HATCHERY AND GENETIC MANAGEMENT PLAN (HGMP)

DRAFT

Hatchery Program	Lower Columbia River ESU Chum Salmon
Species or Hatchery Stock	Grays River Chum (*Oncorhynchus keta*)
Agency/Operator	Washington Department of Fish and Wildlife
Watershed and Region	Columbia Lower Subbasin/Lower Columbia Province
Date Submitted	nya
Date Last Updated	June 22, 2004

Section 1: General Program Description

1.1 Name of hatchery or program.

Grays River/Sea Resources (Chinook River) Chum Salmon

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

Onchorhynchus keta

ESA Status: Threatened

1.3 Responsible organization and individuals.

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

Sea Resources, The Lower Columbia River Fish Recovery Board, Lower Columbia River Fish Enhancement Group, local sport fishing clubs, and citizens and landowners in Wahkiakum, Cowlitz, Clark, and Skamania counties will assist us in our efforts to collect brood stock, rear and liberate fed-fry, determine whether genetic enclaves of chum salmon exist in tributaries of the Lower Columbia River, and develop natural spawning refugias for this species.

USF&WS (United States Fish and Wildlife Service) in cooperation with Burlington Northern Railroad and Washington Trout are developing a controlled-flow spawning channel for Lower Columbia River chum salmon in the Hardy Creek drainage. The physical parameters of this channel plus its monitoring and evaluation components will serve as an important archetype for any additional chum salmon spawning channel development in the ESU. USF&WS also has traps in Hardy Creek and the spring channel of Hamilton Creek to estimate adult and juvenile abundance.

An existing dam near the mouth of Duncan Creek has been modified to allow free passage of adult and juvenile chum salmon. In addition, habitat modifications have been made in the Duncan Creek watershed to provide chum salmon with a protected natural spawning area. A comprehensive monitoring and evaluation plan was developed for this project . It was designed to assess the egg-to-fry survial rates of chum salmon spawning in the renovated Duncan Creek habitat. Moreover, all the chum salmon fry produced from this project are receiving strontium marks or thermal marks on their otoliths so that fry-to-adult survival and straying rates can be estimated. The criteria used to establish the chum salmon spawning habitat in Duncan Creek are being followed at Grays River where an on-going effort is being made to construct a spawning channel for chum returning to this stream. Furthermore, the monitoring and evaluation plan developed for the Duncan Creek project will be largely adopted to evaluate the success of the Grays River channel after it is constructed Funding for modification of the Duncan Creek dam was provided by The Skamania Landowners Association, Washington State Department of Natural Resources Aquatic Lands Enhancement

Account, Washington State Salmon Recovery Funding Board, and the Bonneville Power Administration. Monies to create the renovated spawning habitat at Duncan Creek was provided by NOAA-Fisheries and BPA has provided support to WDFW and PSMFC staff to operate and evaluate the chum salmon reintroduction program at Duncan Creek which began in 2001.Annual reports describing this project have been submitted to BPA beginning in 2002.

In the mainstem Columbia just below Bonneville Dam, several agencies under Bonneville Power Administration funding are evaluating the spawning success of chum salmon found there. Oregon and Washington departments of fish and Wildlife, USF&WS, U.S Geological Survey, and Pacific Northwest Battelle Laboratory have joined together to collect life history and habitat use data for fall chinook and chum salmon below the four lowermost Columbia River mainstem dams so the hydrosystem can be managed in a manner to protect and/or enhance these spawning populations.

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

Funding Sources

Operational Information	Number
Full time equivalent staff	Sixteen man months are dedicated to this project every year which takes place from late October through mid April. Two fish culturists are hired for a two month period of time (Nov – Dec). A Sea Resources’ biologist is also supported for two man months and six individuals in WDFW’s Otolith Lab receive a total of 10 man months of support This equals 1.33 FTEs . It excludes however, all the assistance the project receives from hatchery personnel stationed at Grays River and Beaver Creek hatcheries, WDFW personnel located in Region 5, and PSMFC staff located in the region.
Annual operating cost (dollars)	Approximately $52,000 per year

1.5 Location(s) of hatchery and associated facilities.

Broodstock source	Grays River Chum
Broodstock collection location (stream, RKm, subbasin)	During the first two years of this project a temporary weir and trap were installed at the mouth of Gorley Springs (WRIA 25-0129), a tributary that enters the Grays River, Washington, at Rkm 20.0. The trap was in operation from early November through mid December. In 1999, however, Grays River jumped its banks and completely destroyed the Gorley Springs side channel. Beginning in 2000, chum salmon broodstock have been captured by using seines in three locations, at Rkm 18.7 (close to the highway bridge), Rkm 20.9 (confluence of the West Fork of the Grays River), and beginning in 2001 at the Grays River Hatchery (Rkm 23.2) which is located on the West Fork of the Grays River. Some chum salmon brood stock are also collected by using snagging gear, particularly adjacent to the hatchery. Grays River chum salmon were introduced into the Chinook River (WRIA 25-0001) in 1999. They started to return to the Chinook River in 2002. Brood stock at this location is being collected by using Sea Resources weir located at Rkm 6.6.
Adult holding location (stream, RKm, subbasin)	Grays River Hatchery-located on the West Fork of the Grays River, Washington (WRIA 25-0131) at Rkm 23.3. Grays River chum salmon returning to the Chinook River are held at the Sea Resources Hatchery (WRIA 25-0001) Rkm 6.6 on a as needed basis. The goal of the Chinook River program is to develop a self-reproducing population.
Spawning location (stream, RKm, subbasin)	Grays River Hatchery-located on the West Fork of the Grays River, Washington (WRIA 25-0131) at Rkm 23.3. Sea Resources Hatchery-located (WRIA 25-0001, Rkm 6.6) in the Chinook River (WRIA 25-0001) Columbia Rkm 10.0.
Incubation location (facility name, stream, RKm, subbasin)	Grays River Hatchery-located on the West Fork of the Grays River, Washington (WRIA 25-0131) at Rkm 23.3. Chum salmon spawned at Sea Resources have their gametes transferred to the Grays River Hatchery where they are fertilized, incubated, and thermally marked prior to being returned to Sea Resources Hatchery (WRIA 25-0001, Rkm 6.6) for rearing and release.
Rearing location (facility name, stream, RKm, subbasin)	Grays River Hatchery-located on the West Fork of the Grays River, Washington (WRIA 25-0131) at Rkm 23.3. Sea Resources Hatchery-located (WRIA 25-0001, Rkm 6.6) in the Chinook River (WRIA 25-0001) Columbia Rkm 10.0.

1.6 Type of program.

Integrated Recovery program that utilizes supplementation and re-introduction strategies.

1.7 Purpose (Goal) of program.

The goals of the Lower Columbia River chum salmon recovery project are to: 1) determine if remnant populations of Lower Columbia River chum salmon exist in Lower Columbia River tributaries; 2) If such populations exist, develop stock-specific recovery plans that would involve habitat restoration or the creation of spawning refugias, the capture of native brood stock, factorial mating of adult fish, incubation, thermal marking, and post-emergent rearing of fry and subsequent release of those fish into their native streams followed by an evaluation of fry-to-adult survival. If chum have been extirpated from previously utilized streams, develop re-introduction plans that utilize appropriate genetic donor stock(s) of Lower Columbia River chum salmon and integrate habitat improvement and fry-to-adult survival evaluations; 3) stabilize the Grays River chum salmon population by randomly capturing adults entering Grays River, factorially mating them and subsequently incubating and rearing them in the Grays River Hatchery. All these fry will be thermally marked and released when wild cohorts emigrate out of the Grays River; 4) re-introduce Lower Columbia River chum salmon into the Chinook River basin. A portion of each family produced by the Grays River mating program will be transferred at the fry stage to Sea Resource's hatchery. Once there, the fish will be reared until they reach 1 to 1.5 g in size and at that time they will be liberated into the lower part of the Chinook River, at night, on a falling tide. All of these fry will also be thermally marked. The Chinook River chum salmon re-introduction program ceased in 2002. At that time, 3-yr-old chum salmon returned to the Chinook River and some of these fish were used as brood stock to continue the Chinook River program.

1.8 Justification for the program.

The attempts to recover and restore Lower Columbia chum salmon have been predominately supported by Washington State. In 1998, for example, monies from State Senate Bill 6324 were used by WDFW (Washington Department of Fish and Wildlife) to begin a chum salmon recovery program in Grays River. In this instance, brood stock were captured from Gorley Springs, a Grays River tributary, artificially spawned, thermally marked, and reared at the Grays River Hatchery. Over one hundred thousand reared fry were released from the hatchery in March and April of 1999. In addition to this work, SSB 6324 dollars were used to conduct extensive stream surveys by WDFW to determine if remnant populations of chum salmon existed in tributaries entering the Lower Columbia on the Washington side of the river. In 1999 monies from a legislative appropriation to WDFW for hatchery recovery efforts on ESA listed salmon stocks were used to support the recovery efforts outlined in this document. One aspect of our recovery plan calls for re-introducing Lower Columbia River chum salmon back into streams where they had previously existed. The first attempt at making such a re-introduction relied on the assistance of Sea Resources, a non-profit educational organization headquartered in the Chinook River basin. Since 2000, Sea Resources has provided rearing vessels, water, and labor so that chum salmon native to Grays River can be re-introduced into the Chinook River, one of the lowest tributaries to the Columbia River on the Washington side. They are responsible for rearing the fish and assist in their liberation into the lower part of the Chinook River. In addition, Sea Resources staff are actively working with WDFW to develop high quality chum salmon spawning areas in the Chinook basin so that a self-sustaining, naturally-reproducing population of chum salmon can be re-established in the basin.

In 1996, Sea Resources, a nonprofit educational organization, developed a comprehensive watershed recovery plan for the Chinook River basin (Dewsberry 1997). The plan has six parts: 1) to protect critical upland habitat from landslides and thereby protect the lower river from debris torrents in an effort to re-establish a more natural regime of sediment and organic matter movement through the watershed; 2) to reduce sediment inputs by repairing and stabilizing existing roads in the watershed and when possible to decommission unnecessary roads; 3) to protect and restore the valley floor by re-establishing a mature conifer dominated forest; 4) to restore the lower estuary by (a) removing or redesigning the tide gate located at the mouth of the Chinook River, (b) by limiting development in the lower portions of the watershed, (c) by re-establishing woody debris accumulations in the Chinook estuary and in Baker Bay, and (d) by encouraging beaver dam development in the lower river; 5) to use an existing hatchery to help supplement salmonid populations in the basin, and 6) to evaluate the effects of habitat improvements in upland, valley floor, stream channel, an estuarine areas on habitat characteristics and salmonid abundance (Dewsberry 1997).

The habitat restoration and evaluation work mentioned above and managed by Sea Resources will continue into the foreseeable future. Hence, the basin has the potential to provide a stable and high quality spawning, incubation, and early rearing refuge to Lower River Columbia River salmonids. Sea Resources operations have the support of the Co-managers and the USFWS.

1.9 List of program "Performance Standards".

1) Conduct systematic stream surveys in Lower Columbia River tributaries and use GPS technology and maps to indicate where chum salmon spawn in each surveyed basin. Quantify the occurrence of chum salmon in those systems where they are found.
2) Identify ground water sources and possible spawning channel locations that could be developed in each surveyed watershed.
3) Develop site-specific recovery initiatives for Lower Columbia River chum salmon on a tributary-by-tributary basis, working closely with local citizens, regional salmon enhancement groups, local, federal and state entities.
4) Collect one hundred and fifty to four hundred and fifty thousand eggs from chum salmon returning to the Grays River. Artificially mate these fish in a factorial fashion, collect biological information on each spawner, evaluate egg-to-fry survival rates, thermally mark each individual, and release fed fry (1 to 1.5 g in size) into the Grays River during March and April.
5) Obtain approximately fifty to one hundred twenty five thousand eggs from Grays River origin chum salmon returning to the Chinook River. Spawn the adults at the Sea Resources Hatchery, fertilize the eggs and incubate them at the Grays River Hatchery. Thermally mark all such fish, transfer them as unfed fry to the Sea Resources Hatchery, rear them in raceways and liberate the reared fish in March and April into the lower portion of the Chinook River. This protocol was started in 2002.
6) Work with Sea Resources staff and other interested parties and identify portions of the Chinook basin where chum spawning areas can be produced in an effort to establish suitable spawning areas for this species in the watershed. Annually repeat the release of reared chum salmon fry into the Chinook River for up to twelve years or until a stable, self-sustaining population of naturally reproducing chum salmon has been established in the watershed.

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

Benefits:
1) The discovery of genetic enclaves of chum salmon in Lower Columbia River tributaries with the development and implementation of site-specific recovery efforts for these populations will significantly reduce the likelihood of extinction of this species in the Lower Columbia River. Currently, there are only three known, stable populations of Lower Columbia River chum salmon, the Grays River stock, the Hardy/Hamilton Creek or Bonneville Pool population, and the "205 Bridge" population. Chum have been observed in other tributaries, e.g. the Elochoman, Lewis, Cowlitz, and Washougal rivers and Skamokawa, Abernathy, Germany, St. Cloud, Duncan, and Tanner (an Oregon stream) creeks, but their numbers are low (often less than 10 live individuals). In addition, annual counts of chum salmon at Bonneville and The Dalles Dam show low numbers of fish. Fewer than 100 chum were counted annually at Bonneville Dam from 1970-1997 (except 1987 when 147 fish were counted). Chum were counted at The Dalles Dam only 5 times during this same 18 year period. Those counts totaled 7 fish. This program is designed to support comprehensive, multiple year stream surveys so that the size and stability of these and other possible chum salmon populations in the ESU can be determined.

2) Stabilization of the Grays River chum population. In the recent past most of the natural production from this population occurred in Gorley Springs, a man-made channel, located at Rkm 20. However, in 1999 this side channel was destroyed by flooding. By importing chum into the Grays River hatchery it provides this population with a new source of recruits that is largely protected from the vagaries of high stream flows and major flooding events. Plans are being developed to construct another protected spawning location for chum in the Grays River Basin. Until that occurs, the hatchery program will ensure that chum salmon remain in the basin.

3) Egg-to-fry and smolt-to-adult survival rates of the fish incubated and reared at the Grays River and Sea Resources hatcheries will be significantly greater than those achieved by fish naturally spawning in the Grays River basin. Thus the judicious use of hatchery cultural procedures will help accomplish point two above. In addition, the factorial mating scheme employed at the time of spawning and the number of fish utilized as brood stock will ensure that the effective population size of these fish is maintained at a level where the effects of genetic drift and inbreeding depression are minimized.

4) The introduction of Grays River chum salmon into the Chinook Basin also helps preserve this stock and allows it to colonize a watershed where Lower Columbia chum have been absent for many years.

5) Each cultured fish released will be marked (either by thermal manipulation or other means at the eyed-, alevin- or fry-stage of development) so that its origin and rearing treatment can be deciphered at any later stage in its life cycle. These data will allow objective evaluation, monitoring, survival, distribution-straying, and production assessments to be linked to every recovery effort.

6) Fecundity estimates by age will be generated which could be used to estimate number of eggs deposited by the natural spawning population.

Risks

1) Brood stock trapping via seines could stress fish that escape and therefore potentially decrease their reproductive success.

2) Some brood stock fish may perish prior to spawning either through natural causes or by being stressed by the capture process or because of poor holding conditions after capture.

3) Poor incubation conditions or improper handling of newly fertilized eggs can also cause mortalities to occur while the fish are being incubated in a hatchery setting.

4) Overcrowding, inappropriate feeding rates and food size, poor water quality, and inadequate water exchange during the rearing period can promote the outbreak of diseases in cultured chum salmon and cause some of the reared fish to perish during the rearing period or produce low quality smolts.

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

Up to 320 adults at 1:1 female to male ratio.

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

For 2004 -2005. up to 450,000 fingerlings for the Grays River and up to 125,000 for the Chinook River.

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

Adult fish produced/harvested:

The number of adult fish produced will obviously be affected by the number and size of the fry released and the post-release environmental conditions the fish encounter. Initially, the Grays River supplementation effort calls for the release of one hundred to two hundred thousand fry reared to about 1 to 1.5 grams. The Sea Resources Hatchery effort is designed to release approximately fifty to one hundred twenty five thousand fed fry. Unfed fry-to-adult survival rates in this species typically range from 0.3 to 3% (Salo 1991). Rearing the fish until they reach a gram or slightly larger can significantly increase their survival to one percent or more (Fresh et al. 1980; Kaeriyama 1989; Salo 1991; Fuss and Hopley 1991).

We are unaware of any data that estimates the fry-to-adult survival rates of reared Lower Columbia River chum salmon but speculate that it should average about 1%. This value is one to two percent lower than the survival rates of reared chum originating from more northern populations. We assume that fry-to-adult survival of reared Lower Columbia chum salmon will be lower than that observed in other locations because these fish represent some of the southern-most stocks of this species in North America. Consequently, they may commonly experience challenging environmental circumstances during early life history stages that deleteriously affect their survival rates (WDF 1990). Consequently, the Grays River releases of chum salmon fry are expected to produce five hundred to fifteen hundred adults. These fish mature at ages three, four, and five so for any given return year between 200 to 750 adults from the program are expected to return to the Grays River. The fish liberated from the Sea Resources Hatchery will produce 250 to 750 adults per release, with seventy-five to three hundred returning during the same year.

In the Lower Columbia, chum salmon are only caught incidently (Keller 1999). For example, in 1998 only thirteen chum were harvested and Keller (1999) reported that 1998 was the sixth consecutive year when less than 100 chum were harvested in the Columbia River. By-catches of chum are low because the fish typically enter the Columbia River after the commercial gill net seasons have closed (Keller 1999).

Escapement goal:

The Grays River was once known for its large chum salmon population. Bryant (1949) stated that 7,674 chum salmon were counted in the lower twenty one kilometers of Grays River (including the West Fork) in 1936. Since then the watershed has been extensively logged and subsequent landslides, erosion, and channel changes have seriously damaged salmon spawning areas in the basin. In 1985, the Washington Department of Fisheries built a spawning area on Gorley Springs at Rkm 19 and since that time approximately 38% of the chum spawning in the Grays River have used it as a spawning site (Keller 1996). Escapements into the basin from 1976 through 2000 have ranged from one hundred and seven in 1980 to over three thousand two hundred in 1992 and has averaged twelve hundred during the past decade (WDF 1990--sub basin plan; Keller 1999). Currently, no formal escapement value has been established for Grays River. Instead, the management goal has been to allow as many adult chum salmon as possible to enter the system and spawn. In 1999, a study designed to estimate the duration of freshwater life in adult Grays River chum salmon is being conducted. The results of this study will be used to refine previous population estimates and help determine biologically meaningful escapement levels for the basin.

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

This program began at Grays River in October of 1998. The Sea Resources Hatchery program began in1999.

1.14 Expected duration of program.

The collection of chum salmon brood stock from the Grays River will continue until significant habitat improvements have stabilized the dynamic river-flow patterns currently extant in the basin. Until that can be accomplished, the population will be vulnerable to catastrophic flood events. Stream surveys for adult chum salmon in the Lower Columbia River will continue into the indefinite future. The re-introduction of Lower Columbia River chum salmon (Grays River stock) into the Chinook River, on the other hand, is expected to last for a maximum of twelve years. As mentioned above, chum salmon from Grays river parents have returned to the Chinook River in 2002 (~300 3-yr-old fish) and 2003 (~600 3- and 4-yr-old fish) and some of these fish were used as brood stock to continue the reintroduction program. Consequently, no eggs from adult chum salmon returning the Grays River in 2002 and 2003 were imported into the Chinook River. It is anticipated that chum returning to the Chinook River will continue to be used as brood stock for the rest of the program.

1.15 Watersheds targeted by program.

Initially two watersheds, the Grays River, the Chinook River basins will be the sites for our recovery efforts. Additional, Lower Columbia River tributaries will be targeted for recovery efforts in the future once enough stream survey data have been collected to indicate which systems possess native chum salmon or contain habitat that can be utilized by this species.

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

Alternative 1 Grays River: Allow chum salmon to naturally spawn in the Grays River without any hatchery intervention. This action was not followed because of the unstability of the basin. During late fall and winter months large amounts of rainfall occur throughout the basin and Grays River may change its course, scour or fill large portions of its water course. This dynamic flow regime is caused in part by two factors, upland land practices such as extensive logging and road building and river channelization to protect extant farm lands and homes. Until habitat restoration occurs the river will continue to possess unsuitable, high risk, spawning and incubation locations for chum salmon.

Alternative 2 Grays River: Create a protected spawning area in the Grays River basin for chum salmon. Plans are currently being developed for such an area. If funds can be obtained to produce it chum salmon will be allowed to spawn in this location. A comprehensive evaluation and monitoring effort will need to be carried out to ensure that this area can act as a key spawning and incubation refugia for Grays River Chum. At present, such a protected area does not exist.

Alternative 1 Chinook River: Allow stray Lower Columbia River chum salmon to colonize the Chinook River and not import Grays River chum salmon into the basin. The abundance of Lower Columbia River chum salmon is low enough that it would take many years for a chum population to establish itself in the Chinook River by natural straying. In addition, the tidal gate located at the mouth of the river has created a backwater zone that is used by warmwater fishes. These fish will prey on chum fry and their presence may be enough to curtail or significantly slow down any natural increase in chum abundance in the basin.

Alternative 2 Chinook River: Spawn and incubate chum at the Sea Resources Hatchery instead of incubating eggs from Chinook River chum at the Grays River Hatchery. Release unfed fry from the Sea Resources Hatchery instead of rearing them and releasing them at the mouth of the Chinook River. The Sea Resources Hatchery uses a surface water supply that could be disrupted by floods, tree falls and other events. It can also be heavily silted during heavy rain events. Moreover, at present the hatchery is not set up to thermally mark developing salmon embryos. The facility needs to have a well developed once that occurs it will have a dependable, silt free source of water and thermal marking equipment could be established at the site. Until this occurs, the Grays River Hatchery provides the most secure incubation and thermal marking location for this project.

Section 2: Program Effects on ESA-Listed Salmonid Populations

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

Authorization for Grays River programs includes: Biological Assessment For The Operation Of Hatcheries Funded by The National Marine Fisheries Service (March 99), Concurrent with this HGMP to satisfy Section 7 consultations: WDFW is writing HGMP's to cover all programs produced from and released at Grays River Hatchery and Sea Resources facilities.

2.2 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
Fall Chinook-Natural	L	M
Chum	H	L
H, M and L refer to high, medium and low ratings, low implying critical and high healthy.		

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

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

Lower Columbia River fall chinook salmon *(Onchorhychus.tshawytscha*) are federally listed as "threatened" under the ESA on March 24, 1999.
Lower Columbia River Steelhead *(Onchorhychus. mykiss*), were listed as threatened under the ESA on March 19, 1998. In Washington, the LCR steelhead ESU includes winter and summer steelhead in tributaries to the Columbia River between the Cowlitz River and Wind River.

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

Describe the status of the listed natural population (s) relative to "critical" and "viable" population thresholds.
Critical and Viable population thresholds have not been established for these ESUs and the populations within them. NMFS has formed a Lower Columbia River/Williamette River Technical Review Team to review population status within these ESU and develop critical and viable population thresholds.

Lower Columbia River fall chinook salmon *(Onchorhychus.tshawytscha*) within the Evolutionary Significant Unit (ESU) are federally listed as "threatened" under the Endangered Species Act effective May 24, 1999.

Grays River Fall Chinook
Status: Fall chinook are native to the Grays River. The natural spawners are now a mixed stock of composite production (Table 21). Stock mixing very likely began when hatchery

supplementation was initiated in 1947 (WDF et al. 1993). The majority of spawning takes place in a 3.6-mile area from the covered bridge on the mainstem (RM 10.7) to the Grays River Salmon Hatchery on the West Fork Grays (RM 1.2). Spawning occurs from late September to mid-November (WDF et al. 1993). In the early 1950s, there was an estimated escapement of 1,000 fall chinook to the Grays River (WDF 1951). Seining in 1979 captured few naturally-produced, fall Chinook juveniles. This evidence suggests that few natural fall chinook juveniles were being produced (WDF et al. 1993). Natural spawning escapements from 1967 to 1991 averaged 745 fish, with a low return of 147 in 1967 and a peak of 2,685 in 1978. Natural spawning escapements of 278 fish inGrays River Chinook salmon stock status is rated Depressed in 2002 because of a long-term negative trend and a short-term severe decline in escapements in 1997, 1998 and 2000. Generally, lower Columbia tule fall chinook stocks, including Grays fall chinook, experienced poor survival in the 1990s.

This is a mixed stock with wild production. A native population of fall chinook existed in the Grays River prior to the construction of Grays River Hatchery in 1960. Until recently, a significant portion of the fall chinook spawners in the Grays River were hatchery strays. The fall chinook program at the Grays River Hatchery ended in 1998. The present population is a probably mix of native and hatchery-origin fish with life history characteristics common to those of other lower Columbia River tule fall Chinook stock (**SaSI** 2002).

Columbia River chum salmon *(Onchorhychus. ket*a) - Mainstem Chum were listed as threatened under the ESA on March 25, 1999.

Stock status is rated Depressed in 2002 because of chronically low escapements. This is a native stock with composite production. A hatchery supplementation program designed to increase numbers of naturally spawning Grays River fall chum began at the WDFW Grays River Hatchery in 1998 (**SaSI** 2002).

Chum salmon (target populations) -
The natural population targeted for recovery and supplementation is the Grays River chum salmon stock. As mentioned previously, chum salmon production in the Lower Columbia River has drastically declined over the past fifty years (WDF 1951; WDF et al. 1993). Many lower Columbia tributaries once produced chum, however, at present, significant natural production appears to be limited to three areas: Grays River, Hardy Creek, and Hamilton Creek. The latter two streams are located just below the Bonneville Dam (Rkm 229 and 230 respectively) on the Washington-side of the river. Spawning ground counts made in these drainages since the late 1950's indicate that both streams possess stable populations of chum salmon (WDF et al. 1993). The Grays River population, on the other hand, is considered depressed due to a long-term negative trend in spawning ground escapements (WDF et al. 1993). Because of the generally low abundance of this species throughout the Columbia the NMFS listed Lower Columbia River chum salmon as a threatened species under the auspices of the ESA in early 1999.

The recovery and supplementation plan described in Part 1 calls for the re-introduction of Lower Columbia River chum (Grays River stock) into the Chinook basin. The Chinook River used to contain a native chum salmon population that was apparently extirpated several decades ago (WDF 1951). In the late 1980's, chum salmon from Bear Creek, a Willapa Bay population were transplanted into the Chinook River via a hatchery program run by Sea Resources. Initially adult returns back to the Chinook from this transplant were close to a thousand fish per year, however, recent returns have been low. For example, in 1997 and 1998 twenty or less adults returned (Garth Gale pers. comm.) to the Sea Resources Hatchery. In 1998, it was decided that these non-native chum should be removed to accommodate our effort to re-introduce native Lower Columbia River chum salmon back into the basin. Consequently, in 1999 all adult chum salmon returning to the Sea Resources Hatchery have been destroyed.

Recent stream enhancement work by the Washington Fisheries Department in Gorley Springs (RM 12) had been relatively successful until an upstream dike failed and the river changed course and now flows through the Gorley Springs channel. Other areas such as Crazy Johnson Creek can be quite productive if water flows are adequate. The lack of stable spawning habitat is considered the primary physical limitation on chum production today. Development of other spring-fed spawning areas such as Gorley Springs could improve subbasin chum production. Seasonal low flows sometimes restrict access of chum to preferred off-channel spawning areas, confining them to less stable mainstem reaches. Some mainstem reaches where chum spawn are subject to frequent channel shifts and bedload deposition or scour, all of which reduce intragravel survival. Adults migrate into the river from mid-October through November with peak spawner abundance occurring in late November. Scale analysis indicates 3- and 4-year-old fish are the dominant age classes. During low flow years, chum spawn primarily in the larger mainstem Grays River; during higher flows they can be found in larger numbers in the smaller tributaries.

Chum are believed to enter the river in October and November and reach their spawning peak in early November. Chum spawn in the mainstem Grays from the covered bridge to approximately 0.5 mile upstream of the West Fork confluence (approximately 4 miles). Tributary spawning occurs in the West Fork (RM 13.0), Crazy Johnson Creek (RM 13.3), and Gorley Creek (RM 12) during November and December (WDF et al. 1993). They are also reported to spawn in Fossil Creek (RM 12.4), and Hull Creek (RM 8.2) (Ames and Bergh 1971). In the 1970s, chum spawning index areas existed in Sweigiler Creek (RM 4.1 of the West Fork Grays) and in the South Fork Grays River (RM 17.7) (Jim Fisher and Associates 1999). Wahkiakum Conservation District reports chum spawning in Klints Creek (RM 11.9). In 1973, WDF reported chum presence in Seal Creek (RM 0.15 on Seal Slough) and Malone Creek (RM 2.1), but does not state whether they were spawning in these creeks (Smith et al 1954).

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).

1) Operation of Hatchery Facilities: Facility operation impacts include water withdrawal, hatchery effluent, and intake compliance with impact on listed fish unknown but monitoring and maintenance are conducted along with staff observations. Indirect take from hatchery facilites is unknown.

2) Broodstock Collection: See HGMP section 7.0. Approximately 160 pairs are taken. Take tables are in the back of this document.

3) Genetic introgression: The program is intended to re-establish but not be permanent in nature. The collection of chum salmon brood stock from the Grays River will continue until significant habitat improvements have stabilized the dynamic river-flow patterns currently extant in the basin. Until that can be accomplished, the population will be vulnerable to catastrophic flood events. Stream surveys for adult chum salmon in the Lower Columbia River will continue into the indefinite future. The re-introduction of Lower Columbia

River chum salmon (Grays River stock) into the Chinook River, on the other hand, is expected to last for a maximum of twelve years. If a self-sustaining population is established earlier, then the importation of Grays River fish will cease. Indirect take from genetic introgression is unknwn.

4) Hatchery Production/Density-Dependent Effects: The design of the chum program is intended to minimize the influence of any hatchery and density effects on the existing populations. The stabilization and re-introduction program of both Gray River and the Chinook River accomplishes additional spatial distribution at a minmal productivity level in lieu of habitat improvements while providing the research needed for future decisions. Indirect take is unknown.

5) Disease: Outbreaks in the hatchery may cause significant adult, egg, or juvenile mortality. Over the years, rearing densities, disease prevention and fish health monitoring have greatly improved the health of the fish culture and Procedures for Columbia Basin Anadromous Salmonid Hatcheries (IHOT 1994) chapter 5 have been instrumental in reducing disease outbreaks. Prior to release, the chum program 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. Indirect take from disease is unknown.

6) 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.

Potential Lower Columbia Chum predation and competition effects on listed salmonids: Chum migrating quickly to marine waters soon after emergence. This life history strategy, which chum salmon share with pink salmon, reduces the mortality associated with the variable freshwater environment, but makes chum more dependent on estuarine and marine habitats. Newly emerged chum fry migrate immediately to marine areas, and range in size from 32- 41 mm (Salo 1991). Fry released from the Grays River and Chinook River programs are < 60 mm fl; their small size and dietary preferences make it unlikely that they will predate on fish.

7) Predation (Freshwater):

Relative Body Size: Depending upon temperature regimes in spawning streams, eggs reach the eyed stage after approximately 4-6 weeks of incubation and hatching occurs approximately 8 weeks after spawning. Alevins develop in redds for an additional 10-12 weeks before emerging from the gravel as fry. Newly emerged chum fry migrate immediately to marine areas, and range in size from 32- 41 mm. 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). A recent study on Artic char, a well known as picivorous predator suggested that maximum prey size is approximately 47% of their length (Finstad et al. 2002).

With this wide variation of information on the size of predator on prey relationships (13-50%) range, the best information indicates the 33% predator prey length ratio is valid until further data on a species can be collected. Below are some of the data that is available for chinook fry and fingerling lengths from area Lower Columbia streams:

- Average fork length by week from 26 sampling sites on the Kalama River by week indicate fish 44 mm fl (April 25), 46 mm fl (May 3), 56 mm fl (May 11) and 62 mm fl (May 16). Other lengths thru August are available (Pettet 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.

Due to lack of opportunity, size and life history traits, predation impact would be low.

Dates of Releases: Chum are released starting in March and finished by early April. This timframe is earlier than many listed Chinook.

8) Residualism: Chum limit their freshwater life history by migrating quickly to marine waters soon after emergence. A very small portion of some chum populations will reside in freshwater (<< 1%) rearing there until they reach a maximum size of 70 to 90 mm fl.

9) Migration Corridor/Ocean: Chum salmon juveniles entering the estuary are thought to immediately commence migration seaward, migrating at a rate of 7 - 14 km/day. Rapid seaward movement may reflect either "active" migration in response to low food availability or predator avoidance, or "passive" migration, brought on by strong marine water surface flows. Most juvenile chum salmon are thought to migrate to open ocean waters during the spring and summer of their first year (Salo 1991).

Associated monitoring and evaluation and research programs: 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 in the Lower Columbia Management Area (LCMA). Approximately 5% of the adult chum escapement to the Grays River are tagged and released .

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).
Adults are taken. See take table at the end of this HGMP.

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.
Seining of adults utilizes small mesh cotton/nylon nets designed to minimize entanglement . If tangle nets are used, small mesh prevents gilling and opercle tears. Handling and release of any wild stocks is monitored and take observations have been rare. Any additional mortality from this operation on a yearly basis would be communicated to Fish program staff for additional guidance.

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 hatchery program will be operated under the general procedures of the Summer Chum Salmon Conservation Initiative (WDFW and PNPTT 2000). This program is consistent with the Columbia Basin System Planning Salmon and Steelhead Production Plan for chum salmon in the lower Columbia Sub-basin. Planners recommended that a combination of natural and hatchery production would be the optimal way to produce the most rapid sustainable improvement in chum runs. It assumed the quickest way to rebuild the run would be to combine releases of an appropriate stock into improved habitat (WDF 1990). This approach is being applied in this program.

Additional policy and guidance for hatchery programs in the Lower Columbia programs:

Genetic Manual and Guidelines for Pacific Salmon Hatcheries in Washington. These guidelines define practices that promote maintenance of genetic variability in propagrated salmon (Hershberger and Iwamoto 1981). Also, *Policies and Procedures for Columbia Basin Anadromous Salmonid Hatcheries* (Genetic Policy Chapte 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 detemining 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 recovery and supplementation program described in this HGMP is consistent with the following agreements and plans:
-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)
- 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.

The Columbia River historically contained large runs of chum salmon that supported a substantial commercial fishery in the first half of this century. These landings represented a harvest of half a million chum salmon in the Columbia River in some years (NMFS Status Review, 1996). By 1955, landings had diminished to 10,000 fish. Since 1965, landings have averaged less than 2,000 fish annually. Presently, no Columbia River commercial fisheries target chum. Chum landings occur incidentally to targeted coho seasons in the late fall gill net fishery (WDFW, 1993).

Current commercial fisheries are expected to end prior to the primary migration time or were area/gear specific to minimize chum handling. Commercial landings from 1993-1998 averaged 29 fish. Commercial harvest rates from 1993-1997 averaged less than 2% based on the minimum chum run size (WDFW/ODFW 1999).

The Columbia River system is closed to recreational harvest of chum salmon. Chum angling has been closed on the Oregon side of the Columbia River since 1992 and on the Washington side since 1995. Additionally, a salmon angling closure was adopted for the Grays River in 1994. (WDFW/OFDW, 1998).

3.4 Relationship to habitat protection and recovery strategies.

The lack of stable spawning habitat is considered the primary physical limitation on chum production today (NWPPC, 1990). Natural limiters for the Grays River chum stock include gravel quality and stability and availability of good quality near shore mainstem freshwater and marine habitat. This watershed has been ravaged by logging road construction and subsequent timber harvest since the 1960s, only recently has the rate of road building and harvest subsided. This had led to numerous road and harvest unit slope failures creating tremendous sedimentation and instability of spawning riffles (WDF, 1993).

Formal recovery plans for Columbia River chum have not been made. However, the Columbia Basin System Planning Production Plan addresses habitat protection and recovery for Grays River chum. The recommended strategy emphasizes habitat protection through continuation and expansion of state regulatory programs including the Fisheries Code, the Shorelines Management Act, and the Forest Practices Act. In addition, a habitat risk assessment map for the watershed should be developed to be used by state and local agencies when reviewing and permitting forest practices. It also calls for identifying and remedies for man-caused sources of sediment.

The Plan also suggests developing spring fed natural spawning and incubation channels. For supplementation, it recommends introducing chum fry to selected tributaries of the Grays River through the use of on-site streamside incubators or off-site incubation and short-term, on-site rearing for imprinting size advantage.

Chinook Basin
In 1996, Sea Resources, a nonprofit educational organization, developed a comprehensive watershed recovery plan for the Chinook River basin (Dewsberry 1997). The plan has six

parts: 1) to protect critical upland habitat from landslides and thereby protect the lower river from debris torrents in an effort to re-establish a more natural regime of sediment and organic matter movement through the watershed; 2) to reduce sediment inputs by repairing and stabilizing existing roads in the watershed and when possible to decommission unnecessary roads; 3) to protect and restore the valley floor by re-establishing a mature conifer dominated forest; 4) to restore the lower estuary by (a) removing or redesigning the tide gate located at the mouth of the Chinook River, (b) by limiting development in the lower portions of the watershed, (c) by re-establishing woody debris accumulations in the Chinook estuary and in Baker Bay, and (d) by encouraging beaver dam development in the lower river; 5) to use an existing hatchery to help supplement salmonid populations in the basin, and 6) to evaluate the effects of habitat improvements in upland, valley floor, stream channel, an estuarine areas on habitat characteristics and salmonid abundance (Dewsberry 1997).

Since the completion of their basin recovery plan, Sea Resources has received funds from a variety of sources and has begun implementing many of the habitat changes delineated in their plan. For example, they have established a green house next to their hatchery facility and are currently growing native plants which will later be transplanted throughout the basin. Moreover, they have planted native evergreens in riparian zones and are presently working on stabilizing upland areas by planting native shrubs and trees. They are placing large woody debris in the basin, removing and repairing roads and performing evaluation studies through their environmental education program (for further details on habitat restoration in the basin go to: www.searesources.org). In addition, the hatchery operated by Sea Resources has the infrastructure needed to rear and release chum salmon fry until suitable spawning areas are either artificially created or manifest themselves through natural recovery processes.

The habitat restoration and evaluation work mentioned above and orchestrated by Sea Resources will continue into the foreseeable future. Hence, the basin has the potential to provide a stable and high quality spawning, incubation, and early rearing refuge to Lower River Columbia River chum salmon. Consequently, it was chosen as our initial site to try re-introducing native Columbia chum salmon back into a stream where this species once existed. Finally, the close proximity of the Chinook River to the Columbia River estuary and ocean pastures also made it an attractive site for re-introduction.

3.5 Ecological interactions.

Salmonid and non-salmonid fishes or other species that could:
1) negatively impact program:
Chum salmon (smolts) emigrate from the Columbia River in March and April. Not much is known about their early estuarine life. In Puget Sound, however, newly emerged chum salmon tend to feed on epibenthic prey in shallow nearshore areas until they reach approximately 55 mm in fork length. After reaching this size they become pelagic, feed predominately on zooplankton, and begin moving northward into oceanic pastures. A similar offshore and northward migration strategy may be used by Lower Columbia River chum salmon.

Because of their relatively small size, newly emerged and migrating chum fry are vulnerable to a large array of potential predators. For the Grays River stock, that would include juvenile steelhead, cutthroat trout, northern pike minnow, cottids, and wild and hatchery origin coho and chinook salmon. In the Chinook River basin, a population of warm water fishes (small mouth bass, yellow perch, crappie, blue gills, pumpkin seeds, cat fishes) have established themselves and these fishes along with resident salmonids could act as significant predators. In addition, The U.S. Army Corps of Engineers is attempting to trans-locate a large colony of Caspian Terns to Sand Island, an islet located in Baker Bay close to the mouth of the Chinook River. These birds could significantly impact juvenile chum salmon if they reside for prolonged periods of time in the bay.

The rearing and release strategies developed for our chum recovery program, however, are designed to dampen predation. First, the fish will be reared until they reach about 55 to 60 mm in length (fork) or 1 to 1.5 g in weight. This will make them large enough to escape some of their potential predators and shorten their dependence on shallow estuarine feeding areas thus reducing their exposure to aerial and bottom dwelling predators. Second, the fish will be liberated during darkness on a falling tide in an effort to expedite emigration out of the Columbia River and reduce their visibility. In the Chinook basin, reared chum will be transported about three kilometers downstream and released to avoid a concentration of warm water fishes. Third, even though the fish are reared they will be liberated in March and April, the same time that natural migrants are leaving the system. This should minimize interactions with Caspian Terns and also maximize the likelihood that they will encounter favorable nearshore conditions.

2) be negatively impacted by program:
No negative species interactions are expected to be produced by this program. Because of the size of the released fish and their food habits they are unlikely to directly compete with wild chum salmon fry or with other salmonid fishes using the Columbia estuary. Also the total number of fry that will be liberated is relatively small (approximately 100 to 450 K from Grays River and 50 to 125 K from the Chinook River) and early enough in the Spring to limit any behavioral effects on wild salmonids (e.g. the inducement of premature out-migration) or ancillary predation (e.g. by the creation of a numerical response in predators).

3) positively impact program:
No significant positive interactions caused by other species are expected. The presence of adult chinook, coho, and other salmonid species may increase the amount of micro-nutrients present in the Grays and Chinook rivers. However, only a small proportion (< 1%) of chum fry remain in freshwater to rear for short periods of time and hence they are unlikely to derive much benefit from the carcasses of other salmonids.

4) be positively impacted by program:
Many species, including cutthroat, steelhead and rainbow, coho, and chinook are known to prey on chum fry and consequently juveniles of these species may benefit from increased numbers of chum fry. Besides direct fry consumption, increased numbers of adult chum salmon carcasses into the Grays and Chinook rivers will add micro-nutrients into these streams which by direct or indirect routes would be available to salmonids and other species in the basin. In addition, released fed fry may buffer the effects of predation on wild chum salmon fry.

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.

During the first two years of this program (1998 and 1999) adult chum salmon captured as brood stock were collected at the mouth of Gorley Springs, a man-made channel fed by numerous ground water springs. Once captured, the fish were transported to the Grays River hatchery where they are held in Grays River water until spawning. Beginning in 2000, brood stock have been collected throughout the basin by using seines and hook and line gear. As in previous years the captured adults were held in surface water at the hatchery. Fertilized eggs are incubated in 10-12^{o}C well water at the hatchery until yolk absorption. At that time, any fish selected for transfer to the Sea Resources Hatchery are transported to that facility and placed into raceways supplied with surface water from the Chinook River. Fry that are destined to be released into the Grays River, on the other hand, are placed into 6 m wide x 24.7 m long x 1.2 deep concrete raceways that are supplied with 946 to 1,325 liters/min (0.56 - 0.78 cfs) of 100% well water. Three weeks prior to release, Grays River water will be gradually added to each raceway so that at the end of the rearing period, the fish have been exposed to 100% Grays River water for at least ten days.

At the Sea Resources Hatchery, six or more portable fiberglass raceways (0.9m wide x 0.9m deep x 4.8 m long) will each be provided with 38 to 75 liters/min of surface water.

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.

The facility operates within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit. All hatchery effluent from pond cleaning is discharged into a spare Burrows pond where the solids are allowed to settle out and are later used for fertilizer for our native plant propagation. There is 1/8 in. screening on the hatchery water intake to prevent salmonid fry from entering the intake.

<table>
<tr><th>Potential Hazard</th><th>Risk Aversion Measures</th></tr>
<tr><td>Hatchery water withdrawal</td><td rowspan="2">Grays River Hatchery - Water rights are formalized thru trust water right S2-08676 from the Department of Ecology. Monitoring and measurement of water useage is reported in monthly NPDES reports.
Sea Resources Facility - The facility operates within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit. All hatchery effluent from pond cleaning is discharged into a spare Burrows pond where the solids are allowed to settle out and are later used for fertilizer for our native plant propagation. There is 1/8 in. screening on the hatchery water intake to prevent salmonid fry from entering the intake.
Grays River Hatchery - WDFW has requested funding for future scoping, design, and construction work of a new river intake system to meet NOAA compliance (Mitchell Act Intake and Screening Assessment 2002).</td></tr>
<tr><td>Intake/Screening Compliance</td></tr>
<tr><td rowspan="2">Hatchery effluent discharges. (Clean Water Act)</td><td>Grays River Hatchery - This facility operates under the “Upland Fin-Fish Hatching and Rearing” National Pollution Discharge Elimination System (NPDES) administered by the Washington Department of Ecology (DOE) - WAG 13-1015.</td></tr>
<tr><td>Sea Resources Hatchery
The facility operates within the limitations established in its National Pollution Discharge Elimination System (NPDES) permit. The production from this facility falls below the minimum production requirement for an NPDES permit, but the facility operates in compliance with state or federal regulations for discharge and The facility does not have a discharge permit.</td></tr>
</table>

Section 5. Facilities

5.1 Broodstock collection facilities (or methods).

Grays River Hatchery
Original Protocol: To capture brood stock, a weir and live box were installed in late October in Gorley Springs a man-made, spring fed tributary to Grays River. Trap placement was in a quite pool approximately 30 m from the mouth of Gorley Springs. The 1.2 m wide by 3 m long live box had aluminum pickets supported by 1.9 cm in diameter steel piping. The front end of the trap had a V shaped entrance and the back end had a "Dutch Door" to facilitate fish movement through the live box. The live box also had a screened bottom made from perforated aluminum plate and two plywood lids that could be locked. The weir fence stretched completely across Gorley Springs (approximately 9 m) and had metal pickets set on 3.8 cm centers.
Subsequent Protocol: In 1999/2000, a flood on the Grays River resulted in channel changes that made the trap site on Gorley Springs inoperable. Grays River staff currently uses a combination of hatchery collection (volunteer swim-ins), adult seining and hook and line sampling to collect adult chum from the West fork and mainstem Grays River for use as broodstock (Glaser, 2003).

Captured adults are inspected and selected fish are placed into perforated, 25 cm in diameter x 122 cm long PVC holding tubes and placed into a 760 liter tank mounted on a flat bed truck. The fish are then hauled about 5 Km to the Grays River Hatchery where the tubes are placed into one of the concrete adult holding ponds at the hatchery. Each tube holds only one fish, and the date of capture and sex of the fish are written on the outside of the tube. Sexual maturity is checked on a regular basis and ripe fish are spawned twice a week when available.

Sea Resources Hatchery
Since 2002, brood stock are now collected at the Sea Resources Hatchery. An instream structure to trap and hold adults is used.

Ponds (number)	Pond Type	Volume (cu.ft)	Length (ft.)	Width (ft.)	Depth (ft.)	Available Flow (gpm)
1	Concrete Barrier/Picket Weir with V-Trap for Capturing Adults	672	14.0	12.0	4.0	Seasonal Instream Flow
1	Instream Holding Area above Concrete Barrier/Picket Weir for Holding Adults	672	14.0	12.0	4.0	Seasonal Instream Flow

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

Grays River Hatchery
Selected fish are placed into perforated, 25 cm in diameter x 122 cm long PVC holding tubes and placed into a 760 liter tank mounted on a flat bed truck. The fish are then hauled about 5 Km to the Grays River Hatchery where the tubes are placed into one of the concrete adult holding ponds described below.
Sea Resources Hatchery
Transportation of adults is not needed.

5.3 Broodstock holding and spawning facilities.

Grays River Hatchery

The facility has ten (6 m wide x 24.7 m long x 1.2 deep) concrete raceways, one (18 m wide x 61 m long) earthen pond and two, 12 m wide x 18 m long, concrete ponds that are used for adult holding or juvenile rearing.
Sea Resources Hatchery
An instream holding pond (12 ft x 14ft x 4) is used for holding and as a spawning pond. See section 5.1.

5.4 Incubation facilities.

Grays River Hatchery
The Grays River Hatchery uses vertical stack incubators. The eggs collected from each female are usually fertilized by two or three males. Several minutes after fertilization, or after micropyle closure, the eggs from a single female are recombined and placed into a single tray. A rugose substrate, folded vexar plastic screening, is added to each tray after the eggs have been shocked and picked. The Garys River Hatchery uses 15 vertical stack incubators, flows are 3-5 gpm. The eggs from a single female are usually placed into each tray, in a few rare cases, eggs from several females are combined and placed into a tray. When this occurs loading densities do not exceed 3000 eggs per tray.
Sea Resources Hatchery
Sea Resources Hatchery uses 15 vertical stack incubators, flows are 3-5 gpm and are loaded and hatched at 2500 eggs per tray.

5.5 Rearing facilities.

Grays River Hatchery
Fry produced from one or two egg take dates are placed into a separate, screened off rearing areas established in one or two of the station's, 6 m wide x 24.7 m long x 1.2 deep, concrete raceways. The fish be reared for approximately one to two months before being released into the Grays River. Available flow is 300 pgm and maximumflow index is 2.0-2.5.
Sea Resources Hatchery
Fry produced from one to two egg take dates will be placed into 0.9m wide x 0.9m deep x 4.8 m portable fiberglass raceways. The fish will be reared for approximately one to two months before being trucked 3 Km to a release site in the lower Chinook River.

5.6 Acclimation/release facilities.

Grays River Hatchery
Initially fry are reared in well water, however, during the last three weeks of the rearing period water from the Grays River is added to the raceways. During the last ten days of rearing the fish are reared entirely in Grays River water. All releases will be made during darkness and will coincide with a falling tide.
Sea Resources Hatchery
At this location the fish are reared in fiberglass raceways that are supplied with surface water collected from the Chinook River. Releases occur at the mouth of the Chinook River, during darkness and falling tides.

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

Grays River Hatchery – There has been no significant problems at Grays River Hatchery.
Sea Resources Hatchery - Significant mortality has occurred in the process of cleaning the sediment buildup in the Heath incubators. If the rubber stoppers are not secured properly they may pop out thus starving the trays below of oxygen. Please note however, that this type of mortality has not affected the chum program. As indicated above, fertilized eggs from chum returning to the Chinook River are incubated and thermally marked at the Grays River hatchery to reduce the risk of loss that may occur at the Sea Resources Hatchery.

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.

Grays River Hatchery: Manager lives on-site and/or staff person is on-site 24/7.

Sea Resources Hatchery: Manager lives on-site and/or staff person is on-site 24/7. Water supply for facility is delivered by a single surface water intake. A lost of this intake or supply line would cause catastphopic fish loss at the facility.

Section 6. Broodstock Origin and Identity

6.1 Source.

Grays River Hatchery: Native Grays River stock trapped from Gorley Creek started the initial program in 1998.
Sea Resources Hatchery: In 2000, the Sea Resources facility became part of the Lower Columbia River Chum Restoration Program. Eggs from the Gorley Creek population were used to start this program

6.2.1 History.

Grays River Hatchery: Chum are native to the Grays River (**SaSI** 2002). Brood stock used for the recovery program since 1998 originated from adults trapped at Gorley Creek and the Grays River. No other stock has been used.
Sea Resources Hatchery: Starting in the early 1980's, chum salmon were propagated from Willapa Bay (NRC 1996). Approximately 360,500 chum salmon fry per year were released by this hatchery between 1982 and 1991 (WDF et al. 1993). Willapa Bay chum were phased out and by 1998, less than 20 chum salmon (and only four females) were trapped and spawned at the Sea Resources Hatchery. Startup of the Lower Columbia River Chum Restoration Program in 2000 and 2001, began with offspring from broodstock chum at Grays River. Starting in 2002, broodstock has been from local returns to the Chinook River

6.2.2 Annual size.

Grays River
Program broodstock is collected from from the returning run. See section 7.4.2. Data are peak live plus dead spawners per stream mile (in the lower mainstem Grays (2.4 miles surveyed), the lower West Fork Grays (1.8 miles surveyed) and lower Crazy Johnson Creek (0.2 miles surveyed).

Year	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Count	104	461	199	42	140	242	146	171	314	759	

Chinook River
Abundance of chum salmon in the Chinook River. The Table below represents the estimated number of chum salmon returning to the entire Chinook basin. The data were obtained by performing stream surveys and counting fish over the weir located at the Sea Resources Hatchery.

Year	2002	2003
Count	300	600

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

Grays River
Initial Broodstock was from native fish but after re-introduction, integrated chum spawners back to the Grays River have been used**.**
Sea Resources
Initial Broodstock was from native fish but after re-introduction, integrated chum spawners back to the Chinook River have been used. Obviously until NORs start to return to the Chinook River (the earliest that would occur would be 2005) all the fish used as brood stock that were collected from the Chinook River will be hatchery-origin fish

6.2.4 Genetic or ecological differences.

There are no known genotypic, phenotypic, or behavioral differences between the natural spawning and fish collected for brood stock.

6.2.5 Reasons for choosing.

Chum salmon propagated through this program represent indigenous Grays River stock which is the target of the supplementation. Grays River chum are one of three remaining viable populations in the lower Columbia River. Grays River stock is the closest donor stock for the Chinook River. The Chinook River used to contain a native chum salmon population that was apparently extirpated several decades ago (WDF 1951). In the late 1980's, chum salmon from Bear Creek, a Willapa Bay population were transplanted into the Chinook River via a hatchery program run by Sea Resources. Initially adult returns back to the Chinook from this transplant were close to a thousand fish per year, however, recent returns have been low. For example, in 1997 and 1998 twenty or less adults returned (Garth Gale pers. comm.) to the Sea Resources Hatchery. In 1998, it was decided that these non-native chum should be removed to accommodate our effort to re-introduce native Lower Columbia River chum salmon back into the basin. Consequently, in 1999 all adult chum salmon returning to the Sea Resources Hatchery were destroyed. Grays River chum are one of three remaining viable populations in the lower Columbia River. Grays River stock is the closest donor stock for the Chinook River.

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.

See section 7.2 below.

Section 7. Broodstock Collection

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

Grays River and Chinook River (Sea Resources)
Adult chum salmon returning to the Grays and Chinook rivers will be collected.

7.2 Collection or sampling design

Grays River
The brood stock collection process developed for this recovery effort has two objectives; first, to randomly collect representative fish, and second to proportionately collect them throughout the duration of the run. In 1998 and 1999 we attempted to meet these goals by using the following approach. First, a population estimate was made on the expected abundance of chum salmon returning to Grays River. That estimate coupled with our need for adults (40 to 160 pairs) established an anticipated sampling rate that was used to obtain the quantity of adults needed for the program. For example, suppose that it was estimated that 1,000 adult chum salmon are expected to return to the Grays River. Previously gathered field data indicated that approximately 30 to 40% of these fish were destined to enter Gorley Springs, the tributary where the adult trap was located. Consequently, we would expect to see 300 to 400 adult fish go into this tributary. We also assumed that the sex ratio of these expected migrants will be equal, and therefore 150 to 200 individuals of each sex should be available for sampling. Because Gorley Springs is such an important spawning area, it was decided that not more than 50% of the fish entering this tributary could be used as brood stock. This rule was instituted in an effort to reduce the biological impacts of brood stock removal. As stated above, our goal was to collect anywhere from 40 to 160 pairs of fish. The 50% rule indicates that a maximum of 75 (0.5 x 150) fish of each sex should be collected. In this particular situation our sampling rate would equal 50% and our goal for this return year would be 75 pairs. In those cases where more fish are expected to use Gorley Springs our sampling rate would be reduced. For clarity, assume that an estimated 2000 adults are expected to enter this tributary. Based on this number we would estimate that 1000 fish of each sex would be available to sample for brood stocking. Our maximum goal is 160 fish of each sex and so in this instance our sampling rate would be 16% which would provide us with 160 pairs.

Second, after having established a sampling rate based on expected returns we needed to determine how to use this rate to obtain a random sample of fish. In many chum populations, males tend to arrive on the spawning grounds several days in advance of females and they also tend to stop arriving sooner than females. Consequently, to help ensure that we collected equal numbers of males and females it was important to sample them independently. This could be done in a number of ways. For instance, at a 10% sampling rate, every tenth male and every tenth female could be saved. However, we wanted to avoid any bias in the collection of brood stock, e.g. the purposeful collection of large individuals, and so generated two sets of random numbers, one for each sex. Each random number is assigned to a fish based on its sex and when it was processed.

At the 10% sampling level, 10% of these values would indicate that an individual of a given sex should be saved for brood stock. By using this approach, no predictable pattern of collection occurs and fish are removed at the right frequency in an unbiased fashion. A constant sampling rate also allows us to proportionately sample the run in a consistent fashion. That is, when adult abundance is low the number of adults collected for brood stock is low and vice-a-versa.

On a few occasions we have collected more males than needed (our 50% sex ratio assumption was invalid). Surplus males were returned to Gorley Springs to resume their spawning migration after a two to three day delay. Because spawning occurs shortly above the location of our trap these males are able to resume their reproductive activities soon after liberation. No other salmonids have been captured in the Gorley Springs trap, if any are collected they will be immediately released so that can resume their upstream migration.

Current Grays River Hatchery Broodstock Collection:
Collection Method 1: Adult chum are captured from volitional returns to the fish ladder-V trap located at the downstream end of Grays River Hatchery compound, adjacent to temporary rack and picket weir across the West Fork (Grays River). Collection Method 2: Sexually mature adult chum are seined and/or snagged during early November through mid December in the West Fork Grays River and the mainstem Grays River (State Highway 4 to Gorley Creek).

Chinook River (Sea Resources)
In the Chinook River, all chum returning to the hatchery (up to 100 pairs/year) will be spawned. If adult abundance is predicted to exceed this amount then a random selection process similar to that described for the Grays River population will be employed.

7.3 Identity.

Grays River
Only Grays River chum salmon are expected to return to the Grays River, no other chum populations apparently exist in this part of the Lower Columbia.
Chinook River (Sea Resources)
All chum salmon released into the Chinook River will be thermally marked to identify them as transplants from the Grays River. Prior to 2002 any adult chum returning to the Chinook basin can be considered a stray or descendant of the Bear Creek chum that were planted into the basin. All adult chum returning to the Chinook River prior to 2002 will be destroyed. In 2002, scales will be removed and read to determine the age of the fish, all four-year olds in 2002 will be considered strays and destroyed. Three year-olds will initially be considered as fish returning from the Grays River fry plants. Otoliths will be collected from these fish and decoded to confirm that they originated from our re-introduction effort. This work was done and 100% of the chum sampled possessed thermal marks indicating that they had originated from Grays River chum salmon.

7.4 Proposed number to be collected:

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

Goal is to collect anywhere from 40 to 100 pairs of fish at both sites.

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

Grays River Chum					Sea Resources Chum			
Brood Year	**Males**	**Females**	**Total**		**Brood Year**	**Males**	**Females**	**Total**
1998	45	47	92		2002			
1999	71	71	142		2003			
2000	120	125	245					
2001	106	110	216					
2002	164	162	326					
2003	152	153	305					

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

See section 7.2. Collection and sampling design.

7.6 Fish transportation and holding methods.

Grays River and Chinook River (Sea Resources)
Adults can be transported in a 760 liter tank mounted on a flat bed truck. Adult chum salmon will be held in adult holding ponds at the Grays River and Sea Resources hatcheries until spawning.

7.7 Describe fish health maintenance and sanitation procedures applied.

Adults are held for short periods of time before spawning at both locations. Water conditions during the late fall are cooler and have required no treatment to hold adults.

7.8 Disposition of carcasses.

Grays River and Chinook River (Sea Resources)
Carcasses of chum salmon spawned at the Grays River and Sea Resources hatcheries will be returned to their respective watersheds for nutrient enrichment and productivity enhancement purposes.

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.

Grays River Hatchery-Catastrophic management against equipment failure, water loss, and flooding
Adult Holding: Prior to spawning, brood stock are held at the Grays River Hatchery in the concrete holding ponds mentioned above. When adult chum salmon are collected in Grays River each selected fish is placed into its own 25 cm in diameter x 122 cm long PVC holding tube and held in its tube until spawned. The holding ponds are supplied by gravity-fed Grays River water, if the water supply to the ponds was ruptured that event would be detected by an alarm system. If that occurred the hatchery staff has at least three rescue options. First, depending upon stream conditions, the tubes could be quickly removed from the pond and placed in the nearby Grays River until the water supply to the pond is restored, second the tubes could be moved to nearby raceways or to the earthen pond and supplied with water at those sites, or if none of those locations are suitable, the fish could be liberated into the river.
Sea Resources Hatchery: Brood stock fish are held either in the weir or in adjacent concrete ponds supplied by gravity fed surface water. In the case of the weir, the river itself flow through that structure. In case of catastrophic water loss in the concrete holding ponds the fish could be held in the fish box portion of the weir. If the fish box was not available the adults would be liberated back into the Chinook River

Section 8. Mating

8.1 Selection method.

Fish used for brood stocking at both sites are collected at the trap sites in a random fashion throughout the duration of the spawning run. Obviously, the number of fish spawned per day and who they are mated with depends upon which fish are ripe on a given spawning date. No effort is being made to cross fish with particular phenotypic attributes (e.g. size- and age-at-maturity) in any systematic fashion.

8.2 Males.

A factorial mating scheme, either a 2 x 2 or 3 x 3 is followed whenever possible. To make these matings, the total egg mass of each female is weighed and then divided into the number of aliquots necessary to make the cross, either two or three. Each aliquot is then fertilized by a different male. In a 3 x 3 mating, for example, every female has one third of her eggs fertilized by a different male and every male fertilizes one third of the eggs obtained from three different females. Approximately 30 seconds after the eggs and milt have been activated by water, milt from a "backup" is added to ensure high fertility. Most fertilization occurs within seconds of activation, however, the use of backup males does provide eggs with another chance to be fertilized if the first male used was infertile. This approach is used to ensure that each fish has an opportunity to contribute genetic material to the next generation. If simple one x one crosses are used exclusively there is a risk that individual males and females may be crossed with infertile partners and thus have their potential fitness reduced or eliminated.

8.3 Fertilization.

Grays River Hatchery:
Egg Fertilization and Incubation: Eggs and milt are mixed/mated according to prescribed program protocols (2X2 or 3X3 factorial mating scheme). Fertilized eggs from each female are placed in an individual incubation tray at the Grays River Hatchery. Eggs are incubated full-term (Eyed to Hatched Egg) at Grays River Hatchery.

Prior to gamete extraction, each female is bled by severing a gill arch and is wiped clean of water, mucus and blood in an attempt to minimize contamination and gamete activation. Eggs from each female are collected separately in dry plastic pails. Each lot of eggs is then poured into a plastic colander that sits on top of another colander that has been lined with a plastic bag. The eggs are gently rotated around the colander to remove excess ovarian fluid which is retained by the lower colander. The eggs are then weighed to the nearest tenth of a gram on a top loading electronic balance. Depending upon the type of factorial cross being used, two to three aliquots of eggs are then weighed out and placed into new dry plastic pails. A label with the female's number is placed into each of these pails. A small sub sample of eggs (30 to 100) is then removed from one of the aliquots and weighed to the nearest hundred of a gram. The eggs in the sub sample are then hand counted two times. The data from this sample provides an estimate of the green egg weight of each female (sample weight/egg number = mean green egg weight) and is used to calculate a fecundity estimate (egg mass weight/mean green egg weight = fecundity) for that fish. Five of the eggs from the sub sample are retained and placed in water and allowed to water harden for 24 hours. These eggs are then individually weighed to the nearest mg to provide an estimate of the water-hardened egg weight for each female. The ovarian fluid captured by the lower colander is then poured back into each egg lot and the pails are stored in a cooler supplied with a 10 cm layer of crushed ice that is covered with some light insulating material. Once all the females that are going to be used in a factorial cross have been processed, milt is extracted from the males that will be used to make the cross. Like the females, each of these fish is wiped dry of water, mucus, and blood before milt is collected in dry, 1 liter plastic containers. Each milt sample is labeled and placed into a cooler until all the milt samples have been collected. The cross is made by laying out the pails containing the eggs of the same female into a row. For a three by three cross, nine pails would be laid out, with each row having eggs from the same female and each column having eggs from three different females. Milt from each male is added to one column of pails. At least 5 cc's of milt is added to each pail. Incubation water is poured over the combined gametes and they are gently swirled for 5 to 10 seconds. Milt from a backup male is added after the eggs have been exposed to milt from the first male for 20 seconds. After this new milt has been added, the eggs are again gently swirled for approximately five seconds. They are then allowed to stand for another minute or more. By this time the micropyles in the eggs have closed and the eggs from each female are placed into a single incubation tray and immersed in an iodophor bath for one hour before being placed into normal incubation water.

A considerable amount of ancillary biological data are collected either before or immediately after spawning. For example, prior to gamete removal each fish is measured (Fork Length) to the nearest mm and weighed on an electronic balance to the nearest 0.5 gram. During 1998, 99, 2000, and 2001 eye, liver, heart, muscle, and sometimes fin material is removed for electrophoretic processing. Microsatellite-DNA samples are removed from the opercle of every fish used as brood stock. Three to six scales are collected for later age determination and kidney and spleen samples are removed from each fish for viral screening. Ovarian fluid is also collected from each female and used in the viral screening process which relies on the enzyme-linked immunosorbent assay (ELISA). Because we intend to transfer some of the eggs from each female to the Chinook River it is important that each fish be screened for viral pathogens. Those individual that test positive for viral infestation will not be transferred.

Sea Resources Hatchery:

Identical spawning procedures are used to fertilize eggs collected from Chinook River chum salmon. Biological samples identical to those collected on adult Grays River chum are collected on the fish used as brood stock in the Chinook River.

8.4 Cryopreserved gametes.

No cryopreserved gametes will be used in this recovery/re-introduction program

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.

A factorial mating scheme tends to protect the effective population size of the cultured fish by buffering them from having all of their gametes affected by a single infertile partner (Busack pers. comm.)

Section 9. Incubation and Rearing.

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

The objective of the Grays River program is to pond from 100 to 450 K fry and for the Sea Resources Hatchery, the objective is to pond 50 to 125 K fry. From 1998 through 2003, 91 to 94% of all the eggs collected, produced fry that were ponded at the Grays River Hatchery. During the rearing period, which ranged from 32 to 50 days, mortalities were extremely low, less than 1%. Our program objective is to achieve a 95% survival rate during the rearing period.

9.1.2 Cause for, and disposition of surplus egg takes.

At this stage in the programs urplus eggs are not taken to ensure the maximum release numbers are achieved.

9.1.3 Loading densities applied during incubation.

Grays River Hatchery and the Sea Resources Hatchery
Eggs from a single female will be placed into each incubation tray, or in those instances where eggs from several females are placed into a single tray their combined density will not exceed that recommended by Piper et al. (1982).

9.1.4 Incubation conditions.

Grays River Hatchery
Harmful silt and sediment is cleaned from incubation systems regularly while eggs are monitored to determine fertilization and mortality. Incubation water is well water and temperature is monitored by thermograph and recorded and temperature units (TU) are tracked for embryonic development. Dissolved oxygen content is monitored and have been at acceptable levels of saturation with a minimum criteria of 8 parts per million (ppm). After eyeing, each tray is supplied with folded vexar to provide alevins with a rugose substrate from hatching to yolk absorption. *Sea Resources Hatchery*
The Sea Resources Hatchery is not supplied with well water but instead must rely on surface water from the Chinook River. Storm events can significantly increase the sediment load in the water supply and care must be taken to ensure that incubating eggs are not suffocated by excess siltation. As of 2003, no chum eggs from the re-introduction program have been incubated at the Sea Resources Hatchery. This protocol will be continued until improvements in water quality at the hatchery have been realized.

9.1.5 Ponding.

Grays River chum salmon are transferred into their rearing ponds after yolk absorption is almost complete. A similar ponding strategy is used for both the Grays River and Sea Resources hatcheries.

9.1.6 Fish health maintenance and monitoring.

Fish health and condition are monitored by fish health professionals throughout the rearing period. No fish disease outbreaks occurred during the incubation to ponding period at the Grays River Hatchery from 1998 through 2004 and the mortality levels experienced were lower than the program standards. Fish health is continuously monitored in compliance with Co-manager Fish Health Policy standards (WDFW and WWTIT 1998).

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.

The factorial-mating scheme used ensures that each fish chosen as broodstock will have an almost equal opportunity to contribute genes into the next generation. Egg loading densities in each tray are relatively low ensuring that adequate water exchange can occur.

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.

Grays River Hatchery: *Sea Resources Hatchery*

Typical Broodyear Survival (1998 through 2002)	**Information for 2002 eggtake(Chinook River)at the Sea Resources Inc. facility:**
The current annual egg taking goal for Grays River ranges between 100 and 300 K eggs.	Eggtake= 128631 eggs
Green-Eyed Survival(%)= 94.0	Green-Eyed Survival(%)= 85.6
Eyed-Ponding Survival(%)= 99.0	Eyed-Ponding Survival(%)= 88.5
Fry-Fingerling Survival(%)= 97.0	Fry-Fingerling Survival(%)= 86.9

Table X. Release Information (Location and Number Released) and Survival Rates from Ponding to Release, by Release year, for Chum Salmon reared at Grays River Hatchery.

Year Released	Location	Number of Fed Fry Released	Survival During Rearing Period
1999	West Fork Grays River	109,012	99.00%
2000	West Fork Grays River	135,678	99.60%
2000	Mouth Of Chinook River	62,820	99.43%
2001	West Fork Grays River	203,719	98.97%
2001	Mouth of Chinook River	75,601	99.24%
2002	West Fork Grays River	303,413	99.33%
2002	Mouth of Chinook River	100,127	99.45%

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

The fish are reared using the loading densities recommended by Piper et al. 1982. The rearing water at Grays River is approximately 10^{o}C (50^{o}F) and the fish at release average between 54 to 58 mm (2.3 to 2.1 inches) in length. Flow into each raceway can vary between 946 to 1,325 liters/min (250 to 350 gallons/min). Given these parameters, each raceway can hold a maximum of 73,000 fry at the end of the rearing period. This maximum value was calculated by multiplying the Piper constant at fifty degrees Fahrenheit by the number of gallons entering a raceway and dividing that product by the length of the reared fish or (1.8 Piper constant at 50^{o} F)(350 gpm)/(2.3 fish length in inches = 274 lbs of fish per raceway); since there are 266 fish per pound (1.7 g) at the end of the rearing period that means that the maximal carrying capacity in a Grays River raceway at the end of the rearing period is (266)(274) or 73,000 fish. Our loading density goal for both the Grays River and Sea

Resources hatcheries is to try to rear the fish at less than one-half a pound of fish per gallon per minute for the majority of their rearing period and thus never exceed the loading value recommended by Piper et al. (1982).

9.2.3 Fish rearing conditions.

Temperature, dissolved oxygen, flow rates, pond turn over rate and Total settable Solids (TSS) are monitored at Grays River and Sea Resources. IHOT standards are followed for: water quality, alarm systems, predator control measures (netting) to provide the necessary security for the cultured stock, loading and density. Settleable solids, unused feed and feces are removed regularly to ensure proper cleanliness of rearing containers. All ponds are broom cleaned as needed and pressure washed between broods. Temperature and dissolved oxygen are monitored and recorded daily during fish rearing.

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.

Growth samples were taken from each rearing area on a once-a-week basis to estimate mean body weight values for each group of reared fish. These values were used to adjust the daily ration of food provided to the fish. Growth rates (changes in length or body weight/day) for each group fish averaged around 0.4 mm and 27 mg per day. See also below.

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

Growth samples were taken from each rearing area on a once-a-week basis to estimate mean body weight values for each group of reared fish. These values were used to adjust the daily ration of food provided to the fish. Growth rates (changes in length or body weight/day) for each group fish averaged around 0.4 mm and 27 mg per day. No formal assessments were made of the energy reserves the fish possessed at the time of their release. However, unfed fry have a Fulton Condition Factor of approximately 0.68 $[((wt)/(length)^3)(100,000)]$. Fish from Grays River Hatchery in 1998 had condition factors that were slightly higher than this, indicating that they were a little more robust than unfed fry. Consequently, we feel these fish had adequate reserves to migrate to their estuarine feeding grounds. One of cultural goals in this project is to release fry that have condition factors that range from 0.68 to 1.0. Fish with condition factors greater than one may be obese and not as able to migrate or escape predation as those in a slightly slimmer condition.

Grays River Hatchery Chum General Growth Rates:

Rearing Period	Length (mm)	Weight (fpp)	Growth Rate
February 2003	25-30	1200	NA
March 2003	30-40	500	0.583
April 2003	40-60	300	0.400

Sea Resources Hatchery Chum General Growth Rates:

Rearing Period	Length (mm)	Weight (fpp)	Growth Rate
03/03/03	NA	1274	NA
03/17/03	NA	1026	0.195
03/31/03	NA	513	0.500
04/14/03	NA	300	0.415

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*).

Grays River Hatchery Chum Feed Rates:

Rearing Period	Food Type	Application Schedule (# feedings/day)	Feeding Rate Range (%B.W./Day)	Lbs. Fed Per gpm of Inflow	Feed Conversion
1200-525	Moore Clark Nutra #0	8	2.5	0.06	1.0:1.36
525-300	Moore Clark Nutra #1	3-5	2.5	0.08	1.0:1.8

Sea Resources Hatchery Chum Feed Rates:

Rearing Period	Food Type	Application Schedule (# feedings/day)	Feeding Rate Range (%B.W./Day)	Lbs. Fed Per gpm of Inflow	Feed Conversion
Feb-Mar	Moore Clark Nutra #0	8	2.5	0.06	1.0:1.36
Mar-Apr	Moore Clark Nutra #1	6	2.5	0.08	1.0:1.8

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

Fish health and disease condition will be continuously monitored in compliance with Co-manager Fish Health Policy standards (WDFW and WWTIT 1998).

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

At emergence, chum salmon fry are physiologically able to move directly into seawater. No formal measurements on degree of smoltification are conducted.

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

Some “NATURES” (natural rearing systems) approaches may be employed and evaluated. In particular, some raceways at both hatcheries may be provided with underwater feeders and floating cover. Since chum fry are initially epibenthic feeders we feel that presenting them with food in mid-water may be beneficial. In addition, the use of floating “lily pad covers” will also help the fish retain their fear responses to overhead shadows. At the Sea Resources hatchery we may also provide some of the raceways with dark bottoms and grey to green-blue side walls in an effort to provide the fish with a hetero-chromatic environment that mimics the color conditions found in Baker Bay and in the Columbia River. If these types of environments are implemented they will be carefully evaluated and compared against conventional methods. This will be accomplished in two ways, first be assessing any in-culture costs of these treatments (growth and mortality measurements) and second by comparing the fry-to-adult survival rates of fish produced from the two treatments via thermal marks recovered from returning adults.

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.

Grays River: Spawning-- Ripe fish are killed and then brought into the hatchery incubation room for factorial mating.
Sea Resources: Spawning—Ripe fish are brought into the hatchery and gametes are extracted. Eggs and ovarian fluid are placed into large, labeled zip-lock bags that are supplied with oxygen. The bags are placed into insulated coolers, and placed over a bed of ice covered with some insulation materials. Milt is extracted from the males and also placed into labeled zip-lock bags. Milt depth is depth is less than 1.25 cm, and the bag is filled with oxygen and zipped closed. These bags are also placed into insulated coolers supplied with crushed ice to keep the milt samples from making direct contact with the ice. The packaged gametes are then transferred to the Grays River Hatchery for fertilization.

Grays River Hatchery: Eggs from both the Grays and Chinook River programs are fertilized at the Grays River Hatchery. The resulting embryos are incubated in well water until yolk absorption. If a power failure disrupts the delivery of well water, a backup 80 Kilowatt diesel generator can be used to produce power to run the well pump and water distribution to the developing fish will not be disrupted. If the water line containing well water is ruptured or the pumps delivering well water are destroyed, two options exist. First, if none of the eggs have hatched, each Heath tray can be de-watered and the eggs can be kept moist for up to 24 hrs or longer, until replacement pumps can be installed or the line repaired. If that is not possible, gravity-fed water from Auxiliary Creek or Grays River can be used for incubation. If all water lines are ruptured, egg trays can be carried out to the rearing raceways or earthen pond and supplied with gently moving water at those locations.

Grays River Hatchery Rearing: As mentioned above, fry will be initially reared in well water and eventually acclimated to Grays River water. If well water for whatever reason is not available, the fish can be converted to gravity-fed water originating either from Auxiliary Creek or Grays River. If all water supplies are disrupted, fry can be maintained by supplying each raceway with air stones that are fed by cylinders of compressed air or depending upon conditions in the river and time of year the fish could be released into the Grays River.

Sea Resources Hatchery Rearing: As mentioned earlier, ground water is used to supply the fiberglass raceways used for chum rearing. If that water supply is disrupted, two options exist. First, bottled air can be used to aerate the raceways until repairs can be made. If repair work is expected to take more than several hours then auxiliary pumps will be used to deliver Chinook River water into the raceways. In an extreme emergency the fish can be loaded up and released at the mouth of the Chinook River.

Adult Holding and Spawning: At spawning, kidney, spleen, and ovarian fluid samples are collected from each female, and kidney and spleen samples are taken from each adult male. These samples are screened by WDFW’s virology lab. Any gametes that originate from parental fish infected with viral pathogens will not be transplanted out of basin. At fertilization, all gametes are soaked in an iodophor solution for one hour. During early ontogeny (prior to hatching), dilute formalin is routinely dripped into the incubation water to control *Saprolegnia* and other pathogens. Moreover, at eyeing, eggs are shocked and any mortalities are removed. All embryos are incubated in trays supplied with rugose substrate to prevent inefficient yolk utilization and the occurrence of physical abnormalities. And finally, at ponding, any remaining mortalities and monstrosities are removed. These measures are designed to limit and control any disease outbreaks from spawning to ponding.

Rearing and release: During the rearing phase, routine checks of fish health will be made by WDFW pathologists. Gill disease will be controlled by rearing the fish at relatively low densities and by providing them with whole food pellets as opposed to mash. If disease outbreaks occur the fish will be immediately treated using accepted fish health protocols.

Section 10. Release

10.1 Proposed fish release levels.

Start of the Program: In 1998, one-hundred and ten thousand fed chum salmon juveniles were released into the West Fork of the Grays River. We plan to release anywhere from one-hundred to four-hundred and fifty thousand fed chum salmon into the West Fork on an annual basis. Initial fry releases into the Chinook basin will range between fifty and one-hundred thousand individuals. If the re-introduction effort is successful, and adults returning to the Chinook can be used as brood stock then fry releases will increase slightly and range between one-hundred to a maximum of three-hundred thousand individuals. *Currently:* Up to 400,000 eggs could be taken to produce 350,000 chum for Grays River and the Chinook River. Program releases are subject to annual review based on status of naturally spawning adults in the systems.

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

As mentioned above the release location for the fish reared at the Grays River Hatchery is on the West Fork of the Grays River right at the hatchery location. In the Chinook basin the fish will be trucked downstream approximately 3 Km from the Sea Resources Hatchery to reduce predation losses and expedite their movement into Baker Bay and toward the Pacific Ocean.

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

	Grays River Fingerling Release			Sea Resources Fingerling Release		
Release Year	No.	Date (MM/DD)	Avg Size (fpp)	No.	Date (MM/DD)	Avg Size (fpp)
1998	120000	U	U			
1999	103711	March-April	300			
2000	205110	March	275	62833	March 17 and April 10	304
2001	202833	March	300	74512	March 15, 23, and 30	300
2002	305185	March-April	300	101448	March 18 & 27, and April 3 and 10	311
2003	407006	March-April				
2004	370073	March-April				

Additonal data is provided in table 6.

Table 6. The length, weight, and condition factors of chum salmon juveniles liberated from the Grays River Hatchery in 1998. Data for each release were obtained by sampling 100 individuals just prior to release.

Biological Parameter	Release One March 16, 1999	Release Two March 16, 1999	Release Three March 25, 1999	Release Four April 15, 1999
Mean Length	58.8 mm	56.2 mm	55.2 mm	54.6 mm
SD for Length	2.8	2.8	3.4	2.7
95% +	59.4 mm	56.7 mm	56.0 mm	55.1 mm
95% -	58.2 mm	55.6 mm	54.6 mm	54.0 mm
CV for Length	4.8%	4.9%	6.2%	4.9%
Mean Weight	1.73 g	1.54 g	1.4 g	1.4 g
SD for Weight	0.23	0.24	0.25	0.21
95% +	1.77 g	1.59 g	1.45 g	1.44 g
95% -	1.69 g	1.50 g	1.35 g	1.35 g
CV for Weight	13.4%	15.5%	17.62%	15.33%
Mean Condition	0.84	0.87	0.82	0.85
SD for Condition	0.06	0.05	0.05	0.06
95% +	0.86	0.87	0.83	0.87
95% -	0.84	0.86	0.81	0.84
CV for Condition	6.9%	5.3%	5.88%	6.74%

10.4 Actual dates of release and description of release protocols.

Fed fry will be released from both hatcheries from mid March to mid April. All releases will occur after darkness has fallen and when possible on a falling tide in an effort to protect the fish from in-stream predation and expedite their movement toward the Columbia estuary. The fish are not fed for at least 24 hrs prior to a release to minimize handling stress. At Grays River a stick seine is used to gently concentrate the fish into a relatively small portion of their raceway. Then dip nets are employed to capture the fish and place them in a tote box filled with 750 liters of Grays River water. The tote is lined with a fine mesh (3.125 mm), knotless nylon net and supplied with air stones to keep the water well oxygenated. After the tote has been loaded, a lid is placed on the box and the fish are hauled about 100 meters to the West Fork of the Grays River. Personnel then carefully load the fish into 19 liter capacity plastic buckets which are then hand-carried to the river so that the fish can be gently released. A similar release strategy is used at the Sea Resources site except the fish will are hauled for 1.6 to 4.8 Km to a lower river location before being carefully released into the Chinook River.

10.5 Fish transportation procedures, if applicable.

Fish can be hauled in a WDFW 400 gallon tanker mounted on a pick-up truck or hauled in plastic buckets in a tote in a pickup truck.

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

At Grays River the fry will be converted from well water to Grays River water about two weeks prior to being released. Such a conversion will not be necessary at the Sea

Resources facility since the fish will have been reared entirely in Chinook River water. As mentioned above, the fish will not be fed for at least 24 hrs prior to being released. Loading densities in the transfer tanks will be kept at low levels and all the fish will be released by hand from 19 liter buckets in an effort to reduce stress and disorientation.

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

All the hatchery fish will have their otoliths thermally marked using methods described by (Volk et al. 1990; Volk et al. 1994; Schroder et al. 1996; Volk et al. 1999). Initially two thermal marks will be used, one to indicate that the fish were reared and released at the Grays River Hatchery and another that identifies the fish as having been reared and released into the Chinook River. If NATURES style raceways are tried, additional thermal codes will be used to aid statistical evaluations of the effectiveness of conventional and NATURES rearing methods.

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

Program numbers are set annually by Region 5 staff before the start of the adult collection eliminating any surplus for the program.

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 examine, whenever abnormal behavior or mortality is observed, staff also conducts 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.

Grays River Hatchery-Catastrophic management against equipment failure, water loss, and flooding

Adult Holding: Prior to spawning, brood stock are held at the Grays River Hatchery in the concrete holding ponds mentioned above. When collected in the river, adult chum salmon are placed into their own 25 cm in diameter x 122 cm long PVC holding tube and held until spawned. The holding ponds are supplied by gravity-fed Grays River water, if the water supply to the ponds was ruptured that event would be detected by an alarm system. If that occurred the hatchery staff has at least three rescue options. First, depending upon stream conditions, the tubes could be quickly removed from the pond and placed in the nearby Grays River until the water supply to the pond is restored. Second, the tubes could be moved to nearby raceways or to the earthen pond and supplied with water at those sites, or if none of those locations are suitable, the fish could be liberated into back into the river. Similar protocols would be followed at the Sea Resources hatchery.

Spawning and Incubation to the fry stage: Ripe fish are killed and then brought into the hatchery incubation room for factorial mating. The resulting embryos are incubated in well water until yolk absorption. If a power failure disrupts the delivery of well water, a backup 80 Kilowatt diesel generator can be used to produce power to run the well pump and water distribution to the developing fish will not be disrupted. If the water line containing well water is ruptured or the pumps delivering well water are destroyed, two options exist. First, if none of the eggs have hatched, each Heath tray can be de-watered and the eggs can be kept moist for up to 24 hrs or longer, until replacement pumps can be installed or the line repaired. If that is not possible, gravity-fed water from Auxiliary Creek or Grays River can be used for incubation. If all water lines are ruptured, egg trays can be carried out to the rearing raceways or earthen pond and supplied with gently moving water at those locations

Rearing: As mentioned above, fry will be initially reared in well water and eventually acclimated to Grays River water. If well water for whatever reason is not available, the fish can be converted to gravity-fed water originating either from Auxiliary Creek or Grays River. If all water supplies are disrupted, fry can be maintained by supplying each raceway with air stones that are fed by cylinders of compressed air or depending upon conditions in the river and time of year the fish could be released into the Grays River. At Sea Resources, if a catastrophic water loss occurs during the rearing period, air stones fed by cylinders of compressed air would be used until pumps could be set up to deliver nearby stream water to the raceways. If this proves to be impossible the fish would be transported to the mouth of the Chinook River and liberated.

Grays River and Sea Resources hatcheries-Catastrophic management for disease transmission

Adult Holding and Spawning: At spawning, kidney, spleen, and ovarian fluid samples are collected from each female, and kidney and spleen samples are taken from each adult male. These samples are screened by WDFW?s virology lab. Any gametes that originate from parental fish infected with viral pathogens will not be transplanted out of basin. At fertilization, all gametes are soaked in an iodophor solution for one hour. During early ontogeny (prior to hatching), dilute formalin is routinely dripped into the incubation water to control *Saprolegnia* and other pathogens. Moreover, at eyeing, eggs are shocked and any mortalities are removed. All embryos are incubated in trays supplied with rugose substrate to prevent inefficient yolk utilization and the occurrence of physical abnormalities. And finally, at ponding, any remaining mortalities and monstrosities are removed. These measures are designed to limit and control any disease outbreaks from spawning to ponding.

Rearing and release: During the rearing phase, routine checks of fish health will be made by WDFW pathologists. Gill disease will be controlled by rearing the fish at relatively low densities and by providing them with whole food pellets as opposed to mash. If disease outbreaks occur the fish will be immediately treated using accepted fish health protocols. Staff at Grays River Hatchery and Sea Resources facilities are available 24/7 to respond to emergencies.

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.

- The production and release of chum smolts through fish culture fosters rapid seaward migration, limiting freshwater interactions with naturally produced Chinook and chum juveniles.
- The restoration program at Grays River plants fed fry into the West Fork of the Grays River. The original intent was to release the fish into Gorley Springs. However, it was felt that the stress the fish would experience was greater than any benefit that could be

obtained from this practice. In 1999, Gorley Springs was completely destroyed so fry have been released into the West Fork since the beginning of the program.

- Sea Resources releases fed chum into areas immediately above the confluence of the Chinook River with Baker Bay. Dispersal from this low site reduces competition and predation losses in the Chinook River system.
- All releases will occur after darkness has fallen and when possible on a falling tide in an effort to protect the fish from in-stream predation and expedite their movement toward the Columbia estuary.
- Returning fish from this program are not targeted for harvest.
- WDFW proposes to continue monitoring, research and reporting of chum restoration efforts performance behavior, and intra- and inter-specific interactions with wild fish to assess, and adjust if necessary, recovery re-introduction and release strategies to minimize effects on wild fish.
- WDFW fish health and operational concerns for the chum recovery programs are 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.

10.1) Marking
As mentioned previously every chum salmon produced by our recovery program will be thermally marked to make it possible for us to determine their origin and what type of cultural treatment they experienced.

10.2) Genetic data
Busack and Shaklee (1995) state "Based solely on the distribution of spawning grounds, Columbia River chum can be aggregated into two groups, Grays River and Below-Bonneville Tributaries. The spawning grounds of these two groups are separated by more than one hundred river miles and although information on straying based on coded-wire tags is not available, we do not believe that significant spawner exchange occurs between Grays River and the area just below Bonneville Dam". Extensive collections of eye, muscle, heart, and liver tissues have been collected from a substantial number of chum salmon populations located in Puget Sound, the Straits of Juan de Fuca, coastal Washington and Oregon, the Columbia River, and coastal British Columbia. Electrophoretic evaluations of these samples revealed that . . . "Columbia River chum populations [are] genetically distinct from each other and from all [the] other populations assayed. . .The Grays River and Hamilton Creek populations have a localized allele, *LDH-B1*160*, that [is] only found in the Columbia River. In addition, these collections share alleles with other Washington and Oregon coastal populations that have not been observed in Puget Sound" (Busack and Shaklee 1995). To add to this base line, we are collecting similar tissue samples from each adult used for brood stock. Moreover, punches of material removed from the opercle are being archived for later DNA analyses. These collections will continue into the foreseeable future.

10.3) Survival and fecundity
The fecundity of each female used as brood stock will be determined gravimetrically (see SECTION 7, part 7.3 Fertilization, for a description of how fecundity is calculated at spawning. The eggs from each female are incubated separately from one another and so it is possible to calculate another fecundity estimate at eyeing after the eggs have been shocked. First, all unfertilized or aborted eggs are removed and counted. Then the entire remaining egg mass is weighed to the nearest tenth of a gram after excess water has been removed by placing the eggs in a plastic colander. Prior to placing the eggs in the colander the balance is tared to zero, after the egg mass has been weighed the colander is re-weighed, if the balance registers more than zero, this extra weight, caused by water residue, is subtracted from the egg mass weight. Next, five samples of approximately 20 to 30 eggs are weighed to the nearest one-hundredth of a gram. The number of eggs in each sample is hand counted twice to ensure that an accurate count has been made. Moreover, the weighing boat used for each sample is re-weighed and the weight of any water residue adhering to it is subtracted from the sample weight. These small egg samples provide estimates of a mean eyed egg weight for each female. The total egg mass weight is divided by these estimates and five independent fecundity values are then calculated for each female. A mean fecundity value with a 95% confidence interval calculated for each female and this mean value then becomes the final fecundity estimate for each female.

Relationships between female size (length and weight) and fecundity for individuals maturing at the same age (3, 4, and 5) have not yet been developed for Grays River chum salmon. However, an overall mean fecundity value for females maturing at each of these ages has been calculated from information gathered on the females spawned in 1998 (Table 7). Note that seven females were excluded from this data set. Their reproductive effort ((egg mass weight/total body weight))(100) values indicated that they had spawned at least once prior to being captured. Additional fecundity and reproductive data will be collected on each female used as brood stock throughout the duration of this program.

10.3.2) Survival

a) Collection to spawning

Any losses of brood stock will be recorded. Our goal is to achieve at least a 95% survival rate in the collected brood stock. To reach that goal, each adult is held in its own individual holding tube to protect it from repeated handling and to reduce holding stress.

b) Green eggs to eyed eggs

Survival to the eyed-stage of development is calculated for each female. This is accomplished by dividing the number of dead or aborted eggs found after shocking at the eyed stage by the female’s estimated fecundity. A goal of 92% is the survival standard for this stage in the life cycle.

c) Eyed eggs to release

A survival estimate from eyeing to yolk absorption is calculated in a manner similar to that for green eggs to eyed eggs. At yolk absorption or ponding, the number of dead eggs, alevins and monstrosities produced by each female is counted. This value is then divided by the number of viable eggs each female had at the eyed stage of development to produce an eyed-egg to fry survival rate. The incidence of different types of monstrosities, e.g. scoliosis, twins, bent spines, albinos, mosaics, abnormal fins, and so on, in each female is recorded. In-culture mortality is not calculated for each female. However, each raceway is checked and mortalities are removed and counted on a daily basis. Since we have an estimate of the number of fry placed into each raceway it is possible to determine the mortality of these fish by dividing the number of mortalities observed during the rearing period by the number of fry that were introduced into a raceway. Rearing mortalities at Grays River and Sea Resources typically are less than 1%.

d) Release to adult, to include contribution to:

(i) harvest

Few chum salmon are expected to be harvested even incidentally. As mentioned earlier, the commercial catch of chum salmon in the Columbia River continues to remain low. Nineteen ninety-eight marked the sixth consecutive year when less than one hundred chum were harvested in the river. Generally, chum salmon enter the river in late October, after the commercial gill net seasons have ended (Keller 1999).

(ii) hatchery brood stock

See SECTION 2, part 2.2.3 for a description of how thermal marks will be used to estimate the fry-to-adult survival rates of cultured chum salmon juveniles.

(iii) natural spawning

As part of our effort to evaluate the survival of hatchery-origin chum salmon in the Grays River, stream surveys and collection of otoliths from chum carcasses will occur. These will be decoded and the distribution and abundance of naturally spawning hatchery-origin chum salmon will be calculated on a yearly basis.

10. 4 Monitoring of performance indicators in Section 1.8

Monitoring and Evaluation Objectives

Objective 1: Determine if other genetic enclaves of chum salmon exist in Lower

Columbia River tributaries and if so, implement site-specific recovery efforts for these populations.

Objective 2: Stabilize the Grays River chum salmon population by using the Grays River Hatchery as a protected location for incubation and fry production. Collect enough adults to maintain an appropriate effective population size (40 or more pairs)

Objective 3: Ensure that the survival of brood stock prior to spawning is at least 95% and that their offspring experience expected survival benefits from being sequestered in a hatchery environment. In addition, transplant a portion of each produced family to the Chinook basin in order to establish native Lower Columbia River chum salmon into another river basin. Evaluate the fry-to-adult survival of released fish and compare biological characteristics of hatchery-origin adults to natural-origin cohorts to evaluate domestication effects.

Objective 4: Place distinctive marks on the otoliths of every cultured fish released into the Grays and Chinook River. Ensure that these marks are linked to particular release locations and strategies so that their effects on adult survival can be evaluated.

Monitoring and evaluation tasks that should be completed to meet the above objectives:

Objective 1: Determine if other genetic enclaves of chum salmon exist in Lower Columbia River tributaries and if so to implement site-specific recovery efforts for these populations.

Task 1.1 Conduct annual in-stream surveys of Lower Columbia tributaries beginning in mid-October and continuing through December

Task 1.2 When chum salmon are located use GPS units and local maps to locate and document their spatial and temporal distribution

Task 1.3 Perform a habitat evaluation of each surveyed watershed, determine if ground water sources are available and also document any side channels or other areas where controlled spawning areas could be developed and monitored.

Task 1.4 Collect biological data (scales, GSI and DNA samples) on all available chum salmon carcasses

Task 1.5 Produce annual reports that describe the results of the above surveys and prioritize those populations and areas that should receive supplementation, recovery, or re-introduction efforts.

Task 1.6 Identify which existing populations of chum salmon would be the best potential donor populations for streams which have extirpated populations of chum salmon

Task 1.7 Develop site-specific habitat restoration plans for each location where chum salmon recovery is planned.

Objective 2: Stabilize the Grays River chum salmon population by using the Grays River Hatchery as a protected location for incubation and fry production. Collect enough adults to maintain an appropriate effective population size (40 or more pairs)

Task 2.1 Install on an annual basis an adult collection trap and weir at the mouth of Gorley Springs. From 2000 on use seines and other gear to collect chum salmon throughout Grays River.

Task 2.2 Maintain the adult trap and randomly collect brood stock from the returning adults. From 2000 on, seines and other fishing gear was used to collect a representative sample of adult chum salmon returning to the Grays River

Task 2.3 Collect at least 40 pairs but not more than 200 pairs for brood stocking purposes

Task 2.4 Spawn, incubate and rear some of the offspring produced from each artificially produced family at the Grays River Hatchery and release the subsequent juveniles into the Grays River during mid March through mid April during darkness.

Objective 3: Ensure that the survival of brood stock prior to spawning is at least 95% and that their offspring experience expected survival benefits from being sequestered in a hatchery environment. In addition, transplant a portion of each produced family to the Chinook basin in order to establish a native Lower Columbia River chum salmon into another river basin. Evaluate the fry-to-adult survival of released fish and compare biological characteristics of hatchery-origin adults to natural-origin cohorts to evaluate domestication effects.

Task 3.1 Place all collected brood stock fish into their own holding tube, provide them with optimal water exchange and saturated oxygen levels, routinely check for maturity, return surplus fish within two to three days of capture, spawn the fish when ripe. Evaluate the survival of collected adults and make necessary changes to holding protocols if mortalities occur.

Task 3.2 Monitor the survival of collected gametes from the green egg-to-eyed egg, eyed egg-to-fry, and fry-to-release stages. Ensure that the program's survival standards have been met, modify operational procedures if mortality exceeds standards.

Task 3.3 At the eyed stage of development remove a portion of eggs from each family and place them in a separate incubation tray so that they can be transported to the Sea Resources Hatchery. In 2002 this practice was ended. Since then fertilized eggs from chum salmon returning to the Chinook River have been incubated in separate Heath Trays in the Grays River Hatchery

Task 3.4 Establish portable fiberglass rearing raceways at the Sea Resources Hatchery and develop an operations plan designed to improve the infra-structure of the hatchery

Task 3.5 Via stream survey work in the Grays and Chinook River basins, collect otoliths from adult chum salmon and decode these specimens to determine if they originated from our recovery/re-introduction program.

Task 3.6 When chum salmon return to the Chinook River basin, capture and spawn up to 160 pairs and rear and release their offspring back into the Chinook River in an effort to expedite the development of a locally adapted population.

Task 3.7 Compare biological data (e.g. egg size, reproductive effort, fecundity relationships, occurrence of various monstrosities, gamete viability, etc.) collected from hatchery-origin and natural-origin adult chum salmon and their offspring to evaluate any domestication effects.

Objective 4: Place distinctive marks on the otoliths of every cultured fish released into the Grays and Chinook River. Ensure that these marks are linked to particular release locations and strategies so that the effects of each on adult survival can be evaluated.

Task 4.1 Install, calibrate, and monitor portable water chilling equipment at the Grays River Hatchery. When appropriate, install similar equipment at the Sea Resources Hatchery so that eggs and alevins incubated at that location can be thermally marked.

Task 4.2 Develop thermal mark codes using the 2 of 5 rule to produce distinctive thermal marks on the distinct groups of chum salmon being incubated at the Grays River Hatchery

Task 4.3 Begin marking one to two days after picking eyed eggs and continue the marking process until yolk absorption is almost complete.

Task 4.4 At the end of the marking period, collect ten specimens from each marking group and examine their otoliths to verify the code that was established for that group (voucher samples)

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

Monetary support for the work described here is mainly coming from funds provided to WDFW from the State Legislature. Significant contributions will also come from Sea Resources. Additional funds are needed, however, to carry out the stream survey work, and to help improve the infra-structure at the Sea Resources Hatchery. At present it is uncertain where these dollars will come from.

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

Monitoring, evaluation and research follow scientific protocols with adaptive management process if needed. WDFW will take risk aversion measures to eliminate or reduce ecological effects, injury, or mortality as a result of monitoring activities. Most trap mortalities are the result of extreme environmental conditions that flood traps or equipment failure. WDFW will take precautions to make sure the equipment is properly functioning during the season. If environmental conditions are forecast that will cause high mortality then traps will be removed or opened up to allow unobstructed passage without mortality. Any take associated with monitoring activities is unknown but all follow scientific protocols designed to minimize impact.

Section 12. Research

12.1 Objective or purpose.

Research programs associated with this HGMP are described in the monitoring and evaluation sections above. Research will be directed at determining whether this recovery/re-introduction program is successfully maintaining or increasing chum salmon abundance in the Grays River and introducing a new self-sustaining population of chum salmon into the Chinook basin.

12.2 Cooperating and funding agencies.

Washington Department of Fish and Wildlife

** Sea Resources Inc.

U.S. Fish & Wildlife Service

12.3 Principle investigator or project supervisor and staff.

NA

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

NA

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

NA

12.6 Dates or time periods in which research activity occurs.

NA

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

NA

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

NA

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).

NA

12.10 Alternative methods to achieve project objects.

NA

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

NA

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.

NA

Section 13. Attachments and Citations

13.1 Attachments and Citations

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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:_____________

Take Table 1. Estimated listed salmonid take levels by hatchery activity.

Chum Salmon

ESU/Population	Lower Columbia River Chum
Activity	Fall Chum Restoration Program
Location of hatchery activity	Grays River and Sea Resources Hatcheries
Dates of activity	Sept-April
Hatchery Program Operator	WDFW, Sea Resources

Type of Take	Annual Take of Listed Fish by life Stage (number of fish)			
	Egg/Fry	Juvenile/Smolt	Adult	Carcass
Observe or harrass (a)	nya	nya	nya	nya
Collect for transport (b)	nya	nya	nya	nya
Capture, handle, and release (c)				nya
Capture, handle, tag/mark/tissue sample, and release (d)	nya	nya	nya	nya
Removal (e.g., brookstock (e)	100,000 – 450,000	100,000 – 450,000	100- 400	nya
Intentional lethal take (f)	nya	nya	100-400	nya
Unintentional lethal take (g)	10,000 – 40,000	10,000 – 40,000		nya
Other take (specify) (h)	nya	nya	nya	nya

a. Contact with listed fish through stream surveys, carcass and mark recovery projects, or migrational delay at weirs.
b. Take associated with weir or trapping operations where listed fish are captured and transported for release.
c. Take associated with weir or trapping operations where listed fish are captured, handled and released upstream or downstream.
d. Take occurring due to tagging and/or bio-sampling of fish collected through trapping operations prior to upstream or downstream release, or through carcass recovery programs.
e. Listed fish removed from the wild and collected for use as broodstock.
f. Intentional mortality of listed fish, usually as a result of spawning as broodstock.
g. Unintentional mortality of listed fish, including loss of fish during transport or holding prior to spawning or prior to release into the wild, or, for integrated programs, mortalities during incubation and rearing.
h. Other takes not identified above as a category.