for the number of spawners, as no additional data have been collected.

10.3.2.4. Tilton River/Mayfield Dam Counting House

Data on juveniles from the Tilton River come from migrants that are collected at the Mayfield Dam Counting House. The facility allows staff to count or estimate from subsample all juvenile salmon passing through the facility, implant CWT or other tags as appropriate, take scales and genetic samples, and measure and weigh salmon. At Mayfield Dam, downstream migrants not guided by the louver system into the bypass system pass the dam through the turbines or spillways. Those that survive dam passage continue their migration in the lower Cowlitz River, passing over the Barrier Dam and eventually making their way to the Columbia River and then the Pacific Ocean.

10.3.3. Upper Cowlitz Basin/Cowlitz Falls Fish Facility

Data on juveniles from the Upper Cowlitz Subbasin primarily come from migrants that are collected at the Cowlitz Falls Fish Facility. This facility allows staff to count or estimate from a subsample of all juvenile salmon passing through the facility, implant them with CWT or other tags as appropriate, take scales and genetic samples, and measure and weigh juveniles. At the Cowlitz Falls Fish Facility, only juveniles collected through the flumes or the North Shore Collector are transported downstream. Fish that are not collected at the Cowlitz Falls Fish Facility pass Cowlitz Falls Dam via spill or the turbines and end up in Riffe Lake, where they are considered to be lost to anadromy.

10.3.4. Monitoring Priorities

The main determination questions are:

1. Is the information needed to evaluate population viability and progress toward recovery?
2. Does the parameter affect our program decisions?
3. Is there significant uncertainty about the assumed value?
4. Can the parameter be estimated within the timeline required within the management need?
5. What are the estimated costs of the study relative to the benefits it provides, and is it a priority in relation to existing evaluation efforts? Are there sufficient resources and funding available to accomplish the new study or do other studies have a greater priority?

If a topic answers "no" to all five of these questions, it will no longer be considered for assessment/monitoring. The focus will be on natural populations classified as Primary or Contributing in the Lower Columbia Fish Recovery Plan (LCFRB 2010). Although Stabilizing populations will not be ignored, they are not the focus for monitoring priorities. All hatchery populations will be monitored with respect to their effects on conservation and harvest as well as performance effectiveness.

10.4. Baseline Studies

Baseline studies fulfil the data needs for monitoring population viability, which can be accomplished with life cycle models. These models can be complex or simple. In their simplest form, a single-stage adult-to-adult model is used. For all stocks/populations above Mayfield Dam, we will strive to collect enough information to run a two-stage life cycle model. The benefit of using a two-stage life cycle model, rather than a single-stage model, is that we can compartmentalize covariates to the adult and the juvenile stages and test additional hypotheses. A single-stage life cycle model dictates the assumption that a covariate is affecting the species or population at some point from adults returning to the progeny of those adults returning as adults.

Juvenile abundance will be estimated annually for all populations in the Tilton Subbasin, as well as the Upper Cowlitz Subbasin (above Cowlitz Falls Dam). These estimates will serve as indicators of juvenile production and as the starting point for SAR estimates for all populations.

The Big Table and Condensed Big Table in each population section identifies the most recent 5-year means, FHMP goals, and minimum viability abundance targets for all of the parameters necessary to complete a two-stage life cycle model (Table 10-1). Additionally, the data gathered to populate the Big Table Dataset make it possible to calculate and understand VSP metrics (abundance/productivity/spatial structure/diversity) for each population. It is not currently possible to collect all the necessary data to operate a two-stage life cycle model for all species and populations in the Cowlitz Basin. For species and their corresponding populations in the Lower Cowlitz Subbasin, an adult-to-adult frame will be used due to difficulties associated with estimating juvenile abundance.

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10.5. Directed Study Examples

Directed studies are projects designed to address uncertainty or key issues/data gaps with a single or multiyear study; however, they are not ongoing work that will be continued in perpetuity. A good example of a directed study would be an assessment of water quality (ozonated water, untreated river water, and diluted river water) on the rearing of steelhead at the Cowlitz Trout Hatchery. The study would address a current data gap of concern, the duration would be on the order of 1-3 years, and a specific recommendation would result from completion of the study.

Another major focus of directed studies is to assess ways to address best practices for program management issues. Ideally, we would assess several strategies to manage a perceived program issue to determine the approach that has the greatest efficacy and is the most efficient use of resources.

Many directed study topics have already been identified and will be included in the Monitoring Plan. Another way to think about directed studies would be through examination of the entire Big Table Dataset (Appendix A), which serves as a source of data and a way to easily identify existing data gaps by species, population, and origin. Numerous metrics are identified in the Big Table Dataset, and data are not currently available for many of them; these are the data gaps that baseline and selected directed studies will address and fill (see Appendix C, Summary of Data Gaps and Potential Future Monitoring Needs). If the parameter has not been identified as a baseline study, we would consider it to be a directed study. The topics of greatest uncertainty and potential to affect the program are the following:

- Population identification.
- Hatchery Program performance.
- pHOS management tactics.
- Issues that will require multiple years of data collection before initial results are available.

10.6. Annual Work Product

The annual work product from the M&E efforts will be data inputs into the Condensed Big Table, Big Table, and the FHMP Annual Status Update Report that describes the results of the previous year's monitoring effort throughout the basin and how these relate to population recovery and other specific Settlement Agreement requirements and objectives. This should also include a list of remaining data gaps and key questions that are identified as priorities to address. The preliminary results from the M&E efforts will be disseminated during the Annual Science Conference in early spring to inform the Annual Program Review (APR) and future fisheries management, hatchery management, and Monitoring Plan. This annual APR process will use the information collected each year and test it against FHMP Decision Rules and fish management strategies. Additional data needs and the monitoring needed to address them will be identified from this annual process (as further described in Chapter 12) as necessary.

The Big Tables will primarily serve as a "data warehouse" (see Appendix A, Big Table Dataset). In many cases, data that populate the Big Tables will come from other regional databases where the data are formally housed (i.e., Coordinated Assessments, RMIS, PTAGIS, WDFW FishBooks, etc.). The Big Table Dataset will identify the source of the data it stores. While the FHMP Annual Status Update will not be available until December, the Big Table Dataset will be updated continuously, as the data are collected, to ensure that the most current data are available to all managers and interested parties.

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Table 10-1: The following is a draft example of the values that could be included in a Condensed Big Table. This table would summarize data used to create decisions tools and life cycle models.

Metric	Current (5-year Mean) HOR/NOR	FHMP Goal HOR/NOR	Long-term (Recovery Plan) HOR/NOR
Total Adult Abundance	61,519	#	#
Hatchery-origin	46,281	#	#
Natural-origin	15,238	#	#
Total Adults to Mouth of Cowlitz River	28,360	#	#
Hatchery-origin	16,721	#	#
Natural-origin	11,639	#	#
Hatchery Broodstock (spawned; all ages)	829	#	#
Hatchery-origin	274	# (not %)	# (not %)
Natural-origin	556	# (not %)	# (not %)
pNOB (Effective = spawned; all ages)	0.695	>0.5	1
Adult Spawners in Nature	10,641	# (not %)	# (not %)
Hatchery-origin	8,131	# (not %)	# (not %)
Natural-origin	2,510	# (not %)	# (not %)
pHOS (Effective = spawners in nature)	0.761	<0.4	<0.2
PNI (Effective)	0.448	>0.55	>0.8
Smolt Abundance	1,087,693	#	#
HOR (Smolts Released)	958,815	#	#
NOR (Released into lower Cowlitz River)	128,878	#	#
Smolt Collection Efficiency	76%	%	%
Smolt Passage Survival (FPS)			
Smolt-to-Adult Survival			
Hatchery-origin	?	%	%
NOR (if unavailable, presumed higher than HORs)	?	%	%
Mean Age			
Hatchery-origin	?	#	#
Natural-origin	?	#	#
Precocious Maturation Rate			
Hatchery-origin	?	%	%
Natural-origin	?	%	%
Natural-origin Productivity			
Smolts / spawner	18.8	>1 No decrease?	
Adults + Jacks / spawner	?	Density dependence?	
Total Harvest (from all fisheries)	27,987	#	#
Hatchery-origin	25,687	#	#
Natural-origin	2,299	#	#
Harvest (% of total adult return)	64%	%	%
Hatchery-origin	75%	%	%
Natural-origin	19%	%	%

CHAPTER 11:
OTHER RELATED ISSUES

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11. Other Related Issues

11.1 Resident Fish

Fisheries on resident fish are important to many of the angling public. These fisheries are often utilized by a wide demographic of anglers. Also, these fisheries can provide consistent opportunity even during periods of poor ocean conditions, when anadromous salmonid fisheries may be limited. Therefore, it is important that programs to support these fisheries continue.

Article 5.b of the Settlement Agreement states that:

"Through 2004, the Licensee will provide funding for 50,000 pounds of trout production. Subsequent to 2004, future trout production will be based upon a review by the FTC of the success or failure of the program and any impacts on listed stocks."

Rainbow Trout provided by Tacoma Power will be released into the Cowlitz Basin, consistent with the tenets of the Washington Department of Fish and Wildlife Statewide Steelhead Management Plan: Statewide Policies, Strategies, and Actions (WDFW 2008), which states:

1) *Protect wild steelhead stocks from potential interactions with hatchery-origin Rainbow Trout:*
    a) *Hatchery-origin Rainbow Trout shall not be released in anadromous waters.*
    b) *Hatchery-origin Rainbow Trout shall not be released in lakes if the release would result in significant negative impact to wild steelhead.*
2) *Protect wild steelhead stocks from importation, dissemination, and amplification of pathogens by adhering to the "Salmonid Disease Control Policy of the Co-managers of Washington State."*

It is important that Rainbow Trout from the Resident Fish Program do not interact (spawn) with natural-origin steelhead in the Cowlitz Basin. During the period covered by this FHMP, the FTC will prioritize the need to evaluate potential effects of planted Rainbow Trout, particularly in areas used by natural-origin winter steelhead. If this is determined to be a priority, the M&E Subgroup will recommend approaches to monitor the key metrics of concern. Specific resulting modifications to management (e.g., production and harvest) will be developed at the Annual Program Reviews and included in each year's Annual Operating Plan.

In addition, based on input received during the public review and comment period for the draft FHMP, Tacoma Power will consider alternative approaches to resident fish management in addition to, or instead of, Rainbow Trout production. As program options become available for alternative fisheries, Tacoma Power and the FTC will evaluate their feasibility and applicability to the FERC license and the resident fish program.

11.2 Nutrient Enhancement

11.2.1. History

Prior to the initiation of extractive fisheries in mid-to late-19th century, the Cowlitz River watershed received an annual influx of marine-derived nutrients, which are an important component of Pacific Northwest anadromous salmonid ecosystems that fueled the entire watershed ecosystem (Stockner 2003). Initiation of extractive fisheries and construction of dams led to the dramatic reduction in the amount of marine-derived nutrients delivered to the Cowlitz Basin (Stockner and Ashley 2003). As a result, the productivity and capacity of aquatic and terrestrial ecosystems within the Cowlitz Basin were diminished, as they are directly correlated with the amount of marine-derived nutrients brought to the basin by spawning salmon. Historically, highly abundant Chum, Chinook, and Coho Salmon populations likely supported the majority of marine-derived nutrient delivery to the Cowlitz Basin.

11.2.2. Nutrient Delivery

WDFW has developed a protocol for the design, implementation, monitoring, and reporting of the distribution of carcasses to supplement nutrient levels in streams. Currently, nutrients are being delivered by hatchery- and natural-origin salmon on the spawning grounds. In the future, managers may decide to use further nutrient enhancement as a tool to increase juvenile abundance and condition in specific streams. Ultimately, re-building robust natural-origin salmonid populations in both the upper and lower Cowlitz River is the goal for re-establishing adequate nutrient delivery to the ecosystem.

11.2.3. Proposed Actions

While live salmon are the best way to achieve a more even distribution, some of the required nutrients may need to be delivered via salmon carcasses (from hatchery spawning and surplus; carcass analogs may be used, if available). In some instances, HSRG guidelines may be used as an indicator to determine that existing limits on pHOS levels for some species preclude maximizing nutrient enhancement using live salmon. Additionally, current WDFW policy directs all food-quality salmon carcasses in excess of broodstock and transport needs to be distributed to food banks, which may limit the availability of carcasses available for nutrient enhancement projects.

During this FHMP period, the nutrient enhancement strategy will be reviewed and improved as necessary. Currently, distribution of spawned fall Chinook and Coho Salmon carcasses into the upper Cowlitz and Cispus rivers by Cowlitz Salmon Hatchery staff is the only nutrient enhancement action being undertaken. If additional carcasses are to be distributed into streams for nutrient enhancement, the M&E Subgroup will develop protocols for that action for review by the FTC. Tacoma Power and WDFW, along with regional fishery enhancement groups and other volunteers, will coordinate and conduct the carcass distribution.

11.3 Off-Station Programs

11.3.1. Satellite Rearing Facilities

The use of satellite ponds for acclimation and release of hatchery juveniles above Cowlitz Falls Dam could serve to direct returning adults to the vicinity of their point of release.

This could be used as a temporary tool for accelerating the colonization of unused habitat (i.e., a recolonization strategy). In this case, the strategy would involve selecting tributaries with suitable habitat, acclimating and releasing juveniles in temporary facilities, allowing the returning adults to spawn, monitoring spawner abundance and distribution, and terminating the releases after a few years. The other application of this strategy would be to encourage the return of hatchery fish transported above Cowlitz Falls Dam to locations where they would be available for harvest at a high rate (i.e., a selective harvest strategy). The selective harvest strategy would differ from the colonization strategy in that the objective would be to remove as many of the hatchery fish as possible through harvest. The acclimation ponds would be located where harvest opportunities would be greater and/or the likelihood that unharvested hatchery-origin fish would be unlikely to co- mingle with natural-origin spawners. The harvest strategy could be a more long-term one if it incorporates the ability to remove those hatchery fish that are not caught in the fishery. A consequence of releasing hatchery fish in the upper basin, whether for harvest or recolonization, may be a reduced survival from smolt to adult, because of the reduced Fish Passage Survival. Alternately, outmigrants acclimated to the upper basin may also prove to express higher fitness and return more adults, with broader life history patterns resulting in greater population viability. Smolts released from the acclimation ponds would have to be evaluated for their success. If the fish reared in acclimation ponds in the upper river were transported and released below the Barrier Dam, fish passage loss and ecological interactions in the upper watershed could be avoided, but potential benefits of natural rearing may not be realized.

During the period covered by this FHMP, Tacoma Power will initiate the planning for the satellite rearing facilities, including inception (finalizing what they will be used for), location, and design phases.

11.3.2. Other Out-of-Basin Programs

WDFW has a long history of providing salmonid eggs and/or juveniles to cooperative volunteer groups for Salmon in the Classroom programs, remote site incubators (RSI), and net pen programs throughout Washington, including the Cowlitz Basin. These programs have long been used to advance community interest in salmon/steelhead abundance, engage stakeholders in the propagation of natural resources, and, in some cases, increase harvest opportunity. WDFW also has an obligation to uphold State of Washington agreements (e.g., U.S. v. Oregon Management Agreement, Columbia River Policy) for the use of the State’s fish resources. However, these programs and agreements may also pose a risk to recovery of listed salmonid species in the Cowlitz Basin, and therefore must be reviewed and implemented carefully.

Three types of off-station programs have been supported by the Cowlitz Salmon and Cowlitz Trout hatcheries:

- **In-basin**
    1. Remote site incubators (RSIs)
    2. Net pens/smolt acclimation sites
- **Out-of-basin**
    3. Net pen/egg transfers (for Select Area Fishery Enhancement [SAFE] program net pens)

11.3.3. Remote Site Incubation (RSI)

The use of RSIs, in which eggs are collected at the hatchery and placed in stream-side incubators where they are allowed to hatch and rear in the natural environment, can pose both benefit and risk to natural-origin populations. As part of the 2011 FHMP, Coho Salmon RSIs supported by WDFW cooperative agreements with volunteer organizations were identified for review and phase out. WDFW completed a review and ultimately phased out Coho Salmon RSI programs. Remaining cooperative agreements are focused on egg transfers for small educational programs. During the review process, WDFW identified the pros (benefits) and cons (risks) associated with use of RSIs.

Pros:

- May increase egg-to-fry survival above rates found in the natural environment.
- May increase the local abundance of juvenile salmon.
- May help to distribute juvenile salmon throughout a watershed.
- May reduce “domestication” effects associated with longer term in-hatchery rearing of juvenile salmon.
- Can be fairly low cost – especially with volunteer help.

Cons:

- May not augment harvest in lower Columbia River and tributaries.
  - These fisheries are generally mark-selective (harvested fish must be adipose fin-clipped).
  - Cannot clip adipose fins on RSI-produced fish because they are distributed as eggs (special facilities are needed to safely clip adipose fins at hatcheries).
- May result in competition with natural-origin juvenile salmon.
  - Especially for fully seeded natural-origin populations of salmonids, which have a stream-rearing life history pattern (i.e., spring Chinook Salmon, Coho Salmon, and steelhead).
- May not increase total adult salmon abundance.
  - Fry abundance may not always be the limiting factor in the salmon life cycle, as poor survival of juveniles and adults often keeps populations from expanding.
- May have lower survival than natural-origin fry or direct plants of hatchery-reared fry.
- May pose genetic risks to natural-origin populations if adult returns spawn in the wild; these risks may outweigh benefits to natural-origin populations.
- Risk of catastrophic loss of eggs during incubation at RSI sites.
  - Causes could include flooding and loss of water in egg boxes.
  - RSIs require consistent water source, secure location, and regular monitoring.

  - Survival to release may be higher if fry are raised and released at hatchery facilities, and these fish could be available for harvest.
- Lack of marking complicates monitoring of natural-origin salmon populations.
  - Need to be able to track recovery of natural-origin populations, including accurately estimating pHOS.

In some areas, RSIs have been shown to be a benefit to Chum Salmon (an ESA-listed species in the Cowlitz Basin) and Pink Salmon populations, especially as a means of reintroduction (WDFW and Point No Point Treaty Tribes 2000). Chum and Pink Salmon do not rear extensively in freshwater, so in-basin competition between RSI juveniles and natural-origin salmon is thought to be minimal.

11.3.4. In-basin Net Pens

In-basin net pens are used, where hatchery-origin juveniles are reared (usually until smolted) and then released into the natural environment to continue their outmigration, to produce returning adults that are imprinted to a location different than normal hatchery-origin adults. To date, Cowlitz River in-basin net pens have generally been used to bolster abundance beyond hatchery facility capacity for both harvest and recovery benefits. When used in areas below the Barrier Dam (i.e., Lower Cowlitz Subbasin), these adults may not return to the hatchery with the same level of homing fidelity (they may have a higher stray rate), so they may pose a genetic risk to natural populations because they generate more hatchery-origin salmon on the spawning grounds (increased pHOS) than salmon that are directly released from the hatchery.

The HSRG made the following observations regarding the use of net pens and the practice of outplanting salmonid juveniles (HSRG 2004):

> "*Tagging and genetic studies have shown that outplanting and net pen programs promote stray rates that far exceed natural levels...*"

The HSRG further noted that:

> "…*Outplanting and net pen releases from segregated hatchery programs are especially problematic because of the potentially high level of genetic divergence between the hatchery stock and natural populations where straying and natural spawning may occur. Although the natural spawning success of hatchery-origin fish may be less than that of natural-origin fish when they occur in the same stream, those same data indicate that significant numbers of hatchery-origin fish from nonnative or long-standing "domesticated" populations do indeed spawn successfully and can contribute significant numbers of progeny to naturally spawning populations..."*

For areas above Mayfield Dam, net pens may not impact (and may increase) fidelity of returning fish to the Barrier Dam, but are also subject to more handling and/or re-collection impacts prior to release in the lower river.

11.3.5. Out-of-Basin Net Pens/Egg Transfers

Historically, the Cowlitz Salmon Hatchery has also provided an egg source for out-of-basin net pens for fishery enhancement (i.e., the SAFE program). It is WDFW's perspective that this program poses very low risk to Cowlitz Basin populations and provides alternative commercial fishing locations that reduce the harvest rates on all natural populations in the lower Columbia River tributaries, including potentially reducing impacts on Cowlitz River populations. However, during this FHMP period, Cowlitz Basin program needs, including both recovery and harvest objectives, will be prioritized by developing a surplus plan as part of the spring Chinook Salmon, Coho Salmon, and winter steelhead Transition Plans to define fish/egg disposition and harvest objectives, minimum escapement targets, hatchery surplus disposition, and associated triggers. At times, management authorities may need to be exercised to accommodate State obligations for out-of-basin programs requiring out-of-basin transfer of fish and/or gametes. In these circumstances, the fish and/or gametes will be clearly communicated to the FTC as surplus. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma Power may oppose the surplus.

11.4 Actions

During this FHMP period, newly proposed Cowlitz Basin RSI programs will need to be evaluated to determine their impact (both benefits and risks) to the species being proposed for propagation, and their impact on other naturally produced fish populations prior to implementation. The recovery benefit through reintroduction to vacant or underutilized habitat must outweigh the risks to recovery of natural-origin populations. The “pros and cons” described above can be used as guidance for evaluating these programs.

During this FHMP period, existing in-basin smolt acclimation net-pen programs in Mayfield Lake and downstream of Mayfield Dam will be evaluated for conservation and harvest benefits. If new smolt acclimation net-pen programs are proposed (above or below Mayfield Dam), the benefits to bio-programming at the hatchery, recovery efforts within the basin, and harvest benefits and risks associated with straying will be balanced prior to implementation.

Out-of-basin egg, juvenile, or adult transfers may continue in the future, subject to an agreement between Tacoma Power and WDFW on the costs of these programs, provided the effects on conservation, recovery, and production objectives are fully accounted for. During this FHMP period, plans will be developed within 1 year of completion of the FHMP to prioritize in-basin programs focused on recovery and harvest before considering the export of fish or gametes to out-of-basin programs at the possible detriment of FHMP goals, whenever possible. Until this plan is finalized by the FTC, existing programs will be supported on a case-by-case basis to meet both in-basin and regional obligations. If gametes are exported from the basin, they will be identified as surplus to the FTC by WDFW. If these management actions could negatively impact the ability for Settlement Agreement goals of achieving recovery and harvest opportunity in the Cowlitz Basin, Tacoma may oppose the surplus.

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CHAPTER 12:
ADAPTIVE MANAGEMENT

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12. Adaptive Management: Annual Program Review and Annual Operating Plan

As described in the Columbia River hatchery reform systemwide report, "The management of hatchery programs is an ongoing and dynamic process" that must be "adapted to changing circumstances and new information" (HSRG 2009). Adaptive management is a resource management policy that seeks to improve the management of biological resources through a process where management actions and strategies are adjusted based on new information, which comes from monitoring data that are properly collected and rigorously evaluated. It is a cyclical, structured, and iterative process of decision making. There are five steps in this process and each step is conducted during each decision-making cycle (Figure 12-1):

1) Conduct Program & Collect Data (Hatchery Operations; Management Activities; Monitoring & Evaluation; and Monitoring Plan)
2) Data Analysis (Monitoring & Evaluation)
3) Reporting Results (Cowlitz River Annual Science Conference & Annual Reports)
4) Decision making (Annual Program Review [APR])
5) Planning (Annual Operating Plan [AOP])

Because new information is brought into each cycle, monitoring and evaluation are emphasized. Adaptive management "seeks to improve the management of biological resources by viewing program actions as vehicles for learning" (IHOT 1995). Therefore, management actions are designed, implemented, and monitored as experiments, so that even if they fail, useful information is obtained that can be used to improve future programs and strategies. The adaptive management process allows managers to better understand the interaction of different elements of the system, to better monitor program status, and when necessary and depending on the response of the population, adjust specific parts of programs (e.g., harvest or broodstock collection), thereby maintaining our trajectory toward the ultimate goal of population recovery and harvest opportunity. Annual reports will document the program's results for each year and the success of the program in achieving the goals set in the AOP and, more broadly, progress toward achieving long-term program goals.

The APR is when adaptive management is applied. The APR is a process that allows managers to examine how the program is performing each year, make appropriate changes, and plan for the coming year and beyond, which is documented in the AOP. Development of the AOP is comprised of four steps that lead to the development of a scientifically defensible AOP, which guides the operation of each program for the coming year and into the future (Figure 12-2):

- **Step 1: Update Key Metrics -** Compile empirical data from program M&E activities.
- **Step 2: Update Status and Trends -** Evaluate the direction of key program metrics and progress toward achieving long-term program goals.

Information from Steps 1 and 2 will be presented at the Cowlitz River Annual Science Conference and in annual reports to FERC.

- **Step 3: Annual Program Review –** Review progress toward and, if necessary, update Decision Rules and set annual management targets for the coming year.

- **Step 4: Write the Annual Operating Plan (AOP) -** An action plan that details the management strategy for achieving the management goals (e.g., pHOS, broodstock collection, pNOB, hatchery production) for the coming season for each population. This is the guiding document for all management activities (hatchery production, harvest, and population management actions) to be conducted in the next year.

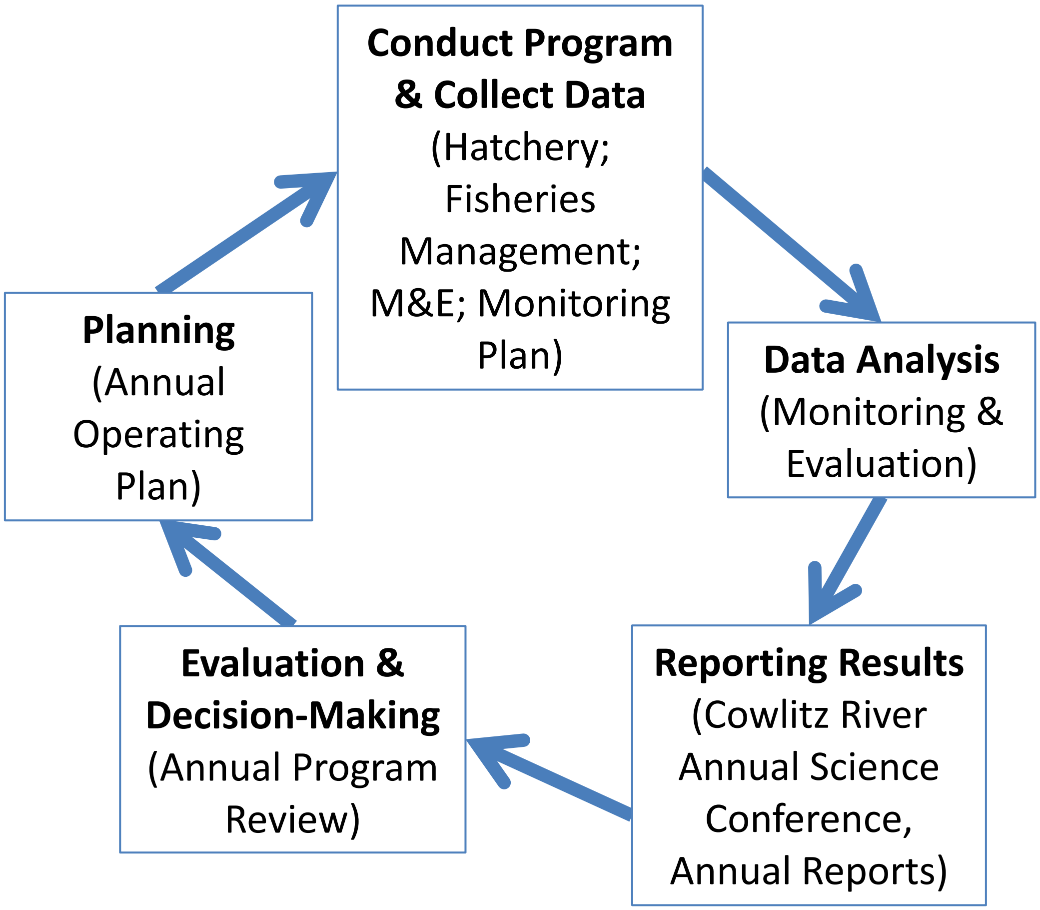

Figure 12-1. The annual adaptive management cycle.

Information obtained during the season may also be used to adaptively change management activities. In summary, the APR is the process that we use to develop the AOP, and M&E is the tool for producing the information required to inform the APR process, allowing managers to “adaptively” manage the programs and the populations they support.

The first two steps in this process include key metrics, which are the assumptions that we are using for planning purposes, status and trend information that shows progress toward achieving goals, and a set of Decision Rules (triggers) that prescribe the appropriate management action given the goals, the assumptions, and the forecast for the coming season. We will adaptively manage these management actions and programs, as directed by the Settlement Agreement and license, and as recommended by the FTC (HSRG 2009; NMFS 2013; WDFW and LCFRB 2016).

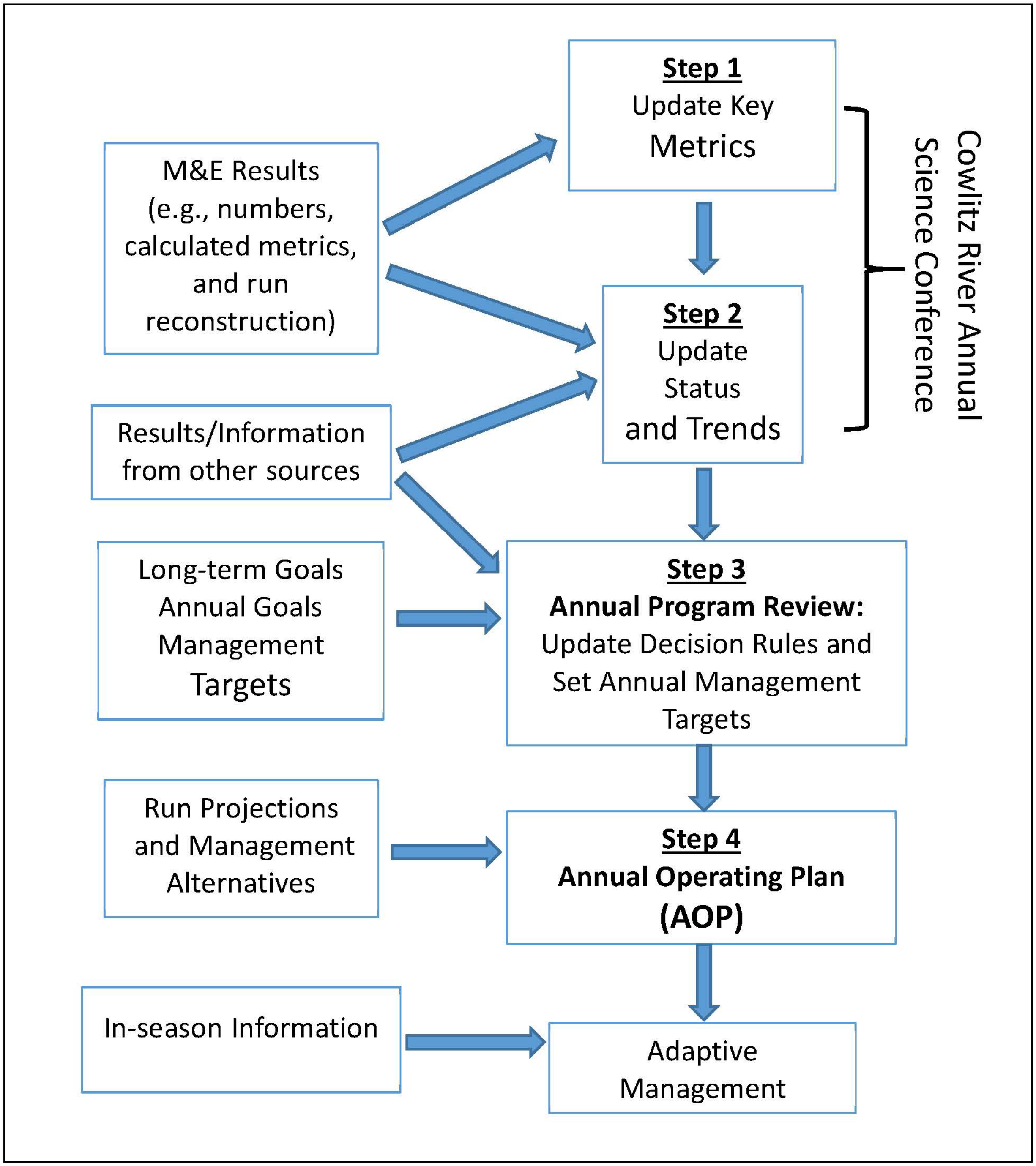

Figure 12-2. Components of the Annual Program Review and development of the Annual Operating Plan.

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12.1. Annual Program Review (APR)

The key to achieving APR adaptive management process resource goals over time is to (Tacoma Power 2013):

a) Assemble the most recent and relevant information, and

b) Use this information to manage and operate fisheries, hatcheries, and the monitoring program in a manner that is consistent with the established guidelines.”

12.1.1. Purpose

The purpose of the APR is to evaluate the Cowlitz River fisheries programs, make necessary and appropriate changes, and produce an AOP that guides the program through the coming year, thereby ensuring progress toward the long-term goals for recovery (healthy and harvestable) of these natural-origin anadromous salmonid populations. The AOP incorporates information from the M&E Program and from outside sources, to complete the adaptive management loop (Figure 12-1), ensuring that the most recent information is used to guide decisions. The APR process also provides an important opportunity to inform and engage the public.

12.1.2. Process and Timeline

The annual decision-making process centers on a pre-season APR workshop to be held in March, under FTC guidance. Before the workshop, key metrics and trends are compiled and the status of each population is updated (Figures 12-1 and 12-2). At the workshop, the key metrics, status information, and trends are examined and Decision Rules are reviewed and modified, as needed. This is then translated into an AOP that will be presented in May and finalized by June. Because spring Chinook Salmon begin returning to the Cowlitz River (and broodstock collection begins) in March, it may not be feasible to include data from the same year within the annual process; in such circumstances, the data will be included in the following annual process (Figure 12-3).

Prior to the APR workshop, Tacoma Power and WDFW will collaboratively update the key metrics and status and trends for each population, based on hatchery operations, fisheries management strategies, and monitoring and evaluation data from the most recent five seasons and the scientific literature. The data and derived metrics for each population are maintained in the Big Table Dataset (Appendix A). The data will be compared with the Decision Rules, a set of triggers that set the management targets for each population for the coming season. Barring extraordinary circumstances, the Decision Rules will only be updated during FHMP revisions or through a challenge and review process led by the FTC (Table 12-1). In other words, decisions will change each year because of new information, but the rules for making those decisions will remain unless strong evidence is provided to change them and the FTC agrees.

As described in Section 1.2, Fisheries and Hatchery Management Plan (FHMP), Tacoma Power is proposing an amendment to change the interval for revising the FHMP. Rather than the current 6-year revision process as specified under License Article 6 and FERC’s 2004 Order Amending New License, the FHMP will be revised every 10 years, with input and support from the FTC.

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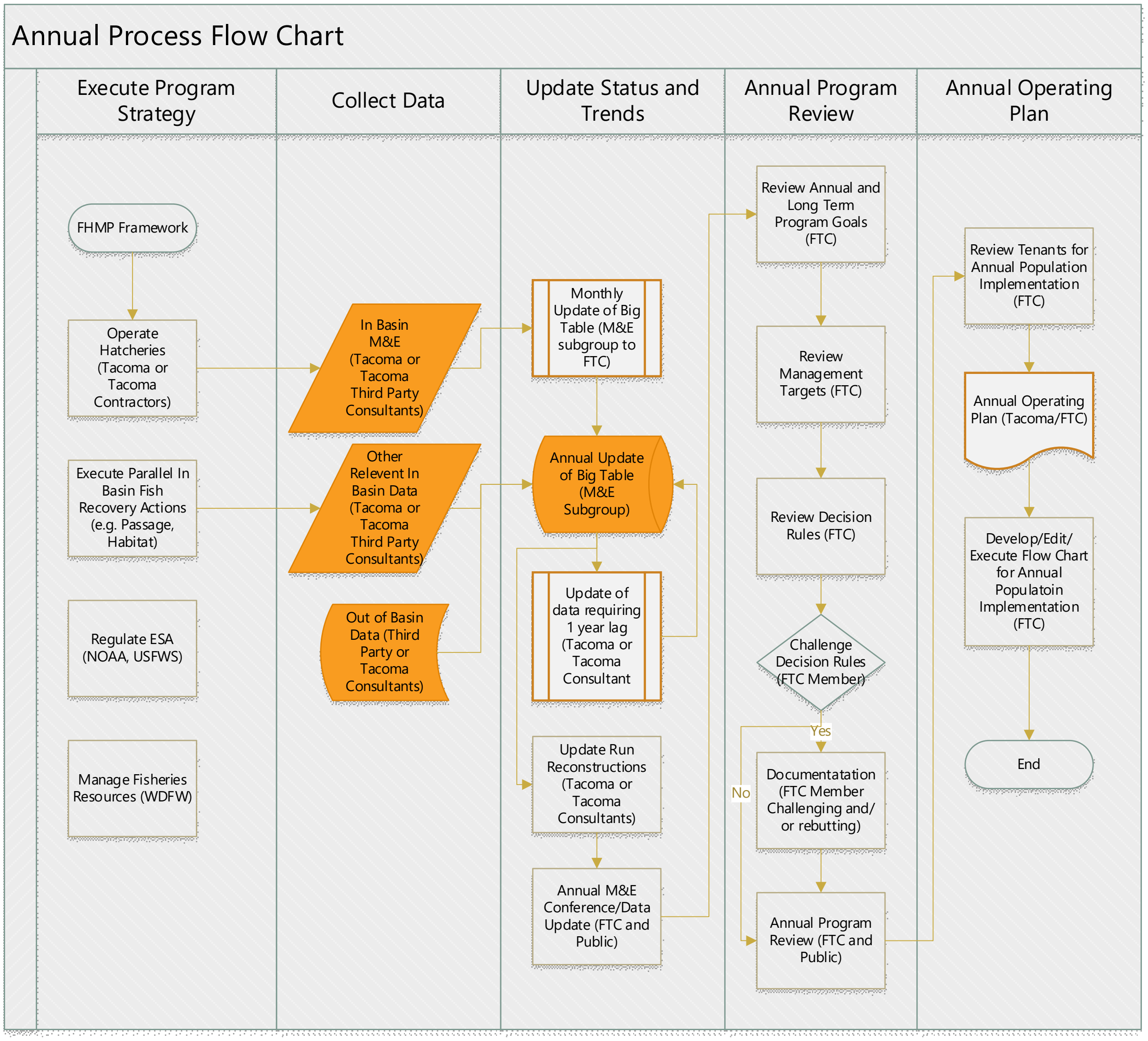

Figure 12-3. Annual Process Flow Chart for implementation of FHMP framework, data collection, analysis, Annual Program Review, and development of Annual Operating Plan.

Table 12-1. Process to challenge Decision Rules

Driver	Process Step
Need to challenge existing Decision Rule identified by Settlement Agreement signatory.	Written challenge presented to FTC supported by literature and /or fish management practices.
Other FTC members disagree with Decision Rule challenge.	Written opinions describing concerns with supporting literature and/or fish management practices provided.
If more information is required.	Third party engaged for further information.
Modification or decision not to modify Decision Rule.	Documented by FTC.

12.1.3. Decision Rules

Decision Rules are biological targets that define the triggers which induce changes in management strategies. They are based on the key metrics described in Chapters 3-9 and ensure an appropriate management response to annual variation in those key metrics. The Decision Rules will be set during development of the Transition Plans (Appendix B) for various metrics and will vary, depending on natural-origin adult abundance to the spawning grounds (for Lower Cowlitz Subbasin populations) or to the Barrier Dam (for populations above Mayfield Dam). These Decision Rules will be incorporated into a simple spreadsheet model or similar tool. This information will then be used to create a population-level annual management plan of the full suite of anticipated scenarios (to be developed; see Section 12.2, Annual Operating Plan). The AOP, as agreed-upon by the FTC, will dictate the management targets given a known or predicted value of a specific metric. Using the minimum viability abundance targets, key metrics, hatchery production goals, and pre-season run projections to the Barrier Dam for a specific population, a sliding scale is an example of one tool that may be used to inform the FTC with the appropriate management target, such as harvest rate, numbers of hatchery-and natural-origin salmon to collect for broodstock and to spawn for a given hatchery program, or the numbers of hatchery-origin salmon to transport upstream (Section 12.2.3).

These management targets constitute the foundation of the operating plan for the coming season and will be documented in the AOP. The Decision Rules are developed collaboratively and are designed to generate management targets that drive the population toward the biological targets that will constitute recovery. They ensure that a consistent strategy is applied over time and provide the flexibility to adjust management targets at regular intervals in response to variations in population dynamics, allowing managers to optimize progress toward conservation goals and, when allowed, sustainable harvest. The Decision Rules will be reviewed annually (at the APR) and may be re-evaluated whenever Settlement Agreement signatories deem it to be necessary.

12.1.4. Development of Decision Rules and Transition Plans

As described in Chapters 3-9 (above), during the period covered by this FHMP, the intent is to develop Transition Plans for the fall Chinook, spring Chinook, Coho Salmon, and winter steelhead programs in order to continue recovery efforts. One of the critical steps in the development of Transition Plans is the development of key Decision Rules (Appendix B). The development of these Decision Rules will require an analysis of high-level limiting factors to determine critical thresholds to shift recovery phases and associated management actions and programs. Some of these programs may implement a sliding scale approach, as described in the example presented in Table 12-2, while others will likely require consideration for additional triggers associated with harvest management, spatial distribution, broodstock integration, and other key transition considerations.

A summary of the proposed transitions for each program, the timing to develop the Transition Plans, and the interim strategies and consideration for implementation while the Transition Plans are being developed is described in Table 12-2. For additional information on information to be included in the Transition Plans, see Appendix B.

Table 12-2. Summary of the planned transitions for each program during this FHMP period, the timing to develop the Transition Plans, and the interim strategies and actions for consideration while the Transition Plans are being developed.

Species	Planned Transition: Current Hatchery Program	Planned Transition: Proposed Hatchery Program	Transition Plan Development	Interim Strategy	Potential Actions During Interim through APR
Fall Chinook Salmon	Lower Cowlitz Subbasin: • Integrated - 1.1 million sub-yearling smolts. • Segregated - 2.4 million sub-yearling smolts.	Tilton Subbasin: • Integrated - 3.5 million sub-yearling smolts.	Within 1 year following submittal of FHMP.	• Use APR process to determine best broodstock collection strategy based on available preseason information. • Develop White Paper describing various perspectives to be considered during development of Transition Plan.	• Increase maximum available transport to Tilton Subbasin so that it is not limited at 1,600. • Evaluate current strategy of using net pens at Mayfield Dam for Fall Chinook Salmon.
Spring Chinook Salmon	Upper Cowlitz Subbasin: • Segregated - 1.8 million yearling smolts.	Continue segregated program while developing a Transition Plan for integrating a portion of hatchery production, and eventually moving to a fully integrated program.	Within 1 year following submittal of FHMP.	• Operate hatchery programs as in 2019.	• Evaluate potential for modifying adult release strategies above Cowlitz Falls. • Develop Study Design to gain clarity on life history strategies of returning adults at separator.
Coho Salmon	• Lower Cowlitz Subbasin, Segregated, 1.2 million yearling smolts. • Upper Cowlitz Subbasin, Integrated, 978,000 yearling smolts.	• Upper Cowlitz Subbasin, Integrated, 2.2 million yearling smolts (short-term). • Upper Cowlitz Subbasin & Tilton Subbasin, Integrated, 2.2 million yearling smolts (long-term).	Within 2 years following submittal of FHMP.	• Operate hatchery programs as in 2019.	• Evaluate potential for modifying adult release strategies above Cowlitz Falls. • Increase maximum available hatchery transported to Upper Cowlitz Subbasin so that it is not limited to 25,000. • Consider increases to transport limit to the Tilton (currently 6,000).

Species	Planned Transition		Transition Plan Development	Interim Strategy	Potential Actions During Interim through APR
	Current Hatchery Program	Proposed Hatchery Program			
Winter Steelhead	• Lower Cowlitz Subbasin, Late-Winter Steelhead, Integrated, 478,000 yearling smolts. • Upper Cowlitz Subbasin, Late-Winter Steelhead, Integrated, 118,000 yearling smolts. • Tilton Subbasin, Late-Winter Steelhead, Integrated, 48,500 yearling smolts.	• Lower Cowlitz Subbasin, Winter Steelhead, Integrated or Segregated, 308,500 yearling smolts. • Upper Cowlitz Subbasin, Winter Steelhead, Integrated, 236,000 yearling smolts. • Tilton Subbasin, Winter Steelhead, Integrated, 100,000 yearling smolts.	Within 1 year following submittal of FHMP.	• Operate hatchery programs as in 2019.	• Evaluate potential for modifying adult release strategies above Cowlitz Falls. • Consider moving to a segregated program in the Lower Cowlitz Subbasin. • Consider relaxing HSRG guidelines during implementation of interim strategies. • Consider pHOS management strategies at Blue Creek including harvest management or barriers. • Consider alternatives to placing live-spawned broodstock into Tilton River.
Summer Steelhead	Lower Cowlitz Subbasin Summer Steelhead Segregated, 650,000 yearling smolts.	Lower Cowlitz Summer Steelhead Segregated – Adjusted 650,000 yearling smolts.	Integral with Lower River Winter Steelhead.	• Operate hatchery programs as in 2019.	• Consider increased recycling in the Lower Cowlitz Subbasin.

12.1.5. Status and Trends

Status and trend monitoring allows managers to evaluate whether the annual goals have been met and whether these populations are progressing toward (and at a satisfactory rate) the minimum viability abundance targets and recovery goals. The results of status and trend monitoring also provide input to the annual review process. Time series of observed values for hatchery performance including smolt-to-adult returns, hatchery effects on life stage survival, size of release, and fish husbandry practices as well as harvest, natural-origin abundance and productivity, pHOS, and PNI will demonstrate progress toward goals, provided that key metrics and our assumptions about them are reasonable and accurate.

12.1.5.1. Conservation and Harvest-driven Rules

The Settlement Agreement states:

> *"Particular emphasis is placed on ecosystem integrity and the restoration and recovery of wild, indigenous salmonid runs to harvestable levels, while also providing significant improvements to area recreational facilities."*

Hatchery broodstock collection and natural escapement/transport above Mayfield Dam will be operated in accordance with a set of pre-determined and agreed-upon Decision Rules described in the Transition Plans (Appendix B). Harvest in ocean, Columbia River, and the Cowlitz River fisheries will also be characterized with potential Decision Rules associated with harvest.

Hatcheries serve different roles for different populations and at different times, often including the purpose of augmenting harvest. For some populations, however, they also serve as gene banks, as tools for recolonization, or as demographic safety nets for imperiled endemic populations. These varying roles are captured in the Decision Rules, which are not expected to change each year. The Decision Rules for each population and each hatchery program are described in Chapters 3-9, above, and summarized in Table 12-1.

12.1.5.2. Rules for Adjusting Overall Hatchery Production to Conform with the 650,000-Pound Standard

Once the Decision Rules have been applied for each population, the overall program must be tested for compliance with the conditions of the Settlement Agreement regarding total production from the Cowlitz Hatcheries and crediting for natural production. The number of hatchery smolts released (hatchery production) is a management variable, but hatchery production is limited subject to conditions in Article 5 of the Settlement Agreement, which states that:

> *"Total hatchery production for all stocks reared at the Cowlitz Hatchery Complex, within the remodeled hatchery, cannot exceed 650,000 pounds, unless a decision is made to abandon the construction of volitional upstream passage during the remainder of the license. The 650,000 pound limit does not include upper basin pre-smolts that may be reared and ponded in the hatchery complex to avoid conflicts with listed species."*

Hatchery production of each species and population will be used to achieve the goals for recovery of listed populations set forth in the Lower Columbia River Salmon Recovery Plan

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(LCFRB 2010) and to provide harvest opportunity. Hatchery production targets will be set annually and will be guided (but not constrained) by the HSRG (2009) guidelines for hatchery influence on endemic populations. The status of naturally produced populations will also affect hatchery production levels. Additionally, this FHMP is written with the intent to maintain flexibility to encourage and accommodate other outside programs.

12.1.5.3. The Crediting Rule

The below text reflects the Crediting Rules as described in the 2011 FHMP. It is anticipated that during the period covered by this FHMP, this language will require updating for consistency and accuracy in order to reflect the new Transition Plans. Updates will be documented in a Crediting Rule Plan. Until these updates have occurred, the 2011 FHMP Crediting Rules will be used.

"The SA requires that the FHMP identify credit mechanisms for the production of high quality natural stocks (Article 6 of the SA). The FHMP proposes a credit mechanism that adjusts hatchery production at the Cowlitz Hatchery Complex based on the number of natural-origin juveniles produced from the Tilton and Upper Cowlitz subbasins. This approach is consistent with Principle 6.1.4 of the SA that states hatchery production numbers are expected to be adjusted downward as wild stocks recover. When originally conceived, the crediting mechanism assumed single populations (stocks) of all species in the Cowlitz Basin (five species total, excluding Chum Salmon). With the completion of the Lower Columbia River Salmon Recovery Plan, the species complex within the Cowlitz River has been delineated to a much finer scale. There are now twelve separate populations among the original five species (excluding Chum Salmon) in the Cowlitz Basin, and adjustments to the original crediting mechanism are warranted. Crediting for the production of natural-origin smolts is possible when they can be captured and transported, which may show a benefit to that specific population, but populations in the Lower Cowlitz Subbasin are not available for capture, and therefore cannot receive a benefit.

The number of juveniles produced from the Upper Cowlitz Subbasin will be calculated at the Barrier Dam. This way, the juvenile estimate includes any losses due to transportation or passage through the dams. The number of natural-origin juveniles from Mayfield would be estimated in the river below the Mayfield Dam.

The juvenile number used each year to set the credit will be based on the most recent 5-year rolling average of juvenile production from the two basins, by species. The 5-year rolling average is meant to account for any large swings in juvenile production that may occur as a result of variability in freshwater habitat conditions, and also to prevent a large reduction in hatchery production that could be required as a result of a single strong year class.

1) *Crediting for naturally produced smolts is an incentive to increase the fish passage survival (FPS) at both Cowlitz Falls and Mayfield dams.*
2) *Credits shall be applied (reduction of hatchery program) on a species-specific and population-specific basis, as defined in the Lower Columbia River Salmon Recovery Plan (LCFRB 2010). Tilton Subbasin populations are an exception (see item 4 below).*
3) *In the event that no hatchery population exists, credits accumulated for that population will remain unused, with the exception of spring Chinook Salmon, where natural-origin spring Chinook Salmon above Cowlitz Falls Dam will be credited against the spring Chinook Salmon Segregated Hatchery Program.*

Until a method is approved and implemented to differentiate sub-yearling migrant spring Chinook Salmon from fall Chinook Salmon in the Upper Cowlitz Subbasin, the number of out-migrating Chinook Salmon juveniles collected will be proportioned to race based on the number of adult fall and spring Chinook Salmon females placed in the Upper Cowlitz Subbasin the prior year. The proportion estimated to be spring Chinook Salmon will be available for crediting. The number estimated to be fall Chinook Salmon will not be available for crediting until and unless a hatchery program is established for that population. All yearling Chinook Salmon migrants collected from the Upper Cowlitz Subbasin will be assumed to be spring Chinook Salmon and credited as such.

4) The Upper Cowlitz Subbasin (including tributary populations above Cowlitz Falls Dam) shall be considered as "Upper River population" and can affect only those hatchery programs developed for those populations. The Upper Cowlitz Subbasin Coho Salmon migrants and Tilton Subbasin fall Chinook Salmon, Coho Salmon, steelhead, and Cutthroat Trout migrants will be credited against the Lower Cowlitz Subbasin hatchery programs (species-specific) to reduce the impacts on hatchery programs for Upper Cowlitz Subbasin populations.

5) In the event that the application of credits (and commensurate reduction in hatchery programs) impacts the ability to achieve the major objectives of the FHMP (conservation and sustainable fisheries), adjustments in the application of credits maybe altered by the FTC (i.e., forego credit or apply credits across populations).

6) A minimum (floor) of hatchery production may be established by the FTC on a population-by-population basis. Note that the floor applies only to crediting. Hatchery production may be reduced below this floor to meet conservation and/or the 650,000-pound standard.

7) Because the number of natural-origin out-migrants is converted to pounds of production for crediting, the base production from which credits are subtracted (by species) is established as numbers of smolts of a specified "base size" at release. If the size at release changes or varies, the base production remains the poundage associated with base production numbers at "base size." For example, spring Chinook Salmon historically have been reared to 5 fish-per-pound (fpp; base size) and 967,000 smolts have been released. Total poundage then is 194,400 pounds (base production). Many more spring Chinook Salmon could be released if the fish-per-pound at release were reduced, but the base production would remain at 194,400 and credits would be subtracted from the poundage number, rather than the number of smolts."

Table 12-3 identifies how natural production credits will be assigned to each hatchery program. The credit mechanism will be calculated as follows:

1. **Yearling:** For each yearling natural-origin juvenile produced from the Upper Cowlitz and Tilton subbasins, hatchery yearling production will be reduced by two fish (2:1 ratio), on a species-specific basis.
2. **Sub-yearling:** For each sub-yearling natural-origin juvenile produced from the Upper Cowlitz and Tilton subbasins, hatchery yearling production will be reduced by 0.5 fish (0.5:1 ratio), on a species-specific basis. If the hatchery releases only sub-yearlings, hatchery sub-yearling production would be reduced at a 2:1 ratio.

Table 12-3. Assignment of natural production credits to hatchery programs (to be updated as necessary as hatchery programs change).

Populations to be Credited for Natural-origin Production	Hatchery Programs Paying for Credits						
	Lower Cowlitz Subbasin Spring Chinook Salmon	Lower Cowlitz Subbasin Fall Chinook Salmon	Lower Cowlitz Subbasin Winter Steelhead	Lower Cowlitz Subbasin Coho Salmon	Upper Cowlitz Subbasin Coho Salmon	Lower Cowlitz Subbasin Cutthroat Trout	Upper Cowlitz Subbasin Winter Steelhead
Upper Cowlitz Subbasin Spring Chinook Salmon	X						
Upper Cowlitz Subbasin Winter Steelhead							X
Upper Cowlitz Subbasin Coho Salmon				X			
Tilton Subbasin Fall Chinook Salmon		X					
Tilton Subbasin Winter Steelhead			X				
Tilton Subbasin Coho Salmon				X			
Tilton Subbasin Cutthroat Trout						X	
Upper Cowlitz Subbasin Cutthroat Trout						X	

The 2:1 or 0.5:1 credit ratio began in year 1 of the FHMP and is applied to a reduction in the Cowlitz Hatchery Complex production obligation beginning with the next brood year for each species. For example, if the most recent 5-year rolling average for brood year (BY) 2019 Coho Salmon natural-origin juveniles was 200,000 (data available in the late spring), the credit would be assigned to the following brood year (BY 2020) egg collection. This ensures that hatchery managers will have sufficient time to plan and implement future broodstock needs.

The calculated credit ratio will remain in force until total smolt-to-adult survival rate data are complete for each brood year and then updated. When possible, SARs will be calculated for both the hatchery- and natural-origin components and the credit ratio calculated as follows:

- Credit Ratio = Natural-origin SAR/ Hatchery-origin SAR.
- SAR is defined as smolt-to-adult survival rate, including all fisheries-induced mortality.
- SAR = Number of adults accounted for from any identifiable group of fish/Number of juveniles released from that same group.

Current 5-year average SAR data are available for natural-origin Coho Salmon, Cutthroat Trout, and winter steelhead from the Tilton River:

- Coho Salmon = Natural-origin SAR / Hatchery-origin SAR = 4.04 / 2.7 = 1.49.
- Cutthroat Trout = Natural-origin SAR / Hatchery-origin SAR = 5.67 / 3.0 = 1.89.
- Steelhead = Natural-origin SAR / Hatchery-origin SAR = 0.99 / 1.0 = 0.99.

Therefore, credits will be applied at the ratio of 1.49 hatchery-origin Coho Salmon/natural-origin Coho Salmon, 1.89 hatchery-origin Cutthroat Trout/natural-origin Cutthroat Trout, and 0.99 hatchery-origin steelhead/natural-origin steelhead rather than the original 2.0/1.0, as described above.

12.2. Annual Operating Plan (AOP)

12.2.1. Purpose

The Annual Operating Plan (AOP) is the guiding document for actions that detail and set targets for the management strategy for each population, including all management activities (hatchery, harvest, and population management actions), to be conducted in the upcoming year. It is an annual, scientifically defensible, and mutually agreed-upon work plan that is consistent with the Settlement Agreement and meets resource goals. Because it documents the goals for each year, it is also a source of information with which managers can evaluate the success of the program in achieving its goals, and quickly identify areas of concern so that managers can promptly make appropriate changes to improve the program.

12.2.2. Timeline

The AOP will be a product of the decisions made at the APR meeting in March. The AOP will be developed by June, which will allow fisheries and hatchery managers time to prepare for the coming year’s activities. This timeline will have to be expedited for spring Chinook Salmon so that management strategies and broodstock collection schedules can be prepared prior to their arrival in the Cowlitz River in March.

12.2.3. Standard Format

A standard AOP format will be developed within 1 year of completion of the FHMP that is clear and concise, with pertinent information provided in tables and guided by the results of the APR process. The AOP documents the key metrics, trends, status, sliding scales, goals/targets, the activities to be accomplished, and the parties responsible for accomplishing them for each cycle (year), such as:

- Pre-season run estimates - total to the Cowlitz River and Barrier Dam Adult Facility.
- Harvest monitoring and target harvest rates in all Cowlitz fisheries.
- Weir and trap management:
  - Broodstock collection - numbers of broodstock to be collected (by origin, sex, age) and collection schedule (by week) for each hatchery program (integrated

and segregated). Based on data from the previous 5 years and pre-season run estimates, including arrival timing, expected age composition, pre-spawn survival rate, fecundity, and average survival by stage through hatchery (i.e., green egg-to-eyed egg, eyed egg-to-fry, fry-to-smolt).

  - Numbers to be released upstream and downstream, by species, destination, age class, and sex.
  - Annual review of disposition plan to assess excess hatchery-origin salmon.
- Hatchery production metrics:
  - Hatchery production goals and current hatchery inventory, by species, hatchery program, and life stage.
  - Survival and health description/status by life stage.
  - Numbers of salmon to be spawned for each species and program, by origin, sex, and age.
  - Expected fecundity and fertility rates.
  - Green eggs to be collected and expected numbers of eyed eggs, fry hatched, parr (at marking), and smolts released; and the expected survival rates to each stage.
  - Growth rate and expected (target) weight at release.
- Release details (e.g., date, location, and method).
- pHOS, pNOB, PNI, and age composition:
- Monitoring and Evaluation (see Chapter 10, which includes a description of the Monitoring Plan):
  - VSP metrics (abundance, spatial distribution, productivity, diversity).
  - Types and numbers of marks/tags applied to each production cohort / evaluation group and their codes.
  - Information on evaluations being conducted.
- Nutrient enhancement.
- Important people to contact, in case of incidents.
- Alternative actions for each activity, in case the run, and the subsequent plan, does not develop as expected.

Many of these targets will be set using sliding scales that will need to be agreed upon and developed prior to the upcoming season (see Table 12-4 as an example. Note: the information presented in the table is intended only as a hypothetical example and does not represent agreed-upon targets or metrics that would be used). Given a known or predicted value of a specific metric, these targets will guide management actions (e.g., number of broodstock to be collected or adults/jacks to be transported upstream) using the minimum viability abundance target, key metrics, hatchery production goals, and run projection to Barrier Dam Adult Facility for a specific population.

Table 12-4. Hypothetical example (for Upper Cowlitz Subbasin spring Chinook Salmon) of a sliding scale to set annual broodstock collection, spawning, and upstream transport management targets. Note1: assumes 90% prespawn survival, 50% females, fecundity = 4,000 green eggs/female, 80% egg-to-smolt survival in hatchery, and total post-transport mortality of 22% for hatchery-origin and 12% for natural-origin adults transported upstream. Note2: The information presented in the table is intended only as a hypothetical example and does not represent agreed-upon targets or metrics that would be used.

Minimum Viability Abundance Target (NOR adults spawning in nature):	3,600	Recovery Phase					
Return to Barrier Dam Adult Facility Needed to Achieve Target:	4,966	Preservation	Recolonization		Local Adaptation	Fully Recovered	
Total Number of Adults/Jacks to be Collected for Broodstock (50% Females):	1,250	% of Minimum Viability Abundance Target Returning to Barrier Dam Adult Facility					
Total Hatchery Smolt Production Goal:	1,800,000	< 10%	10 - 25%	25 - 50%	50 - 100%	100 - 200%	> 200%
Number of NOR ADULTS Returning to Barrier Dam Adult Facility		0-497	498-1,241	1,242-2,483	2,484-4,966	4,967-9,932	>9.932
Percentage of NOR ADULTS that Return to Hatchery Retained for Broodstock		0-100%	50-100%	25-50%	18-35%	9-18%	9%
Minimum Proportion of NOR ADULTS in Integrated Hatchery Program Broodstock (pNOB)		0.500	0.500	0.500	0.700	0.700	0.700
Integrated Hatchery Program		0-497	996-1,125	1,125	1,125	1,125	1,125
Number of Hatchery-origin Collected for Broodstock		0-497	498-625	500	250	250	250
Number of Natural-origin Collected for Broodstock		0-497	498-625	625	875	875	875
Smolts to be Produced		0-1,430,182	1,433,062-1,800,000	1,800,000	1,800,000	1,800,000	1,800,000
Segregated Hatchery Program (pNOB = 0)							
Number of Hatchery-origin Collected for Broodstock		257-1,250	0-255	0	0	0	0
Smolts to be Produced		369,818-1,800,000	0-366,938	0	0	0	0
Adults Transported to Upper Cowlitz Subbasin		5,200	5,200	5,200	2,574-6,545	6,547-14,491	>14,491
Hatchery-origin		5,200	4,584-5,200	3,342-4,583	965-2,455	2,455-5,434	>5,434
Natural-origin		0	0-616	617-1,858	1,609-4,091	4,092-9,057	>9,057
Maximum Transported pHOS Target		1.000	0.650	0.650	0.375	0.375	0.375
Expected Actual Total Spawners in Nature		4,160	3,667-4,703	3,217-5,301	2,023-5,143	5,144-11,386	>11,386
Maximum Actual Spawner pHOS Target		1.000	1.000	1.000	0.300	0.300	0.300
Minimum PNI Target		NA	0.350	0.350	0.670	0.670	0.670

12.2.4. Alternative Plans

Unusual and unforeseen events and circumstances may also warrant in-season management responses. We plan for them as best as we can, and the response options for those that we can anticipate are also provided in the AOP. Unanticipated events will warrant an FTC discussion to determine the course of action.

12.3. Annual Work Products

Following the APR process each year, the FTC will finalize the recommended AOP, and provide status reports on the five FHMP topics identified in Section 6 of the Settlement Agreement:

a) *“the quantity and size of fish to be produced at the Cowlitz Hatchery Complex;*

b) *rearing and release strategies for each stock, including upward and downward production adjustments to accommodate recovery of indigenous stocks;*

c) *credit mechanisms for production of high quality natural stocks;*

d) *plans for Licensee-funded on-going monitoring and evaluation; and*

e) *a fisheries management strategy consistent with the priority objective of maximizing the natural production of wild indigenous fish stocks and species in the basin.”*

The AOP is the blueprint for actions related to the FHMP for the coming year. All work products produced as part of the APR will be included in the AOP.

Annual reports document the success of the program in achieving the goals set in the AOP and provide status reports on the five FHMP topics identified in Section 6 of the Settlement Agreement. Annual reports are the source of the information used in the APR process and fuel adaptive management. The Annual Operating Plan is the blueprint for actions related to the FHMP for the coming year. All work products produced as part of the annual review process, including the AOP, will be included in a comprehensive annual report which will include a concise summary describing all work products from the AOP that has just been completed indicating what work was completed, what was not, and why.

12.4. Roles and Responsibilities

The AOP assigns roles and responsibilities to Tacoma Power and management authority of WDFW for specific actions related to hatchery production, fisheries management, and monitoring and evaluation. The FTC also has responsibilities, including reviewing information brought forward by Tacoma Power and WDFW, applying Decision Rules, conducting an annual meeting/workshop to inform the public about this process and results to date, and approving the AOP for the coming year. The FTC will also identify the most effective way for the public to stay informed. The FTC may also convene to review progress at selected milestones during the year (Figure 12-3).

The process described here is not intended to alter the legal and policy mandates and responsibilities of the management entities involved in the fishery management process in the Cowlitz Basin. This document is meant to document the structure within which those

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responsibilities can be carried out in a manner that is consistent with the Settlement Agreement. Tacoma Power will require the cooperative working relationships described above with WDFW, NOAA Fisheries, and the FTC throughout the APR process in order to provide the data and information to complete the AOP at the end of the workshop.

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CHAPTER 13:
REFERENCES

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Fisheries and Hatchery Management Plan (FHMP)

Appendices

Final

Cowlitz Hydroelectric Project

FERC No. 2016

Tacoma Power

3628 S 35th Street

Tacoma, WA 98409

October 2020

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FHMP APPENDICES

Appendix A	**Big Table Dataset**
Appendix B	**Transition Plans**
Appendix C	**Summary of Data Gaps and Potential Future Monitoring Needs**
Appendix D	**White Paper - Fall Chinook Salmon Broodstock Collection**
Appendix E	**Public Review and Comment**

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APPENDIX A:
BIG TABLE DATASET

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Big Table for Fall Chinook Salmon. Management metrics and ranges of means for the most recent five years for hatchery- and natural-origin data that are available from ISIT, RMIS, Tacoma Power, and WDFW and FHMP adult goals.
*Suggested recovery target for Stabilizing population.

Recovery Targets			
Lower Cowlitz River	Cispus River	Upper Cowlitz River	Tilton River
3,000	1,000*	1,000*	1,000*

Metrics				Last 5 Years Adult Mean: Hatchery (Min–Max)	Last 5 Years Adult Mean: Natural (Min–Max)	Source(s) of Current Data	FHMP Adult Goal: Hatchery	FHMP Adult Goal: Natural
Data to be Collected (Numbers)								
Mature Returns								
Totals			Total Survivors to Maturity	?	?		23,372	11,938
Totals			Total Escapement to Cowlitz River	?	?		7,606	9,017
Harvest	**Fishery Location**	Ocean	Commercial Fishery	?	?			
		Ocean	Tribal Fishery	?	?			
		Ocean	Sport Fishery	?	?			
		Ocean	Total Ocean	7,157	4,542	ISIT	7,044	4,292
		Columbia River	Commercial Fishery	?	?			
		Columbia River	Tribal Fishery	?	?			
		Columbia River	Sport Fishery	?	?			
		Columbia River	Total Columbia River	3,170	1,923	ISIT	3,122	1,818
		Lower Cowlitz River	Commercial Fishery	?	?			
		Lower Cowlitz River	Tribal Fishery	?	?			
		Lower Cowlitz River	Sport Fishery	2,527	189	ISIT		
		Lower Cowlitz River	Total Lower Cowlitz River	2,527	189	ISIT	2,527	189
		Above Mayfield Dam	Cispus River	?	?			
		Above Mayfield Dam	Upper Cowlitz River	209	0	ISIT		
		Above Mayfield Dam	Tilton River	208	142	ISIT		
		Above Mayfield Dam	Total Above Mayfield Dam	417	143	ISIT	417	143
	Fishery Type		Commercial	?	?			
	Fishery Type		Tribal	?	?			
	Fishery Type		Sport	?	?			
	Total Harvest			13,271	6,797	ISIT	13,110	6,441

Stray -ing	Stray Origin	Cowlitz River Population	Outside Cowlitz Basin	?		?			0	0
			In Cowlitz Basin	?		?			0	0
		Other Population Strays in Cowlitz River		?		?			0	0
Trapping	Lower Cowlitz Subbasin Tributary Traps	Delameter Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Lacamas Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Olequa Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Ostrander Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
	Cowlitz Salmon Hatchery	Hatchery Broodstock Collected		1,634	1,821	0	79	ISIT, TPU, WDFW	1,845	2,254
		Released Below Dams		0	204	0	11	TPU, WDFW	0	0
		Released Above Dams	Upper Cowlitz Subbasin	1,381	1,640	3	62	ISIT, TPU, WDFW	0	0
			Tilton Subbasin	809	3,502	2,631	2,693	TPU, WDFW	2,268	4,115
		Mortalities		1	167	1	20	TPU, WDFW	<10%	<10%
		Surplus (Food Bank, Outplant, Nutrient Enhancement, etc)		658	709	0	0	TPU, WDFW	0	0
		Total		4,322	7,097	2,776	2,808	TPU, WDFW	4,570	7,077

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Nature (pre-spawning)	Location	Below Dams	Lower Cowlitz River	Cowlitz River	1,203		3,317		ISIT	1,429	3,333
				Out-of-Program Strays	?	?	?	?		0	0
		Above Dams	Upper Cowlitz/Cispus Rivers		1,296		2		ISIT	1,100	0
			Tilton River		647		2,165			1,429	3,333
		Total			3,146		5,485		ISIT	2,857	6,667
Hatchery Production											
Spawners	**Integrated Hatchery Program**		Prespawn Mortalities		?	?	?	?		<92	<113
			Killed, Not Spawned		?	?	?	?		0	0
			Spawned		?	?	?	?		1,753	2,142
	Segregated Hatchery Program		Prespawn Mortalities		?	?	?	?		0	0
			Killed, Not Spawned		?	?	?	?		0	0
			Spawned		?	?	?	?		750	0
	Total Hatchery		Prespawn Mortalities		156	234	6	27	ISIT, WDFW	<92	<113
			Killed, Not Spawned		?	?		?		0	0
			Spawned		1,435	1,628	60	228	ISIT, WDFW	1,753	2,142
Offspring - Rearing and Release	Integrated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	?	?	?	?		2,289	2,289
				Total	?	?	?	?		4,456,856	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	?	?		2,081	2,081
				Total	?	?	?	?		4,051,688	
				Released	?	?	?	?		0	0
		Fry	Fry Produced	Number	?	?	?	?		3,858,750	
				Size	?	?	NA	NA		?	
			Fry Released	Number	?	?	NA	NA		0	
				Size	?	?	NA	NA		NA	
		Parr	Parr Produced	Number	?	?	NA	NA		3,675,000	
				Size	?	?	NA	NA		?	
			Parr Released	Number	?	?	NA	NA		0	
				Size	?	?	NA	NA		NA	
		Smolts	Smolts Produced	Number	?	?	NA	NA		3,500,000	
				Size	?	?	NA	NA		?	
			Smolts Released	Number	484,927	1,257,737	NA	NA	ISIT, WDFW	3,500,000	
				Size	?	?	NA	NA		?	
		Total Offspring Released			484,927	1,257,737	NA	NA	ISIT, WDFW	3,500,000	
		Marks and Tags	Type: CWT	Number	?					700,000	

Offspring - Rearing and Release	Segregated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	?	?	NA			0	NA
				Total	?	?	NA			0	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	NA			0	NA
				Total	?	?	NA			0	
				Released	?	?	NA			0	NA
		Fry	Fry Produced	Number	?	?	NA			0	
				Size	?	?	NA			?	
			Fry Released	Number	?	?	NA			0	
				Size	?	?	NA			?	
		Parr	Parr Produced	Number	?	?	NA			0	
				Size	?	?	NA			?	
			Parr Released	Number	?	?	NA			0	
				Size	?	?	NA			?	
		Smolts	Smolts Produced	Number	?	?	NA			0	
				Size	?	?	NA			?	
			Smolts Released	Number	2,459,056	2,464,983	NA		ISIT, WDFW	0	
				Size	?	?	NA			?	
		Total Offspring Released			2,459,056	2,464,983	NA		ISIT, WDFW	NA	
		Marks and Tags	Type: CWT	Number	795,610		NA		RMIS	0	
	Total Hatchery Programs	Green Eggs Collected (Fecundity)		Mean	8,828				WDFW	2,289	2,289
				Total	4,013,974	4,121,383	146,209	572,528	ISIT, WDFW	4,456,856	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	?	?		2,081	2,081
				Total	?	?	?	?		4,051,688	
				Released	?	?	?	?		0	0
		Fry	Fry Produced	Number	?	?	NA			3,858,750	
				Size	?	?	NA			?	
			Fry Released	Number	?	?	NA			0	
				Size	?	?	NA			NA	
		Parr	Parr Produced	Number	?	?	NA			3,675,000	
				Size	?	?	NA			?	
			Parr Released	Number	?	?	NA			0	
				Size	?	?	NA			?	
		Smolts	Age-2 Smolts Produced	Number	?	?	NA			3,500,000	
				Size	?	?	NA			?	
			Age-2 Smolts Released	Number	2,937,151	2,962,151	NA		ISIT, WDFW	3,500,000	
				Size	?	?	NA			?	
		Total Offspring Released			2,937,151	2,962,151	NA		ISIT, WDFW	3,500,000	
		Marks and Tags	Type: CWT	Number	795,610		NA		RMIS	700,000	

Natural Production											
Below Dams	Lower Cowlitz River Mainstem	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?	?	?		<176	<333
				Out-of-Program Strays	?	?	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	1,082		2,986		ISIT	1,286	3,000
				Out-of-Basin Strays	?	?	?	?		0	0
		Offspring	Total Eggs Laid		?	?	?	?		?	?
			Smolts Produced		?					NA	60,000
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
	Lower Cowlitz River Tributaries	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?	?	?		0	0
				Out-of-Program Strays	?	?	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	?	?	?	?		0	0
				Out-of-Basin Strays	?	?	?	?		0	0
		Offspring	Total Eggs Laid		?	?	?	?		0	0
			Smolts Produced		?					0	0
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
Above Dams	Cispus River	Spawners	Prespawn Mortalities in Nature	Cispus River	?		?			0	0
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Cispus River	?		?			0	0
				Out-of-Basin Strays	?		?			0	0

Above Dams	Cispus River	Offspring	Total Eggs Laid		?	?		0	0
			Smolts Produced		?			NA	0
			Smolts Trapped & Released	Number Trapped	?			NA	0
				Number Released	?	?		NA	0
				Type of Mark/Tag	?	?		NA	NA
				Number Marked/Tagged	?	?		NA	0
	Upper Cowlitz River	Spawners	Prespawn Mortalities in Nature	Upper Cowlitz River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Upper Cowlitz River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		0	0
			Smolts Produced		55,150		CFFF (TPU/WDFW)	NA	0
			Smolts Trapped & Released	Number Trapped	2,188		CFFF (TPU/WDFW)	NA	0
				Number Released	?			NA	0
				Type of Mark/Tag	NA			NA	NA
				Number Marked/Tagged	?			NA	0
	Tilton River	Spawners	Prespawn Mortalities in Nature	Tilton River	?	?		<129	<300
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Tilton River	?	?		1,286	>3,000
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		?			NA	>88,000
			Smolts Trapped & Released	Number Trapped	45,396		TPU Mayfield	NA	>66,000
				Number Released	?			NA	>66,000
				Type of Mark/Tag	NA			NA	CWT
				Number Marked/Tagged	0			NA	>66,000

Above Dams	Total	Spawners	Prespawn Mortalities in Nature	Tilton River	?		?			<129	<300
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Tilton River	?		?			1,286	>3,000
				Out-of-Program Strays	?		?			0	0
		Offspring	Total Eggs Laid		?		?			?	?
			Smolts Produced		>55,150				Mayfield / CFFF	NA	>88,000
			Smolts Trapped & Released	Number Trapped	47,584				Mayfield / CFFF	NA	>66,000
				Number Released	?					NA	>66,000
				Type of Mark/Tag	NA					NA	CWT
				Number Marked/Tagged	0				TPU, RMIS	NA	>66,000
Smolt Migration											
Smolts	Location	Number of Smolts in Lower Cowlitz River	Lower Cowlitz River		?		?			3,500,000	60,000
			Cispus River		?		?			0	0
			Upper Cowlitz River		?		?			0	0
			Tilton River		?		?			0	66,000
			Total		?		?			3,500,000	126,000
		Number of Smolts at Mouth of Cowlitz River	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
		Number of Smolts in Columbia River Estuary	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
Management Metrics (Rates to be Calculated Using the Data Collected Above)											
Adult Salmon	Harvest Rate	Ocean	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		?	?
			Total Ocean		35.1%		34.7%		ISIT	?	?
		Columbia River	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		?	?
			Total Columbia River		15.3%		14.5%		ISIT	?	?

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Adult Salmon	Harvest Rate	Cowlitz River	Lower Cowlitz River	Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	14.2%		1.5%		ISIT	?	?
				Total Cowlitz River	14.2%		1.5%		ISIT	?	?
			Above Mayfield Dam - Sport	Upper Cowlitz Subbasin	0.8%		0.0%		ISIT	?	?
				Tilton Subbasin	1.3%		1.1%		ISIT	?	?
				Total Above Mayfield Dam	2.1%		1.1%		ISIT	?	?
		Total Harvest		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total	66.7%		51.8%		ISIT	?	?
	Stray Rate	Cowlitz River Salmon	Out-of-Basin		?		?			<5%	<5%
			Cowlitz Basin		?		?			<5%	<5%
			Total		?		?			<5%	<5%
		Out-of-Basin Strays Into Cowlitz River			?		?			<5%	<5%
	Trapped at Barrier Dam	Lower Cowlitz River	Trapping Rate (% of Returns to Cowlitz River)		?	?	NA			NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	NA			NA	NA
				Released Below Dams	?	?	NA			NA	NA
				Released Above Dams	?	?	NA			NA	NA
				Mortalities	?	?	NA			NA	NA
				Surplus	?	?	NA			NA	NA
		Tilton River	Trapping Rate (% of Returns to Cowlitz River)		?	?	?	?		NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	?	?		NA	NA
				Released Below Dams	?	?	?	?		NA	NA
				Released Above Dams	?	?	?	?		NA	NA
				Mortalities	?	?	?	?		NA	NA
				Surplus	?	?	?	?		NA	NA

Adult Salmon	Trapped at Barrier Dam	Upper Cowlitz Subbasin	Trapping Rate (% of Returns to Cowlitz River)		?		?			?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?		?			?	?
				Released Below Dams	?		?			?	?
				Released Above Dams	?		?			?	?
				Mortalities	?		?			?	?
				Surplus	?		?			?	?
		Total	Trapping Rate (% of Returns to Cowlitz River)		25.3%	45.3%	21.7%	21.9%	**ISIT, TPU, WDFW. Reports**	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	27.1%	52.4%	4.2%	4.2%	**ISIT, TPU, WDFW. Reports**	?	?
				Released Below Dams	0.0%	3.6%	0.0%	0.6%	**ISIT, TPU, WDFW. Reports**	?	?
				To Tilton Subbasin	18.9%	28.8%	0.1%	1.9%	**ISIT, TPU, WDFW. Reports**	?	?
				To Upper Cowlitz Subbasin	17.7%	49.7%	92.8%	95.7%	**ISIT, TPU, WDFW. Reports**	?	?
				Mortalities	0.0%	4.8%	0.0%	0.7%	**ISIT, TPU, WDFW. Reports**	?	?
				Surplus	1.0%	1.2%	0.0%	0.0%	**ISIT, TPU, WDFW. Reports**	?	?
	Age (Run Year - Brood Year)	Integrated Hatchery Program	Mean Age		?		NA			4.5	NA
			Age Composition (proportion)	Age-2	?		NA			0%	NA
				Age-3	?		NA			5%	NA
				Age-4	?		NA			50%	NA
				Age-5	?		NA			35%	NA
				Age-6	?		NA			8%	NA
				Age-7	?		NA			2%	NA
		Segregated Hatchery Program	Mean Age		?		NA			NA	NA
			Age Composition (proportion)	Age-2	?		NA			NA	NA
				Age-3	?		NA			NA	NA
				Age-4	?		NA			NA	NA
				Age-5	?		NA			NA	NA
				Age-6	?		NA			NA	NA
				Age-7	?		NA			NA	NA

Adult Salmon	Age (Run Year - Brood Year)	Total Hatchery	Mean Age		3.16	NA	RMIS	4.5	NA
			Age Composition (proportion)	Age-2	0.000	NA	RMIS	0%	NA
				Age-3	0.146	NA	RMIS	5%	NA
				Age-4	0.572	NA	RMIS	50%	NA
				Age-5	0.253	NA	RMIS	35%	NA
				Age-6	0.029	NA	RMIS	8%	NA
				Age-7	0.000	NA	RMIS	2%	NA
		Lower Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	NA
			Age Composition (proportion)	Age-2	NA	?		NA	NA
				Age-3	NA	?		NA	NA
				Age-4	NA	?		NA	NA
				Age-5	NA	?		NA	NA
				Age-6	NA	?		NA	NA
				Age-7	NA	?		NA	NA
		Upper Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	4.5
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	5%
				Age-4	NA	?		NA	50%
				Age-5	NA	?		NA	35%
				Age-6	NA	?		NA	8%
				Age-7	NA	?		NA	2%
		Tilton Subbasin Natural-origin	Mean Age		NA	?		NA	NA
			Age Composition (proportion)	Age-2	NA	?		NA	NA
				Age-3	NA	?		NA	NA
				Age-4	NA	?		NA	NA
				Age-5	NA	?		NA	NA
				Age-6	NA	?		NA	NA
				Age-7	NA	?		NA	NA
		Total Natural-origin	Mean Age		NA	?		NA	4.5
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	5%
				Age-4	NA	?		NA	50%
				Age-5	NA	?		NA	35%
				Age-6	NA	?		NA	8%
				Age-7	NA	?		NA	2%

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Spawning	In Hatchery	Integrated Hatchery Program	Prespawn Mortality Rate	?	?		<5%	<5%
Spawning	In Hatchery	Integrated Hatchery Program	Mean Fecundity	?	?		4,500	4,500
Spawning	In Hatchery	Integrated Hatchery Program	Mean Eyed Fecundity	?	?		4,275	4,275
Spawning	In Hatchery	Integrated Hatchery Program	Fertility	?	?		95%	95%
Spawning	In Hatchery	Segregated Hatchery Program	Prespawn Mortality Rate	?	?	ISIT	NA	NA
Spawning	In Hatchery	Segregated Hatchery Program	Mean Fecundity	?	?		NA	NA
Spawning	In Hatchery	Segregated Hatchery Program	Mean Eyed Fecundity	?	?		NA	NA
Spawning	In Hatchery	Segregated Hatchery Program	Fertility	?	?		NA	NA
Spawning	In Hatchery	Total Hatchery	Prespawn Mortality Rate	8.7-14.7%		ISIT, WDFW	<5%	<5%
Spawning	In Hatchery	Total Hatchery	Mean Fecundity	844-4,728		ISIT, WDFW	4,500	4,500
Spawning	In Hatchery	Total Hatchery	Mean Eyed Fecundity	?	?		4,275	4,275
Spawning	In Hatchery	Total Hatchery	Fertility	?	?		95%	95%
Spawning	In Nature	Lower Cowlitz River	Prespawn Mortality Rate	?	?		NA	NA
Spawning	In Nature	Lower Cowlitz River	Mean Fecundity	?	?		NA	NA
Spawning	In Nature	Cispus River	Prespawn Mortality Rate	?	?		NA	NA
Spawning	In Nature	Cispus River	Mean Fecundity	?	?		NA	NA
Spawning	In Nature	Upper Cowlitz River / Subbasin	Prespawn Mortality Rate	?	?		NA	NA
Spawning	In Nature	Upper Cowlitz River / Subbasin	Mean Fecundity	?	?		NA	NA
Spawning	In Nature	Tilton River	Prespawn Mortality Rate	?	?		<5%	<5%
Spawning	In Nature	Tilton River	Mean Fecundity	?	?		4,500	4,500
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Fertility Rate	?	?		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Eyed Egg-to-Fry Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Fry-to-Parr Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Parr-to-Smolt Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Green Egg-to-Smolt Survival	?	NA		81%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Segregated Hatchery Program	Fertility Rate	?	?		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Segregated Hatchery Program	Eyed Egg-to-Fry Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Segregated Hatchery Program	Fry-to-Parr Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Segregated Hatchery Program	Parr-to-Smolt Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Segregated Hatchery Program	Green Egg-to-Smolt Survival	?	NA		81%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Total Hatchery	Fertility Rate	?	?		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Total Hatchery	Eyed Egg-to-Fry Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Total Hatchery	Fry-to-Parr Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Total Hatchery	Parr-to-Smolt Survival	?	NA		95%	NA
Survival of Offspring to Smolt Stage	In Hatchery	Total Hatchery	Green Egg-to-Smolt Survival	68.6% - 70.9%		ISIT, WDFW	81%	NA

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Survival of Offspring to Smolt Stage	In Nature	Lower Cowlitz River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Cispus River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Upper Cowlitz River / Subbasin	Green Egg-to-Smolt Survival	NA	?		NA	?
		Tilton River	Green Egg-to-Smolt Survival	NA	?		NA	?
	Marking / Tagging Rate	Hatchery-origin	Integrated Hatchery Program	?	NA		?	NA
			Segregated Hatchery Program	?	NA		?	NA
			Total Hatchery	21.5%	NA	RMIS/WDFW	?	NA
		Natural-origin	Lower Cowlitz River	NA	?		?	NA
			Cispus River	NA	?		?	NA
			Upper Cowlitz River / Subbasin	NA	?		?	NA
			Tilton River	NA	?		?	NA
Survival to Maturity	Integrated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	?	NA		0.11%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	?	NA		0.67%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		449	NA
			Smolts / Adult+Jack Spawner	?	NA		899	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	?	NA		>>1	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA

Survival to Maturity	Segregated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?		NA		NA	NA
			to Columbia River Estuary	?		NA		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?		NA		NA	NA
			Parr	?		NA		NA	NA
			Smolts	?		NA		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?		NA		NA	NA
			Parr	?		NA		NA	NA
			Smolts	?		NA		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?		NA		NA	NA
			Smolts / Adult+Jack Spawner	?		NA		NA	NA
			Female-to-Female	?		NA		NA	NA
			Adult-to-Adult	?		NA		NA	NA
			Adult+Jack-to-Adult+Jack	?		NA		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?		NA		NA	NA
	Total Hatchery	Smolt Survival	to Mouth of Cowlitz River	?		NA		?	NA
			to Columbia River Estuary	?		NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	0.043%		NA	RMIS	0.11%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	0.074%		NA	RMIS	0.67%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	3,370	3,462	NA	ISIT, WDFW	449	NA
			Smolts / Adult+Jack Spawner	1,761	1,793	NA	ISIT, WDFW	899	NA
			Female-to-Female	?		NA		>>1	NA
			Adult-to-Adult	?		NA		>>1	NA
			Adult+Jack-to-Adult+Jack	?		NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?		NA		>>1	NA

Survival to Maturity	Lower Cowlitz River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency	NA	NA		NA	NA
		Smolt Passage (Transport) Survival	NA	NA		NA	NA
		Smolt Survival – to Mouth of Cowlitz River	NA	?		NA	?
		Smolt Survival – to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Fry	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Parr	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Fry	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Parr	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner) – Smolts / Female Spawner	?	NA		NA	?
		Productivity (Recruits / Spawner) – Smolts / Adult+Jack Spawner	?	NA		NA	?
		Productivity (Recruits / Spawner) – Female-to-Female	?	NA		NA	>1
		Productivity (Recruits / Spawner) – Adult-to-Adult	?	NA		NA	>1
		Productivity (Recruits / Spawner) – Adult+Jack-to-Adult+Jack	?	NA		NA	>1
		Productivity (Recruits / Spawner) – Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	>1
	Cispus River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency	NA	?		NA	NA
		Smolt Passage (Transport) Survival	NA	?		NA	NA
		Smolt Survival – to Mouth of Cowlitz River	NA	?		NA	NA
		Smolt Survival – to Columbia River Estuary	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Fry	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Parr	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery) – Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Fry	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Parr	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for) – Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner) – Smolts / Female Spawner	?	NA		NA	NA
		Productivity (Recruits / Spawner) – Smolts / Adult+Jack Spawner	?	NA		NA	NA
		Productivity (Recruits / Spawner) – Female-to-Female	?	NA		NA	NA
		Productivity (Recruits / Spawner) – Adult-to-Adult	?	NA		NA	NA
		Productivity (Recruits / Spawner) – Adult+Jack-to-Adult+Jack	?	NA		NA	NA
		Productivity (Recruits / Spawner) – Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	NA

Survival to Maturity	Upper Cowlitz River/ Subbasin Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency			NA	5.8%	CFFF (TPU/WDFW)	NA	NA
		Smolt Passage (Transport) Survival			NA	?		NA	NA
		Smolt Survival	to Mouth of Cowlitz River		NA	?		NA	NA
			to Columbia River Estuary		NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)		Fry	NA	?		NA	NA
				Parr	NA	?		NA	NA
				Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)		Fry	NA	?		NA	NA
				Parr	NA	?		NA	NA
				Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner		?	NA		NA	NA
			Smolts / Adult+Jack Spawner		?	NA		NA	NA
			Female-to-Female		?	NA		NA	NA
			Adult-to-Adult		?	NA		NA	NA
			Adult+Jack-to-Adult+Jack		?	NA		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack		?	NA		NA	NA
	Tilton River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency			NA	?		NA	>75%
		Smolt Passage (Transport) Survival			NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River		NA	?		NA	?
			to Columbia River Estuary		NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)		Fry	NA	?		NA	?
				Parr	NA	?		NA	?
				Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)		Fry	NA	?		NA	?
				Parr	NA	?		NA	?
				Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner)	Smolts / Female Spawner		NA	?		NA	?
			Smolts / Adult+Jack Spawner		NA	?		NA	?
			Female-to-Female		NA	?		NA	>1
			Adult-to-Adult		NA	?		NA	>1
			Adult+Jack-to-Adult+Jack		NA	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack		NA	?		NA	>1

Proportional Natural Influence	**Lower Cowlitz River**	Collected/ Released	pHOS	0.260	ISIT	<0.3
			pNOB	NA		NA
			PNI	NA		NA
		Actual Spawners	pHOS	0.260	ISIT	<0.3
			pNOB	0.072	ISIT	>0.5
			PNI	0.190	ISIT	>0.63
	Cispus River	Collected/ Released	pHOS	?		NA
			pNOB	?		NA
			PNI	?		NA
		Actual Spawners	pHOS	?		NA
			pNOB	?		NA
			PNI	?		NA
	Upper Cowlitz River/Subbasin	Collected/ Released	pHOS	0.972 - 1	TPU, WDFW	NA
			pNOB	NA		NA
			PNI	NA		NA
		Actual Spawners	pHOS	?		NA
			pNOB	?		NA
			PNI	?		NA
	Tilton River	Collected/ Released	pHOS	0.196 - 0.210	TPU, WDFW	<0.3
			pNOB	NA		>0.5
			PNI	NA		>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		>0.5
			PNI	?		>0.63
	Total	Collected/ Released	pHOS	0.152 - 0.530	ISIT, TPU, WDFW	<0.3
			pNOB	0 - 0.185	ISIT, TPU, WDFW	>0.5
			PNI	0.550	ISIT, TPU, WDFW	>0.63
		Actual Spawners	pHOS	0.260	ISIT	<0.3
			pNOB	0.072	ISIT	>0.5
			PNI	0.190	ISIT	>0.63

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Big Table for Spring Chinook Salmon. Management metrics and ranges of means for the most recent five years for hatchery- and natural-origin data that are available from ISIT, RMIS, Tacoma Power, and WDFW and FHMP adult goals.
*Suggested recovery target for Stabilizing population.

<table>
<tr><th colspan="4">Recovery Targets</th><th colspan="4" rowspan="2">Last 5 Years Adult Mean</th><th rowspan="4">Source(s) of Current Data</th><th colspan="2" rowspan="2">FHMP Adult Goal</th></tr>
<tr><th>Lower Cowlitz River</th><th>Cispus River</th><th>Upper Cowlitz River</th><th>Tilton River</th></tr>
<tr><th>NA</th><th>1,800</th><th>1,800</th><th>1,000*</th><th colspan="2">Hatchery</th><th colspan="2">Natural</th><th rowspan="2">Hatchery</th><th rowspan="2">Natural</th></tr>
<tr><th colspan="4">Metrics</th><th>Min</th><th>Max</th><th>Min</th><th>Max</th></tr>
<tr><td colspan="11">Data to be Collected (Numbers)</td></tr>
<tr><td colspan="11">Mature Returns</td></tr>
<tr><td rowspan="2">Totals</td><td colspan="3">Total Survivors to Maturity</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td>13,763</td><td>1,603</td></tr>
<tr><td colspan="3">Total Escapement to Cowlitz River</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td>8,691</td><td>1,522</td></tr>
<tr><td rowspan="20">Harvest</td><td rowspan="16">Fishery Location</td><td rowspan="4">Ocean</td><td>Commercial Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Tribal Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Sport Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Total Ocean</td><td colspan="2">4,328</td><td colspan="2">73</td><td>ISIT</td><td>4,328</td><td>73</td></tr>
<tr><td rowspan="4">Columbia River</td><td>Commercial Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Tribal Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Sport Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Total Columbia River</td><td colspan="2">744</td><td colspan="2">8</td><td>ISIT</td><td>744</td><td>8</td></tr>
<tr><td rowspan="4">Lower Cowlitz River</td><td>Commercial Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Tribal Fishery</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Sport Fishery</td><td colspan="2">5,728</td><td colspan="2">8</td><td>ISIT</td><td></td><td></td></tr>
<tr><td>Total Lower Cowlitz River</td><td colspan="2">5,728</td><td colspan="2">8</td><td>ISIT</td><td>5,728</td><td>8</td></tr>
<tr><td rowspan="4">Above Mayfield Dam</td><td>Cispus River</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Upper Cowlitz River</td><td colspan="2">701</td><td colspan="2">2</td><td>ISIT</td><td></td><td></td></tr>
<tr><td>Tilton River</td><td colspan="2">0</td><td colspan="2">0</td><td>ISIT</td><td></td><td></td></tr>
<tr><td>Total Above Mayfield Dam</td><td colspan="2">701</td><td colspan="2">2</td><td>ISIT</td><td>701</td><td>2</td></tr>
<tr><td colspan="2" rowspan="3">Fishery Type</td><td>Commercial</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Tribal</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td>Sport</td><td colspan="2">?</td><td colspan="2">?</td><td></td><td></td><td></td></tr>
<tr><td colspan="3">Total Harvest</td><td colspan="2">11,501</td><td colspan="2">91</td><td>ISIT</td><td>11,501</td><td>91</td></tr>
</table>

Stray-ing	Stray Origin	Cowlitz River Population	Outside Cowlitz Basin	?		?			0	0
			In Cowlitz Basin	?		?			0	0
		Other Population Strays in Cowlitz River		?		?			0	0
Trapping	Lower Cowlitz Subbasin Tributary Traps	Delameter Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Lacamas Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Olequa Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Ostrander Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
	Cowlitz Salmon Hatchery	Hatchery Broodstock Collected		1,624	1,825	0	0	ISIT, TPU, WDFW	1,100	275
		Released Below Dams		0	131	0	3	TPU, WDFW	0	0
		Released Above Dams	Upper Cowlitz Subbasin	4,750	8,918	208	239	ISIT, TPU, WDFW	1,320	1,155
			Tilton Subbasin	0	148	0	3	TPU, WDFW	0	0
		Mortalities		3	193	0	1	TPU, WDFW	<10%	<10%
		Surplus (Food Bank, Outplant, Nutrient Enhancement)		658	709	0	0	TPU, WDFW	0	0
		Total		9,784	12,629	238	239	TPU, WDFW	2,689	1,589

Nature (pre-spawning)	**Location**	Below Dams	Lower Cowlitz River	Cowlitz River	562		98		ISIT	0	**0**
				Out-of-Program Strays	?	?	?	?		0	0
		Above Dams	Upper Cowlitz/Cispus Rivers		5,899		209		ISIT	1,100	1,100
			Tilton River		?		?			0	0
		Total			6,461		307		ISIT	1,100	1,100
Hatchery Production											
Spawners	**Integrated Hatchery Program**		Prespawn Mortalities		?	?	?	?		<25	<25
			Killed, Not Spawned		?	?	?	?		0	0
			Spawned		?	?	?	?		250	250
	Segregated Hatchery Program		Prespawn Mortalities		180		NA		ISIT	<75	NA
			Killed, Not Spawned		?	?	NA			0	NA
			Spawned		1,645		NA		ISIT	750	NA
	Total Hatchery		Prespawn Mortalities		180		0		ISIT	<25	<25
			Killed, Not Spawned		?	?	?	?		0	0
			Spawned		1,645	1,646	0	0	ISIT/WDFW	1,000	250
Offspring - Rearing and Release	**Integrated Hatchery Program**	Green Eggs Collected (Fecundity)		Mean	?		?			2,292	2,292
				Total	0		0		ISIT	573,024	
		Eyed Eggs (Eyed Fecundity)		Mean	?		?			2,084	2,084
				Total	?		?			520,931	
				Released	?		?			0	0
		Fry	Fry Produced	Number	?					496,125	
				Size	?					?	
			Fry Released	Number	?					0	
				Size	?					NA	
		Parr	Parr Produced	Number	?					472,500	
				Size	?					?	
			Parr Released	Number	?					0	
				Size	?					NA	
		Smolts	Smolts Produced	Number	0					450,000	
				Size	?					?	
			Smolts Released	Number	0					450,000	
				Size	?					?	
		Total Offspring Released			?					450,000	
		Marks and Tags	Type: CWT	Number	?					90,000	

Offspring - Rearing and Release	Segregated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	3,863		NA	WDFW	4,584	NA
				Total	3,148,899		NA	WDFW	1,719,073	
		Eyed Eggs (Eyed Fecundity)		Mean	?		NA		4,167	NA
				Total	?		NA		1,562,794	
				Released	?		NA		0	NA
		Fry	Fry Produced	Number	?		NA		1,488,375	
				Size	?		NA		?	
			Fry Released	Number	?		NA		0	
				Size	0		NA		?	
		Parr	Parr Produced	Number	?		NA		1,417,500	
				Size	?		NA		?	
			Parr Released	Number	?		NA		0	
				Size	51,888		NA	WDFW	?	
		Smolts	Smolts Produced	Number	?		NA		1,350,000	
				Size	?		NA		?	
			Smolts Released	Number	?		NA		1,350,000	
				Size	1,730,357		NA	WDFW	?	
		Total Offspring Released			1,782,246		NA	WDFW	1,350,000	
		Marks and Tags	Type: CWT	Number	259,485		NA	RMIS	0	
	Total Hatchery Programs	Green Eggs Collected (Fecundity)		Mean	3,863		NA	WDFW	3,667	3,667
				Total	3,148,899		NA	WDFW	2,292,098	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	NA		3,334	3,334
				Total	?	?	NA		2,083,725	
				Released	?	?	NA		0	0
		Fry	Fry Produced	Number	?				1,984,500	
				Size	?				?	
			Fry Released	Number	0			WDFW	0	
				Size	?				?	
		Parr	Parr Produced	Number	?				1,890,000	
				Size	?				?	
			Parr Released	Number	90,968-645,076			WDFW, RMIS	0	
				Size	?				?	
		Smolts	Age-2 Smolts Produced	Number	?				1,800,000	
				Size	?				?	
			Age-2 Smolts Released	Number	1,303,849-1,881,888			WDFW, RMIS	1,800,000	
				Size	?				?	
		Total Offspring Released			1,688,156-1,972,857			WDFW, RMIS	1,800,000	
		Marks and Tags	Type: CWT	Number	259,485			RMIS	360,000	

Natural Production									
Below Dams	**Lower Cowlitz River Mainstem**	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	?	?		0	0
				Out-of-Basin Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		0	0
			Smolts Produced		?			NA	0
			Smolts Trapped & Released	Number Trapped	?			NA	NA
				Number Released	?			NA	NA
				Type of Mark/Tag				NA	NA
				Number Marked/Tagged	?			NA	NA
	Lower Cowlitz River Tributaries	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	?	?		0	0
				Out-of-Basin Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		0	0
			Smolts Produced		?			0	0
			Smolts Trapped & Released	Number Trapped	?			NA	NA
				Number Released	?			NA	NA
				Type of Mark/Tag				NA	NA
				Number Marked/Tagged	?			NA	NA
Above Dams	**Cispus River**	Spawners	Prespawn Mortalities in Nature	Cispus River	?	?		<50	<50
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Cispus River	?	?		500	500
				Out-of-Basin Strays	?	?		0	0

Above Dams	Cispus River	Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		?			NA	42,857
			Smolts Trapped & Released	Number Trapped	?			NA	30,000
				Number Released	?			NA	30,000
				Type of Mark/Tag	?			NA	NA
				Number Marked/Tagged	?			NA	0
	Upper Cowlitz River	Spawners	Prespawn Mortalities in Nature	Upper Cowlitz River	?	?		<50	<50
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Upper Cowlitz River	?	?		500	500
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		123,558		CFFF (TPU/WDFW)	NA	42,857
			Smolts Trapped & Released	Number Trapped	20,572		CFFF (TPU/WDFW)	NA	30,000
				Number Released	?			NA	30,000
				Type of Mark/Tag				NA	NA
				Number Marked/Tagged	?			NA	0
	Tilton River	Spawners	Prespawn Mortalities in Nature	Tilton River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Tilton River	?	?		0	0
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		0	0
			Smolts Produced		?			NA	0
			Smolts Trapped & Released	Number Trapped	0			NA	0
				Number Released	?			NA	0
				Type of Mark/Tag				NA	NA
				Number Marked/Tagged	0			NA	0

Above Dams	Total	Spawners	Prespawn Mortalities in Nature	Tilton River	?		?			<257	<600
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Tilton River	?		?			1,000	1,000
				Out-of-Program Strays	?		?			0	0
		Offspring	Total Eggs Laid		?		?			?	?
			Smolts Produced		?					NA	85,714
			Smolts Trapped & Released	Number Trapped	28,223				TPU Mayfield	NA	60,000
				Number Released	?					NA	60,000
				Type of Mark/Tag						NA	CWT
				Number Marked/Tagged	0				TPU, RMIS	NA	0
Smolt Migration											
Smolts	Location	Number of Smolts in Lower Cowlitz River	Lower Cowlitz River		?		?			1,800,000	0
			Cispus River		?		?			0	30,000
			Upper Cowlitz River		?		?			0	30,000
			Tilton River		?		?			0	0
			Total		?		?			1,800,000	60,000
		Number of Smolts at Mouth of Cowlitz River	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
		Number of Smolts in Columbia River Estuary	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
Management Metrics (Rates to be Calculated Using the Data Collected Above)											
Adult Salmon	Harvest Rate	Ocean	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		?	?
			Total Ocean		20.7%		14.9%		ISIT	?	?
		Columbia River	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		?	?
			Total Columbia River		2.8%		1.6%		ISIT	?	?

Adult Salmon	Harvest Rate	Cowlitz River	Lower Cowlitz River	Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	26.9%		1.8%		ISIT	?	?
				Total Cowlitz River	26.9%		1.8%		ISIT	?	?
			Above Mayfield Dam - Sport	Upper Cowlitz Subbasin	2.7%		0.5%		ISIT	?	?
				Tilton Subbasin	0.0%		0.0%		ISIT	?	?
				Total Above Mayfield Dam	2.7%		18.9%		ISIT	?	?
		Total Harvest		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total	53.1%		18.9%		ISIT	?	?
	Stray Rate	Cowlitz River Salmon	Out-of-Basin		?		?			<5%	<5%
			Cowlitz Basin		?		?			<5%	<5%
			Total		?		?			<5%	<5%
		Out-of-Basin Strays Into Cowlitz River			?		?			<5%	<5%
	Trapped at Barrier Dam	Lower Cowlitz River	Trapping Rate (% of Returns to Cowlitz River)		?	?	?	?		NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	?	?		NA	NA
				Released Below Dams	?	?	?	?		NA	NA
				Released Above Dams	?	?	?	?		NA	NA
				Mortalities	?	?	?	?		NA	NA
				Surplus	?	?	?	?		NA	NA
		Tilton River	Trapping Rate (% of Returns to Cowlitz River)		?	?	?	?		NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	?	?		NA	NA
				Released Below Dams	?	?	?	?		NA	NA
				Released Above Dams	?	?	?	?		NA	NA
				Mortalities	?	?	?	?		NA	NA
				Surplus	?	?	?	?		NA	NA

Adult Salmon	Trapped at Barrier Dam	Upper Cowlitz Subbasin	Trapping Rate (% of Returns to Cowlitz River)		43.2%	61.0%	ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	24.1%	0.0%	ISIT, TPU, WDFW	?	?
				Released Below Dams	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				Released Above Dams	70.1%	100.0%	ISIT, TPU, WDFW	?	?
				Mortalities	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				Surplus	5.8%	0.0%	ISIT, TPU, WDFW	?	?
		Total	Trapping Rate (% of Returns to Cowlitz River)		43.2%	61.0%	ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	24.1%	0.0%	ISIT, TPU, WDFW	?	?
				Released Below Dams	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				To Tilton Subbasin	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				To Upper Cowlitz Subbasin	70.1%	100.0%	ISIT, TPU, WDFW	?	?
				Mortalities	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				Surplus	5.8%	0.0%	ISIT, TPU, WDFW	?	?
	Age (Run Year - Brood Year)	Integrated Hatchery Program	Mean Age		?	NA		4.5	NA
			Age Composition (proportion)	Age-2	?	NA		0%	NA
				Age-3	?	NA		5%	NA
				Age-4	?	NA		50%	NA
				Age-5	?	NA		35%	NA
				Age-6	?	NA		8%	NA
				Age-7	?	NA		2%	NA
		Segregated Hatchery Program	Mean Age		?	NA		NA	NA
			Age Composition (proportion)	Age-2	?	NA		NA	NA
				Age-3	?	NA		NA	NA
				Age-4	?	NA		NA	NA
				Age-5	?	NA		NA	NA
				Age-6	?	NA		NA	NA
				Age-7	?	NA		NA	NA

Adult Salmon	Age (Run Year - Brood Year)	Total Hatchery	Mean Age		3.27	NA	RMIS	4.5	NA
			Age Composition (proportion)	Age-2	0.000	NA	RMIS	0%	NA
				Age-3	0.201	NA	RMIS	5%	NA
				Age-4	0.381	NA	RMIS	50%	NA
				Age-5	0.363	NA	RMIS	35%	NA
				Age-6	0.055	NA	RMIS	8%	NA
				Age-7	0.000	NA	RMIS	2%	NA
		Lower Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	NA
			Age Composition (proportion)	Age-2	NA	?		NA	NA
				Age-3	NA	?		NA	NA
				Age-4	NA	?		NA	NA
				Age-5	NA	?		NA	NA
				Age-6	NA	?		NA	NA
				Age-7	NA	?		NA	NA
		Upper Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	4.5
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	5%
				Age-4	NA	?		NA	50%
				Age-5	NA	?		NA	35%
				Age-6	NA	?		NA	8%
				Age-7	NA	?		NA	2%
		Tilton Subbasin Natural-origin	Mean Age		NA	?		NA	NA
			Age Composition (proportion)	Age-2	NA	?		NA	NA
				Age-3	NA	?		NA	NA
				Age-4	NA	?		NA	NA
				Age-5	NA	?		NA	NA
				Age-6	NA	?		NA	NA
				Age-7	NA	?		NA	NA
		Total Natural-origin	Mean Age		NA	?		NA	4.5
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	5%
				Age-4	NA	?		NA	50%
				Age-5	NA	?		NA	35%
				Age-6	NA	?		NA	8%
				Age-7	NA	?		NA	2%

Spawning	In Hatchery	Integrated Hatchery Program	Prespawn Mortality Rate	NA	NA		<5%	<5%
			Mean Fecundity	NA	NA		4,500	4,500
			Mean Eyed Fecundity	NA	NA		4,275	4,275
			Fertility	NA	NA		95%	95%
		Segregated Hatchery Program	Prespawn Mortality Rate	9.8%	NA	ISIT	NA	NA
			Mean Fecundity	3,863	NA		NA	NA
			Mean Eyed Fecundity	?	NA		NA	NA
			Fertility	?	NA		NA	NA
		Total Hatchery	Prespawn Mortality Rate	9.8%		ISIT	<5%	<5%
			Mean Fecundity	3,863	NA	WDFW	4,500	4,500
			Mean Eyed Fecundity	?	NA		4,275	4,275
			Fertility	?	NA		95%	95%
	In Nature	Lower Cowlitz River	Prespawn Mortality Rate	?	?		NA	NA
			Mean Fecundity	?	?		NA	NA
		Cispus River	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		4,500	4,500
		Upper Cowlitz River / Subbasin	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		4,500	4,500
		Tilton River	Prespawn Mortality Rate	?	?		NA	NA
			Mean Fecundity	?	?		NA	NA
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	?	NA		81%	NA
		Segregated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	?	NA		81%	NA
		Total Hatchery	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	60.5% - 75.7%		ISIT, WDFW	81%	NA

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Survival of Offspring to Smolt Stage	In Nature	Lower Cowlitz River	Green Egg-to-Smolt Survival	NA		?		NA	?
		Cispus River	Green Egg-to-Smolt Survival	NA		?		NA	?
		Upper Cowlitz River / Subbasin	Green Egg-to-Smolt Survival	NA		?		NA	?
		Tilton River	Green Egg-to-Smolt Survival	NA		?		NA	?
	Marking / Tagging Rate	Hatchery-origin	Integrated Hatchery Program	?		NA		?	NA
			Segregated Hatchery Program	14.7%	14.9%	NA	RMIS/WDFW	?	NA
			Total Hatchery	14.7%	14.9%	NA	RMIS/WDFW	?	NA
		Natural-origin	Lower Cowlitz River	NA		?		?	NA
			Cispus River	NA		?		?	NA
			Upper Cowlitz River / Subbasin	NA		?		?	NA
			Tilton River	NA		?		?	NA
Survival to Maturity	Integrated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?		NA		?	NA
			to Columbia River Estuary	?		NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	?		NA		0.07%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	?		NA		0.39%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?		NA		450	NA
			Smolts / Adult+Jack Spawner	?		NA		900	NA
			Female-to-Female	?		NA		>>1	NA
			Adult-to-Adult	?		NA		>>1	NA
			Adult+Jack-to-Adult+Jack	?		NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?		NA		>>1	NA

Survival to Maturity	Segregated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	0.075%	NA	RMIS	?	NA
			Smolts	0.677%	NA	RMIS	0.07%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	0.124%	NA	RMIS	?	NA
			Smolts	1.201%	NA	RMIS	0.39%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		450	NA
			Smolts / Adult+Jack Spawner	?	NA		900	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	0.766	NA	ISIT, WDFW	>>1	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA
	Total Hatchery	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	0.08%	NA	RMIS	?	NA
			Smolts	0.677%	NA	RMIS	0.07%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	0.124%	NA	RMIS	?	NA
			Smolts	1.201%	NA	RMIS	0.39%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	2,334	NA	ISIT, WDFW	450	NA
			Smolts / Adult+Jack Spawner	1,163	NA	ISIT, WDFW	900	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	0.766	NA	ISIT, WDFW	>>1	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA

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Survival to Maturity	Lower Cowlitz River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency			NA	NA		NA	NA
		Smolt Passage (Transport) Survival			NA	NA		NA	NA
		Smolt Survival	to Mouth of Cowlitz River		NA	?		NA	NA
			to Columbia River Estuary		NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)		Fry	NA	?		NA	NA
				Parr	NA	?		NA	NA
				Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)		Fry	NA	?		NA	NA
				Parr	NA	?		NA	NA
				Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner		?	NA		NA	NA
			Smolts / Adult+Jack Spawner		?	NA		NA	NA
			Female-to-Female		?	NA		NA	NA
			Adult-to-Adult		?	NA		NA	NA
			Adult+Jack-to-Adult+Jack		?	NA		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack		?	NA		NA	NA
	Cispus River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency			NA	?		NA	>75%
		Smolt Passage (Transport) Survival			NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River		NA	?		NA	?
			to Columbia River Estuary		NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)		Fry	NA	?		NA	?
				Parr	NA	?		NA	?
				Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)		Fry	NA	?		NA	?
				Parr	NA	?		NA	?
				Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner)	Smolts / Female Spawner		?	NA		NA	?
			Smolts / Adult+Jack Spawner		?	NA		NA	?
			Female-to-Female		?	NA		NA	>1
			Adult-to-Adult		?	NA		NA	>1
			Adult+Jack-to-Adult+Jack		?	NA		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack		?	NA		NA	>1

Survival to Maturity	Upper Cowlitz River/ Subbasin Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	25.9%	CFFF (TPU/WDFW)	NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		NA	?
			Smolts / Adult+Jack Spawner	?	NA		NA	?
			Female-to-Female	?	NA		NA	>1
			Adult-to-Adult	?	NA		NA	>1
			Adult+Jack-to-Adult+Jack	?	NA		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	>1
	Tilton River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	?		NA	NA
		Smolt Passage (Transport) Survival		NA	?		NA	NA
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	NA
			to Columbia River Estuary	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	NA	?		NA	NA
			Smolts / Adult+Jack Spawner	NA	?		NA	NA
			Female-to-Female	NA	?		NA	NA
			Adult-to-Adult	NA	?		NA	NA
			Adult+Jack-to-Adult+Jack	NA	?		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	NA	?		NA	NA

Proportional Natural Influence	**Lower Cowlitz River**	Collected/ Released	pHOS	0.874	ISIT	NA
			pNOB	NA		NA
			PNI	NA		NA
		Actual Spawners	pHOS	NA		NA
			pNOB	NA		NA
			PNI	NA		NA
	Cispus River	Collected/ Released	pHOS	?		<0.35
			pNOB	?		>0.6
			PNI	?		>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		>0.6
			PNI	?		>0.67
	Upper Cowlitz River/Subbasin	Collected/ Released	pHOS	0.938	ISIT	<0.35
			pNOB	0.000	ISIT	>0.6
			PNI	0.000	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		>0.6
			PNI	?		>0.67
	Tilton River	Collected/ Released	pHOS	NA		NA
			pNOB	NA		NA
			PNI	NA		NA
		Actual Spawners	pHOS	NA		NA
			pNOB	NA		NA
			PNI	NA		NA
	Total	Collected/ Released	pHOS	0.935	ISIT, TPU, WDFW	<0.35
			pNOB	0.000	ISIT, TPU, WDFW	>0.6
			PNI	0.000	ISIT, TPU, WDFW	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		>0.6
			PNI	?		>0.67

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<u>Big Table for Coho Salmon.</u> Management metrics and ranges of means for the most recent five years for hatchery- and natural-origin data that are available from ISIT, RMIS, Tacoma Power, and WDFW and FHMP adult goals. *Suggested recovery target for Stabilizing population.

Recovery Targets				Last 5 Years Adult Mean				Source(s) of Current Data	FHMP Adult Goal	
Lower Cowlitz River	Cispus River	Upper Cowlitz River	Tilton River	Hatchery		Natural			Hatchery	Natural
3,700	2,000	2,000	2,000*	Min	Max	Min	Max			
Metrics										
Data to be Collected (Numbers)										
Mature Returns										
Totals			Total Survivors to Maturity	?		?			73,029	20,798
Totals			Total Escapement to Cowlitz River	?		?			12,751	14,868
Harvest	Fishery Location	Ocean	Commercial Fishery	?		?				
		Ocean	Tribal Fishery	?		?				
		Ocean	Sport Fishery	?		?				
		Ocean	Total Ocean	38,857		2,185		ISIT	38,800	2,089
		Columbia River	Commercial Fishery	?		?				
		Columbia River	Tribal Fishery	?		?				
		Columbia River	Sport Fishery	?		?				
		Columbia River	Total Columbia River	19,835		1,691		ISIT	19,804	1,617
		Lower Cowlitz River	Commercial Fishery	?		?				
		Lower Cowlitz River	Tribal Fishery	?		?				
		Lower Cowlitz River	Sport Fishery	6,714		887		ISIT		
		Lower Cowlitz River	Total Lower Cowlitz River	6,714		887		ISIT	6,714	887
		Above Mayfield Dam	Cispus River	?		?				
		Above Mayfield Dam	Upper Cowlitz River	1,583		37		ISIT		
		Above Mayfield Dam	Tilton River	1,150		80		ISIT		
		Above Mayfield Dam	Total Above Mayfield Dam	2,733		117		ISIT	2,733	117
	Fishery Type		Commercial	?		?				
	Fishery Type		Tribal	?		?				
	Fishery Type		Sport	?		?				
	Total Harvest			68,139		4,880		ISIT	68,051	4,710
ra y- in Str ay Ori gin	Cowlitz River Population		Outside Cowlitz Basin	?		?			0	0
ra y- in Str ay Ori gin	Cowlitz River Population		In Cowlitz Basin	?		?			0	0

	Other Population Strays in Cowlitz River			?		?			0	0
Trapping	Lower Cowlitz Subbasin Tributary Traps	Delameter Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Lacamas Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Olequa Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
		Ostrander Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				
	Cowlitz Salmon Hatchery	Hatchery Broodstock Collected		1,582	2,305	619	1,696	**ISIT, TPU**	629	943
		Released Below Dams		59	128	0	0	**TPU, WDFW**	0	0
		Released Above Dams	Upper Cowlitz Subbasin	2,699	10,009	2,243	10,445	**ISIT, TPU, WDFW**	2,811	5,154
			Tilton Subbasin	4,237	5,088	4,187	4,912	**ISIT, TPU, WDFW**	1,104	2,577
		Mortalities		2	152	0	62	TPU, WDFW	<10%	<10%
		Surplus (Food Bank, Outplant, Nutrient Enhancement, etc)		13,617	14,660	0	0	**TPU, WDFW**	5,000	0
		Total		21,380		4,806		TPU, WDFW	4,570	7,077
(pre-spawning	Location	Below Dams	Lower Cowlitz River – Cowlitz River	?		?			1,762	4,111
			Lower Cowlitz River – Out-of-Program Strays	?	?	?	?		0	0
		Above Dams	Upper Cowlitz/Cispus Rivers	8,771		2,315		ISIT	1,905	4,444
			Tilton River	3,318		3,605		ISIT	952	2,222

Total				12,089		5,920		ISIT	4,619	10,778
Hatchery Production										
Spawners	**Integrated Hatchery Program**	Prespawn Mortalities		23		53		ISIT	<92	<113
		Killed, Not Spawned		?		?			0	0
		Spawned		274		556		ISIT	1,753	2,142
	Segregated Hatchery Program	Prespawn Mortalities		158		NA		ISIT	0	0
		Killed, Not Spawned		?		NA			0	0
		Spawned		1,241		NA		ISIT	750	0
	Total Hatchery	Prespawn Mortalities		152	181	53	62	ISIT, WDFW	<92	<113
		Killed, Not Spawned		?	?	?	?		0	0
		Spawned		403	556	1,900	2,070	ISIT, WDFW	1,753	2,142
Offspring - Rearing and Release	**Integrated Hatchery Program**	Green Eggs Collected (Fecundity)	Mean	3,561		3,513		ISIT	3,564	3,564
			Total	516,230		942,844		ISIT	2,801,453	
		Eyed Eggs (Eyed Fecundity)	Mean	?	?	?	?		3,240	3,240
			Total	?	?	?	?		2,546,775	
			Released	?	?	?	?		0	0
		Fry – Fry Produced	Number	?	?	?	?		2,425,500	
			Size	?	?	NA	NA		?	
		Fry – Fry Released	Number	?	?	NA	NA		0	
			Size	?	?	NA	NA		NA	
		Parr – Parr Produced	Number	?	?	NA	NA		2,310,000	
			Size	?	?	NA	NA		?	
		Parr – Parr Released	Number	?	?	NA	NA		0	
			Size	?	?	NA	NA		NA	
		Smolts – Smolts Produced	Number	958,815				ISIT	2,200,000	
			Size	?	?	NA	NA		?	
		Smolts – Smolts Released	Number	958,815				ISIT	2,200,000	
			Size	?					?	
		Total Offspring Released		958,815				ISIT	CWT	
		Marks and Tags – Type: CWT	Number	?					440,000	

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Offspring - Rearing and Release	Segregated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	3,513		NA		ISIT	0	NA
				Total	2,176,135		NA		ISIT	0	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	NA			0	NA
				Total	?	?	NA			0	
				Released	?	?	NA			0	NA
		Fry	Fry Produced	Number	?	?	NA			0	
				Size	?	?	NA			?	
			Fry Released	Number	?	?	NA			0	
				Size	?	?	NA			?	
		Parr	Parr Produced	Number	?	?	NA			0	
				Size	?	?	NA			?	
			Parr Released	Number	?	?	NA			0	
				Size	?	?	NA			?	
		Smolts	Smolts Produced	Number	1,234,982		NA		ISIT	0	
				Size	?	?	NA			?	
			Smolts Released	Number	1,234,982		NA		ISIT	0	
				Size	?	?	NA			?	
		Total Offspring Released			1,234,982		NA		ISIT	NA	
		Marks and Tags	Type: CWT	Number	?		NA			0	
	Total Hatchery Programs	Green Eggs Collected (Fecundity)		Mean	1,377	2,956	1,377	2,956	**ISIT, WDFW**	3,564	3,564
				Total	2,393,300	2,692,365	753,352	942,844	**ISIT, WDFW**	2,801,453	
		Eyed Eggs (Eyed Fecundity)		Mean	?		?			3,240	3,240
				Total	?		?			2,546,775	
				Released	?		?			0	0
		Fry	Fry Produced	Number	?	?	NA			2,425,500	
				Size	?	?	NA			?	
			Fry Released	Number	35,128	300,568	NA		**WDFW**	0	
				Size	?	?	NA			?	
		Parr	Parr Produced	Number	?	?	NA			2,310,000	
				Size	?	?	NA			?	
			Parr Released	Number	62,717	131,184	NA		**WDFW**	0	
				Size	?	?	NA			?	
		Smolts	Age-2 Smolts Produced	Number	?	?	NA			2,200,000	
				Size	?	?	NA			?	
			Age-2 Smolts Released	Number	2,193,797	2,503,284	NA		**ISIT, WDFW, RMIS**	2,200,000	
				Size	?	?	NA			?	
		Total Offspring Released			2,291,642	2,935,036	NA			2,200,000	
		Marks and Tags	Type: CWT	Number	?		NA			440,000	

Natural Production											
Below Dams	Lower Cowlitz River Mainstem	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?	?	?		<159	<370
				Out-of-Program Strays	?	?	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	508		4,727		ISIT	1,586	3,700
				Out-of-Basin Strays	?	?	?	?		0	0
		Offspring	Total Eggs Laid		?	?	?	?		?	?
			Smolts Produced		?					NA	158,665
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
	Lower Cowlitz River Tributaries	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?	?	?		0	0
				Out-of-Program Strays	?	?	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	?	?	?	?		0	0
				Out-of-Basin Strays	?	?	?	?		0	0
		Offspring	Total Eggs Laid		?	?	?	?		0	0
			Smolts Produced		?					0	0
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
Above Dams	Cispus River	Spawners	Prespawn Mortalities in Nature	Cispus River	?		?			<86	<200
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Cispus River	?		?			857	2,000
				Out-of-Basin Strays	?		?			0	0

Above Dams	Cispus River	Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		?			NA	64,286
			Smolts Trapped & Released	Number Trapped	?			NA	45,000
				Number Released	?	?		NA	45,000
				Type of Mark/Tag	?	?		NA	NA
				Number Marked/Tagged	?	?		NA	0
	Upper Cowlitz River	Spawners	Prespawn Mortalities in Nature	Upper Cowlitz River	?	?		<86	<200
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Upper Cowlitz River	?	?		857	2,000
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		145,455		CFFF (TPU/WDFW)	NA	64,286
			Smolts Trapped & Released	Number Trapped	118,138		CFFF (TPU/WDFW)	NA	45,000
				Number Released	?			NA	45,000
				Type of Mark/Tag	NA			NA	NA
				Number Marked/Tagged	96,493		RMIS	NA	0
	Tilton River	Spawners	Prespawn Mortalities in Nature	Tilton River	?	?		<86	<200
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Tilton River	?	?		857	2,000
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		?	?
			Smolts Produced		?			NA	64,286
			Smolts Trapped & Released	Number Trapped	28,631		TPU Mayfield	NA	45,000
				Number Released	?			NA	45,000
				Type of Mark/Tag	NA			NA	CWT
				Number Marked/Tagged	25,774		TPU, RMIS	NA	45,000

Above Dams	Total	Spawners	Prespawn Mortalities in Nature	Tilton River	?		?			<257	<600
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Tilton River	?		?			2,571	6,000
				Out-of-Program Strays	?		?			0	0
		Offspring	Total Eggs Laid		?		?			?	?
			Smolts Produced		?					NA	192,857
			Smolts Trapped & Released	Number Trapped	28,223				TPU Mayfield	NA	135,000
				Number Released	?					NA	135,000
				Type of Mark/Tag	NA					NA	CWT
				Number Marked/Tagged	122,267				TPU, RMIS	NA	>45,000
Smolt Migration											
Smolts	Location	Number of Smolts in Lower Cowlitz River		Lower Cowlitz River	2,193,797	2,279,449	?		ISIT, WDFW, RMIS	2,200,000	158,665
				Cispus River	?		?			0	45,000
				Upper Cowlitz River	?		?			0	0
				Tilton River	?		?			0	45,000
				Total	?		?			2,200,000	293,665
		Number of Smolts at Mouth of Cowlitz River		Lower Cowlitz River	?		?			?	?
				Cispus River	?		?			?	?
				Upper Cowlitz River	?		?			?	?
				Tilton River	?		?			?	?
				Total	?		?			?	?
		Number of Smolts in Columbia River Estuary		Lower Cowlitz River	?		?			?	?
				Cispus River	?		?			?	?
				Upper Cowlitz River	?		?			?	?
				Tilton River	?		?			?	?
				Total	?		?			?	?
Management Metrics (Rates to be Calculated Using the Data Collected Above)											
Adult Salmon	Harvest Rate	Ocean		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total Ocean	44.9%	47.6%	12.0%	14.0%	ISIT, TPU	?	?
		Columbia River		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total Columbia River	19.2%	20.5%	6.8%	8.0%	ISIT, TPU	?	?

Adult Salmon	Harvest Rate	Cowlitz River	Lower Cowlitz River	Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	6.3%	24.6%	1.6%	5.5%	ISIT, TPU	?	?
				Total Cowlitz River	6.3%	24.6%	1.6%	5.5%	ISIT, TPU	?	?
			Above Mayfield Dam - Sport	Upper Cowlitz Subbasin	1.8%	13.3%	0.2%	1.9%	ISIT, TPU	?	?
				Tilton Subbasin	1.7%	24.5%	0.7%	1.9%	ISIT, TPU	?	?
				Total Above Mayfield Dam	3.4%		1.0%		ISIT	?	?
		Total Harvest		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total	?		?			?	?
	Stray Rate	Cowlitz River Salmon	Out-of-Basin		?		?			<5%	<5%
			Cowlitz Basin		?		?			<5%	<5%
			Total		?		?			<5%	<5%
		Out-of-Basin Strays Into Cowlitz River			?		?			<5%	<5%
	Trapped at Barrier Dam	Lower Cowlitz River	Trapping Rate (% of Returns to Cowlitz River)		?	?	NA			NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	NA			NA	NA
				Released Below Dams	?	?	NA			NA	NA
				Released Above Dams	?	?	NA			NA	NA
				Mortalities	?	?	NA			NA	NA
				Surplus	?	?	NA			NA	NA
		Tilton River	Trapping Rate (% of Returns to Cowlitz River)		?	?	?	?		NA	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?	?	?	?		NA	NA
				Released Below Dams	?	?	?	?		NA	NA
				Released Above Dams	?	?	?	?		NA	NA
				Mortalities	?	?	?	?		NA	NA
				Surplus	?	?	?	?		NA	NA

Adult Salmon	Trapped at Barrier Dam	Upper Cowlitz Subbasin	Trapping Rate (% of Returns to Cowlitz River)		?		?			?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	?		?			?	?
				Released Below Dams	?		?			?	?
				Released Above Dams	?		?			?	?
				Mortalities	?		?			?	?
				Surplus	?		?			?	?
		Total	Trapping Rate (% of Returns to Cowlitz River)		21.1%	25.4%	36.3%	61.7%	ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	16.0%	19.1%	10.9%	15.1%	ISIT, TPU, WDFW	?	?
				Released Below Dams	0.4%	0.5%	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				To Tilton Subbasin	35.0%	53.3%	21.8%	41.7%	ISIT, TPU, WDFW	?	?
				To Upper Cowlitz Subbasin	29.6%	39.5%	63.4%	84.9%	ISIT, TPU, WDFW	?	?
				Mortalities	0.0%	1.3%	0.0%	1.4%	ISIT, TPU, WDFW	?	?
				Surplus	30.2%	43.9%	0.0%	0.1%	ISIT, TPU, WDFW	?	?
	Age (Run Year - Brood Year)	Integrated Hatchery Program	Mean Age		?		NA			3.9	NA
			Age Composition (proportion)	Age-2	?		NA			0%	NA
				Age-3	?		NA			10%	NA
				Age-4	?		NA			90%	NA
				Age-5	?		NA			0%	NA
				Age-6	?		NA			0%	NA
				Age-7	?		NA			0%	NA
		Segregated Hatchery Program	Mean Age		?		NA			NA	NA
			Age Composition (proportion)	Age-2	?		NA			NA	NA
				Age-3	?		NA			NA	NA
				Age-4	?		NA			NA	NA
				Age-5	?		NA			NA	NA
				Age-6	?		NA			NA	NA
				Age-7	?		NA			NA	NA

Adult Salmon	Age (Run Year - Brood Year)	Total Hatchery	Mean Age		2.92	NA	RMIS	3.9	NA
			Age Composition (proportion)	Age-2	0.000	NA	RMIS	0%	NA
				Age-3	0.085	NA	RMIS	10%	NA
				Age-4	0.915	NA	RMIS	90%	NA
				Age-5	0.001	NA	RMIS	0%	NA
				Age-6	0.000	NA	RMIS	0%	NA
				Age-7	0.000	NA	RMIS	0%	NA
		Lower Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	3.9
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	10%
				Age-4	NA	?		NA	90%
				Age-5	NA	?		NA	0%
				Age-6	NA	?		NA	0%
				Age-7	NA	?		NA	0%
		Upper Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	3.9
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	10%
				Age-4	NA	?		NA	90%
				Age-5	NA	?		NA	0%
				Age-6	NA	?		NA	0%
				Age-7	NA	?		NA	0%
		Tilton Subbasin Natural-origin	Mean Age		NA	?		NA	3.9
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	10%
				Age-4	NA	?		NA	90%
				Age-5	NA	?		NA	0%
				Age-6	NA	?		NA	0%
				Age-7	NA	?		NA	0%
		Total Natural-origin	Mean Age		NA	?		NA	3.9
			Age Composition (proportion)	Age-2	NA	?		NA	0%
				Age-3	NA	?		NA	10%
				Age-4	NA	?		NA	90%
				Age-5	NA	?		NA	0%
				Age-6	NA	?		NA	0%
				Age-7	NA	?		NA	0%

Spawning	In Hatchery	Integrated Hatchery Program	Prespawn Mortality Rate	8.9%		ISIT	<5%	<5%
			Mean Fecundity	?	?		3,000	3,000
			Mean Eyed Fecundity	?	?		2,850	2,850
			Fertility	?	?		95%	95%
		Segregated Hatchery Program	Prespawn Mortality Rate	12.7%	NA	ISIT	NA	NA
			Mean Fecundity	?	NA		NA	NA
			Mean Eyed Fecundity	?	NA		NA	NA
			Fertility	?	NA		NA	NA
		Total Hatchery	Prespawn Mortality Rate	10.8%		ISIT	<5%	<5%
			Mean Fecundity	3,562	6,147	WDFW	3,000	3,000
			Mean Eyed Fecundity	?	?		2,850	2,850
			Fertility	?	?		95%	95%
	In Nature	Lower Cowlitz River	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		3,000	3,000
		Cispus River	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		3,000	3,000
		Upper Cowlitz River / Subbasin	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		3,000	3,000
		Tilton River	Prespawn Mortality Rate	?	?		<5%	<5%
			Mean Fecundity	?	?		3,000	3,000
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	?	NA		81%	NA
		Segregated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	?	NA		81%	NA
		Total Hatchery	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	72.7%		WDFW	81%	NA

Survival of Offspring to Smolt Stage	In Nature	Lower Cowlitz River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Cispus River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Upper Cowlitz River / Subbasin	Green Egg-to-Smolt Survival	NA	?		NA	?
		Tilton River	Green Egg-to-Smolt Survival	NA	?		NA	?
	Marking / Tagging Rate	Hatchery-origin	Integrated Hatchery Program	?	NA		?	NA
			Segregated Hatchery Program	?	NA		?	NA
			Total Hatchery	51.0%	NA	RMIS	?	NA
		Natural-origin	Lower Cowlitz River	NA	NA		?	NA
			Cispus River	NA	?		?	NA
			Upper Cowlitz River / Subbasin	NA	?		?	NA
			Tilton River	NA	?		?	NA
Survival to Maturity	Integrated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	?	NA		0.07%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	?	NA		2.09%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		700	NA
			Smolts / Adult+Jack Spawner	?	NA		1,399	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	?	NA		>>1	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA

Survival to Maturity	Segregated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?		NA		NA	NA
			to Columbia River Estuary	?		NA		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?		NA		NA	NA
			Parr	?		NA		NA	NA
			Smolts	?		NA		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?		NA		NA	NA
			Parr	?		NA		NA	NA
			Smolts	?		NA		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?		NA		NA	NA
			Smolts / Adult+Jack Spawner	?		NA		NA	NA
			Female-to-Female	?		NA		NA	NA
			Adult-to-Adult	?		NA		NA	NA
			Adult+Jack-to-Adult+Jack	?		NA		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?		NA		NA	NA
	Total Hatchery	Smolt Survival	to Mouth of Cowlitz River	?		NA		?	NA
			to Columbia River Estuary	?		NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	?		NA		0.07%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?		NA		?	NA
			Parr	?		NA		?	NA
			Smolts	0.435%		NA	RMIS	2.09%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	1,002	1,868	NA	ISIT, WDFW	700	NA
			Smolts / Adult+Jack Spawner	1,104	1,323	NA	ISIT, WDFW	1,399	NA
			Female-to-Female	?		NA		>>1	NA
			Adult-to-Adult	?		NA		>>1	NA
			Adult+Jack-to-Adult+Jack	?		NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?		NA		>>1	NA

Survival to Maturity	Lower Cowlitz River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	NA		NA	NA
		Smolt Passage (Transport) Survival		NA	NA		NA	NA
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		NA	?
			Smolts / Adult+Jack Spawner	?	NA		NA	?
			Female-to-Female	?	NA		NA	>1
			Adult-to-Adult	?	NA		NA	>1
			Adult+Jack-to-Adult+Jack	?	NA		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	>1
	Cispus River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	75.6%	CFFF (TPU/WDFW)	NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	NA
			to Columbia River Estuary	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		NA	NA
			Smolts / Adult+Jack Spawner	?	NA		NA	NA
			Female-to-Female	?	NA		NA	>1
			Adult-to-Adult	?	NA		NA	>1
			Adult+Jack-to-Adult+Jack	?	NA		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	>1

Survival to Maturity	Upper Cowlitz River/ Subbasin Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	75.6%	CFFF (TPU/WDFW)	NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	NA
			to Columbia River Estuary	NA	?		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	NA
			Parr	NA	?		NA	NA
			Smolts	NA	?		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		NA	NA
			Smolts / Adult+Jack Spawner	?	NA		NA	NA
			Female-to-Female	?	NA		NA	>1
			Adult-to-Adult	?	NA		NA	>1
			Adult+Jack-to-Adult+Jack	?	NA		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	>1
	Tilton River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	?		NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	?
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	NA	?		NA	?
			Smolts / Adult+Jack Spawner	NA	?		NA	?
			Female-to-Female	NA	?		NA	>1
			Adult-to-Adult	NA	?		NA	>1
			Adult+Jack-to-Adult+Jack	NA	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	NA	?		NA	>1

Proportional Natural Influence	**Lower Cowlitz River**	Collected/ Released	pHOS	NA		NA
			pNOB	NA		NA
			PNI	NA		NA
		Actual Spawners	pHOS	0.104	ISIT	<0.3
			pNOB	0.195	ISIT	NA
			PNI	0.584	ISIT	NA
	Cispus River	Collected/ Released	pHOS	?		<0.35
			pNOB	?		NA
			PNI	?		NA
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		NA
			PNI	?		NA
	Upper Cowlitz River/Subbasin	Collected/ Released	pHOS	0.774	ISIT	<0.35
			pNOB	0.695	ISIT	>0.6
			PNI	0.443	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		>0.6
			PNI	?		>0.67
	Tilton River	Collected/ Released	pHOS	0.570	ISIT	<0.35
			pNOB	?		NA
			PNI	?		NA
		Actual Spawners	pHOS	?		<0.3
			pNOB	?		NA
			PNI	?		NA
	Total	Collected/ Released	pHOS	0.309 - 0.698	ISIT, TPU, WDFW	<0.35
			pNOB	0.265 - 0.287	ISIT, TPU, WDFW	>0.6
			PNI	0.266 - 0.441	ISIT, TPU, WDFW	>0.63
		Actual Spawners	pHOS	0.526	ISIT	<0.3
			pNOB	0.195	ISIT	>0.6
			PNI	0.260	ISIT	>0.67

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Big Table for Winter Steelhead. Management metrics and ranges of means for the most recent five years for hatchery- and natural-origin data that are available from ISIT, RMIS, Tacoma Power, and WDFW and FHMP adult goals. *Suggested recovery target for Stabilizing population.

Recovery Targets				Last 5 Years Adult Mean				Source(s) of Current Data	FHMP Adult Goal	
Lower Cowlitz River	Cispus River	Upper Cowlitz River	Tilton River	Hatchery		Natural			Hatchery	Natural
400	500	500	200	Min	Max	Min	Max			
Metrics										
Data to be Collected (Numbers)										
Mature Returns										
Totals	Total Survivors to Maturity			?		?			11,296	1,926
Totals	Total Escapement to Cowlitz River			?		?			11,296	1,926
Harvest	**Fishery Location**	Ocean	Commercial Fishery	?		?				
		Ocean	Tribal Fishery	?		?				
		Ocean	Sport Fishery	?		?				
		Ocean	Total Ocean	0		0		ISIT	0	0
		Columbia River	Commercial Fishery	?		?				
		Columbia River	Tribal Fishery	?		?				
		Columbia River	Sport Fishery	?		?				
		Columbia River	Total Columbia River	0		0		ISIT	0	0
		Lower Cowlitz River	Commercial Fishery	?		?				
		Lower Cowlitz River	Tribal Fishery	?		?				
		Lower Cowlitz River	Sport Fishery	10,249		20		ISIT		
		Lower Cowlitz River	Total Lower Cowlitz River	10,249		20		ISIT	10,249	20
		Above Mayfield Dam	Cispus River	?		?				
		Above Mayfield Dam	Upper Cowlitz River	105		4		ISIT		
		Above Mayfield Dam	Tilton River	30		6		ISIT		
		Above Mayfield Dam	Total Above Mayfield Dam	135		9		ISIT	135	9
	Fishery Type		Commercial	?		?				
	Fishery Type		Tribal	?		?				
	Fishery Type		Sport	?		?				
	Total Harvest			10,385		29		ISIT	10,385	73

Stray -ing	Stray Origin	Cowlitz River Population	Outside Cowlitz Basin	?		?			0	0
			In Cowlitz Basin	?		?			0	0
		Other Population Strays in Cowlitz River		?		?			0	0
Trapping	Lower Cowlitz Subbasin Tributary Traps	Delameter Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				20
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				20
		Lacamas Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				20
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				20
		Olequa Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				20
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				20
		Ostrander Creek	Released Below Weir	?		?				0
			Released Above Weir	?		?				
			Kept for Broodstock	?		?				20
			Mortalities	?		?			0	0
			Killed	?		?				0
			Total Caught	?		?				20
	Cowlitz Salmon Hatchery	Hatchery Broodstock Collected		295	514	110	118	ISIT, TPU, WDFW	296	162
		Released Below Dams		0	265	0	468	TPU, WDFW	0	0
		Released Above Dams	Upper Cowlitz Subbasin	101	193	156	166	ISIT, TPU, WDFW	283	578
			Tilton Subbasin	14	72	205	303	TPU, WDFW	29	231
		Mortalities		1	137	0	12	TPU, WDFW	<10%	<10%
		Surplus (Food Bank, Outplant, Nutrient Enhancement, etc)		3,032	3,450	0	4	TPU, WDFW	0	0
		Total		3,811	4,015	568	1,059	TPU, WDFW	676	1,079

Nature (pre-spawning)	Location	Below Dams	Lower Cowlitz River	Cowlitz River	180		645		ISIT	273	638
				Out-of-Program Strays	?	?	?	?		0	0
		Above Dams	Upper Cowlitz/Cispus Rivers		97		142		ISIT	236	550
			Tilton River		?		?			24	220
		Total			304		1,048		ISIT	534	1,408
Hatchery Production											
Spawners	Integrated Hatchery Program		Prespawn Mortalities		35	36	13	13	ISIT, WDFW	<27	<22
			Killed, Not Spawned		?	?	?	?		0	0
			Spawned		268	268	104	104	ISIT, WDFW	269	221
	Segregated Hatchery Program		Prespawn Mortalities		158		NA			<75	NA
			Killed, Not Spawned		?		NA			0	NA
			Spawned		1,241		NA			0	NA
	Total Hatchery		Prespawn Mortalities		35	36	13	13	ISIT, WDFW	<27	<22
			Killed, Not Spawned		?	?	?	?	_	0	0
			Spawned		263	268	104	107	ISIT, WDFW	269	221
Offspring - Rearing and Release	Integrated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	5,559 - 8,364				ISIT, WDFW	5,500	5,500
				Total	700,192		148,664		WDFW	955,041	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?	?	?		5,225	5,225
				Total	?	?	?	?		868,219	
				Released	?	?	?	?		0	0
		Fry	Fry Produced	Number	?	?	?	?		826,875	
				Size	?	?	?	?		?	
			Fry Released	Number	?	?	?	?		0	
				Size	?	?	?	?		NA	
		Parr	Parr Produced	Number	?	?	?	?		787,500	
				Size	?	?	?	?		?	
			Parr Released	Number	?	?	?	?		0	
				Size	?	?	?	?		NA	
		Smolts	Smolts Produced	Number	?					750,000	
				Size	?	?	?	?		?	
			Smolts Released	Number	407,481				WDFW	750,000	
				Size	?					?	
		Total Offspring Released			407,481				WDFW	CWT	
		Marks and Tags	Type: CWT	Number	?					150,000	

Offspring - Rearing and Release	Segregated Hatchery Program	Green Eggs Collected (Fecundity)		Mean	NA	NA		0	NA
				Total	NA	NA		0	
		Eyed Eggs (Eyed Fecundity)		Mean	NA	NA		0	NA
				Total	NA	NA		0	
				Released	NA	NA		0	NA
		Fry	Fry Produced	Number	NA	NA		0	
				Size	NA	NA		?	
			Fry Released	Number	NA	NA		0	
				Size	NA	NA		?	
		Parr	Parr Produced	Number	NA	NA		0	
				Size	NA	NA		?	
			Parr Released	Number	NA	NA		0	
				Size	NA	NA		?	
		Smolts	Smolts Produced	Number	NA	NA		0	
				Size	NA	NA		?	
			Smolts Released	Number	NA	NA		0	
				Size	NA	NA		?	
		Total Offspring Released			NA	NA		NA	
		Marks and Tags	Type: CWT	Number	NA	NA		0	
	Total Hatchery Programs	Green Eggs Collected (Fecundity)		Mean	5,559 - 8,364		ISIT, WDFW	5,500	5,500
				Total	700,192	148,664	WDFW	955,041	
		Eyed Eggs (Eyed Fecundity)		Mean	?	?		3,240	
				Total	?	?		2,546,775	
				Released	?	?		0	
		Fry	Fry Produced	Number	?	?		826,875	
				Size	?	?		?	
			Fry Released	Number	?	?		0	
				Size	?	?		NA	
		Parr	Parr Produced	Number	?	?		787,500	
				Size	?	?		?	
			Parr Released	Number	?	?		0	
				Size	?	?		NA	
		Smolts	Age-2 Smolts Produced	Number	?			750,000	
				Size	?	?		?	
			Age-2 Smolts Released	Number	407,481		WDFW	750,000	
				Size	?			?	
		Total Offspring Released			407,481		WDFW	CWT	
		Marks and Tags	Type: CWT	Number	?			150,000	

Natural Production											
Below Dams	Lower Cowlitz River Mainstem	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?		?	?	?	?
				Out-of-Program Strays	?	?		0	0	?	?
			Spawners in Nature	Lower Cowlitz River	162		580		ISIT	?	?
				Out-of-Basin Strays	?	?		0	0	?	?
		Offspring	Total Eggs Laid		?	?	?	?		?	?
			Smolts Produced		?					?	?
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
	Lower Cowlitz River Tributaries	Spawners	Prespawn Mortalities in Nature	Lower Cowlitz River	?	?	?	?		<18	<63
				Out-of-Program Strays	?	?	?	?		0	0
			Spawners in Nature	Lower Cowlitz River	?	?	?	?		162	580
				Out-of-Basin Strays	?	?	?	?		0	0
		Offspring	Total Eggs Laid		?	?	?	?		892,980	3,191,760
			Smolts Produced		?					0	0
			Smolts Trapped & Released	Number Trapped	NA					NA	NA
				Number Released	NA					NA	NA
				Type of Mark/Tag	NA					NA	NA
				Number Marked/Tagged	NA					NA	NA
Above Dams	Cispus River	Spawners	Prespawn Mortalities in Nature	Cispus River	?		?			<10	<25
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Cispus River	?		?			107	250
				Out-of-Basin Strays	?		?			0	0

Above Dams	Cispus River	Offspring	Total Eggs Laid		?	?		589,286	1,375,000
			Smolts Produced		?			8,333	
			Smolts Trapped & Released	Number Trapped	?			6,250	
				Number Released	?	?		6,250	
				Type of Mark/Tag	?	?		NA	
				Number Marked/Tagged	?	?		0	
	Upper Cowlitz Subbasin	Spawners	Prespawn Mortalities in Nature	Upper Cowlitz River	?	?		<10	<25
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Upper Cowlitz River	?	?		107	250
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		589,286	1,375,000
			Smolts Produced		13,270		CFFF (TPU/WDFW)	8,333	
			Smolts Trapped & Released	Number Trapped	9,439		CFFF (TPU/WDFW)	6,250	
				Number Released	?			6,250	
				Type of Mark/Tag	NA			NA	
				Number Marked/Tagged	?			0	
	Tilton River	Spawners	Prespawn Mortalities in Nature	Tilton River	?	?		<8	<20
				Out-of-Program Strays	?	?		0	0
			Spawners in Nature	Tilton River	?	?		86	200
				Out-of-Program Strays	?	?		0	0
		Offspring	Total Eggs Laid		?	?		471,429	1,100,000
			Smolts Produced		?			6,667	
			Smolts Trapped & Released	Number Trapped	7,649		TPU Mayfield	5,000	
				Number Released	?			5,000	
				Type of Mark/Tag	NA			CWT	
				Number Marked/Tagged	?			5,000	

Above Dams	Total	Spawners	Prespawn Mortalities in Nature	Tilton River	?		?			<257	<600
				Out-of-Program Strays	?		?			0	0
			Spawners in Nature	Tilton River	?		?			300	700
				Out-of-Program Strays	?		?			0	0
		Offspring	Total Eggs Laid		?		?			1,650,000	3,850,000
			Smolts Produced		?					23,333	
			Smolts Trapped & Released	Number Trapped	17,089				TPU Mayfield	17,500	
				Number Released	?					17,500	
				Type of Mark/Tag	NA					CWT	
				Number Marked/Tagged	?					5,000	
Smolt Migration											
Smolts	Location	Number of Smolts in Lower Cowlitz River	Lower Cowlitz River		?		?			750,000	20,000
			Cispus River		?		?			0	6,250
			Upper Cowlitz River		?		?			0	0
			Tilton River		?		?			0	5,000
			Total		?		?			750,000	37,500
		Number of Smolts at Mouth of Cowlitz River	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
		Number of Smolts in Columbia River Estuary	Lower Cowlitz River		?		?			?	?
			Cispus River		?		?			?	?
			Upper Cowlitz River		?		?			?	?
			Tilton River		?		?			?	?
			Total		?		?			?	?
Management Metrics (Rates to be Calculated Using the Data Collected Above)											
Adult Salmon	Harvest Rate	Ocean	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		0%	0%
			Total Ocean		0%		0%		ISIT, TPU	?	?
		Columbia River	Commercial		?	?	?	?		?	?
			Tribal		?	?	?	?		?	?
			Sport		?	?	?	?		0%	0%
			Total Columbia River		0%		0%		ISIT, TPU	?	?

Adult Salmon	Harvest Rate	Cowlitz River	Lower Cowlitz River	Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport						?	?
				Total Cowlitz River	71.0%		1.6%		ISIT, TPU	71%	2%
			Above Mayfield Dam - Sport	Upper Cowlitz Subbasin	0.7%		0.3%		ISIT, TPU	1%	0%
				Tilton Subbasin	0.2%		0.4%		ISIT, TPU	0%	0%
				Total Above Mayfield Dam	0.9%		2.3%		ISIT, TPU	1%	2%
		Total Harvest		Commercial	?	?	?	?		?	?
				Tribal	?	?	?	?		?	?
				Sport	?	?	?	?		?	?
				Total	71.8%		2.3%		ISIT, TPU	72%	2%
	Stray Rate	Cowlitz River Salmon	Out-of-Basin		?		?			<5%	<5%
			Cowlitz Basin		?		?			<5%	<5%
			Total		?		?			<5%	<5%
		Out-of-Basin Strays Into Cowlitz River			?		?			<5%	<5%
	Trapped at Barrier Dam	Lower Cowlitz River	Trapping Rate (% of Returns to Cowlitz River)		26.6%		NA		ISIT, TPU, WDFW	?	NA
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	14.5%		NA		ISIT, TPU, WDFW	?	NA
				Released Below Dams	0.0%		NA		ISIT, TPU, WDFW	?	NA
				Released Above Dams	1.5%		NA		ISIT, TPU, WDFW	?	NA
				Mortalities	0.0%		NA		ISIT, TPU, WDFW	?	NA
				Surplus	79.4%		NA		ISIT, TPU, WDFW	?	NA
		Tilton River	Trapping Rate (% of Returns to Cowlitz River)		26.6%		47.7%		ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	14.5%		19.5%		ISIT, TPU, WDFW	?	?
				Released Below Dams	0.0%		0.0%		ISIT, TPU, WDFW	?	?
				Released Above Dams	1.5%		53.9%		ISIT, TPU, WDFW	?	?
				Mortalities	0.0%		26.1%		ISIT, TPU, WDFW	?	?
				Surplus	79.4%		0.0%		ISIT, TPU, WDFW	?	?

Adult Salmon	Trapped at Barrier Dam	Upper Cowlitz Subbasin	Trapping Rate (% of Returns to Cowlitz River)		26.6%	47.7%	ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	14.5%	19.5%	ISIT, TPU, WDFW	?	?
				Released Below Dams	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				Released Above Dams	1.5%	53.9%	ISIT, TPU, WDFW	?	?
				Mortalities	0.0%	26.1%	ISIT, TPU, WDFW	?	?
				Surplus	79.4%	0.0%	ISIT, TPU, WDFW	?	?
		Total	Trapping Rate (% of Returns to Cowlitz River)		26.6%	47.7%	ISIT, TPU, WDFW	?	?
			Percentage of Cowlitz Salmon Hatchery Collection	Hatchery Broodstock	14.5%	19.5%	ISIT, TPU, WDFW	?	?
				Released Below Dams	0.0%	0.0%	ISIT, TPU, WDFW	?	?
				To Tilton Subbasin	1.5%	53.9%	ISIT, TPU, WDFW	?	?
				To Upper Cowlitz Subbasin	0.0%	26.1%	ISIT, TPU, WDFW	?	?
				Mortalities	79.4%	0.0%	ISIT, TPU, WDFW	?	?
				Surplus	14.5%	0.5%	ISIT, TPU, WDFW	?	?
	Age (Run Year - Brood Year)	Integrated Hatchery Program	Mean Age		?	NA		?	NA
			Age Composition (proportion)	Age-2	?	NA		?	NA
				Age-3	?	NA		?	NA
				Age-4	?	NA		?	NA
				Age-5	?	NA		?	NA
				Age-6	?	NA		?	NA
				Age-7	?	NA		?	NA
		Segregated Hatchery Program	Mean Age		?	NA		?	NA
			Age Composition (proportion)	Age-2	?	NA		?	NA
				Age-3	?	NA		?	NA
				Age-4	?	NA		?	NA
				Age-5	?	NA		?	NA
				Age-6	?	NA		?	NA
				Age-7	?	NA		?	NA

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Adult Salmon	Age (Run Year - Brood Year)	Total Hatchery	Mean Age		?	NA		?	NA
			Age Composition (proportion)	Age-2	?	NA		?	NA
				Age-3	?	NA		?	NA
				Age-4	?	NA		?	NA
				Age-5	?	NA		?	NA
				Age-6	?	NA		?	NA
				Age-7	?	NA		?	NA
		Lower Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	?
			Age Composition (proportion)	Age-2	NA	?		NA	?
				Age-3	NA	?		NA	?
				Age-4	NA	?		NA	?
				Age-5	NA	?		NA	?
				Age-6	NA	?		NA	?
				Age-7	NA	?		NA	?
		Upper Cowlitz Subbasin Natural-origin	Mean Age		NA	?		NA	?
			Age Composition (proportion)	Age-2	NA	?		NA	?
				Age-3	NA	?		NA	?
				Age-4	NA	?		NA	?
				Age-5	NA	?		NA	?
				Age-6	NA	?		NA	?
				Age-7	NA	?		NA	?
		Tilton Subbasin Natural-origin	Mean Age		NA	?		NA	?
			Age Composition (proportion)	Age-2	NA	?		NA	?
				Age-3	NA	?		NA	?
				Age-4	NA	?		NA	?
				Age-5	NA	?		NA	?
				Age-6	NA	?		NA	?
				Age-7	NA	?		NA	?
		Total Natural-origin	Mean Age		NA	?		NA	?
			Age Composition (proportion)	Age-2	NA	?		NA	?
				Age-3	NA	?		NA	?
				Age-4	NA	?		NA	?
				Age-5	NA	?		NA	?
				Age-6	NA	?		NA	?
				Age-7	NA	?		NA	?

Spawning	In Hatchery	Integrated Hatchery Program	Prespawn Mortality Rate	11.3%		ISIT	<10%	<10%
			Mean Fecundity	5,559 - 8,364		ISIT, WDFW	5,500	5,500
			Mean Eyed Fecundity	?	?		5,225	5,225
			Fertility	?	?		95%	95%
		Segregated Hatchery Program	Prespawn Mortality Rate	NA	NA		NA	NA
			Mean Fecundity	NA	NA		NA	NA
			Mean Eyed Fecundity	NA	NA		NA	NA
			Fertility	NA	NA		NA	NA
		Total Hatchery	Prespawn Mortality Rate	9.8%		ISIT	<10%	<10%
			Mean Fecundity	5,559 - 8,364		ISIT, WDFW	5,500	5,500
			Mean Eyed Fecundity	?	?		5,225	5,225
			Fertility	?	?		95%	95%
	In Nature	Lower Cowlitz River	Prespawn Mortality Rate	?	?		<10%	<10%
			Mean Fecundity	?	?		5,500	5,500
		Cispus River	Prespawn Mortality Rate	?	?		<10%	<10%
			Mean Fecundity	?	?		5,500	5,500
		Upper Cowlitz River / Subbasin	Prespawn Mortality Rate	?	?		<10%	<10%
			Mean Fecundity	?	?		5,500	5,500
		Tilton River	Prespawn Mortality Rate	?	?		<10%	<10%
			Mean Fecundity	?	?		5,500	5,500
Survival of Offspring to Smolt Stage	In Hatchery	Integrated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	60.5% - 75.7%		WDFW	81%	NA
		Segregated Hatchery Program	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	?	NA		81%	NA
		Total Hatchery	Fertility Rate	?	?		95%	NA
			Eyed Egg-to-Fry Survival	?	NA		95%	NA
			Fry-to-Parr Survival	?	NA		95%	NA
			Parr-to-Smolt Survival	?	NA		95%	NA
			Green Egg-to-Smolt Survival	60.5% - 75.7%		WDFW	81%	NA

Survival of Offspring to Smolt Stage	In Nature	Lower Cowlitz River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Cispus River	Green Egg-to-Smolt Survival	NA	?		NA	?
		Upper Cowlitz River / Subbasin	Green Egg-to-Smolt Survival	NA	?		NA	?
		Tilton River	Green Egg-to-Smolt Survival	NA	?		NA	?
	Marking / Tagging Rate	Hatchery-origin	Integrated Hatchery Program	?	NA		?	NA
			Segregated Hatchery Program	?	NA		?	NA
			Total Hatchery	?	NA		?	NA
		Natural-origin	Lower Cowlitz River	NA	NA		?	NA
			Cispus River	NA	?		?	NA
			Upper Cowlitz River / Subbasin	NA	?		?	NA
			Tilton River	NA	?		?	NA
Survival to Maturity	Integrated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	0.69%	NA	**ISIT**	0.69%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	2.56%	NA	**ISIT**	2.56%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	4,426	NA	**ISIT**	4,426	NA
			Smolts / Adult+Jack Spawner	2,096	NA	**ISIT**	2,096	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	15.2	NA	**ISIT**	15.2	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA

Survival to Maturity	Segregated Hatchery Program	Smolt Survival	to Mouth of Cowlitz River	?	NA		NA	NA
			to Columbia River Estuary	?	NA		NA	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		NA	NA
			Parr	?	NA		NA	NA
			Smolts	?	NA		NA	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		NA	NA
			Parr	?	NA		NA	NA
			Smolts	?	NA		NA	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	NA		NA	NA
			Smolts / Adult+Jack Spawner	?	NA		NA	NA
			Female-to-Female	?	NA		NA	NA
			Adult-to-Adult	?	NA		NA	NA
			Adult+Jack-to-Adult+Jack	?	NA		NA	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		NA	NA
	Total Hatchery	Smolt Survival	to Mouth of Cowlitz River	?	NA		?	NA
			to Columbia River Estuary	?	NA		?	NA
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	0.69%	NA	**ISIT**	0.69%	NA
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	?	NA		?	NA
			Parr	?	NA		?	NA
			Smolts	2.56%	NA	**ISIT**	2.56%	NA
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	4,426	NA	**ISIT**	4,426	NA
			Smolts / Adult+Jack Spawner	2,096	NA	**ISIT**	2,096	NA
			Female-to-Female	?	NA		>>1	NA
			Adult-to-Adult	15.2	NA	**ISIT**	15.2	NA
			Adult+Jack-to-Adult+Jack	?	NA		>>1	NA
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	NA		>>1	NA

Survival to Maturity	Lower Cowlitz River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	NA		NA	NA
		Smolt Passage (Transport) Survival		NA	NA		NA	NA
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	>4%
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	?		NA	>6%
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	NA	?		NA	>200
			Smolts / Adult+Jack Spawner	NA	?		NA	>100
			Female-to-Female	NA	?		NA	>1
			Adult-to-Adult	NA	1.88	ISIT	NA	>1
			Adult+Jack-to-Adult+Jack	NA	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	NA	?		NA	>1
	Cispus River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	68.9%	CFFF (TPU/WDFW)	NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	5.72%	ISIT	NA	>3.5%
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	6.09%	ISIT	NA	>4%
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	?		NA	>200
			Smolts / Adult+Jack Spawner	?	124	ISIT	NA	>100
			Female-to-Female	?	?		NA	>1
			Adult-to-Adult	?	0.60	ISIT	NA	>1
			Adult+Jack-to-Adult+Jack	?	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	?		NA	>1

Survival to Maturity	Upper Cowlitz River/ Subbasin Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	68.9%	CFFF (TPU/WDFW)	NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	5.72%	ISIT	NA	>3.5%
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	6.09%	ISIT	NA	>4%
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	?	?		NA	>200
			Smolts / Adult+Jack Spawner	?	124	ISIT	NA	>100
			Female-to-Female	?	?		NA	>1
			Adult-to-Adult	?	0.60	ISIT	NA	>1
			Adult+Jack-to-Adult+Jack	?	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	?	?		NA	>1
	Tilton River Natural-origin	Freshwater Survival/Conversion/ Collection Efficiency		NA	?		NA	>75%
		Smolt Passage (Transport) Survival		NA	?		NA	>99%
		Smolt Survival	to Mouth of Cowlitz River	NA	?		NA	?
			to Columbia River Estuary	NA	?		NA	?
		Smolt-to-Adult Return Rate (SAR; to Cowlitz Salmon Hatchery)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	3.65%	ISIT	NA	>5%
		Total Smolt-to-Adult Survival Rate (TSAR; all maturing/mature salmon that can be accounted for)	Fry	NA	?		NA	?
			Parr	NA	?		NA	?
			Smolts	NA	3.90%	ISIT	NA	>6%
		Productivity (Recruits / Spawner)	Smolts / Female Spawner	NA	?		NA	>200
			Smolts / Adult+Jack Spawner	NA	51	ISIT	NA	>100
			Female-to-Female	NA	?		NA	>1
			Adult-to-Adult	NA	2.51	ISIT	NA	>1
			Adult+Jack-to-Adult+Jack	NA	?		NA	>1
			Adult+Jack+Mini-Jack-to-Adult+Jack+Mini-Jack	NA	?		NA	>1

Proportional Natural Influence	**Lower Cowlitz River**	Collected/ Released	pHOS	0.229	ISIT	<0.35
			pNOB	NA		>0.6
			PNI	NA		>0.63
		Actual Spawners	pHOS	NA		<0.3
			pNOB	NA		>0.3
			PNI	NA		>0.5
	Cispus River	Collected/ Released	pHOS	0.541	ISIT	<0.35
			pNOB	0.199	ISIT	>0.6
			PNI	0.399	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	0.289	ISIT	>0.6
			PNI	?		>0.67
	Upper Cowlitz River/Subbasin	Collected/ Released	pHOS	0.541	ISIT	<0.35
			pNOB	0.199	ISIT	>0.6
			PNI	0.399	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	0.289	ISIT	>0.6
			PNI	?		>0.67
	Tilton River	Collected/ Released	pHOS	0.112	ISIT	<0.35
			pNOB	0.908	ISIT	>0.6
			PNI	0.890	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	0.908	ISIT	>0.6
			PNI	?		>0.67
	Total	Collected/ Released	pHOS	0.280	ISIT	<0.35
			pNOB	0.199	ISIT	>0.6
			PNI	0.447	ISIT	>0.63
		Actual Spawners	pHOS	?		<0.3
			pNOB	0.289	ISIT	>0.6
			PNI	?		>0.67

APPENDIX B:
TRANSITION PLANS

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Appendix B
Transition Plans

As described in FHMP Chapters 3-9, during the period covered by this FHMP, the intent is to transition programs for fall Chinook Salmon, spring Chinook Salmon, Coho Salmon, and winter steelhead in order to advance recovery efforts, while maintaining angling opportunity. One of the critical steps in this transition is the development of Transition Plans that will include the development of key Decision Rules. The development of these Decision Rules will require an analysis of high-level limiting factors to determine critical thresholds to shift the programs. Some of these programs may implement a sliding scale or “stepping-stone” approach, while others will likely require consideration for additional triggers associated with harvest management, spatial distribution, broodstock integration, and other key transition considerations.

As described in FHMP Chapter 12, Adaptive Management, Tacoma Power will work with the FTC in developing Decision Rules to incorporate into each Transition Plan. These will vary, depending on natural-origin adult abundance to the spawning grounds (for Lower Cowlitz Subbasin populations) or to the Cowlitz Barrier Dam (for populations above Mayfield and Cowlitz Falls dams) and the current recovery phase. These Decision Rules will be incorporated into a predictive model. This information will then be used to create a population-level annual management plan of the full suite of anticipated scenarios. The development of these plans will also include a public comment period.

General Steps for Transition Plans

The following outlines the general steps/topics that should be addressed in the development of Transition Plans associated with changes in hatchery programs (e.g., Segregated to Integrated, and/or transition from Lower Cowlitz to Upper Cowlitz programs). Transition Plans need to be developed for the fall Chinook Salmon, spring Chinook Salmon, Coho Salmon, and winter steelhead programs.

- Transition Plans should consider:
    - High-Level Steps for Hatchery Program Development:
        - Define goal(s) of program
            - Conservation/Harvest (by step and recovery phase)
            - Population(s) impacted
        - Consider Management Strategies to achieve program goals
            - Harvest
            - Transport/Disposition Strategies
                - Range (minimum and maximum)
        - Define type of program (Integrated vs. Segregated) – current and proposed
        - Define size (and range) of program
        - Determine transition approach and schedule (timeframe programs will change) and/or trigger points
            - Immediate switch vs. “stepping-stone” transition
            - Integration rate goals during transition – fixed vs. sliding scale
            - Define acceptable pNOB levels (i.e., broodstock mining rates)
        - Define adult collection plan
            - Broodstock source(s)

        - Collection location/methods
        - Collection timing curves
    - Define contingency plan for lack of adults (i.e., secondary sources/options)
    - Define marking/tagging strategy (including any overlap during transition)
        - Consider what type of evaluation needs to occur
    - Define time and size of release and any growth manipulation (outside of standard practice) during rearing
    - Define monitoring and data needs to support program transition
        - Identify Adaptive Management trigger points
- Evaluation of program feasibility
    - Evaluate programs within the proposed suite of all hatchery programs (i.e., overall capacity for facility, bio-programming)
    - Identify hatchery infrastructure changes needed
        - Steps to achieve these
- Other Program Effects:
    - A description of how harvest mitigation will be achieved in the long term for both upper and lower rivers.
        - Production floors (i.e., for the upper Cowlitz River releases) to ensure that harvest goals are met.
    - For integrated programs - Analysis to determine if the population can support the needed level of broodstock mining and if this plan will prevent or delay the populations from reaching “healthy and harvestable” levels.
    - An acknowledgement that if the plan cannot meet recovery and fishery goals, the plan would need to be altered (i.e., adaptive management).
        - Evaluation of applicability of HSRG guidelines during each step of recovery.

A summary of the proposed transitions for each program, the timing to develop the Transition Plans, and the interim strategies and consideration for implementation while the Transition Plans are being developed is presented in Table 12-2.

APPENDIX C: SUMMARY OF DATA GAPS AND POTENTIAL FUTURE MONITORING NEEDS

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Appendix C: Data Gaps and Potential Future Monitoring Needs

Appendix C is a list identifying current areas of monitoring and existing data gaps as presented in the fish species and population chapters of the 2020 FHMP. The following Summary of Data Gaps and Potential Future Monitoring Needs matrices clearly identify baseline and directed monitoring data gaps that will require consideration for prioritization during this FHMP period, as described in Chapters 3 through 9. The summary matrices are intended as a working tool to help identify critical data needs required for tracking recovery metrics and management decisions during each recovery phase during this FHMP period, the results of which will require incorporation into a consolidated database and summarization into the Big Table Dataset. Separate summary matrices are presented below, by species. Additional data gaps and/or monitoring needs may be identified during future discussions (e.g., during Transition Plan development).

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Table C-1: Data Gaps and Potential Future Monitoring Needs for Fall Chinook Salmon

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Data Collection	• Summarize Data and Assumptions for Fall Chinook Salmon into a single shared database for Analysis and Reporting	All
	• Consider Methods to Improve Estimating Abundance in Harvest and on Spawning Grounds	All
	• Incorporate Data into Consolidated Database Characterizing Age Structure and Sexes	All
	• Incorporate Lower Cowlitz Salmon Hatchery Program Data into Consolidated Database and Consider Additional Improvements in M&E to Inform Fisheries Strategies	All
Stock Identification	• Genetic Structure of the Fall Chinook Salmon Populations in the Cowlitz Basin	All
	• Differentiating Natural-Origin Fall vs. Spring Chinook Salmon	UCS/TS
	• Genetic Structure of the Fall Chinook Salmon Populations in the Cowlitz Basin	All
	• Differentiating Natural-Origin of Fall vs. Spring Chinook Salmon	UCS/TS
Smolt Monitoring	• Monitoring and Estimating Abundance of Smolts Leaving the Cowlitz River	All
	• Understanding Fall Chinook Salmon Production from the Lower Cowlitz Subbasin	LCS
	• Understanding Fall Chinook Salmon Production from the Tilton Subbasin	UCS/TS
	• Natural Mortality of Outmigrating Juveniles	All
	• Monitor Dam Passage Survival for Tilton Subbasin Fall Chinook Salmon and Fish Guidance Efficiency at Mayfield Dam	UCS/TS
Survival, Productivity, and Age Composition	• Smolt-to-Adult Return and Total Smolt-to-Adult Survival for Hatchery-Origin and Natural-Origin Fall Chinook Salmon	All
	• Productivity (Recruits/Spawner) of Hatchery-Origin and Natural-Origin Fall Chinook Salmon	All
	• Juvenile Productivity (Smolts/Spawner)	All

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
	• Adult Productivity (Adult Recruits/Parental Spawner)	All
	• Consolidate Age Composition of Hatchery-Origin and Natural-Origin Fall Chinook Salmon into Single Database for Analysis and Reporting	All
Spawning in Nature	• Estimate Adult Fall Chinook Salmon Transported Above Mayfield Dam	UCS/TS
	• Estimates of Total Fall Chinook Salmon in the Lower Cowlitz Subbasin	LCS
	• Estimate Straying in the Lower Cowlitz Subbasin and Elsewhere	All
Hatchery Practices	• Develop Methods to Evaluate Strategies for Improving Survival in the Hatchery, After Release, and Age Composition (Including Precocious Maturation)	All
	• Develop Methods to Evaluate Rearing and Release Strategies to Improve Survival and Age Composition	UCS
Pathology	• Effects of *Ceratonova shasta* on Upper Cowlitz Subbasin Fall Chinook Salmon	UCS/TS

1 LCS = Lower Cowlitz Subbasin; TS = Tilton Subbasin; UCS = Upper Cowlitz Subbasin.

Table C-2: Data Gaps and Potential Future Monitoring Needs for Spring Chinook Salmon

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Data Collection	• Summarize Data and Assumptions for Spring Chinook Salmon into a Single Shared Database for Analysis and Reporting	All
	• Consider Improvements for Monitoring, Evaluation, and Data Collection Efforts for UCS Spring Chinook Salmon	UCS
	• Harvest Estimates of UCS Spring Chinook Salmon in the Pacific Ocean, Columbia River, Lower Cowlitz River, and Upper Cowlitz Subbasin	UCS
	• Monitor Trend of Hatchery-Origin Spring Chinook Salmon Mini-jacks and Jacks and Natural-Origin Jacks	UCS
	• Document Returns of Hatchery-Origin and Natural-Origin Spring Chinook Salmon by Age and Additional Data Needs to Estimate SAR, TSAR, Productivity, and Age Composition	UCS
Stock Identification	• Identify the True Origin of NOR Spring Chinook Salmon Returning to Barrier Dam Adult Facility	UCS
	• Ability to Distinguish between Spring and Fall Chinook Salmon smolts Originating from the Upper Cowlitz Subbasin	UCS
	• Mis-clip Rates for Returning Adults	UCS
Smolt Monitoring	• Ability to Distinguish between Spring and Fall Chinook Salmon smolts Originating from the Upper Cowlitz Subbasin	UCS
	• Spring Chinook Smolt Migration Timing and Survival	UCS
Survival, Productivity, and Age Composition	• Smolt-to-Adult Return and Total Smolt-to-Adult Survival for Hatchery-Origin and Natural-Origin Spring Chinook Salmon	UCS
	• Productivity (Recruits/Spawner) of Hatchery-Origin and Natural-Origin Spring Chinook Salmon	UCS

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
	• Juvenile Productivity (Smolts/Spawner)	UCS
	• Adult Productivity (Adult Recruits/Parental Spawner)	UCS
	• Consolidate Age Composition of Hatchery-Origin and Natural-Origin Spring Chinook Salmon into Single Database for Analysis and Reporting	UCS
Spawning in Nature	• Estimate Spawner Abundance and Pre-spawn Survival of Upper Cowlitz Subbasin Spring Chinook Salmon	UCS
Hatchery Practices	• Number of Upper Cowlitz Subbasin Spring Chinook Salmon Jacks vs. Adults Spawned at Cowlitz Salmon Hatchery	UCS
	• Develop Methods to Evaluate Rearing and Release Strategies to Improve Survival and Age Composition	UCS
	• Monitor Trend of UCS Spring Chinook HOR Mini-jacks and HOR and NOR Jacks	UCS
Proportionate Natural Influence	• Identify Limiting Factors for Spring Chinook Salmon that Influence PNI and pHOS	UCS
VSP Parameters	• Develop Criteria using VSP Parameters for the Eventual Release of Spring Chinook Salmon into the Tilton Subbasin	UCS

[1] UCS = Upper Cowlitz Subbasin.

Table C-3: Data Gaps and Potential Future Monitoring Needs for Coho Salmon

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Data Collection	• Summarize Data and Assumptions for Coho Salmon into a Single Shared database for Analysis and Reporting	All
	• Incorporate Data into Consolidated Database Characterizing Age, Sex, and Origin of all Recoveries	All
	• Determine Goal of the Creel Survey (Coho)	All
	• Maintain M&E Program for Lower Cowlitz Subbasin Coho Salmon	LCS
	• Continue Spawning Ground Surveys for Lower Cowlitz Subbasin Coho Salmon (including Estimates for Pre-spawn Mortality, Spawner Abundance)	LCS
	• Numbers of Natural-Origin Upper Cowlitz Subbasin Coho Salmon that Return at Maturation and their Disposition	UCS, TS
	• Consider Spawning Ground Surveys for Upper Cowlitz Subbasin and Tilton Coho (Pre-spawn Mortality, Spawner Abundance)	UCS, TS
	• Baseline and Directed Studies for Upper Cowlitz Subbasin Coho Salmon	UCS
	• Document and Consider Testing Assumptions for Fallback Rates (e.g., 12%) and Pre-spawn Mortality Rate (e.g., 10%) for Tilton Subbasin Coho Salmon	TS
Stock Identification	• Origin of Spawners in the Lower Cowlitz River vs. Tilton Subbasin	LCS, TS
Smolt Monitoring	• Estimates of Natural Smolt Abundance for Lower Cowlitz Subbasin Coho Salmon	LCS
	• Natural-Origin Smolt Production from the Tilton Subbasin	TS
	• Age of Coho Salmon Migrants Leaving the Upper Cowlitz Subbasin and Tilton Subbasin - Scale Age and Length assumptions	UCS; TS
	• Natural Mortality of Outmigrating Juveniles	All

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
	• Monitor Dam Passage Survival for Tilton Subbasin and Upper Cowlitz Coho Salmon and Fish Guidance Efficiency at Mayfield Dam and Cowlitz Falls Dam	UCS/TS
Survival, Productivity, and Age Composition	• Smolt-to-Adult Return and Total Smolt-to-Adult Survival for Hatchery-Origin and Natural-Origin Coho Salmon	All
	• Calculation of Separate Survival Estimates for the Segregated and Integrated Hatchery Programs for LCS Coho	All
	• Productivity (Recruits/Spawner) of Hatchery-Origin and Natural-Origin Coho Salmon	All
	• Juvenile Productivity (Smolts/Spawner)	All
	• Adult Productivity (Adult Recruits/Parental Spawner)	All
	• Consolidate Age Composition of Hatchery-Origin and Natural-Origin Coho Salmon into Single Database for Analysis and Reporting	All
Spawning in Nature	• Estimates of Coho Salmon Successfully Reproducing in Nature	All
	• Estimates of Coho Spawning in the Lower Cowlitz River, Including Strays from the Tilton and Upper Cowlitz Subbasins	All
	• Estimate HOR Coho Salmon that Stray to Other Spawning locations (outside the Cowlitz Basin)	Hatchery
Hatchery Practices	• Calculation of Separate Survival Estimates for the Segregated and Integrated Hatchery Programs for LCS Coho	All
Proportionate Natural Influence	• Consider Hatchery Influence on Cowlitz Basin Coho Salmon Populations	All
	• Consider Data Necessary to Make Informed Management Decisions with Natural Coho Salmon Spawning in the Mainstem Lower Cowlitz Subbasin and its Tributaries (to Decrease pHOS)	LCS
Pathology	• Effects of *Ceratonova shasta* on Coho Salmon	TS

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Harvest	• Consolidate Harvest Estimates of Hatchery-Origin and Natural-Origin Coho Salmon in the Pacific Ocean, Columbia River, Lower Cowlitz River, Tilton Subbasin, and Upper Cowlitz Subbasin into a Single Database for Reporting and Analysis	All

[1] LCS = Lower Cowlitz Subbasin; TS = Tilton Subbasin; UCS = Upper Cowlitz Subbasin.

Table C-4: Data Gaps and Potential Future Monitoring Needs for Winter Steelhead

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Data Collection	• Summarize Data and Assumptions for Winter Steelhead into a Single Shared Database for Analysis and Reporting	All
	• Estimates of Total Run Size for Hatchery-Origin and Natural-Origin Winter Steelhead	All
	• Adult Winter Steelhead vs. Jacks returning to the Basin	All
	• Incorporate Data into Consolidated Database Characterizing Age Structure and Sexes	All
	• Characterize Metrics for Natural-Origin Survival, Productivity, and Age Composition	All
	• Steelhead Used for Broodstock and Sampled for Scales for Age Estimates	All
Stock Identification	• Distinguishing Smolts Produced Naturally in the Lower Cowlitz Subbasin from those Produced Upstream of Mayfield Dam	All
Smolt Monitoring	• Monitoring and Estimating Abundance of Smolts Leaving the Cowlitz River	All
	• Understanding Winter Steelhead Production from the Lower Cowlitz Subbasin	LCS
	• Understanding Winter Steelhead Production from the Upper Cowlitz Subbasin	UCS
	• Understanding Winter Steelhead Production from the Tilton Subbasin	TS
	• Natural Mortality of Outmigrating Juveniles	All
	• Monitor Dam Passage Survival for Tilton Subbasin Winter Steelhead and Fish Guidance Efficiency at Mayfield Dam	TS/TS
Survival, Productivity, and Age Composition	• Smolt-to-Adult Return and Total Smolt-to-Adult Survival for Hatchery-Origin and Natural-Origin Fall Chinook Salmon	All
	• Productivity (Recruits/Spawner) of Hatchery-Origin and Natural-Origin Fall Winter Steelhead	All

Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
	• Juvenile Productivity (Smolts/Spawner)	All
	• Adult Productivity (Adult Recruits/Parental Spawner)	All
	• Consolidate Age Composition of Hatchery-Origin and Natural-Origin Winter Steelhead into Single Database for Analysis and Reporting	All
	• Age Composition Of Adult Steelhead Being Transported Upstream of Mayfield Dam	TS/TS
Spawning in Nature	• Estimates of Winter Steelhead Successfully Reproducing in Nature	All
	• Locations of Spawning Areas in the Upper Cowlitz, and Cispus Rivers and their Accessible Tributaries	UCS; TS
	• Estimates of Natural Steelhead Spawning Abundance and Pre-spawn Mortality	All
	• Lack of Estimates of Steelhead Spawners by Subbasin in the Upper Cowlitz Subbasin	All
	• Spawning Surveys to Account for Other Losses (e.g., Fallback, Predation, and Pre-Spawn Mortality)	All
	• Effects on Steelhead Adult NOR Abundance from Adult Returns Spawning out of Location	All
Hatchery Practices	• Hatchery Data for Winter Steelhead – Total Eyed Eggs, Fertility, and Scale Information, Sex Ratio, Rate of Precocious Maturation for HORs Incorporated into Single Analysis and Reporting Database	All
Proportionate Natural Influence	• Estimates of pHOS and PNI for Winter Steelhead	All
Harvest	• Estimates of Population-specific Harvest Rates for Hatchery-Origin Steelhead Fisheries in the Pacific Ocean, Columbia River, Lower Cowlitz Subbasin, Upper Cowlitz Subbasin, and Tilton Subbasin	All

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Topic/Theme	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
	• Population-Specific Estimates of Indirect Mortality Rates for Natural-Origin Steelhead Fisheries in The Pacific Ocean, Columbia River, Lower Cowlitz Subbasin, Upper Cowlitz Subbasin, and Tilton Subbasin	All

[1] LCS = Lower Cowlitz Subbasin; TS = Tilton Subbasin; UCS = Upper Cowlitz Subbasin.

Table C-5: Data Gaps and Potential Future Monitoring Needs for Cutthroat Trout, Chum Salmon, and M&E

Species/Topic	Summary of Data Gap/Potential Future Monitoring Need	Affected Populations[1]
Cutthroat Trout	• Summarize Data and Assumptions for Cutthroat Trout into a Single Shared Database for Analysis and Reporting	UCS; TS
	• Estimate Popularity of the Cowlitz Basin Cutthroat Trout Hatchery Program	All
	• Consider Studies to Improve the Efficacy and Management of the Cutthroat Trout Hatchery Program	All
Chum Salmon	• Summarize Data and Assumptions for Chum Salmon into a Single Shared Database for Analysis and Reporting	
M&E	• Estimate Abundance and Productivity Of Salmonid Populations in Tributaries	All
	• Data Inputs for One- and Two-Stage Life Cycle Models	All
	• Big Tables as "Data Warehouse"	All

1 TS = Tilton Subbasin; UCS = Upper Cowlitz Subbasin.

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APPENDIX D:
WHITE PAPER - FALL CHINOOK SALMON BROODSTOCK COLLECTION

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Tacoma Power Fisheries and Hatchery Management Plan

Final Interim Plan for Lower Cowlitz River Fall Chinook Salmon Broodstock Collection

Product of April 30, 2020 Unresolved Interim Plan Workshop

Prepared by R2 Resource Consultants, Inc.

Purpose

The purpose of this white paper is to assist in the development of the Interim Plan to be utilized in 2021 for the collection of broodstock in support of the Cowlitz River Fall Chinook Salmon Hatchery Program by characterizing the issue for which conflict has arisen as well as providing different perspectives surrounding and solutions to the conflict.

Background

The Willamette/Lower Columbia Technical Recovery Team (2004) identified two separate populations of Cowlitz River fall Chinook Salmon, one population in the lower Cowlitz River (Lower Cowlitz Subbasin) and one in the river upstream of Mayfield Dam, encompassing the Cispus, upper Cowlitz, and Tilton river basins (Upper Cowlitz Subbasin). Currently, there is no hatchery program aimed at recovering the Upper Cowlitz Subbasin population. Fall Chinook Salmon hatchery programs consist of a Lower Cowlitz Subbasin Segregated Hatchery Program and a Lower Cowlitz Subbasin Integrated Hatchery Program utilizing natural-origin salmon captured from the lower Cowlitz River. Recovery for the Upper Cowlitz Subbasin fall Chinook Salmon population is currently focused on the Tilton River, and it is proposed that this will be accomplished over time by converting the current Lower Cowlitz Subbasin Segregated and Integrated hatchery programs into a single Upper Cowlitz Subbasin Integrated Hatchery Program.

With the beginning of the Lower Cowlitz Subbasin Integrated Fall Chinook Salmon Hatchery Program in 2013, hatchery-origin broodstock has largely been collected from those salmon returning to the trap ("Hatchery Separator") at the Barrier Dam Adult Facility. The program had a low integration rate, with a large majority of the smolts coming from HORxHOR crosses. Over the past three years (2017-2019), the hatchery program has experienced returns that posed challenges for obtaining sufficient numbers of natural-origin return, and hatchery-origin return, broodstock. These challenges were largely due to poor hatchery-origin adult abundance but were also caused by lower-than-anticipated capture rates of angled natural-origin broodstock. In addition, proportions of hatchery-origin and natural-origin fish used in broodstock collection during this time period have not met goals for recovering population metrics, including the proportion of natural-origin salmon in the broodstock (pNOB) and the proportionate natural influence (PNI).

While most of the hatchery-origin broodstock has been collected from hatchery-origin returns to the hatchery, Washington Department of Fish and Wildlife (WDFW) has been supplementing the numbers with natural-origin adults captured off the spawning grounds in the lower Cowlitz River. The protocols used to capture natural-origin salmon in the lower river targeted adult males. As a result, most of the adults captured and used for broodstock were males (estimated mean of 87%). Relying so heavily on males for the natural-origin contribution is not well understood (personal communication, R. Waples, J. Hard, and P. Moran, NOAA Fisheries) and needs to be addressed by the Monitoring & Evaluation (M&E) Subgroup as part of the Annual Program Review (APR) process. This has been the strategy for broodstock collection until recent years. In 2018 and 2019, low hatchery-origin fall Chinook Salmon abundance occurred and required the use of natural-origin returns to the Hatchery Separator to satisfy broodstock requirements on an emergency basis.

At this time, there is no adequate mechanism by which to identify the population of origin for natural-origin fall Chinook Salmon that return to the Hatchery Separator; these salmon could be headed to the Tilton River for spawning or could be from the Lower Cowlitz Subbasin population, or possibly even strays from nearby river. Given that the recent number of returning natural-origin adults to the lower Cowlitz River has been at or above delisting abundance level, and the focus is on increasing overall abundance in the Tilton River, all natural-origin fish that returned to the Hatchery Separator since 2017 and were not required for broodstock have been trucked and released in the Tilton River to enhance natural reproduction there.

Define the Conflict

The parties do not agree on the appropriate strategy for collecting natural-origin broodstock for the Lower Cowlitz Subbasin Integrated Fall Chinook Salmon Hatchery Program during the interim period while a Transition Plan for fall Chinook Salmon is developed, and concern has been raised that moving to a new broodstock strategy may be risky without first developing and implementing a marking strategy to better inform broodstock and outplanting decisions.

Potential Approaches

Three potential approaches to the collection of natural-origin broodstock have been identified that could be implemented in 2021: (1) follow the 2011 FHMP Existing Strategy, (2) use an Aggregated Strategy collecting natural-origin fish from both the lower river and the Hatchery Separator, or (3) use a Separator Only Strategy collecting all natural-origin fish from the Hatchery Separator. Each of these programs is described briefly below.

1. Following the Existing Strategy, all natural-origin fish for the Lower Cowlitz Subbasin Integrated Fall Chinook Salmon Hatchery Program would be collected from the lower Cowlitz River. All natural-origin returns to the Hatchery Separator would go to the Tilton River.
    a. The natural-origin component of hatchery broodstock would be collected from the lower Cowlitz River only. This would include capturing adults from multiple locations across the spawning grounds and holding areas throughout the lower Cowlitz River via angling, netting, and/or snagging. If the same protocol for capture is used, it would likely continue to result in a higher proportion of natural-origin males caught as compared to females. This protocol targets males as they can be released after sperm collection, whereas removing females for broodstock would be a final action and would reduce the production potential of the Lower Cowlitz Subbasin population.
    b. This approach would maintain the current approach with two separate programs for the Lower Cowlitz Subbasin, one integrated program and one segregated program.
2. The Aggregated Strategy would combine two collection methods. Natural-origin fall Chinook Salmon returns would be collected both in the lower Cowlitz River and from the Hatchery Separator. Any natural-origin returns to the Hatchery Separator in excess of broodstock needs would be transported to the Tilton River.
    a. A portion of the natural-origin broodstock would be captured off the spawning grounds from the lower river, as described in 1 above.

   b. In addition, some number of natural-origin broodstock would be collected from salmon that return to the Barrier Dam Adult Facility.
   c. Due to the mixing of unknown numbers of Tilton River and lower Cowlitz River returning salmon, this approach would likely result in a single integrated program for the entire Upper/Lower Cowlitz Subbasin Integrated Fall Chinook Salmon Hatchery Program.
3. The Separator Only Strategy would collect all natural-origin broodstock from the Hatchery Separator only. This approach would result in a reduced number and proportion of total adult returns being outplanted in the Tilton River.
   a. All natural-origin broodstock would be collected at the Hatchery Separator.
   b. This approach would initiate a separate integrated hatchery program for the Tilton River, and a segregated program may also need to be continued to meet overall production targets.

Differences in Perspectives

1. Existing Strategy

The Existing Strategy was adopted in the 2011 FHMP has been used by fish managers to support the current Lower Cowlitz Subbasin Integrated Fall Chinook Salmon Hatchery Program by mixing hatchery-origin adults with natural-origin adults that are spawning in the lower Cowlitz River. Continued implementation of the Existing Strategy would provide consistent genetics for this hatchery program through 2021. In the original hatchery program, natural-origin salmon from the Lower Cowlitz River were spawned with hatchery-origin salmon; some of the natural-origin salmon currently spawning in the lower Cowlitz River are offspring from that program. Thus, this strategy allows for some of those natural-origin genes to be maintained in the integrated program.

However, there is some uncertainty that the salmon captured in the lower Cowlitz River would have spawned there if left in the river; it is possible at least some of these salmon are intercepted en-route to the Barrier Dam Adult Facility. Further, using predominantly males for the natural-origin component of broodstock is not an accepted hatchery practice and could have potential genetic consequences associated with sex-linked traits if natural-origin males are overrepresented and females are underrepresented in the hatchery population. It is also relevant that a low number of natural-origin salmon have been collected and the mean pNOB for the Integrated Hatchery Program has been very low.

Based on recent return years at the Hatchery Separator and natural-origin capture numbers, it is likely that using the Existing Strategy will result in pNOB for the Lower Cowlitz River Integrated Fall Chinook Salmon Hatchery Program remaining well below that desired to reach recovery goals. The number of broodstock captured off the spawning grounds potentially could be increased with additional effort, but also would increase impact on the natural-spawning lower Cowlitz River population due to uncertainty of the disposition of captured salmon, high egg loss and prespawn mortality rate of collected salmon, and general harassment of all natural-origin salmon on the spawning grounds. Ultimately, the Cowlitz River recovery plans call for moving forward with two distinct fall Chinook Salmon populations, one above Mayfield Dam and one in the Lower Cowlitz Subbasin.

2. Aggregated Strategy

The Aggregated Strategy represents a step toward managing these populations together during the interim period while the Cowlitz River Fisheries Technical Committee (FTC) works to develop and implement plans to fill data gaps. WDFW has been implementing emergency measures that have resulted in the ongoing Lower Cowlitz Subbasin Fall Chinook Salmon Integrated Hatchery Program being aggregated and stated their willingness to maintain this for one more year. This Aggregated Strategy would allow for increased pNOB for the current program and reduce concerns about potential genetic effects on the hatchery population that may be associated with a male-dominated natural-origin component in the Existing Strategy.

There exists uncertainty about the potential effects this approach would have on recovery genetics due to unconfirmed origin of natural-origin salmon at the Hatchery Separator. Until a marking identification strategy is implemented and some data are available to identify Upper Cowlitz Subbasin vs. Lower Cowlitz Subbasin populations, fish managers cannot be confident that the Upper Cowlitz Subbasin program is moving in the direction it needs to go. Even with this uncertainty, WDFW is willing to consider the use of an aggregated broodstock approach as long as there is progress in planning how to differentiate Upper Cowlitz Subbasin and Lower Cowlitz Subbasin stocks and collect data on the abundance of both spawners and naturally produced juveniles.

Concern has been expressed that collecting more natural-origin salmon from the Hatchery Separator for broodstock will result in mixing of upper river and lower river genes because all salmon that return to the Hatchery Separator are assumed to have come from the Tilton River. If this assumption is correct, then collecting broodstock from the lower Cowlitz River for supplementing the Tilton River population would be counterproductive to moving toward recovery goals that include two distinct populations. However, mixing of genes has already occurred for a significant period of time due to Lower Cowlitz Subbasin hatchery-origin fall Chinook Salmon being placed in the Tilton River to spawn with the natural-origin salmon.

3. Separator Only Strategy

Assuming that all, or almost all, salmon arriving at the Hatchery Separator are returning from the Upper Cowlitz Subbasin, collection of fall Chinook Salmon broodstock from the Hatchery Separator would advance the hatchery program toward an Upper Cowlitz Subbasin Integrated Hatchery Program to support recovery in the Tilton River. This approach would allow the program to meet pNOB goals, would improve PNI, and would support enhanced Local Adaptation in both the Tilton River and lower Cowlitz River.

However, because of uncertainty around the origin of natural-origin fall Chinook Salmon that return to the Hatchery Separator, this approach would have risk that some genes from the Lower Cowlitz Subbasin are mixed with those from the Tilton River population. This impact is not currently measurable, but it should also be understood that some level of straying (5-10%) and subsequent gene sharing is normal and healthy for natural salmon populations.

Summary of Root Causes Differences

The different perspectives presented for the three possible approaches for broodstock collection center around concerns of:

1) The current program not meeting the recovery broodstock goals for integrated hatchery population;

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2) The uncertainty around natural-origin fall Chinook Salmon population of origin;
3) Concerns about the potential inability to meet reduced pHOS limits in the Lower Cowlitz Subbasin fall Chinook Salmon population once the hatchery program has transitioned to an Upper Cowlitz Subbasin integrated program;
4) The impacts associated with collection of broodstock off the lower Cowlitz River spawning grounds.

Under the Existing Strategy, the Cowlitz Salmon Hatchery has not met natural-origin broodstock goals and, in some recent years, also has not met hatchery-origin broodstock needs. Also, the capture and use of predominantly males for natural-origin broodstock is not consistent with current standards of hatchery programs used for recovery and poses some risk to the natural-spawning population in the Lower Cowlitz Subbasin. These concerns indicate deficiencies in the current hatchery program and the need to consider a new strategy for broodstock collection and management in 2021 in order to improve hatchery performance.

Plan for Resolution

Within the first year following the FHMP submittal, Tacoma Power and the FTC will develop a Transition Plan that identifies data gaps required to be filled prior to transition (e.g., marking strategy, abundance). Following completion of the Transition Plan and initiation of strategies to fill critical data gaps, the hatchery will begin the use of salmon caught at the Hatchery Separator as the primary source for broodstock unless other circumstances warrant additional consideration by the FTC. In addition, the FTC has developed this white paper to describe various perspectives to be appended to the FHMP for use during development of the Transition Plan.

Agreed-Upon Interim Plan

The agreed-upon plan in the interim is to use the APR process annually to determine how best to collect broodstock based on available preseason information, until the Transition Plan is developed and successfully implemented.

References

Willamette/Lower Columbia Technical Recovery Team. 2004. Status evaluation of salmon and steelhead populations in the Willamette and Lower Columbia river basins. Northwest Fisheries Science Center, Seattle.

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APPENDIX E:
PUBLIC REVIEW AND COMMENT

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Appendix E: Public Review and Comment

The public was engaged to participate and comment on the draft FHMP through public meetings and outreach through Tacoma Power's website. Key engagement points included outreach through the Cowlitz Annual Program Review in July 2019 requesting comments by August 2019, and then again in August 2020. In both cases, an official 30-day public review and comment period was held, the most recent of which occurred for the Draft Final FHMP between July 30, 2020 and September 7, 2020. Comments were received by email and letter by members of the public and are characterized in Table E-1 below.

Tacoma Power also hosted a virtual Public Meeting on August 12, 2020. The meeting included a brief presentation of an overview of the FHMP and the associated process; copies of the slides from the meeting are presented at the end of this appendix. Approximately eight members of the public logged onto the virtual meeting, as well as eight agency representatives.

Questions and comments were also addressed during the public meeting, via GoToMeetings chat feature and are characterized in Table E-2 below.

Based on comments received from the agencies and the public during the official comment period, Tacoma Power revised portions of the FHMP document to improve clarity and accuracy as characterized in the comment responses.

Table E-1: Agency and Public Review (PR) Comments from the 30-Day FHMP Review Period and Tacoma Power's Reponses.

Comment #/ Source	Review Comment	Response from Tacoma Power
Agency or Organization Comments		
PR-1 Coastal Conservation Association (CCA)	It is worth noting that currently the Cowlitz Fisheries Technical committee does not have a recreational fishing representative, and such is evident throughout the draft FHMP. We also note that the Cowlitz River Advisory Group does not have Cowlitz River guide representation, but does have offshore guide representation, which often have conflicting interests.	Thank you for the comment. We look forward to engagement from these groups during development of the Transition Plans and future public involvement.
PR-2 CCA	**Fall Chinook:** Survival of hatchery juveniles is extremely poor, as is the in-river fishery. Anglers on the Cowlitz River have not been allowed to harvest wild fall Chinook (and frequently hatchery Chinook) while ocean anglers from Alaska, British Columbia, Washington coast, Oregon, and lower Columbia River are allowed to harvest wild fall Chinook.	Many of these suggestions are captured in this FHMP. The details will be described during development of the Transition Plan. The public will continue to be engaged during the development of the Transition Plan, and we look forward to engaging in future dialogue to achieve common goals. Past production levels have considered fishery benefits in multiple regions such as coastal fisheries. This will also need to be considered during transition planning. Consideration for this topic can be found in edits to Section 3.0.9 of the FHMP. This Transition Plan is scheduled to be completed by 1 year from submittal of the FHMP.
PR-3 CCA	1. Due to the above concerns, we recommend that the hatchery fall Chinook program be significantly reduced and the production poundage be invested instead into spring Chinook. Cowlitz spring Chinook contribute to endangered Southern Resident Killer Whales, off-shore fisheries, robust recreational fisheries in the lower Columbia River, and provide a significantly better in-river recreational fishery. Proposed changes to the Coho program, as outlined later in this letter, would adequately fill the void during the early fall and likely increase recreational fishing opportunity.	See above response to comment PR-2 regarding fall Chinook Salmon.

Comment #/ Source	Review Comment	Response from Tacoma Power
PR-4 CCA	2. Like the Lewis River, where there is no hatchery fall Chinook program, we believe there is potential to enhance the wild run to a healthy, sustainable level that would provide greater opportunity and more certainty for the in-river, terminal fishery.	See above response to comment PR-2 regarding fall Chinook Salmon.
PR-5 CCA	3. Chinook juveniles caught at the Mayfield trap should be marked so that they can be identified when they return as adults and differentiated from lower river production.	See above response to comment PR-2 regarding fall Chinook Salmon.
PR-6 CCA	4. An escapement level, where recreational anglers can harvest healthy runs of wild fish, should be defined. This issue has been requested by the recreational fishing community for at least the last 5 years.	See above response to comment PR-2 regarding fall Chinook Salmon.
PR-7 CCA	**Spring Chinook:** The current hatchery program pays little attention to the 1991 Washington Department of Fisheries report of Cowlitz spring Chinook, which recommended a size and time of release, 5/lb in March/April, for best survival, and seemingly ignores John Morrison's Cowlitz Hatchery size at release study (2001-2006) which also showed 5/lb in March resulted in the best survival. The current practice of 500,000 fish at 16/lb in November has resulted in abysmal survival. Additionally, the 800,000 fish at 8/lb in March has about half the survival of the 500,000 fish at 5/lb in March. Also, for each raceway the 8/lb group requires nearly twice as many adult broodstock as the 5/lb group; the additional broodstock could be better used for upstream re-introduction or recreational fishing opportunity. With current management practices, the in-river recreational fleet has suffered years of closed and constrained fisheries due to poor adult returns and it is evident that immediate changes are needed.	Tacoma Power and the FTC are committed to continuing to examining release sizes during this FHMP period as it relates to Smolt to Adult Returns (SAR), and adjusting programs as necessary through Annual Program Review (APR) process, which the public is also invited to engage in. Additional considerations will include if size at release may be influence by recovery strategies (integrated vs segregated programs) and will focus on maximizing adult returns for recovery efforts. Current data will be made fully available throughout this process.
PR-8 CCA	1. Production needs can be increased in conjunction with reductions to the fall Chinook program.	See above response regarding spring Chinook.

Comment #/ Source	Review Comment	Response from Tacoma Power
PR-9 CCA	2. Survivals need to be maximized so we have fish for the recreational fishery and upper basin reintroduction. There is room at the Cowlitz Salmon Hatchery to hold the juvenile spring Chinook from November to March by rearing Coho juveniles in Mayfield netpens or in satellite ponds. We request that at least 80% of hatchery spring Chinook juveniles be released at 5/lb in March until new, peer reviewed research indicates a size and time that provides better survival.	See above response regarding spring Chinook.
PR-10 CCA	3. To offset age-selective ocean harvest (older fish are exposed to years more harvest, thereby reducing age-at-return of adults), we support testing a group of selectively bred older fish.	See above response regarding spring Chinook.
PR-11 CCA	**Coho**: 1. We ask that 50% of the Coho broodstock be comprised of early returning fish. This will mimic historic return timing and fill the void for losses in production to the fall Chinook program.	While there are likely some complications regarding this concept, it can be discussed during the development of the Transition Plan. Acknowledgement of this consideration can be found in edits to the FHMP in Section 5.0.9.
PR-12 CCA	2. A portion of Coho rearing can take place in the Mayfield net pens or in satellite ponds in order to make room to grow spring Chinook juveniles to 5/lb in March.	This may be a possibility and will require discussions for testing the appropriateness of the facilities and use as satellite facilities or other facilities are further considered as flexible resources during the bioprogramming stage of the Transition Plans. Consideration for this topic can be found in edits to Section 5.0.9 of the FHMP.
PR-13 CCA	3. An escapement level, at which recreational anglers can harvest healthy runs of wild Coho by area (lower river, Tilton, and above Cowlitz Falls), should be defined.	The FHMP is intended to describe a multifaceted perspective of what is important to stakeholders and limiting factors (see Big Tables). However, we agree with this as one of the needs and describe within this Transition Plan and FHMP the need to work to define this with fisheries managers (NOAA and WDFW).
PR-14 CCA	**Winter Steelhead:** The Cowlitz winter steelhead fishery used to be the largest in the world prior to the termination of the early part of the program. Releasing undersized steelhead	Many of these suggestions are captured in this FHMP. The details will be described during the development of the Transition Plan. The public will be invited to continue to be

Comment #/ Source	Review Comment	Response from Tacoma Power
	smolts on the Cowlitz has been a problem ever since the early program was terminated, resulting in relatively poor adult returns. The early returning Chambers Creek stock was created because research showed that optimum size at release for steelhead was about 6/lb; the early returns allowed the hatchery additional time to ensure proper size at release. Releasing the current late winter steelhead as smaller smolts creates non-migrating residuals that compete with wild fish. The statement on page 6-59 of the FHMP about "replicating historic outmigration size" is not entirely accurate; much research has been done showing that hatchery steelhead need to be larger than their wild counterparts.	engaged during the development of the Transition Plan, and we look forward to engaging in future dialogue to achieve common goals. This Transition Plan will be completed within 1 year from submittal of the FHMP. Additionally, these programs will be evaluated annually within the APR process.
PR-15 CCA	1. We ask that broodstock be managed so that 40% of hatchery winter steelhead return prior to March.	See above response to comment PR-14 regarding winter steelhead.
PR-16 CCA	2. We ask that the program release 90% of winter steelhead smolts in compliance with WDFW steelhead rearing guidelines of 5. 5 to 6/lb. This may require heated water to accelerate egg hatching time and early rearing or other innovative ideas. Also, by moving a portion of the program to earlier spawning, the late run fish will have more water and space to reach adequate size prior to release.	See above response to comment PR-14 regarding winter steelhead.
PR-17 CCA	3. We ask that winter steelhead be managed so that healthy returning adult hatchery steelhead be prioritized for additional angling opportunity, such as placing them in satellite ponds for juvenile and handicapped anglers.	See above response to comment PR-14 regarding winter steelhead.
PR-18 CCA	4. Healthy populations of wild steelhead need to be defined for each region of the Cowlitz.	The FHMP is intended to describe a multifaceted perspective of what is important to stakeholders and limiting factors (see the Big Tables). However, we agree with this as one of the needs and describe within this Transition Plan and the FHMP the need to work to define this with fisheries managers (NOAA and WDFW).

Comment #/ Source	Review Comment	Response from Tacoma Power
PR-19 CCA	**Summer Steelhead:** 1. The ISIT model indicates that 6,600 fish could be recycled, but only half that number has been allowed. We recommend recycling up to the maximum amount of 6,600 fish.	There is an ongoing debate within the FTC regarding the impacts on conservation due to potential stray rates. However, the FHMP is written in a manner that allows for increased recycling rates and expanded timing of recycling if fish are available. The public will be invited to engage in this conversation annually at the Annual Program Review (APR).
PR-20 CCA	2. The number and timing of recycling summer steelhead should be expanded through September to encompass the time when flesh quality is good. Currently, no fish are recycled after August. A prior recycling effort in the 1990s showed that fish recycled in September had the highest harvest rates. October through December provides ample time to remove returning hatchery fish at the barrier dam facility.	See above response regarding summer steelhead.
PR-21 CCA	3. There is no reason supported in the literature that fish should not be recycled multiple times. We ask that all summer steelhead be recycled through September regardless of number of times recycled.	See above response regarding summer steelhead.
PR-22 CCA	4. We ask that all healthy summer steelhead, in excess of broodstock needs through September, be prioritized for recycling as they are extremely valuable to the recreational fishery and that no fish be surplused until after the 6,600 fish cap is reached.	See above response regarding summer steelhead.
PR-23 CCA	**Sea-Run Cutthroat Trout:** The Future Management section of the FHMP draft mentions concern about cutthroat smolts residualizing and creating negative interactions with wild fish. We agree with this assessment but believe there are ways to reduce residualization of these smolts. It is also worth noting that these fish provide an excellent recreational fishery in the late summer and into the early fall.	See response to comment PR-24, below.
PR-24 CCA	1. This issue of residualization manifested when the decision was made to rear cutthroat juveniles in raceways rather than in traditional rearing ponds, which was done for decades.	The cutthroat were shifted to the raceways for rearing in an effort to better understand steelhead survival within the hatchery. However, all options will be considered during the

Comment #/ Source	Review Comment	Response from Tacoma Power
	Research has shown that rearing pond fish have twice the adult survival as fish reared in raceways, and that raceway fish have higher condition factors (plumpness) associated with non-migration. We recommend that all cutthroat be reared in ponds from October until release.	hatchery remodel. Hatchery evaluation data gaps in this area will be considered within the context of other priorities during this FHMP period.
PR-25 CCA	**Chum:** We were very surprised to learn that no action is proposed for a Cowlitz River run that once saw a return of 195,000 fish and has precipitously declined to less than 200 fish. Chum are a popular sport fish and anglers have been requesting their enhancement on the Cowlitz for years. A modest return of even 10% of historical levels would create considerable excitement among recreational anglers and the local economy.	While there are no programs specifically identified to release hatchery-origin Chum Salmon during this FHMP, Tacoma Power and the FTC are open to approaches that may involve artificial production for Chum Salmon from outside entities, as long as those strategies are consistent with a recovery strategy that has been established for Columbia River Chum Salmon (LCFRB 2010; NMFS 2013; WDFW and LCFRB 2016) and are coordinated with the Artificial Propagation Strategy for Chum Salmon that is being developed by WDFW in 2020.
PR-26 CCA	1. We ask that a minimum of 20,000 fingerlings, at 1,000/lb, be released annually in lower river tributaries.	See above response regarding summer Chum Salmon.
PR-27 CCA	2. Also, we would ask that an additional review of historical Chum hatchery releases be conducted. A claim was made that there has never been releases of hatchery Chum in the Cowlitz River but we believe there were several releases in the late 1990s. Please contact Paul Peterson, retired hatchery manager, residing in Mossyrock, for verification.	Section 9.0 (page 9-1) was revised to accurately reflect the historical releases.
PR-28 CCA	**Satellite Rearing Ponds:** It has been 19 years since the Settlement Agreement called for three satellite rearing ponds, and to date no ponds have been built. The current draft FHMP calls for a plan to be made within the next decade, causing yet more delay on this important project.	Tacoma Power is nearing completion of a Draft Satellite Rearing Facility Planning Document, which will be shared with the public for review and comment by the end of 2020. This document includes programmatic concepts for the use of the facilities. Following feedback from the public and FTC, the next step will be to evaluate sites that can meet our design and program criteria, followed by design and construction.
PR-29 CCA	1. We recommend that a commitment be made to build these ponds within the next five years. These ponds would be extremely valuable in creating additional rearing capacity for	See above response about satellite rearing ponds.

Comment #/ Source	Review Comment	Response from Tacoma Power
	spring Chinook or Coho, either of which will allow more room at the hatchery to grow spring Chinook to 5/lb for release in March. As noted earlier, the ponds can also be used for resident trout fishing and/or surplus hatchery steelhead for handicapped and juvenile anglers.	
PR-30 WDFW	We want to acknowledge and thank Tacoma Public Utilities (TPU) for their efforts over the last several months to engage members of the Cowlitz Fisheries Technical Committee in FHMP resolution workshops and reviews of earlier drafts, as well as accepting comments from members of the public and key constituent groups on this and earlier draft versions of the FHMP.	Comment noted.
PR-31 WDFW	**References to the In-Season Implementation Tool (ISIT):** Many references to ISIT remain in this draft. These references create confusion about availability of data, the purpose of the ISIT tool and the planned transition to use of the Big Table. In previous comments, we recommended removal of references to ISIT and stand by that recommendation; however, if that is not possible, we suggest a description of the original purpose of ISIT along with a description of the transition to use of the Big Table format be added earlier in the document. The M&E chapter (section 10.3.1) provides a description of the ISIT tool and the introduction of the Big Table concept. It would be useful to provide a brief summary of this prior to the first references to ISIT. We suggest Section 2.8 (Monitoring and Evaluation) would be a good place for this insertion.	We can accommodate this recommendation. The suggested information was added to Section 1.2 of the FHMP (earlier than Section 2.8), as that was the initial place in the document referring to use of data in the FHMP.
PR-32 WDFW	**Resident Fish (Section 11.1):** We agree with the content of this section, but believe it is very specific to Rainbow Trout and lacks recognition of potential alternatives. Adding flexibility to consider alternative approaches in addition to, or instead of Rainbow Trout production would strengthen this section. As an example, WDFW has received a lot of public	Included edits to Section 11.1 to consider other fishery options as appropriate, in coordination with fisheries managers and FTC.

Comment #/ Source	Review Comment	Response from Tacoma Power
	comment about the land-locked coho fishery in Riffe lake. Evaluating options to enhance that fishery, or others like it, should be considered.	
PR-33 WDFW	**Monitoring Data Gaps:** Appendix C does provide a thorough list of data gaps and potential future monitoring needs, but this is not an exhaustive list. Additional data gaps and/or monitoring needs may arise during future discussions (e.g., during Transition Plan development). We recommend that this be reflected in Chapter 1 and in the introductory paragraph for Appendix C. We also request that review and prioritization of this list by the Cowlitz FTC Monitoring & Evaluation Sub-group be identified as a priority in the first year of FHMP implementation along with M&E Plan development.	Edits made to Appendix C to remove the word "comprehensive," and the introduction to Appendix C was revised as suggested.
PR-34 WDFW	While this final draft does provide direction on fishery and hatchery programs into the future, it is still missing significant detail on how program changes will be implemented and evaluated. It purposefully calls for development of detailed transition plans that will describe preferred options and steps for implementation and define criteria for moving between recovery phases. The FHMP also outlines aggressive timelines for Transition Plan completion. Similarly, the FHMP calls for development of an updated M&E plan within the first year of implementation, as well as completion of a work plan within the first 3 months of FHMP submittal. WDFW agrees with the urgency identified in the FHMP to complete the Transition Plans and M&E Plan and believes it is critically important that TPU maintains its commitment to completing these plans within the timeframes described. We are prepared to begin work with TPU and other FTC members on this next phase of FHMP implementation.	Agreed. This will require commitment by the full FTC and all of its members.

Comment #/ Source	Review Comment	Response from Tacoma Power
Public Review Comments		
PR-35 Jack Tipping	The FHMP again incorrectly says that no hatchery chum have been released in the Cowlitz River. Please see below from Paul Peterson, hatchery manager at the time.	Section 9.0 (page 9-1) was revised to accurately reflect the historical releases.
PR-36 Chris Ness	Present situation: WDFW and Tacoma Power have been studying fish production and returns for many years. Many things have been tried to improve the fish returns--more production, changing species, changing commercial and sport fishing rules and open seasons, etc. Yet the ability to predict returns and provide good fishing for both has been quite variable, and not very satisfying to get fish on the consumer`s table. And JHB has been pushing to get more hatchery production. Some of the salmon runs are endangered in the Columbia River system. Target: Increase fish returning to the rivers--primarily Columbia and Cowlitz--to record levels last seen many years ago. This will help satisfy Commercial and Sport fishermen, provide a great form of entertainment for a lot of people, provide more increased sales from fishing equipment, etc., and provide more revenue to the WDFW from licenses. Lots of "WINS" here. Background: Last year I attended this conference. I sat next to a person who identified himself as a retired biologist who spent his last 20 years as a Cowlitz River Biologist. (I misplaced his name). He gave me some very insightful food for thought--that first off, only 20% of the young fish heading to the ocean from the Cowlitz actually make it to the ocean. In other words, 80% are killed. So I asked him for his best estimate of numbers: Of those killed, HALF are eaten by sea lions, ONE QUARTER are eaten by Cormorants, and the remaining	Predator control is a concern for all fish managers across the Columbia Basin, and working with stakeholders to understand limiting factors for success is built into this FHMP period.

Comment #/ Source	Review Comment	Response from Tacoma Power
	QUARTER are lost from a variety of miscellaneous reasons. So roughly 75% are eaten by predators. This helps focus the problem, and using the 80/20 rule, 80% of most problems are usually from 20% of the causes. This means lessor causes are dams, warmer river temps, overfishing, etc. A WDFW article on the internet a few years ago about sea lion populations indicated the sea lions on the whole west coast have grown in numbers from about 10,000 in the 1950s to about 300,000 today. And about 3,500 to 4,500 now live in the Lower Columbia River. Each requires about 25 lbs of fish per day to survive. And does making more fish in the hatcheries mean that even more sea lions will show up to eat this free food? With very little improvements in fish returns as a result? Proposal: Sensible reductions of overpopulated protected species seems like a reasonable solution. Some will say that "We can't do anything about that, as the Feds have protected the sea lions." I totally disagree. I would start with articles INFORMING THE PUBLIC of the situation. And include all elected congressional reps to receive these publications. When the public understands what is going on here, they can put a lot of pressure on the Feds and their Congressional Representatives to find a more common sense balance between salmon and predators. This requires the WDFW and Tacoma Power to begin a "media blitz" outlining the problem, using different methods to create change than previous. The goal here is to increase fish returning to the rivers. WE NEED TO START NOW! And the cost to inform the public to create pressure on the government to enact change is minor	

Comment #/ Source	Review Comment	Response from Tacoma Power
	compared to building/staffing more hatcheries. And I think the results will be very big, when you compare costs/benefits. Miscellaneous: Even my close fish friends were not aware of how big this problem is, and they asked what they could do. Monica, this is a big issue, and I would hope that this makes it into the highest up folks in the WDFW and Tacoma Power, and that these decision makers will take on the challenge. Chris Ness, retired Professional Engineer, current Master Hunter, fished/hunted in SW Washington since 6 yrs old--now 79. WDFW volunteer of year award 2019.	
PR-37 Clancy Holt	I am Clancy Holt owner & operator of Clancy's Guided Sport Fishing. I actively guided for 61 years & have been operating a guide business for 64 years. Clancy's Fishing Team is comprised of 3 full time guides & 1 part time. I am past president of the Cowlitz River Guides Association, past president of Washington Outfitter & Guides Water Base Division, founding member Fish First For The Lewis River & active politically on many fronts. Our history on the Cowlitz river is legendary. I have a lifetime of hands on experience on the Cowlitz River & understand the problems the Cowlitz River faces. Our headquarters is located 10 minutes from the Blue Creek boat launch. My staff & I have studied the comments regarding the FHMP, that CCA has put forth. We back the CCA plan 100%, it will work. The Cowlitz River could & would be the go to place to fish in the Northwest under the right management plan & supervision. Let's get it done.	Thank you for your feedback. Please see comment responses above. We look forward to working with you as we develop the Transition Plans.

Table E-2: Public Comments from the August 2020 Public Meeting (PM) and Tacoma Power's Reponses.

Comment #/ Source	Public Comment from the August 2020 Public Meeting	Response from Tacoma Power
PM-1 Larry Pryor	FTC slows things way down in their technical process. In the transition plans, can there be a more expedient process than going to the FTC for their comments vs. going to the FTC first.	We are fully committed to working with the FTC and the public to implement the strategies along the way. I share your concern. We have had some conversations about that and one of the solutions is to find a way to standardize a template to work through these conversations. I don't think we can or should walk around the FTC, but I'm committed to working as efficiently as possible. You heard me and Bryce say that some of these topics are high priority or us.
PM-2 Greg King	FHMP does not provide fish for orca whales, Satellite Ponds, or the CTH remodel. There is only a brief paragraph on Satellite rearing ponds. We don't see any forward movement. It feels like Tacoma is kicking the can down the road, but you can only kick it so far. The Settlement agreement is coming up soon and the public may have a different view. I want to know where we stand on these issues and hear some movement from Tacoma on these topics. We went with WDFW and found a potential location for the ponds, and Tacoma has done cultural resources work in the area they identified.	I agree those sections are brief in the FHMP. **Satellite Ponds**: It says we are committed to working through the design and conceptual phase and strategy at a minimum. Tacoma Power would actually like to start building them out during the FHMP period. Anecdotally, one of our motivations is that the FHMP needed to be written to set the stage for the HGMP, which cannot be written effectively without a basic concept of the Satellite Ponds' purpose. I am working through a plan for the Satellite Rearing facilities now and will hopefully provide it to the FTC and have a public discussion by the end of this year. Eric: **Regarding the CTH,** we still have support from upper management to continue the remodel. We just got approved at end of last month to hire PM staff to help develop design basis memorandums. One of my priorities right now to hire those staff with expertise in hatchery remodels. Hoping to have them here on staff no later than Feb., and start getting into the nitty-gritty. We replaced the guts of the ozone plant, upgraded with new machines. It's fully commissioned, and we have high hopes for it. It ran all season without a hitch.
PM-3 Rocky Point	I live on the Cowlitz, watch it every day. Avian predation is a major problem, not just cormorants but mergansers, herons and osprey as well.	We have done a lot of work to help alleviate these issues. This relates to our desire to identify SARs and their limiting factors. We agree this is a data gap. We're a fairly young program, and we've learned a lot over the last 10 years. Bryce said that the

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		FHMP is more focused on hatchery survival, but that doesn't mean the FTC couldn't take on discussions about predation and other limiting factors to understand what we can do. More recent attention on the pinniped issue from the federal government to give the state more flexibility and authority for what it can do about pinnipeds and on the cormorant issue. We recognize it's a slow process, which isn't satisfying for anyone.
PM-4 Unknown	2 it really sucks that some wandering fish are stopping the steelhead recycling program from taking them to Gearhart and not just I-5.	We may have more flexibility within the new FHMP.
PM-5 Unknown	Tacoma Power should be giving the public an accurate river forecast for dam water flows. the public is left guessing on the lower river if the dam will be open or closed. water levels change randomly and we are just left guessing what y'all might do at the dam.	See response to comment PM-6, below.
PM-6 Eric	Second to Rocky Points issue with rapidly, with no apparent reason, river level/flow changes.	Monika: Rocky Point and Eric - have you seen our MyTPU.org/LakeLevels page? We update it a couple times a week with a Cowlitz flow forecast.
PM-7 Rocky Point	that's the river level forecast I use. It's wrong as often as it's right.	See response to comment PM-9, below.
PM-8 Eric (last name not provided)	I have seen the forecasting page. I am confident that the large number of those that comment on the Cowlitz River Facebook page use it as well. The frustration is that we see a river drop of 1' or up 2' day to day with no dramatic change in weather. The overall forecast levels are known, it is the daily shifts with no reason causing the complaining that I have and those that report on the forums/Facebook pages. A quote that caught my attention, and many agreed to it on the web page was that Tacoma Power does not care about the fisherman and will essentially blow out the river the day before WDFW opens the river. The frustration with others is higher than mine, but it is	See response to comment PM-9, below.

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	an issue. I have met some of you in person, and I know you care about the fish, but this is often the feeling from those that don't take the time to visit.	
PM-9 Rocky Point	Tacoma Power surely doesn't decide at the last second to open/close the dam. So we should be notified as soon as y'all think about moving dam controls.	Monika: We hear you on your frustration. I can guarantee you 100% that we care about fish and anglers and are not trying to frustrate you. One of our challenges is that our Power Management group is responsible for balancing many factors when it comes to river flows, including fish flows, power production, grid stability, and recreation. They may need to make changes based on those factors. They also must monitor the weather and snowpack closely and make changes based on current and upcoming conditions. They truly are not trying to frustrate you and they absolutely care about fish and anglers, but they are always walking a fine line between all of these factors. We are in the process of finalizing a Cowlitz Communication Plan, and we hope to help educate the public on our operations so you can be aware of all of these things happening behind the scenes.
PM-10 Eric	Thanks for the reply and I look forward to the communications plan!	Absolutely! Thank you for your interest.
PM-11 Larry Pryor	What I like about the FHMP is the objectives and goals. Like that we're moving toward adult return goals. Needs to have goal to build back wild runs. There are many things you can do in the hatchery to help. Run timing. Predatory predictor – when are the high times of peaks of predation and adjust some common-sense releases. Years ago it was just a production mentality. Applaud you for that. The FHMP is very professional, FERC will like that.	Thanks for that feedback, and thanks for that positive feedback. Within the Transition Plans themselves, there's a build out for goals from getting to one phase to the next, how do you define goals, get to the next phase, once you get to recovery (healthy and harvestable), how do you define that? As we build out the FHMP, that's one of the things we'll look at.
PM-12 Unknown	What is the definition of Natural Origin? There are number of other projects that could be in support of this.	Naturally born by natural processes from live fish. Tim: fish born in nature from adults that spawned in nature on their own. No human introduction of the fish. Didn't pair the

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		adults. Doesn't matter what the parents were, but only that they spawned in nature and the fish was raised in nature completely.
PM-13 Unknown	I see you have objectives for NOR catch and retain. However, I do not see a real number to trigger the harvest. I'm concerned that if the public doesn't see the goals that you will start getting opposition because it also looks like you will be cutting hatchery production as a long term goal. May get some objection to the FHMP. Looks like ultimate goal is to cut back hatchery production and to improve wild catch.	The FHMP is built in phases. We acknowledge that healthy and harvestable is currently ill-defined and as we move through this FHMP period we will be working to define this. I hope you can see that in the FHMP. Bryce: One of the things you should look for in your review is one of WDFW comments is some discussion of the recovery phases. Many of our populations are in a building phase. One of the things we've been pushing on is to develop some criteria re: when you move from one phase to another (i.e., at what point is a population healthy enough so it can sustain harvest). These goals are lacking throughout the Lower Columbia and elsewhere, and recently there has been some new attention on the matter. Likely not going to make into this FHMP but it's definitely on our mind. Using hatchery fish to get natural production started again to get populations built. Working on criteria of when you move from phase to phase, managing for wild fish to become more productive, and then when can you move into a harvest regime. We recognize the need for those goals, and what healthy and harvestable goals look like. Probably won't see numbers in this version, but hopefully we'll develop criteria as we move through the phase changes.
PM-14 Unknown	There is only one paragraph Re; satellite programs. Satellite Ponds moving forward will be more important than ever with the dwindling returns. These programs, particularly in upper Cowlitz will be very important. They may be able to balance when the lower river hatcheries have problems.	See response to comment PR-28, in Table E-1.
PM-15 Unknown	Larry (and others that he's talked to) wants more accountability. Ultimately that's FERC's department but I don't	Matt responded that there are many points within this FHMP built in to specifically engage with the public and track

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	see a place for accountability. That somehow needs to be addressed so we know who to fire.	progress. You are always welcome to contact me with concerns or questions.
PM-16 Unknown	Hatcheries need to boost their egg take to consider outside programs too.	Limiting factors will be considered as part of the topics in this FHMP.
PM-17 Unknown	Is this FHMP only for 6 years? Congratulations, it's a nice looking plan.	We know it takes too long to develop these things. We worked with FERC and the FTC to make this a 10-yr plan instead of 6-yr plan. We committed to engage the public during the 10 yrs. This hasn't received official approval yet, but is what we submitted. We recognize that there is a lot of work that goes into these plans, so having a longer timeframe will be beneficial.
PM-18 Eric	In the front visitor center at the Trout Hatchery, it looks like crap! There is moss and cracks everywhere!	Eric: Yes, it's on hold until the remodel. I would like to personally apologize for that because we're deferring until the remodel. There's asbestos in the building, so it's a huge process, so we have to lump it into remodels; we will address that.
PM-19 Greg King	WDFW is changing some wording in the HSRG. Is Tacoma going to keep the old standards or go with the new recommendations? Also, the FHMP has been really delayed. Sports fishermen have only been able to engage just now. We want to be in the FTC and have asked to be for a long time. You're not getting the full picture from the sports side. We feel left out. We would love to add some stuff into the FHMP, but getting left our year after year and it's frustrating.	We did have some other public review periods. Not sure if you took advantage of that. I'd like to call out that this is NOT your last chance to interact. We will be developing Transition Plans and will engage the public in that process. This is just a next step and not the end of our commitment to engage you.
PM-20 Larry Pryor	Is this FHMP now set for 6 years after it's filed in October or when is the next one due? it looks like a lot of work from this plan would transfer to future plans- to expedite	This FHMP proposes a 10-year cycle, which will need to be formally approved by FERC.

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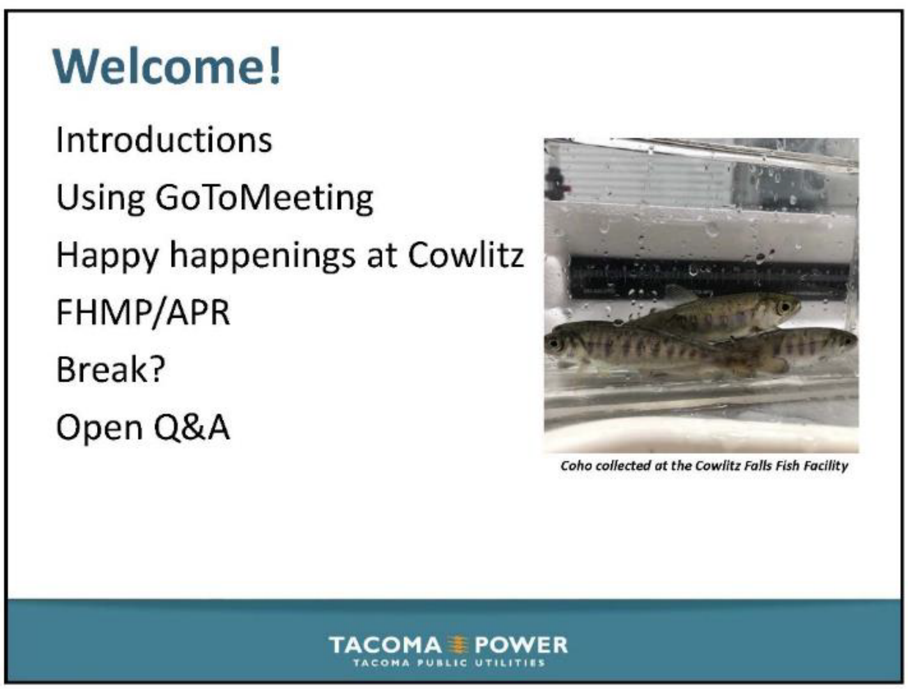
PowerPoint Slides from the August 12, 2020 Public Meeting



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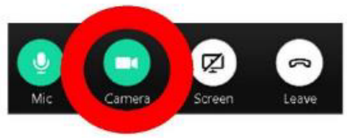
Using GoToMeeting

- Audio/visual controls

- View everyone drop-down
- Can shut off your webcam to preserve bandwidth



- Enlarge presentation by pulling the top bar up

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Using GoToMeeting

- Everyone on mute until open Q&A portion
- However, you can still ask questions or make comments by typing them into the chat box

- Who's joining us via phone?
- We will post the presentation and chat log at **MyTPU.org/Cowlitz**

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Open Q&A

- On a webcam? Please raise your hand.
- Or, type a question into the chat box.
- Or, type your name into the chat box and we'll call on you.
- We will ask people on the phone if they have questions.

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Happy happenings at Cowlitz

- Summer-run steelhead recycling program
- Barrier Dam survey: Aug. 24-28
- Rainbow trout donation
- New ozone plant at the Cowlitz Trout Hatchery
- New Tilton release site

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Overview

- What we all want
- FHMP
  - Schedule
  - Next Steps
    - Transition Plans
    - M&E Plan
  - Public Review
    - Concerns we've heard so far
- 2020 APR
  - … In the world of the pandemic
  - Initial thoughts/feedback

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FHMP Schedule

Action Item	Date	Responsible Party
Public Comment Solicited	August 2019	Public
Document Preparation/Workshops completed	October 2019	Tacoma/FTC
Review Complete Draft FHMP (continuing solicitation of public comments)	11/18/19 – 5/30/20	FTC
Unresolved Topics Workshops	2/15/20 – 3/15/20	Tacoma/FTC
Unresolved Interim Plan Document	4/1/20 – 6/30/20	Tacoma/FTC
Edit Completed Draft FHMP	6/1/20 – 7/31/20	Tacoma/FTC
Public Review Draft Final FHMP	8/1/20 – 9/7/20	Public
Incorporate Comments and Finalize FHMP	9/7/20 – 10/7/20	Tacoma
File FHMP with FERC	10/18/20	Tacoma

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What is in the FHMP

- **History of Cowlitz**
  - How did we get here
  - Why this work is important
- **Recent History of Each Population and Program**
  - Trends
  - Current programs and why
- **Interim Strategy**
  - Develop Transition Plans
    - Stepwise? All at once?
  - Mostly status quo until then
- **Concepts for Next Phase**
  - Recovery
  - Harvest

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After FHMP is Submitted:

- **Transition Plans**
- **Public Input**
- 1 or 2 years (*Spp.* specific)
  - Program Sizes/Range
  - Integration Rate
  - Management Strategies
  - Bio Program
  - Transport/Disposition
  - Marking
  - Time/Size of Release
  - Broodstock Needs
  - Transition Approach
- **M&E Plan**
- **Annual Operating Plan**
- **Single Reporting and Analysis Database**
- 1 year then annually
  - Baseline Studies
  - Directed Studies
  - Focused on data gaps to inform stepwise progress
  - Interim (Appx J – 2011, up to 1 year or as described in work plan)

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Transition Plan - Public

- **What you can expect**
  - Options for public to weigh in on
  - Options considered by FTC
    - Pros and cons

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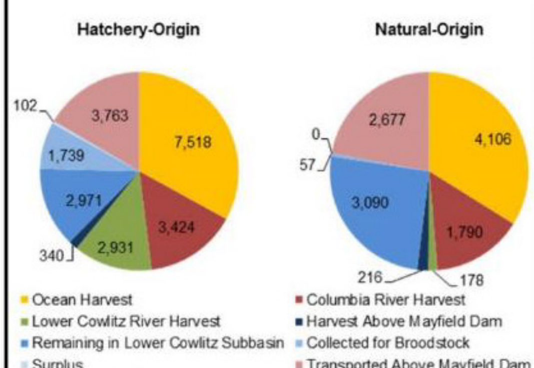
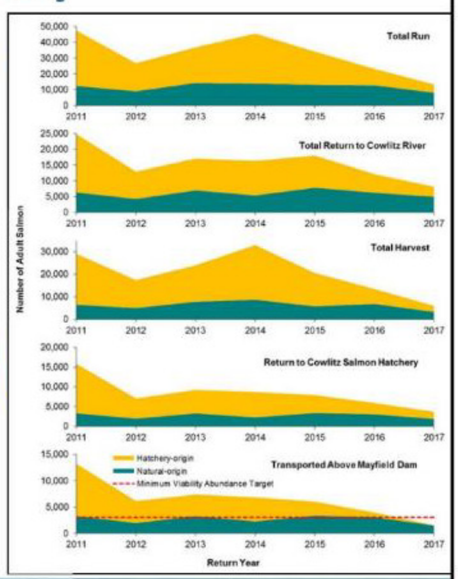
Fall Chinook Summary

Current Hatchery Program(s):	Lower Cowlitz Subbasin - Integrated; 1.1 million sub-yearling smolts
	Lower Cowlitz Subbasin - Segregated; 2.4 million sub-yearling smolts
Proposed Hatchery Program(s):	Tilton River (Upper Cowlitz Subbasin) - Integrated; 3.5 million sub-yearling smolts





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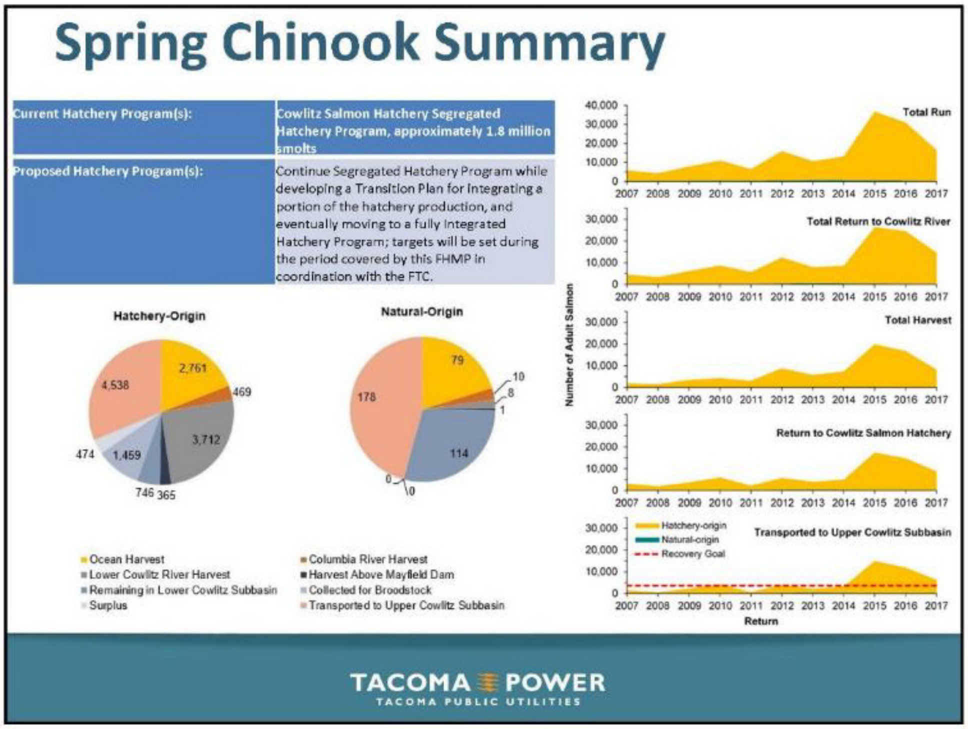

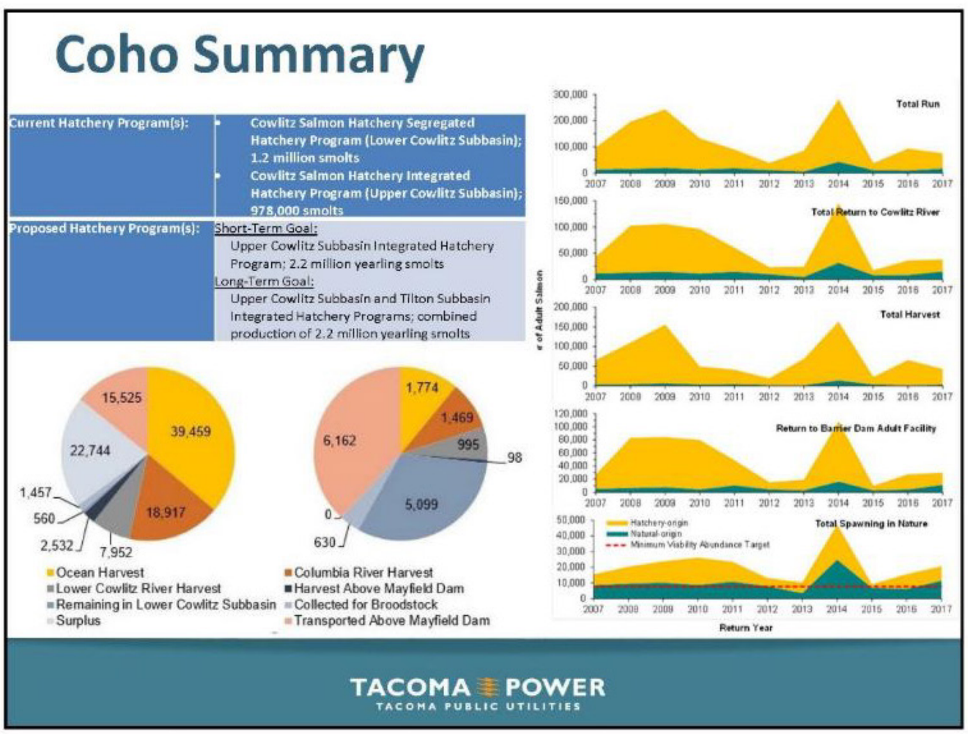

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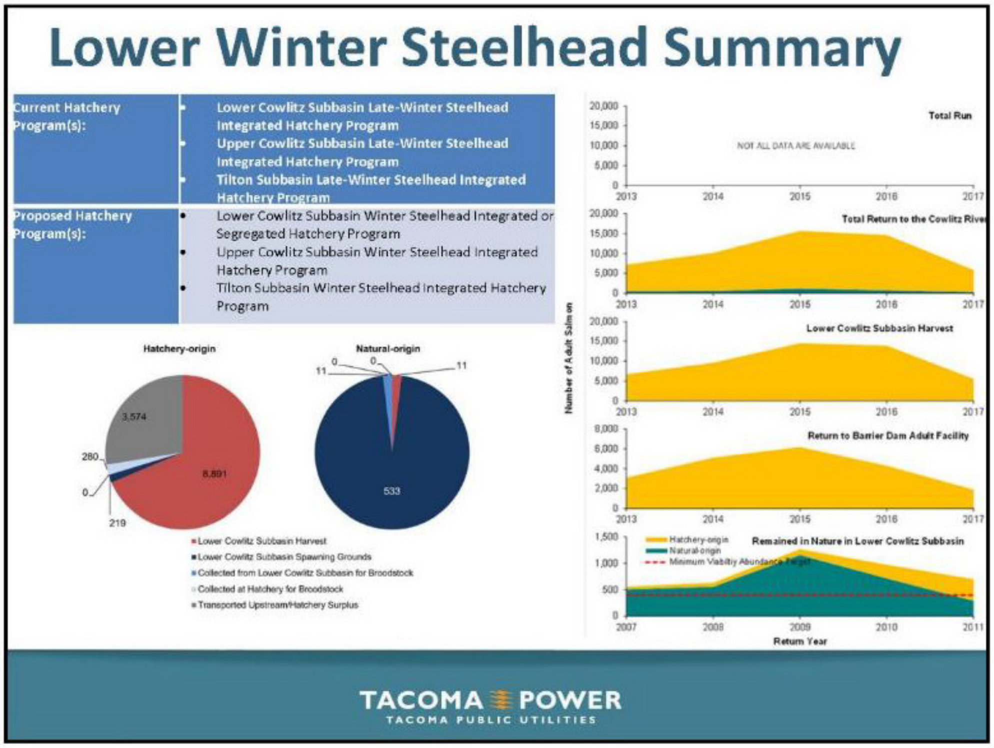

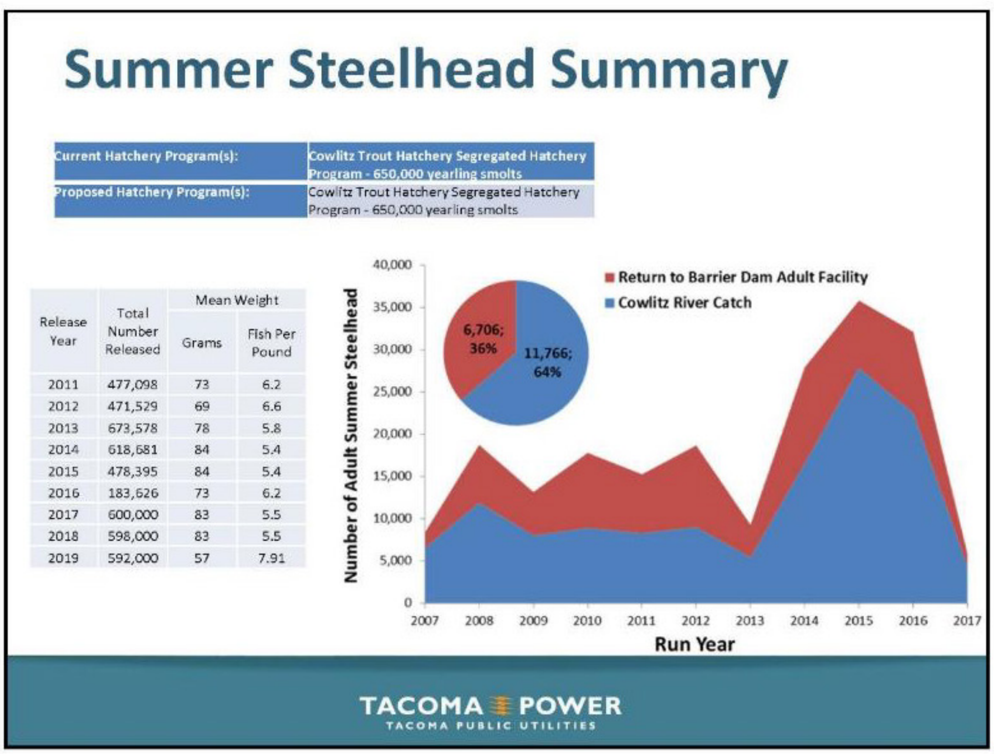

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Public Review – Concerns We've Heard So Far

1. Low Spring Chinook Smolt-to-Adult Returns (SARs)
2. Fall Chinook NOR harvest opportunity
3. Winter steelhead early program
4. Chum

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1. Low Spring Chinook Smolt-to-Adult Returns (SARs)

– Priority topic for FTC
– Monitoring & Evaluation subgroup building estimate
– Limiting Factors for SAR within Transition Plan (Year 1)

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2. Fall Chinook NOR Harvest Opportunity

– Proposed Plan Considers:
- Collection at Barrier Dam Adult Facility for single integrated program during this recovery phase
- Marking strategy to describe effectiveness
- Opportunity to be maintained for increasing HOR returns

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3. Winter Steelhead Early Program

– Transition Plan to (within 1 year) that considers:
- Maximize recreational/harvest opportunity by adjusting summer-run Segregated Hatchery Program production in conjunction with winter steelhead programs.
- Expanding existing hatchery program run-timing to increase fishing opportunities by developing a winter-run steelhead program to more closely emulate historic run-timing.
  - Determine possible sources and timing of implementation

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4. Chum

- No plans to release hatchery-origin chum salmon in the Cowlitz Basin during this FHMP period.
- Does not preclude any entity from artificially propagating chum within the Cowlitz Basin:
  - Consistent with a recovery strategy
  - Coordinated with WDFW the Artificial Propagation Strategy for Chum Salmon

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APR

- Purpose - Plan for operating fisheries in 2021
- Process this year
  - One virtual meeting on Aug. 12, 2020
  - No changes recommended at this time by Tacoma

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2020 Hatchery Production Plan

Species	Before 2011 FHMP Update	2017 APR Goal	2018 APR Goal	2019 APR Goal	2020 APR Goal
Fall Chinook	4,800,000	3,500,000	3,500,000	3,500,000	3,500,000
Spring Chinook	959,800	1,738,529	1,738,529	1,738,529	1,738,529
Coho	2,835,000	2,178,000	2,178,000	2,178,000	2,178,000
Winter Steelhead	690,000	647,000	647,000	647,000	647,000
Summer Steelhead	550,000	625,000	650,000	650,000	650,000
Cutthroat	160,000	100,599	100,599	100,599	100,599

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Public Comment (Break?)

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Open Q&A

- On a webcam? Please raise your hand.
- Or, type a question into the chat box.
- Or, type your name into the chat box and we'll call on you.
- We will ask people on the phone if they have questions.

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Wrap Up

- All comments are due to Matt Bleich or Travis Nelson by 4 p.m. (PST) on Sept. 7, 2020
- Get Comment Form, documents, and email addresses at **MyTPU.org/Cowlitz** (under Public Meetings)

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