Attachment 3

Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead

12-Year Assessment
2010-2022

Appendix II. Chum Recovery Strategy Implementation and Update

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Introduction

The Columbia River Chum Recovery Strategy (CRS) represented the first step in the State of Oregon's plan for recovering chum salmon in tributaries located on the Oregon side of the Columbia River Evolutionarily Significant Unit (ESU). This plan was developed as a supplement to the *Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead* (Plan) and sought to gather information and develop techniques that would provide the framework for establishment of viable chum populations on the Oregon side of the Lower Columbia River (LCR).

Little was known about chum habitat use and movement in Oregon tributaries of the Columbia River at the beginning of this strategy. Because of the lack of knowledge about Columbia River chum salmon in Oregon, development of the recovery strategy was conducted in a systematic way, starting out at a small scale to test hypotheses and then applying proven techniques more broadly.

Together, the Plan and CRS represent a suite of actions intended to: (1) identify and implement corrective measures to address primary and secondary limiting factors, (2) re-establish chum salmon into a portion of Oregon Columbia River tributaries in the Coastal stratum, and (3) monitor performance of the program to evaluate success and allow for adaptive management. The overarching goal of Oregon's recovery strategy was to develop a science-based approach using the best available technical information to reduce risk and increase the probability of success. Eight framework elements were incorporated which served as a foundation for development of the CRS:

1. Identify Methods for Re-Establishing Chum Populations
2. Identify Target Populations
3. Identify Habitat Suitable for Chum
4. Identify and Obtain Brood Source for Use in Reintroduction
5. Identify Facilities for use in Conservation Hatchery Program
6. Identify Production Goals and Program Duration
7. Identify Artificial Production Techniques
8. Identify Release Strategies for Reintroduction Program

From the identified CRS elements, the planning team identified key strategies in three program areas: Habitat, Artificial Propagation and Broodstock Development, and Reintroduction/Out-Planting. For each program area objectives were formed; risks, benefits and critical uncertainties were identified; and actions were listed to implement the objectives. This appendix consists of two sections: the first section summarizes implementation of CRS strategies and actions since adoption of the Plan in 2010 and the second section presents an updated CRS developed by ODFW based on lessons learned during the first 12 years of implementation.

Columbia River Chum Recovery Strategy Implementation

Habitat Evaluation and Restoration

Goal: Identify and implement corrective measures to address primary and secondary limiting factors

Objective: Develop a spawning habitat sampling protocol and evaluate physical habitat and water quality conditions in all historically occupied areas within the Oregon portion of the Columbia River Chum Salmon ESU (priority given to Clatskanie River and Scappoose Creek Recovery Populations) to identify restoration areas, natural recolonization potential, and sites suitable for assisted reintroduction. This program area will identify limiting factors related to freshwater habitat, find areas with the highest potential for re-establishment, and evaluate restoration success.

Action 1: *Develop a chum spawning habitat survey methodology that focuses on assessing gravel quality, presence of hyporheic flow, and areas of upwelling. This survey methodology should be developed and included as a CRS Technical Report.*

This action was completed in 2012 and the Chum Reintroduction Project Habitat Survey Protocol, Version 1 was developed.

Action 2: *With the developed survey methodology and existing High Intrinsic Potential (HIP) map as a guide, initiate an evaluation of existing chum habitat conditions throughout the Oregon portion of the ESU, focusing on the Clatskanie River and Scappoose Creek Recovery Populations.*

This action was completed in the Coastal stratum of the ESU and two reports were produced in 2017, Chum Salmon Habitat Spawning Reports for Youngs Bay and Big Creek, as well as Clatskanie River and Scappoose Creek.

Action 3: *Use information collected from the chum salmon habitat spawning reports to identify high quality habitat and/or areas in need of immediate restoration within each recovery population (focusing on the Clatskanie River and Scappoose Creek Recovery Populations). This information should be used to establish technical guidance on where to begin reintroduction and habitat restoration efforts in these basins.*

This action has not been completed but is in progress. The Oregon Department of Fish and Wildlife (ODFW) assisted the Lower Columbia River Watershed Council (LCRWC) in revisions to their strategic action plan (SAP), which incorporated elements of the chum salmon spawning and habitat assessment reports for the Clatskanie River. Habitat within the Scappoose Creek recovery population was determined to be inadequate for a chum re-introduction program. ODFW staff assisted the North Coast Watershed Association (NCWA) with development of a SAP for chum salmon habitat restoration in the Youngs Bay and Big Creek Recovery Populations (available at https://www.returnoftheredds.com/action-plan). SAP development and landowner outreach occurred in 2020-2021 and several projects are planned.

Action 4: *Use information collected in chum salmon habitat spawning reports to develop a predictive model to estimate juvenile and adult chum salmon carrying capacity under existing environmental conditions. This information should be used to establish technical guidance regarding outplanting densities and quantity of restored habitat needed to maintain base population levels above 100 chum spawners.*

This action has not been completed.

Action 5: *Evaluate results from chum salmon habitat spawning reports to determine if sediment source studies are needed in basins targeted for reintroduction. A sediment source study should be implemented primarily where it is determined that excess fine sediment concentrations are from contemporary sources.*

This action has not been completed.

Action 6: *Implement habitat restoration projects in high priority areas identified in the chum salmon habitat spawning reports.*

This action is ongoing. Only one habitat restoration project has been implemented in the Clatskanie River in 2017 with the assistance of the Columbia County Soil and Water Conservation District (CCSWCD) and the LCRWC. Several attempts have been made by the LCRWC to obtain funding to design restoration projects in the Clatskanie River Recovery Population, but the planning dollars have not been obtained.

Habitat Evaluation and Restoration Summary:
The primary purpose of the habitat objective was to investigate the hypothesized limiting factor of physical habitat quality by documenting the quality and quantity of habitat in basins targeted for re-establishment of chum salmon populations within the Coastal stratum. This was particularly true regarding spawning and incubation habitat. Chum salmon use two interconnected zones in streams, a surface water area where spawning and juvenile life takes place and the hyporheic zone or intra-gravel area where incubation occurs (Schroder 2000). Because chum salmon spend most of their freshwater residency as incubating eggs in intra-gravel areas, the quality of substrate for spawning and incubation takes on additional importance relative to their freshwater survival. Since chum salmon also prefer areas of upwelling flows, habitat surveys went beyond visual observations of surface substrate as a measure of spawning habitat quality.

Chum salmon habitat assessment protocols were developed and basin-wide investigations occurred throughout the Coastal stratum. Surveys indicated that the highest quality and quantity of spawning habitat exists in the Lewis and Clark River in the Youngs Bay Recovery Population, Big Creek in the Big Creek Recovery Population, and the mainstem Clatskanie River in the Clatskanie River Recovery Population. Aside from these locations, it was determined that there was little quality chum salmon spawning habitat remaining in the Coastal stratum. Chum spawning habitat was found to be most degraded in the Scappoose Creek Recovery Population, which prevented it from being a focus area for reintroduction, affecting

further CRS actions. Lastly, no chum habitat assessments have occurred in the Cascade or Gorge strata.

The basin-wide investigations in the Coastal stratum led ODFW to work with the NCWA to develop a chum habitat restoration strategy and assist the LCRWC to update their SAP with information from the spawning habitat results as a prioritization metric. Top priority areas for preservation and restoration are the Lewis and Clark River in the Youngs Bay Recovery Population, Big Creek in the Big Creek Recovery Population, and the mainstem Clatskanie River in the Clatskanie River Recovery Population. Although watershed restoration action priorities were updated, only one restoration project has been completed to date. Capacity, turnover and multiple priorities within watershed councils have severely limited the completion of voluntary restoration actions aimed at chum salmon habitat restoration in the Youngs Bay, Big Creek and Clatskanie River Recovery Populations. Despite this, nearly all the actions identified for the habitat objective have been completed, except for developing a predictive model to estimate carrying capacity or conducting sediment source studies to reduce excessive fine sediments.

Development of a predictive model to estimate carrying capacity has not been a priority due to the lack of a sufficient numbers of returning adults (until 2020) for which the model would be used. A study to conduct sediment source of excessive fine sediments was discussed with the major landowners in the upper watersheds of the Big Creek and Youngs Bay Watersheds as part of the Chum Salmon Habitat Restoration SAP but currently lacks the funding to complete the study and the capacity of local watershed councils to obtain grant dollars.

Artificial Propagation and Broodstock Development:

Goal: Re-establish chum salmon into a portion of Oregon Columbia River tributaries in the Coastal stratum

Objective: Obtain chum salmon eyed-eggs from Grays River, Washington to establish a conservation broodstock in Oregon and use excess returning adults for reintroduction actions in Coastal stratum tributaries.

Action 1: *Develop an inter-governmental agreement between Washington Department of Fish and Wildlife (WDFW) and ODFW for use of Grays River Broodstock to establish a conservation hatchery program in Oregon. The duration of this agreement should be for a period of 12 years.*

This action has been completed. Adult chum were collected at Grays River Hatchery (GRH) from 2010-2014 to establish the broodstock in Oregon and collected again in 2018-2019 due to low returns to Big Creek Hatchery (BCH). From 2015-2016 and from 2020-2022 adult returns to BCH were of sufficient size to maintain the chum conservation broodstock.

Action 2: *Identify a location for a chum salmon conservation hatchery facility in Oregon.*

This action has been completed. BCH is designated as the conservation hatchery for Oregon Columbia River chum salmon in the Coastal stratum.

***Action 3**: Finalize (Grays Stock) Chum Hatchery Genetic Management Plan (HGMP) and submit to National Oceanic and Atmospheric Administration (NOAA) Fisheries for approval.*

This action has been completed. The BCH Chum Salmon Recovery Program HGMP was submitted to NOAA in 2013. The HGMP was further updated in 2016.

***Action 4**: Update or develop new ODFW Hatchery Management Plan to reflect new chum broodstock program.*

This action has been completed. The BCH Management Plan was updated to include Chum Salmon and last updated in 2022.

***Action 5:** Beginning as soon as possible and for the following 5 brood years coordinate with WDFW hatchery staff and provide ODFW personnel as needed to assist with trap, capture, and spawning of chum broodstock in the Grays River (October through December).*

This action has been completed. Assistance in broodstock collection at GRH occurred every year that broodstock was collected from Washington (2010–2014 and 2018–2019).

***Action 6:** Transfer approximately 100,000 to 300,000 thermally marked eyed-eggs annually for a period of no less than 5 years from GRH to the chum hatchery facility for final rearing and release.*

This action has been completed. Transfer of eyed-eggs from GRH occurred from 2010–2014 (Table A-II: 1). Thermal marking occurred on all transferred eyed-eggs.

Table A-II: 1. Thermally marked eyed-eggs transferred from GRH to BCH, 2010–2014.

Year	Eyed-Eggs
2010	115,850
2011	113,500
2012	118,500
2013	99,000
2014	104,000

***Action 7**: Develop and implement a facilities development/modification plan to prepare facility for transition from GRH production to production in Oregon including all elements of adult returns, broodstock collection, spawning, incubation, rearing, and release. Facilities added/upgraded should include capacity for thermally marking otoliths at eyed-egg stage.*

This action has been completed. This effort occurred in 2015 and was formalized in the 2016 revised HGMP. All eyed-eggs from BCH are thermally marked.

Artificial Propagation and Broodstock Development Strategies Summary:
All seven of the actions under this strategy have been completed and ODFW currently operates a successful conservation broodstock for chum salmon. ODFW created an agreement with WDFW to obtain Grays River chum to establish and support a chum conservation broodstock in Oregon. During broodstock establishment (2010–2014), eyed-eggs were transferred to BCH and subsequent adult returns were passed above the hatchery's intake dam to spawn volitionally and supplement egg transfers. Adult returns were modest in 2015 but decreased dramatically in 2016 and 2017 and were insufficient to meet broodstock collection goals. To avoid loss of the entire broodstock, eyed-eggs were again transferred from WDFW in 2018–2019. In the 2020–2022 return years, there were sufficient adult returns to meet broodstock needs and conduct meaningful reintroduction work for the first time. Between the hatchery returns to BCH and egg supplementation from Washington, ODFW has been able to meet the fed fry release goals of 100–300k every year except in 2016. All actions have been completed, and ODFW does not expect a need for additional eyed-egg transfers from GRH.

Artificial Propagation and Reintroduction/Outplanting:

Goal: Monitor performance of the program to evaluate success and allow for adaptive management.

Objective 1: Determine which recovery population (Clatskanie River or Scappoose Creek) will be the target of reintroduction efforts.

Action 1: *Compile information necessary to decide as to which population should have chum reintroduced. Information should include, but is not limited to:*

- *habitat quality and quantity in the Clatskanie River and Scappoose Creek recovery populations*
- *potential sites for the various reintroduction methods proposed*
- *landowner or other constraints*
- *distances and obstacles (direct or indirect) from known chum spawning aggregations*
- *occurrence and level of hatchery fall Chinook spawners*

This action has been completed. To assist with the chum reintroduction effort in Oregon, a Chum Work Group was developed. The group consists of state, federal, and local partners to help inform ODFW and the Chum Reintroduction Coordinator on best strategies. The Chum Work Group used the 2017 Chum Salmon Habitat Spawning Report to determine which recovery population was most suitable for chum salmon reintroduction. The report identified no chum spawning habitat in the Scappoose Creek Recovery Population and a prolonged timeframe for habitat restoration. Therefore, the Scappoose Creek Recovery Population was eliminated as a potential reintroduction site, and the Clatskanie River Recovery Population was selected as the initial site for reintroduction.

Objective 2: Once sufficient adult returns are established to meet broodstock collection goals and to provide excess production, outplant chum into high quality stream habitats within

Scappoose Creek or Clatskanie River Recovery Population areas for 12 years (three chum generations).

Action 1: *Use information collected from the predictive habitat model to estimate juvenile and adult chum salmon carrying capacity. Use carrying capacity estimates to develop a hatchery production schedule to determine outplanting needs for each area.*

This action has been partially completed. The Chum Work Group has helped with the development of the hatchery production schedule, but no habitat or carrying capacity models have been developed.

Action 2: *Conduct site evaluations to identify locations for fed fry releases.*

This action is ongoing. Several locations for broodstock fed fry releases have been identified in Big Creek below the hatchery at the confluence of the Columbia River since 2010. Excess fed fry for reintroduction purposes have not been available in most years, so no other site evaluations have occurred.

Action 3: *Conduct site evaluations to identify locations for use of in-basin incubation, rearing, and release facilities. Number of facilities/locations will depend upon production needs identified in Objective 2 Action 1. Secure lease or access agreements as necessary.*

This action is ongoing. In 2014 and 2015, incubation and release of chum salmon occurred in Perkins Creek (Clatskanie River Recovery Population) (Figure A-II: 1).

Figure A-II: 1. Remote-site Incubator (RSI) installed at Perkins Creek, Oregon, for outplanting chum salmon eyed-eggs. In this photo, water enters the sediment settling barrels on the left side and flows out of the egg barrels on the right side.

Action 4: *Use information collected in Objective 2 Action 3 to determine release locations for direct planting of eyed-eggs using Salmon Egg Planting Devices (SEPD).*

This action has not been completed; other outplanting methods (adult outplanting; outplanting of eyed eggs to RSIs) have been prioritized.

Artificial Propagation and Reintroduction/Outplanting Strategies Summary

Most of the actions identified for successful implementation of this strategy are ongoing or have been partially completed. Since 2010, ODFW has experimentally released fed fry produced by the broodstock at BCH at different sites in Big Creek and under various conditions to determine which release methods promote fry survival and subsequent adult returns. It was discovered that to achieve high survival, fed fry should be released at night, in schools, with an outgoing tide, before the Columbia River reaches 10° C, and asynchronous with other hatchery smolt releases. These methods are now being used whenever feasible.

The Clatskanie River Recovery Population was identified as the preferred reintroduction site. However, reintroduction efforts have been limited by the low returns to BCH. In low return years, adults are prioritized for the conservation broodstock, not reintroduction. Due to low returns, reintroduction efforts prior to 2020 were very limited and experimental in nature, consisting of small numbers of outplanted adults and a single site for remote site egg incubation. Only in 2020-2022 have returns to the hatchery been large enough for substantial reintroduction efforts. Chum were first outplanted into the Clatskanie Recovery Population in 2020 and this action is still in progress. No habitat or carrying capacity models have been developed to guide chum outplanting, but a selection of outplanting locations has been guided by chum habitat assessments.

Eyed-egg Outplanting

Outplanting eyed-eggs to a RSI could be a useful way to maximize production from a set number of gametes. Like the hatchery environment, very high survival rates can be obtained, especially in a system with minimal fine sediments and sufficient flow to feed the RSI. This technique also has the advantage of allowing developing fry to imprint on the stream they are outplanted in. In 2014 and 2015, a RSI was set up to incubate, rear, and release chum in Perkins Creek in the Clatskanie River Recovery Population. Egg-to-fry survival for eggs incubated in the RSI was comparable with BCH fry releases (i.e., >90%). Due to poor adult returns to BCH in subsequent years, no additional eyed-egg outplanting occurred until 2022, when eyed-eggs were outplanted to a RSI on Page Creek in the Clatskanie River Recovery Population (egg-to-fry survival was 92%). Egg implanting with an SEPD or incubation of eggs in instream hatch boxes have not been attempted, but these methods remain a possible option pending evaluation of other methods.

Adult Outplanting

Although adult outplanting was not discussed as a release strategy in the CRS, it has several advantages over other potential methods that were identified, including: 1) logistical ease relative to methods that require artificial spawning in the hatchery; 2) the opportunity to

observe spawning habitat selection by outplanted fish; 3) natural mate selection; and 4) potential information about total life cycle survival in reintroduction sites.

As the chum salmon conservation broodstock was being established at BCH, some excess adults were used for experimental outplanting in Stewart Creek (2013–2015) and Graham Creek (2013) in the Clatskanie River Recovery Population. Graham Creek proved to have insufficient spawning habitat, so outplanting efforts ceased after one year. Reintroduction efforts continued in Stewart Creek for three years. The number of chum outplanted to Stewart Creek annually during this period ranged from 16–31 adults. Juvenile out-migrants were produced and freshwater survival was variable but sufficient in some years to reach replacement at project marine survival rates. However, no returning adults were ever observed. Since Stewart Creek was heavily monitored during this period and returning adults would most likely have been encountered, it is more plausible that environmental conditions (freshwater, estuary, or ocean) or the number of outplanted adults was insufficient to produce a sustainable population in Stewart Creek. Adult chum were also outplanted upstream of BCH for several years (2009–2014) to supplement production in the Big Creek Recovery Population. Juvenile monitoring for chum outplanted above BCH showed little to no production and outplanting ceased in 2014.

Beginning in 2020 and continuing through 2022, adult returns to BCH were sufficient to meet broodstock collection goals and allow for more substantial adult outplanting (Table A-II: 2). In the Big Creek Recovery Population, Bear Creek, Little Bear Creek and Gnat Creek were selected for outplanting due to their proximity to BCH, which made outplanting large numbers of fish logistically feasible. Bear and Little Bear Creeks were also chosen because there are small numbers of Chum Salmon already occurring naturally in the system and because juvenile production from outplanted adults can be monitored with a screw trap that has been operated annually on Bear Creek near head of tide since 2017. All three creeks are often surveyed by ODFW's Program to Restore Oregon's Chum Salmon (PROCS) and/or Oregon Adult Salmonid Inventory & Sampling (OASIS) project, so data from outplanted carcasses can be recovered. In the Clatskanie River Recovery Population, adult chum where outplanted to Stewart Creek, Conyers Creek, and the Clatskanie River. Most adults were released in the Clatskanie River system (66-82% of adults outplanted in the recovery population) because it is large, has multiple tributaries with suitable spawning habitat, and provides the opportunity to monitor chum salmon with both spawning ground surveys and a screw trap (annual operation since 2012). Similar to the Big Creek Recovery Population, the OASIS project and PROCS conduct spawning ground surveys in many of these areas to collect data on outplanted fish.

Table A-II: 2. Distribution of outplanted adult chum salmon in the Big Creek and Clatskanie River Recovery Populations from 2020–2022.

Recovery Population	Location	Year	Females	Males	Total
Big Creek	Bear/Little Bear Cr	2020	400	241	641
		2021	353	283	636
		2022	307	172	479
	Gnat Cr	2020	0	0	0
		2021	49	54	103
		2022	28	17	45
Clatskanie River	Clatskanie R	2020	0	0	0
		2021	706	299	1,003
		2022	217	186	403
	Conyers Cr	2020	0	0	0
		2021	120	48	168
		2022	79	67	146
	Stewart Cr	2020	0	0	0
		2021	28	22	50
		2022	26	34	60

Research, Monitoring and Evaluation

Another goal of the CRS is to integrate research, monitoring, and evaluation (RME) into each element of the plan to evaluate successes and failures and to allow for adaptive management. RME needs are defined under three broad program areas: Habitat and Biological Data Programs, Artificial Propagation (Broodstock Programs), and Reintroduction/Outplanting Programs. For each of these programs, RME strategies and specific actions needed to implement the strategy are listed.

Habitat and Biological Data Program RME

Strategy 1: Conduct systematic spawning surveys of LCR tributaries (with emphasis on the Coastal Stratum populations) to identify presence of chum salmon and establish baseline for recovery efforts.

Action 1: *Develop a chum spawning survey sampling plan consistent with spawning survey methodology identified in (ODFW 2007). Include methodology for otolith collection and DNA sampling.*

This action was completed in 2016. The Chum Reintroduction Project Spawning Survey and Adult Trapping Protocol can be found at the following link: https://odfwchum.forestry.oregonstate.edu/reports-presentations.

Action 2: *Implement chum salmon spawning surveys in LCR tributaries to document occurrence, distribution, abundance (peak counts), stock of origin, age structure, and other biological data.*

This action has been completed. From 2012 through 2016, spawning survey sites were generally exploratory in nature (i.e., Scappoose Creek Recovery Population), used to fill in gaps around coho and fall chinook surveys, or selected to monitor high priority streams such as reintroduction sites (e.g., Stewart and Graham Creeks in the Clatskanie River Recovery Population). In 2016, a chum salmon sampling frame was created for the Youngs Bay, Big Creek, and Clatskanie River Recovery Populations, so that population estimates could be generated. The sampling frame included sites accessible to chum salmon with desirable spawning habitat features (i.e., < 1 percent gradient, small gravel, cold water upwelling). Since 2017, sites in the sampling frame have been selected and surveyed by PROCS and OASIS project staff, although returns and carcass recoveries have been too low in most years to produce population estimates. During years of intense outplanting effort by PROCS and generally good returns to the Lower Columbia River (2021–2022) population estimates have been made for the Youngs Bay, Big Creek, and Clatskanie River Recovery Populations (Table A-II: 3). Over the years, some of the selected sites have become inaccessible to chum salmon or the habitat quality has degraded and become unusable for spawning. Conversely, chum salmon have been documented in reaches that have not been included in the sampling frame. This suggests that the spawning survey frame needs to be periodically refined to capture all the potential chum salmon spawning areas in the Coastal stratum.

Table A-II: 3. Population estimates of Chum Salmon from spawning ground surveys conducted in three recovery populations by PROCS and OASIS staff during fall 2021–2022.

Recovery Population	Year	Reaches Surveyed	Total Miles Surveyed	Total Observed Chum Salmon	Population Estimate
Youngs Bay	2021	7	8.96	71	135
	2022	12	12.81	101	106
Big Creek	2021	4	2.89	18	128
	2022	6	5.15	270	641
Clatskanie River	2021	6	5.90	44	64
	2022	7	5.18	76	111

Strategy 2: Evaluate ecological interactions, particularly predation impacts, associated with the reintroduction of chum salmon into LCR Coastal stratum tributaries.

Action 1: *Develop monitoring protocol to assess outmigration distribution and timing of chum fry released from the chum hatchery facility to determine if they occur in freshwater and estuarine areas concurrent with concentrations of other hatchery origin fish, particularly coho and winter steelhead.*

A pilot seining study found that hatchery chum salmon juveniles co-occurred with hatchery coho salmon smolts at all sampled locations. Hatchery chum salmon, perhaps due to their larger size compared to stream raised juveniles, could migrate through the estuary rapidly and were found near Hammond, OR within two days of release.

PROCS research demonstrated that *Ceratonova shasta* causes mortality in juvenile chum salmon at common spore densities and that *C. shasta* distribution overlaps spatially with tributary habitat where chum salmon are extirpated or less abundant (Homel and Alexander 2022). While *C. shasta* is widespread throughout the LCR there may be temporal separation between the parasite and juvenile chum salmon as the *C. shasta* life cycle is temperature dependent. To limit exposure to *C. shasta*, juvenile hatchery releases are done earlier in the year (March/ early April) prior to when the Columbia River reaches 10 °C to limit *C. shasta* interactions.

Action 2: *As a result of, or concurrent with Strategy 2 Action 1, develop a monitoring protocol to assess predation rates of hatchery-origin coho and winter steelhead on chum fry following releases from the chum hatchery facility. Consider evaluating differential mortalities among multiple release strategies varied spatially and temporally.*

This action has not been completed. A pilot seining study performed gastric lavage on a small number of captured Chinook and coho salmon smolts. No identifiable chum salmon predation was observed though the sample size was small.

The hatchery release strategy was modified to avoid predation by hatchery-origin coho salmon and winter steelhead by timing releases to occur at night, on an outgoing tide, and with as much temporal space as feasible relative to the release of other hatchery fish. Large release groups are preferred to maximize predator swamping.

Action 3: *Use information collected in chum salmon spawning and existing spawning surveys for other species, to describe the potential for competition among adult chum, Chinook, and coho for spawning habitat in Clatskanie River and Scappoose Creek recovery populations once return of chum adults begin. Include assessment of potential for redd superimposition (e.g., chum on fall Chinook) and direct competition for space (e.g., chum vs. fall Chinook; chum vs. coho).*

This action has not been initiated.

Strategy 3: As a continuance of chum salmon habitat evaluation sampling protocol continue to evaluate long-term trends in physical habitat and water quality conditions in Clatskanie River and Scappoose Creek Recovery Populations.

Action 1. *Initiate a long-term evaluation of chum habitat conditions in Clatskanie River and Scappoose Creek recovery populations using the habitat assessment methodology established for chum habitat assessment.*

Continuation of habitat evaluation has not occurred, but water temperature has been monitored in the coastal stratum and is used as an indicator for *C. shasta* presence/absence in both the Clatskanie River and Scappoose Creek Recovery Populations.

Action 2: *Use habitat information collected in Strategy 3 Action 1 and spawning survey information to update habitat carrying capacity model and adjust outplanting production schedules as needed.*

This action has not occurred.

Habitat and Biological Data Program RME Summary

Specific studies on predation, competition, or habitat carrying capacity have been limited by the number and distribution of chum salmon on the landscape; however, baseline information has been collected for fry release timing and a spawning ground survey plan has been implemented. A chum salmon spawning protocol was developed based on the chum habitat assessment and existing ODFW Generalized Random Tessellation Stratified (GRTS) surveys. The protocol selects sites based on identified chum salmon spawning characteristics and includes instructions for biological sampling. Although sites have been surveyed since 2017, population size estimates are only available for some of the recovery populations in the Coastal Stratum in 2021–2022. In most years, survey results primarily show adult chum salmon presence/absence on the landscape. Lastly, because of changes in habitat quality or accessibility, some sites within the frame are no longer used for spawning, while other, unrecognized sites often contain adult chum salmon. Periodic refinement of the spawning survey frame may result in better data collection and eventual population size estimation.

As a result of adaptive management, hatchery reared fed-fry are released directly into the Columbia River estuary at night, at temperatures below 10 degrees Celsius and during high tides to reduce mortality. Chum salmon fry distribution is documented by yearly estuary seining by NOAA (Roegner et al. 2020), which has found that hatchery chum salmon captures at downstream sites (e.g., freshwater wetlands and sloughs) were significantly larger that at upriver sites (Figure A-II: 2). The authors also show that chum salmon fry migrate through the LCR to estuarine sites in a matter of days (Table A-II: 3), suggesting that estuarine habitat provides essential support to juveniles before they enter the ocean.

Chum Salmon on the Oregon side of the LCR have some of the lowest smolt to adult survival (SAR) estimates in the western hemisphere. This has led to ecological interactions research focusing on the endemic parasite *C. shasta.* Homel et al. (2022) investigated the distribution, density, and effects of *C. shasta* on chum salmon juveniles in the LCR. The authors show in both laboratory and field studies that juvenile chum salmon have very high mortality rates when *C. shasta* is present during their migration period, suggesting the parasite is a limiting factor for species survival.

There has been no targeted RME on actions to evaluate ecological interactions between chum and other salmonids. The strategy recommends using information collected from habitat assessments and spawning ground surveys to review potential inter-species interactions on the spawning grounds and developing a habitat carrying capacity model. These actions have not been completed but would be useful now that 2020–2022 returns years have provided excess adults for outplanting.

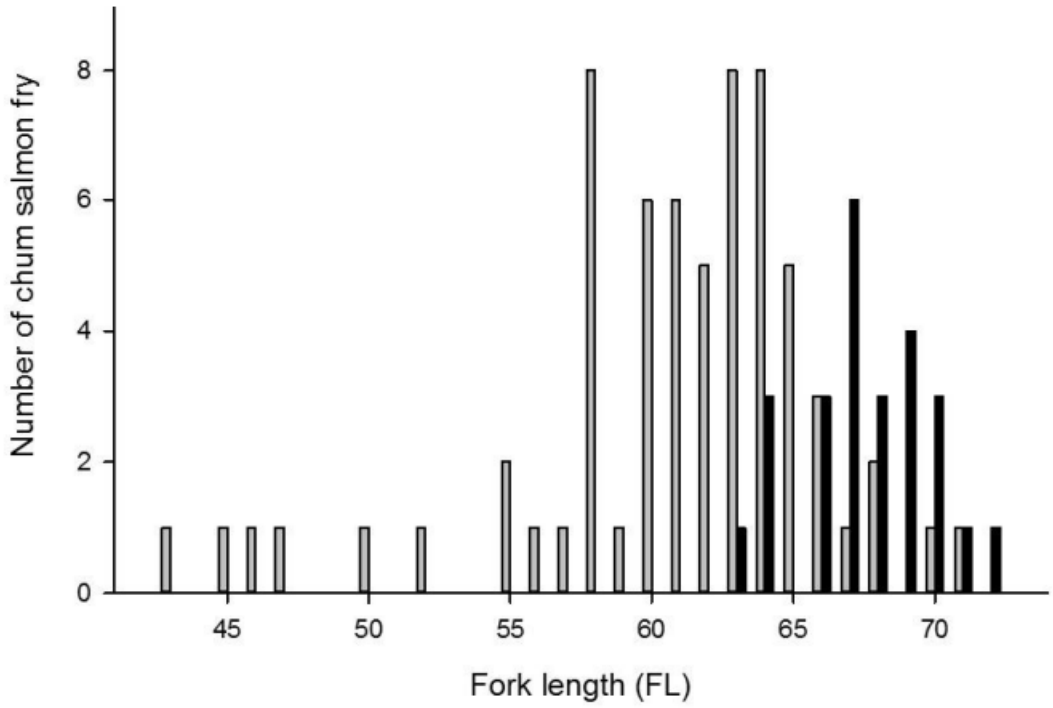

Figure A-II: 2. Length frequency of marked chum salmon (*Oncorhynchus keta*) fry at upriver (Karlson, Minaker, and Russian Islands; gray bars) and downriver (Point Adams Beach; black bars) seine sites in the Columbia River estuary, 16–18 April 2013 (Roegner et al. 2020).

Table A-II: 3. Minimum migration rates (kilometers/hour) of hatchery chum salmon (*Oncorhynchus keta*) fry in the lower Columbia River Estuary, April 16–17, 2013 (Roegner et al. 2020). Migration rates for fish captured on April 18th were not calculated because captured fish could have been released on either April 15th or 17th.

Date	Location	Captured Chum fry	Seine time	Hours since release	Minimum migration rate (km/ h)
16-Apr-13	Minaker Island	8	1200	19.00	0.098
16-Apr-13	Karlson Island	16	1336	20.60	0.091
16-Apr-13	Minaker Island	2	1410	21.17	0.088
17-Apr-13	South Channel	5	0950	40.83	0.228
17-Apr-13	Karlson Island	9	1106	42.10	0.044
17-Apr-13	Karlson Island	9	1339	44.65	0.042
17-Apr-13	Karlson Island	2	1400	45.00	0.042
17-Apr-13	Point Adams Beach	1	925	40.42	0.855
17-Apr-13	Point Adams Beach	15	1135	42.58	0.811

Artificial Propagation (Broodstock Program) RME

Strategy 1: Monitor in-hatchery performance and adult returns at the chum hatchery facility as directed by standards identified in Section 11 of the HGMP for this program.

Action 1: *Monitor attributes and performance of adult chum collected and spawned at the chum hatchery facility by stock of origin (Grays River, WA or Oregon) as described below:*

- *The number of female and male chum salmon collected at adult trap.*
- *Age structure of adult returns as determined by scale analysis.*
- *Origin of adult returns as determined by otolith and/or genetic analysis.*
- *Number of observed pre-spawn mortalities of chum salmon.*
- *Date of entry of chum salmon into hatchery trap (or collected by other means).*
- *Dates of chum salmon spawning.*
- *The number of male and female chum salmon spawned.*
- *Length and weight of females spawned.*
- *Fecundity of females spawned.*
- *Disposition (spawned, stream enrichment, etc.) of adult chum salmon collected.*

All actions are completed on a yearly basis. A compilation of the hatchery results from 2012-2019 can be found in Homel et al. (2021). Results from adult chum salmon spawned at BCH are summarized in annual HGMP reports for NOAA. Annual HGMP reports are available at: https://odfwchum.forestry.oregonstate.edu/reports-presentations.

Action 2: *Monitor attributes and performance of incubating eggs and juvenile chum at the chum hatchery facility (including Grays Stock) as described below:*

- *Monthly number of chum salmon eggs/fish on hand, mortality, feeding rate, and growth.*
- *Results of fish health checks and any incidence of disease occurrence.*
- *Results of water quality sampling.*
- *Collect otolith voucher samples to verify marks.*

All actions are completed on a yearly basis, see ODFW BCH Program Management Plan at https://www.dfw.state.or.us/fish/hatchery/.

Action 3: *Monitor releases of juvenile chum from the chum hatchery facility by stock of origin as described below:*

- *Number of chum salmon released by date.*
- *Fish size at release, average weight, and length frequency distribution.*
- *Location of releases.*
- *Date releases started and ended*

All actions are completed on a yearly basis, see ODFW BCH Program Management Plan at https://www.dfw.state.or.us/fish/hatchery/.

Action 4: *Use information collected from actions 1-3 to determine fry-to-adult survival rates from broodstock program release groups at the chum hatchery facility.*

This action has been completed and is ongoing; see Homel at al. (2021) for a review.

Artificial Propagation (Broodstock Program) RME Summary

From the inception of the program to date, all monitoring and actions identified in the strategy have occurred which has led to an informative evaluation of broodstock performance.

The reason for establishing the BCH broodstock was to create a self-sustaining hatchery population of chum salmon that could be used to support reintroduction efforts on the Oregon side of the LCR. This requires maintaining the conservation broodstock so that > 200,000 fry (ideally >300,000 fry) can be consistently released, while achieving marine survival rates > 0.2 percent so that population growth can occur. In operating this broodstock from 2010 to 2019, variable marine survival has hampered progress towards this goal. If fry release strategies (e.g., timing or fry size) further reduce chum marine survival, efforts have been made to mimic successful methods used in the Grays River program. If poor estuary conditions (e.g., high parasite load or high predation) further reduce chum marine survival, research priorities have been identified to evaluate limiting factors and alternate fry release strategies that could improve survival (e.g., brackish rearing and release). Lastly, if poor ocean conditions further reduce chum marine survival, opportunities to incorporate ocean condition models have been identified to inform fry release timing or reintroduction efforts in a way that maximizes adult returns.

In summary, prior to 2020, the BCH broodstock was not self-sustaining, fry releases were insufficient, and few adults returned to allow for any experimental or full-fledged reintroduction efforts. With a positive turn in ocean conditions and fry-to-adult survival, the broodstock program is now in full production with excess adults available for outplanting in 2020–2022.

Reintroduction/Outplanting Program RME

Strategy 1: Monitor freshwater survival and performance of hatchery fed-fry, direct planted eyed-eggs, and natural production following reintroduction of chum salmon into targeted subbasins.

Action 1: *Develop and implement sampling protocol to monitor freshwater performance, outmigration rates, and life stage specific survival of hatchery and natural origin juvenile chum in basins where reintroduction/outplanting occurs.*

This action has been completed and is ongoing. Smolt traps have been in operation since 2012 and are the primary method of determining freshwater survival and outmigration rates in areas where reintroduction has occurred. Results from these efforts are summarized in ODFW

reports (Wiley and Homel 2020; Homel et al. 2021; Wiley and Homel 2021) available at: https://odfwchum.forestry.oregonstate.edu/reports-presentations.

Strategy 2: Continue to conduct spawning ground surveys with additional emphasis of survey effort on sub-basins targeted for recovery (i.e., Clatskanie River and Scappoose Creek recovery populations).

Action 1: *Develop and implement spawning ground survey sampling protocol to monitor adult returns and track biological parameters. Consider use of mark-and-recapture of adults as needed to estimate total abundance. Assess population parameters in conjunction with results from related actions.*

This action has been completed annually with continued work on survey design and collaboration with other projects to ensure work can be completed concomitant with the effort required for processing broodstock and outplanting adults.

Strategy 3: In conjunction with existing harvest evaluation programs in the Lower Columbia River, monitor commercial gillnet fisheries for incidental harvest of chum salmon, identify harvest rates, and stock of origin.

Action 1: *In conjunction with existing sampling of commercial gillnet fisheries, sample incidentally caught chum for length, scales, otoliths, genetics, area of capture, and date of capture.*

Chum salmon impact rates associated with harvest in the Columbia River fisheries have been determined yearly since 2012 jointly by ODFW and WDFW. Impact rates vary from 0-1.9 percent and for the fall 2022 fishery it was 0.73 percent. Biological sampling of incidentally harvested fish has not occurred by ODFW.

Reintroduction/Outplanting Program RME Summary

Due to low returns to BCH and the need to prioritize maintenance of the conservation broodstock, reintroduction efforts prior to 2020 were limited to small numbers of outplanted adults and a single site for remote site egg incubation. Only in 2020–2022 have adult returns to BCH been large enough for substantial outplanting at multiple locations within selected recovery populations. Monitoring for life stage survival and freshwater performance has occurred (e.g., spawning ground surveys and juvenile trap operation), but evaluation of reintroduction strategies has been limited by inconsistent returns to BCH and the resulting difficulty in consistently implementing any reintroduction strategy over time.

Experimental adult outplanting in Stewart Creek (2013–2015) and Graham Creek (2013) in the Clatskanie River Recovery Population was evaluated with spawning surveys and juvenile traps. The outplanted adults could naturally select mates and spawning areas but traps were installed to prevent outplanted adults from leaving the site. This made it possible to recover most carcasses, count redds, estimate egg deposition and fry production. Fry production was

observed in these Clatskanie River tributaries after outplanting efforts, but overall production varied substantially both among sites and within a site among years. Despite documented fry production, no adults returned in the years expected (2016–2020) from the adult outplanting effort. The lack of returns from adult outplanting could be the result of several factors: 1) fry production was too low to produce returns, especially given observed low marine survival rates in those years; 2) other limiting factors exist in the reintroduction sites or in the migratory corridor to the estuary that cause high mortality either to out-migrating fry or returning adults; or 3) monitoring efforts were not sufficient to detect any returning adults.

In general, outplanting larger numbers of adults appears to correspond with increased juvenile production, although more long-term data is needed for chum salmon in the LCR. This is consistent with the relationship between large spawning aggregations and increased freshwater survival for chum salmon; freshwater survival can increase due to fine sediment being flushed out of spawning gravels when chum salmon spawn in higher densities (Montgomery et al. 1996). However, observed variation in freshwater survival appears to relate to both variation in habitat quality and environmental conditions during egg development, meaning that large numbers of spawning adults may ultimately yield fewer offspring (i.e., low freshwater survival) if habitat conditions are poor. For instance, chum fry outmigration estimates were higher in Bear Creek when fewer adults were outplanted to the system in 2022 compared to 2021 when more adults were outplanted, suggesting that variation in habitat conditions between years were more influential on freshwater survival. Also, the range of freshwater survival estimated at Stewart Creek (7.1–25.3 percent) after outplanting events illustrates that caution should be used when assuming the suitability of a reintroduction site based on limited temporal data. Understanding potential ranges in freshwater survival is critical for identifying habitat restoration needs and for strategically locating reintroduction sites in habitats that will produce maximum returns. Results from experimental adult outplanting were mixed but demonstrated the potential of this reintroduction technique.

Eyed-egg outplanting with the RSI in Perkins Creek produced high egg-to-fry survival for the 2014 and 2015 brood years (93.6 and 94.8 percent, respectively). The only evidence of adult returns from eyed-egg outplanting came from fry captured at a screw trap on the Clatskanie River in 2017 and 2018. Because no adults (parents) were observed in the Clatskanie River, identifying the parentage of collected fry required performing a "grandparents" analysis, where fry genetics were compared to the original adults spawned at BCH (Small et al. 2019). This analysis is much more complicated than a parentage analysis because offspring contain a smaller proportion of shared genes with grandparents (25 percent vs. 50 percent; Small et al. 2019), making relatedness much harder to discern from expected genetic variation. From this genetic analysis, it was determined that 2–6 of the fry captured in 2017 in the Clatskanie River were the progeny of an adult originating from the Big Creek broodstock (Small et al. 2019). The genetic analysis also revealed that all fry captured in 2018 in the Clatskanie River were related to one of the adults spawned in 2014 for eyed egg outplanting in Perkins Creek. These fry would have been offspring of an age-3 return from the first year of outplanting eyed-eggs.

The single putative return from Perkins Creek, while promising, was significantly lower than would be expected given the number of eggs reared in the RSI. Outplanting efforts from

Perkins Creek were approximately half the size of those in Big Creek, and several hundred adults returned from Big Creek outplanting events. The potential return of a single adult suggests that either outplanting efforts at this site would need to be substantially larger (if mortality decreases with larger outplant groups) or that, like Stewart and Graham Creeks, an unidentified limiting factor causes excess mortality in Perkins Creek.

Columbia River Chum Recovery Strategy Update

Based on the preceding review of CRS implementation since adoption of the Plan in 2010, ODFW has identified a new set of recovery strategies and actions for Columbia River Chum Salmon in Oregon. The following section describes overarching strategies and population- and stratum-specific actions in the updated CRS. The CRS will continue to focus primarily on the Coastal stratum with an eye towards future efforts in the Cascade and Gorge strata. The strategies and actions in this update primarily focus on reintroduction efforts in Columbia River tributaries in Oregon. Plan actions to protect and restore habitat in the Columbia River mainstem and estuary are also critical to recovering Columbia River Chum Salmon, including mainstem-spawning populations, and those actions are detailed elsewhere in this assessment.

Strategies

Strategy 1: Maintain a self-sufficient chum salmon conservation hatchery program at BCH that can support substantial outplanting in two Coastal stratum recovery populations.

Strategy 2: Coordinate chum salmon outplanting with effectiveness monitoring to facilitate evaluation and adaptive management.

Strategy 3: Prioritize monitoring of adult chum salmon to evaluate outplanting efficacy, document natural recolonization, and investigate distribution.

Strategy 4: Collect information and develop plans for expansion or transition of recovery actions to the Cascade and Gorge strata.

Actions

1. Big Creek and Clatskanie River Recovery Populations

The Big Creek recovery population is the location of the Conservation Hatchery program at BCH. The primary goal of the Conservation Hatchery program is to maintain a robust broodstock at BCH to support reintroduction efforts. Through the Big Creek Hatchery Chum Salmon Recovery Program HGMP, multiple outplanting strategies are allowed after enough eggs are collected to maintain the brood. Big Creek and Clatskanie River are the two designated recovery populations in the Coastal stratum and will be the focus of outplanting efforts. Outplanting in more than one recovery population: 1) increases the chance of identifying locations where outplanting effectively jump-starts natural production; 2) reduces the logistical challenges of outplanting adults in years with large returns to BCH; and 3) facilitates evaluation of the efficacy of outplanting methods in different environments (e.g., basin size, location, and habitat quality).

Action 1.1: Maintain the Columbia River chum salmon conservation broodstock at BCH. This action is key to all other actions that will be implemented until self-sustaining populations are established in the Coastal stratum. The HGMP will guide collection of adults and eggs at BCH and fry releases will follow established protocol to maximize fry-to-adult survival rates.

Identify criteria that would trigger the end of the program at BCH and/or a transition to another stratum.

Priority: High

Action 1.2: Collect biological samples (tissue, scales, otoliths, etc.) from conservation hatchery broodstock, and other adult chum salmon returning to the hatchery as time and resources allow, to identify natural- and hatchery-origin fish, track age structure and fecundity, determine genetic relationships among returning adults, and facilitate evaluation of outplanting strategies.

Priority: High

***Action 1.3*:** Monitor adult chum salmon returns via spawning ground surveys (SGS). SGS design will be determined by PROCS in coordination with the OASIS project. SGS design will be flexible and consider outplanting locations, staff resources, and other factors. Carcass recovery is a top priority and genetic samples will be collected to evaluate outplanting effectiveness.

Priority: High

***Action 1.4*:** Continue outplanting chum salmon in the Clatskanie River and Big Creek recovery populations for 6-8 years (two chum salmon generations) if adequate adult returns to BCH and other resources necessary for outplanting are available. In the Big Creek recovery population, outplanting efforts will continue to focus on Bear Creek and Little Bear Creek, although other locations will also be considered. Initially, multiple outplanting methods (e.g., adult outplanting; outplanting eyed-eggs in RSIs; direct releases of fed or unfed fry) will be used, but one or more of these methods may be emphasized or discontinued based on initial monitoring results. Otolith thermal marking and/or parentage-based tagging (PBT) will be used to identify outplant groups whenever possible.

Priority: High

***Action 1.5*:** Develop and implement a monitoring plan to evaluate the efficacy of different outplanting methods. Monitoring the effectiveness of these methods is paramount to adaptively managing chum salmon reintroduction efforts within and outside the Coastal stratum. The monitoring plan will primarily focus on the effectiveness of different outplanting methods in producing adult returns but monitoring of other life stages may also occur as resources allow.

Priority: High

***Action 1.6*:** After outplanting chum salmon in the Clatskanie River and Big Creek recovery populations for 6-8 years (two chum salmon generations), review monitoring results with the Chum Work Group and determine whether outplanting will: 1) continue for another 3-4 years

(1 chum salmon generation); 2) pause until additional monitoring data is available; or 3) end in one or both of these recovery populations and shift to other recovery actions.

Priority: High

Action 1.7: Emphasize habitat protection and restoration in the Clatskanie River recovery population and the portion of the Big Creek recovery population where reintroduction efforts are occurring. Provide outreach and education to entities in these watersheds in support of developing restoration projects targeting chum salmon. These same groups could also assist with monitoring chum salmon re-establishment.

Priority: High

***Action 1.8*:** Develop outplanting guidelines based on monitoring results and logistics. The guidelines will provide direction on adult and juvenile outplanting, including location, density of releases, and timing of activities.

Priority: Medium

***Action 1.9*:** Monitor juvenile chum salmon to identify potential limiting factors. Develop an action plan that describes specific goals for juvenile monitoring in collaboration with other organizations conducting research (e.g., estuary sampling) to capitalize on community effort and prioritize limited resources.

Priority: Medium

Action 1.10*:* Evaluate spawning habitat using established methodology every 10 years to assist with development of predictive habitat and carrying capacity models. Evaluate spawning habitat at the sub-basin or reach level following watershed restoration using volunteers for effectiveness monitoring.

Priority: Medium

Action 1.11: Develop recovery criteria. When abundance levels reach a threshold determined by the Chum Work Group, develop recovery scenarios.

Priority: Low

2. Youngs Bay Population

This population is a "control" population that will be used to monitor natural recolonization in the absence of active reintroduction efforts. The Youngs Bay recovery population sits adjacent to Big Creek, the location of the conservation hatchery program. Through monitoring, ODFW can estimate recolonization rates. Monitoring has shown that the Lewis and Clark sub-basin

has some of the best available spawning habitat in the Coastal stratum and is supporting natural chum salmon spawning, especially in strong return years.

***Action 2.1*:** Conduct yearly SGS in the Youngs Bay recovery population using the chum salmon spawning frame. SGS design will be determined by PROCS in coordination with the OASIS project. Collect biological data from carcasses to determine origin, age, and genetic relationships. During high return years, or if resources to conduct surveys are not available, environmental Deoxyribonucleic Acid (eDNA) sampling may be used in place of SGS to monitor adult chum salmon presence and distribution.

Priority: High

Action 2.2: Emphasize the importance of promoting natural recolonization through restoration for this recovery population. Provide outreach and education to entities in the watershed in support of developing restoration projects targeting chum salmon. These same groups could also assist with monitoring chum salmon re-establishment.

Priority: High

Action 2.3*:* Evaluate spawning habitat using established methodology every 10 years to assist with development of predictive habitat and carrying capacity models. Evaluate spawning habitat at the sub-basin or reach level following watershed restoration using volunteers for effectiveness monitoring.

Priority: Medium

Action 2.4: Monitor juvenile fish production using outmigrant traps if resources are available and/or in collaboration with other groups. This data may help inform limiting factors questions and provide long-term trends.

Priority: Low

Action 2.5: Develop recovery criteria. When abundance levels reach a threshold determined by the Chum Work Group, develop recovery scenarios.

Priority: Low

3. Scappoose Population

Action 3.1: Monitor adult chum salmon occurrence within the chum salmon spawning frame as time and resources allow using eDNA, SGS, and public encounters.

Priority: Low

Action 3.2: Consider the importance of promoting natural recolonization through restoration for this recovery population. Provide outreach and education to entities in the watershed in support of developing restoration projects targeting chum salmon, including the potential use of chum salmon spawning channels.

Priority: Low

4. Cascade and Gorge Strata

Although chum salmon reintroduction efforts will continue to focus on the Coastal stratum in the near term, there is also a need to prepare for potential future work in the Cascade and Gorge strata. The following actions are intended to inform and advance future discussions of project expansion or transition into the Cascade and Gorge strata.

***Action 4.1*:** Determine what role spawning channels play in chum salmon recovery efforts.

Priority: High

Action 4.2: Monitor adult chum salmon occurrence in the Clackamas River, Sandy River, Lower Gorge, and Upper Gorge recovery populations using eDNA, SGS, dam counts, and public encounters as time and resources allow.

Priority: Medium

***Action 4.3*:** Develop a chum salmon spawning frame for the Clackamas River, Sandy River, Lower Gorge, and Upper Gorge recovery populations.

Priority: Medium

Action 4.4 Identify a stratum for the next reintroduction effort. Use the Chum Reintroduction Project Habitat Survey Protocol V1 and HIP habitat to assess the amount of high-quality habitat within the stratum populations. Determine which population(s) will be the target for reintroduction and which will be monitored for recolonization.

Priority: Medium

***Action 4.5*:** Investigate potential watersheds and hatchery facilities for a conservation hatchery program in the selected stratum based on rearing capacity, ability to thermally mark otoliths, potential to implement release and outplanting strategies, and other relevant criteria.

Priority: Medium

***Action 4.6*:** Estimate operating costs and personnel needs for development of a new conservation hatchery program for reintroduction in the Cascade or Gorge stratum. Investigate possible funding sources for a second conservation hatchery program.

Priority: Medium

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