HATCHERY AND GENETIC MANAGEMENT PLAN
FOR
IRON GATE HATCHERY COHO SALMON

Prepared for:

National Oceanic and Atmospheric Administration

National Marine Fisheries Service

Arcata, California

Prepared by:

California Department of Fish and Wildlife

Northern Region

&

PacifiCorp

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LIST OF ACRONYMS

AD	Adipose fin-clip
BW	Body Weight
CDFW	California Department of Fish and Wildlife
CFS	Cubic Feet per Second
CHSRG	California Hatchery Scientific Review Group
ESA	Federal Endangered Species Act
ESU	Evolutionarily Significant Unit
FDA	Federal Food and Drug Administration
FPP	Fish per Pound
FERC	Federal Energy Regulatory Commission
GIS	Geographic Information System
GPD	Grams per Day
GPM	Gallons per Minute
HSRG	Hatchery Scientific Review Group
HSRP	Hatchery Scientific Review Panel
HCP	Habitat Conservation Plan
HGMP	Hatchery and Genetic Management Plan
HOR	Hatchery Origin
HOS	Hatchery Origin Spawner
ICP	Interim Conservation Plan
IGH	Iron Gate Hatchery
KBRA	Klamath Basin Restoration Agreement
KHSA	Klamath Hydroelectric Settlement Agreement
KRTF	Klamath River Task Force
LM	Left Maxillary-clip
MGD	Million Gallons per Day
ML	Milliliters
MM	Millimeters
mtDNA	Mitochondrial DNA
NCRWQCB	North Coast Regional Water Quality Control Board

NMFS	National Marine Fisheries Service
NOAA	National Oceanic Atmospheric Administration
NOR	Natural Origin
NOS	Natural Origin Spawner
NPDES	National Pollutant Discharge Elimination System
PFMC	Pacific Fisheries Management Council
pHOS	Proportion Hatchery Origin Spawners
pNOB	Proportion Natural Origin Broodstock
PNI	Proportionate Natural Influence
PPM	Parts per Million
RM	Right maxillary-clip
RWQCB	Regional Water Quality Control Board
SAR	Smolt-to-adult ratio
SONCC	Southern Oregon/Northern California Coast (ESU)
USFWS	United States Fish and Wildlife Service
TRH	Trinity River Hatchery
TRT	Technical Recovery Team
VSP	Viable Salmonid Population
YOY	Young-of-the-year

EXECUTIVE SUMMARY

The California Department of Fish and Wildlife (CDFW) is applying for an Endangered Species Act (ESA) Section 10(a)(1)(A) permit the for Iron Gate Hatchery (IGH) coho salmon program. The ESA Section 10 application incorporates a Hatchery and Genetic Management Plan (HGMP) developed by CDFW and PacifiCorp Energy (PacifiCorp). The National Marine Fisheries Service (NMFS) will use the information in this HGMP to evaluate hatchery impacts on salmon and steelhead listed under the ESA. The primary goal of an HGMP is to devise biologically-based hatchery management strategies that ensure the conservation and recovery of salmon and steelhead species (http://www.nwr.noaa.gov/Salmon-Harvest Hatcheries/Hatcheries/HGMPs.cfm). Through implementation of this HGMP, and the ESA Section 10 permit, the Iron Gate Hatchery coho salmon program will be operated to conserve listed species, namely coho salmon. The HGMP is built around the principles and recommendations of the Hatchery Scientific Review Group (HSRG) and more recently, the California Hatchery Scientific Review Group (CHSRG) recommended that the draft HGMP for the coho program should be approved and implemented. These principles and recommendations represent the best science available for operating hatchery facilities consistent with the conservation of salmonid species.

This HGMP covers activities related to the artificial production of coho salmon at IGH for the period 2014-2024. This includes the interim period until mainstem Klamath River dams of the Klamath Hydroelectric Project (Federal Energy Regulatory Commission Project No. 2082) are anticipated to be removed (2020) pursuant to the Klamath Hydroelectric Settlement Agreement (KHSA) and a new HGMP would be developed for any new or revised programs at IGH or other hatchery facilities in the area. The potential removal of Iron Gate Dam (IGD) would eliminate the current cold-water source for IGH and will likely create a situation in which salmon and steelhead can no longer be produced at this facility. Continuation of artificial production of coho salmon following removal of IGH will depend on whether future studies identified in the KHSA identify a viable alternative source of water. After 2020, it may be necessary to maintain hatchery production elsewhere in the basin. The measures and facilities necessary for ongoing coho salmon production following potential removal of Iron Gate dam are uncertain and the subject of ongoing study. However, based upon the results of these ongoing studies, and the development of reintroduction plans associated with anticipated removal of the mainstem Klamath River dams, this HGMP may be amended in the future to ensure hatchery operations during the term of the HGMP are consistent with the most current plans for species conservation and reintroduction efforts. It's useful to consider future hatchery operations to provide context for present day management actions. The hatchery program could provide opportunities for coho re-colonization in the Klamath River, and could facilitate local adaptation of coho populations to the environment. The criteria for determining changes to ongoing hatchery operations will be based on time and natural origin (NOR) run-size to Upper

Klamath Population Unit (upstream from Portuguese Creek to Spencer Creek) tributaries and mainstem habitat. This type of an adaptive management approach has been described in the alternatives analysis included with this HGMP. Ongoing hatchery operations goals beyond 2020 are anticipated to be adjusted by CDFW and NMFS, and will be based upon reintroduction strategies and available hatchery facilities.

Although IGH is currently operated as a mitigation hatchery to compensate for habitat blocked between IGD and the Copco developments, a conservation focus for the coho salmon program has been deemed necessary to protect the remaining genetic resources of the Upper Klamath coho salmon Population Unit. Recent adult coho returns to this population (and to the entire Klamath River) have been decreasing over time to the point where less than 55 fish returned to the hatchery and the largest tributary in this population unit (Bogus Creek) in 2009.

During the term of the ESA Section 10 permit the coho salmon program will be operated to protect and conserve the genetic resources of the Upper Klamath Population Unit. As natural coho salmon production increases over time, due to the implementation of habitat and other recovery actions, it is expected that the program will be operated as an "integrated type" program, as defined by the HSRG. A hatchery program is an "integrated type" if the intent is for the natural environment to drive the adaptation and fitness of a composite population of fish that spawns both in a hatchery and in the wild. As noted previously, the focus of the hatchery will be to conserve the genetic resources of the Upper Klamath Population Unit, which is part of the Southern Oregon Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU). Because SONCC coho salmon are listed as "threatened" under the ESA, NMFS refers to a hatchery that operates in this manner as an Integrated Recovery program.

This HGMP was developed based in part on the key findings of an alternatives analysis for the existing coho program, which are as follows:

1. Based on the data available, natural abundance (wild coho salmon only) of the Upper Klamath Population Unit is below the high risk abundance level (425) established by NMFS.

2. Adult coho salmon natural production needs to be increased to reduce demographic and life history diversity risks to the population unit.

3. Hatchery operations need to strike a balance between genetic and demographic risk to the combined (hatchery origin and natural origin) coho salmon population.

4. Habitat quality and quantity need substantial improvement to maintain natural coho salmon production in the basin.

Based on these findings, the IGH coho salmon program will be modified with a conservation focus, wherein hatchery production is used to protect the genetic resources of the Upper Klamath Population Unit until habitat conditions improve. Habitat improvement and research actions have been implemented as part of PacifiCorp's Interim Conservation Plan (ICP; PacifiCorp 2008) and are currently being implemented as part of PacifiCorp's Coho salmon Habitat Conservation Plan (HCP;PacifiCorp 2012). Other habitat improvement and research actions are also ongoing under the direction of the CDFW, the U.S. Fish and Wildlife Service (USFWS), NMFS, and Klamath basin Tribes. Hatchery management under this HGMP, conservation actions under the HCP, and other ongoing initiatives, will be coordinated to maximize the conservation benefits of existing programs.

The IGH program will operate in support of the basin's coho salmon recovery efforts by conserving a full range of the existing genetic, phenotypic, behavioral, life history and ecological diversity of the run. The program will include conservation measures, genetic analysis, and rearing and release techniques that will improve fitness and reduce straying of hatchery fish to natural spawning areas. CDFW and PacifiCorp will use adaptive management to respond to changes in coho salmon populations over time.

An active broodstock management plan, based on real-time genetic analysis, will be implemented each year to reduce inbreeding. Additionally, the total hatchery spawning population will consist of up to 50 percent natural origin coho to increase population diversity and fitness.

In accordance with applicable regulations, monitoring and evaluation activities in the ESA Section 10 permit and this HGMP are focused on ensuring that the performance standards and indicators identified for the program are achieved, and that critical uncertainties are addressed.

The first uncertainty needing resolution is the total number of naturally produced adult coho salmon present in the Upper Klamath Population Unit. While data are available on coho salmon abundance in the mainstem Klamath River and Bogus Creek, abundance information is limited for the approximately 112 kilometers of habitat present in smaller tributary streams associated with the Upper Klamath Population Unit. Without this demographic information it is difficult to properly manage the population or determine the risk the hatchery program poses to coho salmon populations in these streams. This information will be collected through the use of spawning and carcass surveys conducted by CDFW or PacifiCorp.

The second uncertainty is the reproductive success of hatchery and natural origin coho salmon spawning in the wild. Hatchery coho salmon spawning naturally with wild coho salmon may reduce the overall fitness of the wild component, resulting in decreased survival and population productivity. These data will be collected through the implementation of an adult genetic monitoring program in natal streams. Until these data become available, the risks associated with hatchery coho salmon spawning naturally will be addressed by controlling the proportion of hatchery coho salmon that enter Bogus Creek, and by incorporating natural origin coho salmon into the hatchery broodstock. These actions will ensure that the two components of the population (hatchery and natural) have similar genetic and physiological traits.

Hatchery culture practices will be improved to increase egg-to-smolt survival rates. The increase in survival will be achieved by improving egg incubation conditions and covering raceways with netting (completed in 2011) to reduce bird predation on juveniles. Egg incubation conditions will be investigated to identify measures that will further improve survival. These actions may include 1) changes to incubation methods, 2) improvements in egg rearing water quality, 3) filtering organic matter from the water source, 4) using moist-air incubation, 5) decreasing egg density in incubation trays, and 6) modifying coho salmon spawning protocol when using spawning matrix to insure milt is viable.

1.0 GENERAL PROGRAM DESCRIPTION

1.1 NAME OF HATCHERY PROGRAM

Iron Gate Coho Salmon Program

1.2 SPECIES AND POPULATION UNDER PROPOGATION AND ESA STATUS

Coho salmon (*Oncorhynchus kisutch*) propagated at IGH are part of the Southern Oregon/Northern California Coast (SONCC) Evolutionary Significant Unit (ESU). The SONCC ESU includes all coho salmon populations from Cape Blanco, Oregon to Punta Gorda, California. On May 6, 1997, the National Marine Fisheries Service (NMFS) published the final rule establishing a threatened status for coho salmon in the SONCC ESU (62 Fed. Reg.24588). At the time of this listing determination, NMFS excluded hatchery stocks from the listing because artificially produced coho salmon were considered to be non-essential for recovery of the listed species. NMFS subsequently proposed status review updates for 26 listed ESUs (67 Fed. Reg. 79899; December 31, 2001). Thereafter, on June 28, 2005, NMFS promulgated final listing determinations for 16 salmon ESUs, including the SONCC ESU (70 Fed. Reg. 37160). The SONCC listing included coho salmon produced at IGH, Trinity River Hatchery (TRH) and Cole M. Rivers Hatchery (CRH) as part of the ESU.

The California Fish and Game Commission also listed coho salmon as a threatened species pursuant to the California Endangered Species Act within the California portion of the SONCC coho salmon ESU on March 30, 2005.

1.3 RESPONSIBLE ORGANIZATION AND INDIVIDUALS

<u>Statewide Fisheries Program Branch</u>

Name and Title:	Stafford Lehr, Branch Chief, Fisheries Branch
Agency or Tribe:	California Department of Fish and Wildlife (CDFW)
Address	830 S Street
	Sacramento, CA 95811
Telephone:	(916) 445-3181
Fax:	(916) 327-8854
Email:	slehr@wildlife.ca.gov

<u>Northern Region (Region 1) Manager</u>

Name and Title:	Neil Manji, Regional Manager
Agency or Tribe:	California Department of Fish and Wildlife (CDFW)
Address	601 Locust Street
	Redding, CA 96001
Telephone:	(530) 225-2363
Fax:	(530) 225-2381
Email:	neil.manji@wildlife.ca.gov

<u>Northern Region Fisheries Project Leader</u>

Name and Title:	Curtis Milliron, Fisheries Program Manager
Agency or Tribe:	California Department of Fish and Wildlife
Address:	601 Locust Street
	Redding, CA 96001
Telephone:	(530) 225-2280
Fax:	(530) 225-2381
Email:	cmilliron@wildlife.ca.gov

<u>Northern Region Hatchery Program Supervisor</u>

Name and Title:	Linda Radford, Senior Hatchery Supervisor
Agency or Tribe:	California Department of Fish and Wildlife
Address:	601 Locust Street
	Redding, CA 96001

Telephone:	(530) 225-2369
Fax:	(530) 225-2381
Email:	lradford@wildlife.ca.gov

Iron Gate Hatchery Management

Name and Title:	Keith Pomeroy, Fish Hatchery Manager II
Agency or Tribe:	California Department of Fish and Wildlife
	Northern Region
Address:	8638 Lakeview Road
	Hornbrook, CA 96044
Telephone:	(530) 475-3420
Fax:	(530) 475-0421
Email:	kpomeroy@wildlife.ca.gov

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

Pursuant to agreements with NMFS and CDFW, PacifiCorp has agreed to fund the development and implementation of the HGMP by CDFW. PacifiCorp's actions in support of this HGMP are thus described in this HGMP and included in the associated application for a permit under ESA section 10(a) (1) (A).

1.4 FUNDING SOURCE, STAFFING LEVEL, AND ANNUAL HATCHERY PROGRAM OPERATIONAL COSTS

The hatchery employs seven permanent positions, which include a Fish Hatchery Manager II, Fish Hatchery Manager I, Office Technician, Fish and Wildlife Technicians (4) and seasonal personnel when funds are available. The 2010 operating budget for IGH was ~ $1.2 million.

PacifiCorp constructed IGH and historically supplied 80 percent of the annual operating cost. The CDFW contributed 20 percent of the annual budget to support the hatchery operation and fund the salmon and steelhead yearling production programs. Starting in 2010, PacifiCorp began funding 100 percent of the hatchery operations pursuant to the KHSA.

1.5 LOCATION(S) OF HATCHERY AND ASSOCIATED FACILITIES

IGH is located on Copco Road, approximately eight miles east of Hornbrook, Siskiyou County, California (Figure 1). Global positioning systems (GPS) coordinates for IGH are 41.93324 North and 122.43572 West. The primary spawning facility is located at the base of IGD (a 173-foot earthen dam) at River kilometer (Rkm) 306 (River mile 190.1). This facility includes a fish ladder consisting of 20 ten-foot weir-pools that terminates in a trap, a spawning building and six 30-foot circular holding ponds. The main hatchery is located about ½ mile downstream from the dam and consists of three buildings; office, hatchery and shop, eight concrete raceways consisting of four 100 foot ponds each, four employee residences, as well as an eight-step auxiliary fish ladder and trap adjacent to the hatchery rearing ponds (near Bogus Creek).

1.6 PROGRAM TYPE

During the term of this HGMP (2014-2024) the program will function as an *integrated recovery program*. An integrated recovery program is defined as an artificial propagation project primarily designed to aid in the recovery, conservation or reintroduction of particular natural population(s), and the fish produced are intended to spawn in the wild or be genetically integrated with the targeted natural population(s) (NMFS 2002). Performance standards for the program will be based on those developed for an integrated type program as defined by the Hatchery Scientific Review Group (HSRG 2004A).

1.7 PROGRAM PURPOSE

The purpose of the program is to aid in the conservation and recovery of the Upper Klamath Population Unit by conserving genetic resources and reducing short-term extinction risks prior to future restoration of fish passage above IGD.

This conservation and recovery program has been incorporated as part of a suite of mitigation actions listed in the current Federal Energy Regulatory Commission (FERC) license for PacifiCorp's Klamath Hydroelectric Project (FERC Project No. 2082), under PacifiCorp's Interim Conservation Plan (ICP) (PacifiCorp 2008)**,** and Coho salmon Habitat Conservation Plan (PacifiCorp 2012)**.** Under future restoration scenarios the responsible parties will modify the program to meet the continuing recovery needs and mitigation responsibilities related to potential losses associated with the operations and maintenance of the PacifiCorp hydroelectric project.

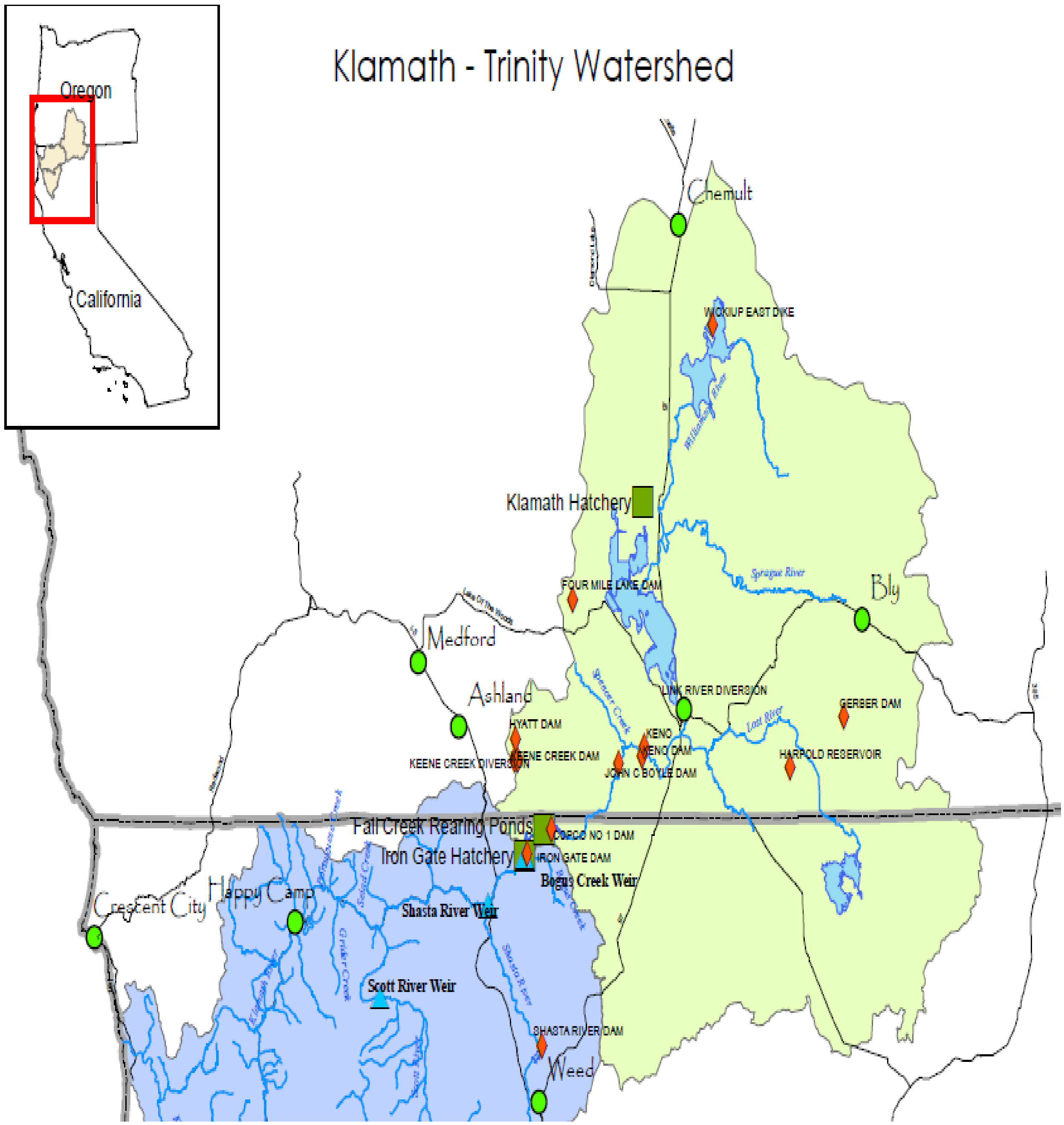


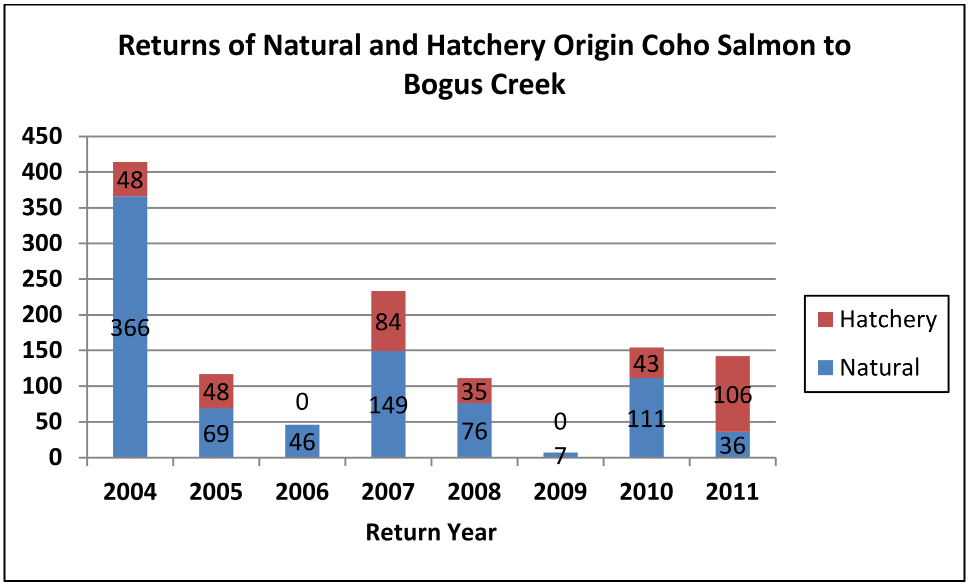
Figure 1. Map of the Klamath River Basin showing the location of Iron Gate Hatchery (at Iron Gate)

1.8 PROGRAM JUSTIFICATION

The justification for this integrated recovery program is based on the current and future needs of the population. In theory, a conservation and recovery program is intended to reduce the risk of extinction for naturally spawning coho salmon in the Upper Klamath Population Unit and to conserve the genetic variability of the population for purposes of maintaining its viability and adaptability. Adult coho salmon returns to the Upper Klamath Population Unit (and to the entire Klamath River) have generally been declining over time. This decrease in run size is evident from the coho salmon escapement data presented in Figure 2 for Bogus Creek (the tributary immediately downstream of IGH), and Figure 3 for IGH[1].

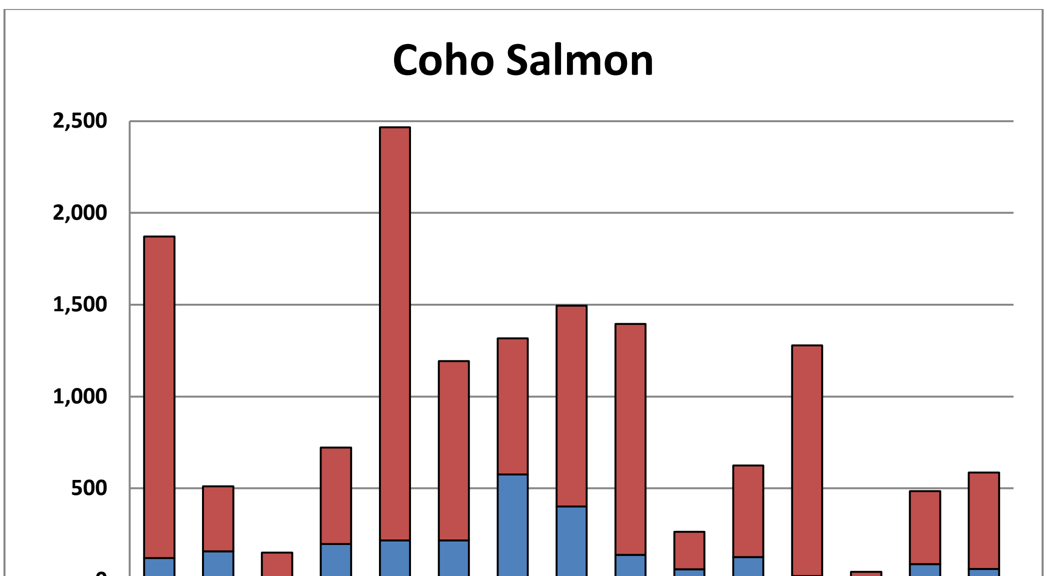
Based on available information, Bogus Creek coho represent the largest naturally spawning population in the Upper Klamath Population Unit. However, hatchery origin strays into Bogus Creek have constituted on average, about 28 percent of the escapement (Figure 2). This level of straying by hatchery coho salmon typically occurs in streams in close proximity to a hatchery. Based on the declining adult escapement data, it appears that habitat conditions are likely insufficient to maintain this population over time, thus justifying the need for a hatchery program to conserve the remaining genetic resources of the coho salmon population and reduce short-term extinction risks.

[1] Coho salmon have also been observed spawning in Seiad Creek. The average number of coho redds observed from 2007-2009 in this stream was 8.3 (Corum R.A. 2010. Draft Middle Klamath Tributary Coho Spawning Survey Report)



*- Although there is a longer record for total returns to IGH, accurate returns for Bogus Creek extend back only to 2004. Hatchery composition in Bogus Creek for 2009 is uncertain as only 1 fish was collected on the spawning grounds.

Figure 2. Total hatchery and natural origin coho returns to Bogus Creek (2004-2011) (CDFW data files)*.



	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
HOR	1751	354	139	525	2249	977	742	1094	1257	203	499	1256	35	398	525
NOR	121	157	12	198	217	216	575	401	138	60	126	22	11	87	61

*** -** Note that in 2009, 11 of the 46 coho were from the Trinity River hatchery.

Figure 3. Adult coho returns to IGH 1997 to 2011 (CDFW data files)*.

The proposed program was developed based on the key findings of the alternatives analysis conducted for IGH coho salmon. These findings are summarized below and presented in detail in Appendix A.

Key Findings:

1. Natural abundance of the Upper Klamath Population Unit is below (~200) the high risk (depensation) abundance level (425) established by NMFS (Williams et al. 2008). The depensation thresholds identify densities at which populations are at heightened risk of a reduction in per capita growth rate[2]. However, this estimate includes areas upstream of IGD that are currently not assessable to coho salmon.

2. Overall, if a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction (Williams et al. 2008). Adult coho salmon natural production needs to be increased to reduce demographic risks to the population.

3. Hatchery operations need to strike a balance between genetic and demographic risk to the combined (hatchery origin and natural origin) coho salmon population.

4. Habitat quality and quantity need substantial improvement to maintain natural coho salmon production in the basin.

[2] There is considerable uncertainty as to coho abundance levels in the Upper Klamath Population Unit (Yurok Tribe comments on draft IGH Coho HGMP, 2010). However, based on the data available, it appears that in 2009 natural coho salmon abundance was less than the 425 depensation threshold for the Upper Klamath River population.

Based on these findings, the hatchery program will enhance or benefit the survival of the listed natural population (integrated recovery program) by:

1. Supporting the basin's coho salmon recovery effort by conserving a full range of the existing genetic, phenotypic, behavioral and ecological diversity of the run. The program will include conservation measures, genetic analysis, and rearing and release techniques that maximize fitness and reduce straying of hatchery fish to natural spawning areas (CDFW 2004).

2. Aiding in the recovery of the population by reducing demographic risks to the naturally spawning sub-populations that appears to be below depensation levels.

3. Maintaining productivity of the population so that it can benefit from future restoration of fish passage to approximately 92.8 river km of habitat upstream of IGD.

In conjunction with hatchery production, and to achieve the long-term recovery of the species, habitat and research actions are currently being implemented as part PacifiCorp's ICP and HCP, NMFS Federal Recovery efforts, as well as other local and regional initiatives under the direction of state and federal agencies, basin Tribes, and local watershed groups. The implementation of the HGMP will be in coordination and cooperation with these groups and their efforts.

This HGMP contemplates that the hatchery conservation actions may be implemented in distinct phases (Appendix A). The first phase of the HGMP will focus on protecting the genetic resources of the Upper Klamath Population Unit. In subsequent phases, the hatchery program could provide opportunities for coho salmon re-colonization and facilitate local adaptation of coho salmon populations to the new environment. The criteria for moving between phases will be based on time and natural origin (NOR) run-size in Upper Klamath Population Unit tributaries and mainstem habitat. Under the KHSA, PacifiCorp is obligated to fund continued hatchery operations for a period of 8 years after potential removal of IGD. Revised hatchery management goals and strategies will be developed by CDFW and NMFS in response to reintroduction of coho to habitat above IGD (KHSA 2010). At that time it is expected that a new HGMP would be developed for any new or revised programs at Iron Gate or other hatchery facilities in the area.

Although this HGMP only covers the period from 2014-2024, a longer-term hatchery strategy is contemplated to assist in the recovery of Klamath River coho salmon. Thus, descriptions of the actions that may be implemented in all three phases are provided below with conceptual information provided in later phases due to uncertainty regarding the future of the IGH following the anticipated removal of IGD pursuant to the Klamath Hydroelectric Settlement Agreement (KHSA). Under the KHSA, PacifiCorp is obligated to fund continued hatchery operations for a period of 8 years after potential removal of IGD. Revised hatchery management goals and strategies will be developed by CDFW and NMFS in response to reintroduction of coho to habitat above IGD (KHSA 2010).

1.8.1 Phase 1 (2014-2024)

In Phase 1 (Table 1), the hatchery program will focus on protecting genetic resources of the population. Hatchery origin (HOR) and all natural origin (NOR) coho salmon adults returning to the hatchery may be used for broodstock. Coho salmon in excess to hatchery broodstock needs may be released back to the river or euthanized if necessary in order to keep controls on the HOR percentages within the Klamath River. The decision to release the fish would be dependent on the strength of the population relative to depensation levels and research activities attempting to quantify total natural production and hatchery stray rates in natal spawning areas. The goal of this program is to achieve a proportionate natural influence (PNI) of greater than 0.5 over time as NOR abundance increases (HSRG 2004A). Major actions included in this phase are as follows:

- As needed to meet production goals, up to 270 adult coho salmon would be collected from hatchery facilities. To meet program goals, the broodstock would consist of between 20 to 50 % NOR coho salmon, which would allow for the achievement of a PNI > 0.5.
- A weir would be operated in Bogus Creek to safely collect additional broodstock (natural and/or hatchery origin) if adult returns to the hatchery are insufficient to meet the 75,000 yearling coho release target. No restrictions would be placed on the number of HOR adults spawning naturally for run-sizes to Bogus Creek of 309 NOR adult coho or less (Table 1)[3].
- Once the number of NORs entering Bogus Creek has exceeded 309 in a single year, the Bogus Creek weir will be operated to control the spawning composition (HOR and NOR) in Bogus Creek in subsequent years to maintain a properly integrated population following HSRG guidelines. The Bogus Creek weir would also be used to control spawning composition (HOR and NOR) in Bogus Creek itself.

[3] There are 15.46 Intrinsic Potential kilometers present in Bogus Creek and the 309 NOR target level based on the low risk spawner density of 20 fish/IP km as described in Williams et al. (2008). As more is learned on natural spawner abundance and genetic variability that currently exist within the entire Upper Klamath Population Unit, the target value and potential sources of NOR brood stock that could be integrated into the program will be evaluated to ensure that any genetic risks are reduced in balance with risk of demographic extinction. This decision would be made in concert with NMFS.

- A broodstock management program will be operated annually that relies on real-time genetic analysis to identify mating schemes that reduce the level of inbreeding occurring in the hatchery population.
- Hatchery practices will be improved to increase egg-to-smolt survival and reduce bird predation problems in raceways.
- Finally, actions identified in PacifiCorp's HCP, the Klamath Basin Restoration Agreement (KBRA) and other habitat plans will be implemented to improve habitat conditions for fish in the basin (KBRA 2010).

1.8.2 Phase 2

In Phase 2, it is envisioned that IGH, or other hatchery production facilities if IGH is no longer viable following potential dam removal, could provide fish needed for the re-colonization of habitat made available upstream of IGD from either dam removal or the implementation of fish passage above mainstem Klamath River dams as part of a new FERC license for the Project.

1.8.3 Phase 3

In Phase 3, hatchery management, if needed, may be altered to foster local adaptation of the population throughout the Upper Klamath Population Unit as well as provide fish for harvest.

A key assumption in bringing natural fish into the hatchery is that their survival and reproductive success (as measured by the number of returning adults produced by their offspring) is higher in the hatchery environment than in the wild. Data on recruits per spawner (R/S) for fish spawning in Bogus Creek versus the hatchery is shown in Figure 4. Hatchery R/S for these brood years has averaged 2.5 compared to a 0.4 value for Bogus Creek natural production. The hatchery has outperformed (higher R/S) natural production in four of the five years where data are available. It should be noted, that natural production has not been self-sustaining for four of these brood years, as indicated by R/S values less than 1.0.

Table 1. Phase 1 IGH hatchery coho program management (2014-2024).

IGH Coho Program	Time Period	Purpose	NOR Run-size to Bogus Creek	Natural Escapement	Broodstock Management	Size of hatchery program (yearling smolts)	Key Monitoring Activities
Phase 1	2014 To 2024	Integrated Recovery	0-309 (i.e. minimum escapement target)	All fish not used for broodstock may be returned to the Klamath River dependent on monitoring results for hatchery straying and natural fish abundance. All hatchery fish would be marked using a visually distinguishable tag* Managers to determine yearly the number of HOR spawning naturally	Use HORs and NORs returning to the hatchery. Jacks incorporated into brood Collect adults at Bogus Creek weir if returns to hatchery are insufficient to meet brood needs	75,000	Spawning and carcass surveys in all spawning areas associated with Upper Klamath Population Unit- quantify HOR and NOR abundance, collect genetic information via pedigree analysis. **

			>309 adults	All fish not used for broodstock may be returned to the Klamath River dependent on monitoring results for hatchery straying and natural fish abundance. All hatchery fish would be marked using a visually distinguishable tag* HOR escapement to Bogus Creek controlled to achieve the > 0.50 PNI criterion.	Sufficient NOR adults are incorporated to achieve 0.50 PNI criterion (PNI > 0.5) for combined hatchery/Bogus Creek population	75,000	

***-** A key assumption regarding the release of excess hatchery fish to the stream at abundances less than 309 is that demographic risks of low escapement exceeds genetic risks associated with having high pHOS (proportion of hatchery origin spawners in natural escapement).

**- A more detailed Pedigree study plan would be developed with CDFW and NMFS geneticists prior to conducting field work.

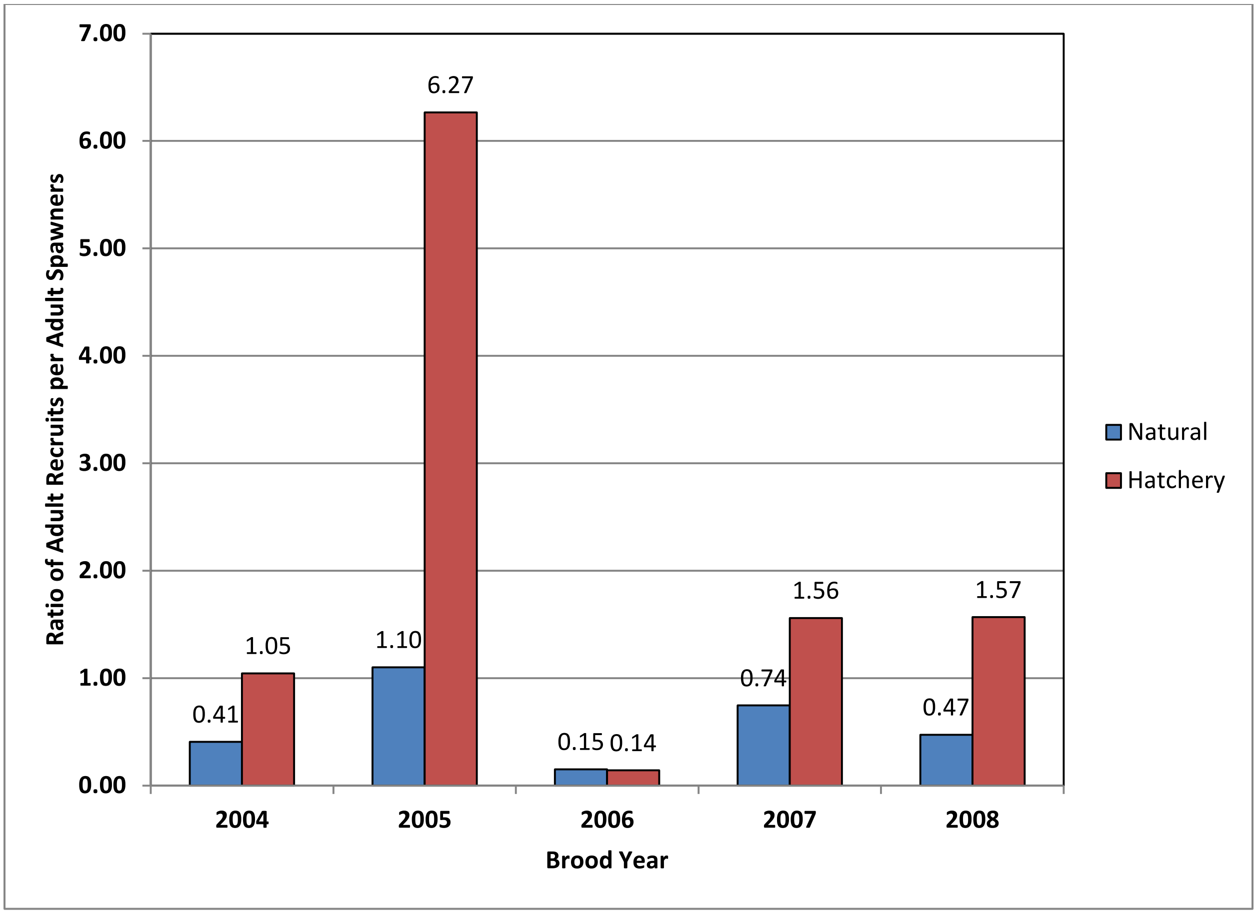


Figure 4. Ratio of adult recruit-per-adult spawner data for natural coho salmon population in Bogus Creek and hatchery coho salmon populations returning to IGH and Bogus Creek.

The Iron Gate R/S values are based on poor hatchery survival conditions that resulted in an average egg-to-smolt survival rate of 33 percent for brood years 2004 to 2006. Actions described later in this report are expected to increase this survival rate to greater than 60 percent and a goal of 80 percent. This reduces the number of spawners required to produce the same number of juveniles and should result in about a doubling of average R/S from 2.5 to 5.0 (approximate). If these improvements had been in place for past brood years, hatchery R/S would have been higher than natural R/S in all five years examined. Thus, the available data indicate that an assumption of increased survival and higher R/S for fish spawned in the hatchery is supported.

The decision not to control the proportion of hatchery-origin coho salmon spawning naturally at run-size less than 309 to Bogus Creek is based on the assumption that at this level of escapement, demographic risks for the population are higher than the genetic risks associated from hatchery influence. This value will be challenged yearly based on the results of genetic work proposed as part of the monitoring plan. CDFW geneticists will work closely with NMFS staff to better refine broodstock management for the Upper Klamath Population Unit. Additionally, the decision to release excess hatchery adults back to the natural environment to spawn will also be based on the results of the genetics work and spawning surveys designed to estimate the proportion of hatchery coho salmon spawning naturally (pHOS). If pHOS levels exceed identified targets, then excess hatchery fish may not be released back to the river.

1.9 LIST OF PERFORMANCE STANDARDS

The hatchery program will be operated to achieve performance standards as listed in Table 2. The program's annual Monitoring & Evaluation (M&E) Plan addresses this HGMP's performance standards through measurement of associated performance indicators (Table 3). Metrics for each of the indicators are discussed in the M&E section (Section 11) of this HGMP.

Table 2. IGH Coho program performance standards.

Performance Standard	**Definition**
Achieve Best Management Hatchery Practices	Culture practices developed by the CDFW to increase life-stage specific survival rates, protect the genetic resources of the cultured population, produce a high quality rearing environment, and achieve effluent discharge standards
Produce High Quality Smolts	High quality smolt is defined as having similar genetic, physical, behavioral traits and survival rates of naturally produced smolts.
Achieve Production Target(s)	Collect, culture and release the number of adults, eggs, and juveniles required to achieve yearly production targets
Achieve Conservation Objective(s)	The conservation objective of the program is to protect the genetic resources of Klamath River coho.
Achieve Harvest Objectives	Provide for sport, commercial and tribal harvest of IGH origin coho when run-size allows.

1.10 LIST OF PERFORMANCE INDICATORS

Benefits and risks associated with performance indicators are listed in Table 3. In this HGMP the achievement of the indicator is considered a benefit; non-achievement a risk.

1.10.1 Performance indicators addressing benefits.

A list and description of performance indicators addressing benefits is provided in Table 3 below.

1.10.2 Performance indicators addressing risks.

A list and description of performance indicators addressing risks is provided in Table 3.

Table 3. Benefits and risks associated with each performance indicator.

Indicator	**Benefits and Risks**
Broodstock Composition, Timing, Structure Similar to natural Fish	**Benefit:** Achievement ensures that the hatchery population reflects the characteristics of the natural population to the extent possible by including natural origin fish as broodstock, collecting fish randomly throughout the entire portion of the run, and including jacks in broodstock. **Risk:** To the extent these indicators do not represent the natural population, the more divergent the two populations become, thereby reducing natural population productivity and diversity and creating a separate hatchery run.
High Adult Holding and Spawning Survival Rate, and Egg-to-Fry-to-parr-to Smolt Survival Rates	**Benefit:** Hatchery culture practices that maximize life-stage survival make the most efficient use of the resource, and reduce the need to include additional NOR adults for use as broodstock. **Risk:** Low survival rates indicate poor hatchery culture practices. Because of this, the hatchery may be artificially selecting for genes/traits that are more conducive for survival in the hatchery rather than the natural environment.
Mating Protocols (%jacks, %males, pNOB) that minimize inbreeding and conserve existing	**Benefit:** Proper mating protocols ensure high fertilization rates (increase survival) and maximize genetic diversity of the broodstock. The use of jacks maintains genetic continuity between generations. **Risk:** Poor mating protocols may reduce genetic diversity and thereby reduce overall population productivity and reproductive success in the natural

Indicator	Benefits and Risks
diversity	environment.
High Proportionate Natural Influence (PNI)	**Benefit:** Achieving the PNI goal (>0.50) ensures that the natural, rather than the hatchery environment, is driving local adaptation. Fish better adapted to the natural environment are more productive and more resilient to environmental change. **Risk:** Low PNI (<0.50) is an indicator that the hatchery environment is driving local adaptation. Fish adapted to this environment are less likely to perform well in the wild and therefore reduce the productivity and diversity of the natural component of the combined population.
Number and Severity of Disease Outbreaks is low	**Benefit:** Having fewer and less severe disease outbreaks reduces the disease risks that hatchery populations and operations pose to natural populations. This results in better natural population productivity, diversity and spatial structure as natural populations located close to the hatchery may be more impacted than those further away. **Risk:** Frequent and severe disease outbreaks reduce population productivity and require higher numbers of natural and hatchery origin Broodstock to produce a similar number of fish. The use of more natural origin fish in the hatchery reduces natural spawning escapement, which may reduce population productivity, spatial structure and diversity.
Hatchery Effluent Quality is High	**Benefit:** Achieving high quality hatchery effluent maintains water quality in the receiving stream. Good water quality is essential for the production of all anadromous fish species. **Risk:** Hatchery effluent that degrades water quality may decrease the survival and overall productivity of the natural population.
Release Timing, Fish Health, Size and Condition of Released Fish Produce High Survival	**Benefit:** Releasing healthy fish at the correct size and time increases overall survival and reduces the release numbers needed to achieve conservation and harvest objectives. **Risk:** Releasing fish that are too large may result in increased predation on natural fish populations. A mismatch between release timing and environmental conditions required for good survival may reduce overall hatchery performance.
Smoltification Level that Promotes Rapid Migration	**Benefit:** Achieving proper physiological condition creates a fish that rapidly migrates to the ocean and is able to make the physical changes needed to enter the marine environment; resulting in increased survival.

Indicator	Benefits and Risks
	Risk: Releasing fish not ready to migrate results in these fish residing in the receiving streams. Here they compete with wild fish for food and space, reducing natural population productivity. If the hatchery fish are larger in size than wild fish, they may predate on these wild juveniles, decreasing their abundance.
High Smolt-to-Adult Return Rate (SAR)	**Benefit:** High SAR is an indicator that the hatchery is producing a high quality smolt that is able to survive in the natural environment from point of release to return as an adult. The higher the survival rates the fewer hatchery fish that need to be produced to achieve conservation and harvest objectives. Decreased hatchery production reduces competition with the natural population, which may result in increased natural fish production. **Risk:** Low survival rates indicate that rearing practices are producing a fish of lesser quality. Hatchery production levels required to achieve conservation and harvest objectives may be higher than optimal and represent a risk to natural populations.
High Natural Adult Abundance	**Benefit:** High natural adult abundance levels indicate that the population is healthy and has low risk of extinction. Abundance is an indicator of the need for a hatchery program. As natural production levels increase, conservation and harvest objectives can be met with less reliance on hatchery programs. **Risk:** Low natural abundance is indication that environmental conditions may be insufficient to maintain the population over time (high extinction risk). Hatchery production, with all of its inherent risks to natural populations, is needed to achieve conservation and harvest objectives.
Similar Adult Run-timing (HOR and NOR)	**Benefit:** For integrated programs, the run-timing of hatchery and natural runs should match, as this is an indicator that the two populations are expressing similar life-histories, and that both are being exposed and adapting to the full range of environmental conditions present in the basin. **Risk:** A mismatch in run-timing between the two populations (HOR and NOR) indicate that hatchery practices are selecting for life-histories dissimilar to those being expressed by the natural population. The two populations may become more divergent over time resulting in greater genetic impacts to natural populations from hatchery fish spawning in the natural environment. This could include a loss in productivity, diversity and spatial structure.
Low pHOS	**Benefit:** Limiting the proportion of hatchery fish on the spawning grounds

Indicator	Benefits and Risks
	(pHOS) reduces possible genetic impacts to the natural population. **Risk:** The more dissimilar the two populations the larger the risk hatchery strays pose. In a well integrated program, the proportion of natural origin fish in the hatchery brood (pNOB) must exceed the proportion of hatchery fish on the spawning grounds (pHOS). This is to ensure that the populations possess similar genetic and phenotypic traits.
Low HOR straying	**Benefit:** Good homing fidelity of HOR fish to the hatchery is important for eliminating the genetic risks hatchery fish pose to wild fish from interbreeding. The higher the homing fidelity the lower the risk. High homing rates also ensure that broodstock are available for culture so that wild populations do not need to be excessively used to achieve production targets. **Risk:** High HOR straying rates may result in the population becoming more and more adapted to the hatchery rather than the natural environment. This makes the population less resistant or adaptable to environmental change and reduces population diversity.
Similar Reproductive success of NOR and HOR spawning naturally (NOS and HOS)	**Benefit:** The reproductive success of both NOR and HOR fish in nature is an indicator of the ability of each to maintain themselves in a natural environment. The ideal conservation hatchery program should produce a fish with the reproductive success of a natural fish. This indicates that the two components of the population are virtually identical in their ability to reproduce themselves in the wild and that hatchery culture practices have been successful. **Risk:** Low reproductive success of hatchery fish, or decreasing productivity of natural origin fish spawning with hatchery fish, may be indicative that the hatchery is having negative impacts on population productivity.
Protective Harvest Rate	**Benefit:** Maintaining appropriate harvest rates ensure that the population is able to maintain itself over time. **Risk:** Harvest rates that reduce population abundance and escapement levels needed to maintain the population over time increases the risk of population extinction, decreased diversity and spatial structure

1.11 EXPECTED SIZE OF PROGRAM

The program is expected to produce 75,000 yearling coho each year[4]. On average the 75,000 juveniles released has produced approximately 866 returning adults since 2000. This level of returns has been sufficient to maintain broodstock, supply sufficient excess adults for future coho management goals in the basin, and provide limited tribal harvest. A higher production level was considered, but the risks associated with increased hatchery strays from such a program to natural populations were deemed unacceptable. The M&E program will be used to adjust hatchery production and operations over time to better protect wild coho populations.

1.11.1 Proposed coho salmon annual broodstock collection level

The number of coho salmon used historically for broodstock is shown in Table 4. The numbers have varied due to egg and juvenile losses associated with low egg fertilization rates, need for juvenile culling for genetic reasons, and bird predation in raceways. Each of these factors caused broodstock needs to be greater than normally required for a program designed to produce 75,000 yearling coho salmon smolts. Actions proposed in this HGMP are designed to reduce or eliminate each of the factors so that the numbers of adults needed for broodstock are reduced over time.

The HSRG standards require that the proportion of NOR in the hatchery brood (pNOB) must exceed the proportion of HOR on the spawning grounds (pHOS). This action ensures that the natural, rather than the hatchery, environment drives local adaptation. The HSRG also recommends that pNOB be 20 percent at a minimum for hatchery broodstock. Therefore, the IGH will target a 20 percent minimum contribution (50 percent maximum) of natural origin coho salmon to the broodstock[5].

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[4] Release numbers may vary each year based on in-hatchery survival rates and adult returns. In the long-term, the number of hatchery fish released will be within +/- 10 percent of the 75,000 fish release goal.

[5] The 50% maximum value for pNOB was established in consultation with NMFS to reduce impacts associated with removing a large number of natural spawners from the population. It is recognized that both the 20 percent and 50 percent values for natural fish inclusion are targets that may not be achieved in some years due to low natural returns or misidentification of the origin (NOR versus HOR) of returning adults.

Table 4. Number of coho salmon returns to Iron Gate Hatchery by sex, age, females spawned and eggs harvested for BY 1993 through BY 2009 (IGH records).

Year	Males	Females	Jacks	Females Spawned	#. of Eggs	Fecundity
1993	361	314	29	219	503,326	2,298
1994	100	72	97	57	141,397	2,481
1995	708	793	29	294	782,170	2,660
1996	1,715	1,831	551	200	547,255	2,736
1997	825	1,047	302	126	304,728	2,418
1998	243	268	158	122	298,357	2,446
1999	90	61	18	35	86,519	2,472
2000	295	428	631	95	270,151	2,844
2001	972	1,494	107	126	404,370	3,209
2002	566	627	108	187	609,193	3,258
2003	609	708	241	197	502,048	2,548
2004	630	865	239	276	799,623	2,897
2005	596	799	30	103	295,101	2,865
2006	112	151	69	85	236,406	2,781
2007	300	325	154	124	316,155	2,550
2008	508	770	24	148	455,480	3,078
2009	21	25	18	20	53,435	2,672
Average	509	622	165	142	388,571	2,718

With implementation (and achievement) of mitigation measures designed to increase in-hatchery survival rates, the program will require a minimum of approximately 135 (50 percent of which may be NOR) adult spawners. Fish excess to hatchery broodstock needs may be released back to the river or euthanized if necessary in order to keep controls on the HOR percentages within the Klamath River. The number of females required for broodstock was calculated based on the following assumptions using formula 1 below:

- Fecundity = 2,800 (varies each year)
- Egg-to-Smolt Survival = 60 percent
- Total Juvenile Release = 75,000

Formula 1:

Total Juvenile Release/Egg-to-Smolt Survival/Fecundity = 45 females

The total number of males (jacks and adults combined) needed is based on a 2:1 ratio of male to female spawners (45* 2 = 90 males). The use of multiple males per female spawning is designed to increase maximize effective population size and reduce the impact of variation in fertilization rates. Jacks (included as part of the male count) will be incorporated into broodstock as needed to reduce inbreeding and allow gene flow between brood years. The actual number of males used overall and per female would be developed each year in consultation with CDFW and NMFS geneticists.

The maximum number of males, females and jacks used each year is likely to vary based on the active broodstock management program and in-culture hatchery survival rates. Under this program, real-time genetic analysis of all spawners will be used to develop a spawner list based on relatedness[6]. The goal of this program will be to reduce inbreeding among hatchery broodstock. In 2010, the total number of broodstock required to effectively implement this program was 270 fish. This number was calculated based on the use of formula 1 with an egg-to-smolt survival rate of 30 percent (the value observed under current culture conditions). The number of broodstock required is expected to decrease with implementation of this HGMP as egg incubation survival rate increases.

[6] The genetic program was implemented with the 2010 brood year.

1.11.2 <u>Proposed annual fish release levels (maximum number) by life stage and location</u>

Table 5 provides the annual production goals for IGH for all species cultured. Coho salmon production will be set at 75,000 yearling fish[7]. All coho salmon will be released from IGH to the Klamath River. Releasing directly from the hatchery is assumed to maximize homing fidelity to the hatchery, thus reducing risks of hatchery straying to natural populations. Any deviations to the coho salmon release size or release location will be approved by NMFS and CDFW annually.

Table 5. Iron Gate Hatchery salmon and steelhead production goals.

Species	Life Stage	Number
Coho	Yearling	75,000
Chinook	Yearling	900,000
	Smolts	5,100,000
Steelhead	Yearling	200,000

1.12 CURRENT PROGRAM PERFORMANCE

The current performance of the IGH coho program is summarized in Table 6. Juvenile release numbers have varied by brood year, and are dependent on adult returns to the facility and in-hatchery survival rates by life-stage. Coho smolt-to-adult rates (SAR) have averaged 0.99 percent for brood years 2000 to 2008. The average number of adults produced since 2000 is 808. However, these numbers do not include hatchery fish that stray to other streams downstream of Bogus Creek (Shasta River for example) or for fish caught in freshwater and ocean fisheries. Together, it is roughly estimated that strays and harvest add an additional 10-15 percent to the total hatchery adult production total.

The 0.99 percent SAR for IGH coho is lower than SARs observed for other hatchery programs. For example, coho production at the Trinity River hatchery has averaged 3.0 percent for brood years 2000 to 2007, and outperformed IGH in all years (Figure 5). The difference in survival may be attributed to different environmental conditions in release streams, exposure to *Ceratomyxa Shasta*, and/or IGH culture practices that have resulted in substantial inbreeding. It is expected that the implementation of the genetic spawning matrix, improved hatchery culture practices and the release of fish in smolted condition are actions identified in the HGMP that will help increase coho salmon survival rate.

[7] The precision of the release size estimate will be +/- 10 percent.

Table 6. The number of juveniles released, IGH origin adult returns to IGH and Bogus Creek and corresponding smolt-to-adult survival ratio (SAR) for IGH coho salmon (BY 1998-2008).

Brood Year	# Juveniles Released	Adults	SAR
1998	77,147	2,054	2.66%
1999	46,254	916	1.98%
2000	67,933	620	0.91%
2001	74,271	1,037	1.40%
2002	109,374	1,302	1.19%
2003	74,716	191	0.26%
2004	89,482	577	0.64%
2005	118,187	1,291	1.09%
2006	53,950	24	0.04%
2007	117,832	387	0.33%
2008	121,000	492	0.41%
Average	86,404	808	0.99%

This HGMP includes actions to improve culture practices to determine if SAR can be improved. These actions are described later in this document.

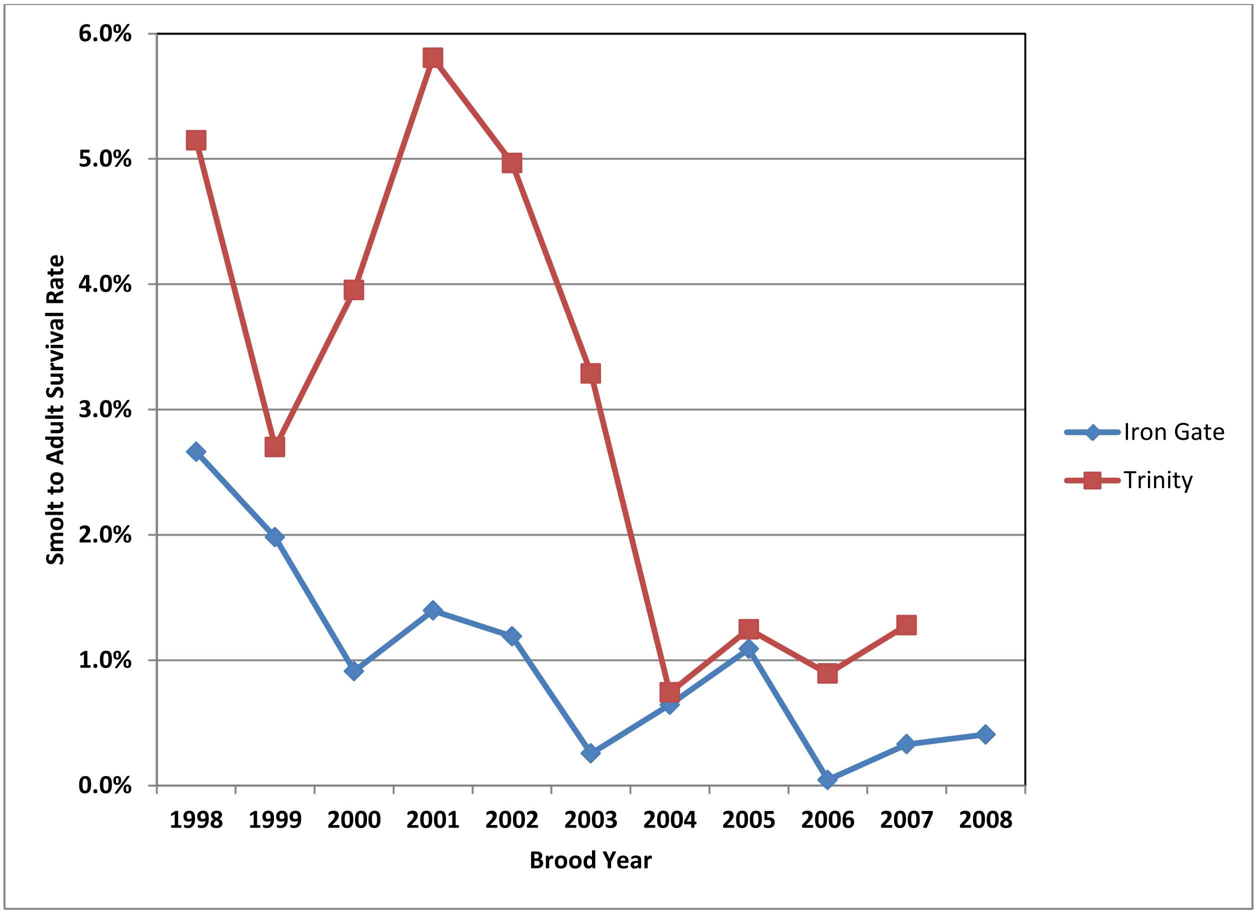

Figure 5. Smolt-to-adult survival ratios for Trinity River Hatchery and IGH coho programs (brood years 2000-2008) (calculated from IGH and Trinity annual hatchery reports).

1.13 DATE PROGRAM STARTED (YEARS IN OPERATION)

CDFW began artificial propagation at Iron Gate Hatchery in 1966 and has operated the program for 46 years.

1.14 EXPECTED DURATION OF PROGRAM

The Klamath Hydroelectric Settlement Agreement (KHSA) outlines a process that may potentially result in the removal of four of the Klamath Hydroelectric Project (Project) dams, including IGD, in 2020. The current water supply to IGH is the Iron Gate reservoir and PacifiCorp has begun a study to evaluate hatchery production options that do not rely on the current IGH water supply. As part of the KHSA's Interim Measures, PacifiCorp will fund 100 percent of the hatchery operations and maintenance cost necessary to fulfill annual mitigation objectives developed by the CDFW and NMFS for a period of eight years following potential removal of Iron Gate dam[8]. Revised hatchery management goals and strategies will be developed by CDFW and NMFS in response to reintroduction of coho salmon to habitat above IGD (KHSA 2010). At that time it is expected that a new HGMP would be developed for any new or revised programs at Iron Gate or other hatchery facilities in the area.

1.15 WATERSHEDS TARGETED BY PROGRAM

The Klamath River basin is the targeted watershed, specifically the Upper Klamath Population Unit, which includes the tributaries and the mainstem upstream of Portuguese Creek and downstream of IGD. In the future, fish production may be used to assist in recovery of the Shasta River and Scott River Population Units.

1.16 INDICATE ALTERNATIVE ACTIONS CONSIDERED FOR ATTAINING PROGRAM GOALS, AND REASONS WHY THOSE ACTIONS ARE NOT BEING PROPOSED

An alternatives analysis was conducted on the current IGH coho salmon program to determine the best approach for meeting identified conservation, harvest and policy goals (Appendix A). The five alternatives examined were as follows:

1. Maintain Current Program
2. Eliminate Hatchery Production and Improve Habitat
3. Implement a Segregated program consistent with HSRG guidelines
4. Implement an Integrated program consistent with HSRG guidelines
5. Implement a reduced hatchery program

The results of the alternatives analysis led to four major findings[9]:

1. Natural coho salmon populations are below the depensation thresholds for abundance established

[8] PacifiCorp's dams will be removed pursuant to the KHSA if the Secretary of the Interior determines that their removal will advance fisheries restoration and is in the public interest.

[9] Data used to conduct the alternatives analysis is highly uncertain (Yurok Tribe, August 31, 2010, Karuk Tribe August 31, 2010). However, it was based on the best available information available at this time.

by NMFS in the Upper Klamath Population Unit (425) and Shasta River Population Unit (531 fish), and need to be increased if extinction is to be avoided.

2. Adult natural coho salmon production needs to be increased to reduce demographic and life history diversity risks to the population unit.
3. Hatchery operations need to strike a balance between genetic and demographic risk to the combined (hatchery origin and natural origin) coho salmon population.
4. Habitat quality and quantity need substantial improvement to maintain natural coho salmon production in the basin.
5. Hatchery production should not be reduced due to decreased life history diversity, increased risks of inbreeding, and the possibility of Ryman-Laikre effects (i.e. gene swamping) (Ryman-Laikre 1991).

None of the five alternatives examined resulted in outcomes consistent with the findings. Therefore, the preferred alternative consists of the habitat improvements included in alternative 2, and progressing towards the hatchery operational guidelines for an integrated program described in alternative 4 over time. Because of low current NOR abundance, the program will be operated during Phase 1 to achieve a PNI of > 0.5. This approach will minimize the number of NOR coho required to properly integrate the program. PNI is expected to increase to >0.67 in Phase 2 and Phase 3 of the program as NOR abundance increases due to increased population fitness, improved habitat conditions and increased habitat access. This combination of actions was determined most likely to result in outcomes consistent with the findings described above and would most likely result in increase of the abundance, productivity and life-history diversity of the Upper Klamath Population Unit.

2.0 PROGRAM EFFECTS ON NMFS ESA-LISTED SALMONID POPULATIONS

A description of the effects the program may have on ESA listed Klamath River coho salmon are discussed below.

2.1 LIST ALL ESA PERMITS OR AUTHORIZATIONS IN HAND FOR THE HATCHERY PROGRAM

None.

2.2 PROVIDE DESCRIPTIONS, STATUS, AND PROJECTED TAKE ACTIONS AND LEVELS FOR NMFS ESA-LISTED NATURAL POPULATIONS IN THE TARGET AREA

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

2.2.1.1 *Coho salmon (Southern Oregon/Northern California Coasts ESU (SONCC))*

Coho salmon adults return to spawn at age three after spending 18 months in the ocean, but some sexually mature males (jacks) return after one summer in the ocean. Age-four adults are less common in waters south of British Columbia. Adult coho salmon in general enter fresh water to spawn from September through January. Data collected at the Bogus Creek weir showed that adult coho salmon entered the stream in mid-October, peaked in November, with the last fish observed in late December (Knechtle 2009a). This run-timing is similar to that observed at IGH (Chesney 2009).

The egg incubation period (November through April) is inversely related to water temperature, but the embryos usually hatch after eight to twelve weeks. The fry emerge from the gravel between March and July, with peak emergence occurring from March to May, depending on when the eggs were fertilized and the water temperature during development (Shapovalov and Taft 1954).

After one year in freshwater, coho salmon yearling smolts begin migrating downstream to the ocean in late-March or early April. Because hatchery fish are released during this same time period, both hatchery and wild fish are present in the river at the same time (Table 7).

Table 7. Relative number and outmigration timing of hatchery and naturally spawned yearling coho salmon screw-trapped at Big Bar, Klamath River from 1997 through 2004 seasons (CDFW data files).

Year	Yearling		
	Natural	Marked	Date of Observance
1997	8	4	May 7 – June 30
1998	1	2	May 21 – May 27
1999	3	6	May 28 – July 29
2000	9	3	April 30 – May 20
2001	9	0	April 9 – May 27
2002	25	1	May 28 – June 30
2003	13	3	April 30 – July 8
2004	2	3	April 9 – May 27

The amount of time hatchery coho salmon spend in the river ranges from less than 0.5 to 2 months. Hatchery origin juveniles make up approximately 6.6 percent of the coho salmon smolts sampled in the Lower Klamath River (CDFW 2003). Hatchery fish in the lower river were larger than natural coho salmon for the year 2000 through 2002, but 25 mm smaller in 2003 (Table 8) (CDFW 2003).

Table 8. Mean fork length (mm) and standard deviation of IGH hatchery, and natural origin juvenile coho salmon captured in the Klamath estuary (2000-2003) (CDFW 2003).

Year	Natural	Hatchery
2000	134 ± 13	171.00
2001	141 ± 14	167± 17
2002	132 ± 13	156.00
2003	157 ± 18	132 ± 24
Average	141	157

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

Natural and hatchery origin coho salmon, primarily from the Upper Klamath Population Unit, are the ESA-listed stock directly affected by the program. The primary take activity will be the collection of broodstock necessary to rear 75,000 yearling coho salmon smolts as part of an integrated recovery program.

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

IGH origin coho salmon have the potential to impact all Klamath River coho population units. These units are:

- Lower Klamath
- Middle Klamath
- Upper Klamath
- Scott River
- Shasta River
- Salmon River

IGH coho salmon are known to stray and spawn in the Shasta River. Based on CDFW data files, IGH coho have made up from 0-29 percent of the spawners in the Shasta River from 2001 to 2006. Data for the Scott River is not available, but it's likely that hatchery origin fish are present here as well (Knechtle 2009b). Data collected by Corum (2010, 2011) in small middle and upper Klamath tributaries did not show the presence of hatchery origin fish in these streams; however, surveys have been limited in regards to kilometers surveyed and in-season frequency.

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

A summary of the current status of coho salmon in the Upper Klamath, Shasta River, Scott River and Mid-Klamath Population Units is presented below. The information presented below is consistent with the draft recovery plan for coho salmon (NMFS 2012).

2.2.2.1 *Current Status of Coho Salmon in the Upper Klamath Population Unit*

<u>Spatial Structure and Diversity</u>

The Upper Klamath Population Unit is currently comprised of approximately 103 kilometers of mainstem habitat and numerous tributaries to the mainstem Klamath River upstream of Portuguese Creek to Iron Gate Dam. Historically, the population may have extended upstream of Iron Gate Dam to Spencer Creek. Iron Gate Dam, the lowest of five mainstem dams, blocks access to approximately 676 kilometers of spawning, rearing and migratory habitat for anadromous fish. As a result coho salmon within the Upper Klamath Population Unit spawn and rear primarily within several of the larger tributaries between Portuguese Creek and Iron Gate Dam, namely Bogus, Horse, Beaver, and Seiad Creeks. A small proportion of the population spawns within the mainstem channel, primarily within the section of the river several miles below Iron Gate Dam. A population of coho salmon parr and smolts rear within the mainstem Klamath River by using thermal refugia near tributary confluences to survive the high water temperatures and poor water quality common to the Klamath River during summer months.

Many of the streams comprising the Upper Klamath Population Unit are small and may go dry near their confluence with the mainstem Klamath River, however, these intermittent tributaries remain important rearing habitat for coho salmon. Coho salmon have adapted life history strategies (spatial and temporal) to use intermittent streams. For example, adult coho salmon will often stage within the mainstem Klamath River at the mouth of natal streams until hydrologic conditions allow them to migrate into tributaries, where they are able to find more suitable spawning conditions, and juveniles can find adequate rearing conditions and cover. In summer when the lower sections of these tributaries may go dry, the shaded, forested sections upstream provide cold water over-summering rearing habitat for juvenile coho salmon. By early spring, when outmigration of one-year old coho salmon primarily occurs, base flows of these small streams are relatively high and maintain full connectivity with the mainstem Klamath River.

Surveys by CDFW between 1979-1999 and 2000-2004 showed coho salmon as being moderately well distributed downstream of Iron Gate Dam in the Upper Klamath Population Unit. Juveniles were found in 21 of the surveyed 48 tributary streams. Streams with coho presence in both 1979-99 and 2000-05 included Grider, Seiad, Horse, Walker, Beaver, W. Fork Beaver, Cottonwood, Bogus, Little Bogus, and Dry Creeks. Additional juvenile surveys conducted between 2002 and 2009 found coho using Tom Martin, Walker, Seiad, Grider, Beaver, Humbug, O'Neil, and Horse Creeks (Karuk Tribe and HCRD, unpublished data). No juveniles were found in Lumgrey, Willow, Bittenbender, Barkhouse, Empire, Cottonwood, Bogus, and Kuntz Creeks during these surveys. Adult spawning surveys between 2003 and 2005 found coho salmon adults spawning in Canyon Creek (tributary to Seiad), Seiad Creek, and Grider Creeks (Karuk Tribe, unpublished data). No evidence of spawning was found in Little Horse Creek.

Little is known about the genetic and life history diversity of the population, however, the population is highly influenced by the hatchery and has likely experienced a loss of life history diversity due to environmental conditions and loss of habitat. Currently, genetic work is being conducted to determine the genetic makeup of wild and hatchery fish from the Upper Klamath Population Unit.

In summary, the more restricted and fragmented the distribution of individuals within a population, and the more diversity, spatial distribution, and habitat access diverge from historical conditions, the greater the extinction risk. Williams et al. (2008) determined that at least 20 coho per-intrinsic potential (IP) km of habitat are needed (8,500 spawners total) to approximate the historical distribution of coho salmon and their habitat in the Upper Klamath Population Unit. The current population is well below this and has a reduced genetic and life history diversity. Overall, the Upper Klamath Population Unit is at an elevated risk of extinction because its spatial structure and diversity are substantially limited compared to historical conditions.

<u>Population Size and Productivity</u>

If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 425 coho salmon must spawn in the Upper Klamath Population Unit each year to avoid such effects of extremely low population sizes (depensation threshold). The low risk spawner threshold for the population is 8,500 spawners. However, about 43.3 percent of the available IP kilometers that define the Upper Klamath Population Unit occur upstream of Iron Gate Dam in areas that are not currently accessible to anadromous fish.

Based on juvenile surveys in the Upper Klamath Population Unit between 2002 and 2005 there is low production in the Upper Klamath Population Unit tributaries with fewer than 200 juveniles found in most tributaries and most years (Karuk Tribe and HCRD, unpublished data). The greatest number of juveniles was just over 1,000, which were found in Horse Creek in 2005. Spawning surveys also give an indication of the population size and productivity. In 2003 the total spawner abundance for surveyed streams was 10 adults, in 2004 it was 108 adults, and in 2011 it was 52 adults. The majority of fish were found spawning in Seiad and Grider Creeks (Karuk Tribe, unpublished data).

Fish counts from the weir on Bogus Creek, returns to the hatchery, and various tributary spawner surveys provide some indication of the current population size (Figure 6). Adult returns to the hatchery between 2004 and 2011 have averaged around 772 fish with the lowest returns (~46) in 2009 and the highest returns (1,495) in 2004. Returns to Bogus Creek are influenced by hatchery strays but have averaged around 152 fish. Tributary spawner surveys indicate low numbers of coho salmon (<100) in the remaining habitat. Using a variety of methods, including these data and an IP database, Ackerman et al. (2006) developed run size approximations for tributaries in the upper Klamath River reach. The authors estimated the recent abundance of the Upper Klamath Population Unit to be between 100 and 4,000 adults, which is less than the 4,815 spawners needed for the low risk spawner threshold for those areas of the Upper Klamath Population Unit that are currently accessible to coho salmon downstream of the Iron Gate Dam.

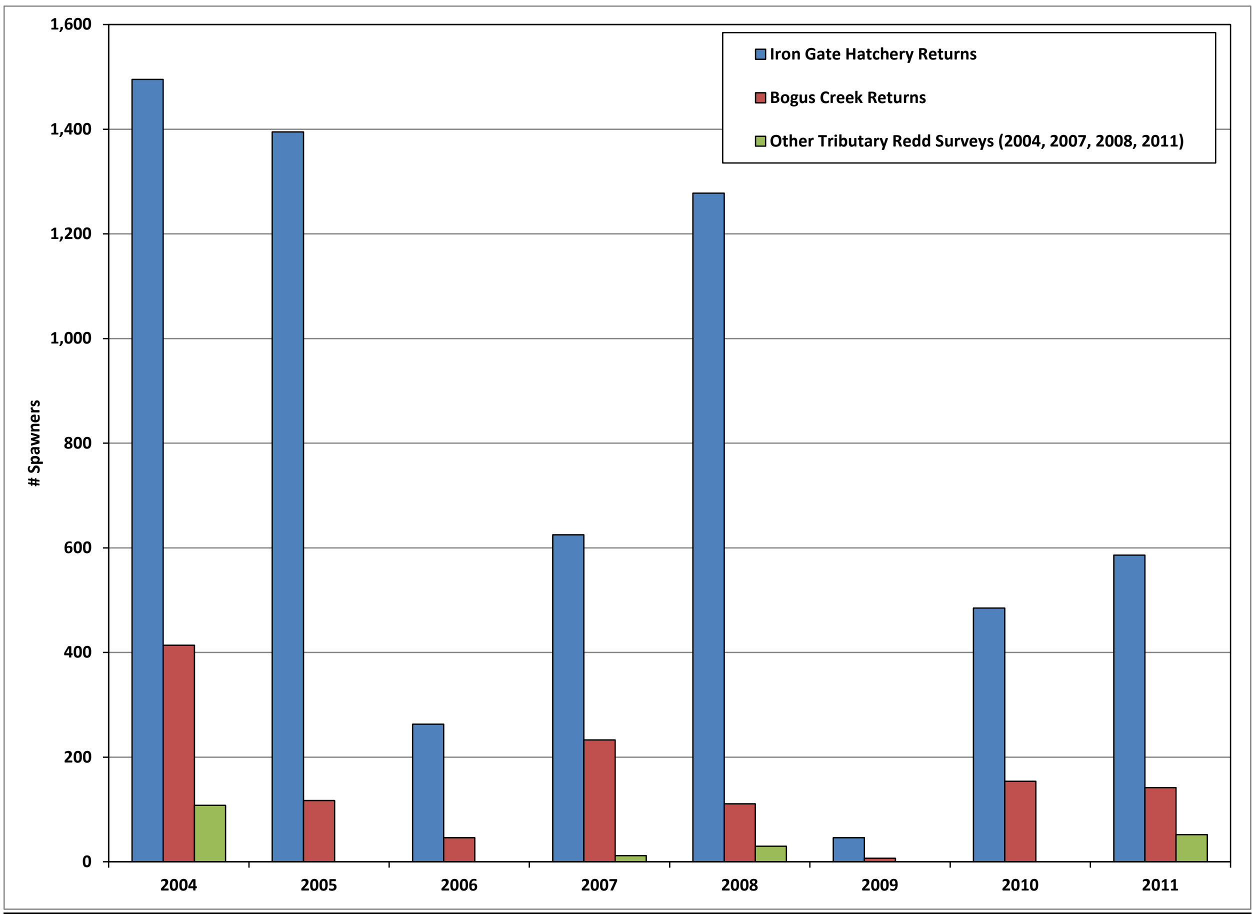

Figure 6. Returns of coho salmon to the Upper Klamath Population Unit based data from various sources.

More recently, CDFW estimated that minimum natural run size was only 664 fish in 2009. This number of fish is approximately 30 percent of the High Risk annual abundance level established by NMFS (2010) (Table 9). A High Risk population is one where a species faces significant risks from internal and external processes that can drive a species to extinction (NMFS 2010). Coho salmon returns to the Upper Klamath Population Unit was only 7 NOR fish in 2009. A total of 46 coho adults returned to IGH in 2009. The population growth rate of the Upper Klamath Population Unit has not been estimated but given the current trends in spawner abundance and the high incidence of hatchery fish and inbreeding depression, it is likely that population growth is negative.

Table 9. 2009 natural coho salmon spawning escapement and High and Low Risk annual abundance levels by population unit (NMFS 2010, Williams et al. 2008).

Population Unit	2009 Unmarked Adult Returns	High Risk Annual Abundance Level	Low Risk Annual Abundance Level
Lower Klamath	No Data	205	5,900
Middle Klamath	No Data	113	3,900
Upper Klamath	7	425	8,500
Scott River	81	441	8,800
Shasta River	9	531	10,600
Salmon River	No Data	115	4,000
South Fork Trinity	567	242	6,400
Lower Trinity River		112	3,900
Upper Trinity River		64	2,400
Total	664	2,248	54,400
Percent of Risk Standard		30%	4%

Adverse Hatchery Related Effects

The amount of hatchery strays spawning in upper Klamath tributaries is unknown but presumed to be high. Iron Gate Hatchery (IGH) is located within the Upper Klamath Population Unit and it releases approximately 6 million Chinook salmon, 75,000 coho salmon, and 200,000 steelhead trout annually. The hatchery releases Chinook salmon under a volitional release program from the middle of May to the end of June. After June 1 discharge from IGD is usually in decline and water temperatures are increasing, further increasing stressful conditions for wild, juvenile coho salmon. Adult coho salmon are counted at IGH, where the proportion of hatchery fish is likely to be the highest in the entire basin due to the homing of hatchery fish back to their place of birth. From 1996 to 2010, on average 77 percent of these adults originated from a hatchery (Chesney and Knechtle 2011a). From 2004 to 2010, on average 34 percent of observed adults at Bogus Creek were of hatchery origin (Chesney and Knechtle 2010). Adverse hatchery-related effects pose a very high stress to all life stages because hatchery origin adults make up greater than 30 percent of the total number of adults. The average percentage of hatchery coho salmon carcasses recovered at the Shasta River fish counting facility from 2001, 2003, and 2004 was 16 percent (Ackerman et al. 2006) and stray rates in upper Klamath tributaries proximal to the hatchery are likely comparable. Although the actual proportion of hatchery fish in the river changes from year to year, and depends largely on natural returns, these data indicate that substantial straying of IGH fish may be occurring into important tributaries of the upper Klamath River. Straying has the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999).

Extinction Risk

Based on the above descriptions of the population viability parameters and the criteria set forth by Williams et al. (2008), the Upper Klamath Population Unit is at a high risk of extinction. This conclusion is based on the small population size of the natural population (below the low risk spawner threshold), large hatchery influence (hatchery fraction >5 percent), assumed negative population growth rate, reduced spatial structure, and low spawner density.

2.2.2.2 *Current Status of Coho Salmon in the Shasta River Population*

Spatial Structure and Diversity

The diversity and complexity of the physical and environmental conditions found within the Shasta River basin historically have contributed to the legacy of coho salmon in the SONCC coho salmon ESU and contributed to this population being considered a Functionally Independent Population (Williams et al. 2008). Historical instream river conditions, fostered by unique cold spring complexes, that created abundant summer rearing habitat, and abundant off channel overwintering habitat, aided in the success and survival of coho salmon utilizing the Shasta River basin.

Williams et al. (2008) determined that at least 20 coho per-IP km of habitat are needed (10,600 spawners total) to approximate the historical distribution of Shasta River coho salmon and habitat. The current distribution of spawners is limited to the mainstem Shasta River from river kilometer 27 to river kilometer 36.8, Big Springs Creek, lower Parks Creek, and the Shasta River Canyon. Juvenile rearing is also currently confined to these same areas, as well as in Yreka Creek and the upper Little Shasta River. This is a fragment of the IP and therefore, the Shasta River coho salmon population is at high risk of extinction because its spatial structure and diversity are very limited compared to historical conditions.

Population Size and Productivity

If a spawning population is too small, the production and survival of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Two out of three Shasta River coho salmon brood years have abnormally low abundance levels, indicating reduced population size and productivity that may have recently resulted in their extirpation. Spawning surveys of the Shasta River and its tributaries have been occurring since 2001, and have resulted in observations of coho salmon in only five reaches of the Shasta Valley and Canyon that consistently sustain small numbers of rearing salmon juveniles. Productivity and population size are likely being impacted from the continued operation of IGH. IGH is located along the Klamath River at the base of IGD approximately 21 km upstream of the mouth of the Shasta River. As adults, hatchery fish can stray into the Shasta River Basin when migrating back upstream, and there they can interbreed with wild Shasta River coho salmon, artificially increasing their numbers, simplifying their genetics and in the long term decreasing the productivity of wild coho salmon.

Williams et al. (2008) determined at least 531 salmon must spawn in the Shasta River each year to avoid effects of extremely low population sizes. Adult spawning surveys and fish counting weir information started in 1934 are conducted by the CDFW. These weir counts indicate that adult spawning coho salmon number between 0-400 for most years[10]. These brood year population estimates are low, and have not trended upward over time. Therefore, the Shasta River coho salmon population is at high risk of extinction given the unstable and low population size and presumed negative population growth rate.

Adverse Hatchery Related Effects

Adverse hatchery influences in the Shasta River Basin are a high stress for all life stages. There are no hatcheries nor artificial propagation in the Shasta River basin, but there is a fish hatchery on the Klamath River at the base of Iron Gate Dam, approximately 13 miles (21 km) upstream of the mouth of the Shasta River. Approximately 75,000 coho salmon fry, along with 6,000,000 fall Chinook salmon and 200,000 steelhead yearlings are released from the Iron Gate Hatchery each year. As adults, some of these fish stray into the Shasta River basin when migrating back upstream, and there they can interbreed with

[10] These counts should be considered indices as the weirs were not operational in periods of high flow.

wild Shasta River coho salmon, simplifying their genetics and in the long term decreasing the productivity of wild coho salmon. On average, 16 percent of adult carcasses recovered in the Shasta River basin in 2001, 2003, and 2004 were of hatchery origin (Ackerman et al. 2006). Hatchery coho salmon returns to the Shasta River fish counting facility from 2001 to 2004 (Ackerman et al. 2006), and from 2007 to 2010 (Chesney and Knechtle 2011b), averaged 23 percent. This reduces genetic diversity that is essential for long-term species survival. Williams et al. (2008) concluded that when naturally spawning populations consist of over 5 percent hatchery fish, the risk of extinction for the population is at least moderate. Adverse hatchery-related effects pose a high stress to all life stages because hatchery origin adults make up greater than five percent, but less than 30 percent of the total number of adult coho salmon (Appendix B).

<u>Extinction Risk</u>

The Shasta River coho salmon population size is currently low and unstable, less than the 531 spawners that are necessary to avoid the effects of low population sizes (depensation). Rearing juvenile coho salmon are often forced to enter the Klamath River when they are not yet mature enough to swim in strong current or avoid predators, and where they are exposed to poor water quality and pathogens. Based on the criteria set forth by Williams et al. (2008) the Shasta River population is at a high risk of extinction. This conclusion is based on the extremely small population size of the population (below depensation), declines in population abundance over the past 50 years (precipitous decline), and a spawner density below threshold levels (<1 per IP km).

2.2.2.3 *Current Status of Coho Salmon in the Scott River*

<u>Spatial Structure and Diversity</u>

The diversity and complexity of the physical and environmental conditions found within the Scott River Basin have contributed to the evolutionary legacy of coho salmon in the SONCC ESU, and contributed to this population being considered a Functionally Independent population (Williams et al. 2008). Juvenile fish have been found rearing in Shackleford Creek and its tributary Mill Creek, Etna Creek, French Creek, Patterson Creek, Kidder Creek, Sugar Creek and Mill Creek (near Scott Bar). Spawning and/or redds have been observed in the mainstem Scott River and its tributaries, including: East Fork Scott River, South Fork Scott River, Sugar Creek, French Creek, Miners Creek, Etna Creek, Kidder Creek, Patterson Creek, Shackleford Creek, Mill Creek, and Canyon Creek. Potential coho salmon rearing habitat is distributed throughout the Scott River watershed and the IP data show the highest values (IP > 0.66) throughout the Scott Valley and low gradient reaches of tributaries to the Scott River.

Williams et al. (2008) determined that at least 20 coho per-IP km of habitat are needed (8,800 total spawners) to approximate the historical distribution of Scott River coho salmon and habitat. Routine fish surveys of the Scott River and its tributaries have been occurring since 2001 and have documented coho salmon presence in 11 tributaries, with the 6 most productive of these tributaries consistently sustaining rearing salmon juveniles in limited areas. The other 5 tributaries do not consistently sustain juvenile coho salmon, indicating that the diversity of this population is restricted by available rearing habitat. As the current spatial structure and distribution of spawners is limited, and suitable rearing habitat is scattered and covers only a small portion of historic IP, the Scott River coho salmon population is at high risk of extinction.

Population Size and Productivity

If a spawning population is too small, the production and survival of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 441 coho salmon must spawn in the Scott River each year to avoid such effects of extremely low population sizes.

The Scott River coho salmon population size is not precisely known. Continuing adult spawning surveys and fish counting weir information that restarted in 2007 indicate that adult spawning coho salmon number 1,000 or more every third brood year. This relatively larger brood year population is still less than estimated pre-1960 annual returns of adult coho salmon. Rearing coho salmon experience limited summering rearing habitat in the Scott River, as indicated by the occurrence of fish stranding nearly every summer. This results in severe reductions in the number of juvenile fish that survive to out-migrate to the ocean, or in the prematurely forced exit of young-of-the-year fish downstream into the Klamath River. Therefore, the Scott River coho salmon population is at high risk of extinction, given the extremely low population size and presumed negative population growth rate.

Adverse Hatchery Related Effects

Adverse hatchery influences in the Scott River are a medium stress for all life stages. A small egg collecting station operated on Shackleford Creek from 1925 to 1940 (Leitritz 1970). No hatcheries or artificial propagation occur in the Scott River basin, but Iron Gate Hatchery is about 50 miles (80.5 km) upstream of the mouth of the Scott River, within the Klamath River basin. Juvenile fish often outmigrate from the Scott River into the Klamath River when they are still undersized, to escape rising water temperatures. These juvenile outmigrants encounter large numbers of released IGH Gate hatchery fish also utilizing cold water refugia along the mainstem Klamath River and experience competition for prey resources and exposure to disease. A limited survey of Scott River spawning grounds occurred in 2004, 2005, 2008, 2009, 2010, and 2011; in nearly all years, no hatchery fish were observed (Quigley 2005, Siskiyou RCD, CDFW). Adverse hatchery-related effects pose a medium risk to all life stages, due to the presence of IGH and TRH in the Klamath basin.

Extinction Risk

The Scott River coho salmon population is currently low and unstable. Two of the three coho salmon brood years appear to be well below depensation levels; typically less than the 441 spawners that are necessary to avoid the effects of low population sizes. Juvenile fish numbers are reduced by stranding as summer flows recede and rearing habitat disappears, constraining both diversity and spatial structure. Based on the criteria set forth by Williams et al. (2008) the Scott River population is at high risk of extinction.

2.2.2.4 *Current Status of Coho Salmon in the Mid-Klamath River*

Spatial Structure and Diversity

Juvenile surveys have been conducted over the past several decades by various parties including the Karuk Tribe, the Mid-Klamath Watershed Council (MKWC), and the U.S. Forest Service (USFS). These surveys have found coho salmon juveniles rearing in Hopkins, Aikens, Bluff, Slate, Red Cap, Boise, Camp, Pearch, Whitmore, Irving, Stanshaw, Sandy Bar, Rock, Dillon, Swillup, Coon, Kings, Independence, Titus, Clear, Elk, Little Grider, Cade, Tom Martin, China, Thompson, Fort Goff, and Portuguese creeks (USFS unpublished data, Soto et al. 2008, MKWC unpublished data). Surveys conducted between 2002 and 2009 indicate that juvenile coho are most abundant in Aikens, Bluff, Boise, Camp, Red Cap, Sandy Bar, Slate, and Stanshaw Creeks (USFS and Karuk Tribe unpublished data). Most of the observations are of juveniles using the lower parts of the tributaries and it is likely that many of these fish are non-natal rearing in these refugia areas. Natal rearing is likely confined to those tributaries where spawning is occurring and where sufficient rearing habitat exists (Slate, Red Cap, Elk, Indian, Clear, and Camp Creeks).

Coho salmon spawning surveys have been limited in the mid-Klamath and therefore information on adult distribution is meager. Spawning adult coho have been documented in Bluff, Red Cap, Camp, Boise, South Fork Clear, and Indian creeks (Soto et al. 2008) and spawning surveys by the Karuk Tribe found adults spawning in Aikens, China, Elk, and the South Fork of Clear Creek. A total of 13 streams in 2007 and 20 streams in 2008 were surveyed (Corum 2010). Out-migrant trapping between 2002 and 2008 on Red Cap and Camp Creeks found juveniles less than 40 mm, indicating that there was likely natal rearing occurring (USFS unpublished data). In addition, coho salmon have been observed spawning in side channels, tributary mouths, and shoreline margins of the mainstem Klamath River between Beaver Creek

(RM 161) and Independence Creek (RM 94) (Magnusen and Gough 2006).

Williams et al. (2008) determined that at least 34 coho per-IP km of habitat are needed (3,900 spawners total) to approximate the historical distribution of Middle Klamath River coho salmon and habitat. Adults and juveniles appear to be well distributed throughout the mid-Klamath area; however use of some spawning and rearing areas is restricted by water quality, flow, and sediment issues. Since many of the mid-Klamath tributaries are used for non-natal rearing very little is known about the population's true distribution. Also, little is known about the genetic and life history diversity of the population, but it is expected to be limited because of the depressed population size and the influx of hatchery strays that is likely occurring. The Middle Klamath River coho salmon population is likely at high risk of extinction because its diversity is very limited compared to historical conditions. Its spatial distribution appears to be good but too little is known to infer its extinction risk based on spatial structure.

Population Size and Productivity

Little data exists on the mid-Klamath coho population, but runs are thought to be extremely reduced compared to historic levels. Based on the best available data, the estimated total population size is around 1,000-1,500 in strong run years and less than 100 in weaker run years (Ackerman et al. 2006). A few tributaries in the mid-Klamath (e.g. Boise, Red Cap, Clear, and Indian Creeks) are thought to support significant populations of coho salmon, however total spawner abundance and population productivity is unknown. Spawning surveys by the Karuk tribe in 2003, 2004, 2007, and 2008 found only a handful of redds and adult coho salmon each year. A total of two redds and three live coho salmon adults were found in 2007 for a total of approximately 0.4 adult coho per surveyed kilometer. During the 2008/2009 spawning season a total of 8 redds were found for a total of 0.5 fish/km (Corum 2010).

Juvenile counts indicate that productivity is relatively low with less than 12,000 juvenile coho found between 2002 and 2009 during surveys of mid-Klamath tributaries (USFS unpublished data). Many of these juveniles are likely from other populations and the actual number of juveniles produced by the mid-Klamath population could be much lower.

Based on the available data it appears that the Middle Klamath River coho salmon population has a spawner abundance of less than 1000 individuals and is at moderate risk of extinction given the low population size and negative population growth rate. If a spawning population is too small, the survival and production of eggs or offspring may suffer because it may be difficult for spawners to find mates, or predation pressure may be too great. This situation accelerates a decline toward extinction. Williams et al. (2008) determined at least 113 coho salmon must spawn in the mid-Klamath each year to avoid such effects of extremely low population sizes. Based on current estimates of the population, it is likely that the population is above depensation but it well below the low risk spawner threshold of 4,000 fish. Based on its abundance and productivity it is likely at moderate risk of extinction.

Adverse Hatchery Related Effects

Hatchery influences pose a medium stress for the population. Juveniles released from hatcheries compete with wild coho salmon juveniles for rearing habitat, migratory habitat, prey items, and thermal refugia. Hatchery juveniles are often larger and can displace wild juveniles in pools and other high quality habitats. In addition, when hatchery coho salmon adults return, a small percentage can stray and spawn with wild adults. Straying has the potential to reduce the reproductive success of the natural population (Mclean et al. 2003, Chilcote 2003, Araki et al. 2007) and negatively affect the diversity of the interior Klamath populations via outbreeding depression (Reisenbichler and Rubin 1999, HSRG 2004B). In addition, hatchery adults can increase crowding and disease transmission to wild adults when they are congregated in pools.

Extinction Risk

Because spawner abundance data and information about the natal population is so limited it is difficult to evaluate what the risk of extinction for this population may be. Based on the criteria set forth by Williams et al. (2008) the mid-Klamath population is likely at a moderate to high risk of extinction. This conclusion is based on the small population abundance (likely between 0 and 1,000 spawners depending on the year), the likely chance that the population is experiencing a chronic or precipitous decline in abundance over time, and a current spawner density likely below threshold levels (<1 per IP km). This population is fairly well distributed across the watershed, as evidenced by juvenile presence in most mid-Klamath tributaries, however, it is difficult to distinguish how well distributed the natal population is. It is also difficult to assess the number of spawners in all of the tributaries and to distinguish between non-natal and natal coho juveniles.

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

Hatchery program activities that may lead to the take of ESA-listed coho include:

Hatchery Operations

There are three potential sources of take associated with the IGH coho salmon program: take associated with the collection of spawners at the hatchery, take of natural coho salmon juveniles by adverse interactions (predation and competition) with hatchery production, and take associated with M&E activities.

Both HOR and natural origin (NOR) adults are used as broodstock at the hatchery. Because hatchery practices do not result in 100 percent survival by life stage, there are losses associated with each phase of operations. Under existing hatchery operations, a maximum of 270 coho salmon may be needed for broodstock. As the HGMP is implemented, it is expected that survival rates in the hatchery will improve and that the target of 135 coho salmon for broodstock will be met. Of the fish needed for broodstock, up to 50 percent of these will be of NOR. Additionally, some NOR adults not needed for broodstock may enter the facility; the collection, tagging and release of NOR fish back to the river may result in injury or mortality. It is expected that less than 1 percent of the fish collected and released will suffer injury sufficient to result in mortality (Keith Pomeroy, Hatchery Manager II, pers. comm. 2012). Any deviations to the above referenced brood stock collection targets must be approved by NMFS and CDFW annually.

Hatchery Releases

The potential for take of naturally-spawned juvenile coho salmon may result from intraspecific predation of fry by hatchery yearlings and from intraspecific competition between yearlings (Allee 1981, Larkin 1956). Some of the released hatchery coho salmon yearlings reside in the Klamath River above Big Bar for approximately 0.5 to 2 months and then migrate quickly to the ocean (CDFW 2003). The extent of intraspecific competition or predation by hatchery coho salmon yearlings with their wild counterparts during residency is unknown. No data has been collected in the Klamath River to quantify hatchery juvenile coho predation rates on wild salmonid fry or fingerlings.

Monitoring and evaluation

The operation of the Bogus Creek weir to enumerate coho salmon spawning escapement and collect (if needed) broodstock for the program may result in take of additional coho salmon. The level of take from handling will depend on the number of fish that return to the weir and are handled.

Spawning ground and carcass surveys are assumed to not result in directed take or mortality of adult fish, but will likely result in harassment of live fish on the spawning grounds. It is estimated that up to 6,000 carcasses, including 50 NOR and HOR live adults may be impacted by this work. Additionally, handling and harassment of juvenile fish will occur during operation of the Bogus Creek downstream weir. Up to 10,500 fish may be handled and tagged annually during trapping operations.

Hatchery Operations

The projected annual take levels for listed fish by life stage (juvenile and adult) has been quantified (to the extent feasible) by the type of take resulting from hatchery operations (e.g. capture, handling, tagging, injury, or lethal take) (Table 10). In general, it is expected that up to 5,000 adult coho salmon would be impacted by hatchery operations[11]. Of these 5,000, a maximum of 135 NOR would be used as broodstock, the disposition of the remainder will be determined by CDFW in consultation with NMFS.

Hatchery Releases

The 75,000 coho salmon juveniles released each year pose predation, competition and disease risks to naturally produced coho salmon, interactions that may result in take of listed coho salmon. While these possible impacts have not been quantified, PCDRISK-1 modeling (see Section 3.5) indicate that hatchery coho salmon releases likely take less than 6 percent of the natural juvenile coho salmon population.

Monitoring and Evaluation

Spawning and carcass surveys used to quantify adult composition (HOR and NOR) and collect genetic samples for determining spawning success may result in take of some coho salmon. Expected take from these activities is shown in Table 10 under Monitoring and Evaluation activities. It is estimated that up to 6,000 carcasses (3,000 HOR and 3,000 NOR), and 50 NOR and HOR live adults may be impacted by this work. The juvenile numbers in this row represent the number (10,500) of coho salmon that may be collected as part of the monitoring program at Bogus Creek weir/trap operations or the mainstem Klamath River (associated with hatchery operations).

2.2.3.1 *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*

The take levels in Table 10 will be monitored directly by CDFW staff on a daily basis. If the total take[13] is likely to exceed authorized levels, CDFW will consult with NMFS to determine appropriate actions.

[11] The 5,000 fish value results in large run years as a result of high HOR survival rates. HOR fish are included in the take table as they are considered a component of the listed population.

[13] The HGMP includes take estimates by activity, location, and type of take. Exceedance of authorized take will only occur if the total take exceeds the total amount of individuals by life stage included in Table 10.

Table 10. Summary of hatchery activities.

Location	Life Stage	Activity	Natural Origin (NOR)/ Year	Natural Origin (NOR subadult)/ Year	Hatchery Origin (HOR)/ Year	Hatchery Origin (HOR) subadult/ Year	Total per Year
Iron Gate Hatchery main fish ladder and auxiliary fish ladder.	Adult	Broodstock collection and associated activities (genetic sampling, etc.)	119 [a]	16 [a]	221 [a b]	49 [a b]	270 [a b]
		Disposition of excess salmon	1,940	425	1,940 [c]	425 [c]	4,730
Bogus Creek fish counting weir [d]	Adult	Broodstock collection	60	8	60	7	135 [d]
		Disposition of excess salmon	1000	180	1,000 [c]	180 [c]	2,360
Bogus Creek fish counting facility	Fry	Juvenile trapping, marking, and tagging	1,750	N/A	1,750	N/A	3,500
	Juvenile		1,750	N/A	1,750	N/A	3,500
	Smolt		1,750	N/A	1,750	N/A	3,500
Spawning grounds - monitoring and evaluation activities	Adult	Spawning surveys	41	9	41	9	100
		Tissue sampling/pedigree analysis	2,419	531	2,419	531	5,900

Location	Life Stage	Activity	Natural Origin (NOR)/ Year	Natural Origin (NOR) subadult)/ Year	Hatchery Origin (HOR)/ Year	Hatchery Origin (HOR) subadult/ Year	Total per Year
Iron Gate Hatchery and Bogus Creek trap	Juvenile and Smolt	Gill ATPase sampling	192	N/A	192	N/A	384
Iron Gate Hatchery	Juvenile and Smolt	Fish Health and Disease Monitoring	N/A	N/A	60	N/A	60
		Disease Research Educational Display, and/or culling	N/A	N/A	2,000	N/A	2,000
Iron Gate Hatchery	Eggs	Culling of excess hatchery eggs	N/A	N/A	100,000	N/A	100,000

[a] If there are less than 135 natural-origin coho salmon adults at IGH, natural-origin coho salmon adults from Bogus Creek will be used to supplement the broodstock at IGH to achieve the 20 to 50 percent natural-origin broodstock target. If there are less than 135 hatchery-origin coho salmon adults at IGH, hatchery-origin coho salmon adults from Bogus Creek will be used to supplement the broodstock at IGH.

[b] Maximum number of HOR adult coho salmon that can be taken if no NOR adult coho salmon return to IGH and fewer than 309 adult NOR coho salmon return to Bogus Creek.

[c] HOR coho salmon excess to hatchery broodstock needs may be released back to the river or euthanized if necessary in order to minimize HOR spawner percentages within the Klamath River. The decision to release coho salmon would be dependent on the strength of the coho salmon escapement at Bogus Creek (i.e., euthanization may only occur if there are over 309 NOR adult coho salmon in Bogus Creek) and research activities attempting to quantify total natural production and hatchery stray rates in natal spawning areas.

[d] Broodstock collection in Bogus Creek will only be done when managers determine that it is unlikely that sufficient natural-origin and/or hatchery-origin adult coho salmon will return to IGH.

3.0 RELATIONSHIP OF PROGRAM TO OTHER MANAGEMENT OBJECTIVES

3.1 DESCRIBE ALIGNMENT OF THE HATCHERY PROGRAM WITH ANY ESU-WIDE HATCHERY PLAN OR OTHER REGIONALLY ACCEPTED POLICIES. EXPLAIN ANY PROPOSED DEVIATIONS FROM THE PLAN OR POLICIES

The program has been designed to protect the genetic resources of the Upper Klamath Population Unit consistent with applicable agency guidelines and policies. Proposed actions and approaches are consistent with the principles and recommendations of the HSRG (2004b) developed for Pacific Northwest Hatchery programs. More recently, based on their review of the draft HGMP, the CHSRG recommended that this HGMP be approved and implemented (California HSRG 2012).

3.2 LIST ALL EXISTING COOPERATIVE AGREEMENTS, MEMORANDA OF UNDERSTANDING, MEMORANDA OF AGREEMENT, OR OTHER MANAGEMENT PLANS OR COURT ORDERS UNDER WHICH THE PROGRAM OPERATES

3.2.1 Klamath Hydroelectric Project FERC License

The hatchery program is operated as required by the FERC license for the Klamath Hydroelectric Project (FERC Project No. 2082). Construction of IGH was required by Article 49 of the FERC Project license. Article 50 of the Project license requires PacifiCorp to fund 80 percent of the ongoing operations and maintenance costs of IGH. PacifiCorp began funding 100 percent of IGH operations and maintenance costs in 2010 pursuant to the KHSA (see below).

3.2.2 Klamath Hydroelectric Settlement Agreement (KHSA)

The hatchery program is also operated consistent with the Klamath Hydroelectric Settlement Agreement (KHSA 2010). Under the KHSA, PacifiCorp commenced funding 100 percent of ongoing hatchery operations and maintenance costs in 2010. Hatchery operations include development and implementation of a HGMP as well as a 25 percent constant fractional marking program for fall Chinook. In addition, PacifiCorp will provide funding to meet ongoing hatchery mitigation objectives developed by the CDFW in consultation with NMFS for a period of eight years following the potential decommissioning of IGD. The proposed program is consistent with the KHSA.

3.2.3 PacifiCorp Interim Conservation Plan

PacifiCorp, through discussions with NMFS, developed an ICP based on NMFS' 2007 Biological Opinion. The ICP was finalized in 2008 and includes a set of conservation actions that are designed to minimize potential Project impacts on ESA-listed species, and provide important conservation benefits for those species and their habitats. Under the ICP, PacifiCorp proposed the development and implementation of an HGMP for IGH. With the completion and approval of the HGMP the program will be consistent with this plan.

3.2.4 PacifiCorp Habitat Conservation Plan

PacifiCorp and NMFS worked collaboratively to develop an HCP for an ESA Section 10(a)(1)(B) incidental take permit for operations and maintenance of the Hydroelectric Project for an interim period consistent with the duration of this HGMP. The HCP was completed in 2012, and incorporates the terms of the ICP with revisions, as well as including an objective of improving hatchery operations through development and implementation of an HGMP. Conservation actions included in the HCP are intended to work in conjunction with the HGMP to conserve listed species in the near- and long-term.

3.2.5 Klamath Basin Restoration Agreement (KBRA) for the Sustainability of Public and Trust Resources and Affected Communities

The KBRA is intended to result in effective and durable fisheries solutions for the entire Klamath River basin which will: 1) restore and sustain natural fish production and provide for full participation in ocean and river harvest opportunities of fish species throughout the Klamath Basin; 2) establish reliable water and power supplies which sustain agricultural uses, communities, and National Wildlife Refuges; and 3) contribute to the public welfare and the sustainability of all Klamath Basin communities. The program is consistent with the conservation objectives of the KBRA.

3.2.6 The Klamath River Basin Fishery Resources Restoration Act

Congress passed Public Law #99-552 in 1986. This act created the 20-year Klamath River Basin Fisheries Resources Restoration Conservation Area Restoration Program and Klamath River Restoration Task Force, which were comprised of federal, state and local officials, tribal representatives and commercial and sport anglers. In 1991, the Task Force developed the Long Range Plan for the Klamath River Basin Conservation Area Fisheries Restoration Program (KRBFTF 1991). The Act also established the Klamath Fisheries Management Council (KFMC), which recommended annual commercial, sport and tribal harvest levels to the Pacific Fisheries Management Council. With the completion and approval of the HGMP the program will be consistent with this plan.

3.2.7 Memorandum of Agreement between CDFW and BIA

This agreement authorizes the Bureau of Indian Affairs to unilaterally set the season and monitor the Yurok Tribal fishery. With the completion and approval of the HGMP the program will be consistent with this plan.

3.3 RELATIONSHIP TO HARVEST OBJECTIVES

Until coho run size increases dramatically there are no harvest objectives for the IGH coho hatchery program.

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

Accurate estimates of the number of IGH coho captured in fisheries is not available; but is assumed to be reflective of the rates described below for SONCC coho in general. Below is a summary of the harvest information provided by NMFS staff (Greer Maier, NMFS, pers. comm. 2010)

In 1993, the retention of coho salmon in ocean commercial fisheries was prohibited from Cape Falcon, Oregon south to the U.S./Mexico border. The following year, coho salmon retention was prohibited in ocean recreational fisheries from Cape Falcon, Oregon to Horse Mountain, California, and expanded to include all California waters in 1995. These prohibitions have continued to prohibit direct sport and commercial harvest of coho salmon off the California and Southern Oregon coast, the lone exceptions being a mark-selective recreational coho salmon fishery that took place between 1998 and 2002 and again in 2009 in Oregon waters. Directed river harvest of coho salmon has not been allowed within the SONCC coho salmon ESU since 1994. California's inland waters have been closed to coho retention since 1998.

The Yurok fishery has been monitored since 1992 and during that time harvest has ranged from 27 to 1,168 fish caught annually. Based on estimates of upstream escapement (in-river spawners and hatchery returns) this fishery is thought to amount to an average harvest rate of 4.4 percent for the period (CDFW 2004).

SONCC-origin coho salmon experience incidental morality due to hooking and handling in other fisheries (e.g., the Chinook fishery north of Humbug Mountain). Incidental ocean harvest rates for the period 1998-2003 ranged from 0.5 percent to 11.7 percent (Table 11). To reduce bycatch impacts, the Pacific Fisheries Management Council (PFMC) has set the by-catch limit at 13 percent (see link below). (http://www.pcouncil.org/salmon/stock-assessment-and-fishery-evaluation-safe-documents/preseasonreports/)

Table 11. Incidental catch rates of SONCC coho salmon in ocean fisheries (1998-2009)

Migration Year	Incidental Catch in Ocean Fisheries	Migration Year	Incidental Catch in Ocean Fisheries
1998	0.117	2004	0.086
1999	0.049	2005	0.055
2000	0.060	2006	0.052
2001	0.030	2007	0.058
2002	0.077	2008	0.010
2003	0.096	2009	0.028

3.4 RELATIONSHIP TO HABITAT PROTECTION AND RECOVERY STRATEGIES

The hatchery program is designed to assist in the recovery of Klamath River coho. The purpose of the hatchery program in Phase 1 (this HGMP) is the conservation and protection of the species genetic resources. In subsequent phases, the hatchery program will focus on re-colonization of habitat and then local adaptation and recovery. The hatchery will provide the quality fish needed to reintroduce coho salmon to stream habitat newly opened with either volitional fish passage or removal of the Klamath Hydroelectric Project. Key recovery efforts underway in the basin are presented below.

3.4.1 SONCC Coho Salmon Recovery Planning

In 2001, NMFS initiated development of a coho salmon recovery plan for the SONCC by convening a Technical Recovery Team (TRT) consisting of federal, state, academic, Tribal, local agencies and stakeholder groups. Phase I of the recovery plan developed delisting criteria and identified factors for decline, actions to circumvent or reduce impacts and monitoring needs. Phase II will develop potential recovery methods to achieve the goals developed by the Technical Recovery Team. In 2012 NMFS released the public draft of the SONCC coho salmon recovery plan for public review and comments.

Monitoring and evaluation associated with the hatchery program will address some of the monitoring needs identified by the TRT. The primary need being surveys of coho adult NOR and HOR escapement levels to small Upper Klamath Population Unit tributaries.

3.4.2 Recovery Strategy for California Coho Salmon

CDFW (2004) developed general recovery measures for the Klamath River Basin, as well as specific recommendations for the smaller watershed units that make up the larger hydrologic framework. The Hydrologic Subunits within the Klamath River Basin include Klamath Glen, Orleans, Ukonom, Happy Camp, Seiad Valley, Beaver Creek, Hornbrook and Iron Gate. There are numerous stakeholder and watershed groups involved in coho recovery and management efforts within the upper Klamath River subbasin. These groups include in part, Shasta Valley CRIMP, Shasta Valley Resource Conservation District, Klamath Resource Information System, French Creek Watershed Advisory Group. Siskiyou Resource Conservation District, Scott Valley Watershed Council, Salmon River Restoration Council, Karuk Tribal Fisheries, Yurok Tribal Fisheries, in addition to many Trinity River entities.

The coho salmon recovery plan includes hatchery operational principles to minimize the loss of diversity in existing coho salmon populations with hatchery influence. The plan recommends conservation strategy for hatchery operations, which includes comprehensive genetic analyses to detect inbreeding, out-breeding and domestication, as well as rearing and release techniques that maximize fitness and reduce straying. The plan recommends rigorous monitoring for all aspects of hatchery operations that affect the health and survival of both hatchery and natural coho salmon stocks as well as an evaluation of the hatchery's long-term success.

The IGH coho salmon program has been designed to be consistent with this plan to the extent possible given current agreements (KHSA for example).

3.5 ECOLOGICAL INTERACTIONS

3.5.1 Organisms that Could Negatively Impact Program

Organisms that have the potential to cause significant negative effects to the success of the IGH coho salmon program are steelhead, Chinook and coho salmon, as well as brown trout, otters, kingfishers, cormorants, mergansers, herons, marine mammals, and other animals that are part of the natural ecology and interact with hatchery-reared coho in the Klamath through predation and competition.

Disease organisms such as *Ceratomyxa shasta*, which is prevalent in the Klamath River, can have a large effect on coho survival (Nichols et al. 2008). The authors found that in 2007 coho salmon infection rates from this organism was 48 percent, making adaptation to the marine environment in the infected fish difficult.

3.5.2 Organisms that Could Be Negatively Impacted by Program

Competition between artificial and wild stocks occur when hatcheries plant large numbers of fish into the natural environment. IGH's coho salmon program has the potential to cause adverse effects to natural salmonid stocks through a variety of factors common to artificial propagation. Potential negative effects of hatchery stocks on wild stocks will be reduced with the implementation of this HGMP and operation of IGH as an integrated program. Potential mechanisms for potential negative impact include:

- Competition for food and space between natural and hatchery coho salmon yearlings
- Predation of wild salmonid young-of-the-year (YOY) by hatchery yearlings
- Disease transfer between hatchery and natural coho salmon stocks
- Influencing outmigration behavior of natural coho salmon
- Incidental coho salmon catch in Chinook salmon and steelhead fisheries
- Artificial selection of spawners leading to fewer effective spawners
- Loss of genetic diversity or replacement of natural stocks
- Inbreeding and out-breeding depression

Because cumulative hatchery coho impacts on natural coho population have not been documented, the PCDRISK- 1 model[12] was run to determine predation, competition and disease affects hatchery fish may pose to the natural population given some simple assumptions (Busack et. al. 2005). The model was developed by the Washington State Department of Fish and Wildlife and the Northwest Indian Fisheries Commission as part of their Risk Assessment Modeling Project for hatcheries. It was chosen for this HGMP as it provides a risk assessment of hatchery production effects to natural populations when empirical data is lacking.

The assumptions used in PCDRISK-1 modeling were as follows:

1. Hatchery coho release size – 75,000
2. Natural population size-75,000[13]
3. Hatchery fish size at release 157 mm, wild coho 141 (See Table 8)[14].
4. Percent overlap in time and space – 100 percent (See Table 7)
5. Amount of time juvenile hatchery coho in-river – 22 days (Beeman et. al 2008)
6. Average stream temperature at time of release (April)- 13 degrees C (Beeman et. al 2008)

Modeling results indicated that hatchery fish induced mortality on naturally produced coho salmon from predation, competition and disease is likely less than 6 percent. The impact is lower if natural population abundance is greater than 75,000, and higher if lower than 75,000.

[12] The PCD in PCDRISK stands for Predation, Competition and Disease.

[13] The larger the ratio of hatchery fish to natural fish the larger the impact. Since data are not available on natural coho abundance the ratio was set to 1:1, a conservative assumption (i.e. high impact).

[14] Impacts of hatchery coho juvenile releases on wild coho fry were not estimated as fry would be utilizing different habitat than that of hatchery smolts and therefore there would be only minor interactions.

Coho juveniles may also prey on fall Chinook juveniles rearing in the Klamath River. Because fall Chinook juvenile abundance is likely in the millions, program impacts to this population are likely small. For example, assuming a fall Chinook juvenile population of 1 million, an average juvenile size of 50 mm, and the other environmental conditions described for coho above, PCDRISK-1 modeling indicated that total mortality on fall Chinook from coho production was less than 0.001.

The monitoring proposed in Section 11 provides a means for reducing risks through better broodstock management, reduction of HOR adults on the spawning grounds as NOR run size increases, and the release of migratory ready juveniles. What impacts that do occur from hatchery production are being mitigated by the implementation of habitat actions below IGD to improve habitat for coho, and, secondarily, for other species that rely on this habitat to complete their life-histories.

3.5.3 Organisms that Could Be Positively Impacted by Program

The hatchery program is designed to provide benefits to ESA-listed coho by acting as a reserve for this species genetic resources. Because of declining coho salmon run-size in the basin, the habitat may not be capable of supporting natural production. The hatchery program will provide the adults and juveniles needed over time to prevent extinction and for reintroduction into newly opened habitat through habitat restoration activities or dam removal. The hatchery program could also provide excess adults, eggs or juveniles for supplementation efforts in the Upper Klamath, Scott River and Shasta River Population Units if deemed appropriate by NMFS and CDFW. Hatchery coho salmon also provide a food source for multiple species (otter, mergansers, herons, etc.).

The HSRG standards require that the proportion of natural origin fish in the hatchery brood (pNOB) must exceed the proportion of hatchery fish on the spawning grounds (pHOS). This action ensures that the natural, rather than the hatchery, environment drives local adaptation. The HSRG also recommends that pNOB be 20 percent at a minimum. Therefore, the IGH will target a 20 percent minimum contribution (50 percent maximum) of natural origin fish to the broodstock[15].

[15] The 50 percent maximum value was established in discussions with NMFS to reduce impacts associated with removing a large number of natural spawners from the population. It is recognized that both the 20 percent and 50 percent values for natural fish inclusion are target values that may not be achieved in some years due to low natural returns or misidentification of the origin (NOR versus HOR) of returning adults.

4.0 WATER SOURCE

4.1 WATER SOURCE (SPRING, WELL, SURFACE), WATER QUALITY PROFILE, AND NATURAL LIMITATIONS TO PRODUCTION ATTRIBUTABLE TO THE WATER SOURCE

The water supply for IGH originates at the 17- and 70-foot depths of Iron Gate Reservoir. This water source is not significantly different from mainstem water in the upper Klamath where the natural coho salmon population occurs; therefore there are no natural limitations to production from the water source. Water temperatures range from 38-45 ^{o}F (3.7-7.2 ^{o}C) and 50-60 ^{o}F (10-15.7^{o} C) in the winter and summer months, respectively. Water temperature in the hatchery is within the threshold limits for coho salmon growth and development. The summer water temperatures in the hatchery are cooler than the natural river temperatures (which typically exceed 20 ^{o} C) since hatchery supply water is blended from two depths in Iron Gate reservoir. Water chemistry is routinely monitored following requirements of the NPDES permit.

The different depths of the two intake valves (17- and 70-foot) provide partial control of water temperature. Water flows by gravity to the hatchery by way of an aeration tower capable of processing up to 54 cfs or 35 million gallons per day (mgd). The spawning and rearing facilities utilize 24 cfs and 30 cfs, respectively.

Approximately 18 to 28 cfs (12 to 18 mgd) of water flows through the holding ponds and down the fish ladder. Hatchery workers bypass a small amount of water through a tube that returns fish from the spawning house to the river.

Ambient water quality for IGH is presented in Table 12. A figure showing IGH water facilities is provided in Figure 7.

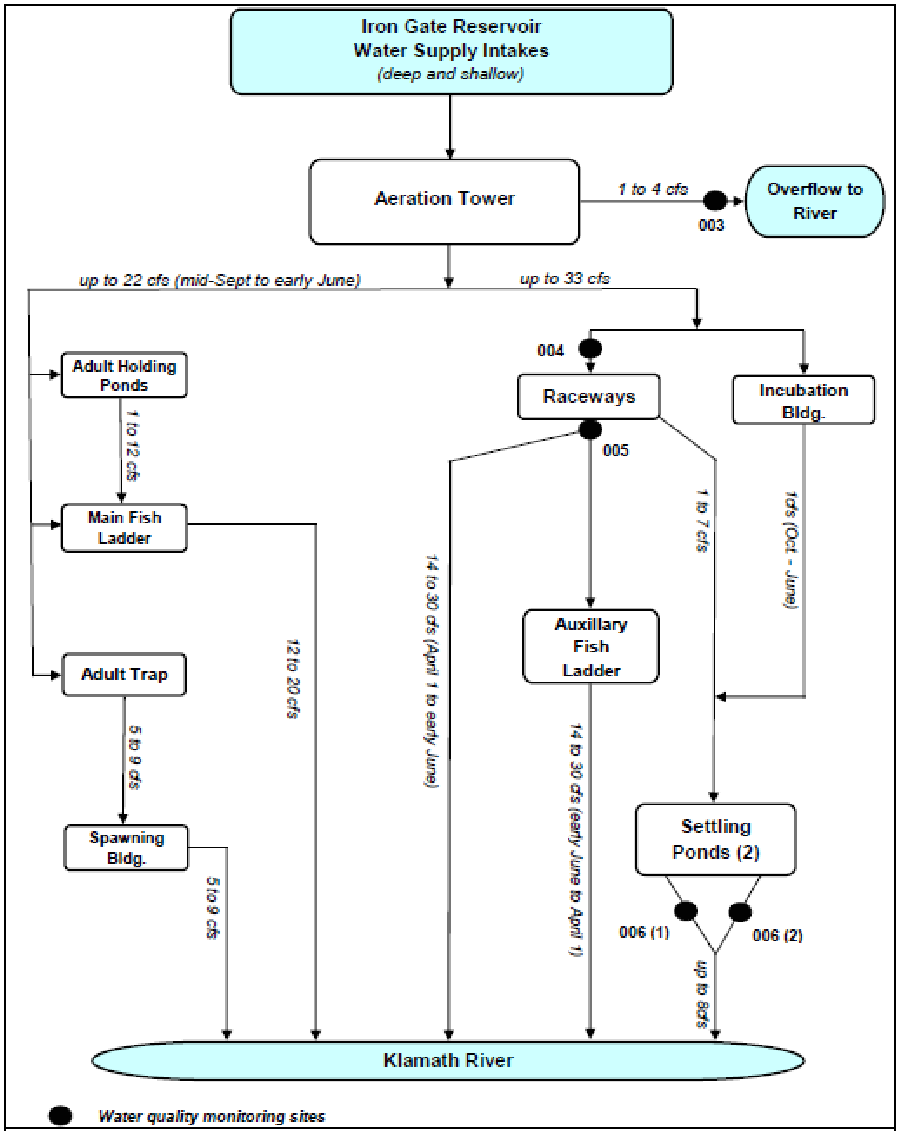

Figure 7. IGH water routing and associated water quality monitoring sites.

Table 12. Iron Gate hatchery influent water conditions.

Parameter	Units
Dissolved Oxygen	8 ppm (summer)
	12 ppm (winter)
Suspended Solids	Below detection.
pH	7.0 – 8.0
Temperature*	Maximum: 60 ^{o}F
	Minimum: 38 ^{o}F
2010 Monthly Average Water Temperature (^{0}F)	
January – 39.7	July- 54.0
February- 41.7	August- 53.3
March- 43.7	September- 57.3
April- 46.7	October- 54.0
May- 53.3	November- 55.7
June- 57.3	December- 42.0

* approximate

The North Coast Regional Water Quality Control Board (NCRWQCB) establishes conditions for hatchery operations to maintain the beneficial use of the Klamath River as authorized by the Clean Water Act (CWA) for the National Pollutant Discharge Elimination System (NPDES) Permit Program. This program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. The NCRWQCB water quality standards establish limits on effluent discharge including prohibiting direct effluent discharge from the hatchery to the Klamath River with any detectable level of chemical with exception of carbon dioxide. The effluent discharge standards required by NPDES Permit No.CA0006688 for IGH are presented in Table 13. The NCRWQCB requires effluent sampling on a monthly basis during February, March, April, May, and September and reporting of the results quarterly as well as annually to document permit compliance.

Table 13. Daily and monthly effluent discharge standard for Iron Gate Hatchery established by the California North Coast Regional Water Quality Control Board.

Parameter	Daily Maximum	Monthly Maximum
Total Suspended Solids	15 mg/l	8.0 mg/l
Total Settleable Solids	0.2 ml/l/hr	0.1 ml/l/hr
pH	6.5 – 8.5	6.5 – 8.5
Dissolved Oxygen	7.0 ppm (minimum)	7.0 ppm (minimum)
Turbidity	20% over background	20% over background
Flow	5.5 mgd	No standard

4.2 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

Impingement or entrainment of listed species due to water diversion for IGH is not possible because water intakes are located above IGD - above the current range of listed species. Similarly, there is negligible risk of coho salmon take as a result of effluent discharge due to the rigid standards outlined in the NPDES Permit, which have been developed to be protective of designated beneficial uses, which include salmonid rearing, spawning, and migration life stages.

Regularly scheduled cleaning maintains sanitary conditions within the hatchery ponds by removing excess feed, metabolic waste, algae, silt and other organic materials. This material is diverted into two settling ponds for treatment prior to being discharged into the Klamath River. Portions of raceway water are discharged into the Klamath River when the raceways are not being cleaned.

5.0 FACILITIES

A description of hatchery facilities used to raise coho is presented below.

5.1 BROODSTOCK COLLECTION FACILITIES (OR METHODS).

The primary fish ladder leads coho salmon into a trap adjacent to the spawning house at IGD. Hatchery personnel crowd fish toward the spawning house and manually raise a screen to allow 30-50 fish to enter and spill into a basket, which sits in a holding tank. Chinook salmon receive an electric shock to pacify the fish for handling, but the shock duration is lessened to $\leq$ 5 seconds if coho salmon are present. When coho numbers increase they are pacified by use of CO_2. The basket lifts hydraulically to a level that allows the fish to slide onto a table where hatchery workers sort them by species, sex and identifying marks. Coho salmon excess to hatchery broodstock needs may be released back to the river or euthanized if necessary in order to keep controls on the HOR percentages within the Klamath River. Coho salmon collected at the auxiliary fish ladder at IGH, or in the future at the Bogus Creek weir, will be transported from these sites and handled in a similar manner.

5.2 FISH TRANSPORTATION EQUIPMENT (DESCRIPTION OF PEN, TANK TRUCK, OR CONTAINER USED).

An auxiliary eight-step weir-pool fish ladder and trap is located adjacent to the hatchery rearing ponds. Hatchery workers transfer coho salmon from the auxiliary ladder to the primary trap at the foot of the dam using a 400 gallon rectangular tank mounted on a flatbed, one ton truck. Oxygenation is maintained by a centrifugal pump and a custom built slotted manifold that recirculates water from the tank. The pump is operated by a 5 hp gasoline powered engine. The truck is pump filled with water from the auxiliary trap and temperature is not regulated. The tank truck is backed to a slide that directs coho as they are mechanically lifted and removed from the trap. The tank has a large rectangular opening on the top with a hinged lid to facilitate loading fish from the auxiliary trap. Approximate capacity is about 60 adult salmonids for each trip. A smaller opening (salmon gate) at the rear of the tank is used to empty the contents of the tank into the main trap at the base of the dam. The tank bottom is sloped slightly rearward into a large slide which directs coho into the main trap at the base of the dam. Loading fish and a one way trip from the auxiliary ladder to the main trap is less than 5 minutes. Fish transported from the Bogus Creek weir would be a few minutes longer but no more than a 10 minute trip after loading.

Generally, 30-50 percent of all coho salmon enter IGH at the auxiliary fish ladder contingent on Klamath River flow conditions. The remainder of the broodstock is collected at the ladder at IGD.

Bogus Creek fish needed for broodstock would be collected at the weir, transferred to the truck and transported to spawning facilities similar to that done for the auxiliary ladder.

5.3 BROODSTOCK HOLDING AND SPAWNING FACILITIES.

The hatchery workers place unripe hatchery-marked coho salmon (and coho awaiting the results of genetic sampling) into one of the six 5 x 30-foot circular concrete holding ponds that are connected to the spawning building (at IGD) by flumes running the length of the building; three on each side of the building. Each of these tanks has a separate water supply valve and center drain and is capable of holding approximately 750 adult salmon.

The Bogus Creek weir will be checked a minimum of twice a day for the presence of coho salmon adults. Caught fish will be removed from the weir trap and transported to the adult holding facilities at the dam if needed for broodstock.

5.4 INCUBATION FACILITIES.

The hatchery building contains 123 incubator stacks with eleven trays in each stack, which have the capacity to incubate approximately eleven million Chinook salmon, 500,000 coho salmon and one million steelhead eggs. A total of 13 stacks (11 trays per stack) are available for coho salmon production. The hatchery building uses approximately 1.5 cfs of water during peak production. Water from overhead three-inch pipes provides water to the top tray of each stack, which remains empty to buffer the force of the cascading water and act as a settling basin. Three fiberglass troughs and four fiberglass tanks are located on the inside of the hatchery building, in addition to four fiberglass tanks on the outside. The hatchery building's plumbing configuration allows water to recycle through the incubator system in case of emergency. The Operation Manual provides a detailed schematic of the hatchery building plumbing system.

In the future a water filtration system, or moist air incubator, may be added to the system if on-going monitoring results indicate that such systems would increase egg-incubation survival.

5.5 REARING FACILITIES.

Rearing ponds consist of a series of eight paired concrete raceways that are ten feet wide and 400 feet long. Each raceway can be divided into a series of four 100-foot long ponds using a screen or dam boards. The first pond of each series can be subdivided into two 50-foot ponds to isolate smaller fish lots, if necessary. Water enters into each raceway series through three rectangular openings in the head flume. Each opening has an adjustable valve, which controls water flow through the raceways. Generally, the hatchery maintains water depth at 24 inches by using four 2” x 6” boards below each pond. Raceway effluent discharges directly from the ponds and is distributed either to the Klamath River through the fish release pipe, auxiliary ladder or to settling ponds. The distribution for the raceway effluent discharge depends on its use within the pond series and conditions outlined in the NPDES Permit.

To reduce fish losses from bird predation, raceways rearing coho salmon were covered with netting in 2011. This action was implemented when identified as a serious mortality issue in the draft HGMP.

5.6 ACCLIMATION/RELEASE FACILITIES.

As previously discussed, the raceway tailrace discharge can be manipulated to empty directly into the Klamath River. Fish are acclimated in the raceway and volitionally released or crowded through this mechanism to the river. The current policy at IGH is to allow coho salmon yearlings to leave volitionally over a one week period.

5.7 DESCRIBE OPERATIONAL DIFFICULTIES OR DISASTERS THAT LED TO SIGNIFICANT FISH MORTALITY.

Bacterial Columnaris (*Flavobacterium columnare*), a ciliated protozoan called Ich (*Ichthyophthirius multifiliius*) and two myxozoans *Ceratomyxa shasta.* and *Parvicapsula minibicornis* naturally occur within the Klamath River Basin. These pathogens infect natural salmonid populations, especially during stressful environmental conditions (CDFW 2003). Despite their natural occurrence within the Klamath River Basin, these pathogens are not major sources of mortality at IGH. However, minor outbreaks of costia (*Ichthyobodo necator*), bacterial gill disease (*Flavobacterium branchiophilum),* columnaris and coldwater disease ((*Flavobacterium psychrophilum*) occur infrequently (Kim Rushton, Hatchery Manager II, Personal Communication 2010). Most of these conditions affect fish at the fingerling life stage. The hatchery workers avert most disease outbreaks by reducing pond density, as necessary.

Soft shell (aka coagulated egg yolk) disease historically accounted for most coho salmon mortality at IGH. The causative agent (bacterium or possibly an amoeba) is endemic in the water supply. The hatchery workers prevent the introduction and spread of this disease among eggs by application of a daily PVP iodine treatment, which has reduced soft-shell disease issues. Studies of the efficacy of reduced iodine treatment are underway at IGH and suggest that perhaps one half as much iodine is effective for protecting eggs.

Egg-survival rates are still low at the hatchery. Hatchery staff is currently experimenting with changes in PVP iodine treatment levels and egg incubation densities to increase survival rate. If these actions do not increase survival rate then alternative actions (such as moist-air incubation) will be tested.

Bird predation on juvenile hatchery coho salmon has been an issue in the past, but this problem was fixed with the addition of netting over raceways rearing coho salmon in 2011.

5.8 AVAILABLE BACK-UP SYSTEMS AND RISK AVERSION MEASURES

Hatchery operations have an inherent element of risk during each stage of fish culture due to the potential for disrupted water supply, poor water quality, disease outbreaks, fish handling and transport. The hatchery managers train all staff members to respond to any unforeseen emergency and avert stochastic fish loss. A hatchery employee is on duty at all times or on standby in housing on the hatchery grounds for quick response, as necessary.

The hatchery employs all possible measures to avert stochastic fish mortality. For example; 1) the hatchery building has both an electric and diesel-powered pump that are individually capable of recirculating water within the incubator/trough system for 24-30 hours[16], 2) the hatchery water system is equipped with an alarm to notify staff in the case of disrupted water supply, and 3) trained personnel are available at all times to respond to any unforeseen emergency. In addition, the facility has alarms that sound when water supply problems occur[17] and back-up systems are being updated to current culture standards.

Drills are conducted periodically, twice a year to familiarize the staff with the operation of the standby system in the hatchery building. This includes water flow management and operation of the facility in case of a water and/or power outage. Measures are discussed as to the final disposition of the each species in case of a catastrophic event; depending on the life stage and consequences of salvage compared to wild stocks and ambient river conditions.

Daily operations include removal of dead fish from the hatchery ponds and an assessment of fish health, behavior and physical attributes. Fish culturists report abnormal mortality levels, behavior or condition that indicates disease outbreak or parasitic infestation to the CDFW Pathology Lab. A fish pathologist immediately tests for pathogenic agents and prescribe treatment, as necessary. In addition, fish pathologists take ovarian fluid samples from coho salmon spawners at IGH each year and test for bacterial and viral agents, specifically Renebacterium *salmoninarum*, the causative agent for Bacteria Kidney Disease and Infectious Hematopoietic Necorsis Virus (IHNV), a lethal virus for salmon and trout for which there is no effective treatment.

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[16] The generator is started weekly as part of the weekly checks performed by the staff at Iron Gate Hatchery.

[17] Although the water source for the hatchery is the reservoir, debris plugging the intake has not been an issue.

The hatchery is located at the foot of IGD and immediately upstream of Bogus Creek. The elevated foundation of the hatchery infrastructure above Bogus Creek protects the facility from flooding. There is minimal potential for flooding from the Klamath River due to controlled flow releases for power generation from the Klamath Power Project.

Bird netting was added in 2011 to the raceways used for rearing coho to minimize predation caused by birds.

6.0 BROODSTOCK ORIGIN AND IDENTITY

A description of broodstock origin and identity is presented in the sections to follow.

6.1 SOURCE

Only Klamath River origin coho salmon will be used for broodstock in the IGH program. Trinity River Hatchery fish, Cole M. Rivers and other hatchery populations will not be used as broodstock if they are collected at IGH.

6.2 SUPPORTING INFORMATION

6.2.1 History

Historic information for coho salmon in the Klamath River was scarce until the Federal Bureau of Fisheries constructed a fish weir near the Klamathon town site (River Mile 185.6). The weir provided a means to count fish and take eggs for the State. In 1911, Sisson Hatchery (Mount Shasta Hatchery) released coho salmon fry into both the Sacramento and Klamath rivers from eggs taken at the weir (Snyder 1931).

In 1912, the Bureau of Fisheries also built a hatchery near Hornbrook and raised Chinook and coho salmon from 1912 to 1916 (Table 14). The federal government closed the hatchery in 1919 and relinquished its authority in the Klamath River Basin, which temporarily gave the California Fish and Game Commission unilateral management responsibility.

Table 14. Coho salmon egg-take and production at Hornbrook, California from 1910 through 1916 (CDFW data files).

Season	Eggs taken	Coho Produced	Numbers Released into Klamath River	
			Fry	Yearling
1910	2,109,000	Unknown	700,000	NA
1911	NA	NA	NA	NA
1912	NA	17,320	17,320	NA
1913	3,129,000	2,632,300	2,548,960	NA
1914	NA	2,375,770	1,398,000	NA
1915	2,823,000	2,169,050	2,169,050	NA
1916	NA	61,000	50,000	11,000

In 1919, the California-Oregon Power Company built a fish hatchery on Fall Creek and rebuilt the Klamathon weir to mitigate for lost habitat above Copco No. 1 dam (Leitriz 1970). The California Fish and Game Commission funded Fall Creek Hatchery as a source of salmon and steelhead eggs until 1961. Approximately 3,400,000 Chinook salmon and 600,000 steelhead were released on average between 1930 and 1948 (KRBTTF 1991).

IGD was built in 1961 as part of the Klamath Hydroelectric Project (Project) and is operated under a license issued by the FERC. Under the FERC license, PacifiCorp was required to construct a fish hatchery to mitigate for lost spawning and rearing habitat between Copco No. 2 Dam and IGD.

Prior to 1976, the Klamath River Basin had a long history of stock import. The earliest record in the late 1800s indicates a plant of 300,000 fry and 160,000 yearling coho salmon directly into Trinity River and Supply Creek from Fort Gaston, near Hoopa. These fish originated from Redwood Creek near Orick, CA and another unknown source, probably from outside of the basin (CDFW 2002). Darrah Springs and Mad River hatcheries planted the Klamath Basin with fish from the Alsea River, OR (1962-63 and 1971-72), Big Creek, OR (1968), Cascade Hatchery, OR (1970), Klaskanine River, WA (1964, 1966-67), Noyo River, Fort Bragg, CA (1970-71) and Freshwater Creek, Humboldt County, CA (1988).

In 1965, IGH began coho salmon production with 85,020 fingerlings and 65,000 eggs imported from TRH, which originated at Cascade Hatchery in Oregon (Riley 1967a). In 1966, 1967 and 1968, respectively, CDFW procured 1,932 eggs, 23,645 eggs, and 15,037 eggs from Klamath River coho salmon. CDFW imported 65,500 eyed-eggs, 76,946 eyed-eggs, and 60,450 eyed-eggs from Cascade Hatchery in 1966, 1967 and 1968, respectively, to augment production at IGH (Riley 1967 b, 1968). In 1975, TRH transferred 72,400 eggs to IGH to augment the 90,569 eggs taken from endemic coho salmon stock (Arnold 1977, Hubbell 1991). Since 1976, IGH used only Klamath River coho salmon as broodstock. However in 2009, 11 Trinity River hatchery fish were included in the broodstock (approximately 25 percent of the fish spawned).

6.2.2 Annual size (of Spawning Stock)

Typically, the hatchery has collected (i.e. kept as broodstock) about 200 coho spawners to hedge against in-hatchery losses. Because of the low returns of both natural and hatchery origin coho salmon in recent years (Table 15), it is now necessary to increase the overall survival from hatchery spawner to returning adult in order to a) assure that the hatchery component of the population is sustainable over time and b) increase the proportion of natural origin spawners in the broodstock to at least 20 percent (maximum of 50 percent). Specific measures will be taken to ensure a minimum 60 percent in-hatchery survival (see Section 9). The goal however is to increase egg-to-smolt release survival to 80 percent.

Table 15. Annual return of unmarked (NOR) and marked (HOR) adults to the Iron Gate Hatchery and Bogus Creek from 2004 to 2011 (CDFW data files).

	IGH		Bogus Creek	
Year	NOR	HOR	NOR	HOR
2004	401	1,094	367	42
2005	138	1,257	54	48
2006	60	203	44	0
2007	126	499	149	84
2008	22	1,256	76	35
2009	11	46*	7	0
2010	84	344	111	43
2011	61	386	36	106
Average	113 (15%)	617 (85%)	108 (70%)	46 (30%)

* 11 of the 46 fish were from Trinity River Hatchery. Trinity origin fish will no longer be used for broodstock.

The annual size of the IGH coho salmon broodstock is determined by the mitigation smolt production goal of 75,000. The maximum number of fish needed for broodstock will depend on in-hatchery survival rates by life stage and requirements of the active broodstock management program that was implemented in 2010 (See section 7.4). It is estimated that a maximum of 270 fish (males, females, jacks) may be needed for broodstock until egg incubation survival rates improve.

6.2.3 Past and proposed level of natural fish in broodstock

A variable fraction of the annual return of coho salmon to IGH is of natural origin. Prior to Brood Year (BY) 1994, when hatchery fish were first marked, it is likely that the hatchery spawned natural stock in the same proportion as they occurred in the return to the hatchery (roughly 15 percent in most years). Between 2004 and 2009 the goal was to incorporate 10 unmarked adults in a total brood take of 200 adults[18]. In 2009 the goal changed to maximizing NOR and HOR crosses in the coho salmon broodstock and a total of seven (six adults, one jack) unmarked fish were used in the broodstock out of a total of 40 fish. The poor returns of both the natural and hatchery components of the Upper Klamath coho run in recent years call for greater emphasis on preservation of the genetic resources. Over the next decade, or until habitat conditions improve significantly, the broodstock management of the IGH will emphasize

[18] The 10 adult fish NOR goal was achieved in years 2004-2007, with 9 and 6 NOR adults used in 2008 and 2009, respectively.

conservation. The IGH program will seek, over time, to achieve the standards recommended by the Hatchery Scientific Review Group for what they refer to as a contributing population (HSRG 2009)[19]. A contributing population requires that the proportion of natural origin fish in the hatchery brood (pNOB) must exceed the proportion of hatchery fish on the spawning grounds (pHOS) (i.e. a PNI of > 0.5). The HSRG also recommends that pNOB be 20 percent at a minimum. Therefore, the IGH will target a 20 percent minimum contribution of natural origin fish to the broodstock. To reduce impacts to natural production pNOB will not exceed 50 percent.

Information about spawner abundance and composition in the upper Klamath and its tributaries is limited, however, the available evidence suggest that Bogus Creek-IGH population may represent the core of the remaining population. In the near term the proposed approach is to actively manage the abundance and composition in Bogus Creek and in the hatchery and to monitor escapement in the remainder of the upper Klamath River[20]. The need to incorporate broodstock from other areas will be determined over time as genetic and population data are collected as part of the M&E plan (Section 12).

Since the coho population is at a risk of demographic extinction, the broodstock strategy must balance this risk against genetic risks associated with hatchery influence. The proposed strategy is outlined in the schedule presented in Table 16.

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[19] The Upper Klamath Population Unit is one of nine units that "Contribute" to the health of the entire Klamath River coho salmon population. The HSRG defines a contributing population as one where small to medium improvements are needed to achieve recovery objectives. If dams are removed, the population definition may be changed to a Primary; which is a population that is targeted for full restoration.

[20] Note that as more is learned about NOR escapement in other tributaries HOR escapement may be managed based on combined NOR production for all tributaries associated with the Upper Klamath Population Unit rather than just that in Bogus Creek.

Table 16. "Sliding scale" schedule for managing IGH coho salmon broodstock and natural spawning escapement in Bogus Creek.

	Escapement	Hatchery Broodstock	HOR Escapement to Bogus Creek
Low Adult Escapement	NOR 0-309	Minimum pNOB = 20%, maximum of 50%	No limit on pHOS
High Adult Escapement	NOR > 309	Minimum pNOB = 20%, maximum of 50%	pHOS < 50%, PNI >0.5

In the near-term it is expected that low adult escapement conditions will occur relatively frequently. As run size increases, and if harvest rates remain low, high escapement conditions will occur more often.

Note that the HSRG standards (i.e. pNOB > pHOS) will be met only at high natural fish escapement levels. In low escapement years a greater proportion of hatchery fish will be allowed to spawn naturally in Bogus Creek to maintain a minimum natural spawner abundance of 309 adults, if possible[21]. The incorporation of jacks and avoidance of sibling and half-sibling crosses will help maintain existing genetic diversity and increase the effective population size.

6.2.4 Genetic or ecological differences

Olin (1984) found a generally low level of diversity in California coho salmon. CDFW (2002) reasoned the low diversity was a result of declining abundance of all or a large portion of the existing natural spawning populations, or some level of homogenization of stocks. Historical stock transfers and outplanting of coho salmon may also explain the absence of geographic patterns of genetic variation in California. NMFS (2004a) reported a close relationship between microsatellite DNA samples from IGH and Trinity River coho salmon within the Northern group and a determination that IGH stock were considered to be no more than moderately diverged from the local natural population. However, NMFS (2004b) expressed concern about latent founder effects from non-indigenous broodstock from Cascade Hatchery in Oregon and TRH, which were used, in part, to start the coho salmon program at IGH (Hubbell 1991). In addition, the Salmon Hatchery Inventory and Effects Evaluation Report (SHIEER)

[21] Disposition of excess hatchery fish will be made in consultation each year with NMFS.

(NMFS 2004a) stated that the historic peak run timing shifted slightly later from early November to the period of mid- November to mid-December (NMFS 2004b). This report theorized that the hatchery might be selecting adults from the later part of the run, due to the location of the hatchery in the uppermost reach of the river. It is also possible that the change in run timing is the result of egg culling methods which may have selected for eggs from the later portion of the run.

SHIEER indicated that age-2 fish returns are more numerous than their natural counterparts in the Klamath River, although direct comparison is not possible due to high winter flows, which makes counting weirs inoperable (NMFS 2004b). Grilse have comprised 18 percent of coho salmon returns to IGH since the 1984/1985 season.

IGH traditionally excluded jacks from broodstock. This practice artificially selects for size and life history and results in the reduction in intergenerational gene flow. Generally, maintenance of genetic diversity requires the use of jacks as broodstock. Coho salmon broodstock management will be updated as needed based on genetic analysis and escapement targets, with pHOS and pNOB adjusted accordingly.

NMFS has identified nine distinct coho population components in the Klamath Basin. The Upper Klamath Population Unit is one of these. The genetic information available suggests relatively little variability among the coho populations in the ESU (Weitkamp et al. 1995).

6.2.5 Reasons for choosing broodstock

The main purpose of the hatchery program is conservation; hence the local coho salmon population is the most appropriate broodstock.

6.3 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

The following management options are proposed to minimize domestication and divergence, as well as mitigate adverse genetic or ecological effects to listed natural fish because of broodstock selection practices

- All fish releases will be externally marked for identification upon return

  Rationale: This allows managers to determine and control the proportion hatchery fish spawning naturally (reduced adverse genetic impacts) and implement selective fisheries for HOR adult if needed.

- Only local broodstock will be spawned, either hatchery fish originating from IGH or unmarked fish volitionally entering IGH or captured at the Bogus Creek weir

  Rationale: Fish locally adapted to the receiving environment are assumed to have higher survival rates and fitness.

- Trinity River hatchery (or any other non-IGH hatchery fish) fish will not be used as broodstock

  Rationale: The use of non-locally adapted as broodstock reduces population fitness and survival

- When available a minimum of 20 percent and maximum of 50 percent, of the broodstock will consist of natural origin (unmarked) coho salmon.

  Rationale: Incorporation of natural origin fish as broodstock ensures that the hatchery population does not diverge genetically from the natural population.

- Broodstock (ripe) will be collected throughout the run with no bias toward physical characteristics (e.g. size)

  Rationale: Collecting fish throughout the entire migration maximizes retention of natural run characteristics and helps ensure that hatchery practices are not selecting for specific traits that may reduce fitness.

- Jacks will be incorporated into the broodstock at rates defined in the spawning matrix.

  Rationale: Jacks allow for gene flow between brood years and eliminate divergence between years.

- Spawner abundance and hatchery to wild composition of natural spawning escapement in Bogus Creek will be monitored and managed

  Rationale: The goal is to have the natural rather than the hatchery environment drive local adaptation. Fish adapted to the natural environment are likely to have higher survival rates and be more resilient to environmental change.

- Spawning escapement abundance and hatchery-wild composition in other Klamath tributaries will be monitored

  Rationale: Hatchery fish strays spawning in the wild have the potential to reduce the fitness, diversity, productivity and survival rates of natural populations. Straying rates > 5 percent are assumed to pose significant risks to natural origin fish.

- Pedigree (genetic) analyses will be conducted to determine productivity of NOR and HOR adults spawning naturally

  Rationale: Hatchery origin fish spawning with natural origin fish may reduce the productivity of the natural population. The pedigree analysis will allow researchers the ability to quantify this effect and alter HOR stray rates accordingly.

7.0 BROODSTOCK COLLECTION

7.1 LIFE HISTORY STAGE TO BE COLLECTED (ADULTS, EGGS, OR JUVENILES)

Adult females, adult males and precocious males (jacks) will be collected for broodstock.

7.2 COLLECTION METHOD OR SAMPLING DESIGN

The goal of the broodstock collection protocol is to maintain genetic diversity and genetic continuity with the naturally spawning coho salmon population. The intent is also for the natural environment to drive the adaptation of both the natural and hatchery components of the Upper Klamath Population Unit.

Broodstock will be collected in three locations, the auxiliary ladder at the hatchery, the main ladder at IGD and, if necessary, at the weir located in Bogus Creek. Broodstock will be collected at random throughout the entire run in all locations (Table 17).

7.3 IDENTITY

Adults and jacks used as broodstock will be uniquely identified (using holding tubes, PIT tags or floy tags) and segregated so that they may be uniquely identified when spawned. The unique marker will be cross referenced with the tissue sample number to allow hatchery personnel to spawn pairs according to the genetic analysis results used in establishing mating protocols. Coho salmon yearlings are marked with a left maxillary-clip for identification as IGH fish. In contrast, coho salmon reared at Cole M. Rivers and Trinity River hatcheries are marked with an adipose fin-clip and right maxillary-clip (RM), respectively. IGH will not spawn any of these non-IGH fish if they enter the facility unless directed by the NMFS.

Table 17. Timing of coho returns to IGH hatchery by week for BY 1993-2006.

	Oct					Nov				Dec				Jan	
	40	41	42	43	44	45	46	47	48	49	50	51	52	1	2
2006			5	25	80	78	82	44	18						
2005			3	29	144	275	478	174	210	98	3	10	1		
2004			30	203	385	336	265	118	143	124	122	4	1	3	
2003		6	54	125	313	329	343	146	192	20	26	1	4		
2002		6	16	31	87	173	148	200	206	264	40	228	0	0	2
2001		6	59	139	397	444	430	564	323	69	124	0	0	18	
2000	2	14	94	236	250	209	195	152	96	43	44	15	2	1	
1999			5	10	21	27	68	17	9	12					
1998			18	112	122	190	307	242	68	51	10	17			
1997			58	258	533	626	217	142	68	51	10	17			
1996	6	22	200	746	1,275	692	575	296	226	28	8	22	3		
1995			4	51	318	368	400	300	78	38	20	3			
1994		1	3	16	64	48	49	15	30	10	20	13			
1993			9	12	30	146	154	67	142	81	54	0	4	5	
Average	**0.04%**	**0.3%**	**2.8%**	**9.8%**	**19.8%**	**19.4%**	**18.3%**	**12.2%**	**8.9%**	**4.4%**	**2.4%**	**1.6%**	**0.1%**	**0.1%**	**0.04%**

7.4 PROPOSED NUMBER TO BE COLLECTED

7.4.1 Program goal

With implementation (and achievement) of mitigation measures designed to increase in-hatchery survival rates, the program will require a minimum of approximately 135 adult spawners (45 female, 90 male). The number of females required for broodstock was calculated based on the following assumptions:

- Fecundity = 2,800
- Egg-to-Smolt Survival = 60 percent
- Total Juvenile Release = 75,000

Formula 1:

Total Juvenile Release/Egg-to-Smolt Survival/Fecundity = 45 females

The total number of males (jacks and adults combined) needed is based on a 2:1 ratio of male to female spawners (45* 2 = 90 males); this action increases diversity and fertilization rates (which have been low in past years). Jacks would be incorporated into broodstock based on the spawning matrix developed by NMFS and CDFW geneticists.

The maximum number of males, females and jacks used each year is likely to vary based on the active broodstock management program implemented in 2010 and in-culture hatchery survival rates (male to female rate may vary). Under this program, real-time genetics analysis of all spawners will be used to develop a spawner list based on relatedness. The goal of this program will be to reduce inbreeding among hatchery broodstock. The total number of broodstock required to effectively implement this program in 2010 was 270 fish (male to female ratio may vary). This number was calculated based using formula-1 with an egg-to-smolt survival rate of 30 percent (the value observed under current rearing conditions). As in-hatchery survival rates increase to the target 90 percent value for egg incubation, broodstock needs will be closer to the 135 fish spawner target.

Broodstock may consist of up to 50 percent NOR coho.

7.4.2 Broodstock collection levels for the last twelve years

Historical broodstock collection numbers can be found in Table 18.

Table 18. IGH coho broodstock collection levels, number of eggs collected and juvenile released (1998-2010).

Year	Males	Females	Jacks	#. of Eggs	Juveniles Released
1998	243	268	158	298,357	77,147
1999	90	61	18	86,519	46,250
2000	295	428	631	270,151	67,933
2001	972	1,494	107	404,370	74,271
2002	566	627	108	609,193	109,374
2003	609	708	241	502,048	74,716
2004	630	865	239	799,623	89,482
2005	596	799	30	295,101	118,487
2006	112	151	69	236,406	53,950
2007	300	325	154	316,155	117,832
2008	508	770	24	455,480	121,000
2009	21	25	18	53,435	22,236
2010	193	235	57	259,490	155,480
Average	380	520	143	352,794	86,781

7.5 DISPOSITION OF HATCHERY-ORIGIN FISH COLLECTED IN EXCESS OF BROODSTOCK NEEDS

Excess broodstock may be returned to the mainstem Klamath River at Iron Gate, or in Bogus Creek to spawn naturally at times of low (309 or less) NOR escapement levels. Coho salmon in excess to hatchery broodstock needs may be released back to the river or euthanized if necessary in order to keep controls on the HOR percentages within the Klamath River. At higher NOR escapement levels the proportion of HOR fish on the spawning ground will be controlled to achieve pHOS and PNI objectives for each phase of the program (See Table 1). Data reported by Currier (2004) indicated that fish released from the hatchery return primarily to Bogus Creek, but also spawn in the mainstem Klamath River and Shasta River. Excess broodstock may be released at other locations within the Upper Klamath, Shasta River and Scott River

Population Units if approved by NMFS and CDFW as part of NMFS approved supplementation programs.

7.6 FISH TRANSPORTATION AND HOLDING METHODS

Hatchery personnel relocate salmon from the auxiliary fish ladder to the spawning house using a flatbed truck, outfitted with a custom 400-gallon tank. Water re-circulates by pump and spray bars at the top of the tank maintain aeration (see section 5.2 for more detail). The travel time from the auxiliary fish ladder to the spawning house is approximately three minutes or less. Hatchery workers transport eggs to the hatchery building in solid-color plastic buckets to protect them from ultra-violet rays and sunlight. This same approach and equipment will be used to collect and transport broodstock from Bogus Creek to IGH.

7.7 DESCRIBE FISH HEALTH MAINTENANCE AND SANITATION PROCEDURES APPLIED

IGH workers use a commercial iodophor solution to disinfect materials and equipment throughout the hatchery, especially invasive equipment such as spawning needles and knives. Hatchery workers sanitize equipment between and among all incubational and rearing units, especially during disease outbreaks or parasitic infestations. Hatchery workers take additional precaution, as necessary, to avoid the spread of disease by using equipment in an incubation or rearing pond that is specific to that site.

7.8 DISPOSITION OF CARCASSES

Broodstock carcasses will be disposed of offsite and not released back to the river for uses such as nutrient enhancement due to disease concerns. For example, coho are carriers of the myxosporean parasite *Ceratomyxa shasta* that cause the disease ceratomyxosis. This disease is known to cause high rates of mortality in salmonid species (Nichols et al. 2008).

7.9 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

Since 1995, each hatchery in the SONCC ESU has marked coho salmon yearling releases with a unique external fin or maxillary clip. These marks provide the means to determine the number or ratio of hatchery and naturally spawned coho salmon within watersheds, as well as the rate of straying intra- and inter-basin. Marking also provides each rearing facility the means to identify propagated and natural spawning stock for implementing an integrated hatchery program.

The genetic and demographic risks to the naturally spawning component from taking unmarked coho salmon (up to 135 NOR fish) for broodstock are outweighed by the demographic benefit to the integrated population as a whole from the greater recruit per spawner ratio achieved by the hatchery. This plan employs protocols to balance the demographic benefit to this natural population against the genetic and ecological risk posed by hatchery production and employs a newly emerging conservation theory (Mobrand et al. 2005).

Additionally, broodstock collection facilities at the dam, hatchery and in Bogus Creek will utilize handling practices that will ensure high survival rates of collected fish. For example, fish are moved using water to water transport, and handled fish are anesthetized to reduce stress.

8.0 MATING

8.1 SELECTION METHOD

Spawner selection will be based on the results of genetic analysis of tissue samples collected from all coho collected as broodstock. The results of this analysis will be used to develop a mating matrix designed by geneticists to minimize inbreeding effects and to allow for gene flow between brood years. The breeding protocol will specify which male and female crosses will result in the least likelihood of inbreeding. The breeding matrix will allow for spawning crosses to occur regardless of fish origin (HOR or NOR) or age.

8.2 MALES

The sex ratio of coho salmon entering IGH has not changed over the length of the program. Males consistently make up 51 percent of all adult coho entering IGH. As noted in the previous section up to 180 males (and 90 females) may be used as broodstock.

At IGH, jacks have comprised 18 percent of coho salmon returns to IGH since the 1984/1985 season. Data on the proportion of NOR jack spawning naturally is not known but will be developed over time through the M&E program. Jacks will be incorporated into broodstock at rates as determined by the spawning matrix to avoid inbreeding. Note that jacks also provide the only means for maintaining genetic continuity between year classes for coho salmon. Inclusion of jacks is particularly important given the low abundance of the upper Klamath spawning population in recent years.

8.3 FERTILIZATION

The coho eggs are fertilized, using wet spawning by stripping milt into an egg pan with salt solution (one ounce of salt per gallon of water) prior to egg placement. Half the eggs from one female will be used per egg pan. Technicians will then add milt from one male to each pan of eggs and gently stir by hand. Disease protocols call for eggs to be treated with a 100 ppm iodine solution for a minimum of 15 minutes, allowed to water harden and then transported to the hatchery building. Each family consisting of 1/2 the eggs from one female will be incubated separately.

Fertilization and incubation protocols will be evaluated each year and altered in accordance with genetic goals identified by CDFW and NMFS staff[22].

Hatchery staff entering incubation facilities are required to sterilize their gear and equipment prior to handling eggs. Equipment used for incubation is segregated for hatchery building use only.

8.4 CRYOPRESERVED GAMETES

There are no plans for a gamete preservation program at IGH. However, milt may be temporally stored from individual males to increase flexibility and meet relatedness goals. A gamete preservation program could be added at a later date if that measure is deemed feasible and appropriate for this hatchery program by the NMFS.

8.5 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

The IGH coho salmon program is designed to serve as a conservation program for the listed coho salmon population in the Upper Klamath Population Unit. The broodstock policy described above and the proposed mating protocol are intended to help reduce demographic extinction risks, while preserving genetic diversity.

Specific measures to reduce risk include: maintaining a minimum naturally spawning abundance in Bogus Creek, managing composition of hatchery and natural fish in both the hatchery and natural spawning populations to allow the natural environment to drive adaptation of the integrated population. The use of multiple males, including jacks will help increase effective population size and gene flow among brood years. The use of a genetically based spawning matrix will reduce inbreeding. Monitoring of spawner abundance and composition in tributaries will detect excessive straying of hatchery fish. Finally, additional measures to improve in-hatchery survival will increase the recruit per spawner ratio for the hatchery and thus reduce the number of NORs needed to meet the 20 percent pNOB target.

[22] For example, in 2010 fertilization rates were low possibly due to the time required to find a suitable mate as identified in the spawning matrix. In 2011, hatchery staff will experiment with refrigerating milt as a means to preserve it until needed for spawning.

9.0 INCUBATION AND REARING

9.1 INCUBATION

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

The number of eggs taken has averaged approximately 389,000 since 1993 (Table 4). Green egg-to-ponding survival rates from 1998 to 2011 have averaged 47 percent (Figure 8)[23]. The cause of the low survival rate is not known with certainty but may be associated with high detritus load in the water supply, fungus growth, or low fertility rates. Studies were implemented in 2010 to determine the cause of the mortality and a solution will be implemented based on study results. Until a solution can be fully implemented and tested for effectiveness, egg-take in the near-term is expected to reflect historic levels at approximately 250,000. Over time as survival conditions improve the egg-take levels will be reduced if permitted by the spawning matrix.

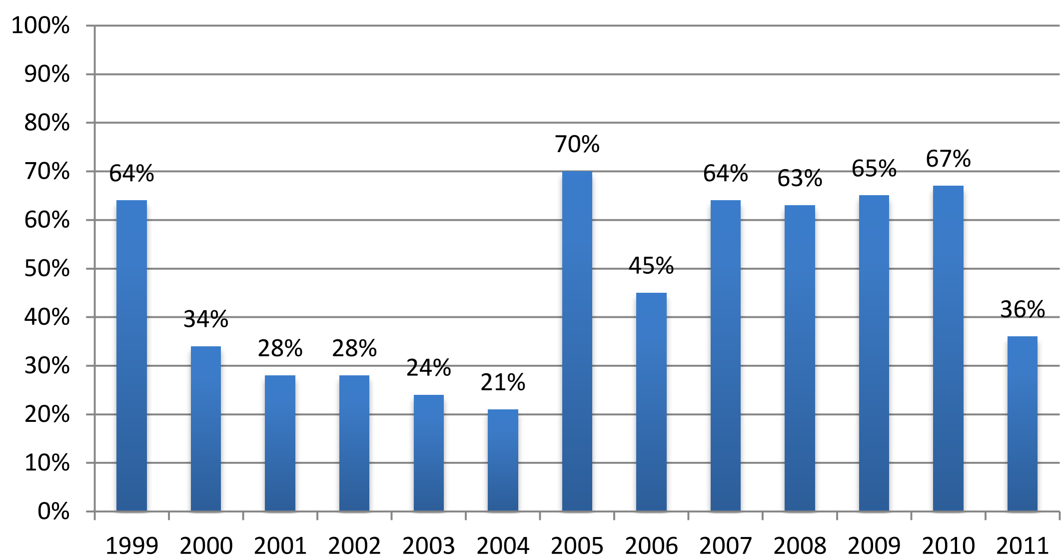


Figure 8. Green-egg to fry ponding survival rates for brood years 1999-2011.

[23] Note that in the mid-2000's it was common hatchery practice was to collect more eggs than needed and then cull these eggs consistently throughout each lot during the spawning year. This action ensured that egg take was always sufficient to achieve production targets.

9.1.2 Cause for, and disposition of excess egg takes

As survival targets are achieved and documented at the hatchery the goal is to not exceed egg-take by more than 10 percent of that needed to achieve the juvenile release target.

In the short term (< 3 years) as solutions to reduce egg mortality are being tested, excess egg-take may occur. This excess would result when egg survival is higher than what was observed historically. The excess eggs would be culled (at the eyed stage) and disposed of in an upland area or in a landfill. Protocols for egg culling would be developed at the end of each spawning season in consultation with NMFS and CDFW geneticists.

9.1.3 Loading densities applied during incubation

Maximum egg density is approximately 2,000 – 3,000 coho salmon eggs (20-30 ounces with an average size of 100 eggs per ounce) per incubator tray. Densities may be altered if egg survival rates remain low. Additionally, a moist air incubation system may be experimented with if survival rates do not achieve target levels. If successful, the system would be implemented immediately.

9.1.4 Incubation conditions

The hatchery building contains 123 incubator stacks (13 stacks for coho), which consist of eleven vertical flow incubation units each. Each stack receives a flow of approximately 3-5 gallons per minute (GPM) depending on life stage. The hatchery building provides a dark environment with suitable ambient water temperature (approximately 40-45^{o}F) and dissolved oxygen content (>8 mg per liter) for egg development. The confines of the incubators and a closed hatchery building protect eggs at the tender stage. The top tray of each incubator stack remains unfilled to buffer the force of cascading water and filter sediment and detritus. The hatchery makes daily assessment of incubator environmental conditions such as water temperature and the number of dead eggs after the development past the tender egg stage.

9.1.5 Ponding

Hatchery personnel move coho salmon fry to nursery tanks and then rearing ponds when the majority of fish have buttoned-up or when the majority of the yolk sac is consumed. Degree of button up is a subjective quantity determined by hatchery personnel.

As fry develop and the yolk sac is consumed, a healing process is apparent. The cutaneous layer of the ventral surface is very pink after the sac is absorbed and turns flesh colored as it grows together and heals. The fish are ponded when they are considered swim ups, a condition that fry develop when they are ready to take food, whether in a natural or artificial rearing environment. Salmonids are ponded at IGH when greater than 50 percent of the fish have completely healed and are in the swim up stage. Cumulative temperature units (TU) are approximately 2900-3000 TU from the date of fertilization. The coho are typically at 1,400 to 1,450 fish/pound at ponding, which is 0.31 - 0.32g per fish. IGH does not take length measurements, therefore mean length or mean weight data are not available. Ponding of all fish is forced. There is no mechanism for fish to move volitionally from the incubator stacks to the ponding facilities. The ponding dates vary widely from year to year and a range for all the lots taken in brood year 2008 was from February 27 to April 15 2009.

9.1.6 Fish health maintenance and monitoring

Hatchery personnel flush egg trays (Heath) with iodine at the rate of 300 milliliters per day per stack and handpick dead eggs after embryos reach the eyed-egg stage. Standard health and sanitation procedures require hatchery workers to clean sediment and organic materials from incubator trays and sterilize all equipment with iodine antiseptic to avert the spread of fungus, bacteria and viruses between egg trays or stacks. Health and sanitation procedures include fungus and dead egg removal using a pipette or other mechanical hand tools. For large lots of eggs, hatchery personnel pour eyed eggs into a mechanical apparatus called a "bouncer", which separates viable from dead ova, and removes fungus and shell residue. After bouncing hatchery workers return live eggs to clean Heath trays to continue incubation. Eggs may be picked daily or less frequently (depending on observed egg losses) after they have eyed. However, in the future eggs will not be run through the "bounce picker" as eggs from individual females will be kept in separate incubator trays by family.

IGH employs experienced fish culturists; most have spent their entire careers rearing salmonids at CDFW facilities. These professionals maintain healthy rearing conditions and proper growth rates and conversely, recognize adverse conditions, including disease that may negatively influence production. In the rare event of a disease outbreak during incubation, individual stacks and trays are isolated to stop the spread of the disease. Similarly, raceway production can also be isolated. At the first sign of problems in coho survival or health a CDFW pathologist is contacted. Samples of fish are sent to this person for diagnosis and direction regarding treatment or the Pathologist makes an on-site visit and diagnosis.

9.1.7 **<u>Risk aversion measures that will be applied to minimize the likelihood for adverse genetic and ecological effects to listed fish during incubation</u>**

In the past egg survival has been relatively low due to unknown factors. Studies are underway to determine the source of the problem and take corrective actions. Until the cause of the problem is known and corrected, eggs will be incubated in lower densities per tray. In 2010, egg survival increased to 80 percent but it is not clear if this was the result of lower incubation densities.

The hatchery building provides a secure location for all phases of egg development. The environment within each incubation tray maintains optimal conditions for egg development; dark and ample, well-oxygenated flow. The water supply within the hatchery building recycles by auxiliary electric or diesel pump in the rare case of disrupted flow. Individual incubation trays will segregate egg lots by family to maintain separation of progeny from all contributing parents in the broodstock. Hatchery workers, at the direction of geneticists, may cull eyed eggs to develop fingerling production that is reflective of parental natural or hatchery origin to maximize effective population size and to retain natural or spawn timing characteristics.

9.2 REARING

9.2.1 **<u>Provide survival rate data (*average program performance*) by hatchery life stage for the most recent period data are available</u>**

Juvenile ponding to yearling release survival rates have ranged from 43 percent to 84 percent, and averaged 66 percent for brood years 1999-2011 (Figure 9).

Historical ponding to yearling survival rates were most likely due to bird predation. IGH employed temporary netting over the raceways from 1995-2000, but it was removed in 2001 because of worker safety concerns. A new safer netting system was installed in 2011 at the hatchery to reduce bird predation on ESA-listed coho salmon. The program has a goal of achieving a ponding-to-yearling smolt survival rate of 90 percent for each brood year.

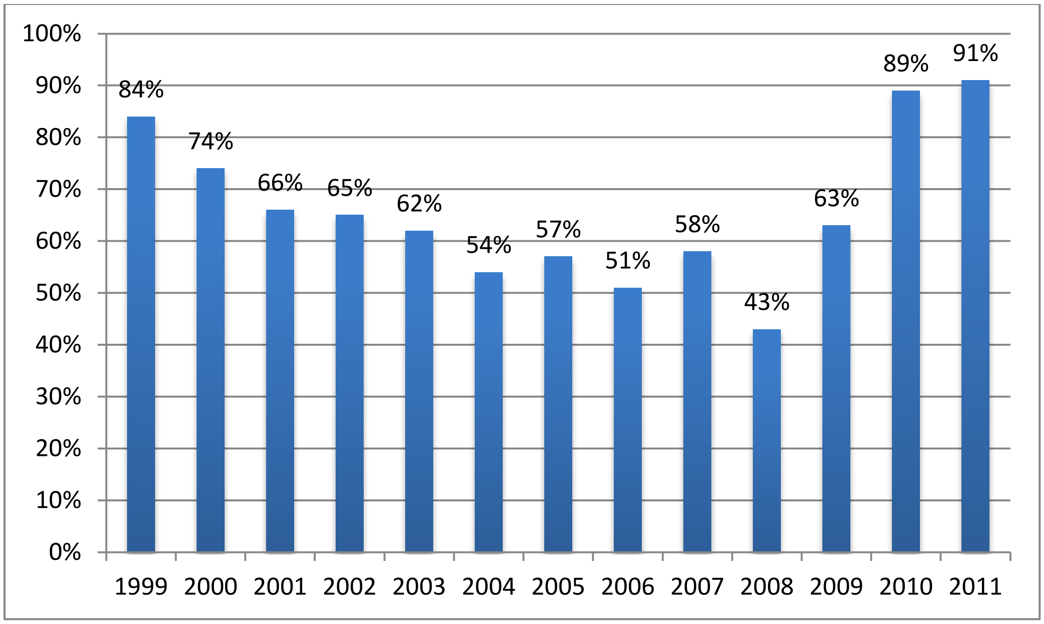


Figure 9. Coho fry (at ponding) to smolt release survival rates for brood years 1999-2011.

9.2.2 Density and loading criteria

The hatchery conducts biweekly standard weight counts to determine growth rate and prevent raceway overcrowding. The hatchery maintains raceway density at less than 1.5 lb. fish/cubic foot (the maximum density allowed). Additional ponds are used for rearing coho salmon in some years to disperse fish to improve growth rate and to meet the standard for release size. The hatchery tracks average weight (fpp) and maintains mortality counts by species for each pond series.

9.2.3 Fish rearing conditions

Water temperatures range from 39-45 ^{o}F (3.8-7.2 ^{o}C) and 50-60 ^{o}F (10-15.7^{o} C) in the winter and summer months, respectively. Water temperature in the hatchery is within the threshold limits for coho salmon growth and development. Water chemistry (dissolved oxygen, pH etc.) is routinely monitored.

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

The average monthly weight of coho salmon reared at IGH is shown in Table 19. Data on fish condition factor and length are not available.

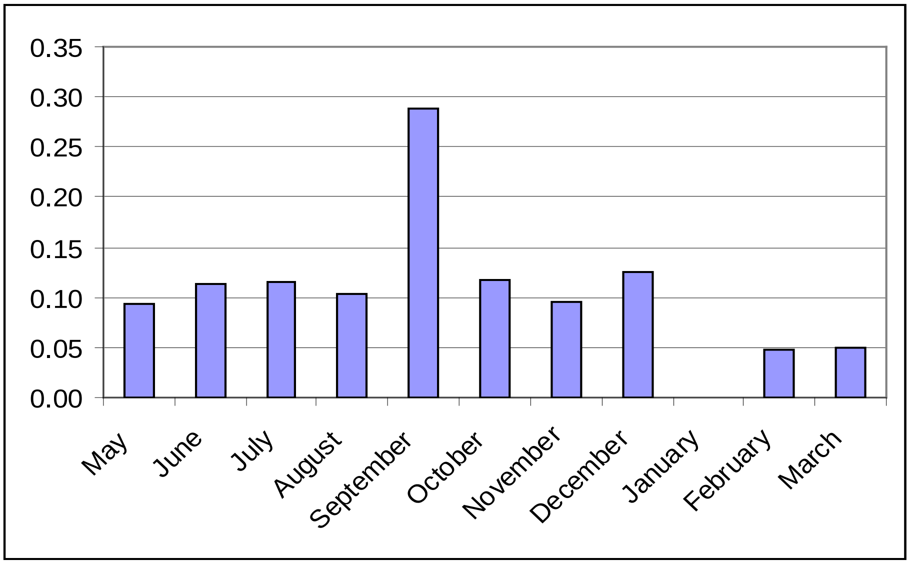
Table 19. Brood year 2001 & 2002 monthly weight counts (fish/lb) for IGH coho.

Date BYO1	Weight Count (fish/lb)	Date BY02	Weight Count (fish/lb)
May 02	227	May 03	248
June 02	130	June 03	111
July 02	59	July 03	68
Aug 02	37	Aug 03	50
Sept 02	28	Sept 03	40
Oct 02	17	Oct 03	25
Nov 02	15	Nov 03	21
Dec 02	13	Dec 03	20
Jan 03	11	Jan 04	19
Feb 03	11	Feb 04	19
Mar 03	11	Mar 04	17

The program in the past has targeted a release size of 10-20 fish per pound (fpp). Future fish size at release will be set at 15 fpp (+/- 2 fpp.), a size more reflective of a naturally produced smolt.

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

The average monthly growth rate (GPD) for coho reared at IGH is shown in Figure 10.



*-Fish are released in April of each year

Figure 10. Average monthly growth rate (grams/day) for coho reared at IGH hatchery*

9.2.6 Indicate food type used, daily application schedule, feeding rate range and estimates of total food conversion efficiency during rearing (*average program performance*)

Hatchery technicians conduct monthly weight counts to evaluate growth and estimate feed volumes. IGH feeds coho salmon Bio-Oregon Bio-Vita, and Silver Cup slow sinking salmon diet. Fish culturists increase food pellet size with fish size to account for their ability to ingest larger food particles. Table 20 presents food/body weight conversion for two typical years.

Table 20. Coho salmon food/body weight conversion rate.

Year	Pounds of Feed	Fish Production Pounds	Estimated Conversion Rate (lbs/lbs)
2002	20,400	5,713	3.6
2003	22,200	6,836	3.2

9.2.7 <u>Fish health monitoring, disease treatment, and sanitation procedures</u>

Hatchery conditions influence fish health; therefore, maintaining a clean rearing facility is a continuous part of standard hatchery operations. Hatchery workers remove dead fish from raceway ponds each day. They also conduct fish health maintenance and sanitation procedures, including biweekly pond cleaning, to remove accumulated solids and fish feces. Fish culturists monitor fish health daily by counting the number of dead fish recovered in each raceway and inspecting live fish for behavioral and external signs of disease (Table 21).

Fish pathologists test fingerling coho salmon for viral, bacterial and parasitic agents at IGH monthly or more frequently if the hatchery manager reports increased mortality levels of cultured fish. The protocols followed are based on the American Fisheries Society Blue Book, which identifies procedures for the detection and identification of pathogens.

Disease testing requires a sacrifice of up to 60 coho salmon fingerlings. If a severe disease outbreak occurs, the hatchery manager notifies the Fish Pathology Lab in Rancho Cordova to identify the pathogenic agent and recommend a prescribed treatment. Testing for severe disease outbreaks requires about 5 to 10 moribund fish, while certifying the health of emigrating smolts requires 20 fish (as per AFS Blue Book) and certifying the hatchery for specific pathogens requires 60 coho fingerlings or smolts.

Table 11. Behavioral and external signs of disease for cultured coho salmon.

Behavioral	External
Flashing	Darkening
Going off feed	Increased Mucus
Listlessness	Bleeding
Riding high	Popeye
Piping (breathing at surface)	Open Sores or fungus growth
Swimming at sides or in circles	Deformities, Flared Opercula, Abdominal Swelling

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

In the past, coho salmon smolts were not analyzed for gill ATPase activity, thyroxin nor plasma sodium levels before release. IGH used monthly weight-count to evaluate growth rate without sacrificing the fish. Physiological smolt characteristics (gill Na+, K+ and ATPase activity) are an indirect measure of seawater tolerance and migration speed. IGH personnel currently use physical "smolt" characteristics (dark fins, silvery appearance, jumping at water supply and screens) as indices of smolt development.

In the future, both ATPase and smolt characteristic indices will be used to determine smoltification level. A total of 32 fish will be collected at random from the population weekly (starting in March) and measured (non-lethal) for gill ATPase levels[24]. The collection of these data will help ensure that most or all released fish are physiologically ready to migrate rapidly to the ocean, and successfully transition in to saltwater. Collection of these data are not anticipated to result in major alterations to the current release schedule (March 1 to April 15) since current releases generally coincide with natural emigration timing for smolt coho salmon in the Upper Klamath River basin. However, the smolt indices may result in small

[24] Non-lethal sampling for ATPAse is performed by anesthetizing the fish to be sampled and then removing (clipping) a small piece of the gill tissue. The sample fish is then allowed to recover before being released back to the raceway or the river.

adjustments in release timing that are anticipated to improve survival.

9.2.9 **Indicate the use of "natural" rearing methods**

Fish are reared on river water and are exposed to sunlight. Natural rearing techniques such as the use of artificial substrate or exposure to fish predators have not been incorporated into the program.

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

Bird netting has been installed (2011) to reduce bird predation rates on coho salmon reared at IGH. This action will increase the survival rate of cultured fish. Additionally, fish are reared at densities and water flow rates that CDFW staff has found over time to maximize the survival rates of coho. High survival rates ensure that hatchery practices minimize selection for traits that perform best in the hatchery environment.

10.0 RELEASE

10.1 PROPOSED FISH RELEASE LEVELS

The number, size, time of release and release location of coho salmon at IGH is presented in Table 22. Fish are released from IGH in the Klamath River. In the future fish (and or eggs) may be released in other areas of the basin if approved by NMFS for coho recovery. Permits needed for these releases will be developed and submitted to NMFS by the appropriate parties to the action. Any deviations to the referenced release goals identified in Table 22 must be approved by NMFS and CDFW.

Table 22. Coho salmon proposed fish release level, size, date and location.

Age Class	Maximum Number	Size (fpp)	Release Date Range	Release Location
Yearling	75,000 +/- 10%	15 fpp. (+/- 2 fpp)	March 1- April 15	Klamath River (at Iron Gate Hatchery)

10.2 SPECIFIC LOCATION(S) OF PROPOSED RELEASE(S)

Stream, river, or watercourse: Klamath River
Release point: Rkm 306
Major watershed: Klamath River
Basin or Region: Upper Klamath River
GPS Coordinates 41.9299407 N /122.4418359 W

10.3 ACTUAL NUMBERS AND SIZES OF FISH RELEASED BY AGE CLASS THROUGH THE PROGRAM

Table 23 presents the average number and size of coho salmon plants for the last eighteen years.

Table 23. Average size and number of coho salmon plants for the last eighteen years.

Year of Release	Number of Yearling	Average Weight (fpp)	Year of Release	Number of Yearling	Average Weight (fpp)
1993	144,998	14.0	2002	67,933	14.0
1994	76,999	13.0	2003	74,271	13.0
1995	79,506	18.0	2004	109,374	16.0
1996	74,250	10.0	2005	74,716	10.0
1997	81,498	8.5	2006	89,482	15.0
1998	79,607	11.0	2007	118,487	10.9
1999	75,156	12.0	2008	53,950	14.0
2000	77,147	7.0	2009	117,832	12.1
2001	46,250	13.0	2010	121,000	15.5

10.4 ACTUAL DATES OF RELEASE AND DESCRIPTION OF RELEASE PROTOCOLS

The release dates for coho salmon from 2000 through 2010 are presented in Table 24. Volitional release starting April 1 is currently the standard release protocol for coho salmon yearlings. Any yearlings remaining after three weeks are forced out of the raceway and into the Klamath River.

Table 24. Coho salmon release dates from 2000 through 2010.

Year	Release Date(s) *
2000	March 30
2001	March 29
2002	March 27

2003	March 27
2004	March 29
2005	April 13
2006	April 10 - 17
2007	April 2 - 13
2008	April 2 - 9
2009	April 17
2010	April 1-8

*- Single release date means that fish were forced from the raceways due to avian predation concerns

10.5 FISH TRANSPORTATION PROCEDURES, IF APPLICABLE

Coho salmon are released directly into the Klamath River from the hatchery and no fish transportation procedures are employed.

10.6 ACCLIMATION PROCEDURES

There is little difference between the river and hatchery water temperature at the time of release, therefore thermal acclimation before planting is not necessary. The hatchery does not use feeding techniques (e.g. change in feeding ration) to encourage smoltification or rapid migration from the raceways.

10.7 MARKS APPLIED, AND PROPORTIONS OF THE TOTAL HATCHERY POPULATION MARKED, TO IDENTIFY HATCHERY ADULTS

All IGH coho salmon are marked with a left maxillary-clip. This mark allows them to be identified as HOR fish when they return to spawning grounds and the hatchery, but also keeps them from being targeted for harvest as only ad-clipped fish can be kept in ocean fisheries (Oregon only). Marking crews perform a quality control check on the marks applied by subsampling a portion of the clipped fish each day.

10.8 DISPOSITION PLANS FOR FISH IDENTIFIED AT THE TIME OF RELEASE AS EXCESS TO PROGRAMMED OR APPROVED LEVELS

This plan provides a mechanism to maintain releases within 10 percent of the hatchery's production goal of 75,000 yearlings by tracking in-hatchery survival rates by life stage. It is unlikely that fish in excess of the approved program level will occur. However, if excess fish become available they may be incorporated in potential supplementation programs, culled, or may be used for research and educational purposes as deemed appropriate in consultation with NMFS and CDFW.

10.9 FISH HEALTH CERTIFICATION PROCEDURES APPLIED PRE-RELEASE

CDFW certifies the health and disease status of coho salmon prior to release. Data are collected on smoltification, fat reserves and fish length and weight. The fish are examined for bacteria, whirling disease, viruses and external parasites following AFS Blue Book protocols.

10.10 EMERGENCY RELEASE PROCEDURES IN RESPONSE TO FLOODING OR WATER SYSTEM FAILURE

The IGH spawning house flooded in 1964 during construction of the dam, but there has been no subsequent flooding event. The hatchery's risk for flooding is minimal because the facility was built above the Bogus Creek floodplain and below IGD, which regulates flow releases. In the event of a water system failure or imminent disaster that may result in significant mortality of coho salmon the hatchery manager will release these fish to the stream if possible.

10.11 RISK AVERSION MEASURES THAT WILL BE APPLIED TO MINIMIZE THE LIKELIHOOD FOR ADVERSE GENETIC AND ECOLOGICAL EFFECTS TO LISTED FISH RESULTING FROM FISH RELEASES

To reduce impacts of hatchery releases to naturally produced coho salmon, fish will be released at a size (15 fpp) that mimics the size of a wild coho juvenile (Table 8). This action is anticipated to reduce hatchery competition and predation on both natural origin coho and fall Chinook salmon.

Prior to release, ATPase data will be collected from juvenile hatchery fish to determine their smoltification status. In addition, hatchery personnel will physically examine coho weekly for physical signs (silvery color, dark fin tips) of smoltification. The three signs of smoltification (ATPase, physical and behavioral) will be used to determine when screens should be pulled and fish allowed to volitionally migrate from the hatchery. Fish that are ready to smolt are more likely to migrate rapidly to the estuary upon release, again reducing competition and predation effects on naturally produced coho salmon.

11.0 MONITORING AND EVALUATION OF PERFORMANCE INDICATORS

11.1 PLANS AND METHODS PROPOSED TO COLLECT DATA NECESSARY TO RESPOND TO EACH "PERFORMANCE INDICATOR" IDENTIFIED FOR THE PROGRAM

The coho monitoring and evaluation (M&E) program is focused on:

- Ensuring that performance indicators and standards are achieved.
- Addressing the critical uncertainties and assumptions that affect the combined performance and genetic makeup of the natural and hatchery components of the Upper Klamath Population Unit.
- Those hatchery operations required to produce healthy, disease-free fish that will survive to adulthood and return at high rates.

The M&E program will be implemented following NMFS approval of the HGMP and will continue throughout the expected duration of this HGMP (i.e. until 2024). Current related monitoring programs which are covered under existing exceptions under protective regulations that are promulgated under ESA section 4(d), will be used in conjunction with implementation of new monitoring activities. If NMFS issues the ESA section 10(a)(1)(A) permit for which CDFW submitted an application along with this HGMP, then these M&E activities are anticipated to be covered under the ESA section 10(a)(1)(A) permit. In-hatchery and natural population monitoring and evaluation activities will be coordinated by a Hatchery Evaluation Team (HET). The HET will consist of CDFW and NMFS hatchery staff, biologist(s), geneticist(s), pathologist(s) and PacifiCorp representatives. The HET will ensure that the HGMP is effectively implemented and that culture practices are consistent with best management practices.

The results of all data collection and analyses will be reported yearly as part of the hatchery operations report. Information provided in the report will follow recommendations currently being developed by the California Hatchery Scientific Review Panel. Study plans will be updated yearly as needed to adapt to changing environmental conditions, fish population status, study results and advancements in fisheries and hatchery science.

Results of the M&E program will be used to adaptively manage both the hatchery and natural components of the Upper Klamath Population Unit. For example, as natural production increases, the number and proportion of HOR adults allowed on the spawning grounds will decrease. Additionally, actions such as the use of bird netting and any methods used to improve in-hatchery fish survival rates will be monitored and additional actions taken prior to the next brood year if survival goals are not achieved.

Details on the monitoring methods for each performance indicator are summarized in Table 25 and presented in more detail (where needed) in section 11.1.1.

Table 25. IGH coho hatchery operations indicators, metrics and M&E methods.

Performance Indicator	Performance Metric	Monitoring and Evaluation Method
Hatchery Facility and Operations Monitoring		
Broodstock composition, timing, age structure	Similar to wild fish	Culture and monitoring staff will collect data in Bogus Creek, hatchery and in other streams to determine that the hatchery and wild populations are similar in regards to these attributes. Information will be reported in annual reports.
Adult Holding and Spawning Survival Rate	≥ 95%	Culture staff will enumerate-data to be reported in annual operating reports.
Proportion natural origin brood pNOB	~20% to 50%	Culture staff will quantify pNOB for each brood year and report it in annual operating reports.
Egg-to-Fry Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Fry-to-Parr Survival Rate	> 90%	Culture staff will enumerate-data to be reported in annual operating reports.
Egg-to-Smolt survival rate	>60%	Hatchery culture staff to enumerate loss by life stage for each brood year. Data to be reported in annual operating reports.
Smoltification Level	Similar to Wild fish	ATPase data will be collected on both hatchery and wild juvenile fish released from the hatchery or captured in the Bogus Creek trap.
Release Size	15 fpp	Size at release information will be collected throughout the rearing period to ensure that fish size at release is +/- 2 fpp. Length frequency data will be collected as well from each raceway.

Smolt-to-Adult survival rate (SAR).	≥ 1%	SAR will be measured from point of release to return to the hatchery. All yearling coho salmon released will be marked with a left-maxillary clip to distinguish them from coho salmon released from the Trinity River and other hatcheries. The adipose fin will remain intact to reduce harvest rates in ocean and freshwater fisheries.
Total smolt-to-Adult survival rate (TSAR).	≥ 1.25%	Total coho salmon survival will combine SAR with the number of hatchery fish caught in all fisheries and found spawning naturally.
Harvest Contribution	<13%	Harvest data collected by resource managers in all fisheries will be summarized in the annual hatchery report.
Disease Control and Prevention: Maximize survival at all life stages using disease control and disease prevention techniques. Prevent introduction, spread or amplification of fish pathogens.	Necropsies of fish to assess health, nutritional status, and culture conditions. Performance indicators will be based on test performed.	Pathology staff will conduct health inspections of cultured fish on at least a monthly basis and during any disease or parasite outbreak. Pathologist will implement corrective actions as needed.
Hatchery effluent discharges monitoring (Clean Water Act)	Various based on regulations	All hatchery facilities will operate under the "Upland Fin-Fish Hatching and Rearing" National Pollution Discharge Elimination System (NPDES) general permit which conducts effluent monitoring and reporting and operates within the limitations established in its permit.

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

The results of the alternatives analysis indicated that insufficient information is available on natural coho production and composition (HOR and NOR) to properly manage the Upper Klamath Population Unit. The success of the preferred program is also highly dependent on the ability to manage broodstock (i.e. achieve PNI targets). The M&E program will therefore implement studies needed to determine:

- The total number of natural origin spawners (pNOS).
- The proportion of hatchery fish on the spawning grounds (pHOS).
- The genetic characteristics of hatchery and natural spawners.
- The proportion of natural fish used as broodstock (pNOB).
- The estimated proportion of natural influence based on pNOB and pHOS data.
- The effective spawning success of hatchery and natural fish in the wild.

The data collected as part of the M&E plan will be used to adaptively manage the program. For example:

1. Broodstock management at the hatchery will be highly dependent on the genetic analysis of broodstock candidates. This information will be used to determine whether broodstock collection should be expanded to additional streams or remain focused at the hatchery and in Bogus Creek. This data will continue to be collected and will be used for decision making throughout the life of the HGMP.

2. The proportion of hatchery fish spawning naturally in the Upper Klamath Population Unit (as well as Shasta River and Scott River) will determine if the program is sized correctly and the need to take additional actions to protect coho resources[25]. Spawning surveys proposed in the HGMP and conducted by CDFW in other basins (Shasta, Scott etc.) will collect the data needed to make this determination.

3. Data collected on the reproductive success of hatchery fish on the spawning grounds will also quantify hatchery fish impacts and benefits to achieving recovery objectives. Data collection efforts will continue annually. The first set of data upon which to base management decisions will be available within 2 years of ESA Section 10 permit issuance.

4. Spawning surveys will provide needed data on stock structure, hatchery stray rates (both IGH and Trinity River) and spawner distributions. This information will be used to adjust hatchery production (if needed), reduce hatchery stray rates and identify coho strongholds (if they exist) that may need to

[25] IGH stray rates into the Shasta and Scott rivers are currently evaluated by CDFW and others as part of sampling at weirs, video counts and spawning surveys.

be better protected from hatchery fish influence or targeted for habitat actions.

5. The genetic analysis and spawning surveys will provide the needed data to determine appropriate program size. Genetic information will determine if enough adults (and jacks) are incorporated into the brood each year to prevent founder effects, etc. The quantification of hatchery stray rates will determine if the release size produces too many HOR adults on the spawning grounds and therefore needs to be reduced. Data to make this decision will be available following approval and implementation of this HGMP.

A brief description of the M&E plan for addressing in-river and hatchery operations performance indicators are presented below. Current related monitoring programs, which are covered under existing exceptions under protective regulations that are promulgated under ESA section 4(d), will be used in conjunction with implementation of new monitoring activities. If NMFS issues the ESA section 10(a)(1)(A) permit for which CDFW and NMFS submitted an application along with this HGMP, then, these M&E activities are anticipated to be covered under the ESA section 10(a)(1)(A) permit.

In-river M&E

Adult Coho Surveys

The spawn timing, distribution, and abundance of coho that migrate into the tributaries in Table 25 will be determined using a spatially balanced probabilistic sampling design framework[26]. This is the same approach that is currently outlined in the California Coastal Salmonid Population Monitoring Program (Adams et al. 2011)

The spawn timing of each species (duration) will be measured by starting the surveys just prior to the expected onset of spawning and continuing the surveys until no new adults, jacks, or redds are observed on the spawning grounds. The overall sampling design will follow the U.S. Environmental Protection Agency (EPA) – Environmental Monitoring and Assessment Program – Generalized Random Tessellation Stratified (GRTS)[27] sampling method to select a spatially balanced random sample of river and stream reaches to survey each year. This method is recommended by NMFS in their recent *Guidance for Monitoring Recovery of Pacific Northwest Salmon and Steelhead* (NMFS 2009) and by the American Fisheries Society (AFS) in their *Salmonid Field Protocols Handbook, Techniques for Assessing Status*

[26] The streams in Table 26 will initially be surveyed to determine if they are of sufficient size and flow to support coho salmon. If so, they will be surveyed each year according to the protocols described.

[27] http://www.epa.gov/NHEERL/arm/analysispages/software.htm.

and Trends in Salmon and Trout Populations (Johnson et al. 2007)[28]. To assist in study design, all streams will be surveyed the first year of the study to better define coho distribution and identify those streams that have the potential to support coho production.

Coho salmon spawning and carcass surveys will be conducted yearly in the mainstem Klamath River and tributaries associated with the Upper Klamath Population Unit (Table 26) using a stratified sampling program. The surveys will be conducted weekly starting in mid-September and continuing through January 15th. Spawner surveys will be conducted by walking along the stream bank or wading in the stream counting and entering all carcasses, redds and live fish observed. Carcasses will be examined to determine species, sex, and/or missing fins. The fork lengths (FL) of fish are measured from the tip of the snout to middle of the tail to the nearest centimeter (cm). Counted carcasses are either cut in half or marked with a hog ring to eliminate being counted in subsequent surveys. All data will be entered on the daily salmon spawning stock survey field form. Length of carcasses will be estimated to the nearest 5 cm using a 110 cm measuring board with 1 cm increments. Sex will be determined by secondary sexual characteristics visible on the carcass such as presence or absence of a developed kype, size of adipose fin, or as in severely decayed carcasses, internal anatomy can be used. Carcasses will be classified based on length frequencies. Carcasses will also be examined for origin and spawn determination. Scales, tissues and otoliths may be collected from each fish. Carcasses may be marked with a hog ring to allow for recapture data collection. Data collected will be compiled and submitted during the annual report. Carcasses will be counted to estimate escapement and tissue samples taken for genetic analysis. Egg retention rates will be assessed for female carcasses. Fish will be classified as exhibiting completely unspawned (all or nearly all eggs intact), partially spawned (>50% of eggs intact), or spawned out (few to no eggs retained). Tissue samples will be collected from a subsample of the carcasses (HOR and NOR) for genetic analyses (see pedigree analysis measure)[29].

Coho redds will be enumerated and uniquely marked (tape, GPS etc.) during each survey. The combined carcass and redd counts will be used to estimate adult NOR and HOR escapement levels and spawn-timing to each stream and for the Upper Klamath Population Unit as a whole.

As part of its annual monitoring program, CDFW will continue to operate video counting stations in Shasta and Scott Rivers to determine coho escapement levels and composition (HOR and NOR). These data will be summarized and reported in annual reports for each basin. These efforts will be permitted under a seperate Section 10 permit and 4d annual permits respectively.

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[28] Note that both status and trends monitoring will be included in the GRTS design.

[29] Sample size will be determined as more is learned about the number of adults returning to each stream.

Table 26. Coho carcass and spawning candidate survey streams.

Coho Survey Areas	
Mainstem Klamath (Portuguese to Iron Gate)	Kohl Creek
Dry Creek	Dona Creek
Seiad Creek	McKinney Creek
Grider Creek (including the West Fork)	Dogget Creek
Walker Creek	Grouse Creek
Oneil Creek	Beaver Creek (including West Fork)
Jim Creek	Willow Creek
Mack Creek	Bogus Creek/Little Bogus Creek
Tom Martin Creek	Cottonwood Creek
Kinsman Creek	Ash Creek
Everill Creek	Humbug Creek
Buckhorn Creek	Dutch Creek
Collins Creek	Lumgrey Creek
Horse Creek	

Pedigree Analysis

A pedigree analysis will be used to determine the reproductive success of both the natural and hatchery components of the coho run. The DNA needed for the study will be obtained from fin clips taken from both hatchery and naturally produced coho adults from the survey streams. The study will be used to:

- Monitor trends in the genetic composition and diversity in each stream
- Determine reproductive success of hatchery and natural coho spawners
- Determine hatchery contribution to natural production
- Determine effective population size

These data are needed for quantifying program impacts and the effectiveness of the broodstock management approach included in the preferred alternative. Additionally, if adult surveys find insufficient numbers of adult coho to conduct genetic work, consideration will be given to sampling juveniles if appropriate.

The results of this data collection effort may be used to develop guidelines for pHOS for Bogus Creek and other tributaries. Also, the data collection effort may allow experiments to be conducted to evaluate the impact different pHOS levels may have on NOR and HOR reproductive success.

Weir Operations

CDFW currently monitors the number and composition of HOR and NOR coho adults entering the Shasta River, Scott River and Bogus Creek on an annual basis. The focus of this monitoring effort is to determine run size and population composition (natural versus hatchery). Since this existing monitoring effort determines run-size information, this data will be used to assess HGMP metrics and assist in decision making.

BOGUS CREEK

Based on current data, Bogus Creek has the largest natural origin coho spawning population in the Upper Klamath Population Unit. Currently, it is equipped with a weir that allows for video counts of fish passing upstream and for the possible collection of adults for broodstock. The weir also provides for the opportunity to control the proportion of HOR adults spawning naturally (pHOS) to achieve fitness objectives as indicated by the resulting PNI score (target > 0.5).

PNI will be calculated as:

PNI = pNOB/ (pHOS + pNOB) where:

pNOB = Proportion of natural-origin broodstock in the hatchery

pHOS = Proportion of hatchery-origin fish in the natural spawning escapement

The M&E plan calls for continued operation of the weir (by CDFW staff) during the coho migration period (September through early January). The weir structure will be improved to operate at higher flows, better manage debris and collect adult and jack coho for hatchery broodstock if needed. As NOR run size increases, the weir will be used to remove HOR adults from the spawning grounds to achieve pHOS and PNI objectives. Achievement of these objectives is expected to improve fitness and encourage local adaptation overtime.

The adult weir at Bogus Creek is an Alaskan style weir. It is designed to sample 100% of the upstream migrating salmonids but allow fish to move freely through the structure in front of the viewing window and video camera. The video equipment is set to run in time lapse mode and will be operated 24 hours a day, 7 days a week, during the adult migration season. As each fish swims through the counting flume a video image will be recorded (8 frames per second) on digital recording medium. Live fish will be handled, tagged and transported if needed for broodstock at IGH. Incidental take associated with the transport of adult fish from the Bogus Creek weir to the hatchery facility is anticipated to be less than 1%. The number and type of fish that die during transportation operations will be recorded and included in the annual report. If the incidental mortality rate exceeds 1%, additional conservation measures will be implemented to increase survival. Conservation measures may include increased aeration, fewer fish per trip, and other preventative measures that will decrease the likelihood of mortality during transport. Hatchery staff will implement these measures on an as needed basis. The facilities will be inspected daily. During each inspection the weir panels will be cleaned of debris, the video equipment will be inspected and cleaned, and all wash back carcasses will be examined and sampled to collect biological data. Population estimates will be derived from a direct count of all fish, by species, recorded during the migration season. All wash back carcasses (post spawn) tat drift downstream and settle on the weir panels during the season are sampled.

Adult and juvenile fish will be allowed to pass through the fish counting facility unabated in both directions, when broodstock are not being collected. There has been no mortality associated with operation of the video facility. However, should fish get trapped or receive injuries that result in mortality while passing through the structure they will be counted and biological data including sex, length, scale samples, and spawning condition shall be collected. The weir panels force upstream migrating salmon and steelhead adults to swim through a narrow counting flume where the camera is able to record their movements to a digital recording device. Therefore, operation of the video fish counting facilities may alter normal upstream migration patterns at each location. The Department has observed large numbers of adult salmon holding downstream of the facility that have been operating for the last several years and it does not seem to delay migration timing.

Juvenile Migration

A trapping facility (screw trap or weir) will be operated in Bogus Creek (or just downstream in the mainstem) to collect demographic data on juvenile run-timing and abundance, size, smoltification levels and smolt-to-adult survival rates. This information will be used to determine if hatchery practices are producing a high quality smolt capable of surviving in the natural environment.

Smolt development of hatchery and natural origin juveniles will be determined by measuring gill Na+, K+-ATPase activity over time. Tracking enzyme levels will help determine the migratory status of hatchery juveniles released from the hatchery. Gill Na+, K+-ATPase samples will be collected (non-lethally) from the gill tissue of coho salmon smolts using the techniques described in Schrock et al. (1994). Gill samples will consist of HOR and NOR for a total of 64 gill samples collected each week for approximately 6 weeks. Results obtained from the hatchery and natural fish populations will be tracked over time and compared to one another[30]. ATPase sampling will be adaptively managed and may be modified or discontinued, if needed, in consultation between CDFW, NMFS and PacifiCorp. Hatchery managers will use information on the physiological condition of the fish to refine the hatchery release schedule. Fish-rearing practices will be adjusted so that the timing and migratory status (as indicated by gill Na+, K+-ATPase levels) of the two groups (NOR and HOR) match to the extent possible. The assumption is that the more hatchery fish reflect the wild fish template, the more likely they are to survive in the natural environment. Juveniles will be captured, handled and marked at the weir located on Bogus Creek. Captured fish may be anesthetized with CO2 (alka seltzer gold), measured, weighed, PIT tagged and then released once they have recovered. Scale samples may be collected for age determination. Tissue and otolith samples may be collected from incidental juvenile mortalities to support ongoing genetic and microchemistry research. Passive array antennas will monitor movement. Recaptured PIT tagged fish will be measured and weighed again for condition factor analysis.

Radio Tagging and tracking

During broodstock collection, excess HOR female coho salmon may be radio-tagged and released back to

[30] The efficacy of the study to achieve objectives will be evaluated by the HET each year.

the Klamath River to track movements of adult coho salmon. CDFW will be responsible for all activities related to the handling and radio tagging of the excess female coho salmon. Radio-tagged coho salmon will be released back into the Klamath River at the hatchery spawning building and tracked in order to: (1) assess movements into tributaries; (2) assess pre-spawn mortality; and (3) assess percent immigration into the Shasta River (specifically out of the canyon into the valley).

This part of the M&E program will also serve as a pilot study for radio tracking female coho salmon that may be taken from the hatchery for the Shasta River supplementation project. Take of female coho salmon from handling and harassment that may occur during tagging will be included under the take coverage for the 4,730 excess coho salmon at the hatchery (See table 6). Up to 25 female coho salmon may be identified for radio tagging.

Transmitter insertion methods will generally follow protocols for esophageal implants provided by Eiler (1990) and English et al. (2005). Esophageal implants are preferable to surgical methods because the process: (1) takes less than 2 minutes; (2) does not require anesthetizing of individuals; and (3) reduces the amount of stress associated with tagging. Before tagging, the radio transmitters will be sterilized in a 10:1 solution of water and iodine disinfectant for 10 minutes. Radio transmitters will be inserted through the esophagus into the stomach cavity using a semi-flexible tube, until the transmitter stops at the posterior end of the stomach. The insertion tube will then be gently removed, leaving the transmitter in the stomach and the antenna protruding from the fish's mouth. Care will be taken to avoid pushing the transmitter through the stomach wall.

Hatchery Operations

The hatchery monitoring component of M&E will collect the necessary data and complete the analyses required to document that the performance indicators and metrics provided in Table 25 are achieved. M&E results will be reported in the annual hatchery operations plan.

11.1.2 Indicate Whether Funding, Staffing, and Other Support Logistics are Available or Committed to Allow Implementation of the Monitoring and Evaluation Program

Under the KHSA and related HCP, PacifiCorp has committed to provide necessary funding for CDFW to implement provisions of this HGMP at IGH, including components of the related M&E activities. CDFW, USFWS and other agencies will provide staff and facilities for natural production monitoring in tributaries such as the Shasta and Scott River, as a compliment to IGH HGMP M&E activities.

11.2 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

In-river and hatchery monitoring activities will use best management practices to reduce injury and mortality rates on listed coho.

When monitoring hatchery populations, great care is taken at reducing the number of disturbances the hatchery population undergoes; thereby reducing fish stress and susceptibility to disease. Fish are sampled daily to quantify performance indicators dealing with life stage survival and disease loss. Sampling is done quickly and is coordinated with raceway cleaning. All gear used in sampling efforts are sterilized to prevent disease transfer between raceways.

Fish marked as part of survival or production studies use state-of-the -art facilities for this effort. Fish are anesthetized to reduce handling mortality and stress, and work is performed at times when fish are not undergoing substantial physiological change (e.g. smoltification).

Weirs used for sampling are inspected daily to ensure they are operating as designed. Debris caught on weir pickets is removed as needed to limit impacts such as descaling that may occur as juvenile fish pass through weir spacing's. Adults collected at the weirs are transferred quickly from streamside to transport systems. If sampled, the adults and juvenile are anesthetized to reduce stress, and allowed to recover prior to release to reduce the chance of predation.

Spawning and carcass surveys are conducted in a manner that reduces interactions with live fish or redds. Surveyors approach the stream cautiously and scan for spawning adults. If adults are observed spawning, the number of spawners is counted but the surveyors do not approach the fish. When carcasses are recovered in-stream, surveyors are careful not to step on redds. Because physical signs of coho redds decrease quickly over time, tape is used to mark (on a tree etc.) each time a redd is observed. This tape alerts the crew to not disturb the area, even though a redd may not be visible.

Negative effects of take upon listed fishes will be minimized by utilizing noninvasive data collection whenever possible. NOAA and CDFW guidelines will be strictly adhered to in order to further minimize effects to listed species where effects and take cannot be avoided.

1. Collecting

• The number of specimens collected will be kept to the minimum the investigator determines necessary to accomplish study goals.

• Capture techniques should be as environmentally benevolent as possible within the constraints of sampling design.

• Trap and net sets should be examined at a regular and appropriate schedule, particularly in warm water, to avoid excessive net mortality.

• Live capture should be designed to prevent or minimize injury to the animal.

• Care should be exercised to avoid accidental capture of non-target species. Those captured should be released immediately.

• Collection should be conducted so as to leave the habitat as undisturbed as possible.

2. Restraint and Handling

• Investigators must use the least amount of restraint necessary to do the job.

• Animals should be handled quietly and with the minimum personnel necessary.

• Darkened conditions which alleviate stress and subdue certain species should be used whenever possible and appropriate.

• Chemicals chosen for immobilization should consider the impacts of the chemical on target organisms.

3. Animal Marking

• Careful testing of markers on preserved or captive animals before use on wild animals is recommended to determine effects on behavior, physiology, and survival.

• Investigators must also consider the nature and duration of restraint, the amount of tissue affected, whether distress is momentary or prolonged, whether the animal, after marking will be at greater than normal risk, whether the animal's desirability as a mate is reduced, and whether the risk of infection or abscess formation is minimal.

• Fin clipping is a recommended procedure, but the importance of each fin to the survival and well-being of target fishes must be determined on a case-by-case basis before being used.

• Marking techniques involving tissue removal or modification (branding, etc.) should be preceded by local anesthetic (aerosols containing benzocaine, such as Cetacaine, may be applied) and followed by the application of a topical antiseptic.

• Tags should not be used which could cause physical impairment or enhance the risk of entanglement in underwater vegetation.

• Brightly colored tags which compromise a fish's camouflage should not be used.

• The size, shape, and placement of tags should permit normal behavior of the animal to the greatest extent possible.

• Externally attached radio transmitters should neither conceal nor enhance the appearance of dorsal fins or opercular flaps, and should be attached so as to eliminate or minimize the risk of entanglement with underwater vegetation or other obstructions.

5. Disposition Following Studies

• Upon completion of studies, researchers should release wild-caught specimens whenever this is practical and ecologically appropriate. Exceptions are if national, state, or locals laws prohibit release, or if release might be detrimental to the well-being of the existing gene pools of native fishes in a specific geographic area.

• Field-captured fishes should be released only: (a) at the site of the original capture, unless conservation efforts or safety considerations dictate otherwise (release should never be made beyond the native range of the distribution of a fish without prior approval of the appropriate state and federal agencies, and approved relocations should be noted in subsequent publication of research results), (b) if their ability to survive in nature has not been irreversibly impaired, (c) where it can be reasonably expected that the released animal will function normally within the population, (d) when local and seasonal conditions are conducive to survival, and (e) when release is not likely to spread pathogens.

• Captured animals that cannot be released or are not native to the site of intended release should be properly disposed of, either by distribution to colleagues for further study or, if possible, by preservation and disposition as teaching or voucher specimens in research collections.

• Investigators must be careful to ensure that animals subjected to a euthanasia procedure are dead before disposal.

• In those rare instances where specimens are unacceptable for deposition as vouchers or teaching purposes, disposal of carcasses must be in accordance with acceptable practices as required by applicable regulations.

12.0 RESEARCH

No research is proposed as part of this HGMP. If research needs are identified in the future, a study plan will be submitted to NMFS for approval.

13.0 ATTACHMENTS AND CITATIONS

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14.0 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:

Signed by:______________________________________ Date:____________

Name: _____________________________________

Title: _____________________________________

APPENDIX A- ALTERNATIVES ANALYSIS

1.0 IGH COHO ALTERNATIVES ANALYSIS

An alternatives analysis was conducted on the current IGH coho salmon program to determine the best approach for meeting identified conservation, harvest and policy goals. The five alternatives examined were as follows:

- Maintain current program
- Eliminate hatchery production/improve habitat
- Implement a segregated program consistent with Hatchery Scientific Review Group (HSRG) guidelines
- Implement an integrated program consistent with HSRG guidelines
- Implement a reduced hatchery program

The analysis was completed using the AHA (All H Analyzer) model developed by the HSRG for analyzing anadromous salmon hatchery programs (www.hatcheryreform.us). The model estimates coho salmon population abundance and fitness out over 100 generations. It also provides estimates of adult spawning escapement, the proportion of hatchery fish on the spawning grounds (pHOS), proportion of natural origin spawners needed for broodstock (pNOB) and the number of hatchery origin (HOR) and natural origin (NOR) adults caught in fisheries.

The analysis should be considered a "what-if" type analysis that considers possible management scenarios. As more data are collected on population structure and abundance the analysis will be updated.

A brief description of each of the alternatives is provided in sections to follow. The benefits and risks to the achievement of conservation, harvest and policy goals associated with the implementation of each alternative are also provided.

The analysis begins with a discussion of the hatchery, harvest and natural production (habitat) assumptions used for completing the analysis.

1.1 ANALYSIS ASSUMPTIONS

1.1.1 Population Description

The IGH coho salmon program is considered part of the Upper Klamath Population Unit. The population unit inhabits the mainstem Klamath River and tributary habitat from Portuguese Creek (non-inclusive) to Spencer Creek (inclusive), a tributary that is currently inaccessible to coho due to the presence of Iron

Gate and Copco Dams.

1.1.2 Natural Spawner Abundance

Data on coho salmon natural population abundance is sparse for this population. Klamath River mainstem spawning surveys indicate that on average only 9 redds were observed from 2001 to 2008 (Table A-1).

Counts of adult coho in Bogus Creek, a tributary located directly below IGH, ranged from 7 to 409 (average 151) from 2004 through 2009; with the lowest value occurring in 2009 (Figure A-1). A large portion (25 percent) of these coho consisted of hatchery strays from IGH (Table A-2). Decreasing number of coho returning to the creek over time may limit which hatchery options are available in the future.

Table A-1. Mainstem Klamath River coho salmon redds observed during fall/winter surveys from Iron Gate Dam to Indian Creek (CDFW data files).

Year	# of Redds
2001	21
2002	6
2003	7
2004	6
2005	6
2006	NA
2007	NA
2008	8
Average	9

NA- Not available

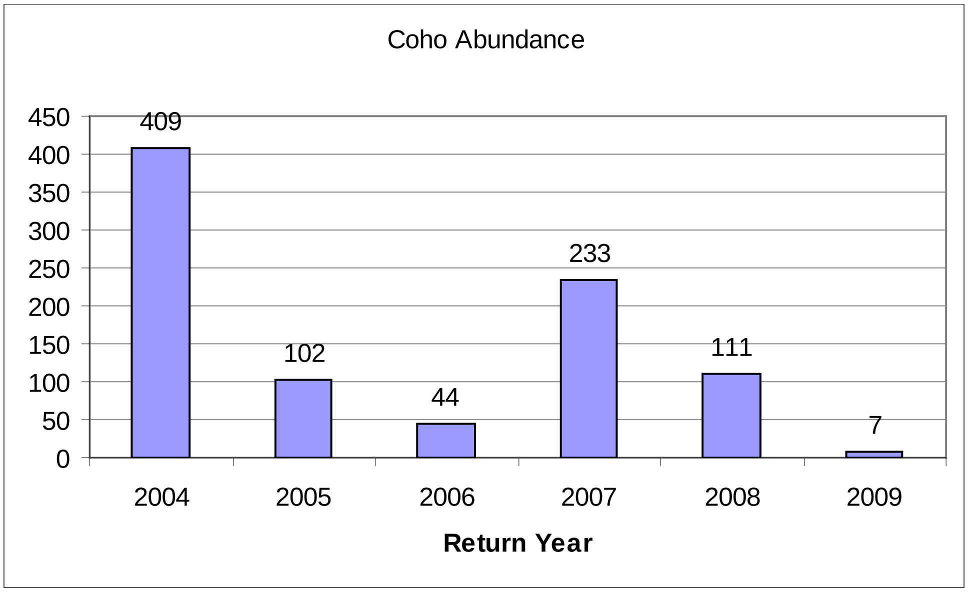

Figure A-1. Total hatchery and natural origin coho returns to Bogus Creek (2004-2009) (CDFW data files).

Table A- 2. Coho counts in Bogus Creek from 2004 to 2009 (CDFW data files).

Run Year	Adult Coho	Wild	Hatchery	% Hatchery
2004	409	367	42	10%
2005	102	54	48	47%
2006	44	44	0	0%
2007	233	149	84	36%
2008	111	76	35	32%
2009	7	7	NA	
Average	**151**	**116**	**42**	**25%**

NA- Not available

Little data are available for other tributaries associated with the Upper Klamath Population Unit[31]. Lacking better information, it was assumed that these tributaries (in total) produce a similar number of wild coho as Bogus Creek; a conservative assumption. The lack of abundance data for these tributaries is a major uncertainty that will be addressed as part of a monitoring program for the hatchery.

For AHA modeling purposes, an estimate of habitat productivity and capacity are needed. These numbers were developed by selecting a set of values that best reflect:

1. Bogus Creek adult NOR coho escapement minimum (7), maximum (367) and average values (116) (Table A-2), doubled to account for production in other tributaries. This results in an adult coho abundance range of 14-734

2. Observed harvest level/rates (6 percent).

3. Genetic fitness loss of 50 percent to account for HOR impacts to natural spawners.

Based on these assumptions productivity and capacity was estimated at 2.3 and 800, respectively (Table A-3).

[31] From 2007-2009 coho redd data collected in Seiad Creek ranged from 4-15, and averaged 8.3.

Table A-3. Summary of Current natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS (NOR productivity and capacity of 2.3 and 800).

		Max	Min	Ave
NOR Escapement (adults)		734	71	228
HOR Total Escapement (plus strays)		289	50	94
HOS Effective Escapement		231	40	76
Total Natural Escapement (NOS & All HOS)		1,023	130	322
Total Harvest		253	44	82 (67 HOR)
Hatchery Broodstock		212*	212	212
Excess at Hatchery		2,731	308	759
Total Run-size		4,219	685	1,376
PNI		0.17		
pHOS		25%		
Population Fitness (range 0.5 to 1)		0.50		

* Assumes that the program collected more eggs than required to meet juvenile release targets. Excess eggs were culled at the eyed egg life-stage.

1.1.3 Harvest

The 2010 Biological Opinion for the operation of the Bureau of Reclamation's Klamath Project indicates that harvest rates on Klamath River coho are expected to average 6 percent, and not exceed 13 percent (NMFS 2010)[32]. IGH coho salmon are not targeted in ocean fisheries, thus harvest results from incidental catch of other populations. Coho are harvested by tribal fisheries in the Klamath River at low levels.

1.1.4 Hatchery

The hatchery has a mitigation goal of releasing 75,000 yearling smolts each year, as included in PacifiCorp's Federal Energy Regulatory Commission license for operation of the Klamath Hydroelectric Project (FERC Project No. 2082). Adult return data indicate that smolt-to-adult survival rates average approximately 1.10 percent. CDFW incorporates a minimum of 10 natural origin (NOR) adult coho salmon into the hatchery broodstock in each brood year if available. In 2009, all HOR and NOR fish entering the hatchery were used as broodstock.

The number of coho salmon adults returning to the hatchery has generally been sufficient to meet the broodstock needs. However, in 2009 adult coho salmon returns back to the hatchery was only 46 fish, of which 25 were females. This level of adult escapement was insufficient to meet the 75,000 yearling release goal.

1.2 MAINTAIN CURRENT COHO PROGRAM

The current coho salmon hatchery program has a goal of releasing approximately 75,000 coho yearlings to the mainstem Klamath River each spring (April). Based on an observed average return rate of 1.34 percent, the 75,000 yearling coho release produces approximately 1,000 adults, on average, for each brood year (Table A-3)[33]. The majority of these fish return to IGH, however some hatchery origin (HOR) adults spawn naturally in small tributaries such as Bogus Creek and in the Shasta River.

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[32] NMFS 2010. Biological Opinion for the Operation of the Klamath Project between 2010 and 2018.

[33] HOR number is based on total of broodstock, excess at hatchery, HOR escapement, and HOR harvest.

Benefits and Risks of Current Program

1. The 75,000 coho yearlings release achieves mitigation goals contained in the FERC Project license (Policy Benefit).

2. Impacts (predation, competition for food and space) of coho yearling releases on naturally produced coho salmon and other species would continue at similar levels (Conservation Risk).

3. Incorporation of natural origin (NOR) adult coho into the hatchery broodstock maintains genetic continuity with the natural coho salmon population and increases the total abundance of the combined (HOR and NOR) population (Table A-3) (Conservation Benefit).

4. HOR adults on the spawning grounds make up anywhere between 10-47 percent of the total spawning population. The large proportion of hatchery fish on the spawning grounds results in a Proportionate Natural Influence (PNI) of ~0.17. This value is far below the HSRG recommended value of 0.67 for biologically important populations. In short, the combined natural and hatchery population genetics are being driven by the hatchery rather than the natural environment, thereby reducing population fitness to 0.50 (0.5, lowest score possible)(Conservation Risk) (Table A-3).

5. Average NOR abundance (228) for the population unit falls well below the high risk annual abundance level (425) established by NMFS (NMFS 2010).

6. The program is producing some fish for harvest (Harvest Benefit); although the number is quite low ~82 adults, of which 67 are of hatchery origin (Table A-3).

7. The inability to harvest a higher proportion of returning HORs, results on average in more HOR adult coho returning to the basin than are needed for broodstock (Table A-3). This can result in more HOR adults spawning naturally (HOS) in key spawning areas. HOR adults on the spawning grounds reduce the fitness of the natural population (Conservation Risk).

1.3 ELIMINATE HATCHERY PRODUCTION/IMPROVE HABITAT

Under this alternative the IGH coho program would be eliminated and mitigation goals would focused on improving habitat in the basin[34].

Benefits and Risks of Eliminating Program

1. All negative hatchery impacts to the natural population are eliminated (Conservation Benefit). NOR population fitness score increases to 1.0 over time (highest score possible, Table A-4).

2. The effectiveness of habitat actions to improve coho salmon abundance and productivity may take a number of years before results are realized (Conservation Risk).

3. Habitat-focused strategy would provide benefits to other species where they co-exist (Conservation and Harvest Benefit).

4. Incidental harvest provided by hatchery coho salmon eliminated (Harvest Risk).

5. Total average population abundance decreased from 1,376 to 529, minimum population size decreased from 685 to 243 (Table A-4). Alternative results in increased demographic risk of population extinction (Conservation Risk).

6. Average NOR abundance (529) for the population unit rises ABOVE the high risk annual abundance level (425) established by NMFS (NMFS (Conservation Benefit); but is substantially BELOW the low risk annual abundance level of 8,500 (NMFS 2010) (Conservation Risk).

To achieve similar adult minimum, average and maximum abundance levels as the current hatchery program would require that habitat actions result in a coho productivity and capacity of approximately 4.0 and 1,400, respectively (Table A-5).

[34] Habitat improvement projects are being funded and implemented by PacifiCorp as part of a Habitat Conservation Plan (HCP).

Table A-4. Summary of natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS with program elimination (NOR productivity and capacity of 2.3 and 800).

		Max	Min	Ave
NOR Escapement (adults)		1,835	243	529
HOR Total Escapement (plus strays)		-	-	-
HOS Effective Escapement		-	-	-
Total Natural Escapement (NOS & All HOS)		1,835	243	529
Total Harvest		117	16	34
Hatchery Broodstock		-	-	-
Excess at Hatchery		-	-	-
Total Run-size		1,952	258	563
PNI		Not Applicable		
pHOS		0%		
Population Fitness (range 0.5 to 1)		1.0		

Table A-5. Summary of natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS with program elimination AND improved habitat (NOR productivity and capacity of 4.0 and 1,400).

		Max	Min	Ave
NOR Escapement (adults)		**4,091**	**616**	**1,224**
HOR Total Escapement (plus strays)		**-**	**-**	**-**
HOS Effective Escapement		**-**	**-**	**-**
Total Natural Escapement (NOS & All HOS)		**4,091**	**616**	**1,224**
Total Harvest		**261**	**39**	**78**
Hatchery Broodstock		**-**	**-**	**-**
Excess at Hatchery		**-**	**-**	**-**
Total Run-size		**4,353**	**655**	**1,302**
PNI		**Not Applicable**		
pHOS		**0%**		
Population Fitness (range 0.5 to 1)		**1.0**		

1.4 IMPLEMENT SEGREGATED PROGRAM

The program would be changed to a segregated program designed to meet HSRG guidelines for such a program. The program would be operated as follows:

- No NOR adults would be incorporated into the broodstock. All NOR adult and jack coho salmon arriving at the hatchery would be released back to the river.
- In-hatchery survival rates would be increased by improving culture practices which includes reducing bird predation in raceways.
- The program would continue to target a release 75,000 yearling fish each year to achieve mitigation goals.
- A more robust weir would be constructed in Bogus Creek to insure that pHOS in this stream did not exceed the 5 percent value recommended by the HSRG (target would be set at 1 percent). This action would create conditions where 99 percent of the HOR adults returning to the basin would be collected or harvested.

Under this alternative total run size ranges from 850 to 5,334 adults (1,674) average). NOR escapement to the spawning grounds averages 512 adults and varies annually between 233 and 1,772 (Table A-6).

Table A-6. Summary of natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS with the implementation of a Segregated program (NOR productivity and capacity of 2.3 and 800).

		Max	Min	Ave
NOR Escapement (adults)		1,772	233	512
HOR Total Escapement (plus strays)		15	3	5
HOS Effective Escapement		12	2	4
Total Natural Escapement (NOS & All HOS)		1,786	236	517
Total Harvest		320	53	100 (68 HOR)
Hatchery Broodstock		76	76	76
Excess at Hatchery		3,151	485	981
Total Run-size		5,334	850	1,674
PNI		Not Applicable		
pHOS		1%		
Population Fitness (range 0.5 to 1)		0.96		

Benefits and Risks of a Segregated Program

1. Harvest benefits (incidental) of the program would be maintained. Harvest levels may be increased if it were possible to implement selective fisheries by adipose clipping all HOR released from IGH. (Harvest Benefit). The higher the harvest rate the lower the trapping effectiveness required for the weir (Conservation Benefit).

2. PacifiCorp mitigation goal may be maintained (Policy Benefit)

3. Achieving a pHOS of approximately 1 percent in Bogus Creek would reduce hatchery impacts on NOR fitness (0.96) (Conservation Benefit) (Table A-6).

4. Reducing the number of HOR adults spawning naturally may pose demographic (i.e. abundance) and life history diversity risks to the population (Conservation Risk). There is therefore a trade-off between improving population fitness by removing hatchery fish from the spawning grounds, and increasing demographic and diversity risks to the population from this same action.

5. Average NOR abundance (517) for the population unit rises ABOVE the high risk annual abundance level (425) established by NMFS (NMFS 2010) (Conservation Benefit); but well BELOW the low risk annual abundance level of 8,500 (NMFS 2010) (Conservation Risk).

6. In good survival years, the number of adult coho excess to broodstock needs would be quite large (3,151) (Table A-6). While the weir may prevent HOR adults from entering Bogus Creek, the number of these HOR's entering and spawning in other smaller tributaries and the mainstem is unknown (Conservation Risk).

7. Over time, hatchery practices select for fish adapted to the hatchery environment rather than the natural environment. If the natural run were to become extinct, the remaining HOR component would have lower natural fitness and therefore be less suitable for a reintroduction effort (Conservation Risk).

1.5 IMPLEMENT INTEGRATED PROGRAM

This alternative implements an HSRG Integrated coho program at IGH. The program is designed to achieve the HSRG PNI criterion (0.67) for biologically important populations. This program would be implemented as follows:

- To achieve the PNI value of 0.67 or greater, the proportion of NOR adults used as broodstock would be increased to ~20% (i.e. 20% of all broodstock would be of natural origin).
- Hatchery production would be maintained at 75,000 yearling coho.
- Hatchery culture practices would be improved to increase egg-to-smolt survival rates. Facilities would be constructed to reduce bird predation in raceways.
- A more efficient weir would be installed in Bogus Creek to prevent HOR adults from spawning in this stream.

Under this alternative total run size ranges from 845 to 5,341 adults (1,674 average). NOR escapement to the spawning grounds averages 497 adults and varies annually between 213 and 1,763 (Table A-7).

Table A-7. Summary of natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS with the implementation of a Integrated program (NOR productivity and capacity of 2.3 and 800).

		Max	Min	Ave
NOR Escapement (adults)		**1,763**	**213**	**497**
HOR Total Escapement (plus strays)		**15**	**3**	**5**
HOS Effective Escapement		**12**	**2**	**4**
Total Natural Escapement (NOS & All HOS)		**1,778**	**216**	**502**
Total Harvest		**320**	**53**	**100 (68 HOR)**
Hatchery Broodstock		**76**	**76**	**76**
Excess at Hatchery		**3,167**	**500**	**996**
Total Run-size		**5,341**	**845**	**1,674**
PNI		**0.96**		
pHOS		**1%**		
Population Fitness (range 0.5 to 1)		**0.99**		

Benefits and Risks of an Integrated Program

1. PNI objective is exceeded (0.96) resulting in an increase in population fitness from the current score of 0.5 to 0.99 (Table A-7) (Conservation Benefit).

2. Minimum, average and maximum NOR escapement increases by more than 100% over the current program. Increased adult abundance reduces population demographic and diversity risks (Table A-7) (Conservation Benefit).

3. Average NOR abundance (497) for the population unit falls ABOVE the high risk annual abundance level (425) established by NMFS (NMFS (Conservation Benefit); but substantially BELOW the low risk annual abundance level of 8,500 (NMFS 2010) (Conservation Risk).

4. The well integrated (i.e. high fitness) hatchery program produces ~1,100 adult coho returns. These fish act as a gene bank for the population (protecting species diversity), and ensure that enough fish return each year to reduce demographic risks associated with low natural production (Conservation Benefit).

5. HOR adults returning to the hatchery also provide a source of fish needed to quickly reintroduce coho to streams upstream of IGD with the implementation of dam removal or fish passage facilities (Conservation Benefit).

6. Harvest benefits of the program would be maintained (Harvest Benefit).

7. Returning adults excess to broodstock needs increase; results in higher risk of HOR adults spawning naturally in the system (Conservation Risk).

1.6 REDUCED HATCHERY PRODUCTION

In this alternative, hatchery production is reduced by 50 percent to 37,500 yearling coho. The program would be run as an integrated type program with a PNI > 0.67. The program would be implemented as follows:

- To achieve the PNI value of 0.67 or greater, the proportion of NOR adults used as broodstock would be increased to ~20% (i.e. 20% of all broodstock would be of natural origin).
- Hatchery production would be reduced to 37,500 yearling coho.
- Hatchery culture practices would be improved to increase egg-to-smolt survival rates. Facilities would be constructed to reduce bird predation in raceways.
- A more efficient weir would be installed in Bogus Creek to prevent HOR adults from spawning in this stream.

Under this alternative total run size ranges from 552 to 5,341 3,650 (1,120 average). NOR escapement to the spawning grounds averages 514 adults and varies annually between 229 and 1,802 (Table A-8).

Table A-8. Summary of natural coho and IGH coho program escapement, harvest, broodstock and HSRG performance indicators of PNI and pHOS with the implementation of Reduced Hatchery Production (NOR productivity and capacity of 2.3 and 800, PNI > 0.67).

		Max	Min	Ave
NOR Escapement (adults)		1,802	229	514
HOR Total Escapement (plus strays)		7	1	2
HOS Effective Escapement		6	1	2
Total Natural Escapement (NOS & All HOS)		1,810	230	516
Total Harvest		219	34	67
Hatchery Broodstock		38	38	38
Excess at Hatchery		1,583	250	498
Total Run-size		3,650	552	1,120
PNI		0.98		
pHOS		<1%		
Population Fitness (range 0.5 to 1)		1.0		

Benefits and Risks of an Integrated Program

1. The 37,500 coho yearlings release does not achieve mitigation goals contained in the FERC Project license (Policy Risk).

2. Fewer NOR coho (~8) are needed for broodstock than required for the 75,000 fish integrated alternative. (Conservation Benefit).

3. The small number of fish used as broodstock (38) increases the probability of inbreeding and Ryman-Laikre effects (i.e. gene swamping) compared to the alternatives that release 75,000 yearlings (Ryman and Laikre 1991). Both effects can result in decreased effective population size and fitness. (Conservation Risk)

4. PNI objective is exceeded (0.98), resulting in an increase in population fitness from the current

score of 0.5 to 1.0 (Table A-8) (Conservation Benefit).

5. Minimum, average and maximum NOR escapement increases by more than 50% over the current program. Increased adult abundance reduces population demographic and diversity risks compared to the current program (Table A-8) (Conservation Benefit).

6. Average NOR spawner escapement (514) for the population unit falls above the high risk annual abundance level (425) established by NMFS (Conservation Benefit); but substantially BELOW the low risk annual abundance level of 8,500 (NMFS 2010) (Conservation Risk).

7. The well-integrated (i.e. high fitness) hatchery program produces an estimated 500 HOR adult coho returns. These fish act as a gene bank for the population (protecting species diversity), and ensure that more fish return each year to reduce demographic risks associated with low natural production (Conservation Benefit).

8. HOR adults returning to the hatchery also provide a source of fish needed to quickly reintroduce coho to streams upstream of IGD with the implementation of dam removal or fish passage facilities (Conservation Benefit).

9. Harvest benefits of the program would be reduced (Harvest Risk).

10. Returning adults surplus to broodstock needs decrease; resulting in lower risk of HOR adults spawning naturally in the system (Conservation Benefit).

11. The smaller program increases the risk that the entire brood year may be lost due to random variation in post-release survival (Conservation Risk).

1.7 PREFERRED ALTERNATIVE

1.7.1 Rationale for Selection

The preferred alternative was developed based on the key findings of the alternatives analysis. These findings are provided below.

Natural abundance of the Upper Klamath Population Unit is below the high risk abundance level (425) established by NMFS

The best data available on natural coho salmon spawner abundance (Bogus Creek) indicates that natural fish abundance may be as low as 7 fish for the population unit (Table A-2). Although there are likely adult coho salmon spawning in other smaller tributaries, estimates of abundance are currently not available. Because of the low abundance figure a hatchery program is needed to serve as a gene bank for the population as the adult escapement data indicate that current habitat quality and quantity may be insufficient to support natural production.

Adult coho production needs to be increased to reduce demographic and life history diversity risks to the population unit

A hatchery program with its higher egg-to-adult survival rates can be used as a tool to increase coho salmon abundance. The results from the Segregated and Integrated alternatives indicate that better broodstock management practices will increase the fitness of the natural population and result in increased abundance and inherent diversity over time. A key action required to achieve these improvements is to control the proportion of HOR fish spawning naturally, and incorporate NOR fish into the broodstock.

Hatchery operations need to strike a balance between genetic and demographic risk to the combined (HOR and NOR) population

The alternatives analysis showed that a well integrated hatchery program produces the largest benefits in regards to creating a population that is highly fit, abundant and adapted to the natural environment. This type of hatchery fish will be well suited for use in future reintroduction efforts in the basin.

However, to create a well integrated hatchery program requires that sufficient natural production be available to supply hatchery broodstock and maintain natural production. The maintenance of some natural production is important as it is the natural environment that selects for those characteristics that will succeed over time. Currently, natural coho salmon production appears insufficient to achieve either objective. Extreme low abundance poses serious demographic risks, possibly leading to extinction of the population unit.

Until natural production increases sufficiently to integrate the hatchery program, it is important to allow excess hatchery fish to spawn naturally to the extent possible in order to reduce demographic risks. Some naturally produced adults must be incorporated into the broodstock to maintain genetic continuity between the natural and hatchery components of the population. Once natural production levels increase, a well integrated hatchery program that addresses both demographic and genetic risks can be implemented.

Habitat quality and quantity need substantial improvement

Natural production is not likely to increase dramatically unless habitat is improved. Adult coho salmon returns demonstrate that current habitat conditions are insufficient to maintain the population unit. Therefore, actions designed to improve habitat quality and quantity needs to be implemented as soon as possible. Hatchery management needs to be coordinated with these actions so that the maximum gain in population performance is achieved. A key action being proposed is the establishment of coho production, through dam removal or fish passage, in stream reaches currently blocked by IGD. The role that hatchery programs (if any) will play in this reintroduction effort needs to be accounted for.

Hatchery production should not be reduced

A hatchery program with a reduced production goal (e.g. 50 percent of current production) would create risks as compared to maintaining the current program. A major issue with a reduced program would be that the smaller number of fish used for broodstock would increase the probability of inbreeding and Ryman-Laikre effects (i.e. gene swamping) occurring in the population, which can result in decreased effective population size and fitness. Due to yearly run-timing variation and run size, a reduced program would make it difficult for hatchery managers to consistently collect broodstock that represent the full range of life history diversity present in the population. In addition, the smaller the number of fish released from a reduced hatchery program would increase the probability that random events may result in unexpected low adult returns and loss of an entire brood year. This risk was present in 2009 for the current (larger) program when only 46 adults returned to the hatchery (see HGMP Figure 3, above).

1.7.2 <u>Preferred Alternative</u>

The preferred alternative is a gene banking program, wherein hatchery production is used to protect the genetic resources of the Upper Klamath Population Unit until habitat conditions improve.

The new program will be implemented in three phases. The purpose of the hatchery program in Phase 1 is gene banking, in Phase 2 it is re-colonization and Phase 3, local adaptation. The criteria for moving from phase to phase is based on time and NOR run-size to Upper Klamath Population Unit tributaries and mainstem habitat.

In Phase 1 (Table A-8), the hatchery program will be run as a gene bank. HOR and all NOR adults returning to the hatchery will be used for broodstock. Fish excess to hatchery broodstock needs will be released back to the mainstem Klamath River (50%) and Bogus Creek (50%). An improved weir would be operated in Bogus Creek to collect additional broodstock if adult returns to the hatchery are insufficient to meet the 75,000 yearling coho salmon release target. Restrictions would not be placed on the number of HOR spawning naturally for run-sizes to Bogus Creek of 250 or less (Table A-8). The program would be integrated when natural run-size exceeds 250 NOR to Bogus Creek. A more efficient weir would be constructed in Bogus Creek to control spawning composition (HOR and NOR). Hatchery practices would be improved to increase egg-to-smolt survival and reduce bird predation problems in raceways. Finally, actions identified in PacifiCorp's HCP, the KBRA (if funded) and other habitat plans will be implemented to improve habitat conditions for fish in the basin.

In Phase 2 (Table A-9), the purpose of the hatchery is to provide fish for re-colonization of habitat made available upstream of Iron Gate Dam from either dam removal or the implementation of fish passage. This phase is expected to start in 2024.

In Phase 3 (Table A-10), hatchery management is altered to foster local adaptation of the population throughout the Upper Klamath Population Unit. Adult spawning escapement targets (NOR) will be set for the population unit. The hatchery will be operated as an integrated program based on total NOR abundance estimates for the entire population unit (mainstem, Bogus Creek, Jenny Creek, Shovel Creek, Spencer Creek and smaller tributaries). The program will achieve a PNI of least 0.67. Hatchery production would be eliminated when NOR escapement exceeds 4,500 adults (approximately 50% of the low risk abundance level defined by NMFS).

Table A-9. Phase 1 (Gene Banking) IGH hatchery coho program management (2010-2020).

IGH Coho Program	Time Period	Purpose	NOR Run-size to Bogus Creek	Natural Escapement	Broodstock Management	Size of hatchery program (yearling smolts)	Key Monitoring Activities
Phase 1	2014 To 2024	Gene banking	0-250 adults (i.e. minimum escapement target)	All fish not used for broodstock may be returned to the Klamath River (50%) and Bogus Creek (50%) Restrictions on HOR spawning naturally to be determined by managers	Use HORs and NORs returning to the hatchery. Jacks incorporated into brood Collect adults at Bogus Creek weir if returns to hatchery are insufficient to meet brood needs	75,000	Spawning and carcass surveys in all spawning areas associated with Upper Klamath Population Unit-quantify HOR and NOR abundance, conduct genetic analyses

			>250 adults	All fish not used for broodstock are returned to the Klamath River HOR escapement to Bogus Creek controlled to achieve 0.50 PNI criterion	Sufficient NOR adults are incorporated to achieve 0.50 PNI criterion in Bogus Creek	75,000	

Table A-10. Phase 2 (re-colonization) IGH hatchery coho program management (2019-2024).

IGH Coho Program	Time Period	Purpose	NOR Run-size to Bogus Creek	Natural Escapement	Broodstock Management	Size of hatchery program (yearling smolts)	Key Monitoring Activities
Phase 2	2024-2028	Re-colonization	0-250 adults (i.e. minimum escapement target)	All fish not used for broodstock may be returned to the Klamath River (50%) and Bogus Creek (50%) Restrictions on HOR spawning naturally to be determined by managers	Use HORs and NORs returning to the hatchery. Jacks incorporated into brood Collect adults at Bogus Creek weir if returns to hatchery are insufficient to meet brood needs	75,000	Same as Phase 1 Sampling extended to tributaries and mainstem habitat upstream of Iron Gate Dam

IGH Coho Program	Time Period	Purpose	NOR Run-size to Bogus Creek	Natural Escapement	Broodstock Management	Size of hatchery program (yearling smolts)	Key Monitoring Activities
			>250 but <500 adults	All fish not used for broodstock are returned to the Klamath River HOR escapement to Bogus Creek controlled to achieve PNI criterion of 0.5	Integrate program to achieve PNI of 0.50 in Bogus Creek…based on 3 year rolling average No restrictions on HOR adults spawning in tributaries upstream of Iron Gate Dam	75,000	
			>500	All fish not used for broodstock are returned to the Klamath River	Integrate program to achieve PNI of 0.67 in Bogus Creek…based on 3 year rolling average No restrictions on HOR adults spawning in tributaries upstream of Iron Gate Dam	75,000	

Table A-11. Phase 3 (local adaptation) IGH hatchery coho program management (2028+).

IGH Coho Program	Time Period	Purpose	NOR Run-size to Upper Klamath	Natural Escapement	Broodstock Management	Size of hatchery program (yearling smolts)	Key Monitoring Activities
Phase 3	2028+	Local Adaptation	To be determined	All fish not used for broodstock are returned to the Klamath River No restrictions on HOR spawning naturally in habitat above Iron Gate pHOS limited to < 10% in Bogus Creek and other tributaries below Iron Gate	Use HORs and NORs returning to the hatchery. Jacks incorporated into brood Collect adults at Bogus Creek weir (and other tributaries) if returns to hatchery are insufficient to meet broodstock needs Once escapement target reached, achieve PNI of 0.67 for entire Upper Klamath Population Unit.	75,000	Same as Phase 1 Sampling extended to tributaries and mainstem habitat upstream of Iron Gate Dam
			>4,500	NOR fish only	**Program eliminated**		

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Appendix B. TAKE TABLES FOR HATCHERY ACTIVITIES

Table B-1. Estimated listed salmonid take levels by hatchery activity.

Take Information for Culling, Fish Health Monitoring, and Research and Educational Activities at Iron Gate Hatchery

Line	Species	Origin	Life Stage	Sex	Expected Take	Unintentional Mortality	Take Action	Observe/Collect Method	Procedures
1	SONCC Coho Salmon	Listed Hatchery intact adipose	Juvenile	Male and Female	60	0	Intentional (Directed) Mortality	Hand and/or Dip Net	
Details: 60 juvenile HOR coho salmon will be euthanized annually for fish health and disease monitoring									
2	SONCC Coho Salmon	Listed Hatchery intact adipose	Egg	Male and Female	100000	0	Intentional (Directed) Mortality	Incubation Tray	
Details: It may be necessary to cull up to 100,000 eggs to stay within the smolt release goals of 75,000 (+- 10%).									
3	SONCC Coho Salmon	Listed Hatchery intact adipose	Juvenile	Male and Female	2000	0	Collect and Transport Live Animal	Hand and/or Dip Net	
Details: Up to 2,000 hatchery juvenile coho salmon that are excess to the 75,000 (+/- 10%) release goal may be used for research and/or educational purposes or may be culled as deemed appropriate by NMFS annually.									
4	SONCC Coho Salmon	Listed Hatchery intact adipose	Juvenile	Male and Female	192	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Hand and/or Dip Net	Tissue sample (other internal tissues); Tissue Sample Fin or Opercle; Tissue Sample Scale
Details: Up to 192 hatchery juvenile coho salmon will be sampled annually to determine smoltification levels through non-lethal sampling for ATPAse by removing (clipping) a small piece of the gill tissue. Sampled fish will then be allowed to recover before being released back to the raceway.									

Take Information for Broodstock Collection (Main and Auxiliary Fish Ladder) at Spawning Facility at Iron Gate Hatchery.

Line	Species	Origin	Life Stage	Sex	Expected Take	Unintentional Mortality	Take Action	Observe/Collect Method	Procedures
1	SONCC Coho Salmon	Natural	Adult	Female	45	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
2	SONCC Coho Salmon	Natural	Adult	Male	74	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
3	SONCC Coho Salmon	Natural	Subadult	Male	16	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: The combination of lines 1 through 3 represent the maximum amount of take of NOR fish proposed under the HGMP to meet production goals. This assumes a maximum of 50% NOR for each broodstock annually.									
4	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Female	73	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
5	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Male	148	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
6	SONCC Coho Salmon	Listed Hatchery intact adipose	Subadult	Male	49	0	Intentional (Directed) Mortality	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: The combination of lines 4 through 6 represent the maximum amount of take of HOR fish proposed under the HGMP to meet production goals. This also assumes the worst case scenario (i.e. maximum amount of take) if no NOR fish return to the hatchery and NOR fish in Bogus Creek are low.									
7	SONCC Coho Salmon	Natural	Subadult	Male	425	4	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
8	SONCC Coho Salmon	Natural	Adult	Male and Female	1940	19	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: For lines 7 & 8 broodstock will be spawned at IGH. Surplus broodstock may be returned to the mainstem Klamath River or Bogus Creek to spawn naturally									
9	SONCC Coho Salmon	Listed Hatchery intact adipose	Subadult	Male	425	25	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
10	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Male and Female	1940	125	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Fish Ladder (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: For lines 9 & 10 broodstock will be spawned at IGH. Surplus broodstock may be returned to the mainstem Klamath River or Bogus Creek to spawn naturally, or may be euthanized to control HOR. Broodstock carcasses will be disposed of offsite and not released back to the river									

Take Information for Broodstock Collection and Adult Escapement Monitoring at the Bogus Creek Weir

Line	Species	Origin	Life Stage	Sex	Expected Take	Unintentional Mortality	Take Action	Observe/Collect Method	Procedures
1	SONCC Coho Salmon	Natural	Adult	Female	23	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
2	SONCC Coho Salmon	Natural	Adult	Male	37	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
3	SONCC Coho Salmon	Natural	Subadult	Male	8	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
4	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Female	23	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
5	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Male	37	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
6	SONCC Coho Salmon	Listed Hatchery intact adipose	Subadult	Male	7	1	Collect and Transport Live Animal	Weir (only if associated with fish handling)	
Details: For lines 1 through 6 these fish represent potential broodstock fish that will be used to meet annual production goals if the number of fish returning to the hatchery is insufficient. If they are not used they will be marked and handled in the same manner as surplus broodstock									
7	SONCC Coho Salmon	Natural	Adult	Male and Female	1000	10	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
8	SONCC Coho Salmon	Natural	Subadult	Male	180	2	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: For lines 7 & 8 broodstock will be spawned at IGH. Surplus broodstock may be returned to the mainstem Klamath River or Bogus Creek to spawn naturally.									
9	SONCC Coho Salmon	Listed Hatchery intact adipose	Adult	Male and Female	1000	10	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
10	SONCC Coho Salmon	Listed Hatchery intact adipose	Subadult	Male	180	2	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Weir (only if associated with fish handling)	Tag,Floy; Tag,PIT; Tissue Sample Fin or Opercle
Details: For lines 9 & 10 broodstock will be spawned at IGH. Surplus broodstock may be returned to the mainstem Klamath River or Bogus Creek to spawn naturally, or may be euthanized to control HOR. Broodstock carcasses will be disposed of offsite and not released back to the river									

Take Information for Juvenile Outmigration Trap- Bogus Creek Weir.

Line	Species	Origin	Life Stage	Sex	Expected Take	Unintentional Mortality	Take Action	Observe/Collect Method	Procedures
1	SONCC Coho Salmon	Natural	Fry	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
2	SONCC Coho Salmon	Natural	Juvenile	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
3	SONCC Coho Salmon	Natural	Smolt	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
4	SONCC Coho Salmon	Listed Hatchery intact adipose	Fry	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
5	SONCC Coho Salmon	Listed Hatchery intact adipose	Juvenile	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
6	SONCC Coho Salmon	Listed Hatchery intact adipose	Smolt	Male and Female	1750	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tag,PIT; Tissue Sample Fin or Opercle; Tissue Sample Scale
7	SONCC Coho Salmon	Natural	Juvenile	Male and Female	192	0	Capture/Mark, Tag, Sample Tissue/Release Live Animal	Trap, Screw	Tissue sample (other internal tissues)
Details: for line 7 up to 192 juvenile coho salmon will be sampled annually to determine smoltification levels through non-lethal sampling for ATPAse by removing (clipping) a small piece of the gill tissue. Sampled fish will then be allowed to recover before being released.									

Take Information For Spawning Surveys Mainstem Klamath and its Tributaries.

Line	Species	Origin	Life Stage	Sex	Expected Take	Unintentional Mortality	Take Action	Observe/Collect Method	Procedures
1	SONCC Coho Salmon	Natural	Adult	Male and Female	2419	0	Observe/Sample Tissue Dead Animal	Spawning surveys	Tissue sample (other internal tissues); Tissue Sample Fin or Opercle; Tissue Sample Scale
2	SONCC Coho Salmon	Hatchery	Adult	Male and Female	2419	0	Observe/Sample Tissue Dead Animal	Spawning surveys	Tissue sample (other internal tissues); Tissue Sample Fin or Opercle; Tissue Sample Scale
3	SONCC Coho Salmon	Natural	Subadult	Male	531	0	Observe/Sample Tissue Dead Animal	Spawning surveys	Tissue sample (other internal tissues); Tissue Sample Fin or Opercle; Tissue Sample Scale
4	SONCC Coho Salmon	Hatchery	Subadult	Male	531	0	Observe/Sample Tissue Dead Animal	Spawning surveys	Tissue sample (other internal tissues); Tissue Sample Fin or Opercle; Tissue Sample Scale
5	SONCC Coho Salmon	Hatchery	Spawned Adult/ Carcass	Male and Female	41	0	Observe/Harass	Spawning surveys	
6	SONCC Coho Salmon	Hatchery	Subadult/ Carcass	Male	9	0	Observe/Harass	Spawning surveys	
7	SONCC Coho Salmon	Natural	Spawned Adult/ Carcass	Male and Female	41	0	Observe/Harass	Spawning surveys	
8	SONCC Coho Salmon	Natural	Subadult/ Carcass	Male	9	0	Observe/Harass	Spawning surveys	
Details: For lines 3, 4, 6 & 8 a subadult is considered a spawned jack or grilse.									