June 10, 2016

4(d) Rule Limit 6
Evaluation and Recommended Determination

Title of RMP: Joint Hatchery and Genetic Management Plans for Dungeness River Hatchery Spring Chinook Salmon, Dungeness River Pink (Fall-Run) Salmon, and the Dungeness River Hatchery Coho Salmon

RMP Submitted by: Washington Department of Fish and Wildlife
Jamestown S'Klallam Tribe

ESU/DPSs: Puget Sound Chinook Salmon ESU
Hood Canal Summer Chum Salmon ESU
Puget Sound Steelhead DPS

4(d) Rule Limit: ESA 4(d) Rule Limit 6

NMFS Tracking Number: NWR-2013-9701

1 BACKGROUND

NOAA's National Marine Fisheries Service (NMFS) issued a final Endangered Species Act (ESA) 4(d) Rule adopting regulations necessary and advisable to conserve Puget Sound Chinook salmon and Hood Canal summer-run chum salmon (50 CFR 223.203(b); 70 FR 37160, June 28, 2005). The 4(d) protective regulations adopted for the two salmon ESUs were subsequently applied to Puget Sound steelhead in a separate final rule (73 FR 55451, June 25, 2008). Under limit 6 of the Rule, ESA section 9 take prohibitions for these listed salmonid species do not apply to hatchery activities that are undertaken in compliance with a resource management plan (RMP) developed jointly by the Tribes and the State of Washington that is consistent with the 4(d) Rule criteria. The Washington Department of Fish and Wildlife (WDFW) and Jamestown S'Klallam Tribe, as co-managers of the fisheries resource under *United States v. Washington* (1974) (hereafter referred to as "the co-managers"), have provided NMFS with three Hatchery and Genetic Management Plans (HGMP) for supportive breeding and associated monitoring and evaluation actions in the Dungeness River watershed that will affect ESA-listed Puget Sound Chinook salmon, Hood Canal summer chum salmon, and Puget Sound steelhead. The HGMPs provide the framework through which the Washington State and Tribal jurisdictions can jointly manage Dungeness River salmon hatchery operations, and monitoring, and evaluation activities, while meeting requirements specified under the ESA. The proposed plans are interrelated and interdependent through shared salmon population recovery and harvest augmentation objectives and effects; broodstock collection locations and actions; fish rearing and release sites; monitoring and evaluation actions; and funding sources. The co-managers developed the plans jointly, and have provided the HGMPs for review and determination by NMFS as to whether the joint plans address the criteria of limit 6 of the 4(d) Rule, and whether limitation of application of ESA section 9 take prohibitions will

therefore apply for hatchery and associated monitoring and evaluation actions operating consistent with the HGMPs. Building from the Dungeness River watershed chapter of the Shared Strategy for Puget Sound (SSPS 2005), these comprehensive hatchery resource management actions for Dungeness River salmon are described by the co-managers for NMFS' consideration in the form of HGMPs. While, for the purposes of this evaluation, description of the proposed activities will focus on the descriptions given in the individual plans, for the purposes of the proposed recommendation, because of the integral connection between the plans and the intent of the co-managers in developing the plans, the co-managers' three joint HGMPs will be considered a RMP.

2 PROPOSED ACTION

The three HGMPs submitted by the co-managers describe proposed Dungeness River Hatchery salmon population supportive breeding, harvest augmentation, and associated monitoring and evaluation actions affecting listed Puget Sound Chinook salmon, Hood Canal summer chum salmon, and Puget Sound steelhead within the Dungeness River watershed, including Dungeness Bay. Applications for ESA authorizations under the section 4(d) Rule, limit 6, must provide the necessary information described in 50 CFR part 222.308, or 50 CFR 223.203, respectively. The HGMPs were reviewed upon their final submittal in updated form, and NMFS determined that they were sufficient for NMFS to proceed in its evaluation of effects of the plans, positive and negative, on listed fish (April 24, 2013, letter from Bob Turner, NMFS, to Phil Anderson, WDFW and Scott Chitwood, Jamestown S'Klallam Tribe).

The HGMPs describe programs for spring Chinook salmon (WDFW 2013a), fall-run pink salmon (WDFW 2013b), and coho salmon (WDFW 2013c) (Table 1). The three programs would use the native or extant populations of each salmon species in the Dungeness River as broodstock, and release their progeny as smolts into the Dungeness River watershed. The programs would provide hatchery salmon production to help meet fish loss mitigation responsibilities, preserving critically depressed native salmon populations and partially off-setting adverse impacts on natural-origin salmon and their habitat resulting from past and on-going human developmental activities in the Dungeness River basin (Haring 1999), and from climate change. The goals of the programs are to meet population recovery objectives and fisheries harvest augmentation responsibilities by providing hatchery fish for the purposes of: (1) conserving the native salmon resources, (2) supporting values associated with Treaty-reserved fishing rights to meet Jamestown S'Klallam tribal commercial, ceremonial, and subsistence needs, and (3) meeting regional and international commercial and recreational fisheries objectives.

The programs would mitigate for lost natural-origin fish production by producing Dungeness River basin-origin salmon to preserve and help restore depressed native populations (Chinook and fall-run pink salmon), and provide tribal commercial, ceremonial and subsistence fisheries, and non-Indian recreational and commercial harvest, of the extant coho salmon population in the river by the Jamestown S'Klallam Tribe and Washington state citizens, respectively. The proposed programs would also include monitoring of program performance and effects in the Dungeness River and adjacent marine areas, while applying measures that would minimize risks of adverse genetic, demographic, or ecological effects on listed fish and other natural populations. In addition

Table 1. Proposed hatchery programs for Dungeness River salmon.

Hatchery Program	Operator
Dungeness River Hatchery Spring Chinook (Integrated)	WDFW
Dungeness River Hatchery Pink (Fall-Run) Salmon (Integrated)	WDFW
Dungeness River Coho Hatchery Program (Segregated)	WDFW

to conserving at-risk salmon populations, the programs would also help meet tribal fishery harvest allocations that are guaranteed through treaties, as affirmed in *U.S. v. Washington* (1974). The hatchery-origin salmon produced through the programs would also help meet Pacific Salmon Treaty harvest sharing agreements with Canada. The HGMPs were designed to be consistent with the strategies and actions specified in the Dungeness River watershed recovery plan, the salmon recovery strategy for the basin (SSPS 2005 – Volume II). The watershed plan describes how the hatchery programs would operate in conjunction with harvest management, habitat restoration, and habitat protection actions to achieve near- and long-term goals for natural and hatchery production of salmon in the Dungeness River basin.

The three salmon supportive breeding programs are proposed by the co-managers for evaluation and determination for their consistency with ESA 4(d) Rule limit 6 criteria. If determined to be in compliance with the 4(d) Rule, the salmon hatchery programs would operate in conjunction with on-going habitat restoration and harvest management actions implemented consistent with the objectives of the recovery plan for the watershed (SSPS 2005) until healthy, natural-origin salmon populations that would sustain fisheries are restored.

All co-manager supportive breeding and associated monitoring and evaluation actions currently proposed by the co-managers for Dungeness River watershed salmon populations are included in the HGMPs. Supportive breeding actions proposed in the HGMPs, including descriptions of the facilities where the majority of actions occur and broodstock collection locations and methods, are summarized below.

Each proposed hatchery program would be based at WDFW's Dungeness River Hatchery, located adjacent to the Dungeness River at river mile (RM) 10.5 (WDFW 2013a). As a satellite facility for Dungeness River Hatchery, Hurd Creek Hatchery (RM 0.2 on Hurd Creek, tributary to the Dungeness River at RM 2.7) would be used to support incubation, rearing and release of Chinook, pink, and coho salmon. Two acclimation ponds (Gray Wolf Acclimation Pond (RM 1.0 on the Gray Wolf River, tributary to the Dungeness River at RM 15.8) and Upper Dungeness Acclimation pond (RM 15.8 on the Dungeness River) would be off-station (or satellite) rearing and release locations in support of the Dungeness River Hatchery Chinook salmon program (WDFW 2013a). Another satellite operation, the Mainstem Dungeness River weir (river mile 2.5 on the Dungeness River) would be used to collect Chinook salmon and fall-run pink salmon for use as broodstock (WDFW 2013a; WDFW 2013b). A juvenile out-migrant trap (screw trap) is operated annually at river mile 0.5 on the Dungeness River during the spring and summer months to estimate numbers of seaward migrating smolts, enabling estimation of productivity and survival rates for hatchery

and naturally produced salmon. This out-migrant trap is operated under a separate annual ESA take authorization afforded through ESA 4(d) rule limit 7. Surface water is withdrawn from the Dungeness River, Canyon Creek, Hurd Creek, and the Gray Wolf River to rear fish in the facilities. The Hurd Creek Hatchery also uses groundwater withdrawn from five wells to augment surface water sources for fish rearing. Effects on downstream aquatic life of effluent discharge at the facilities are regulated and monitored through Federal National Pollutant Discharge Elimination System (NPDES) permits issued where required to each facility. All of the programs would use broodstock collected and spawned from adult fish representing the remaining native, extant salmon populations in the Dungeness River. Juvenile progeny of these Dungeness River population-origin salmon would be incubated, hatched, and reared at the hatchery facilities for several months (subyearling Chinook and pink salmon), or one year (yearling Chinook and coho salmon). All juvenile fish would be released as seawater-ready, migrating smolts directly from the hatcheries and acclimation ponds. Adult Chinook and pink salmon recruiting to the hatcheries or collected as broodstock that are surplus to hatchery broodstock needs would be released back into the watershed to spawn naturally. Adult coho salmon that are surplus to hatchery broodstock needs would be provided to a WDFW-contracted fish buyer or distributed in watershed areas for nutrient enhancement purposes.

Monitoring and evaluation actions associated with implementation of the proposed programs would include measures designed to assess supportive breeding program performance and effects. Spawning ground surveys would be used to estimate annual escapement abundances and distribution of each species by origin (hatchery and natural-origin) in natural spawning areas within the watershed. Biological sampling of carcasses would be conducted to determine age class, sex ratios, and fish origin through mark and/or tag (e.g., coded wire tags) observations and recoveries. All fish reared in the hatchery would be monitored and sampled for mortality rates by life stage, fish health (by fish health professionals), and for population census purposes. All hatchery-origin fish would be marked and/or tagged prior to their release into the natural environment to allow for assessment of smolt to adult survival rates and to determine origin of adult returns. Mass marking would also allow for differentiation of hatchery- from natural-origin adult fish escaping to the Dungeness River, and identification of salmon by origin during the juvenile fish emigration periods.

The predominant HGMP actions and effects would occur in the Dungeness River and its tributaries, extending from the upper-most reaches accessible to migrating salmon in the watershed, downstream to the river mouth, including Dungeness Bay (Figure 1). This area includes the Dungeness River Hatchery, Hurd Creek Hatchery, Gray Wolf River Acclimation Pond and Upper Dungeness River Acclimation Pond sites, the portions of the Dungeness River watershed where fish produced by the programs would be released as juveniles and return as adults, and the estuary through which migrating hatchery-origin fish would pass as they enter the river as adults or exit the river as newly released juveniles. The affected area would include all freshwater and estuary areas used by the extant populations of listed Chinook salmon, summer chum salmon, and steelhead originating from the Dungeness River watershed. For coho salmon,

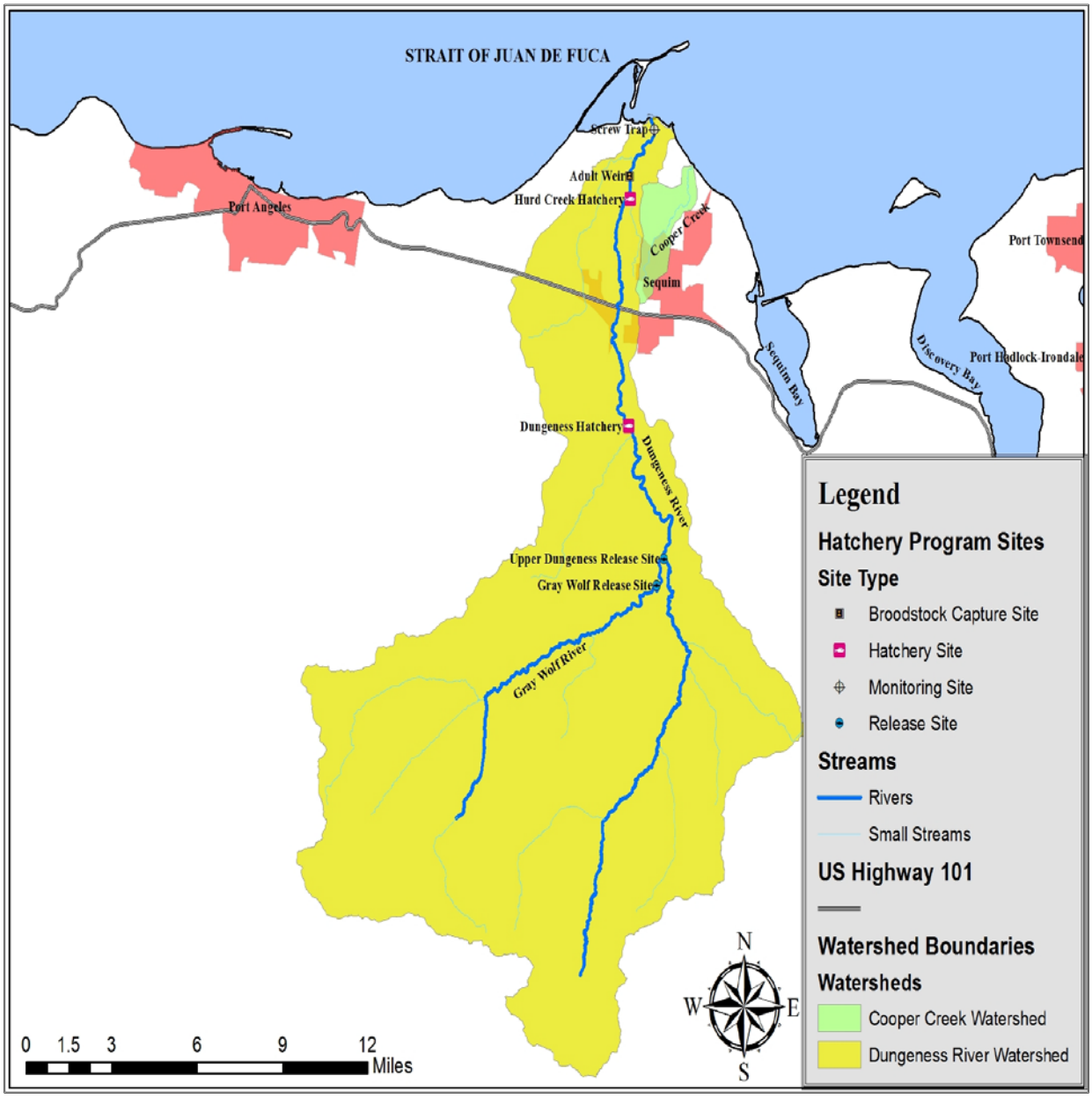

Figure 1. Action area for the proposed continued operation of salmon hatcheries for conservation and fisheries harvest augmentation purposes in the Dungeness River watershed.

the affected area would include Cooper Creek, an adjacent watershed where a very small number of Dungeness River Hatchery-origin coho salmon fingerlings (2,000 fish) would be released as part of an education and outreach program.

3 EVALUATION

The final 4(d) Rule for salmon and steelhead states that the prohibitions of paragraph (a) of the rule (50 CFR 223.203(a)) do not apply to actions taken in compliance with a RMP jointly developed by the States of Washington, Oregon, and/or Idaho and the Tribes, provided that elements of the rule are met, including the following:

- The Secretary of Commerce (Secretary) has determined pursuant to 50 CFR 223.209(b) [the Tribal 4(d) Rule] and the government-to-government processes therein that implementing and enforcing the joint tribal/state plan will not appreciably reduce the likelihood of survival and recovery of affected threatened ESUs and DPSs.

In making that determination for a joint plan, the Secretary has taken comment on how any hatchery and genetic management plan addresses the criteria in §223.203(b)(5).

As per the Tribal 4(d) Rule, NMFS consulted with the Jamestown S'Klallam Tribe and WDFW during the development of the three salmon HGMPs through government-to-government and technical work group meetings. These occasions presented the opportunity to provide technical assistance, to exchange information and discuss what would be needed to conserve the listed species, and to be consistent with legally enforceable tribal rights and with the Secretary's trust responsibilities to the treaty tribes.

The following discussion evaluates whether the submitted plans address the criteria in section 223.203(b)(5) of the 4(d) Rule for salmon and steelhead.

3.1 Limit 5 Criteria and RMP Evaluation

3.1.1 5(i)(A) The HGMP has clearly stated goals, performance objectives, and performance indicators that indicate the purpose of the program, its intended results, and measurements of its performance in meeting those results.

Goals, performance objectives (standards), and performance indicators for the three Dungeness River Hatchery salmon programs are clearly described in sections 1.7, 1.9, and 1.10, respectively of each HGMP (WDFW 2013a; 2013b; 2013c).

The general goals of the programs described in section 1.7 of each HGMP are to meet population recovery objectives and fisheries harvest augmentation responsibilities by providing hatchery fish for the purposes of: (1) conserving the native salmon resources, (2) supporting values associated with Treaty-reserved fishing rights to meet Jamestown S'Klallam tribal commercial, ceremonial, and subsistence needs, and (3) meeting regional non-Indian recreational and commercial fisheries objectives. The programs would mitigate for lost natural-origin fish production by producing native Dungeness River basin salmon to preserve and help restore the populations (Chinook and fall-run pink salmon), and provide commercial, ceremonial and subsistence fisheries, and recreational and commercial harvest, of coho salmon by the Jamestown S'Klallam Tribe and

Washington state citizens, respectively. In addition to conserving at-risk Chinook and fall-run pink salmon populations, goals of the programs would include helping to meet tribal fishery harvest allocations that are guaranteed through treaties, as affirmed in *U.S. v. Washington* (1974). The hatchery-origin salmon produced through the programs would also help meet Pacific Salmon Treaty harvest sharing agreements with Canada. The HGMPs were designed to be consistent with the strategies and actions specified in the Dungeness River watershed recovery plan, the salmon recovery strategy for the basin (SSPS 2005 – Volume II).

Performance standards derived from the Northwest Power Planning Council (NPPC) Artificial Production Review (APR) (NPPC 2001), and performance indicators that would be used to gauge compliance with each of the standards, are described for the three salmon hatchery programs in section 1.11 of each of the HGMPs (WDFW 2013a; 2013b; 2013c). Responsive monitoring and evaluation actions that would be implemented to collect information relevant to each indicator are also described in that section. Separate performance standards, indicators, and monitoring and evaluation actions are presented to track achievement of hatchery program performance relative to objectives, and monitor program effects on affected fish populations. HGMP implementation approaches would be generally designed to determine; program consistency with proposed hatchery actions and intended results (e.g., juvenile fish release and adult return levels); measurement of the program's success or failure in attaining results; and, effects of the program on natural-origin fish populations in the Dungeness River watershed.

In general, species-specific standards and indicators included in each HGMP address the four viable salmonid population parameters for the native salmon populations that are the subjects of the plans. Performance standards and indicators addressing abundance would track achievement of broodstock collection goals by origin (hatchery or natural); maintenance of on-station juvenile fish release objectives; the status of *total* adult return levels and returns by origin; and natural smolt production. Performance standards and indicators addressing productivity would track hatchery smolt to adult survival rates and natural-origin population growth and recruitment. Population spatial structure standards and indicators would address hatchery and natural adult fish migration dispersal in the watershed, and the need to augment natural fish spawning in watershed areas through spawning by hatchery-origin adult fish. Program standards and indicators for diversity would track hatchery program success in maintaining hatchery populations that would retain the genetic traits for the target, native salmon populations, marking all hatchery-origin fish to allow for monitoring of program effects on diversity, and determining broodstock and spawner composition by origin.

For all proposed programs, annual natural and hatchery-origin salmon and steelhead population abundances would be assessed by monitoring adult returns to the Dungeness River mainstem and tributary spawning areas and to the hatchery release locations. Abundance estimates derived through these methods would be evaluated to determine the standing of the listed Chinook salmon and non-listed pink and coho salmon populations relative to escapement abundance objectives. The estimated contribution of hatchery-origin salmon to the hatcheries, and to natural spawning areas would be monitored by marking and/or tagging all hatchery-origin fish prior to their release as juveniles to allow for their distinction from natural-origin fish upon return as adults. Estimates

of fish-origin would be made based on mark or tag observation and recovery, and age class composition through scale sampling. Using mark recovery information, the number of natural and hatchery-origin salmon contributing to annual escapement would be estimated.

Assessments of natural-origin Chinook salmon (and non-listed pink and coho salmon) productivity would be enabled by monitoring of natural-origin adult abundances and trends through hatchery escapement levels and spawning ground surveys. The productivity performance standards and indicators proposed for fish maintained in, and produced by, the hatcheries would be assessed through review of broodstock collection, holding, and spawning results, and the performance of the hatchery program in producing healthy fish, meeting desired smolt to adult survival rates, and meeting the program goal of restoring a healthy, self-sustaining population that maintains the genetic characteristics of the existing Chinook salmon stock (WDFW 2013a).

The degree to which the Chinook salmon program, and the programs propagating non-listed pink and coho salmon, meet performance standards and indicators for spatial structure would be determined through spawning ground surveys conducted upstream and downstream of the Dungeness River Hatchery program fish release sites.

Compliance with diversity-related performance standards and indicators would be indicated through completion of genetic and otolith mark recovery analyses of adult Chinook salmon escaping to natural spawning areas and the hatchery fish release locations, and annual tracking of population morphometric, meristic, and life history characteristics. Monitoring of the number and proportion of hatchery-origin and natural-origin Chinook salmon in natural spawning areas within the action area would be additional diversity indicators.

3.1.2 5(i)(B) The HGMP utilizes the concepts of viable and critical salmonid population thresholds, consistent with the concepts contained in the technical document entitled "Viable Salmonid Populations."

HGMPs proposed for consideration under the 4(d) Rule must use the concepts of viable and critical thresholds as defined in the NMFS Viable Salmonid Population (VSP) document (McElhany et al. 2000). Application of these VSP concepts is needed to adequately assess and limit the take of listed salmonids for the protection of the species. Listed salmonids may be purposefully taken for broodstock purposes only if: the donor population is currently at or above the viable threshold and the collection will not impair its function; the donor population is not currently viable but the sole objective is to enhance the propagation or survival of the listed ESU; or the donor population is shown with a high degree of confidence to be above the critical threshold although not yet functioning at viable levels, and the collection will not appreciably slow attainment of viable status for that population.

Section 2.2.2 of the Dungeness River Hatchery HGMPs describes the status of the listed Dungeness Chinook salmon, summer chum salmon and steelhead populations relative to "critical" and "viable" population thresholds. Goal population viability parameters bearing on the abundance, diversity, spatial structure, and productivity status of the Dungeness Chinook salmon

population were developed by the co-managers and the Puget Sound Technical Recovery Team as part of the Shared Strategy for Puget Sound salmon recovery planning process, including abundance criteria (Table 2) (SSPS 2005; WDFW 2013a).

Table 2. Minimum viability spawning abundance, abundance at equilibrium or replacement, and spawning abundance and productivity at maximum sustainable yield for a recovered state for the Dungeness Chinook salmon population and for the entire Puget Sound Chinook Salmon ESU.

Population - Region	TRT Minimum Viability Abundance [e]	Status Under Properly Functioning Conditions (PFC)			NMFS Escapement Thresholds	
		Equilibrium Abundance	Spawners at MSY	Productivity at MSY	Critical [a]	Rebuilding [b]
Dungeness	4,700	4,700	1,000	3	200 [c]	925 [d]
ESU	261,300	307,500	70,948	3.2	261,300	261,300

Source: Ford et al. 2011; WDFW 2013a.

[a] Critical natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000a).

[b] Rebuilding natural-origin escapement thresholds under current habitat and environmental conditions (McElhany et al. 2000; NMFS 2000a).

[c] Based on generic VSP guidance (McElhany et al. 2000; NMFS 2000a).

[d] Based on alternative habitat assessment.

[e] The TRT minimum viability abundance for the two Strait of Juan de Fuca populations, was the equilibrium abundance or 17,000, whichever was less.

The Puget Sound Recovery Implementation Technical Team (RITT) assembled viability goals for Hood Canal summer-run chum salmon that are part of the Strait of Juan de Fuca population (Sands et al. 2009; see Table 3). No specific viability goals were developed for the summer chum salmon spawning aggregation in the Dungeness River because the numbers of summer chum adults returning to the watershed are so low that they may not represent a self-sustaining stock. However, the Dungeness River is considered an important watershed for restoring the diversity of the Strait of Juan de Fuca summer chum salmon population component of the listed ESU (Sands et al. 2009). Viability goals for the Puget Sound steelhead DPS were finalized for the steelhead populations included in the Puget Sound steelhead DPS in 2015 (Hard et al. 2015).

The population viability goals, where available, were incorporated by WDFW and the Jamestown S'Klallam Tribe in planning and guiding the proposed implementation of the Dungeness River Hatchery salmon programs (WDFW 2013a). The viability goals would be used as reference points for identifying the status of the listed salmon and steelhead populations during implementation of the hatchery programs. The goals would be used to gauge the program performance and effects in achieving population recovery goals and conservation or risk reduction objectives specified in the HGMPs, and for determining the need for adjustment of the hatchery actions. The following sections identify the current status of the listed Chinook salmon, summer chum salmon, and steelhead populations in the watershed. General descriptions of how the

Table 3. Population viability parameters for the Strait of Juan de Fuca (JDF) summer chum salmon population of Hood Canal summer chum salmon.

Population - Region	Spawner Abundance		Spatial Structure	Diversity	Productivity
	TRT	HCCC			
Dungeness	-	-	Most spawning aggregations within 20 km of adjacent aggregations; Major spawning aggregations not more than 40 km apart	SJF population has one or more persistent spawning aggregations from the Dungeness & Sequim/Admiralty diversity units	$\geq$ 1.0
Strait of JDF	4,500 – 6,400	2,080			

Source: Sands et al. 2009; PNPTT and WDFW 2003; HCCC 2005.

hatchery programs for Chinook, pink and coho salmon would be implemented to benefit VSP parameters for listed Chinook and summer chum salmon, or not harm the viability status of those listed salmon populations and steelhead, are provided.

Dungeness Chinook Salmon

The Dungeness Chinook salmon population is among the 22 populations of Chinook salmon in the region delineated by NMFS as part of the Puget Sound Chinook salmon ESU (Ruckelshaus et al. 2006). The Dungeness Chinook salmon population is grouped with one other population – Elwha - in the Strait of Juan de Fuca biogeographical region for Puget Sound Chinook salmon ESU recovery planning purposes (SSPS 2005; NMFS 2006b). Under NMFS recovery and delisting criteria for the listed ESU, two or more populations within the biogeographical region need to be recovered to a low extinction risk status for the ESU to be considered recovered and delisted (NMFS 2006b). Hatchery-origin Chinook salmon produced through the Dungeness River Hatchery program (WDFW 2013a) are included with the natural-origin component of the Dungeness Chinook salmon population as part of the ESA-listed ESU (70 FR 37160, June 28, 2005).

The extant Dungeness Chinook salmon population is considered a spring/summer-run timed (or "early") population, based on spawn timing (WDF and WWTIT 2004). Weir operations in 1997 and 2001 indicate that most of the adult Chinook enter the river by early August (PSIT and WDFW 2010a). Spawning occurs from mid-August to mid-October (WDFW and WWTIT 1994). Spawning begins about two weeks earlier in the upper Dungeness River and in the Gray Wolf River than in the main stem below its confluence with the Gray Wolf River (WDFW and WWTIT 1994; Ruckelshaus et al 2006). The area of spawning extends to the falls on the Dungeness River at RM 18.7 where the falls, just above the mouth of Gold Creek, block further access to anadromous fish. Chinook salmon also spawn at least into the lower 6.1 miles of the Gray Wolf River, although the river is accessible to migrating anadromous fish to RM 8.0

(WDFW and WWTIT 1994; Haring 1999). Chinook salmon spawn in the lower Dungeness River downstream of Dungeness River Hatchery, and in lower Canyon Creek below the existing hatchery water intake dam at RM 0.08 (Haring 1999). Myers et al (1998) reported that Dungeness Chinook adults mature primarily at age four (63%), with age 3 and age 5 adults comprising 10% and 25%, of the annual returns, respectively. Recent scale analyses data collected for Dungeness Chinook indicate that adult hatchery-origin fish return to the river at the following age class proportions: subyearling-origin adults: Age 2 (8%), 3 (36%), 4 (48%), 5 (8%), and 6 (0%); yearling-origin adults: Age 2 (1%), 3 (17%), 4 (56%), 5 (23%), and 6 (3%). Dungeness Chinook salmon predominantly exhibit an ocean-type life history trajectory (95 to 99 percent of the total emigrating population, with juveniles emigrating seaward from mid-February through the end of July as fry, fingerlings, or sub-yearlings smolts after just a few months of rearing in the watershed (Myers et al.1998; Topping and Kishimoto 2008; Topping et al. 2008). A very small portion of the population may rear in the river for a year and emigrate seaward as yearlings (Marlowe et al. 2001; SSPS 2005). Through juvenile outmigrant trapping at RM 0.5 just above the point of tidal influence, Topping et al (2006) found two distinct peaks in natural-origin Chinook salmon seaward emigration, indicating newly emerged fry and subyearling smolt migration trends. Emigration abundance peaks occurred on March 16 for fry (average individual size of 39 mm fl) and June 8 for subyearling smolts (average size of 74 mm fl). Fry accounted for an estimated 24% of the emigrating juvenile population and 76% emigrated seaward as subyearling smolts (Topping et al. 2006).

Abundance - The current abundance of Dungeness Chinook salmon is substantially reduced from historical levels (SSPS 2005). The historical equilibrium abundance level[1] for the Dungeness population is 8,100 fish (Ruckelshaus et al. 2002). From 1986 through 2000, the average total escapement in the watershed was 153 fish. Between 2000 and 2011, the estimated average total annual naturally spawning Chinook salmon escapement was 559 fish (Figure 2; WDFW 2013a). The recent year Chinook salmon abundance measured as natural spawning escapement to the river is 6.9% of the historical equilibrium abundance for the population. Assessments of current habitat productivity in the watershed suggest that the Dungeness River can theoretically support 699 Chinook salmon spawners, and that the Gray Wolf River is underutilized (SSPS 2005). Chinook salmon produced in the Dungeness River Hatchery are included as part of the Dungeness population, and listed with natural-origin fish as threatened (NMFS 2003). Hatchery-origin Chinook salmon make up a sizeable fraction of the annual naturally spawning adult abundance, averaging 77% for the basin in recent years (2000-2011), and ranging from 39% to 96% (WDFW 2013a). The highest observed hatchery-origin escapements (2001-2006) reflect years when adult fish progeny of captive broodstock program Chinook salmon returned to spawn (PSIT and WDFW 2010a). A captive broodstock program initiated to preserve and rebuild the population was, by design, terminated after the 2003 brood (2006 return year), and escapements correspondingly decreased in return years 2007 through 2009. A reinitiated supplementation

1 "Historical equilibrium abundance" is the estimated maximum (upper level) number of naturally spawning Chinook salmon under properly functioning habitat conditions in the Dungeness River watershed. The lower level of the *planning* range for equilibrium spawner abundance is 4,700 fish.

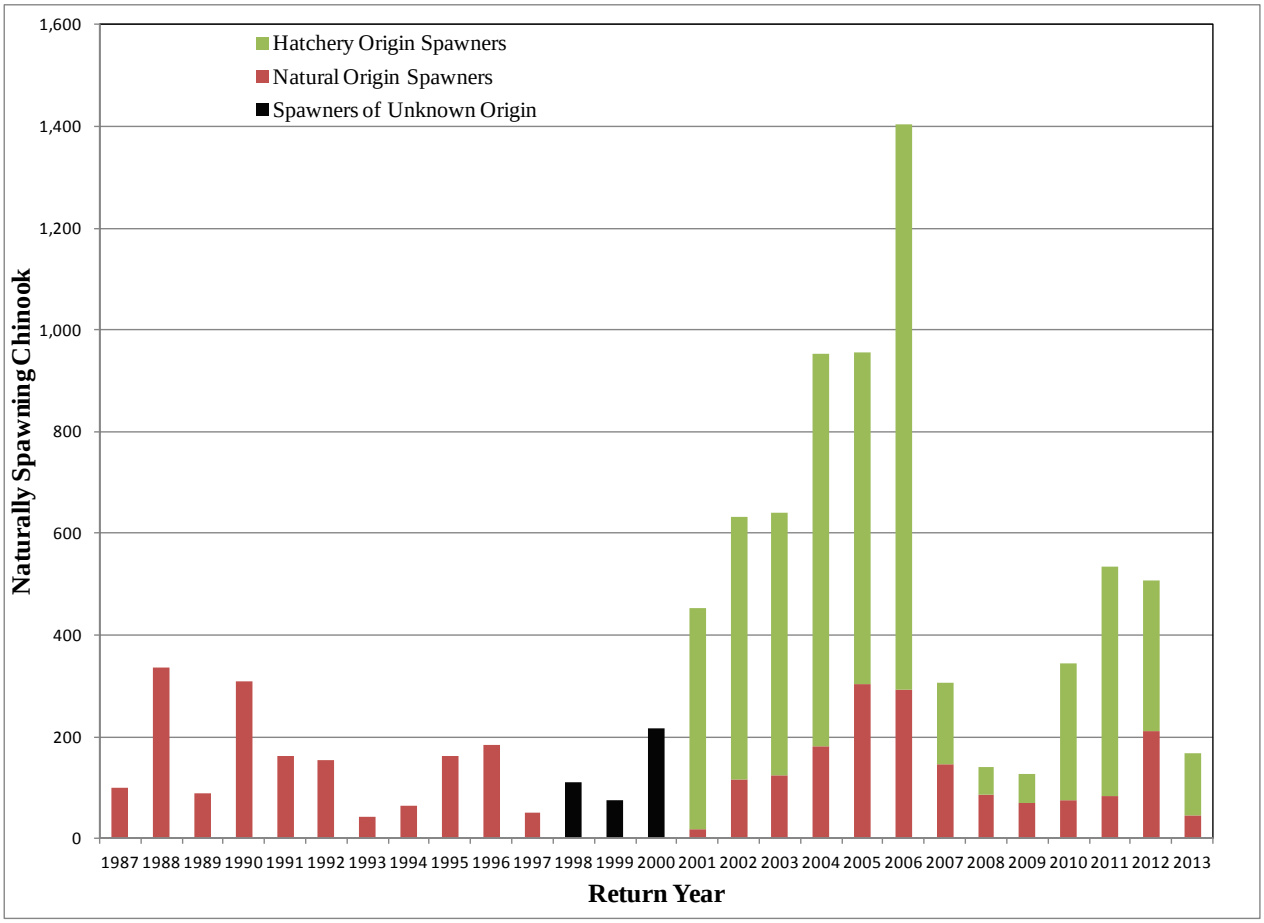

Figure 2. Estimated annual naturally spawning Chinook salmon escapement abundance in the Dungeness River for 1987 – 2013. Data sources: PSIT and WDFW 2010a; WDFW 2013a; WDFW unpublished data 2014, accessed via: https://fortress.wa.gov/dfw/score/score/species/population_details.jsp?stockId=1240

hatchery program based on subyearling fish releases is increasing adult returns and natural spawning levels (return years 2010 and 2011).

Spatial Structure - Spatial structure for the Dungeness Chinook population has also been affected over time relative to historical levels. A full spanning weir operated beginning in the 1930s in association with the Dungeness River Hatchery program to collect broodstock at RM 10.8 precluded unrestricted upstream access and spawning in the upper Dungeness River watershed for 50 years, although some Chinook salmon were known to have regularly escaped upstream during that period (Haring 1999; SSPS 2005). The rack was removed in the 1980s. Although Chinook salmon continue to have access to their historical geographic range of habitat, and now spawn throughout the entire river, recent year low adult return levels have led to underutilization of accessible areas, especially in the Gray Wolf River (SSPS 2005).

Human development actions in the watershed have degraded available spawning and migration areas for adult fish and refugia for rearing juvenile salmon to the detriment of Chinook salmon survival (Haring 1999). Side channel habitat in the lower river, once available for spawning and rearing, has been lost due to diking and other land and water-use activities. Spatial structure for the population has been adversely affected through dikes, levees and other actions to control the lower reaches of the river and tributaries. Water withdrawals for agricultural and municipal uses have substantially reduced flows needed during the adult salmon upstream migration and spawning periods, result in spawning redds being constructed in channel areas that are extremely susceptible to sediment scour and deposition (Haring 1999; SSPS 2005).

Diversity - Genetic diversity of the Dungeness Chinook salmon population has been substantially reduced by anthropogenic activities over the last century. Extensive human disruptions in the watershed, including sporadic releases of non-native hatchery fall Chinook salmon in the last century, may have severely impacted a late-returning life history of Chinook salmon that existed in the watershed (Ruckelshaus et al. 2006, citing Williams et al. 1975, Jamestown S'Klallam Tribe 2003). Recent assessments indicate that only one Chinook salmon stock with no discontinuity in spawning distribution through time or space exists in the basin (Marlowe et al. 2001; Ruckelshaus et al. 2006). The Puget Sound Chinook salmon TRT concluded that the late-returning life history in the Dungeness River was a significant part of the historical diversity of the Chinook salmon population (Ruckelshaus et al. 2006). Evidence suggests that the Puget Sound Chinook Salmon ESU has lost 15 spawning aggregations that were either demographically independent historical populations or major components of the life history diversity of the remaining 22 extant independent historical populations identified (Ruckelshaus et al. 2006). Nine of the 15 putatively extinct spawning aggregations were thought to be spring or summer-run type Chinook salmon. The disproportionate loss of early-run life history diversity represents a particularly important loss of the evolutionary legacy of the historical ESU. As a now rare race in the region, the substantially reduced abundance of the Dungeness spring/summer-run population relative to historical levels represents a risk to remaining ESU diversity.

Productivity - Productivity for Dungeness Chinook salmon has remained relatively stable at very low levels since the Puget Sound Chinook ESU was listed in 1999. Although the most recent NMFS status review for the ESU found that productivity trends for the population from 1982 through 2006, as measured by recruit per spawner and spawner to spawner rates, are slightly positive, the population is consistently experiencing spawner returns well below replacement levels (Table 4 from Ford et al. 2011).

Table 4. Average productivity for the Dungeness Chinook salmon population, and the entire ESU, for five-year intervals measured as recruits per spawner (R/S) and spawners per spawner (S/S) for natural origin fish. "ESU" refers to the aggregate Puget Sound Chinook evolutionarily significant unit.

Brood Years	**1982-1986**		**1987-1991**		**1992-1996**		**1997-2001**		**2002-2006**		**Trend**	
Population	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**	**R/S**	**S/S**
Dungeness	*0.58*	*0.21*	*0.31*	*0.11*	*0.25*	*0.20*	*1.67*	*0.93*	*0.44*	*0.18*	*0.11*	*0.08*
ESU	*9.57*	*2.19*	*5.05*	*0.96*	*3.01*	*1.24*	*2.70*	*1.19*	*1.67*	*0.67*	*-1.81*	*-0.28*

Source: Ford et al. 2011. R/S, S/S, and trend findings based on assumptions for years where escapements were not sampled to determine actual hatchery: natural-origin escapement ratios.

Although the Dungeness Chinook population appears to be stable over the longer term, low egg to juvenile outmigrant survival rates reflect a general low productivity for the population. WDFW has operated rotary screw traps in the lower Dungeness each year since 2005 to estimate the number of seaward migrating juvenile salmon produced in the basin. Recent year estimates of juvenile outmigrant Chinook salmon production ranged from a high of 136,724 in 2006 to a low of 9,674 smolts in 2010 (Topping et al. 2006; Topping and Kishimoto 2008; Topping et al. 2008 [2)]). Based on updated annual juvenile outmigrant estimates, annual naturally spawning adult escapement estimates, and assuming average spawner fecundity, estimated egg-to-smolt survival has averaged approximately 4% over the 2005 through 2011 adult return period. For comparison, in the Skagit River, where natural habitat is in better condition for Chinook salmon productivity, from 1989 through 2006, egg-to-smolt survival estimates averaged 11% (Kinsel et al. 2008).

Chinook salmon produced through the Dungeness River Hatchery program are not the focus of any directed harvest in fisheries within the analysis area. Mark recovery data using tagged Elwha hatchery subyearlings as the surrogate indicate that Dungeness River Hatchery-origin Chinook salmon are harvested incidentally at very low levels in southern U.S. mixed stock marine area fisheries targeting more abundant Chinook stocks and other species (PSIT and WDFW 2010a). Fishery mortality in U.S. fisheries in the analyses area is expected to remain very low, because Chinook salmon-directed commercial and recreational fisheries are not expected to occur, and coho and pink salmon fisheries will continue to be regulated to limit incidental Chinook salmon mortality (PSIT sand WDFW 2010a). Incidental harvest of Dungeness River Chinook salmon occurs predominantly in Canadian troll, sport and net fisheries, which account for an estimated 35.4% of total recoveries (all fisheries plus escapement) of coded wire-tagged subyearling fish for the brood years for which Dungeness Chinook tag recovery data are available (WDFW 2013a). Canadian fishery impacts on U.S. Chinook salmon populations are managed and limited in accordance with U.S./Canada Pacific Salmon Treaty harvest sharing agreements.

Review of estimated average total exploitation rates for Strait of Juan de Fuca Chinook salmon for the periods 1983-1987 (76%), 1998-2000 (38%), 2001-2003 (29%), and 2004-2006 (36%)

2 Updates to annual juvenile abundance estimates presented in these reports accessed at: http://wdfw.wa.gov/conservation/research/projects/puget_sound_salmonids/dungeness/index.htm

indicate that harvest rates declined by 53% (PSIT and WDFW 2004; 2010a). Incidental harvests in current U.S. marine area fisheries are managed to further limit impacts on Dungeness Chinook salmon. When projected total (hatchery and natural-origin fish) escapement to the Dungeness River exceeds 500 fish, U.S. fisheries are managed to not exceed a 10.0% exploitation rate on the population. If escapement is projected to be below 500 fish, U.S. fisheries will be managed to further reduce incidental mortality to an exploitation rate on adult and sub-adult Dungeness Chinook salmon of less than 6.0% (PSIT and WDFW 2010a; NMFS 2011a).

Dungeness River Summer-Run Chum Salmon

The Hood Canal summer-run chum salmon ESU was listed a threatened species under the ESA in 1999 (64 Fed. Reg. 14508, March 25, 1999) and reconfirmed in 2005 (70 Fed. Reg. 37160, June 28, 2005). The ESU includes all natural-origin summer-run chum salmon in the eastern Strait of Juan de Fuca and Hood Canal of western Washington. Based on genetic analysis, historical and present geographic distribution, straying patterns, and life history variation, Sands et al. (2009) identified two independent populations of natural-origin summer-run chum salmon. One population (Strait of Juan de Fuca population) occurs in eastern Strait of Juan de Fuca watersheds (including Chimacum Creek), and the second (Hood Canal population) occurs in Hood Canal watersheds. NMFS designated critical habitat for the Hood Canal summer-run chum salmon ESU to include the portions of the Dungeness River watershed accessible to summer chum salmon, Dungeness Bay, and adjacent nearshore marine waters (70 Fed. Reg. 52630, September 2, 2005).

The Strait of Juan de Fuca population includes as a component a very small summer chum salmon aggregation that spawns in the Dungeness River. The Dungeness River is not included in the 1993 Puget Sound salmon stock inventory as currently supporting a summer chum population (WDF et al. 1993). Summer chum have been periodically observed during the months of September and October in the Dungeness River in the course of monitoring and collecting Chinook and pink salmon escapement data. These data indicated that a modest sized, self-sustaining run is present in the system. The Summer Chum Salmon Conservation Initiative (SCSCI) (WDFW AND PNPTT 2000) rated Dungeness River summer chum salmon as “of special concern” in status because of the lack of historical or current stock assessment information. Summer chum salmon have been infrequently observed in small numbers in the Dungeness River, and the historical size of this spawning aggregation is unknown (WDFW and PNPTT 2000; WDFW 2013a). There is uncertainty about whether the Dungeness River represents a subpopulation or a minor spawning aggregation within the Strait of Juan de Fuca population (Sands et al. 2009). Under the SCSCI, the Dungeness River was not recommended for initiation of a hatchery-based supplementation program to recover the species in the watershed. No project was recommended until sufficient knowledge about the summer chum population is collected to make an adequate assessment of the risks and potential for successful implementation of a supportive breeding program (WDFW and PNPTT 2000). There is therefore no associated, listed hatchery-origin summer chum salmon group.

Summer chum adults observed in the watershed migrate into the mainstem river beginning in late August. Spawning occurs from late August through early October, generally in the lowest 1 to 2 miles of the mainstem portion of the river, but adults have been recovered in some years at Dungeness River Hatchery (RM 10.5) (WDFW and PNPTT 2000; NMFS 2002c). Age class at return data are lacking for summer chum salmon in the Dungeness River. Most natural-origin summer-run chum salmon in the ESU return to spawn as either three or four year-old fish, with five year-olds comprising a smaller proportion (~5%) of total annual returns (WDFW and PNPTT 2000). Juvenile life history data for summer chum salmon in the Dungeness River is also lacking, but natural-origin summer-run chum salmon fry in other watersheds within the Strait of Juan de Fuca portion of the ESU emerge from stream gravels predominantly in late March and April (Tynan 1997; WDFW and PNPTT 2000), and out-migrate at an individual size of 39-40 mm (fl) immediately, without delay in freshwater, to marine waters (Schreiner 1977; Koski 1981; Salo 1991).

Abundance - Although escapement estimates for summer chum are lacking, extensive monitoring of adult salmon spawning in the Dungeness River has occurred during August through October since at least 1986 through spawner surveys focused on Chinook and pink salmon. Surveys of salmon on the Dungeness River from 1974 through 1978 suggest that the watershed had few to no summer chum spawners in most years, but in 1976, 199 summer chum salmon were observed (WDFW and PNPTT 2000). Subsequent surveys confirmed very low annual abundances of the species, with estimated Dungeness River escapement representing 1.5% of total spawning abundance for the Strait of Juan de Fuca population in 2004 and 0.02% in 2005 (Sands et al. 2009). But survey conditions are typically rated as poor to fair during spawner surveys in the Dungeness River and the emphasis on other species sometimes results in incomplete coverage of potential summer chum holding and spawning areas (WDFW and PNPTT 2000). Since 1987, however, summer-timed chum salmon have been observed in the Dungeness River every year, with partial peak counts ranging between 0 and 60 fish. For the most recent five years for which data are available (2007-2011), 0 to 3 summer chum salmon were observed annually during Chinook and/or pink salmon-directed spawning ground surveys. The potential contribution of summer chum spawning to abundance of the Strait of Juan de Fuca population under recovered habitat conditions is unknown. However, the NMFS Biological Review Team estimated that the Dungeness River could potentially support a summer chum salmon spawning aggregation of about 6,000 to 20,000 fish considering the extent of accessible habitat and assuming its recovery to properly functioning (historical) conditions for the species (Sands et al. 2009).

Primary factors that contributed to summer chum salmon population abundance declines across the ESU were habitat degradation, logging, over-harvest in fisheries, and climate effects (NMFS 2006a). The specific factors responsible for the current, poor status of summer chum salmon in the Dungeness River are unknown, but likely similar to those habitat-related factors identified above for Chinook salmon and steelhead.

Other Viability Parameters - There are no other population viability data available for summer chum salmon in the Dungeness River, due to the species' sporadic and low level of occurrence in the watershed.

Fisheries harvest impacts on summer chum salmon in the Dungeness River are unknown, but likely have been very low due to the low and infrequent observations of the species. NMFS' ESA authorization for the co-managers' harvest management plan for Hood Canal summer chum salmon recognized that the status of the summer chum salmon population in the Dungeness River is unknown (NMFS 2001). No critical thresholds are therefore required or applied in the river to manage harvest impacts on the species. As an implementation term, NMFS required initiation by the co-managers of escapement surveys sufficient to determine the status of Dungeness River summer chum salmon population (NMFS 2001).

Dungeness River Steelhead

The Puget Sound Steelhead Technical Recovery Team (PSSTRT) delineated one extant steelhead population that is native to the Dungeness River watershed and part of the listed Puget Sound steelhead DPS: Dungeness River Winter-Run (Myers et al. 2015). A summer-run component of the steelhead return to the Dungeness River is thought to have existed historically in the upper accessible reaches of the mainstem Dungeness River and Gray Wolf River (Haring 1999), but it is uncertain whether the race still persists in the watershed. In a recent evaluation of Washington steelhead populations, WDFW reported that the summer-run race in the Dungeness River is still extant (Scott and Gill 2008). Although, the population delineated recently by the PSSTRT includes only winter-run steelhead, the group concluded that further monitoring is needed to establish whether native summer-run fish are still present and if they are part of a combined summer/winter population or represent an independent population (Myers et al. 2015). Under DPS viability criteria developed by the PSSTRT, at least one winter-run and one summer-run population of the six populations including Dungeness River in the Olympic Major Population Grouping will be identified as key populations needing to be restored to a low extinction risk status for recovery and delisting of the DPS (Hard et al. 2015). Hatchery-origin steelhead released from Dungeness River Hatchery (not part of the proposed actions considered in this document) are not derived from the native Dungeness River winter-run population, and are not included as part of the listed DPS.

The Dungeness River winter-run steelhead population includes fish spawning in the mainstem Dungeness and Gray Wolf rivers (Myers et al. 2015). The extent of spawning is confined to areas downstream of naturally impassable barriers to migration on the Dungeness River and the Gray Wolf River. Dungeness River steelhead enter the river on their spawning migration from November to early June. Spawning occurs from March through June, with peak spawning in May (Myers et al. 2015). Although data are lacking for the Dungeness population, most natural-origin winter-run steelhead in Puget Sound return to spawn as four year-old fish, with five year-olds comprising a large proportion of total returns (Myers et al. 2015). Dungeness River winter steelhead spawning distribution extends from the Dungeness River mainstem at RM 18.7, downstream to the upper extent of tidewater (Haring 1999). Winter steelhead distribution is assumed to also include the Bell, Gierin, Cassalery, Cooper, Meadowbrook, Matriotti, Beebe, Lotsgazell, Woodcock, Mud, Bear, Hurd, Bear, Canyon, and Gold Creek watersheds, and the Gray Wolf River. WDFW juvenile out-migrant trapping data for the 2005 migration year indicate

that natural-origin Dungeness River basin steelhead juveniles emigrate seaward as smolts between February and early July, with peak migration during the first two weeks of May (Topping et al. 2006; Topping and Kishimoto 2008; Topping et al. 2008). Steelhead smolt individual sizes observed in the WDFW the trapping study ranged from 85-mm to 290-mm (fl), and averaged 170 mm (fl).

Abundance - As cited in Myers et al. (2015), in the 1940s, winter-run steelhead fishing in the Dungeness River was considered among the best in the State. In 1903, during its second year of operation, the Dungeness River Hatchery produced 3,100,840 steelhead, representing egg contribution from approximately 2,200 females; assuming a 1:1 sex ratio, the total return that year to the river could have exceeded 4,400 steelhead. As a surrogate indicator of relative abundance, catch estimates based on adjusted catch recording card returns from sport harvest averaged 348 steelhead from 1946 to 1953 prior to the introduction of "large numbers of hatchery fish" (Myers et al. 2015). Due to high turbidity conditions, the ability to conduct spawner surveys in the Dungeness River when natural steelhead spawn is limited. The Jamestown S'Klallam Tribe has conducted spawner surveys in each year beginning in 2010. Prior to 2010, the last escapement estimate for Dungeness winter steelhead was in the 2000/2001 season with an estimated escapement of 183 based on redd counts in index areas. The Jamestown S'Klallam Tribe completed preliminary estimates of post March 10th steelhead spawners for the entire seasons for 2009/10, 2010/2011, 2012/2013, and 2013/2014. These counts reflect natural-origin steelhead escapement, since hatchery-origin EWS that escape to spawn naturally generally complete spawning before March 10 (WDFW 2014a). Natural-origin winter-run steelhead escapement estimates for these return years averaged 619 fish; ranging from 329 fish (2009/2010) to 871 fish (2012/2013) (C. Burns, Jamestown S'Klallam Tribe, and M. Haggerty, Haggerty Consulting, unpublished draft escapement estimates, January 23, 2015). An estimate of the intrinsic potential-based spawner capacity indicates that the Dungeness River watershed could support the production of 2,465 to 4,930 natural-origin steelhead (Myers et al. 2015).

In the most recent status review for the Puget Sound Steelhead DPS, NMFS found that, since 1995, natural-origin Puget Sound steelhead abundance has shown a widespread declining trend over much of the DPS (NWFSC 2015; NMFS 2011b). Similarly, winter-run steelhead counts made opportunistically in selected areas in the Dungeness River watershed have been very low and have steadily declined since the early 1990s (WDFW 2013a). The estimated probability that the Dungeness River winter-run steelhead population would decline to 10% of its current fish abundance (~100 fish) within 100 years is high but cannot be calculated because of the lack of sufficient abundance data (Ford et al. 2011). The co-managers' identify a critical threshold for winter-run steelhead of 125 fish, reflecting the estimated escapement level needed so that the annual effective size, or number of successful breeders, would not be lower than 50 if a ratio of the annual number of effective breeders to spawner census of at least 0.40 was achieved. The viable threshold for the population, reflecting a level of population abundance associated with a very high probability of persistence, or conversely, a very low risk of extinction, for a period of 100 years, ranges from 500 to 750 fish (PSIT and WDFW 2010b).

Spatial structure - Spatial structure of the winter-run steelhead population has likely been adversely affected by habitat loss and degradation to the same degree, and for the same reasons mentioned above for Dungeness Chinook salmon. However, due to their later run timing, spatial structure for the winter-run steelhead population was not likely affected by seasonal operation of the Dungeness River Hatchery weir to collect Chinook salmon adults as broodstock from the 1930s through the 1980s. Summer-run steelhead distribution in the watershed may have been adversely affected by the weir when it was in operation over that period.

Diversity - Available data indicate that steelhead diversity in the Dungeness River watershed has declined relative to historical levels. It is likely that the historically extant summer-run component of the steelhead return has declined to very low levels or has become extirpated. As with Chinook salmon in the watershed, degradation and loss of habitat in the watershed, and past harvest practices, have reduced the diversity of the species in general relative to historical levels. Genetic diversity for the native winter-run population may have been adversely affected by releases of non-native Chambers Creek steelhead from Dungeness River Hatchery, although there are currently no published genetic data indicating that introgression associated with planting of the non-native stock has occurred.

Productivity - With an estimated mean population growth rate of -0.096 ($\lambda = 0.908$) and process variance of < 0.001, Ford et al. (2011) reported high confidence ($P < 0.05$) that a 90% decline in the Dungeness River winter-run steelhead population will not occur within the next 20 years (but will occur within 30 years), and that a 99% decline will not occur within the next 40 years (but will occur within 55-60 years). However, for other years and values of decline, there is less certainty about the precise level of risk to the population (Ford et al. 2011). WDFW juvenile outmigrant trapping at the Dungeness River mouth from 2005 to 2011 showed an average annual production of natural-origin winter-run steelhead smolts of 11,729 smolts (range 6,125 to 19,600 fish) (WDFW 2013a). Annual steelhead smolt productivity appears to be trending upwards based on these short term annual observations.

Steelhead were historically harvested in the Dungeness River from December through February, using fish traps or lines, although Dungeness Bay and in-river conditions may not have been amenable for harvesting fish during the summer months (Myers et al. 2015, citing Gunther 1927). Current fisheries for winter-run steelhead returning to the Dungeness River target non-listed hatchery-origin fish produced through the Dungeness River Hatchery program (this and following from PSIT and WDFW 2010b). Tribal steelhead fisheries, for commercial, subsistence and ceremonial purposes, are normally open for up to four and a half days per week from the second week of December through February in Area 6D (Dungeness Bay) and in the Dungeness River. Tribal regulations permit use of nets and hook-and-line gear. Tribal fishing is excluded within a 1500-foot radius at the mouth of the Dungeness River as a measure to reduce impacts on milling/staging adult fish. The tribal hook-and-line subsistence fishery in the river is open from December through mid-March, under a daily bag limit of 2 fish. The recreational fishery in the Dungeness River is open from mid-October through January, from the mouth upstream to the Dungeness Forks Campground. Game fish regulations set a daily bag limit of two fish over 14 inches, composed of marked (hatchery origin) steelhead, sea run cutthroat, or resident trout. The

Gray Wolf River is closed to recreational fishing from November through early June. Annual tribal and recreational fisheries harvests of mainly hatchery-origin winter-run steelhead in the analyses area from 1998 through 2008 averaged 15 fish (range 0 to 67 fish) and 54 fish (range 23 to 200 fish), respectively (PSIT and WDFW 2010b). Recreational fishing regulations require the release of unmarked (wild) steelhead, and both recreational and treaty fisheries close at the end of January, in advance of the peak of wild steelhead entry.

In summary, the viability status of listed salmonid populations in the Dungeness River watershed, including Dungeness Chinook salmon, is poor. It is therefore prudent to take precautionary measures to preserve and help restore the populations, including but not limited to the implementation of a supportive breeding program for Chinook salmon, and risk reduction measures through the three salmon hatchery programs that would help protect listed Chinook salmon, summer chum salmon, and steelhead. NMFS understands and appreciates the arguments, pro and con, regarding hatchery use, in particular, genetic effects associated with supportive breeding. NMFS' current thinking on the genetic risk of hatchery operations and the uncertainties about that risk, especially the risk of hatchery-induced selection are stated in (NMFS 2011a):

> "At this time, based on the weight of available scientific information, NMFS believes that artificial breeding and rearing is likely to result in some degree of genetic change and fitness reduction in hatchery fish and in the progeny of naturally spawning hatchery fish relative to desired levels of diversity and productivity for natural populations. Hatchery fish thus pose a threat to natural population rebuilding and recovery when they interbreed with fish from natural populations. That risk is outweighed under circumstances where demographic or short-term extinction risk to the population is greater than risks to population diversity and productivity. However, the extent and duration of genetic change and fitness loss and the short and long-term implications and consequences for different species, for species with multiple life-history types, and for species subjected to different hatchery practices and protocols remains unclear and should be the subject of further scientific investigation. As a result, NMFS believes hatchery intervention is a legitimate and useful tool to help avert, at least in the short-term, salmon and steelhead extinction, but otherwise managers should seek to reduce interactions between hatchery and natural-origin fish as the risk of extinction is reduced consistent with the overall recovery of the ESU, implementation of treaty Indian fishing rights, non-Indian fisheries, and harmony with other applicable laws and policies."

In each review of an HGMP, NMFS starts from this viewpoint and applies all relevant scientific information (including new studies), as well as other relevant factors specific to the watershed where the proposed hatchery operations take place, in order to complete its determination. Considering that the Dungeness River Chinook salmon population is currently critically depressed in status, failure to implement supportive breeding would subject the population to unnecessary

risk. Because the hatchery plan for the species considered here as an RMP applies VSP criteria that are incorporated as recovery goals and into monitoring objectives, it is consistent with this 4(d) rule criterion that listed Chinook salmon may be purposefully taken for use as broodstock.

3.1.3 5(i)(C) Taking into account health, abundances, and trends in the donor population, broodstock collection programs reflect appropriate priorities.

The proposed hatchery salmon programs account for the health, abundance, and trends in the listed Dungeness River Chinook salmon, summer chum salmon, and steelhead populations affected by broodstock collection actions, and reflect appropriate priorities, consistent with the conservation (Chinook and pink salmon) and harvest augmentation (coho salmon) intents of the HGMPs. Under this 4(d) Rule criterion, a prioritized purpose of a broodstock collection program using listed fish is to reestablish an indigenous salmonid population for conservation purposes, including restoration of similar at-risk populations within the same ESU, and reintroduction of at-risk populations to under-seeded habitat. Consistent with this prioritized purpose, the Dungeness River Hatchery Chinook salmon program would be operated for conservation purposes, with a primary goal of creating a viable, self-sustaining natural-origin Dungeness Chinook salmon population by using supportive breeding to preserve and restore the currently depressed native population. All three salmon hatchery programs would be implemented using methods that would adequately safeguard listed fish in the Dungeness River that are affected incidentally by broodstock collection activities.

As described in the HGMP (WDFW 2013a), the proposed hatchery Chinook salmon program takes into account the health, abundance, and trends for the ESA listed Dungeness Chinook salmon population by serving as a supportive breeding program for a critically depressed natural-origin population, incorporating natural-origin fish as broodstock to maintain the genetic diversity of the native population, and limiting removal levels of returning adult fish from the natural environment as the status of the natural population improves. Broodstock are collected from indigenous-origin adults returning to Dungeness River. The average naturally spawning Chinook salmon adult escapement to the watershed in recent years (2000 through 2011) is 559 fish, which is only 6.9% of the historical equilibrium abundance for the population. Data for 2010 and 2011 indicate that the supportive breeding effort implemented as proposed in the HGMP is increasing the health and abundance of adult Chinook salmon returning to spawn naturally. Commensurate with larger releases of subyearling hatchery-origin fish, and improvements in hatchery subyearling and yearling release sizes and timings, naturally spawning adult returns in 2010 and 2011 were 345 and 535 fish, respectively. These naturally spawning return abundances compare with lower all natural-origin fish returns in previous years (2008: 140 fish; 2009: 128 fish) because no (brood year 2004), or substantially fewer (brood year 2005) subyearling or yearling smolt releases occurred through the program in the two primary contributing brood years (WDFW 2013a – Table 10.3.1). As a measure to limit divergence of the propagated population, broodstock would be collected from the run at large at all trapping/capture sites in the Dungeness River. Natural-origin adults are incorporated as broodstock to help ensure that the hatchery and naturally-produced fish remain genetically similar, and as a further means to reduce the risk of genetic divergence between the hatchery and natural populations. To allow for their

differentiation from natural-origin Chinook salmon, all hatchery-origin fish would receive a coded wire tag, enabling detection and parsing of fish by origin during broodstock collection operations that would help meet genetic diversity preservation objectives.

Measures are applied to safeguard the health and abundance of listed salmon and steelhead in the Dungeness River that may be affected incidentally by broodstock collection activities associated with the proposed Chinook, pink, and coho salmon hatchery programs. Coho salmon broodstock are collected as volunteers to the Dungeness River Hatchery trap during the adult return period for the species, and incidental effects on listed Chinook and summer chum salmon and steelhead, which have different adult migration timings and that do not recruit to the hatchery trap are unlikely. In-river activities proposed to collect Chinook and pink salmon as broodstock (i.e., opportunistic seining, gillnetting, and hook and line capture; operation of the mainstem river weir) would be confined to specific locations and periods to reduce the risk of negative impacts on spawning Chinook and summer chum salmon adults and their redds. Non-target listed fish are avoided in watershed areas outside of the hatcheries where Chinook and pink salmon broodstock are collected. Any listed Chinook and summer chum salmon, and steelhead that are unintentionally captured during broodstock collection actions targeting Chinook, pink, and coho salmon would be immediately released. Because of their relatively later return timing as adults (November to early-June), listed Dungeness River steelhead are unlikely to be encountered or affected during the August through October periods when broodstock collection actions directed at Chinook and pink salmon would be implemented. Broodstock collection actions for coho salmon will have no effect on steelhead because all coho salmon adults required as broodstock are collected as volunteers to the Dungeness River Hatchery trap, well removed from areas where steelhead may be present. The carcasses of pink salmon, and secondarily coho salmon, spawned for use as broodstock are returned to the river as a means to benefit rearing natural-origin listed fish through nutrient enhancement.

The above approaches support a finding that the proposed broodstock collection activities for the programs reflect appropriate priorities for benefiting and safeguarding the donor natural-origin Chinook salmon population for the Dungeness River Hatchery Chinook salmon program, and the listed Chinook salmon, summer chum salmon, and steelhead populations that may be incidentally affected by broodstock collection activities associated with the three proposed hatchery salmon programs.

3.1.4 5(i)(D) The HGMP includes protocols to address fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management.

The three proposed Dungeness River Hatchery HGMPs include protocols, or “best management practices” (BMPs) for fish health, broodstock collection, broodstock spawning, rearing and release of juveniles, deposition of hatchery adults, and catastrophic risk management. These practices, when implemented, would be appropriate for their purpose of adequately limiting the risk of substantial direct and incidental adverse effects on listed fish in the Dungeness River watershed for the following reasons.

Fish Health

BMPs addressing fish health, including fish health maintenance and hatchery sanitation procedures applied during broodstock collection, mating, fish incubation, rearing, and release, are detailed in performance standard and indicator, adult management, and fish rearing and release sections of each of the Dungeness River Hatchery salmon HGMPs. Fish health monitoring and evaluation measures are also described in those HGMP sections.

The hatchery programs would be operated in compliance with "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State" protocols (NWIFC and WDFW 2006). The co-manager policy delineates Fish Health Management Zones and defines inter and intra-zone transfer policies and guidelines for eggs and fish that are designed to limit the spread of fish pathogens between and within watersheds (NWIFC and WDFW 2006). They would also comply with standard fish health diagnosis, maintenance and hatchery sanitation practices referenced in the policy (as per PNFHPC (1989) and AFS (1994) guidelines) to reduce the risks of fish disease pathogen amplification and transfer within the hatchery and to fish in the natural environment. For all salmon propagated through the Dungeness River Hatchery programs, fish health specialists and pathologists from the WDFW Fish Health Section would provide fish health management support and diagnostic fish health services (WDFW 2013a; 2013b; 2013c).

Adult fish collected as broodstock for the program would be held at the hatcheries for up to a five month period before they are spawned. Because the holding period is extended in duration, minimally invasive fish health maintenance procedures would be conducted during the pre-spawn holding period to reduce the risk of handling injuries that would lead to secondary infections (e.g., dermal fungal invasion). Behavior and external condition of the fish would be routinely observed, in addition to occasional non-lethal sampling to detect external parasites in conjunction with other handling. Any fresh pre-spawning mortalities of adult fish would be removed from holding ponds and examined. If necropsy is warranted, the carcass would be either examined immediately by fish health staff or frozen and examined during the next monitoring visit. At the time of annual spawning, lots of 60 adult fish would be sampled and analyzed for pathogens and parasites at the tribal and state fish health labs. Fish health would be monitored by hatchery staffs throughout the juvenile fish rearing periods at the hatcheries. WDFW fish health professional staff would visit the hatchery fish rearing sites monthly, or as needed, to perform routine monitoring of juvenile fish, advise hatchery staff on disease findings, and recommend remedial or preventative disease treatments with administration of therapeutic and prophylactic treatments when appropriate. Vaccinations of rearing fish populations to reduce the incidence of specific fish diseases would also be provided, as needed. Consistent with the co-manager fish health policy (NWIFC and WDFW 2006), all fish scheduled for release from the hatcheries would be certified as disease-free prior to release through collection and diagnostic analysis of representative samples of pre-smolts. WDFW maintains a fish health database to identify trends in fish health and disease and implement fish health management plans based on findings.

BMPs for monitoring the health of fish in hatcheries specified in the co-managers' fish health policy (NWIFC and WDFW 2006) help reduce the likelihood of disease transmission from

hatchery salmonids to naturally produced fish. When implemented, these BMPs would help contain any fish disease outbreaks in the hatcheries, minimizing the release of diseased fish from hatcheries, and reducing the risks of disease transfer and amplification to natural-origin fish (NMFS 2012). BMPs applied to minimize risks of adverse effects on listed Chinook salmon, summer chum salmon, and steelhead associated with fish disease pathogen transfer and amplification for the three proposed Dungeness River Hatchery HGMPs are based on best available science, and are expected to be sufficiently protective of listed natural and hatchery fish populations.

Broodstock Collection

Sections 6 and 7 of the HGMPs describe BMPs for broodstock selection and collection, carrying forth salmon production goals and objectives for the hatchery programs, and addressing adult fish capture, transport, holding, and handling practices.

The extant Dungeness River Chinook, pink, and coho salmon populations returning as adults to the watershed are the brood sources for the proposed hatchery programs. Salmon adults serving as broodstock would be collected mostly as volunteers homing back to the primary juvenile hatchery fish release site - Dungeness River Hatchery. However, broodstock collection of Chinook and pink salmon would also occur outside of the hatchery release locations in the lower mainstem river using a variety of methods. For Chinook salmon, a full river spanning weir on the mainstem Dungeness River at RM 2.5, and opportunistic netting, hook and line capture, and gaffing of adult fish from the river would be used to collect broodstock. With the exception of collection at the mainstem river weir, pink salmon broodstock would be collected in the lower river using the same methods. The weir is placed in the river preferably in May, or as soon as river conditions allow for operation. Fish are generally trapped five days a week (seven if necessary), until the end of September. The live box used to collect fish at the weir is checked twice daily to reduce the duration of time fish are held, and the risk of fish injury or mortality during holding. Lower river netting or hook and line capture of pink and Chinook salmon would occur up to three days per week, from July through September. All fish collected and retained as broodstock would be held in the water in fish bags for no more than two hours prior to transport to Hurd Creek Hatchery for holding and spawning. Fish would be transported at low densities in transport trucks to reduce stress and reduce the risk of mortality.

Risk minimization protocols that would be applied to reduce the likelihood of harm to listed Dungeness River Chinook salmon, summer chum salmon, and steelhead include: random collection and selection for spawning of Chinook salmon broodstock across the entire breadth of the total annual adult return period to reduce the risk of hatchery-induced selection effects; minimization of in-river broodstock collection activity to reduce the risk of negative impacts on actively spawning fish and redds; monitoring to ensure that adult broodstock collection operations do not substantially alter spatial and temporal distribution of naturally-produced salmonid populations; although Chinook salmon surplus to broodstock needs are usually not collected, any male Chinook salmon trapped in excess of broodstock needs would be released back into the river; immediate release of any non-target listed and non-listed fish incidentally captured during

broodstock collection activities; and maintenance of adult fish retained for use as broodstock in high quality, low temperature well water if they are not ready to spawn to enhance their survival to maturation. Broodstock collected for spawning would be representative of the migration timing, sex ratio, age class, and morphological traits for the extant returning adult salmon populations from which broodstock are taken.

The only Dungeness River Hatchery program proposed for propagating listed fish – Dungeness Chinook salmon (WDFW 2013a) - was founded, and would continue to be sustained through the collection of broodstock from the indigenous adult salmon population returning to the Dungeness River. The ESA-listed hatchery- and natural-origin components of the Dungeness population are genetically indistinguishable and are thought to represent what remains of the historic, genetically unique and independent Dungeness Chinook salmon population (Ruckelshaus et al. 2006). Under the proposed program, the objectives and methods applied in recent years to collect returning Dungeness Chinook salmon adults for use as broodstock would remain unchanged. Annual collection and spawning of up to 112 adult fish (assuming a 1:1 sex ratio) would be required to attain the proposed annual juvenile fish release goal of 200,000 fish. Because of depressed natural-origin Chinook salmon survival and productivity, broodstock collection in the mainstem river and at Dungeness River Hatchery in recent years has likely been comprised of predominately first generation hatchery-origin fish (73%), with natural-origin fish (that may be progeny of hatchery-origin spawners) accounting for the remainder (27%) (data from WDFW 2013a). The higher proportion of hatchery-origin fish collected as broodstock would be expected to continue for the immediate future until natural-origin Chinook salmon abundance and productivity improve as the supportive breeding program is implemented and as habitat is restored to properly functioning conditions.

Broodstock Spawning

BMPs for broodstock spawning are described in section 8 of the HGMPs. Risk reduction measures would be applied to minimize the likelihood for adverse genetic or ecological effects on listed salmon and steelhead resulting from Chinook, pink, or coho salmon broodstock spawning. Given that Chinook salmon are the only listed species under propagation, the Dungeness River Hatchery Chinook salmon HGMP is the focus of consideration for consistency with this criterion. To help accomplish genetic diversity loss and demographic risk reduction objectives, the hatchery Chinook salmon program would implement best available science spawning actions consistent with HSRG (2004) and WDFW (Seidel 1983) broodstock spawning guidelines. Proposed mating procedures for listed Chinook salmon are also consistent with NMFS guidelines for hatchery propagation under the ESA (Hard et al. 1992). Spawning actions implemented at Dungeness River Hatchery would be guided during the spawning season by WDFW geneticists to reduce risks of genetic diversity loss and hatchery-induced selection effects. Full details regarding proposed spawning practices, and evaluations of the effects of hatchery salmon broodstock spawning on listed Chinook salmon are presented in the HGMP (WDFW 2013a).

Following the aforementioned guidelines, spawning protocols implemented through the Dungeness River Hatchery Chinook salmon program would ensure that all broodstock are

spawned across the entire adult fish maturation period (WDFW 2013a). Chinook salmon adults to be spawned would be chosen at random from the available gene pool held at the hatcheries. Out-of-basin stray Chinook salmon would not be knowingly spawned or incorporated into the gene pool. Mating practices applied would help ensure that egg-takes would be representative of the entire Chinook salmon run in the Dungeness River in terms of migration timing, sex ratio, age composition, and morphology.

To help minimize the risk of directed artificial selection of traits that could lead to divergence of the propagated component of the population from the returning, extant population from which it is derived, spawning protocols that would maximize the representation of each individual adult fish into the entire brood would be implemented (this and following from WDFW 2013a). The primary goal would be to ensure that Chinook salmon egg-takes each year are representative of the entire spring Chinook salmon return for the year. Both hatchery and natural-origin fish would be spawned, consistent with proportions of each origin collected as adults from the river. To minimize the risk of directed, artificial selection of traits that could negatively affect the diversity and fitness of the Chinook salmon population, factorial crosses would implemented when possible during spawning to maximize the representation of each individual adult into the entire brood. Factorial 2x2 crosses would be the preferred mating method. Eggs spawned from two females would be separated into two containers per female, and milt expressed from two males would be separated into two containers per male. The eggs and milt from the separate containers would then be mixed in all possible pairwise combinations.

Rearing and Release of Juveniles

BMPs for salmon rearing and release through the three programs are described in sections 9 and 10 of the HGMPs. Rearing and release practices proposed for implementation would help ensure release of healthy seawater-ready smolts that emigrate downstream rapidly after release, leading to high juvenile fish survival rates to adult return. Potential effects of ecological interactions between newly released hatchery-origin salmon and natural-origin salmon and steelhead in the action area are described in the Section 2.0 of the HGMPs.

In general, the progeny of all fish spawned through the programs would be incubated and reared using water sources, water quantities, facilities, and fish cultural practices proven to be effective in promoting high egg-to-smolt survival rates, ensuring fish health, and meeting annual juvenile fish release goals. In particular, fish rearing densities and feeding amounts and methods would be consistent with fish growth and health maintenance protocols generally applied in successful Pacific Northwest anadromous fish rearing operations. Reducing the risk of adverse ecological effects on natural-origin salmon and steelhead after the juvenile hatchery salmon are released is also an important objective. Post-release interactions of concern include competition between hatchery-origin salmon and natural-origin salmon and steelhead for food and space, and hatchery fish predation on natural-origin fish. To reduce competition and predation risks, all juvenile fish releases would be made at fish sizes, life stages, and at times that would reduce or avoid substantial spatial and temporal interactions with natural-origin salmon and steelhead. Rearing practices for the supportive breeding program propagating listed Chinook salmon, bearing on the

adequacy of the program for safeguarding listed fish while under propagation, are summarized below. Release practices for all salmon that would be produced through the three HGMPs are also summarized below. Full details regarding the rearing and release practices that would be applied are provided in the three HGMPs.

All eggs collected from females retained for spawning for the Dungeness River Hatchery Chinook salmon program would be incubated to the eyed egg life stage and through hatching at WDFW's Hurd Creek Hatchery. Fertilized eggs from each female spawned would be held in individual vertical incubator trays supplied with well water at constant temperature of 48°F and water flow of 3 gpm. After reaching the eyed stage, eggs would be reloaded in the trays at low densities of 3.5 pounds per tray as a means to promote high egg to fry survival rates. Layered Vexar™ screening would be placed in the incubator trays to provide complex substrate mimicking natural incubation conditions for hatched alevins. Upon emergence, fry would be ponded and reared to a size of 150 fish per pound (fpp) at Hurd Creek Hatchery, at which time all fish would be tagged with CWTs to allow for their later identification as hatchery-origin fish. The fingerlings would then be transported for continued rearing to smolt size and acclimation for 6 to 9 weeks at their eventual release sites at Dungeness River Hatchery, Upper Dungeness Acclimation Pond, and the Gray Wolf Acclimation Pond. All Chinook salmon would be reared at these locations within the loading guidelines set forth in the co-managers fish health policy (NWIFC and WDFW 2006) and Piper's Fish Hatchery Management Manual (Piper et al. 1982). Consistent with these guidelines, for all phases of rearing as a measure to produce healthy fish, maximum Chinook salmon rearing densities would be maintained at 3 pounds of fish per gpm of water inflow or less, and under 0.35 pounds of fish per cubic foot of rearing space. All Chinook salmon would be fed a high quality commercial diet at amounts and frequencies that would meet fish growth rate objectives and maintain fish health. Fish mortality levels and fish health would be monitored daily by hatchery staff. All rearing facilities would be continuously attended, or attended on a daily basis, by trained hatchery personnel to ensure that the listed Dungeness Chinook salmon under propagation are safeguarded. The Dungeness River Hatchery Chinook salmon HGMP includes data indicating that egg-to-smolt survival rates for fish reared in the program have been very high (Section 9, Table 9.2.1.1), and reflective of a well operated program that adequately safeguards listed fish while under propagation.

Proposed Chinook, pink, and coho salmon individual fish release sizes, timings and locations would minimize the magnitude and duration of any interactions with listed natural-origin Chinook salmon, summer chum salmon, and steelhead that would lead to adverse effects from competition or predation. Proposed release practices would balance the need to also mimic natural smolt emigration timings for each species. All fish would be released as seawater-ready, migrating smolts to ensure rapid emigration downstream through watershed areas where interactions with rearing listed fish may occur. Fish size, behavior, population uniformity (goal CV of <10%) and morphology would be monitored at the hatchery rearing locations to assess readiness of the fish for release as smolts. Up to 50,000 Chinook salmon yearling smolts at a size of 9 fpp (about 168 mm fork length (fl) would be volitionally released from Hurd Creek Hatchery in April each year, and up to 150,000 subyearlings smolts at a size of 50 fpp (about 95 mm fl) would be released in equal lots of 50,000 fish from Dungeness Hatchery, Upper Dungeness Acclimation Pond, and

Gray Wolf Acclimation Pond in May or June. Up to 100,000 pink salmon fry at a size of 450 fpp (56 mm fl) would be force released in April from Hurd Creek Hatchery each year, coinciding with the seaward emigration time of the natural-origin component of the population. Up to 500,000 coho salmon yearlings at an average size of 17 fpp (140 mm fl) would be released in May or June from Dungeness River Hatchery each year.

In summary, BMPs included in the HGMPs and proposed for juvenile salmon rearing and release would reduce the risk of adverse ecological interaction effects (competition and predation) on listed natural-origin fish populations in the Dungeness River watershed, while promoting high juvenile fish to adult return survival rates consistent with meeting proposed program conservation or harvest augmentation objectives.

Disposition of Hatchery Adults

Protocols for the disposition of adult salmon and steelhead are described in section 7.5 of the proposed salmon HGMPs. Chinook salmon spawned through the hatchery program for the species would be disposed of through collection by commercial fish buyers under contract with the agency. WDFW would disperse carcasses from spawned pink salmon into the river near the point of collection of the fish for nutrient enrichment purposes. Coho salmon collected at Dungeness River hatchery would be provided to contracted fish buyers as whole fish if surplus to broodstock needs, or used for nutrient enhancement if spawned or in unsalable condition. Marine-derived nutrients provided by decaying hatchery adult carcasses would benefit natural productivity in the watershed, improving growth and survival conditions for rearing and emigrating natural-origin salmon and steelhead.

Catastrophic Risk Management

The three HGMPs include catastrophic risk management protocols designed to reduce the risk of injury and mortality of listed salmon and steelhead associated with hatchery operation. Inclusion of these protocols in the proposed plan for Chinook salmon addresses the need to operate the program for the species in a manner that adequately safeguards listed fish while under propagation.

The Dungeness River Hatchery Chinook salmon HGMP describes available back-up water supply systems, and risk aversion measures, that would be applied at each of the facilities rearing Chinook salmon as part of the program, that minimize the likelihood for listed Chinook salmon mortalities resulting from equipment failure, water loss from power failure, vandalism, and flooding. At the Dungeness River Hatchery, gravity fed surface water can be used as a backup water supply for rearing fish in the event of loss of the primary water supply. At the Gray Wolf Acclimation Pond, a gravity fed water supply is used, which reduces the likelihood of water supply loss to Chinook salmon under propagation that would result from power loss if pumps were used to supply water. At Hurd Creek Hatchery, a generator would supply back-up power in the event of power loss, and a surface water backup supply is available to rearing ponds in response to total loss of all power sources. Chinook salmon eggs for the program are incubated on

well water at Hurd Creek Hatchery to reduce the risk of egg losses due to siltation and from fish disease pathogens. The primary hatchery sites (Dungeness River and Hurd Creek) are attended full time by qualified fish culture staff, and water supply systems at the hatcheries have low-flow alarms with 24-hr/day monitoring to indicate, and allow rapid responses to, water supply failures, vandalism, or other events threatening fish survival. The Dungeness River Hatchery Chinook salmon HGMP describes emergency fish release procedures that would be applied to respond to water system failures that cannot be remedied in an expeditious manner. Emergency fish release measures would include: providing a temporary water supply to fish held in the ponds through gravity-fed sources; transporting the fish to other hatchery rearing locations for temporary holding until threats to the fish were remedied; and allowing fish to prematurely migrate from the ponds into the river. During a flood or drought events that would threaten rearing fish and water supplies, fish would be released early directly into the Dungeness River to prevent mortalities due to injury if the Chinook salmon were instead retained in the hatchery.

In summary, catastrophic risk management protocols included in the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a) are proposed to safeguard listed Chinook salmon while maintained in the hatchery rearing sites. As described above, facility operational and management measures for the programs are specifically designed to minimize the potential for water supply loss through power loss and/or flooding, pump failure, and vandalism that would lead to the loss of listed fish while under propagation.

3.1.5 5(i)(E) The HGMP evaluates, minimizes, and accounts for the propagation programs' genetic and ecological effects on natural populations, including disease transfer, competition, predation, and genetic introgression caused by straying of hatchery fish.

The Dungeness River Hatchery Chinook, pink, and coho salmon HGMPs submitted for NMFS review provide evaluations of potential genetic and ecological effects on listed Dungeness River Chinook salmon, summer chum salmon, and steelhead in section 2.0 of each proposed plan. Each HGMP includes risk minimization measures to (in HGMPs Sections 6-10) that would reduce the risks of adverse disease transfer, competition, predation, and genetic introgression effects. Each HGMP accounts for potential effects on listed fish in section 2.0 and in appended take tables.

In general, the HGMPs would apply risk averse hatchery salmon management approaches that allow for the adaptive management of supportive breeding actions based on: the performance of the programs in conservation (Chinook and pink salmon plans) or harvest augmentation (coho salmon plan) objectives; and, limitation of adverse effects on listed fish to acceptable levels.

Genetic Effects

In addition to providing a potential benefit to the Dungeness Chinook salmon population by increasing the abundance of the total population, preserving remaining diversity in a degraded habitat, and increasing population spatial structure, the supportive breeding program for Chinook salmon (WDFW 2013a) may also pose genetic diversity loss risks to the target Chinook salmon

population. The pink and coho salmon HGMPs (WDFW 2013b; 2013c) would propagate species that cannot interbreed with listed species present in the Dungeness River watershed, and thus would not pose genetic diversity loss threats to listed fish. Likewise, because the species cannot interbreed, Chinook salmon produced through the Dungeness River Hatchery programs would not pose genetic risks to listed summer chum salmon and steelhead in the watershed.

Potential genetic risks to Dungeness Chinook salmon that may be associated with Dungeness River Hatchery Chinook salmon HGMP implementation are loss of within-population diversity, outbreeding effects, and hatchery-induced selection ("domestication") (NMFS 2012).

Loss of Within-Population Diversity

Loss of within-population genetic diversity (variability) is defined as the reduction in quantity, variety and combinations of alleles in a population (Busack and Currens 1995). Quantity is defined as the proportion of an allele in the population and variety is the number of different kinds of alleles in the population. Genetic diversity within a population can change from random genetic drift and from inbreeding. Random genetic drift occurs because the progeny of one generation represents a sample of the quantity and variety of alleles in the parent population. Since the next generation is not an exact copy of the parent generation, rare alleles can be lost, especially in small populations where a rare allele is less likely to be represented in the next generation (Busack and Currens 1995). Inbreeding is the interbreeding of related individuals. Inbreeding per se does not lead directly to changes in the quantity and variety of alleles but can increase both individual and population homozygosity. This homozygosity can change the frequency of phenotypes in the population which are then acted upon by the environment. If the environment is selective towards specific phenotypes then the frequency of alleles in the population can change (Busack and Currens 1995). Increased homozygosity can lead to a reduction in fitness called inbreeding depression.

The proposed Dungeness River Hatchery Chinook salmon supportive breeding program has the potential to reduce the genetic diversity of the target Dungeness Chinook salmon population. Although WDFW endeavored to include as many families as possible to establish the captive broodstocks used to found the hatchery population, and in annual broodstock collections from fish returning to the river for the current program, a subset of the total adult run-at-large is represented in the propagated population. The recent year (2000-2011) average total (hatchery- and natural-origin) adult return to the river is 653 fish (range 218 – 1,546 fish), with returns estimated at 457 fish and 681 fish in 2010 and 2011, respectively. The number of adult fish removed from the river for use as broodstock in the current program operating in 2010 and 2011 was 112 fish (25% of the 2010 adult return) and 146 fish (21% of the 2011 adult return), respectively (data from WDFW 2013a). Assuming the proportions of the total adult return collected as broodstock remain the same as in recent years, there is the potential that annual adult broodstock collections as proposed in the HGMP would not include a representative sample of the genetic diversity for the extant Dungeness Chinook salmon population.

To reduce the threat of within-population diversity loss, the Dungeness River Hatchery Chinook salmon program, has implemented, or would implement the following measures (WDFW 2013a):

- In founding the original hatchery program, the risk of within population genetic diversity loss was reduced by selecting the indigenous Chinook salmon population for use as captive broodstock. Further, the duration of the captive broodstock program was limited to a six year period (1992 through 1997 broods) to reduce the risk of genetic diversity loss associated with captive breeding.
- Measures would be applied to help ensure that broodstock collected for the program are representative of the total run-at-large each year.
    - Broodstock would be collected randomly throughout the entire adult Chinook salmon return period to the watershed.
    - The program would endeavor to ensure that run timing, location, age, and sex ratio of the Chinook salmon population collected as broodstock each year are reflective of the total adult return for each year with regards to run timing, return location, age class, and sex ratio.
    - Run timing, return location, age class, and sex ratio data would be collected annually from the total returns and from fish collected as broodstock to monitor whether hatchery broodstock are reflective of the run-at-large.
    - All female Chinook salmon collected through the mainstem weir, netting, gaffing, or as volunteers to the hatcheries would be used in the spawning operation, thereby reducing sources of bias that could lead to a non-representative sample of the broodstock.
    - Otoliths would be collected from adult fish spawning naturally and fish retained as broodstock for analysis to determine the proportion hatchery origin spawners and proportion natural origin broodstock levels associated with the Chinook salmon program.
    - Factorial mating strategies applied through the program help ensure that all fish collected have an equal opportunity to contribute to the production of progeny as a measure to retain the genetic diversity of the Chinook salmon population collected and spawned.
    - All males collected, including jacks, would be included in spawning. If fewer gravid males than matured females are available on any spawning day, males would be live spawned, marked with an operculum punch, and returned to the hatchery holding pond for potential re-spawning. Such males would not be spawned more than twice.
    - Fish surplus to hatchery needs will be released into the Dungeness River to allow the fish to spawn naturally, increasing the number of adult fish of the total population that would not be exposed to hatchery-related selection effects.

Outbreeding Depression

As reviewed in NMFS (2012), outbreeding depression is a loss in fitness after interbreeding with another population. Outbreeding depression can be a simple loss of adaptation caused by changes

in allele frequency or by the introduction of new alleles. It can also result in the disruption of co-adapted gene complexes.

The proposed Dungeness River Hatchery Chinook salmon program would be sustained only through the collection of broodstock from the adult salmon population returning to the Dungeness River (WDFW 2013a). The program is designed to preserve remaining diversity of a unique population of the species in the Dungeness River watershed, and would not increase the risk of outbreeding depression to the population by using an out-of-basin-origin Chinook salmon stock for propagation. There are no data indicating that Dungeness Chinook salmon stray into the other watersheds in Puget Sound where other Chinook salmon populations are present, and where those populations would be affected by Dungeness River hatchery-origin Chinook spawning. However, measures would still be implemented through the Dungeness River Hatchery program to reduce the risk of outbreeding depression and straying resulting from production of returning adult hatchery-origin Chinook salmon:

- The proposed program would continue to propagate and release only fish from the local extant Dungeness River population.
- Measures would be implemented at the time of spawning to avoid incorporation out-of-basin strays into the gene pool. Adults collected as broodstock would be checked for the presence of coded wire tags (all fish produced by the program are marked with a coded wire tag only), and no fish with an adipose fin clip will be spawned.
- All juvenile fish released through the program would be marked with wire tags and/or otolith marks to allow for monitoring and evaluation of straying and natural spawning of Dungeness River hatchery-origin Chinook salmon in watersheds where adult fish may potentially stray.
- Straying into adjacent watersheds where other natural-origin Chinook salmon populations exist would be monitored through mark and tag recovery programs implemented at hatchery broodstock collection sites and during spawning ground surveys.
- To reduce the risk of straying, juvenile fish reared through the program would be adequately acclimated to their sites of release in the Dungeness River to encourage a high return fidelity to those release sites when the fish return as adults.

Hatchery-Induced Selection ("Domestication")

Hatchery-induced selection (commonly called "domestication") pertains to fitness loss and phenotypic change caused by differences between the hatchery and natural environments (includes intentional selection and relaxation of selection), and sampling "errors" during fish culture (includes advertent or inadvertent selection of traits for fish under propagation). Hatchery-induced selection may lead to changes in quantity, variety, and the combination of alleles between a hatchery population and its source population that are the result of selection in the hatchery environment (Busack and Currens 1995). This hazard is also defined as the selection for traits that favor survival in a hatchery environment and that reduce survival in natural environments (NMFS 2012). The concern is that hatchery-induced selection effects will decrease

the performance of hatchery fish and their descendants when exposed to natural selection conditions in the wild. Busack and Currens (1995) identified three types of hatchery-induced selection: intentional or artificial selection, representing purposeful attempts to change the population to meet management needs, such as time of adult return or spawning time; biased sampling during some stage of culture leading to hatchery-induced selection caused by errors during any stage of hatchery operation; and, unintentional or relaxed selection that may cause genetic changes to occur because salmon in hatcheries usually have (by design) much higher survival rates during the incubation and juvenile rearing periods than they would have in the wild.

First generation hatchery-origin fish make up a very high proportion of the total adult return to the Dungeness River, and of fish collected as broodstock or spawning naturally in the river each year. Data from the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a) indicate that from 2001 through 2011, the average proportion of hatchery-origin fish of the total naturally spawning Dungeness Chinook population was 73%, ranging from 39% to 96%. Although broodstock propagated through the program was originally founded through removal of eggs or fry from redds created by "wild" Chinook salmon, the practice of collecting broodstock from natural spawners ended after the 1997 brood year. Since that time, broodstock spawned have been captured from returns to the river or as volunteers to the hatchery. It is therefore highly likely that the proportion of hatchery-origin fish of the total spawned population is high and reflective of the proportion of hatchery-origin fish in the total annual return observed in recent years (averaging 73%). With these high proportions of hatchery-origin chinook salmon in the naturally spawning population and in hatchery broodstock, studies for other species in other watersheds suggest that there are high risks of hatchery-induced selection that could be associated with implementation of the Dungeness River Hatchery Chinook salmon HGMP.

As justification for the program, the WDFW plan for the supportive breeding program states that although some progress has been made in preserving and restoring habitat critical for natural-origin Chinook salmon survival and productivity, actions to restore habitat have not kept pace with other components of the Chinook salmon recovery effort (WDFW 2013a). Among those efforts are actions proposed in the Dungeness River Hatchery Chinook salmon program that have assisted in increasing adult returns. Habitat conditions continue to place all salmonid stocks at great risk (WDFW 2013a). Considering the severely depressed abundance status of natural-origin Dungeness Chinook salmon returns, and very low productivity for fish migrating, spawning, and rearing in currently degraded habitat, it is highly likely that the demographic risk faced by the natural population outweighs any hatchery-induced selection risks that would result from hatchery intervention as proposed in the Dungeness River Hatchery Chinook salmon HGMP. The conservation-directed program is specifically designed to preserve what remains of the Dungeness Chinook salmon population, and implement measures to retain extant genetic diversity until natural habitat is restored to properly functioning conditions.

The following genetic risk management measures are proposed in the HGMP to reduce the risk of intentional or unintentional hatchery-induced selection and biased sampling effects on Dungeness Chinook salmon population diversity (from WDFW 2013a):

- Broodstock used to sustain the program each year would be Dungeness Chinook salmon collected from the run-at-large adult return to the Dungeness River.
- Broodstock would be collected randomly across the breadth of the adult return timing, and representative of the age class distribution and sex ratio for the species, from the combined number of fish collected at the Dungeness River Hatchery trap, lower river mainstem river trap, and from the mainstem river through seining, gillnetting, gaffing, or hook and line capture.
- In collecting adult Chinook salmon randomly from the total run-at-large in the mainstem river, natural-origin adults would be included as broodstock, which should assist in maintaining genetic similarity between fish propagated through the hatchery program and naturally-produced fish.
- In-river broodstock collection activities would be implemented in a manner that would protect naturally spawning Chinook salmon and their redds.
- The survival and diversity of the population collected and maintained for spawning until maturity would be enhanced by holding the fish in high quality well water.
- Mating protocols would be applied to reduce the risk of directed or unintentional selection of traits that could negatively affect the diversity of the population. These protocols would include:
    - Maximize representation of individual adult fish in the propagated population through use of all Chinook salmon, including jacks, collected randomly from broodstock retained for spawning.
    - Factorial 2x2 crosses would be the preferred method used for mating, but if necessary, other combinations can be utilized to maximize genotypic diversity. In 2x2 crosses eggs from two females would be split into two separate containers per female, milt from two males would be split into two separate containers per male, and eggs and milt would be mixed in all possible pairwise combinations.

Ecological Effects

As called for under this criterion, the ecological effects resulting from implementation of the HGMPs are also evaluated, minimized (through application of operational practices), and accounted for in the HGMPs (section 2.0 in WDFW 2013a; 2013b; 2013c). Ecological effects of concern include fish disease pathogen transfer, resource competition, and predation effects on listed Chinook salmon, summer chum salmon, and steelhead that may result from implementation of the three salmon HGMPs.

Disease

The three HGMPs address general threats from disease transfer in section 2.0 of each plan. Fish disease transfer and amplification risk reduction measures are more specifically addressed for broodstock selection and collection actions in sections 6.0 and 7.0; incubation and rearing actions in section 9; and for fish release actions in section 10.0. Within these section, the plans describe fish disease pathogen issues of concern and actions that would be implemented to minimize risks of disease transfer and amplification. As noted in the plans, all hatchery actions would be

implemented in accordance with the "Salmonid Disease Control Policy of the Fisheries Co-managers of Washington State (NWIFC and WDFW 2006). Protocols described in the policy and applied through the programs would help reduce risks of fish disease to propagated and natural fish populations through regular fish health monitoring and reporting, and application of best management practice measures to reduce fish health risks. The health of salmon under propagation would be monitored and managed consistent with fish health policy practices. Under the fish health plan, professional fish pathologists from the WDFW Fish Health Section would visit the hatchery rearing locations monthly, or as needed to perform routine monitoring of adult and juvenile fish, advise hatchery staff on disease findings, and recommend disease treatments when appropriate. All fish monitored for fish health assessment purposes would be sampled consistent with co-manager policy, and procedures referenced in the policy, to minimize the proportion of the total rearing population exposed to handling and non-lethal and lethal sampling. In addition, all WDFW hatchery personnel are trained in standard fish propagation and fish health maintenance methods to help ensure that fish under propagation are adequately protected from catastrophic loss due to poor hatchery practices, adverse water quality conditions, or fish health issues associate with poor water quality or inadequate water quantity.

High egg-to-smolt survival rates for fish propagated in the proposed hatchery programs (sections 9.1.1 and 9.2.1 of the HGMPs) indicate that protocols for monitoring and addressing the health of fish in hatcheries have been successful in containing disease outbreaks in the Dungeness River Hatchery programs, minimizing the release of fish carrying disease pathogens, and reducing the risk of transfer to wild fish populations. For these reasons, fish disease pathogen transmittal and amplification risks that would be associated with HGMP implementation appear to be adequately addressed and minimized.

Competition

Release of hatchery–origin species into a listed species' habitat, or where they may access the habitat of listed species, may harm listed species and therefore constitutes a "take" under the ESA (NMFS 1999). Among the mechanisms of potential harm is competition (Tartara and Berejikian 2012). Competition occurs when the demand for a resource by two or more organisms exceeds the available supply. If the resource in question (e.g., food or space) is present in such abundance that it is not limiting, then competition is not occurring, even if both species are using the same resource. Adverse impacts of competition may result from direct interactions, whereby a hatchery-origin fish interferes with the accessibility to limited resources by naturally produced fish, or through indirect means, as when utilization of a limited resource by hatchery fish reduces the amount available for naturally produced fish (SIWG 1984). Specific hazards associated with adverse competitive impacts of hatchery salmonids on listed naturally produced salmonids may include food resource competition, competition for juvenile rearing sites, and, to a lesser extent, competition for spawning sites (NMFS 2012). For these competition risks between fish origins or fish species to occur, substantial levels of spatial and temporal overlap, and limited resources shared by the fish must exist (Tartara and Berejikian 2012).

To reduce the risk of spatial overlap between juvenile hatchery-origin and listed natural-origin fish that might lead to competition effects, the primary juvenile hatchery-origin fish release locations for the programs would be in the lower Dungeness River. The release of fish in the lower watershed would reduce the intensity and duration or interactions with natural-origin fish relative to releasing hatchery fish in upper portions of the watershed where natural-origin fish would primarily rear. All coho salmon smolts would be released from Dungeness Hatchery at RM 10.5, as would one-third (50,000) of subyearling Chinook salmon. All yearling Chinook salmon and all pink salmon would be released from Hurd Creek Hatchery, which is tributary to the Dungeness River at RM 2.7. Up to 100,000 subyearling Chinook salmon smolts would be released in mid or upper river areas through the acclimation pond sites at Dungeness River (RM 15.8) and Grey Wolf River (RM 1.0). Fish released from these locations would emigrate seaward through downstream areas where rearing or migrating natural-origin fish may also be present.

In addition to spatial overlap, the degree to which listed natural-origin fish and hatchery-origin juvenile salmon and steelhead will interact, potentially leading to competition effects, also depends on the opportunity for temporal overlap between the two groups (Tartara and Berejikian 2012). All fish produced by the programs for release in the watershed would be released as seawater-ready fish (smolts or fry) as a measure to foster rapid emigration seaward, and clearance from watershed area where they may compete with natural-origin fish. The majority of juvenile Chinook salmon produced through the Dungeness River Hatchery program would be released from the four rearing sites as sub-yearling smolts in June, after the majority of juvenile Chinook salmon, summer chum salmon, and steelhead have emigrated seaward. Release of subyearling Chinook salmon in June would be designed to reduce temporal overlap with juvenile listed fish, and the opportunity for substantial competition effects from the hatchery-origin subyearling Chinook salmon release component of total production of the species. Yearling Chinook salmon would be released from Hurd Creek Hatchery in April, and would be the potential for temporal overlap with any emigrating natural-origin Chinook salmon, summer chum salmon, and steelhead juveniles present in the two miles of lower river downstream of the hatchery and in the estuary. Hatchery yearling coho salmon releases from Dungeness River Hatchery would be delayed until May through June each year as a measure to minimize interactions with, and competition risks to, the majority of rearing and emigrating natural-origin Chinook salmon, summer chum salmon, and steelhead present in the lower watershed. Coho salmon fry would be transported for release into Copper Creek, a Strait of Juan de Fuca tributary where no listed fish species are present that would be affected through competition. Fall pink salmon fry would be released from Hurd Creek Hatchery during the natural-origin pink salmon fry emigration period in April. Because of their release timing, fall pink salmon fry would have the potential to interact with, and compete with, any co-occurring natural-origin Chinook salmon and summer chum salmon juveniles in the two miles of the lower river downstream of the hatchery and in the estuary.

The co-managers have included hatchery management measures in the proposed HGMPs designed to reduce competition risks to listed fish from hatchery-origin salmon in the Dungeness River action area:

- As a primary juvenile hatchery fish production strategy, all yearling coho salmon and Chinook salmon, all pink salmon fry, and one-third of the total number of subyearling Chinook salmon produced each year would be released into the lowest portion of the watershed from Dungeness River Hatchery (RM 10.5) or Hurd Creek Hatchery (RM 2.7). The lower river release locations limit the duration of hatchery fish presence in freshwater, reducing the duration of interaction – and hence spatial and temporal overlap - with natural-origin fish populations rearing or migrating adjacent to or downstream of the hatcheries.
- All sub-yearling Chinook salmon, yearling Chinook salmon, pink salmon fry, and yearling coho salmon would be released from the hatcheries into the Dungeness River as readily migrating fish, in a physiological condition ready for transition to a seawater existence. The practice of releasing only actively migrating smolts that would exit freshwater rapidly would reduce the duration of interaction with natural-origin Chinook salmon, summer chum salmon, or steelhead in the lower river of a life stage vulnerable to competition for food or space.
- Hatchery- and natural-origin emigration timing and abundance would be monitored each year through operation of the WDFW juvenile outmigrant trapping program in the lower Dungeness River at RM 0.5 to evaluate whether hatchery juvenile release timings pose a risk of substantial harmful ecological interactions with listed natural-origin fish. Alternate hatchery fish release timings or other mitigation measures would be developed to minimize such interactions.

Predation

Risks to naturally produced salmon and steelhead attributable to direct predation (direct consumption) or indirect predation (increases in predation by other predator species due to enhanced attraction) can result from hatchery salmonid releases (NMFS 2012). Hatchery-origin fish may prey upon juvenile naturally produced salmonids at several stages of their life history. Newly released hatchery smolts have the potential to consume naturally produced fry and fingerlings that are encountered in freshwater during downstream migration. Hatchery smolts that do not emigrate and instead take up stream residence near the point of release (residuals) have the potential to prey on rearing natural-origin juvenile fish over a more prolonged period. Hatchery salmonids planted as non-migrant fry or fingerlings, also have the potential to prey upon natural-origin salmonids in the freshwater where they co-occur. In general, naturally produced salmonid populations will be most vulnerable to predation when naturally produced populations are depressed and predator abundance is high, in small streams, where migration distances are long, and when environmental conditions favor high visibility (NMFS 2012).

The risk of hatchery-origin smolt predation on natural-origin juvenile fish is dependent upon three factors: (1) the hatchery fish and their potential natural-origin prey must overlap temporally; (2) the hatchery fish and their prey must overlap spatially; and, (3) the prey should be less than 1/3 the length of the predatory fish (NMFS 2012). Considering natural fish occurrence and proposed hatchery-origin fish life stage and release timings into the Dungeness River where predator-prey interactions would potentially occur, the hatchery-origin species and life stages with substantial

spatial and temporal overlap with vulnerable juvenile listed Chinook salmon, summer chum salmon, and steelhead would be yearling Chinook and coho salmon released from Dungeness River Hatchery and Hurd Creek Hatchery. Chinook salmon yearlings released in April into Hurd Creek through the proposed Dungeness River Chinook Hatchery program would be of large enough size to prey on juvenile Chinook salmon less than approximately 50 mm (fl) present in the lower Dungeness River, and on any summer chum fry present, when the hatchery fish would be released. Hatchery yearling Chinook salmon would not encounter juvenile natural-origin steelhead in April that would be of a size vulnerable to predation. Although of similarly large size at the time of their release, hatchery-origin coho salmon yearlings would be released in mid-May, after summer chum fry had emigrated seaward and when any co-occurring natural-origin Chinook salmon and steelhead would generally be too large to be vulnerable to predation.

The proposed programs for yearling Chinook and coho salmon would reduce the potential for predation on listed juvenile salmon and steelhead through application of the following measures:

- All hatchery-origin Chinook salmon yearlings would be released as migration-ready smolts directly from Hurd Creek Hatchery, which is located in the lowest portion of the river (RM 2.7). All coho salmon yearlings would be released into the Dungeness River from Dungeness River Hatchery at RM 10.5. These release sites minimize the areal extent where any co-occurring natural-origin fish would be exposed to interactions with the yearling hatchery fish.
- All hatchery fish would be released as migration-ready smolts that would quickly emigrate from the lower Dungeness River and disperse into marine waters, minimizing the duration of interaction with any natural-origin salmonids of a size vulnerable to predation.
- There will be few natural-origin fish of any species in the lower Dungeness River that would serve as prey for hatchery-origin yearlings when and where proposed juvenile fish releases would occur due to the currently depressed status of listed fish populations in the watershed.
- If naturally-produced smolt outmigration timing, determined by monitoring in the mainstem or tributaries, suggests that proposed release timings for Chinook salmon and coho salmon from the hatcheries would result in predation on listed natural-origin fish, alternate release timings or other mitigation measures would be developed to minimize such interactions.

3.1.6 5(i)(F) The HGMP describes interrelationships and interdependencies with fisheries management.

The three Dungeness River Hatchery salmon HGMPs describe the relationship of the proposed actions with fisheries management in section 3.0 of each plan. Of primary concern for the purposes of this evaluation is integration of the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a) with fisheries management actions affecting the listed hatchery-origin fish produced through the program, and the natural-origin Chinook salmon population that is the target stock for recovery.

The HGMPs indicate that all WDFW-managed hatchery programs in the Puget Sound region, including the three Dungeness River Hatchery programs, would operate consistent with the *U.S.* v. *Washington* (1974) fisheries management framework. This legal framework sets forth required measures for coordinating State and tribal implementation of agreed hatchery programs, defining artificial production objectives, and maintaining treaty-fishing rights through the court-ordered Puget Sound Salmon Management Plan (PSSMP 1985). This fisheries resource co-management process requires that both the State of Washington and the Puget Sound Tribes develop salmon hatchery program goals and objectives, and reach agreement on the function, purpose, and fish production strategies for all Puget Sound hatchery programs.

As described in the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a), the program operates for conservation purposes. Harvest augmentation is not an objective of the Dungeness River Hatchery Chinook salmon HGMP. There will therefore be no tribal or WDFW fisheries in the Dungeness River or Dungeness Bay directed at harvest of Dungeness Chinook salmon. Fisheries directed at other Chinook salmon stocks and other species (including coho salmon produced for harvest augmentation purposes through the Dungeness River Hatchery program) may harvest Dungeness Chinook salmon incidentally. Because of region-wide fisheries harvest management measures implemented by the co-managers consistent with this intent, the total annual incidental fisheries harvest rate on Dungeness Chinook salmon has been low. Fishery impact modeling based on coded wire tag recovery data projects a total exploitation rate of 56.3% for fisheries that incidentally harvest Dungeness Chinook salmon (LOAF 2014). Canadian area fisheries account for 95% of the total incidental harvest of Dungeness Chinook salmon, and the exploitation rate in Washington State fisheries is projected to be 2.8% (LOAF 2014). The co-managers indicate that in-river and U.S. marine area fisheries will continue to be managed applying time and area restrictions that would minimize incidental harvest effects on listed Dungeness Chinook salmon (LOAF 2014).

Harvest impacts on listed Chinook salmon and Hood Canal summer chum salmon associated with fisheries intercepting Dungeness River Chinook salmon (WDFW 2013a), and fisheries targeting Dungeness River Hatchery coho salmon (WDFW 2013c), were previously evaluated and authorized by NMFS through separate ESA consultations (NMFS 2001; NMFS 2011a), and are subject to reevaluation and pending authorization in 2015. The NMFS (2001) consultation evaluated the consistency of comanager fisheries resource management plan management measures implemented for Hood Canal and Strait of Juan de Fuca region salmon fisheries with 4(d) rule, limit 6 criteria for listed Hood Canal summer-run chum salmon. NMFS determined that, implementing and enforcing the resource management plan would not appreciably reduce the likelihood of survival and recovery of the Hood Canal summer-run chum salmon ESU (NMFS 2001). The NMFS (2010) consultation evaluated the effects of the co-managers' harvest management RMP (PSIT and WDFW 2010a) for all Puget Sound region salmon and steelhead fisheries potentially affecting listed Puget Sound Chinook salmon, pursuant to 50 CFR 223.209 (Tribal Rule) and the government-to government processes therein. NMFS determined under 50 CFR 223.203(b)(6) that implementing and enforcing the RMP would not appreciably reduce the likelihood of survival and recovery of the Puget Sound Chinook Salmon ESU (NMFS 2011a).

Harvest resulting from the production of pink salmon through the proposed Dungeness River Hatchery HGMP (WDFW 2013b) would not be expected to result in any substantial fisheries removal effects on listed fish species. The program operates for conservation purposes, and there would be no design to provide fish for harvest in any fisheries within the watershed that would affect listed salmon or steelhead. Because of the depressed abundance status of the natural-origin fall-run pink salmon population used as donor broodstock, the proposed program would produce modest numbers of adult fish, with all resultant returns to the river needed for natural spawning, or for meeting annual hatchery broodstock requirements. No reference is made in the pink salmon HGMP to substantial effects of any marine area fisheries targeting pink salmon that could potentially incidentally harvest listed Chinook salmon, summer chum salmon, and steelhead.

3.1.7 5(i)(G) Adequate artificial propagation facilities exist to properly rear progeny of naturally spawned broodstock, to maintain population health and diversity, and to avoid hatchery-influenced selection and domestication.

The issue under this criterion is the adequacy of hatchery facilities in safeguarding listed salmon – for the HGMPs under review, listed Dungeness Chinook salmon - from harm while the fish are under propagation. The operation of concern would be the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a). The hatchery-origin Chinook salmon population propagated through the programs is no more than moderately diverged from the associated Dungeness natural-origin Chinook salmon population (70 FR 37204, June 28, 2005). The hatchery-origin Chinook salmon produced through the program are therefore included with natural-origin Chinook salmon in the Dungeness River as part of the listed Puget Sound Chinook salmon ESU (70 FR 37160; Jones 2011). The two other HGMPs proposed for implementation (WDFW 2013b; 2013c) would not propagate listed fish species and are not of concern for compliance with this criterion.

Water sources and facilities that would be used to collect and hold listed Chinook salmon broodstock, incubate eggs, and rear and release juvenile fish are described in sections 4 and 5 of the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a). Included in those sections are assessments of ecological and genetic risks to listed Chinook salmon, and descriptions of measures that would be applied to minimize the likelihood for adverse effects on listed fish while the fish are maintained in hatchery facilities for propagation.

Under the Dungeness River Hatchery Chinook salmon HGMP, four separate hatchery locations are proposed to effectuate various portions of the program – Dungeness River Hatchery, Hurd Creek Hatchery, Gray Wolf Acclimation Pond, and Upper Dungeness Acclimation Pond. The water sources and facilities that would be used to propagate listed Dungeness Chinook salmon are located at WDFW hatchery sites that have been successfully operated for the purposes of hatchery salmon. As described in sections 4 and 5 of the Dungeness River Hatchery Chinook salmon HGMP, the hatchery facilities used to implement the conservation program have the necessary surface and groundwater sources, fish trapping and holding facilities, egg incubation and fish rearing vessels, and fish release facilities that would ensure proper rearing of the progeny of

natural- and hatchery-origin Chinook salmon broodstock collected from adult returns to the Dungeness River. The water sources and WDFW facilities are state-of-the-art for the hatchery propagation of anadromous fish species and adequate for their purpose as proposed for the hatchery production of Chinook salmon. The HGMPs also describe how the fish would be reared to maintain fish health through implementation of co-manager fish health policy protocols (NWIFC and WDFW 2006). Those protocols have proven adequate to protect salmon and steelhead from fish disease transfer and amplification effects in practice in regional hatcheries (NMFS 2012), including those located in Puget Sound (WDFW and PSTT 2004). As indicated in sections 8 and 9 of the Dungeness River Hatchery Chinook salmon HGMP (WDFW 2013a), the program has a demonstrated record of maintaining high survival rates for each Chinook salmon life stage under propagation (i.e., green to eyed egg; eyed egg to fry; and fry to smolt release). High survival rates for the various Chinook salmon life stages are consistent with goal rates identified for well-run hatchery programs (Fuss and Ashbrook 1995). Measures that would be implemented to protect the genetic diversity of the listed Chinook salmon population while under propagation are proposed in HGMP sections 6 through 10 (WDFW 2013a).

3.1.8 5(i)(H) Adequate monitoring and evaluation exist to detect and evaluate the success of the hatchery program and any risks potentially impairing the recovery of the listed ESU.

Adequate monitoring and evaluation actions are proposed in the three HGMPs to evaluate the performance of each program in meeting Dungeness River Chinook and pink salmon conservation, and Dungeness River Hatchery coho salmon harvest augmentation objectives. Adequate monitoring and evaluation actions to identify hatchery-related effects on ESA-listed fish are also proposed. These actions are summarized in Section 1.10, and are further described in Section 11.0 of each HGMP ("Monitoring and Evaluation of Performance Indicators"). Included in section 1.10 are descriptions of monitoring and evaluation measures that would be implemented to assess plan benefits and risks addressing hatchery program performance indicators. Monitoring and evaluation objectives and responsive actions that would be implemented under the HGMPs are summarized below.

The primary monitoring and evaluation objective for the two conservation hatchery plans for Chinook salmon and pink salmon (WDFW 2013a; 2013b) is assessment of the status of the target Dungeness River populations and the success of the programs in achieving restoration goals for the species. Monitoring and evaluation actions that would be implemented to determine whether this objective is met include spawning ground/redd surveys and hatchery escapement monitoring to determine total Chinook and pink salmon return abundances to the Dungeness River and the hatcheries. The number and distribution of tagged, untagged, and otolith marked fish escaping to the watershed each year would be monitored to determine the status of the natural- and hatchery-origin salmon returns relative to goal levels. In addition to regular foot surveys to census salmon spawning abundance, count redds, and sample carcasses to identify fish origin in natural spawning areas, adult fish abundance, origin, and distribution data would be collected through monitoring of weir counts at Dungeness River Hatchery and (when operating) at the Dungeness River (Game Farm) mainstem weir. Adult fish returns abundance, timing, age class, sex ratio,

and fish health condition data would be collected at the hatchery and weir collection locations to monitor the effects of the programs in increasing adult returns and maintaining the run traits of the target populations. Juvenile fish outmigrant data collected through annual operation of a downstream-migrant trap in the mainstem Dungeness River would allow for assessment of the natural spawning success of the salmon populations. Operated by WDFW's Wild Salmon Production Evaluation Unit, and permitted for listed fish takes through a separate ESA review process, juvenile outmigrant trapping would provide data regarding abundance by species and origin, and salmon migrational behavior (seasonal timing, migration rate, and migration duration). These data would be essential for identifying Chinook and pink salmon survival and productivity, and the effects of the conservation hatchery programs in assisting in the restoration of viable populations.

The demographic and ecological effects of the three salmon programs on listed salmon and steelhead populations in the Dungeness River are also monitored. The primary objective would be to determine whether the programs were harming juvenile and adult Chinook salmon, summer chum salmon, or steelhead as a result of operation of the hatcheries, collection of broodstock, and the production of juvenile fish that would return as adults. In general, actions taken at the hatcheries to meet this objective would include monitoring of water withdrawal and effluent discharge to ensure compliance with permitted levels; monitoring of broodstock collection, egg take, fish survival rates, and smolt release levels for each program to determine compliance with program goals; and fish health monitoring and reporting in compliance with co-manager Fish Health Policy requirements. Data collected through operation of the WDFW juvenile out-migrant trap in the lower river, and a juvenile coho salmon outmigrant trap in Matriotti Creek operated by the Jamestown S'Klallam Tribe, would allow assessment of emigrating natural- and hatchery-origin fish abundance and overlap in timing between natural-origin species and newly released hatchery-origin fish. Other data collected at the trap that would be used to assess hatchery effects are fish size, origin (marked/tagged vs. unmarked/untagged) and other biological data (e.g., tissue samples for genetic analyses). To ensure proper care and maintenance of trapped fish as a means to minimize take of listed fish, the trap would be checked by WDFW frequently to reduce holding duration, and trapping would be suspended during high flow events to reduce the risk of fish injury and mortality. Other risk aversion measures that are implemented to minimize take are specified in annual NMFS 4(d) Evaluation and Determination documents authorizing WDFW research in Puget Sound (NMFS 2015).

In summary, hatchery-related monitoring and evaluation actions proposed in the HGMPs that would be implemented to meet program objectives would include:

- Counting and sampling (scale, mark/tag and/or otolith) and identification of age class distribution and sex ratio of adults returning to the hatcheries and escaping to spawn naturally to assess fish species status and origin;
- Mark, tag, and tissue sampling of adult Chinook salmon returning to the hatchery and of carcasses recovered in natural spawning areas to enable evaluation of hatchery program performance in increasing natural returns, and effects on natural-origin fish;
- Marking and/or tagging of all fish released through the hatchery programs to allow for assessment of hatchery-origin adult contributions to total returns to the river and

natural spawning; productivity of naturally spawning salmon and steelhead; post-release migration behavior of hatchery fish in the river; and survival of program-origin fish from smolt release to adult return to the river;

- Documentation of fish cultural techniques used for listed Chinook salmon propagation to gauge whether the program is meeting objectives and to identify the need for adjustment to adequately safeguard the listed fish, including: broodstock collection and handling procedures, fish and egg condition at time of spawning, fertilization procedures, incubation methods/densities, temperature unit records by developmental stage, egg shocking methods, fungus treatment methods for eggs; start feeding methods, rearing/pond loading densities, feeding schedules and rates; fish release locations and methods; and fish mortality levels by life stage;
- Sampling and monitoring of fish health for all species under propagation consistent with co-manager Fish Health Policy procedures.

In sum, measures for monitoring HGMP performance and for determining the effects of the programs on recovery of the listed Puget Sound Chinook Salmon ESU, Hood Canal Summer chum Salmon ESU, and Puget Sound Steelhead DPS are proposed for implementation, and the plans are consistent with this criterion.

3.1.9 5(i)(I) The HGMP provides for evaluating monitoring data and making any revisions of assumptions, management strategies, or objectives that data show are needed.

The HGMPs describe the intent to evaluate monitoring data, and apply results to adjust hatchery actions as needed to improve performance or reduce unanticipated adverse effects on listed fish. Each of the three proposed HGMPs identify objectives and actions needed to determine hatchery program performance in meeting stated preservation, restoration, and/or production objectives for the specific species that are the focus of each HGMP (HGMP sections 1.10), and effects on target and non-target natural-origin fish populations in the Dungeness River watershed. In compliance with this 4(d) Rule criterion, the HGMPs would apply adaptive management and risk management approaches in their implementation of hatchery and research actions. These approaches are applied in response to uncertainties regarding the effects of hatchery actions, the pace of recovery of critical habitat needed to sustain the species, and salmon and steelhead preservation and recolonization needs.

Under the HGMPs, data collected relating to hatchery program performance and effects would be evaluated by WDFW and the Jamestown S'Klallam Tribe to determine whether the three salmon programs were meeting their respective objectives. As identified in Section 1.10 of the HGMPs, monitoring and evaluation results would be used to determine whether performance standards addressing program benefits and risks (performance and effects) were met. The co-managers indicate in the HGMPs that funding and staff resources would be committed to monitor and

evaluate the programs through review by the Dungeness River Chinook Technical Advisory Committee[3], WDFW Fish Program and Jamestown S'Klallam tribal technical staffs.

As the overarching plan for the production of Chinook salmon in the Puget Sound region, the co-managers' Resource Management Plans for Puget Sound Chinook Salmon Hatcheries (WDFW and PSTT 2004; PSIT and WDFW 2010a; NMFS 2011a; and (pending) PSIT and WDFW 2015) provide further details regarding how hatchery performance and effects data will be evaluated and applied through an adaptive management approach. As described in the RMPs, through adaptive management, monitoring and evaluation actions would be applied to allow the co-managers to make sound hatchery program management decisions while operating in the face of uncertainty about future conditions and effects. Key elements of the co-managers' adaptive management framework as applied to the Dungeness River Hatchery salmon programs would be:

- An integrated strategy for prioritizing actions considering the entire Puget Sound region and its salmon populations (e.g., the role of Dungeness Chinook in the recovery of the ESU (NMFS 2011a);
- Defined goals and objectives for hatchery programs;
- A framework of artificial production strategies for reaching goals and objectives;
- Strategy-specific guidelines for operating hatchery programs;
- Scientific tools for evaluating hatchery operations, including statistical analyses, risk-benefit assessments, and independent scientific review;
- A decision-making framework for considering in-season, annual, and long-term changes in hatchery objectives and standard operating modes described in the HGMPs and resolving disputes;
- Implementation using available resources.

Primary information that would be applied in the adaptive management framework regarding program performance and effects would be provided through evaluation of adult salmon return data. All juvenile hatchery-origin salmon released through the Dungeness River Hatchery programs would be marked or tagged. Mass marking of all juvenile hatchery-origin salmon would allow for their differentiation from natural-origin fish, and identification and recovery as returning adults at the hatcheries and on the spawning grounds. These adult fish recovery data would be applied by the co-managers for making hatchery program effect and natural salmon population viability status determinations, and identifying the need to adjust the program to meet objectives.

Consistent with Implementation Terms that would be issued as part of the NMFS 4(d) decision, annual reports for the programs submitted by WDFW and the Jamestown S'Klallam Tribe would be jointly reviewed by the co-managers and NMFS to document program results, and determine if the programs assumptions, management strategies, or objectives need to be adjusted. Under a

3 The Dungeness River Chinook Technical Advisory Committee (TAC) was formed as the forum for WDFW, the Jamestown S'Klallam Tribe, NWIFC and the USFWS to coordinate, through regular meetings, recovery actions for the Dungeness Chinook salmon population, and implementation of the Dungeness River Hatchery Chinook salmon HGMP.

NMFS ESA determination for the proposed programs, these reports would be completed by April of each year, and would be displayed on the NMFS West Coast Region website with the HGMPs for public information purposes.

3.1.10 5(i)(J) NMFS provides written concurrence of the HGMP which specifies the implementation and reporting requirements.

Written concurrence with the RMP, and the HGMPs of which it is composed, is a requirement specific to Limit 5 of the 4(d) Rule, rather than of Limit 6, under which this RMP is considered. Instead, under Limit 6, NMFS' role is to make a determination as to whether implementing and enforcing the joint tribal/state plan will appreciably reduce the likelihood of survival and recovery of affected threatened ESUs, including consideration of how the HGMPs address the criteria of Limit 5. With the current document, NMFS has documented its determination. NMFS will notify the co-managers of our determination and of implementation and reporting requirements specified herein [50 CFR 223.203(b)(5)(J)].

3.1.11 5(i)(K) The HGMP is consistent with plans and conditions set within any Federal court proceeding with continuing jurisdiction over tribal harvest allocations.

The Dungeness River Hatchery salmon HGMPs were developed by WDFW and the Jamestown S'Klallam Tribe pursuant to the *United States v. Washington* (1974) fisheries and hatchery management framework. The HGMPs are one component of an overall effort to preserve and recover to a healthy, fishable status listed Chinook salmon, summer chum salmon, steelhead, and other non-listed anadromous salmon populations native to the Dungeness River watershed, consistent with the Dungeness River watershed component of the Shared Strategy Recovery Plan (Ruckelshaus et al. 2005), and the Hood Canal Coordinating Council's Summer Chum Plan (HCCC 2005). Adopted by NMFS on January 19, 2007 (72 FR 2493; NMFS 2006) and May 24, 2007 (72 FR 29121; NMFS 2007) respectively, the ESU recovery plans for Chinook salmon and summer chum salmon have hatchery and habitat components, and include monitoring, research, and habitat protection, assessment, and restoration recommendations to complement artificial production. The hatchery actions proposed in the Dungeness River Hatchery salmon HGMPs are included within, and consistent with these ESU recovery plans. The recovery plans and the HGMPs have shared salmon and steelhead recovery actions that include as objectives return of salmonid populations to statuses that will meet treaty-reserved fishing rights for the Puget Sound Tribes.

There are no other plans or conditions set within Federal court proceedings, including memorandums of understanding, court orders or other management plans, that direct operation of the proposed salmon hatchery programs.

4 NOTICE OF PENDING RECOMMENDATION

As required by Limit 6 of the 4(d) Rule, the Secretary sought comment from the public on the pending determination as to whether or not the RMP would appreciably reduce the likelihood of

survival and recovery of threatened Puget Sound Chinook Salmon ESU, Hood Canal Summer Chum Salmon ESU, or Puget Sound steelhead DPS together with a discussion of the biological analysis underlying that determination (80 FR 9260, February 20, 2015). Comments were received, and were considered in developing this final recommended determination.

5 DETERMINATION

NMFS has reviewed the three plans provided by WDFW and the Jamestown S'Klallam Tribe pursuant to limit 6 of the 4(d) Rule, and evaluated them together against the requirements of the 4(d) Rule. Based on this review and evaluation, NMFS' determination is that activities implemented as described in the three plans would not appreciably reduce the likelihood of survival and recovery of ESA-listed Puget Sound Chinook salmon, Hood Canal summer chum salmon, or Puget Sound steelhead, and that the plans address all of the criteria specified in Limit 5 of the 4(d) Rule. If the Regional Administrator concurs with this pending determination, take prohibitions would not apply to activities implemented in accordance with the three co-manager HGMPs composing the hatchery RMP for salmon populations in the Dungeness River watershed.

6 REEVALUATION CRITERIA

NMFS will reevaluate this determination if: (1) the actions described by the HGMPs are modified in a way that causes an effect on the listed species that was not previously considered in NMFS' evaluation; (2) new information or monitoring reveals effects that may affect listed species in a way not previously considered; or (3) a new species is listed or critical habitat is designated that may affect NMFS' evaluation of the HGMPs.

7 REFERENCES

7.1 Federal Register Notices

64 FR 14508. March 25, 1999. Endangered and threatened species: threatened status for two ESUs of chum salmon in Washington and Oregon.

70 FR 37160. June 28, 2005. Final ESA listing determinations for 16 ESUs of West Coast salmon, and final 4(d) protective regulations for threatened salmonid ESUs.

70 FR 37204. June 28, 2005. Policy on Consideration of Hatchery-origin Fish in Endangered Species Act Listing Determinations for Pacific Salmon and Steelhead.

70 FR 52630. September 2, 2005. Endangered and Threatened Species; Designation of Critical Habitat for 12 Evolutionarily Significant Units of West Coast Salmon and Steelhead in Washington, Oregon, and Idaho; Final Rule.

71 FR 836. January 5, 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead.

72 FR 2493. January 19, 2007. Endangered and Threatened Species; Recovery Plans. NMFS announcement of the adoption of its Endangered Species Act (ESA) Recovery Plan (Recovery Plan) for the Puget Sound Chinook Salmon (Oncorhynchus tshawytscha) Evolutionarily Significant Unit (ESU).

72 FR 26722. May 11, 2007. Final ESA listing determination for Puget Sound steelhead.

72 FR 29121. May 24, 2007. Endangered and Threatened Species; Recovery Plans. NMFS announcement of the adoption of an Endangered Species Act (ESA) Recovery Plan (Recovery Plan) for the Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon (Oncorhynchus keta) Evolutionarily Significant Unit (ESU).

73 FR 55451. September 25, 2008. Endangered and Threatened Species: Final Protective Regulations for Threatened Puget Sound Steelhead.

76 FR 157. August 15, 2011. Endangered and Threatened Species; 5-Year Reviews for 17 Evolutionarily Significant Units and Distinct Population Segments of Pacific Salmon and Steelhead.

7.2 Literature Cited

American Fisheries Society (AFS), Fish Health Section. 1994. Bluebook – Suggested Procedures for the Detection and Identification of Certain Finfish and Shellfish Pathogens.

Anderson, J.H., P. Faulds, W. Atlas, and T. Quinn. 2012. Reproductive success of captively bred and naturally spawned Chinook salmon colonizing newly accessible habitat. Evolutionary Applications ISSN 1752-4.

Busack, C. A., and K. P. Currens. 1995. Genetic risks and hazards in hatchery operations: Fundamental concepts and issues. Pages 71-80 in H. L. Schramm, Jr. and R. G. Piper, editors. Uses and effects of cultured fishes in aquatic ecosystems. American Fisheries Society Symposium 15, Bethesda, MD.

FAO-UN (Food and Agriculture Organization of the United Nations). 1981. Conservation of the genetic resources of fish: problems and recommendations. Report of the Expert Consultation on the Genetic Resources of Fish, Rome, Italy, 9-13 June 1980. FAO Fisheries Technical Paper 217. 43p.

Ford, M.J. (ed.). 2011. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-NWFSC-113. 281p.

Fuss, H.J., and C. Ashbrook. 1995. Hatchery operation plans and performance summaries. Volume I, Number 2, Puget Sound. Assessment and Development Division. Hatcheries Program. Washington Department of Fish and Wildlife. Olympia, Washington. 300 p (approx).

Hard, J.J., R.P. Jones, M.R. Delarm, and R.S. Waples. 1992. Pacific salmon and artificial propagation under the Endangered Species Act. U.S. Dept. Commer., NOAA Tech. Memo. NMFS F/NWC-2. 56p.

Hard, J. J., J. M. Myers, E. J. Connor, R. A. Hayman, R. G. Kope, G. Lucchetti, A. R. Marshall, G. R. Pess, and B. E. Thompson. 2015. Viability Criteria for Steelhead within the Puget Sound Distinct Population Segment. May 2015. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-129. 367p.

Haring, D. 1999. Salmonid habitat limiting factors - water resource inventory area 18 - final report. December, 27, 1999. Washington State Conservation Commission. Lacey, WA. 202 p.

HSRG (Hatchery Scientific Review Group). 2004. Hatchery reform; principles and recommendations of the Hatchery Scientific Review Group. Long Live the Kings. Seattle, Washington. Available from: http://hatcheryreform.us/hrp_downloads/reports/hsrg_princ_recs_report_full_apr04.pdf.

HCCC (Hood Canal Coordinating Council). 2005. Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan. Hood Canal Coordinating Council. 334p. plus eight appendices.

Jones, R. 2011. 2010 5-Year Reviews - updated evaluation of the relatedness of Pacific Northwest hatchery programs to 18 salmon evolutionarily significant units and steelhead distinct population segments listed under the Endangered Species Act. June 29, 2011 memorandum to Donna Darm, NMFS Northeast Region Protected Resources Division. Salmon Management Division, Northwest Region, NMFS. Portland, Oregon. 57p.

Kinsel, C., M. Zimmerman, L. Kishimoto, and P. Topping. 2008. Annual report 2007 Skagit River salmon production evaluation. December, 2008. Washington Department of Fish and Wildlife. Olympia, Washington. 74p.

Koski, K.V. 1975. The survival and fitness of two stocks of chum salmon (Oncorhynchus keta) from egg deposition to emergence in a controlled stream environment at Big Beef Creek. Ph.D. thesis. College of Fish., Univ. Washington. 212p.

LOAF (List of Agreed Fisheries). 2014. 2014-15 Co-Managers' List of Agreed Fisheries (May 1, 2014 - April 30, 2015). May 16, 2014. Washington Department of Fish and wildlife and Northwest Indian Fisheries Commission. Olympia, Washington. 90p.

Marlowe, C., B. Freymond, R.W. Rogers, and G. Volkhardt. 2001. Dungeness River Chinook Salmon Rebuilding Project – Progress Report 1993-1998. Wash. Dep. Fish. & Wildl. Prog. Rpt. No. FPA 00-24. 94p.

McElhany, P., M.H. Ruckelshaus, M.J. Ford, T.C. Wainwright, and E.P. Bjorkstedt. 2000. Viable salmonid populations and the recovery of evolutionary significant units. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-42, 158p.

Myers, J.M., and 10 co-authors. 1998. Status review of chinook salmon from Washington, Idaho, Oregon, and California. U.S. Dept. of Commerce, NOAA Tech. Memo. NMFS-NWFSC-35. 443p.

Myers, J. M., J. J. Hard, E. J. Connor, R. A. Hayman, R. G. Kope, G. Lucchetti, A. R. Marshall, G. R. Pess, and B. E. Thompson. 2015. Identifying Historical Populations of Steelhead within the Puget Sound Distinct Population Segment. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-128. 175p.

NMFS (National Marine Fisheries Service). 1999. A conceptual framework for conservation hatchery strategies for Pacific salmonids. T.A. Flagg and C.E. Nash (editors). U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-38. 46p.

NMFS. 2001. Endangered Species Act - section 7 consultation - biological opinion and incidental take statement for programs administered by the Bureau of Indian Affairs and activities authorized by the U.S. Fish and Wildlife service supporting tribal salmon fisheries affecting listed Puget Sound Chinook and Hood Canal summer-run chum salmon evolutionarily significant units. NMFS Northwest Regional Office, Salmon Management Division. Seattle, Washington. 29 p.

NMFS. 2003. Hatchery broodstock summaries and assessments for chum, coho, and Chinook salmon and steelhead stocks within evolutionarily significant units listed under the Endangered Species Act. Salmon and Steelhead Hatchery Assessment Group (SSHAG). NMFS, Northwest Fisheries Science Center. Seattle, Washington. 326p.

NMFS. 2006a. Puget Sound Chinook salmon recovery needs report. Puget Sound Domain Team. Salmon Recovery Division, Northwest Region, National Marine Fisheries Service. Seattle, Washington. 50p.

NMFS. 2006b. Final Supplement to the Shared Strategy's Puget Sound Salmon Recovery Plan. NMFS, Northwest Region, Portland, Oregon. 47 p.

NMFS. 2007. Final Supplement to the Hood Canal and Eastern Strait of Juan de Fuca Summer Chum Salmon Recovery Plan. May 16, 2007. National Marine Fisheries Service, Northwest Region, Seattle, WA. 53 p.

NMFS. 2009. Evaluation and recommended determination of a tribal resource management plan submitted for consideration under the Endangered Species Act's Tribal Plan Limit [50 CFR 223.204] for the period January 1, 2009 - December 31, 2016. March 27, 2009. NMFS Protected Resources Division. Portland, Oregon. 46 p.

NMFS. 2010. Puget Sound Chinook salmon population recovery approach (PRA) - NMFS Northwest Region approach for distinguishing among individual Puget Sound Chinook salmon ESU populations and watersheds for ESA consultation and recovery planning purposes. Public Review Draft, November 30, 2010. Puget Sound Domain Team, National Marine Fisheries Service, Northwest Region. Seattle, Washington. 19p.

NMFS. 2011a. Evaluation of and recommended determination on a resource management plan (RMP), pursuant to the salmon and steelhead 4(d) rule - comprehensive management plan for Puget Sound Chinook: harvest management component. NMFS Northwest Regional Office, Salmon Management Division. Seattle, Washington. 244p.

NMFS. 2011b. 5-year review: summary & evaluation of Puget Sound Chinook, Hood Canal summer chum, Puget Sound steelhead. National Marine Fisheries Service, Northwest Region. Portland, Oregon. 51p.

NMFS. 2012. Effects of hatchery programs on salmon and steelhead populations: reference document for NMFS ESA hatchery consultations. Craig Busack, Editor. March 7, 2012. NMFS Northwest Regional Office, Salmon Management Division. Portland, Oregon. 50p.

NFMS. 2015. Letter to Mrs. Charmane Ashbrook, Washington State Department of Fish and Wildlife, from Mr. William W. Steele, National Marine Fisheries Service responding to request for evaluation of fishery research program under the Endangered Species Act 4(d) rule's research limit (50 CFR 223.203(b)(7) and determination that take prohibitions under Section 9 of the ESA do not apply to research activities specified in the WDFW fishery research program as submitted. March 4, 2015. U.S. Dept. of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, West Coast Region. Long Beach, California.

NWFSC (Northwest Fisheries Science Center). 2015. Status review update for Pacific salmon and steelhead listed under the Endangered Species Act: Pacific Northwest. NMFS, Seattle, WA. 357p.

NWIFC (Northwest Indian Fisheries Commission) and WDFW (Washington Department of Fish and Wildlife). 2006. The salmonid disease control policy of the fisheries co-managers of Washington State (revised July 2006). Fish Health Division, Fish Program. Washington Department Fish and Wildlife, Olympia, Washington. 38p.

NPPC (Northwest Power Planning Council). 2001. Performance standards and indicators for the use of artificial production for anadromous and resident fish populations in the Pacific Northwest. Portland, Oregon. 19 p.

PNFHPC (Pacific Northwest Fish Health Protection Committee). 1989. Model comprehensive fish health protection program. 19 p.

Piper, R., I.B. McElwain, L.E. Orme, J.P. McCraren, L.G. Fowler, J.R. Leonard, A.J. Trandahl, and V. Adriance. 1982. Fish Hatchery Management. United States Dept of Interior, Fish and Wildlife Service. Washington, D.C.

PNPTT (Point No Point Treaty Tribes) and WDFW (Washington Department of Fish and Wildlife Service). 2003. Summer chum salmon conservation initiative. An implementation plan to recover summer chum salmon in the Hood Canal and Strait of Juan de Fuca Region. Supplemental Report No. 5 - Interim Summer Chum Salmon Recovery Goals. October 2003. Washington Department of Fish and Wildlife, Olympia, Washington. 40 p.

PSIT (Puget Sound Indian Tribes) and (WDFW) Washington Department of Fish and Wildlife. 2004. Puget Sound Chinook salmon hatcheries, a component of the comprehensive Chinook salmon management plan. March 31, 2004. Northwest Indian Fisheries Commission. Lacey, Washington.

PSIT (Puget Sound Indian Tribes) and WDFW (Washington Department of Fish and Wildlife). 2010a. Puget Sound Comprehensive Chinook Management Plan: Harvest Management Component. Northwest Indian Fisheries Commission. Olympia, Washington. 237p.

PSIT (Puget Sound Indian Tribes) and WDFW (Washington Dept. Fish and Wildlife). 2010b. Puget Sound Steelhead Harvest Management Plan. January 7, 2010. Northwest Indian Fisheries Commission. Lacey, Washington. 224 p.

PSIT and WDFW. 2015. Comprehensive Management Plan for Puget Sound Chinook: Harvest Management Component. Northwest Indian Fisheries Commission. Lacey, Washington.

PSSMP (Puget Sound Salmon Management Plan). 1985. United States vs. Washington (1606 F.Supp. 1405).

Ruckelshaus, B., B. Ack, K. Berg, B. Cairns, D. Davidson, B. Kelly, R. Kinley, J. Koenings, P. Kremen, S. Lewis, B. Lohn, J. Manning, C. Mosher, B. Nichols, J. Ryan, R. Sims, M. Shelby, D. Trout, and T. Williams. 2005. Puget Sound salmon recovery plan. Submitted by the Shared Strategy Development Committee, plan adopted by NMFS Jan. 19, 2007. Available online at: http://www.sharedsalmonstrategy.org/plan/index.htm

Ruckelshaus, M.H., K.P. Currens, R.R. Fuerstenberg, W.H. Graeber , K. Rawson, N.J. Sands, and J.B. Scott. 2002. Planning Ranges and Preliminary Guidelines for the Delisting and Recovery of the Puget Sound Chinook Salmon Evolutionarily Significant Unit Puget Sound Technical Recovery Team April 30, 2002. Northwest Fisheries Science Center, NMFS. 20 p.

Ruckelshaus, M.H., K.P. Currens, W.H. Graeber, R.R. Fuerstenberg, K. Rawson, N.J. Sands, and J.B. Scott. 2006. Independent populations of Chinook salmon in Puget Sound. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-78, 125 p.

Salo, E.O. 1991. Life history of chum salmon (Oncorhynchus keta). Pages 231-310 in C. Groot and L. Margolis, editors. Pacific salmon life histories. UBC Press, Univ. British Columbia, Vancouver, British Columbia.

Sands, N. J., K. Rawson, K. Currens, W. Graeber, M. H. Ruckelshaus, R. Fuerstenberg, and J. Scott. 2009. Determination of independent populations and viability criteria for the Hood Canal summer chum salmon evolutionarily significant unit. U.S. Dept. of Commerce, NOAA Tech. Memo., NMFS-NWFSC-101, 58 p.

Schreiner, J.U. 1977. Salmonid outmigration studies in Hood Canal, Washington. M. S. Thesis. Univ. Washington. 91 p.

Scott, J.B., Jr., and W.T. Gill, eds. 2006. Oncorhynchus mykiss: assessment of Washington State's anadromous populations and programs. Draft report. Washington Department of Fish and Wildlife, Olympia, Washington.

Seidel, P. 1983. Spawning Guidelines for Washington Department of Fisheries Hatcheries. Washington State Department of Fisheries. Olympia, Washington.

SSPS (Shared Strategy for Puget Sound). 2005. Dungeness Watershed Profile. June 2005. In Volume II of the Shared Strategy for Puget Sound. Plan adopted by the National Marine Fisheries Service (NMFS). January 19, 2007. Submitted by the Shared Strategy Development Committee. Shared Strategy for Puget Sound. Seattle, Washington. 12p.

SIWG (Species Interaction Work Group). 1984. Evaluation of potential interaction effects in the planning and selection of salmonid enhancement projects. J. Rensel, chairman and K. Fresh editor. Report prepared for the Enhancement Planning Team for implementation of the Salmon and Steelhead Conservation and Enhancement Act of 1980. Washington Dept. Fish and Wildlife. Olympia, Washington. 80p.

Tartara, C.P., and B.A. Berejikian. 2012. Mechanisms influencing competition between hatchery and wild juvenile anadromous Pacific salmonids in fresh water and their relative competitive abilities. Environ Biol. Fish. 94:7–19.

Topping, P., G. Volkhardt, and L. Kishimoto. 2006. 2005 Dungeness River Juvenile Salmonid Production Evaluation. IN: 2005 Juvenile Salmonid Production Evaluation Report - Green River, Dungeness River and Cedar Creek. Report #FPA 06-10. Fish Program, Science Division, Washington Department of Fish and Wildlife. Olympia, Washington. 101 p.

Topping, P., and L. Kishimoto. 2008. 2006 Dungeness River Juvenile Salmonid Production Evaluation. *In:* 2006 Juvenile Salmonid Production Evaluation Report - Green River, Dungeness River and Cedar Creek. Report #FPA 08-05. Fish Program, Science Division, Washington Department of Fish and Wildlife. Olympia, Washington. 136 p.

Topping, P., M. Zimmerman, and L. Kishimoto. 2008. Juvenile Salmonid Production Evaluation Report - Green River and, Dungeness River Chinook Monitoring Evaluations in 2007. Fish Program, Science Division, Washington Department of Fish and Wildlife. Olympia, Washington. 97 p.

Tynan, T. 1997. Life history characterization of summer chum salmon populations in the Hood Canal and eastern Strait of Juan de Fuca regions. Report #H97-06. Assessment and Development Division, Hatcheries Program. Washington Department of Fish and Wildlife. Olympia, WA.

United States v. Washington. 1974. 384 F. Supp 312 (W.D. Wash.), aff'd, 500F.2nd 676 (9thCr. 1975, cert. denied), 423 U.S. 1086 (1976), Seattle, Washington.

WDF (Washington Department of Fisheries), WDW (Washington Department of Wildlife), and WWTIT (Western Washington Treaty Indian Tribes). 1993. 1992 Washington State salmon and steelhead stock inventory (SASSI). Internal Report to Washington Dept. Fish Wildlife., 212 p.

WDF (Washington Department of Fisheries) and WWTIT (Western Washington Treaty Indian Tribes). 1994. 1992 Washington state salmon and steelhead stock inventory. Appendix two: coastal stocks. Fish Program, Washington Department of Fish and Wildlife. Olympia, Washington. 588p.

WDFW (Washington Dept. Fish and Wildlife). 2013a. Hatchery and genetic management plan (HGMP) - Dungeness River Hatchery spring Chinook (integrated) - spring Chinook (Oncorhynchus tshawytscha) - Dungeness River. January 18, 2013. Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, Washington 98501-1091. 52 p.

WDFW (Washington Dept. Fish and Wildlife). 2013b. Hatchery and genetic management plan (HGMP) Dungeness River pink (fall-run) salmon hatchery program (integrated)- January 17, 2013. Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, Washington 98501- 1091. 47 p.

WDFW (Washington Dept. Fish and Wildlife). 2013c. Hatchery and genetic management plan (HGMP) - Dungeness River coho hatchery program (segregated). January 18, 2013. Washington Department of Fish and Wildlife, 600 Capitol Way N., Olympia, Washington 98501- 1091. 45 p.

WDFW. 2014. Dungeness River Early Winter Steelhead Hatchery Program Hatchery and Genetic Management Plan. Olympia, WA. July 28, 2014. 69p.

WDFW and PNPTT (Point No Point Treaty Tribes). 2000. Summer chum salmon conservation initiative - Hood Canal and Strait of Juan de Fuca region. Washington Department of Fish and Wildlife. Olympia, Washington. 424p. plus appendices.