HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

DRAFT

Hatchery Program	Deep River Spring Chinook Net Pen Program (SAFE)
Species or Hatchery Stock	Chinook Salmon *(Oncorhynchus tshawytscha)*
Agency/Operator	Washington Department of Fish and Wildlife
Watershed and Region	Columbia Estuary Subbasin/Columbia River Estuary Province
Date Submitted	nya
Date Last Updated	August 16, 2004

Section 1: General Program Description

1.1 Name of hatchery or program.

Deep River Spring Chinook Net Pen Program

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

Spring chinook salmon (*Oncorhynchus tshawytscha*)

ESA Status: Threatened

1.3 Responsible organization and individuals.

Name (and title):	Aaron Roberts
	Lower Columbia Hatcheries Complex Manager
Agency or Tribe:	Washington Department of Fish & Wildlife
Address:	600 Capitol Way N. Olympia WA. 98501-1091
Telephone:	(360) 225-6201
Fax:	(360) 225-6330
Email:	robertsa@dfw.wa.gov

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

Co-operators	Role
Bonneville Power Administration	Funding Source and Administrator (SAFE Net Pen Program)
Oregon Department of Fish and Wildlife	Sponsor and Regional Fisheries Management Entity
Clatsop County (Oregon)	Sponsor

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

Funding Sources
Bonneville Power Administration

Operational Information	Number
Full time equivalent staff	Supplied from Grays River Hatchery
Annual operating cost (dollars)	$148,750

1.5 Location(s) of hatchery and associated facilities.

Broodstock source	Cowlitz River Spring Chinook Stock (Cowlitz Salmon Hatchery) and/or Lewis River Spring Chinook (Speelyai Hatchery)
Broodstock collection location (stream, RKm, subbasin)	Cowlitz Salmon Hatchery/Cowlitz River/RKm 78.8/Cowlitz Subbasin; Lewis River Hatchery Trap/North Fork Lewis River/RKm 20.9/Lewis Subbasin; and Merwin Trap/North Fork Lewis River/RKm 25.8/Lewis Subbasin
Adult holding location (stream, RKm, subbasin)	Cowlitz Salmon Hatchery/Cowlitz River/RKm 78.8/Cowlitz; and Speelyai Hatchery/North Fork Lewis River/RKm 45.1/Lewis Subbasin
Spawning location (stream, RKm, subbasin)	Cowlitz Salmon Hatchery/Cowlitz River/RKm 78.8/Cowlitz Subbasin; and Speelyai Hatchery/North Fork Lewis River/RKm 45.1/Lewis Subbasin
Incubation location (facility name, stream, RKm, subbasin)	Cowlitz Salmon Hatchery/Cowlitz River/RKm 78.8/Cowlitz Subbasin; Speelyai Hatchery/North Fork Lewis River/RKm 45.1/Lewis Subbasin; and Grays River Hatchery/West Fork Grays River (Approximately 37.0 RKm from the confluence of the Grays and Columbia River/RKm 3.2/Grays River Subbasin
Rearing location (facility name, stream, RKm, subbasin)	Grays River Hatchery/West Fork Grays River (Approximately 37.0 RKm from the confluence of the Grays and Columbia River/RKm 3.2/Grays River Subbasin; and Cowlitz Salmon Hatchery/Cowlitz River/RKm 78.8/Cowlitz Subbasin

1.6 Type of program.

Isolated Harvest

1.7 Purpose (Goal) of program.

- Rear and release 330,000 spring chinook at 10 fpp into the Deep River drainage for the Columbia River mainstem.
- Deep River Net Pen spring chinook target non-mainstem Columbia River harvest opportunities for the commercial industry and the sport fishery.
- The goal for the SAFE programs was to determine the feasibility of creating and expanding terminal known stock fisheries in the Columbia River basin to allow harvest of strong anadromous salmonid stocks while providing greater protection to depressed fish stocks. BPA funds this net pen research project as part of its region-wide effort to mitigate for the loss of wildlife habitat and fish runs from the construction of hydroelectric projects in the Columbia River. Production of spring chinook at the Deep River Net Pens is exclusively for the Select Area Fishery Evaluation (SAFE) program. The SAFE Project was initiated in late 1993 with funding by the Bonneville Power Administration under the Northwest Power Planning Council.

1.8 Justification for the program.

In its 1993 Strategy For Salmon, the Northwest Power Planning Council recommended that

terminal fishing sites be identified and developed to harvest abundant fish stocks while minimizing the incidental harvest of weak stocks. The Council called on the Bonneville Power Administration (BPA) to: "Fund a study to evaluate potential terminal fishery sites and opportunities. This study should include: general requirements for developing those sites (e.g., construction of acclimation/release facilities for hatchery smolts so that adult salmon would return to the area for harvest); the potential number of harvesters that might be accommodated; type of gear to be used; and other relevant information needed to determine the feasibility and magnitude of the program. Beginning in 1993, BPA initiated the Columbia River Terminal Fisheries Project, a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Young's Bay and other sites in Oregon and Washington (BPA 1993). Terminal fisheries are being explored as a means to increase the sport and commercial harvest of hatchery fish while providing greater protection of weak wild salmon stocks. The project will be conducted in three distinct stages: an initial 2-year research stage to investigate potential sites, salmon stocks, and methodologies; a second 3-year stage of expansion in Young's Bay and introduction into areas of greatest potential as shown from initial stage; and a final 5-year phase of establishment of terminal fisheries at full capacity at all acceptable sites.

By 2000, several new sites were established on the Lower Columbia including Deep River and Steamboat Slough (now discontinued).

To minimize impacts on listed fish by WDFW facilities operation and the Deep River Net Pen program, the following Risk Aversions are included in this HGMP:

Table 1. Summary of risk aversion measures for the Deep River coho net pens program.

Potential Hazard	**HGMP Reference**	**Risk Aversion Measures**
Water Withdrawal	4.2	*Operation of Net Pen Facilities:* The Deep River Net Pen Facilities meet State water quality guidelines and satisfy all permit requirements including Washington Department of Ecology #1995-SW00373 and Army Corps of Engineers 404 Permit for Navigable waters No. 98-1-01828. The Net Pen Facility meets guidelines not requiring the following permits: e) "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System (NPDES) general permit (>20,000 lbs total on site production and > 5,000 lbs of fish feed per month).
Intake Screening	4.2	
Effluent Discharge	4.2	
Broodstock Collection & Adult Passage	7.9	Not applicable, See Lewis and Cowlitz systems HGMPs.
Disease Transmission	7.9, 10.11	*Fish Health Policy in the Columbia Basin*. Details hatchery practices and operations designed to stop the introduction and/or spread of any diseases within the Columbia Basin. Also, *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (Genetic Policy Chapter 5, IHOT 1995).
Competition & Predation	See also 2.2.3, 10.11	Current risk aversions and future considerations are being reviewed and evaluated for further minimizing impacts to listed fish.

1.9 List of program "Performance Standards".

See section 1.10.

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

The following plans and methods are proposed to collect data for each Performance Indicator: The goal of the project is to determine the feasibility of creating and expanding select area, known stock fisheries in the Columbia River Basin to allow harvest of strong anadromous salmonid stocks while providing greater protection to depressed stocks. This goal is being accomplished by addressing nine defined project objectives:

1) Survey and categorize potential select area fishing sites in the Columbia River basin for basic physical characteristics (high, medium, and low).

2) Determine the capability of the medium and high select area fishing sites for rearing and acclimating anadromous fish species in net pens or other facilities.

3) Determine the capability of the medium and high select area fishing sites to allow manageable and economically competitive harvest of returning fish.

4) For the medium and high select area fishing sites, determine the potential for harvest of target and non-target fish species.

5) Evaluate the suitability of various anadromous fish stocks for use in the medium and high select area fishing sites.

6) Determine the generic costs and logistics of a large-scale net pen rearing program (overwinter rearing and short-term acclimation) and estimate the variables for each of the medium and high select area fishing sites.

7) Evaluate the effects of a large-scale net pen rearing program (over-winter rearing and short-term acclimation) for select area fishing on hatchery production programs.

8) Determine the effects on upriver fish runs, escapements, and Zone 6 fisheries of shifting various levels of historical Zone 1-5 commercial fisheries to select area sites.

9) Coordinate activities with ODFW, WDFW, CEDC, BPA, NMFS, and Salmon For All (SFA).

Benefits		
Performance Standard	**Performance Indicator**	**Monitoring & Evaluation**
Assure that hatchery operations support Columbia River fish Mgt. Plan *(US v Oregon)* and SAFE production and harvest objectives	Contribute to a meaningful harvest for SAFE area fisheries. Achieve a 10-year average of 0.50 % smolt-to-adult survival (1650 fish at current production levels).	Survival and contribution to fisheries will be estimated for each brood year released. Work with co-managers to manage adult fish returning in excess of broodstock need.
Maintain outreach to enhance public understanding, participation and support of Washington Department of Fish & Wildlife (WDFW) hatchery programs.	Provide information about agency programs to internal and external audiences. For example, local schools and special interest groups tour the facility to better understand hatchery operations. Off station efforts may include festivals, classroom participation, stream adoptions and fairs.	Evaluate use and/or exposure of program materials and exhibits as they help support goals of the information and education program. Record on-station organized education and outreach events.
Program contributes to fulfilling tribal trust responsibility mandates and treaty rights	Follow pertinent laws, agreements, policies and executive and judicial orders on consultation and coordination with Native American tribal governments	Participate in annual coordination meetings between the co-managers to identify and report on issues of interest, coordinate management, and review programs (FBD process).
Implement measures for broodstock management to maintain integrity and genetic diversity (see Cowlitz and Lewis Rive HGMPs)	A minimum of adults are collected throughout the spawning run in proportion to timing, age and sex composition of return (see Cowlitz and Lewis Rive HGMPs).	Annual run timing, age and sex composition and return timing data are collected. Adhere to WDFW spawning guidelines. (WDFW 1983).
Region-wide, groups are marked in a manner consistent with information needs and protocols to estimate impacts to natural and hatchery origin fish	Use mass-mark (100% adipose-fin clip) for selective fisheries with additional groups Ad+CWT for evaluation purposes as needed.	Returning fish are sampled throughout their return for length, sex, mark and
Maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens. Follow Co-managers Fish Health Disease Policy (1998).	Necropsies of fish to assess health, nutritional status, and culture conditions.	WDFW Fish Health Section inspect adult broodstock yearly for pathogens and monitor juvenile fish on a monthly basis to assess health and detect potential disease problems. As necessary, WDFW's Fish Health Section recommends remedial or preventative measures to prevent or treat disease, with administration of therapeutic and prophylactic treatments as deemed necessary A fish health database will be maintained to identify trends in fish health and disease and implement fish health management plans based on findings.
	Release and/or transfer exams for pathogens and parasites.	1 to 6 weeks prior to transfer or release, fish are examined in accordance with the Co-managers Fish Health Policy
	Inspection of adult broodstock (See Cowlitz and Lewis River HGMPs) for pathogens and parasites	At spawning, lots of 60 adult broodstock are examined for pathogens
	Inspection of off-station fish/eggs prior to transfer to hatchery for pathogens and parasites.	Controls of specific fish pathogens through eggs/fish movements are conducted in accordance to Co-managers Fish Health Disease Policy.

1.10.1 Risks:

Risks		
Performance Standard	**Performance Indicator**	**Monitoring & Evaluation**
Minimize impacts and/or interactions to ESA listed fish	Hatchery operations comply with all state and federal regulations. Hatchery juveniles are raised to smolt-size (10.0 fish/lb) and released from the Net Pens at a time that fosters rapid migration downstream. Mass mark production fish to identify them from naturally produced fish (except CWT only groups, if included).	As identified in the HGMP: Monitor size, number, date of release and mass mark quality. Additional WDFW projects: straying, in stream evaluations of juvenile and adult behaviors, NOR/HOR ratio on the spawning grounds, fish health documented.
Artificial production facilities are operated in compliance with all applicable fish health guidelines, facility operation standards and protocols including IHOT, Co-managers Fish Health Policy and drug usage mandates from the Federal Food and Drug Administration	Hatchery goal is to prevent the introduction, amplification or spread of fish pathogens that might negatively affect the health of both hatchery and naturally reproducing stocks and to produce healthy smolts that will contribute to the goals of this facility.	Pathologists from WDFW's Fish Health Section monitor program monthly. Exams performed at each life stage may include tests for virus, bacteria, parasites and/or pathological changes, as needed.
Ensure hatchery operations comply with state and federal water quality and quantity standards through proper environmental monitoring	NPDES permit compliance WDFW water right permit compliance	Flow and discharge reported in monthly NPDES reports.
Water withdrawals and in stream water diversion structures for hatchery facility will not affect spawning behavior of natural populations or impact juveniles.	Hatchery intake structures meet state and federal guidelines where located in fish bearing streams.	At Gray River Hatchery Barrier and intake structure compliance assessed and needed fixes are prioritized.
Hatchery operations comply with ESA responsibilities	WDFW completes an HGMP and is issued a federal and state permit when applicable.	Identified in HGMP and Biological Opinion for hatchery operations.
Harvest of hatchery-produced fish minimizes impact to wild populations	Harvest is regulated to meet appropriate biological assessment criteria. Mass mark juvenile hatchery fish prior to release to enable state agencies to implement selective fisheries.	Harvests are monitored by agencies and tribes to provide up to date information.

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

Not applicable, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Age Class	Max. No.	Size (ffp)	Release Date	Location			
				Stream	Release Point (RKm)	Major Water-shed	Eco-province
Yearling	330000 FBD	10	Late April-Early May	Deep River	6.4	Columbia Estuary	Columbia River Estuary

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

Percent survival (total expanded recoveries/total CWT releases) has been used to indicate the relative success of the annual releases. For brood years 1996 –1999, mean survival ranged from a low of 0.03% to a high of 1.34%, average 0.50%. Contribution (% of total adult return) for all SAFE programs averaged 83.5% to SAFE commercial fisheries; On average 19% of Deep River Net Pen spring chinook were recovered at WDFW, ODFW hatcheries, although no escapement is intended for this program. (Select Area Fishery Evaluation Project 1997-2000 Annual Reports, Miller December 2002; WDFW Hatchery Data files 2004).

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

The first year of operation for this hatchery was 1996.

1.14 Expected duration of program.

It was expected that after 10 years of research potential expansion to a full capacity fishery would begin. A major review (BPA Funding Process) of the Deep River program and the SAFE program as a whole will occur in 2004.

1.15 Watersheds targeted by program.

Columbia Estuary Subbasin/Columbia River Estuary Province

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

1.16.1 Brief Overview of Key Issues:

This is part of the SAFE program, which was to provide non-mainstem Columbia River harvest opportunities for the commercial industry and sport fishery. A major review (BPA Funding Process) of the Deep River program and the SAFE program as a whole will occur in 2004. The future of the program is uncertain. The survival of spring chinook has been low, which is probably related to the late release time (May) of the smolts. The release of these smolts is delayed to assure chum emigration. Coho production has been extensively evaluated, however spring chinook production is only beginning to be evaluated.

1.16.2 Potential Alternatives to the Current Program:

Alternative 1: Transport the fish closer to the Columbia River mouth for release. This may increase survival, but towing the pens is not an option due to the sunken debris load in lower Deep River. Other options such as trucking will need to be explored. Transportation of spring chinook smolts may not be an option due to excessive handling stress and the reduction of survival.

1.16.3 Potential Reforms and Investments:

Reform/Investment 1: Monitoring and evaluation of the project should continue. Any means of releasing these spring chinook at an earlier time must be devised.

Reform/Investment 2: Funding for the alternate transportation of smolts would be needed.

Section 2: Program Effects on ESA-Listed Salmonid Populations

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

None. Currently the project is operating under the Columbia River Terminal Fisheries Project, a 10-year comprehensive program to investigate the feasibility of terminal fisheries in Young's Bay and other sites in Oregon and Washington (BPA 1993) and the Final Environmental Assessment of Lower Columbia Fisheries Research Project (BPA, 1995) and the resultant Finding of No Significant Impact (FONSI).

2.2.1 Descriptions, status and projected take actions and levels for ESA-listed natural populations in the target area.

The following ESA listed natural salmonid populations occur in the subbasin where the program fish are released:

ESA listed stock	Viability	Habitat
Chum (Sea Resources)- Integrated	U	U
Fall Chinook (Sea Resources)- Integrated	M	M
Coho- Hatchery and Natural (Proposed)	Na	Na
H, M and L refer to high, medium and low ratings, low implying critical and high healthy.		

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

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

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

None.

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

Lower Columbia River coho *(Oncorhynchus kisutch*) has been proposed for listing as "threatened" on June 14, 2004.

Lower Columbia River fall chinook salmon *(Oncorhynchus tshawytscha*) are federally listed as "threatened" under the Endangered Species Act.

Columbia River chum salmon *(Oncorhynchus keta*) - Mainstem Chum were listed as "threatened" under the ESA on March 25, 1999.

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

Lower Columbia River coho (*Oncorhynchus kisutch*) were proposed for listing as "threatened" on June 14, 2004.
Status: NMFS concludes that the LCR coho ESU includes all naturally spawned populations of coho salmon in the Columbia River and its tributaries from the mouth of the Columbia up to and including the Big White Salmon and Hood Rivers. Twenty-one artificial propagation programs are considered to be part of the ESU as NMFS has determined that these artificially propagated stocks are genetically no more than moderately divergent from the natural populations (NMFS, 2004b). Columbia River early and late stock coho produced from Washington hatcheries are genetically similar. The Gravs River wild coho run is a fraction of its historical size with USFWS surveys in

1936 and 1937 indicating coho presence in all accessible areas of the Grays River and its tributaries; no population estimate was made. WDF estimated 2,500 natural spawning late coho in the Grays River in 1951. Hatchery production accounts for most coho returning to Grays River. Natural spawning of early stock coho is presumed to be very low; natural production of late stock coho is likely less then 15% of smolt density estimate. Smolt density model estimated basin potential to be 125,874 smolts (LCFRB Grays River Subbasin Report, Volume 11, Chapter 4).

Lower Columbia River fall chinook salmon *(Oncorhynchus tshawytscha*) are federally listed as "threatened" under the Endangered Species Act. Sea Resources chinook are part of the Lower Columbia fall Chinook ESU. Numbers for chinook to Sea Resources is not available. Populations of fall Chinook are present in adjacent watersheds to the Deep River including: Skamokawa, Grays River, Elochoman and the Chinook River.

Table 2. Fall chinook salmon abundance estimates in the LCMA (FMEP 2003)

Year	Cowee-man River	Elocho-man River	Grays River	Skamo-kawa Creek	Cowlitz River	Green River	Toutle River	Kalama River	EF Lewis River	NF Lewis River	Washougal River
1990	241	136	287	123	2,698	123		20,54	342	17,506	2,062
1991	174	178	188	123	2,567	123	33	5,085	230	9,066	3,494
1992	424	190	4	150	2,489	150		3,593	202	6,307	2,164
1993	327	274	40	281	2,218	281	3	1,941	156	7,025	3,836
1994	525	688	47	516	2,512	516	0	2,020	395	9,939	3,625
1995	774	144	29	375	2,231	375	30	3,044	200	9,718	2,969
1996	2,148	508	351	667	1,602	667	351	10,630	167	14,166	2,821
1997	1,328	1,875	12	560	2,710	560		3,539	307	8,670	4,529
1998	144	220	93	1,287	2,108	1,287	66	4,318	104	5,929	2,971
1999	93	707	303	678	997	678	42	2,617	217	3,184	3,105
2000	126	121	89	852	2,700	852	27	1,420	323	9,820	2,088
2001	646	2,354	251	4,951	5,013	4,951	132	3,714	530	15,000	3,901
2002	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na
2003	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na	Na

Columbia River chum salmon *(Oncorhynchus keta*) - Mainstem Chum were listed as threatened under the ESA on March 25, 1999. Sea Resources chum and Grays River chum are part of a recovery program with WDFW.

Table 3. Peak spawning ground counts for chum salmon in index reaches in the LCMA (M Groesbeck WDFW; Streamnet).

Fall Chum Return Year	Grays River				Hamilton Creek			Hardy Creek
	Mainstem	West Fork	Crazy Johnson Creek	Total	Spawning Channels		Total	
					Hamilton	Spring		
1990	569	0	117	686	35	16	51	192
1991	327	37	239	603	8	11	19	206
1992	3,881	491	374	4,746	141	8	149	1,153
1993	2,334	113	91	2,538	16	4	20	395
1994	42	0	105	147	47	22	69	435
1995	219	0	483	702	4	16	20	214
1996	1,302	408	463	2,173	5	81	86	273
1997	79	55	485	619	31	114	145	105
1998	154	214	145	513	43	237	280	443
1999	222	100	927	1,249	17	165	182	157
2001	1,124	833	249	2,206	56	143	199	20
2002	448	1,630	1,260	3,338	226	462	688	498
2003	Na	Na	Na	Na	Na	Na	Na	Na

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

Describe hatchery activities: The following activities listed below are identified as general hatchery actions that are identified in the ESA Section 7 Consultation "Biological Opinion on Artificial Propagation in the Columbia River Basin" (March 29, 1999).

Note: As this is a rearing and release program only, direct take is not associated with this program and no take tables are included.

Broodstock Program

Broodstock Collection: There are no adult collection, egg taking or incubation activities associated with this program.

Genetic introgression: SAFE program tries to attain a 100% harvest of all adult returns to eliminate any escapement. Returns from initial years indicated an 81% harvest rate with 19% escapement to nearby hatcheries and none recovered in stream surveys (BPA, 1998; WDFW Hatchery Data files). No spring chinook are located in nearby watersheds. Fall chinook spawn timing is believed to be too late to be affected. No genetic impact on chum. Indirect take from genetic introgression is unknown.

Rearing Program

Operation of Hatchery Facilities: Net pen rearing is conducted under the criteria and policies of the Integrated Hatchery Operations team (IHOT). Full time rearing at the net pens does not occur and avoids summer and early fall temperatures (60-70 degrees F) that are detrimental to the project and surrounding environment. Appropriate net pen mesh size confines the program until fish are in smolt condition and ready for release. Siting and placement of the net pen complexes are permitted and rearing activities meet State water quality (NPDES Clean Water Act) guidelines and satisfy all permit requirements. Indirect take from this operation is unknown.

Disease: Over the years, rearing densities, disease prevention and fish health monitoring have greatly improved the health of the programs at Lower Columbia River Hatcheries. Policies and

Procedures for Columbia Basin Anadromous Salmonid Hatcheries (IHOT 1994) Chapter 5 have been instrumental in reducing disease outbreaks. Listed stocks are geographically removed from the net pen sites. Prior to release, the spring chinook population health and condition is established by the Area Fish Health Specialist. This is commonly done 1-3 weeks pre-release. Indirect take from disease is unknown.

Release Program:

Hatchery Production/Density-Dependent Effects: Hatcheries can release numbers of fish that can exceed the density of the natural productivity in a limited area for a short period of time and can compete with listed fish. The net pens are not in typical salmonid rearing habitat. Fish are released as active smolts that will emigrate in order to minimize the affect of the release. Indirect take from density dependent effects is unknown.

Competition: Salmon and steelhead feed actively during their downstream migration (Becker 1973; Muir and Emmelt 1988; Sager and Glova 1988) and if they do not migrate they can compete with wild fish. WDFW is unaware of any studies that have empirically estimated the competition risks to listed species posed by the program described in this HGMP. Studies conducted in other areas indicate that this program is likely to pose a minimal risk of competition:

1) Coho, chinook and steelhead released from hatchery programs as smolts typically migrate rapidly downstream. The SIWG (1984) concluded that "migrant fish will likely be present for too short a period to compete with resident salmonids." Studies have shown that coho moved downstream quickly, suggesting that coho spend very little time in the river after release (Fuss and Byrne 1995). Coho smolts released from the Marblemount Hatchery on the Skagit River migrated approximately 11.2 river miles day (Puget Sound data from Seiler et al. 1997; 2000). On station release in large systems may travel even more rapidly – migration rates of approximately 20 river miles per day were observed by steelhead smolts in the Cowlitz River (Harza 1998).
2) NMFS (2002) noted that "..where interspecific populations have evolved sympatrically, chinook salmon and steelhead have evolved slight differences in habitat use patterns that minimize their interactions with coho salmon (Nilsson 1967; Lister and Genoe 1970; Taylor 1991). Along with the habitat differences exhibited by coho and steelhead, they also show differences in foraging behavior. Peterson (1966) and Johnston (1967) reported that juvenile coho are surface oriented and feed primarily on drifting and flying insects, while steelhead are bottom oriented and feed largely on benthic invertebrates."
3) Flagg et al. (2000) concluded, "By definition, hatchery and wild salmonids will not compete unless they require the same limiting resource. Thus, the modern enhancement strategy of releasing salmon and steelhead trout as smolts markedly reduces the potential for hatchery and wild fish to compete for resources in the freshwater rearing environment. Miller (1953), Hochachka (1961), and Reimers (1963), among others, have noted that this potential for competition is further reduced by the fact that many hatchery salmonids have developed different habitat and dietary behavior than wild salmonids." Flagg et al (2000) also stated "It is unclear whether or not hatchery and wild chinook salmon utilize similar or different resources in the estuarine environment."
4) Fresh (1997) noted that "Few studies have clearly established the role of competition and predation in anadromous population declines, especially in marine habitats. A major reason for the uncertainty in the available data is the complexity and dynamic nature of competition and predation; a small change in one variable (e.g., prey size) significantly changes outcomes of competition and predation. In addition, large data gaps exist in our understanding of these interactions. For instance, evaluating the impact of introduced fishes is impossible because we do not know which nonnative fishes occur in many salmon-producing watersheds. Most available information is circumstantial. While such

information can identify where inter- or intra specific relationships may occur, it does not test mechanisms explaining why observed relations exist. Thus, competition and predation are usually one of several plausible hypotheses explaining observed results."

5) Studies from Fuss (2000) on the Elochoman River and Riley (2004) on two Willapa Bay tributaries (Nemah and Forks Creek) indicate that hatchery reared coho and chinook can effectively leave the systems within days or weeks.

Predation (Freshwater): When discussing predation by yearling fish (both hatchery and wild) the magnitude of predation will depend upon the characteristic of the population of salmonids, the habitat in which the population occurs, overall food availability besides fish and the characteristics of the hatchery program (e.g., release time, release location, number released, and size of fish released). In the absence of site-specific empirical information, the identification of risk factors can be a useful tool for reviewing hatchery programs while monitoring and research programs are developed and implemented.

WDFW is unaware of studies that have estimated the predation risks to listed fish posed by the Deep River Net Pen spring chinook program. In the absence of site-specific empirical information, the identification of risk factors can be a useful tool for reviewing hatchery programs while monitoring and research programs are developed and implemented:

Predation Risk Factors:

Environmental Characteristics: These characteristics can influence the level of predation (see SIWG 1984 for a review) with risk greatest in small systems during periods of low flow and high clarity. The net pen sites in the Deep River are not located in typical salmonid habitat and have only minimal utilization by listed fish. Tidal influence from the Columbia mainstem creates a moving slough type environment and can encourage emigration on an out-going tidal event. Releases can be made on outgoing tidal events for quick dispersal.

Dates of Releases: The release date can influence the likelihood that listed species are encountered. There are limited studies on migration timing of naturally produced chinook but listed chinook from the Lower Columbia ESU are believed to emigrate over a wide window from March through August (LCFRB Technical Reports 2004). Chum are present in the mainstem Columbia from the Grays River and Sea Resources chum restoration programs. Release dates are in May to allow chum to vacate the basin and other listed fish to have additional time to grow to a size that minimizes potential predation.

Relative Body Size: Studies and opinions on size of predator/prey relationships vary greatly and although there is evidence that salmonids can prey upon fish up to 50% of their body length, most prey consumed is probably much smaller. Keeley and Grant (2001) suggest that the mean prey size for 100-200 mm fl salmonids is between 13-15% of predator body size. Salmonid predators were thought to be able to prey on fish up to approximately 1/3 of their length (USFWS 1994), although coho salmon have been observed to consume juvenile chinook salmon of up to 46% of their total length in aquarium environments (Pearsons et al. 1998). Artic char are well known as piscivorous predators, but recent studies suggest the maximum prey size is approximately 47% of their length (Finstad et al. 2002). The "33% of body length" criterion for evaluating the potential risk of predation in the natural environment has been used by NOAA Fisheries and the USFWS in a number of biological assessments and opinions (c.f., USFWS 1994; NMFS 2002). Although predation on larger Chinook juveniles may occur under some conditions, WDFW believes that a careful review of the Pearson and Fritts (1999) study supports the continued use of the "33% of body length criterion" until further species data for these systems can be collected. Data for some listed populations are present below:

- Fork lengths of naturally produced chinook from the Lewis River system during the month of June indicate fish 48-55 mm fl (Columbia River Progress Report 2003-16). The Lewis River system fall chinook stock timing is the latest for the Columbia tributary stocks, and considered to be the worst case scenario (smaller size) when compared to other Columbia River systems.
- Abernathy Creek (WRIA 25) indicated lengths of 36mm – 40mm from March to April 1 (P. Hanratty, WDFW, pers comm. 2004). Growth for wild chinook from Abernathy Creek from the first of April to May 1 is unknown.
- Average fork lengths, from 26 sampling sites on the Kalama River by week, indicate fish are 44 mm fl (April 25), 46 mm fl (May 3), 56 mm fl (May 11) and 62 mm fl (May 16). Other lengths through August are available (R. Pettit, WDFW 1990).
- Fork lengths from Cedar Creek (tributary to the N.F. Lewis River) indicate that average chinook lengths reach approximately 50 mm fl between the weeks of April 12 and April 19, 2004, and are growing rapidly with fish 55-60 mm fl by April 26 and May 3, 2004.

Release Location and Release Type: The likelihood of predation may also be affected by the location and the type of release. Other factors being equal, the risk of predation may increase with the length of time that fish co-mingle. In the freshwater environment, this is likely to be affected by distribution of the listed species in the watershed, the location of the release and the speed at which fish released from the program migrate. Net pen complexes are situated low in the Deep River drainage and within tidal influence. Fish have been reared and acclimated at the site for six months prior to release.

We have provided a summary of empirical information and theoretical analysis of competition and predation interactions that may be relevant to the Deep River Net Pen program.

Potential Deep River spring chinook predation and competition effects on listed salmonids: The proposed annual production goal for this program is 330,000 fish. This time frame of release could encounter listed fish (emerging chinook, chum and proposed coho) in the Deep River, Grays River or Sea Resources sub-basins. Chinook are released at 10 FPP (155 mm fl). Due to size differences between chinook smolts and fingerling listed stocks, competition is unlikely with different prey items and habitat preferences. In addition, the net pens are located well below the existing in-stream rearing habitat. At 10 FPP, potential predation on listed chinook or chum would be on fish of 51 mm fl and smaller. Indirect take from predation is unknown.

Listed chum:

In addition to releases occurring after chum emigration, mean lengths from the Grays River Hatchery and Sea Resources (Chinook River) chum recovery programs indicate chum size at release are: 56.2 – 58.8 mm fl (in mid-March), 55.2 mm fl (late March), and 54.6 mm fl in mid-April (Lower Columbia Chum HGMP 2004). The Grays River/Sea Resources chum recovery program is closely aligned with the Duncan Creek and Ives Island Chum Recovery programs. Fish are released at 1.0-1.5 grams or 50-55 mm fl on a staggered basis from mid-March through May (Bonneville Population of Columbia River Chum Salmon HGMP 2004). Chum from Duncan Creek appear to complete emigration by late April (Figure 1).

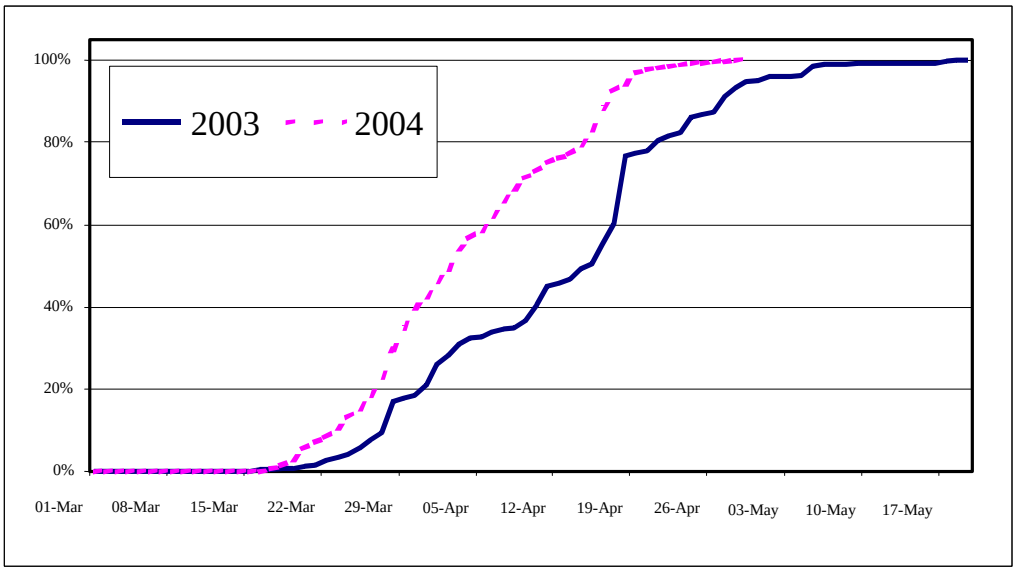

Figure 1 Chum salmon out migration timing at Duncan Creek for Brood Year 2002 & 2003.

Listed coho (proposed):
Current lengths and data for proposed listed coho in the Grays River basin are unknown. Depending on water temperatures, hatchery coho fry during the month of April can range from 42 – 40 mm fl in April and 52 mm fl in May (Grays River Hatchery data 2004). Indirect take from predation and competition is unknown.

Residualism: To maximize smolting characteristics and minimize residualism, WDFW adheres to a combination of acclimation, volitional release strategies, size, and time guidelines.

- Condition factors, standard deviation and co-efficient of variation (CV) are measured through out the rearing cycle and at release.
- Feeding rates and regimes throughout the rearing cycle are programmed to satiation feeding to minimize out-of-size fish and programmed to produce smolt size fish at date of release.
- Based on past history, fish have reached a size and condition that indicates a smolted condition at release.
- Releases occur within known time periods of species emigration from acclimated ponds.
- Releases from these ponds are volitional with large proportions of the populations moving out initially with the remainder of the population vacating within days or a few weeks.
- Minimal residualism from WDFW chinook programs following these guidelines in surveys has been observed. Studies conducted on the Lewis River, Hawkins and Tipping (1999) found no residualized hatchery spring chinook.

Indirect take from residualism is unknown.

Migration Corridor/Ocean: It is unknown to what extent listed fish are available both behaviorally or spatially on the migration corridor. Once in the mainstem, Witty et al. (1995) concluded that predation by hatchery production on wild salmonids does not significantly impact naturally produced fish survival in the Columbia River migration corridor. Evidence in estuarine and nearshore environments indicate that diets are often dominated by invertebrates with Durkin (1982) reporting that diet of coho smolts (128-138 mm fl) in the Columbia River estuary was composed almost entirely of invertebrates without evidence of salmonids as prey (HSRG 2004). There appear to be no studies demonstrating that large numbers of Columbia system smolts emigrating to the

ocean affect the survival rates of juveniles in the ocean in part because of the dynamics of fish rearing conditions in the ocean. Indirect take in the Mainstem Corridor/Ocean are unknown.

Monitoring:

Associated Monitoring Activities - The following monitoring activities are conducted in the Lower Columbia Management Area (LCMA) for adult steelhead and salmon: redd surveys are conducted for winter steelhead in the SF Toutle, Coweeman, EF Lewis and Washougal rivers. Redd surveys are also conducted in the Cowlitz River for fall and spring chinook. Mark-recapture surveys provide data for summer steelhead populations in the Wind and Kalama rivers. Mark-recapture carcass surveys are conducted to estimate populations of chinook salmon in Grays, Elochoman, Coweeman, SF Toutle, Green, Kalama, NF Lewis, EF Lewis rivers and Skamokawa, Mill, Abernathy, and Germany creeks and for all chum salmon populations. Snorkel surveys are conducted for summer steelhead in the EF Lewis and Washougal rivers. Trap Counts are conducted on the Cowlitz, NF Toutle, Kalama, and Wind rivers and on Cedar Creek, a tributary of the NF Lewis River. Area-Under-the-Curve (AUC) surveys are conducted to collect population data for chum salmon in Grays River and Hardy and Hamilton creeks. All sampling of carcasses and trapped fish include recovery of coded wide tagged (CWT) fish for hatchery or wild stock evaluation. Downstream migrant trapping occurs on the Cowlitz, Kalama, NF Lewis, and Wind rivers, Cedar Creek, and will expand to other basins as part of a salmonid life cycle monitoring program to estimate freshwater production and wild smolt to adult survival rates. Any take associated with monitoring activities is unknown but all follow scientific protocols designed to minimize impact.

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

In other HGMPs provided to NOAA (Puget Sound, Upper Columbia), indirect takes from hatchery releases such as predation and competition is highly uncertain and dependant on a multitude of factors (i.e. data for population parameters - abundance, productivity and intra-species competition) and although HGMPs discuss our current understanding of these effects, it is not feasible to determine indirect take (genetic introgression, density effects, disease, competition, predation) due to these activities. No take tables will provided for this program.

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

Any additionally mortality from this operation on a yearly basis would be communicated to WDFW Fish Program and NOAA staff for additional guidance.

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

Unknown.

Section 3: Relationship of Program to Other Management Objectives

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

The Select Area Fishery Evaluation Project (SAFE) is integrated with *U.S. v Oregon* and the Columbia River Fish Management Plan (CRFMP) and with hatchery plans documented in WDFW's yearly Future Brood Document (FBD), and Lower Columbia Fisheries Management and Evaluation Plan (2002 FMEP) which has been agreed to by NOAA for listed steelhead, chum, and chinook in the ESU. The project was initially operated under the Final Environmental Assessment of Young's Bay Salmon Rearing and Release program (BPA 1993). Currently SAFE programs are aligned with the Environmental Assessment of Lower Columbia Fisheries Research Project (BPA, 1995).

WDFW hatchery programs in the Columbia system adhere to a number of guidelines, policies and permit requirements in order to operate. These constraints are designed to limit adverse effects on cultured fish, wild fish and the environment that might result from hatchery practices. Following is a list of guidelines, policies and permit requirements that govern WDFW Columbia hatchery operations:

Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington. These guidelines define practices that promote maintenance of genetic variability in propagated salmon (Hershberger and Iwamoto 1981). Also, *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (Genetic Policy Chapter 5, IHOT 1995).

Spawning Guidelines for Washington Department of Fisheries Hatcheries. Assembled to complement the above genetics manual, these guidelines define spawning criteria to be use to maintain genetic variability within the hatchery populations (Seidel 1983). Also, *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (Genetic Policy Chapter 7, IHOT 1995).

Stock Transfer Guidelines. This document provides guidance in determining allowable stocks for release for each hatchery. It is designed to foster development of locally adapted broodstock and to minimize changes in stock characteristics brought on by transfer of non-local salmonids (WDF 1991).

Fish Health Policy in the Columbia Basin. Details hatchery practices and operations designed to stop the introduction and/or spread of any diseases within the Columbia Basin. Also, *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (Genetic Policy Chapter 5, IHOT 1995).

National Pollutant Discharge Elimination System Permit Requirements This permit sets forth allowable discharge criteria for hatchery effluent and defines acceptable practices for hatchery operations to ensure that the quality of receiving waters and ecosystems associated with those waters are not impaired.

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

The program described in this HGMP is consistent with the following agreements and plans:

- Columbia River Terminal Fisheries Project (SAFE)
- Columbia River Compact
- Final Environmental Assessment of Lower Columbia Terminal Fisheries Research Project
- The Columbia River Fish Management Plan
- U.S. vs. Oregon court decision
- Production Advisory Committee (PAC)
- Technical Advisory Committee (TAC)
- Integrated Hatchery Operations Team (IHOT) Operation Plan 1995 Volume III.
- Pacific Northwest Fish Health Protection Committee (PNFHPC)
- In-River Agreements: State, Federal, and Tribal representatives
- Northwest Power Planning Council Sub Basin Plans
- Washington Department of Fish and Wildlife Wild Salmonid Policy

3.3 Relationship to harvest objectives.

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

The production developed for this program will be integrated with *U.S. v Oregon* and the Columbia River Fish Management Plan (CRFMP) and with hatchery plans documented in WDFW's yearly Future Brood Document (FBD), and Lower Columbia Fisheries Management and Evaluation Plan (2002 FMEP) which has been agreed to by NOAA for listed steelhead, chum, and Chinook in the ESU.

SAFE programs are specifically targeted for Columbia Estuary harvest. The existing program is harvested by 77% in the SAFE area, 10% in the mainstem Columbia outside the SAFE areas, 10% immediate ocean with approximately 3% escapement. Since 1995 brood, fisheries in the Deep River select area site averaged 97.1% fish of net pen origin. The purpose of each Deep River net pen program is to provide fish for isolated harvest opportunity in the Deep River basin. However, these hatchery programs benefit other fisheries as well. Spring chinook are an important target species in Columbia River commercial and recreational fisheries and tributary recreational fisheries. All Deep River net pen spring chinook are adipose fin-clipped. Wild fish release regulations are in place for commercial and recreational fisheries in the lower Columbia River, as well as some ocean fisheries. Specific hatchery selective commercial and recreational fisheries in the lower Columbia target hatchery spring chinook. Therefore, recent exploitation rates by commercial and recreational fisheries are higher for Deep River Net Pen spring chinook compared to other hatchery spring chinook programs. However, recent commercial and sport harvest in the terminal areas has not been as high as desired so the programs are being reviewed.

To maximize harvest of returning adults and minimize catch of non-SAFE stocks, extremely high harvest rates have been documented by coded wire tag results for coho (98.3%), spring chinook (92.4%), selected area bright fall chinook (96.3%), and upriver bright fall chinook (96.4%). In all spring fisheries combined, impact on Snake River wild spring chinook was 0-7 adults (0.00% - 0.07%) from 1992-2000. All impacts to upriver bright fall chinook during 1997-2000 never exceeded 0.1% for all SAFE fisheries combined.

Brood year	SAR (%)	Escapement	Catch
1996	0.03	7	13
1997	1.34	144	409
1998	NA	NA	NA
1999	0.15	6	244

3.4 Relationship to habitat protection and recovery strategies.

Subbasin Planning and Salmon Recovery:
The current Grays River HGMP processes are designed to deal with existing hatchery programs and potential reforms to those programs. A regional sub-basin planning process (Draft Grays River Subbasin Summary May 17, 2002 and May 2004) is a broad-scale initiative that will provide building blocks of recovery plans by the Lower Columbia Fish Recovery Board (LCFRB) for listed fish and may well use HGMP alternative ideas on how to utilize hatchery programs to achieve objectives and harvest goals. In order to assess, identify and implement restoration, protection and recovery strategies, Region 5 staff is involved in fish and wildlife planning and technical assistance in concert through the LCFRB including the role of fish release programs originating from Grays River Hatchery.

Habitat and Protection Processes:
WDFW is presently conducting or has conducted habitat inventories within the Grays River subbasin. Ecosystem Diagnosis and Treatment (EDT) compares habitat today to that of the basin in a historically unmodified state. It creates a model to predict fish population outcomes based on habitat modifications. WDFW is also conducting a Salmon Steelhead Habitat Inventory Assessment Program (SSHIAP), which documents barriers to fish passage. WDFW's habitat program issues hydraulic permits for construction or modifications to streams and wetlands. This provides habitat protection to riparian areas and actual watercourses within the watershed. The Washington Department of Fish and Wildlife also administers the Washington State Hydraulic Code (RCW 75). This law requires that anyone wishing to use, divert, obstruct, or change the natural flow or bed of any waters of the state to first secure a Hydraulic Project Approval (HPA) from WDFW, so that potential harm to fish and fish habitat can be avoided or corrected. WDFW's habitat program issues hydraulic permits for construction or modifications to streams and wetlands. This provides habitat protection to riparian areas and actual watercourses within the watershed.

Limiting Factors Analysis:
A WRIA 25 (Grays-Elochoman) habitat limiting factors analysis (LFA) report has been completed by the Washington State Conservation Commission with the input from WDFW Region 5 staff. The Grays River suffers from severe habitat degradation (siltation, poor water quality). This is the result of widespread ongoing logging in the watershed. Freshwater and estuarine ecosystems have been degraded by past and present human activities that have reduced the habitat quality, quantity, and complexity. The primary land use activities responsible for these include: road building, timber harvesting, agriculture, and rural development. These upslope and riparian activities have increased sediment, altered large woody debris (LWD) availability and recruitment, increased water temperatures, changed runoff patterns, and reduced river flow.

3.5 Ecological interactions.

Below are discussions on both negative and positive impacts relative to the Lewis River spring chinook program and are taken from the Puget Sound listed and non-listed HGMP template (WDFW and NOAA 2003).

(1) Salmonid and non-salmonid fishes or species that could negatively impact the program: Spring chinook smolts can be preyed upon through the entire migration corridor from the river sub-basin to the mainstem Columbia River and estuary. Northern pikeminnows and introduced spiny rays, as well as avian predators, including gulls, mergansers, cormorants, belted kingfishers, great blue herons and night herons along the Columbia mainstem sloughs, can prey on spring chinook smolts. Mammals that can take a heavy toll on migrating smolts and returning adults include: harbor seals, sea lions, river otters and Orcas.

(2) Salmonid and non-salmonid fishes or species that could be negatively impacted by the program: Co-occurring natural salmon and steelhead populations in local tributary areas and the Columbia River mainstem corridor areas could be negatively impacted by program fish. Of primary concern are the ESA listed endangered and threatened salmonids: Snake River fall-run Chinook salmon ESU (threatened); Snake River spring/summer-run Chinook salmon ESU (threatened); Lower Columbia River Chinook salmon ESU (threatened); Upper Columbia River spring-run Chinook salmon ESU (endangered); Columbia River chum salmon ESU (threatened); Snake River sockeye salmon ESU (endangered); Upper Columbia River steelhead ESU (endangered); Snake River Basin steelhead ESU (threatened); Lower Columbia River steelhead ESU (threatened); Middle Columbia River steelhead ESU (threatened); and the Columbia River distinct population segment of bull trout (threatened). Listed fish can be impacted through a complex web of short and long term processes and over multiple time periods which makes evaluation of this net effect difficult. WDFW is unaware of studies directly evaluating adverse ecological effects to listed salmon. See also Section 2.2.3 Predation and Competition.

3) Salmonid and non-salmonid fishes or other species that could positively impact the program. Multiple programs including fall chinook, Type S and Type N coho and steelhead programs are released in or near this system and limited natural production of chinook, coho, and steelhead occurs in this system along with numerous non-salmonid fishes (sculpins, lampreys and sucker etc.).

4) Salmonid and non-salmonid fishes or species that could be positively impacted by the program. A host of freshwater and marine species that depend on salmonids as a nutrient and food base may be positively impacted by program fish. The hatchery program may be filling an ecological niche in the freshwater and marine ecosystem. A large number of species are known to utilize juvenile and adult salmon as a nutrient and food base (Groot and Margolis 1991; and McNeil and Himsworth 1980). Wild co-occurring salmonid populations might be benefited as hatchery fish migrate through an area. The migrating hatchery fish may overwhelm predator populations, providing a protective effect to the co-occurring wild populations. Pacific salmon carcasses are also important for nutrient input back to freshwater streams (Cederholm et al. 1999). Successful or non-successfully spawner adults originating from this program may provide a source of nutrients in oligotrohic coastal river systems and stimulate stream productivity. Carcasses from returning adult salmonids have been found to elevate stream productivity through several pathways, including: 1) the releases of nutrients from decaying carcasses has been observed to stimulate primary productivity (Wipfli et al. 1998); 2) the decaying carcasses have been found to enrich the food base of aquatic invertebrates (Mathisen et al. 1988); and 3) juvenile salmonids have been observed to feed directly on the carcasses (Bilby et al. 1996). The Grays/Deep River drainages are thought to be inadequately seeded with anadromous fish carcasses. Assuming

integrated spawning and carcass seeding efforts, approximately 100 – 500 spring Chinook adult carcasses could contribute approximately 1,000 – 5,000 pounds of marine derived nutrients to organisms in these systems. *Saprolegniasis* occurrences in young hatchery fish have been observed in greater frequency on Mitchell Act stations that have nutrient enhancement projects and in some cases, circumstantial evidence suggests more outbreaks of gill and tail fungus are the result of nutrient enhancement efforts. Staff is continuing to monitor observations or occurrences of this possibility.

Section 4. Water Source

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

The Deep River Net Pens are located directly in the Deep River and the river supplies all water to these programs.

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

Fish rearing activities meet State water quality guidelines and satisfy all permit requirements including Oregon Department of Environmental Quality #101198 and Washington Department of Ecology #1995-SW-00373.

- Net pen sites are geographically isolated from listed fish habitat.
- Siting of the pens has sufficient depth and flow for siting guidelines.
- Net pen mesh sizes retain program fish through out the rearing period.
- Program fish are confined in structures until an active smolting phase and time is achieved.
- Discharge effluents are under NPDES permit guidelines for monthly feed limits and total program production.
- The net pens sites are monitored for water quality to determine whether any change is occurring in local biochemical composition.

Section 5. Facilities

5.1 Broodstock collection facilities (or methods).

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs.

5.2 Fish transportation equipment (description of pen, tank, truck, or container used).

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

5.3 Broodstock holding and spawning facilities.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

5.4 Incubation facilities.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

5.5 Rearing facilities.

Fish from fry to subyearling stage have been reared in standard ponds at Grays River Hatchery. In earl winter, the program is transferred by truck to the net pen sites.

Net Pen Site 1:
A majority of the spring chinook program has been reared at the "Site 1" net pen location approximately 0.9 RKm upstream of the State Highway 4 Bridge (Walt Kato Landowner Site). This net pen complex is made up of a total of eleven net pens with two rows of four net pens side by side oriented in the Deep River North to South. An additional three net pens are aligned in a single row south of the east bank of four in a row pens. One net pen frame has been covered over with plywood for use as a staging platform for staff.

Net Pen Site 2:
Approximately 1.2 RKm downstream of the State Highway 4 Bridge is net pen complex "Site 2" (Robert Fauver Landowner Site). This net pen complex has a total of sixteen net pens with similar dimensions as site 1. This complex has two rows of eight net pens side to side oriented in the Deep River North to South.

As of 2004, an additional twelve net pens of similar dimensions from the discontinued Steamboat Slough coho site will be incorporated at Deep River Net Pen "Site 2". These pens will be used as additional pens needed for the Deep River Spring Chinook (SAFE) program.

5.6 Acclimation/release facilities.

Pens (No.)	Pond Type	Volume (cu.ft)	Length (ft.)	Width (ft.)	Depth (ft.)	Flow (gpm)	Max. Flow Index	Max. Density Index
10	Net Pens- Deep River Site	5200	20	20	13.0	NA	U	U

Fish are acclimated to the Lower Deep River and mainstem Columbia River tidal influence. Fish have been reared for approximately 3-5 months at this site until May. The fish are currently released directly from the current net pen sites but options of towing the complexes closer to the main stem Columbia for release will be a future option.

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

- Avian (kingfishers and blue heron) and mammal (otter and mink) predation impact the program and can cause significant mortality.
- The current May 1st release timeframe can occur after smolting behavior starts in March in some years. With smolting behavior, fish stress levels increase with the population using energy trying to escape from the pens. Pushing and swarming against the net pen sides results in scale loss and some body abrasions. Along with elevating temperatures starting in April, overall fish health can deteriorate because of smolt stress.
- Loss of the fish in the program has been estimated at 10-35% in some years.

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

- The program is distributed over multiple net pen units to reduce overall risk.
- Net pen mesh sizes used are appropriate to retain the fish until smolt stage is reached without premature escape.
- Predator measures of cover nettings and electrical grid fences are used to minimize predation impact.
- Grays River staff provides operational support 5 times weekly or as needed.
- Grays River staff communicates with fish program and fish health staff for any program or fish health issues.

Section 6. Broodstock Origin and Identity

6.1 Source.

The program broodstock are derived from Cowlitz and/or Lewis River sub-basins. Smolts derived from this broodstock are released in the Columbia Estuary sub-basin, which does not have any streams that naturally produce spring chinook. Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

6.2.1 History.

Broodstock Source	Origin	Year(s) Used	
		Begin	End
Cowlitz River Spring Chinook (Cowlitz Salmon Hatchery)	H	1996	Present
Lewis River Spring Chinook (Speelyai Hatchery)	H	U	U

6.2.2 Annual size.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

6.2.4 Genetic or ecological differences.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

6.2.5 Reasons for choosing.

The broodstock chosen has the desired life history traits (early return timing) to meet harvest goals.

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

Section 7. Broodstock Collection

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.2 Collection or sampling design

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.3 Identity.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.4 Proposed number to be collected:

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.4.2 Broodstock collection levels for the last twelve years (e.g. 1990-2001), or for most recent years available.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.6 Fish transportation and holding methods.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.7 Describe fish health maintenance and sanitation procedures applied.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

7.8 Disposition of carcasses.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

Section 8. Mating

8.1 Selection method.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs.

8.2 Males.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

8.3 Fertilization.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

8.4 Cryopreserved gametes.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

Section 9. Incubation and Rearing.

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.1.2 Cause for, and disposition of surplus egg takes.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.1.3 Loading densities applied during incubation.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.1.4 Incubation conditions.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.1.5 Ponding.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.1.6 Fish health maintenance and monitoring.

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

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

Not applicable to the Deep River net pens, see Cowlitz and Lewis River Spring Chinook HGMPs

9.2.1 Provide survival rate data (*average program performance*) by hatchery life stage (fry to fingerling; fingerling to smolt) for the most recent twelve years (1990-2001), or for years dependable data are available.

Spring Chinook reared at Deep River Net pens suffer high mortality during rearing in most years. This is exacerbated by the late date of release (May). BKD has been the leading cause of mortality Some relief has been found by selectively using only progeny from adults with low BKD titer. It is not possible to collect all mortalities but loss has been estimated to be 10-35%.

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

Following some density related studies conducted in the mid 1990's, all SAFE net pen projects are programmed to not exceed 0.50 lbs./cf3 for chinook. Current loadings will be further reduced with the addition of additional net pens in 2004.

9.2.3 Fish rearing conditions.

The net pens sites have been monitored for water quality to determine whether any change is occurring in local biochemical composition. Monthly measurements of water chemistry and macro invertebrate populations have been conducted before, during and after each rearing period.

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

DEEP RIVER REARING/ACCLIMATION PHASE (Grays River Hatchery Spring Chinook Data)

Rearing Period: December; Length(mm)= 137; Weight(fpp)= 21; Growth Rate= NA.

Rearing Period: January; Length(mm)= 146; Weight(fpp)= 18; Growth Rate= 0.143.

Rearing Period: February; Length(mm)= 151; Weight(fpp)= 14; Growth Rate= 0.222.

Rearing Period: March; Length(mm)= 155; Weight(fpp)= 13; Growth Rate= 0.071.

Rearing Period: April; Length(mm)= 159; Weight(fpp)= 11; Growth Rate= 0.154.

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

Same as above, see section 9.2.4.

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

Rearing Period: December-Release; Food Type= Moore Clark Nutra 2.5mm; Application Schedule= 3 days/week; Feeding Rate(%BW/day)= 1.0; Food Conversion during Period= 1.0:0.22

Rearing Period: February-Release; Food Type= BioAqua 2.5mm; Application Schedule= 28 days over period; Feeding Rate(%BW/day)= 1.0; Food Conversion during Period= 1.0:0.26

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

WDFW staff conducts work at the net pens 5 days weekly. Observations and weekly progress is communicated to the area Fish Health Specialist monthly. Loss rate above normal < 1 fish per day (0.02) or problems are reported immediately. After release, net pens are removed from the water, dried and broom cleaned at the hatchery grounds and stored until needed for the next cycle.

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

Besides time, size and condition factors, staff can observe aggressive swarming against net pen sides. During final length frequency and weight sampling, staff can observe smolt and parr appearance ratios. Loose scales during feeding events are early signs of smolt development. From past history, hatchery specialists will reduce feed regimes in early spring as fish show signs of smolting. Also at this time feed conversions fall and fish appear leaner with condition factors falling well below 1.0 (K) to .90 (K). ATPase activity is not measured.

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

Net pen rearing can acclimate fish to environmental conditions in the river. River flows, ambient temperatures, turbidity are natural cues that can help with the fitness of the fish. Also, potential food items such as crustaceans or insects from the river could be attracted to the pens and benefit the fish. Pens also are subject to indirect mammal and avian predation attempts that can ultimately benefit coho smolt survival. This occurs when birds will perch on the net pen covers and the walkways and try to spear potential prey from within the pen. Mammals will crowd the net pen sides to try and catch fish from the net pens.

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

- Protocols for population size, fish health disinfection and genetic guidelines followed.
- Eggs water hardened in iodophor (1:600).
- Multiple incubation and rearing units are used.
- Staff is available to respond to emergencies.
- IHOT guidelines are followed for rearing, release and fish health parameters.

Section 10. Release

10.1 Proposed fish release levels.

Up to 330,000 smolts.

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

Fish are released from the upper net pen complex "Site 1" located at approximately RKm .9 upstream of the State Highway 4 bridge and from the lower net pen complex "Site 2" located at approximately RKm 1.2 downstream of the State Highway 4 bridge.

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

	Yearling Release		
Release Year	No.	Date (MM/DD)	Avg Size (fpp)
1998	56414	April 22	5.0
1999	39678	May 13	6.8
2000	0		
2001	159565	May 9	11.0
2002	95940	May 16	10.0
2003	123,904	April 30	10.0

Releases will be increased up to 330,000 when possible.

10.4 Actual dates of release and description of release protocols.

Net pen sides are lowered to allow fish to swim out of the pens. An option exists to tow the net pen complex to the Columbia mainstem if needed to further avoid further risks to chum salmon. (see dates of release, above)

10.5 Fish transportation procedures, if applicable.

The fish have been released from the net pen locations. In the future, a tug could be used to tow the net pen complexes closer to the mainstem confluence area.

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

Fish at ~15 fpp are transferred in mid November from the Grays River Hatchery to the Deep River net pens (RKm 6.4). Fish are reared at these net pen sites from ~15 fpp to smolts (10-14 fpp) during period mid November/early December to early May. Smolts are acclimated in the net pens at the Deep River site, and are released during the period of late April-early May after natural chum salmon have cleared the area.

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

15.5 % of the program production is adipose-fin clipped/coded-wire tagged with the remainder being mass marked (adipose-fin clip only).

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

The level of fish transferred to the net pen complexes would not exceed program levels so releases would not have surplus numbers.

10.9 Fish health certification procedures applied pre-release.

Prior to release, the population health and condition is established by the Area Fish Health Specialist. This is commonly done 1-3 weeks pre-release and up to 6 weeks on systems with pathogen free water and little or no history of disease. Prior to this examination, whenever abnormal behavior or mortality is observed, staff also contacts the Area Fish Health Specialist. The fish specialist examines affected fish, and recommends the appropriate treatment. Reporting and control of selected fish pathogens are done in accordance with the Co-managers Fish Disease Control Policy and IHOT guidelines.

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

Complex manager would contact and inform regional management of the situation. Policy would generally be to retain fish at the site. Net pen operation includes an Emergency Response Plan pursuant to section S6.A-J of the Upland Fin-fish Hatching and Rearing national Pollutant Discharge Elimination System Waste Discharge General Permit that outlines contingency plans in case of emergencies. Emergency release of fish in case of severe flooding could be one of the emergency plan options.

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

- Net pen sites are geographically isolated from listed fish habitat.
- Siting of the pens has sufficient depth and flow for siting guidelines.
- Program fish are confined in structures until an active smolting phase.
- Discharge effluents are under NPDES permit guidelines for monthly feed limits and total program production.
- The net pens sites are for water quality to determine whether any change is occurring in local biochemical composition.
- The production and release of only smolts through fish culture and volitional release practices fosters rapid seaward migration with minimal rearing of delay in the rivers, limiting interactions with naturally produced steelhead juveniles.
- WDFW uses acclimation and release of smolts in lower river reaches where possible, this in an area below known wild fish spawning and rearing habitat.
- WDFW has reduced the program release size and program numbers by 50% from 2003.
- Release is timed after peak chum emigration has been monitored.
- All program fish are mass marked for heavy harvest removal.
- WDFW proposes to continue monitoring, research and reporting of hatchery smolt migration performance behavior, and intra and interspecific interactions with wild fish to access, and adjust if necessary, hatchery production and release strategies to minimize effects on wild fish.
- WDFW fish health and operational concerns for the Grays River Net Pen program is communicated to Region 5 staff for risk management or needed treatment. See also section 9.7.

Section 11. Monitoring and Evaluation of Performance Indicators

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

The goal of the project is to determine the feasibility of creating and expanding select area, known stock fisheries in the Columbia River Basin to allow harvest of strong anadromous salmonid stocks while providing greater protection to depressed stocks. This goal is being accomplished by addressing nine defined project objectives:

1) Survey and categorize potential select area fishing sites in the Columbia River basin for basic physical characteristics (high, medium, and low).

2) Determine the capability of the medium and high select area fishing sites for rearing and acclimating anadromous fish species in net pens or other facilities.

3) Determine the capability of the medium and high select area fishing sites to allow manageable and economically competitive harvest of returning fish.

4) For the medium and high select area fishing sites, determine the potential for harvest of target and non-target fish species.

5) Evaluate the suitability of various anadromous fish stocks for use in the medium and high select area fishing sites.

6) Determine the generic costs and logistics of a large-scale net pen rearing program (overwinter rearing and short-term acclimation) and estimate the variables for each of the medium and high select area fishing sites.

7) Evaluate the effects of a large-scale net pen rearing program (overwinter rearing and short-term acclimation) for select area fishing on hatchery production programs.

8) Determine the effects on upriver fish runs, escapements, and Zone 6 fisheries of shifting various levels of historical Zone 1-5 commercial fisheries to select area sites.

9) Coordinate activities with ODFW, WDFW, CEDC, BPA, NMFS, and Salmon For All (SFA).

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

To be reviewed for 2004.

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

To be reviewed for 2004.

Section 12. Research

12.1 Objective or purpose.

Research is not directly associated with the program. Program monitoring and evaluation provides an information feedback for adaptive management of the program. (See section 11.1.1, above).

12.2 Cooperating and funding agencies.

12.3 Principle investigator or project supervisor and staff.

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

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

12.6 Dates or time periods in which research activity occurs.

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

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

12.9 Level of take of listed fish: number of range or fish handled, injured, or killed by sex, age, or size, if not already indicated in Section 2 and the attached "take table" (Table 1).

12.10 Alternative methods to achieve project objects.

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

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

Section 13. Attachments and Citations

13.1 Attachments and Citations

1.) Becker, C.D. 1973. Food and growth parameters of juvenile Chinook salmon, *Oncorhynchus tshawytscha*, in central Columbia River. Fish. Bull. 71: 387-400.

2.) Berg, R. and D. Nelson. 2003. Mitchell Act hatcheries intake and fish passage study report. Washington Dept. of Fish and Wildlife. Olympia, Wa.

3.) Bilby, R.E., B.R. Fransen, and P.A. Bisson. 1996. Incorporation of nitrogen and carbon from spawning coho salmon into the trophic system of small streams: evidence from stable isotopes. Can. J. Fish. Aquat. Scit. 53: 164-173.

4.) Byrne, J. and H.J. Fuss. 1998. Annual coded-wire tag program Washington: Missing Production Groups. Annual Report 1998. Bonneville Power Administration, Portland, Or. Project Number 89-066. 107 pp.

5.) Durkin, J.T. 1982. Migration characteristics of coho salmon (*Oncorhynchus kisutch*) smolts in the Columbia River and its estuary. In: V.S. Kennedy (editor), Estuarine comparisons, p. 343-364. Academic Press, New York.

6.) Enhancement Planning Team. 1986. Salmon and steelhead enhancement plan for the Washington and Columbia River conservation area. Preliminary Review Draft.

7.) Finstad, A.G., P.A. Jansen, and A. Langeland. 2001. Production and predation rates in a cannibalistic arctic char (*Salvelinus alpinus* L.) population. Ecol. Freshw. Fish. 10: 220-226.

8.) Flagg, T.A., B.A. Berejikian, J.E. Colt, W.W. Dickhoff, L.W. Harrell, D.J. Maynard, C.E. Nash, M.S. Strom, R.N. Iwamoto, and C.V.W. Mahnken. 2000. Ecological and behavioral impacts of artificial production strategies on the abundance of wild salmon populations. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-41: 92p.

9.) Fresh, K.L. 1997. The role of competition and predation in the decline of Pacific salmon and steelhead. *In* D.J. Stouder, P.A. Bisson, and R.J. Naiman (editors), Pacific salmon and their ecosystems: status and future options, p. 245-275. Chapman Hall, New York.

10.) Fuss, H.J., J. Byrne, and C. Ashbrook. 1998. Stock characteristics of hatchery-reared salmonids and Washington Department of Fish and Wildlife Columbia River Hatcheries. Washington Department of Fish and Wildlife, Annual Report H98-03. 65 pp.

11.) Fuss, H.J. and P. Seidel. 1987. Hatchery incubation techniques at WDF hatcheries. Washington Department of Fisheries, Technical Report 100. 86 p

12.) Gregory, S.V., G.A. Lamberti, D.C. Erman, K.V. Koski, M.L. Murphy, and J.R. Sedell. 1987. Influence of forest practices on aquatic production. *In* E.O. Salo and T.W. Cundy (editors), Streamside management: forestry and fishery interactions. Institute of Forest Resources, University of Washington, Seattle, Washington.

13.) Hatchery Scientific Review Group (HSRG). 2004. Hatchery Reform: Principles and recommendations of the HSRG. Long Live the Kings, 1305 4th Ave., Suite 810, Seattle, Wa.

14.) Harza. 1999. The 1997 and 1998 technical study reports, Cowlitz River Hydroelectric Project. Vol. 2, 35-42.

15) Hershberger, W.K., and R.N. Iwamoto. 1981. Genetics Manual and Guidelines for the Pacific Salmon Hatcheries of Washington. Univ. of Wash. College of Fisheries. Seattle, Wa. 83 pp.

16.) Hochachka, P.W. 1961. Liver glycogen reserves of interacting resident and introduced trout populations. Can. J. Fish. Aqua. Sci. 48: 125-135.

17.) IHOT (Integrated Hatchery Operations Team). 1995. Operation plans for anadromous fish production facilities in the Columbia River basin. Volume III-Washington. Annual Report 1995. Bonneville Power Administration, Portland Or. Project Number 92-043. 536 pp.

18.) Johnston, J.M. 1967. Food and feeding habits of juvenile coho salmon and steelhead trout in Worthy Creek, Washington. Master's thesis, University of Washington, Seattle,Wa.

19.) Keeley, E.R. and J.W.A. Grant. 2001. Prey size of salmonid fishes in streams, lakes and oceans. Can. J. Fish. Aquat. Sci. 58: 1122-1132.

20.) Kline, T.C., J.J. Goring, Q.A. Mathisen, and P.H. Poe. 1997. Recycling of elements transported upstream by runs of Pacific salmon: I $d^{15}N$ and $d^{13}C$ evidence in Sashin Creek, southeastern Alaska. Can. J. Fish. Aquat. Sci. 47: 136-144.

21.) Levy, S. 1997. Pacific salmon bring it all back home. BioScience 47: 657-660.

22.) Lister, D.B., and H.S. Genoe. 1970. Stream habitat utilization by cohabiting underyearlings of Chinook (Oncorhynchus tshawytscha) and coho (O. kisutch) in the Big Qualicum River, British Columbia. J. Fish. Res. Board. Can. 27: 1215-1224.

23.) Lower Columbia Fish Recovery Board (LCFRB). 2004. Lower Columbia salmon and steelhead recovery and sub-basin plan. Lower Columbia Fish Recovery Board, Washington state.

24.) Marshall, A. R., C. Smith, R. Brix, W. Dammers, J. Hymer, and L. LaVoy in Busack, C. and J.B. Shaklee, editors. 1995. Genetic diversity units and major ancestral lineages of salmonid fishes in Washington. Washington Department of Fish and Wildlife, Fish Management Program, Technical Report # RAD 95-02. 62 pp.

25.) Mathisen, O.A., P.L. Parker, J.J. Goering, T.C. Kline, P.H. Poe, and R.S. Scalan. 1988. Recycling of marine elements transported into freshwater systems by anadromous salmon. Verh. Int. Ver. Limnol. 23: 2249-2258.

26.) Miller, R.B. 1953. Comparative survival of wild and hatchery-reared cutthroat trout in a stream. Trans. Am. Fish. Soc. 83: 120-130.

27.) Muir, W.O. and R.L. Emmelt. 1988. Food habits of migrating salmonid smolts passing Bonneville Dam in the Columbia River, 1984. Regulated River 2: 1-10.

28.) NMFS (National Marine Fisheries Service). 1999. Biological Opinion On Artificial Propagation in the Columbia River Basin. National Marine Fisheries Service, Northwest Region

29.) NMFS (National Marine Fisheries Service). 2002. Biological opinion on artificial propagation in the Hood Canal and eastern Strait of Juan de Fuca regions of Washington State. National Marine Fisheries Service, Northwest Region.

30.) Nilsson, N.A. 1967. Interactive segregation between fish species. *In* The biological basis for freshwater fish production. *Edited by* S.D. Gerking. Blackwell Scientific Publications, Oxford. pp. 295-313

31.) Pearsons, T.N., G.A. McMichael, K.D. Ham, E.L. Bartrand, A. l. Fritts, and C. W. Hopley. 1998. Yakima River species interactions studies. Progress report 1995-1997 submitted to Bonneville Power Administration, Portland, Oregon. DOE/BP-64878-6.

32.) Pearsons, T.N., and A.L. Fritts. 1999. Maximum size of Chinook salmon consumed by juvenile coho salmon. N. Am. J. Fish. Manage. 19: 165-170.

33.) Peterson, G.R. 1966. The relationship of invertebrate drift abundance to the standing crop of benthic drift abundance to the standing crop of benthic organisms in a small stream. Master's thesis, Univ. of British Columbia, Vancouver, B.C.

34.) Piper, R. et al. 1982. Fish Hatchery Management. United States Dept. of Interior, Fish and Wildlife Service. Washington, D.C.

35.) Reimers, N. 1963. Body conditioning, water temperature and over-winter survival of hatchery-reared trout in Convict Creek, California. Trans. Amer. Fish. Soc. 92: 39-46

36.) Taylor, E.B. 1991. A review of local adaptation in Salmonidae with particular reference to Pacific and Atlantic salmon. Aquaculture 98: 185-207.

37.) Sager, P.M. and G.J. Glova. 1988. Diet feeding periodicity, daily ration and prey selection of a riverine population of juvenile Chinook salmon, *Oncorhynchus tshawytscha*. J. Fish. Biol. 33: 643-653.

38.) Seidel, Paul. 1983. Spawning Guidelines for Washington Department of Fish and Wildlife Hatcheries. Washington Department of Fish and Wildlife. Olympia, Wa.

39.) SIWG (Species Interaction Work Group). 1984. Evaluation of potential species 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 Department of Fisheries. Olympia, WA. 80pp

40.) Slaney, P.A., B.R. Ward. 1993. Experimental fertilization of nutrient deficient streams in British Columbia. *In* G. Schooner and S. Asselin (editors), Le developpmente du saumon Atlantique au Quebec: connaitre les regles du jeu pour reussir. Colloque international e la Federation quebecoise pour le saumon atlantique, p. 128-141. Quebec, decembre 1992. Collection *Salmo salar* n°1.

41.) Slaney, P.A., B.R. Ward, and J.C. Wightman. 2003. Experimental nutrient addition to the Keogh River and application to the Salmon River in coastal British Columbia. *In* J.G. Stockner,(editor), Nutrients in salmonid ecosystems: sustaining production and biodiversity, p. 111-126. American Fisheries Society, Symposium 34, Bethesda, Maryland.

42.) Steward, C. and T.C. Bjornn. 1990. Supplementation of salmon and steelhead stocks with hatchery fish: a synthesis of published literature. Tech. Rpt. 90-1. Idaho Cooperative Fish and Wildlife Research Unit. University of Idaho, Moscow, ID.

43.) USFWS (U.S. Fish and Wildlife Service). 1994. Biological assessment for operation of U.S. Fush and Wildlife Service operated or funded hatcheries in the Columbia River Basin in 1995-1998. Submitted to National Marine Fisheries Service (NMFS) under cover letter, dated August 2, 1994, from William F. Shake, Acting USFWS Regional Director, to Brian Brown, NMFS.

44.) Ward, B.R., D.J.F. McCubbing, and P.A. Slaney. 2003. Evaluation of the addition of inorganic nutrients and stream habitat structures in the Keogh River watershed for steelhead trout and coho salmon. . *In* J.G. Stockner,(editor), Nutrients in salmonid ecosystems: sustaining production and biodiversity, p. 127-147. American Fisheries Society, Symposium 34, Bethesda, Maryland.

45.) Washington Department of Fisheries. 1991. Stock Transfer Guidelines. Hatcheries Program, Washington Department of Fisheries. Olympia, Wa.

46.) Washington Department of Fish and Wildlife (WDFW). 1987-2003. Semi-Annual Operations Reports for Lower Columbia Fisheries Development Program Mitchell Act Hatcheries (Washington State). Washington Dept. of Fish and Wildlife. Olympia, Wa.

47.) Washington Department of Fisheries (WDF), Washington Department of Wildlife (WDW), and Western Washington Treaty Indian Tribes (WWTIT). 1992. 1992 Washington State salmon and steelhead stock inventory (SASSI). Washington Dept. Fish and Wildlife, 600 Capitol Way N, Olympia, WA. 98501-1091. 212 pp.

48.) Washington Department of Fisheries (WDF) and Washington Department of Wildlife (WDW). 1993. 1992 Washington State salmon and steelhead stock inventory - Appendix three Columbia River stocks. Washington Dept. Fish and Wildlife, 600 Capitol Way N, Olympia, WA. 98501-1091. 580 pp.

49.) Washington Department of Fish and Wildlife (WDFW). 1997. Wild Salmonid Policy, draft environmental impact statement. Washington Dept. of Fish and Wildlife. Olympia, Wa.

50.) Washington Department of Fish and Wildlife. 1998. Water resource inventory area river mile indices for the Columbia and Snake river basins. Unpublished document. Habitat Management Division, Washington Department of Fish and Wildlife, Olympia, WA.

51.) Washington Department of Fish and Wildlife (WDFW). Select Area Fishery Evaluation Project, 1997-2000 Annual Reports.

52.) Washington Department of Ecology. 2002. A guide to instream flow setting in Washington state. Olympia, Wa.

53.) Wipfli, M.S., J. Hudson, and J. Caouette. 1998 Influence of salmon carcasses on stream productivity: response of biofilm and benthic macroinvertebrates in southeastern Alaska, U.S.A. Can J. Fish. Aquat. Sci. 55: 1503-1511.

54.) Witty, K., C. Willis and S. Cramer. 1995. A review of potential impacts of hatchery fish on naturally produced salmonids in the migration corridor of the Snake and Columbia Rivers. S.P. Cramer and Associates, Inc., 600 NW Fariss, Gresham, Oregon.

55.) Wood, J.W. 1979. Diseases of Pacific Salmon, their prevention and treatment, 3rd edition. Washington Department of Fisheries, Hatchery Division, Olympia, Washington. 82 p.

Section 14. CERTIFICATION LANGUAGE AND SIGNATURE OF RESPONSIBLE PARTY

14.1 Certification Language and Signature of Responsible Party

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

Name, Title, and Signature of Applicant:

Certified by_____ Date:_____