HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

Hatchery Program:	**Big Creek Hatchery Chum Salmon Recovery Program**
Species or Hatchery Stock:	**Chum Salmon (ODFW Stock-104)**
Agency/Operator:	**Oregon Department of Fish and Wildlife**
Watershed and Region:	**Lower Columbia River/Big Creek and other tributaries/Oregon**
Submitted to NOAA: **First Update Submitted:**	**January 23, 2013** **August 23, 2016**
Date Last Updated:	**July 25, 2016**

SECTION 1. GENERAL PROGRAM DESCRIPTION

1.1) Name of hatchery or program.

Big Creek Hatchery Chum Salmon Recovery Program.

1.2) Species and population (or stock) under propagation, and ESA status.

Chum Salmon *Oncorhynchus keta* (stock-104) originated from an integrated stock of Grays River wild-origin and hatchery-origin broodstock. On arrival of eyed eggs at Big Creek Hatchery in 2010 from Grays River Hatchery, the ODFW assigned stock number 104 to this Chum Salmon stock. The Columbia River Chum Salmon was listed as Threatened ESU under the federal Endangered Species Act (ESA) in March 1999. The Grays River Hatchery stock is part of the Columbia River chum ESU and is listed under the ESA. Therefore, the Big Creek Hatchery stock of Chum Salmon (stock 104) originating from the Grays River stock is considered to be an ESA listed population.

1.3) Responsible organization and individuals.

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Other agencies, Tribes, co-operators, or organizations involved, including contractors, and extent of involvement in the program:

Grays River Hatchery, Washington Department of Fish and Wildlife (WDFW) – This facility/location served as the original broodstock source for the Big Creek Hatchery Chum Salmon Program. The facility provided adult capture and holding, egg incubation, and otolith marking during the startup phase of this program. Although the intent is to establish a self-sustaining broodstock source in Oregon, the continued cooperation from WDFW Grays River Hatchery will remain a potential contributor to the program if necessary, as determined annually by broodstock needs and availability.

1.4) Funding source, staffing level, and annual hatchery program operational costs.

Big Creek Hatchery is operated by the Oregon Department of Fish and Wildlife, with 7 FTE staff. One of the FTE staff is stationed at Klaskanine Hatchery for assistance at that facility. The annual operational cost for Big Creek Hatchery fiscal year 2015–16 is approximately $987,000. Costs are funded 70% by Mitchell Act funds, and 30% is from state funding sources. The chum program was allocated $39,916 for the recovery program for fiscal year 2015-2016 from the Mitchell Act funding. Big Creek Hatchery is the primary location for brood collection, spawning, incubation, marking, rearing and release activities for this program. These activities may also occur at other sites or locations as outlined in this document or to be determined in the future.

1.5) Location(s) of hatchery and associated facilities.

Big Creek Hatchery, OR: Big Creek Hatchery is located 16 miles east of Astoria, Oregon, 2 miles south of Knappa off Highway 30, and is approximately 3 miles upstream from Big Creek's confluence with the Columbia River. The site is at an elevation of approximately 75 feet above the sea level, at latitude 46^{o} 08' 46" N

(46.1460) and longitude 123º 34' 45" W (123.5806).

Adult trapping, egg incubation, and rearing of chum fry occurs on station at the hatchery facility. Refer to sections 4-9 for details on hatchery facilities. If necessary to meet the goals of the chum reintroduction project, off station sites may be utilized (see note below). Releases of chum fry may occur in Big Creek at the hatchery, or off site lower in Big Creek or other lower Columbia River tributaries as determined by broodstock needs or other elements of the chum reintroduction project.

Alternative Egg Incubation Facilities, Oregon: The program may conduct egg incubation activities at locations other than Big Creek (or Grays River) Hatchery during the implementation of the Chum Recovery Strategy (ODFW 2010) if necessary to meet program goals or as part of research activities associated with the program. Alternative locations could include another hatchery facility (such as Gnat Creek or Klaskanine hatcheries), or remote sites yet to be determined. Alternative methods (hatch boxes, fed or unfed fry out-planting, egg planting) are being used or may also be considered.

Grays River Hatchery, WA: The Grays River Hatchery is located on the West Fork of Grays River, Washington, at RKm 23.3. The following activities may be conducted at this hatchery facility if necessary to meet the goals of the program. Adult collection, egg incubation, and rearing of chum fry occurs at the hatchery facility (brood collection also occurs via net or hook and line in areas downstream of the hatchery). Refer to the Grays River Hatchery Chum HGMP for facility details.

1.6) Type of program.

The Big Creek Hatchery Chum Salmon Recovery Program is part of the Lower Columbia Chum Salmon reintroduction and recovery project. The program is intended to help recover self-sustaining Chum Salmon populations along the Oregon side of the Columbia River. Currently, this is an integrated recovery program incorporating natural origin fish in the broodstock. Refer to Section 6 for more details.

1.7) Purpose (Goal) of program.

The long term goal of the project is to assist with the reintroduction of Chum Salmon to the Oregon side of the lower Columbia River and the establishment of self-sustaining natural populations. In the short term the program is being operated to establish a hatchery Chum Salmon population in Big Creek to provide a source of broodstock for the recovery program. The program releases fed fry into Big Creek to establish a locally adapted chum broodstock. Adults, eggs, and/or fry may be out-planted to other locations as part of the reintroduction or research efforts.

1.8) Justification for the program.

The populations of chum salmon along the Oregon side of the lower Columbia River ESU include Young's Bay, Big Creek, Clatskanie River, Scappoose Creek, Clackamas River, Sandy River, Lower Gorge, and Upper Gorge (ODFW 2010). Multiple smaller tributaries that drain directly into the Lower Columbia River are part of these Chum Salmon populations. Although there may be some remnant chum salmon populations in the lower Columbia River, Chum Salmon are considered to be functionally extirpated from Oregon tributaries of the Columbia River Basin (McElhany et al. 2007; ODFW 2005), which provides a strong justification to operate this recovery program. Therefore, the current program is aimed at reintroduction and reestablishment of self-sustaining populations of Chum Salmon along the Oregon side of the lower Columbia River. The chum reintroduction effort will have minimum adverse effects on other ESA listed salmonids inhabiting the targeted program area and out-migrating through the lower Columbia River, as chum fry typically out-migrate at relatively smaller sizes compared to other listed salmonid smolts. Chum fry released from Big Creek Hatchery may have thermal otolith marks, coded wire tags (CWTs), or other identifying marks to be able to differentiate them from natural origin chum and to facilitate research efforts.

1.9) List of program "Performance Standards".

See Section 1.10.

1.10) List of program "Performance Indicators", designated by "benefits" and "risks."

1.10.1) "Performance Indicators" addressing benefits.

See Table 1.1 for performance indicators addressing benefits

Table 1.1 Program performance indicators with associated benefits

	Benefits	
Performance Standard	**Performance Indicator**	**Monitoring and Evaluation**
Develop locally adapted chum broodstock.	Collect up to 600,000 eggs annually. Release up to 300,000 fed fry annually in Big Creek. Additional fry may be out-planted to other lower Columbia tributaries (number TBD).	Quantify egg take and fry release numbers from Big Creek Hatchery. Record adult returns to Big Creek Hatchery.
Adults/eggs/fry out-planting are carried out in tributaries and locations suitable for Chum Salmon spawning and rearing.	Out-plant adults/eggs/fry into suitable habitats that will be selected through identifying current habitat conditions and modeling attributes that comprise high quality habitat.	Document numbers of adults/eggs/fry out-planted at different tributaries and locations. Monitor returning adults in locations where reintroduction occurred through adult trapping and/or spawning ground surveys. Monitor returns into other systems through spawning ground surveys and/or carcass recovery/sampling. Also, monitor juvenile production as a result of adult or egg outplanting.
Hatchery released chum are identifiable.	All hatchery releases will have thermal otolith marks, CWT marks, fin clips, or other identifying marks	Estimate mark retention rates prior to release.
Restore self-sustaining naturally spawning chum populations.	Presence of naturally-produced adult chum salmon on the Oregon side of the Lower Columbia River.	Monitor adult returns in tributaries with adult traps and/or conduct spawning ground surveys, if sufficient funding is available.
Program is self-sufficient with locally adapted chum broodstock.	Enough eggs are taken annually from broodstock returning to Big Creek Hatchery to meet release goals.	Broodstock holding, adult survival and spawning data including fecundity and egg/fry survival are monitored to ensure that production goals are met.
Conduct natural production M&E to improve program performance.	Develop comprehensive M&E plan for natural spawning and fry out-migration in chum reintroduced tributaries.	Conduct M&E tasks that may be outlined or suggested by the Re-introduction Plan or the Chum Recovery Workgroup.
Achieve within hatchery performance measures.	IHOT standards & ODFW policies (Fish Hatchery Management and Fish Health Management) are met.	Rearing and fish health parameters are monitored to ensure that fish culture standards are met.

1.10.2) "Performance Indicators" addressing risks.

See Table 1.2 for performance indicators addressing risks.

Table 1.2 Performance indicators with associated risks

	Risks	
Performance Standard	**Performance Indicator**	**Monitoring and Evaluation**
Minimize impacts to ESA listed and other native species from enumeration and broodstock collection activities.	Level of trapping and handling mortality of coho salmon and other wild ESA listed stocks at Big Creek Hatchery and other traps.	Handling mortalities will be enumerated and steps taken to reduce mortality, if necessary.
Minimize impacts to ESA listed and other native species from disease transmission.	Program will be in compliance with the ODFW Fish Health Management Policy and fish transfer guidelines.	ODFW pathology will examine the fish regularly and prior to transfer or release.
Minimize impacts to ESA listed and other native species from hatchery-produced fry releases.	Released chum fry outmigrate quickly.	Chum fry will be released at a size and at locations and times that facilitates quick outmigration to minimize competition.
Comply with the Oregon Water Quality Standards for hatchery effluents.	Hatchery is operated in compliance with the NPDES permit requirements.	Monitor water quality parameters and results are reported to Oregon Department of Environmental Quality.

1.11) Expected size of program.

This program may collect up to 600,000 eggs for production needs.
Approximately 300,000 fry can be reared and marked at Big Creek Hatchery.

Currently the release is approximately 200,000 fed fry. When sufficient brood is available, the release goal may increase to 300,000 fed fry. Approximately 100,000 eggs are currently utilized for out-planting to remote sites. The number of eggs and/or fry out-planted may be increased to accommodate reintroduction needs, up to a combined total of 600,000. Additional eggs may be taken and/or fry reared if necessary to meet reintroduction or research related goals. Alternative egg or fry rearing locations may be utilized as needed to meet program goals.

1.11.1) Proposed annual broodstock collection level (maximum number of adult fish).

Approximately 240 pairs (240 males and 240 females) are needed for broodstock. Actual numbers may vary depending on fecundity, survival, or changing program needs. Additional broodstock may also be collected for egg and/or fry production for outplanting and adult outplanting for natural production to different tributaries.

1.11.2) Proposed annual fish release levels (maximum number) by life stage and location.

Annual fish release levels are presented in Table 1.3.

Table 1.3. Proposed annual releases.

Life Stage	Release Location	Annual Release Level
Eggs (out-planting)	Eggs out-planting sites include Perkins Creek and Stewart Creek (Figure 1). Maintenance of these sites or selection of replacement or additional sites will be determined by the Chum Recovery Workgroup. (Tributaries to Youngs Bay will be considered for egg out-planting depending on the population status of the area as well as disturbances due to existence commercial fishery).	Release goals are determined by the availability of excess eggs at Big Creek Hatchery, recovery goals for the target stream, and the current level of natural production in that stream. As such, release goals are determined by the Chum Recovery Workgroup, subject to the constraints listed above. Up to 100,000 eggs are currently out-planted annually. This number may increase to meet reintroduction needs.
Unfed Fry (out-planting)[1]	TBD[2]	TBD[2]
Fed Fry (Future Broodstock) [1]	Big Creek	Up to 300,000
Fed Fry (out-planting) [1]	TBD[2]	TBD[2]
Fingerling	None	--
Adult (out-planting)	Adult out-planting sites have included Graham Creek, Stewart Creek, Big Creek, Little Creek, and Bear Creek. Maintenance of these sites or selection of replacement or additional sites will be determined by the Chum Recovery Workgroup.	Release goals are determined by the carrying capacity of each site, number of chum collected at Big Creek Hatchery, fecundity, and level of natural production in a site. Site carrying capacity is currently being evaluated and release goals are determined by the Chum Recovery Workgroup, subject to the constraints listed above.

Notes:

1) Fry release numbers may increase in the future depending on chum salmon reintroduction/recovery requirements for adults, eggs, and fry productions. Egg take may be as high as 600,000 eggs.
2) TBD means to be determined annually based on the results of monitoring and evaluation of potential chum habitat and reintroduction techniques. Guidelines will be provided by the Chum Salmon Recovery Workgroup.

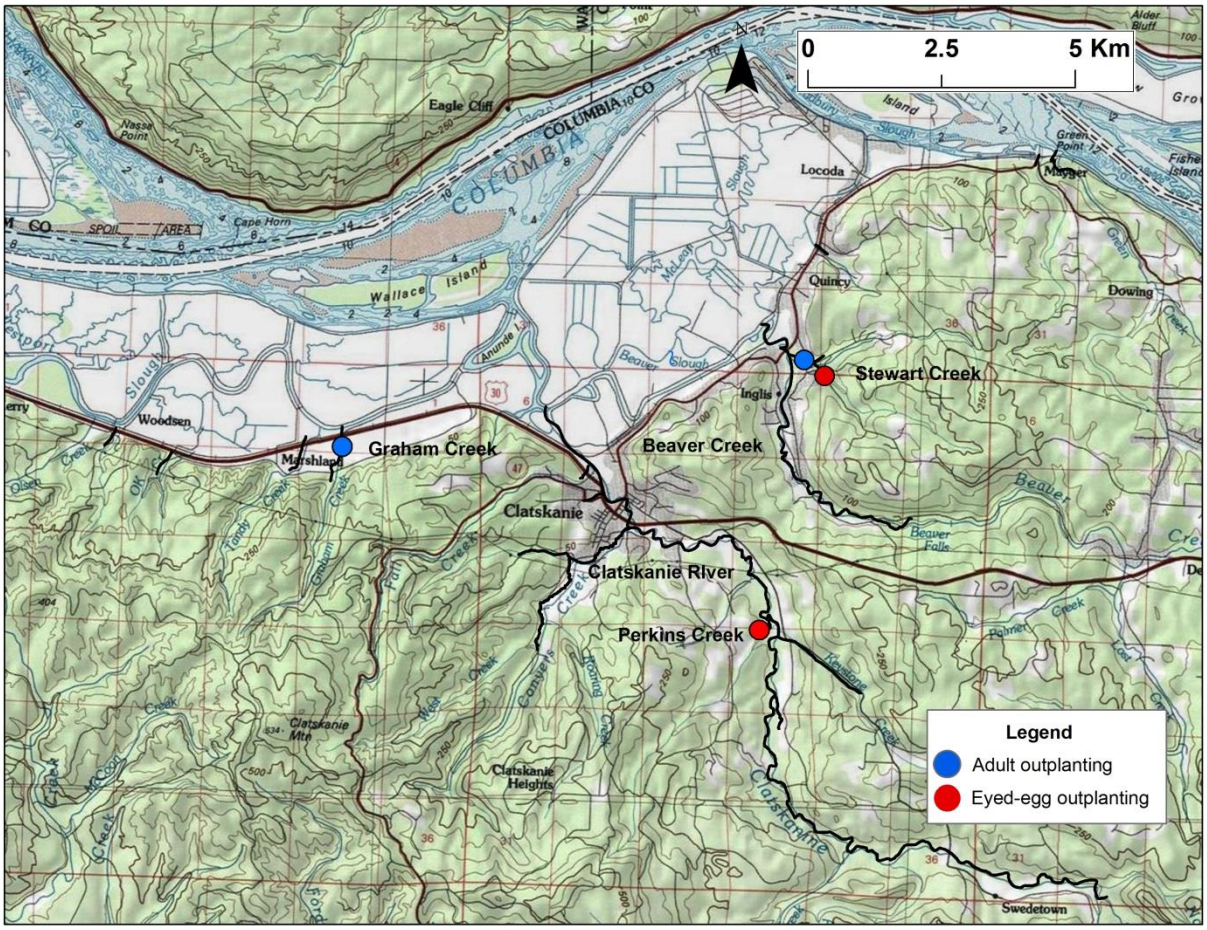

Figure 1. Map showing Chum Salmon eyed-eggs and adult out-planting tributaries.

1.12) Current program performance, including estimated smolt-to-adult survival rates, adult production levels, and escapement levels. Indicate the source of these data.

The first release of hatchery Chum Salmon fry into Big Creek began in 2011. From 107,000 fry released, 43 age-3 and 55 age-4 hatchery adults returned to Big Creek Hatchery. Data are not available on the number of age-5 hatchery adults that returned in 2015, and therefore estimates of marine survival and brood year escapement are not available. Other reintroduction activities are ongoing, but adults have not returned from those efforts and no estimate of adult production can be made at this time.

1.13) Date program started (years in operation), or is expected to start.

The program started with the 2010 brood year. The first release of hatchery Chum Salmon fry occurred in April, 2011.

1.14) Expected duration of program.

The Chum Salmon recovery program using Big Creek Hatchery has recently developed stock as a component of the Lower Columbia Chum Reintroduction Project. The program is ongoing and is expected to continue as long as is necessary to meet the goals of this program.

1.15) Watersheds targeted by program.

The program targets watersheds in the lower Columbia River as outlined in the Chum Recovery Strategy (ODFW 2010). This includes, but is not limited to, the Big Creek, Gnat Creek, Bear Creek, Youngs Bay (and tributaries), Clatskanie, and Scappoose basins, and other tributaries on the Oregon side of the river.

1.16) Indicate alternative actions considered for attaining program goals, and reasons why those actions are not being proposed.

Alternative 1. *Allow Chum Salmon to naturally migrate and spawn in streams within the lower Columbia River watershed without any hatchery intervention:* Chum Salmon have been functionally extirpated from many locations on the Oregon side of the Columbia River for many years. Despite other populations present within the lower Columbia River (for example Grays River on the Washington side), chum have not naturally re-colonized available habitat within the Oregon portion of the lower Columbia River. Although occasional reports of adult and juvenile Chum Salmon have been received, no self-sustaining populations have become established. Therefore this alternative is not considered viable at this time.

SECTION 2. PROGRAM EFFECTS ON ESA-LISTED SALMONID POPULATIONS.

2.1) List all ESA permits or authorizations in hand for the hatchery program.

This program is a component of the Chum Recovery Strategy (ODFW 2010) that was approved by NMFS as part of the federal recovery plan for listed salmon and steelhead in the lower Columbia River. Currently, there is no written authorization in hand for the take of listed fish. The NMFS supports this Chum Salmon reintroduction effort, through participation and cooperation with the Chum Salmon Recovery Workgroup. And ODFW submitted the HGMP for Big Creek Hatchery Chum Salmon recovery program to NMFS on 01/23/2013 for ESA permit or take authorization. This is an updated version of the previously submitted HGMP.

2.2) Provide descriptions, status, and projected take actions and levels for ESA-listed natural populations in the target area.

2.2.1) Description of ESA-listed salmonid population(s) affected by the program.

- Identify the ESA-listed population(s) that will be directly affected by the program.

Lower Columbia River Chum Salmon of both wild- and hatchery-origin are ESA listed populations. These populations will be directly affected while taking these fish during broodstock collection or when handled in other research activities (such as downstream migrant traps). Previous reports and current spawner surveys suggest that chum are functionally extirpated within the sub-basins targeted for reintroduction (McElhany et al. 2007; ODFW 2005).

- Identify the ESA-listed population(s) that may be incidentally affected by the program.

The lower Columbia wild Coho Salmon and fall Chinook Salmon may be incidentally affected by the Chum Salmon hatchery program and reintroduction efforts. Wild Coho Salmon and fall Chinook Salmon may be handled during chum brood collection or juvenile sampling activities.

Other listed salmonid species (Lower Columbia steelhead, Middle Columbia steelhead, Upper Willamette steelhead and Chinook Salmon, Snake River Spring/Summer and Fall Chinook Salmon) may be present within the range of lower Columbia River chum and may be incidentally affected by the program (likely to be affected primarily through interactions with hatchery chum juveniles). Effects are expected to be very minimal on these populations.

Other species of ESA listed fish, including Green Sturgeon and eulachon are also present in the lower Columbia River, but effects from this Chum Salmon re-introduction program on these species is assumed to be minimal to non-existent, based on temporal migration differences and preferred habitat needs while in the estuary.

2.2.2) Status of ESA-listed salmonid population(s) affected by the program.

- Describe the status of the listed natural population(s) relative to "critical" and "viable" population thresholds.

The Willamette/Lower Columbia Technical Recovery Team (WLC-TRT) has not determined critical and viable population thresholds for the Oregon lower Columbia fall Chinook, chum, or coho populations in the vicinity of the Big Creek Chum salmon program. However, the WLC-TRT has established "default

value" minimum population viability criteria of 1,400 for ChinookSalmon and 1,100 for Chum Salmon for use as a general value for lower Columbia fall Chinook and chum populations. A default minimum viable population criterion has not been identified by the WLC-TRT for coho, although the Lower Columbia Recovery Board (LCFRB) has assumed a value of 600 for Washington lower Columbia coho populations. This is the same criterion identified by the WLC-TRT for lower Columbia steelhead.

The WLC-TRT and ODFW have both assessed the current viability status of salmon and steelhead populations in the lower Columbia ESUs. Both assessments used the same persistence probability criteria to estimate extinction risk for each population. To estimate the extinction risk, four key attributes were evaluated: 1) abundance and productivity; 2) diversity; 3) spatial structure; and 4) habitat. The populations were ranked from 0-4, with category 0 representing a 0-40% chance of persistence in the next 100 years and category 4 representing a 99 percent chance of persistence in the next 100 years. A population was considered viable with a category 3, or higher, score. The status assessment includes fall Chinook, coho, and chum populations in Youngs Bay tributaries, Big Creek, Scappoose Creek, and the Clatskanie River. The persistence probability scores of both the WLC-TRT and ODFW are reflected as a range (Figure 1). The scores for fall Chinook are generally low ranging from 1-2, for chum very low at less than 1, and for coho low from 1 to 2.

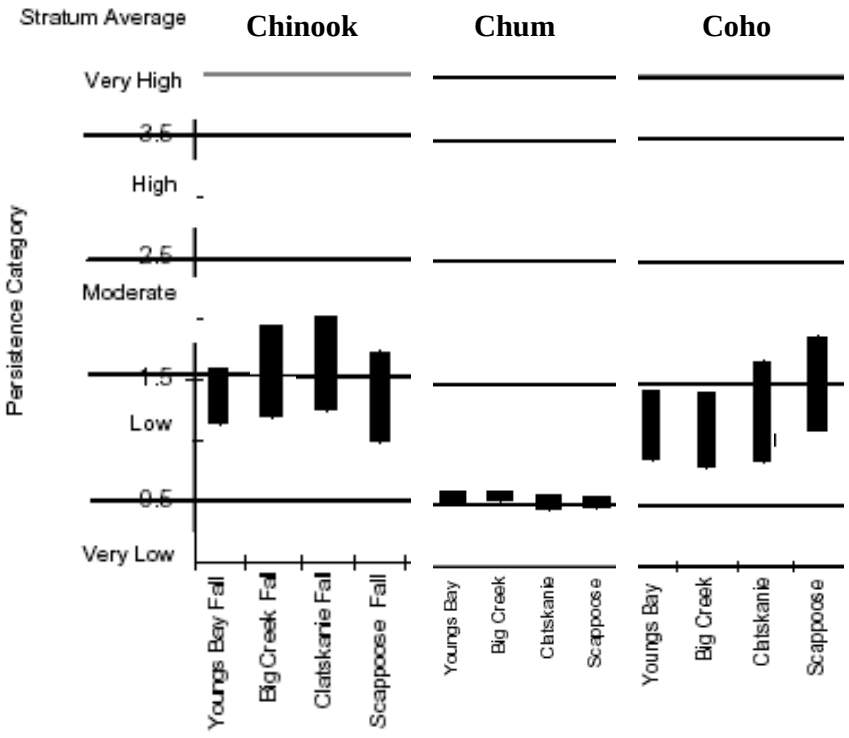

Figure 1. Current viability status of fall Chinook Salmon, Chum Salmon and Coho Salmon populations in Youngs Bay, Big Creek, Clatskanie River, and Scappoose Creek. Figure adapted from McElhany et al. (2004).

- Provide the most recent 12 year (e.g. 1988-present) progeny-to-parent ratios, survival data by life-stage or other measures of productivity for the listed population. Indicate the source of these data.

Very little data exists in regards to survival, productivity or abundance of the listed natural population of Chum Salmon in Big Creek. Limited survey occurred between tidewater and the hatchery rack (i.e., downstream of the hatchery), which recorded the peak counts of Chum Salmon in the area but not the total counts. Consequently, the peak counts may not match the total numbers of Chum Salmon returns to Big Creek Hatchery. Observed peak count data from spawning surveys in Big Creek (from head of tide upstream to the hatchery weir) are presented in Table 2.1.

Table 2.1. Peak counts of spawning Chum Salmon in Big Creek, 2002-2015

Spawning Year	Stream	Adult Chum Peak Count
2002	Big Creek	0
2003	Big Creek	1
2004	Big Creek	1
2005	Big Creek	0
2006	Big Creek	0
2007	Big Creek	0
2008	Big Creek	0
2009	Big Creek	1
2010	Big Creek	0
2011	Big Creek	1
2012	Big Creek	16
2013	Big Creek	6
2014	Big Creek	23
2015	Big Creek	68

Returns of Chum Salmon and natural Coho Salmon adults to Big Creek Hatchery are presented in Table 2.2.

Table 2.2. Chum and wild Coho Salmon escapement into Big Creek Hatchery, 1990-2015. Beginning in 2013, Chum Salmon adults could be hatchery origin (H) or unmarked (putative wild origin; W).

Run Year	No. of Chum at Big Creek Hatchery Trap	No. of Wild Coho at Big Creek Hatchery Trap*
1990	10	
1991	3	
1992	2	
1993	1	
1994	6	
1995	0	
1996	0	
1997	3	
1998	3	
1999	0	
2000	0	
2001	4	18
2002	0	55
2003	27	331
2004	24	128
2005	9	201
2006	192	252
2007	1	225
2008	3	246
2009	22	515
2010	23	275
2011	4	168
2012	37	215
2013	43 (H); 15 (W)	251
2014	165 (H); 135 (W)	644
2015	163 (H); 87 (W)	88

Source: Big Creek Hatchery. *No coho were passed above hatchery barrier prior to run year 2001.

In addition, adult chum have been observed on various spawning surveys on occasion. Observations have been recorded in the Lewis and Clark River, Klaskanine River, Bear Creek and Little Creek.

Some limited data on egg to fry survival is available from monitoring efforts associated with adult chum released to spawn naturally (Table 2.3).

Table 2.3. Estimated egg to fry survival of naturally spawning Chum Salmon fry in Big Creek observed during 2006, 2012, and 2014 brood years survey.

Brood Year	Location	Males	Females	Estimated fry	Estimated egg to fry survival
2006	Bear Creek	25	25	240	0.38%
2012	Big Creek	13	24	228	0.38%
2014	Big Creek	68	63	13,264	8.60%

- Provide the most recent 12 year (e.g. 1988-1999) annual spawning abundance estimates, or any other abundance information. Indicate the source of these data. (Include estimates of juvenile habitat seeding relative to capacity or natural fish densities, if available).

Natural spawning escapement estimates for fall Chinook Salmon in Big Creek, Plympton Creek, and other Lower Columbia River tributaries in Oregon are shown in Table 2.4 and abundance indicators for coho and chum in Big Creek is shown above in Table 2.2.

Table 2.4. Fall Chinook Salmon aggregate natural spawning escapement estimates for select lower Columbia River sub-basins (1990-2015), as well as Plympton Creek and Big Creek (1998-2015).

Run Year	Lower Columbia Tributaries[a]	Plympton Creek			Big Creek	
		LRH[b]	BUB[c]		LRH[b]	SAB[d]
1990	2,545	na	na		na	na
1991	1,712	na	na		na	na
1992	2,230	na	na		na	na
1993	2,225	na	na		na	na
1994	5,189	na	na		na	na
1995	3,906	na	na		na	na
1996	2,307	na	na		na	na
1997	2,175	na	na		na	na
1998	1,206	545	0		461	8
1999	2,057	1,085	44		725	6
2000	2,843	1,158	0		1,197	61
2001	11,651	3,908	0		7,227	7
2002	22,685	10,071	0		11,677	0
2003	30,036	9,393	0		19,308	0
2004	12,225	5,060	0		5,970	0
2005	7,464	2,620	0		4,220	0
2006	1,140	391	0		153	0
2007	1,341	451	0		304	0
2008	6,593	1,108	0		4,772	0
2009	5,326	2,118	0		2,028	0
2010	10,895	3,430	0		6,574	87
2011	8,090	3,289	0		2,682	0
2012	7,038	1,819	2[e]		1,396	0
2013	4,818	1,591	12[e]		664	130
2014	6,931	2,745	2[e]		1,442	9
2015	4,325	2,038	0		749	0

[a] Expanded spawning ground surveys for nine Oregon lower Columbia River tributaries; South Fork Klaskanine, North Fork Klaskanine, Lewis and Clark River, Youngs River, Bear Creek, Big Creek, Plympton Creek, Gnat Creek, and Clatskanie River. Numbers include jacks (Source: WDFW Fall Chinook Big Sheets).
[b] LRH = Lower River Hatchery stock (hatchery tules).
[c] BUB = Bonneville Upriver Bright stock (stock destined for the Mid-Columbia River above Bonneville Dam).
[d] SAB = Select Area Bright stock.
[e] SAB's

- Provide the most recent 12 year (e.g. 1988-1999) estimates of annual proportions of direct hatchery-origin and listed natural-origin fish on natural spawning grounds, if known.

The hatchery program for Chum Salmon reintroduction and recovery began with the first fry release of Chum Salmon into Big Creek in 2011. Age 3 adults from

this release returned to Big Creek in the fall of 2013. Early estimates of hatchery-origin chum on natural spawning grounds are based on (1) recovery of CWT fish in Oregon on spawning surveys, and (2) recovery of CWT fish (or fish with thermal marks on the otoliths that correspond to Big Creek) on surveys in Washington. These estimates are incomplete because they do not include data for all potential age classes that could spawn. Also, estimates of hatchery origin chum in natural spawning areas in Oregon are only based on recovery of CWT. Examination of otoliths from carcasses may reveal additional hatchery chum spawning naturally (i.e., from Chum Salmon that lost their CWT). See table 2.5 for details.

Table 2.5. Recoveries of hatchery origin adult Chum Salmon in Oregon and Washington, 2010-11 brood years.

Brood Year	Returns to Big Creek Hatchery	Hatchery Recoveries in WA	Hatchery Recoveries in OR
2010	Age-3 (n = 43) Age-4 (n = 55) Age-5 (n = 42; data are provisional)	Age-3 (n = 27) Age-4 (n = 121) Age-5 (n = 0)	Age-3 (n = 0) Age-4 (n = 2) Age-5 (n = 0)
2011	Age-3 (n = 107) Age-4 (n=113; data are provisional) Age-5 (have not returned yet)	Age-3 (n = 17) Age-4 (n=50) Age-5 (have not returned yet)	Age-3 (n = 0) Age-4 (n = 0) Age-5 (have not returned yet)
2012	Age-3 (n = 3; data are provisional) Age-4 (have not returned yet) Age-5 (have not returned yet)	Age-3 (n = 0) Age-4 (have not returned yet) Age-5 (have not returned yet)	Age-3 (n = 0) Age-4 (have not returned yet) Age-5 (have not returned yet)

2.2.3) Describe hatchery activities, including associated monitoring and evaluation and research programs, that may lead to the take of listed fish in the target area, and provide estimated annual levels of take

- Describe hatchery activities that may lead to the take of listed salmonid populations in the target area, including how, where, and when the takes may occur, the risk potential for their occurrence, and the likely effects of the take.

1) *Water Withdrawal/Effluents for Hatchery Operations*: Hatchery operations may impact listed salmonids through water withdrawal, hatchery effluents, intake structures etc., but continuous monitoring and proper facility maintenance are conducted by hatchery staff to minimize the impacts. Indirect take of listed salmonids due to these activities is unknown.

2) *Brood Collection:* Intentional or incidental take of Columbia River Chum or incidental take of the lower Columbia River Chinook Salmon, or lower Columbia River Coho Salmon may occur during Chum Salmon brood collection activities. It is expected that broodstock would be collected through volitional return of adults to the trap at the Big Creek Hatchery; however other sources of brood and collection techniques may be utilized if necessary. As a result, the take of listed natural chum, coho, or Chinook trap would be limited to potential handling mortality. It is unlikely that other listed species would enter the hatchery trap, but if this occurred they would be subject to the same risk during handling in the hatchery trap.

3) *Competition for Food and Space:* Incidental take of fry/juveniles of the lower Columbia River Chinook, Columbia River chum, steelhead or lower Columbia River coho may occur due to competition between hatchery-released chum fry and naturally-produced fry/smolts in Big Creek, the lower Columbia River and the estuary, but these effects are expected to be minimal due program size, smaller size of chum fry at release and release strategy.

4) *Disease and Habitat Carrying Capacity:* Rearing of fish in the hatchery environment provides some level of risk associated with disease and disease transmission. This is expected to be minimized by hatchery procedures used to treat and control a variety of diseases present. Habitat carrying capacity can be a concern in some instances. Due to a short residency time and younger migration age, interactions between chum and naturally produced listed salmonids are likely to be negligible. Chum Salmon habitat is very likely underutilized as natural production is very low currently, and few juveniles are available to fill this niche.

- Provide information regarding past takes associated with the hatchery program, (if known) including numbers taken, and observed injury or mortality levels for listed fish.

Small numbers of Chum Salmon have been collected annually at the Big Creek Hatchery trap. Prior to adults returning from hatchery releases, all adults were released to spawn naturally (Table 2.6).

Table 2.6. Disposition of returning unmarked adult Chum Salmon collected at Big Creek Hatchery.

Return Year	Unmarked Return #	Unmarked Return Disposition
2003	27	•Released into Little Creek
2004	24	•Released into Little Creek
2005	9	•Released into Little Creek
2006	198	•50 released into Bear Creek •148 released into Little Creek
2007	1	•Released into Bear Creek
2008	3	•Released into Bear Creek
2009	22	•Transported above Big Creek Gorge and released
2010	26	•Transported above Big Creek Gorge and released
2011	4	•Transported above Big Creek Gorge and released
2012	37	•Transported above Big Creek Gorge and released
2013	15	•Transported above Big Creek Gorge and released
2014	135	•Transported above Big Creek Gorge and released
2015	87	•74 spawned at Big Creek •11 out-planted in Stewart Creek •2 mortality

- Provide projected annual take levels for listed fish by life stage (juvenile and adult) quantified (to the extent feasible) by the type of take resulting from the hatchery program (e.g. capture, handling, tagging, injury, or lethal take).

Projected annual take estimates for the Lower Columbia ESUs are provided in Table 2.7.

Table 2.7. Estimated annual take of the lower Columbia River listed salmonids due to Chum Salmon reintroduction and recovery program. Take of fry and smolts would usually occur from February 1 to June 30 during program monitoring activities. Take of adults would occur typically from October 1 – December 31 due to brood collection and adult monitoring.

Action	Lower Columbia Chinook		Columbia Chum		Lower Columbia Coho	
	Life stage	Estimated Annual take	Life stage	Estimated Annual take	Life stage	Estimated Annual take
Observe or harass						
Collect for transport			Adult	10-500[a]		
Capture, handle, and release	Fry	15,000	Fry	35,000	Fry Smolt Adult	100,000 25,000 100
Capture, handle, tag/mark/tissue sample, and release	Fry Adult	10,000 500	Fry Adult	15,000 50-2500[a]	Fry Smolt Adult	25000 15,000 800
Capture and remove (e.g., broodstock)			Adult	500[b]		
Intentional lethal take			Fry	150		
Unintentional lethal take	Fry Adult	750 5	Fry Adult	3,100 35	Fry Smolt Adult	3750 400 8
Other take (specify)						

Notes:

[a]Numbers of marked and unmarked adults collected (and potentially marked and tissue sampled) and transported to outplanting sites will vary depending on annual returns to the hatchery or to re-introduction sites. The number is expected to increase as recovery progresses and population abundance increases.

[b]Numbers of chum broodstock shown in the above table include both hatchery-origin and unmarked (putative wild) adults, and these numbers will increase as reintroduction efforts get underway.

- Indicate contingency plans for addressing situations where take levels within a given year have exceeded, or are projected to exceed, take levels described in this plan for the program.

Procedures for brood collection, juvenile trapping, or other activities associated with the hatchery and the chum reintroduction project will be modified immediately if take exceeds, or is projected to exceed, levels prescribed in this plan. This includes, but is not limited to, changes in hatchery operation and/or research efforts, or cessation of activities as warranted to remain within take limits.

SECTION 3. RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1) Describe alignment of the hatchery program with any ESU-wide hatchery plan (e.g. *Hood Canal Summer Chum Conservation Initiative*) or other regionally accepted policies (e.g. the NPPC *Annual Production Review* Report and Recommendations - NPPC document 99-15). Explain any proposed deviations from the plan or policies.

This program has been undertaken in accordance with the Oregon Columbia River Chum Salmon Recovery Strategy, described in the *Chum Recovery Strategy (ODFW 2010).*

3.2) List all existing cooperative agreements, memoranda of understanding, memoranda of agreement, or other management plans or court orders under which program operates.

(1) The Native Fish Conservation Policy, ODFW, 2003.
(2) Fish Health Management Policy, ODFW, 2003.
(3) Fish Hatchery Management Policy, ODFW, 2003.
(4) NPDES Permit for Big Creek Hatchery operations.
(5) Integrated Hatchery Operations Team (IHOT)- Policy and Procedures for Columbia Basin Anadromous Salmonid Hatcheries.
(6) Draft MOA between ODFW and WDFW regarding broodstock collection, thermal otolith marking and egg shipment.

This HGMP is consistent with these plans and commitments, as well as with the *Chum Recovery Strategy (ODFW 2010).*

3.3) Relationship to harvest objectives.

Chum Salmon populations in the lower Columbia River comprise a single ESU, which was listed as threatened in 1999. The aim of this program is to reintroduce and reestablish self-sustaining populations of Chum Salmon along the Oregon side of the lower Columbia River Basin. This program is not producing fish for harvest. ESA-listed chum are intercepted in fisheries in the lower Columbia River. The NOAA-authorized take level is 5% of the estimated chum return under the Fishery Management Plan for these fisheries (Geoffrey Whisler, ODFW, personal communication). All Chum Salmon captured in these fisheries must be released.

3.3.1) Describe fisheries benefitting from the program, and indicate harvest levels and rates for program-origin fish for the last twelve years (1988-99), if available.

This is a reintroduction and recovery program for the extirpated Chum Salmon

along the Oregon side of the lower Columbia River. No targeted harvest of chum occurs. Therefore, this program will not offer any harvest benefits.

3.4) Relationship to habitat protection and recovery strategies.

The Big Creek Hatchery Chum Salmon program is a component of the *Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead (ODFW and NMFS 2010).* This program will be implemented as per Oregon's Columbia River Chum Salmon Recovery Strategy, to reintroduce hatchery-origin chum salmon to help re-establish self-sustaining runs of chum due to habitat loss, habitat degradation, and loss of connectivity are likely major factors associated with extirpation of chum salmon from these watersheds, and consequently lack of natural re-colonization. Habitat improvement measures may be undertaken in the future if adequate funding is available and opportunities present themselves, although this is not the primary focus of the project.

3.5) Ecological interactions.

(1) Interactions with species that could negatively impact program:

Chum salmon fry are released at a relatively smaller size compared to outmigrating smolts of other species that are either produced naturally or released from fish hatcheries. Consequently, the outmigrating chum fry of the program may be vulnerable to large groups of predators. These predators could be of varieties of freshwater and marine species residing in or migrating through the Columbia River and estuary corridors, including but not limited to Coho Salmon, steelhead, Northern Pikeminnow, Smallmouth Bass, seagulls, double-crested cormorants, Caspian terns, pinnipeds, and hatchery released Coho and Chinook Salmon, and steelhead smolts which may significantly reduce the overall survival rates of Chum Salmon. To minimize the predation effects, chum fry may be reared at the hatchery until they reach the target size for release which should improve their ability to escape predators and out-migrate quickly. Also, releases of chum fry may occur late in the day or in the evening, which may reduce their visibility to predators and allow them to escape predation during initial migration under the cover of darkness.

(2) Interactions with species that could be negatively impacted by program:

Chum salmon reintroduction is a small program compared to other harvest hatchery programs. Since chum salmon fry are smaller in size at release it is expected that other species may not be negatively impacted by the Chum Salmon program. It is not known whether chum releases from the hatchery could negatively impact the very few naturally produced fry of Chum Salmon within the area. However, the listed naturally-produced juvenile salmonids using the lower Columbia River estuary may be affected by releases of Chum

Salmon due to food competition with chum fry that may occur in primarily shallow habitats in the estuary for three to four weeks (Curtis Roegner, NOAA, personal communication). It is not clear to what degree these chum fry are feeding or growing in the estuary prior to their migration to the ocean. The impact, however, is expected to be minimal due to smaller size of the chum program and also because of the smaller size of chum fry at release.

(3) Interactions with species that could positively impact program:

Other salmonid species that naturally spawn in the target stream may positively impact program fish by contributing nutrients from decaying carcasses.

(4) Interactions with species that could be positively impacted by program:

The program might provide benefits to other salmonid species in the basin by contributing nutrients from decaying carcasses that may increase productivity of the rivers and riparian zone. Chum Salmon also might play an important role in community ecology since this population historically existed sympatrically with other species within the basin. Specifically, chum spawn in the lowest reaches of rivers that tend to have the highest aggradation of fine sediments. Chum Salmon spawning aggregates may transport substantial amounts of fine sediment and improve the habitat for other riverine species. Further, because of the smaller size of out-migrating Chum Salmon fry they may serve as prey for other listed salmonids throughout the migration corridor and estuary.

SECTION 4. WATER SOURCE

4.1) Provide a quantitative and narrative description of the water source (spring, well, surface), water quality profile, and natural limitations to production attributable to the water source.

Big Creek Hatchery is supplied with gravity flow water from Big Creek, Mill Creek, and two springs. Water from Big Creek is directed to an intake system by a weir spanning the stream approximately 1/2 mile upstream of the hatchery. Water from Mill Creek is directed to an intake system by a weir spanning the stream just upstream of the hatchery. Water availability varies from 5,200 to 18,000 gallons per minute (gpm) with a total water right of 80 cubic feet per second (cfs).

Seasonal low flows limit production during July-September. The water supply is secured with flow alarms at the intake(s) and the head box. Big Creek Hatchery Chum Salmon egg incubation and early fry rearing typically occurs on natural

spring water (other sources could be used if needed). Fry are transferred to outside containers, usually supplied with Big Creek water, for final rearing. Water used for incubation and rearing has met or exceeded the recommended Integrated Hatchery Operations Team (IHOT) water quality standards for temperature, ammonia, carbon dioxide, chlorine, pH, copper, dissolved oxygen, hydrogen sulfide, dissolved nitrogen, iron, and zinc.

4.2) Indicate risk aversion measures that will be applied to minimize the likelihood for the take of listed natural fish as a result of hatchery water withdrawal, screening, or effluent discharge.

Big Creek Hatchery has water rights to take water from four different sources (see Section 4.1), with an average annual take of 257 ft^3/sec. from these combined sources. The facility complies with the current water rights, water withdrawals, and annual water uses reporting to Oregon Department of Water Resource.

In June of 2012, new water intake screening was installed at Big Creek Hatchery which complies with NOAA screening criteria. This minimizes risk that naturally produced juveniles will enter the hatchery water supply.

The facility operates under a National Pollutant Discharge Elimination System (NPDES) permit, to comply with the Oregon Water Quality Standards. Water quality is monitored as per permit requirements and data are reported to the NPDES permit implementing agency, the Oregon Department of Environmental Quality.

SECTION 5. FACILITIES

5.1) Broodstock collection facilities (or methods).

Adult Chum Salmon used for broodstock are typically collected at the Big Creek Hatchery trap. Fish are kept in the adult holding pond until spawning. The adult trapping facility at Big Creek Hatchery is located at RM 3.3 on Big Creek. The adult holding area consists of a large upper pond and a lower pond divided into 7 sections with a total holding capacity of about 10,000 fish, depending on the species. This facility is also used to collect brood for other species e.g. coho, Chinook, and winter steelhead.

If necessary to achieve production goals or research needs, adult Chum Salmon broodstock may be collected from Grays River (the original source of brood) or possibly in other lower Columbia River tributaries. Adults may be collected in traps, by hook and line, tangle nets, or other similar methods as determined by location and feasibility of each method.

5.2) Fish transportation equipment.

The transfer of fish on-station is done using a distribution box, irrigation pipe and a gas powered pump. All off-station transfers are done with the use of a large liberation truck or portable tank mounted in a pickup. Additional information is provided below in Table 5.1.

Table 5.1. Fish transportation facilities used at Big Creek Hatchery.

Equipment type	Capacity (gallons)	Supplemental Oxygen (y/n)	Normal transit time	Chemicals used
Tank	250-1000	Y	Varied	None

5.3) Broodstock holding and spawning facilities.

The adult holding area at Big Creek Hatchery consists of a large upper pond and a lower pond that is divided into 7 sections with a total holding capacity of about 10,000 fish, depending on the species. The dimensions of the lower pond are 80 ft x 29.5 ft x 3 ft, with a working volume of 6,301 ft^3. The dimensions of the upper pond are 95 ft x 36.5 ft x 5 ft, with a working volume of 15,881 ft^3. Flow through both ponds is 15-20 ft^3/sec. Fish are normally spawned in a covered work area adjacent to the ponds.

5.4) Incubation facilities.

Big Creek Hatchery currently has a total of 18 deep troughs (15.5 ft x 1.33 ft x 1.25 ft), 48 shallow troughs (15.5 ft x 1.42 ft x 0.58 ft), and 96 vertical incubation trays. Natural spring water is typically used for incubation of chum salmon eggs. Temperature is checked daily using a digital thermometer and spring water generally is about 47°F. Dissolved oxygen is randomly monitored, and usually remains between 7 ppm and 10 ppm. In September, 2013, a water chiller and chiller building were installed. This system facilitates otolith marking.

Eggs out-planted to lower Columbia River tributaries are placed in remote site incubators and incubate under natural conditions.

If necessary to meet reintroduction needs, other incubation locations may be considered. Alternative locations could include another hatchery facility (such as Gnat Creek Hatchery or Klaskanine Hatchery), or remote sites yet to be determined.

5.5) Rearing facilities.

Table 5.2 below shows the rearing facilities at Big Creek Hatchery. Any of these facilities may be used for Chum Salmon fry rearing.

Table 5.2. Fish rearing facilities at Big Creek Hatchery.

Pond Type	Number	Length (ft)	Width (ft)	Depth (ft)	Volume (ft^3)	Max flow (gpm)
Raceways	9	160	10	2.75	39,600	400-750
Raceways	21	80	20	2.75	92,400	400-750
Rearing Pond	1	85	30	4.75	12,112.5	400-750
Canadian Troughs	4	21	2.58	1.25	270.9	20

If necessary to meet reintroduction needs, other rearing locations may be considered. Alternative locations could include another hatchery facility (such as Gnat Creek Hatchery or Klaskanine Hatchery), or remote sites yet to be determined.

5.6) Acclimation/release facilities.

Chum Salmon fry may be released directly from the hatchery facility or hauled and released into lower Big Creek or other lower Columbia River tributaries as dictated by research or reintroduction needs. Fry that are released other than from the hatchery are typically hauled in liberation tanks equipped with an oxygen injection system and recirculation pumps.

Acclimation of chum is not currently conducted but will be considered if necessary to achieve research or reintroduction goals. Sites and facilities would need to be determined if acclimation is desired in the future.

Out-planting of eyed eggs is currently conducted in Perkins Creek and Stewart Creek in the Clatskanie River population. Additional out-planting of eyed-eggs in other locations may be considered as part of the re-introduction efforts.

5.7) Describe operational difficulties or disasters that led to significant fish mortality.

There have been no operational difficulties or disasters at the facility that have led to significant chum salmon fry mortality. Further, no incidences of this nature have occurred with other species in the past 20 years.

5.8) Indicate available back-up systems, and risk aversion measures that will be applied, that minimize the likelihood for the take of listed natural fish that may result from equipment failure, water loss, flooding, disease transmission, or other events that could lead to injury or mortality.

The hatchery stock of Chum Salmon is part of the Lower Columbia River Chum Salmon ESU, and is listed under the federal ESA. To prevent the transmission of diseases, adult fish, eggs and fry shall be treated as per prescriptions written by ODFW fish pathologists. Culled eggs or dead fry shall be disposed of in a

manner that prevents transmission of pathogens to the receiving watershed. To prevent any catastrophic fish loss due to water failure, alarms are installed on all water systems critical to the operations. The alarm system will notify the staff of any emergency situations at the facility. Also, the facility is staffed full-time to assure the security of fish stocks reared within the hatchery facilities.

SECTION 6. BROODSTOCK ORIGIN AND IDENTITY

Describe the origin and identity of broodstock used in the program, its ESA-listing status, annual collection goals, and relationship to wild fish of the same species/population.

6.1) Source.

Chum Salmon broodstock originated from an integrated program at the Grays River Hatchery (Washington). After several years of importing eggs from Grays River stock chum and releasing in Big Creek, adults returning to Big Creek Hatchery are the primary source of hatchery broodstock. Grays River stock, or chum collected from other lower Columbia River tributaries, may be used to supplement the Big Creek Hatchery broodstock if needed to meet production goals or re-introduction goals. Currently, approximately 320 adults (160 males and 160 females) are needed to meet production goals. This number may vary depending on fecundity, egg survival, etc., or if needed to meet research or re-introduction goals.

Columbia River Chum Salmon, including both naturally produced and hatchery-produced fish, are ESA listed as threatened. This program is intended to help establish self-sustaining naturally produced populations on the Oregon side of the lower Columbia River.

6.2) Supporting information.

6.2.1) History.

The Chum Salmon reintroduction program at Big Creek Hatchery began in brood year 2010 with eyed eggs shipped from Gray River Hatchery, Washington. The eggs at Grays River Hatchery were produced by integrating naturally-produced and hatchery-produced broodstock, and both stocks were native to the Grays River. Proportions of hatchery and wild fish used in broodstock are presented in Table 6.1. Historically, the broodstock of chum salmon for the Grays River Hatchery originated in 1988 with adults that were trapped at Gorley Creek and the Grays River. Now that adults are returning to Big Creek, broodstock is primarily collected at Big Creek Hatchery. Brood (or eggs) collected from Grays River or potentially other lower Columbia River tributaries are alternate sources if needed.

6.2.2) Annual size.

As Big Creek broodstock have begun to return to Big Creek Hatchery, annual release goals have increased. From 2010 through 2013, the annual release goal was 100,000 fed-fry. In 2014 and 2015, the annual release goal was 200,000 fed fry, with excess production released as eyed-eggs using remote site incubators in the Clatskanie River population. Currently, the annual release goal is 300,000 fed fry and 100,000 eyed-eggs. This requires approximately 160 pair of chum salmon to meet the collection goal. When sufficient returns permit, we may collect approximately 480 adults (240 males and 240 females) to meet the maximum production goal of 600,000 eggs. This number may vary depending on fecundity, egg survival, etc., or if needed to meet research or re-introduction goals. Additional adults may be collected for out-planting, or for egg and/or fry production for out-planting, to lower Columbia tributaries as part of reintroduction efforts, if needed.

6.2.3) Past and proposed level of natural fish in broodstock.

Previous broodstock collections and composition of naturally produced Chum Salmon are presented in Tables 6.1 and 6.2.

Table 6.1. Past broodstock collection level at Grays River Hatchery which might be of natural-origin, 1998-2012.

Brood Year	Males	Females	Total	% of wild fish	% of hatchery fish
1998	45	47	92	100	0.0
1999	71	71	142	100	0.0
2000	120	125	245	100	0.0
2001	106	110	216	36.1	63.9
2002	164	162	326	40.6	59.4
2003	152	153	305	60.8	39.2
2004	149	154	303	87.5	12.5
2005	69	62	131	58	42.0
2006	57	59	116	17.2	82.8
2007	67	67	134	94.8	5.2
2008	43	44	87	90.8	9.2
2009	44	63	107	92.5	7.5
2010	143	144	287	92.7	7.3
2011	145	149	294	96.6	3.4
2012	107	112	219	99.5	0.5

Source: Grays River Hatchery Chum Salmon HGMP, 2014.

Table 6.2. Big Creek broodstock composition.

Brood Year	Males	Females	Total	% of wild fish	% of hatchery fish
2014 (Big Creek)*	45	40	85	0	100
2015	84	85	169	28	72

*In 2014, 100,000 eggs were transferred to Big Creek Hatchery from Grays River Hatchery. Wild/hatchery composition of those eggs is not available yet.

Note: in 2014, 100,000 eggs were transferred from the Grays River and no data are available on the wild and natural composition of that brood year at this time.

At Big Creek Hatchery, in order to meet the maximum production needs of 600,000 eggs, about 240 pairs (240 males and 240 females) of hatchery-produced and/or naturally-produced broodstock may be collected annually. Additional broodstock may also be collected for egg and/or fry production for out-planting and/or adult out-planting activities to lower Columbia River tributaries. Naturally produced chum will be integrated annually as available and as needed to meet the goals of the re-introduction program as long as their removal from the naturally spawning population does not jeopardize efforts to restore self-sustaining populations.

6.2.4) Genetic or ecological differences.

Chum Salmon along the Oregon side of the lower Columbia River are functionally extirpated. Grays River chum stock, which are geographically closer to Big Creek, is one of the only three populations still sustaining as a viable population (source: Grays River Hatchery Chum Salmon HGMP 2004). Because of its closer proximity, it is assumed that the Grays River Chum Salmon may face minimal ecological challenges to adapt to the environmental conditions in Big Creek (or other lower Columbia tributaries on the Oregon side), and therefore, the Grays River stock was chosen for the reintroduction program. Also, it was reported in the Grays River Hatchery chum salmon HGMP 2004 that there were no known genotypic, phenotypic, or behavioral differences between the natural-origin and hatchery-origin chum that were collected for broodstock purpose. However, it's possible there may be some differences in age structure, sex ratio, and/or run timing.

6.2.5) Reasons for choosing.

After consulting the Washington Department of Fish and Wildlife's geneticist, there was concurrence that Grays River Chum Salmon would be the most genetically appropriate broodstock for use into Oregon's coast strata tributaries (Small et al., 2011). Also refer to Section 6.2.4

6.3) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish that may occur as a result of broodstock selection practices.

Adult fish are collected proportionately throughout the duration of the run and randomly selected for spawning, to maintain genetic diversity within the hatchery-produced Chum Salmon population. Broodstock shall be collected to meet the desired spawning ratio of male to female 1:1, if possible

SECTION 7. BROODSTOCK COLLECTION

7.1) Life-history stage to be collected (adults, eggs, or juveniles).

Chum Salmon become sexually mature when they are between 3 and 5 years old, with most fish maturing when they are 4 years old (Wydoski and Whitney 2003). Therefore, only adult Chum Salmon are collected for broodstock.

7.2) Collection or sampling design.

Broodstock are primarily collected at Big Creek Hatchery trap (beginning with brood year 2014), where Chum Salmon enter the trap volitionally. Hatchery-origin and/or natural origin adults returning to Big Creek Hatchery trap may be used for egg and fry production, and/or adult out-planting for natural production in the targeted areas. Adult out-planting may occur, if adult returns exceed hatchery production requirement or rearing capacity as dictated by reintroduction efforts. Disposition of returning adults may vary annually. See Table 2.6 for recent disposition of returning Chum Salmon adults.

Broodstock for the program may also be collected at Grays River, WA, and eyed-eggs are shipped to Big Creek Hatchery. At Grays River Hatchery, adult Chum Salmon are collected from the Grays River and its tributaries during early November through mid-December using trap, seine net and, hook and line methods. See Table 6.1 for past Grays River broodstock collection levels.

Alternatively, adults may also be collected from other lower Columbia River tributaries if needed or desired as part of reintroduction or research needs.

7.3) Identity.

Chum Salmon of the LCR of both hatchery- and wild-origin are ESA listed populations. Hatchery produced juveniles may be given an internal or external mark to distinguish them from naturally produced chum. Marking could include otolith marks, coded wire tags, fin-clips, or alternative methods to be determined.

7.4) Proposed number to be collected:

7.4.1) Program goal (assuming 1:1 sex ratio for adults):

Broodstock are currently collected with a goal of a 1:1 male to female ratio. In order to produce 600,000 eyed eggs for Big Creek Hatchery program it takes about 240 pairs of adults. Additional broodstock may be collected for egg and/or fry production for out-planting and also for adult out-planting for natural production in lower Columbia River tributaries.

7.4.2) Broodstock collection levels for the last twelve years (e.g. 1988-99), or for most recent years available:

Broodstock have been collected at Big Creek Hatchery beginning with brood year 2014. In 2014, 300 adult chum were collected, and in 2015, 250 adult Chum Salmon were collected.

Data from past broodstock collection levels at Grays River Hatchery are shown in Table 6.1.

7.5) Disposition of hatchery-origin fish collected in surplus of broodstock needs.

Adult chum in excess of production needs may be passed upstream of the hatchery weir into Big Creek, or may be out-planted to lower Columbia River tributaries as part of the reintroduction effort.

7.6) Fish transportation and holding methods.

The fish transportation equipment used at Big Creek Hatchery is described in Section 5.2. The transfer of fish on-station is done using a distribution box or portable tank on the back of a pickup, irrigation pipe and a gas powered pump. All off-station transfers are done with the use of a large liberation truck portable tank mounted in a pickup. IHOT guidelines for transportation are followed while transporting adult fish. The facility has two adult holding ponds which are located only a few yards from the adult trapping facility.

7.7) Describe fish health maintenance and sanitation procedures applied.

Big Creek Hatchery propagation programs follow the ODFW Fish Health Management Policy and protocols, including broodstock health inspection/treatment and while transferring eggs or adults and/or disposal of carcasses, to maintain fish health and prevent transmission of diseases. Adult chum are typically held a relatively short period of time and treatment is usually not necessary. If needed, a flow through formalin treatment is applied. Other methods or other approved chemicals (for example hydrogen peroxide) may also be utilized.

At Grays River Hatchery, adult Chum Salmon are held for a short period of time before spawning and consequently it has not been necessary to treat the holding adults. Refer to Grays River Hatchery HGMP for more information.

7.8) Disposition of carcasses.

Adult Chum Salmon carcasses may be used for stream nutrient enrichment or are disposed of in a landfill.

7.9) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the broodstock collection program.

Fish trap and adult holding ponds at Big Creek hatchery will be observed daily. Both naturally produced or hatchery-produced chum, are handled carefully. Adults not needed for broodstock may be released upstream of the hatchery weir or out-planted to other lower Columbia River tributaries to spawn naturally. Alarms are installed on water supply systems that will notify any emergency situations to hatchery staff 24 hours a day, to prevent any catastrophic fish losses due to water system failure. ODFW Fish Health Management Policy shall be strictly followed to maintain fish health and prevent transmission of diseases (see Section 7.7). If there is any emergency situation, hatchery staff also may contact district or Chum Reintroduction Project staff for appropriate actions.

SECTION 8. MATING

Describe fish mating procedures that will be used, including those applied to meet performance indicators identified previously.

8.1) Selection method.

Chum Salmon broodstock at Big Creek Hatchery are collected throughout the duration of the spawning run. Chum adults are held in the hatchery holding ponds until ready to spawn. Adults are regularly checked for spawning condition, and ripe fish are selected for spawning (typically weekly throughout run).

8.2) Males.

Ripe males are randomly selected for mating from all age classes. Males are typically only used once for spawning. In the case of a shortage of males, individual fish may be spawned with more than one female.

8.3) Fertilization.

Chum Salmon spawning at Big Creek Hatchery is typically done in a 2x2 matrix spawning format to increase family group size and genetic diversity. Alternative ratios may be utilized for spawning if necessary, for example if there is a shortage of males.

If used as an egg source, fertilization at Grays River Hatchery is practiced in a 2x2 or 3x3 matrix design, to maintain genetic diversity with the population. Refer to the Grays River Hatchery Chum HGMP for more detail.

Female fish are typically killed and bled by severing the caudal peduncle prior to spawning. The eggs from each female are removed and placed into an individual

bucket. In the 2x2 matrix format, eggs from two females are combined, and then split into two separate buckets. Sperm from two males is added, one to each bucket (although males may be used more than once in the case of a shortage). Family groups are labeled for identification during incubation.

The fertilized eggs are typically rinsed using spring water and drained. To prevent transmission of diseases, fertilized eggs are disinfected with an iodine solution prior to incubation. At the time the males and females are stripped, ovarian fluid samples are taken to test for replicating viral agents. After spawning, pyloric caeca, kidney and spleen samples are also be taken to test for bacterial kidney disease, IHN virus or other infectious pathogens. Fertilized eggs that test positive for infectious diseases may be kept to continue incubation or destroyed as per direction of ODFW fish health specialists.

8.4) Cryopreserved gametes.

No cryopreserved gametes are currently used in the Chum Salmon reintroduction program. Cryopreservation may be considered if necessary to meet research or reintroduction goals.

8.5) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic or ecological effects to listed natural fish resulting from the mating scheme.

Broodstock are typically collected throughout the entire run period. Pairs of males and females are mated randomly to avoid any bias for fish size or other external characteristics. Brood collection throughout the entire run and random selection for spawning are believed to help maintain genetic diversity. Preventive measures as per ODFW Fish Health Management Policy shall be followed during mating to prevent transmission of diseases between stocks and to the watershed.

SECTION 9. INCUBATION AND REARING

9.1) Incubation:

9.1.1) Number of eggs taken and survival rates to eye-up and/or ponding.

During brood years 2010 and 2011, an estimated 116,000 and 115,000 eyed eggs, respectively, were shipped from Grays River Hatchery, WA, to Big Creek Hatchery. Reported egg survival at Grays River Hatchery ranged from 91-94%. Survival of eyed eggs received from Grays River or eggs collected during spawning at Big Creek Hatchery has exceeded 97% (Table 9.1).

Table 9.1. Eyed eggs to fry survival rates of chum salmon at Grays River Hatchery (2010-14) and Big Creek Hatchery (2014-15).

Brood Year	No. of eggs taken	Eyed Egg to Ponding Survival (%)
2010	116,000	98.7
2011	115,000	98.0
2012	118,500	98.6
2013	99,000	97.6
2014 (GR)	104,000	98.9
2014 (BC)	135,371	97.2
2015 (BC)	268,000	97.3

Source: Big Creek Hatchery, and HMS database.

9.1.2) Cause for, and disposition of surplus egg takes.

Additional eggs may be taken if needed to meet production goals, research needs, or for re-introduction efforts (out-planting to other lower Columbia River tributaries).

9.1.3) Loading densities applied during incubation.

Eggs are incubated in either vertically stacked trays or in larger incubation baskets. Eyed eggs are loaded at a density of approximately 7,000 – 7,500 eggs per tray for incubation. The mean weight of eyed eggs is about 90 eggs per ounce (approximately 80 ounces per tray). Incubation baskets contain up to 25,000 eggs at the viable stage, or up to 15,000 eyed eggs (about 278 ounces and 167 ounces per basket, respectively).

If necessary to meet reintroduction needs, other incubation locations may be considered. Alternative locations could include another hatchery facility (such as Gnat Creek Hatchery or Klaskanine Hatchery), or remote sites yet to be determined. Loading densities may vary but would likely be similar.

9.1.4) Incubation conditions.

At Big Creek Hatchery viable and eyed eggs are typically incubated in spring fed water at a relatively constant temperature of about 47 degrees (although some temperature manipulation is possible to speed or slow development). Flow of water through each tray is 4-5 gpm while flow through bulk incubation baskets is about 10 gpm. Dissolved oxygen is randomly monitored, but usually remains around 10 ppm during the incubation period.

If necessary, eggs may be obtained from Grays River Hatchery. At Grays River Hatchery, eggs are incubated in spring fed water at a temperature range of 48 – 49^{o}F. Refer to the Grays River Hatchery Chum HGMP for more details.

If necessary to meet reintroduction needs, other incubation locations may be considered. Alternative locations could include another hatchery facility (such as

Gnat Creek Hatchery or Klaskanine Hatchery), or remote sites yet to be determined. Conditions at alternative sites may vary but are likely to be similar.

9.1.5) Egg Transfers.

Prior to the 2015, eyed eggs of Chum Salmon were transferred from Grays River Hatchery to Big Creek Hatchery during the initial phases of this program. Now that a broodstock source is established in Big Creek, egg transfers from Grays River Hatchery will only be necessary in years when there is a broodstock shortage. Alternatively, additional eggs could be transferred from Grays River to meet other research or re-introduction needs.

Eyed eggs may be transferred to other facilities or be out-planted to other lower Columbia River tributaries as needed to meet research or reintroduction goals. If conducted, locations are to be determined.

9.1.5) Ponding.

Chum Salmon at Big Creek Hatchery are ponded once they are 100% button-up, at an approximately1523 temperature units (TU), which usually occurs in early to mid-February. The average length of fry at ponding is approximately 33 mm, and the average weight is about 0.4 g. The number of fish per pound is approximately 1,222 while ponding. The ponding of Chum Salmon fry occurs into a rearing tank of 58 ft^3, and the flow is maintained at about 15 gpm.

9.1.6) Fish health maintenance and monitoring.

Incubation trays are checked regularly, and dead eggs are removed for proper disposal. Disinfection procedures are implemented during incubation, preventing pathogen transmission between stocks of fish. Eggs are monitored to determine fertilization efficiency and embryonic development. Following eyed-up stage, eggs are inventoried, and dead or undeveloped eggs are removed and disposed of as described in the disease control guidelines. Dead or culled eggs are discarded in a manner that prevents transmission of diseases to the receiving watershed. Fish Health Management Policy, IHOT, Pacific Northwest Fish Health Protection committee (PNFHPC), and other state or tribal guidelines are followed for fish health inspections. No fish disease outbreaks have occurred during the period of chum salmon egg incubation and rearing at Big Creek Hatchery.

9.1.7) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation.

At Big Creek Hatchery, Chum Salmon eggs are typically incubated in natural spring water, which is believed to be the preferred ecological condition for Chum Salmon natural spawning and egg incubation. Water quality profiles during

incubation are good, including temperature and dissolved oxygen. Preventive fish health care measures are being followed during egg incubation to prevent disease outbreaks and transmission of diseases. Dead eggs are removed regularly for proper disposal. Water supply system is equipped with alarms, to prevent any catastrophic effects due to reduced or interrupted flows during incubation/rearing.

9.2) Rearing:

9.2.1) Provide survival rate data (*average program performance*) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1988-99), or for years dependable data are available.

Fry survival from ponding to release is presented in Table 9.2

Table 9.2. Survival rates of Chum Salmon from ponding to release at Big Creek Hatchery.

Brood Year	Fry Survival Ponding to Release (%)
2010	98.7
2011	98.9
2012	98.9
2013	99.0
2014	97.0
2015	Not Yet Available

Source: ODFW's HMS database.

9.2.2) Density and loading criteria (goals and actual levels).

Chum Salmon fry are transferred to rearing containers at the time of ponding. Rearing containers are managed for a density of ≤ 10 lb./gpm. Actual rearing densities range from 1.6 lb/gpm to 7.0 lb/gpm. Rearing containers are also managed for a volume of ≤ 1 lb./ft^3. The actual rearing volume ranges from 0.41 lb/ft^3 to 0.84 lb/ft^3.

If alternative rearing locations are utilized, rearing densities would be managed under the same goals.

9.2.3) Fish rearing conditions.

At Big Creek Hatchery, rearing temperatures are monitored daily via remote electronic thermometer (or other methods if needed). During Chum Salmon fry rearing in raceways (December – early April) water temperature usually varies from 33-50°F. Dissolved oxygen level during colder months is usually between 7 and 10 ppm. Water flow through the rearing ponds varies from 15-300 gpm, depending on pond volume. Settleable solids, uneaten feed and fecal matter are removed regularly to ensure proper cleanliness of rearing containers. Ponds are visually inspected, and fish mortalities removed daily. Juvenile rearing density

and loading guidelines are as per IHOT standards and/or standardized agency guidelines, life stage-specific survival studies conducted at other facilities, staff experience (e.g. trial and error) and/or other criteria (see Sections 5.5 for rearing facilities and 9.2.2 for Chum Salmon fry rearing density and loading criteria).

9.2.4) Indicate biweekly or monthly fish growth information (*average program performance*), including length, weight, and condition factor data collected during rearing, if available.

Sample growth rate information of Chum Salmon at Big Creek Hatchery is presented in Table 9.3.

Table 9.3. Average monthly growth (#fish/lb) of Chum Salmon at Big Creek Hatchery (brood years 2010-2015).

Hatchery	Month	Size (fish/lb)
Big Creek	February	669
Big Creek	March	244
Big Creek	April	170

Source: Big Creek Hatchery or HMS database.

9.2.5) Indicate monthly fish growth rate and energy reserve data (*average program performance*), if available.

See Table 9.3 for typical monthly fish growth data of Chum Salmon (#fish/lb). Energy reserve data are not available.

9.2.6) Indicate food type used, daily application schedule, feeding rate range (e.g. % B.W./day and lbs/gpm inflow), and estimates of total food conversion efficiency during rearing (*average program performance*).

Table 9.4. Typical food type, fish size, daily feeding rate and food conversion ratios for Chum Salmon at Big Creek Hatchery (brood year 2010). Note: Bio Oregon Feed is the current brand used. Brands may change over time.

Type of Food	Fish Size (#fish/lb)	Application Rate (% of body weight)	Food Conversion	Average
Bio Oregon Feed (Starter #0)	1222-596	2.8	Feb = 0.71	
Bio Oregon Feed (Starter #1)	596-408	2.8	Mar = 0.76	
BioOregon Feed (Starter #1 & #2)	408-224	2.5	Apr = 0.84	0.77

Source: Big Creek Hatchery

9.2.7) Fish health monitoring, disease treatment, and sanitation procedures.

Fish health is monitored regularly in every month, which is a requirement of ODFW Fish Health Management Policy. No disease issues have occurred during the first 5 years of incubation and rearing of Chum Salmon eggs/fry at Big Creek Hatchery.

9.2.8) Smolt development indices (e.g. gill ATPase activity), if applicable.

Chum Salmon at Big Creek Hatchery are released as fry in early April. Typically the average size is around 170 fish per pound. Chum Salmon fry average approximately 65 mm in length and average weight is approximately 1.5 g at release. Release size may change in the future as additional survival metrics become available. No ATPase gill activities are measured.

9.2.9) Indicate the use of "natural" rearing methods as applied in the program.

No natural rearing techniques are used at Big Creek Hatchery. Use of natural spring water may mimic a naturally preferred water source for Chum Salmon.

When out-planted eggs are used as part of the reintroduction project, eggs would be incubated under natural environmental conditions in one or more lower Columbia River tributaries. Any adults released in Big Creek or other lower Columbia River tributaries spawn naturally. Eggs and fry from these spawners incubate and rear in the natural environment.

9.2.10) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish under propagation.

The Chum Salmon stock under this propagation program is an ESA listed population. Broodstock are currently collected throughout the entire run to get a broad cross-section of adults. The program uses an integrated broodstock to maintain or increase genetic diversity within the hatchery fish. Also, fish are randomly selected for spawning to avoid artificial selection for certain characteristics (e.g. size, color etc.). These measures may help to ensure that the propagated stock maintains sufficient genetic diversity for their long-term sustainability.

During egg incubation and pond rearing, ODFW Fish Health Management Policy is followed to maintain fish health and prevent transmission of diseases between rearing ponds and stocks. The water supply system is equipped with alarms to prevent fish mortalities due to failure of the water supply system.

SECTION 10. RELEASE

Describe fish release levels, and release practices applied through the hatchery program.

10.1) Proposed fish release levels.

Release levels, locations, and protocols for the eggs, fry, and adult out-planting program will be determined by the Chum Salmon Re-introduction Project. Proposed annual release levels are presented in Table 10.1.

Table 10.1. Proposed annual releases.

Life Stage	Release Location	Annual Release Level
Eggs (out-planting)	Eggs outplanting sites include Perkins Creek and Stewart Creek (Figure 1). Maintenance of these sites or selection of replacement or additional sites will be determined by the Chum Recovery Workgroup. (Tributaries to Youngs Bay will be considered for egg out-planting depending on the population status of the area as well as disturbances due to existence commercial fishery).	Release goals are determined by the availability of excess eggs at Big Creek Hatchery, recovery goals for the target stream, and the current level of natural production in that stream. As such, release goals are determined by the Chum Recovery Workgroup, subject to the constraints listed above. Up to 100,000 eggs are currently out-planted, but may increase to meet reintroduction goals.
Unfed Fry (out-planting)	TBD	TBD
Fed Fry (Future Broodstock)	Big Creek	Up to 300,000
Fed Fry (out-planting)	TBD	TBD
Fingerling	None	--
Adult (out-planting)	Adult outplanting sites have included Graham Creek, Stewart Creek, Big Creek, Little Creek, and Bear Creek. Maintenance of these sites or selection of replacement or additional sites will be determined by the Chum Recovery Workgroup.	Release goals are determined by the carrying capacity of each site, number of chum collected at Big Creek Hatchery, fecundity, and level of natural production in a site. Site carrying capacity is currently being evaluated and release goals are determined by the Chum Recovery Workgroup, subject to the constraints listed above.

Notes:

1) Fry release numbers will increase in the future depending on chum salmon reintroduction/recovery requirements for adults, eggs, and fry productions. Egg take may reach up to 600,000 eggs.
2) TBD means to be determined annually based on the results of monitoring and evaluation of potential chum habitat and reintroduction techniques. Guidelines will be provided by the Chum Salmon Recovery Workgroup.

10.2) Specific location(s) of proposed release(s).

Release Location to Establish Chum Broodstock:
Stream, river, or watercourse: Big Creek
Release point: Big Creek (RM 3.3 or downstream for juveniles. Adults may be released upstream)
Major watershed: Big Creek
Basin or Region: Lower Columbia River

Release Locations for Chum Out-planting/Reintroduction:
Stream, river, or watercourse: Stewart Creek
Release point: RM 0-1 (Upstream of confluence with Beaver Creek Slough)
Major watershed: Clatskanie River
Basin or Region: Lower Columbia River

Release Locations for Chum Out-planting/Reintroduction:
Stream, river, or watercourse: Perkins Creek
Release point: RM 0-1 (Upstream from confluence with Clatskanie River)
Major watershed: Clatskanie River
Basin or Region: Lower Columbia River

Release Locations for Chum (Adult, Eggs or Fry) Out-planting/Reintroduction:
Stream, river, or watercourse: Other tributaries
Release point: TBD
Major watershed: TBD
Basin or Region: Lower Columbia River

10.3) Actual numbers and sizes of fish released by age class through the program.

Past fish release information is presented in Table 10.2**.**

Table 10.2. Annual fish release numbers, date, age class, and average size of Chum Salmon fry released into Big Creek (brood years 2010 - 2014).

Brood Year	Release Date	No. of Fry Released	Average Size (fish/lb)
2010	4/7/11	106,624	224
2011	4/9/12	110,090	218
2012	4/15/13 4/17/13	58,131 50,375	168 178
2013	4/17/14	100,863	185
2014	4/24/15 5/15/15	123,207 66,981	190 180
2015	April 2016	Not yet available	

10.4) Actual dates of release and description of release protocols.

See Table 10.2 above for release dates. These release dates were chosen to achieve the desired size for marking and for size of fish at release. Past releases

from Grays River Hatchery demonstrated that released fish of similar size contributed better fry to adult survival.

Chum Salmon fry are released into Big Creek. Typically fish are released directly from the hatchery. Releases may occur during evening hours if possible to provide some protection from predators under the cover of darkness during initial downstream migration. If releases occur downstream in Big Creek or in other lower Columbia River tributaries, fry are transported using a portable liberation truck. Release from portable liberation tanks may occur by hand using net bags, or via liberation tubes into the stream.

Chum Salmon fry released from Big Creek Hatchery are typically marked. Thermal otolith marks, coded wire tags (CWTs), fin clips, or other identifiable marks may be used so as to distinguish between hatchery-produced and naturally-produced adults upon return. Additional unique marking may apply in the future for eggs and fry out-planting program to different tributaries.

10.5) Fish transportation procedures, if applicable.

Current chum fry releases in Big Creek are typically directly from the hatchery. Any releases that have occurred or may occur off station in lower Big Creek or other lower Columbia River tributaries are done using a portable liberation equipped with an oxygen injection system for transportation to the release site.

Adult Chum Salmon released above the hatchery or out-planted in other lower Columbia River tributaries may be hauled in a portable liberation unit, or in a larger liberation truck.

Fry from out-planted eggs are released from the incubation site directly into the stream or are allowed to naturally emerge.

10.6) Acclimation procedures (*methods applied and length of time*).

No acclimation of Chum Salmon fry occurs currently. Acclimation may be considered as part of re-introduction efforts if deemed necessary to meet goals of the program.

10.7) Marks applied, and proportions of the total hatchery population marked, to identify hatchery adults.

Chum Salmon fry are marked internally and/or externally using thermal otolith marking, coded wire tags, and/or fin clips. Other marking techniques may be considered if necessary. The goal is to mark 100% of the chum fry so that they can be distinguished from naturally produced chum. All otolith marks applied are coordinated with the Washington Department of Fish and Wildlife otolith marking lab so that distinct marks are applied (no duplication with other

programs). Additional unique marking strategies may apply in the future for eggs and fry out-planting program to lower Columbia tributaries.

10.8) Disposition plans for fish identified at the time of release as surplus to programmed or approved levels.

The objective of the chum salmon reintroduction program is to help establish self-sustaining populations of chum salmon in tributaries on the Oregon side of the lower Columbia River. Eggs or fry beyond hatchery fry production levels may be used for out-planting to suitable habitats for natural rearing as part of the reintroduction efforts.

Eggs or fry above hatchery production or research/reintroduction needs may be released to standing water bodies, or destroyed.

10.9) Fish health certification procedures applied pre-release.

Under ODFW's Fish Health Management Policy, fish health is examined at prelease for all propagated fish and, only certified fish are released.

10.10) Emergency release procedures in response to flooding or water system failure.

In the event of flooding or a water system failure, emergency release of Chum Salmon fry will only occur if hatchery staff have exhausted all possibilities for retaining the fish. Hatchery staff may consult with Chum Reintroduction Project staff or district fish staff if time allows. Release will be into Big Creek or other lower Columbia River tributaries.

10.11) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from fish releases.

Chum Salmon fry are released at a time and size that promotes rapid migration. This should minimize interactions with naturally produced fish species in the lower Columbia River. When possible, releases may occur during evening hours, providing the cover of darkness for initial migration and reducing predation opportunity during the first night of migration. Hatchery released chum are marked so that they can be distinguished from naturally reared chum. This will allow for informed management decisions during reintroduction efforts (such as out-planting of adult chum).

Release protocols and locations for eggs, fry and adult out-planting program are to be determined as part of re-introduction efforts, but will be designed to assist with the goal of establishing self-sustaining populations of chum on the Oregon side of the lower Columbia River.

SECTION 11. MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1) Monitoring and evaluation of "Performance Indicators" presented in Section 1.10.

11.1.1) Describe plans and methods proposed to collect data necessary to respond to each "Performance Indicator" identified for the program.

Performance Indicators are described in section 1.10.
Monitoring of hatchery operations, including egg take, egg survival, fry growth and survival, marks, release numbers, adult returns, and other performance metrics is carried out by hatchery staff. Data is collected at each stage, entered and stored on the ODFW Hatchery Management System database.

Monitoring and evaluation of elements of re-introduction efforts will be conducted by Chum Salmon Reintroduction Project staff. See Section 12 for details on research activities associated with this program.

11.1.2) Indicate whether funding, staffing, and other support logistics are available or committed to allow implementation of the monitoring and evaluation program.

Funding for the Big Creek Hatchery Chum Salmon program is from federal Mitchell Act funds for hatchery operations associated with the chum program. Funding is currently available, but is subject to Congressional approval during each fiscal cycle. Funding for reintroduction efforts is provided by the Pacific Coastal Salmon Recovery Fund administered by NOAA Fisheries. Refer to Section 12 for more detail on research and monitoring associated with this program.

11.2) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish resulting from monitoring and evaluation activities.

Monitoring of in-hatchery performance is a routine part of the fish rearing process and does not pose substantial risk to hatchery reared chum in this program. Monitoring of naturally produced Chum Salmon will be conducted in a manner that minimizes risk to natural populations of chum or other listed species through handling, observation, or other methods. See section 12 for a description of research efforts.

SECTION 12. RESEARCH

Fish habitat surveys, research into critical uncertainties associated with reintroduction, and a limiting factors analysis for Chum Salmon reintroduction in Oregon are ongoing. After evaluation of these data, if additional research or experimental programs are under taken on Chum Salmon reintroduction techniques, beyond activities described below, then detailed research program(s), take levels, risk aversion measures, etc., shall be submitted as an appendix to this HGMP.

12.1) Objective or purpose.

The purpose of this program is to facilitate reintroduction of Chum Salmon into the Oregon portion of the Lower Columbia River ESU as per the Chum Salmon Reintroduction Plan (Homel 2014; draft) and direction of the Chum Recovery Workgroup. Briefly, the project includes: (1) creating a conservation broodstock (potentially including constructing and operating spawning channels), (2) collecting baseline data prior to reintroduction in order to assess effects of reintroduction, (3) collecting and analyzing habitat data to make recommendations for restoration projects, (4) reintroducing chum salmon into habitats they formerly occupied, (5) supplementing existing populations, where applicable, (6) monitoring the success of reintroduction and recolonization, and (7) conducting research on critical uncertainties about reintroduction strategies and factors that limit survival/ reproduction in freshwater and estuary habitats.

As such, this project monitors multiple life stages of wild and hatchery-origin Chum Salmon before, during, and after reintroduction. Data collection is currently focused on juvenile outmigration, adult returns, and estuary occupancy, but may include behavioral studies or egg survival research in the future.

- For outmigration and adult return data, estimates may be made using traps positioned low in the watersheds to achieve an integrative measure of salmon production throughout the watershed. Currently, the project operates up to five out-migration traps and one adult trap, but trapping effort may vary depending on funding and research/ monitoring needs.

- Estuary occupancy data collection may involve use of beach seines or trawls, and is done as part of specific research questions throughout the Oregon portion of the Columbia River estuary.

- Reintroduction and supplementation activities have occurred in the Big Creek and Clatskanie River populations, including outplanting wild and hatchery adults and outplanting eyed-eggs using remote site incubators. These efforts will continue in locations outlined in the Chum Reintroduction Plan (Homel 2014) and as determined by the Chum Recovery Workgroup.

In completing this work, the Chum Salmon Reintroduction Coordinator collaborates with state, federal, and non-governmental organizations to develop and implement a reintroduction strategy, and to conduct the necessary research to inform recovery efforts.

12.2) Cooperating and funding agencies.

Research, monitoring, and evaluation are funded by the Pacific Coastal Salmon Recovery Fund through NOAA Fisheries. Additional research and reintroduction activities have been funded through ODFW Restoration and Enhancement, Bonneville Power Administration (BPA; through a collaboration with Washington Department of Fish and Wildlife, WDFW), and the U.S. Forest Service. Collaborators on research and monitoring work include NOAA, U.S. Forest Service, WDFW, and BPA. Other collaborators and funding sources may be pursued in the future depending on research questions and availability of funding.

12.3) Principle investigator or project supervisor and staff.

Name (and title): Erik Suring, LCM Project Leader
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Email: Kristen.M.Homel@state.or.us

12.4) Status of stock, particularly the group affected by project, if different than the stock(s) described in Section 2.

All as described in Section 2.

12.5) Techniques: include capture methods, drugs, samples collected, tags applied.

Juvenile sampling:
Rotary screw traps, inclined plane traps, and box and panel traps will be used to capture juvenile salmonids migrating downstream. Traps generally begin fishing in February and, as stream flows allow, are fished continuously until catch diminishes to low levels or low stream flows preclude further trap operation, usually by mid-June. The traps will be checked and cleared of fish and debris once per day; visits will be more frequent during storm events and periods of high

debris transport.

Fish will be anesthetized with MS-222 and enumerated by species and age or size group (nearest millimeter fork length, FL). Coho Salmon *(O. kisutch)* will be identified as fry (age 0) or smolts (age 1+). All captured Chum Salmon (*O. keta*) and Chinook Salmon (*O. tshawytscha*) will be fry (age 0).

Capture efficiency of out-migrant traps will be evaluated daily for each species and age/size class by marking up to 150 fish from each category with a small clip from the caudal lobe then releasing clipped fish upstream of the trap.

Adult sampling:
Adults will be captured using box and weir adult traps, or other approved trapping designs (e.g. floating weir) depending on the size of the target system. The traps are fished from October through December and are fished continuously, as conditions allow. The trap will be checked and cleared of fish and debris daily; visits will be more frequent during storm events or periods of high debris transport.

Captured adult Chum Salmon may be implanted with t-bar anchor tags (e.g., Floy tags) or Peterson disc tags, and will have scales removed for aging and a fin clip removed for genetic analysis. Additional data will be collected on length and condition. During tagging and handling, the fish is held in a padded cradle to minimize stress. After sampling, the fish is released upstream of the trap in slow water and is observed until it swims away. Other tagging options include radio telemetry tags, acoustic telemetry tags, visual implant elastomers, and passive integrated transponder tags, as research needs require. These tags would be implanted using established best practices in surgery and animal care.

Estuary sampling:
Chum Salmon may be captured in the estuary using beach seines, trawls, or other types of nets and traps, as appropriate. The following samples may be collected from captured fish: scales, fin clip, tissue plug, and stomach contents (via gastric lavage). Other sampling may occur, depending on research needs. For invasive sampling or tagging, fish will be anesthetized with MS-222, as described above.

Reintroduction activities:
Specific reintroduction activities include transporting adult Chum Salmon to reintroduction sites using a liberation truck, outplanting unfed or fed fry in acclimation ponds, and outplanting eyed-eggs in remote site incubators. Each of these activities is done experimentally and survival and stray rates are assessed by recovering carcasses or removing samples (e.g., tissue for genetic analysis) from live fish. These tissue samples (also including otoliths from carcasses) may be processed to determine the origin of the fish in hand in relation to known marks applied to outplanted fish.

12.6) Dates or time period in which research activity occurs.

Juvenile research (e.g., trapping) will occur between February and June. Adult research (e.g., trapping or movement studies) will occur from October through January. Egg research may occur between December and February, and estuary research may occur between March and July.

12.7) Care and maintenance of live fish or eggs, holding duration, transport methods.

Eyed-eggs may be transported to Remote Site Incubators (RSIs). To do so, burlap sacks are soaked in stream water and then placed into a box. The eggs are gently poured into the box and more wet burlap is placed on top to cover them. Eggs are immediately transported to RSI sites. At the RSI site, eggs are gently poured into egg trays, which are then stacked into the RSI barrels. Each RSI set up consists of multiple water intake lines (all screened) that run into settling barrels. Filters in these barrels reduce the amount of fine sediment that is transported into the egg barrels. Water flows out of the top of the settling barrel and drops into a pipe where it then flows into the bottom of the egg barrel. The water is oxygenated as it flows through an "x" shaped pipe on the bottom of the barrel. Above this pipe, there is a tray with pea gravel (sterilized using argentine), and then above this is a layer of PVC substrate. This provides cover to hatched fry. Egg trays sit on top of the PVC substrate and are held in place by a metal bracket. The outflow to the barrel is always open and connects to a pipe that drops down to the creek. Fry may volitionally leave the barrel when they are ready.

Live juvenile fish will be held in aerated containers and anesthetized with MS-222 for the minimum amount of time required to enumerate, measure, and mark the fish. This may occur during juvenile trapping or beach seining. If fry should be held in acclimation ponds at a release site, a separate protocol will be developed and submitted as an addendum to this HGMP.

Adult fish may be handled during operation of adult traps, active capture in the estuary, or when handled at Big Creek Hatchery prior to outplanting. At traps, adults will be placed in a cradle for enumeration and measurements before being released into an upstream recovery pool for volitional escape. Should movement studies be conducted requiring more involved surgical techniques, adult fish would be anesthetized with MS-222 and handled according to established best practices.

In the estuary, adults may be captured using tangle nets or gill nets. These nets would be checked frequently to avoid causing excessive stress to fish. The purpose of these studies would be to understand adult encounter rates in fisheries in different habitats. All collected fish would be measured for length, scales would be removed for aging, the fish would be scanned for presence of a CWT, and a fin clip would be removed to determine the population of origin.

Lastly, for outplanting fish using a liberation truck, water in the truck is oxygenated at 2 psi and prepared with an additive (Vida Life; 25 ml/ 200 gallons water) to prevent loss of the fish slime coat. The tank is filled to about 350 gallons of water and up to 20 adult Chum Salmon may be transported at one time. At the release site, individuals are removed from the tank using a large dip net and carried to the creek where they are released in slow water. Any Chum Salmon that return to Big Creek Hatchery, post-release, may be opercle punched, any tag numbers may be recorded, and the individual may be released again. If stream conditions do not permit outplanting the fish again, it may be incorporated into the broodstock.

12.8) Expected type and effects of take and potential for injury or mortality.

The majority of take will be capture and handle which have minimal impact on the fish. From past experience operating adult traps and screw traps on the Oregon coast, mortalities are typically below 1% for adults, below 1% for smolts, and below 3% for fry

12.9) Level of take of listed fish: number or range of fish handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table".

See Table 2.7 for the projected take level.

12.10) Alternative methods to achieve project objectives.

The best available techniques shall be used in this monitoring program, to minimize take levels while achieving the project objectives.

12.11) List species similar or related to the threatened species; provide number and causes of mortality related to this research project.

See Table 2.7.

12.12) Indicate risk aversion measures that will be applied to minimize the likelihood for adverse ecological effects, injury, or mortality to listed fish as a result of the proposed research activities.

To minimize take levels, traps will be observed daily with visits more frequent during storm events, periods of high debris transport, or period of high fish abundance. In cases of high flows or excessive debris loads adult traps and screw traps will not be fished to reduce fish mortality.

SECTION 13. ATTACHMENTS AND CITATIONS

Citations:

Homel, K. 2014. Chum Salmon Reintroduction Plan (draft). Oregon Department of Fish and Wildlife, Clackamas, OR, 201 pages.

McElhany, P., T. Backman, C. Busack, S. Kolmes, J. Myers, D. Rawding, A. Steel, C. Steward, T. Whitesel, and C. Willis. 2004. Status evaluation of salmon and steelhead populations in the Willamette and lower Columbia River basins. Willamette/Lower Columbia Technical Recovery Team. NOAA Fisheries, Northwest Fisheries Science Center, Seattle, WA.

McElhany, P., M. Chilcote, J. Myers, and R. Beamesderfer. 2007. Viability Status of Oregon Salmon and Steelhead Populations in the Willamette and Lower Columbia Basins Part 3: Columbia River Chum. Report prepared for the Oregon Department of Fish and Wildlife and the National Marine Fisheries Service.

Oregon Department of Fish and Wildlife. 2006. 2005 Oregon native fish status report. Volume II. Assessment methods and population results. Oregon Department of Fish and Wildlife, Salem, Oregon.

Oregon Department of Fish and Wildlife. 2010. Oregon's Columbia River Chum Salmon Recovery Strategy, Appendix 1 of the Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead, Salem, Oregon.

Oregon Department of Fish and Wildlife and National Marine Fisheries Service (ODFW and NMFS). 2010. Lower Columbia River Conservation and Recovery Plan for Oregon Populations of Salmon and Steelhead. Oregon Department of Fish and Wildlife, Salem, OR. 423 pp. Available at: http://www.dfw.state.or.us/fish/CRP/lower_columbia_plan.asp.

Small, M. P., B. Glaser, T. Hillson, and C. Bowman. 2011. Population genetic structure and recovery of chum salmon in the Lower Columbia River. WDFW Molecular Genetics Lab report, Olympia, WA, 32 pages.

Wydoski, R.S. and R. R. Whitney. 2003. Inland Fisheries of Washington, 2nd Edition, American Fisheries Society, Bethesda, Maryland *in association with* University of Washington Press, Seattle and London. 322 pp.

SECTION 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

"I hereby certify that the information provided is complete, true and correct to the best of my knowledge and belief. I understand that the information provided in this HGMP is submitted for the purpose of receiving limits from take prohibitions specified under the Endangered Species Act of 1973 (16 U.S.C.1531-1543) and regulations promulgated thereafter for the proposed hatchery program, and that any false statement may subject me to the criminal penalties of 18 U.S.C. 1001, or penalties provided under the Endangered Species Act of 1973."

Name & Title of Applicant #1: Chris Knutsen, North Coast Watershed District Manager

Signature: _____ Date: 8/4/16

Name & Title of Applicant #2: Jeff Boechler, N. Willamette Watershed District Manager

Signature: _____ Date: 8-11-16

Certified by: Scott Patterson, Fish Propagation Program Manager, ODFW, Salem

Signature: _____ Date: 8/15/2016

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ADDENDUM A. PROGRAM EFFECTS ON OTHER (AQUATIC OR TERRESTRIAL) ESA-LISTED POPULATIONS. (Anadromous salmonid effects are addressed in Section 2)

15.1) List all ESA permits or authorizations for USFWS ESA-listed, proposed, and candidate salmonid and non-salmonid species associated with the hatchery program.

See Section 2.1

15.2) Describe USFWS ESA-listed, proposed, and candidate salmonid and non-salmonid species and habitat that may be affected by hatchery program.

There are three non-anadromous and/or non-salmonid species of fish in the LCR that are federally listed under the ESA (Table 15.2-1). Other ESA listed species are listed in table 15.2-2.

Table 15.2-1. Federally listed non-anadromous and/or non-salmonid fish species that could be incidentally affected by the hatchery program.

Species	Population	Status	Range in Lower Columbia River Basin	Type of Interaction with Salmon and Steelhead
Bull Trout (Salvelinus confluentus)	Columbia River	Threatened	Lower Columbia River Main-stem	Predator of juvenile salmon and steelhead
Eulachon (*Thaleichthys pacificus*)	Southern DPS	Threatened	Columbia River and tributaries	Freshwater prey of salmon and steelhead
Green Sturgeon (*Acipenser medirostris*)	Southern DPS	Threatened	Columbia River Estuary	Bycatch in salmon fisheries

Table 15.2-2. Other listed or candidate species in the area of the hatchery program.

Group	Name	Population	Status
Marine Mammals	Killer whale (*Orcinus orca*)	Southern Resident	Endangered
Mammals	Columbian white-tailed deer (*Odocoileus virginianus leucurus*)	Columbia River DPS	Endangered
Mammals	red tree vole (*Arborimus longicaudus*)	North Oregon Coast DPS	Candidate
Birds	Short-tailed albatross (*Phoebastria* (=Diomedea) *albatrus*)	Entire	Endangered
Birds	Yellow-billed Cuckoo (*Coccyzus americanus*)	Western U.S. DPS	Threatened
Birds	Western snowy plover (*Charadrius alexandrinus nivosus*)	Pacific coastal pop.	Threatened
Birds	Northern spotted owl (*Strix occidentalis caurina*)	Entire	Threatened
Birds	Marbled murrelet (*Brachyramphus marmoratus*)	CA, OR, WA	Threatened

Birds	Streaked Horned lark (*Eremophila alpestris strigata*)		Threatened
Insects	Oregon silverspot butterfly (*Speyeria zerene hippolyta*)	Entire	Threatened
Flowering Plants	Nelson's checker-mallow (*Sidalcea nelsoniana*)		Threatened

15.3) Analyze effects.

Direct take of Bull Trout, Eulachon, and Green Sturgeon will not occur as a result of Big Creek Hatchery Chum Salmon Recovery Program. There might be indirect interaction with these fish species as listed in table A.2-1 but any interaction should be negligible.

No direct or indirect take of USFWS-listed species (Table A.2-2) will occur nor will they be adversely affected due to operations of Big Creek Hatchery for Chum Salmon production and releases.

15.4) Actions taken to minimize potential effects.

Not applicable, as no take of USFWS-listed species will occur or be adversely affected by Chum Salmon Recovery Program.

15.5) References.